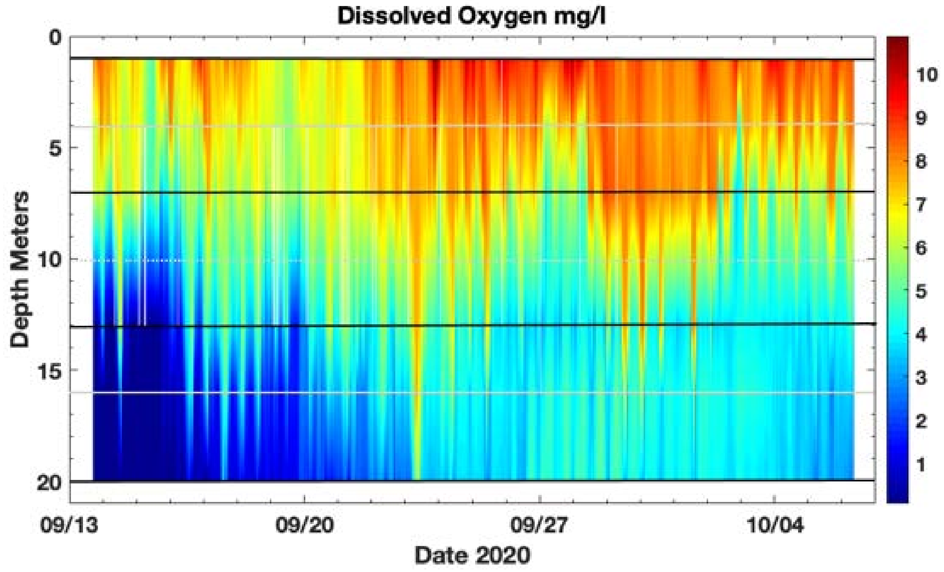
2021 STAC proposal outline: Establishing sustainable, cost effective monitoring and assessment recommendations to fully address Chesapeake Bay TMDL water quality standards assessment

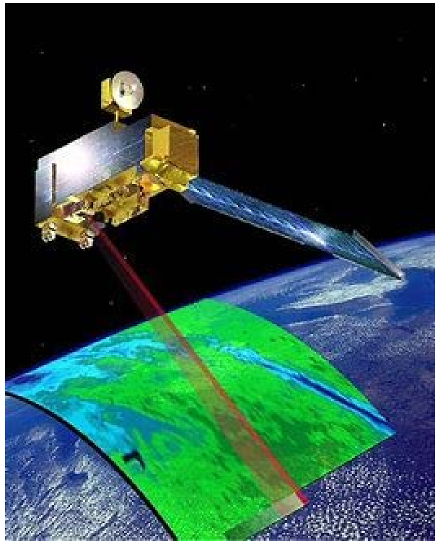
Peter Tango

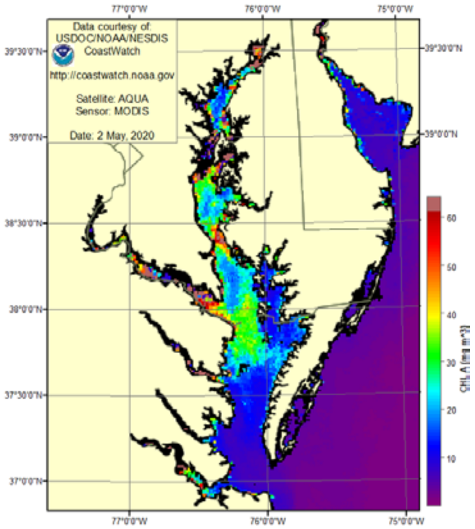
USGS@CBPO

CAP WG

11/17/2020







Through the 2014 Chesapeake Bay Watershed Agreement, *the Chesapeake Bay Program has committed to…*

Goal: *Water Quality*

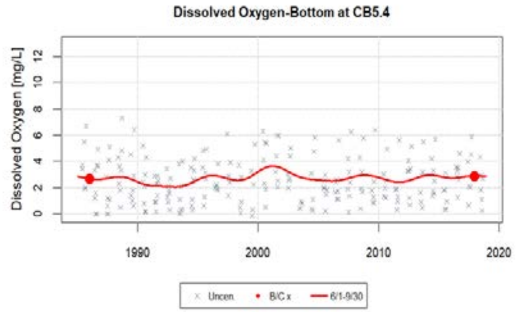
Outcome:

Continually improve the capacity to monitor and assess the effects of management actions being undertaken to implement the Bay TMDL and improve water quality. Use the monitoring results to report annually to the public on progress made in attaining established Bay water-quality standards and trends in reducing nutrients and sediment in the watershed.

Chesapeake Bay Monitoring Programming

Successes and Challenges

- New analysis tools
  - e.g. GAMs, bay models, pilot work with AI/Machine Learning algorithms
- Enhanced communications
  - Bay Barometer, blogs, social media, partner meetings, Data Dashboard
- Implemented CBP's Strategic Science and Research Framework
  - Identify/fill gaps)
- Advanced scientific syntheses completed
  - publications and reports on Bay and watershed science)
- Supported an MOU using Citizen Science-based data
  - Chesapeake Data Explorer >300,000 data points



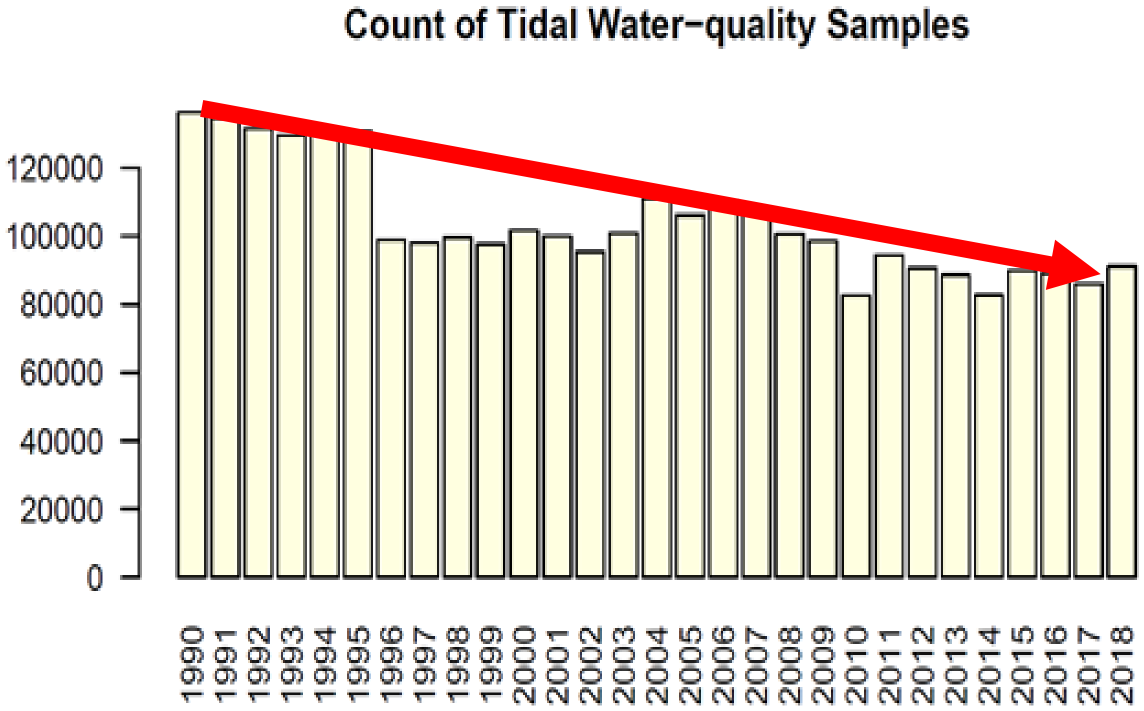
Successes and Challenges

- **Unassessed criteria *for 17 years*** remain a hurdle for delisting decisions of State-adopted water quality standards with our existing framework
- **Financial stresses** on Bay cruises, SAV aerial survey, NTN
- **Contraction** of traditional long-term monitoring programming
- **Slow** pace for expanded assessment of water-quality standards
- **Limited** non-traditional data use in assessments
- **Limited** use of new interpretation and interpolation options

= Inability to report on standard attainme

Designated Use	Dissolved oxygen Criteria Concentration/Duration		Temporal Application
Migratory fish spawning and nursery use	7-day mean $\geq$ 6 mg/L tidal habitats with 0-0.5ppt salinity		February 1 – May 31
	Instantaneous min $\geq$ 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	$\geq$ 5.5 mg/L Salinity: (0-0.5ppt)	Year-round
		$\geq$ 5 mg/L Salinity: >0.5ppt	
	7-day mean	$\geq$ 4 mg/L	
	Instantaneous min $\geq$ 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 $\geq$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

What is our Expected and Actual Progress?



Monitoring Capacity: Good/Fair/Poor

- Capacity is highly stressed and declining
- Data collections remain "marginal" for the Bay criteria assessment, "adequate" for the watershed loads estimates

Proposed STAC Workshop Structure

Opening Workshop event

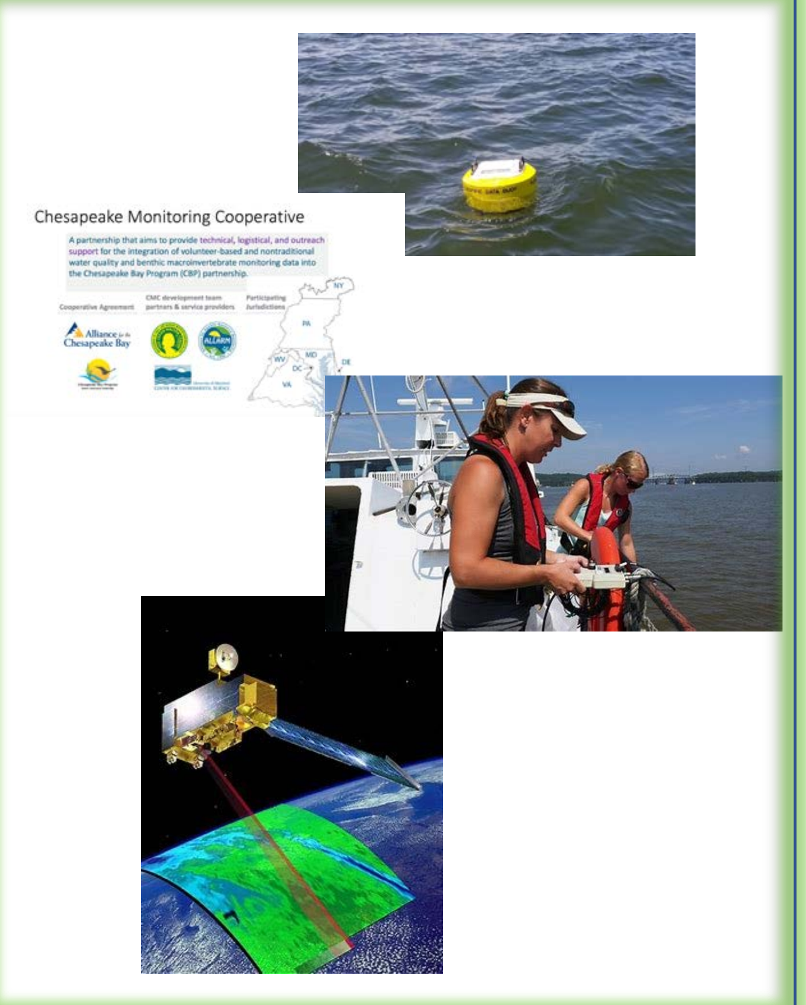
- 6 (or more) options to address our monitoring and assessment challenges, enhance capacity in monitoring and assessment

- Address each option or theme –
    - pros, cons,

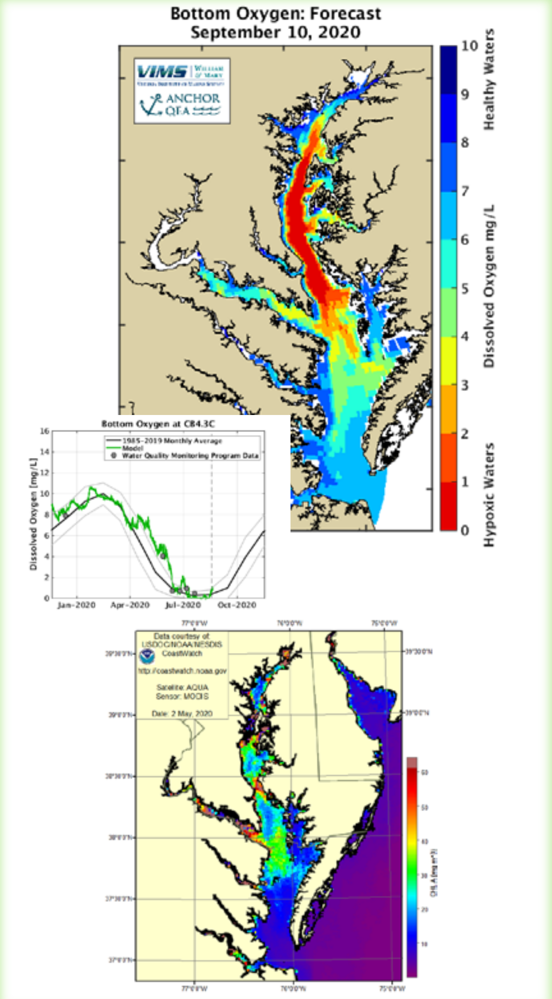
Second workshop event

- Review examples of how it works or doesn't work and produce a recommendation for what is needed to adopt and implement in a timely manner (not 17 years) actions to meet assessment needs of our water quality standards.
- Establish steps to adoption and implementation of capacity building targets for improved assessment of TMDL criteria in the water quality standards by 2025

Issue: With no new funding, we have ripe opportunities to expand use of our toolbox to estimate conditions over much of the Bay and its tributaries



Update integrated monitoring approach



Update analytical and assessment approaches

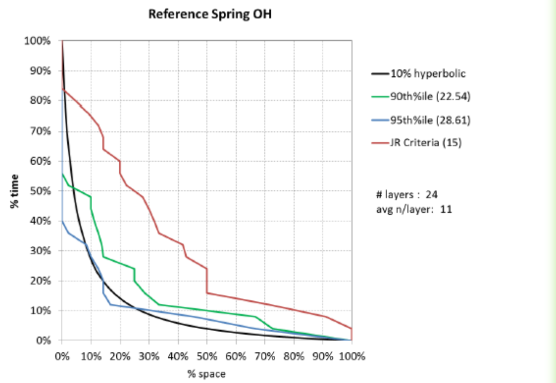


Figure 4b. Spring oligohaline CFD curves for chlorophyll *a* from reference water quality conditions.

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
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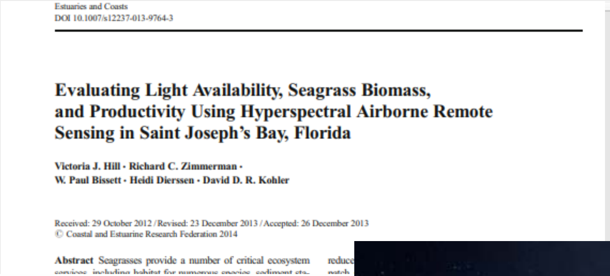
Dissolved Oxygen Criteria

Measured

Unmeasured

Improved capacity
Fill Habitat Assessment Gaps

SAV: Satellite assessment of SAV in high resolution in estuaries over large areas is already being done, AI/ML interpretation make high thru-put assessment feasible


Estuaries and Coasts
DOI 10.1007/s12237-013-9764-3

Evaluating Light Availability, Seagrass Biomass, and Productivity Using Hyperspectral Airborne Remote Sensing in Saint Joseph's Bay, Florida

Victoria J. Hill · Richard C. Zimmerman · W. Paul Bissett · Heidi Dierssen · David D. R. Kohler

Received: 29 October 2012 / Revised: 23 December 2013 / Accepted: 26 December 2013
© Coastal and Estuarine Research Federation 2014

Abstract Seagrasses provide a number of critical ecosystem


Contents lists available at ScienceDirect
Journal of Great Lakes Research
journal homepage: www.elsevier.com/locate/jglr

Mapping and monitoring the extent of submerged aquatic vegetation in the Laurentian Great Lakes with multi-scale satellite remote sensing

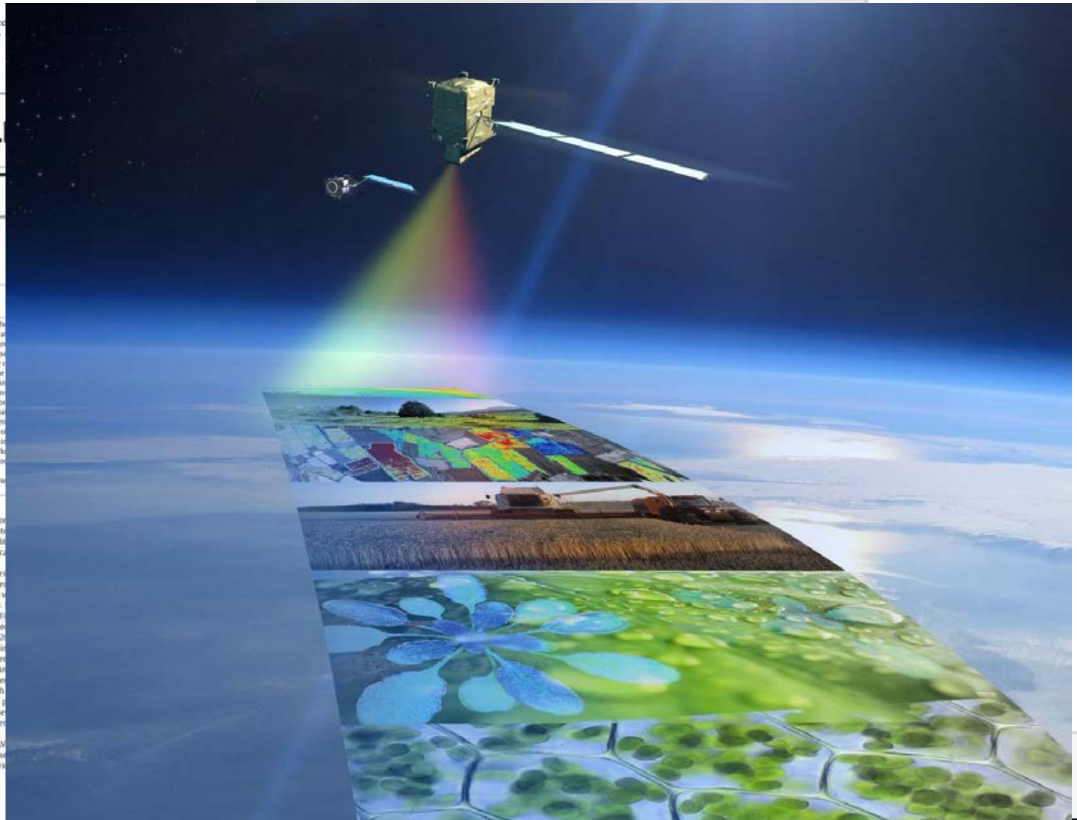
Robert A. Shuchman, Michael J. Sayers, Colin N. Brooks

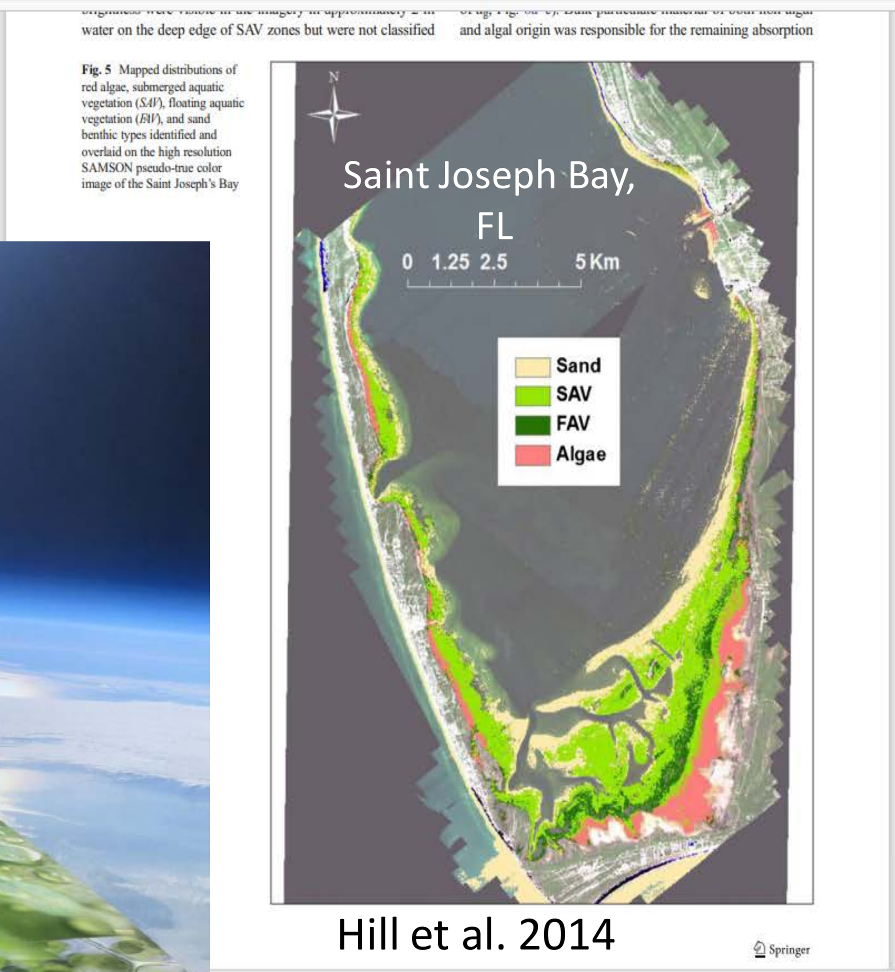
ARTICLE INFO

ABSTRACT

Introduction

Satellite imagery offers the potential to map submerged aquatic vegetation (SAV) in the near shore waters of the Great Lakes.




water on the deep edge of SAV zones but were not classified

and algal origin was responsible for the remaining absorption

Fig. 5 Mapped distributions of red algae, submerged aquatic vegetation (SAV), floating aquatic vegetation (FAV), and sand benthic types identified and overlaid on the high resolution SAMSON pseudo-true color image of the Saint Joseph's Bay

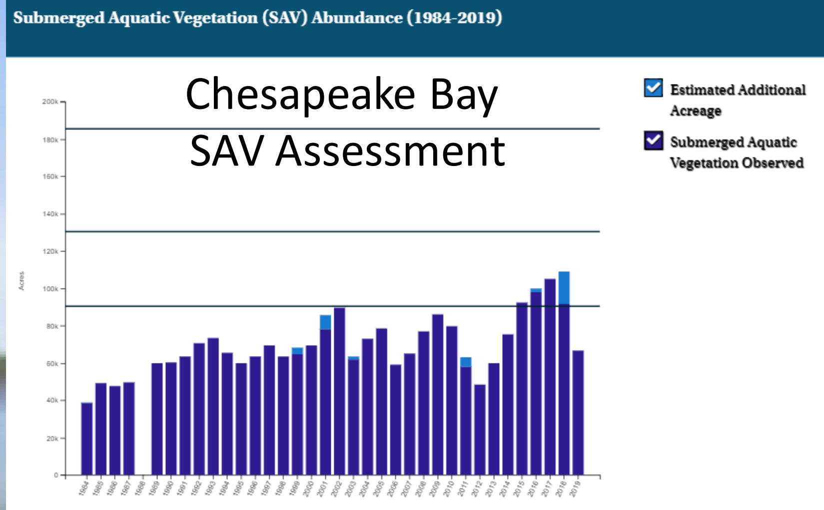
Hill et al. 2014

Springer

Exploring Satellite Image Integration for the Chesapeake Bay SAV Monitoring Program

~a Responsive STAC Workshop~

Co-Chairs 2019-2020:
Brooke Landry and Peter Tango



Recent success:

* VIMS – recent gap filling data
Needs with satellite imagery
For the SAV annual survey

* Zimmerman Lab at ODU

* Workshop focused on the protocol
steps needed from planning
data collection through phases
of interpretation

***FREE DATA* ($300K worth of FREE)**

Dissolved Oxygen: 2018 Chesapeake Bay Program Partnership Memorandum of Understanding: *Using Citizen and Non-traditional Partner monitoring data to assess progress toward restoration.*

OCTOBER 12, 2018

Chesapeake Bay Program
A Watershed Partnership

MEMORANDUM OF UNDERSTANDING

AMONG

The State of Delaware, the District of Columbia, the State of Maryland, the State of New York, the Commonwealth of Pennsylvania, the Commonwealth of Virginia, the State of West Virginia, the Interstate Commission on the Potomac River Basin, the Susquehanna River Basin Commission, the Metropolitan Washington Council of Governments, the United States Environmental Protection Agency, the Chesapeake Bay Commission, and the Chesapeake Monitoring Cooperative.

REGARDING

Using Citizen and Non-traditional Partner Monitoring Data to Assess Water Quality and Living Resource Status and Our Progress Toward Restoration of a Healthy Chesapeake Bay and Watershed

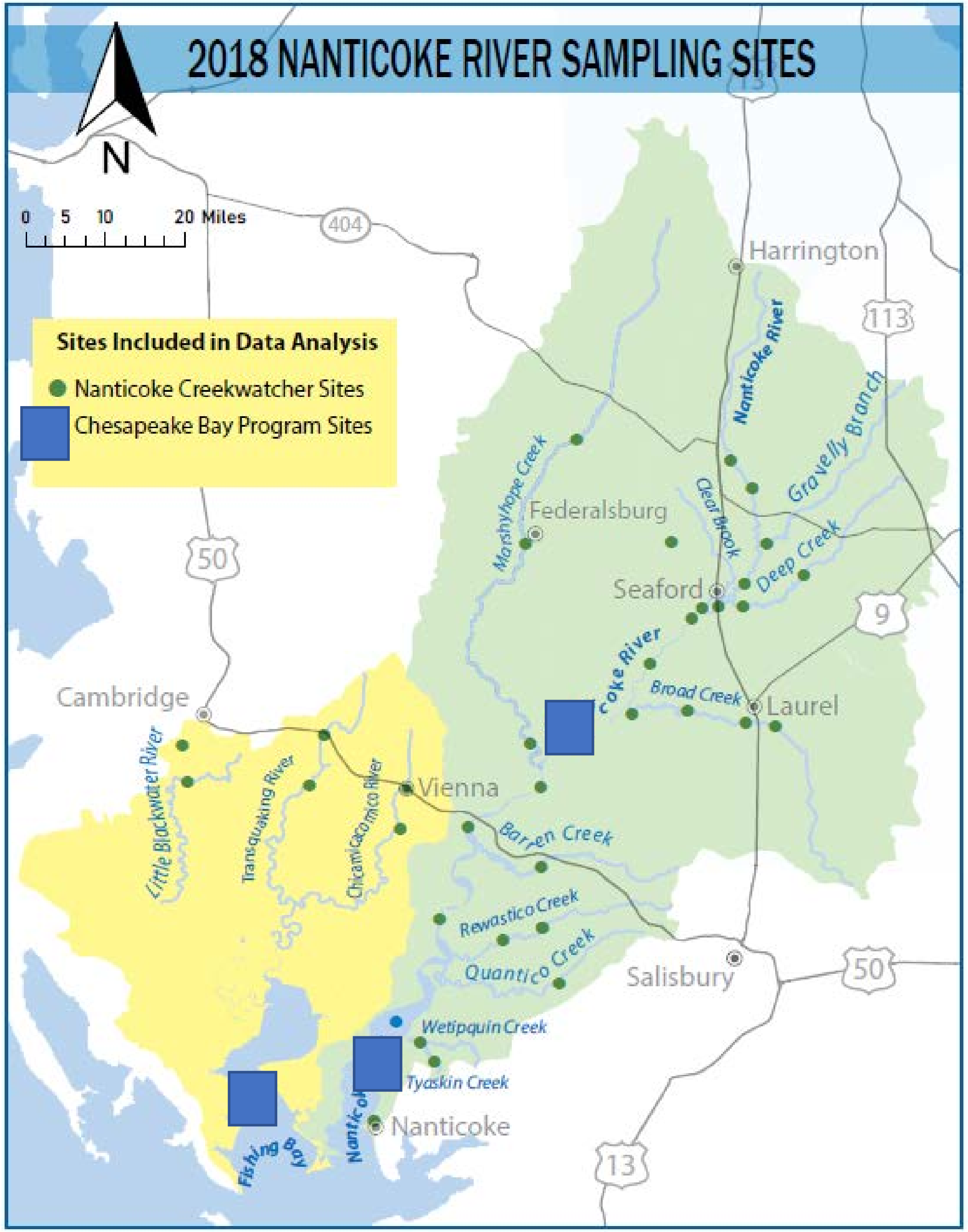
WHEREAS, the health of the Chesapeake Bay and its watershed depends on individual and community-based stewardship by the more than 18 million people who call this watershed home;

WHEREAS, the Clean Water Act states that all existing and readily available information must be evaluated for assessment of our nations waterways and the Chesapeake Bay Program is a leader in leveraging resources through a partnership approach;

NOW, THEREFORE, we, the undersigned representatives of the District, state, interstate, and federal entities with responsibility for monitoring the waters and resources of the Chesapeake Bay and its watershed agree that we will:

- Work cooperatively with the CMC and the Chesapeake Bay Program partnership to support and sustain a network of citizen science and non-traditional monitoring partners.
- Endorse an open-access clearinghouse of quality-assured environmental data generated by citizen

$470K per year Investment in Data collection by Cit Scientists and nontraditional partners



Let's invest and analyze smarter!

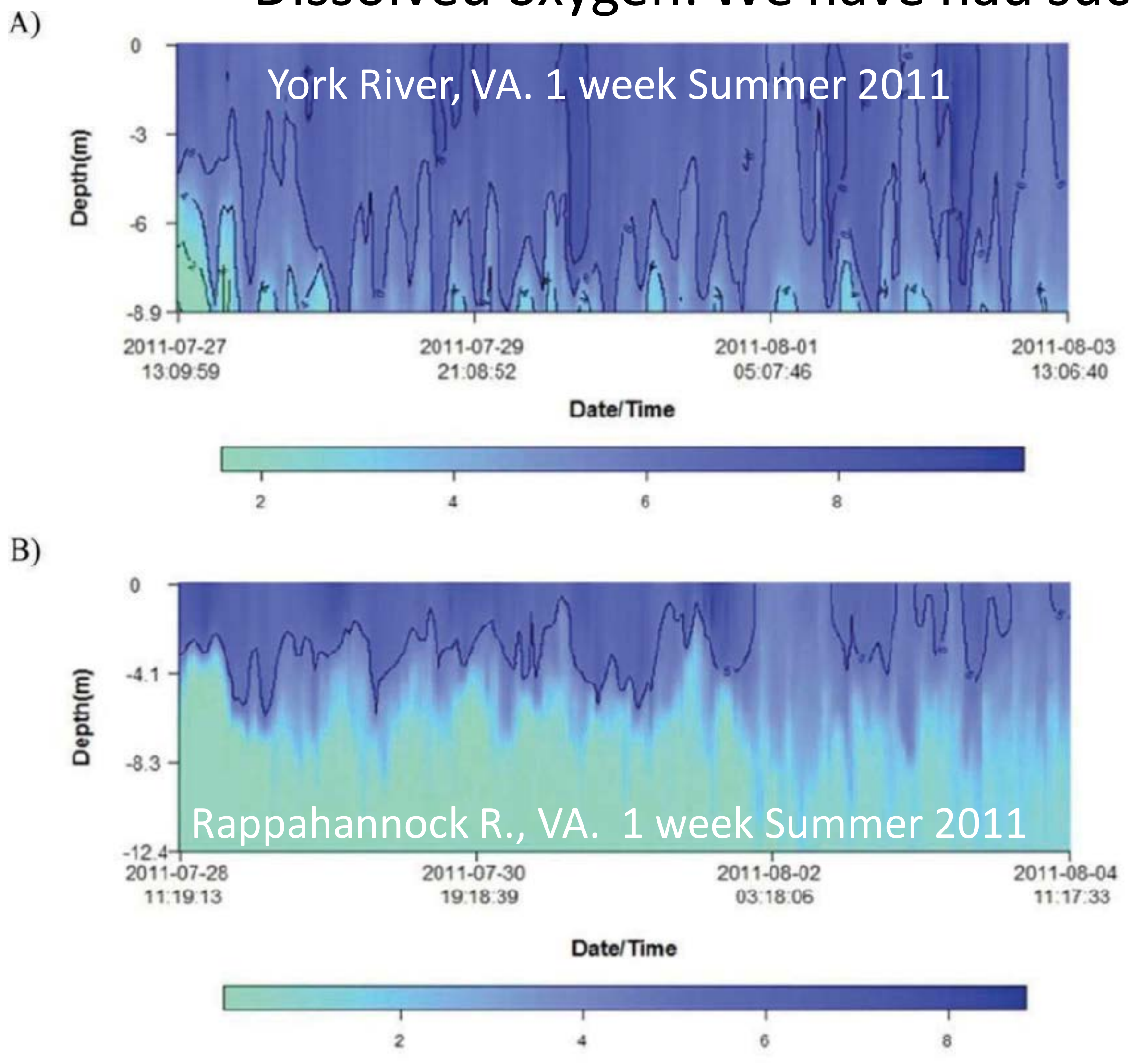
Nanticoke Creekwaters are
Approved for Tier 3 D.O. monitoring
(Water quality standards approved)

Do we continue to compute standards
Attainment based on 3 sites visited
1x per month That is 12 data points for
the summer,

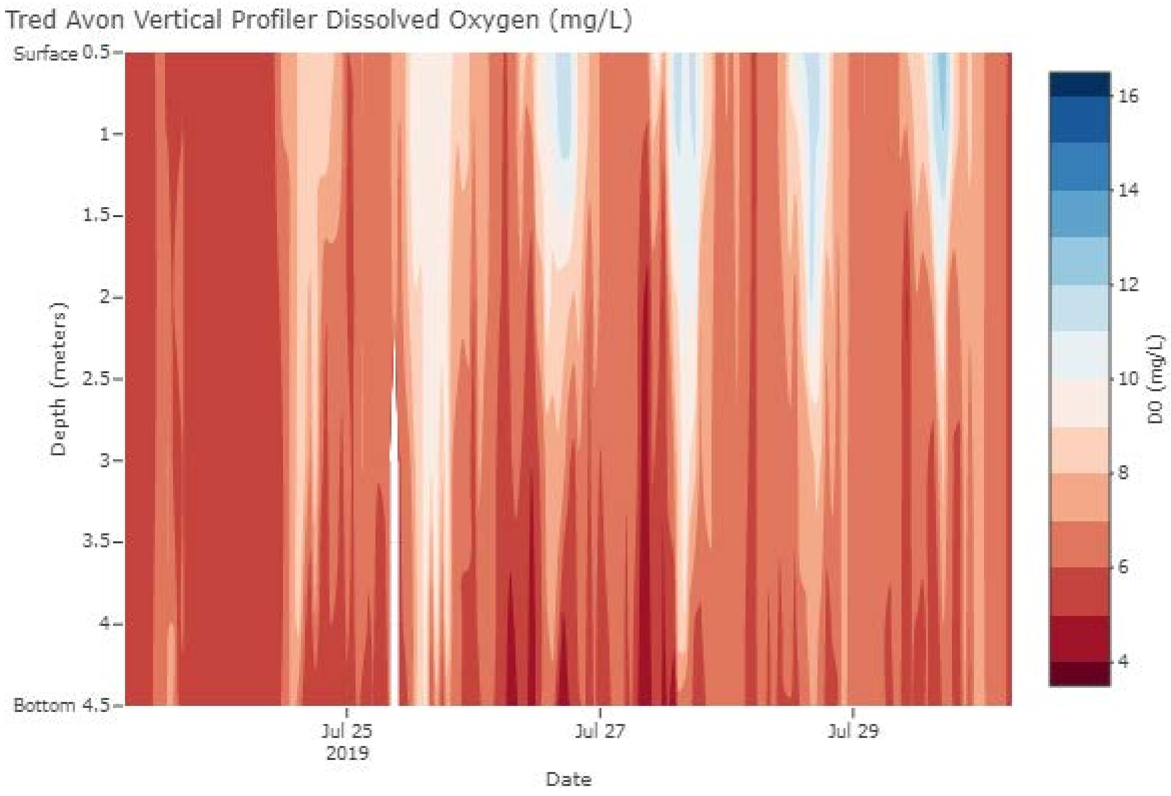
Or

Do we include 30 sites collected
weekly to evaluate D.O. standards? That is
Over 120 data points for one season?
That is a 10x increase in information over
our existing monitoring program by incorporating
their data, and that is just one tributary system.

Dissolved oxygen: We have had success with profilers in shallow river habitats



Water Quality Profiler data
(Tuckey and Fabrizio 2016)

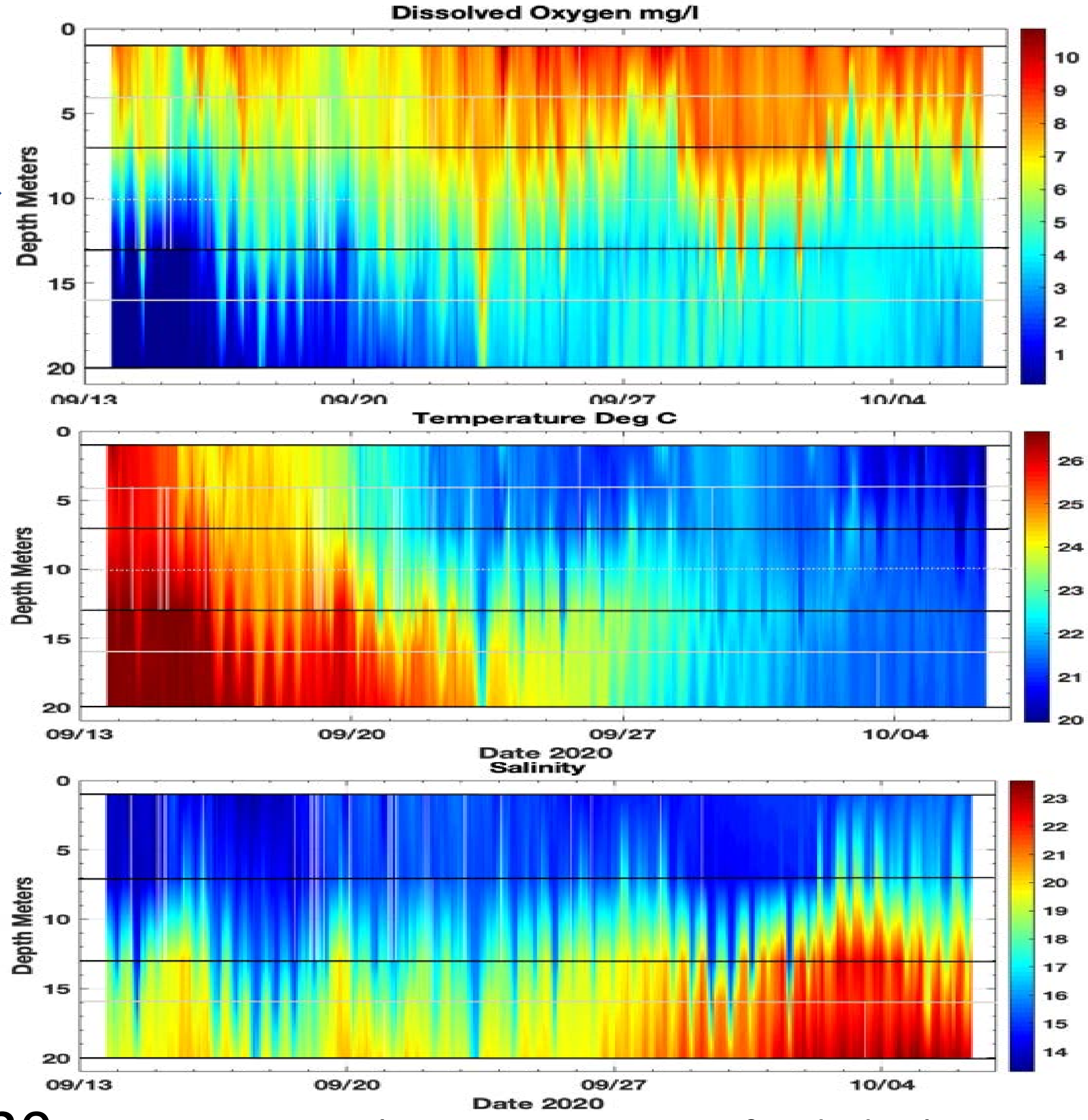


MD DNR Water Quality Profiler - hourly
About 1 week, 4.5meter depth, Tred Avon River
July 26- July 30, 2019

M. Trice
MD DNR

Dissolved oxygen: We have had success with profilers in the open bay habitats

- 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



~ $50K Instrument with high data return on investment

September 2020

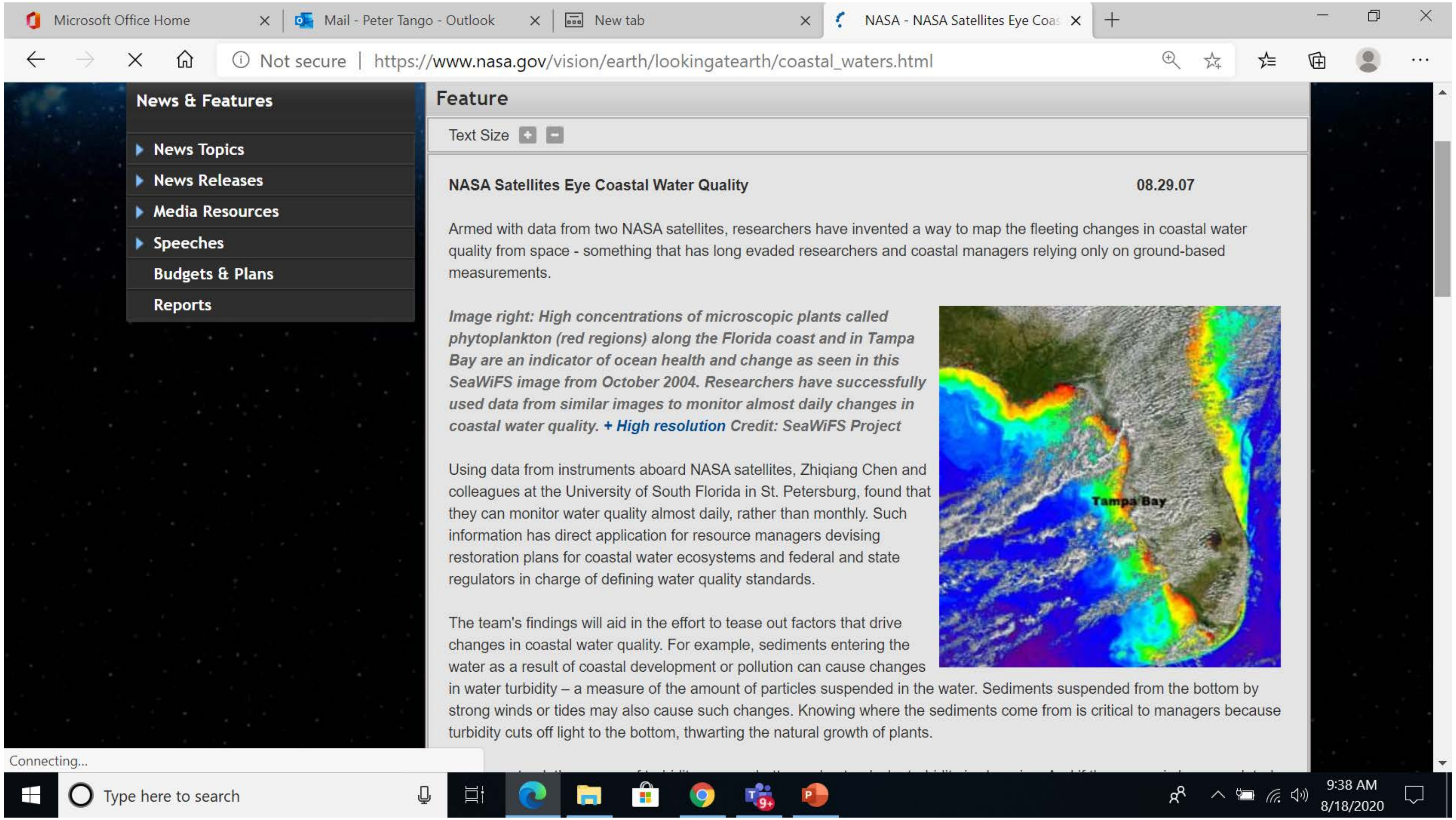
D. Wilson 2020. CBT GIT-funded pilot project data

Continuous vertical profiler collecting data at 10 minute intervals provides assessment support for all criteria applicable in all designated uses.

- Instantaneous minimum
- 1 day mean
- 7 day mean
- 30 day mean
- Seasonal mean

*No other form of monitoring is achieving this level of information support throughout the water column.

Chlorophyll: Florida is EPA approved for assessing coastal chlorophyll *a* water quality standards with satellite image interpretation since 2012

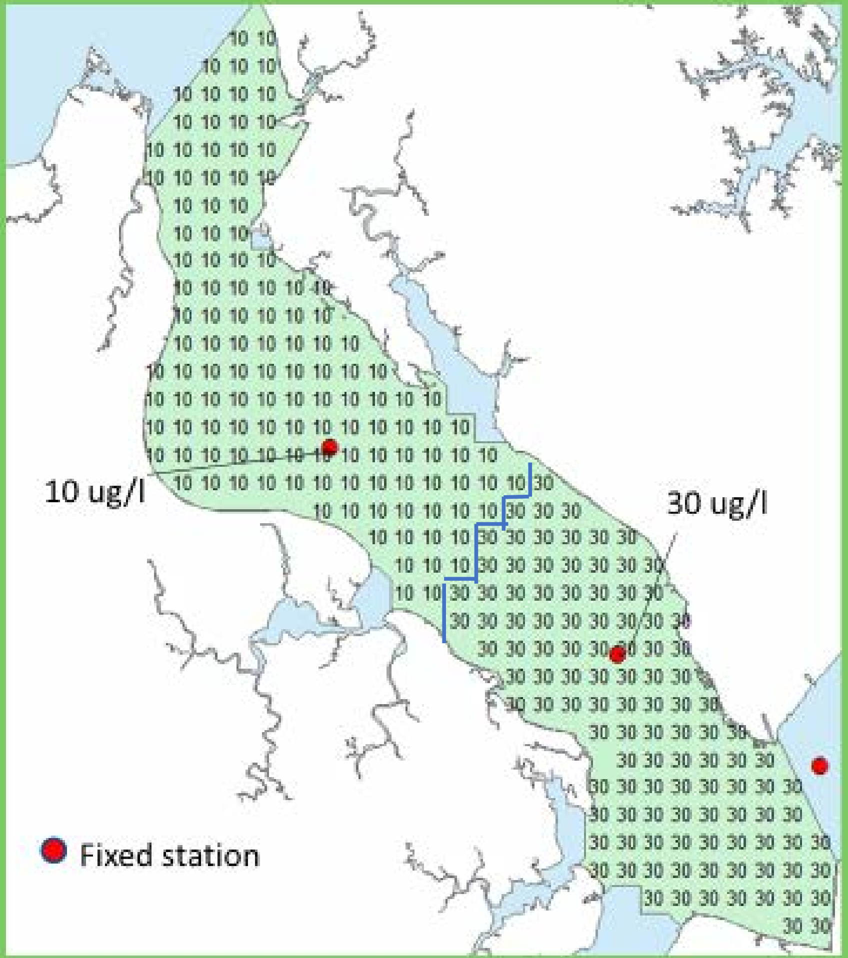


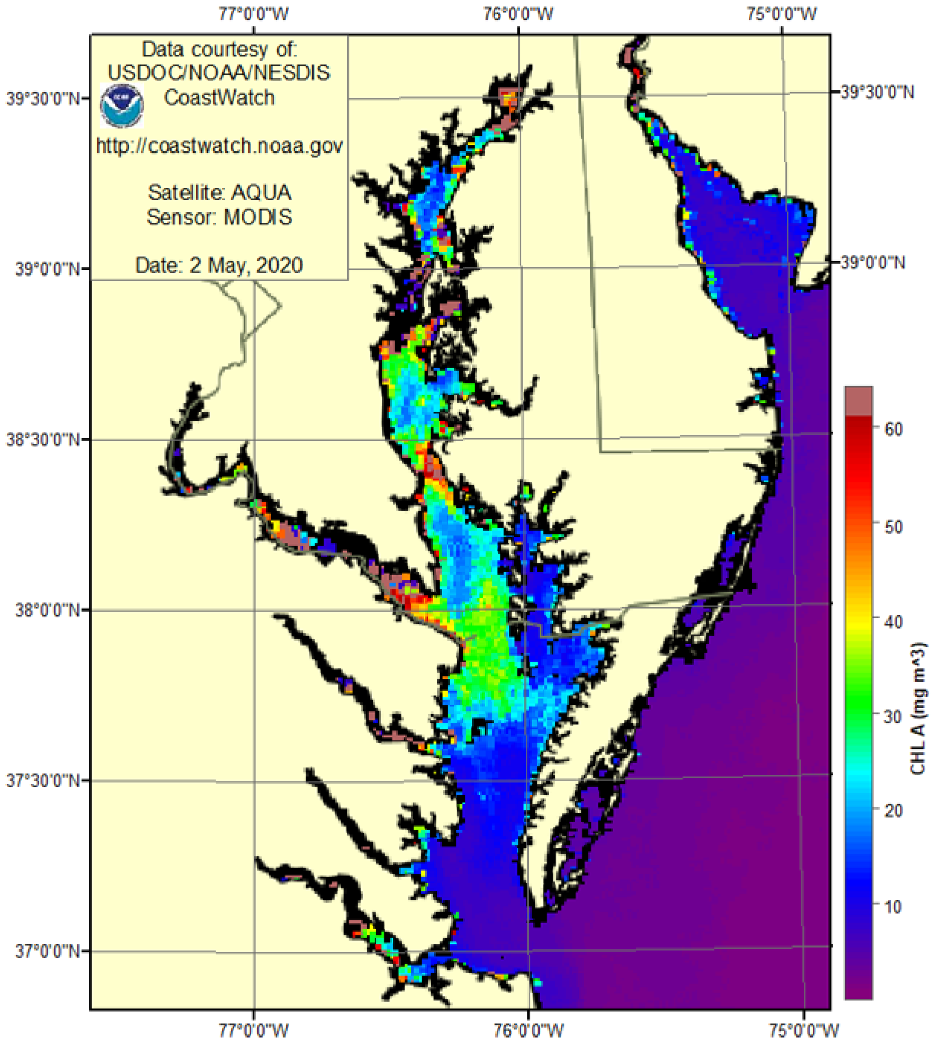
Chlorophyll *a*: And there are opportunities here in the bay to get single day, baywide assessments with alternate assessment protocol strategies, e.g. Hi-res satellite imagery

1 Bay segment, 2 fixed stations, limited variability expressed **vs. Full bay and tribs, continuous gradient CHLA**

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

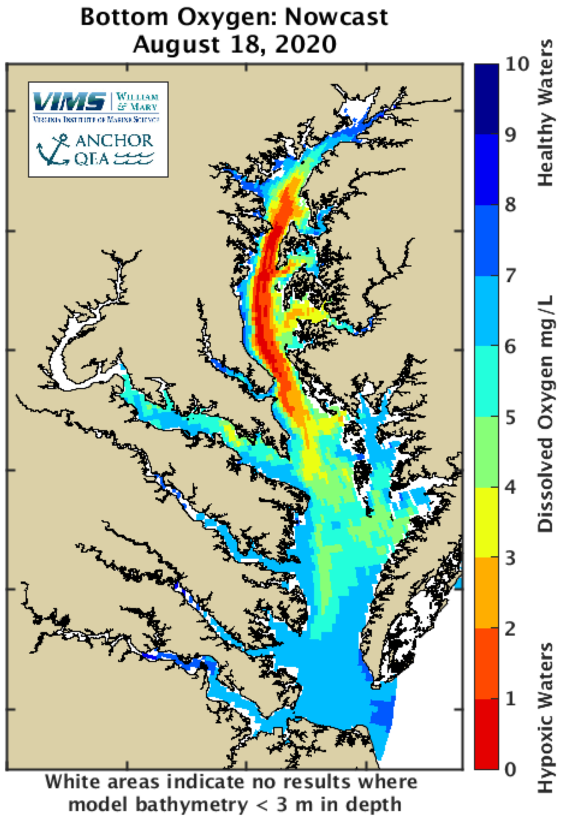
Note: It does not create or rely on any statistical model of spatial variation (e.g., a variogram).



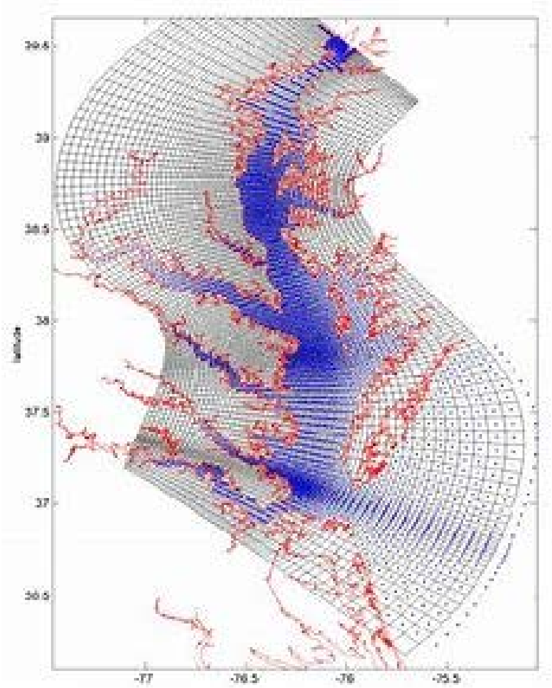


Data Interpolation – We are not nimble for data integration. 1980s methods in our 2020s world. We can do much better.

- Is ChesROMS our next generation interpolator?



- Are we ready to create the 4-D interpolator?



- *Post-doc feasible project with AI/ML and enhanced monitoring*

Reminder

Through the 2014 Chesapeake Bay Watershed Agreement, *the Chesapeake Bay Program has committed to…*

Goal: *Water Quality*

Outcome:

Continually improve the capacity to monitor and assess the effects of management actions being undertaken to implement the Bay TMDL and improve water quality. Use the monitoring results to report annually to the public on progress made in attaining established Bay water-quality standards and trends in reducing nutrients and sediment in the watershed.

Draft workshop themes on how we improve capacity

- Theme 1. NO NEW DATA
- Sustain existing long-term water quality monitoring program as it is.
  - Option 1. Use existing data with new rules of interpretation.
    - Pro and Con – if 1-2 samples can represent an estimate of the 30-day mean, why don't we use 1 sample as an estimate of the instantaneous minimum, 1-day mean, and 7-day mean criterion assessments?
  - Option 2. Update the standards for dissolved oxygen to be reported based on the Multimetric Water Quality Standards Indicator results
    - Pro and Con – EPA relies on the Indicator results for tracking and reporting progress on meeting water quality standards. Revise the standards to make the indicator the basis for the standard assessment
  - Option 3. Fully implement Conditional Probability approach ("Umbrella Criterion Assessment").
    - Pro and Con – the methods have been documented in 1996, 2004 and 2017. Establish future cycles as using these methods to report achievement of all DO standards.

Workshop Themes on improving capacity

- Theme 2. INTEGRATE NEW DATA and NEW TOOLS
  - Option 1. Apply existing analyses to data with improved resolution in space and time
    - Pro and Con – incorporate Tier 3 Cit Sci and Nontraditional Partner Data, Incorporate vertical profiler data, Incorporate Satellite data into existing assessments.
  - Option 2. Apply new data interpretation approaches
    - Pro and Con. Florida is using satellite image assessment of CHLA proxy measures with uncertainty evaluated in order assessment standards. We use proxies in the watershed for phosphorus load estimation from suspended sediment data. AI/Machine learning algorithms are capable of fine scale assessment of submerged aquatic vegetation. NASA generated baywide estimates of turbidity in shallow water. Why aren't we using these methods to help us assess the Bay?
  - Option 3. Develop next generation interpolation with low and high frequency monitoring feeds
    - Pro and Con – Inverse distance weighting has no connection to underlying influences on constituent distributions. Is 4-D interpolation through machine learning algorithm development now feasible? Why not use ChesROMS?

Comments and Suggestions Welcome!

- Structure of Workshop?
- Draft Themes and Options are open for editing, additions/deletions
- Workshop Team volunteers