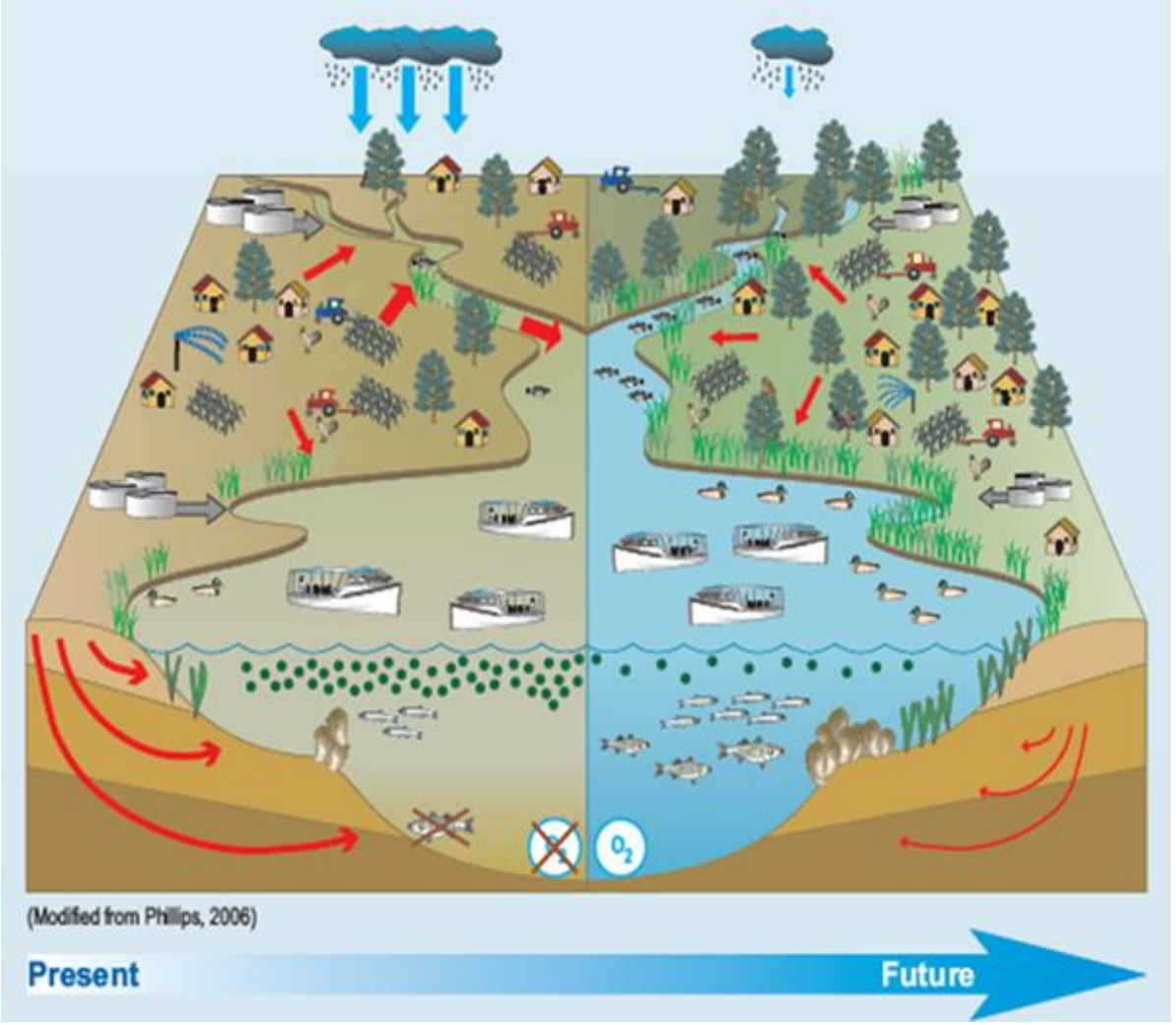
Tidal Tributary Trend Summaries

Integrated Trends Analysis Team

CBP Modeling Workgroup Quarterly
January 7, 2021
Virtual

ITAT Mission

To inform Chesapeake Bay Watershed and Estuary restoration by detecting ***and discerning the causes*** of restoration and degradation trajectories



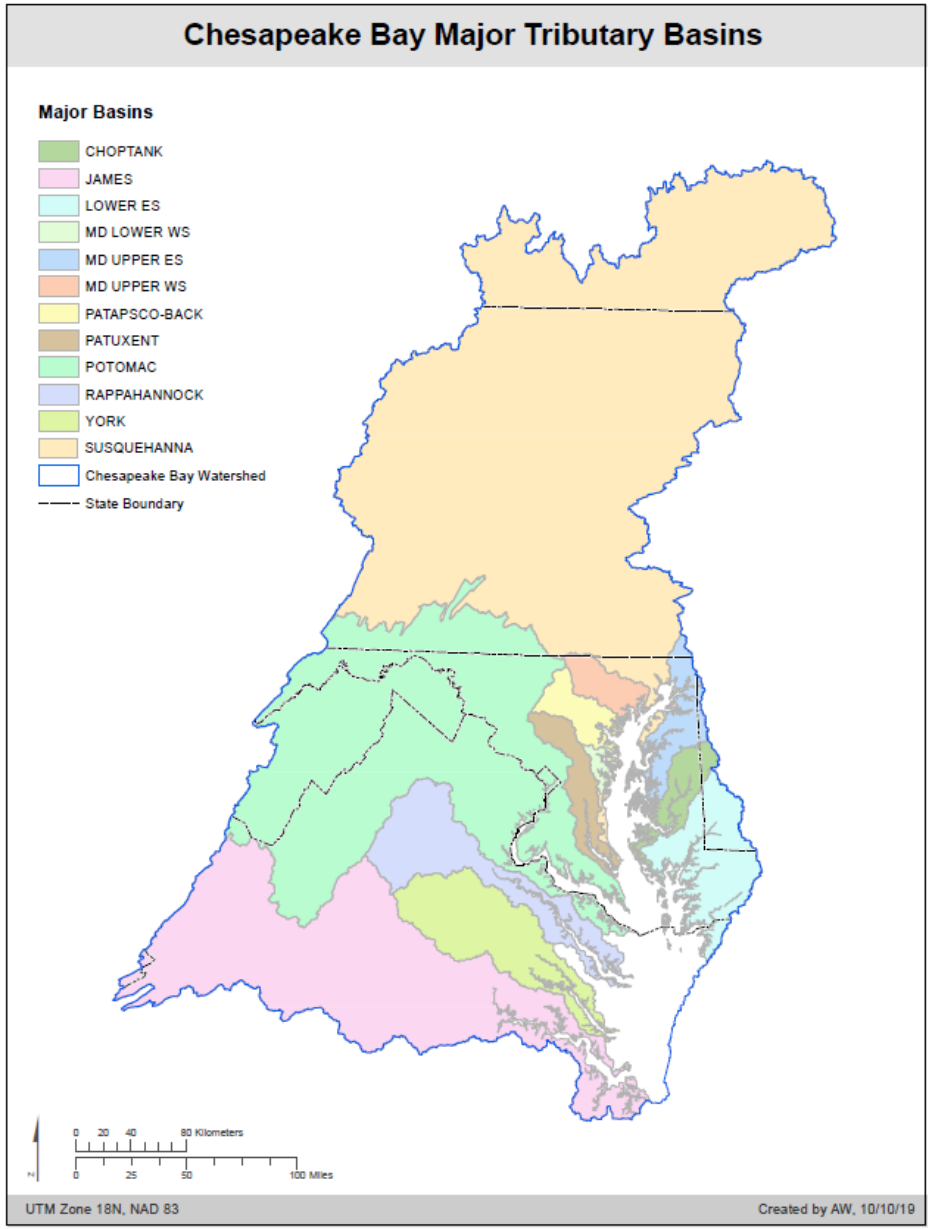
Our Marching Orders

SRS Outcome	Related Outcomes	Research Category	Need
Standards and Attainment	Fish habitat, oysters, blue crabs, vital habitats	Analysis	Improve understanding of tidal water quality response to loads and BMPs
Standards and Attainment	Fish habitat, oysters, blue crabs, vital habitats	Analysis	improve understanding of bay living resources response to watershed and bay management
Standards Attainment and Monitoring	WQ Indicator needs/ongoing interest in tracking wq progress	Analysis	Tracking/Explaining attainment/attainment deficit patterns and trends
WQGIT/Modeling	Implement an estuary model in local waters	Analysis/Modeling	to assist tidal jurisdictions with local waters assessments and implementation efforts
Fish Habitat	habitat, water quality	Analysis	Tidal tributary Fish Habitat Assessment: 1. compile habitat and environmental, stressor, biological dataset; 2. analyze biological response data for relevance; 3. pilot fish habitat assessment; 4. conduct watershed regional assessment; 5. ID/develop spatial tools useful to partners

What are the Tributary Reports?

We are in the process of compiling tributary basin summaries for 12 major tributaries or tributary groups in the Chesapeake Bay Watershed:

1. Potomac
2. Rappahannock
3. Upper Mainstem
4. Choptank, Little Choptank, Honga
5. York (includes Mattaponi and Pamunkey)
6. MD Upper Western Shore:
   - Bush, Gunpowder, Middle
7. Patapsco/Back
8. MD Lower W. Shore:
   - Severn, Magothy, Rhode/West, South
9. Patuxent
10. James (includes Elizabeth and Lafayette)
11. MD Upper Eastern Shore:
    - Northeast, Back Creek, Elk, Sassafras, Chester, Eastern Bay
12. Lower E. Shore:
    - Fishing Bay, Nanticoke, Manokin, Wicomico, Big, Pocomoke, Tangier



Who are the tributary reports for?

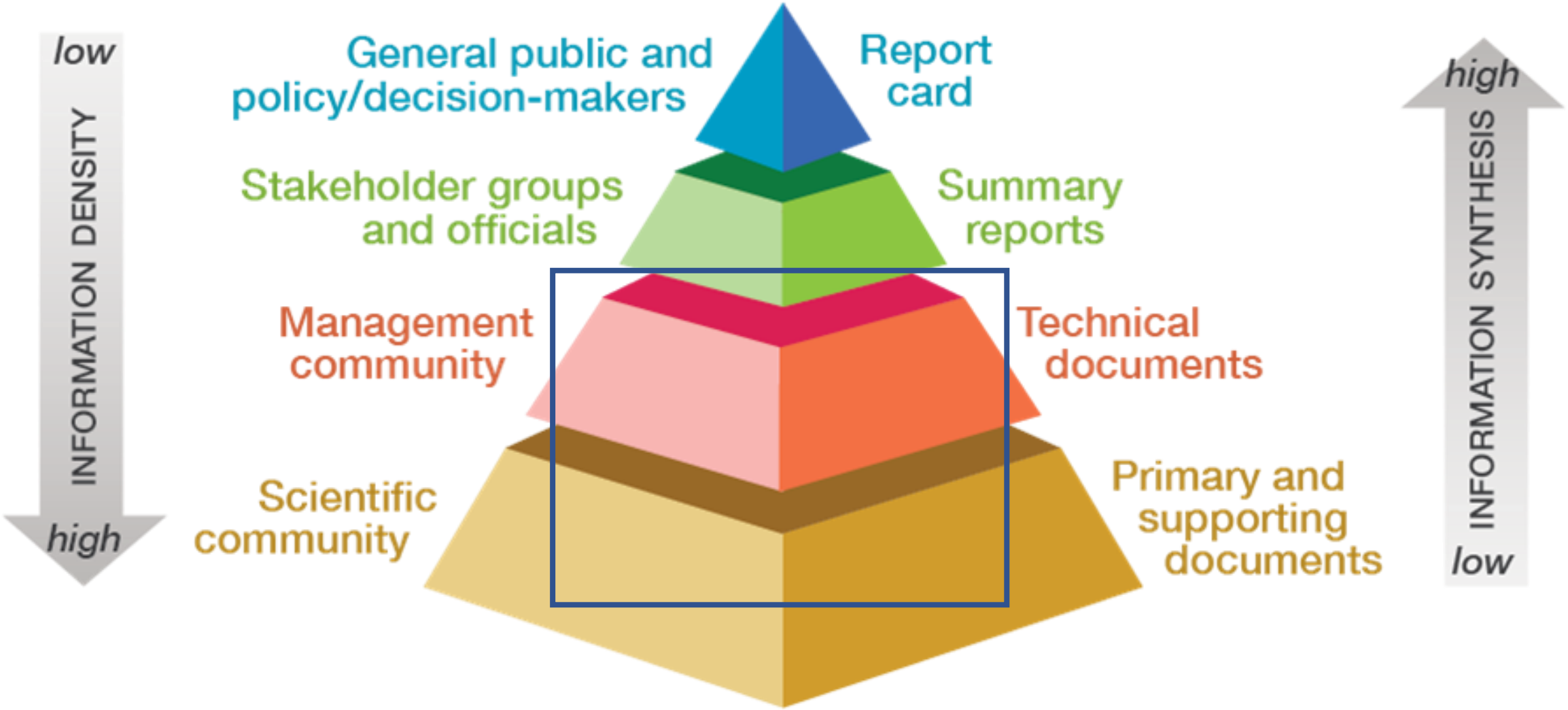


Figure courtesy UMCES Integration and Application Network, ian.umces.edu

Goals: What should people to get out of these reports?

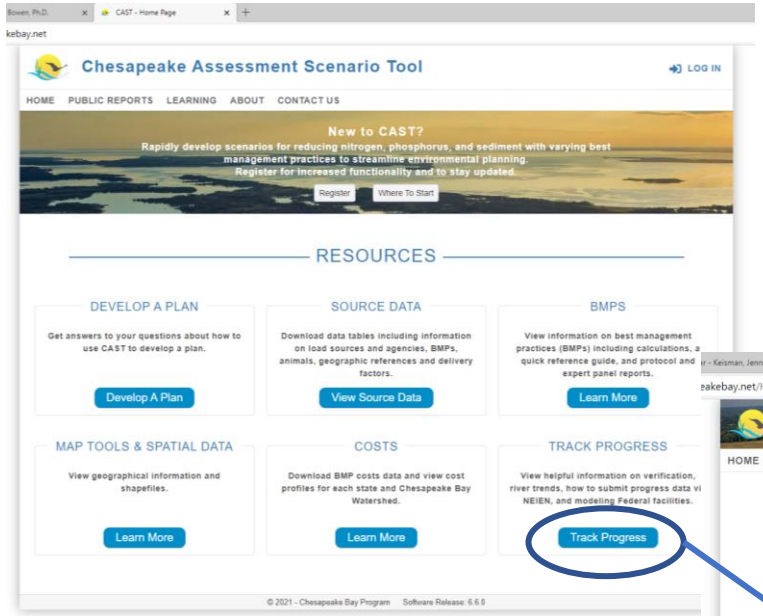
For technical managers and watershed organizations:

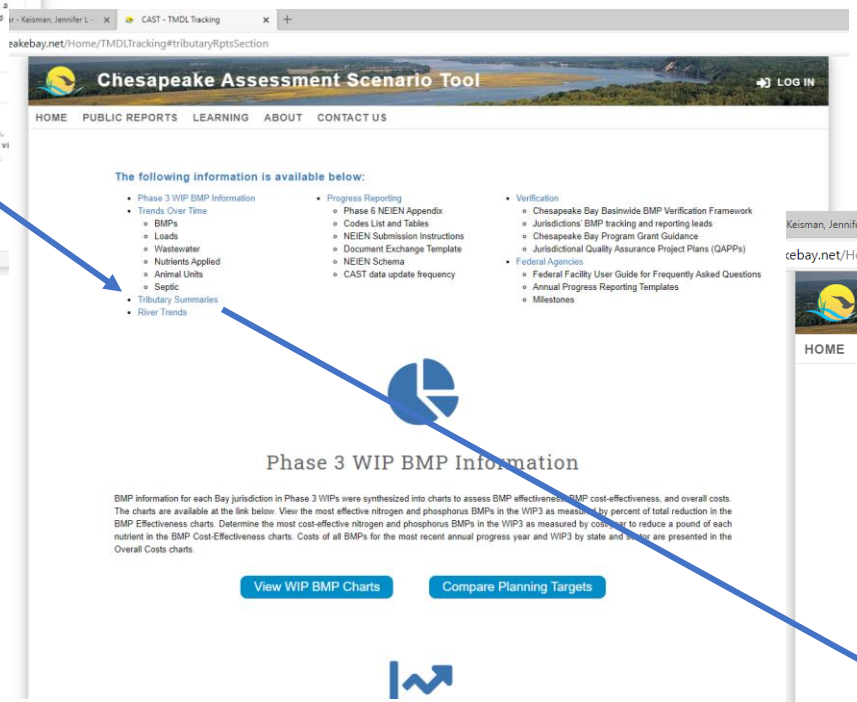
- ✓ A summary of how your river is doing and how that has changed over time;
- ✓ An understanding of the factors that affect water quality in the tributary basin, and how those have changed over time;
- ✓ A snapshot of the level of implementation in the tributary basin for major BMPs that can improve water quality.

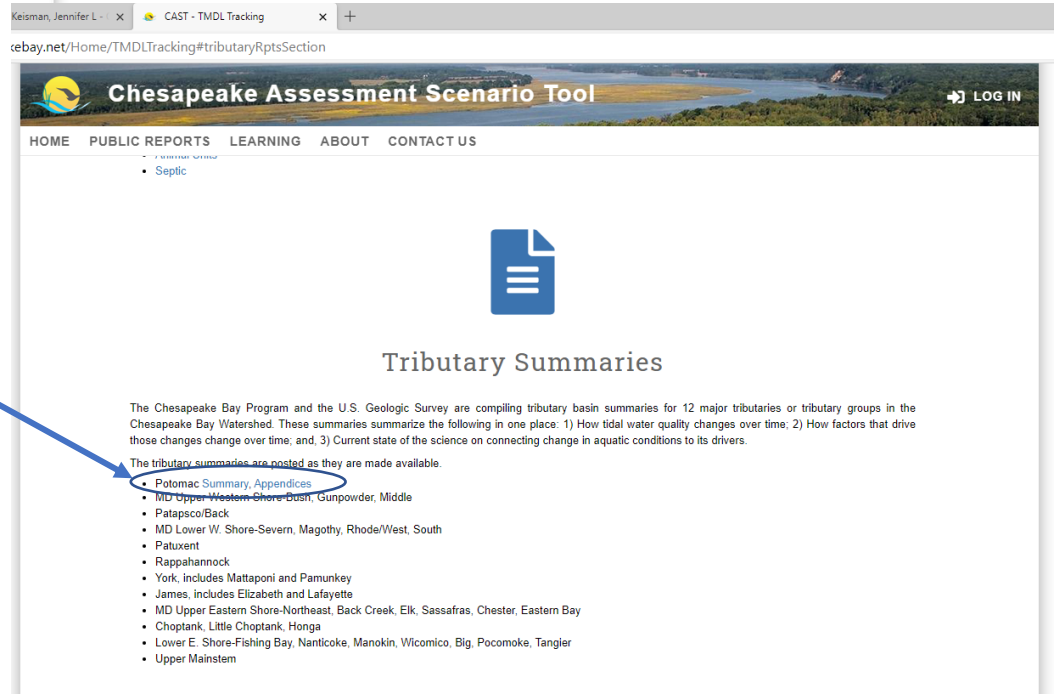
For researchers:

- ✓ Serve as a vehicle for targeting research to advance our ability to explain observed changes and predict future change. … next generation tributary multiple models would be able to use these reports for reference/as a starting point…

Where to find the summaries: Potomac report now available!







Standard content across all summaries

"Here's where we're talking about"

"Here is the DO standards attainment status"

"This is how the primary water quality variables have changed over time"

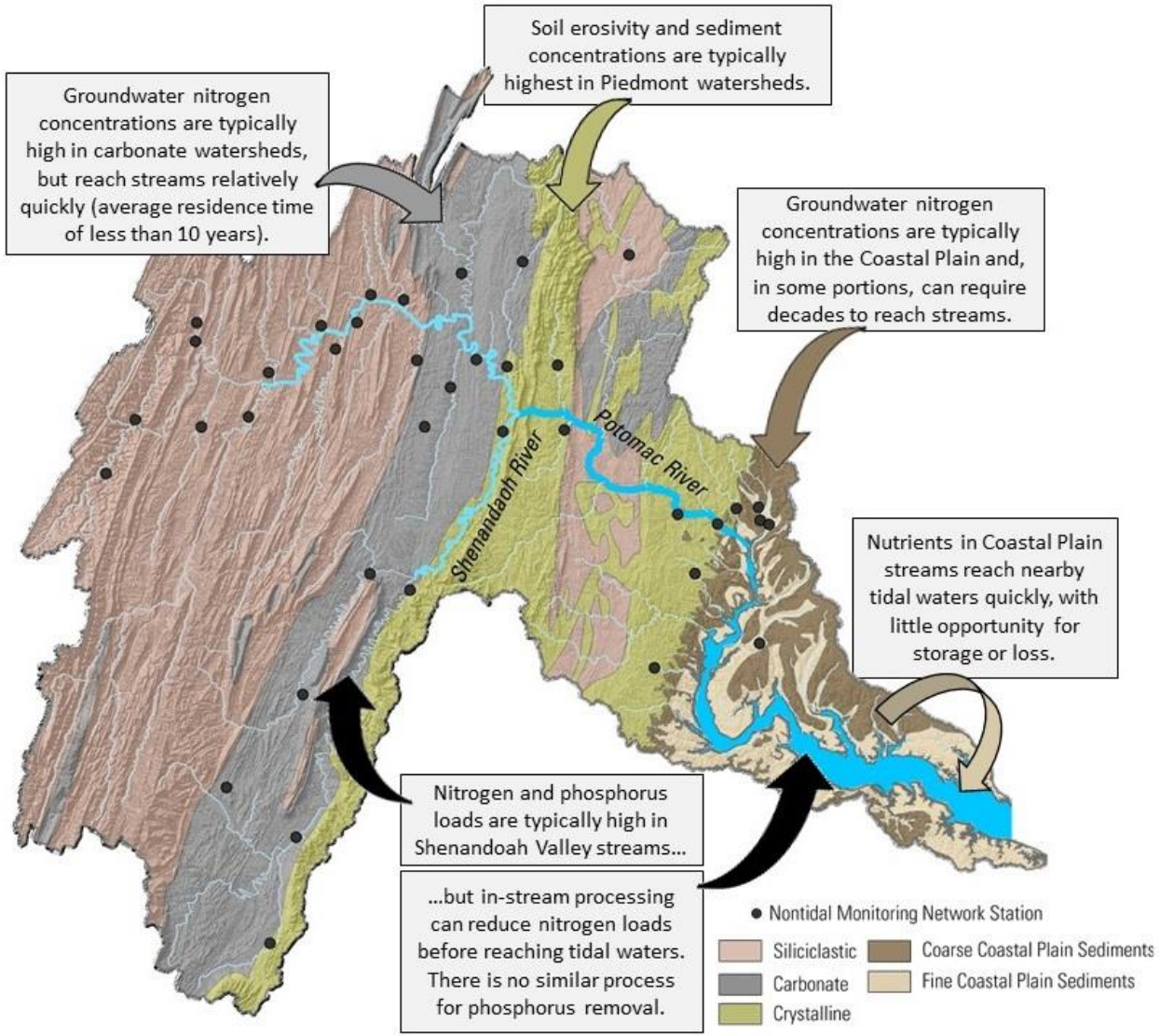
"The possible reasons why"

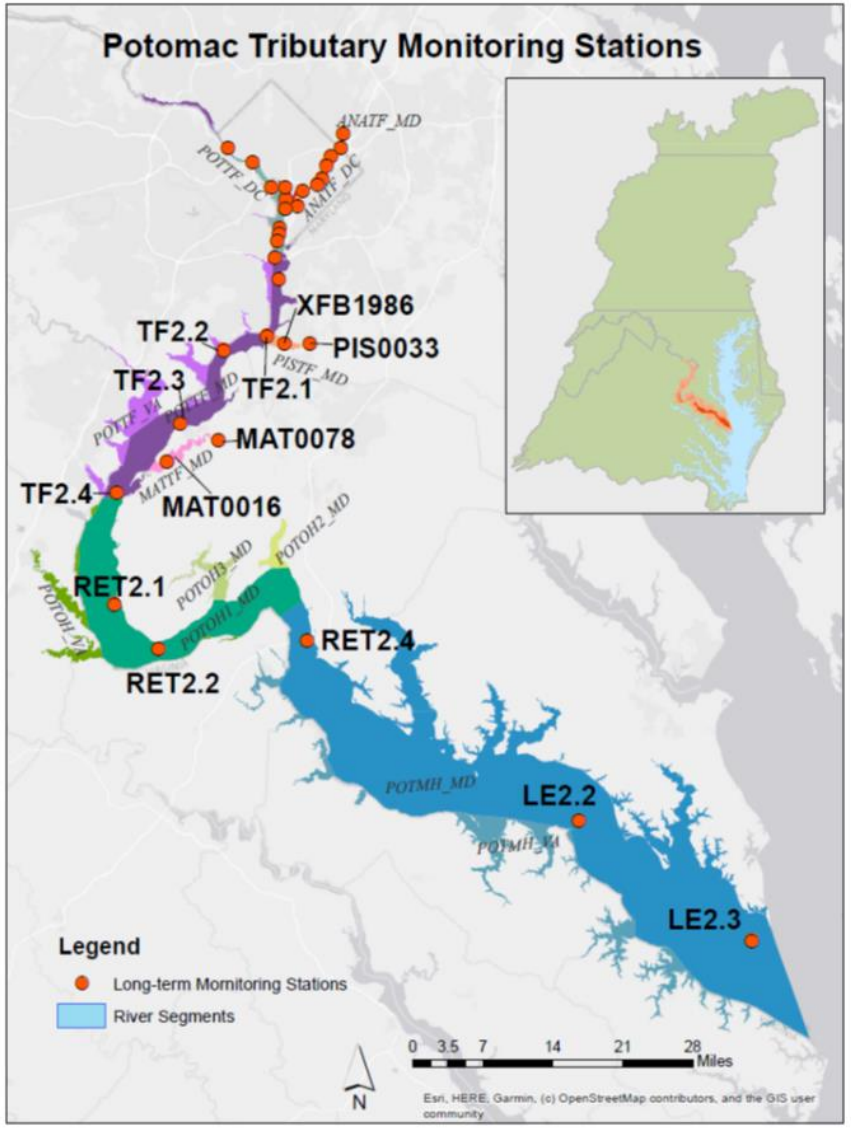
"In a nutshell"

"The rest of the water quality variables, in case you're interested"

Contents

Where (Potomac)



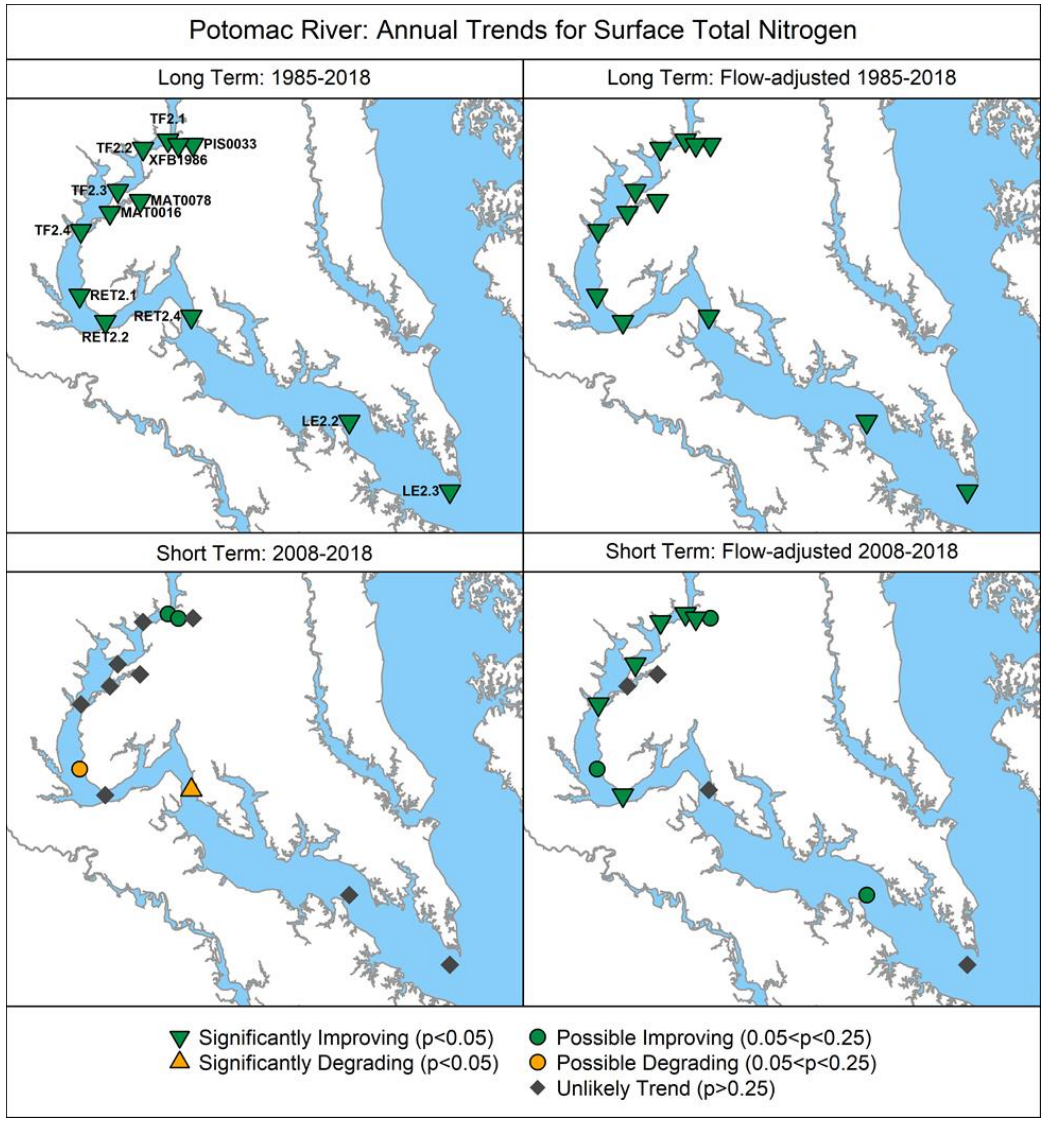


Change over time in “primary” variables (TN, TP, Chlorophyll, Secchi, DO)

For each of the 5 major parameters, a panel map shows whether the variable is improving or degrading…

Observed Long-term (period of record) trend results

Observed most recent 10-year trend results



Flow-adjusted long-term trend results

Flow-adjusted most recent 10-year trend results

Note how flow-adjustment improves short-term trend

Change over time in “primary” variables (TN, TP, Chlorophyll, Secchi, DO)

And a panel chart shows the pattern over time at each monitoring station, grouped by segment.

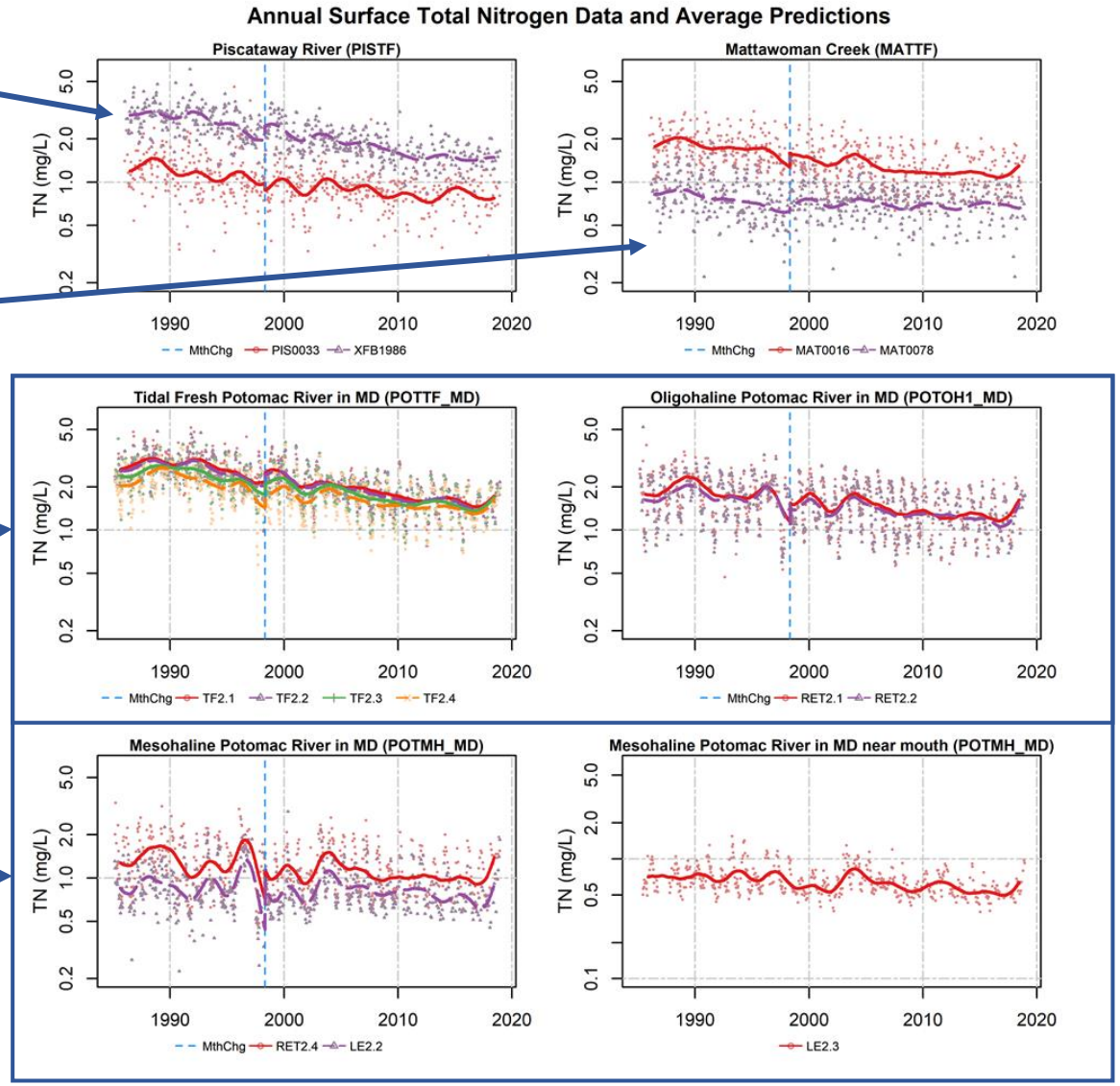
Piscataway River surface TN:
- Has declined steadily over time at both stations.
- Is consistently lower at the upstream station.

Mattawoman Creek surface TN:
- Early decline has flattened out in the last several years.
- Is consistently lower at the upstream station.

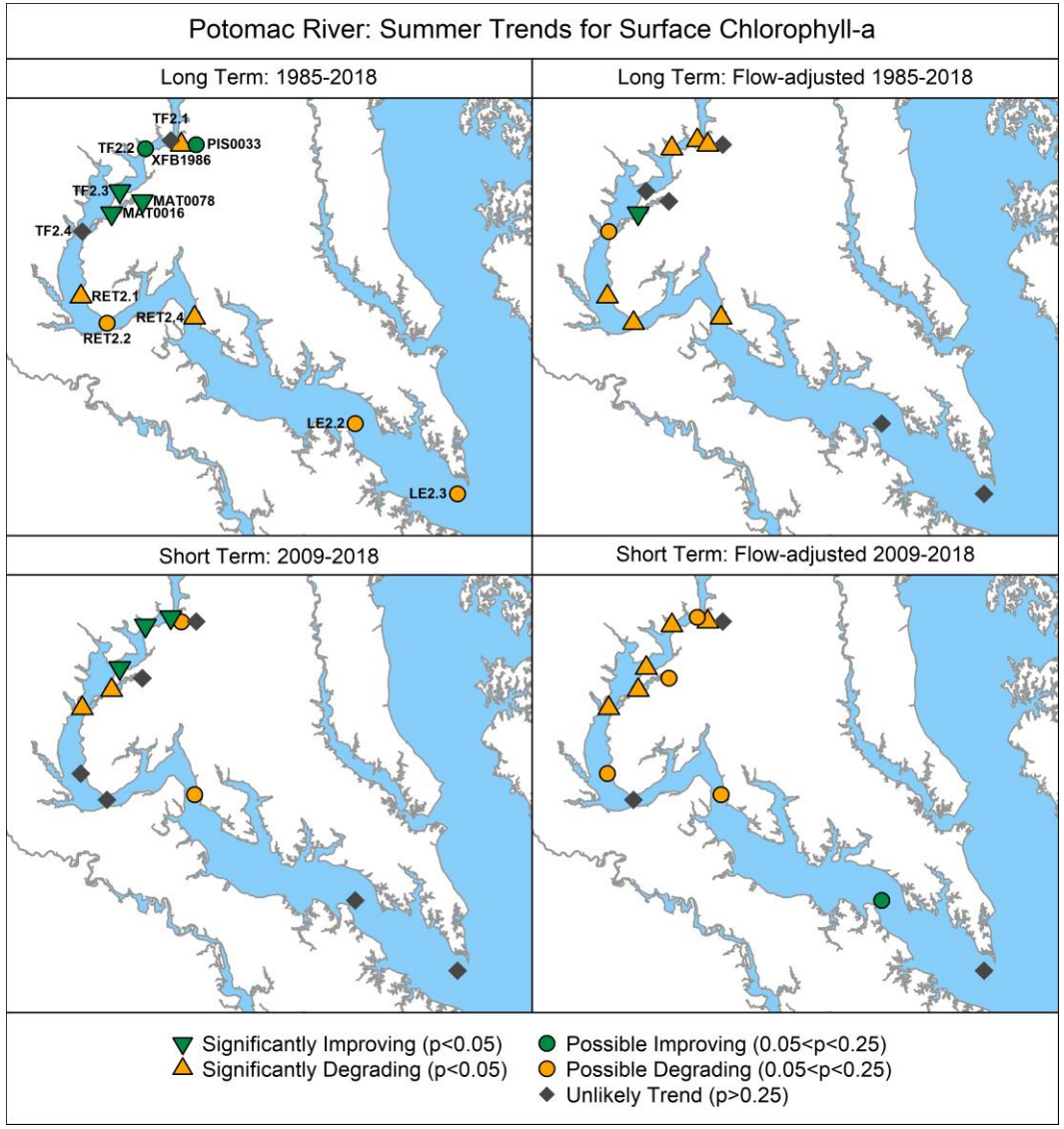
Tidal Fresh and Oligohaline Potomac surface TN:
- Concentrations and patterns of change over time are similar at all stations.

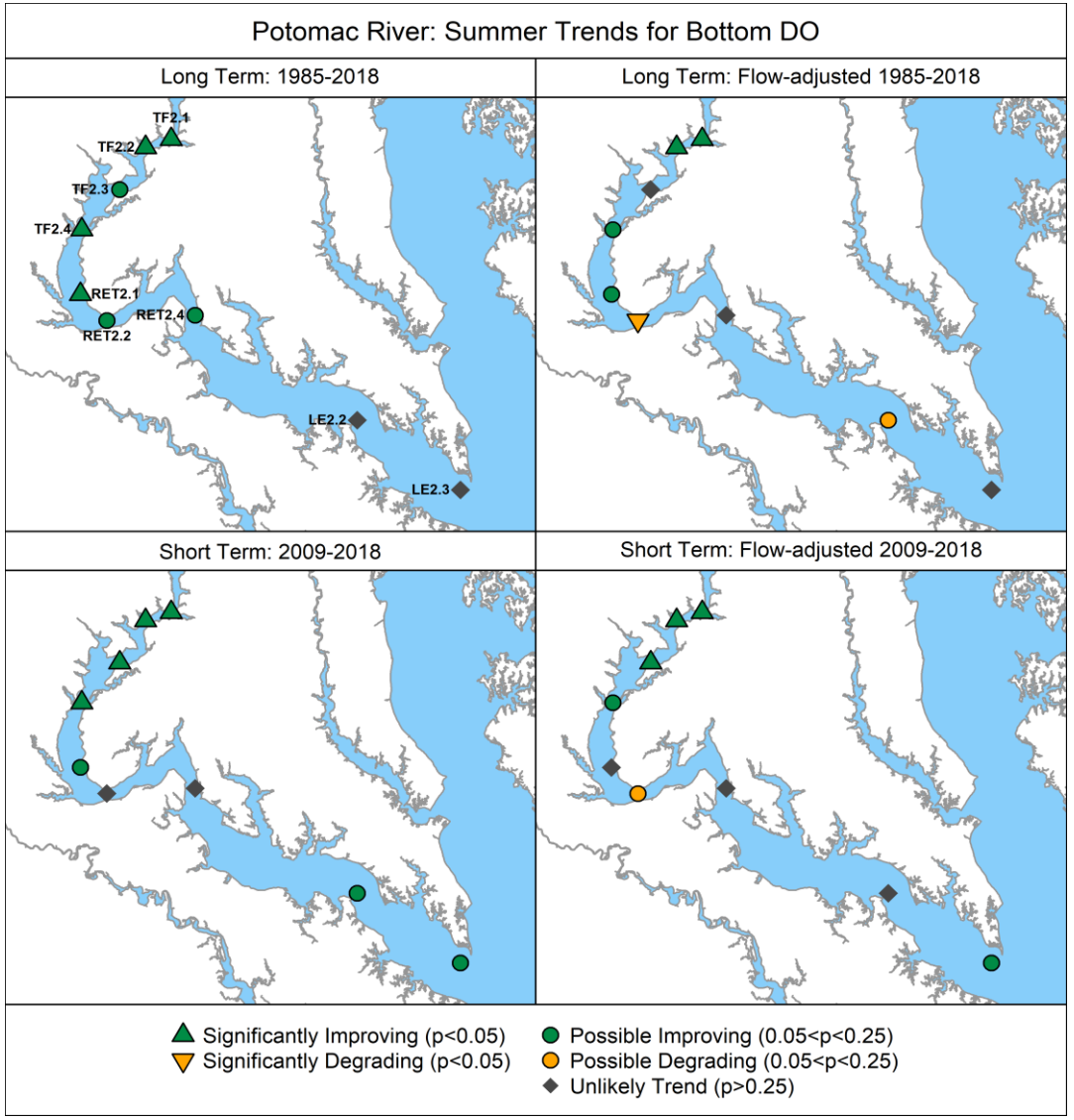
Mainstem Potomac, in general:
- The temporal pattern flattens out as you move downstream, particularly in the past 10 years

- Uptick at all mainstem Potomac stations last year (*recall the difference between observed and flow-adjusted 10-year trend)*



Compare patterns across constituents within a tributary





Factors: Changes in Watershed Loads

Figure 19. Estimated total loads of nitrogen (TN), phosphorus (TP), and suspended sediment (SS) from the RIM and below-RIM areas of the Potomac River.

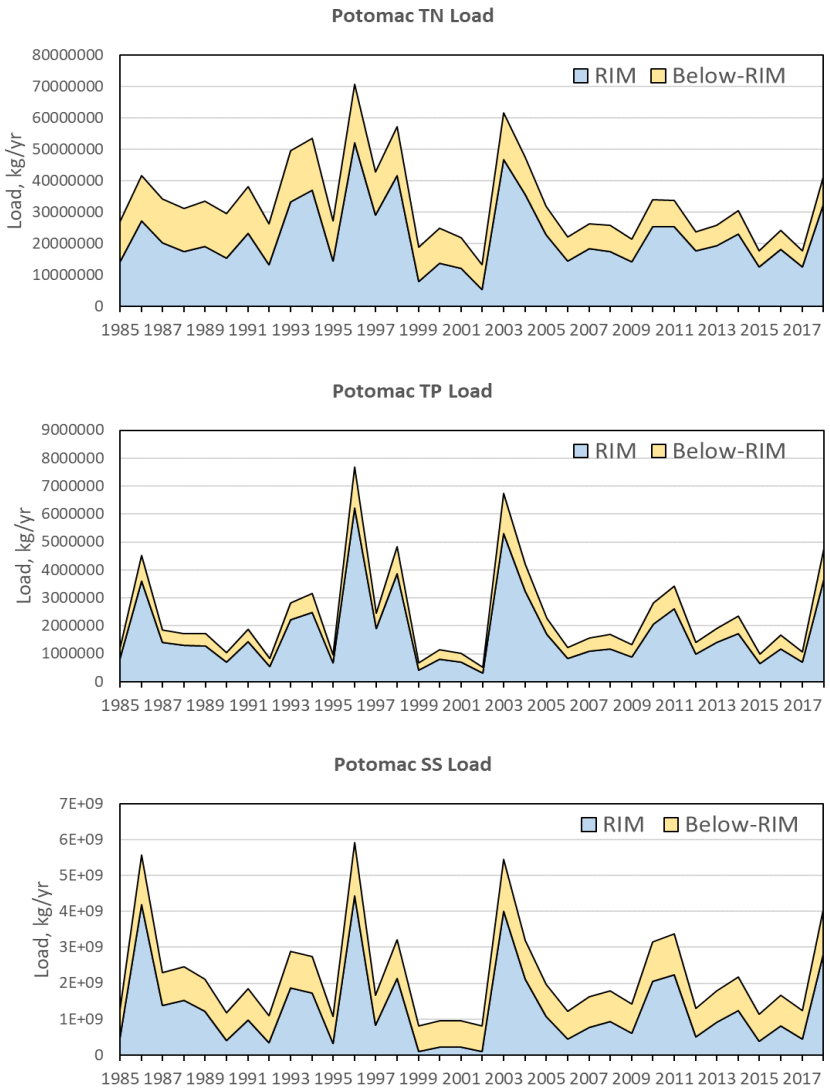
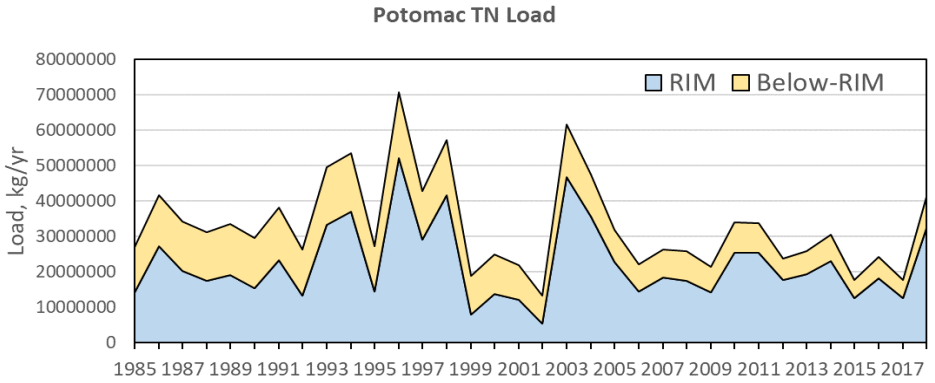


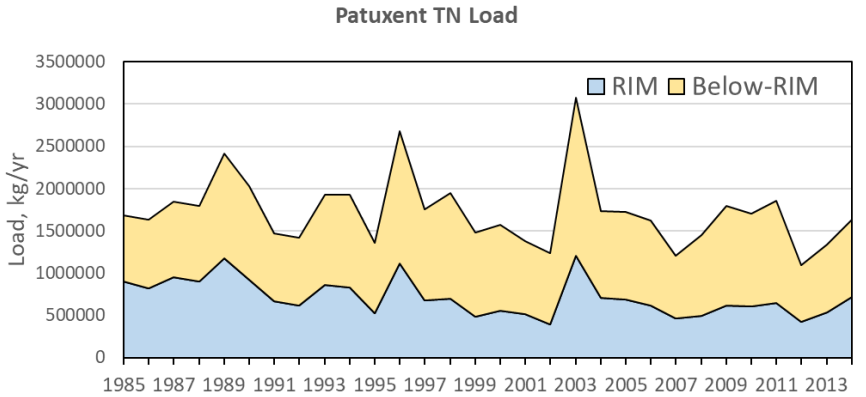
Table 4. Summary of Mann-Kendall trends for the period of 1985-2018 for total nitrogen (TN), total phosphorus (TP), and suspended sediment (SS) loads from the Potomac River watershed.

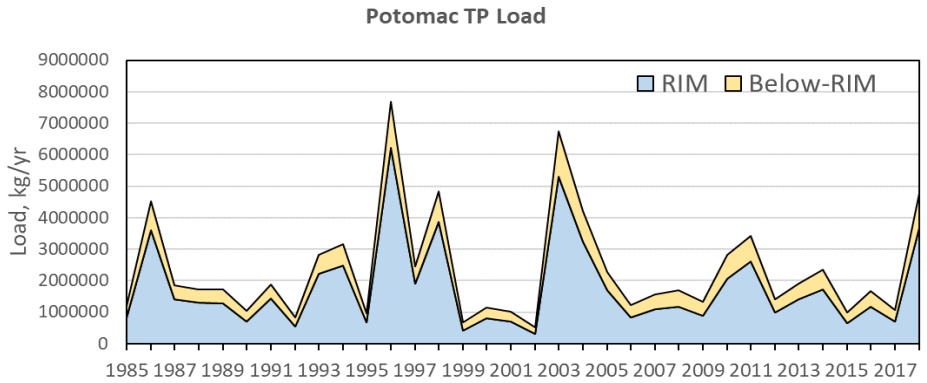
Variable	Trend, metric ton/yr	Trend p-value
TN		
Total watershed	-349	< 0.05
RIM watershed [1]	-47	0.73
Below-RIM watershed [2]	-306	< 0.01
Below-RIM point source	-316	< 0.01
Below-RIM nonpoint source [3]	13	0.53
Below-RIM tidal deposition	-7.6	< 0.01
TP		
Total watershed	1.6	0.93
RIM watershed	0.0	1.00
Below-RIM watershed	2.4	0.48
Below-RIM point source	-1.8	< 0.05
Below-RIM nonpoint source	4.7	0.22
SS		
Total watershed	-4,988	0.74
RIM watershed	-6,426	0.72
Below-RIM watershed	-280	0.91
Below-RIM point source	-138	< 0.01
Below-RIM nonpoint source	-152	0.98

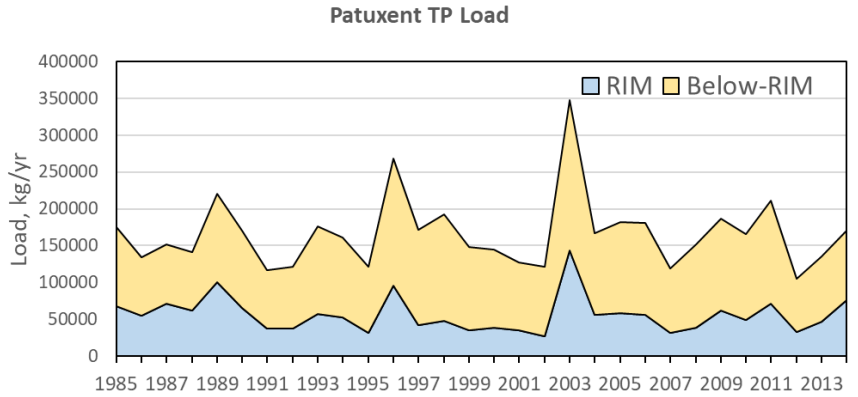
[1] Loads for the RIM watershed were estimated loads at the USGS RIM station 01646580 (Potomac River at Chain Bridge, at Washington, D.C.; https://cbrim.er.usgs.gov/loads_query.html).
[2] Loads for the below-RIM watershed were obtained from the Chesapeake Bay Program Watershed Model (https://cast.chesapeakebay.net/).
[3] Below-RIM nonpoint source loads were obtained from the Chesapeake Bay Program Watershed Model's progress runs specific to each year from 1985 and 2018, which were adjusted to reflect actual hydrology using the method of the Chesapeake Bay Program's Loads to the Bay indicator (see https://www.chesapeakeprogress.com/clean-water/water-quality).

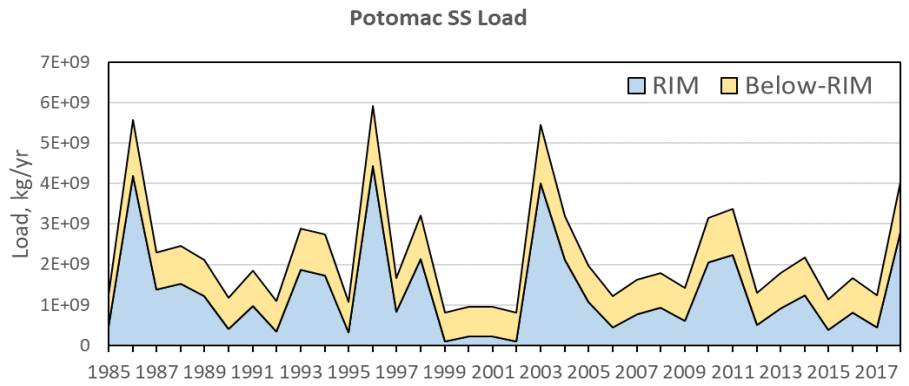
Characteristics and changes vary across basins…

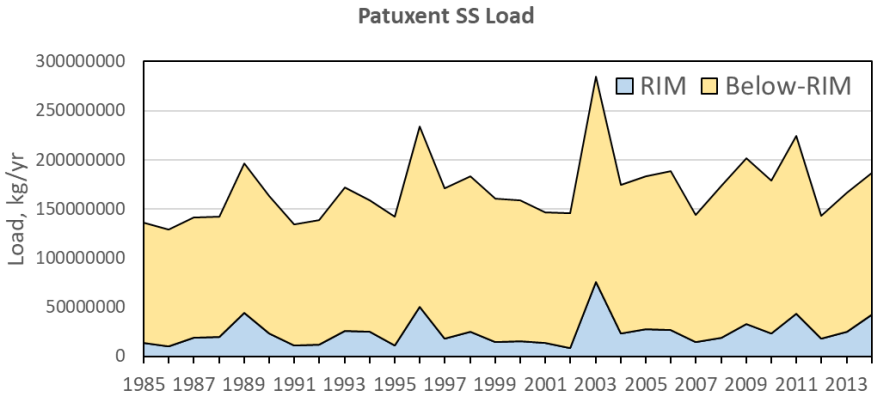




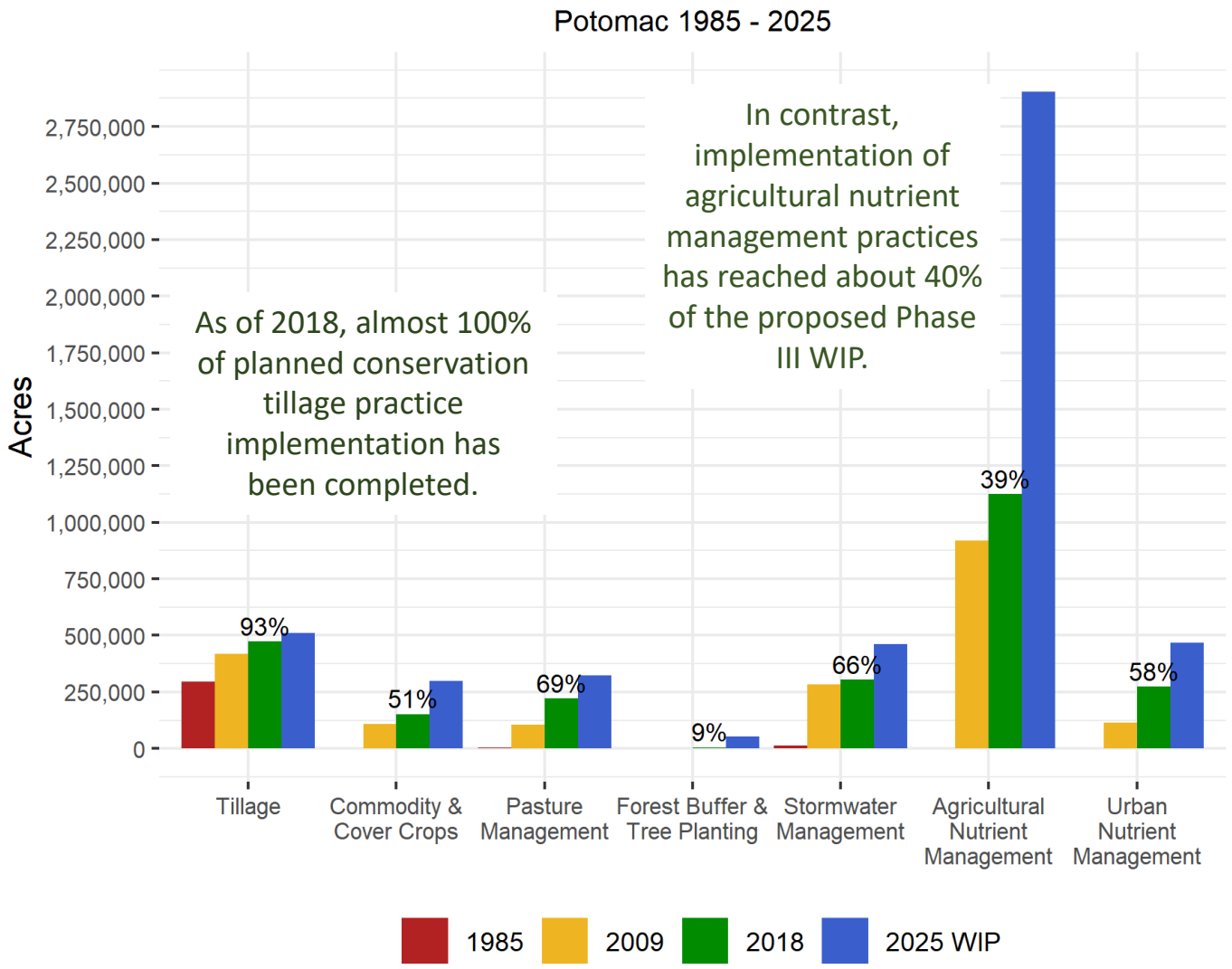




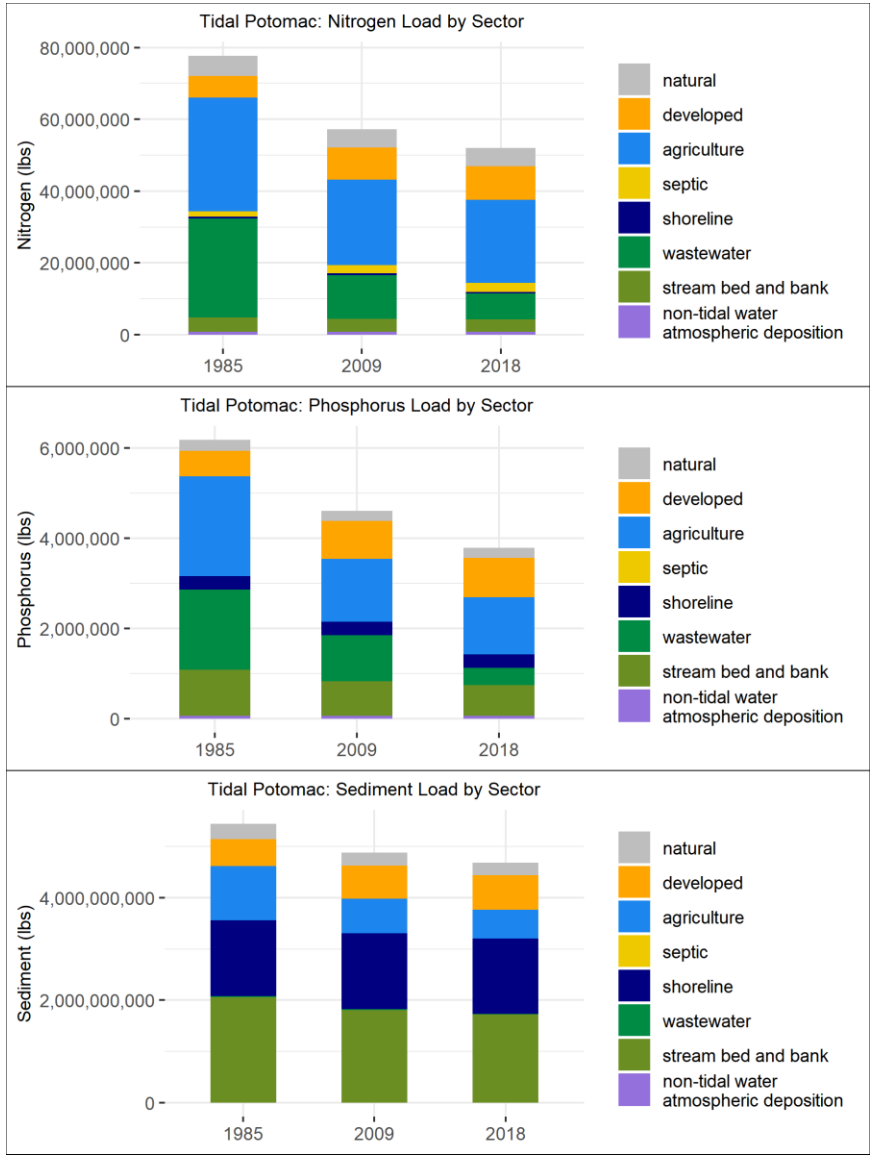




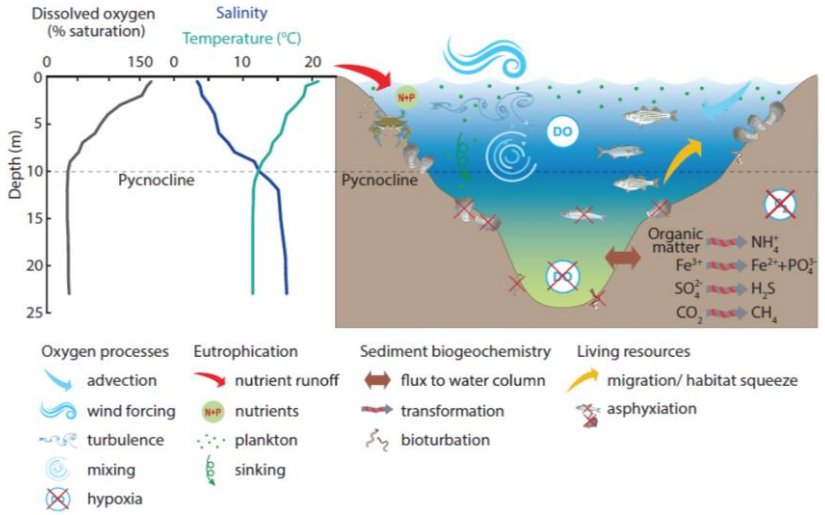
Factors: BMP implementation and expected changes by source sector

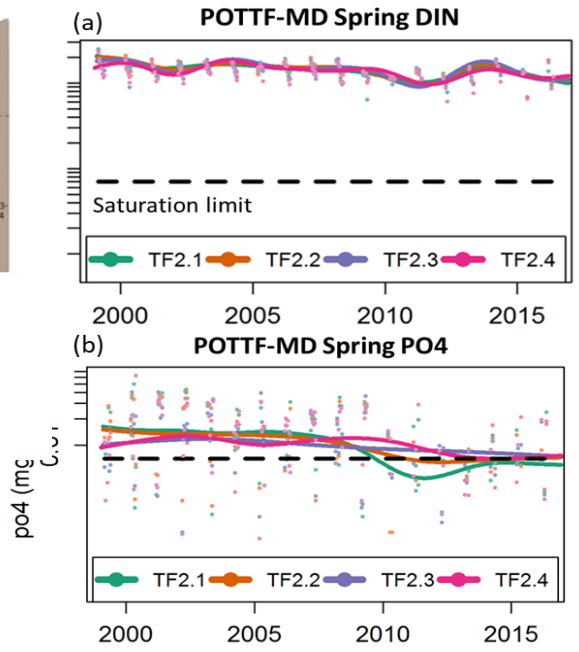


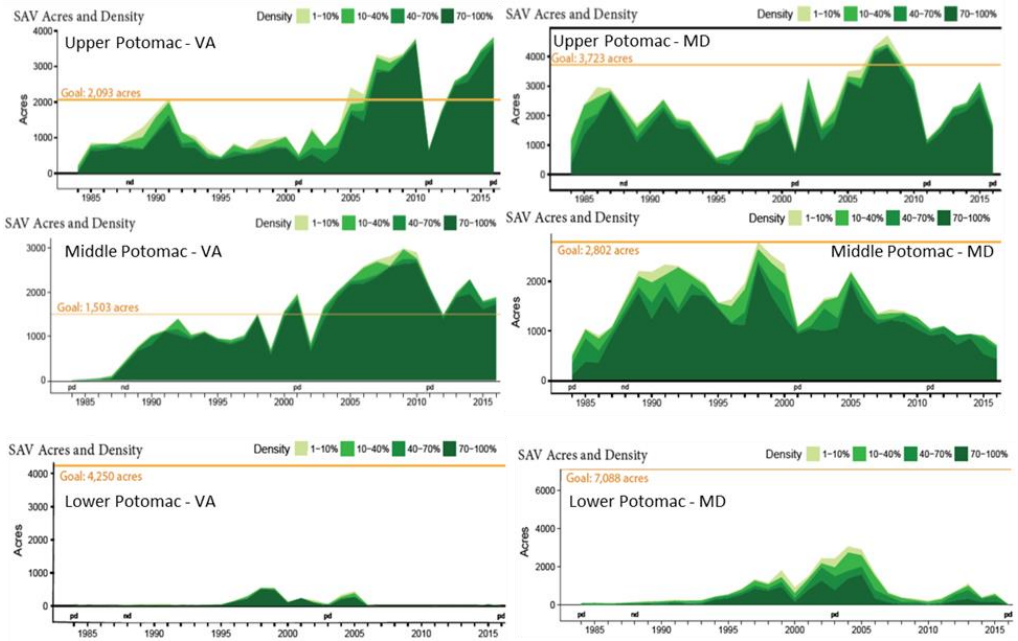
Values above the 2018 bars are the percent of the 2025 goal achieved.

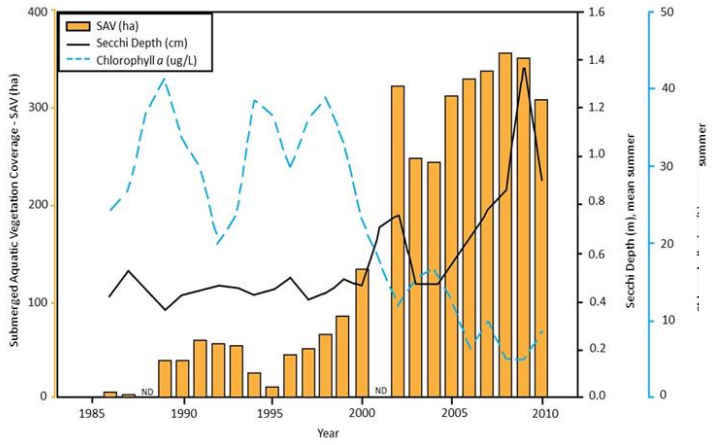


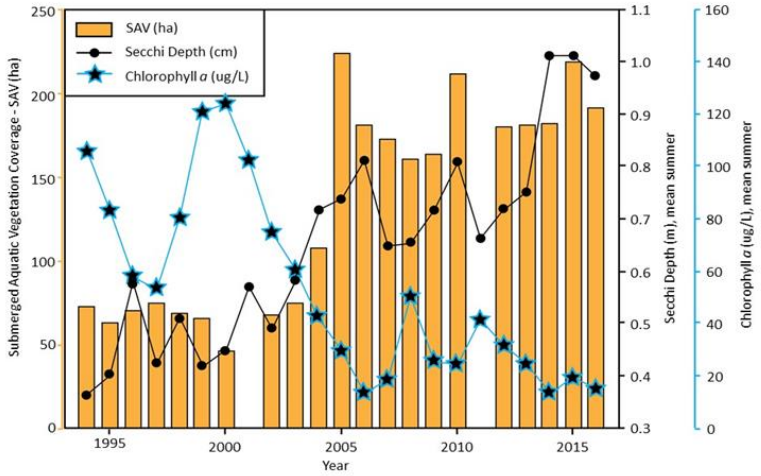
Insights on Change: draws from literature and explores hypotheses

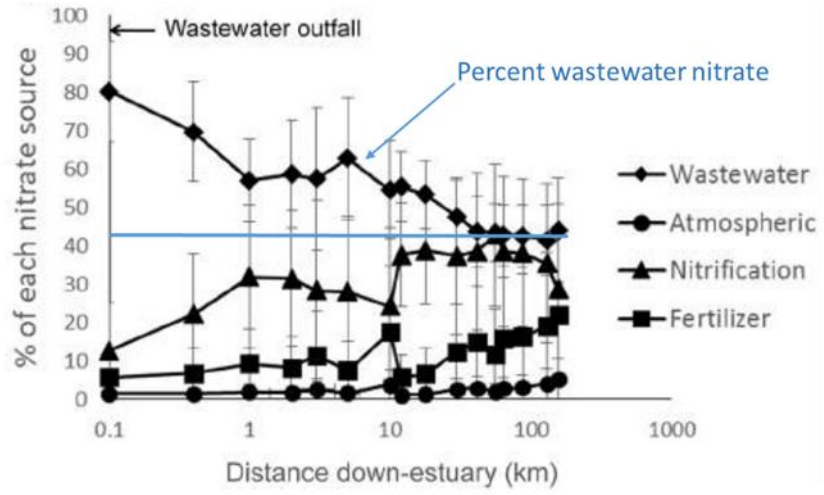












Potomac Tributary Trends Summary

Total nutrient concentrations have been decreasing at most stations in the Potomac River over the long-term, with improvements persisting in the last 10 years as well.

- These trends follow from the decreasing discharge from TN and TP sources in the watershed.

Despite the overall improvements in both nitrogen and phosphorus concentrations observed in these studies and in the current trend results, many of the chlorophyll-a and secchi trends are still degrading.

- Research suggests that there is a "saturation limit" for phytoplankton use of nutrients (Buchanan et al., 2005; Fisher and Gustafson, 2003). There may only be a response in phytoplankton to nutrient reductions when the dissolved nitrogen and/or phosphorus concentrations cross under their saturation limits.

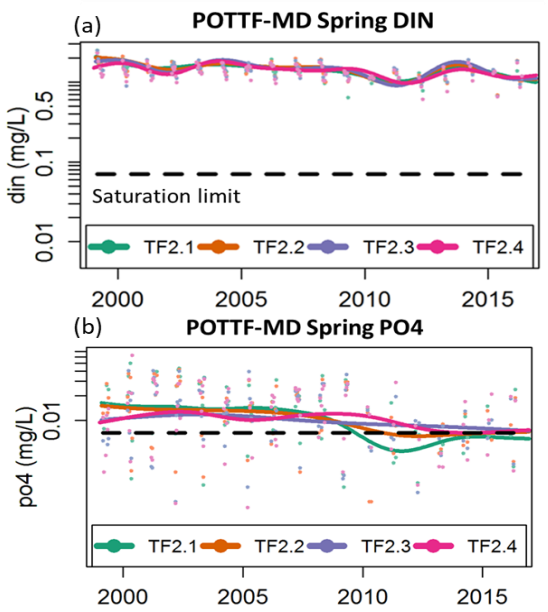
Recent improvements in oxygen concentrations are promising.

- Where chlorophyll-a concentrations have either leveled out or improved, there may be less phytoplankton biomass available to fuel summer oxygen depletion.

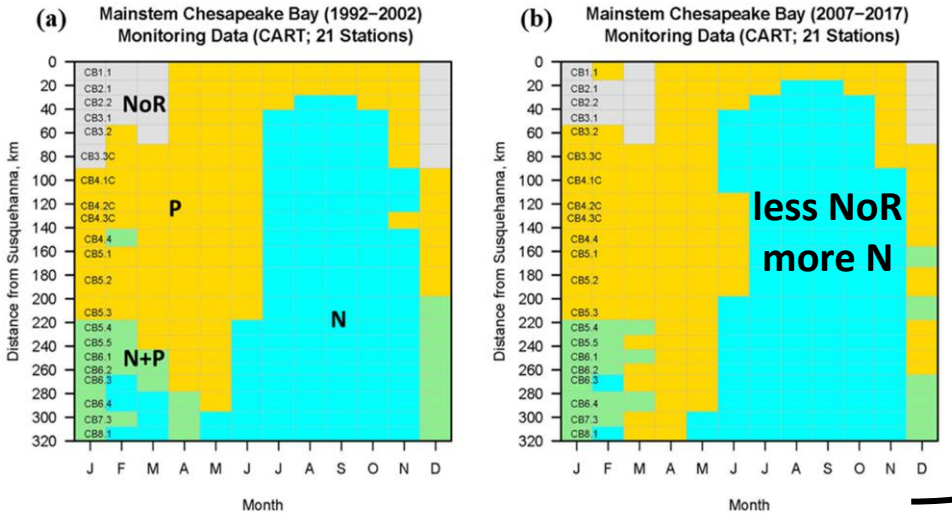
Other factors such as import of nutrients from the mainstem bay (Pennino et al., 2016), varying bivalve populations (Phelps, 1994), SAV populations, and temperature increases (Ding and Elmore, 2015) could all be playing a role in the response trajectory of the Potomac River for all of these parameters.

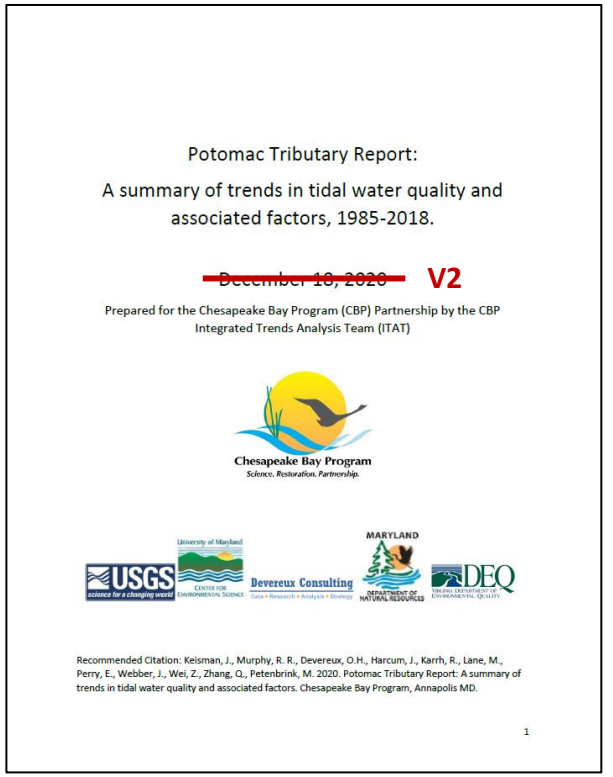
Living Documents: Emerging Insights

In the summary now as *one possible explanation…*



Emerging work on changes in nutrient limitation





Potomac Tributary Report:

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

~~December 18, 2020~~ **V2**

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

Chesapeake Bay Program
Science. Restoration. Partnership.

USGS science for a changing world · University of Maryland Center for Environmental Science · Devereux Consulting · Maryland Department of Natural Resources · DEQ Virginia Department of Environmental Quality

Recommended Citation: 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.

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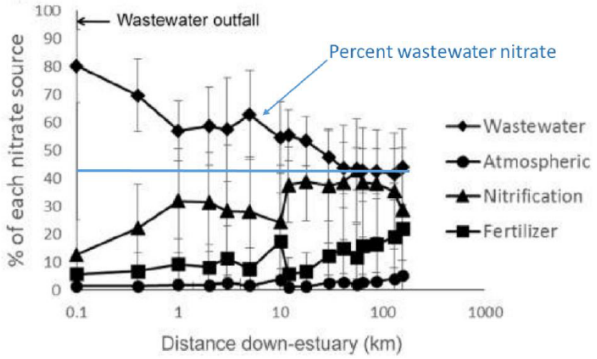
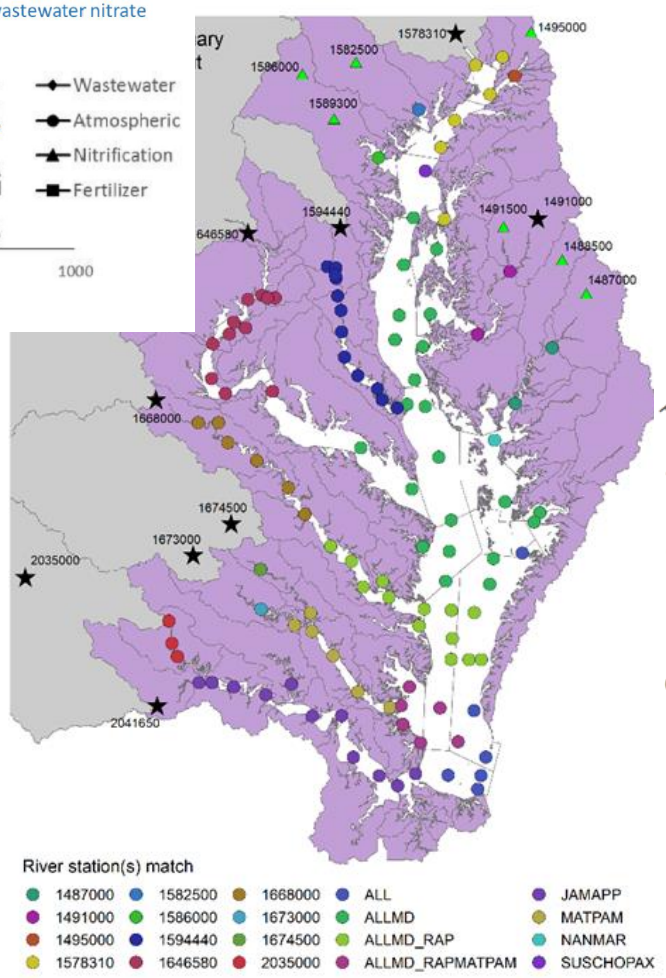
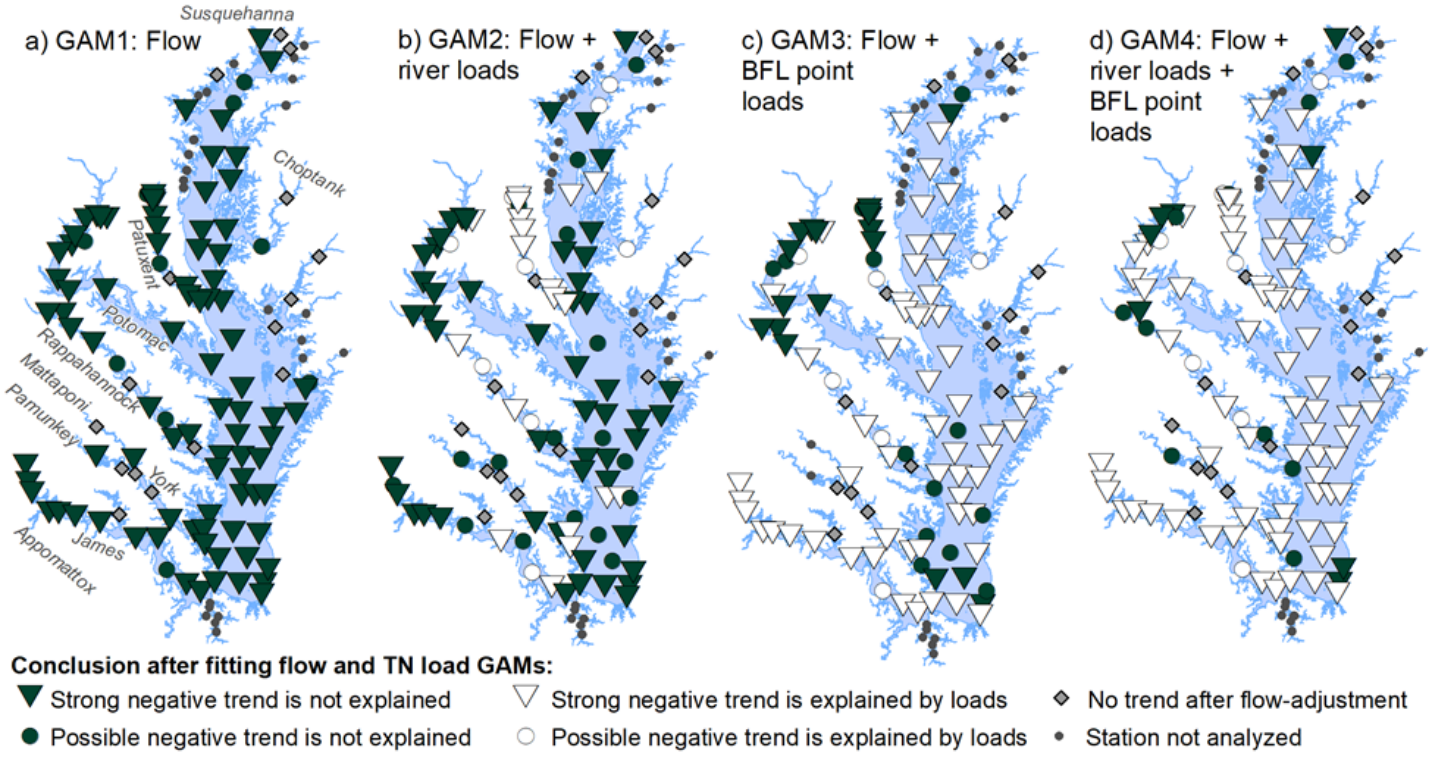
Living Documents: Emerging Insights

In the summary now:
research has shown that nitrate from Blue Plains reaches the Mainstem





Emerging work quantifies the relative influence RIM loads and Below-RIM point source loads on nutrient trends at each tidal station



Current Status: FY21 plans

2021 Priorities:

- Produce figures and tables for all 12 tributary summaries (March 2021)
- Add tributary volume calculations (FY21)
- 1985 – 2018 Rappahannock summary (technical meeting requested for 2021)
- 1985 – 2018 Upper Mainstem summary (draft materials in FY21; technical discussions TBD)