Developing automated, customizable reporting tools for the NERRS System Wide Monitoring Program

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National Monitoring Conference

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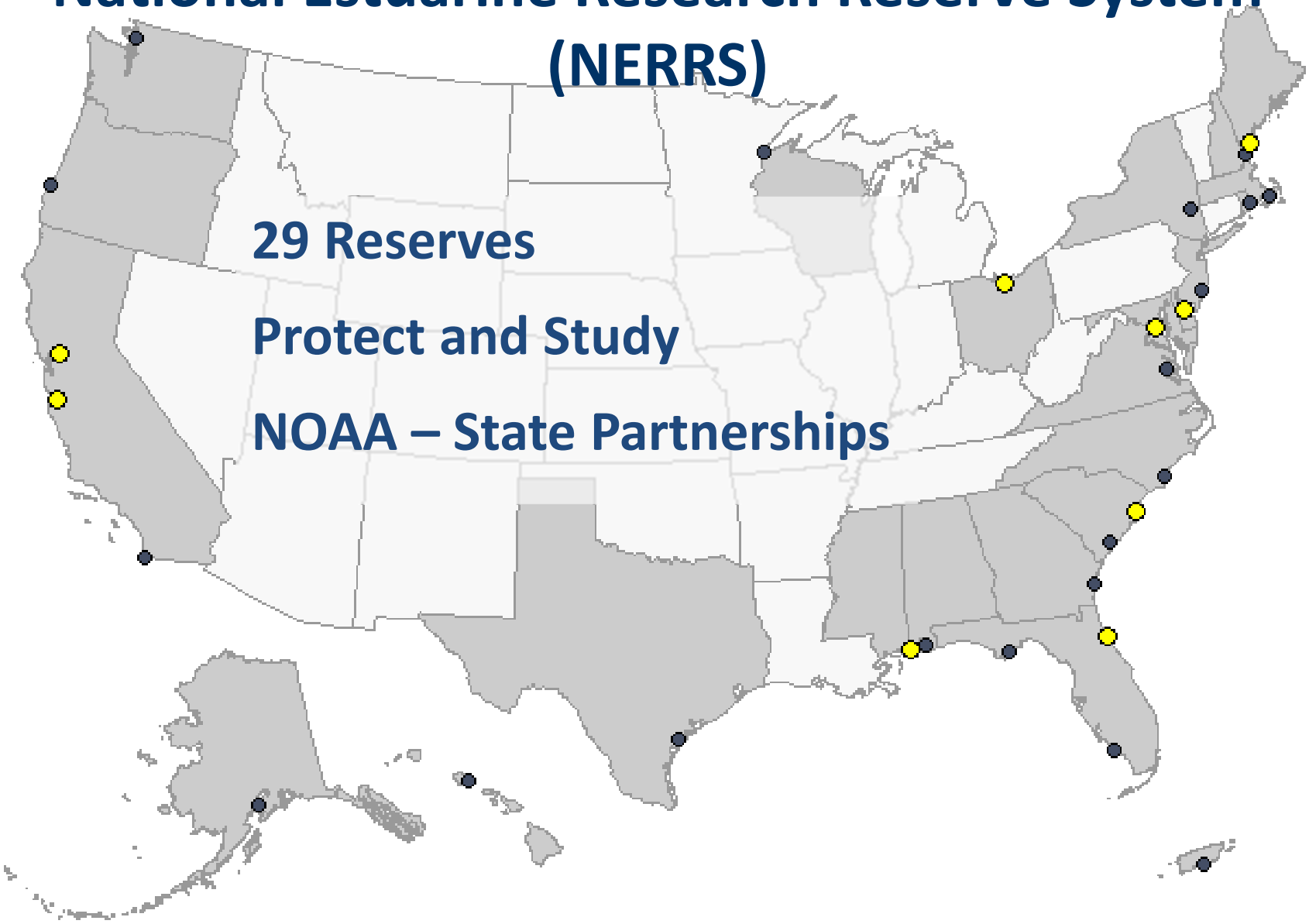
Office for Coastal Management

National Estuarine Research Reserve System (NERRS)



29 Reserves

Protect and Study

NOAA – State Partnerships

System-Wide Monitoring Program (SWMP)

Long-term monitoring

- **1995 to present**
- **Uniform equipment**
- **Consistent approach and oversight**
- **Community driven standards and protocols**
- **Rigorous, consistent QA/QC approach and flags**

Four water quality stations

- T, S, pH, DO, Turbidity, Depth
- Automated, 15-minute

Four nutrient stations

- Chl, NO2, NO3, NH4, PO4
- Monthly grab samples

Meteorology station

- Temp, Press, Winds, RH, Precip, Light

The Issue: Too much data!

Challenges

- Never enough time
- Never enough money
- Staff turnover
- Varying technical ability
- 29 different sets of interests

Solution Requirements

- An automated analysis process
- Must be “easy”
- Needs system-wide buy-in

The Solution

Committees!

- **Technical Advisory Comm.**
  - Keep graphics and plots credible
- **Product Advisory Comm.**
  - Design product
  - Define audience(s)
- **Both**
  - Testing and outreach

Solution

- **Multi-step process**
- **Flexible template**
- **Robust R package**

Highlights

- **Little R knowledge needed**
- **Majority of work in Excel and PowerPoint**

Workflow

Automated

- 1000+ plots generated(?)
- RStudio script
- PowerPoint draft

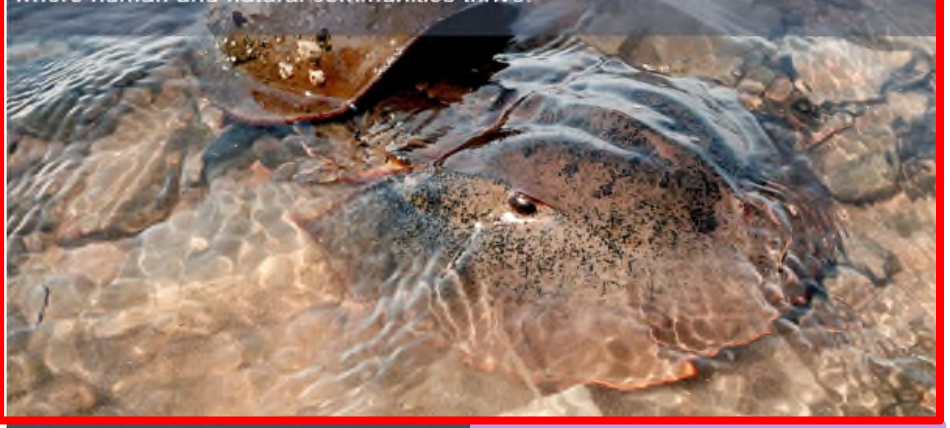
Manual

- Determine story
- Edit Excel spreadsheet
- Launch RStudio script
- Edit PowerPoint
- Save as PDF for printing

We Set the Theme, They Tell The Story

ESTUARY TRENDS: WEATHER & WATER QUALITY

Resilient estuaries and coastal watersheds - where human and natural communities thrive.



Great Bay National Estuarine Research Reserve (NERR)

This reserve is a complex embayment and New Hampshire's largest estuarine system, encompassing all of Great Bay and Little Bay, as well as the tidal portions of five major river systems: Bellamy, Oyster, Lamprey, Squamscott, and Winnicut. The Great Bay Reserve includes diverse land and water areas, including upland forest, salt marsh, mudflats, tidal creeks, rocky intertidal, eelgrass beds, and upland field habitats. The Bay's cultural heritage is equally diverse, from paleo-Indian villages dating to 6,000 years ago to colonial transportation and industrial use, to a proposed oil refinery in 1973. For more information go to: **http://greatbay.org/**

2016 HIGHLIGHTS

It was **dryer** - **precipitation** was **below** the long-term historical average

It was **warmer** - late winter/early spring **air temperatures** were **higher** than the long-term historical average

The highest observed inorganic **nitrogen** (DIN) concentrations **occurred** in the rainy **winter** season at two out of four locations

An **algal bloom** occurred in the **summer** at one out of four locations

Water quality issues influence **human** and **environmental health.** The more we **monitor** our **water**, the better we will be able to **recognize** and **prevent problems.**

HOW IS OUR ESTUARY CHANGING?

Precipitation is not changing

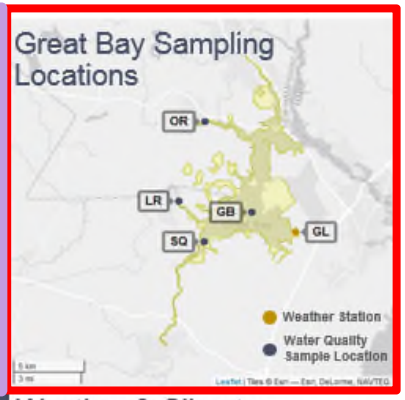
Air Temperature is not changing

Phosphorus (ortho-phosphate) is increasing at three out of four locations

Algae growth is not changing

Dissolved Oxygen is decreasing at three out of four locations

Great Bay Sampling Locations



Trends in Weather & Water Quality*

Location ID	Location Name	Air Temperature	Precipitation
GL	Greenland	—	—

Location ID	Location Name	Water Temperature	Salinity	Dissolved Oxygen	pH	Turbidity
GB	Great Bay	—	↑	↓	—	—
LR	Lamprey River	↑	↑	↓	↑	—
OR	Oyster River	—	↑	—	↑	↓
SQ	Squamscott River	—	↑	↓	↑	—

Location ID	Location Name	Ortho-phosphate	Ammonium	Nitrite	Nitrate	Chlorophyll-a
GB	Great Bay	—	↓	X	X	—
LR	Lamprey River	↑	—	X	X	—
OR	Oyster River	↑	—	X	X	—
SQ	Squamscott River	↑	↑	X	X	—

X Insufficient Data ↑ Increasing — Not Changing ↓ Decreasing

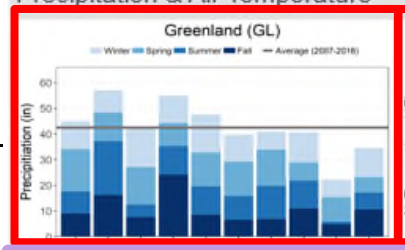
Weather & Climate – What is the Difference?

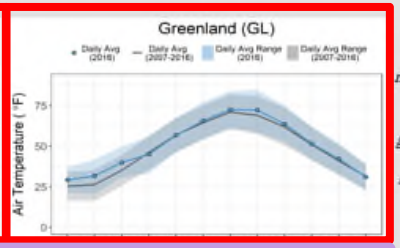
WEATHER is what you see outside on any particular day in terms of precipitation, temperature, humidity, cloudiness, visibility and wind.

CLIMATE tells us the average daily weather for an extended period of time (years, decades, centuries) at a certain location.

Weather Can Have A Major Impact On Water Quality

Precipitation & Air Temperature





Weather data helps scientists and managers understand water circulation patterns, plant growth, shellfish and fish distribution, storm frequency and intensity and much more…

Precipitation was ~8 inches less than the long-term historical average in 2016

Air Temperature was much higher in January through March compared to the long-term historical average in 2016

Excel Template – Overall Parameters

Parameter	Parameter_Category	Parameter_Type	Log_Scale	WQ_Threshold
temp	wq	instantaneous	F	
sal	wq	instantaneous	T	
do_mgl	wq	instantaneous	F	2
ph	wq	instantaneous	F	
turb	wq	instantaneous	T	
depth	wq	instantaneous	F	
atemp	met	instantaneous	F	
rh	met	instantaneous	F	
bp	met	instantaneous	F	
wspd	met	instantaneous	F	
maxwspd	met	instantaneous	F	
totprcp	met	cumulative	F	
totpar	met	cumulative	F	
po4f	nut	instantaneous	F	
nh4f	nut	instantaneous	F	
no2f	nut	instantaneous	F	
no3f	nut	instantaneous	F	
no23f	nut	instantaneous	F	
chla_n	nut	instantaneous	F	
din	nut	instantaneous	F	
dip	nut	instantaneous	F	

Global_Decisions--> | Flags | Years_of_Interest | Seasons | Mapping | Bonus_Settings | Analyses--> | Basic_Plotting | Threshold_Pl ...

Excel Templates – Yearly Changes

	A	B	C	D	E	F
1	Variable_Name	Type	Description	Change	Text	File_N
2	txt_cs_ttl	text	Title for nutrients page	No	Do We Have Too Many Nutrients In The Water?	
3	txt_cs_intro	text	Descriptive text to intr	Yes	Phytoplankton (also called microalgae) are tiny, plant-like organisms that need nutrients (nitrogen and phosphorus) to grow. Phytoplankton are critical to estuarine and ocean health. However, some conditions, such as excess nutrients, can cause phytoplankton blooms. The blooms can decrease the dissolved oxygen underwater life needs to survive, negatively impact human health, and close fishery harvest areas.	
4	txt_cs_plot_ttl_1	text	Title for the top plot	Yes	Nitrogen	
5	txt_cs_plot_caption_1	text	Caption for the top plo	Yes	Dissolved inorganic nitrogen (DIN) is the type of nitrogen in the water phytoplankton need to grow. At Elkhorn Slough NERR, data show that DIN concentrations are not changing over the long-term. Most of the measurements are in the fair to good range. However, the critical threshold of 0.5 mg/L is exceeded and usually, during the winter rainy season.	
6	txt_cs_plot_ttl_2	text	Title for the bottom pl	Yes	Algae	
7	txt_cs_plot_caption_2	text	Caption for the bottom	Yes	Phytoplankton growth is measured by chlorophyll a concentrations. At Elkhorn Slough NERR, data show that chlorophyll a levels are not changing over the long-term. Most of the measurements are in the fair to good range. Concentrations exceed the critical threshold of 20 ug/L, at times, at all sampling locations. Concentrations most often exceed the critical threshold at North Marsh.	
8	txt_cs_map_ttl	text	Title for trend map	Yes	How is Oxygen Changing?	
9	txt_cs_map_caption	text	Caption for trend map	Yes	Dissolved oxygen increased at North Marsh and South Marsh. Most of the measurements vary between the poor to good range at all locations.	
10	txt_cs_outreach_ttl	text	Title for outreach secti	Yes	Small Changes You Can Make To Help	
11	txt_cs_outreach_point_1	text	Outreach option #1	Yes	Limit use of fertilizers/pesticides and apply responsibly	
12	txt_cs_outreach_point_2	text	Outreach option #2	Yes	Use compost as fertilizer in gardens	
13	txt_cs_outreach_point_3	text	Outreach option #3	Yes	Collect pet droppings	

Page_One | Page_Two | **Page_Three** | Page_Four | Trend_Table

Build on SWMPr:
Retrieve, Organize, and Analyze Estuarine Data

README.md

Marcus W. Beck, beck.marcus@epa.gov

Linux and OS X: build error

Retrieve

`all_params`	Retrieve any number of records starting with the most recent at a given station, all parameters. Wrapper to `exportAllParamsXMLNew` function on web services.

Organize

`comb.swmpr`	Combines swmpr objects to a common time series using setstep, such as combining the weather, nutrients, and water quality data for a single station. Only different data types can be combined.

Analyze

`aggreswmp.swmpr`	Aggregate swmpr objects for different time periods - years, quarters, months, weeks, days, or hours. Aggregation function is user-supplied but defaults to mean.
`aggremetab.swmpr`	Aggregate metabolism data from a swmpr object. This is primarily used within `plot_metab` but may be useful for simple summaries of raw daily data.

Miscellaneous

`calcKL`	Estimate the reaeration coefficient for air-sea gas exchange. This is only used within the `ecometab` function.

Beck MW. 2016. SWMPr: An R package for retrieving, organizing, and analyzing environmental data for estuaries. The R Journal. 8(1):219-232. https://journal.r-project.org/archive/2016-1/beck.pdf

SWMPrExtension:
More Functions to Retrieve, Organize, and Analyze Estuarine Data

README.md

Retrieve

`all_params`	Retrieve any number of records starting with the most recent at a given station, all parameters. Wrapper to `exportAllParamsXMLNew` function on web services.
`all_params_dtrng`	Retrieve records of all parameters within a given date range for a station. Optional argument for a single parameter. Wrapper to `exportAllParamsDateRangeXMLNew` .

Analyze

`aggreswmp.swmpr`	Aggregate swmpr objects for different time periods - years, quarters, months, weeks, days, or hours. Aggregation function is user-supplied but defaults to mean.
`aggremetab.swmpr`	Aggregate metabolism data from a swmpr object. This is primarily used within `plot_metab` but may be useful for simple summaries of raw daily data.

README.md

Retrieve

`import_local_nut`	A modified version of import_local from the `SWMPr` package. This version allows the user to specify the collection method (`CollMethd`) argument to separate monthly nutrient sampling data from monthly 24-hr nutrient sampling data.

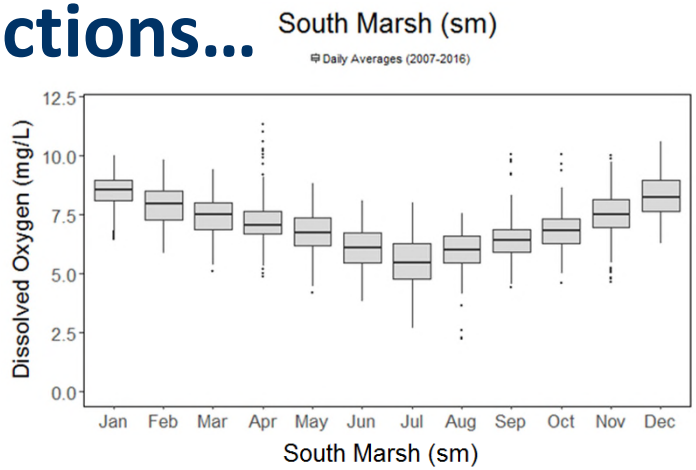
Analyze

`annual_range.swmpr`	For a user-specified year, calculate averages, average ranges, and min/max observed ranges the on a monthly or seasonal basis
`historical_daily_range.swmpr`	Compare a user-specified year against historical data on a daily basis.
`historical_range.swmpr`	Compare a user-specified year against historical data on a monthly/seasonal basis.
`raw_boxplot.swmpr`	Generate a monthly/seasonal boxplots of raw data
`seasonal_barplot.swmpr`	Generate monthly/seasonal barplot for parameters that are better viewed in on a cumulative basis (e.g. precipitation).
`seasonal_boxplot.swmpr`	Generate monthly/seasonal boxplots for daily average statistics (min/average/max) across a user-specified time period.Includes the option to calculate a median value for a target year and include a line for a water quality threshold.
`threshold_identification.swmpr`	Identify dates and times that a user-specified water quality threshold is exceeded. For continuous monitoring data, the user can also specify the length of time the threshold must be exceeded for the event to be included (e.g. DO must be < 2

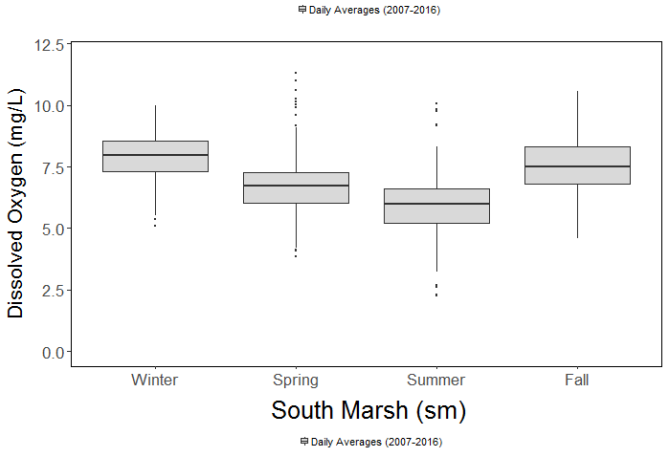
Easy Customization

Options are built into functions…

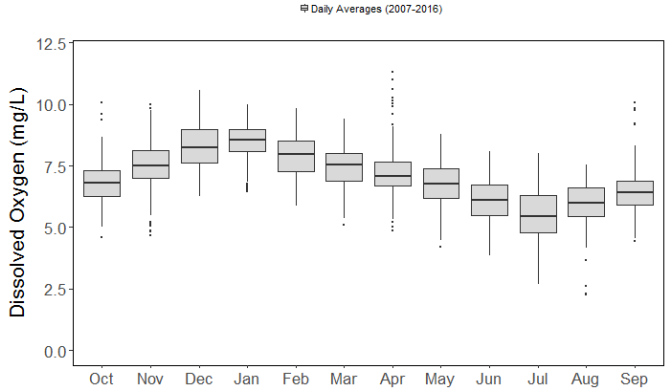
```r
x <-
  seasonal_boxplot(dat, param = 'do_mgl'
                   , hist_rng = c(2007, 2016)
                   , plot_title = T)
```




```r
y <-
  seasonal_boxplot(dat, param = 'do_mgl'
                   , hist_rng = c(2007, 2016)
                   , season = list(c(1,2,3), c(4,5,6), c(7,8,9), c(10, 11, 12))
                   , season_names = c('Winter', 'Spring', 'Summer', 'Fall')
                   , plot_title = T)
```



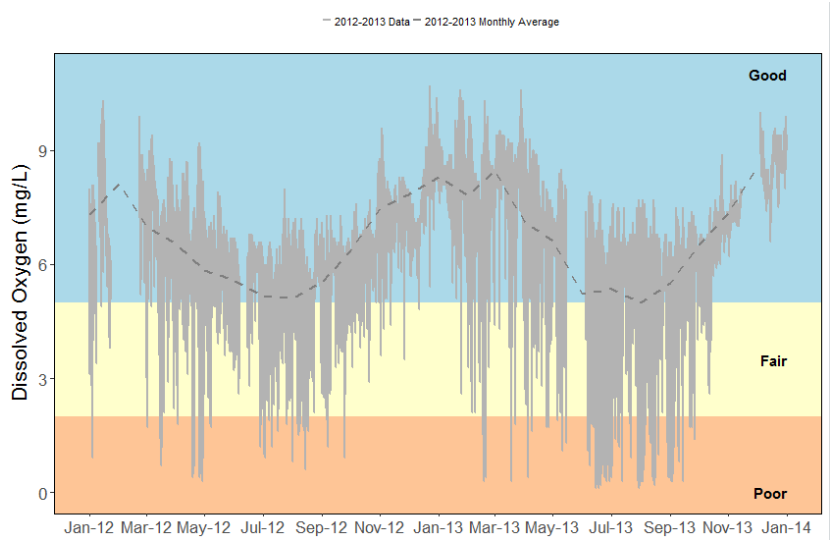

```r
x <-
  seasonal_boxplot(dat, param = 'do_mgl'
                   , hist_rng = c(2007, 2016)
                   , season_start = 'Oct'
                   , plot_title = T)
```



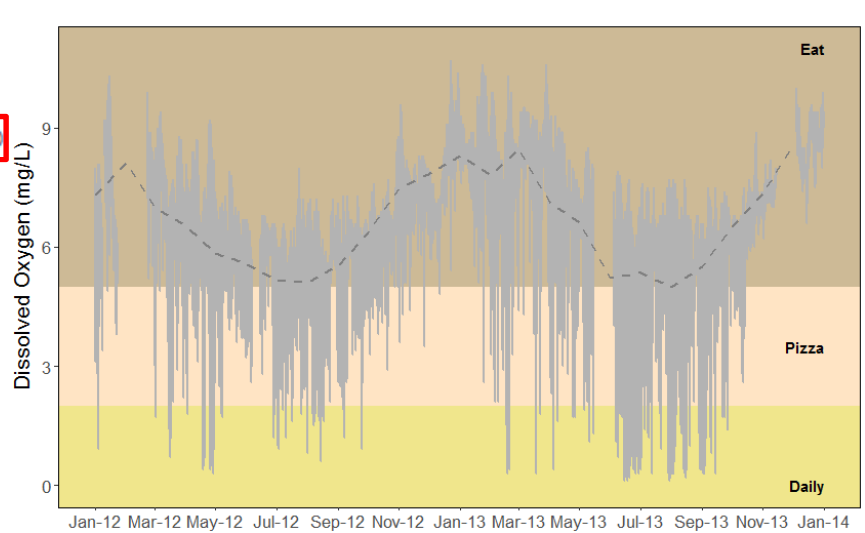
Easy Customization

Options are built into functions…

```
x <-
  threshold_plot(dat_wq, param = 'do_mgl'
                 , thresholds = c(2, 5)
                 , threshold_labs = c('Poor', 'Fair', 'Good')
                 , monthly_smooth = T
                 , threshold_cols = c('#FEC596', '#FFFFCC', '#ABD9E9'))
```




```
x2 <-
  threshold_plot(dat_wq, param = 'do_mgl'
                 , thresholds = c(2, 5)
                 , threshold_labs = c('Daily', 'Pizza', 'Eat')
                 , monthly_smooth = T
                 , threshold_cols = c('khaki', 'bisque', 'wheat3'))
```



Why Do It This Way?

- Fits into the existing SWMPr framework
- Easy way to distribute R code
- Easy to document process
- One stop shop for basic customization
- Easier maintenance over time
- Flexibility to use outside of the “reserve template”

Example: Grand Bay Page 1

- Introduce the Reserve
- Brief annual highlights

ESTUARY TRENDS: WEATHER & WATER QUALITY

Resilient estuaries and coastal watersheds -where human and natural communities thrive.

Photo Credit: Kim Cressman

Grand Bay National Estuarine Research Reserve (NERR)

This reserve represents one of the most biologically productive ecosystems in the northern Gulf of Mexico. The habitat within the reserve supports rare and endangered plant and animal species, important marine fisheries, and archeological sites. The site encompasses black needle rush marshes, maritime pine forests, pine savanna, salt pannes and pools, and pitcher plant bogs. Many species of carnivorous plants and orchids are present in the higher savanna habitats. For more information go to:

http://grandbaynerr.org/

2017 HIGHLIGHTS

It was wet - the annual rainfall total was the highest recorded by Grand Bay SWMP since monitoring started in 2004.

Dissolved inorganic nitrogen (DIN) was in the good to fair range for all locations.

An algal bloom occurred in the summer at three out of four locations.

Water quality issues influence human and environmental health. The more we monitor our water, the better we will be able to recognize and prevent problems.

Example: Waquoit Bay Page 1

- Introduce the Reserve
- Brief annual highlights

ESTUARY TRENDS: WEATHER & WATER QUALITY

Resilient estuaries and coastal watersheds - where human and natural communities thrive.

Waquoit Bay National Estuarine Research Reserve (NERR)

This reserve is located on the south shore of Cape Cod, Massachusetts and contains open waters, salt and freshwater marshes, barrier beaches, sand dunes, rivers, mixed pine and oak forests, and sandplain grasslands.

Waquoit Bay, approximately 825 acres, is the dominant water feature and once supported one of the most diverse estuarine fish communities in the state. Waquoit Bay is still important to commercial and recreational shellfish and finfish fisheries. For more information go to:

http://www.waquoitbayreserve.org/

2016 HIGHLIGHTS

It was drier - precipitation was below the long-term historical average

It was hotter – August and September air temperatures were higher than the long-term historical average

Dissolved inorganic nitrogen (DIN) concentrations were low for most of the year at all locations

Consistent with previous years, an algal bloom occurred in the summer at the Childs River location

Water quality issues influence human and environmental health. The more we monitor our water, the better we will be able to recognize and prevent problems.

Example: Grand Bay Page 2

This year's story

Ex: Algal bloom and precipitation

Show trends that matter

HOW IS OUR ESTUARY CHANGING?

Precipitation is not changing.

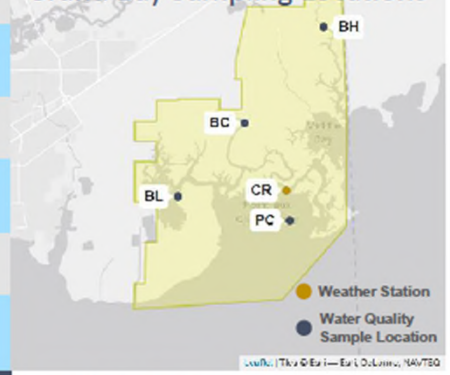
Air and Water Temperature are increasing.

Algae growth is increasing at three out of four locations.

Dissolved Oxygen is not changing.

Salinity is decreasing.

Grand Bay Sampling Locations



Trends in Weather & Water Quality*

Location ID	Location Name	Air Temperature	Precipitation
CR	Crooked Bayou	↑	—

Location ID	Location Name	Water Temperature	Salinity	Dissolved Oxygen	pH	Turbidity
BC	Bayou Cumbest	↑	↓	—	↓	↓
BH	Bayou Heron	—	↓	—	↓	↓
BL	Bangs Lake	↑	↓	—	—	↓
PC	Point Aux Chenes Bay	↑	↓	—	↓	—

Location ID	Location Name	Chlorophyll-a
BC	Bayou Cumbest	↑
BH	Bayou Heron	—
BL	Bangs Lake	↑
PC	Point Aux Chenes	↑

*Based on data collected from 2007-2017

X Insufficient Data ↑ Increasing — Not Changing ↓ Decreasing

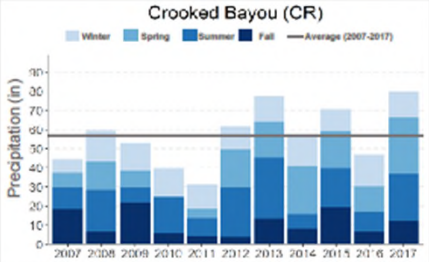
Weather & Climate – What is the Difference?

WEATHER is what you see outside on any particular day in terms of precipitation, temperature, humidity, cloudiness, visibility and wind.

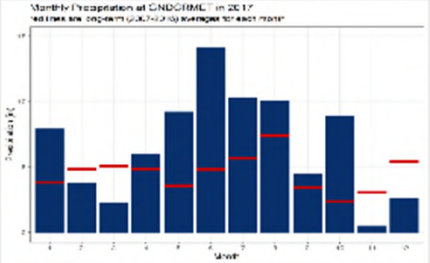
CLIMATE tells us the average daily weather for an extended period of time (years, decades, centuries) at a certain location.

Weather Can Have A Major Impact On Water Quality

Precipitation at Grand Bay NERR in 2017



Rainfall was the highest in our SWMP station's 12-year history: 80" in 2017!



Most of the extra rainfall occurred in May, June, and July.

Weather data helps scientists and managers understand water circulation patterns, plant growth, shellfish and fish distribution, storm frequency and intensity and much more…

Example: Waquoit Bay Page 2

This year's story

Ex: Timing of precipitation

Show trends that matter

HOW IS OUR ESTUARY CHANGING?

Precipitation has decreased over the last ten years (but has increased since the 1980s)

Water Temperature is increasing

Dissolved Inorganic Nitrogen is relatively unchanged

Chlorophyll-a (phytoplankton proxy) is increasing at Menauhant

Dissolved Oxygen is decreasing

Waquoit Bay Sampling Locations

Trends in Weather & Water Quality*

Location ID	Location Name	Air Temperature	Precipitation
CH	Carriage House	—	↓

Location ID	Location Name	Water Temperature	Salinity	Dissolved Oxygen	Turbidity
CR	Childs River	↑	↑	↓	—
MH	Menauhant	—	↑	—	↑
MP	Metoxit Point	↑	↑	↓	—
SL	Sage Lot	↑	↑	↓	—

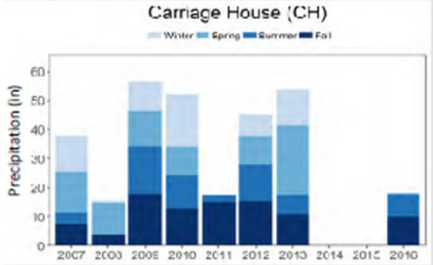
Location ID	Location Name	Ortho-phosphate	Ammonium	Nitrate/Nitrite	Chlorophyll-a
CR	Childs River	—	—	—	—
MH	Menauhant	↓	—	—	↑
MP	Metoxit Point	—	—	—	—
SL	Sage Lot	—	—	↑	—

** Based on data collected from 2007-2016*

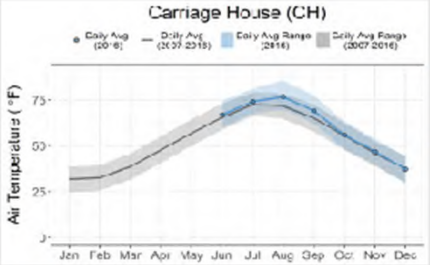
X Insufficient Data ↑ Increasing — Not Changing ↓ Decreasing

Weather Can Have A Major Impact On Water Quality

Precipitation & Air Temperature



Precipitation was ~12 inches less than the long-term historical average in 2016



Air Temperature was hotter in August and September in 2016 compared to the long-term historical average

Weather data helps scientists and managers understand water circulation patterns, plant growth, shellfish and fish distribution, storm frequency and intensity and much more…

Example: Grand Bay Page 3

Choose graphs to tell story

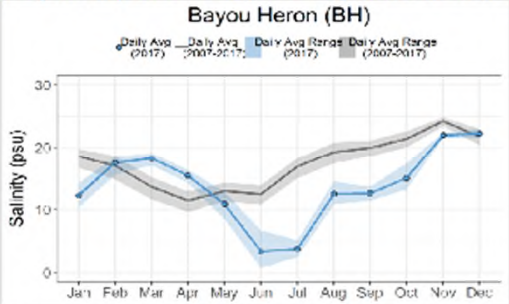
Extra space for local message

Office for Coastal Management

What is an estuary?

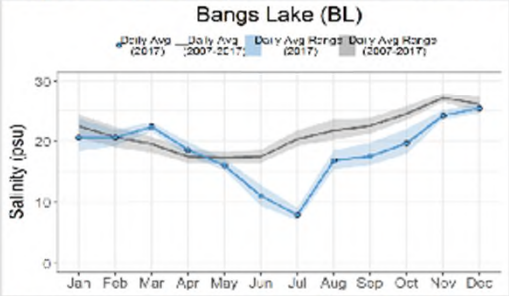
An estuary is a semi-enclosed body of water with unique properties that allow for a dynamic ecosystem and environment. It's where fresh and salt water meet. An estuary provides habitat for nurseries for ecologically and economically important species, is a great place for recreational activities like fishing, kayaking, and photography, and many other ecosystem services. The only constant thing about estuaries is that they're always changing. The Grand Bay Estuary's two water quality monitoring sites highlighted below show just how dynamic our estuary can be.

Salinity at Bayou Heron (more upland-influenced)



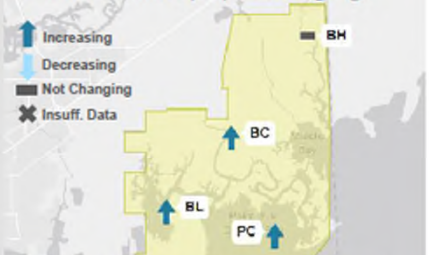
Bayou Heron is our most freshwater-influenced site. High rainfall causes both salinity and pH at this station to drop. The drop in pH is natural! The watershed is undeveloped, and full of pine trees - which cause the water to become darker in color and more acidic, just as tea leaves or coffee grinds cause water to turn into these hot, tasty beverages. To see real-time data from this station (especially interesting during storms), visit http://nerrsdata.org and type in 'gndbhwq' for the station code.

Salinity at Bangs Lake (more marine-influenced)



Bangs Lake is our second-most saltwater-influenced site. Typical summer rain storms will cause salinity to decrease, but dropping below 8 ppt is uncommon. Additionally, the higher salinity at this site buffers it against pH changes; they are not dramatic like those at Bayou Heron.

How is Chlorophyll Changing?



Chlorophyll-*a* is an indicator of how much phytoplankton (single-celled algae) is growing in the water column. At three of our sampling locations, this has been increasing over time.

How does changing salinity affect our waters?

- When there's more water from higher rainfall, both salinity and pH go down.
- Changing salinity is a condition that some species have adapted to for living in an estuary, like some marsh plants and animals.
- Historical accounts mention the presence of productive oyster reefs, but today, the Grand Bay Estuary's freshwater inflow- or sometimes lack thereof- may have an influence on why oysters are not as productive. In fact, in the early 1900s, residents of the Pecan community where the Grand Bay NERR is located, dug a canal from a nearby river to connect it to the estuary to try to increase freshwater input for oysters. It is an early example of local restoration efforts.

Photo Credit: Sandra Huynh

Water Quality is a MAJOR Driver of Ecosystem Change

What happens on the land affects the quality of the water and the health of the plants and animals that live in the estuary.

Example: Waquoit Bay Page 3

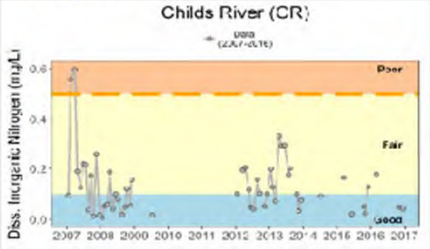
Choose graphs to tell story

Extra space for local message

Do We Have Too Many Nutrients In The Water?

Phytoplankton (also called microalgae) are tiny, plant-like organisms that need nutrients (nitrogen and phosphorus) to grow. Phytoplankton are critical to estuarine and ocean health. However, some conditions, such as excess nutrients, can cause phytoplankton blooms. The blooms can decrease the dissolved oxygen underwater life needs to survive, negatively impact human health, and close fishery harvest areas. In our area, these excess nutrients come from wastewater, fertilizers, and the burning of fossil fuels.

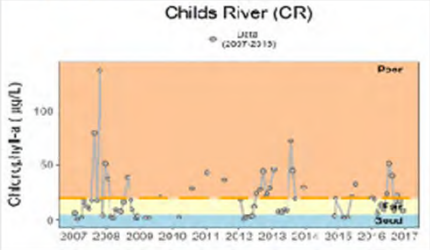
Nitrogen



A critical threshold value is used to determine if a water quality measurement is at a level where negative impacts may occur.

Dissolved inorganic nitrogen (DIN = ammonium + nitrate + nitrite) is the type of nitrogen in the water which phytoplankton need to grow. At Waquoit Bay NERR, data show that DIN concentrations are not changing over the long-term at any of the four sites. Most of the measurements are in the fair to good range. The critical threshold of 0.5 mg/L has not been exceeded at Childs River since 2007.

Phytoplankton



Phytoplankton growth is measured by chlorophyll-a concentrations. At Waquoit Bay NERR, data show that chlorophyll-a levels are not changing over the long-term at three locations, and are increasing at one location. Most of the measurements are in the fair to good range, except for those collected at the Childs River. Concentrations at the Childs River frequently exceed the critical threshold of 20 µg/L.

How is Oxygen Changing?

Dissolved oxygen decreased at Childs River, Metoxit Point, and Sage Lot. The timing of hypoxic (low oxygen) events often occurs during periods of higher water temperatures and increased human presence in the area.

Small Changes You Can Make To Help

- Support diverse forms of wastewater treatment
- Limit use of fertilizers and pesticides , use compost instead
- Support land conservation initiatives
- Collect pet droppings
- Plant trees and rain gardens
- Redirect downspouts away from impervious surfaces like driveways and sidewalks
- Wash cars and boats on lawn and not the driveway

Water Quality is a MAJOR Driver of Ecosystem Change

What happens on the land affects the quality of the water and the health of the plants and animals that live in the estuary.

Example: Grand Bay Page 4

Uniform final page

Local contact info and branding

Office for Coastal Management

Why Estuaries Matter

Economic Impacts

Coastal shoreline counties provided 53 million jobs and contributed $7.4 trillion (nearly 44%) of the nation's gross domestic product in 2012.

Community Benefits

Estuaries protect coastal communities by reducing flooding and storm surge impacts, enhancing water quality, and providing commercial and recreational benefits.

Healthy Ecosystems

Up to two-thirds of the nation's commercial fish and shellfish spend some part of their life cycle in an estuary or depend on this resource for food.

Habitat Diversity

Habitat types include shallow open waters, freshwater/salt marshes, swamps, sandy beaches, mud/sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools and seagrasses.

Tracking The Health of Our Estuaries 24/7

The **NERRS** is a partnership program between NOAA and the coastal states to manage designated reserves. More than 1.3 million acres of estuarine land and water are protected. Each reserve is managed on a daily basis by a lead state agency or university with input from local partners. The health of every reserve is continuously monitored by the **System Wide Monitoring Program** (SWMP). SWMP is a **robust, long-term,** and **versatile** monitoring program that uses the NERRS network to intensively study estuarine reference sites for evaluating ecosystem function and change. Reserve-generated data and information are available to local citizens and decision makers. For more information, go to: **https://coast.noaa.gov/nerrs/**

NERRS is a network of 29 coastal reserves established for long-term research, education and stewardship.

More Information...

For Stakeholders

Access data at the System Wide Monitoring Program (SWMP) Graphing Application website: **https://coast.noaa.gov/swmp/**

For Scientists

Access data at the Central Data Management Office (CDMO) website: **http://www.nerrsdata.org/**

Have Questions?

Contact Kim Cressman
kimberly.cressman@dmr.ms.gov
(228) 475-7047

Grand Bay NERR- providing the science needed for today and tomorrow

Example: Waquoit Bay Page 4

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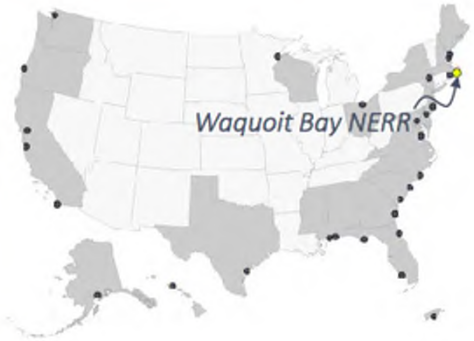

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Have Questions?

Contact: Research Coordinator

Megan.Tyrrell@state.ma.us

(508) 457-0495 x 105

Waquoit Bay NERR - providing the science needed for today and tomorrow

Office for Coastal Management

Key Benefits of Open Science for NERRS Reporting Tools

- Literally building on other people's work
- Making your data even more readily accessible
- Providing a framework for others contributions into the future
- Increasing communication with the public while minimizing overhead

Photo Courtesy of Chesapeake Bay NERR – Maryland

Questions?

Dave.Eslinger@noaa.gov

843-740-1270

https://github.com/NOAA-OCM/SWMPrExtension

or

SWMPrExtension on CRAN