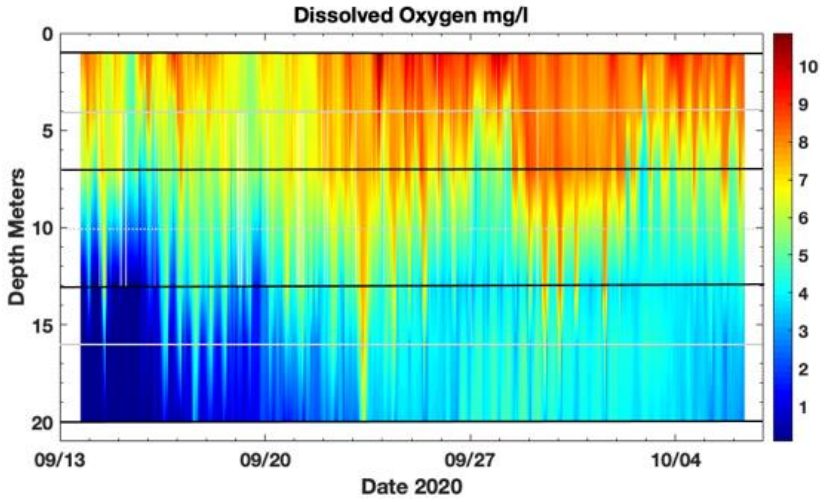
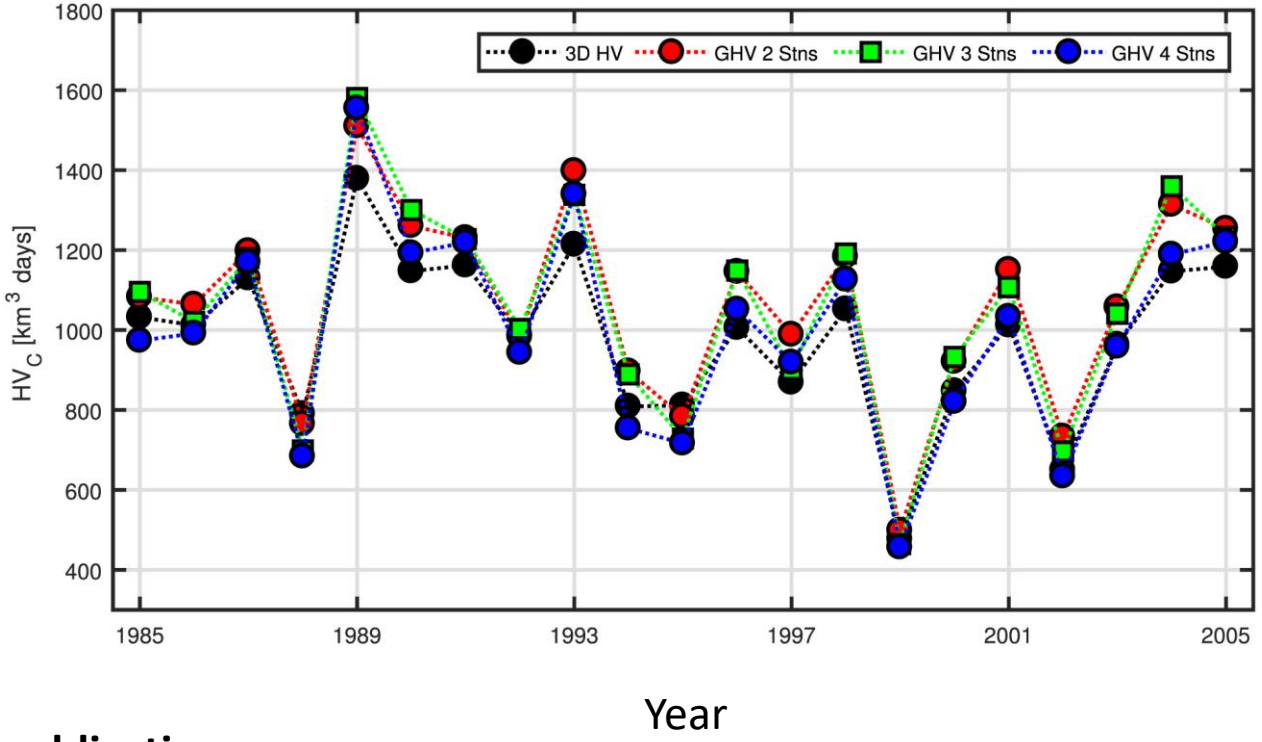
GIT-Funded Open Bay Hypoxia Assessment with New Technologies - Pilot Project. A first look at 2020 results

Peter Tango
USGS@CBPO

STAR Meeting Presentation
10/22/2020



Inspiration on monitoring strategy alternatives: Estimating annual hypoxic volume for Chesapeake Bay with as few as 2 realtime vertical profile stations in the open Bay.



3DHV=Model absolute hypoxic volume
GHV2 = estimate from 2 stations
GHV3 = estimate from 3 stations
GHV4 = estimate from 4 stations

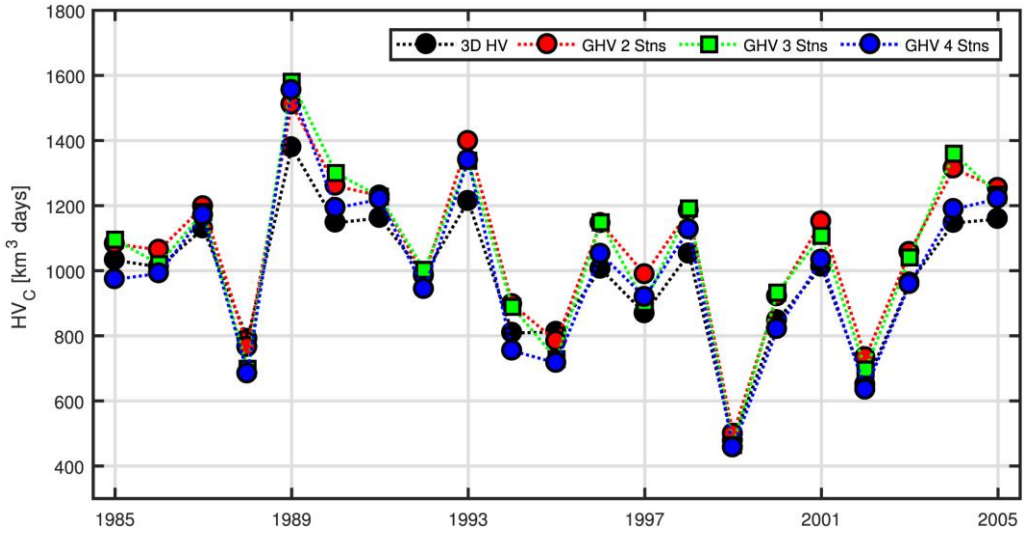
Key publications:

Bever, A. J., Friedrichs, M. A. M., Friedrichs, C. T., Scully, M. E., & Lanerolle, L. W. J. 2013. Combining observations and numerical model results to improve estimates of hypoxic volume within the Chesapeake Bay, USA. *Journal of Geophysical Research: Oceans*, **118**, 4924– 4944.

Bever et al. 2018. Estimating Hypoxic Volume in the Chesapeake Bay Using Two Continuously Sampled Oxygen Profiles. JGR Oceans https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JC014129

Can we take model world insights into real world operations?

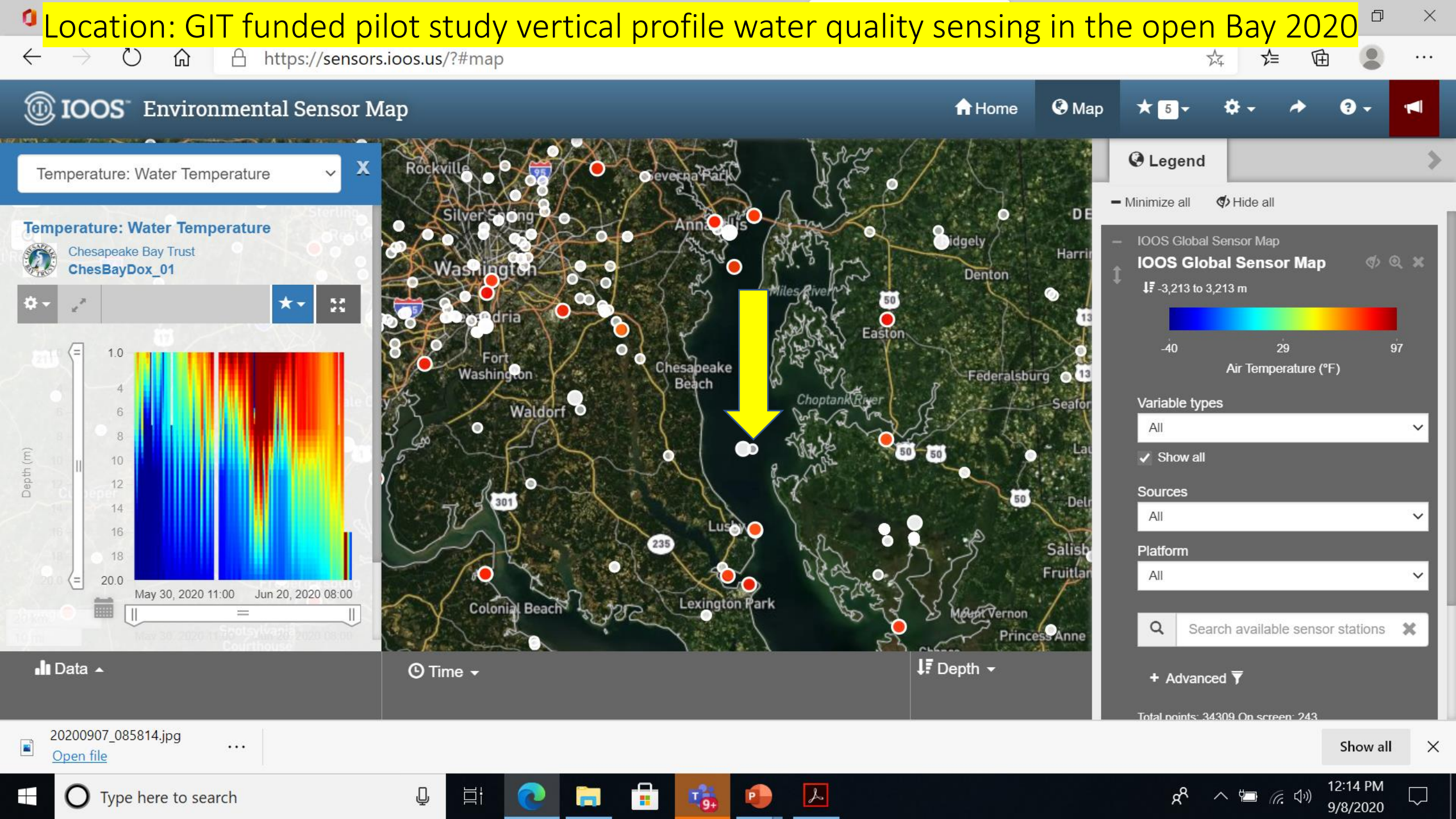
- That was model world…



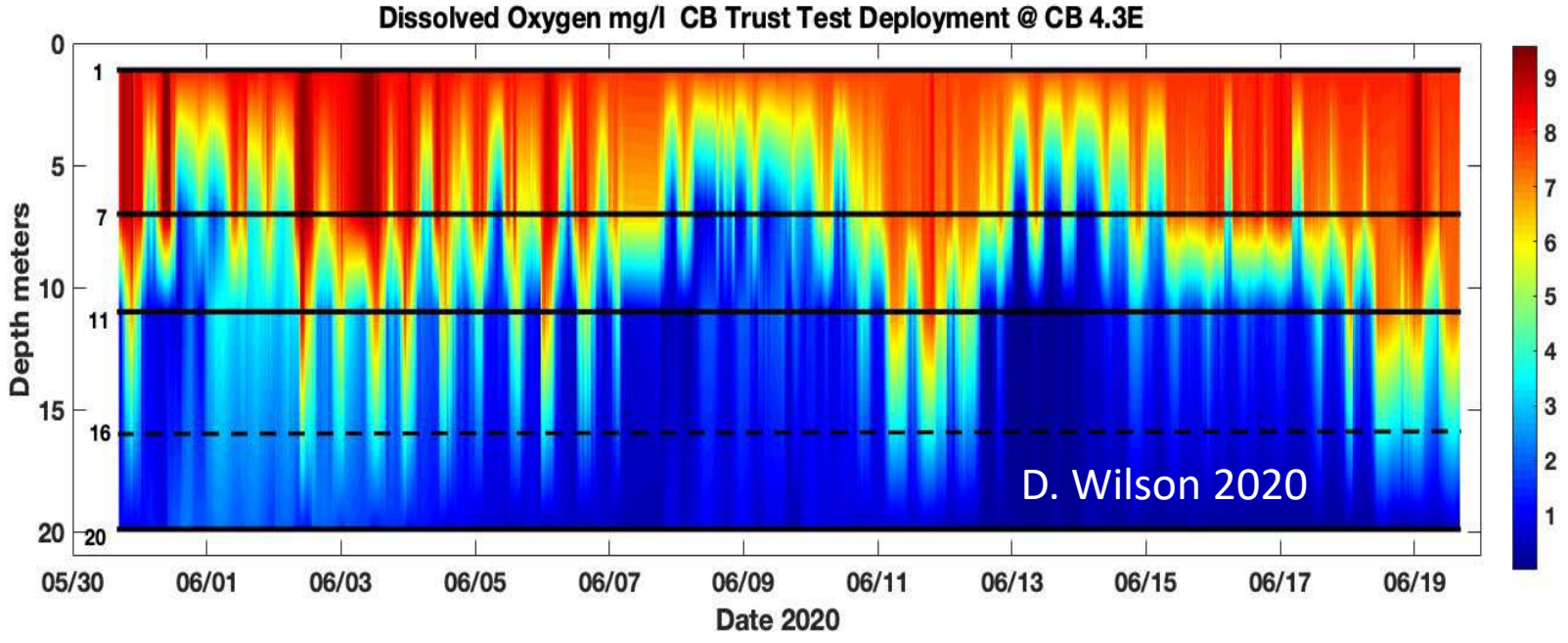
- Question 1 - Can we cost effectively and efficiently collect data with a robust monitoring infrastructure in the wild and woolly conditions of Chesapeake Bay?

2020 GIT Project Goal:
Proof of concept in testing a portable, easily deployable, modest price sensor array for open bay, realtime water quality data collection.

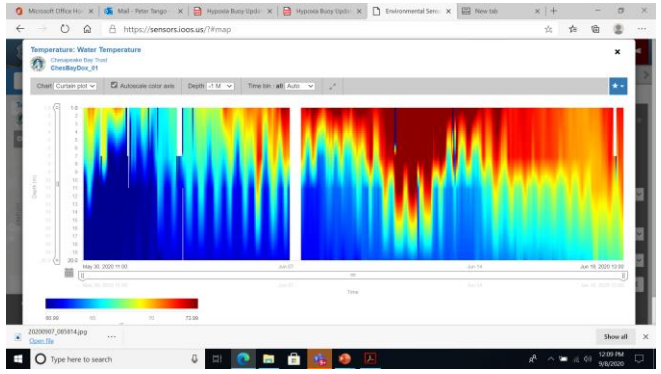
Location: GIT funded pilot study vertical profile water quality sensing in the open Bay 2020



GIT funded Pilot study vertical profile water quality sensing in the open Bay 2020



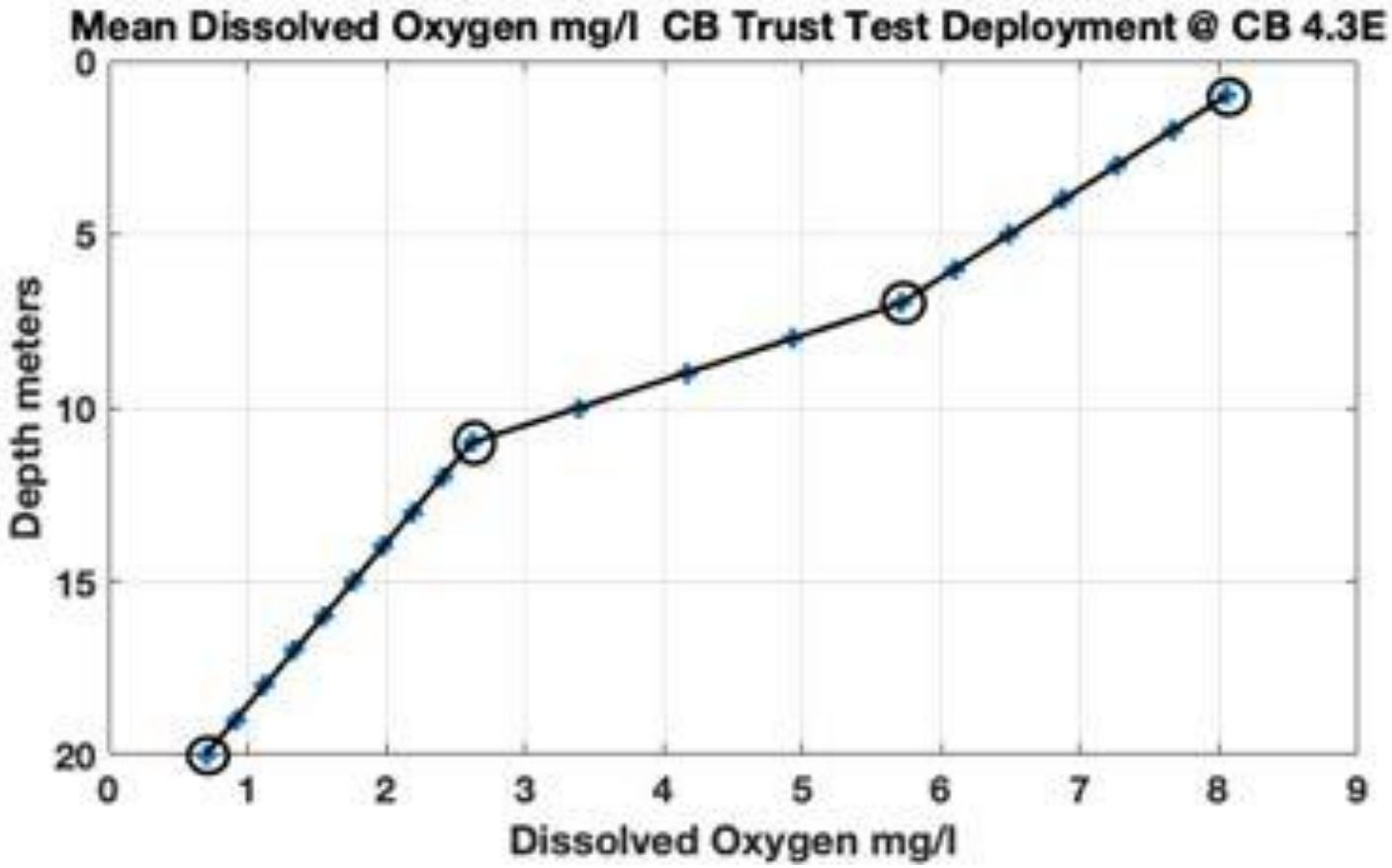
IOOS Website raw data



* Missing data at 1m filled in with greater value of <100 % saturation OR measured value at 7 m>
- 16 m sensor malfunctioned shortly after deployment. Data missing.

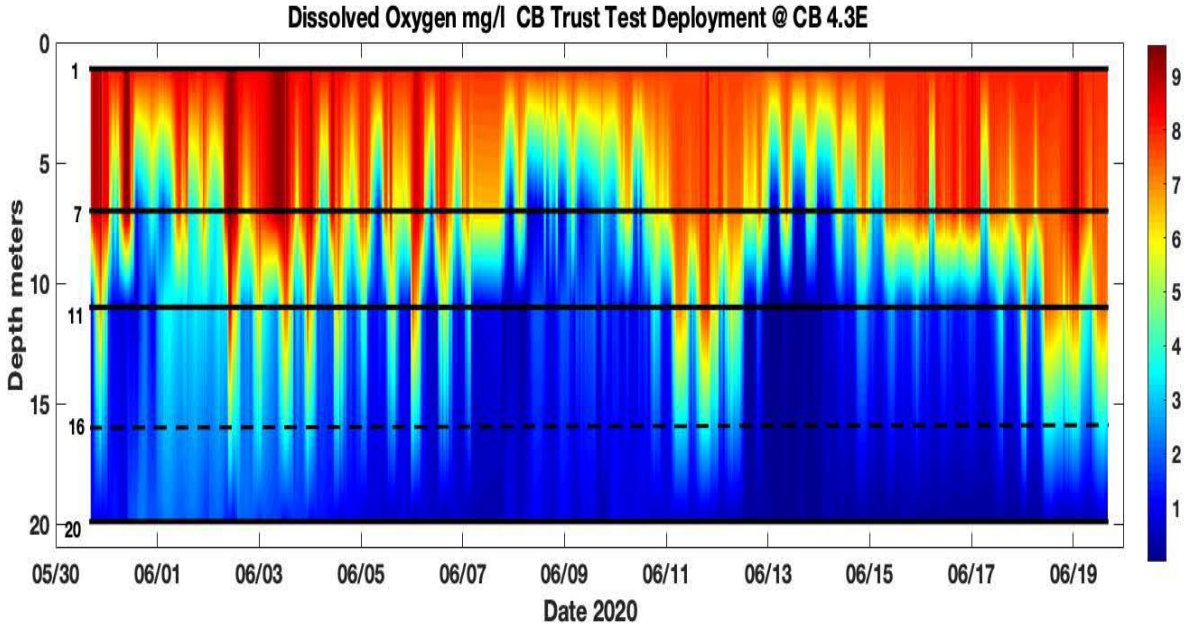
* Make sure all data manipulations programmed in S9 database to covert raw sensor data to engineering values (particularly Pressure, Conductivity, and Salinity)

“Monthly Mean DO” (3 weeks) for June 2020 based on data collected every 10-minutes, linear estimation of data between sensors. Approximately 3000 data points at each depth used to estimate the mean structure of the water column DO distribution from the profiler sensors.

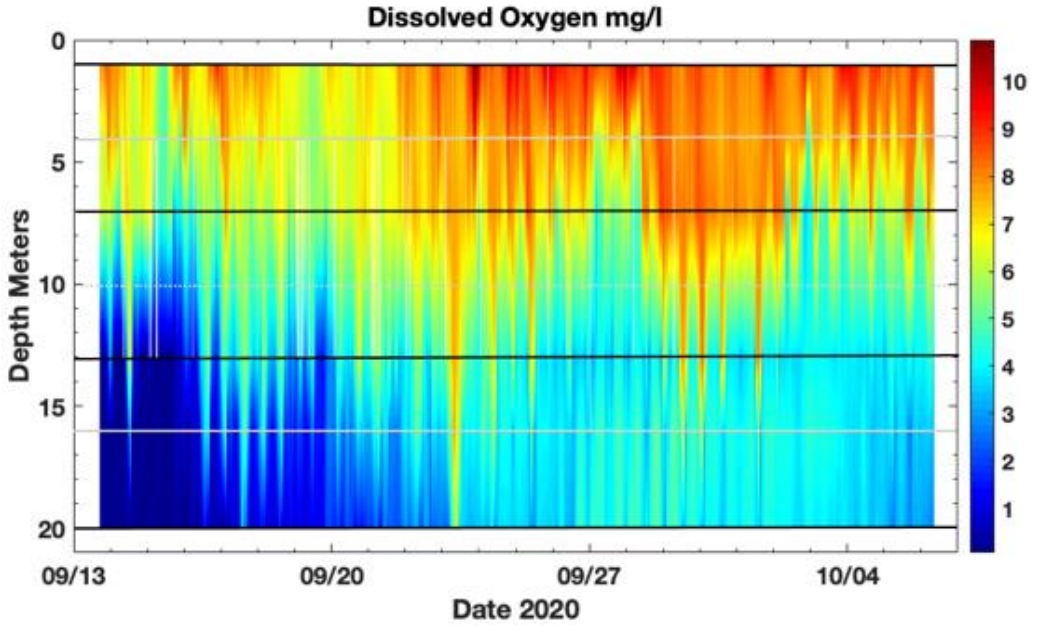


With our existing, world class traditional monitoring program, we estimate the mean from 2 sample collections in a month

June 2020
Dark blue = hypoxia



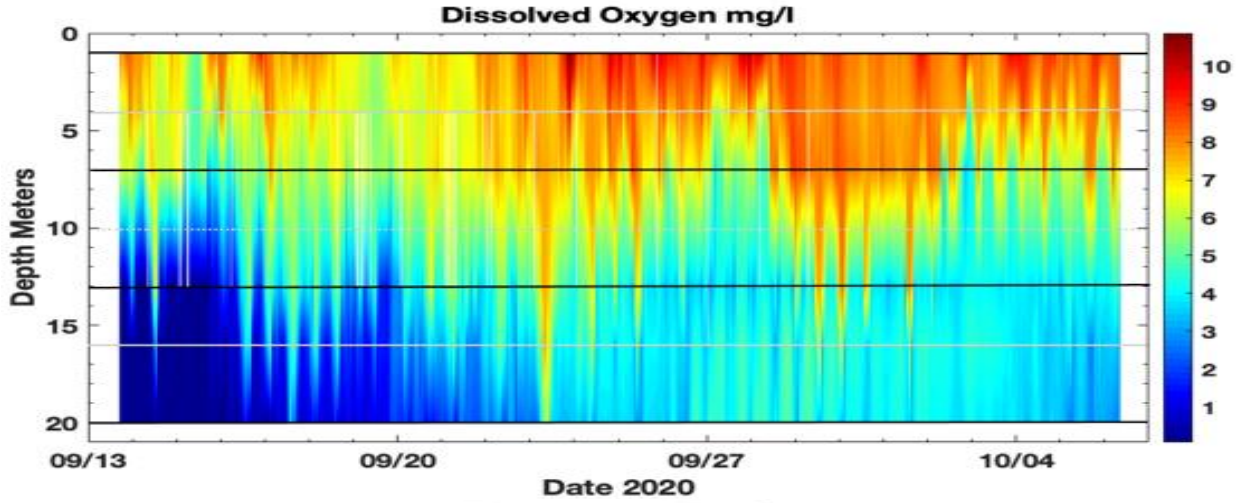
September 2020
Turnover in the bay,
end of hypoxia



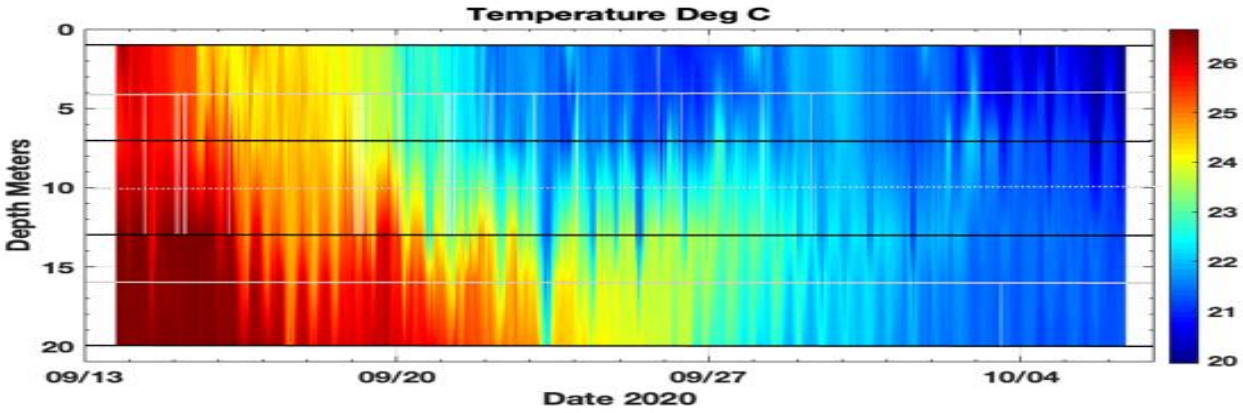
- Horizontal lines represent sensor locations in the water column.
- Water column was 20m in June location, 22m in September location
- Location is CB4.3 E, open bay near the mouth of the Choptank River

September 2020

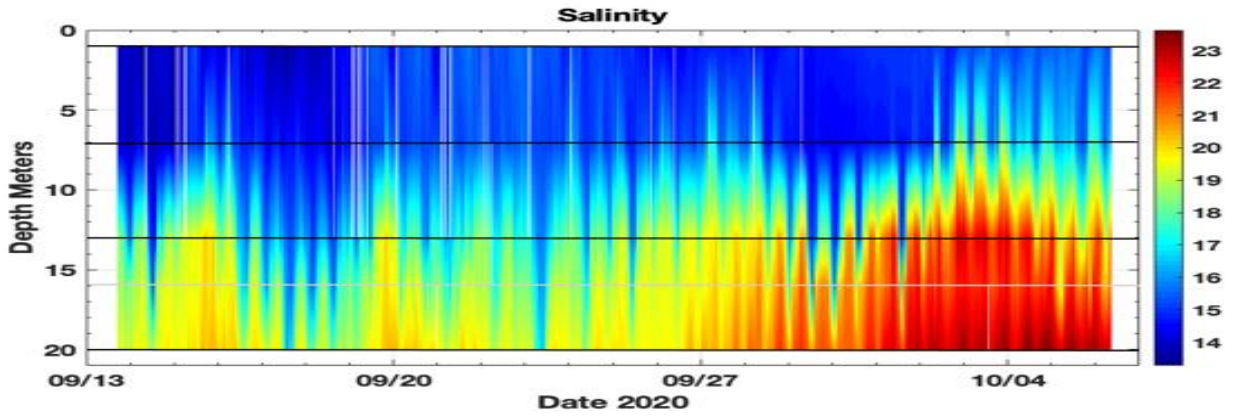
- Dissolved oxygen – water at this station becomes oxygenated



- Temperature stratification is lost and becomes isothermal



- Salinity stratification declines before oxygen rich high salinity water moves into the bottom waters

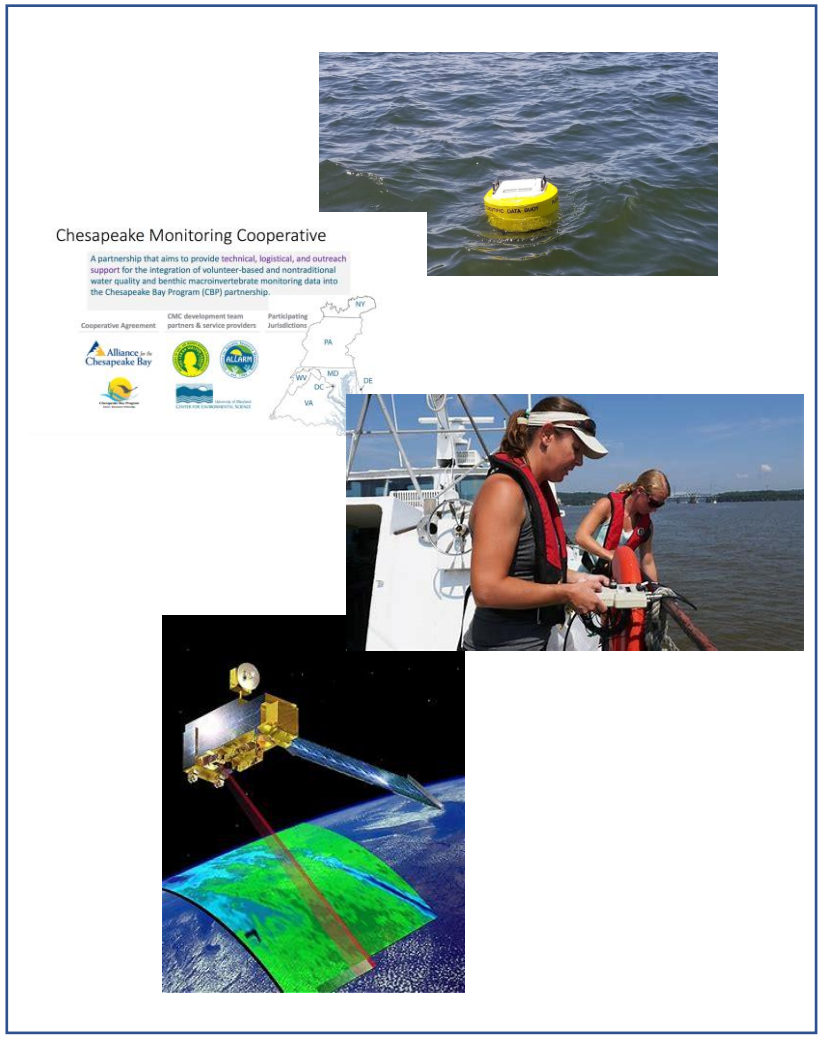


D. Wilson 2020. CBT GIT-funded pilot project data

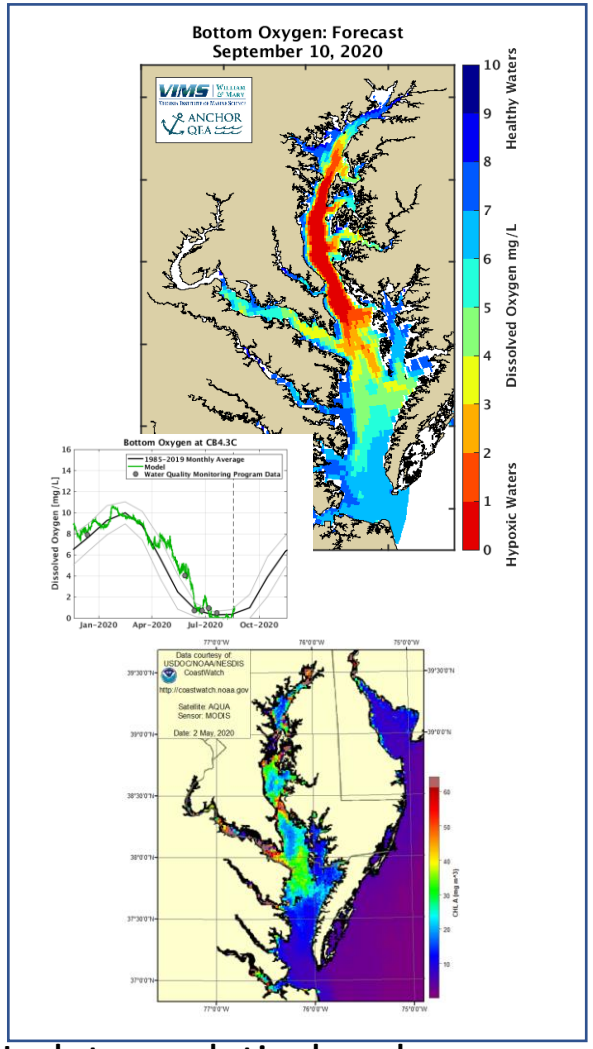
Importance

- ***Here is a tool that shows we can acquire data we need from throughout the water column in open bay habitat.***
- ***Vertical profiling data collection is not a solution to all our needs on its own. Its use needs context (i.e., strategy for how many, locations, sensor densities, analysis framework of the data).***
- ***It is an important, long-sought after piece of the puzzle to advance our accounting of bay conditions relative to short and long duration dissolved oxygen criteria***

We have ripe opportunities to expand use of our toolbox to estimate conditions over much of the Bay and its tribs



Update integrated monitoring approach



Update analytical and assessment approaches

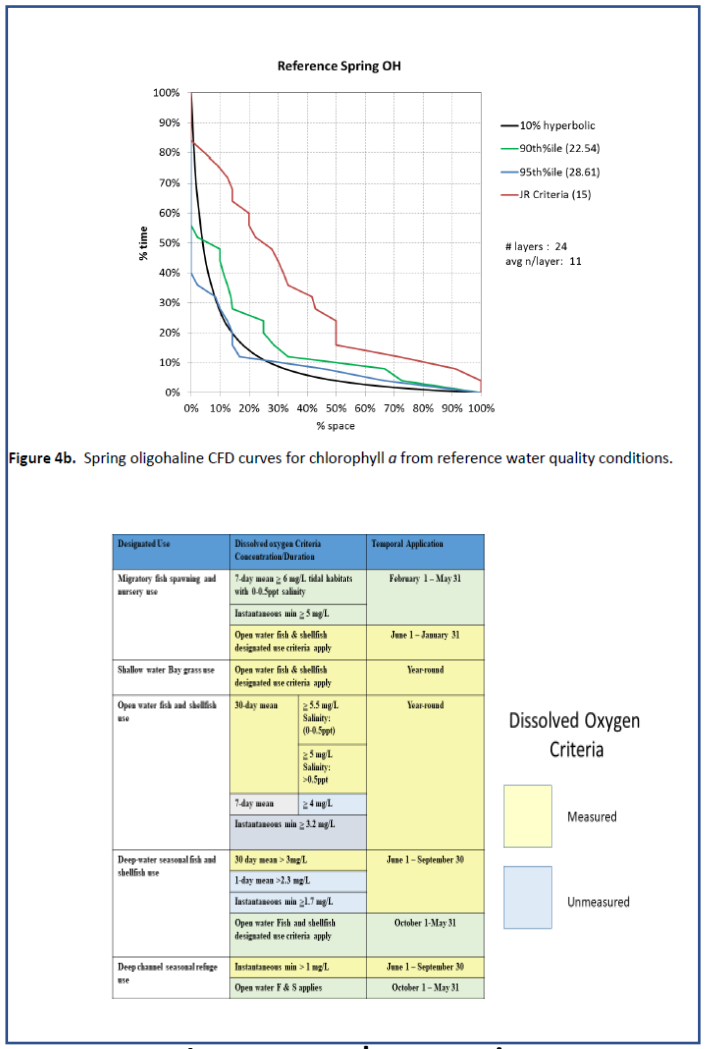


Figure 4b. Spring oligohaline CFD curves for chlorophyll *a* from reference water quality conditions.

Designated Use	Dissolved oxygen Criteria Concentration/Duration		Temporal Application
Migratory fish spawning and nursery use	7-day mean ≥ 6 mg/L tidal habitats with 0-0.5ppt salinity		February 1 – May 31
	Instantaneous min ≥ 5 mg/L		
	Open water fish & shellfish designated use criteria apply		June 1 – January 31
Shallow water Bay grass use	Open water fish & shellfish designated use criteria apply		Year-round
Open water fish and shellfish use	30-day mean	≥ 5.5 mg/L Salinity: (0-0.5ppt)	Year-round
		≥ 5 mg/L Salinity: >0.5ppt	
	7-day mean	≥ 4 mg/L	
	Instantaneous min ≥ 3.2 mg/L		
Deep-water seasonal fish and shellfish use	30 day mean > 3mg/L		June 1 – September 30
	1-day mean >2.3 mg/L		
	Instantaneous min ≥1.7 mg/L		
	Open water Fish and shellfish designated use criteria apply		October 1-May 31
Deep channel seasonal refuge use	Instantaneous min > 1 mg/L		June 1 – September 30
	Open water F & S applies		October 1 – May 31

Dissolved Oxygen Criteria

Measured

Unmeasured

Improved capacity
Fill Habitat Assessment Gaps

Next steps – Adaptive Monitoring for Adaptive Management

- STAR-STAC collaboration on evaluating this and other opportunities for enhancing monitoring and assessment capacity in the program.
  - Develop recommendations for adapting our monitoring program to address gaps in assessment using this and other monitoring advances

- CAP WG evaluation of protocols for data analysis and interpretation

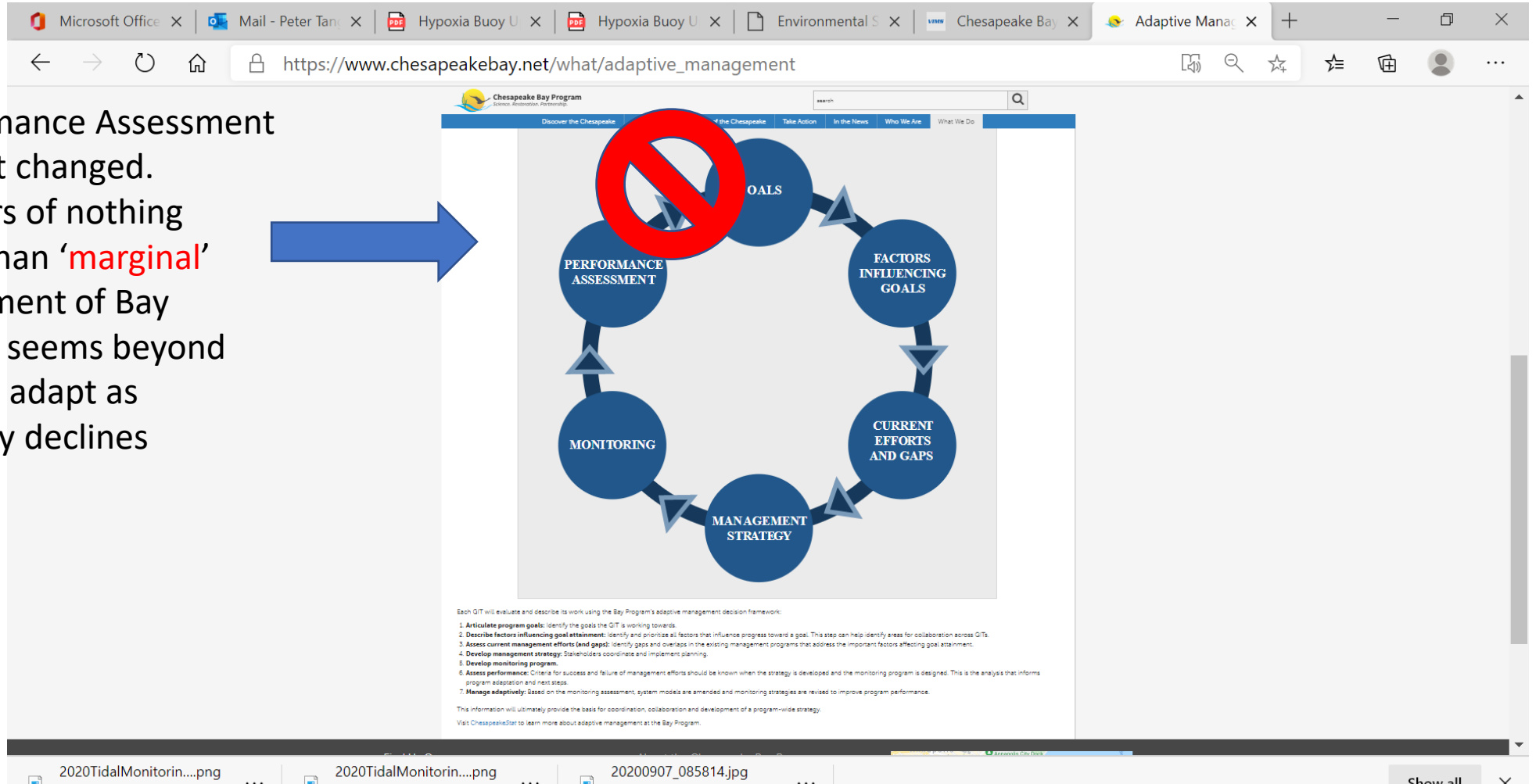
- Presentations to other groups involved in habitat assessments (e.g., Sustainable Fisheries GIT, Fish Habitat WG) and agencies/institutions targeting future investments that can improve our habitat evaluations

- THE END…

Extra slides of importance to future presentations

AFTER 17 YEARS WE NEED ACTIONS TO ADOPT and ADAPT OUR PROGRAM

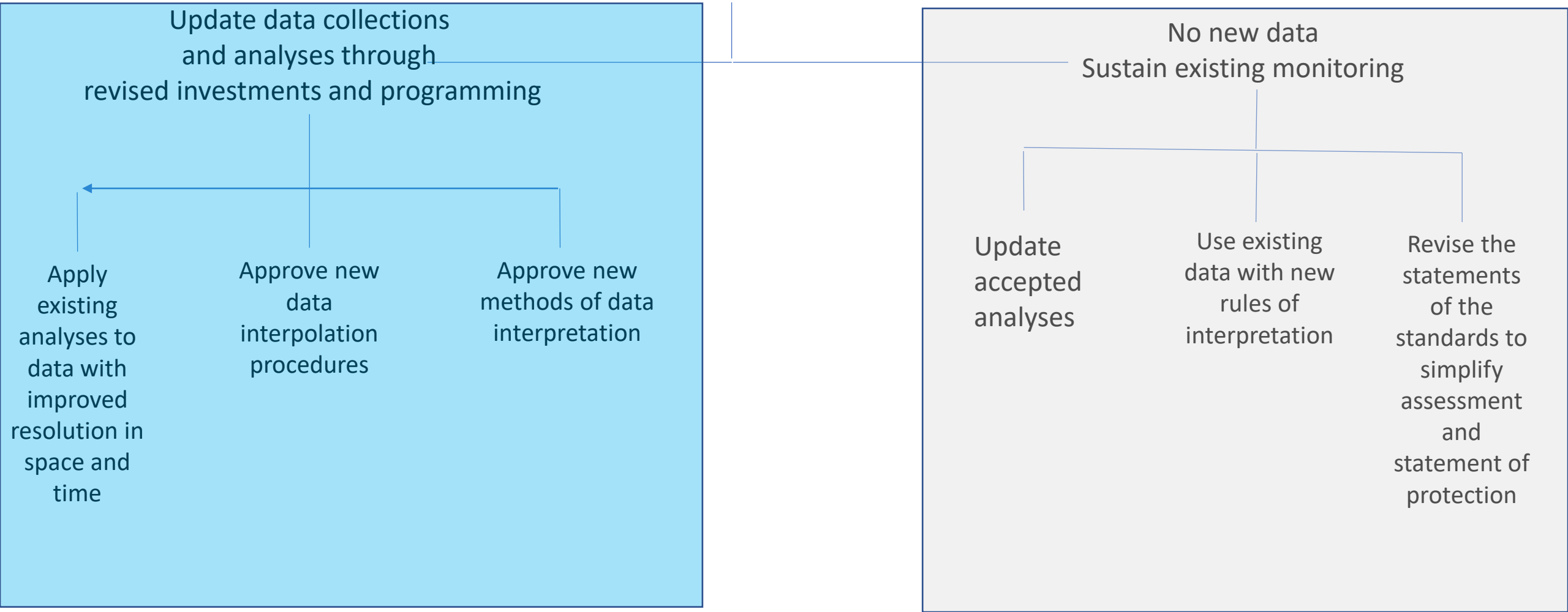
Performance Assessment
Has not changed.
17 years of nothing more than 'marginal' assessment of Bay criteria seems beyond time to adapt as capacity declines



AFTER 17 YEARS WE NEED ACTIONS TO ADAPT

WE NEED NEARTERM COMMITMENT AND IMPLEMENTATION OF UPDATES TO THE PROGRAM TO MEASURE WATER QUALITY STANDARDS ATTAINMENT

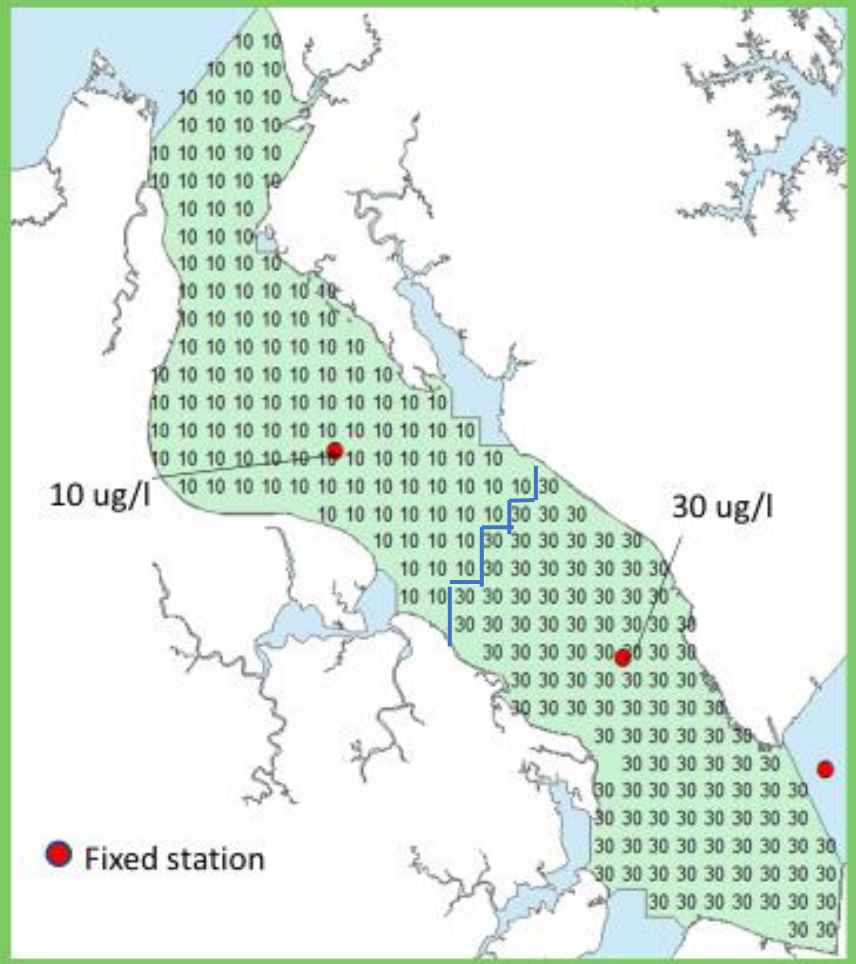
MANAGEMENT and POLICY OPTIONS



This is an IDW interpolation with 2 stations on CHLA, lower James River.

The Interpolator fills "in" and "out" so that we can calculate the aerial extent of exceedence.

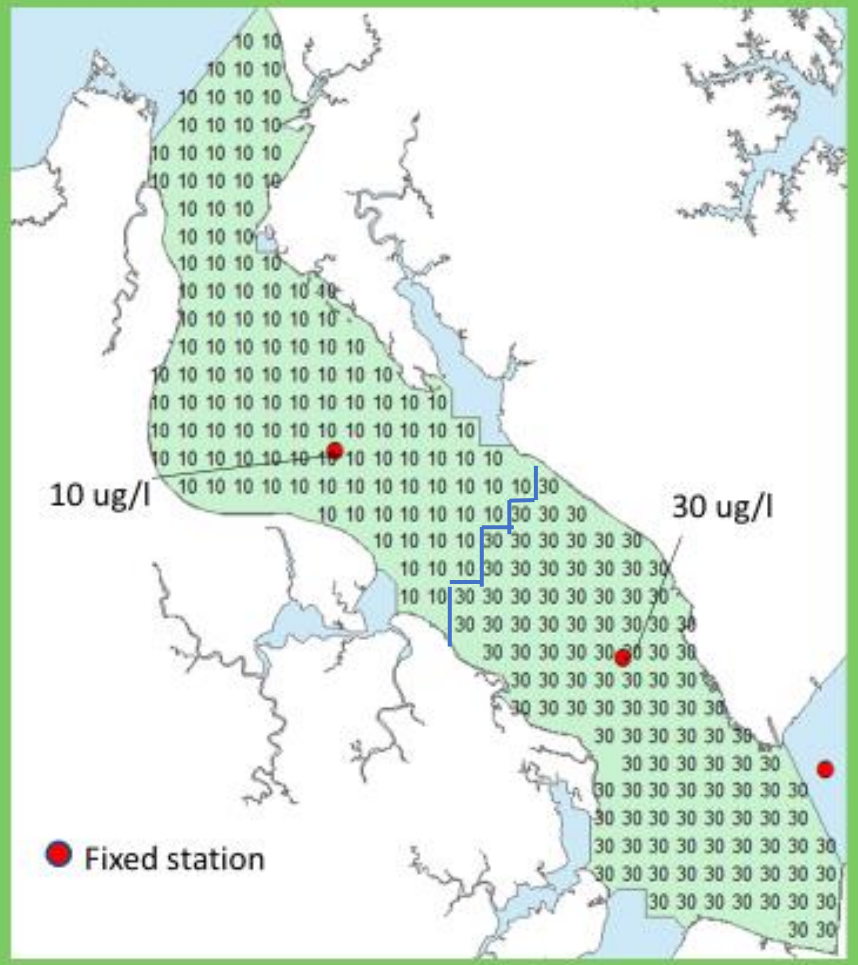
Note: It does not create or rely on any statistical model of spatial variation (e.g., a variogram).

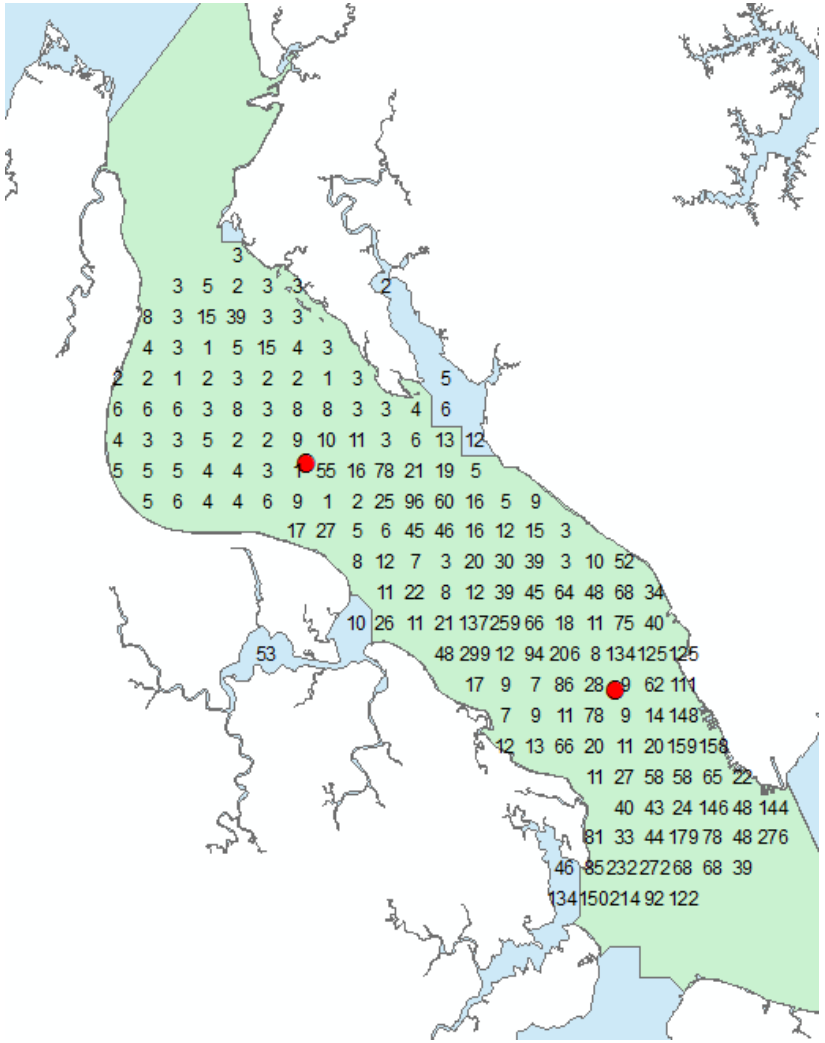


Interpolation of Dataflow provides insights on variability missed in this case. Almost nothing actually equals 10 ug/L or 30 ug/L around those two stations. Important for criteria assessment and tracking progress.

The Interpolator fills "in" and "out" so that we can calculate the aerial extent of exceedence.

Note: It does not create or rely on any statistical model of spatial variation (e.g., a variogram).

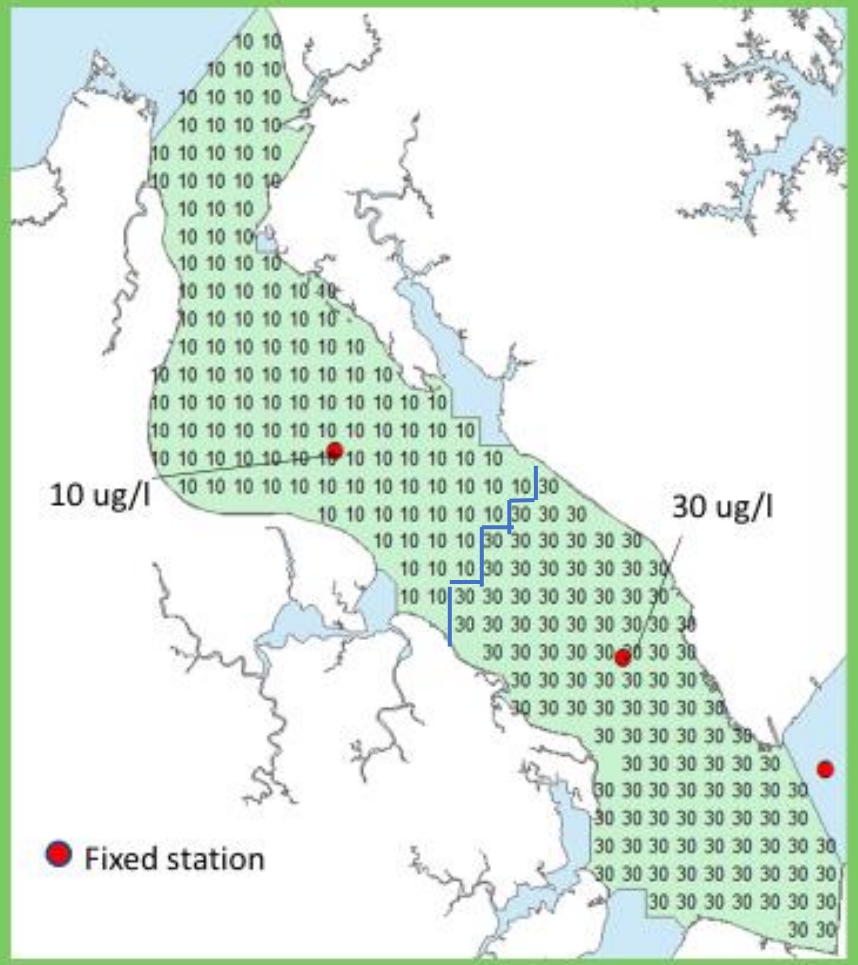


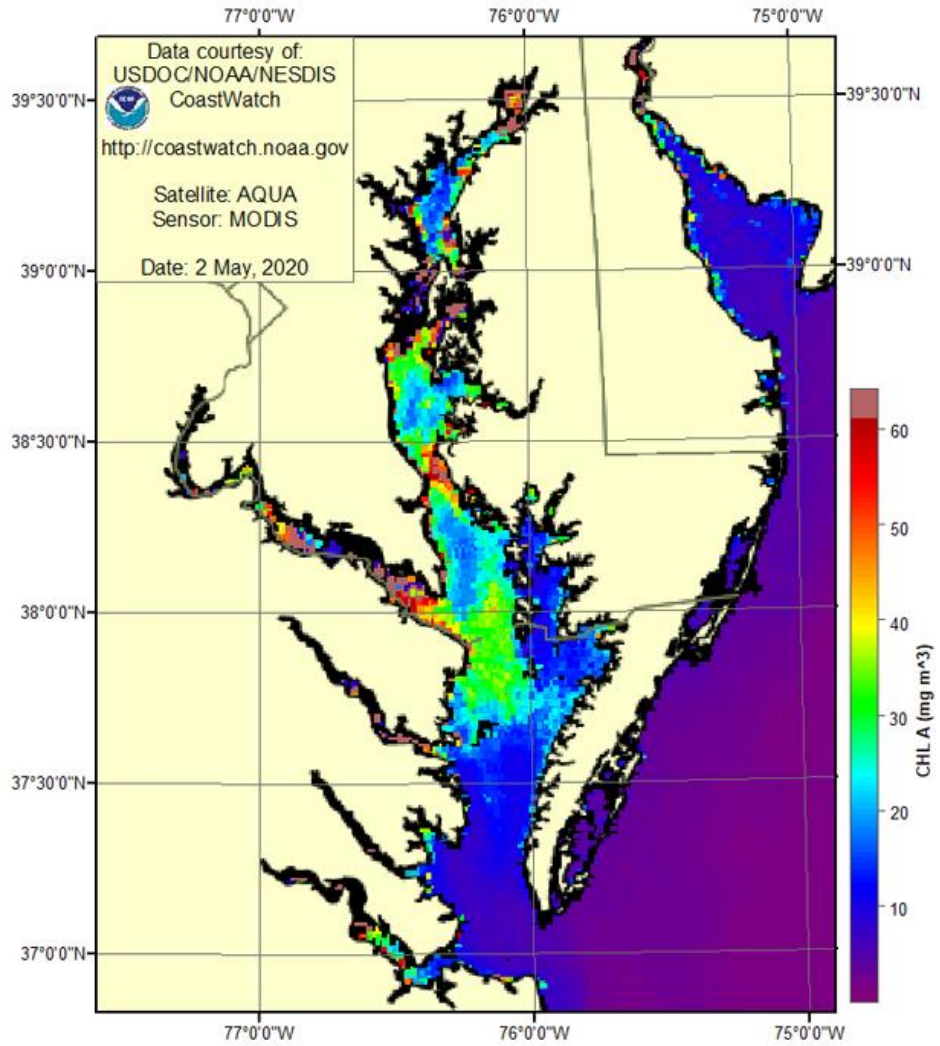


And there are opportunities to get single day, baywide assessments with alternate assessment protocol strategies, e.g. Hi-res satellite imagery

The Interpolator fills "in" and "out" so that we can calculate the aerial extent of exceedence.

Note: It does not create or rely on any statistical model of spatial variation (e.g., a variogram).

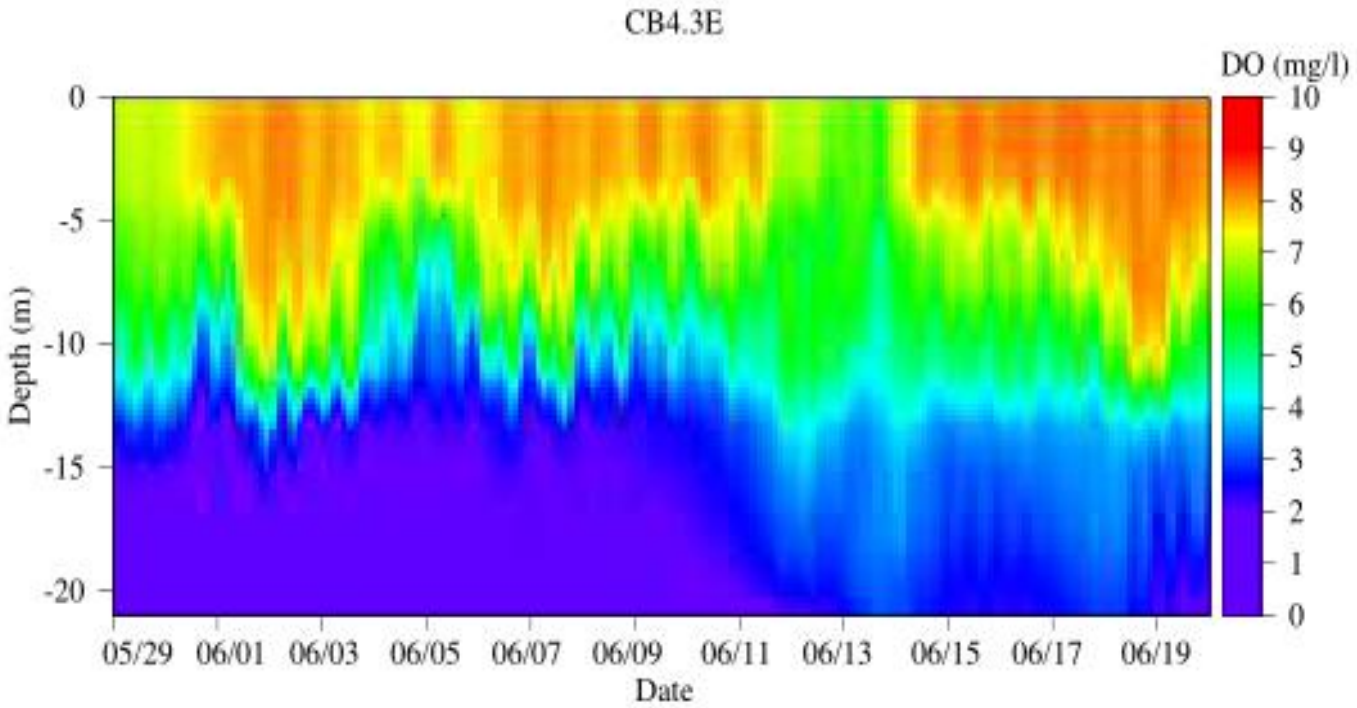


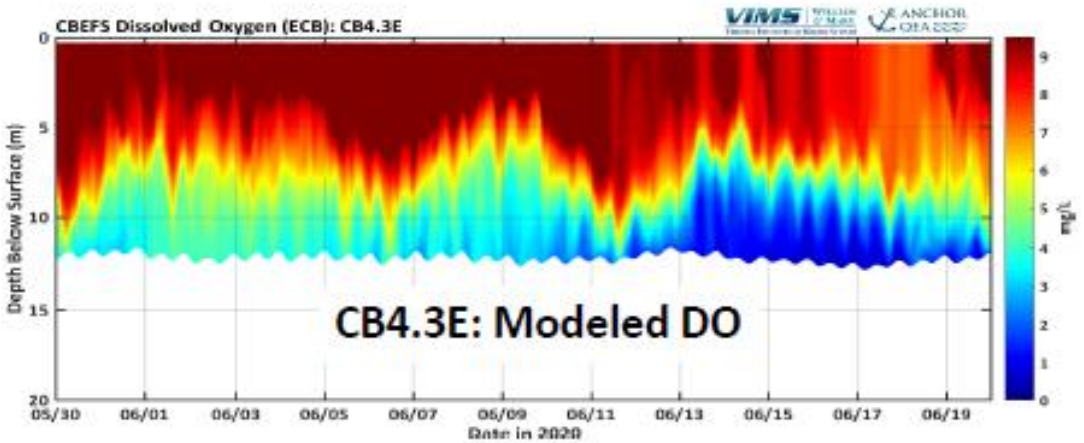


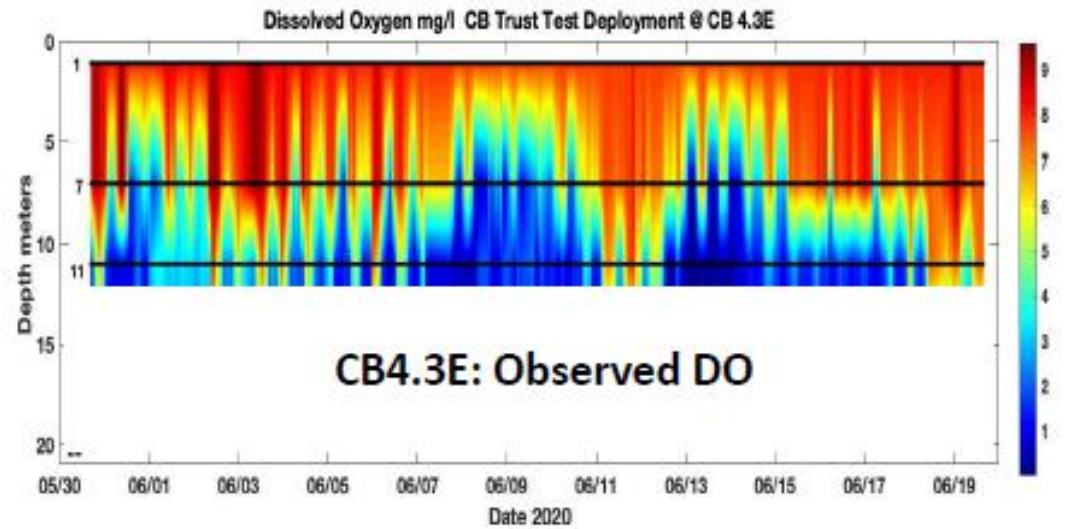
Other DO profile examples from Chesapeake Bay tributaries

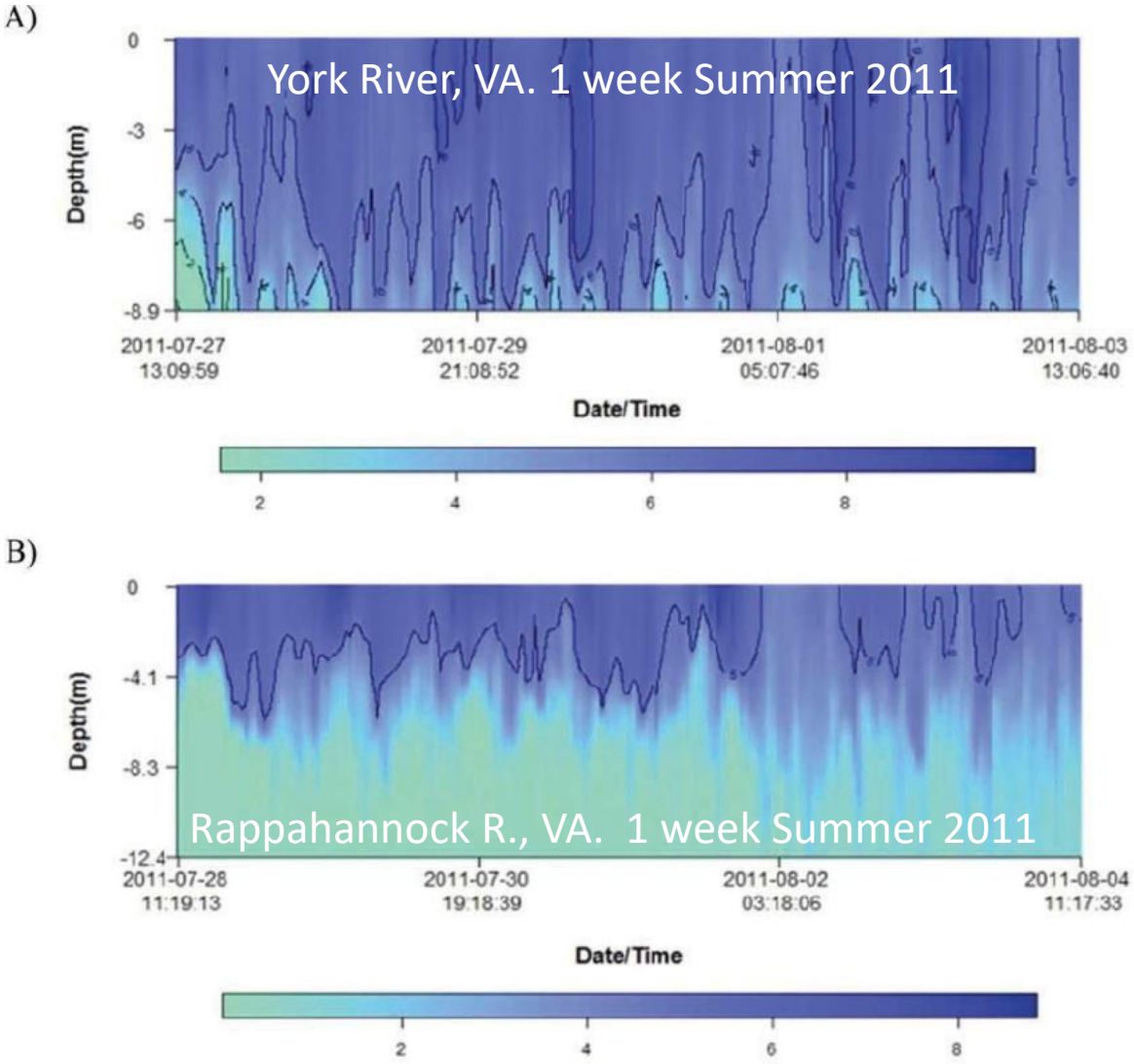
First look model comparisions…

CB3D-ICM 1994

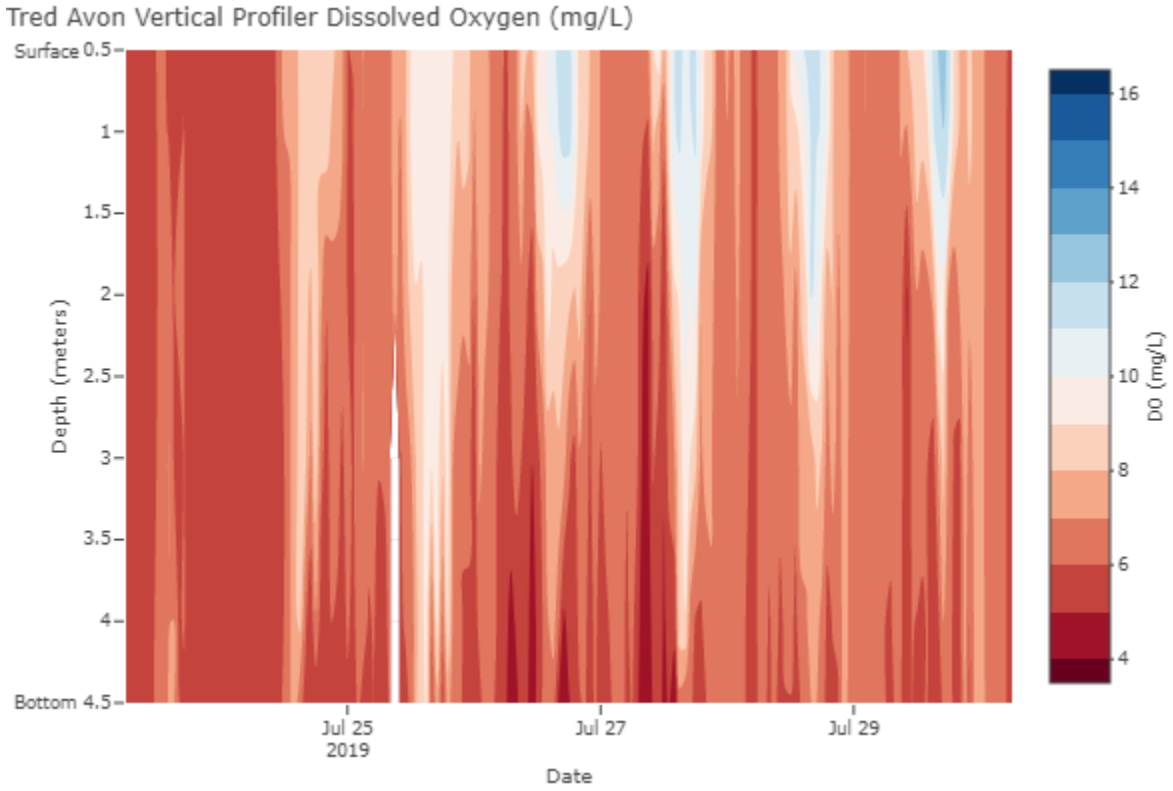






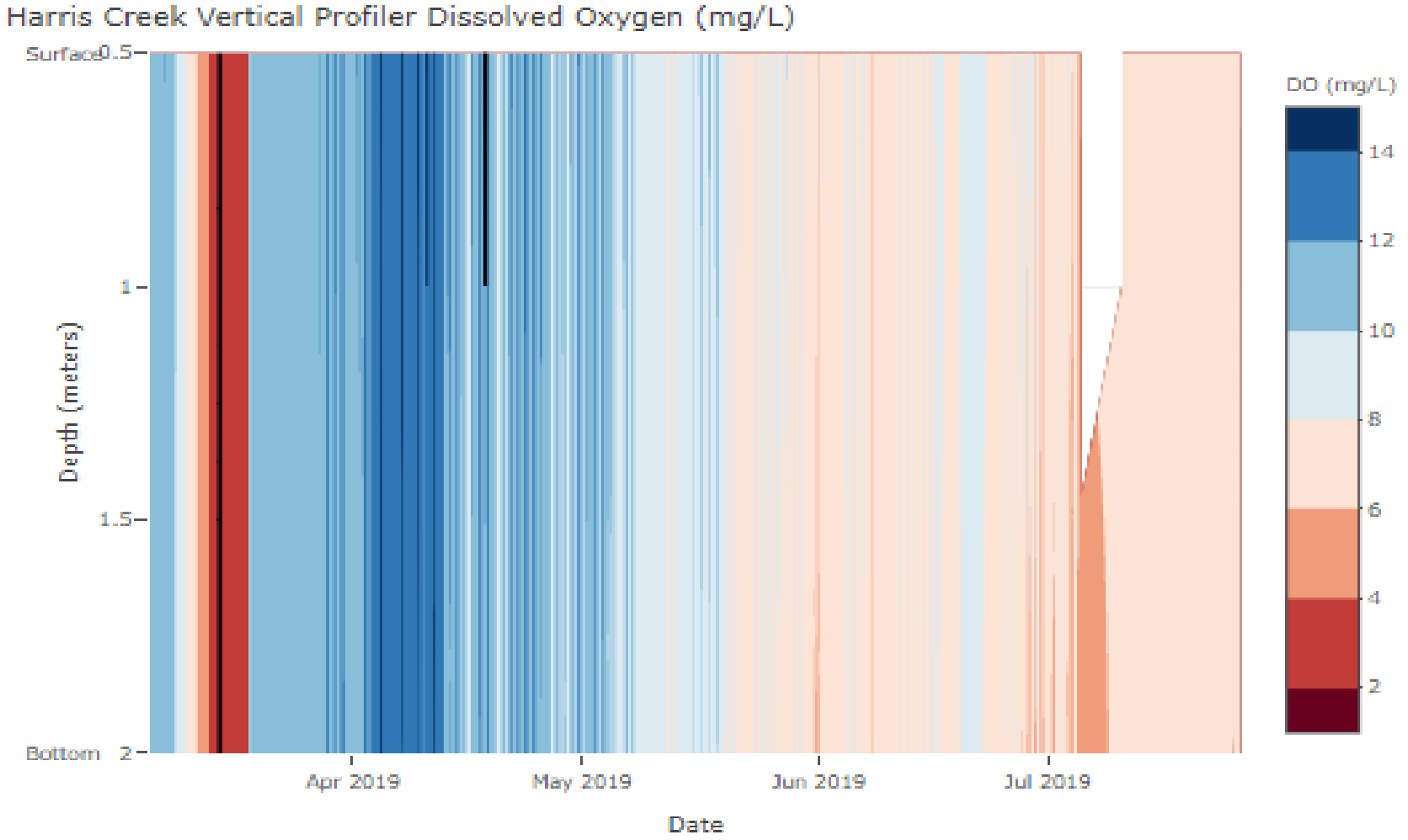


Water Quality Profiler data
(Tuckey and Fabrizio 2016)



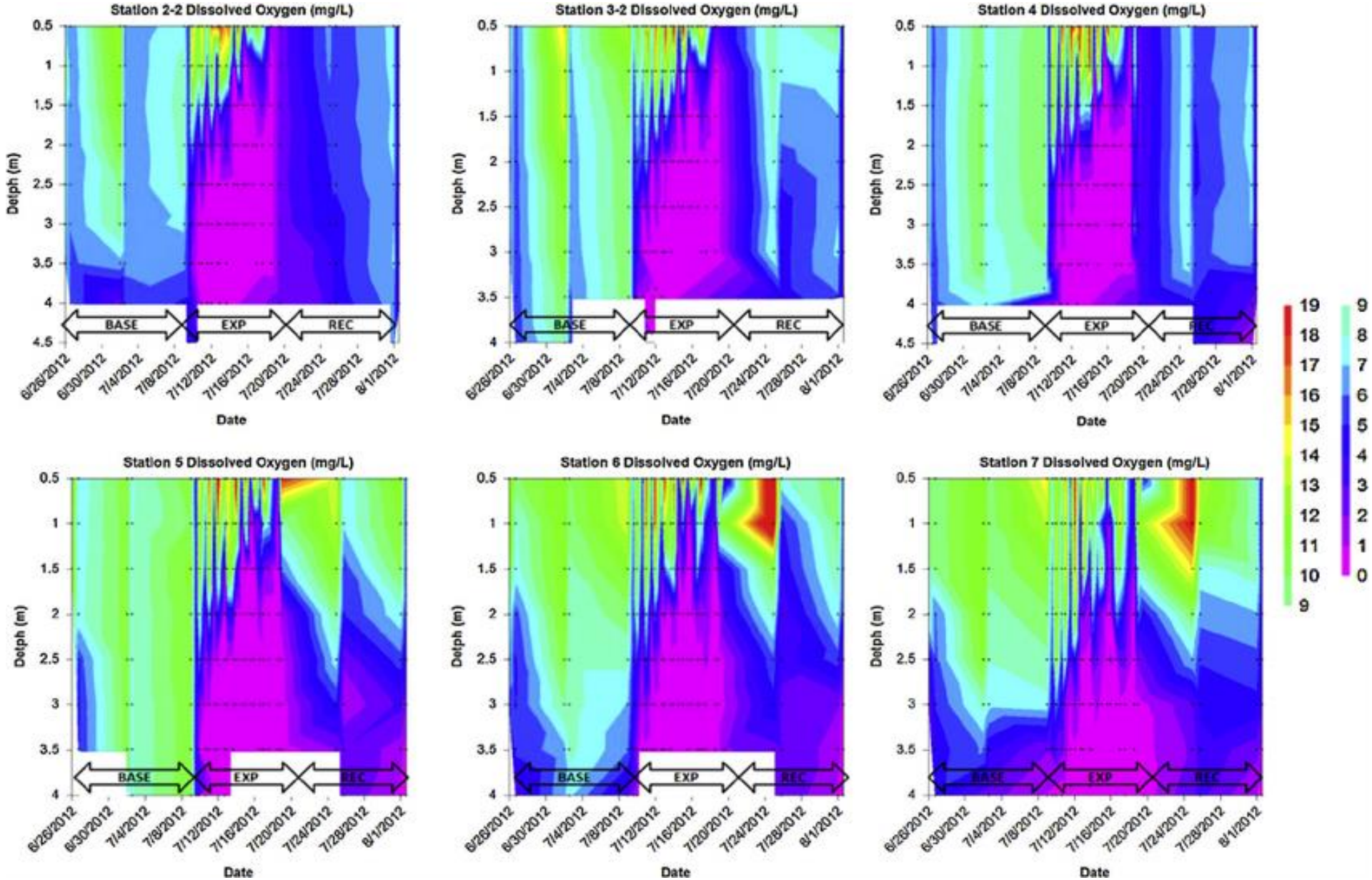
MD DNR Water Quality Profiler - hourly
About 1 week, 4.5meter depth, Tred Avon River
July 26- July 30, 2019

M. Trice
MD DNR



M. Trice
MD DNR

**Data are provisional and have not yet been through our rigorous Quality Assurance procedures.*



L. Harris et al. 2015. Rock Creek MD