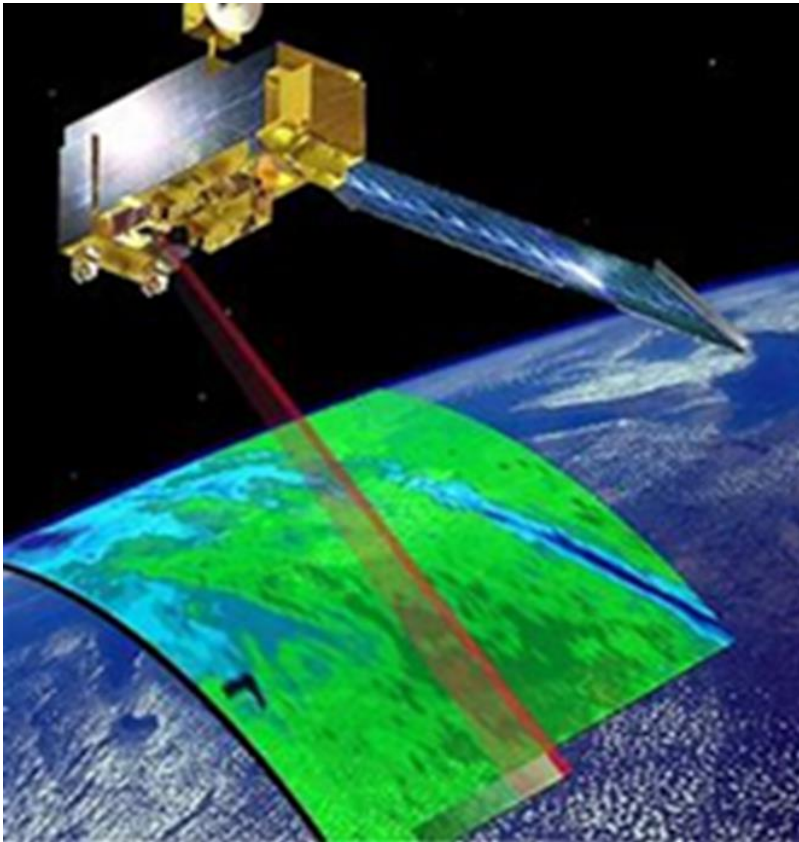


## OVERVIEW

2021 Advancing Monitoring Approaches to Enhance Tidal Chesapeake Bay Habitat Assessment including Water Quality Standards for Chesapeake Bay Dissolved Oxygen, Water Clarity/SAV and Chlorophyll *a* Criteria  
A Programmatic CBP STAC Workshop Proposal

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Peter Tango CAP WG May 14, 2021



Advancing Monitoring Approaches to Enhance Tidal Chesapeake Bay Habitat Assessment including Water Quality Standards for Chesapeake Bay Dissolved Oxygen, Water Clarity/SAV and Chlorophyll *a* Criteria  
**A Programmatic CBP STAC Workshop Proposal**

- 
- **Submitted By**
- Criteria Assessment Protocol Workgroup
- Scientific, Technical Assessment and Reporting Team (its Modeling WG, and Status and Trends WG).
- **Workshop Steering Committee Members**
- \* Peter Tango, Chair, USGS, Chair of the Criteria Assessment Protocol Workgroup.
- Tish Robertson, Virginia Department of Environmental Quality
- Bill Dennison, University of Maryland College of Environmental Studies, STAC
- Brooke Landry, Maryland Department of Natural Resources
- William Richardson, U.S. Environmental Protection Agency

# Objectives

- The workshop objective is to develop actionable recommendations on adaptive monitoring and assessment for the next generation Chesapeake Bay Program tidal monitoring program.



# The Path Ahead

# Individual workshop 1-2 day events – building off of research, WG meetings, past workshops

SAV – status of satellite assessment and AI interpretation

Light limitation – status and options with satellite-based interpretation, what is needed to operationalize the existing work – more calibrations, different satellites, decision on average conditions versus daily conditions – what are the decisions needed for applying satellite based assessment baywide?

Chlorophyll a - status and options with satellite-based assessment and interpretation. Work is progressing on this front. FL uses it for chla standards assessment, what is left for us to get from where we are in Chesapeake Bay to where we need to be? What is the research, what are the decisions, what is the protocol? Can we adopt FL methods now?

Dissolved oxygen – how are we applying the new data sources to DO assessments? What is the state of the 4-D water quality estimator and what do we need to work on to take it into operation?





Chesapeake Bay Program's

***Scientific and Technical Advisory Committee***

# **Exploring Satellite Image Integration for the Chesapeake Bay SAV Monitoring Program**

A STAC Workshop

Virginia Institute of Marine Science

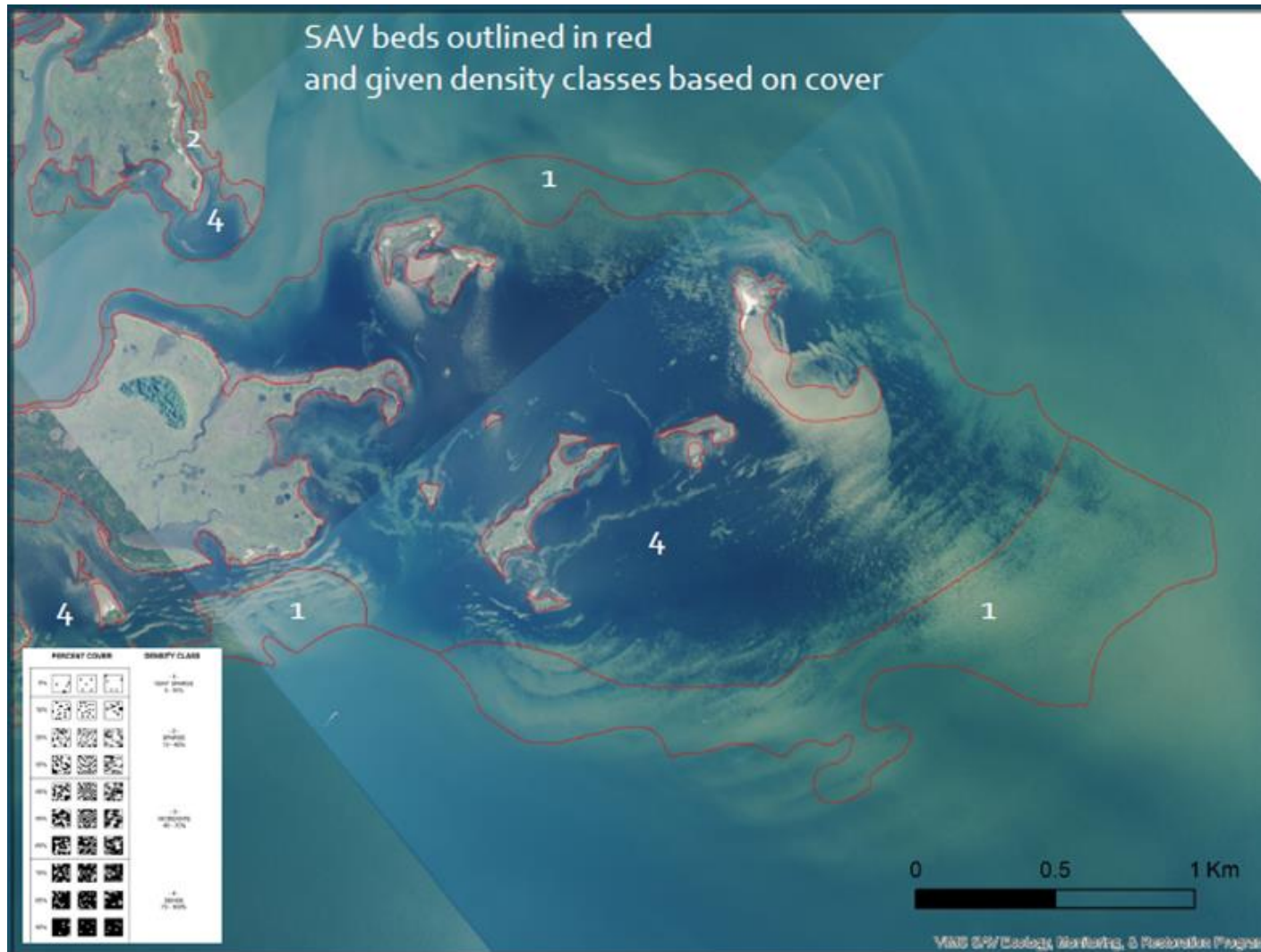
October 2019 – February 2020

Co-chairs Brooke Landry (MD DNR) and Peter Tango (USGS)



WILLIAM  
& MARY





## Basic workshop findings

- Satellite images can provide comparable assessment of SAV to aerial-fixed based images.
- Getting suitable images requires a different process from the aerial images.
- There are issues of ownership with the specific satellite we worked with



# Workshop Results: Take Home Points

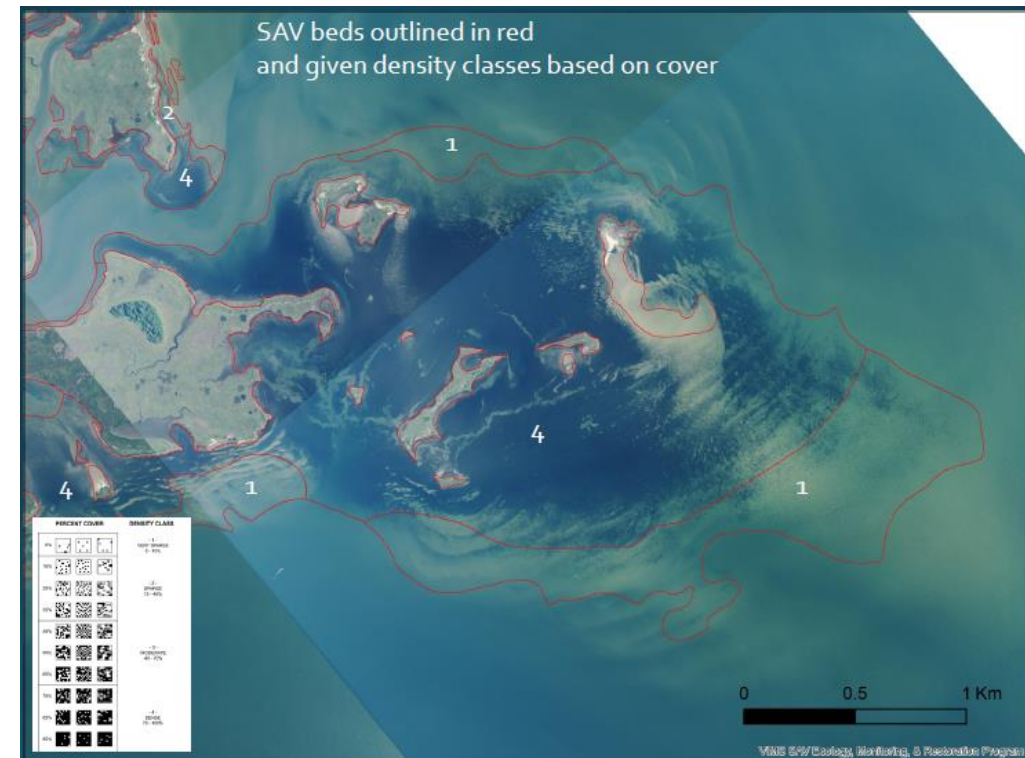


**Algorithms/AI/machine learning will eventually automate mapping:**

With funding, algorithms could be ready in 3-5 years.

**Using AI may yield more precise results but we need to assess the relationship between AI derived and hand-mapped SAV:**

Current method of hand delineation clumps SAV patches, whereas AI would split them, excluding the sparsely populated space in between patches. May be able to fix this by then clumping the patches together to more closely replicate VIMS methodology.



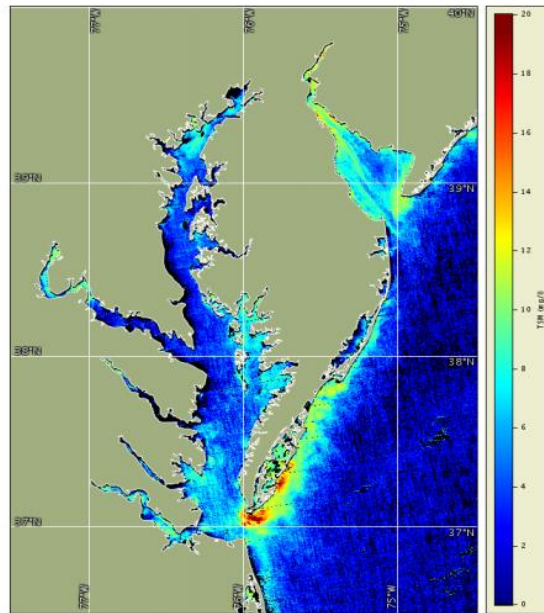


# STAC Workshop on Advanced Monitoring: SAV Session

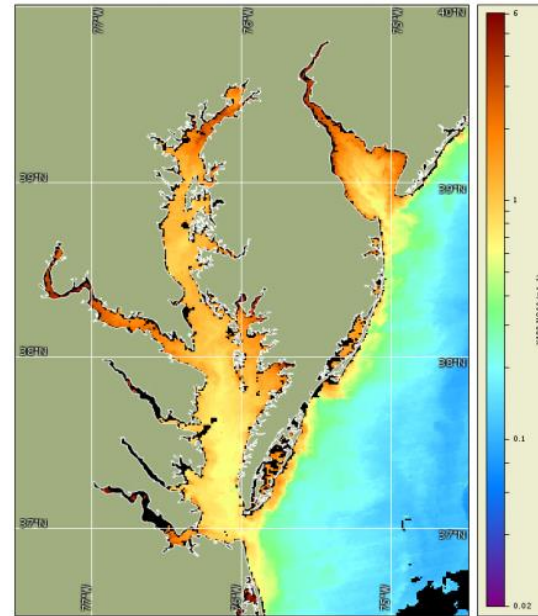
- Pick up where we left off in the SAV focused workshop
- Advances have been made in the last year on improving quality of satellite images and the data we can extract from them.
- AI algorithm assessment of images has advanced
- Assess progress and develop recommendations on overcoming remaining hurdles to satellite-based assessments and AI-based interpretation.  
*Actionable investments* is what we are looking for.

# NOAA CoastWatch satellite products for water clarity

## Total Suspended Matter Sediment Concentration



## Water Turbidity Diffuse Light Attenuation: $K_d490$ & $K_dPAR$



**Contact:** Ron Vogel (UMD/ESSIC & NOAA/STAR), [ronald.vogel@noaa.gov](mailto:ronald.vogel@noaa.gov)



# Water Turbidity from Satellite

- **Diffuse Light Attenuation Coefficient,  $K_d490$  ( $m^{-1}$ )**

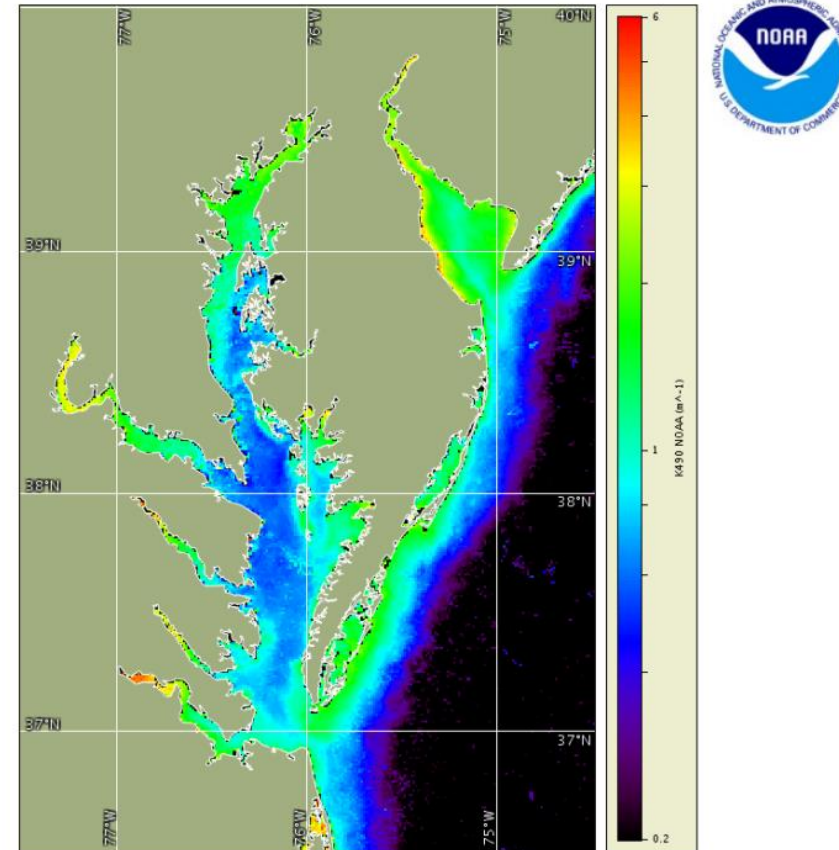
- Definition: reduction in diffuse light over a distance in the water, at wavelength 490 nm
- Depth of measurement: varies with amount of particles in the water, i.e. euphotic zone
- Measured by 5 satellites: NASA, NOAA, EUMETSAT
- Instruments: MODIS (1), VIIRS (2), OLCI (2)
- Each passes over Chesapeake Bay once per day
- Clouds cause missing data

- 250 m – 1 km spatial resolution

- MODIS algorithms (specific to Ches Bay):

- 1 km: Wang et al., JGR, 2009
  - Separate algorithms for clear open ocean and turbid coastal waters weighted into combined product
- 250 m: Tomlinson et al., Rem Sens Letters, 2018
  - High-resolution bands regressed to match Wang

- VIIRS algorithm: MODIS-Wang applied to VIIRS



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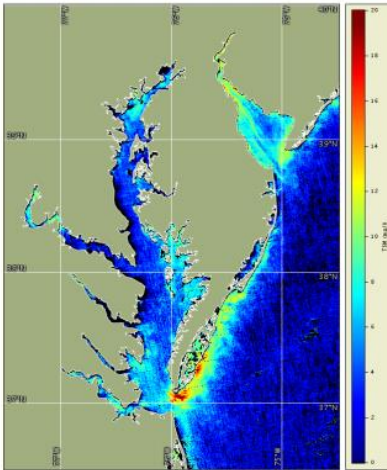
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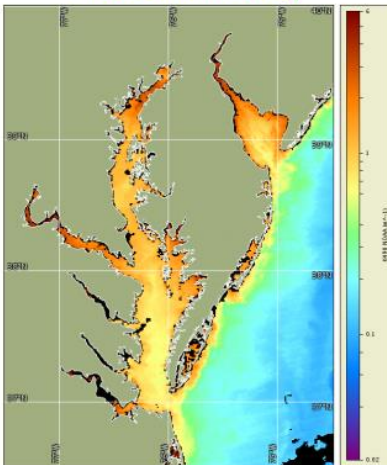




### Total Suspended Matter



### Water Turbidity



## Summary: Data Considerations

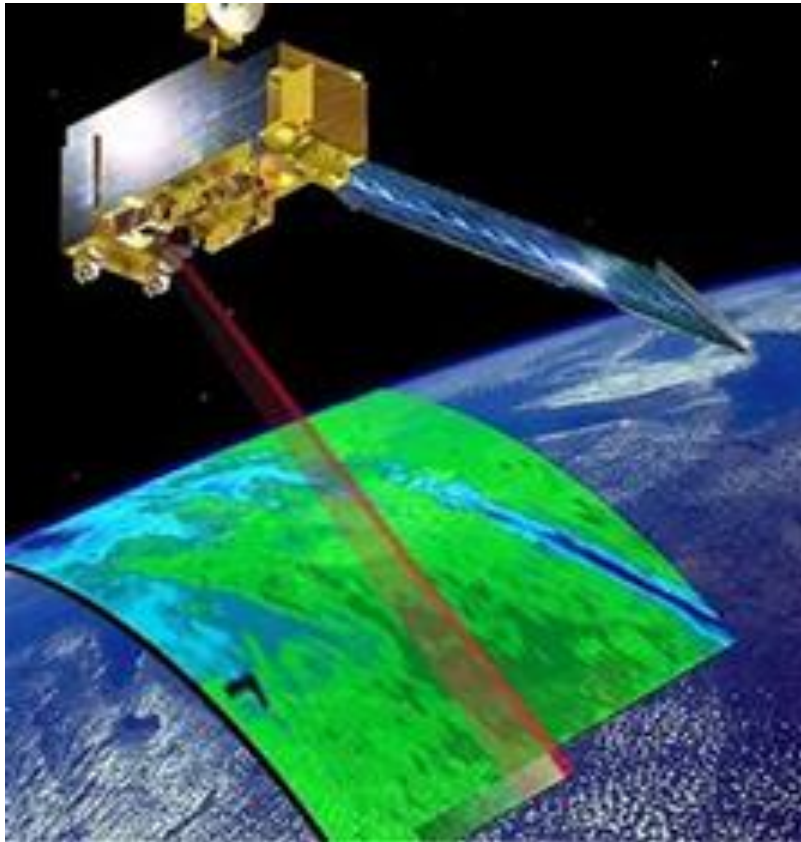
- Spatial resolutions: 1 km, 750 m, 375 m, 300 m, 250 m  
coarser  
finer
- Number of satellites: 5
  - instruments: MODIS (1), VIIRS (2), OLCI (2)
- Overpass times (daily):
  - OLCI: ~10:30 AM
  - MODIS & VIIRS: ~3:00 PM
- Coverage (averaged data) vs. accuracy (instantaneous data)
- Length of record: MODIS 2009, VIIRS 2012, OLCI recent



# STAC Workshop on Advanced Monitoring: Light limitation session

- Review status of the work to understand state of the science
- Establish perceived limitations of utility
- Consider options to overcome challenges to its use – e.g., accuracy and uncertainty, more calibration sites needed, interpolation opportunities, interpretation opportunities
- Recommend work to address any limitations based on a likely protocol for interpreting the data in a manner we can use for water quality standards attainment assessment. *Actionable investments* is what we are looking for.

# CHLA Can we make assessments like FL?



https://floridadep.gov/dear/water-quality-standards/content/numeric-nutrient-criteria-development

## Numeric Nutrient Criteria Development

Home » Divisions » Division of Environmental Assessment and Restoration » Water Quality Standards » Numeric Nutrient Criteria Development

### Water Quality Standards Quick Links

- Surface Water Quality Standards Classes, Uses, Criteria
- Water Quality Standards Meeting Calendar
- Triennial Review of Water Quality Standards
- Fish Consumption Survey Project
- Outstanding Florida Waters

### Numeric Nutrient Standards for Florida Waters

#### Background

For many decades Florida has had a narrative nutrient water quality criterion in place to protect Florida's waters against nutrient over-enrichment. In 2009, the department initiated rulemaking and, by 2011, adopted what would be the first set of statewide numeric nutrient standards for Florida's waters. By 2015, almost all of the remaining waters in Florida have numeric nutrient standards.

The vast majority of Florida's freshwater streams, lakes and springs are covered by numeric interpretations of the nutrient criterion, and only wetlands (except for the Everglades Protection Area) and South Florida canals are not covered by numeric nutrient criteria. Non-perennial streams, man-made or physically altered canals/ditches with poor habitat used primarily as water conveyances for flood control, irrigation, etc., and tidal creeks may also be solely covered by the narrative criterion once properly documented as meeting one of the exclusions for the definition of a stream. The Florida coastline is separated into estuary and coastal segments. Numeric nutrient criteria are established for all estuary segments, including criteria for total nitrogen, total phosphorus, and chlorophyll a. For open ocean coastal waters, numeric criteria are established for chlorophyll a that are derived from satellite remote sensing techniques.

#### Numeric Nutrient Standards

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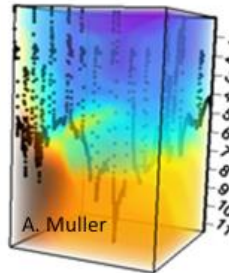
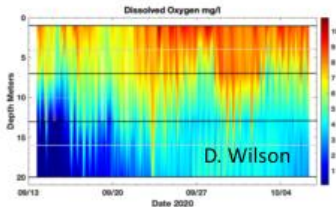


# Dissolved oxygen – 4D WQ estimation to support water quality stds assessment

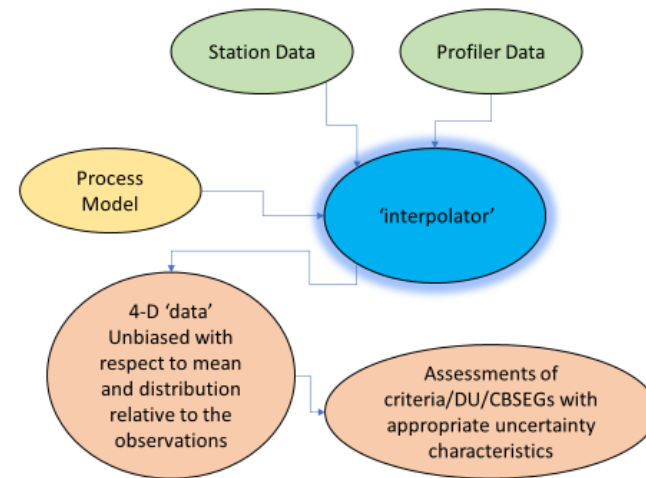
## 4D BORG (Bay Oxygen Research Group) (aka, “Interpolator Innovation Team”)

Peter Tango/Rebecca Murphy  
Team Leads

April 2021 Opening Meeting of the BORG



### Vision: WQ Criteria Assessment (Habitat Assessment)



An ‘interpolator’ would take inputs from station data, profiler data, and process models to produce a complete historical hourly record of DO on perhaps a 200x200x1 meter cell framework.

We would want to specify that the resulting history was unbiased relative to several different distribution metrics

Assessments would be carried out in those areas and times-scales when uncertainty estimates are within acceptable ranges.

This could perhaps be tested using ChesROMs as the profiler data and WQSTM as the process model.

**\* Work underway by 4D BORG**

**= 4-D Water quality estimator team**

**= 4-D Water quality estimator team**

# Summer/early fall season CAP WG work Alignment with STAC Workshop and PSC review

- Reviewing each theme – targeting knowledge status and questions to use in the workshop work sessions.
- Do you have a preference on the order for the roll out of topics?
- Do you have any folks you would like invited for a particular theme?
- Can we have volunteers to present on our existing assessment methods for comparison with options being discussed?

Detailed needs – small bites, coming soon.

Teams/Groups	April 2021	May	June	July	Aug	Sept	Oct	Nov	Dec	2022	
	SPRING Status and vulnerabilities of existing network			SUMMER – Innovation Assessment, Financials of Sustaining networks			FALL Evaluate limitations, Financials for adopting innovations, recommendations			Winter	
NTN	Network support spreadsheet, vulnerabilities, financials, design options			Network revision proposals – BMP, climate, historical; financials of vulnerabilities next 5 years			Analysis innovation – target, timeline, investment. Formalize network & analysis revision recommendations			Consolidate recommendations, financials for PSC Presentation	
CAP WG with DIWG	Tidal Mon program status, vulnerabilities, financials			Satellite SAV readiness, data management, QA needs	Satellite Iel readiness, data management, QA needs	Satellite CHLA readiness, data management, QA needs	Cit Sci targets, expectations	STAC Workshop: Knitting together innovations in –			
Hypoxia Collaborative	Establish Team, kick-off mtg, provide Vision, input on stakeholder requirements, initial deployment targets			Network design, sampling design adjustments							
Cit Sci	Award of contract			Tier 3 documents			Use of Cit Sci data can				
Fish Forage/Black Duck/117e grants	Is Spring 800 necessary?						Formalize recommendations and financials of existing and proposed modifications to program				
Fish Habitat	Del			Monitoring network design, data management and QA needs			STAC Workshop panels support				
SAV	Track aquatic			Prep for STAC Workshop – sharpen financial assessment			STAC Workshop: AI options, AI progress to improve efficiencies, comparability of method outputs, document path and financials				
4-D Interpolator	Establish Team, provide Vision, stakeholder requirements			Guidance and development phase with monthly updates			STAC Workshop: Shaping development, envisioning products to address WQ 50s reporting needs, fish habitat needs				
STAC Workshop	Pre-planning work		Planning and organizing phase			Early Themed Workshop meetings			Continue		
STAR/WQGIT updates	Presentation prep		Input from all GIVs		Presentation prep		Input from all GIVs		Presentation prep: STAC Workshop panels, meeting support as targeted	Early PSC material RFI and review	
PSC Presentation											X

Detailed plans, dates, homework assignment assistance  
planning is in progress here