Using open science tools for water quality management in the Peconic Estuary Watershed

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What we'll cover today

- Some open science tools for analyzing 'censored' water quality data
- Initial water quality management targets adopted by PEP
- Open science tools for tracking and reporting progress on meeting the adopted targets
- Next steps

Using R tools to analyze censored water quality data

- ‘Censoring’ occurs when data points are known to fall within a certain range, but their actual values are unknown.
- It’s a common issue in water quality data sets:
  - **Secchi depth** values flagged as ‘visible on bottom’, and bacterial counts flagged as ‘too numerous to count’ are termed **‘right-censored’**.
  - **Laboratory results** flagged as ‘below detection limit’ or ‘below practical quantitation limit’ are termed **‘left-censored’**.
- Can lead to biased parameter estimates and misleading results in hypothesis tests.

Fortunately, statistical methods for addressing these issues are available from other fields

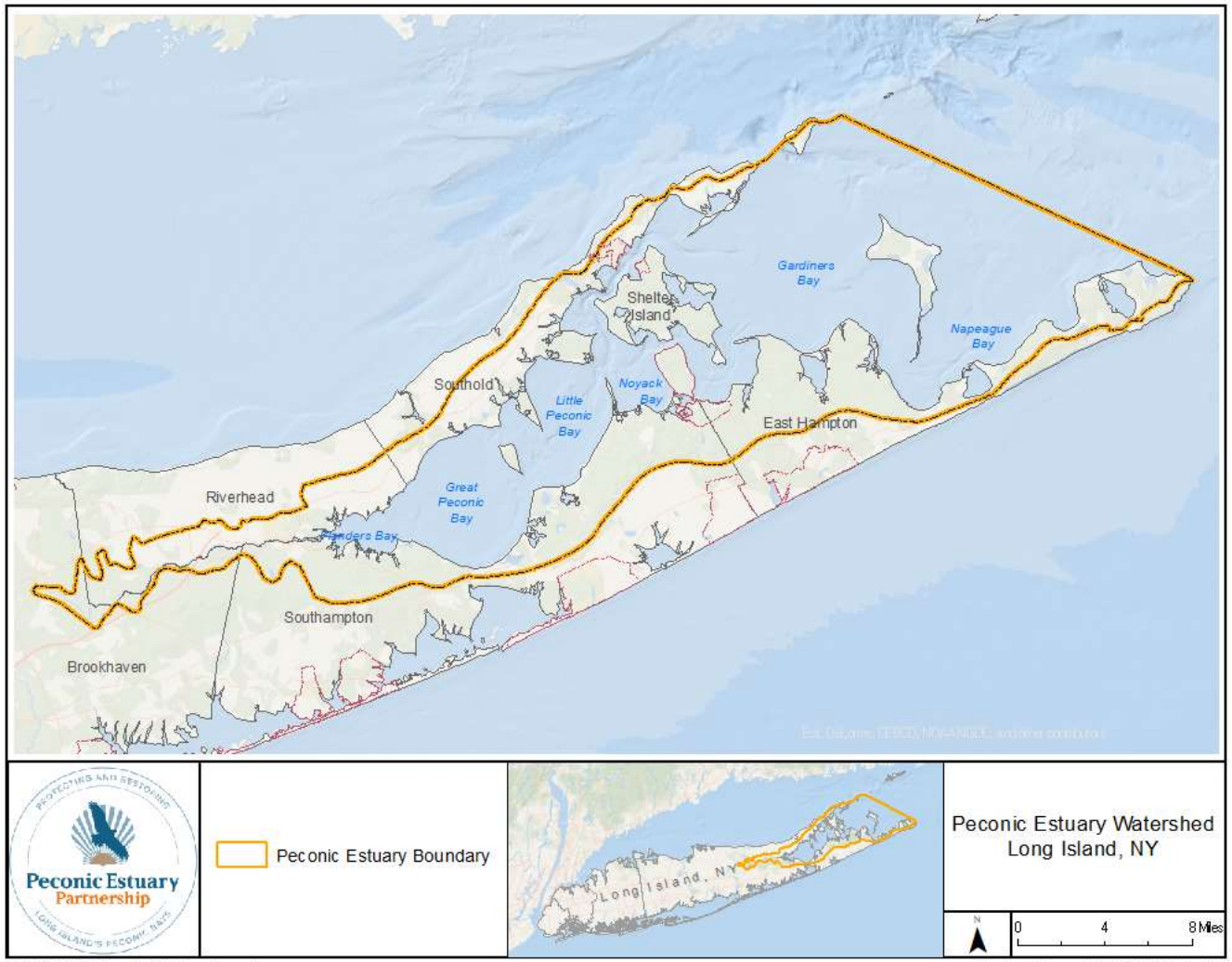
- **Medicine (clinical trials)** – estimating mean or median survival times, and testing for differences in survival times between treatments. (Right-censored data, because survival times are unknown for patients who are still alive at the end of the trial.)
- **Engineering/manufacturing** – analogous situation when analyzing **time-to-failure** data for machines or components. (Right-censored data, because time-to-failure is unknown for parts that are still functioning correctly at the end of the trial.)
- **Environmental health/occupational exposure studies** – Results of many samples are reported as 'below detection limit' (left-censored data).

Some R packages for analyzing censored (and non-censored) data

- **EnvStats** – a package for 'environmental statistics, including US EPA guidance'
  - Available at https://cran.r-project.org/web/packages/EnvStats/index.html.
  - Covers most (but not all) situations encountered with environmental sampling data.
  - Developed by statisticians with water quality and hazardous waste site cleanup experience.

- **Survival** – a statistical package for analyzing clinical trial data
  - Available at https://cran.r-project.org/web/packages/survival/index.html.
  - Focused on right-censored data from clinical trials.
  - Developed by statisticians at major research hospitals.

Peconic Estuary Partnership's Water Quality Monitoring Strategy



Peconic Estuary Partnership's
Water Quality Monitoring Strategy

June 2020

Peconic Estuary Partnership
PROTECTING AND RESTORING LONG ISLAND'S PECONIC BAYS

NE IW PCC

PEP Technical Advisory Committee Recommendations

Approved by PEP Management and Policy Committees on February 5th, 2020

Adopt provisional targets for water clarity (Secchi disk depth), chl-a concentration, and dissolved oxygen (DO).

Median Secchi disk depths should be 2 meters (m) or greater during the April 1 through October 31 growing season.

Median chlorophyll-a concentrations should be no greater than 5.5 ug/l during the April 1 through October 31 growing season.

Dissolved oxygen concentrations should comply with New York State's acute (never less than 3 mg/l) and chronic (> 4.8 mg/l as daily average in 90% of samples) dissolved oxygen criteria.

Primarily based on targets proposed in the Suffolk County 2020 Subwatersheds Wastewater Plan.

Reporting and Management Segments:
Eastern, Central and Western Zones

Report results on an annual basis.

Use ‘stoplight graphics’ for public-facing documents, collating data by main stem estuary segment.

Track and report water temperature, salinity, pH and harmful algal blooms on an annual basis as the adoption of numerical targets are not currently anticipated for these parameters.

Secchi depth and chlorophyll-*a* targets in the three Peconic Estuary reporting zones for the years 1976 – 2018.

Estuary Segment	YY	Median Chla (µg/L)	Median Secchi Depth (ft)
West	1976	22.2	3.5
West	1977	--	6.0
West	1978	--	5.3
West	1979	--	5.0
West	1980	--	--
West	1981	--	--
West	1982	--	--
West	1983	--	--
West	1984	--	--
West	1985	--	2.5
West	1986	--	4.0
West	1987	--	4.0
West	1988	12.6	3.5
West	1989	5.0	7.0
West	1990	4.2	5.0
West	1991	6.0	3.5
West	1992	4.0	4.0
West	1993	3.8	4.5
West	1994	3.5	5.5
West	1995	6.9	4.0
West	1996	7.4	5.5
West	1997	7.8	5.5
West	1998	3.8	5.5
West	1999	3.4	5.5
West	2000	3.2	5.0
West	2001	4.1	5.0
West	2002	3.8	5.5
West	2003	4.3	5.5
West	2004	4.4	5.0
West	2005	3.9	5.5
West	2006	4.8	6.0
West	2007	4.7	6.0
West	2008	4.8	5.5
West	2009	4.3	5.0
West	2010	9.0	5.0
West	2011	4.9	5.0
West	2012	3.9	5.0
West	2013	5.1	7.0
West	2014	3.2	6.0
West	2015	2.6	5.5
West	2016	3.6	4.5
West	2017	6.7	4.0
West	2018	5.4	5.0

Estuary Segment	YY	Median Chla (µg/L)	Median Secchi Depth (ft)
Central	1976	--	--
Central	1977	--	--
Central	1978	--	--
Central	1979	--	--
Central	1980	--	--
Central	1981	--	--
Central	1982	--	--
Central	1983	--	--
Central	1984	--	--
Central	1985	--	--
Central	1986	--	5.0
Central	1987	--	3.5
Central	1988	12.0	4.5
Central	1989	4.6	7.0
Central	1990	3.5	7.0
Central	1991	8.6	3.3
Central	1992	3.2	5.5
Central	1993	3.0	6.5
Central	1994	2.7	7.5
Central	1995	4.8	5.5
Central	1996	3.9	7.5
Central	1997	4.1	7.5
Central	1998	2.6	7.5
Central	1999	2.2	7.5
Central	2000	1.6	7.0
Central	2001	2.4	7.0
Central	2002	3.1	7.0
Central	2003	2.3	11.0
Central	2004	2.5	8.0
Central	2005	1.9	8.0
Central	2006	2.9	10.0
Central	2007	3.8	10.0
Central	2008	2.9	8.0
Central	2009	2.5	8.0
Central	2010	4.5	6.5
Central	2011	2.8	7.5
Central	2012	2.7	6.0
Central	2013	3.1	8.0
Central	2014	2.3	7.0
Central	2015	1.9	7.0
Central	2016	2.4	6.0
Central	2017	3.3	6.0
Central	2018	2.3	6.0

Estuary Segment	YY	Median Chla (µg/L)	Median Secchi Depth (Fft)
East	1976	--	--
East	1977	--	--
East	1978	--	--
East	1979	--	--
East	1980	--	--
East	1981	--	--
East	1982	--	--
East	1983	--	--
East	1984	--	--
East	1985	--	--
East	1986	--	6.5
East	1987	--	5.0
East	1988	7.5	6.0
East	1989	4.5	8.5
East	1990	3.0	8.5
East	1991	5.0	6.0
East	1992	2.5	7.5
East	1993	2.8	7.5
East	1994	2.4	9.0
East	1995	2.9	7.0
East	1996	3.0	10.0
East	1997	3.2	10.0
East	1998	2.1	12.0
East	1999	1.6	11.0
East	2000	1.2	9.0
East	2001	1.9	10.0
East	2002	2.5	8.5
East	2003	2.4	12.0
East	2004	2.8	9.5
East	2005	1.5	11.0
East	2006	2.7	10.0
East	2007	3.3	10.0
East	2008	2.4	10.0
East	2009	2.2	11.0
East	2010	2.8	12.0
East	2011	2.4	10.0
East	2012	2.1	8.0
East	2013	2.4	11.0
East	2014	1.9	9.0
East	2015	1.5	10.0
East	2016	2.2	8.0
East	2017	2.1	8.0
East	2018	2.9	8.0

Data source: Suffolk County Department of Health Services

As an initial target for pathogens, adopt the Enterococcus threshold currently used by the County and State to determine estuarine/marine swimming beach closures.

Enterococcus counts at estuarine/marine swimming beaches should not exceed 104 colony forming units per 100 milliliter water sample (104 cfu/100ml).

New standards are currently under State review. Once new standards are in place, target will be updated.

Example stoplight graphic for Enterococcus-related beach closures for 2010-2018

Beach Name	2010	2011	2012	2013	2014	2015	2016	2017	2018	Subtotals
Alberts Landing Beach	0	0	0	0	0	0	0	0	1	1
Camp Blue Bay Beach	0	0	0	0	0	0	0	0	1	1
Camp Quinipet Beach	0	1	0	0	0	2	1	0	1	5
Clearwater Beach	0	0	0	0	0	0	0	0	1	1
Cornell Cooperative Extension Marine Center Beach	0	0	0	0	0	0	0	0	0	0
Crescent Beach - Shelter Island	0	0	0	0	0	0	0	1	0	1
Culloden Shores Beach	0	0	0	0	0	0	0	0	0	0
Devon Yacht Club Beach	0	0	0	0	0	0	1	0	1	2
East Lake Drive Beach	0	0	0	0	0	0	0	0	0	0
Fifth Street Park Beach	0	0	0	0	0	2	0	2	1	5
Fleets Neck Beach	0	1	0	0	0	0	0	0	0	1
Foster Memorial Beach	0	0	0	0	0	0	0	0	0	0
Founders Landing Beach	2	1	1	1	0	0	1	3	1	10
Goose Creek Beach	1	0	1	0	0	0	0	0	0	2
Havens Beach	2	1	0	0	0	0	0	0	0	3
Maidstone Beach	0	0	0	1	0	0	0	0	0	1
Meschutt Beach	0	0	1	0	0	0	1	0	1	3
Nassau Point Causeway Beach	0	1	0	0	0	0	0	1	1	3
New Suffolk Beach	0	1	0	0	0	0	0	0	0	1
Norman E. Klipp Park Beach	0	0	0	0	1	0	0	1	0	2
Perlman Music Camp Beach	0	0	0	0	0	0	1	0	1	2
Pridwin Hotel Beach	1	1	0	0	0	0	0	0	1	3
Shelter Island Heights Beach Club Beach	0	0	1	0	0	0	0	0	1	2
Silver Sands Motel Beach	0	1	0	1	0	0	0	0	2	4
South Jamesport Beach	1	0	1	0	0	0	0	0	2	4
Southampton Peconic Beach & Tennis Club Beach	0	0	0	1	0	0	0	0	0	1
Veteran's Memorial Park Beach	0	1	0	2	0	0	0	0	1	4
Wades Beach	0	0	0	0	0	0	0	1	0	1

Green = zero closures
Yellow = one closure
Red = two or more closures

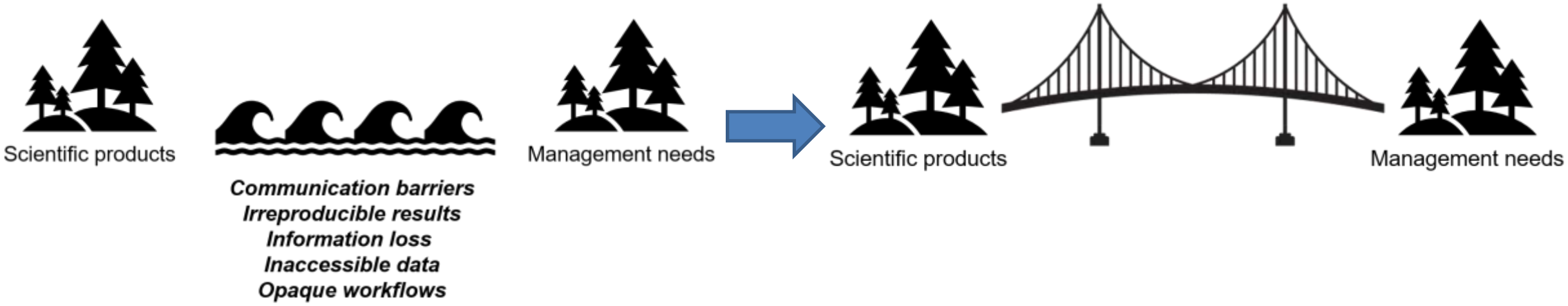
Data source: Suffolk County Department of Health Services

Peconic Estuary Monitoring Collaborative

Function as a sub-committee of the Technical Advisory Committee to help advise the completion of the Next Steps outlined in the Water Quality Monitoring Strategy.

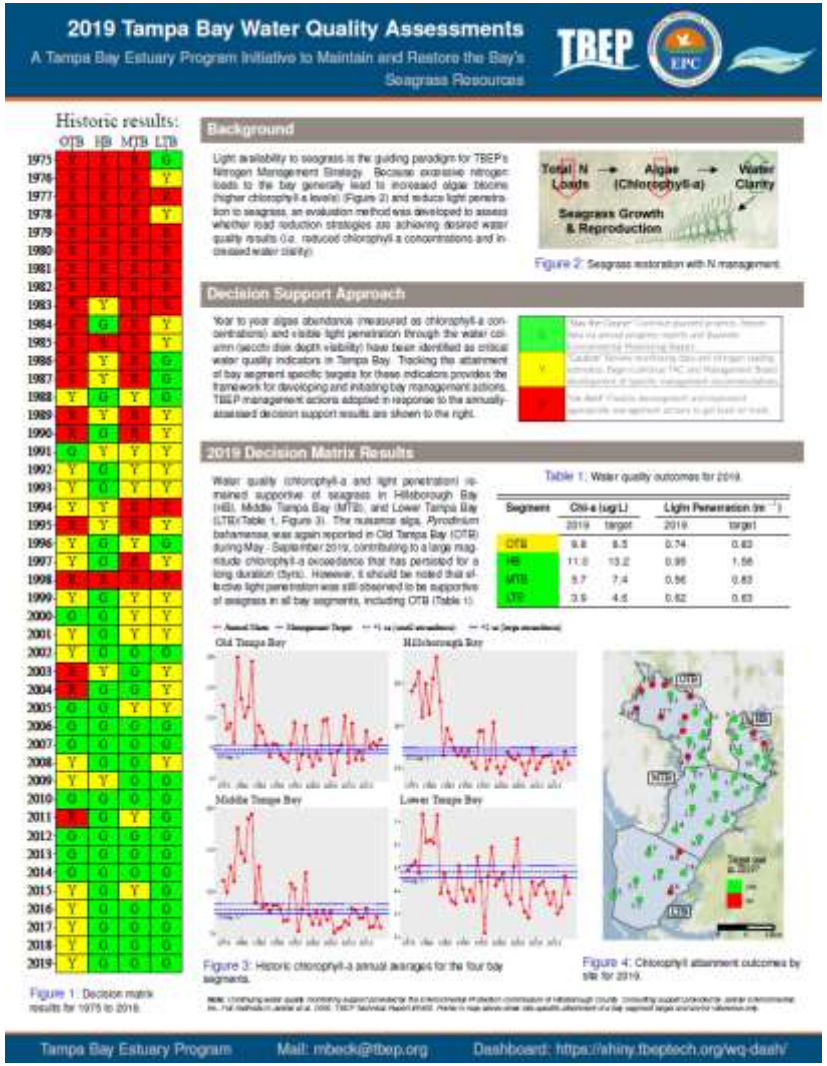
Collaborative composed of main water quality monitoring programs in the Estuary.

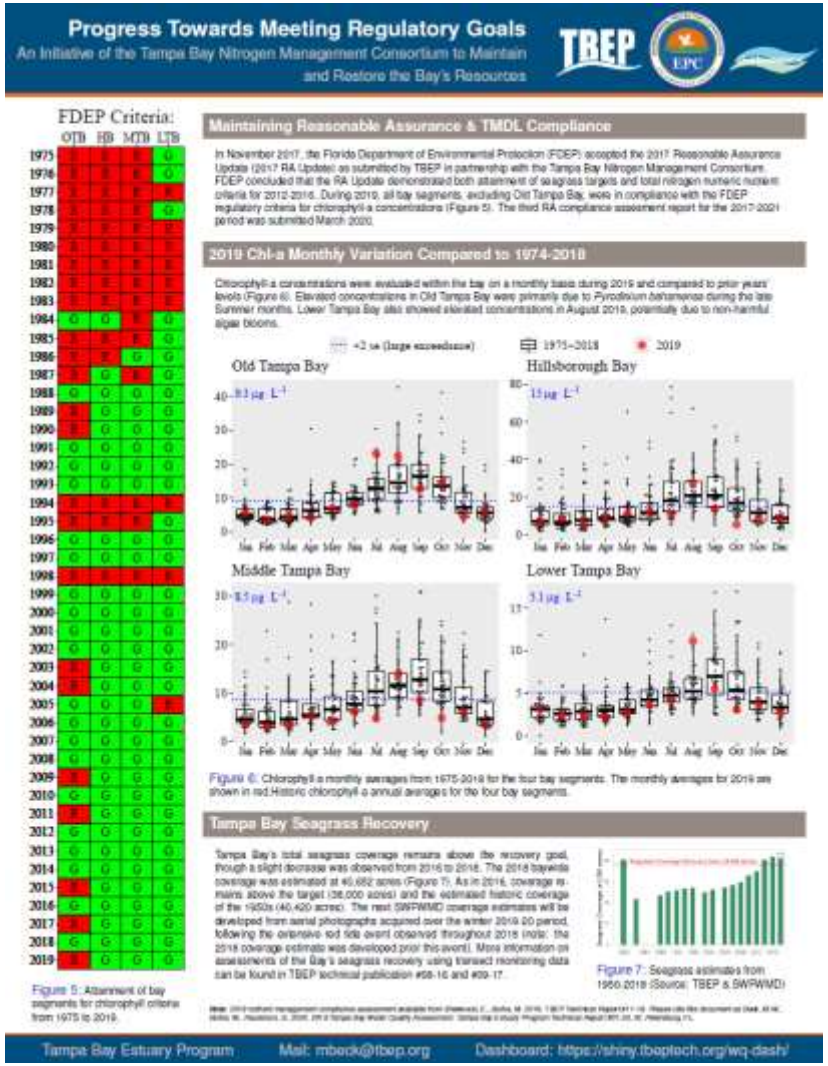
A goal for 2020 is to use open science tools to track and report progress toward water quality goals- bridge the divide between scientific products and management needs.

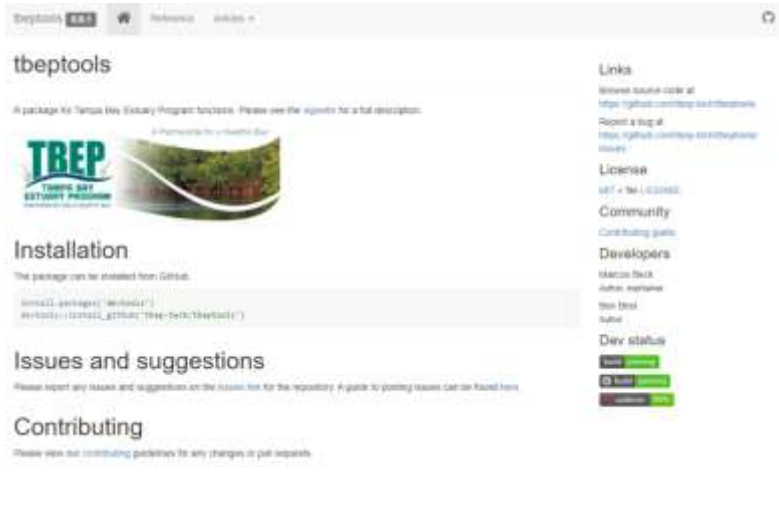


Courtesy: Marcus Beck (TBEP)

Open Science at TBEP

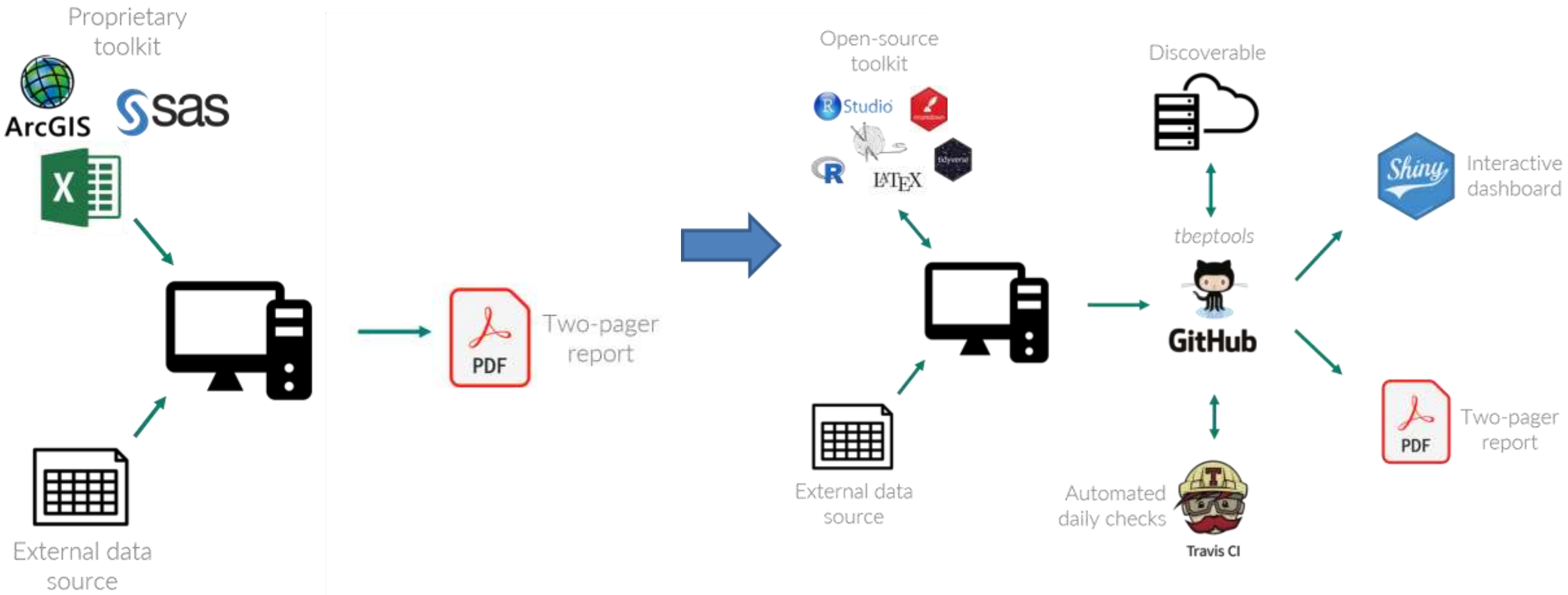






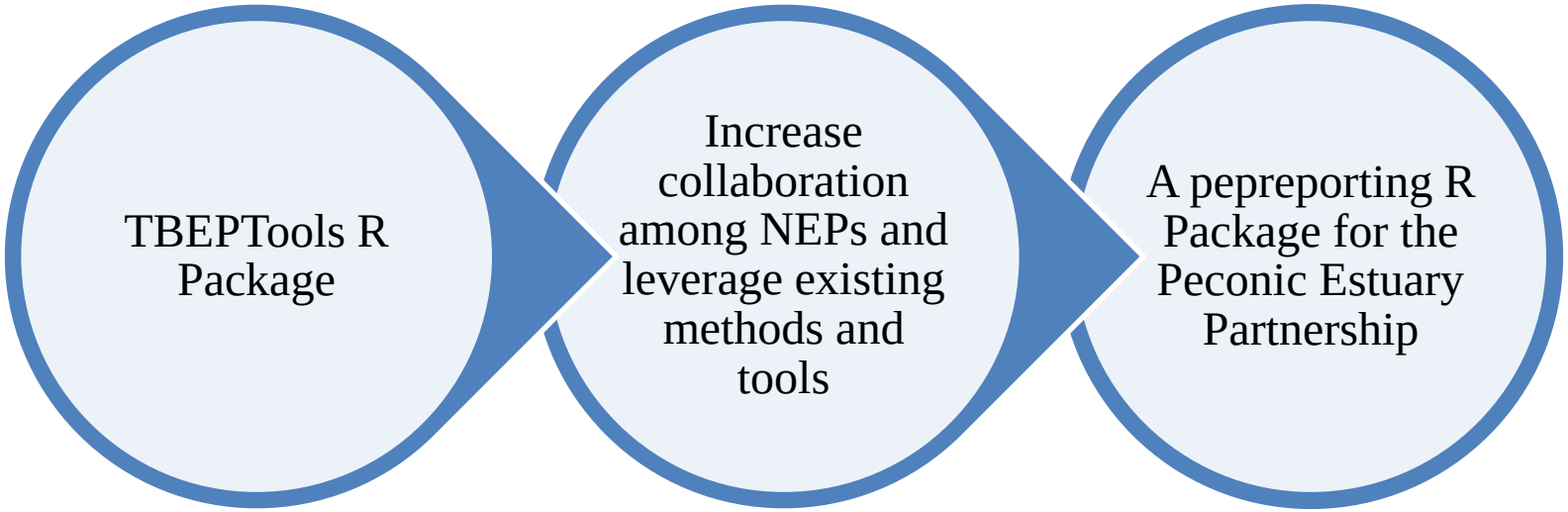
Courtesy: Marcus Beck (TBEP)

The Old Way vs. The New Way



Courtesy: Marcus Beck (TBEP)

Tech Transfer



- Import raw data, estimate indicators, and report outcomes.
- Foundational methods for indicator reporting.
- Freely available on GitHub for anyone to view source code, download for use, and make requests for additions.

pepreporting R PACKAGE

pepreporting 0.0.0.9000 | Reference | Articles

Introduction

Installing pepreporting

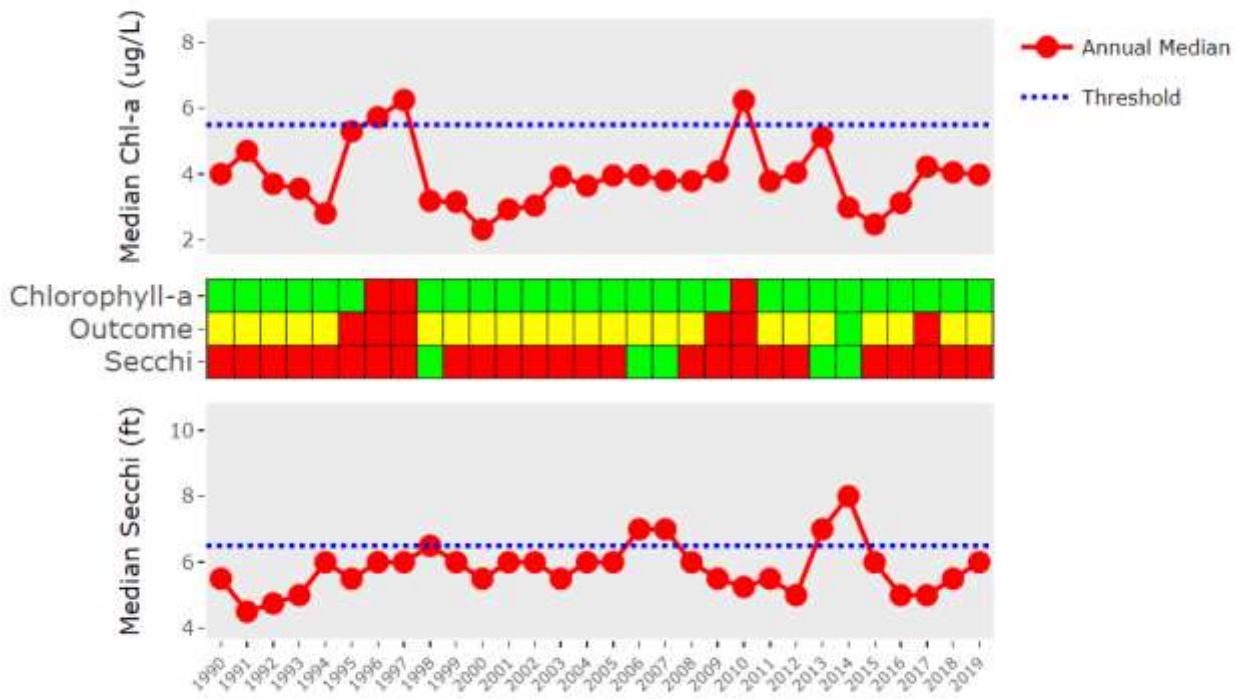
Begin by installing the package from GitHub. The source code is available on the tbep-tech GitHub group web page: https://github.com/tbep-tech/pepreporting.

First, install the devtools package, load devtools, then install and load pepreporting. Note that pepreporting only needs to be installed once, but it needs to be loaded every new R session (i.e., `library(pepreporting)`).

```
install.packages('devtools')
library(devtools)
install_github('tbep-tech/pepreporting')
library(pepreporting)
```

Reporting and Next Steps

```
show_plotlypep(rawdat, bay_segment = 'Western')
```



Chlorophyll outcomes	Light attenuation outcomes			
	0	1	2	3
0	Green	Yellow	Yellow	Yellow
1	Yellow	Yellow	Yellow	Red
2	Yellow	Yellow	Red	Red
3	Yellow	Red	Red	Red

- Graphs and figures from existing water quality data sets.
- Analyze spatial divisions/segments and application of targets in Estuary.
- Develop Stoplight graphic for public-facing documents, update annually.
- Jointly consider chlorophyll-a and water clarity endpoints, duration and magnitude of exceedance.
- Annual water quality reporting.
- Pliable foundation to adjust thresholds, data and reporting methods.

Courtesy: Marcus Beck (TBEP)

Reporting and Next Steps

Track progress towards CCMP goals and inform management efforts for 2020 and beyond.

```
show_matrixpep(dat, asreact = TRUE, nrows = 8)
```

Year	Western	Central	Eastern
1990	yellow	green	green
1991	yellow	yellow	yellow
1992	yellow	yellow	green
1993	yellow	green	green
1994	yellow	green	green
1995	red	yellow	green
1996	red	green	green
1997	red	green	green

1–8 of 30 rows Previous 1 2 3 4 Next

Year	Western	Central	Eastern
1998	yellow	green	green
1999	yellow	green	green
2000	yellow	green	green
2001	yellow	green	green
2002	yellow	green	green
2003	yellow	green	green
2004	yellow	green	green
2005	yellow	green	green

9–16 of 30 rows Previous 1 2 3 4 Next

```
show_matrixpep(dat, asreact = TRUE, nrows = 8)
```

Year	Western	Central	Eastern
2006	yellow	green	green
2007	yellow	green	green
2008	yellow	green	green
2009	red	green	green
2010	red	yellow	green
2011	yellow	green	green
2012	yellow	yellow	green
2013	yellow	green	green

17–24 of 30 rows Previous 1 2 3 4 Next

Year	Western	Central	Eastern
2014	green	green	green
2015	yellow	green	green
2016	yellow	yellow	green
2017	red	yellow	green
2018	yellow	yellow	green
2019	yellow	green	green

25–30 of 30 rows Previous 1 2 3 4 Next

Thank you!

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