Chesapeake Bay Total Maximum Daily Load Indicator

Chesapeake Bay Commission

Gary Shenk USGS@CBPO

5/2/2024

Total Maximum Daily Load (TMDL)

What management practices…

…. will reduce nitrogen, phosphorus, and sediment to levels …

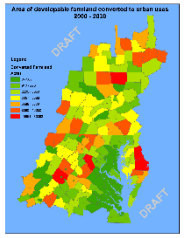
…. that will achieve levels of dissolved oxygen, clarity, and chlorophyll in the Bay…

… that are supportive of living resources?

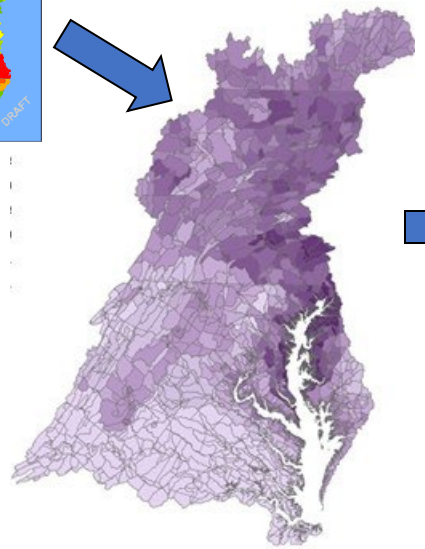
Photo credit: CBP

CBP Decision Support System

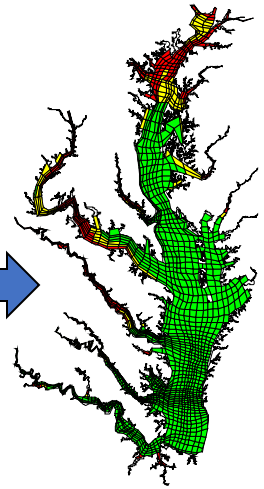
Land Use Change Model



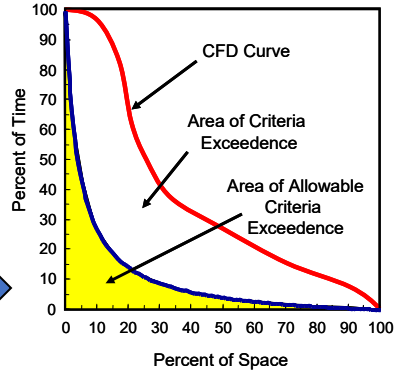
Watershed Model (CAST)



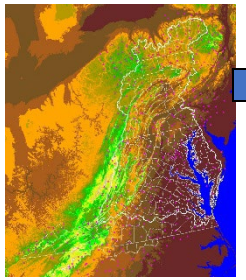
Estuary Model



Criteria Assessment Procedures



Atmospheric Model



What management practices…

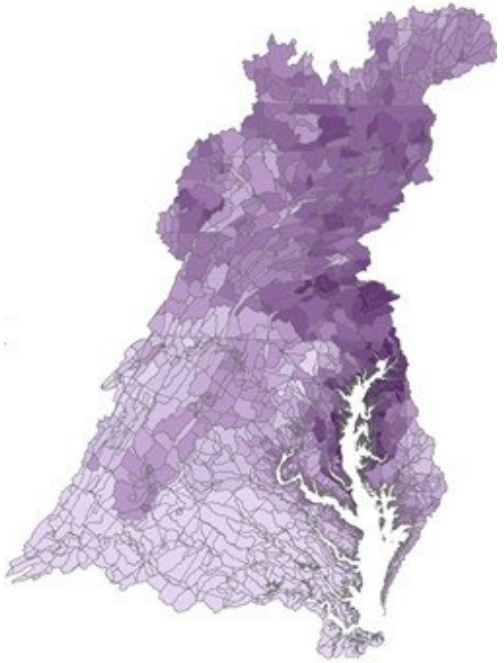
…. will reduce nitrogen and phosphorus to levels …

…. that will achieve appropriate dissolved oxygen, clarity, and chlorophyll in the Bay?

Nutrient Targets

Major	State		2018 Planning Targets approved by PSC	
Major	State	StateBasin	Nitrogen	Phosphorus
Potomac	DC	DC Potomac	2.42	0.130
Eastern Shore	DE	DE Eastern Shore	4.55	0.108
Eastern Shore	MD	MD Eastern Shore	15.21	1.286
Patuxent	MD	MD Patuxent	3.21	0.301
Potomac	MD	MD Potomac	15.30	1.092
Susquehanna	MD	MD Susquehanna	1.18	0.053
Western Shore	MD	MD Western Shore	10.89	0.948
Susquehanna	NY	NY Susquehanna	11.53	0.587
Eastern Shore	PA	PA Eastern Shore	0.45	0.025
Potomac	PA	PA Potomac	6.11	0.357
Susquehanna	PA	PA Susquehanna	66.59	2.661
Western Shore	PA	PA Western Shore	0.02	0.001
Eastern Shore	VA	VA Eastern Shore	1.43	0.164
James	VA	VA James	25.92	2.731
Potomac	VA	VA Potomac	16.00	1.892
Rappahannock	VA	VA Rappahannock	6.85	0.849
York	VA	VA York	5.52	0.556
James	WV	WV James	0.04	0.005
Potomac	WV	WV Potomac	8.18	0.427

- Nutrient loads in million lbs/year
  - Watershed model (CAST) used to assess progress toward these goals



- Why not use monitoring directly?

Photo credit: CBP

Natural System

Monitoring

Modeling

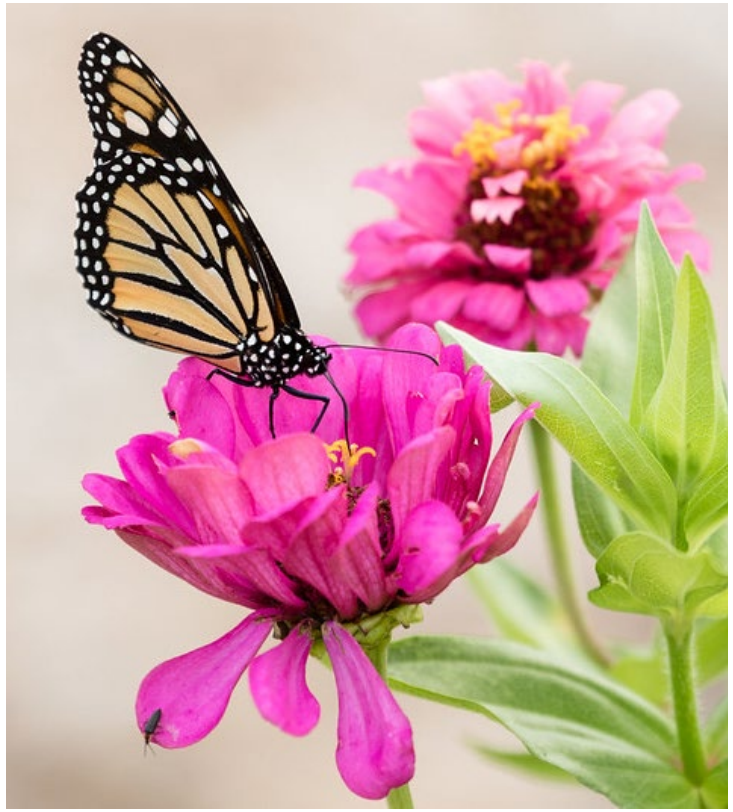


Photo credit: CBP

Photo credit: CBP

Natural System

Monitoring

Modeling

Reality
But
Imprecise
Incomplete

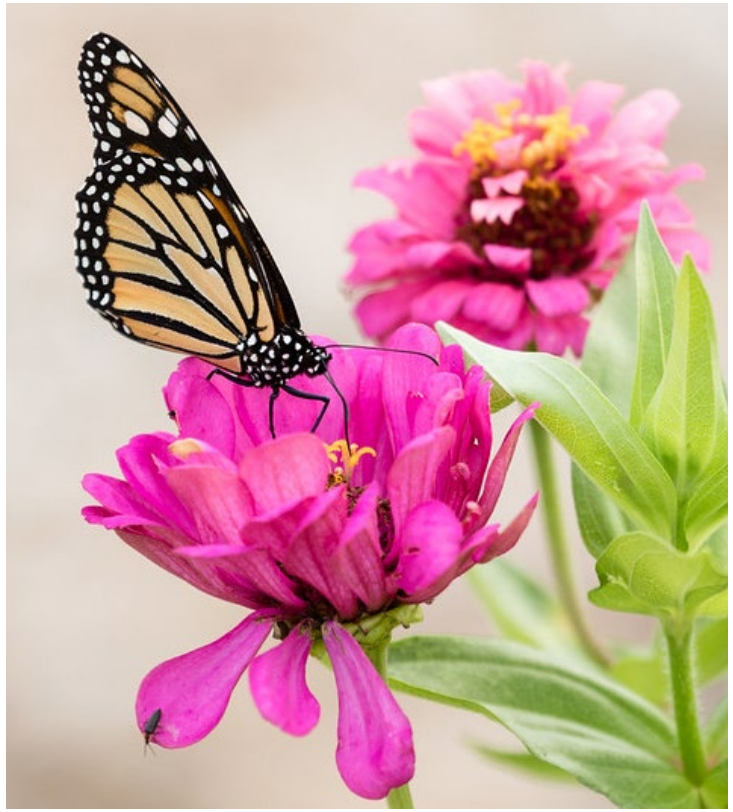


Photo credit: CBP

Photo credit: CBP

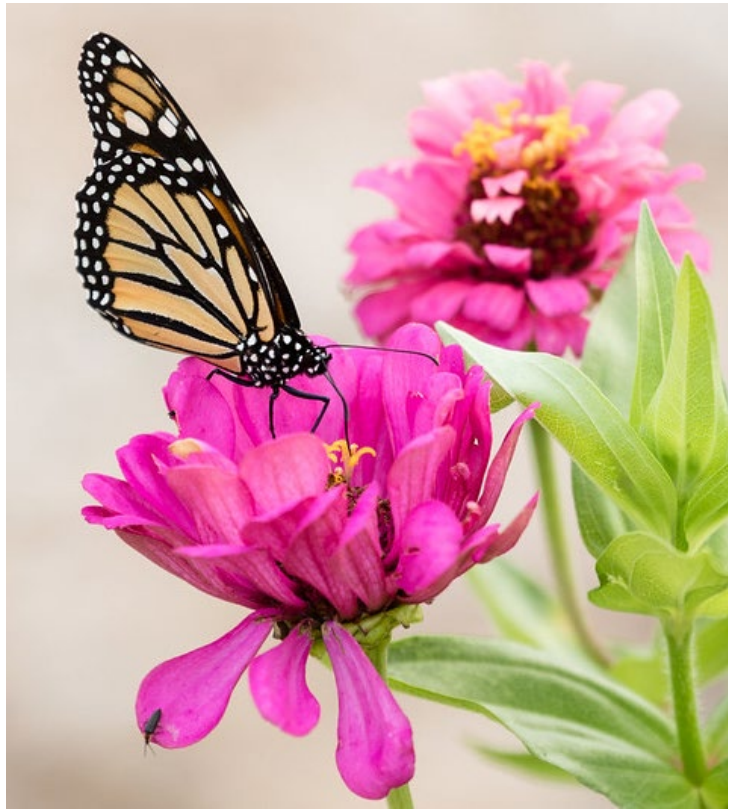
Natural System

Monitoring

Reality
But
Imprecise
Incomplete

Modeling

Precise
Complete
But
Not Reality



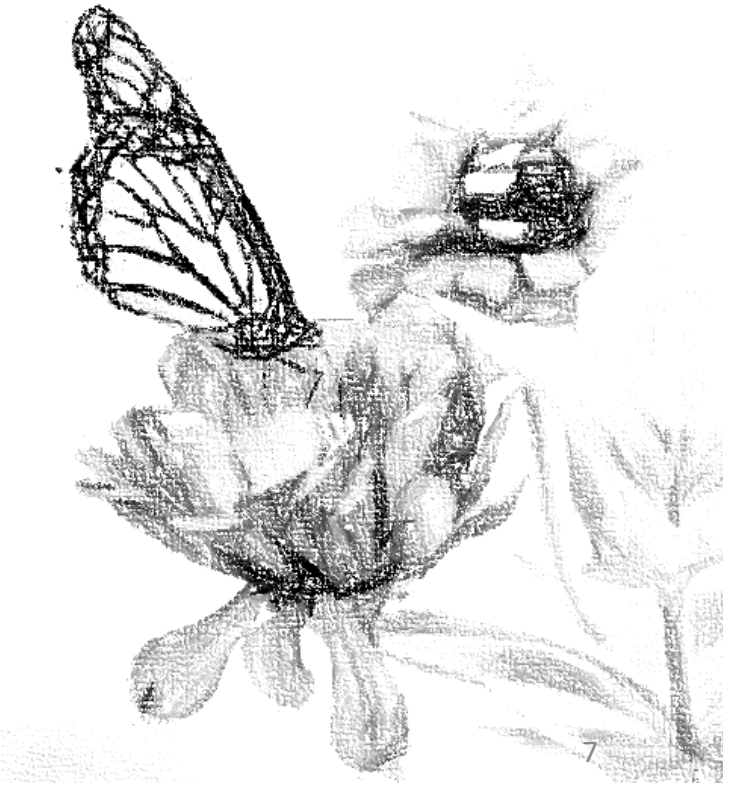
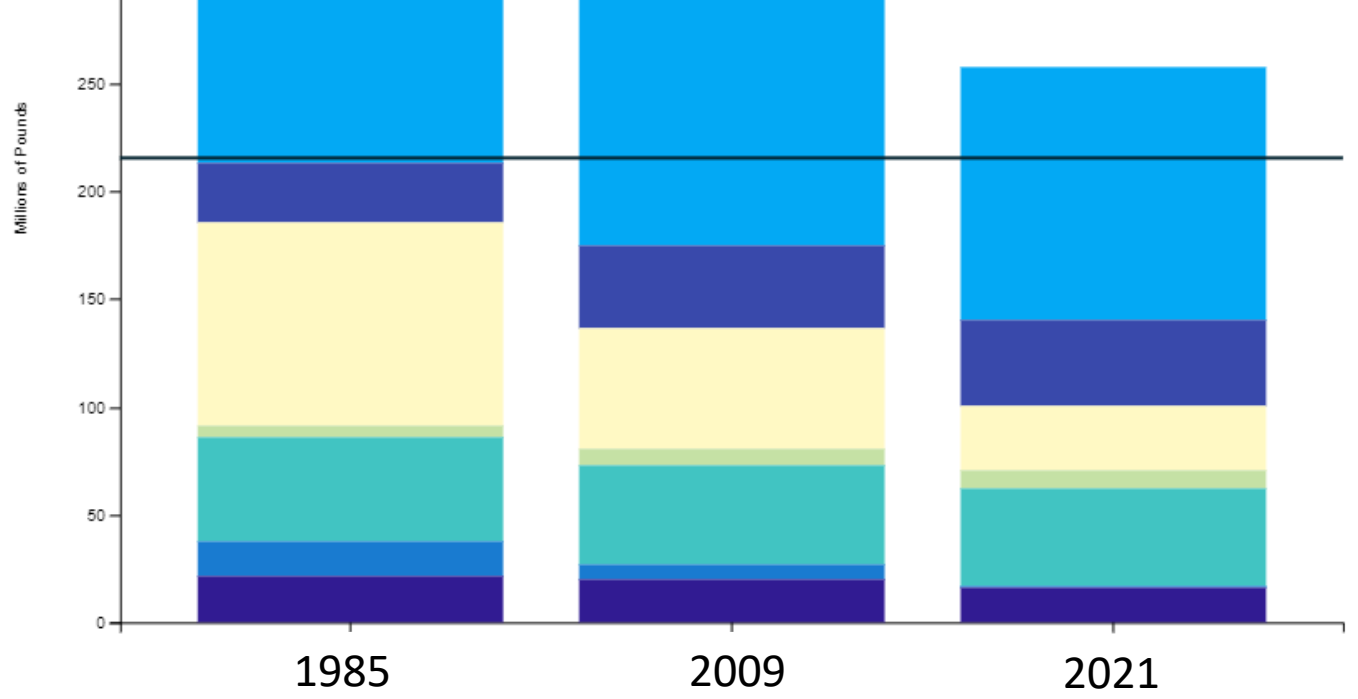


Photo credit: CBP

WIP Indicator

We have implemented much of the plan



Modeled Nitrogen Loads to the Chesapeake Bay (1985-2021)

Loads simulated using CAST19 and jurisdiction-reported data on wastewater discharges. *The natural sector wetlands which are preferable land use types with the lowest loading rates among sources.

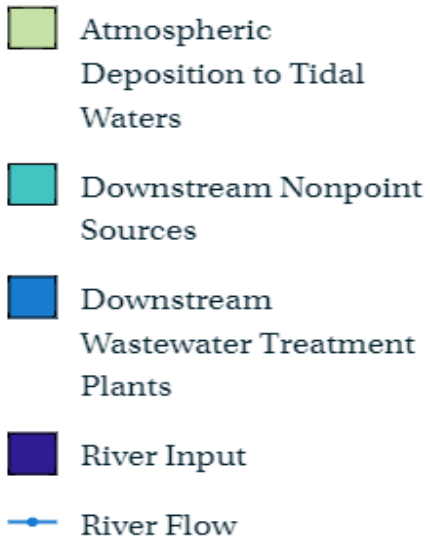
VIEW CHART VIEW TABLE

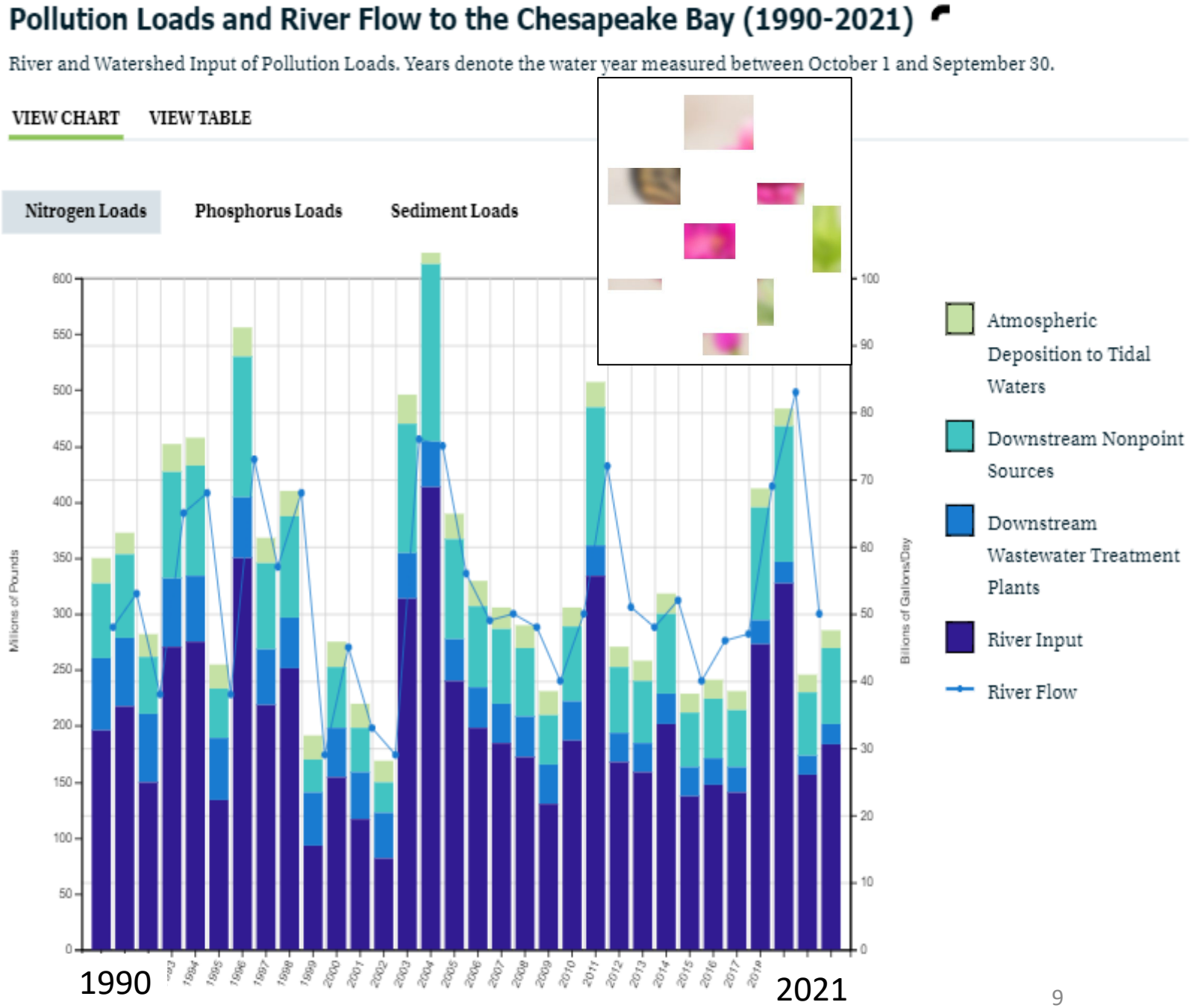
Loads by Source Loads by Jurisdiction

https://www.chesapeakeprogress.com/clean-water/watershed-implementation-plans

Nontidal Load Indicator

Extreme variability
No Clear Trend





https://www.chesapeakeprogress.com/clean-water/water-quality

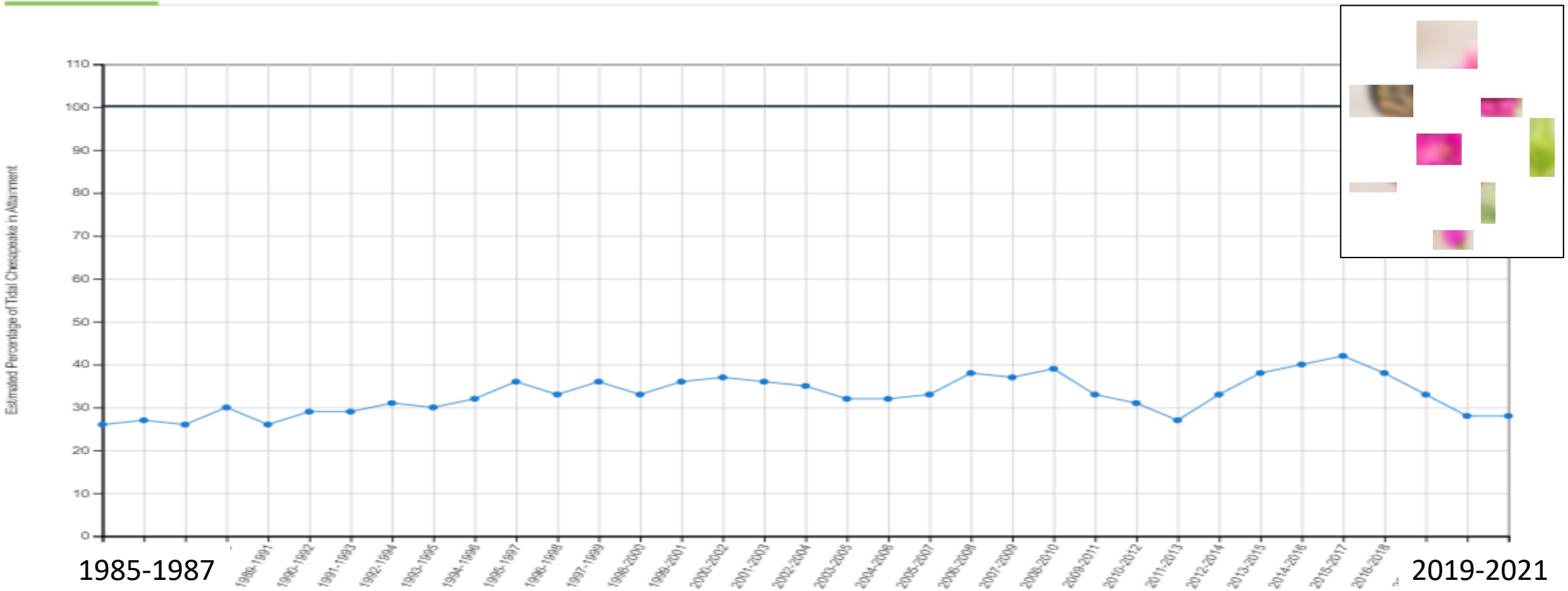
Tidal Water TMDL Indicator

Very slow positive change

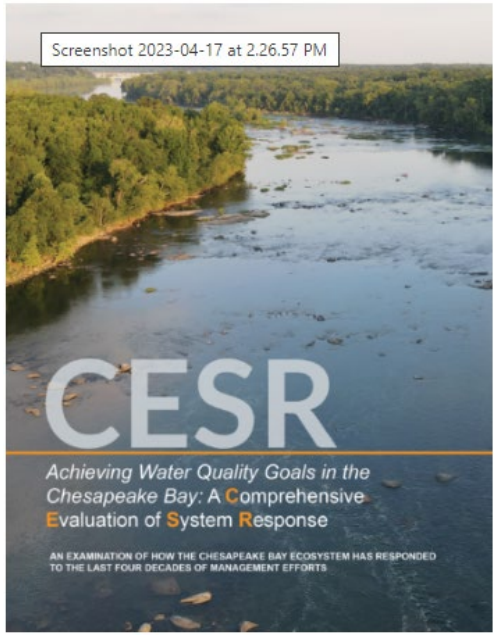
Water Quality Standards Attainment (1985-2021)

Water quality is evaluated using three parameters: dissolved oxygen, water clarity or underwater grass abundance, and chlorophyll a (a measure of algae growth).

VIEW CHART VIEW TABLE

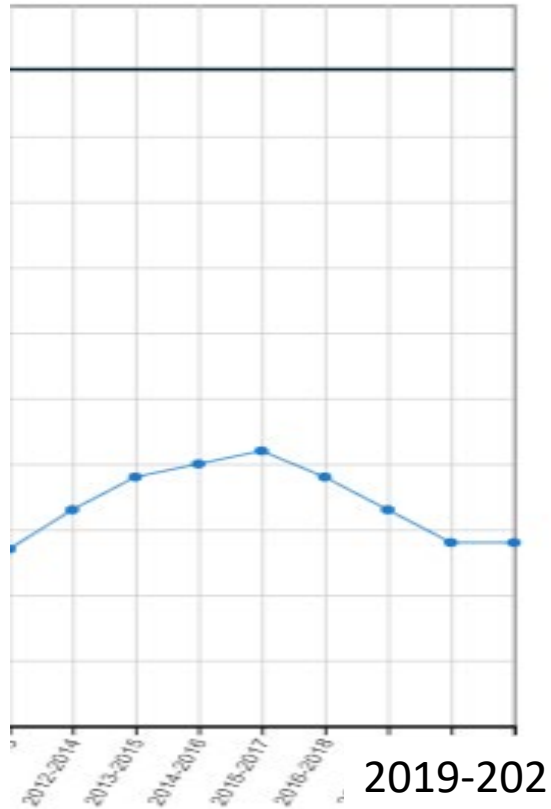


STAC Comprehensive Evaluation of System Response Report



- Why do we have this gap?
- Nonpoint source not generating enough reductions.
- *Are we getting the nitrogen and phosphorus reductions predicted by the modeling system?*

bundance, and chlorophyll a (a

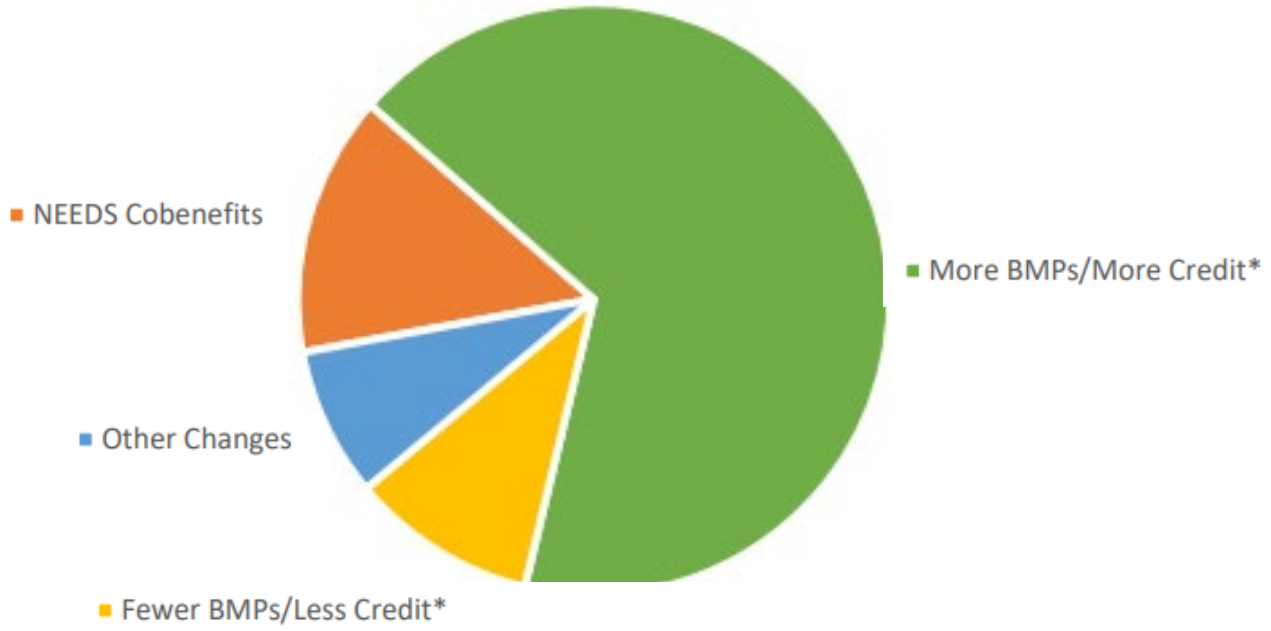


2019-2021

https://www.chesapeake.org/stac/cesr/

Chesapeake Governance Study
D.G. Webster, Dartmouth College

What about the watershed model (CAST) should be improved?



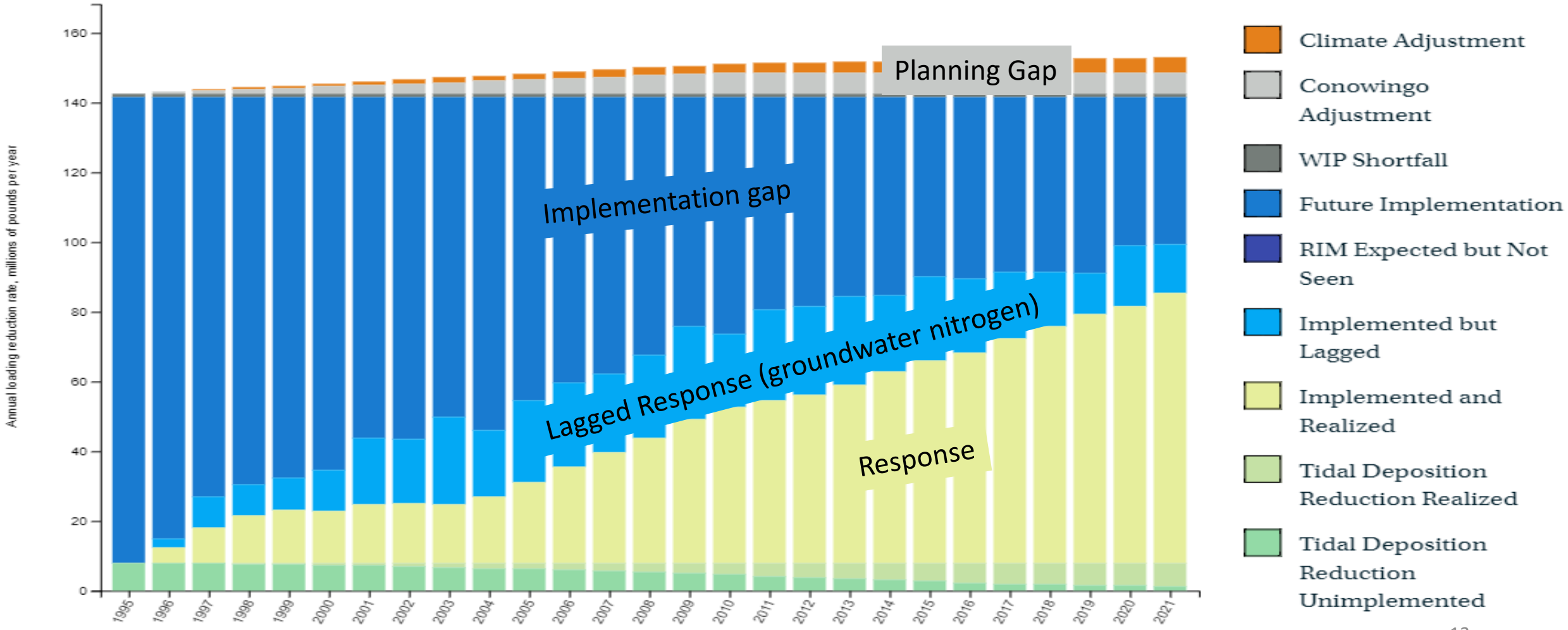
https://digitalcommons.dartmouth.edu/cgi/viewcontent.cgi?article=5309&context=facoa

Chesapeake Bay TMDL Indicator: Total Nitrogen

This indicator combines monitored and modeled data to estimate the progress of annual pollution loading rate reductions since 1995 in response to implemented management practices.

https://www.chesapeakeprogress.com/clean-water/water-quality

VIEW CHART VIEW TABLE

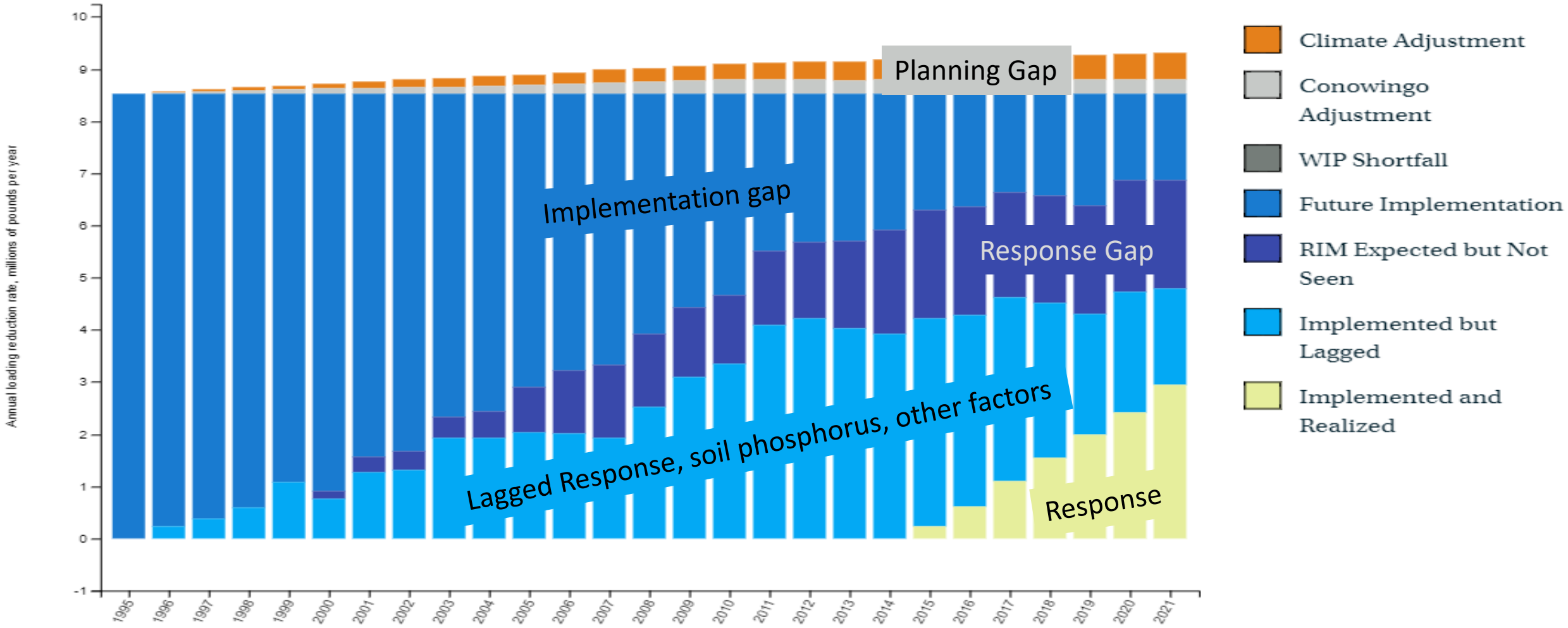


Chesapeake Bay TMDL Indicator: Total Phosphorus

This indicator combines monitored and modeled data to estimate the progress of annual pollution loading rate reductions since 1995 in response to implemented management practices.

https://www.chesapeakeprogress.com/clean-water/water-quality

VIEW CHART VIEW TABLE



Individual station interface

https://wqs.chesapeakebay.net/metric/

Purpose

Monitored and Expected Total Reduction Indicator for the Chesapeake (METRIC)

* This app is designed for comparing the monitored load trend and CAST-estimated load trend for the Chesapeake Bay Non-Tidal Network (NTN) stations.

* This app contains load and trend data for 83, 66, and 66 NTN stations for Total Nitrogen (TN), Total Phosphorus (TP), and Suspended Sediment (SS), respectively.

* This app is an extension to the Chesapeake Bay Total Maximum Daily Load (TMDL) Indicator, which has been approved and published on Chesapeake Progress.

User selection

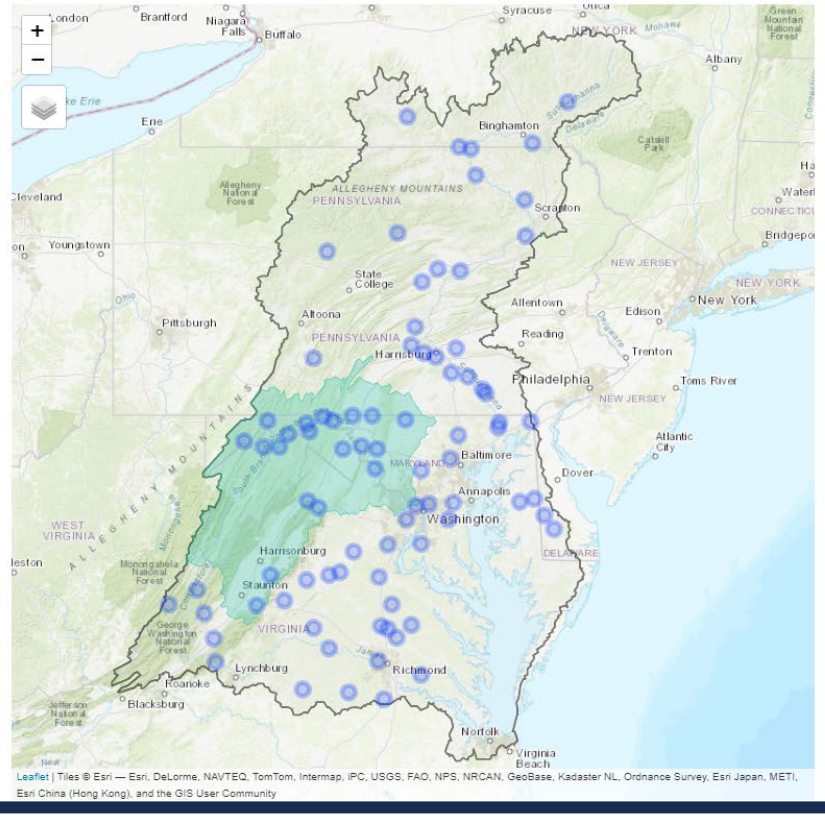
Step 1: Select the water-quality parameter:

◉ Total Nitrogen ○ Total Phosphorus ○ Suspended Sediment

Step 2: Select the monitoring station by clicking either Map or Table:

Map | Data Table

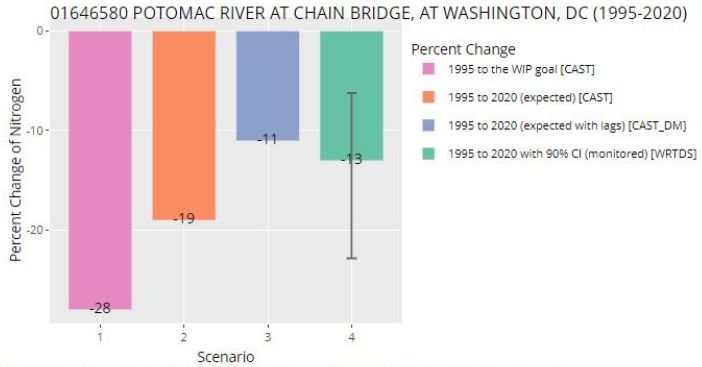
Tip: Move mouse cursor to any circle marker to show the station name.



Results

About | Timeseries | WIP Goal | Progress | Download

Interactive Plot



(Note 1: Negative values indicate load reductions; positive values indicate load increases.)

(Note 2: To obtain values in million pounds (Mlbs), multiply the percent change shown in this plot by the CAST load in the first year of the assessment period, which is available in the Data Table under the About tab.)

Data Type

WRTDS: Monitored load - computed using the USGS WRTDS flow-normalization method (source).

CAST: Expected load in the long term - computed using the Chesapeake Bay Program Watershed Model (source).

CAST_DM: Expected load with lags - computed using the Chesapeake Bay Program Watershed Model (source).

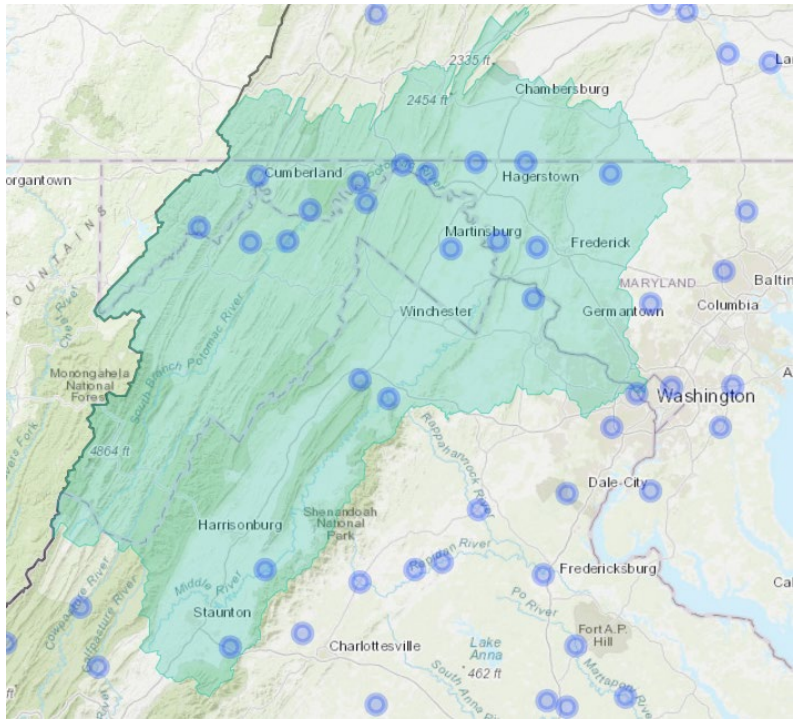
Interpretive Text

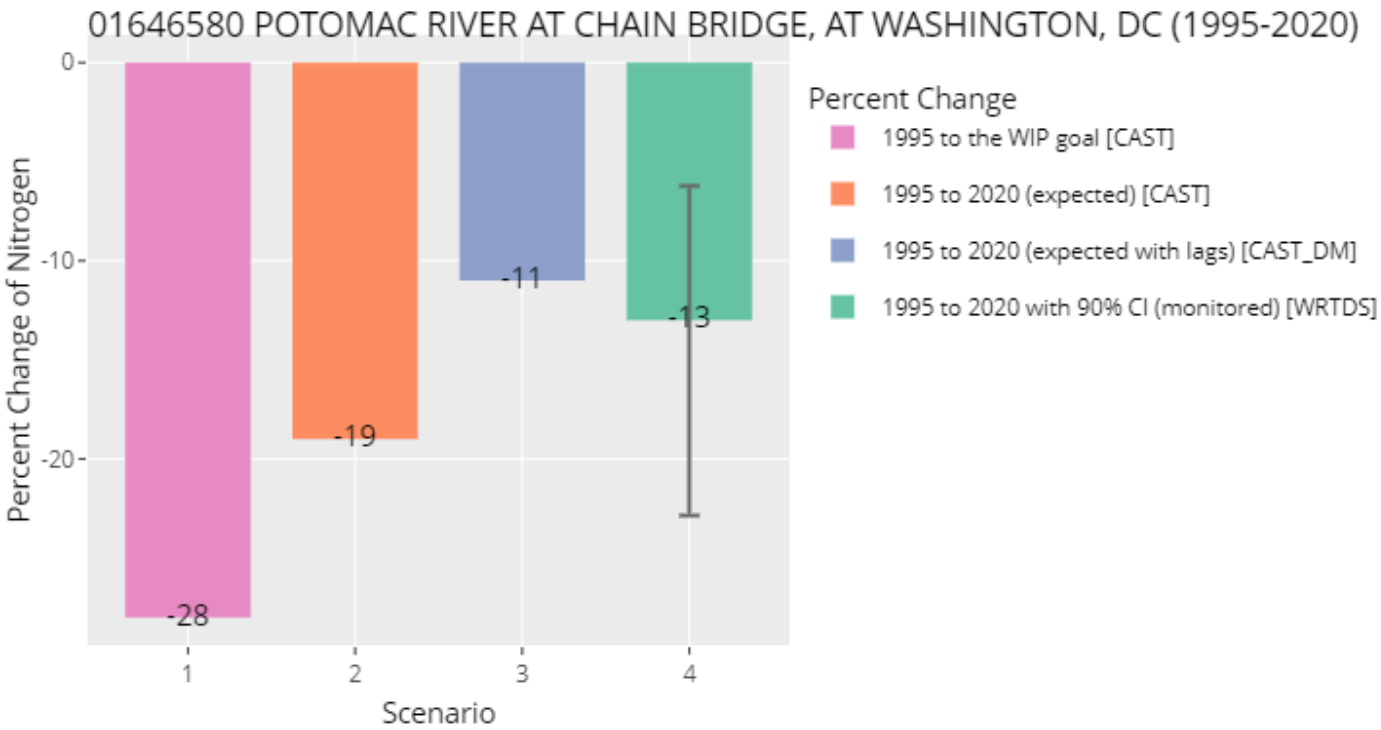
For Nitrogen at 01646580 POTOMAC RIVER AT CHAIN BRIDGE, AT WASHINGTON, DC, the period of analysis is 1995-2020.

1. Overall reduction - comparing the baseline year of 1995 with the WIP goal:
[Bar 1] CAST estimates a reduction of 28 percent in the long term from implementation of the WIP using 2025 land use and inputs.

2. Current progress - comparing the baseline year of 1995 with the current year of 2020:
[Bar 2] CAST estimates a reduction of 19 percent in the long term from 2020 land use, inputs, and management practices.
[Bar 3] The Dynamic Watershed Model (i.e., CAST_DM) estimates that a reduction of 11 percent would have been seen by 2020, accounting for lags, sampling frequency, and other factors.
[Bar 4] The river monitoring data (i.e., WRTDS) show a reduction of 13 percent with a 90% uncertainty range of (-23%, -6%).

Example 1: 01646580 Potomac River Total Nitrogen





Interpretive Text

1. CAST estimates a 28 percent reduction in the long term from **implementation of the WIP** using 2025 land use and inputs.
2. CAST estimates a 19 percent reduction in the long term from **2020** land use, inputs, and management practices.
3. The Dynamic Watershed Model estimates that only a 11 percent reduction would have been seen by 2020, accounting for lags, sampling frequency, and other factors.
4. The river monitoring data show a 13 percent reduction with a 90% uncertainty range between 6 and 23 percent reduction.

Implication: The observed response is as expected over the period of 1995-2020.

Results:
WIP Goal

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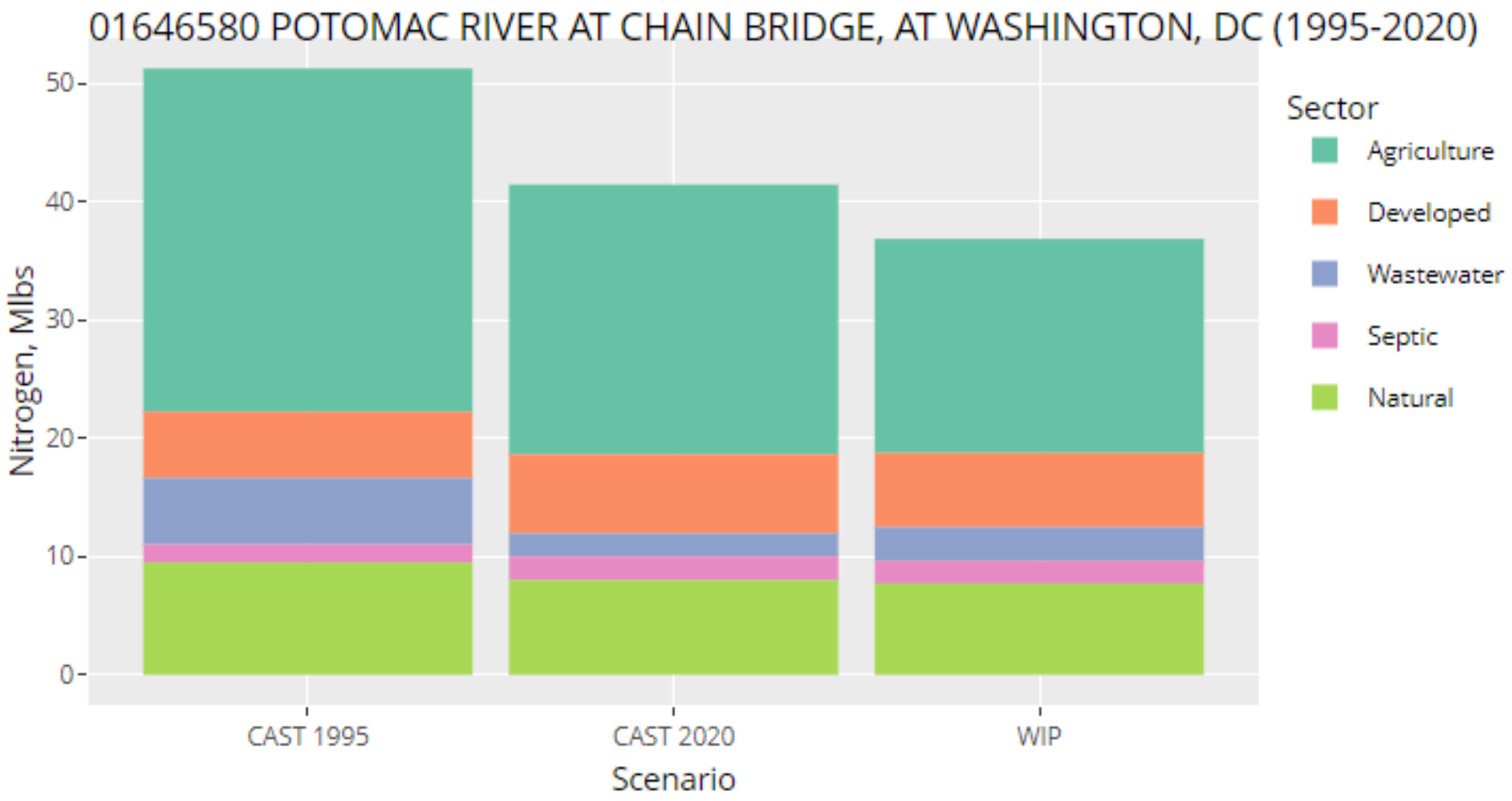
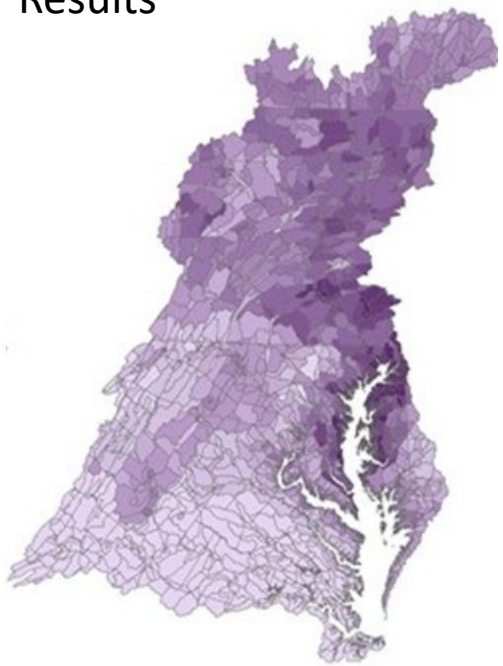
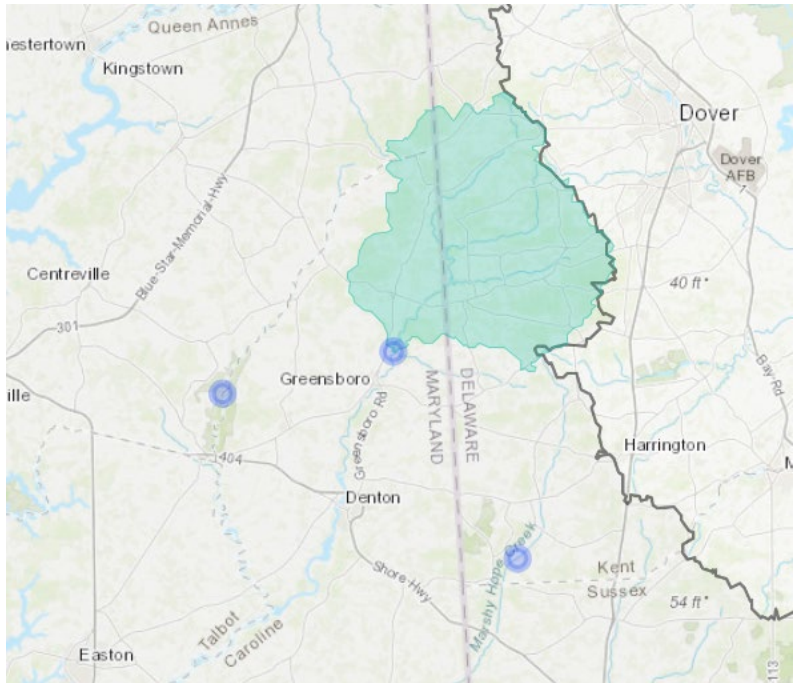
Interactive Plot

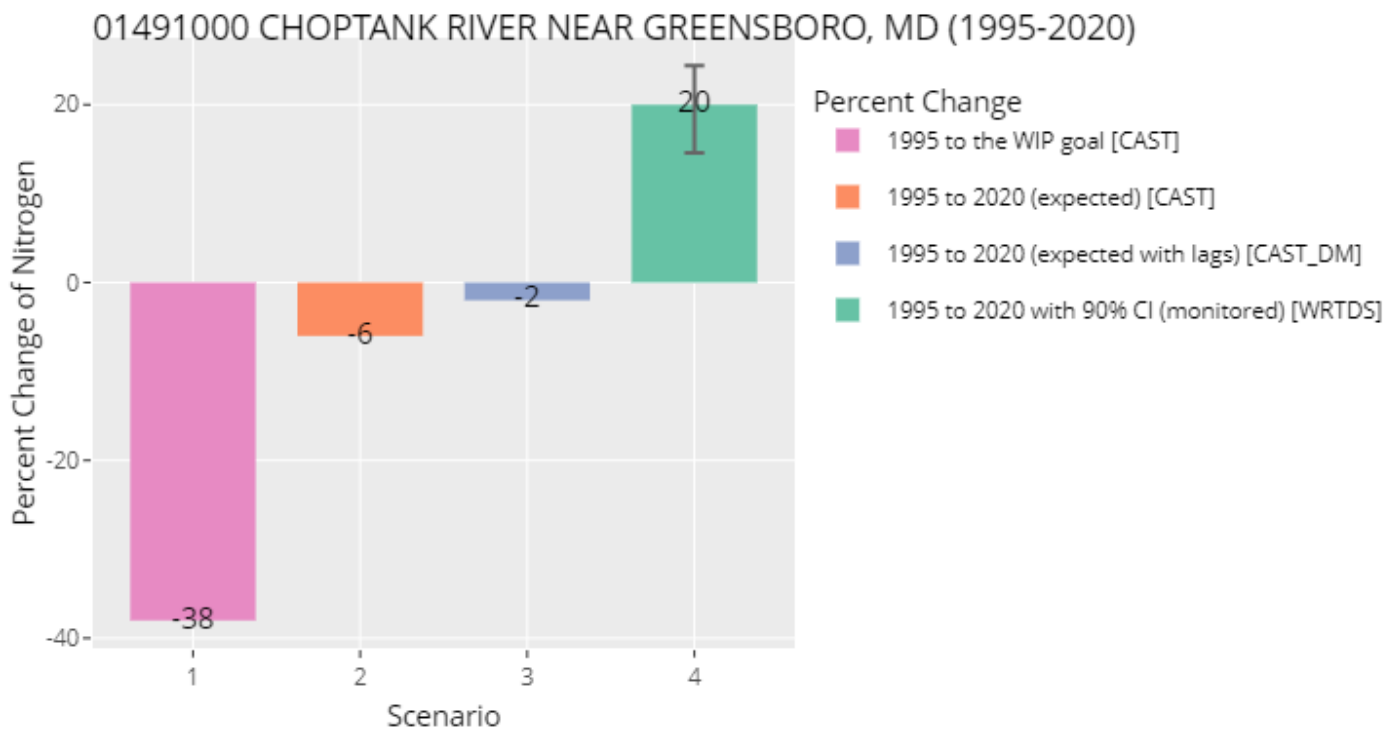


Watershed Model (CAST) Results



Example 2: 01491000 Choptank River Total Nitrogen





Interpretive Text

1. CAST estimates a 38 percent reduction in the long term from implementation of the **WIP** using 2025 land use and inputs.
2. CAST estimates a 6 percent reduction in the long term from **2020** land use, inputs, and management practices.
3. The Dynamic Watershed Model estimates that only a 2 percent reduction would have been seen by 2020, accounting for lags, sampling frequency, and other factors.
4. The river monitoring data show a 20 percent increase with a 90% uncertainty range between 15 and 24 percent increase.

Implication: The observed response is less than expected over the period of 1995-2020.

Results:
WIP Goal

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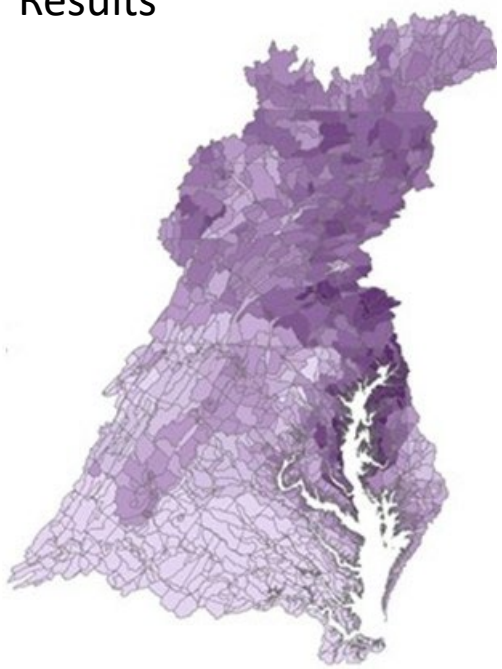
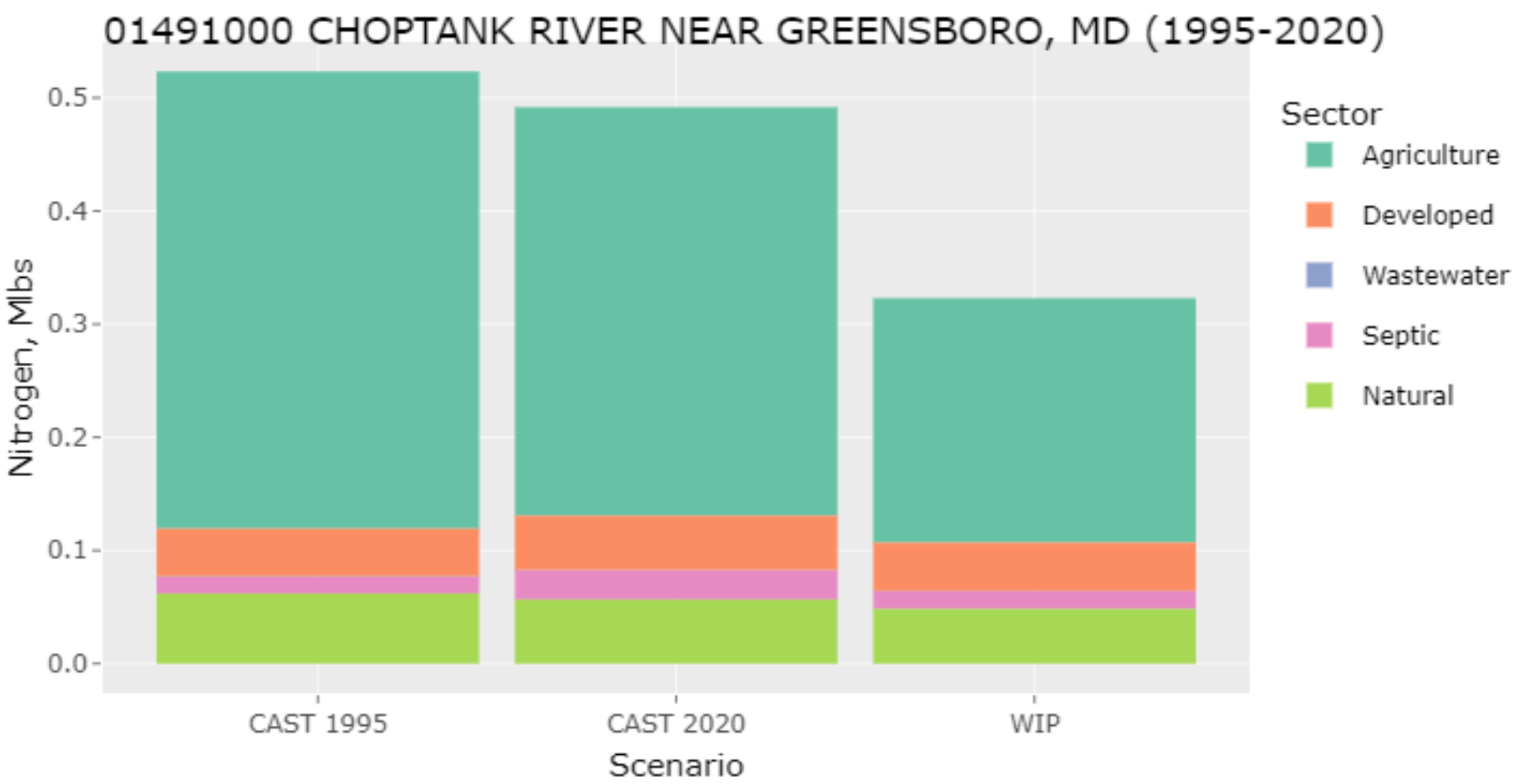
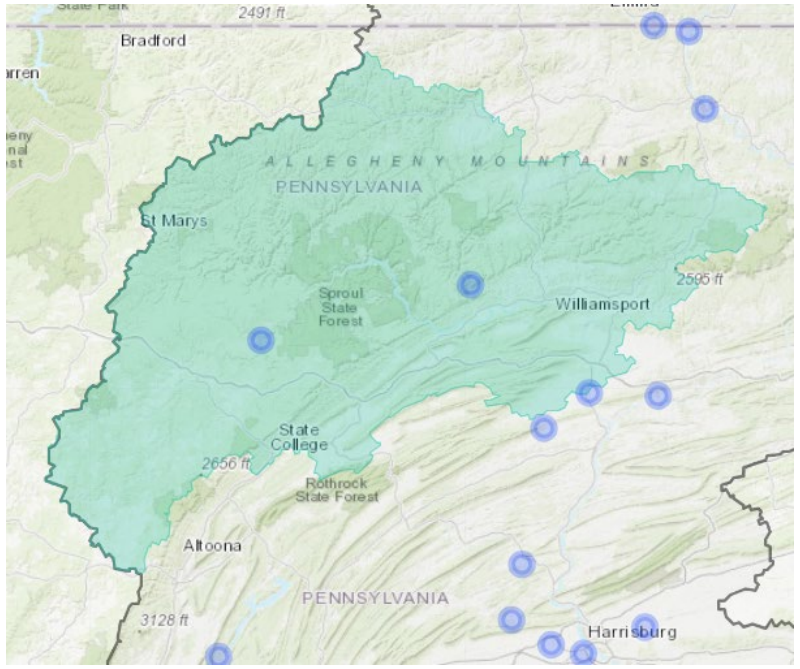
Interactive Plot

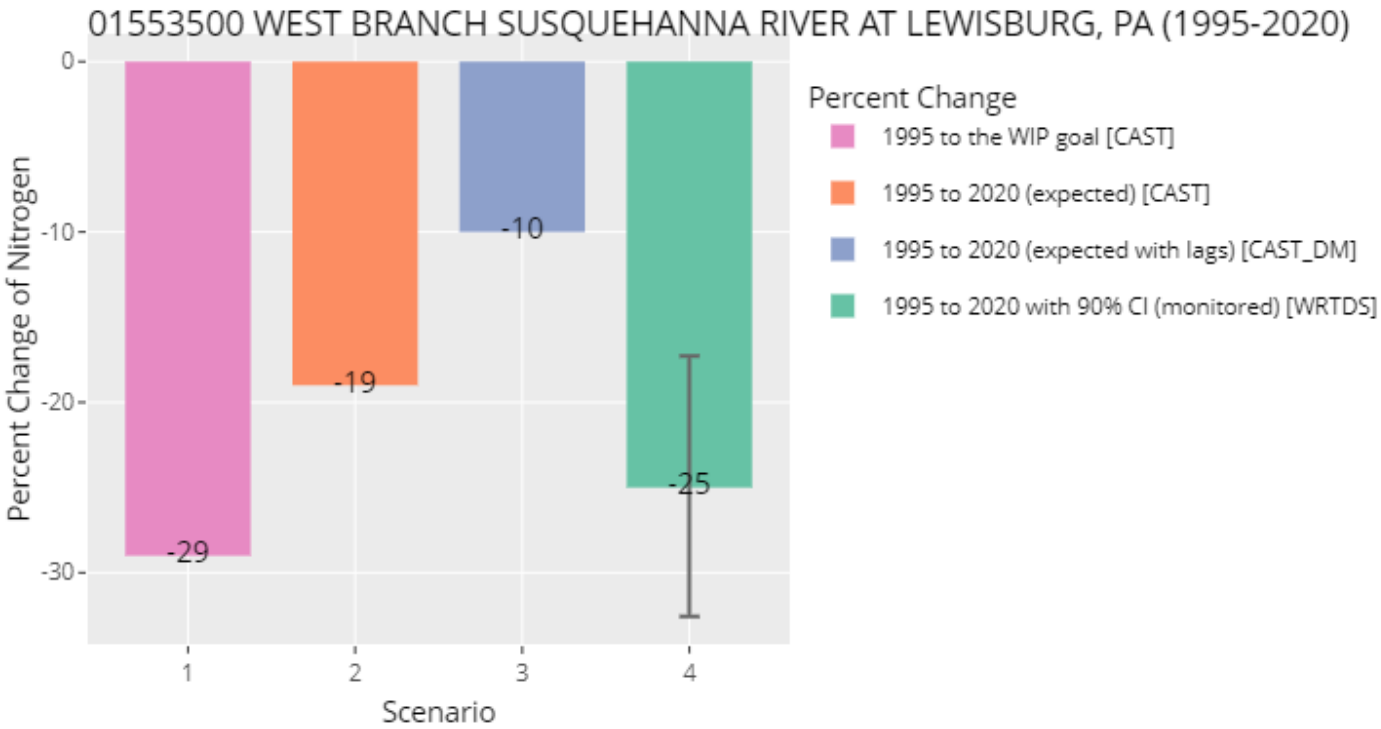
Watershed Model (CAST) Results





Example 3: 01553500 West Branch Susquehanna River Total Nitrogen





Interpretive Text

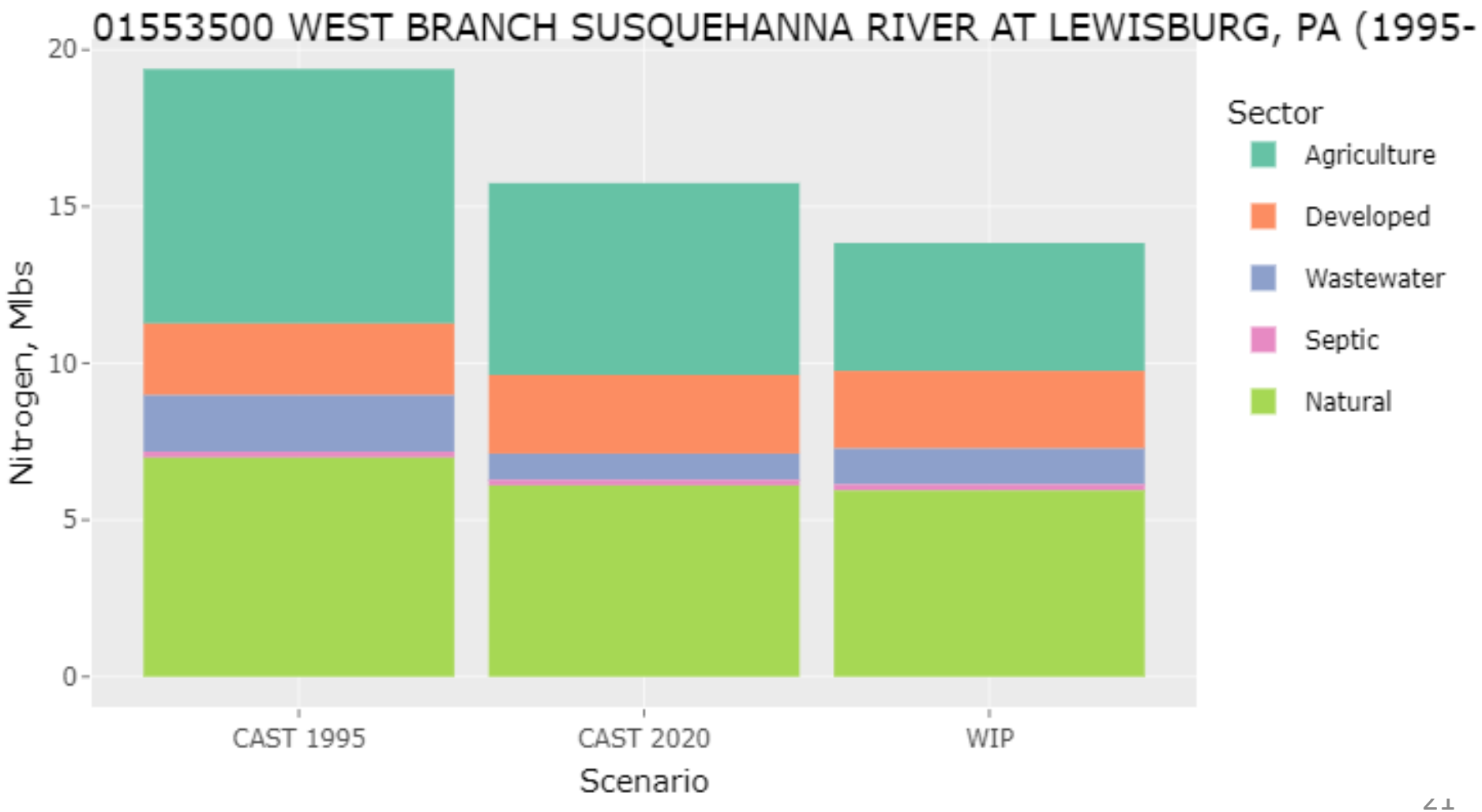
1. CAST estimates a 29 percent reduction in the long term from implementation of the WIP using 2025 land use and inputs.
2. CAST estimates a 19 percent reduction in the long term from 2020 land use, inputs, and management practices.
3. The Dynamic Watershed Model estimates that only a 10 percent reduction would have been seen by 2020, accounting for lags, sampling frequency, and other factors.
4. The river monitoring data show a 25 percent reduction with a 90% uncertainty range between 17 and 33 percent reduction.

Implication: The observed response is more than expected over the period of 1995-2020.

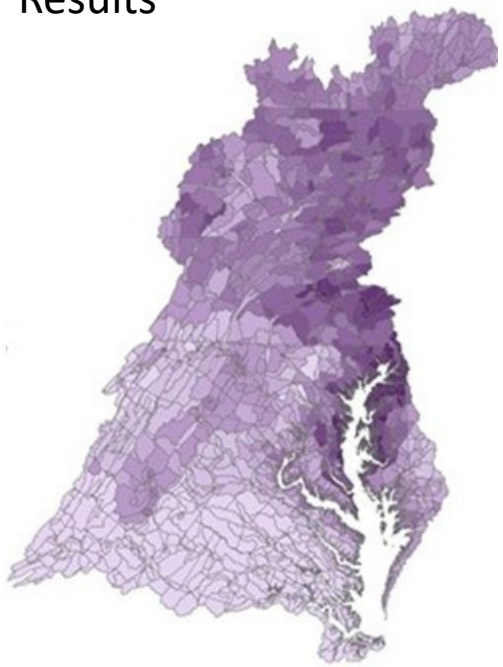
Results:
WIP Goal

About | Timeseries | WIP Goal | Progress | Download

Interactive Plot



Watershed Model (CAST) Results



Reception and Uses

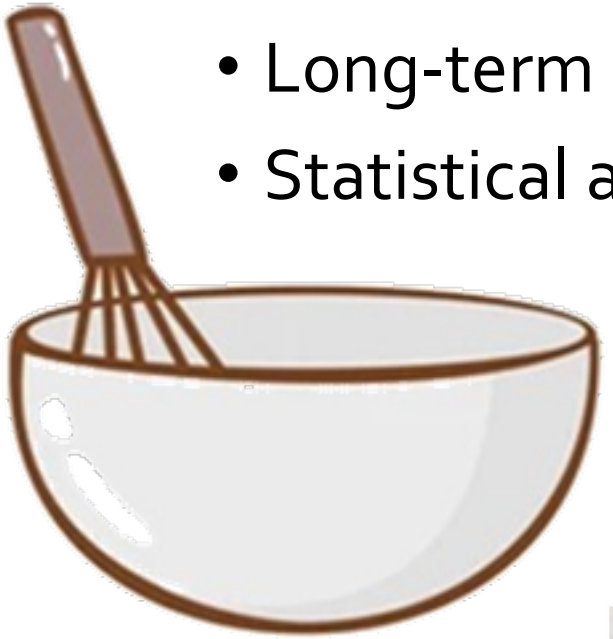
- Significant interest from across the CBP

- Facilitates conversations comparing modeled and monitored outcomes
  - Have we implemented enough?
  - Are we seeing the expected results?
  - How does my watershed compare to similar watersheds?

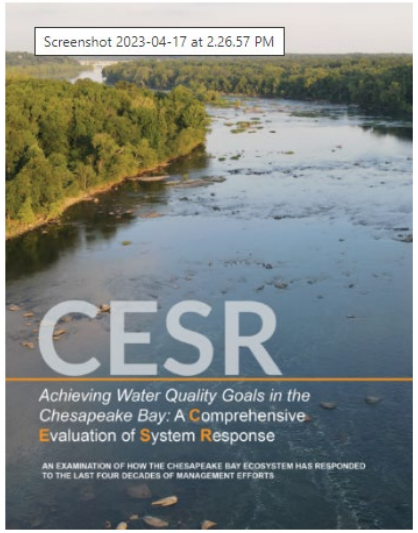
- Invites research questions
  - Why are we seeing lower response in phosphorus?
  - Are there similar responses for similar watersheds?
  - What is happening in specific watersheds?

Why Now?

- Models with lag estimates
- Long-term monitoring data
- Statistical analysis methods



STAC CESR report Prominent Authorship from VA Tech



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5/2/2024