CBP Tributary Summaries: Communication Tool on Water Quality Changes to Inform Management Decisions

ICPRB 2023 Potomac River Conference: One River's Perspective on a Changing Climate

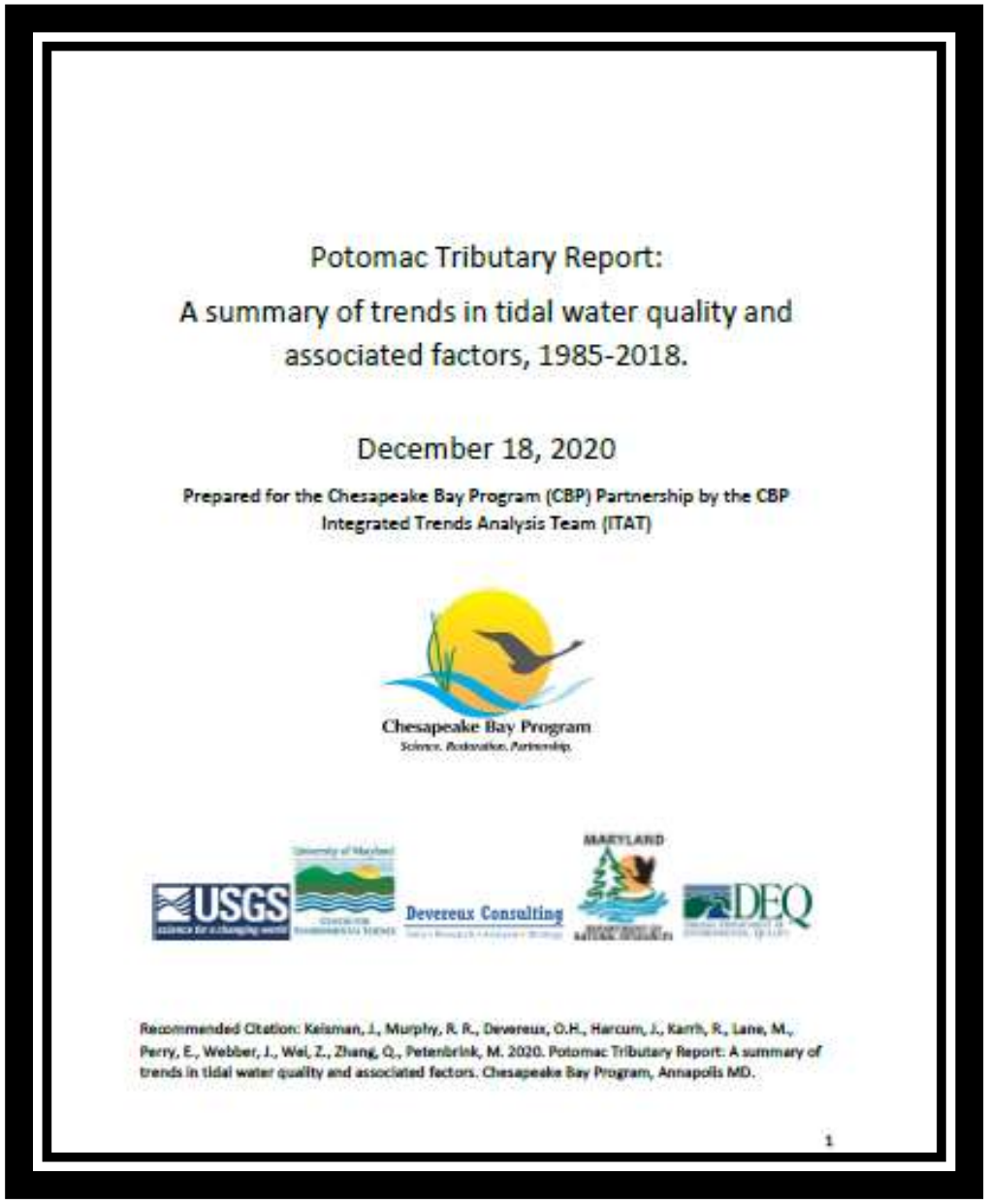
September 21, 2023

Presented by: Alex Gunnerson (Chesapeake Research Consortium)

On Behalf of: The Chesapeake Bay Program Integrated Trends Analysis Team and partners

Overview of Presentation

- Tributary Summaries
  - What are the Tributary Summaries?
  - Looking at the Potomac Tributary Summary
  - Tributary Summaries Storymap
  - Next Steps for the Tributary Summaries


Potomac Tributary Report:

A summary of trends in tidal water quality and associated factors, 1985-2018.

December 18, 2020

Prepared for the Chesapeake Bay Program (CBP) Partnership by the CBP Integrated Trends Analysis Team (ITAT)

Chesapeake Bay Program

Science. Restoration. Partnership.

USGS

Devereux Consulting

MARYLAND DEQ

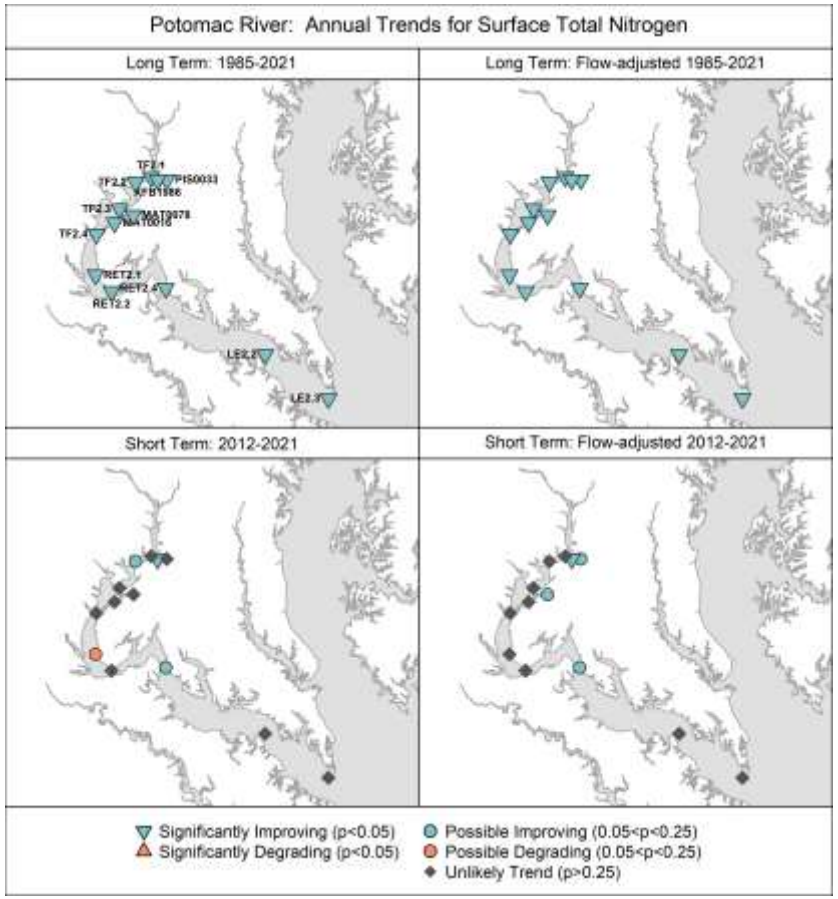
Recommended Citation: Kelaman, J., Murphy, R. R., Devereux, O.H., Harcum, J., Karrh, R., Lane, M., Perry, E., Webber, J., Wei, Z., Zhang, Q., Petenbrink, M. 2020. Potomac Tributary Report: A summary of trends in tidal water quality and associated factors. Chesapeake Bay Program, Annapolis MD.

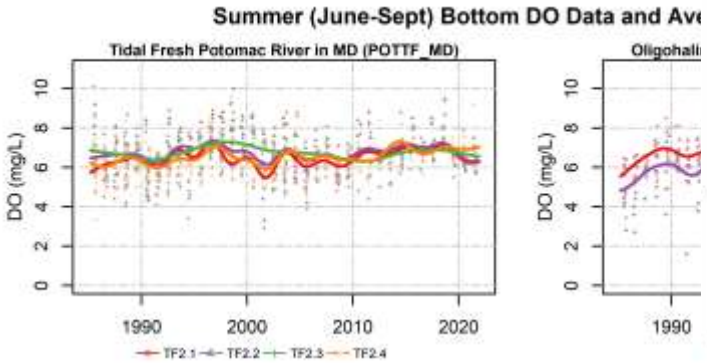
1

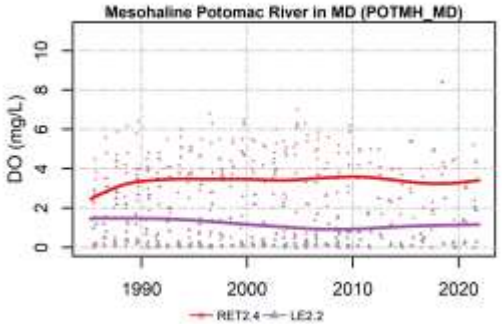
What are the Tributary Summaries?

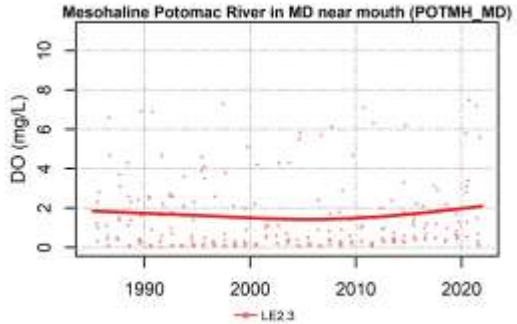
A compilation of information by tributary or region on:

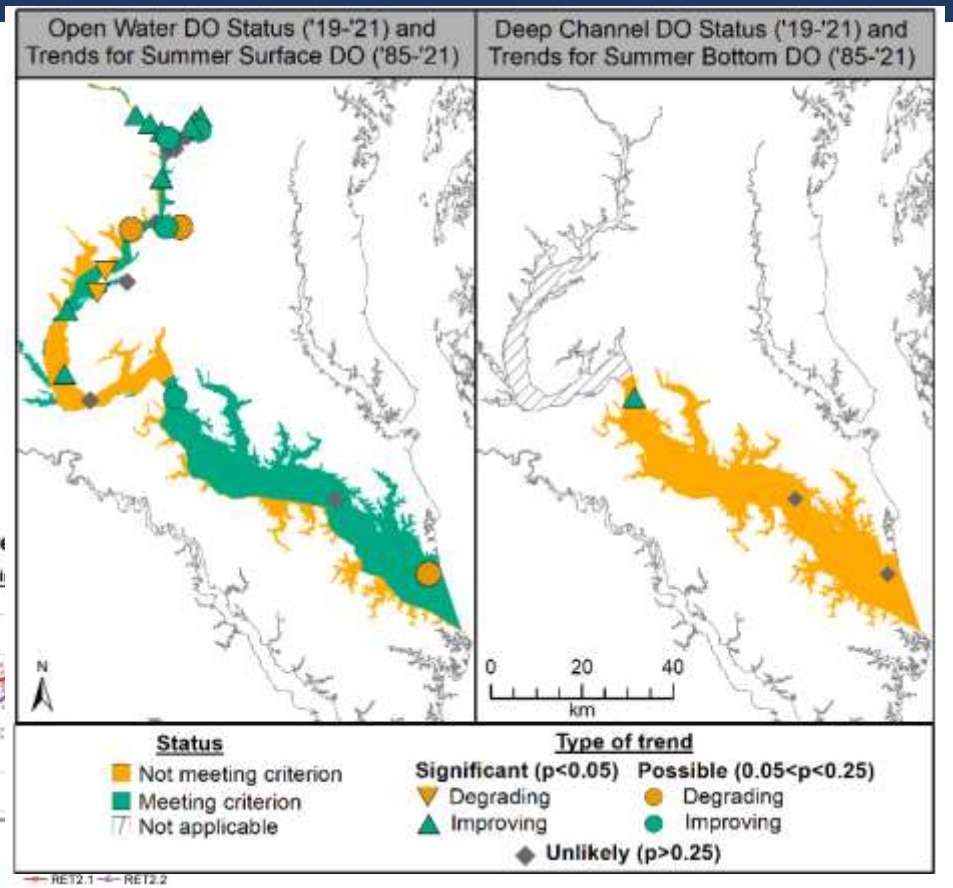
- **Tidal water quality and trends**







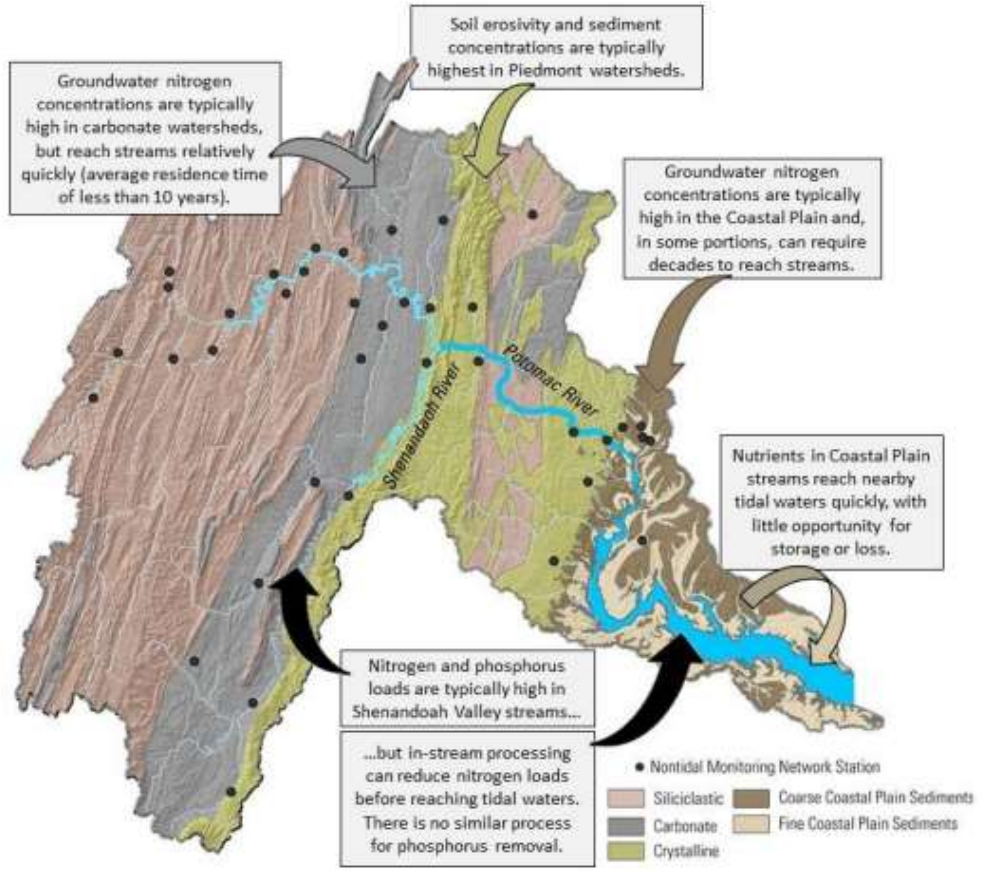


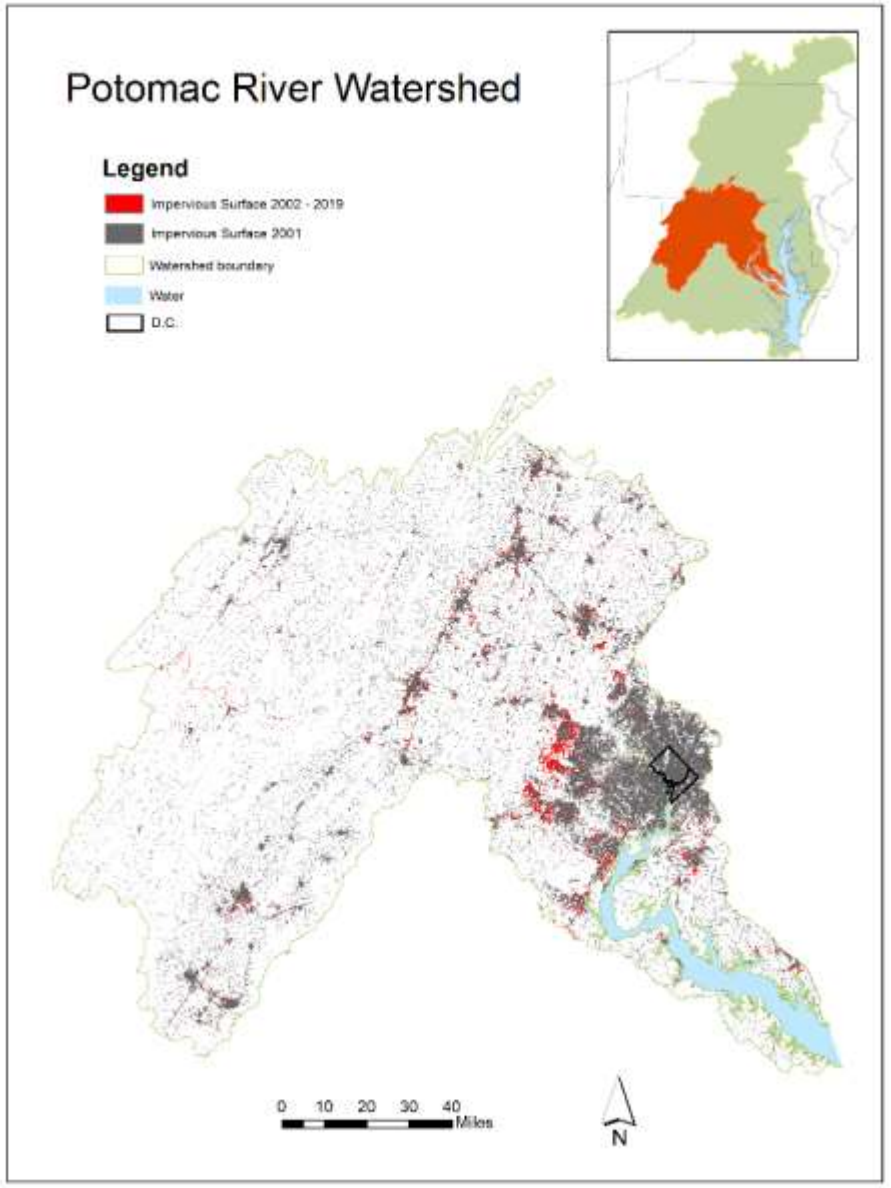


What are the Tributary Summaries?

A compilation of information by tributary or region on:

- Tidal water quality and trends,
- **Watershed characteristics and changes**





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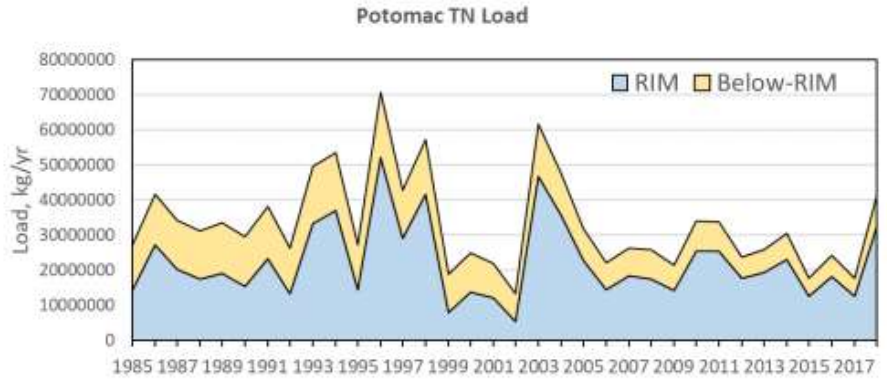
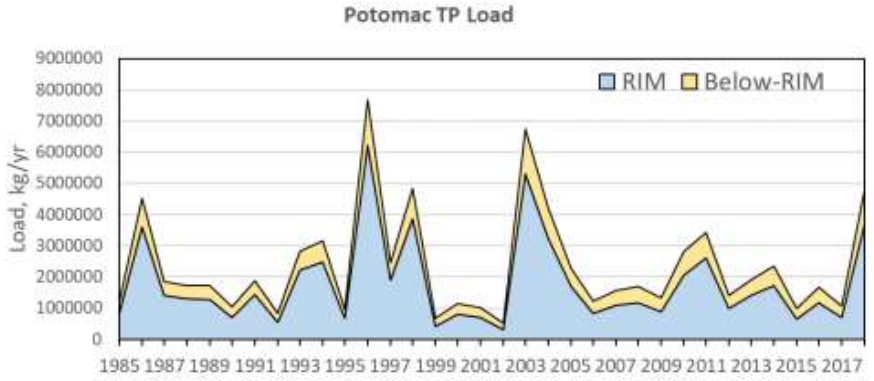




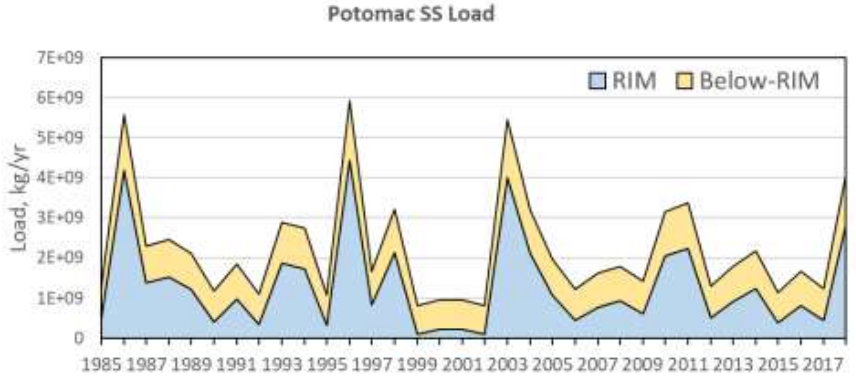


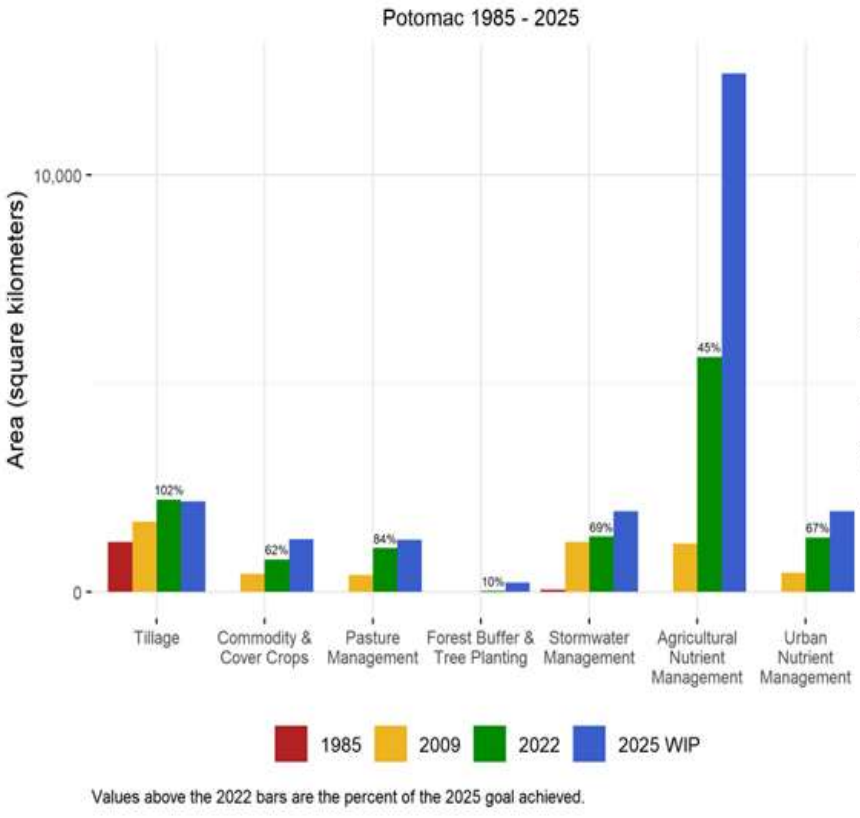
Table 3. Trends (2009 – 2018) in flow normalized total nitrogen (TN), total phosphorus (TP), and suspended sediment (SS) for nontidal network monitoring locations in the Potomac River watershed.

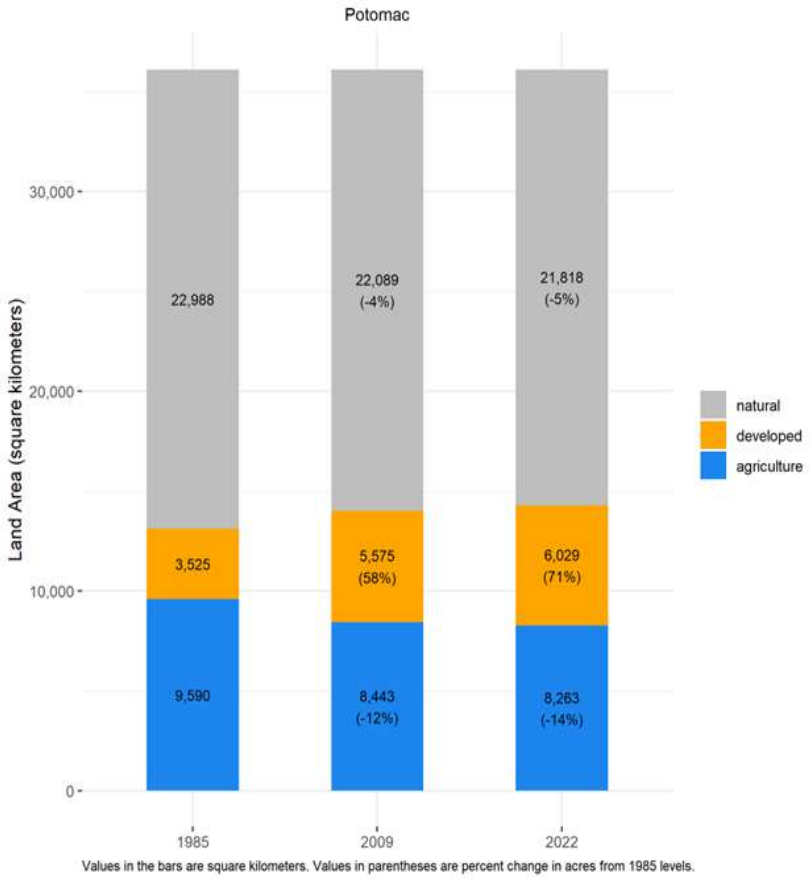
Parameter	No. of stations	Value	Trend direction		
			degrading	improving	no trend
TN	28	n	7	14	7
		median %	15.4%	-5.8%	1.1%
TP	18	n	0	12	6
		median %	-	-28.9%	8.5%
SSC	18	n	5	5	8
		median %	23.7%	-24.4%	5.2%

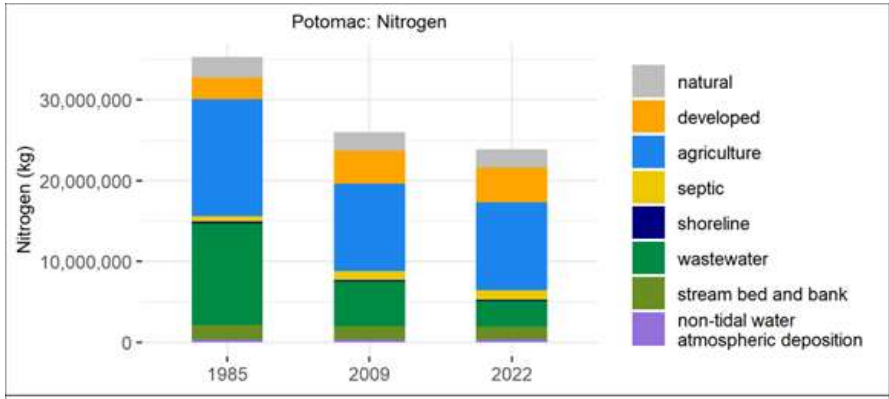
What are the Tributary Summaries?

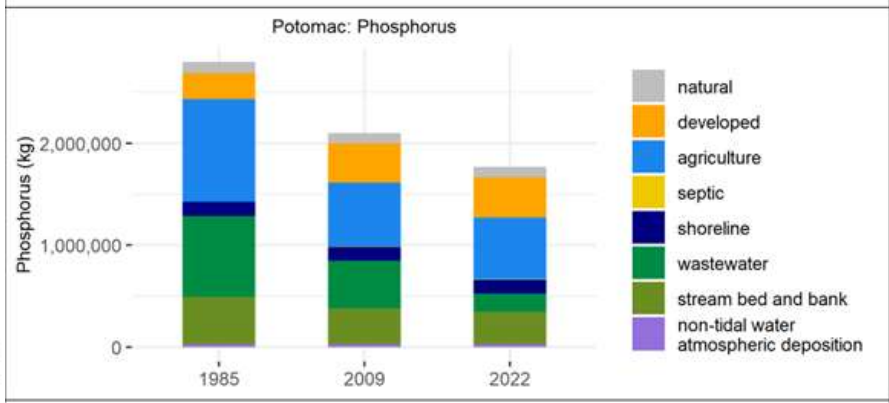
A compilation of information by tributary or region on:

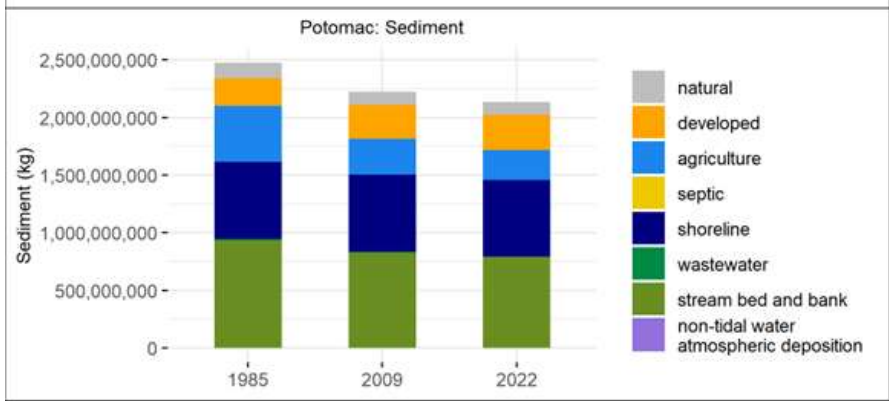
- Tidal water quality and trends,
- Watershed characteristics and changes,
- **Landscape drivers.**



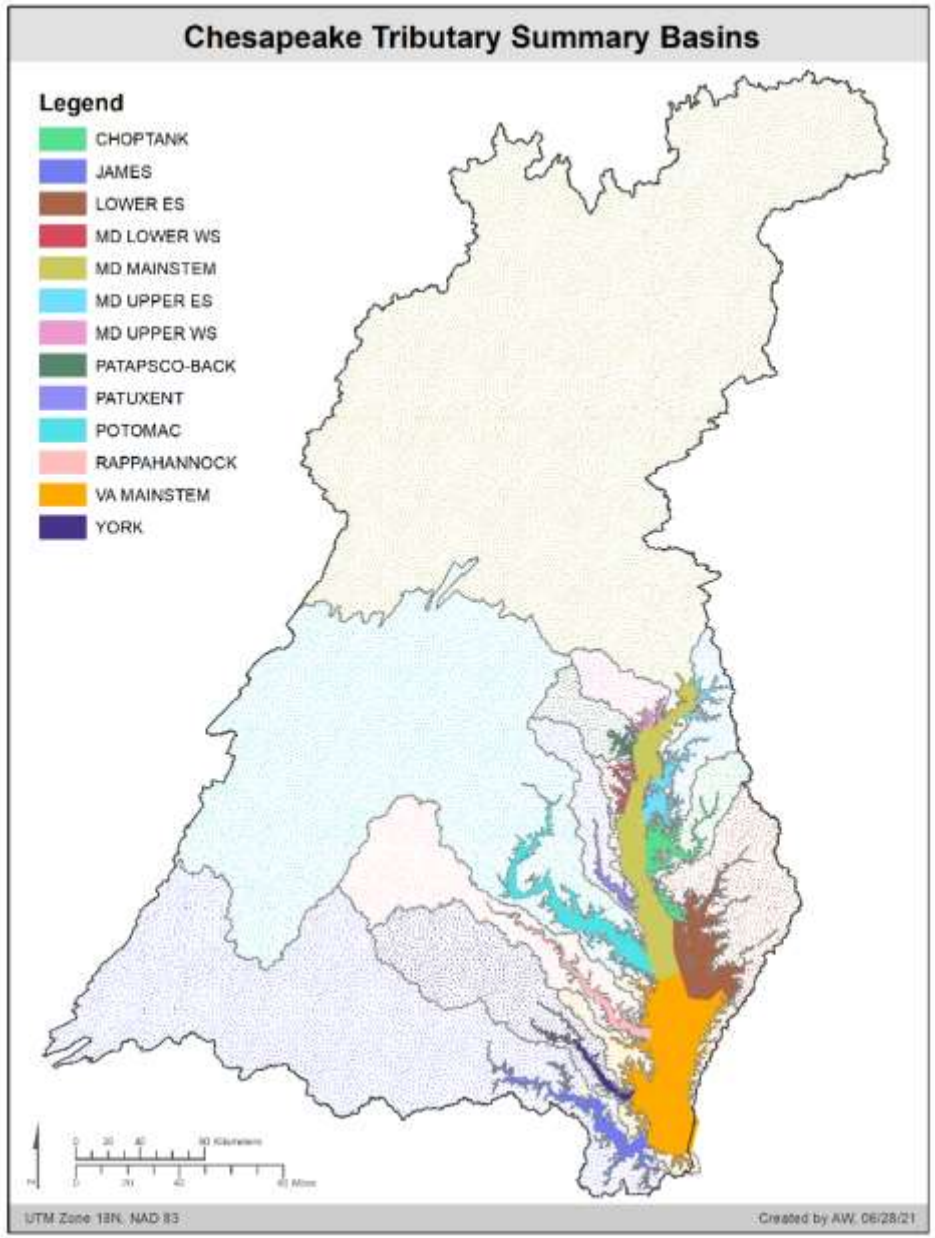








13 Tributary Summaries



- **Maryland Mainstem** *(The 5 Chesapeake Bay mainstem segments within the MD state boundary. Drainage basins include the Susquehanna River and upper Chesapeake shorelines)*
- **Maryland Upper Eastern Shore** *(The Northeast, Bohemia, Elk, Back Creek, Sassafras, and Chester Rivers, the C&D Canal, and Eastern Bay)*
- **Choptank** *(the Choptank, Little Choptank, and Honga)*
- **Maryland Upper Western Shore** *(Bush, Gunpowder, Middle Rivers)*
- **Maryland Lower Western Shore** *(Magothy, Severn, South, Rhode, and West)*
- **Patapsco & Back Rivers**
- **Patuxent** *(includes the Western Branch tributary)*
- **Potomac**
- **Rappahannock** *(includes the Corrotoman tributary)*
- **York** *(includes the Mattaponi and Pamunkey tributaries)*
- **James** *(includes the Appomattox, Chickahominy, and Elizabeth tributaries)*
- **Lower E. Shore** *(includes the Nanticoke, Manokin, Wicomico, Big Annemessex, and Pocomoke rivers & Tangier Sound)*
- **Virginia Mainstem** *(no summary but Appendices are provided)*

Who is the audience for the tributary summaries?

- Technical managers within jurisdiction agencies
  - Local watershed organizations
- Federal, state, and academic researchers

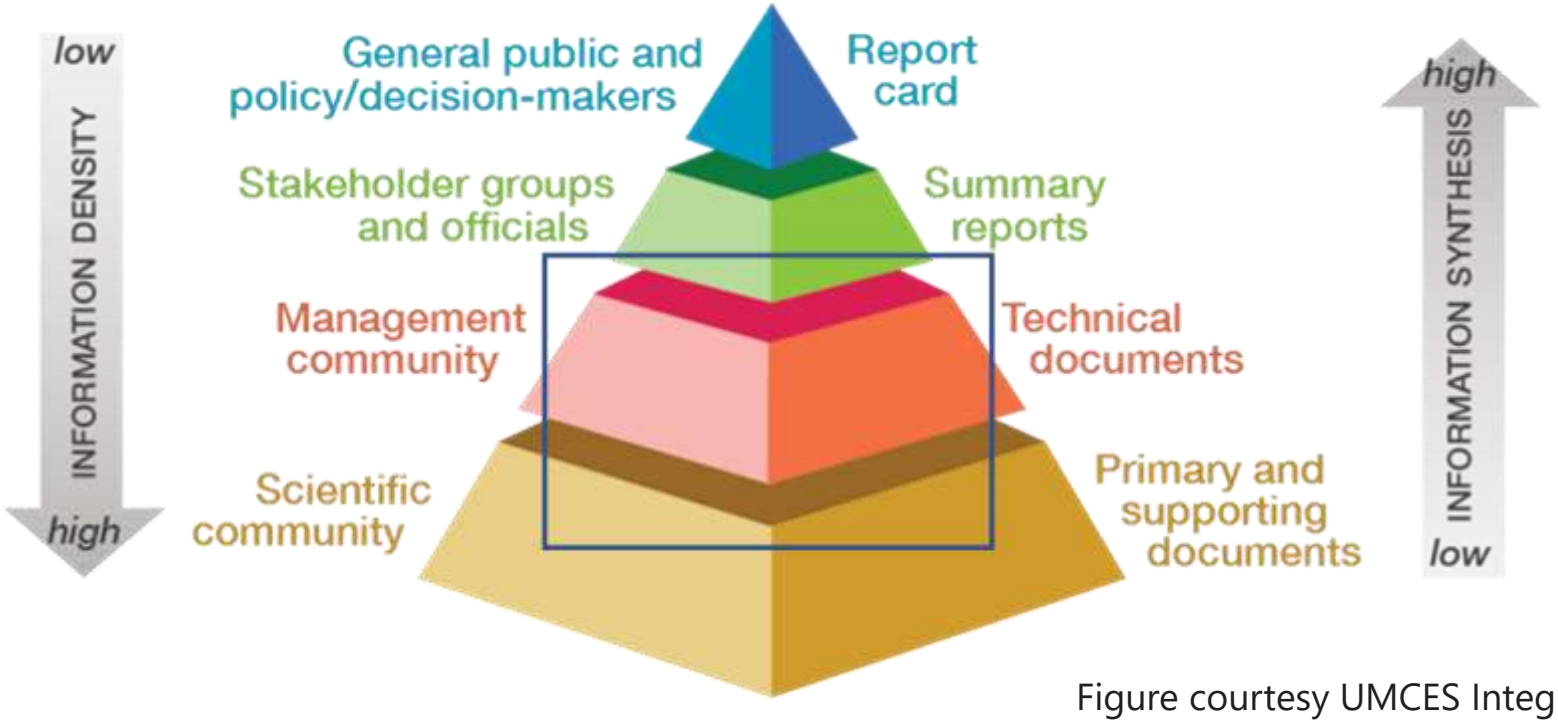
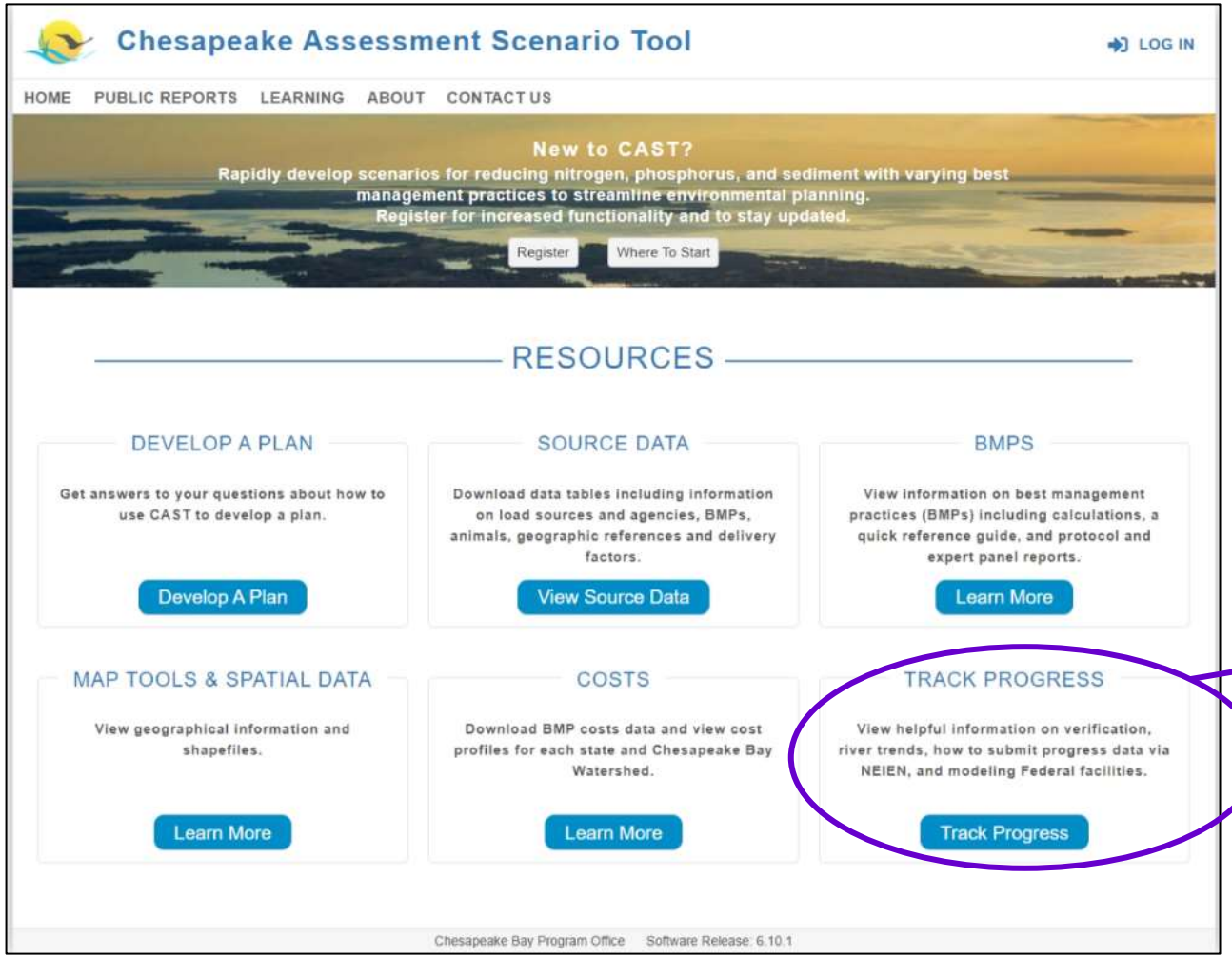
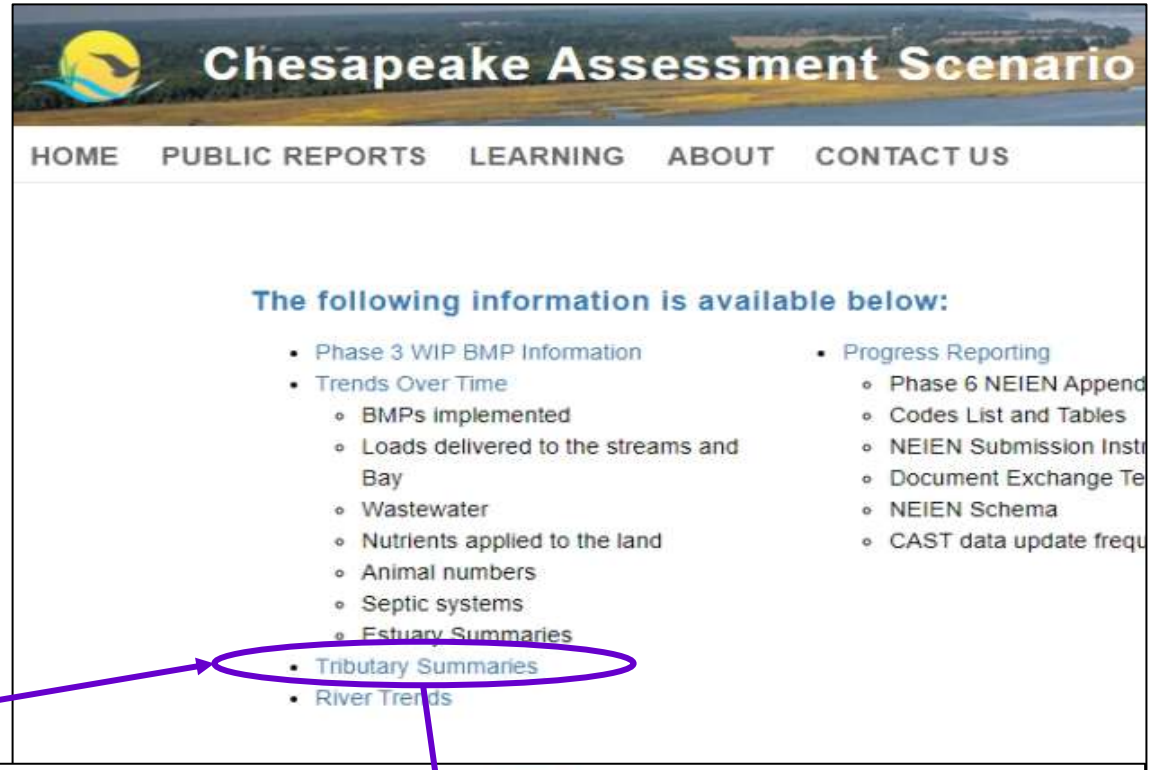
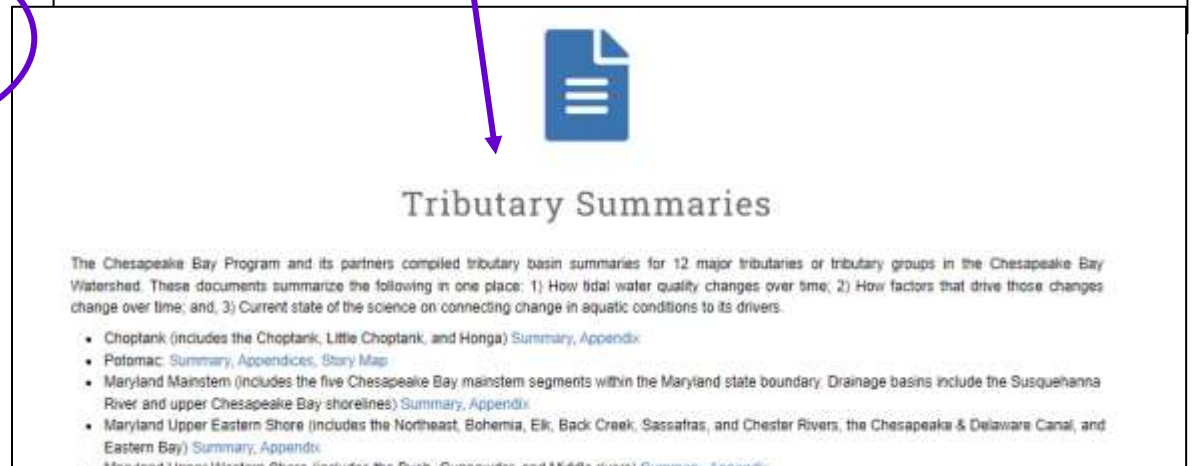


Figure courtesy UMCES Integration and Application Network, ian.umces.edu

Where can I access the tributary summaries?



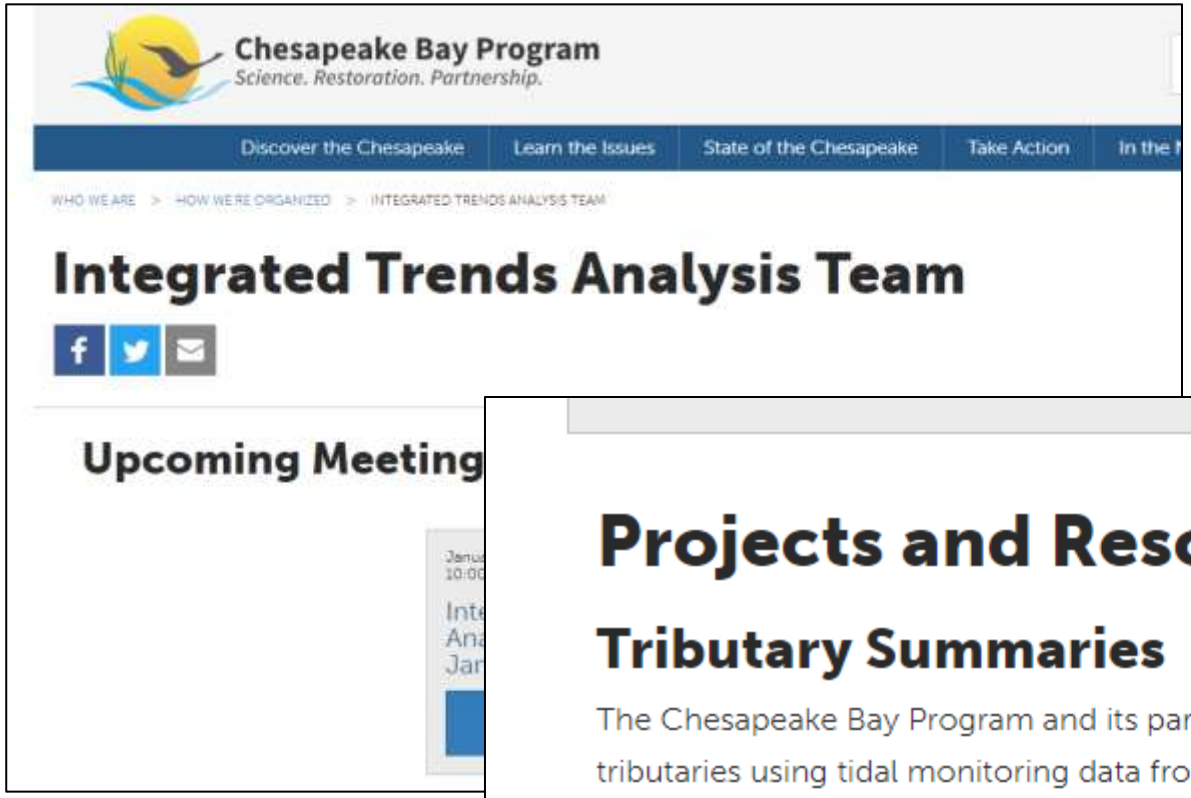




[CAST - TMDL Tracking (chesapeakebay.net)]

Where can I access the tributary summaries?

https://www.chesapeakebay.net/who/group/integrated_trends_analysis_team



Projects and Resources

Tributary Summaries

The Chesapeake Bay Program and its partners produce tributary basin summary reports for the Bay's 12 major tributaries using tidal monitoring data from more than 130 monitoring stations throughout the mainstem and tidal portions of the Bay. These reports use water quality sample data to summarize 1) How tidal water quality (TN, TP, DO, Chlorophyll a, Secchi Depth) has changed over time, 2) How and which factors may influence water quality change over time, and 3) Recent research connecting observed changes in aquatic conditions to its drivers.

These documents can be found here: https://cast.chesapeakebay.net/Home/TMDLTracking#tributaryRptsSection

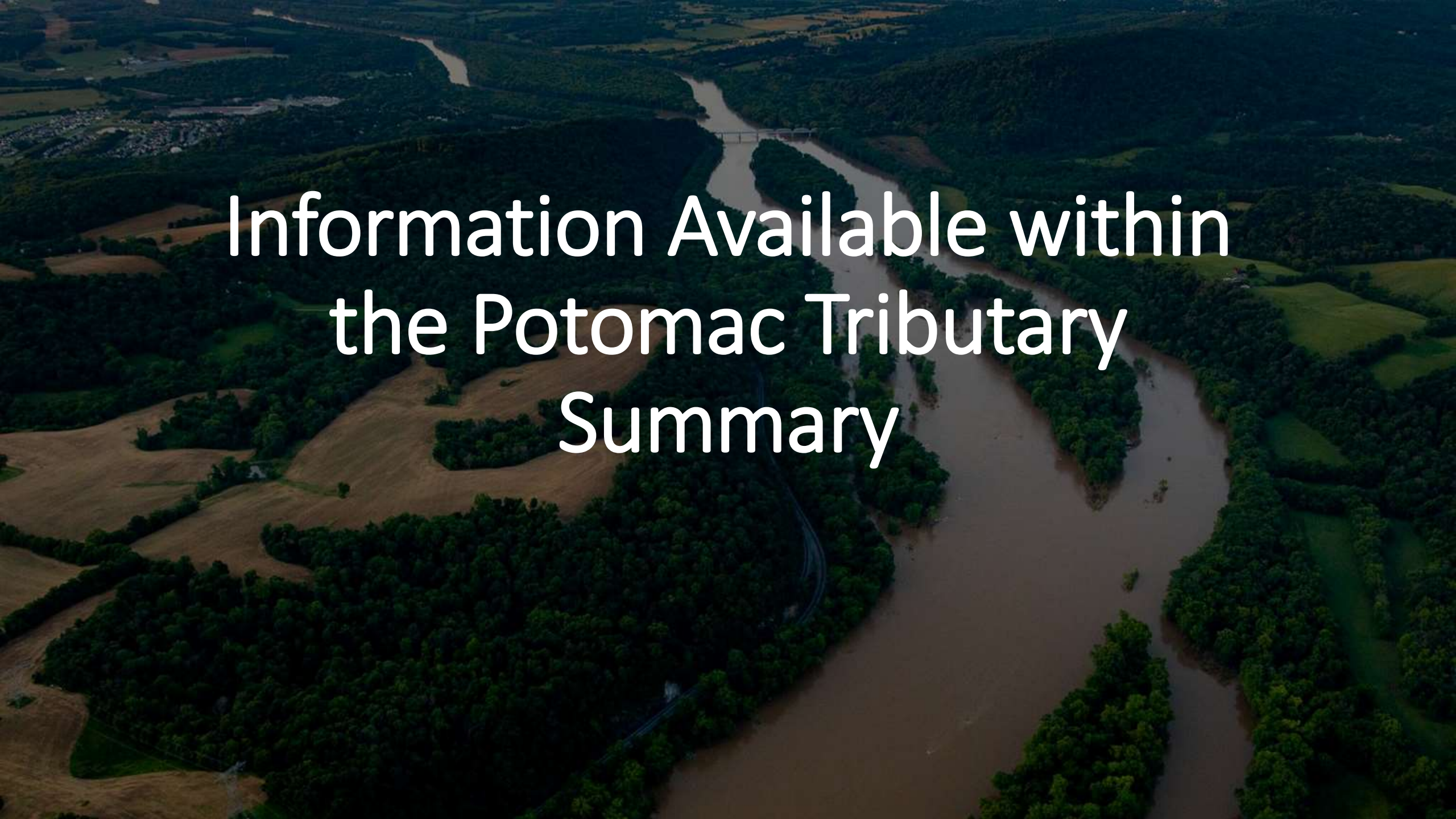
How do we use the information found in the tributary summaries?

- As readily-available ***background*** for change over time in tidal water quality observed with monitoring data.

- To answer questions such as:
  - *Have water quality indicators in my river been improving or degrading over time?*
  - *How have landscape factors that drive water quality change in my watershed changed over time?*
  - *What clues do they provide that might explain observed water quality change (or lack of change)?*
  - *What should I target to turn a degrading trend around or maintain improvements for future water quality and living resource conditions?*
  - *What should scientists focus our analyses on to provide better answers in the future?*

<u>Looking at one tributary summary today:</u>

1) Potomac Tributary Summary



Information Available within the Potomac Tributary Summary

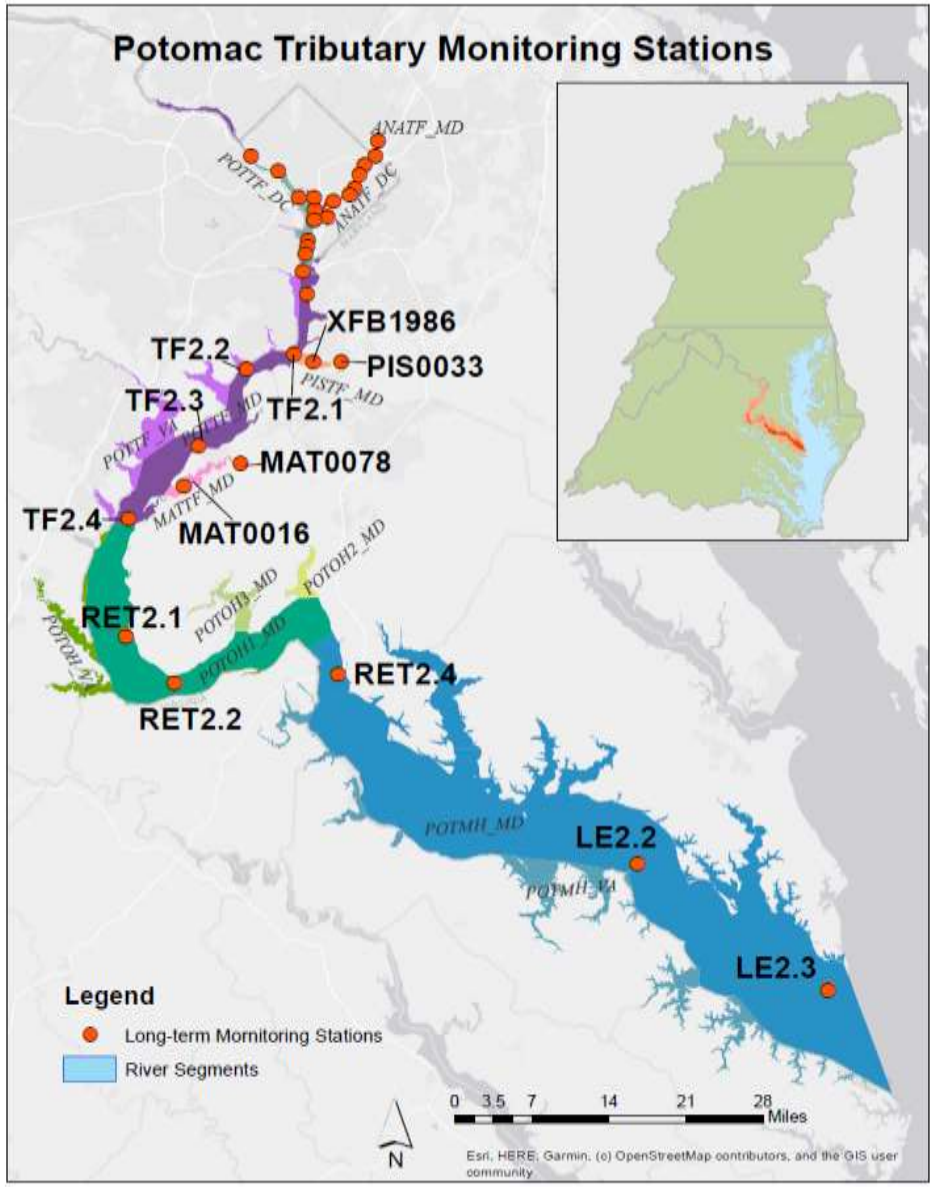
Example 1: Potomac Tributary Summary

- Completed Dec, 2020. Uses data from 1985-2018.
  - Components of this presentation come from more frequently updated data sources that go through 2021

- Currently working to update with 2022 data.

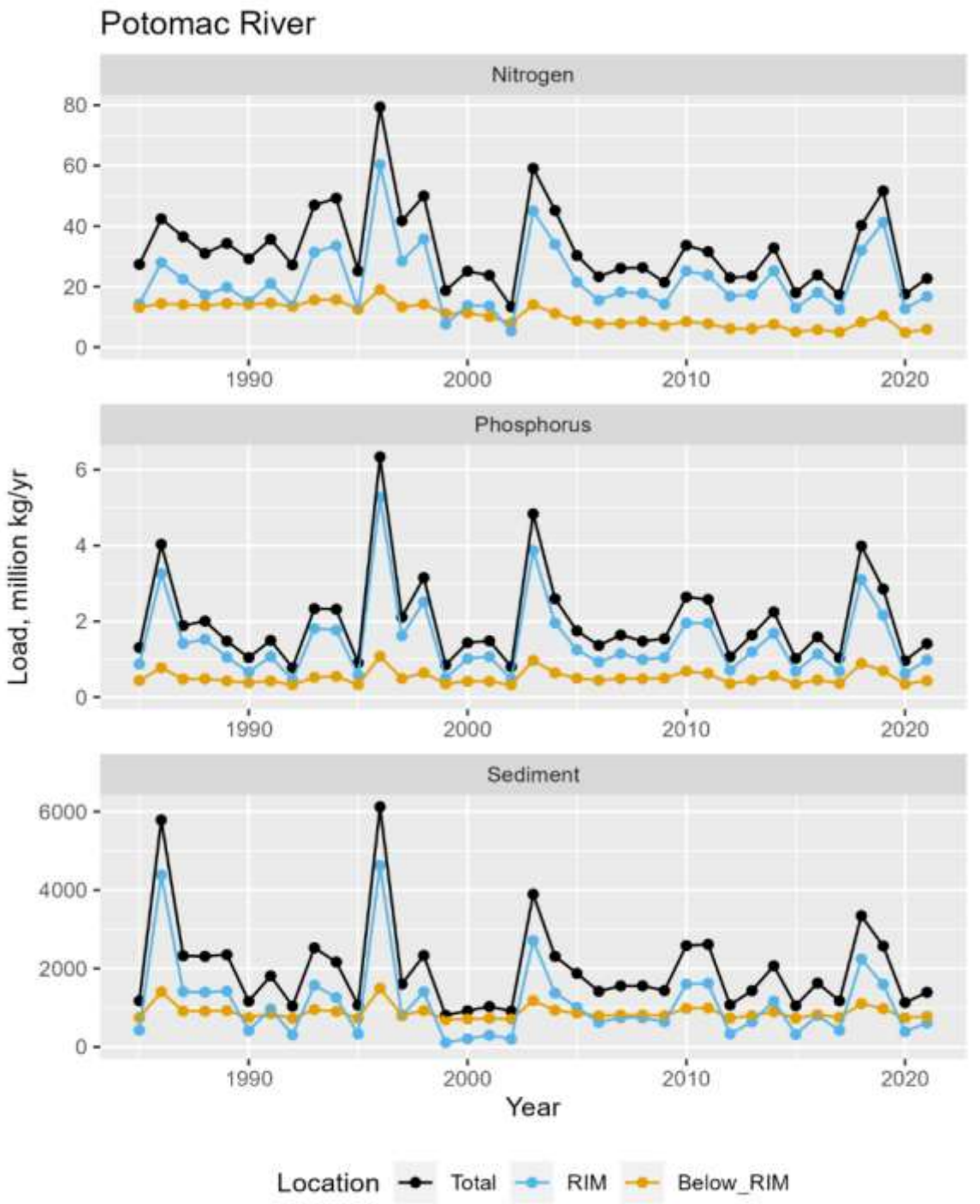
Keisman, J., Murphy, R. R., Devereux, O.H., Harcum, J., Karrh, R., Lane, M., Perry, E., Webber, J., Wei, Z., Zhang, Q., Petenbrink, M. 2020. Potomac Tributary Report: A summary of trends in tidal water quality and associated factors. Chesapeake Bay Program, Annapolis MD.

- Story Map produced by USGS: https://wim.usgs.gov/geonarrative/potomactrib/



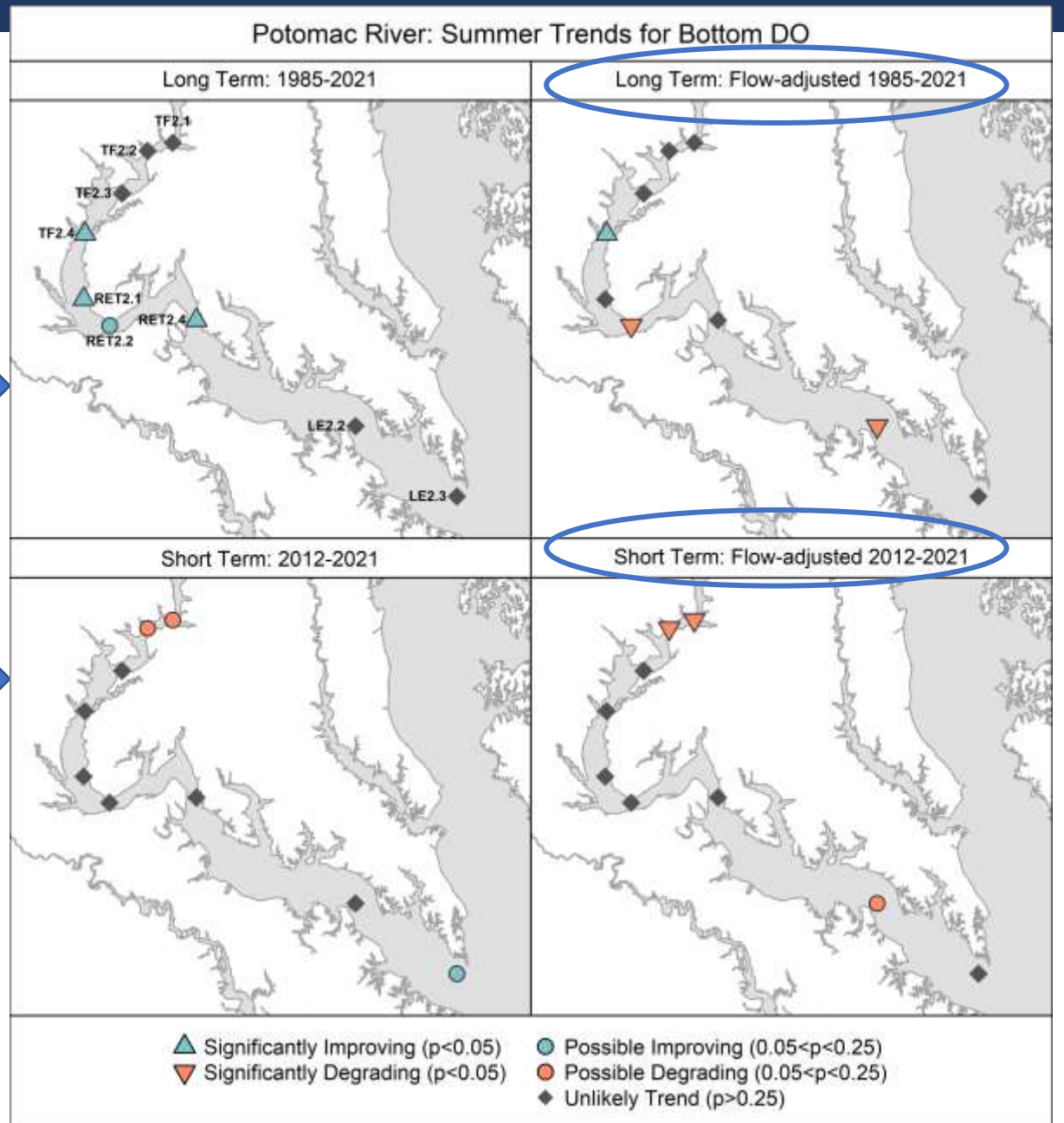
Example 1: **Estimated Loads**

- *Estimated loads to tidal portions of the tributary from USGS River Input Monitoring (RIM) Stations at the tidal-nontidal interface.*
- *True condition loads are highly variable due to freshwater flow.*
- <u>Estimated loads to the tidal Potomac:</u>
  - TN has an overall decline that is significant due to substantial efforts to reduce Nitrogen loads from WWTPs and the introduction of the Clean Air Act.
  - TP and SS has an overall decline that is not significant.



Example 1: Bottom Dissolved Oxygen (DO)

- Long Term vs Short Term Trends:
  - Long term observed change
  - Long term flow-adjusted change (i.e., if flow had been average)
  - Recent 10-year observed change
  - 10-year flow-adjusted

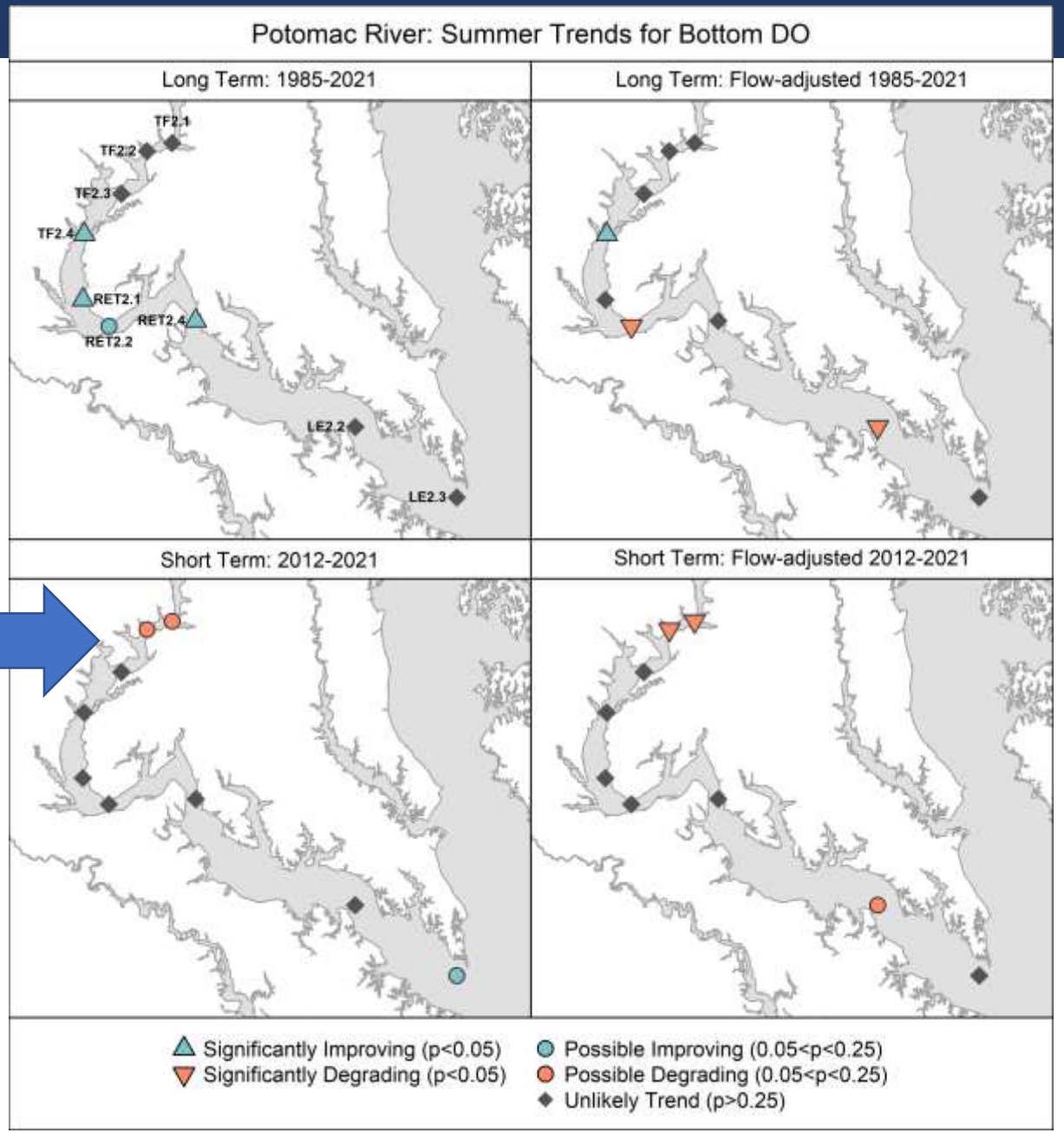


Example 1: Bottom DO

Bottom DO trends in the tidal Potomac:

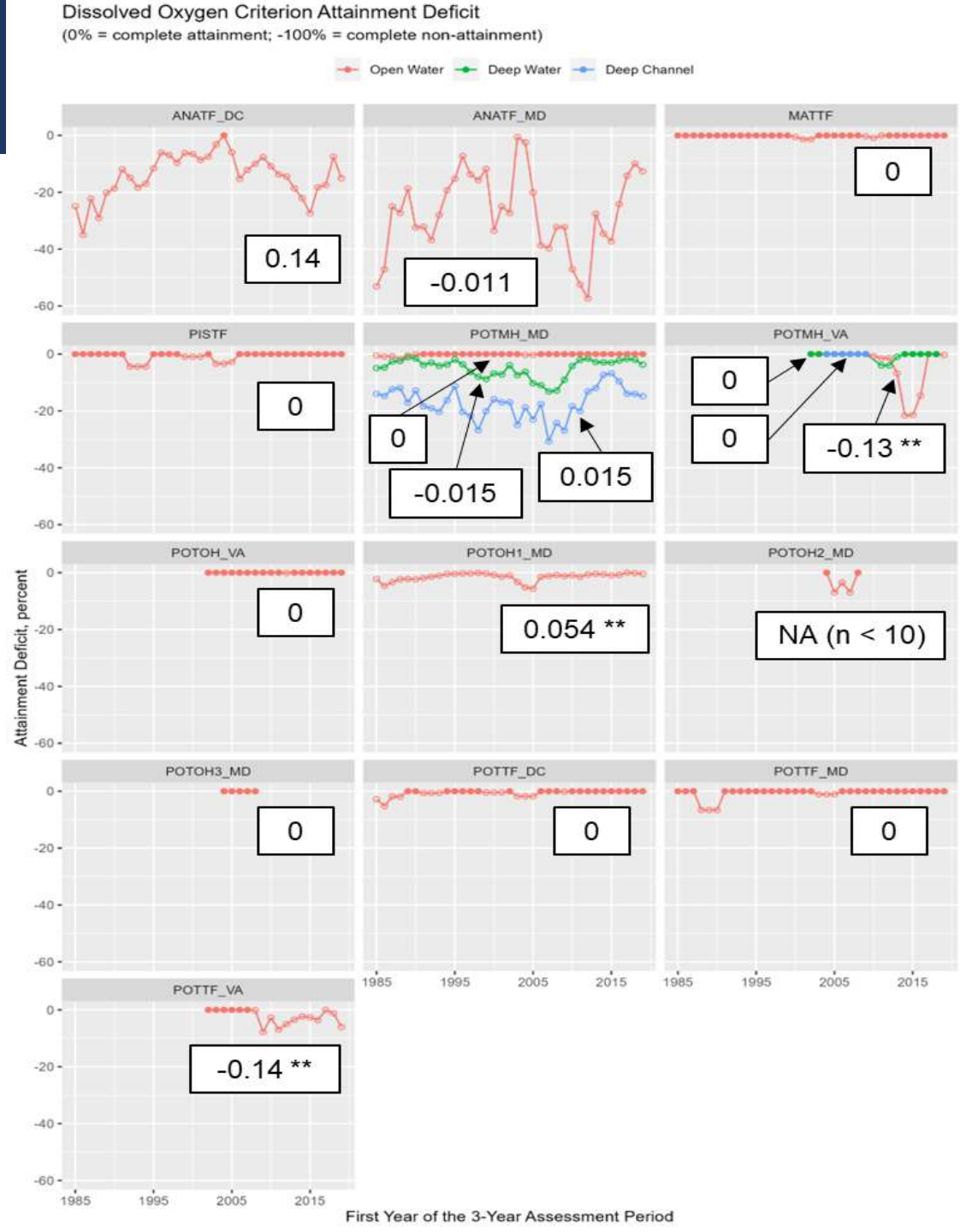
- Summer (June-Sept) bottom DO is improving at many stations, but flow-adjusted trends show some decreases.

- Summer DO is really variable, and we are seeing degrading trends higher up in the tributary for short term trends compared to unlikely trends in the long term.



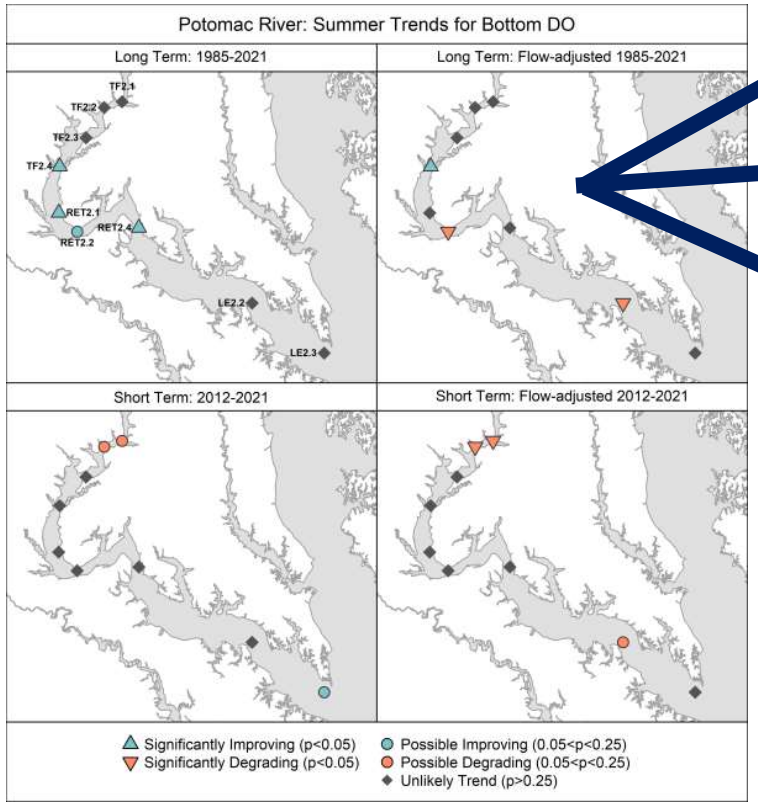
Example 1: Water Quality (WQ) Status

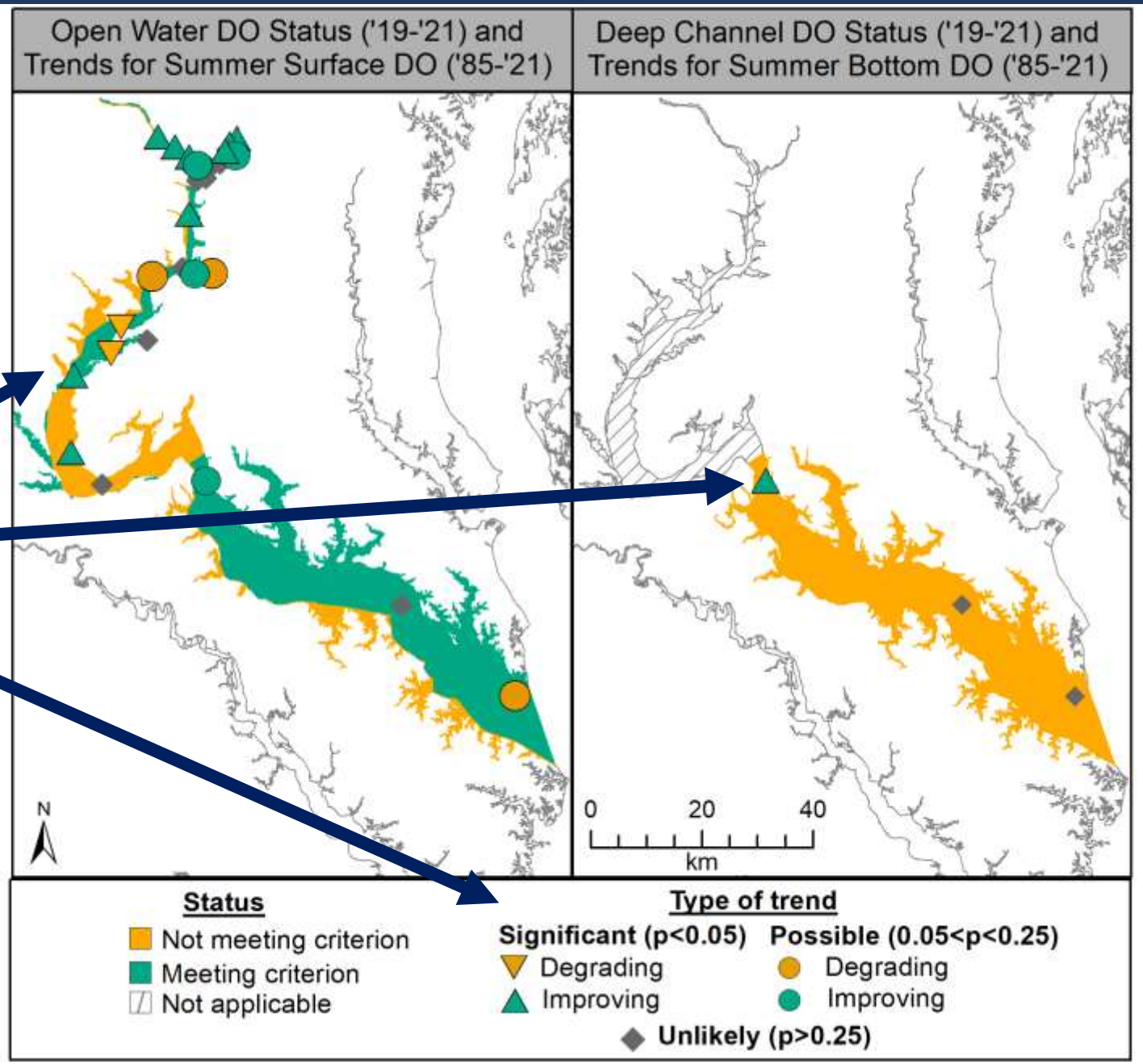
- Attainment deficit for Open Water, Deep Water, and Deep Channel DO criteria for three-year assessment periods from the start of monitoring through the current (2019-2021) assessment period.
- A value of 0% indicates full attainment for a given criterion
- Negative values indicate percent non-attainment (deficit)
- Numbers associated with a given line are the Sen Slope estimates.



Example 1: WQ Status

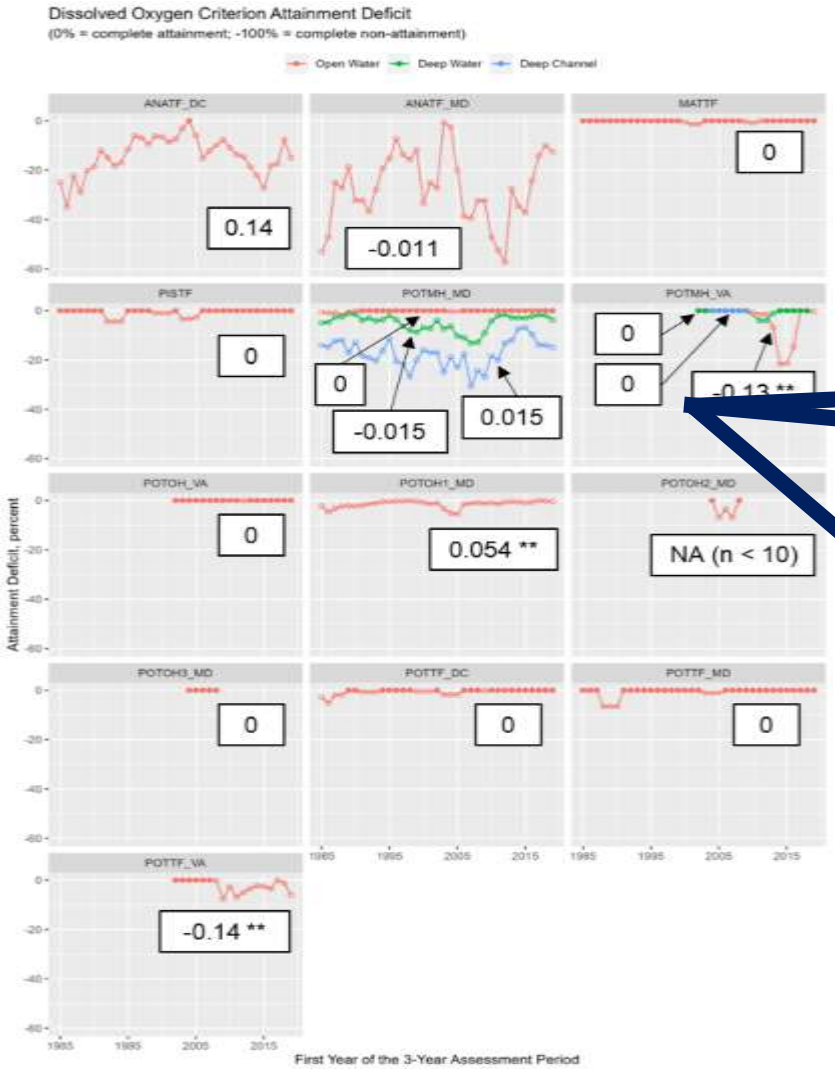
1. Trends in station-level DO concentrations

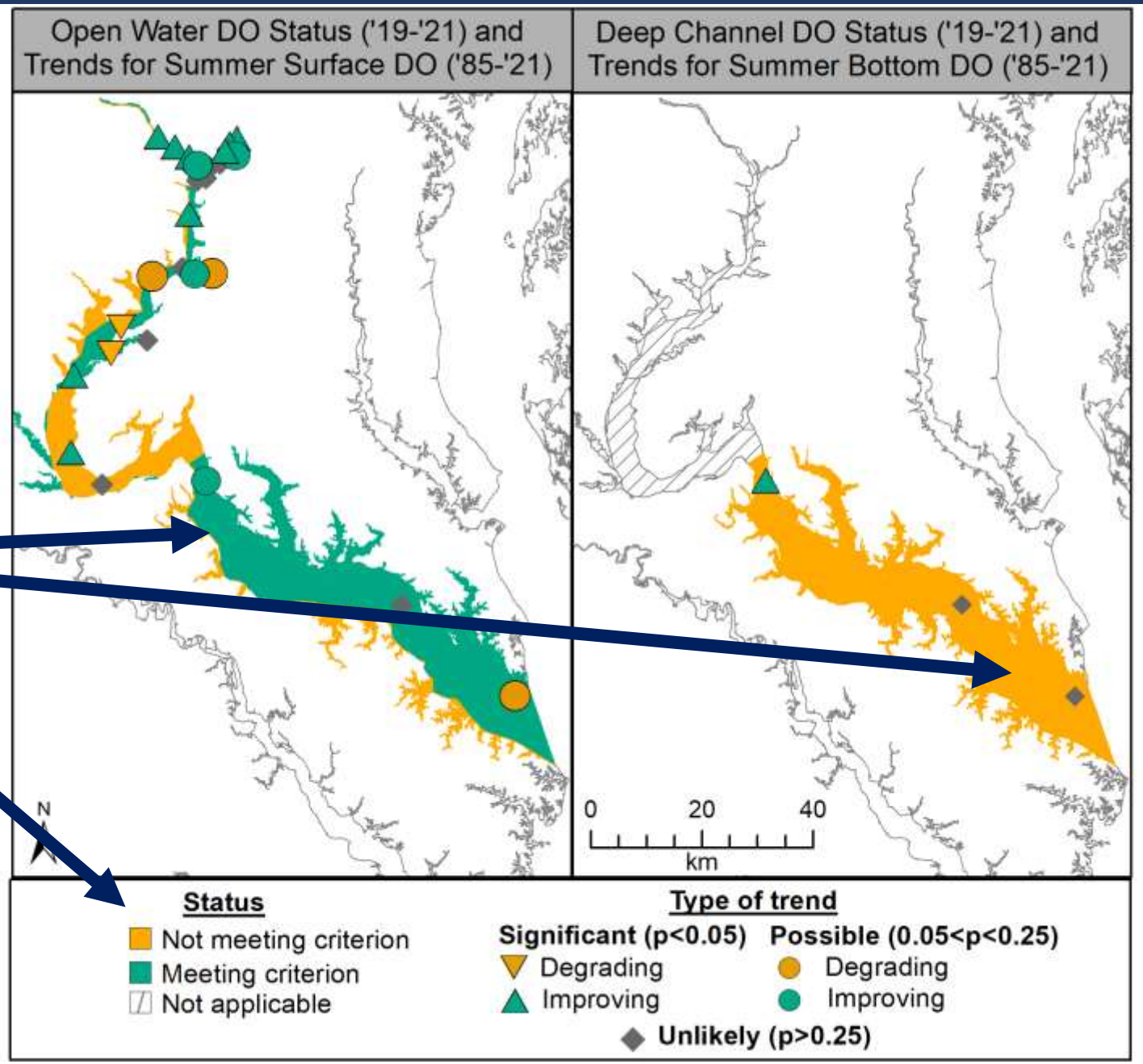




Example 1: WQ Status

2. DO Criterion Status



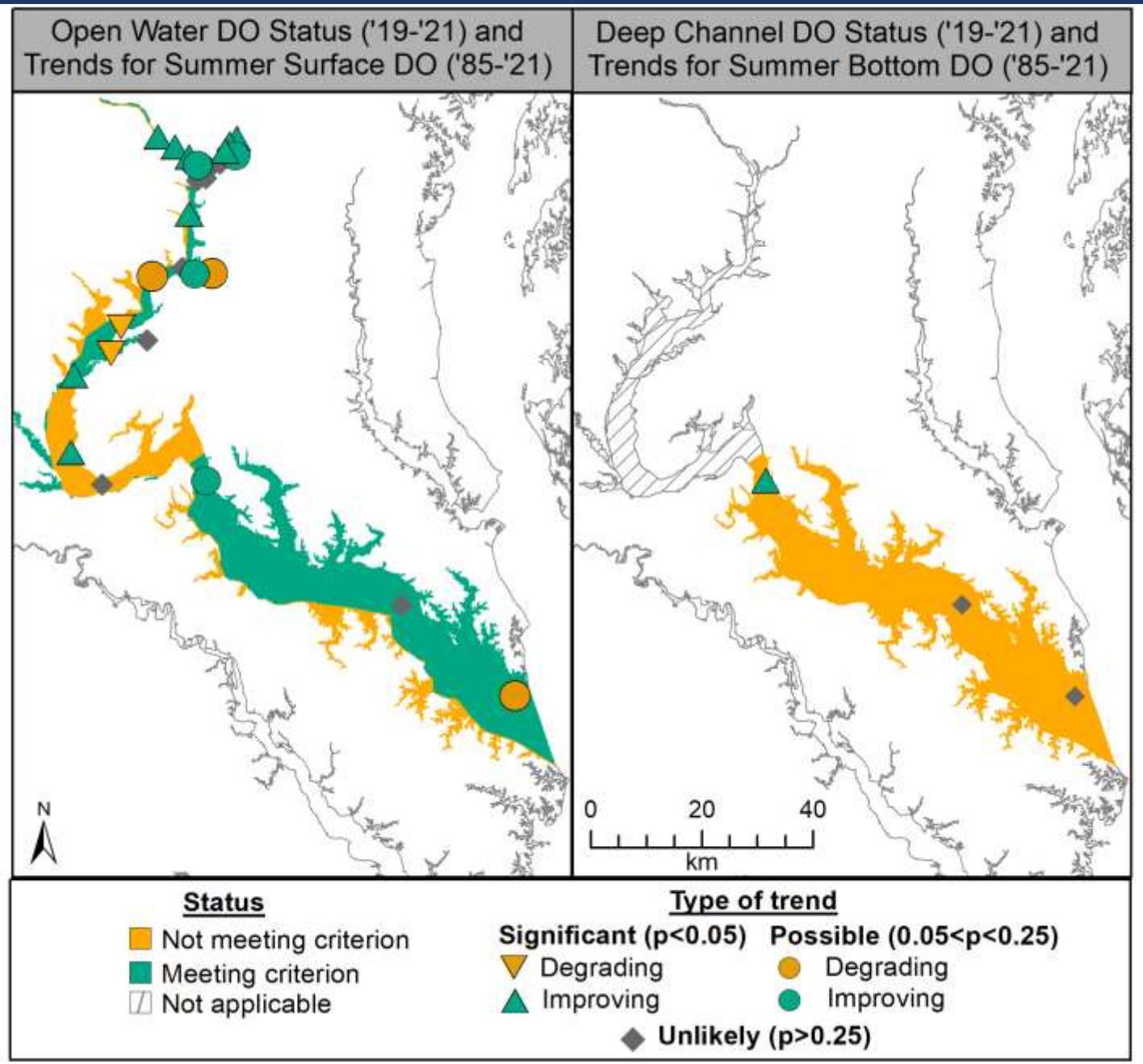


Case Study 1: WQ Status

- Comparing 1) trends in station-level DO concentrations to 2) the computed DO criterion status for a recent assessment period can reveal valuable information:

  - Whether **progress is being made towards WQ attainment in a segment that is not meeting the water quality criteria**,

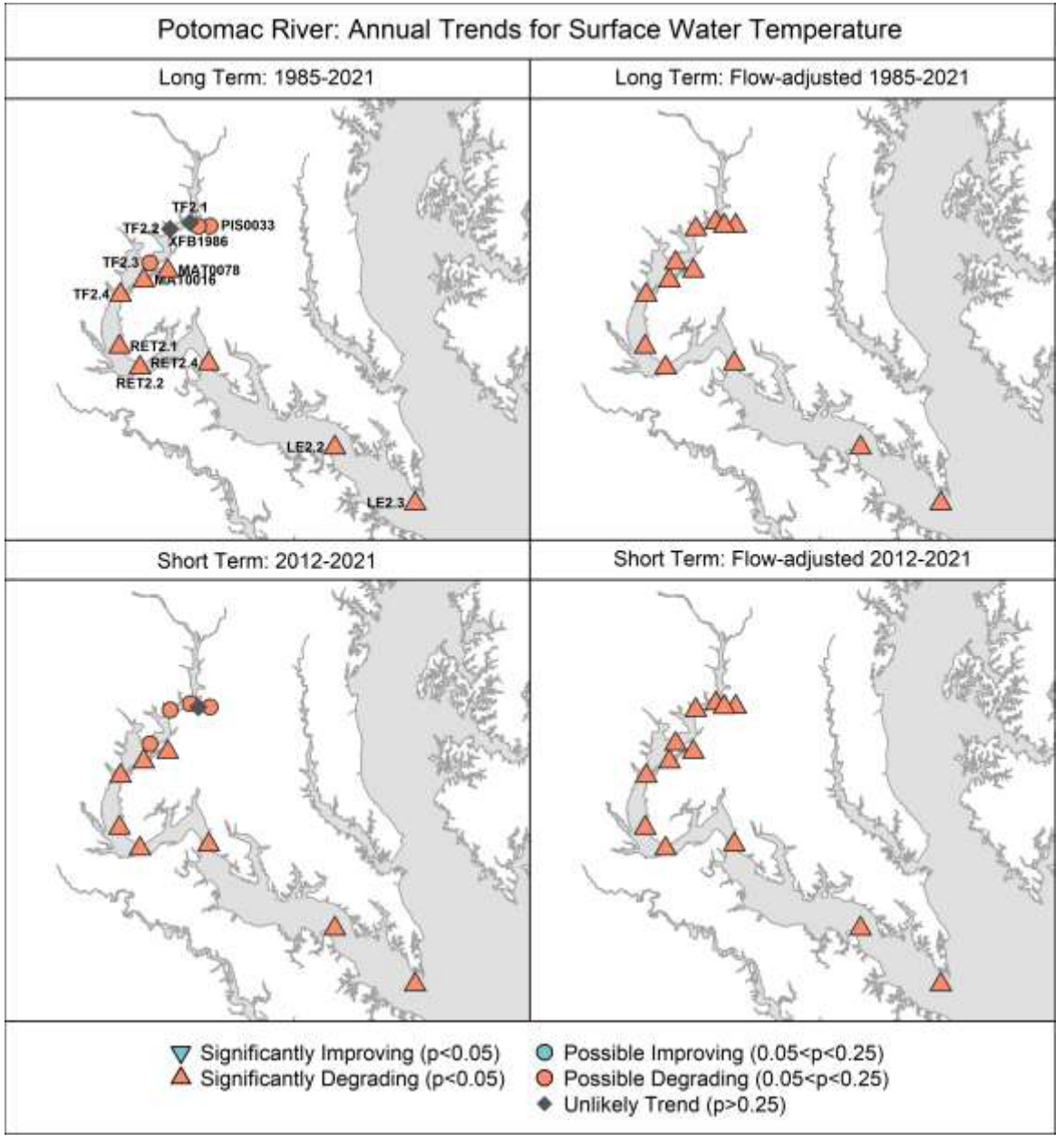
  - **or** conversely the possibility that **conditions are degrading even if the WQ criteria are currently being met**.



Climate Change

Current Tributary Summary

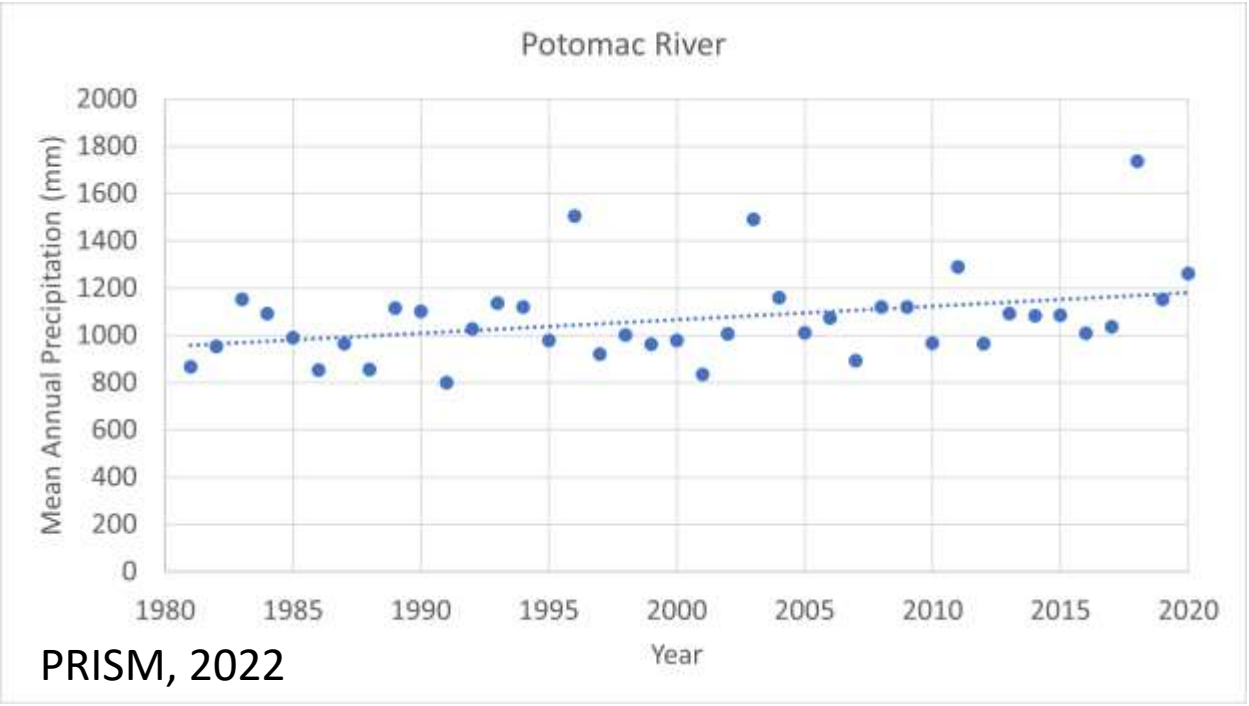
- Surface water temperature trends



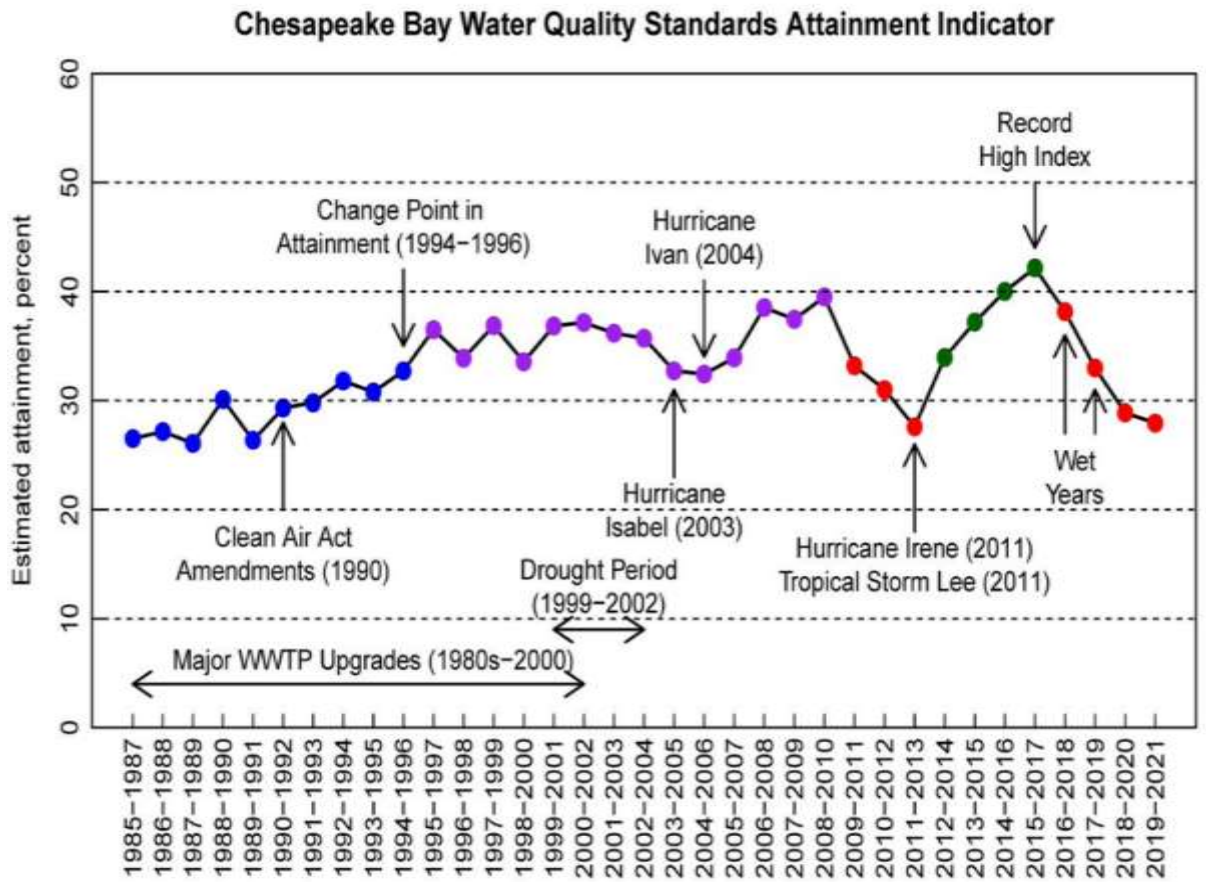
Climate Change

New Climate Change Section <u>(Under Review – Subject to change)</u>

- Extreme Weather and Increased Precipitation
- Warming Water Temperatures
- Sea Level Rise
- Connection to Living Resources



PRISM, 2022



Zhang et al., 2018

Example 1: Insights on Changes Section

- Pulls in additional research to provide further context for the WQ trends and changes in the watershed…

…To answer questions like:

→ ***How do tidal waters respond to actions in the watershed?*** *(Actions may include WWTP upgrades, implementation of agricultural best management practices to reduce nutrient pollution, etc.*

<u>Two important findings from the Potomac Tributary Summary:</u>

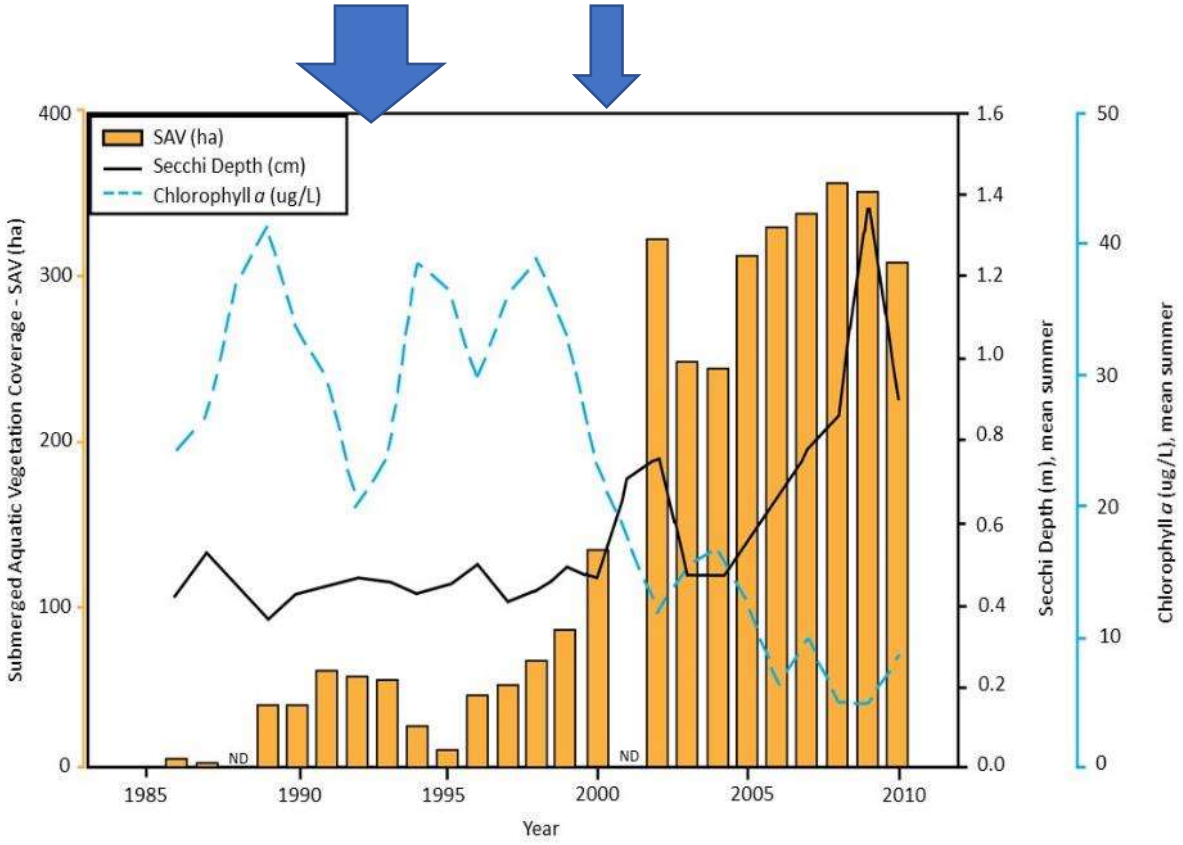
1. Local tidal water response to large nutrient reductions happens and is clearly shown with the data.

2. Long-term tidal water response to watershed-wide nutrient reductions is happening in the tidal waters.

Important Finding 1) *Local response to large nutrient reductions happens*

Mattawoman Creek:

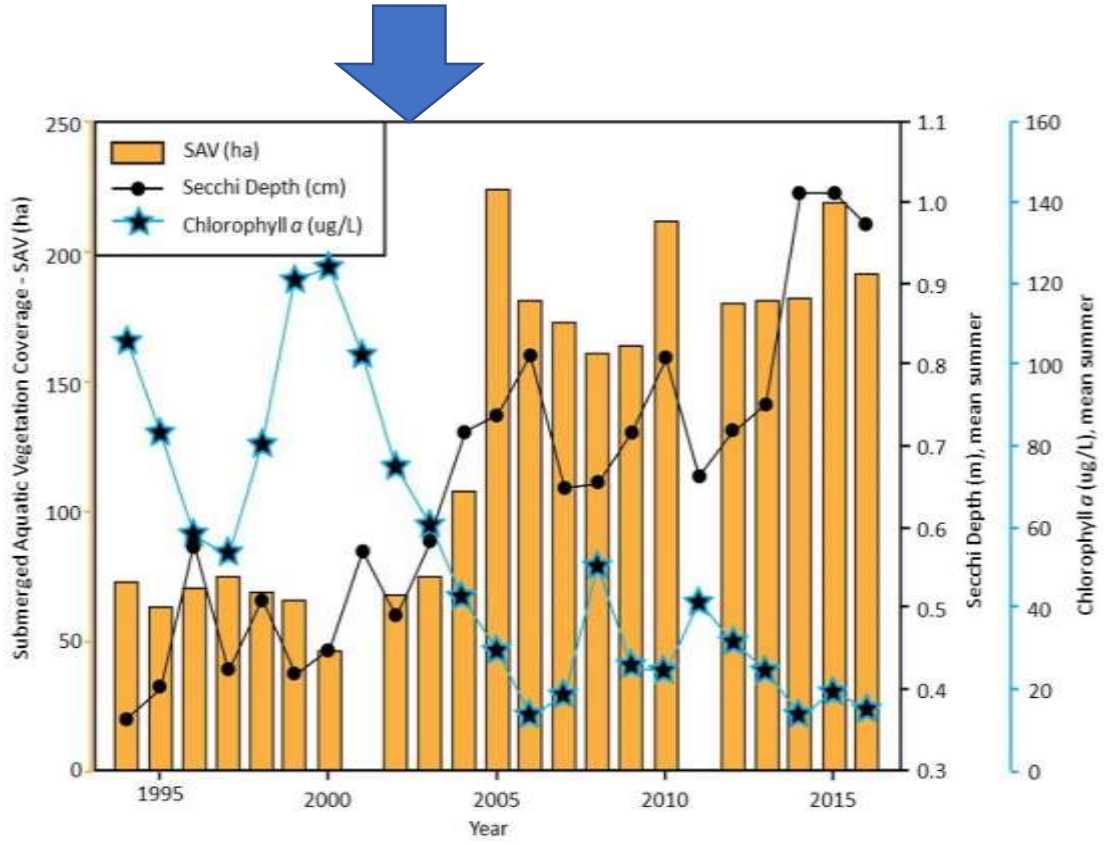
Very large Wastewater (WW) load reductions



SAV coverage (ha), water clarity (Secchi disk depth), and algal biomass (chlorophyll *a* concentration) in Mattawoman Creek. From Boynton *et al.* (2014).

Gunston Cove:

Very large WW load reduction

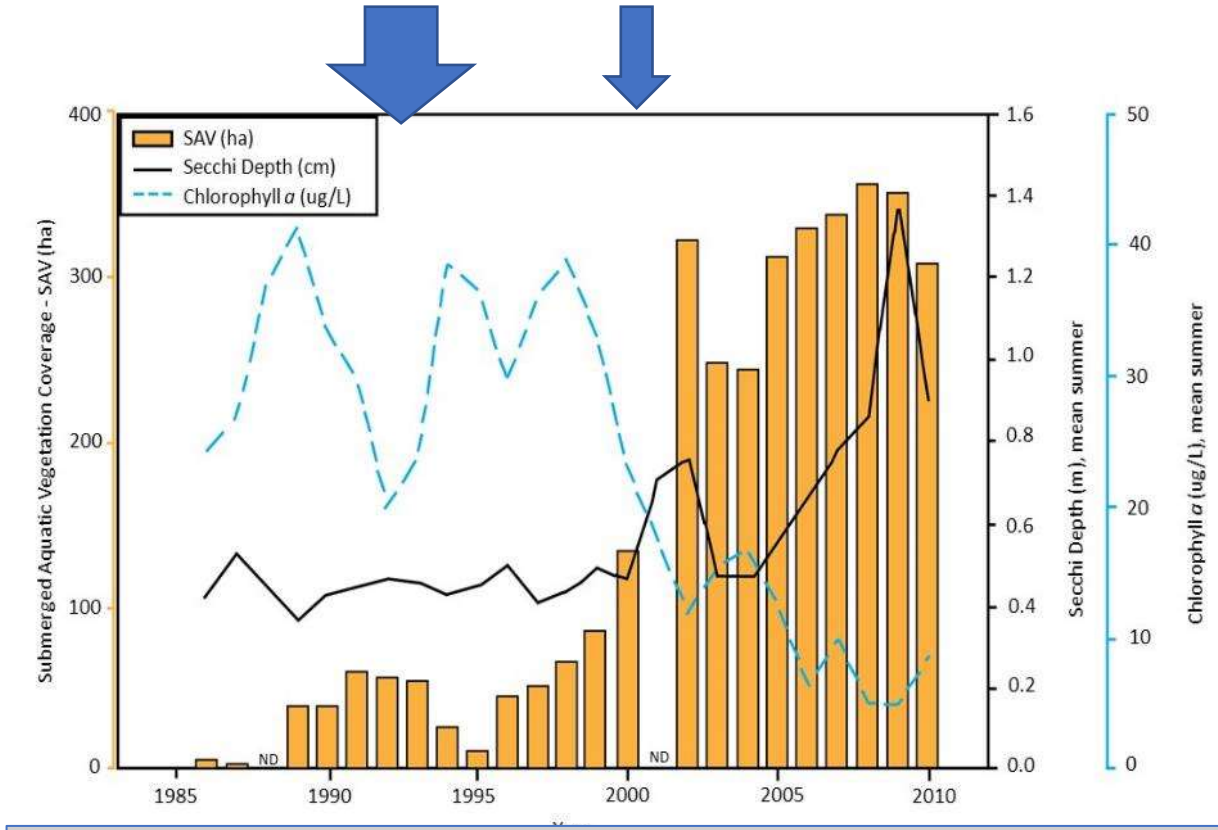


Algal biomass (as chlorophyll *a*), Secchi depth, and SAV acreage for the period 1994 – 2016 in Gunston Cove. From Jones *et al.* (2017).

Important Finding 1) *Local response to large nutrient reductions happens*

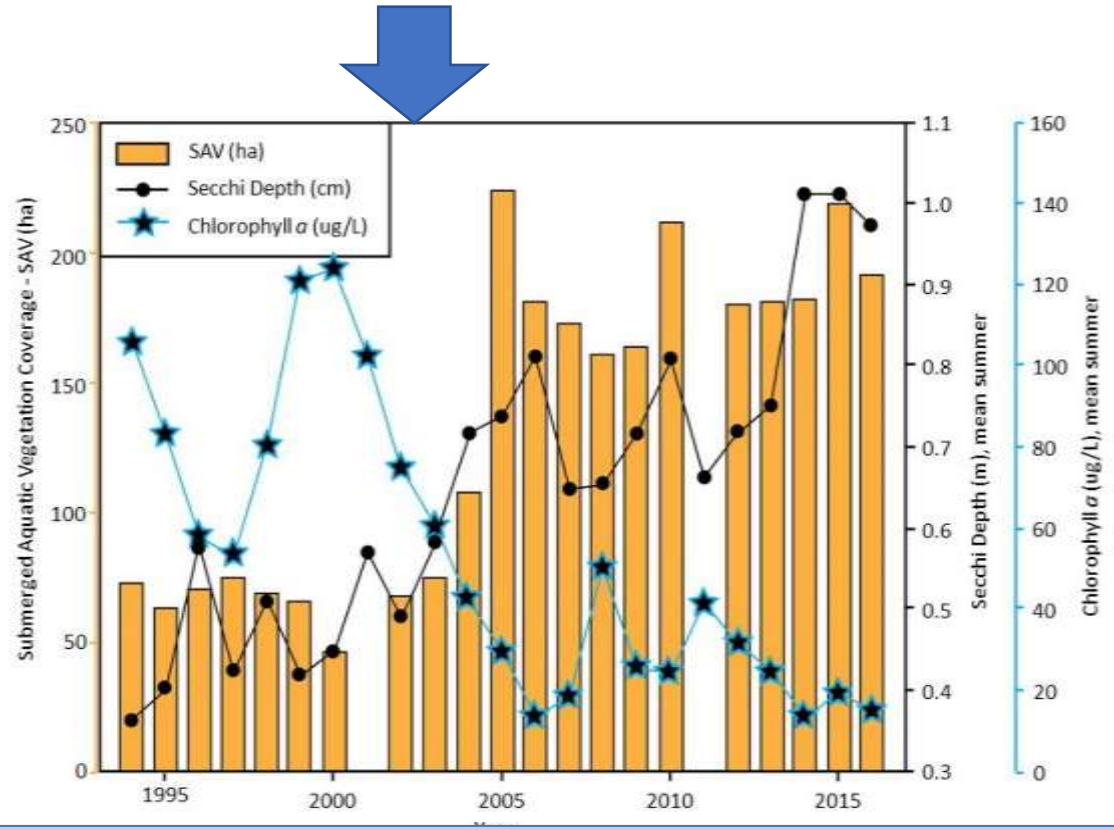
Mattawoman Creek:

Very large WW load reductions



Gunston Cove:

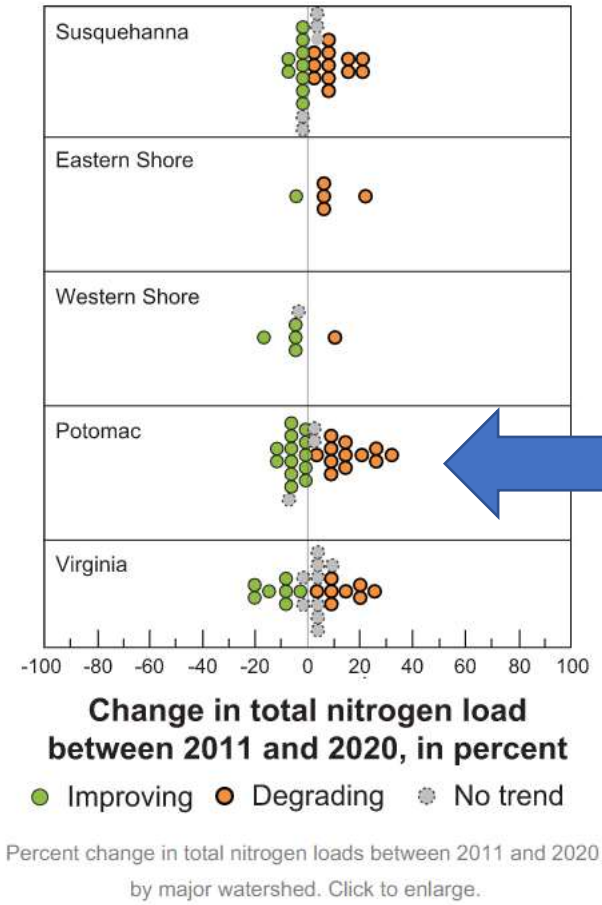
Very large WW load reduction



<u>What this tells us:</u> This data clearly shows that investment in large-scale nutrient reductions is successful for improving water quality dramatically in local systems.

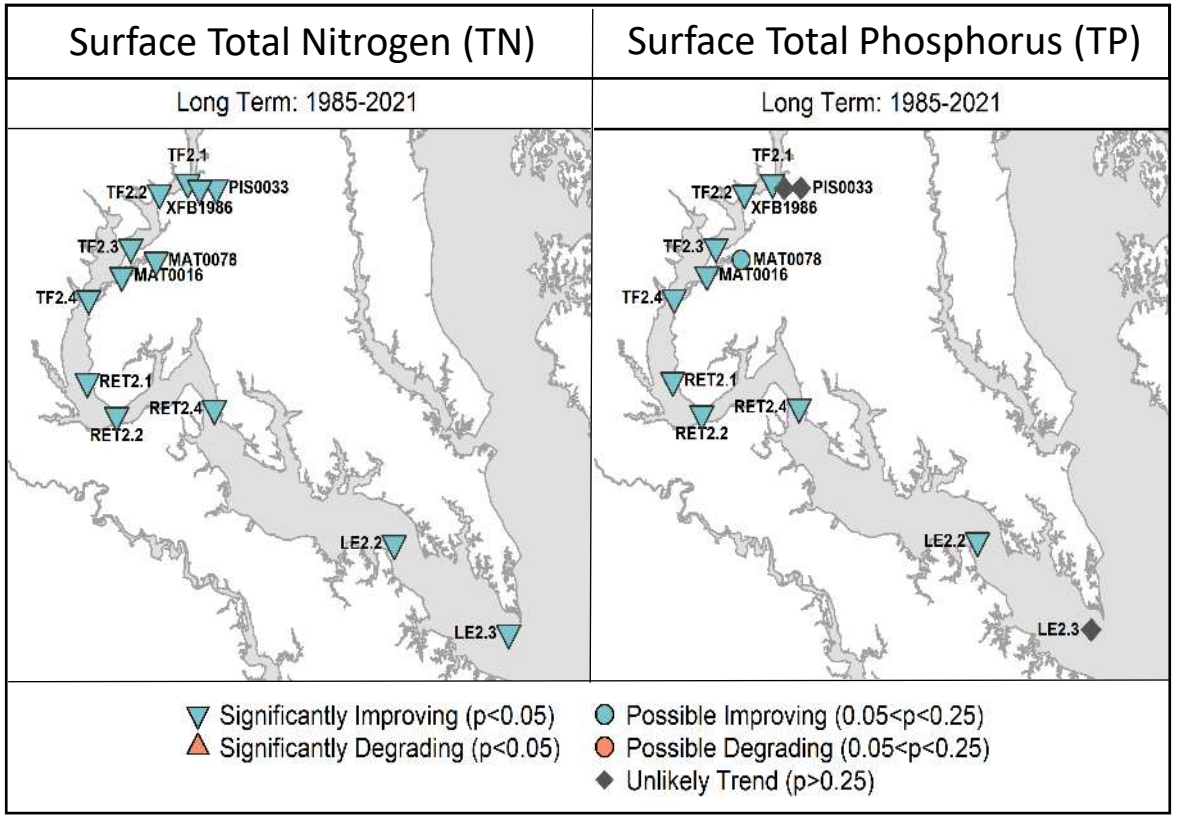
Important Finding *2) Long-term response to watershed changes is happening*

- Tidal nutrient concentrations have decreased at almost all tidal stations.



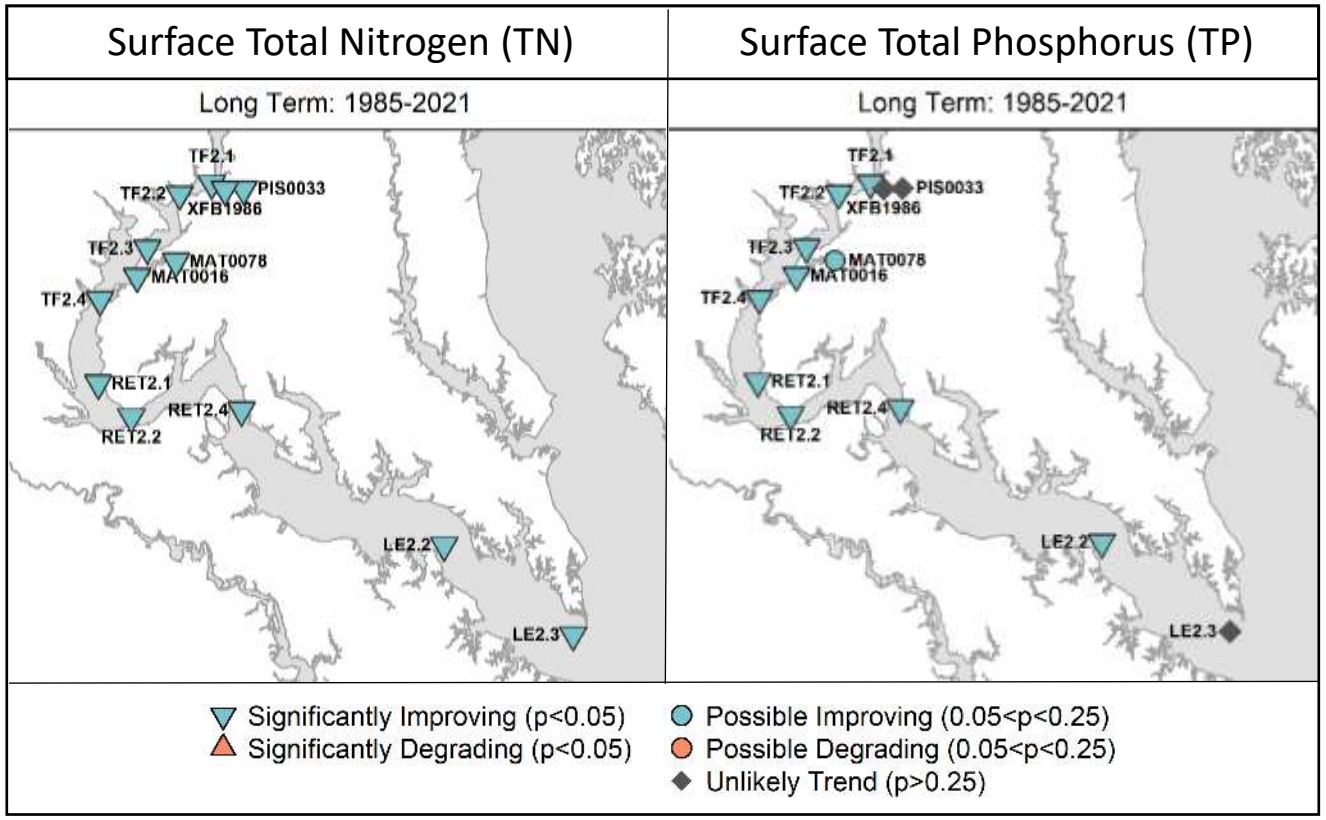
Percent change in total nitrogen loads between 2011 and 2020 by major watershed. Click to enlarge.

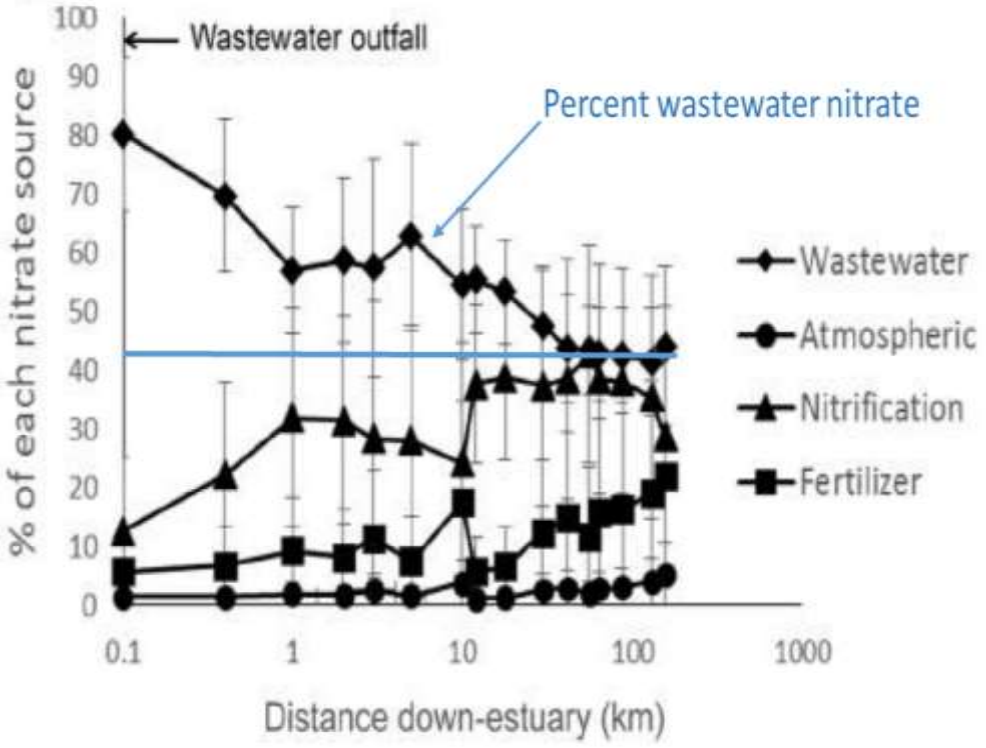
- About the same number of Potomac stations improved as degraded for total nitrogen load.



Important Finding *2) Long-term response to watershed changes is happening*

- These tidal trends are **not just local response**, but have been shown to be impacted by loads from many types of sources.

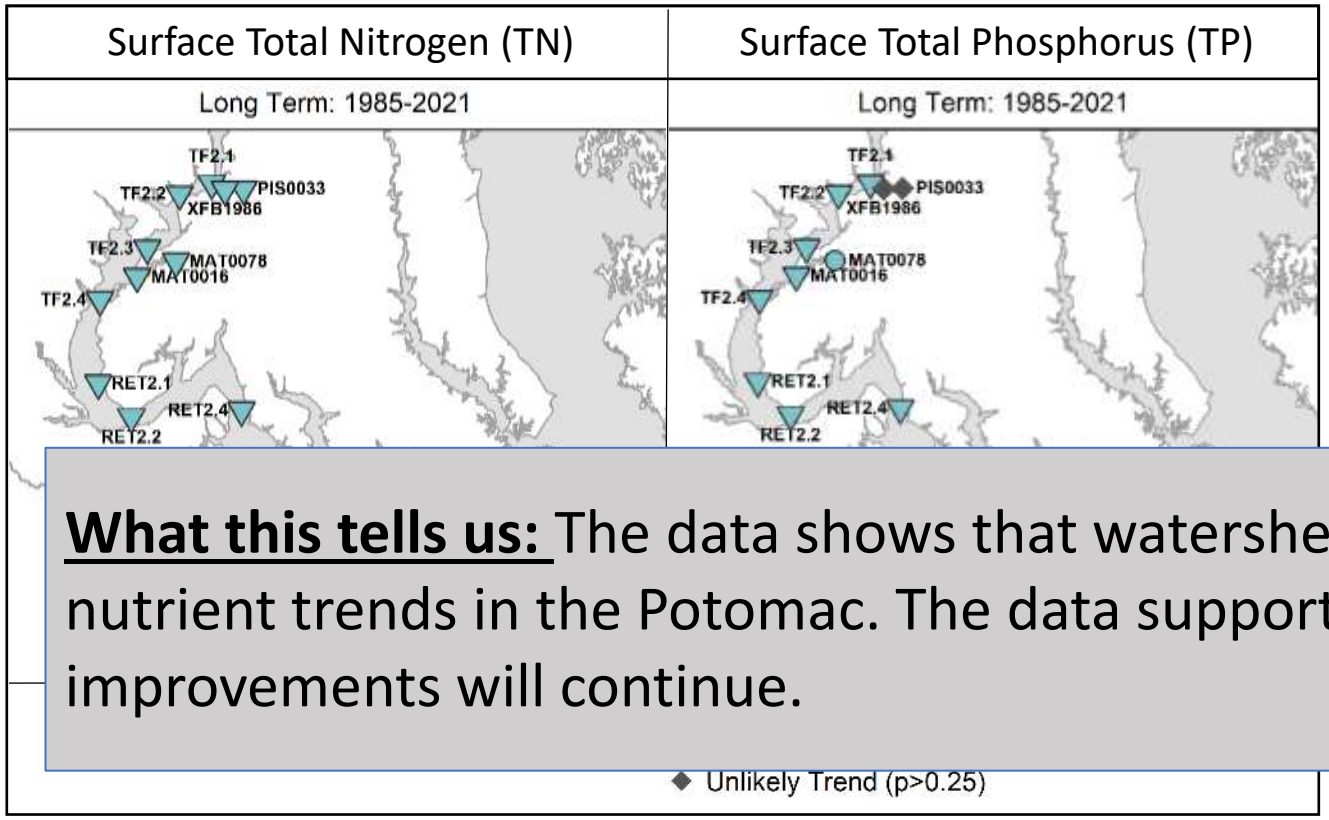


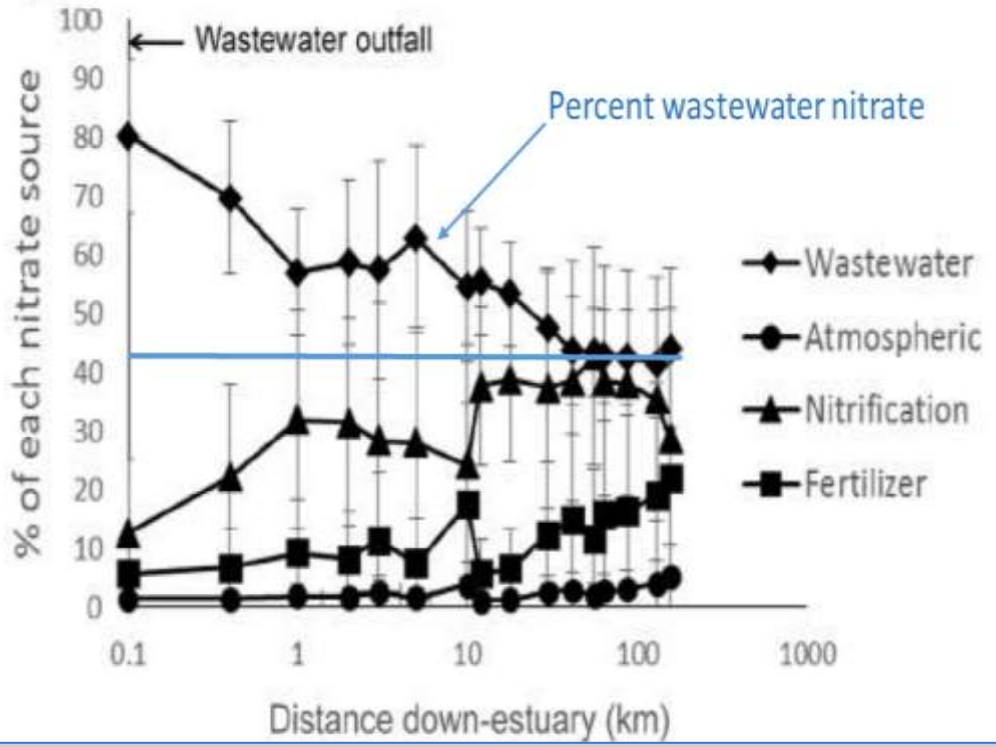


Mean annual change in the percent contribution of nitrate from wastewater, fertilizer, atmospheric deposition, and nitrification, based on an isotope mixing model, with distance down-estuary from wastewater treatment plant output. Adapted from Pennino *et al.* (2016).

Important Finding *2) Long-term response to watershed changes is happening*

- These tidal trends are **not just local response**, but have been shown to be impacted by loads from many types of sources.





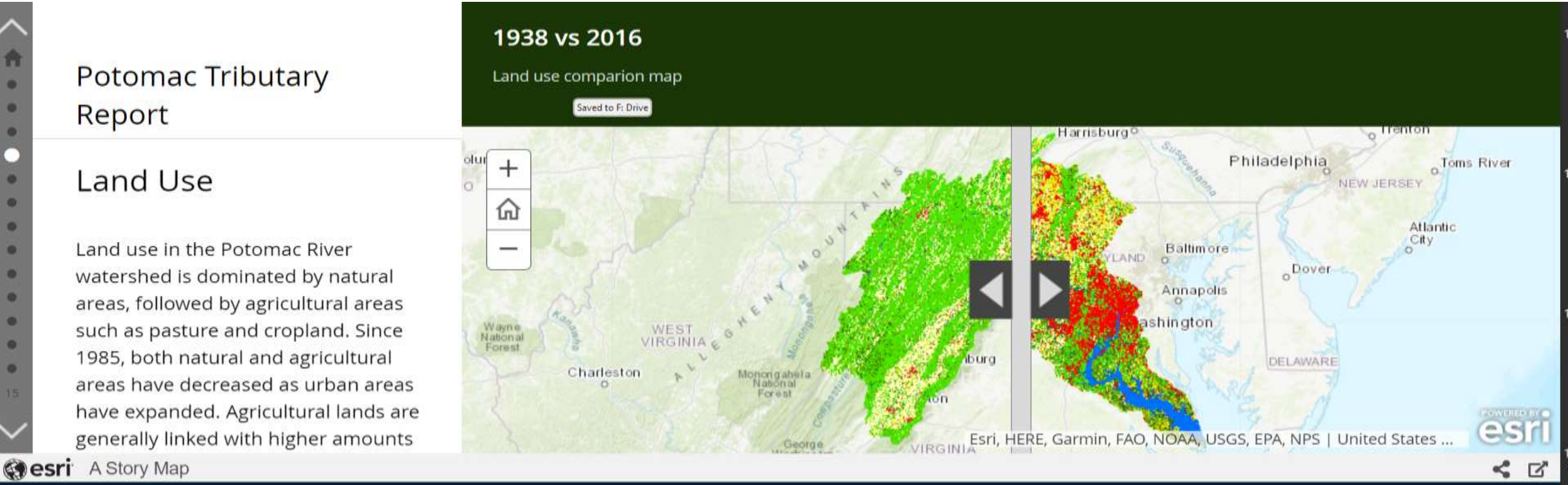
What this tells us: The data shows that watershed-wide nutrient reductions have improved nutrient trends in the Potomac. The data support the conclusion that with more reductions, improvements will continue.


Tributary
Summaries
Storymaps

Tributary Summaries Storymaps

- Potomac Storymap: https://geonarrative.usgs.gov/potomactrib/

- ITAT Intern completed a storymap template for each Tributary Summary and an example for the Rappahannock (submitted for USGS review)



Next Steps for the Tributary Summaries

- Complete USGS review for James Tributary Summary – in progress, Q3 and Q4 2023.
- Submit story map template to USGS geonarrative review in progress, Q3 2023.
- Update all tributary summaries with data through 2022 (1985-2022) as a data release through USGS – Q1 and Q2 2024.
- Develop corresponding story maps for each of the 13 tributary summaries with data through 2022 based on the template. Submit to USGS geonarrative review – Q1 and Q2 2024

Links and References

CAST/Tributary Summaries: https://cast.chesapeakebay.net/Home/TMDLTracking#tributaryRptsSection

Potomac Story Map: https://wim.usgs.gov/geonarrative/potomactrib/

References:

Boynton, W. R., C. L. S. Hodgkins, C. A. O'Leary, E. M. Bailey, A. R. Bayard and L. A. Wainger, 2014. Multi-decade responses of a tidal creek system to nutrient load reductions: Mattawoman Creek, Maryland USA. Estuaries Coasts 37:111-127, DOI: 10.1007/s12237-013-9690-4.

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Contact Information

Thank you!!

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