Chesapeake Bay Watershed Tributary Summaries

Water Quality Goal Implementation Team

September 27, 2021

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Rappahannock Tributary Summary:

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

June 7, 2021

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

Chesapeake Bay Program
Science. Restoration. Partnership.

This tributary summary is a living document in draft form and has not gone through a formal peer review process. We are grateful for contributions to the development of these materials from the following individuals: Jeni Keisman, Rebecca Murphy, Olivia Devereux, Jimmy Webber, Qian Zhang, Meghan Petenbrink, Tom Butler, Zhaoying Wei, Jon Harcum, Renee Karrh, Mike Lane, and Elgin Perry.

What are the Tributary Summaries?

A compilation of information on the landscape drivers of changes in water quality and standards attainment

- ✓ Analysis is available in a single report
  - ✓ Readers can spend their time learning about their watershed
  - ✓ Removes the complication of determining what data they need to find and how to pull the data together
  - ✓ Connects the dots for readers

Contents

Who are the Tributary Summaries for?

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

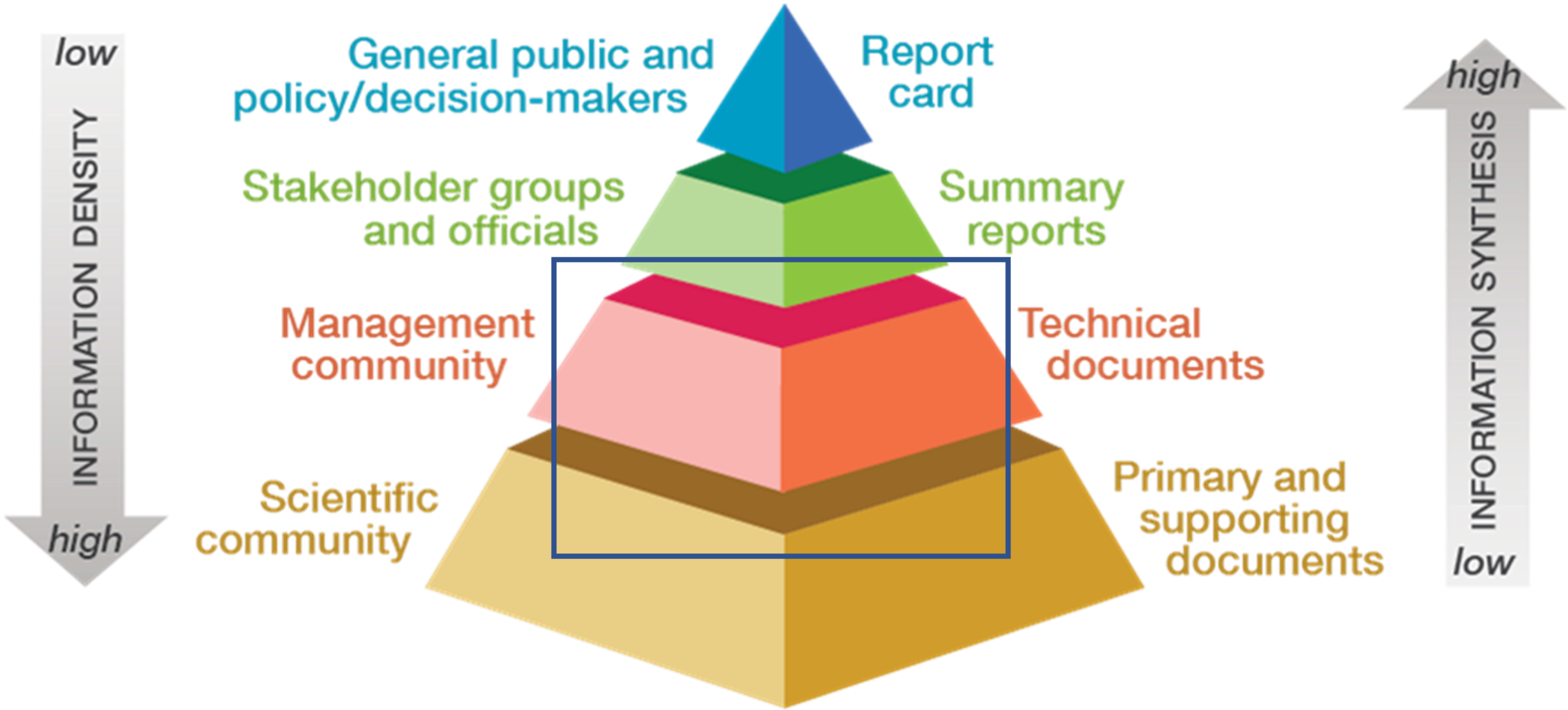
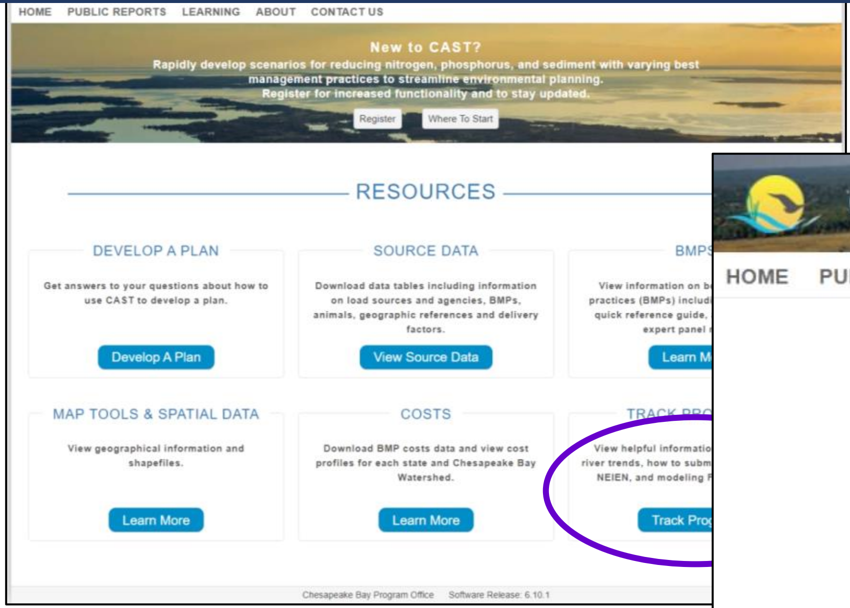
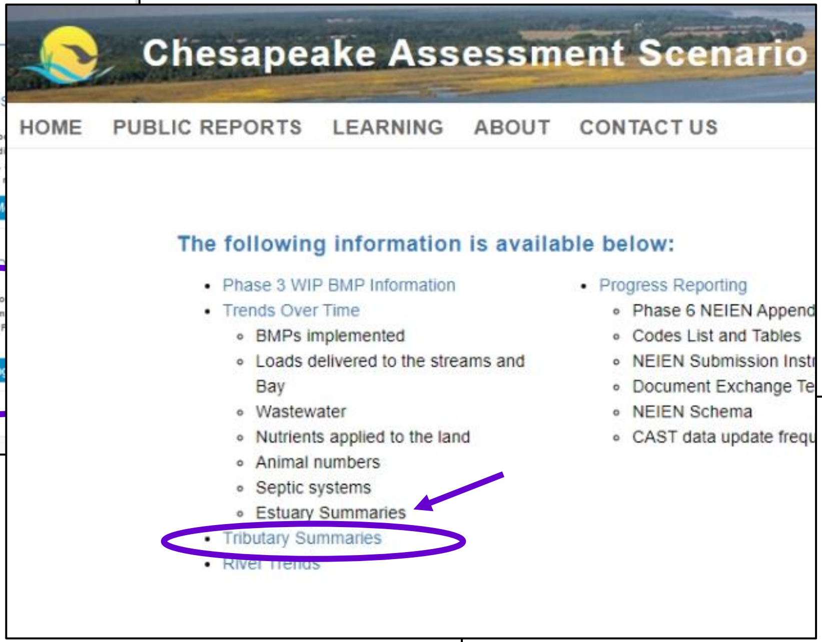


Figure courtesy UMCES Integration and Application Network, ian.umces.edu

Where can I get the Tributary Summaries?

[CAST - TMDL Tracking (chesapeakebay.net)]



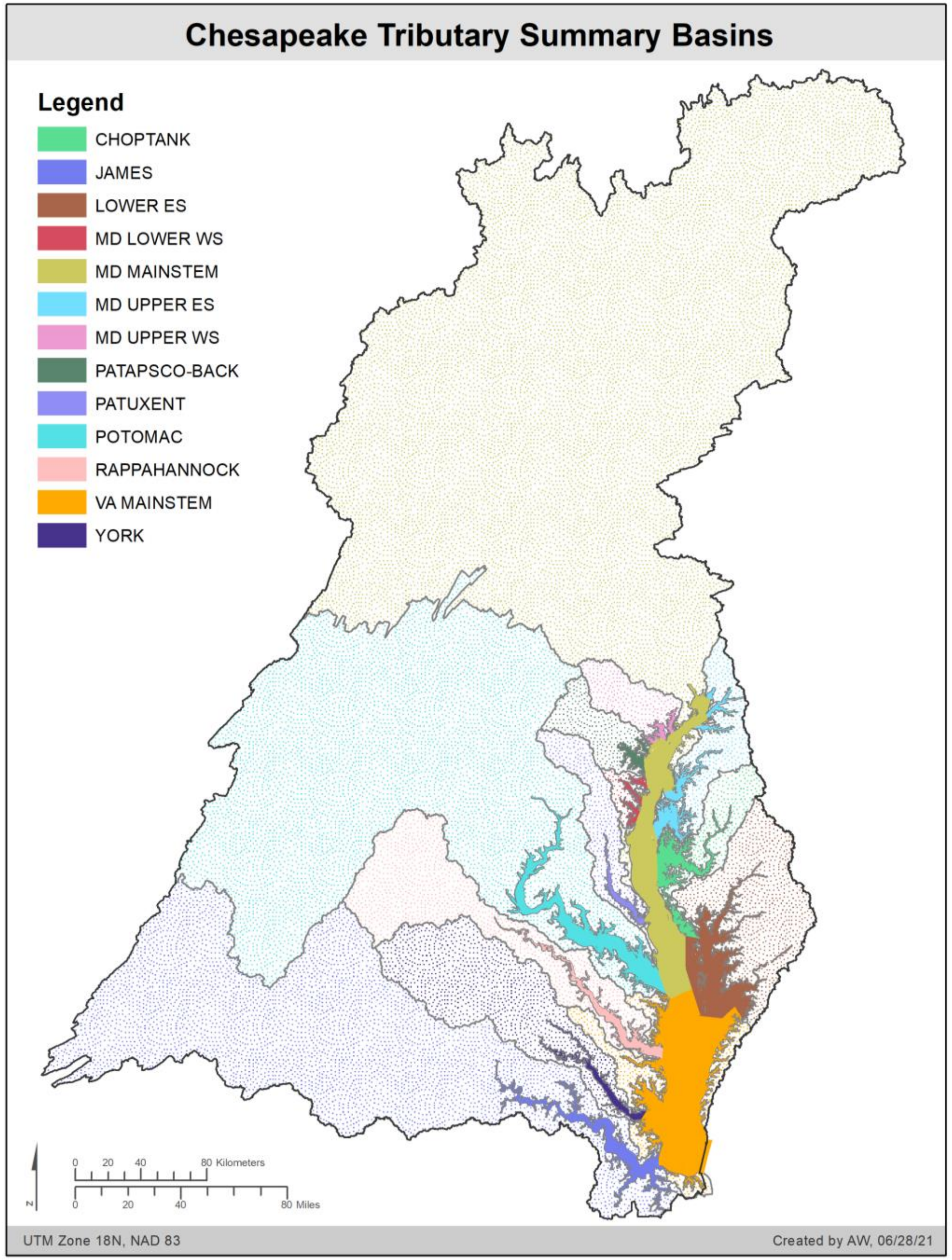


Tributary Summaries

The Chesapeake Bay Program and its partners compiled tributary basin summaries for 12 major tributaries or tributary groups in the Chesapeake Bay Watershed. These documents summarize the following in one place: 1) How tidal water quality changes over time; 2) How factors that drive those changes change over time; and, 3) Current state of the science on connecting change in aquatic conditions to its drivers.

- Choptank (includes the Choptank, Little Choptank, and Honga) Summary, Appendix
- Potomac: Summary, Appendices, Story Map
- Maryland Mainstem (includes the five Chesapeake Bay mainstem segments within the Maryland state boundary. Drainage basins include the Susquehanna River and upper Chesapeake Bay shorelines) Summary, Appendix
- Maryland Upper Eastern Shore (includes the Northeast, Bohemia, Elk, Back Creek, Sassafras, and Chester Rivers, the Chesapeake & Delaware Canal, and Eastern Bay) Summary, Appendix
- Maryland Upper Western Shore (includes the Bush, Gunpowder, and Middle rivers) Summary, Appendix
- Maryland Lower Western Shore (includes the Magothy, Severn, South, Rhode, and West rivers) Summary, Appendix
- Patapsco and Back Summary, Appendix
- Patuxent (includes the Western Branch tributary) Summary, Appendix
- Rappahannock (includes the Corrotoman tributary) Summary, Appendices
- York (includes the Mattaponi and Pamunkey tributaries) Summary, Appendices
- James (includes the Appomattox, Chickahominy, and Elizabeth Tributaries) Summary, Appendix
- Lower E. Shore (includes the Nanticoke, Manokin, Wicomico, Big Annemessex, and Pocomoke Rivers, and Tangier Sound) Summary, Appendix
- Virginia Mainstem: Summary not available, Appendices

12 Tributary Trend Summaries



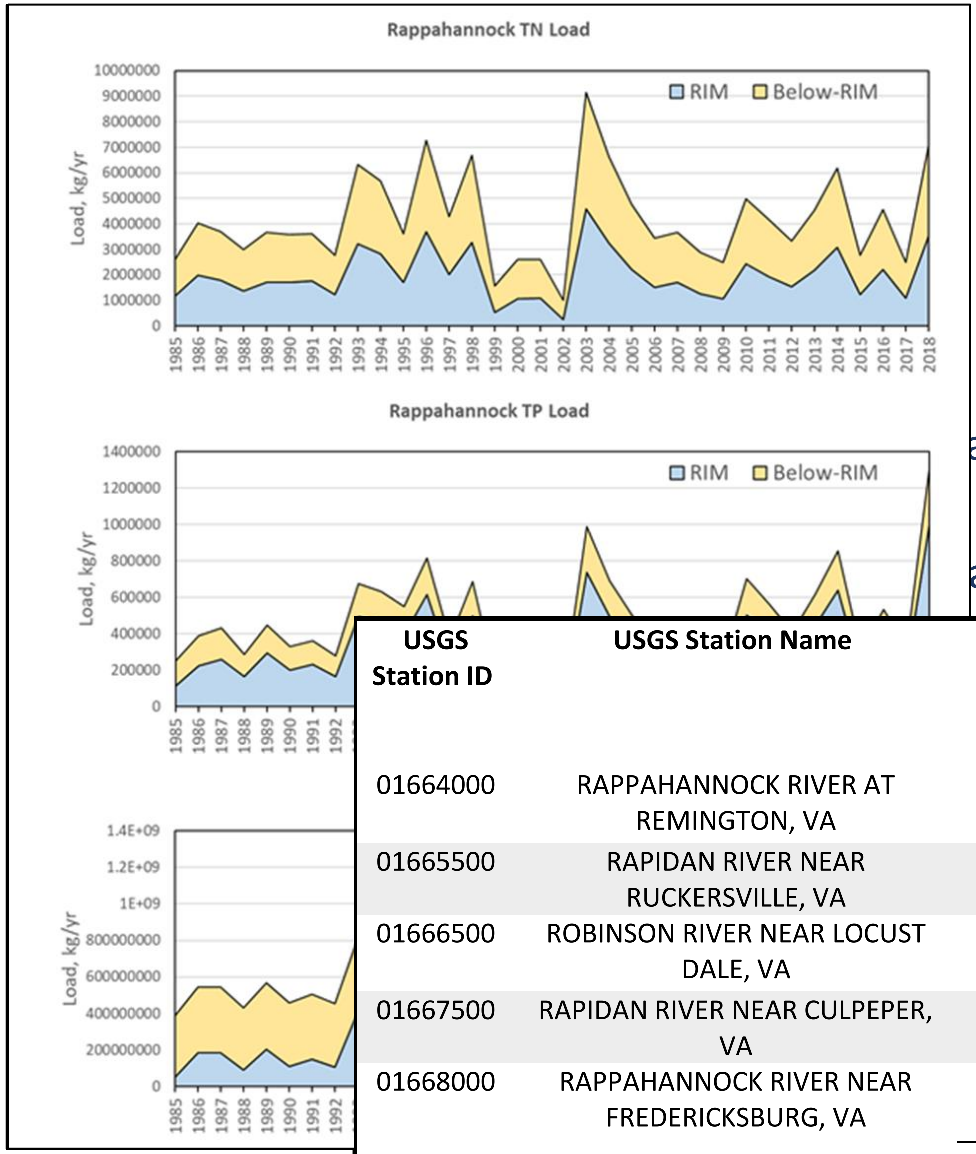
- **Maryland Mainstem** *(The 5 Chesapeake Bay mainstem segments within the MD state boundary. Drainage basins include the Susquehanna River and upper Chesapeake shorelines)*
- **Maryland Upper Eastern Shore** *(The Northeast, Bohemia, Elk, Back Creek, Sassafras, and Chester Rivers, the C&D Canal, and Eastern Bay)*
- **Choptank** *(the Choptank, Little Choptank, and Honga)*
- **Maryland Upper Western Shore** *(Bush, Gunpowder, Middle Rivers)*
- **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)*

Questions the tributary summaries can answer

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

Questions the tributary summaries can answer

Has water quality been improving or degrading?



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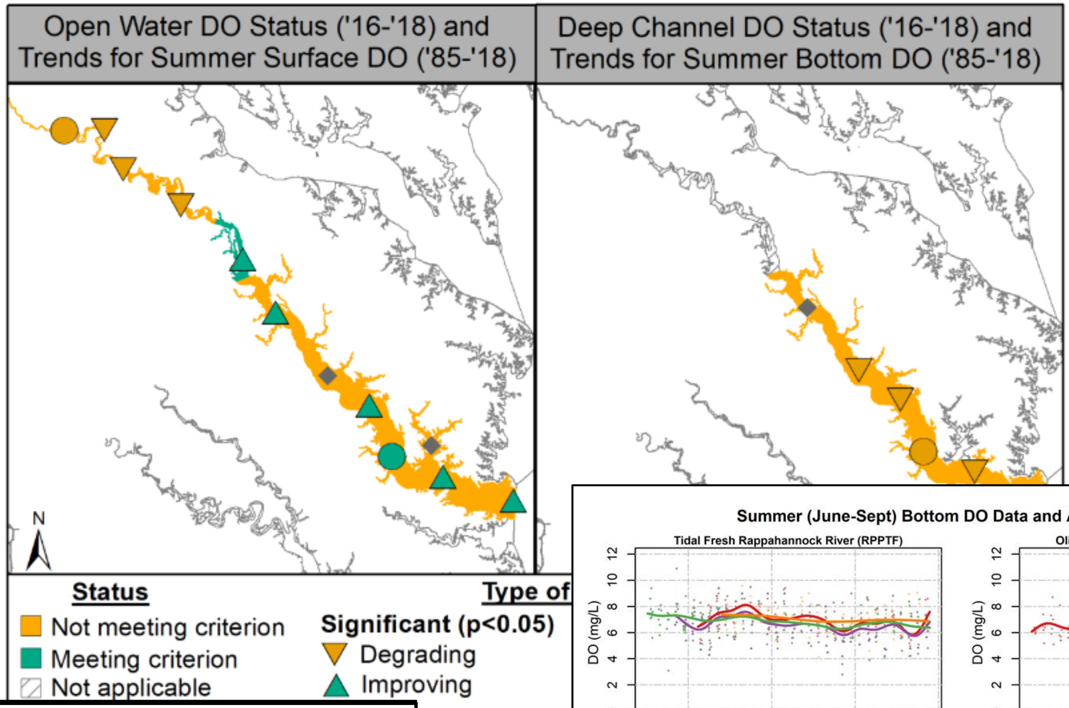
USGS Station ID	USGS Station Name	Trend start water year	Percent change in FN load, through water year 2018		
			TN	TP	SS
01664000	RAPPAHANNOCK RIVER AT REMINGTON, VA	1985	24.4	-	-
		2009	15.4	-	-
01665500	RAPIDAN RIVER NEAR RUCKERSVILLE, VA	2009	-5.1	-	-
01666500	ROBINSON RIVER NEAR LOCUST DALE, VA	1985	2.5	-	-
		2009	3.5	-	-
01667500	RAPIDAN RIVER NEAR CULPEPER, VA	2009	-8.9	-6.8	-7.1
01668000	RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA	1985	-12.7	52.5	79.9
		2009	6.3	27.9	28.3



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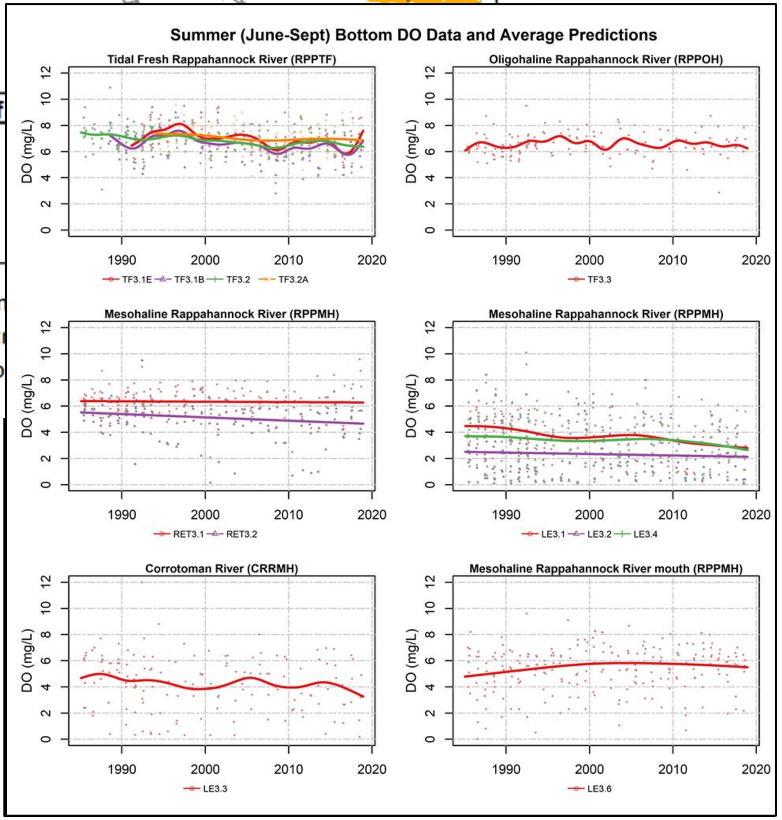


Questions the tributary summaries can answer

How have factors that affect water quality changed over time?

Land use change

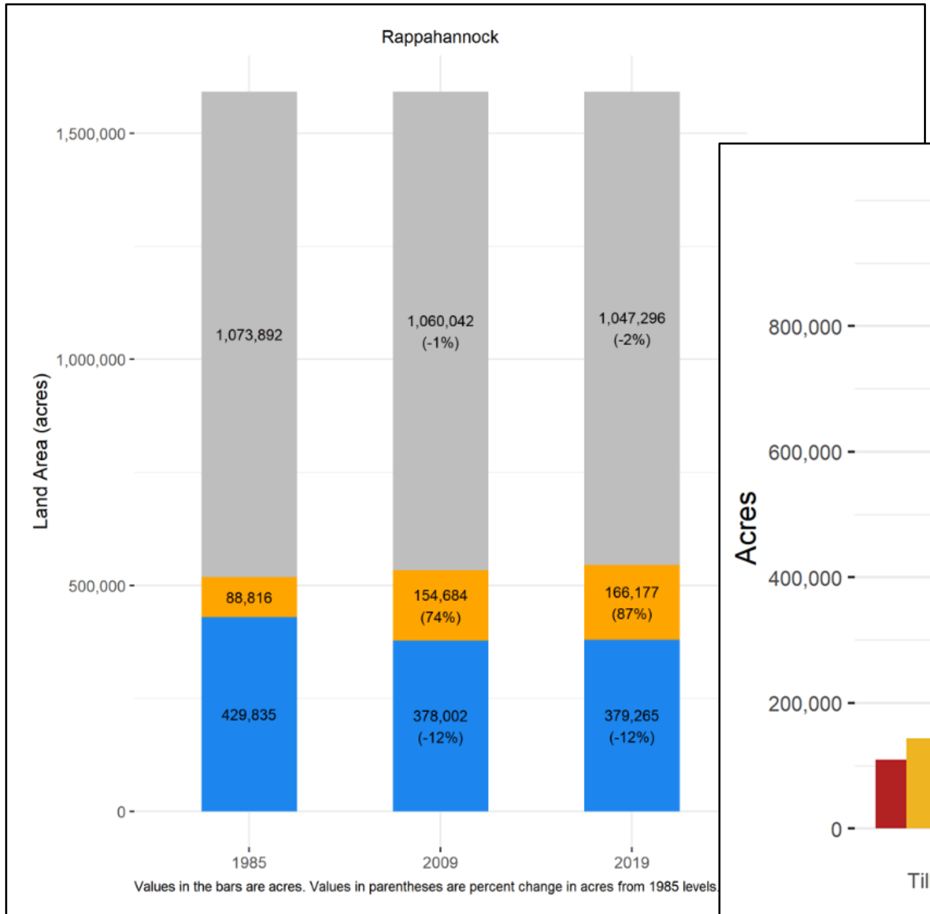
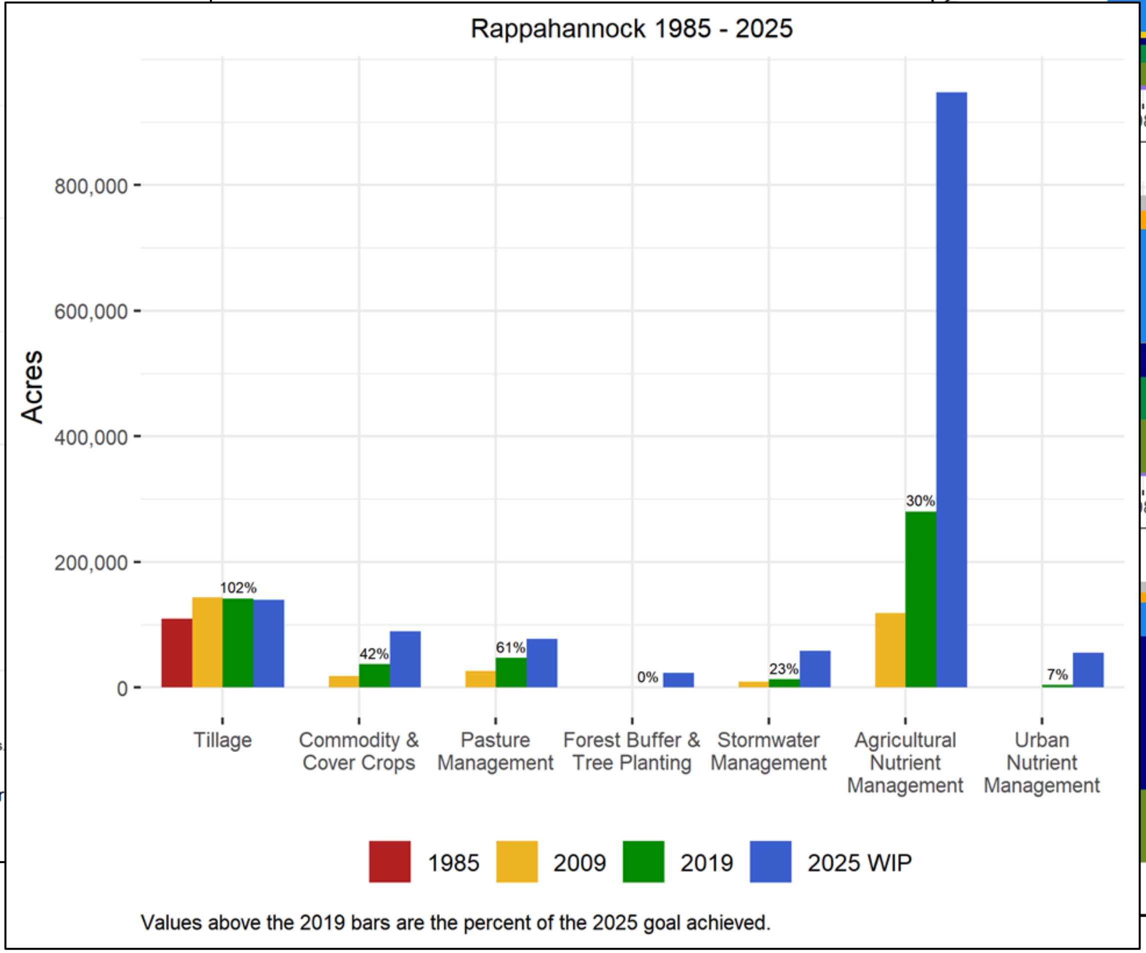
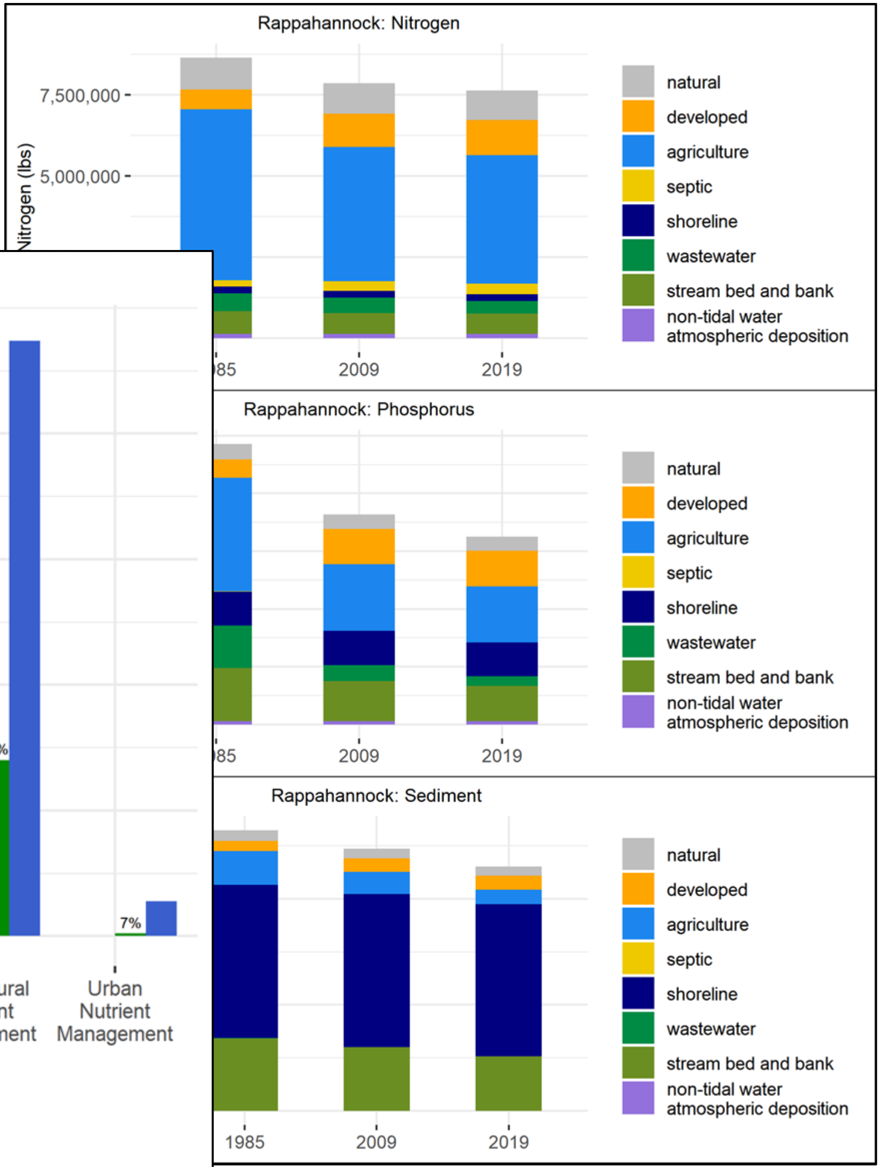


Figure 2. Distribution of land uses in the Rappahannock watershed. Percentages ar
from 1985 for each source sector.

BMP Implementation relative to 2025 WIP



Changes in loads by source sector



Questions the tributary summaries can answer

What might explain observed water quality change?

Segments not attaining; DO trends are mixed…

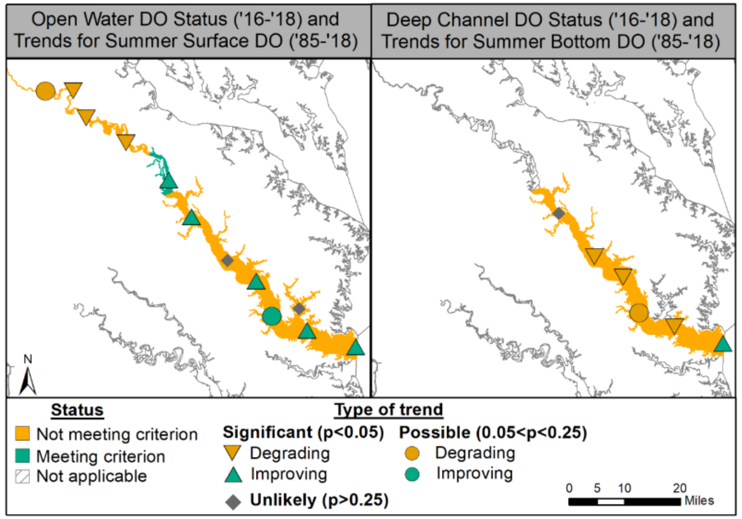
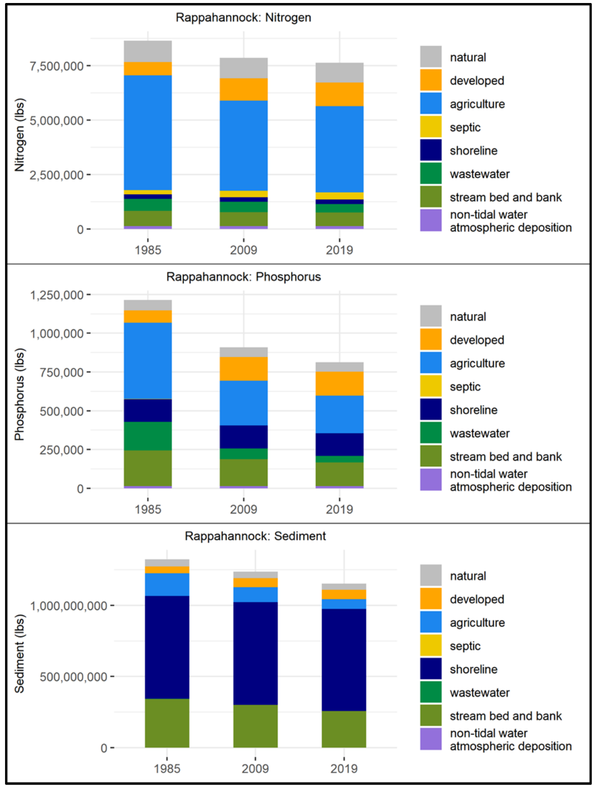


Figure 5. Pass-fail DO criterion status for 30-day OW summer DO and DC instantaneous DO designated uses in Rappahannock segments along with long-term trends in DO concentrations. Base map credit Chesapeake Bay Program, www.chesapeakebay.net, North American Datum 1983.

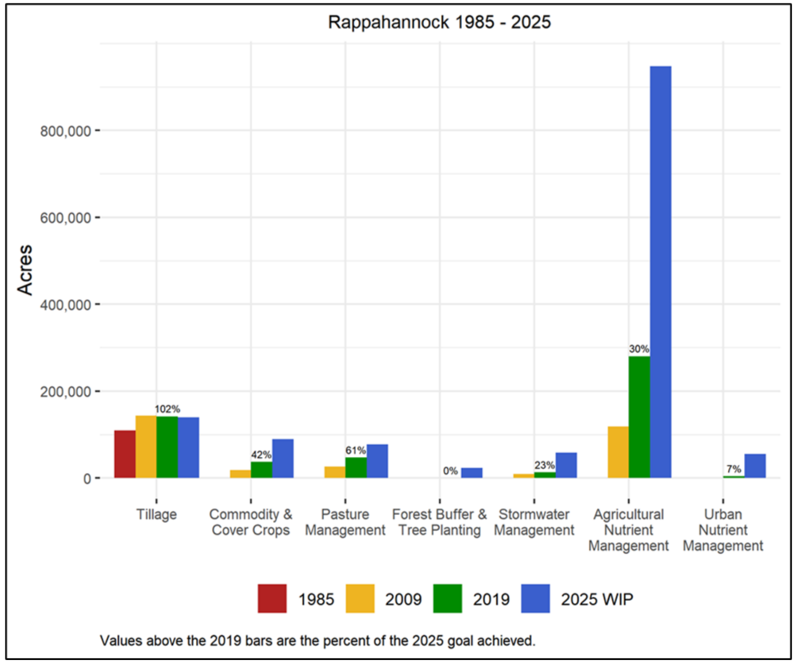
Loads expected to decline…



But we're not seeing it…

USGS Station ID	USGS Station Name	Trend start water year	Percent change in FN load, through water year 2018 TN	TP	SS
01664000	RAPPAHANNOCK RIVER AT REMINGTON, VA	1985 2009	24.4 15.4	- -	- -
01665500	RAPIDAN RIVER NEAR RUCKERSVILLE, VA	2009	-5.1	-	-
01666500	ROBINSON RIVER NEAR LOCUST DALE, VA	1985 2009	2.5 3.5	- -	- -
01667500	RAPIDAN RIVER NEAR CULPEPER, VA	2009	-8.9	-6.8	-7.1
01668000	RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA	1985 2009	-12.7 6.3	52.5 27.9	79.9 28.3

Many implementation rates still low…



Rappahannock River Example

Answer #1: Have water quality indicators been improving or degrading?

	Open Water Summer (30-day mean)			
time period	RPPTF	RPPOH	RPPMH	CRRMH
1985-1987				
1986-1988				
1987-1989				
1988-1990				
1989-1991				
1990-1992				
1991-1993				
1992-1994				
1993-1995				
1994-1996				
1995-1997				
1996-1998				
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2005-2007				
2006-2008				
2007-2009				
2008-2010				
2009-2011				
2010-2012				
2011-2013				
2012-2014				
2013-2015				
2014-2016				
2015-2017				
2016-2018				

	DW Summer (30-day mean)	DC Summer (instantaneous)
time period	RPPMH	RPPMH
1985-1987		
1986-1988		
1987-1989		
1988-1990		
1989-1991		
1990-1992		
1991-1993		
1992-1994		
1993-1995		
1994-1996		
1995-1997		
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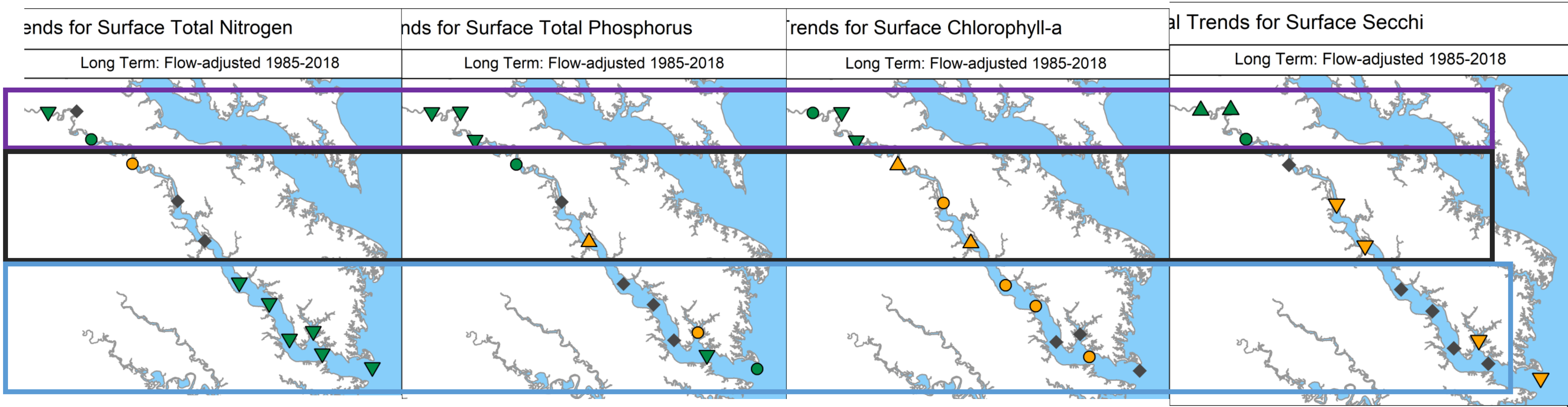
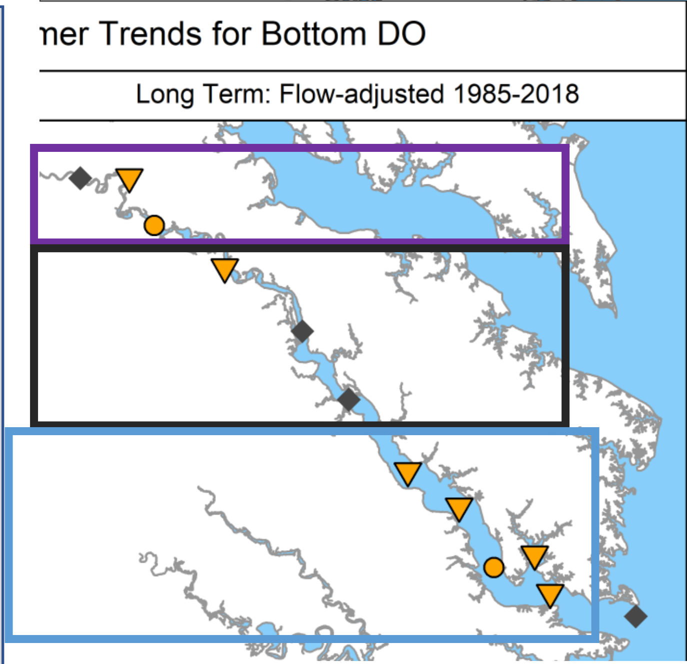
2015-2017		
2016-2018		





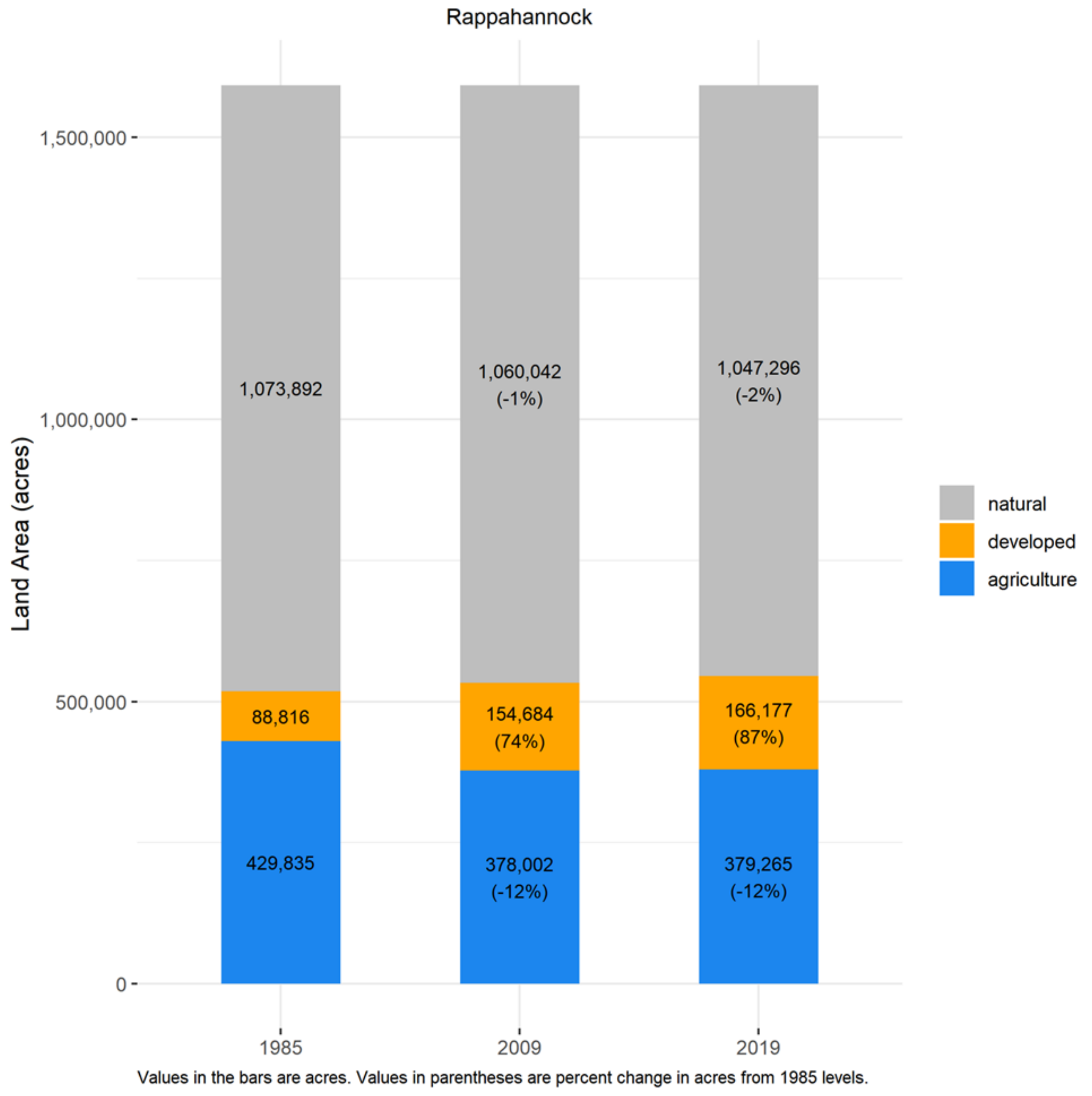
- Freshest 3 stations appear to be improving for all parameters, except DO (but possible lower DO is due to lower phytoplankton concentrations = less oxygen production)
- In middle estuary (TF3.3, RET3.1 and RET3.2) nutrients are fairly constant, increasing in a very few cases, and high in general. Chlorophyll is increasing in both seasons at these stations, with consistent degradation of secchi.
- Lower estuary has decreasing N, but P is mixed. Chlorophyll and secchi are either increasing or constant at these stations. The degrading summer bottom DO is probably due to the increasing phytoplankton in this region as well as the middle Rapp stations.

→ Unexplained change: increasing in chlorophyll-a in spite of decreases in nutrient concentrations at many stations. We are seeing similar patterns in other tributaries (Potomac, Patuxent, etc).

Answer #2: How landscape factors have changed over time

- Developed land area increased by about 77,400 acres (87%) from 1985-2019.

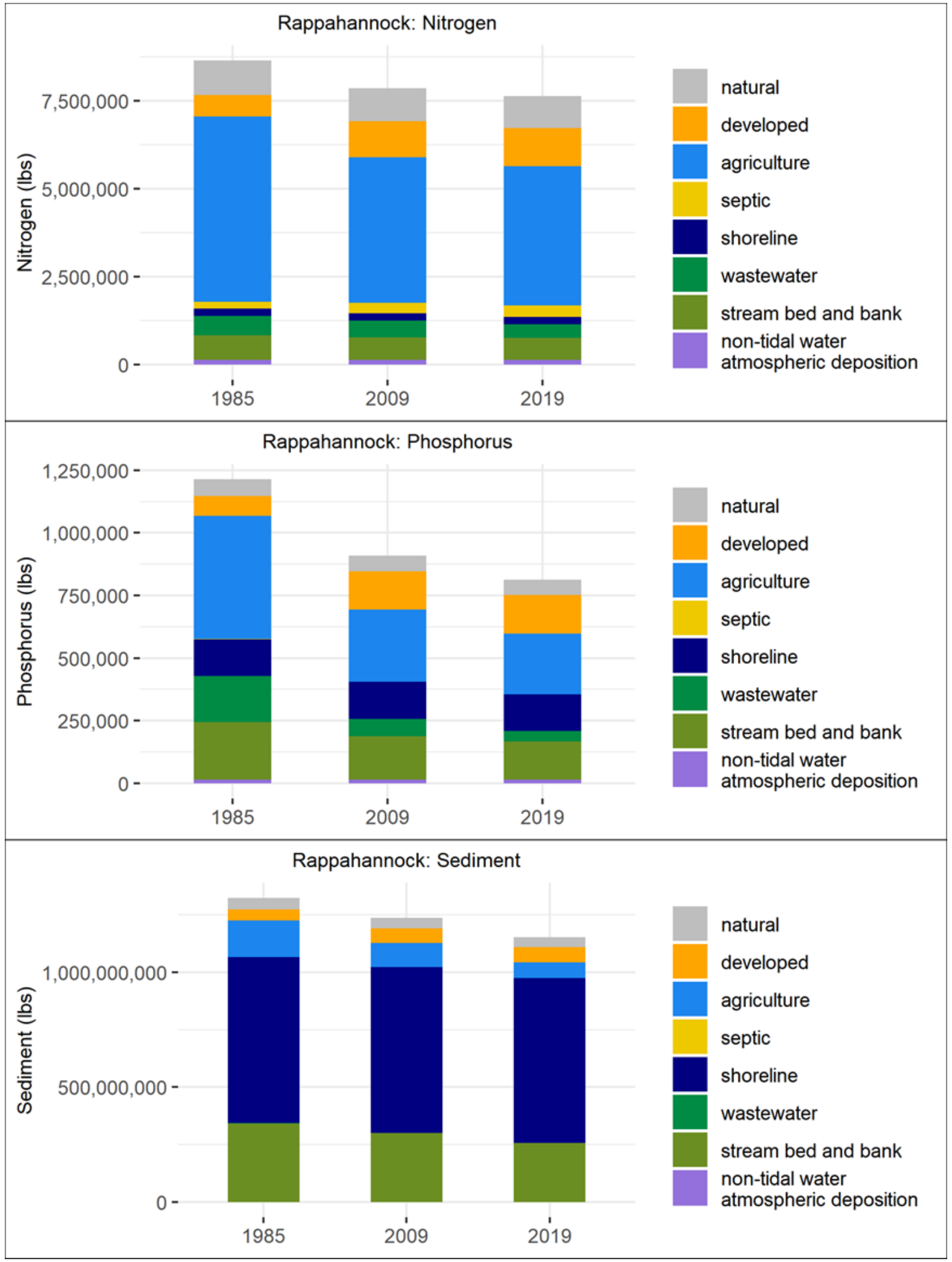
- Agricultural land area declined by about 50,600 acres and natural by about 26,600 acres.



Answer #2: How landscape factors have changed over time

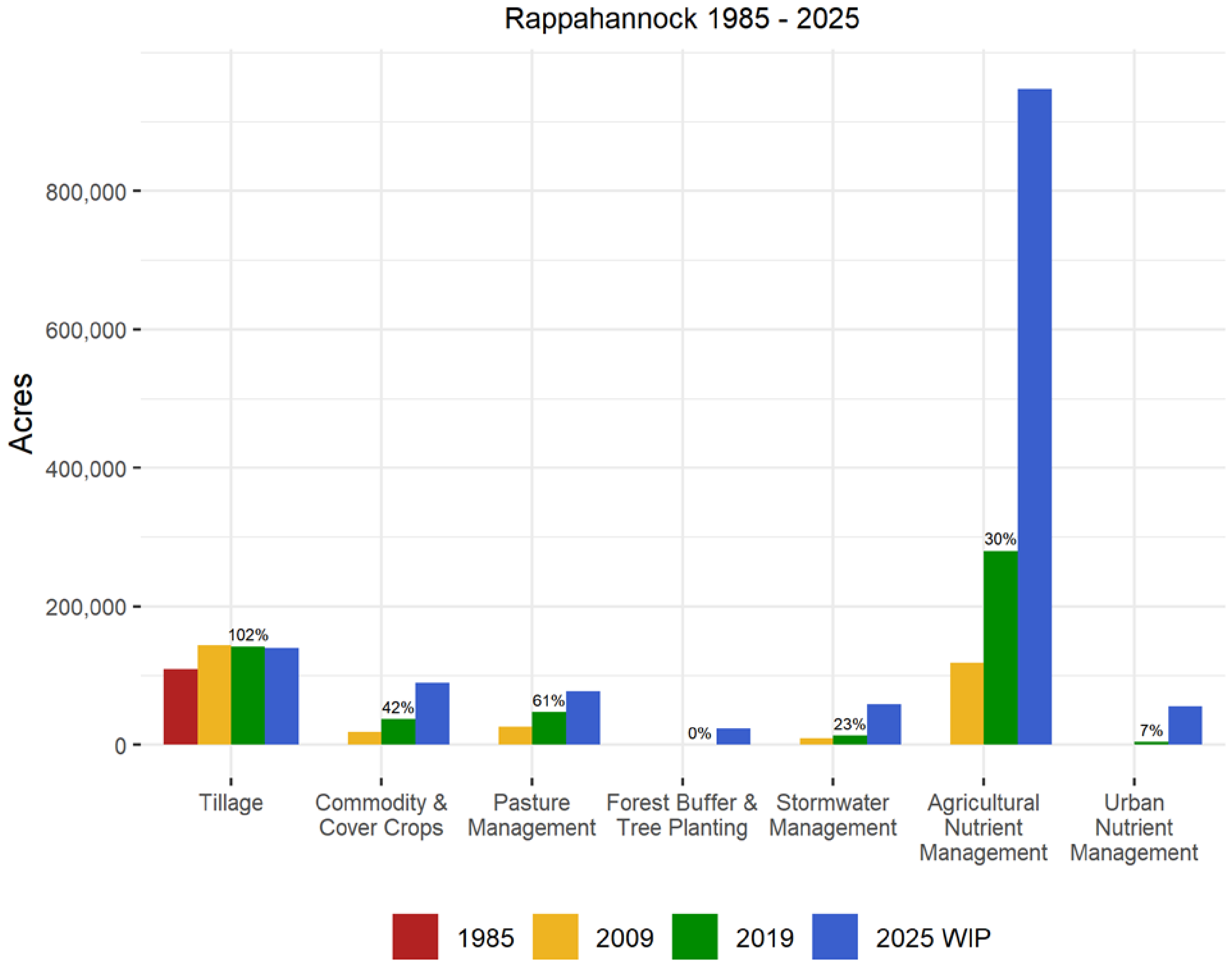
Between 1985-2019:

- Expected declines in N,P, and S loads from the agriculture, natural, streambed/bank, and wastewater sectors.
- Loads from developed sectors are expected to increase.



Answer #2: How landscape factors have changed over time

- Conservation tillage is at 102% of 2025 WIP
- Other BMPs have farther to go. For example:
  - Ag nutrient management = 30%
  - Stormwater management = 23%
  - Urban nutrient management = 7%
  - Animal waste management systems = 6%
  - Forest buffer and tree planting = 0%



Values above the 2019 bars are the percent of the 2025 goal achieved.

Answer #3: How this translates to water quality change in loads

- Flow-normalized N, P, and SS load trends throughout the watershed are mixed

- Loads from the RIM station near Fredericksburg increased (degraded) from 2009-2018.

USGS Station ID	USGS Station Name	Trend start water year	Percent change in FN load, through water year 2018		
			TN	TP	SS
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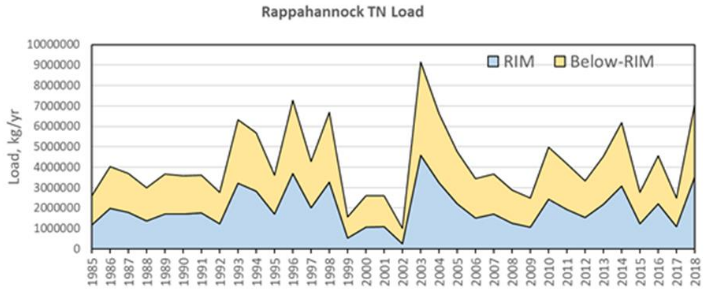
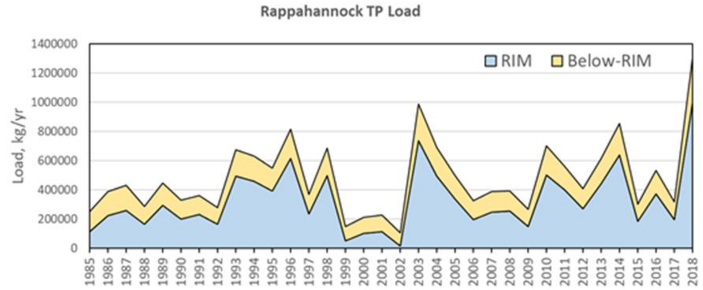
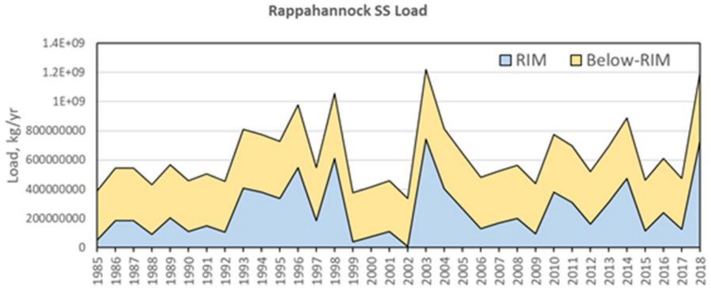
		2009	6.3	27.9	28.3

Overall, no significant trend in estimated N, P, or SS loads from the watershed to tidal waters

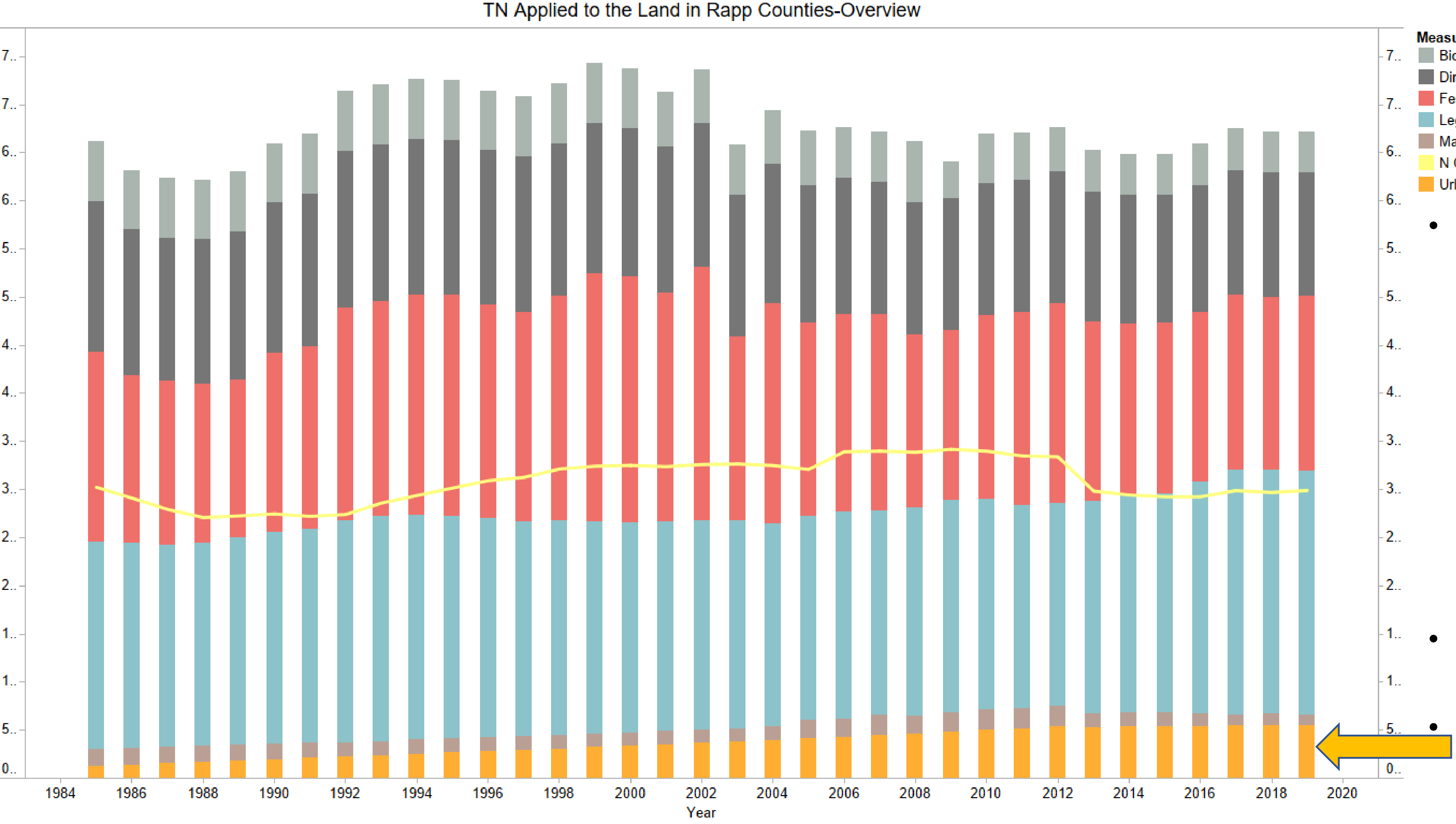
- Small declines in below-RIM nitrogen point source and tidal N deposition were countered by large increases from the RIM
- Small declines in below-RIM PS and NPS phosphorus inputs countered by P larger increase from RIM
- Small declines in PS sediment inputs countered by larger increases from other sources







Answer #4: Targets for Managers



- Development needs to be managed.
    - Increase urban stormwater regulations
    - Restrict building where wastewater treatment isn't available
- Maintain/grow forest
- Continue ag efforts.

Answer #5: Targets for scientists

Some key unexplained changes:

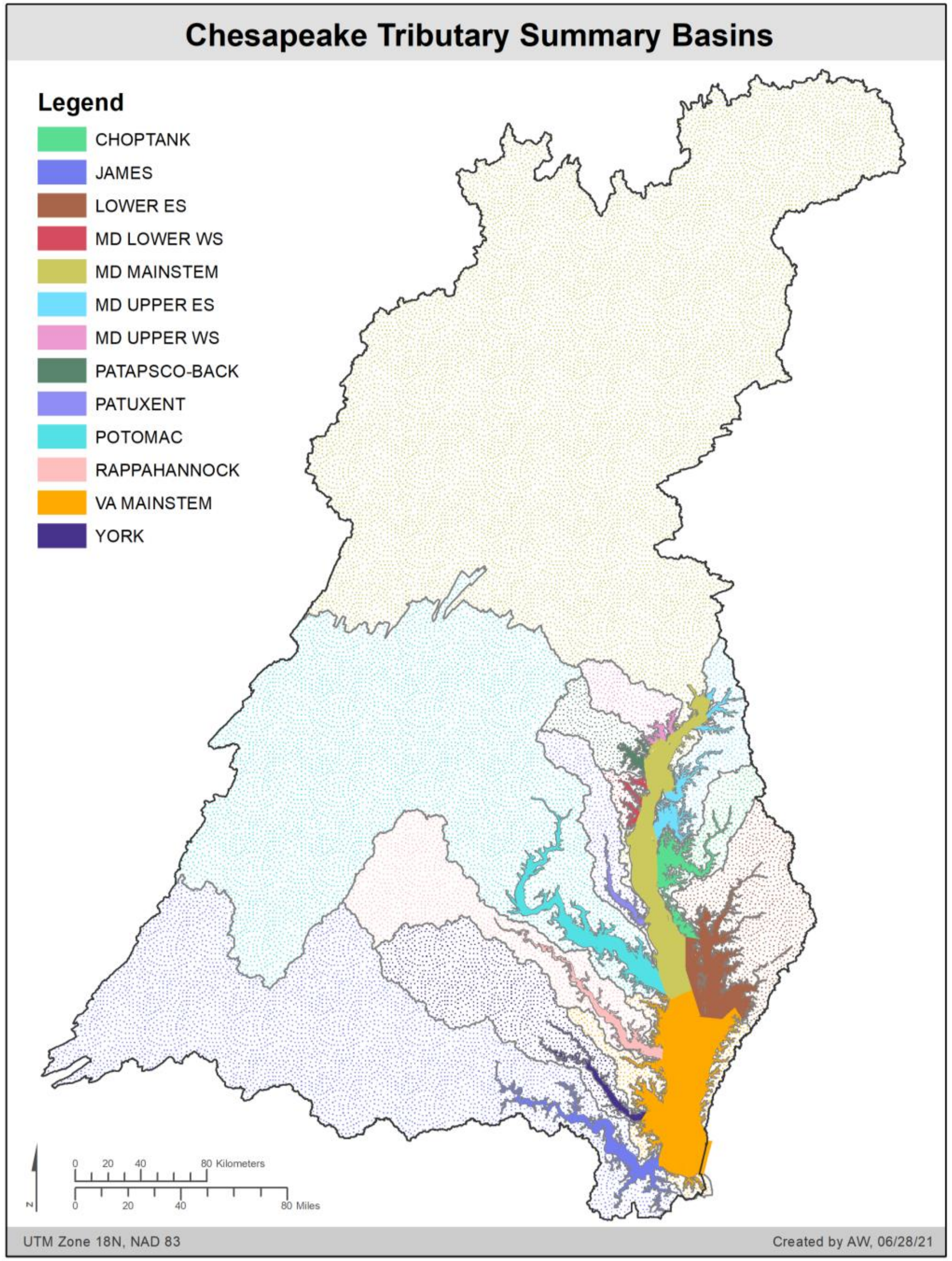
- Improving (declining) nutrient concentrations in the tidal fresh given that RIM concentrations have not declined.

- Increasing chlorophyll-a and lack of improvement or degradation in Secchi depth that aren’t clearly associated with increases in nutrient concentrations.
  - We also see this in other tributaries, including the Potomac and Patuxent.
  - Degrading summer bottom DO is probably due to the increasing phytoplankton in this region as well as the middle Rappahannock stations.

- Drivers of improving vs. degrading nutrient trends in different sub-basins around the watershed
  - Can they be related to spatial patterns of BMP implementation and land use change?
  - Why haven’t landscape changes to date resulted in improving (declining) overall N, P, and S loads?

Updating the Tributary Summaries

- Tributary Summaries were produced in 2020
- Summaries can be updated biannually
- Much of the process is automated and documented



Updating the Tributary Summaries

- "Insights on Change" sections synthesize insights from the Summary's content, local expert knowledge, and the state of the science.
- Tackle through ITAT-coordinated breakout groups and tributary modeling teams.

Contents

Questions?

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