

Integrated Analysis Tools for the NERRS System-Wide Monitoring Program Data

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Overview

- Background of National Estuarine Research Reserves (NERRS) System-Wide Monitoring Program (SWMP)
- Genesis of SWMPrats.net community of practice
- Features of SWMPrats.net
 - ▶ SWMPr
 - ▶ widgets
 - ▶ forum
- Continuing work, training, and engagement



What is NERRS/SWMP?

NERRS

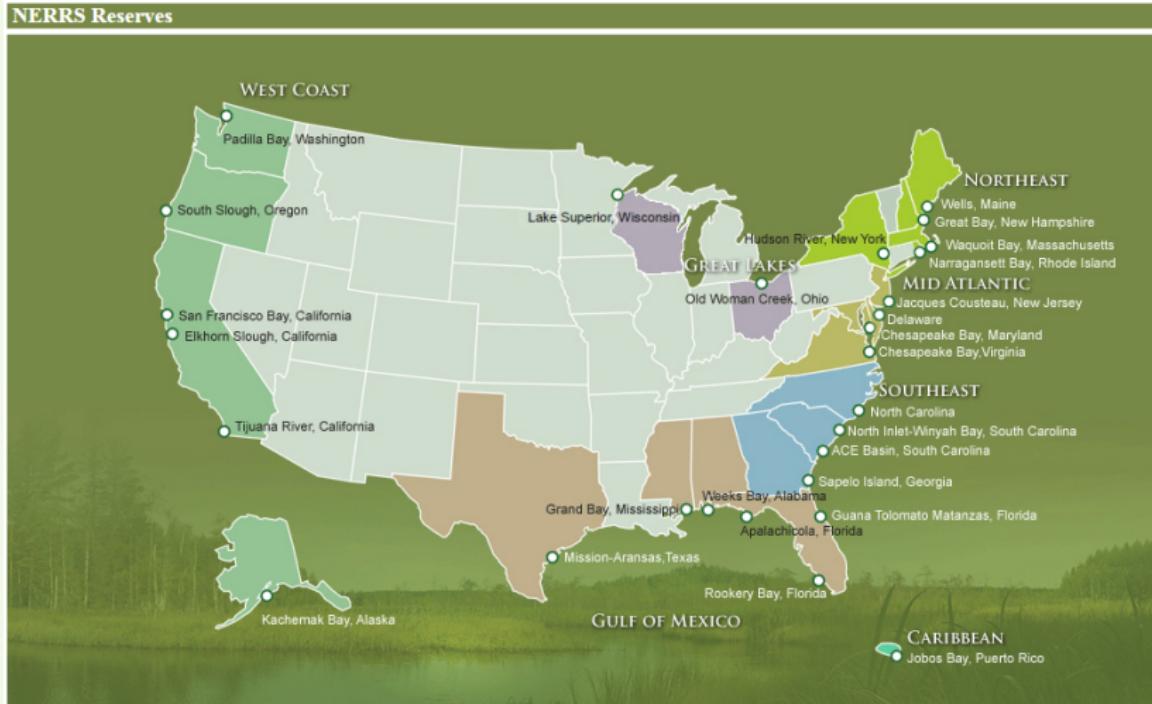
National Estuarine Research Reserve System, established by Coastal Zone Management Act of 1972. Focus on *long-term research, monitoring, education, and stewardship* for more effective coastal management.

SWMP

System Wide Monitoring Program, initiated in 1995 to provide *continuous monitoring* data at over 140 stations in each of the 28 NERRS reserves



What is NERRS/SWMP?



<http://nerrs.noaa.gov/ReservesMap.aspx>



What is NERRS/SWMP?

Each reserve has fixed, continuous monitoring stations for *water quality* (15 min), *meteorology* (15 min), and *nutrients* (monthly)

Water quality

temperature,
conductivity, salinity,
dissolved oxygen,
depth, pH, turbidity,
fluorescence

Meteorology

air temperature,
humidity, pressure,
wind speed, wind
direction, PAR,
precipitation

Nutrients

phosphate,
chlorophyll, nitrate,
nitrite, ammonium,
Kjeldahl nitrogen,
urea



What is NERRS/SWMP?

Data maintained by the Centralized Data Management Office (CDMO)



What is NERRS/SWMP?

Hallmarks of SWMP - Standardized instruments and protocols,
rigorous QAQC, very large dataset

- All 28 reserves use identical instruments and standardized protocols
- All data are managed by the NERRS Centralized Data Management Office
- Database meets the definition of “big data”



What is NERRS/SWMP?

As of last month, > 63 million SWMP data records available

Raw data will look like this...

A	B	C	D	E	F	G	H	I	J	K	L	
1	StationCode	isSWMP	DateTimeStamp	Historical	Provisional	CollMeth	REP	F_Record	PO4F	F_PO4F	NH4F	F_NH4F
2	apacpnut	P	1/10/2012 10:20	0	1	1	1		0.003 <-4> [SBL]		0.03 <0>	
3	apacpnut	P	2/7/2012 11:41	0	1	1	1		0.005 <0>		0.019 <0>	
4	apacpnut	P	3/5/2012 11:51	0	1	1	1		0.003 <-4> [SBL]		0.041 <0>	
5	apacpnut	P	4/4/2012 10:30	0	1	1	1		0.003 <-4> [SBL]		0.043 <0>	
6	apacpnut	P	5/9/2012 10:12	0	1	1	1		0.003 <0>		0.053 <0>	
7	apacpnut	P	5/9/2012 10:15	0	1	1	2		0.003 <-4> [SBL]		0.022 <0>	
8	apacpnut	P	5/9/2012 10:20	0	1	1	3		0.003 <0>		0.016 <0>	
9	apacpnut	P	6/5/2012 8:30	0	1	1	1		0.003 <-4> [SBL]		0.04 <0>	
10	apacpnut	P	7/3/2012 9:58	0	1	1	1 {CSM}		0.004 <0>		0.094 <0>	
11	apacpnut	P	7/3/2012 9:59	0	1	1	2 {CSM}		0.004 <0>		0.066 <0>	
12	apacpnut	P	7/3/2012 10:01	0	1	1	3 {CSM}		0.005 <0>		0.069 <0>	
13	apacpnut	P	8/7/2012 9:53	0	1	1	1 {CSM}		0.003 <-4> [SBL]		0.05 <0>	
14	apacpnut	P	9/5/2012 10:56	0	1	1	1		0.003 <-4> [SBL]		0.026 <0>	
15	apacpnut	P	10/2/2012 9:22	0	1	1	1		0.003 <-4> [SBL]		0.042 <0>	
16	apacpnut	P	10/2/2012 9:27	0	1	1	2		0.003 <-4> [SBL]		0.024 <0>	
17	apacpnut	P	10/2/2012 9:32	0	1	1	3		0.003 <0>		0.042 <0>	
18	apacpnut	P	11/6/2012 10:30	0	1	1	1		0.003 <-4> [SBL]		0.07 <0>	
19	apacpnut	P	11/26/2012 11:39	0	1	1	1		0.003 <-4> [SBL]		0.041 <0>	



What are the needs?

NERRS researchers, managers, and technicians need more tools for trend analysis:

- Understand regional and national trends while retaining the ability to determine local trends
- Train users
- Maintain a versatile and evolving data analysis approach
- Create a community of practice



NERRS / SWMP

Data Analysis Workshop: Time Series

November 17, 2014

One-day training workshop at 2014 annual meeting

- Attended by over 70 NERRS staff, representing 19 of 28 reserves
- General focus on time series analysis, simple applications with SWMP data
- Pre/post workshop materials, including an R package for SWMP



Genesis of SWMPrats



A working group was formed from this meeting

*S*ystem- *W*ide *M*onitoring *P*rogram *R*esources for the
*A*nalysis of *T*ime *S*eries

SWMPrats.net is our base of operations...



A website with information and tools for SWMP data analysis

The SWMPrats.net web pages serve as a time series and data analysis information and tool resource for the National Estuarine Research Reserve System (NERRS) System-wide Monitoring Program (SWMP).

Trends in SWMP parameters

Created by Marcus W. Beck, beck.marcus@noaa.gov, Todd O'Brien, todd.o'brien@noaa.gov

This widget is an interactive tool to evaluate trends in SWMP data. Trends are described by an increase or decrease in values over time using a simple linear regression of summarized data. The significance of the trend is indicated by the color of the bars. Red indicates a significant positive trend. The color green indicates a significant negative trend. The color grey indicates no significant trend for decreasing and red increasing. The significance is indicated by radius of the circle and color shading where larger points with darker colors indicate a strong trend. Original data are available from NOAA's National Centers for Environmental Information.

Select parameter:

swmp Temperature (C)

Select summary by:

Years anomalies

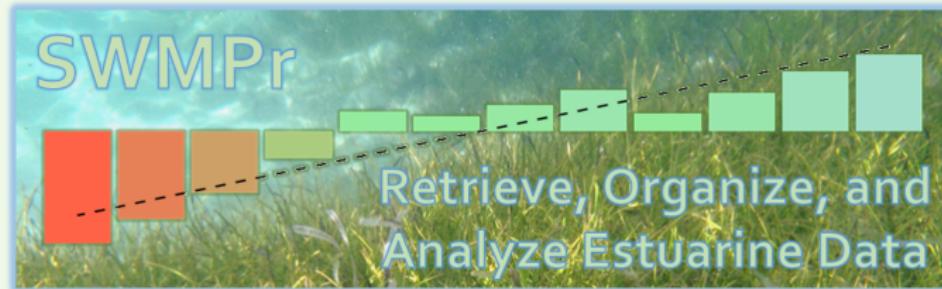
Select date range:

1980-2014

oceanname, Temperature (C), NED (p=0.01)



SWMPrats.net: The SWMPr package



SWMPr is an open-source R package described on the website, v2.1.5 is now available

```
> # install/load from R  
> install.packages('SWMPr')  
> library(SWMPr)
```



SWMPrats.net: The SWMPPr package

The software addresses the unglamorous but necessary challenges of analyzing time series, specific to SWMP

What are some challenges?

- Dealing with ‘bad’ data
- Subsetting by date ranges, parameters
- Combining data from different sites
- Standardizing time steps
- ...and analysis

A	B	C	D	E	F	G	H	I	J	K	L
1	StationCo_idSWMP	DateFirstStamp	Historical	Provisional	Correlation	REP	F_Record	PDR	F_PDR	NHDF	F_NHDF
2	apeprin P	1/10/2012 10:30	0	1	1	1	3	0.003 <-4 [SWL]	0.03 <0	0.003 <-4 [SWL]	0.03 <0
3	apeprin P	1/10/2012 10:30	0	1	1	1	3	0.003 <-4 [SWL]	0.03 <0	0.003 <-4 [SWL]	0.03 <0
4	apeprin P	3/5/2012 11:51	0	1	1	1	3	0.003 <-4 [SWL]	0.041 <0	0.003 <-4 [SWL]	0.041 <0
5	apeprin P	4/4/2012 10:30	0	1	1	1	3	0.003 <-4 [SWL]	0.043 <0	0.003 <-4 [SWL]	0.043 <0
6	apeprin P	5/9/2012 10:12	0	1	1	1	3	0.003 <0	0.053 <0	0.003 <0	0.053 <0
7	apeprin P	5/9/2012 10:12	0	1	1	1	2	0.003 <-4 [SWL]	0.032 <0	0.003 <-4 [SWL]	0.032 <0
8	apeprin P	5/9/2012 10:30	0	1	1	1	3	0.003 <-4 [SWL]	0.053 <0	0.003 <-4 [SWL]	0.053 <0
9	apeprin P	5/9/2012 10:30	0	1	1	1	2	0.003 <-4 [SWL]	0.044 <0	0.003 <-4 [SWL]	0.044 <0
10	apeprin P	7/3/2012 9:58	0	1	1	1	3 [SWL]	0.004 <0	0.004 <0	0.004 <0	0.004 <0
11	apeprin P	7/3/2012 9:58	0	1	1	1	2 [SWL]	0.004 <0	0.006 <0	0.004 <0	0.006 <0
12	apeprin P	7/3/2012 10:59	0	1	1	1	3 [SWL]	0.005 <0	0.005 <0	0.005 <0	0.005 <0
13	apeprin P	8/7/2012 10:59	0	1	1	1	3 [SWL]	0.005 <0	0.005 <0	0.005 <0	0.005 <0
14	apeprin P	9/5/2012 9:56	0	1	1	1	2	0.003 <-4 [SWL]	0.030 <0	0.003 <-4 [SWL]	0.030 <0
15	apeprin P	10/2/2012 9:22	0	1	1	1	3	0.003 <-4 [SWL]	0.042 <0	0.003 <-4 [SWL]	0.042 <0
16	apeprin P	10/2/2012 9:27	0	1	1	1	2	0.003 <-4 [SWL]	0.034 <0	0.003 <-4 [SWL]	0.034 <0
17	apeprin P	10/2/2012 9:32	0	1	1	1	3	0.003 <0	0.042 <0	0.003 <0	0.042 <0
18	apeprin P	11/6/2012 10:40	0	1	1	1	3	0.003 <-4 [SWL]	0.07 <0	0.003 <-4 [SWL]	0.07 <0
19	apeprin P	11/6/2012 11:49	0	1	1	1	2	0.003 <-4 [SWL]	0.041 <0	0.003 <-4 [SWL]	0.041 <0



Package description published in The R Journal this year

SWMPr: An R Package for Retrieving, Organizing, and Analyzing Environmental Data for Estuaries

by Marcus W Beck

Abstract The System-Wide Monitoring Program (SWMP) was implemented in 1995 by the US National Estuarine Research Reserve System. This program has provided two decades of continuous monitoring data at over 140 fixed stations in 28 estuaries. However, the increasing quantity of data provided by the monitoring network has complicated broad-scale comparisons between systems and, in some cases, prevented simple trend analysis of water quality parameters at individual sites. This article describes the **SWMPr** package that provides several functions to facilitate data retrieval, organization, and analysis of time series data in the reserve estuaries. Previously unavailable functions for estuaries are also provided to estimate rates of ecosystem metabolism using the open-water method. The **SWMPr** package has facilitated a cross-reserve comparison of water quality trends and links quantitative information with analysis tools that has use for more generic applications to environmental time series.



SWMPrats.net: The SWMPr package

Proof of concept, import and combine wq and weather data from Apalachicola Bay

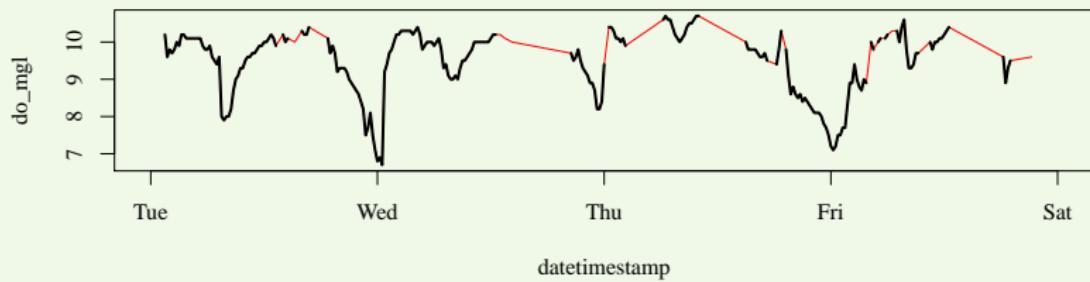
```
> # import data
> data(apaebmet)
> data(apacpwq)
> met <- apaebmet
> wq <- apacpwq
>
> # combine, two hours time step
> # only overlapping date ranges
> dat <- comb(met, wq, timestep = 120,
+   method = 'intersect')
```

Try doing the same by hand...

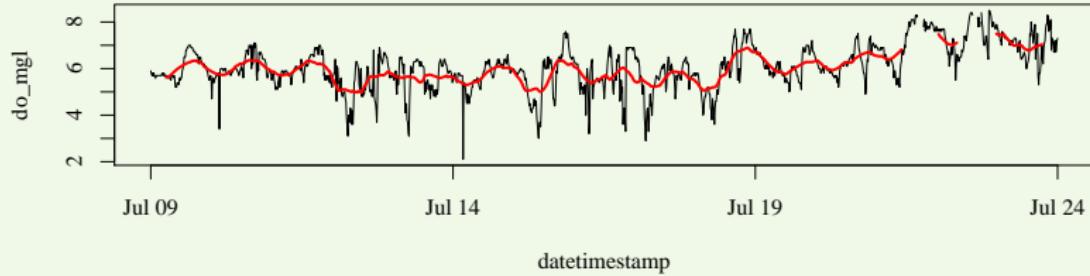


SWMPrats.net: The SWMPr package

Example: fill missing data with `na.approx`



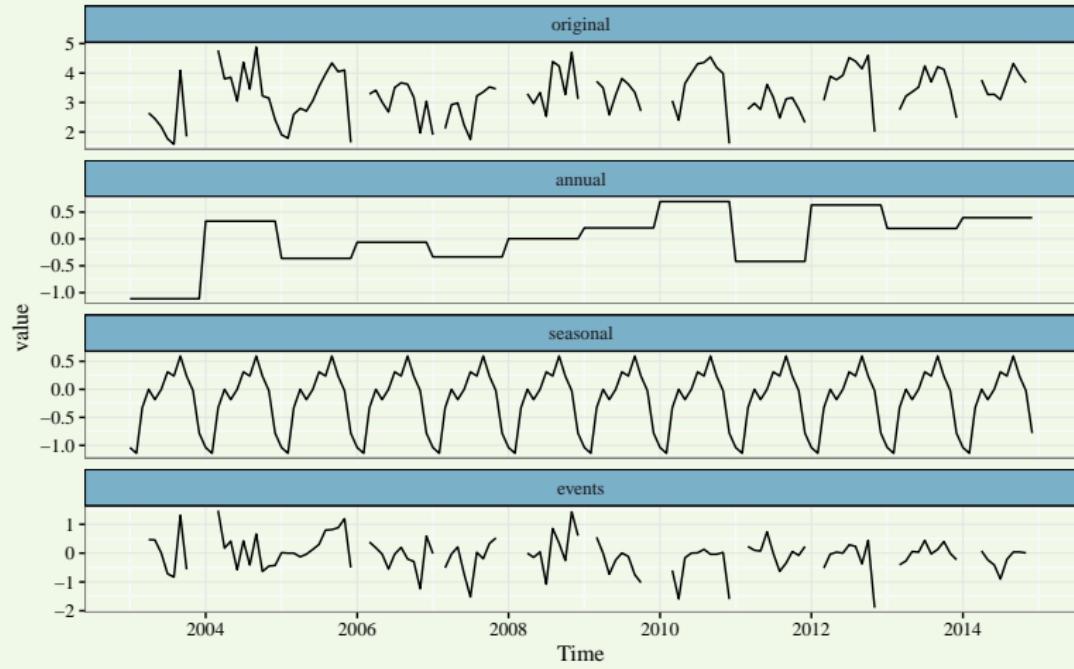
Example: smooth data with `smoother`





SWMPrats.net: The SWMPr package

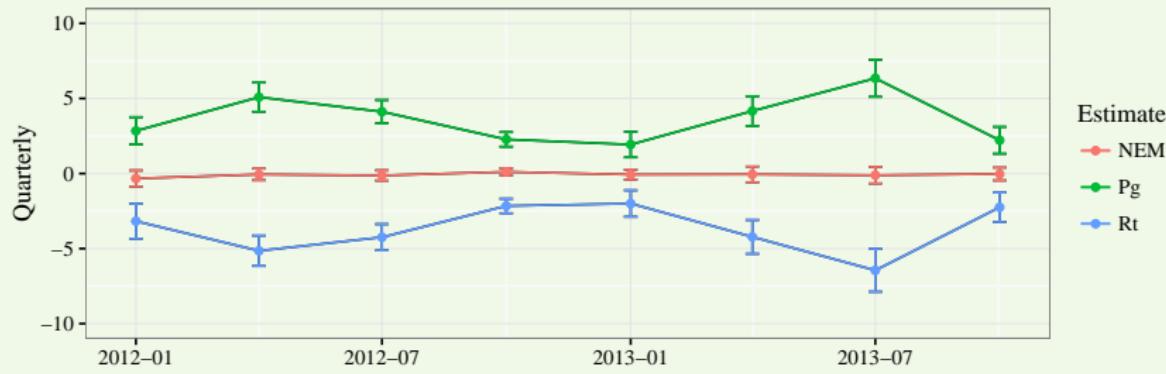
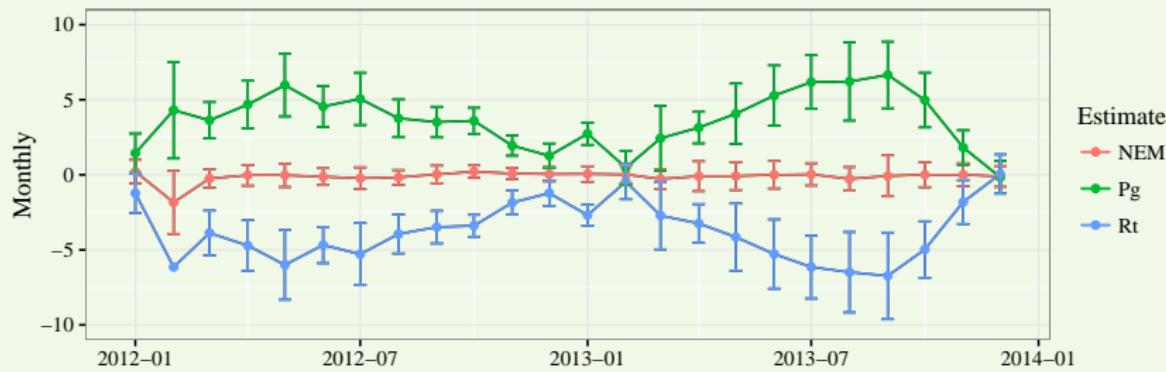
Example: time series decomposition with `decomp_cj` (chl-a at cbmocnut)





SWMPrats.net: The SWMPr package

Example: estimate ecosystem metabolism with `ecometab` (`apadbwq`)

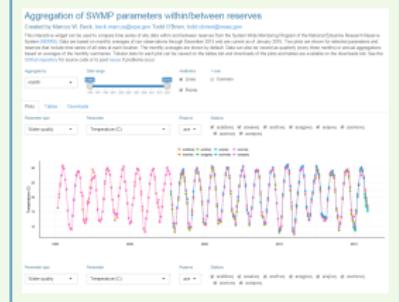
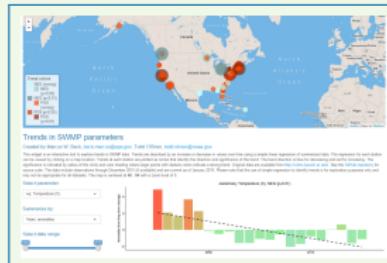
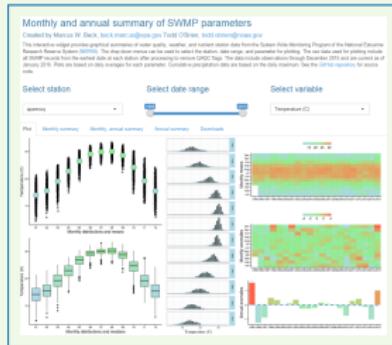




The most common question - has there been a change over time at my site (long-term trends)?

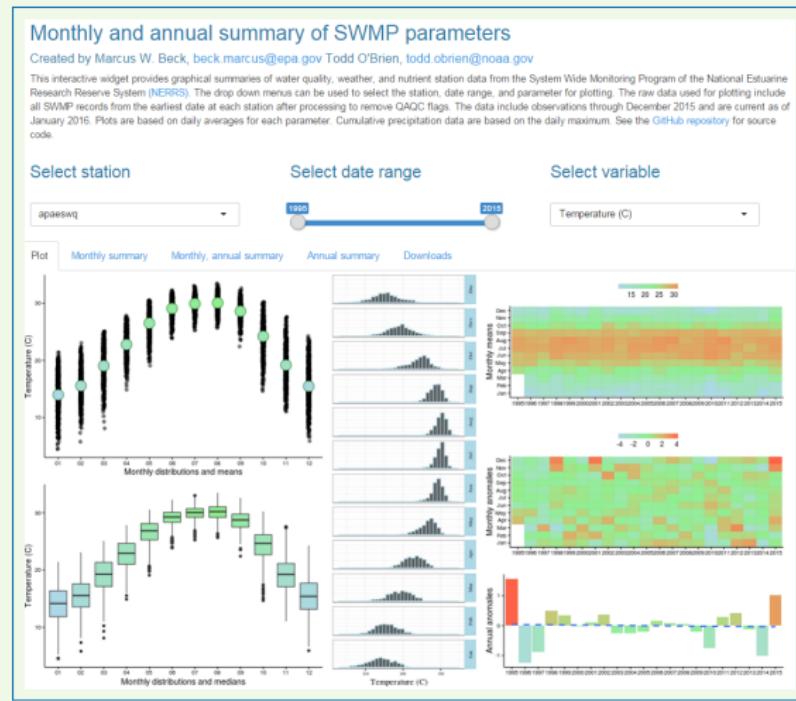
Three Shiny applications allow users to visualize trends in SWMP data

These apps allow ‘reactive’ use of SWMPr functions



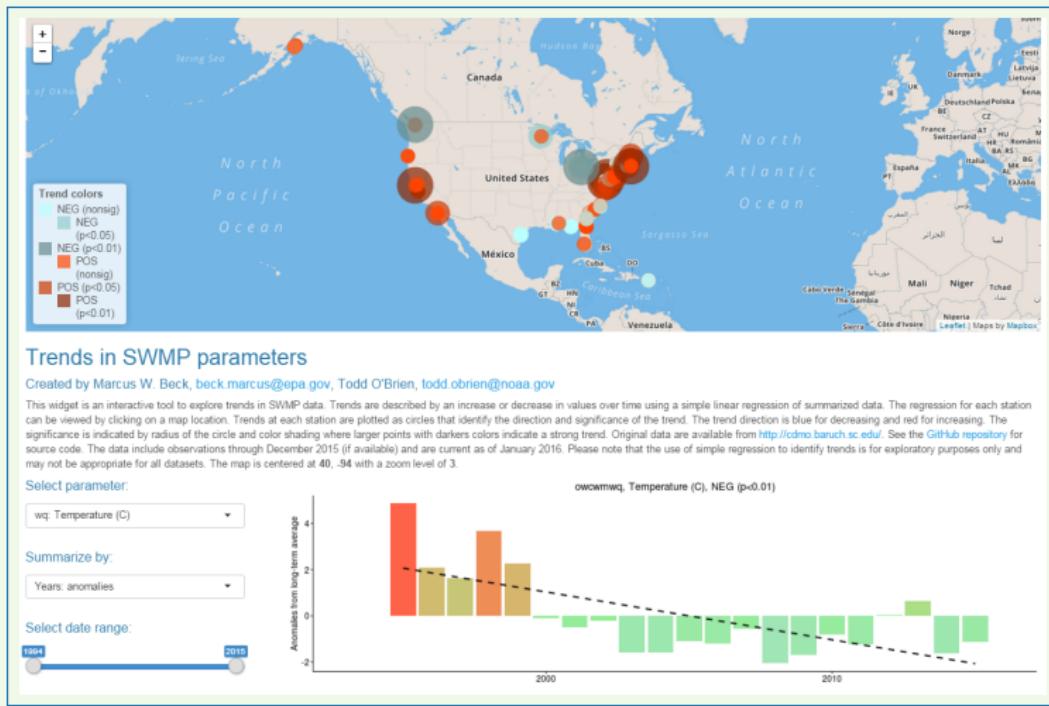


SWMP summary plots: https://beckmw.shinyapps.io/swmp_summary/



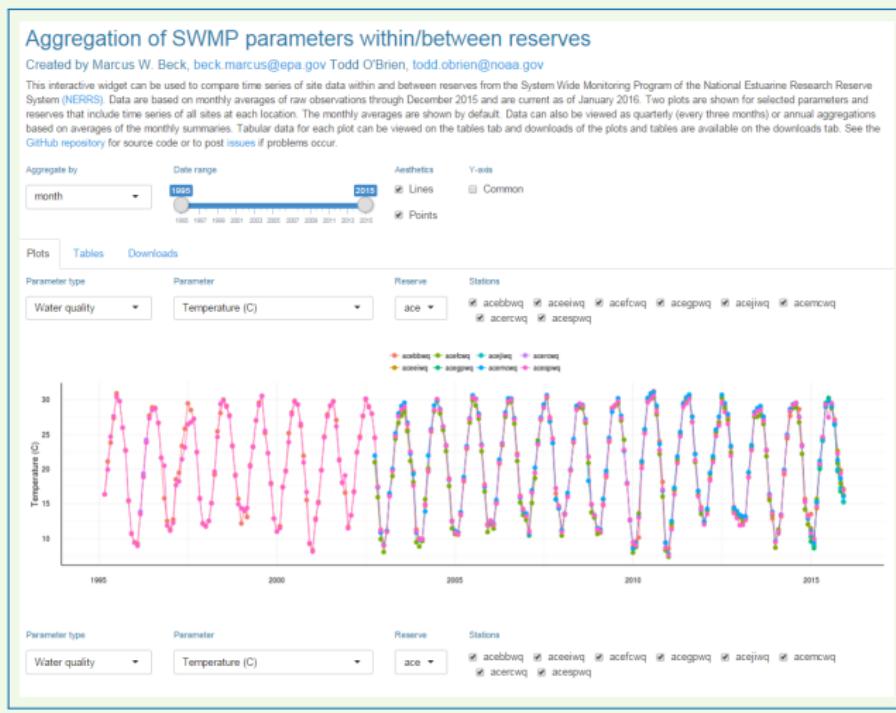


SWMP trends map: https://beckmw.shinyapps.io/swmp_comp/





SWMP aggregation: https://beckmw.shinyapps.io/swmp_agg/





SWMPrats.net: Forum

Last but not least, a discussion forum for all things analytical

SWMPrats.net

Welcome, Guest

Username: Password: Remember me

[Login](#)

Forgot your password? Forgot your username? Create an account

Forum > Recent Topics

21 Topics Year Board Categories Go Page: 1 2

Recent Discussions					
1 Replies		SWMPr manuscript available Category: SWMPr Help/Support Topic started 2 days 6 hours ago by Marcus Beck		9 Views	Last Post by Kim_Cressman 7 hours 40 minutes ago
1 Replies		POTM April 2016 - Simple Chlorophyll Graph Category: POTM: Single Variable Exploration Topic started 1 week 5 days ago by Kim_Cressman		58 Views	Last Post by Marcus Beck 2 days 6 hours ago
2 Replies		Basic R resources Category: SWMPr Help/Support Topic started 1 week 5 days ago by Kim_Cressman		29 Views	Last Post by Kim_Cressman 5 days 5 hours ago



Last but not least, a discussion forum for all things analytical

TOPIC: POTM (Jan-2016): The Menu Command

- POTM (Jan-2016): The Menu Command 3 months 2 days ago

#57

Todd.O'Brien

OFFLINE

Moderator



Posts: 6

Karma: 3



The January "POTM" should perhaps be called a "PPOTM" (Practical Programming of the Month).

Select a file (enter ZERO to quit): |

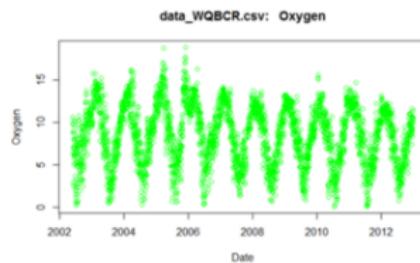
```
1: data_ACEBB.csv  
2: data_ELKNM.csv  
3: data_NOCRC.csv  
4: data_WQBCR.csv
```

Selection: 3

Pick a variable (0 to exit):

```
1: DATE.YMD  
2: Temperature  
3: Salinity  
4: Oxygen  
5: Turbidity  
6: AirTemp
```

Selection: 3



The R **menu** command will take a data structure (e.g. a list of all *.csv file names found in the current working directory, or a list of column headings present in a data table) and list it out as a numbered menu of choices (e.g., a list of five items would show a menu with options 1 – 5



Continuing work and engagement

SWMPrats.net is in its infancy but already seeing heavy use

- Over 4000 visits to the website this year
- 3140 downloads of SWMPr to date
- Apps have been used 160 hours in the last three months

Additional training workshops Oct. 2015, planned for 2016





Continuing work and engagement



SWMPrats is an ad hoc group formed organically from the NERRS community

Success depends on:

- Healthy discourse between the creators and users
- In-person training workshops
- Benefits of open-source resources



Continuing work and engagement



- SWMP data are now more accessible and analyses are tractable
- Site, regional, and national comparisons provide capacity to develop understanding of climate and anthropogenic drivers of change in estuarine systems
- As the dataset expands, these tools will facilitate evaluation of long-term trends within and between locations

Continuing work and engagement



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To get this presentation: https://github.com/fawda123/NWQMC_16

Apps: <http://swmprats.net/swmp-widgets/summary-plots>,
<http://swmprats.net/swmp-widgets/trends-maps>,
<http://swmprats.net/swmp-widgets/swmp-widget-aggregation>

Visit the development site for the most recent version of SWMPr:
<https://github.com/fawda123/SWMPr>