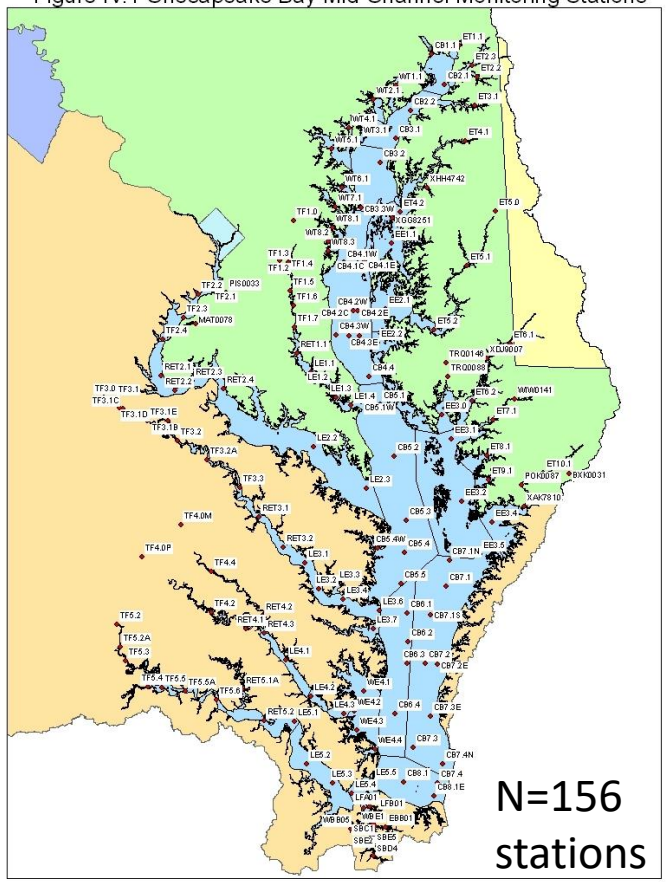
Tidal Monitoring Network Overview

Peter Tango and Breck Sullivan
USGS
Monitoring Networks Kickoff Meeting
January 11, 2023

The Chesapeake Bay Long-term Tidal Water Quality Monitoring Network: 1984-present

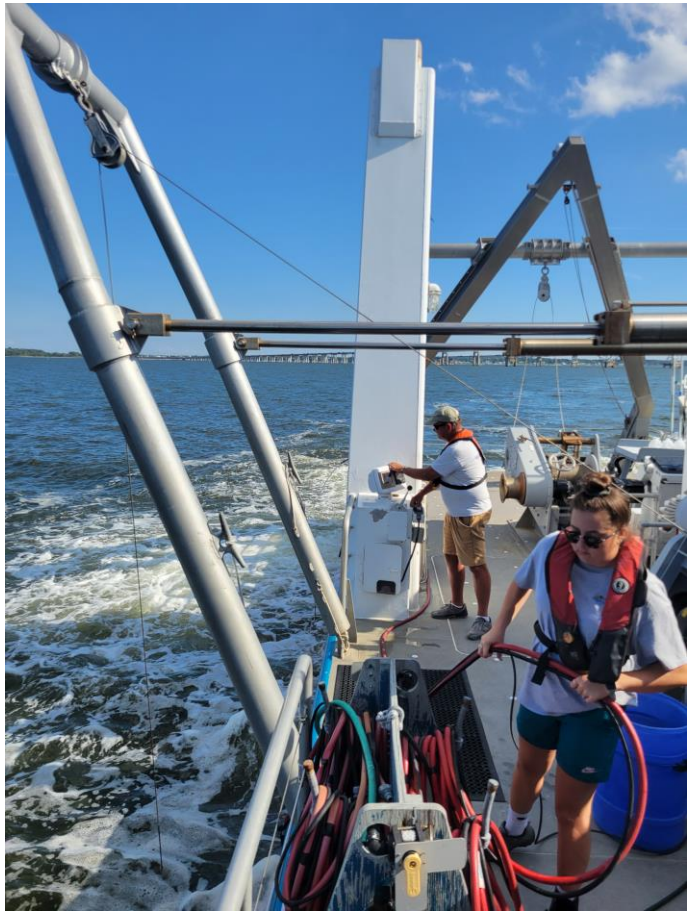
Figure IV.1 Chesapeake Bay Mid-Channel Monitoring Stations



Framework:

- Annual monitoring (n=156 stations)
- Seasonal coverage
- Biweekly to monthly sampling
- Physical, chemical, biological parameters

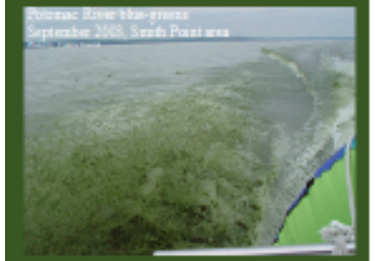
MD DNR



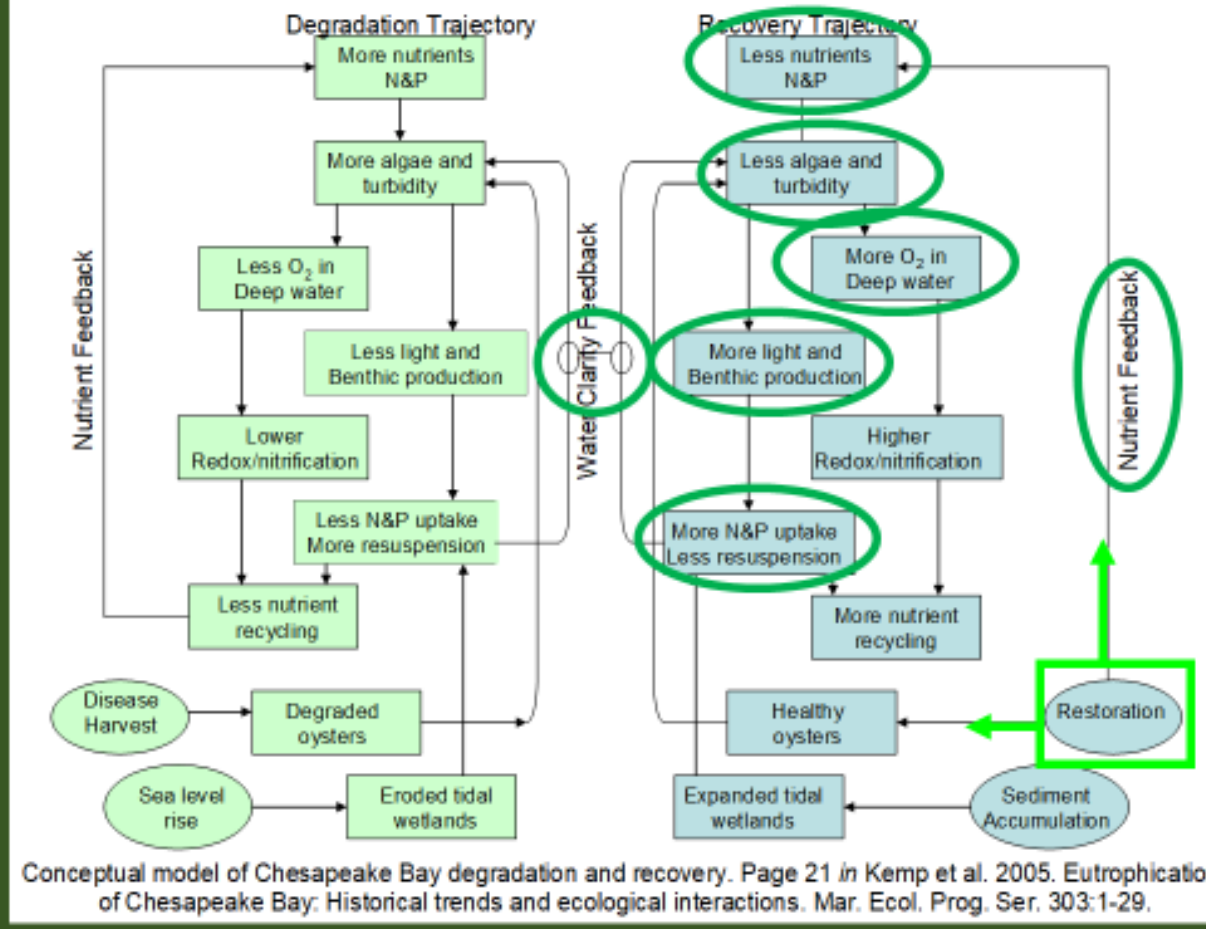
MD DNR

There is scientific support behind what we monitor

Less of this…



Credits: MD DNR



Conceptual model of Chesapeake Bay degradation and recovery. Page 21 *in* Kemp et al. 2005. Eutrophication of Chesapeake Bay: Historical trends and ecological interactions. Mar. Ecol. Prog. Ser. 303:1-29.

More of this…

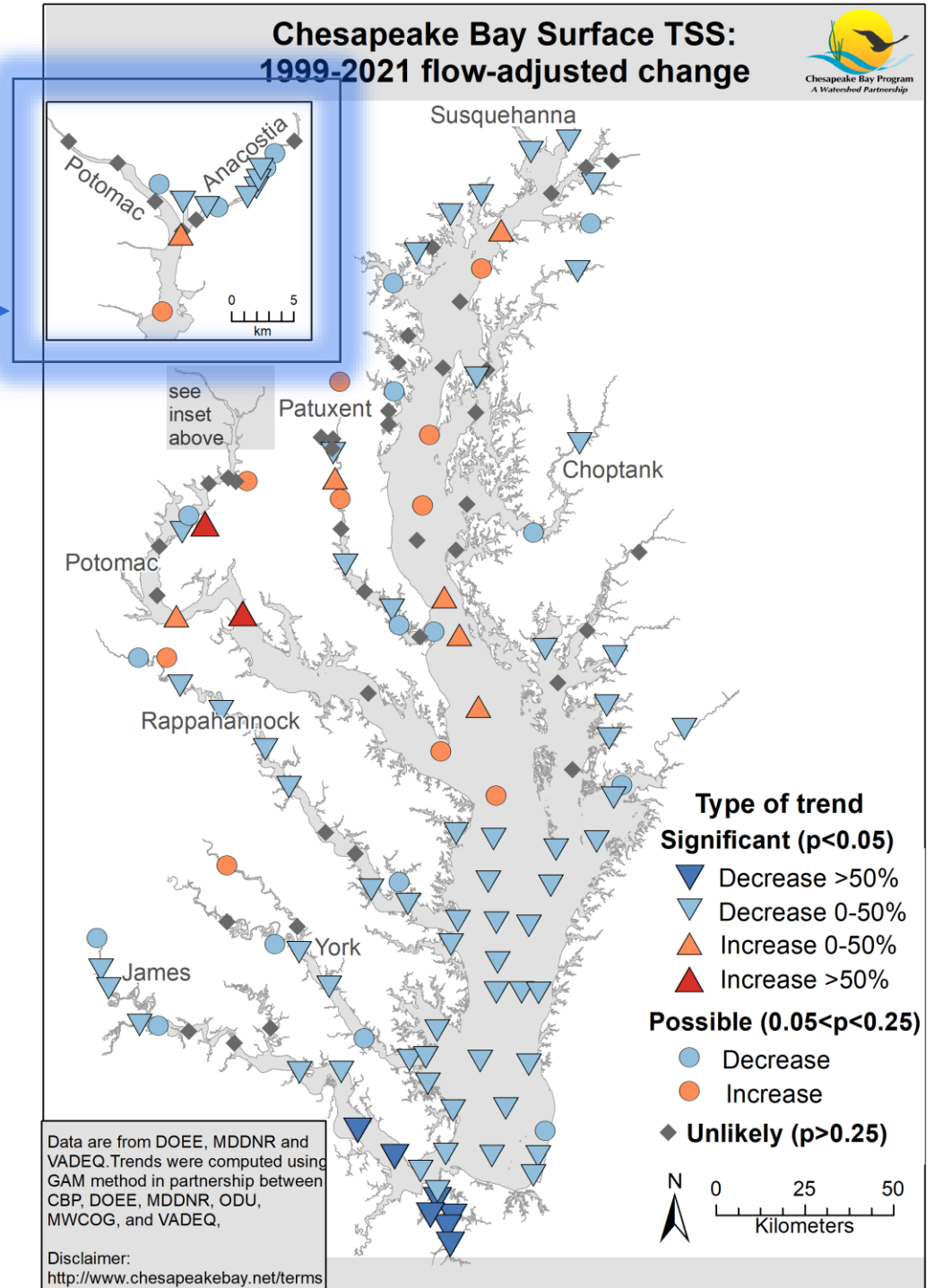
Credit: Bay Journal

Credit: UMCES

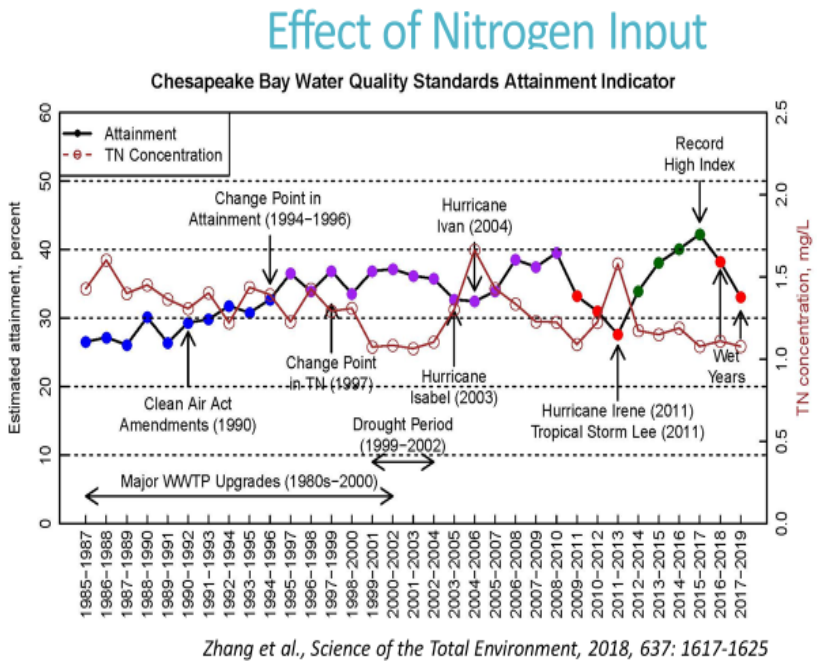
Conceptual Model of the Chesapeake Bay Ecosystem and Response Trajectories

Recent additions!
Washington D.C. stations

- Results presented on the applicable maps for this year
- Future work could include:
  - Additional parameters,
  - Analysis of the results with the team, and
  - Inclusion in Potomac Tributary Report during next revision.



The Chesapeake Bay Long-term Tidal Water Quality Monitoring Network: 1984-present

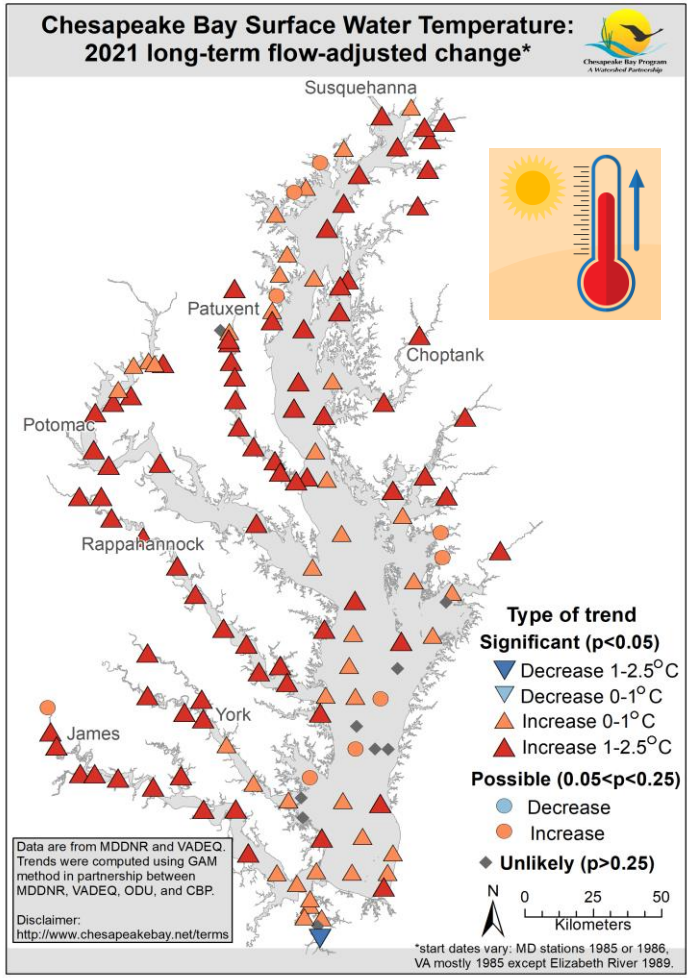


Water quality standards indicator

Qian Zhang/CBP Monitoring and Modeling Teams

Uses

- Status and trends, metrics and indicators – bay response to management and climate
- Supports water quality criteria assessment CWA 303d
- Model development, calibration, verification



CBP Integrated Trends and Analysis Team

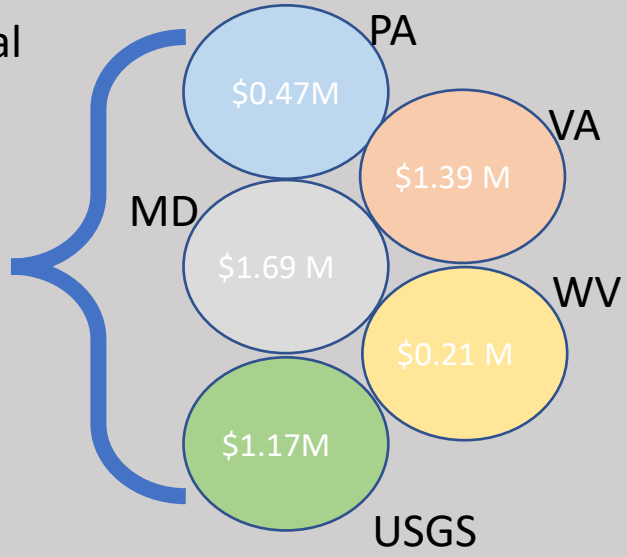
Current Funding of the Network

Integrated partner contributions: It takes a village.

PSC Meeting April 2021: Pre-Monitoring Review, Pre Bipartisan Infrastructure Law $$$

Tidal and Nontidal Water Quality Monitoring

$ 5.0 M



$ 400 K — SAV

$ 450 K — Citizen Science

$ 5.85 M — **CBPO Support for monitoring**

>$ 12M Chesapeake Monitoring Program Partnership Investment

State 117e Matching Funds — $ 3.76 M

Estimated Additional Partner Network Support — $ 2.0 M

USGS Streamflow and Water Quality Monitoring — $ 250K

SAV Partners (MDE, MD DNR, VA CZW, VA) — $ 412 K

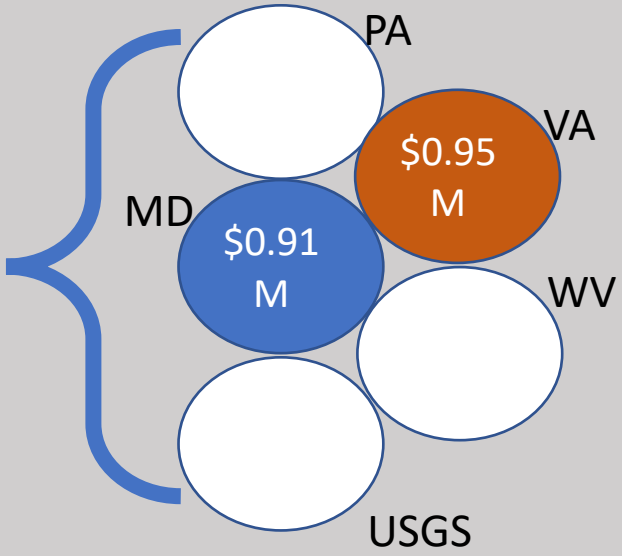
Citizen Science — priceless

Partner support for monitoring — $ 6.5 M

Integrated partner contributions: It takes a village.

Tidal-only funding: Monitoring Kickoff Meeting January 2023

Tidal-only Water Quality Monitoring



SAV

Citizen Science

CBPO Support for monitoring

Annual Average State 117e Matching Funds: $ 1.86 M

Estimated Additional Partner Network Support

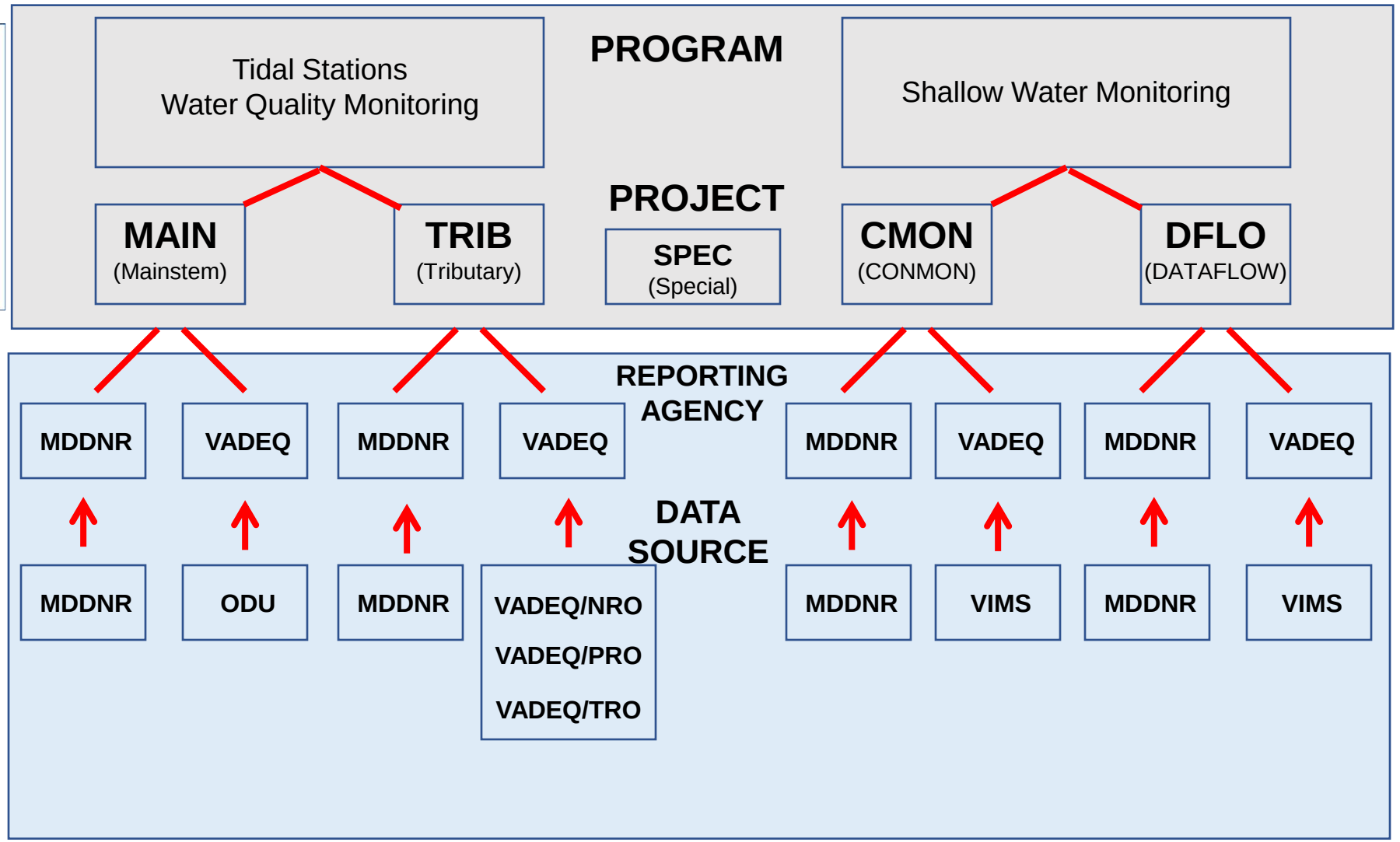
USGS Streamflow and Water Quality Monitoring

SAV Partners (MDE, MD DNR, VA CZW, VA)

Citizen Science

Partner support for monitoring

CBP Water Quality Database
Tidal Data
EPA Clean Water Act 117e Grants with State Matching funds



Note: Washington DC: Investment details not yet factored in but recognized ☺

Data being analyzed and added to tidal water quality status and trends outputs

Basic Functions | Select data and map options

See CBP Bay Trends at https://baytrends.chesapeakebay.net/baytrendsmap/

Contact Breck Sullivan, Amy Goldfischer, Alex Gunnerson for web support.

1. Choose Data

Choose file to load

- (●) Non-linear Trend (Long Term)
- ( ) Non-linear Trend (Short Term)
- ( ) Non-linear Trend with Flow Adjustment (Long Term)
- ( ) Non-linear Trend with Flow Adjustment (Short Term)

2. Choose Map Layer (parameter|layer|season)

Filters

Filter by 'Map Layer'

Select mapLayer:

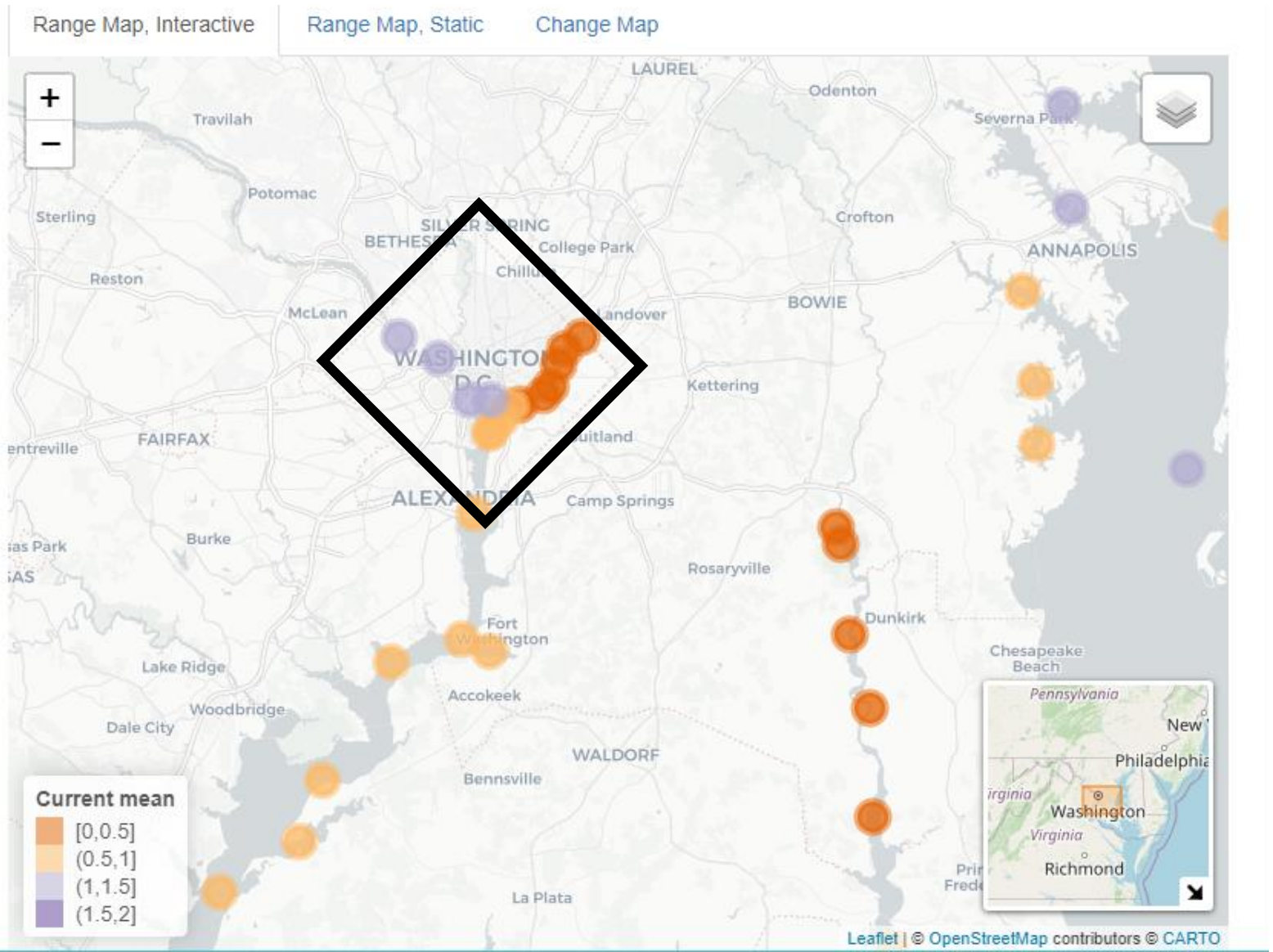
SECCHI|Surface|Annual

3. Map Options

3.a. Range Map Options

Color Palette (Range Map Only)

Range Map, Interactive | Range Map, Static | Change Map



Monitoring Recommendations

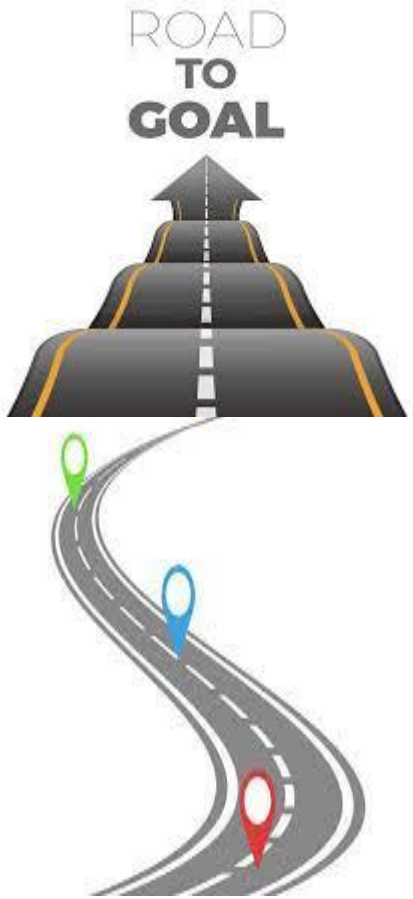
Tidal Water Quality (WQ) Monitoring Network

CBP NETWORK	Project	CATEGORY	Award Entity	FUNDING				
				Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Tidal WQ	8 new sites for vertical sensor arrays packages	Infrastructure	NOAA	$422,000				
Funder				EPA				
Tidal WQ	Operate and maintain vertical sensor arrays	Operation & Maintenance	NOAA-IA	$142,000	$259,000	$272,000	$285,000	$298,000
Funder				EPA	EPA	EPA	EPA	EPA
Tidal WQ	4D interpolator	Operation & Maintenance	USGS IA-MD		$60,000	$60,000	$60,000	$60,000
Funder					EPA	EPA	EPA	EPA
Tidal WQ	Nutrient limitation survey, calibrate and verify models	Operation & Maintenance	RFA	$275,000	$275,000			
Funder				EPA	EPA			

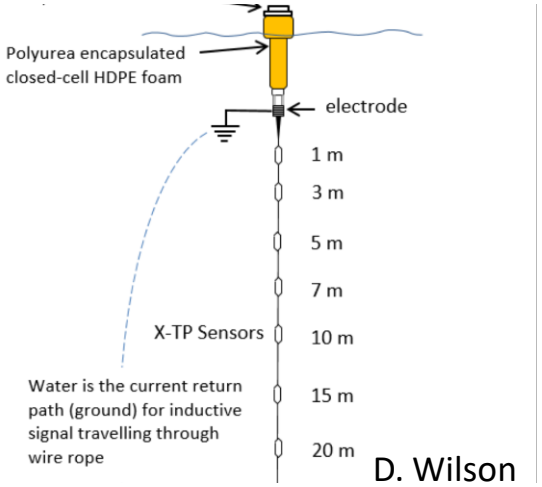
Why do we need the hypoxia network?

20 years of unmet data needs to support criteria that underpin dissolved oxygen water quality standards assessments in all 92 segments of Chesapeake Bay

- **Criteria derived**: USEPA (2003) dissolved oxygen criteria were published with time scales of assessment that includes 1) instantaneous values, 2) 1-day mean, 3) 7 day mean, 4) 30-day means.
- **Limited Monitoring Capacity**: USEPA (2003) describes tidal network capacities only as “Fair” to support criteria assessments
    - **Hundreds of necessary criteria assessment decisions have NO data to support their evaluation with “Fair” network.**



Why do we need the hypoxia network?

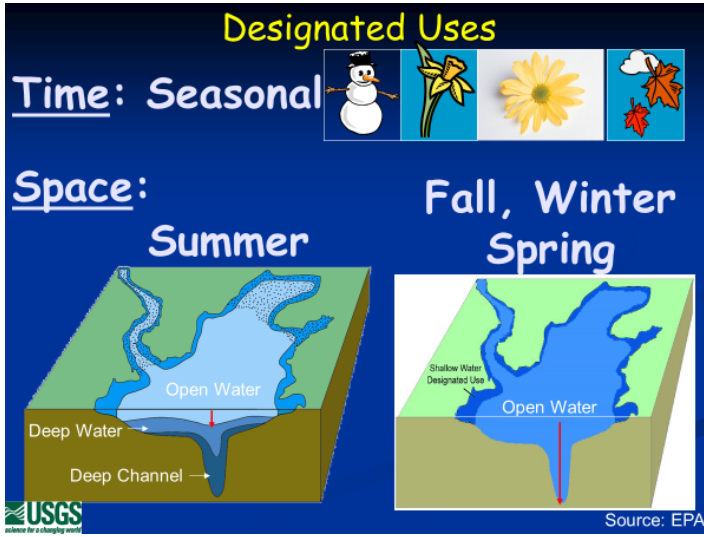


- **Monitoring vision**: USEPA (2003) highlights "Adequate" and "Recommended" levels of monitoring needed for criteria assessment

★ requires vertical water quality profile assessments with continuous data collection.

- **The vertical array network is fulfilling the 2003 vision for capacity to conduct the necessary monitoring to support**
  - **1) all time scales needed**
  - **2) in all habitats needed**

to support Chesapeake Bay dissolved oxygen criteria attainment assessments.

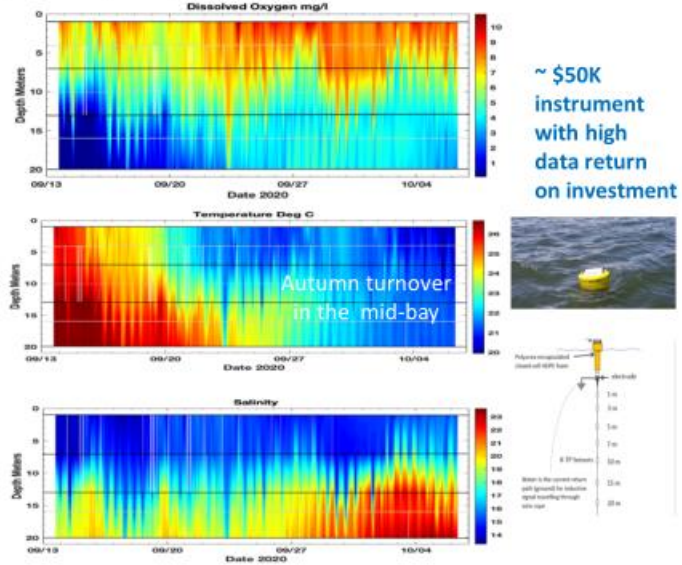


Value of investments in vertical array network

- For the first time in our partnership's history, we are capable of gathering required data in the habitats outlined in the Clean Water Act-based water quality standards at the temporal density necessary to assess all of our dissolved oxygen criteria.

Addressing the data issues: 2019-20 GIT Funded Pilot Project
on robust, cost-effective high frequency water quality profiling data collection

- **Dissolved oxygen**
- **Temperature**
- **Salinity**



~ $50K instrument with high data return on investment

Autumn turnover in the mid-bay

Sept-Oct 2020 mid-Bay CB4.3

Why do we need a 4-dimensional interpolator?

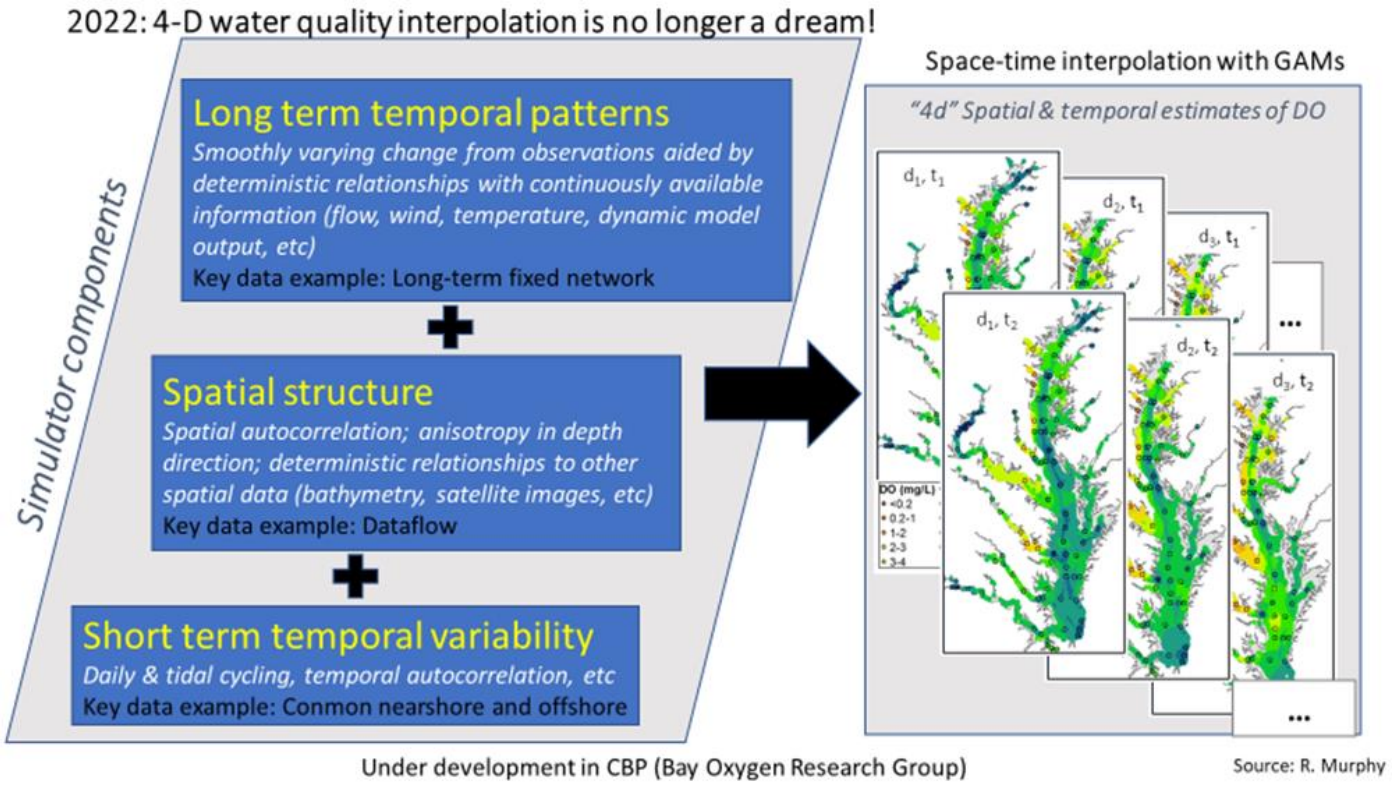
- Tool needed to handle the 4D nature of the criteria assessment and its data requirements
  - unassessed criteria assessment
  - improved fish habitat assessment
  - Improved monitoring designs
  - modeling calibration and verification

- 2008 4D Interpolation STAC Workshop Report findings:

  - *4D interpolation is just a dream…*

2022 4D Interpolator Development Progress

- 4D interpolation is feasible, it's happening!



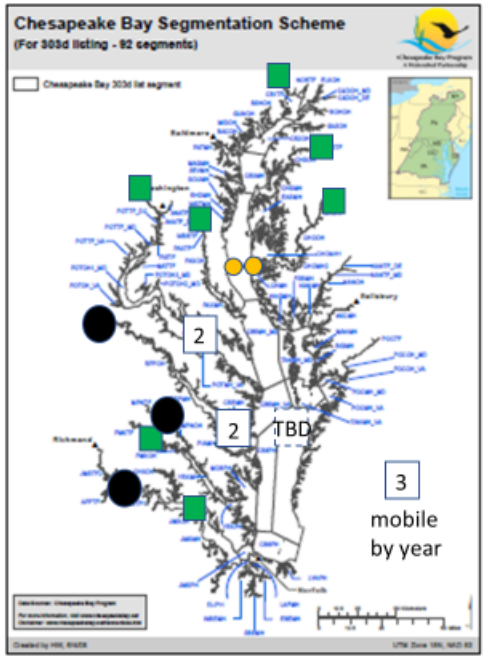
It's Happening 2022

Bay Oxygen Research Group

Supporting monitoring design is integrating data resources informed by research

We are refining the monitoring design to support 4D assessments supported by science

- NOAA supports 2 vertical sensor arrays
- Virginia DEQ/USGS coordinate on 3 river input continuous monitors
- 2021-22 PSC Monitoring Review proposal for capacity to support 8 new tidal water vertical array sites
  - 7 new river input con-mons at tidal/nontidal boundary
  - New 4-D water quality interpolator tool development



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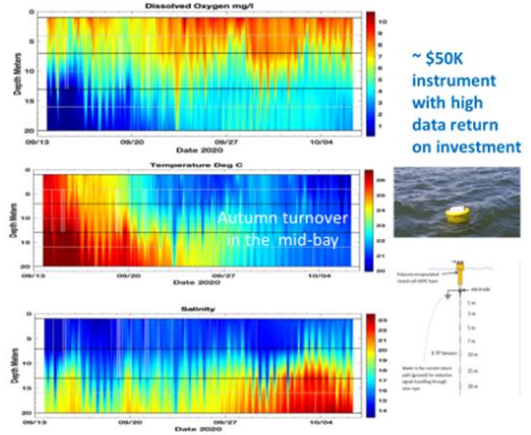


~ $50K instrument with high data return on investment

Sept-Oct 2020 mid-Bay CB4.3

D. Wilson 2020. 2019-2020 Chesapeake Bay Trust GIT-funded pilot project results

CBP Hypoxia Collaborative

We have an outline of how to use the 4D tool output for assessment of all Bay oxygen water quality criteria for 2025

water quality criteria and has therefore not been able to delist any of the 92 Chesapeake Bay segments. A new analysis system, built on an expanded data collection effort, is envisioned that will allow assessment of all water quality criteria. Figure 1 shows the flow of information in the proposed system.

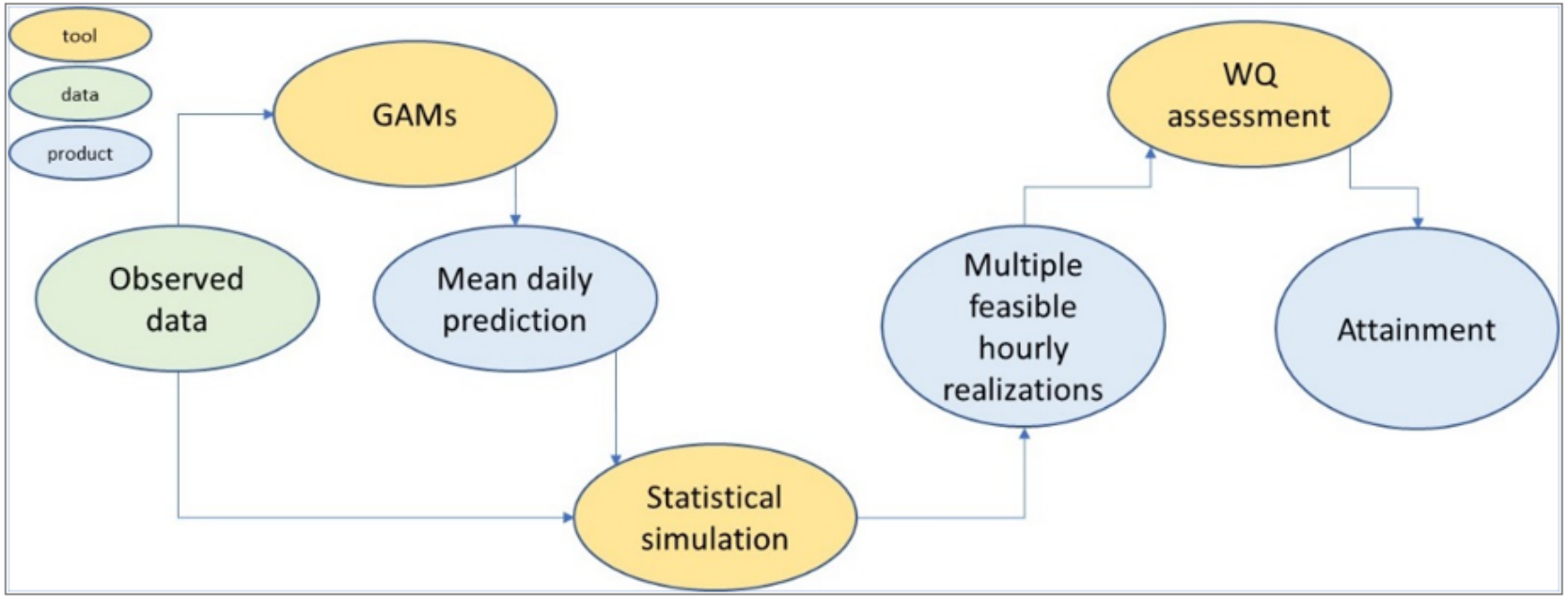
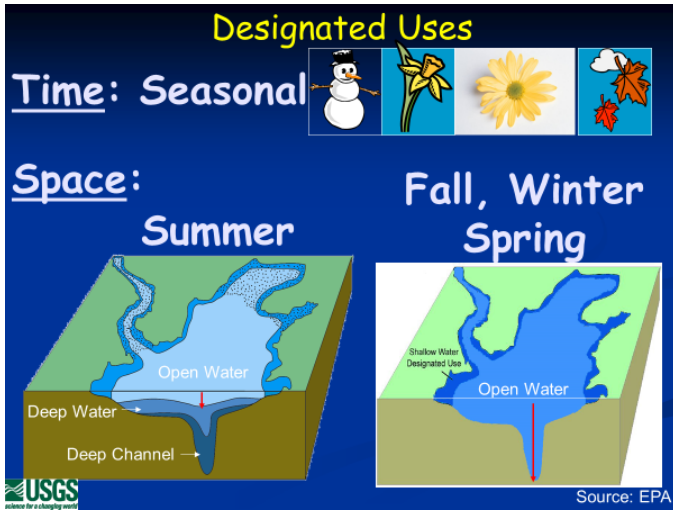


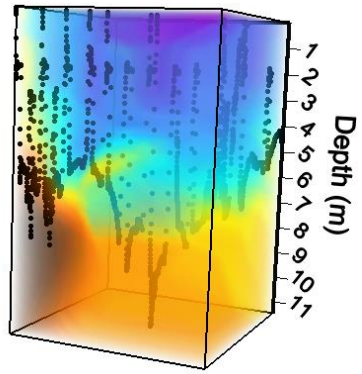
Figure 1: Interpolation and attainment assessment system

Source: G. Shenk, Elgin Perry, Rebecca Murphy/Bay Oxygen Research Group

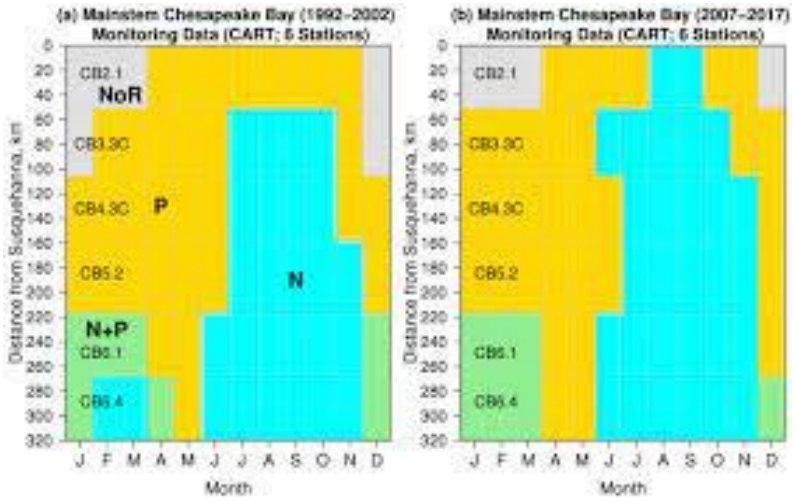
Value of investments in 4D interpolator

- For the first time in the history of the CBP partnership, our combined resources will provide the capacity to address Space and Time needs for assessing all dissolved oxygen criteria in all habitats.





Why evaluate Nutrient Limitation?

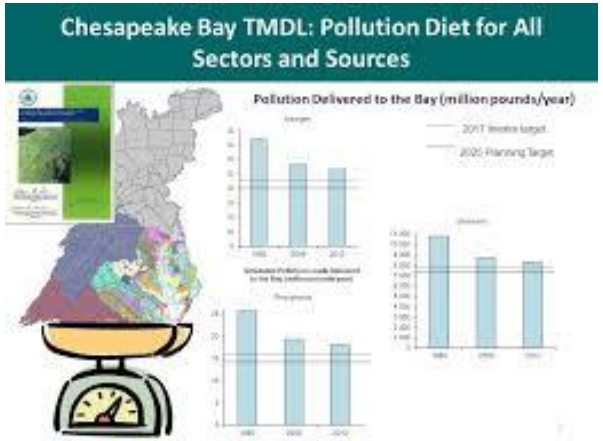


- Test current statistical models of water quality change developed by matching lab analyses to field results (i.e., Cost effective monitoring validation of a key bay condition indicator)
- Calibrate and verify bay models of water quality

Value of investments in Nutrient Limitation

- Direct, fundamental assessment of whether the Bay is responding its Pollution Diet.

- Validate published methods used to create modern nutrient limitation assessments from Chesapeake Bay long-term water quality monitoring program measurements.



Q. Zhang et al.
Water Research
(2021)

Discussion questions

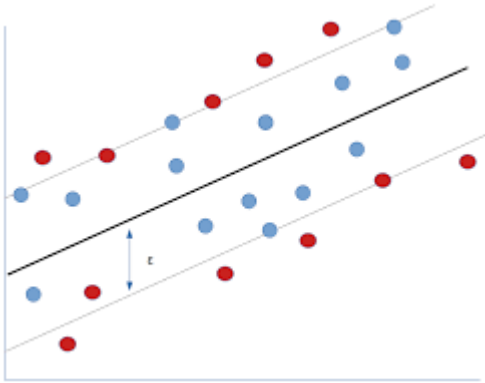
Discussion Questions

- Are any of the technical aspects of the recommendations unclear?
- Is there something else about the current funding you'd like to better understand?
- Which recommendations is your agency willing to partner on supporting? (Jamboard)
- Which CBP outcomes does your agency have interest in better coordinating monitoring or addressing other needs? (Jamboard)
- How can we sustain the networks when the infrastructure money goes away in 2025?
- Short discussion on ideas for next steps

JAMBOARD LINK

Future growth that aims at more robust, cost-effective, further integrated assessments

- Satellite-based assessments for core networks
  - Annual, baywide level water clarity assessment – presently targeting select segments
  - Annual, baywide chlorophyll criteria assessment– presently targeting select segments
  - Annual, baywide, multi-season SAV assessments – presently 1 season
- Enhanced spatial resolution from Community (Citizen) Science Tier 3 monitoring efforts
- Analysis support – not addressed in the 2021-22 PSC Monitoring review.



Adaptive Management Decision-Support:
From planning to sample collection to actionable knowledge

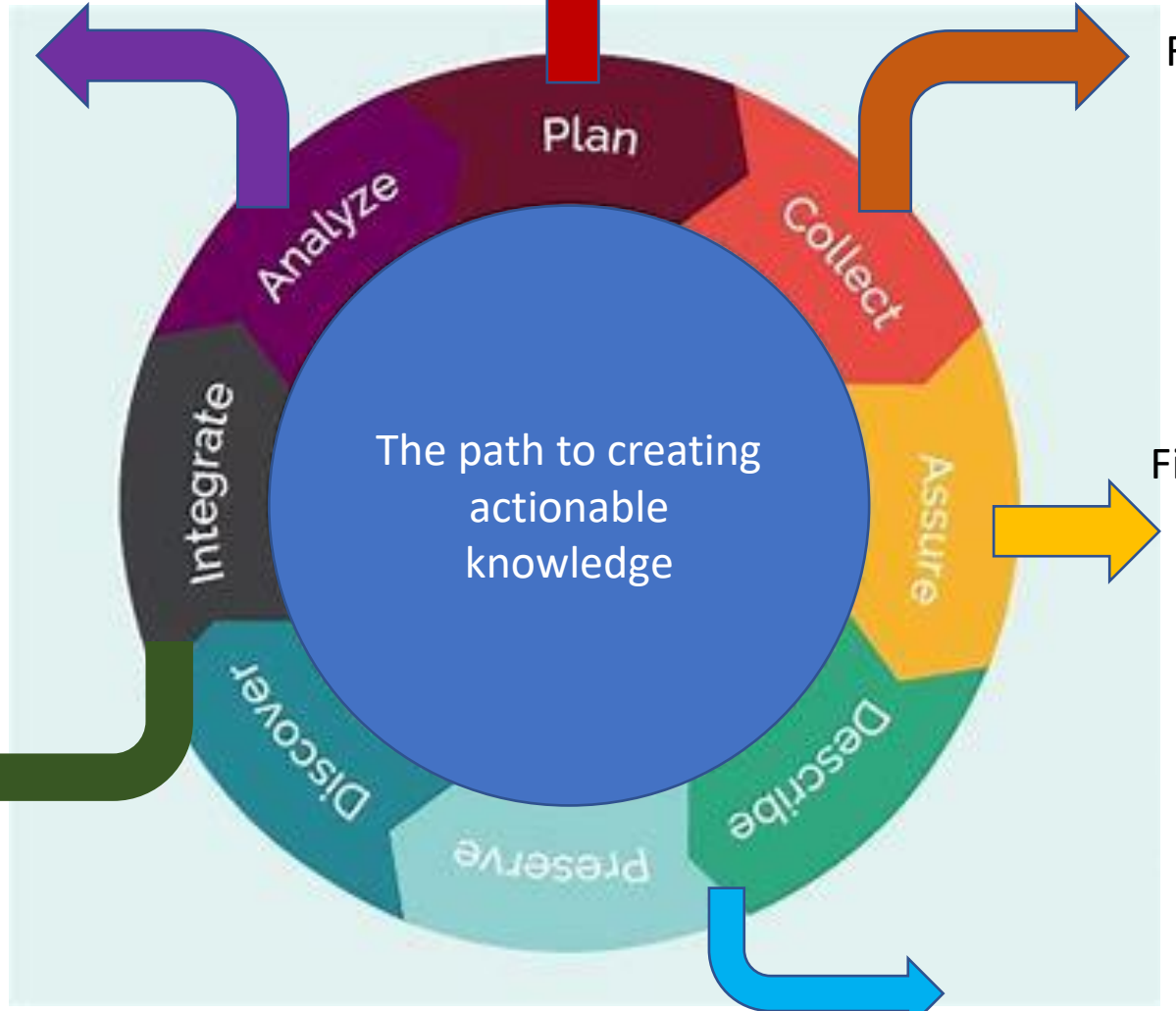
ACTIONABLE KNOWLDGE

INFORMATION

Method development
Synthesize
Translate
Data visualization
Report
Communicate

Administration
Coordination

Sensors
Field measures
Lab measures



Field, lab & data management
QA program

Model
Calibrate
Verify

Metadata management
IT data input and storage management