

# Nitrogen, Phosphorus, and Suspended Sediment:

## Loads and Trends Measured from the Chesapeake Bay Nontidal Monitoring Network (NTN)

An update through water year 2023

**March 26, 2025**

Jimmy Webber, [jwebber@usgs.gov](mailto:jwebber@usgs.gov)

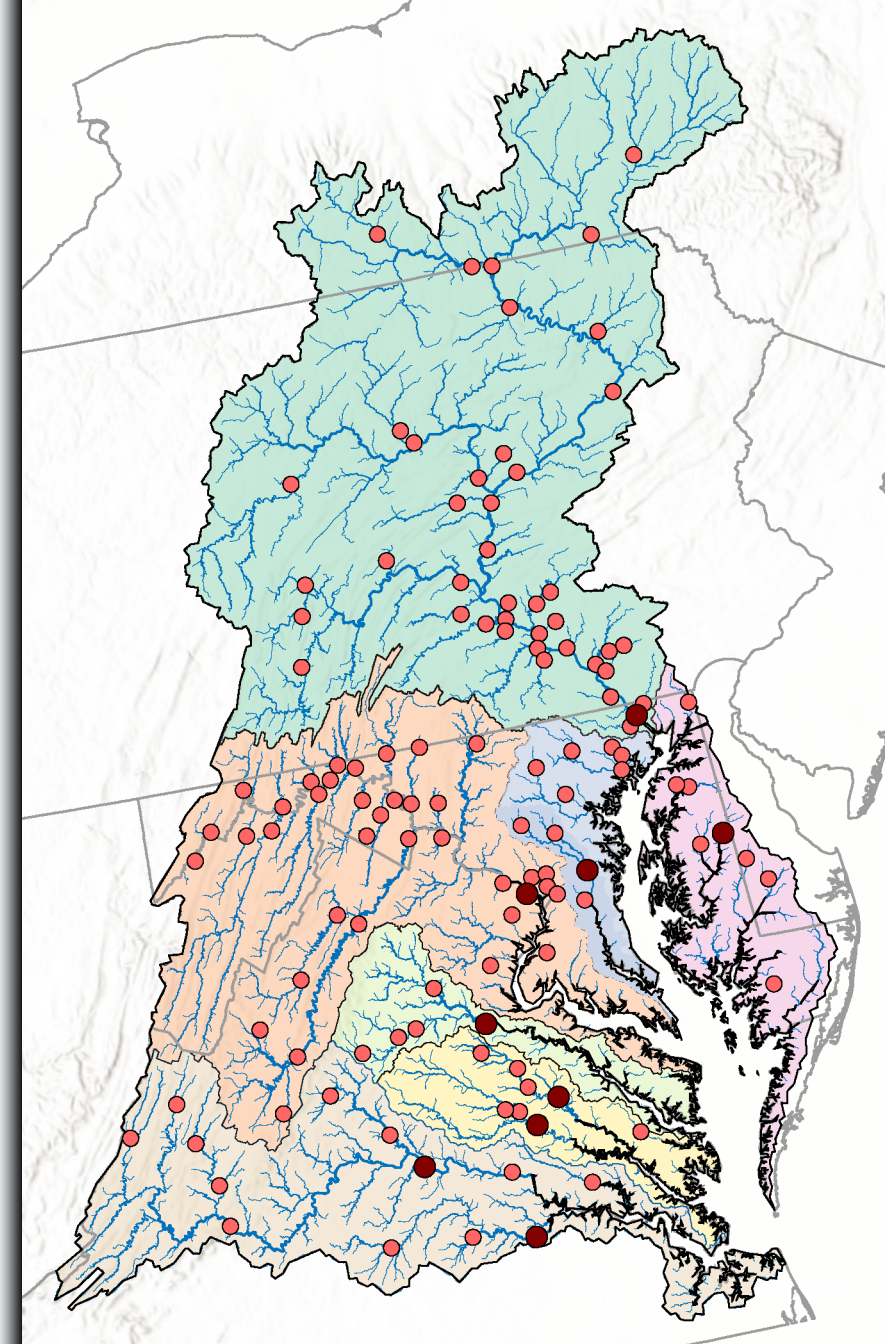
Chris Mason, [camason@usgs.gov](mailto:camason@usgs.gov)

James Colgin, [jcolgin@usgs.gov](mailto:jcolgin@usgs.gov)

Alex Soroka, [asoroka@usgs.gov](mailto:asoroka@usgs.gov)

***NTN loads and trends were recently computed  
using monitoring data through water-year 2023.***

The overall objective of this presentation is to  
summarize the new load and trend results.



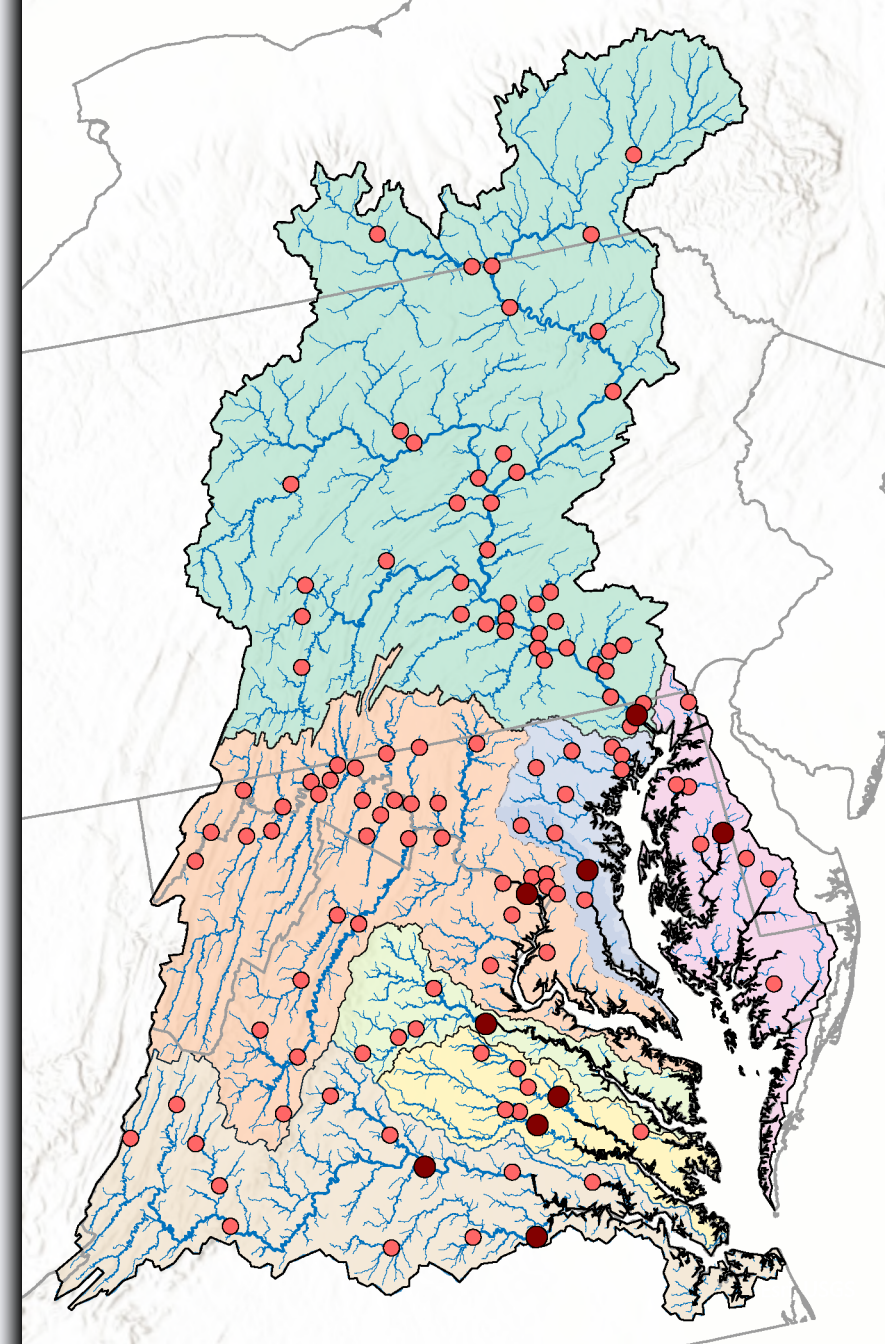
# Nitrogen, Phosphorus, and Suspended Sediment:

## Loads and Trends Measured from the Chesapeake Bay Nontidal Monitoring Network (NTN)

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*March 26, 2025*

1. Major Messages
2. Monitoring Network and Methods
3. Streamflow and Per-Acre Loads (Yields)
4. Nutrient and Sediment Trends
5. Resources to Learn More



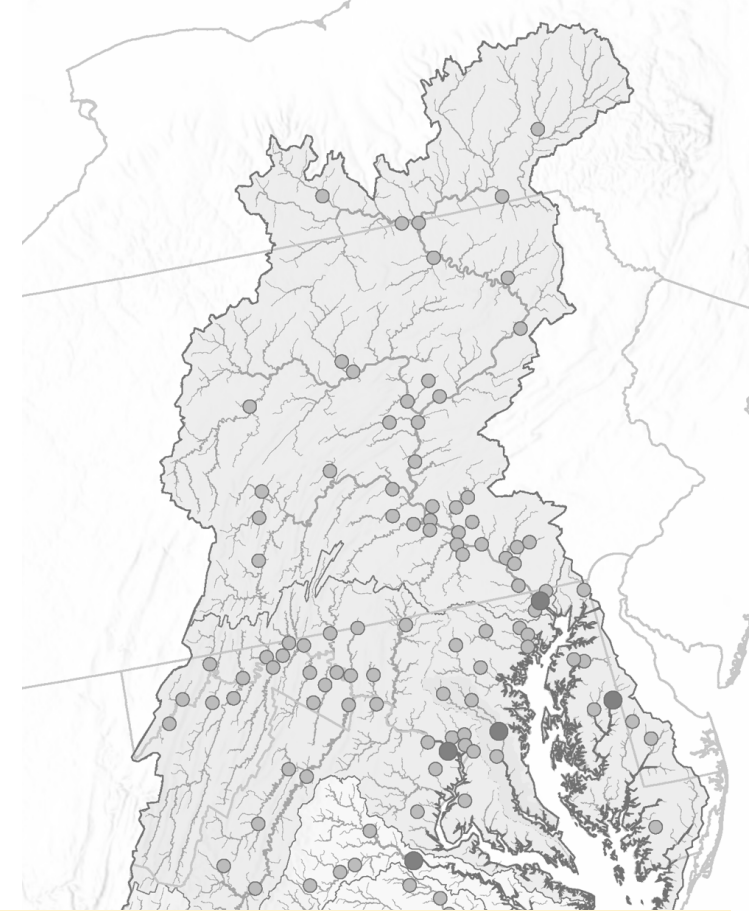


A black and white photograph of a person wearing a cap and a safety vest, standing on a bridge and operating a large water sampling device. The device is mounted on a trailer with large tires and has a spool of cable. The person is holding a handle or lever. In the background, a river flows through a wooded area. A traffic cone is visible on the ground near the device.

# Major Messages

# Major Messages: NTN Loads and Trends

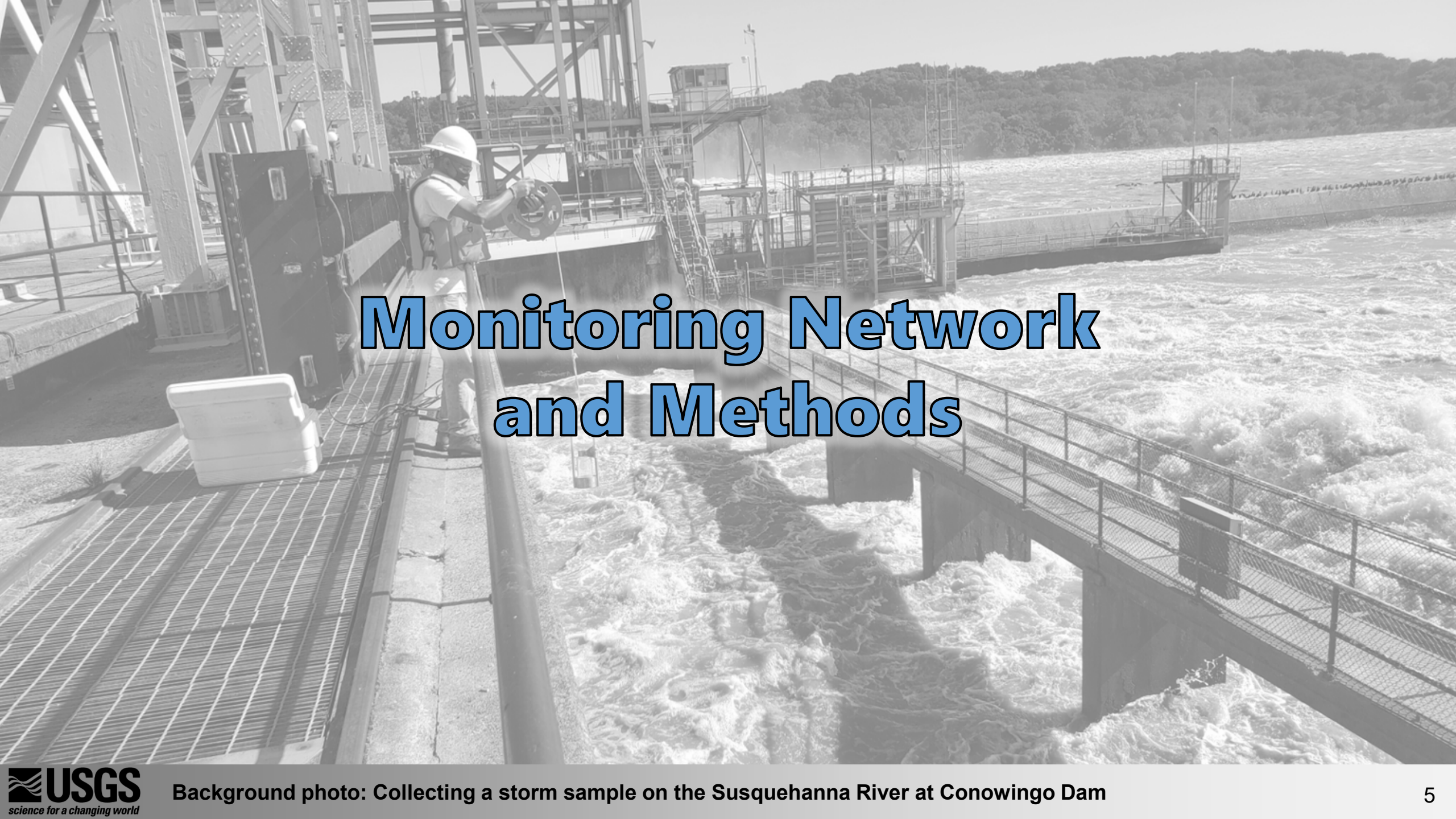
1. Loads and trends have been calculated through water year 2023 using reproducible and accurate water-quality datasets.  
***The quality of NTN data has never been better.***
2. Per-acre nutrient and sediment loads are typically highest in agricultural and/or urban watersheds.
3. Most long-term trends<sup>1</sup> of total nitrogen (n=43) and total phosphorus (n=16) ***improved***.
4. The combined amounts of nitrogen, phosphorus, and sediment from NTN stations nearest the Bay all ***decreased*** since 2014.
5. Improving short-term trends (2014 – 2023) of total nitrogen, total phosphorus, and suspended sediment were detected at less than half of all stations.
6. The USGS will continue to work with Chesapeake Bay partners to evaluate and explain these observed water-quality patterns.



**And to strengthen our understanding about the effects of nontidal river loads on tidal water-quality conditions!**

**Visit our website to explore these results in more detail:**  
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# Monitoring Network and Methods



# Monitoring data are used to compute water-quality load and trends

NTN monitoring data are collected at 123 stations by the US Geological Survey (USGS), state agencies, and other partners throughout the watershed.

**Daily streamflow** is measured at all stations.

**Monthly water-quality samples** are collected at all stations.

**Storm-targeted water-quality samples** are collected at most stations.



## Number of Stations by River Basin

- Susquehanna.....42
- Potomac.....37
- Eastern Shore.....8
- MD Western Shore....10
- Rapp. / York / James..26

Loads and trends are computed for five water-quality parameters using WRTDS<sup>1</sup>:

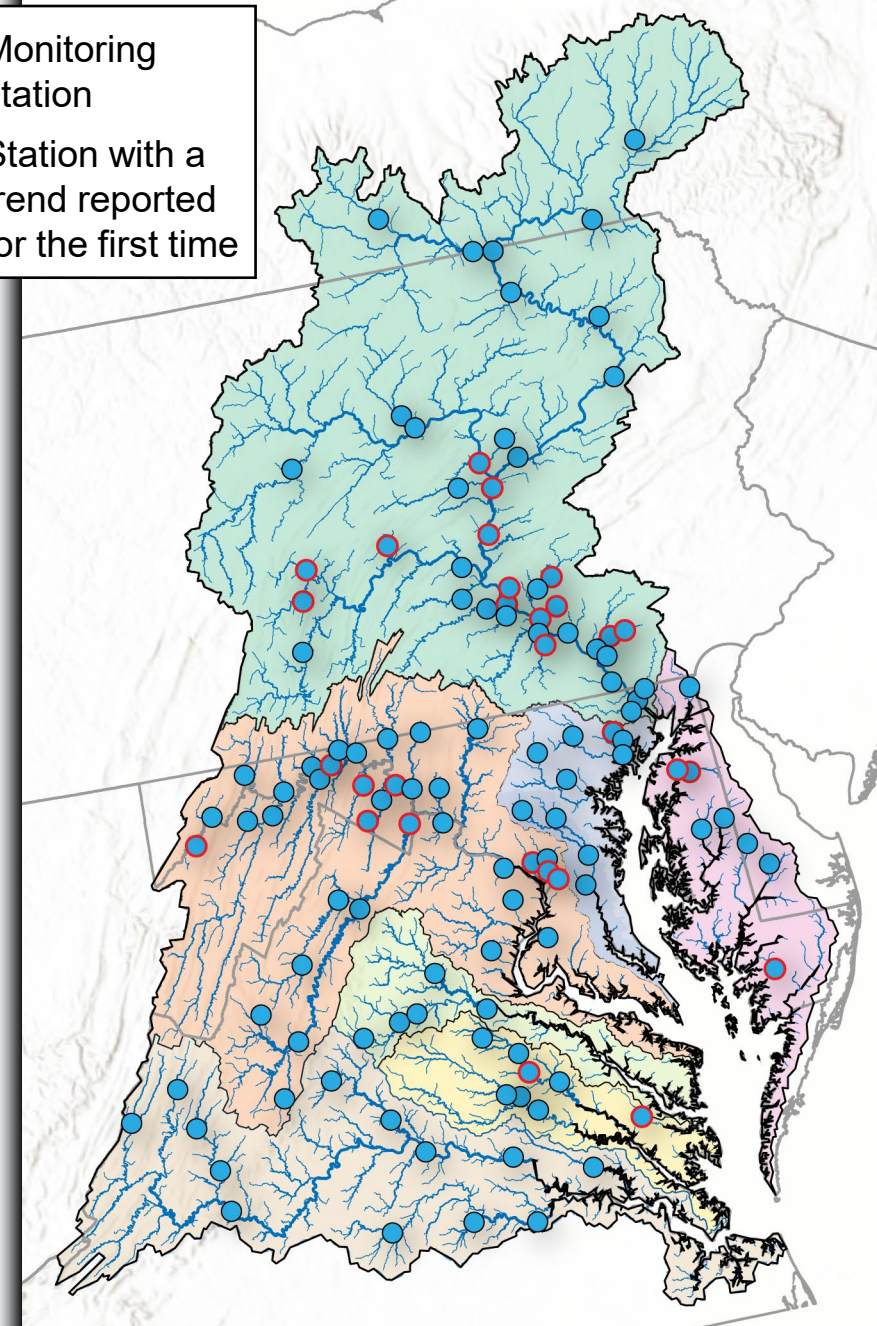
- Total nitrogen (TN)
- Nitrate + nitrite (NO<sub>x</sub>)
- Total phosphorus (TP)
- Orthophosphate (PO<sub>4</sub>)
- Suspended sediment (SS)

- **Loads** are computed for 122 stations.
- **Short-term trends**<sup>2</sup> are computed for 120 stations<sup>3</sup>.

31 stations have a trend reported for the first time!

- **Long-term trends**<sup>4</sup> are computed for 43 stations.

Monitoring station  
Station with a trend reported for the first time





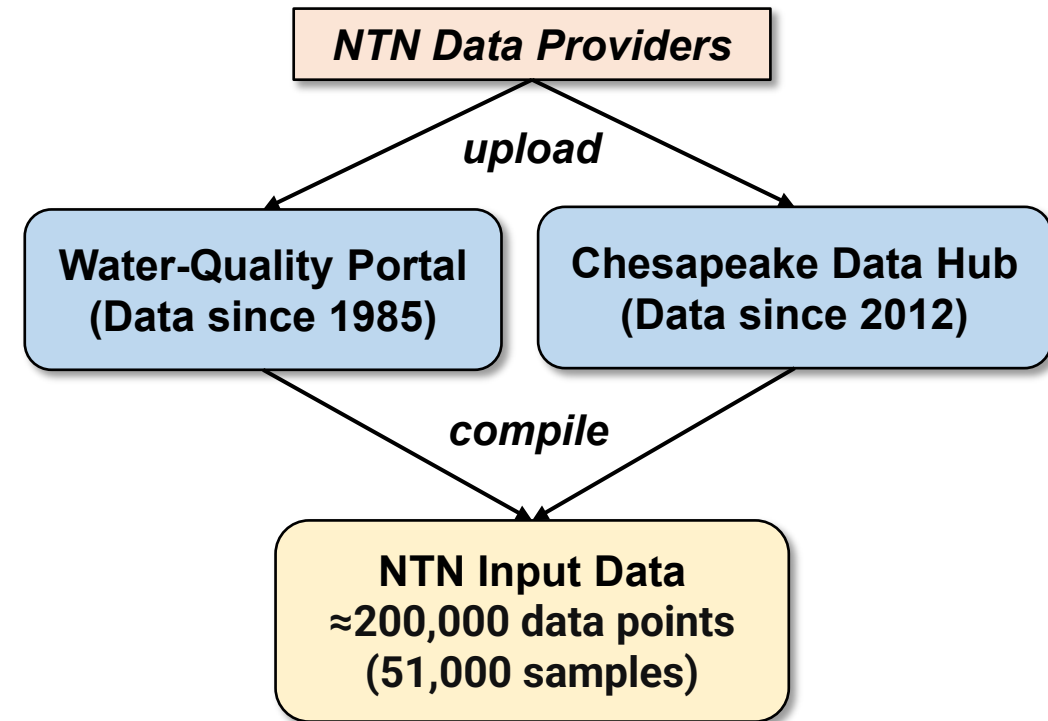
# A reproducible set of water-quality samples was built from publicly accessible databases to compute load and trend results

Previous NTN results were computed from a static table of water-quality sample data. With each NTN update, we appended new sample results to the static table.

↳ That process worked well, but it was difficult to verify historical sample results.

For this NTN update, we rebuilt the water-quality sample dataset using two publicly accessible databases: (1) the Water-Quality Portal and (2) the Chesapeake Data Hub.

We used these databases to create a **reproducible** and **accurate** set of sample data to compute NTN loads and trends<sup>1</sup>.



Is 51,000 samples a lot?

It is an average of about 3.5 NTN samples collected **every day** since 1985!

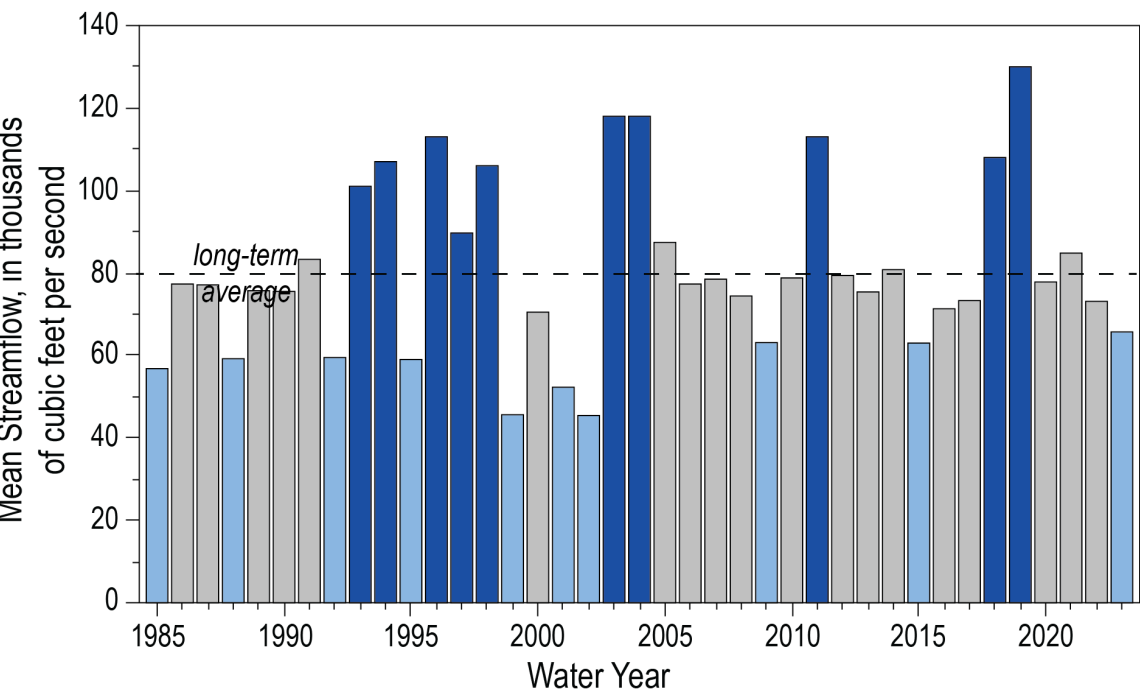


# Streamflow and Per-Acre Loads (Yields)



# Streamflow has a large effect on water-quality loads

The estimated annual-mean streamflow entering the Bay<sup>1</sup> in water year 2023 was about **17% less** than the 1937 – 2023 average.

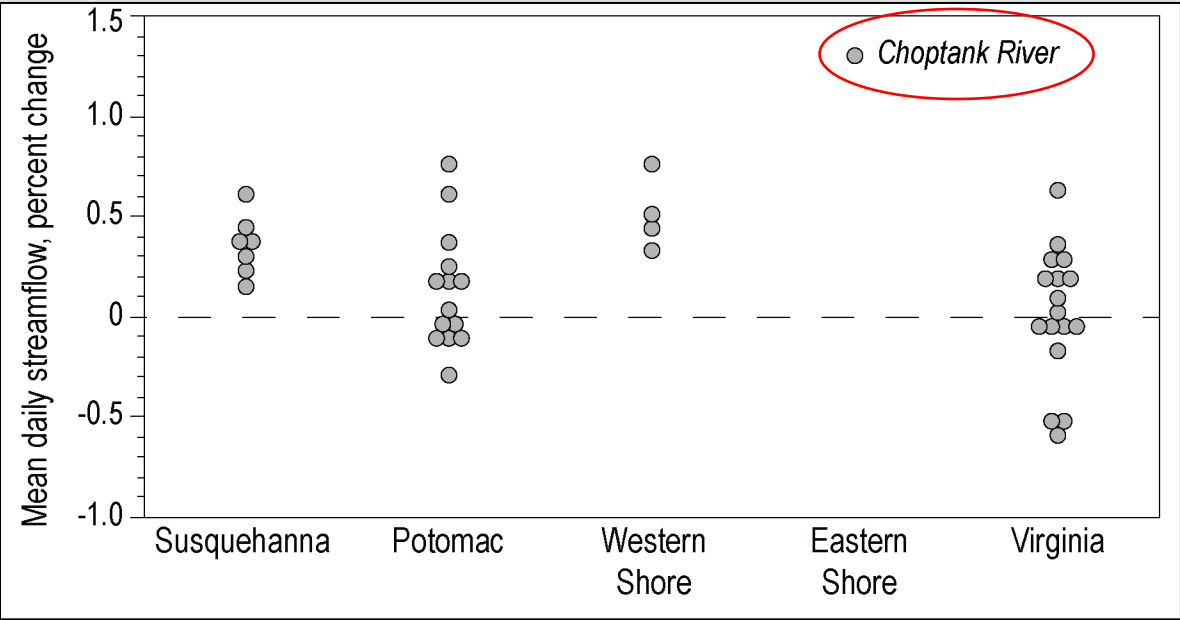


### EXPLANATION

- Below 25<sup>th</sup> percentile of all annual observations
- Between 25<sup>th</sup> and 75<sup>th</sup> percentiles of all annual observations
- Above 75<sup>th</sup> percentile of all annual observations

Water-quality trends are based on **FN loads**, which remove most of the year-to-year differences in streamflow. However, long-term trends in streamflow can affect water-quality trends.

We computed long-term streamflow trends (~1985 – 2023) at the 43 long-term NTN stations.



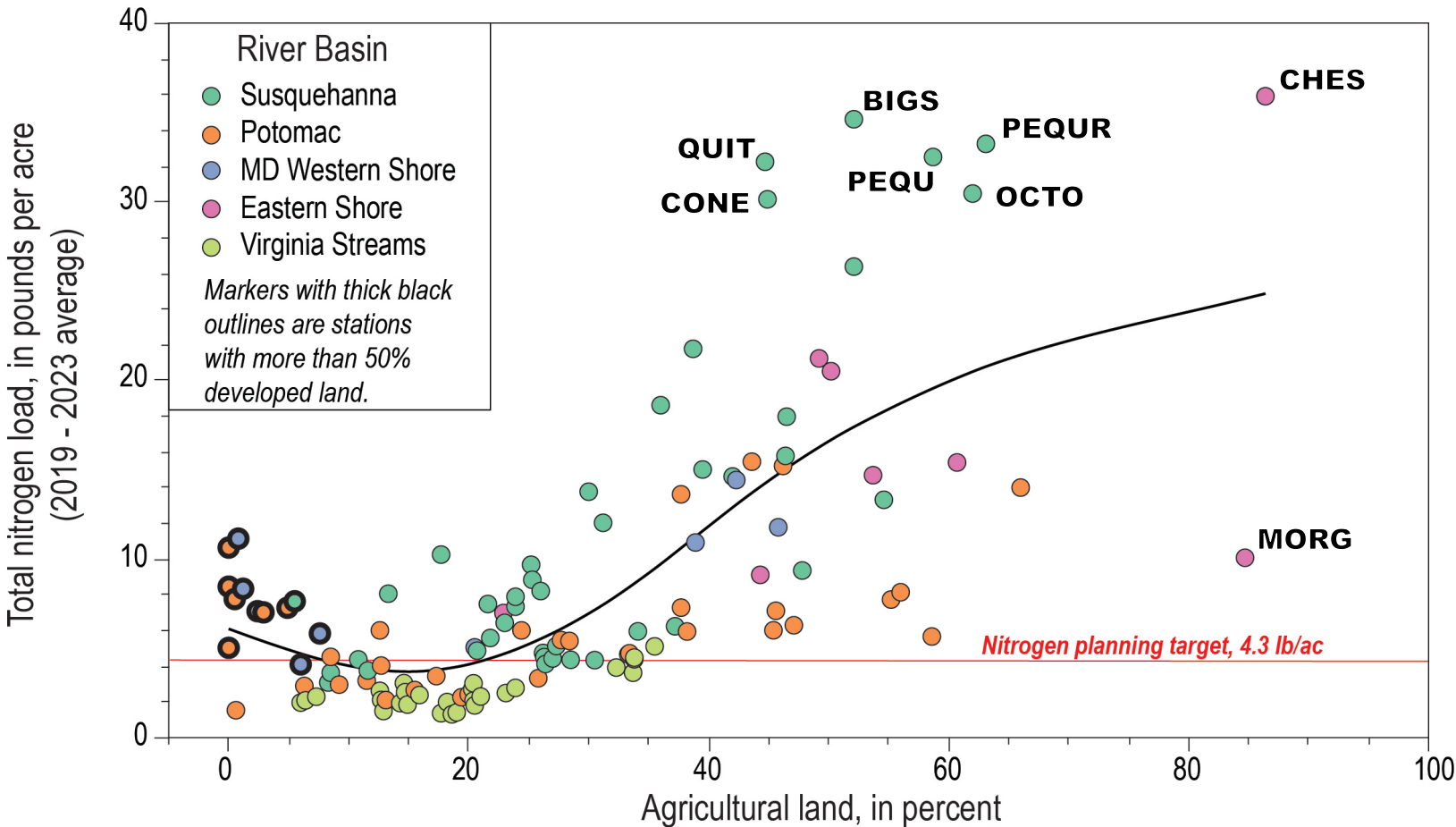
Long-term trends in mean-daily streamflow were only significant at the Choptank River (01491000).

<sup>1</sup>Streamflow entering the Bay estimated from monitored and unmonitored watershed area:  
[www.usgs.gov/centers/chesapeake-bay-activities/science/freshwater-flow-chesapeake-bay](http://www.usgs.gov/centers/chesapeake-bay-activities/science/freshwater-flow-chesapeake-bay)

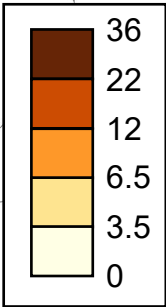
# Total Nitrogen (TN): Per-Acre Loads (2019 – 2023 Average)

Per-acre TN loads are typically highest in agricultural watersheds<sup>1</sup>.

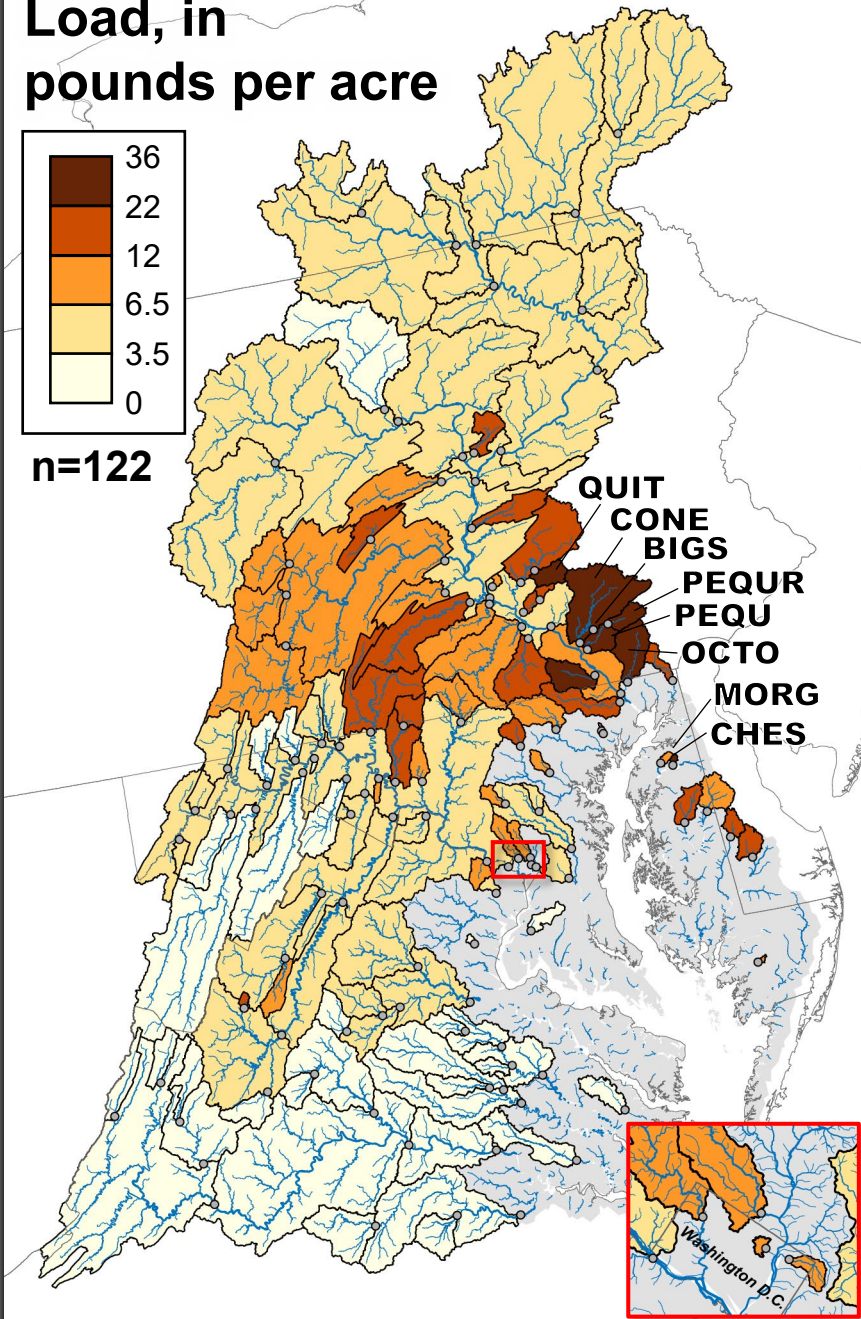
67% of stations have a per-acre load that exceeds a nitrogen planning target of 4.3 lb/ac<sup>2</sup>.



Load, in pounds per acre



n=122



<sup>1</sup>Land use conditions in 2023, from National Land Cover Database: <https://doi.org/10.5066/P94UXNTS>

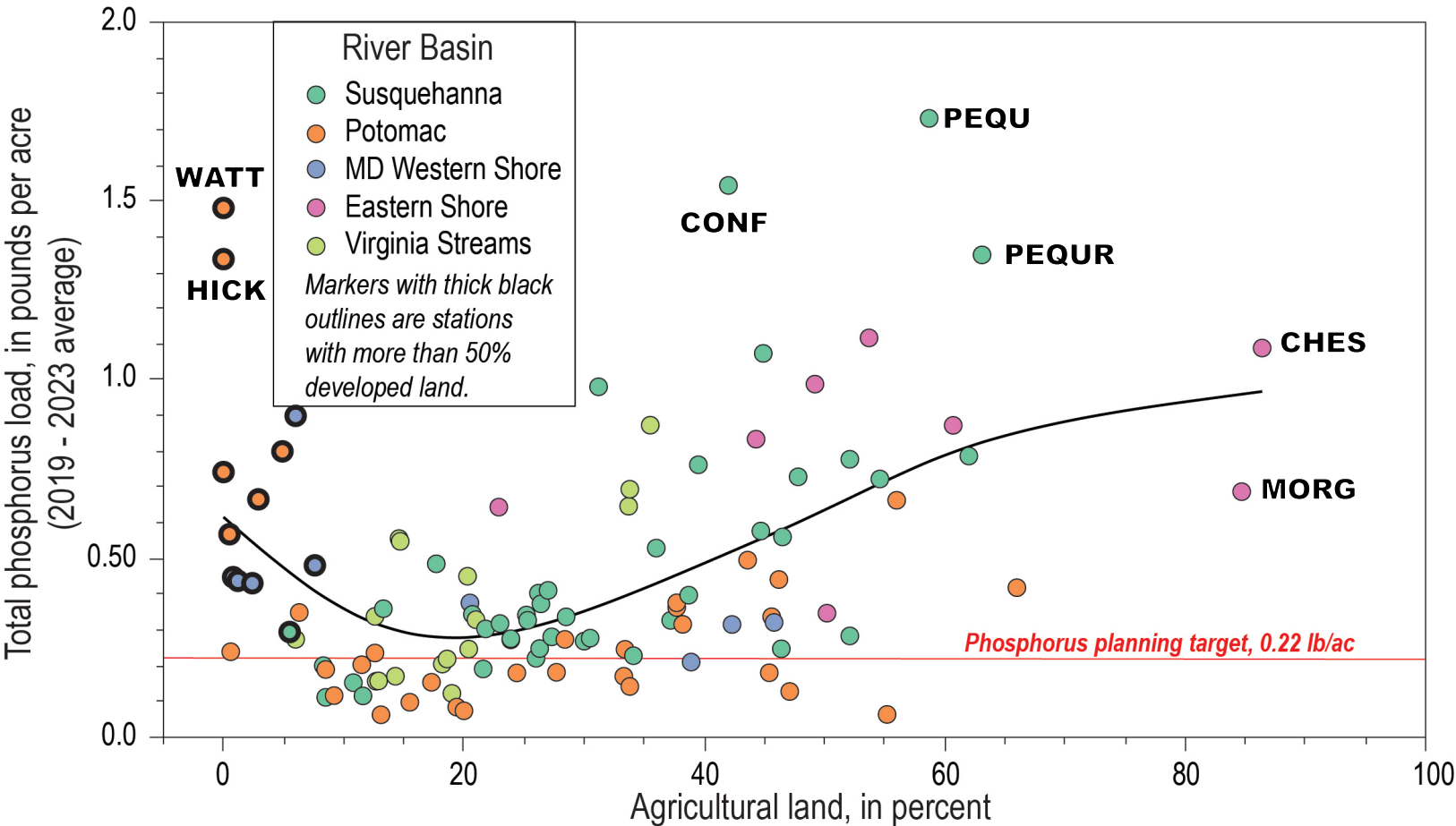
<sup>2</sup>A nitrogen planning target for the Chesapeake Bay watershed was summarized from METRIC: [wqs.chesapeakebay.net/metric](https://wqs.chesapeakebay.net/metric)



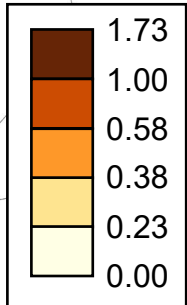
# Total Phosphorus (TP): Per-Acre Loads (2019 – 2023 Average)

Per-acre TP loads are typically highest in **developed** and **agricultural** watersheds<sup>1</sup>.

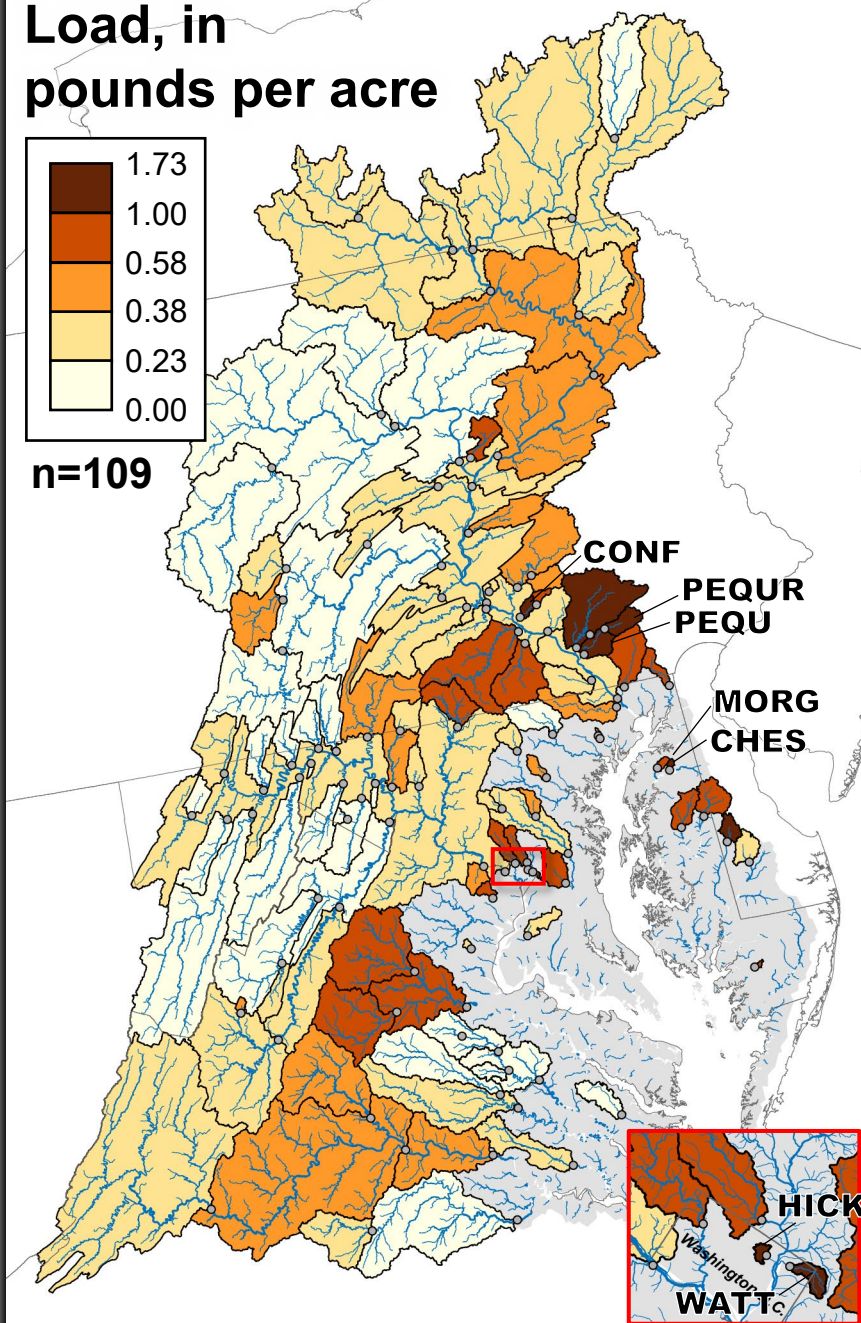
**75%** of stations have a per-acre load that exceeds phosphorus planning target of 0.22 lb/ac<sup>2</sup>.



Load, in pounds per acre



n=109



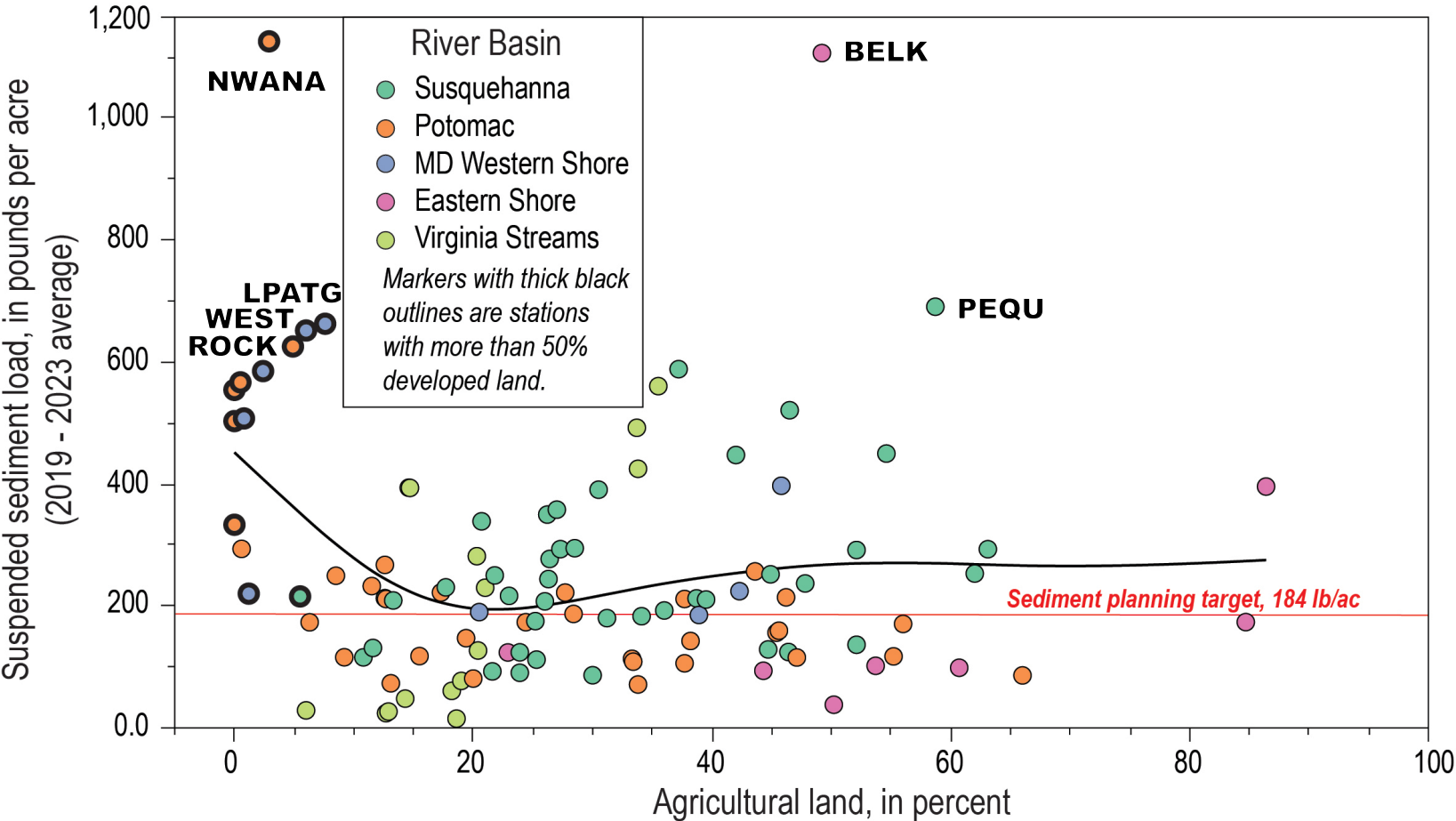
<sup>1</sup>Land use conditions in 2023, from National Land Cover Database: <https://doi.org/10.5066/P94UXNTS>

<sup>2</sup>A phosphorus planning target for the Chesapeake Bay watershed was summarized from METRIC: [wqs.chesapeakebay.net/metric](https://wqs.chesapeakebay.net/metric)

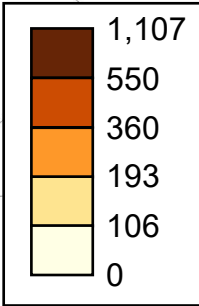
# Suspended Sediment (SS): Per-Acre Loads (2019 – 2023 Average)

SS per-acre loads are typically highest in **developed** watersheds<sup>1</sup>.

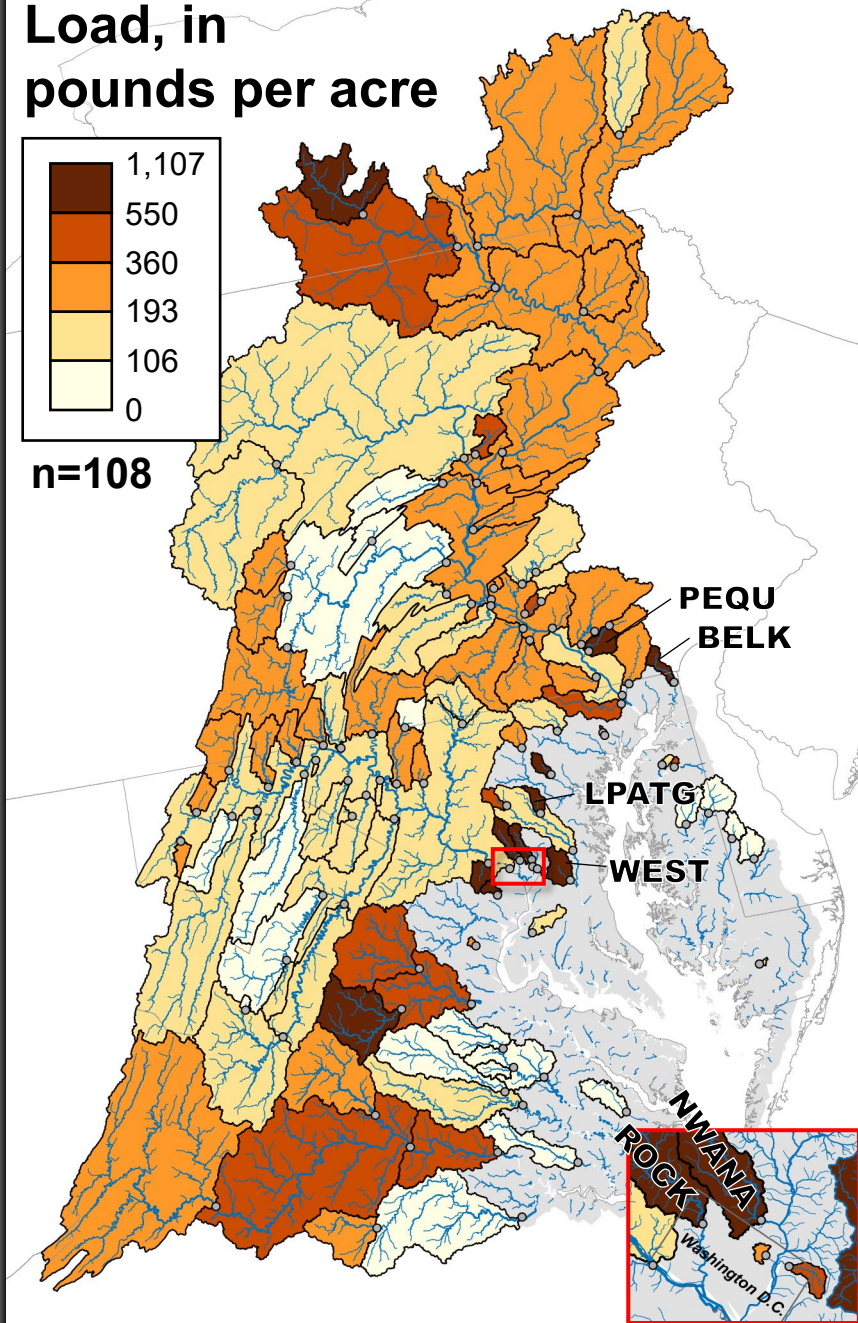
**58%** of stations have a per-acre load that exceeds a sediment planning target of 184 lb/ac<sup>2</sup>.



Load, in pounds per acre



n=108



<sup>1</sup>Land use conditions in 2023, from National Land Cover Database: <https://doi.org/10.5066/P94UXNTS>

<sup>2</sup>A sediment planning target for the Chesapeake Bay watershed was summarized from METRIC: [wqs.chesapeakebay.net/metric](https://wqs.chesapeakebay.net/metric)





# Nutrient and Sediment Trends



# The combined amount of nitrogen from NTN stations nearest the Bay decreased by 8% since 2014<sup>1</sup>

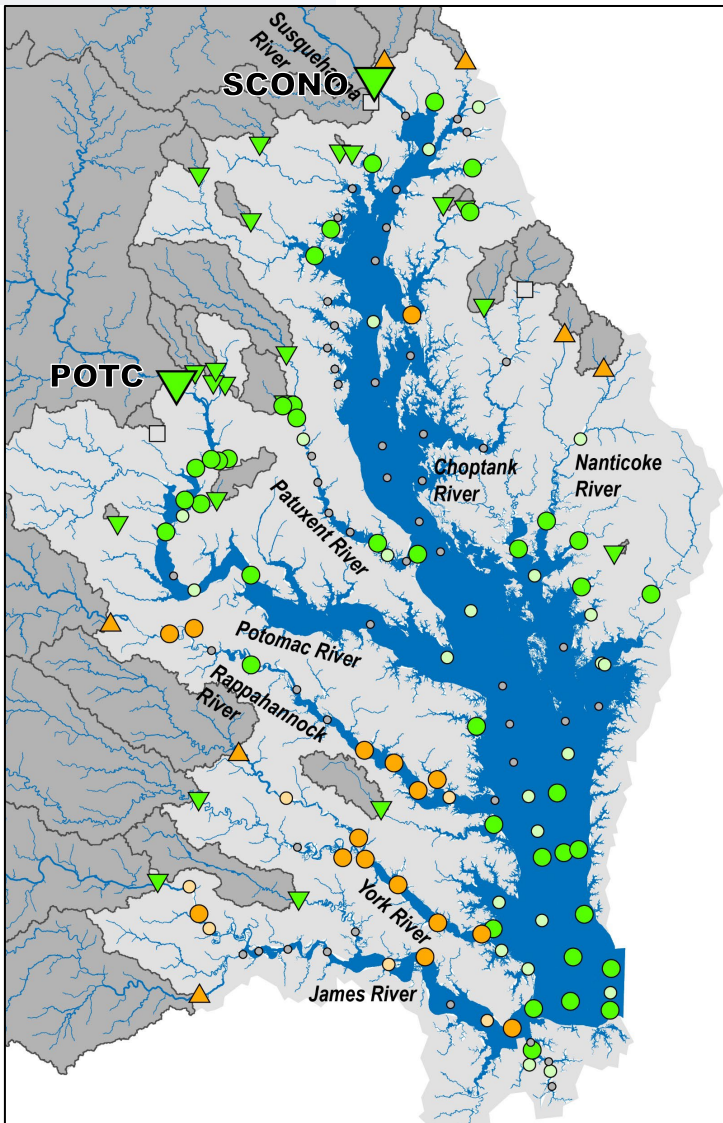
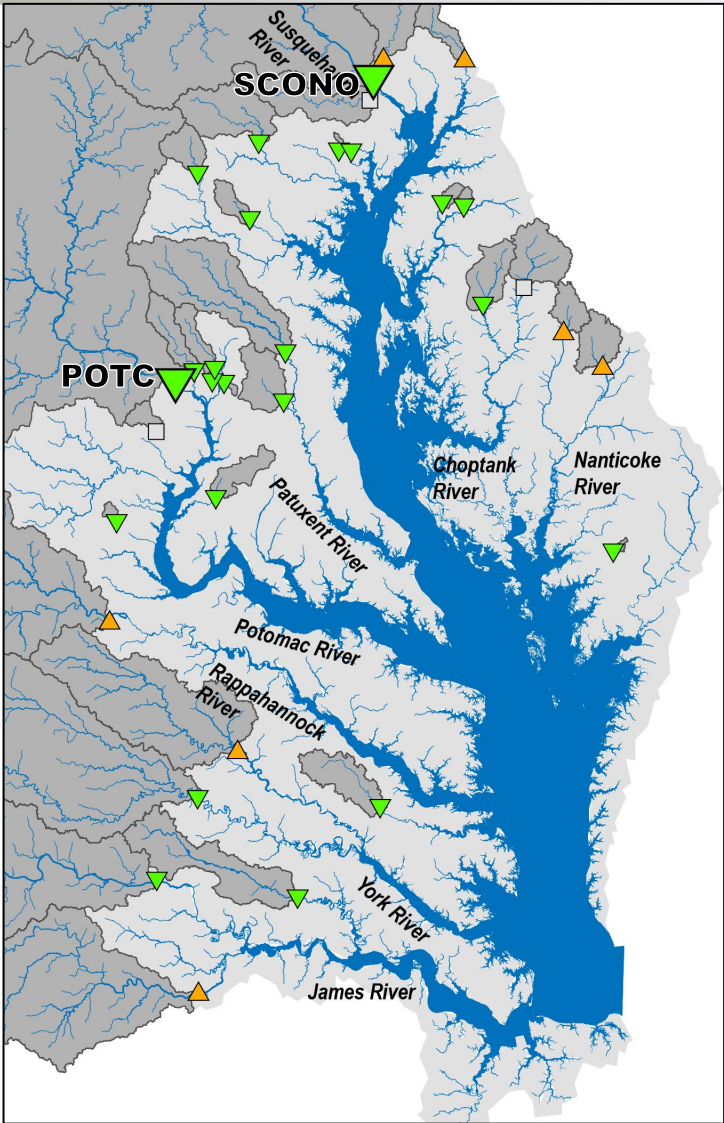
The NTN monitored area is about **81%** of the Chesapeake Bay watershed area.

### Watershed Area

- NTN Watershed
- Chesapeake Bay

### NTN Trend: TN, 2014 - 2023

- Improving
- Degrading
- No Trend



### Tidal Trend: TN, 2014/15 – 2022/23, Non-linear with Flow Adjustment Surface, Annual

- Significant increase
- Possible increase
- Unlikely
- Possible decrease
- Significant decrease

[baytrends.chesapeakebay.net](https://baytrends.chesapeakebay.net)

<sup>1</sup>Calculated as a change in flow-normalized load from 2014 through 2023 at 33 downstream NTN stations.

This information is preliminary and is subject to revision. It is being provided to meet the need for timely best science. The information is provided on the condition that neither the U.S. Geological Survey nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the information.



# The combined amount of phosphorus from NTN stations nearest the Bay decreased by 12% since 2014<sup>1</sup>

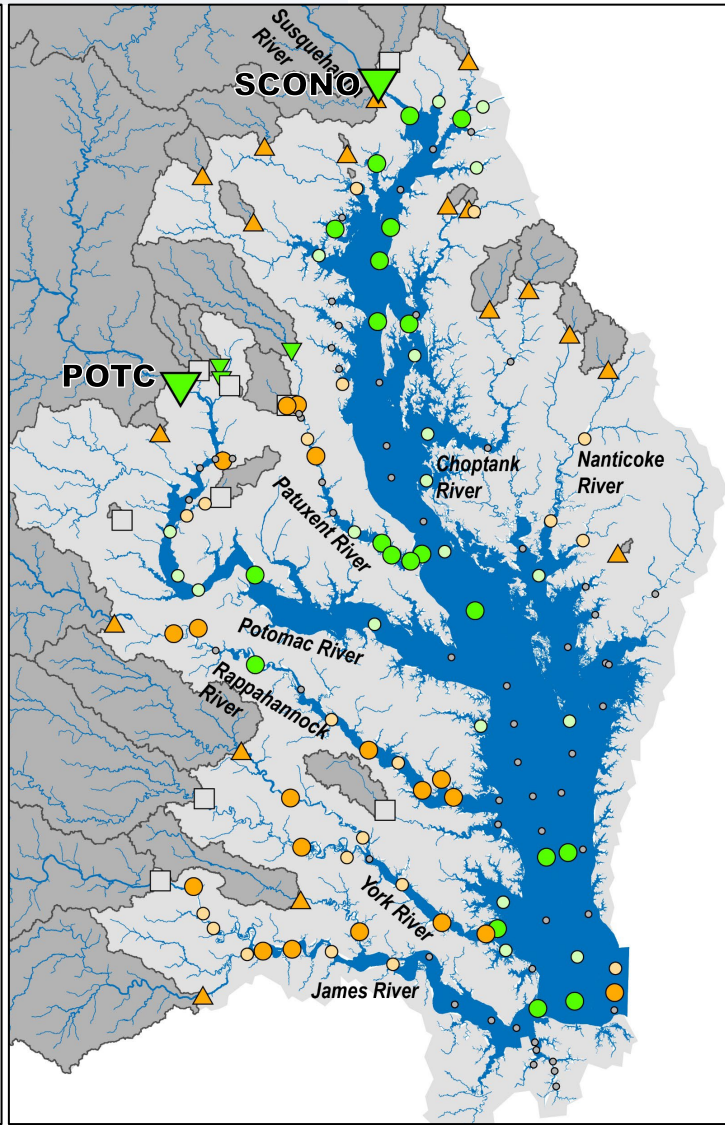
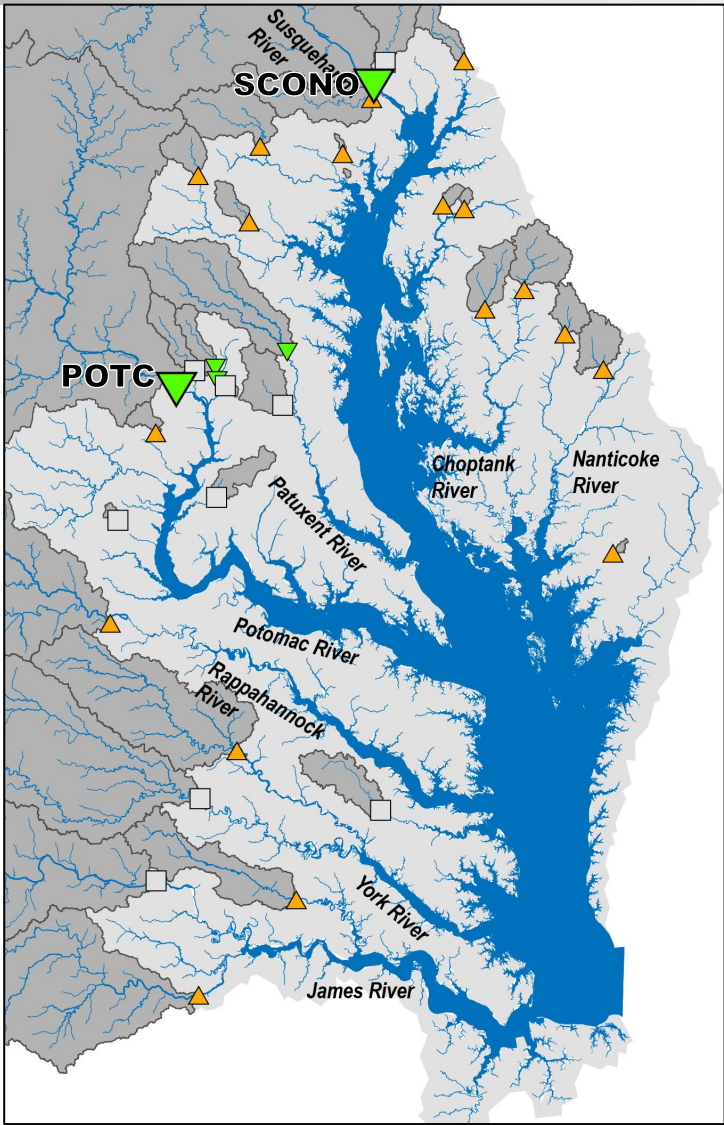
The NTN monitored area is about **81%** of the Chesapeake Bay watershed area.

### Watershed Area

- NTN Watershed
- Chesapeake Bay

### NTN Trend: TP, 2014 - 2023

- Improving
- Degrading
- No Trend



### Tidal Trend: TP, 2014/15 – 2022/23, Non-linear with Flow Adjustment Surface, Annual

- Significant increase
- Possible increase
- Unlikely
- Possible decrease
- Significant decrease

[baytrends.chesapeakebay.net](https://baytrends.chesapeakebay.net)

<sup>1</sup>Calculated as a change in flow-normalized load from 2014 through 2023 at 33 downstream NTN stations.

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# The combined amount of suspended sediment from NTN stations nearest the Bay decreased by 6% since 2014<sup>1</sup>

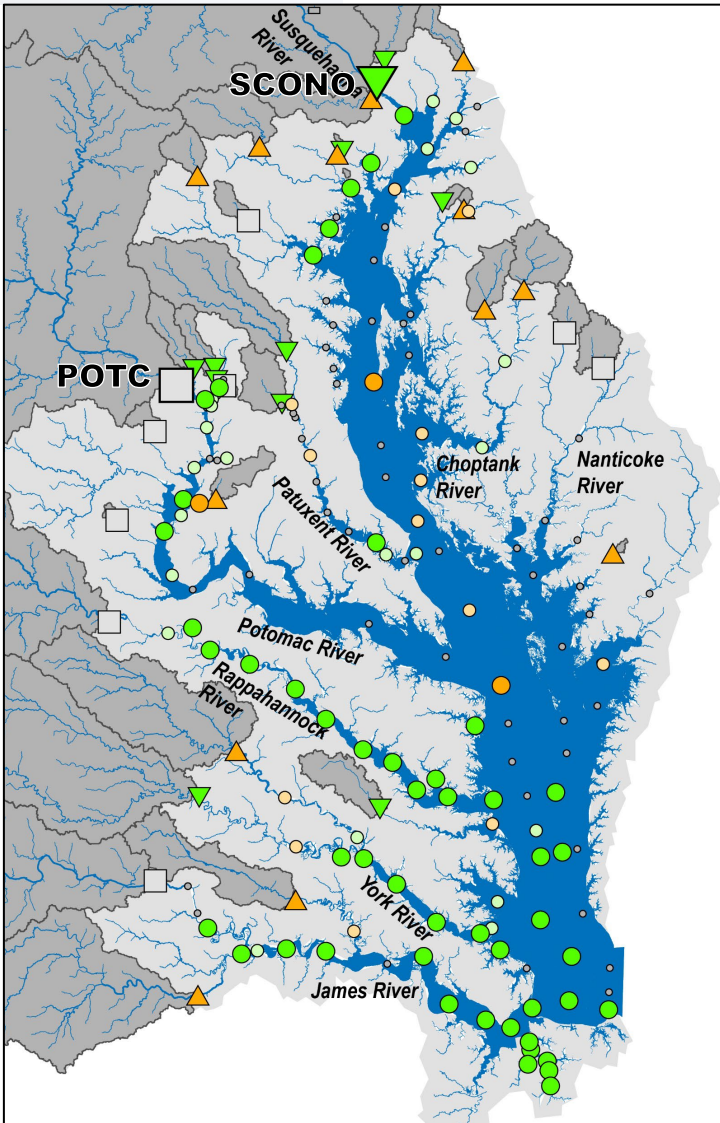
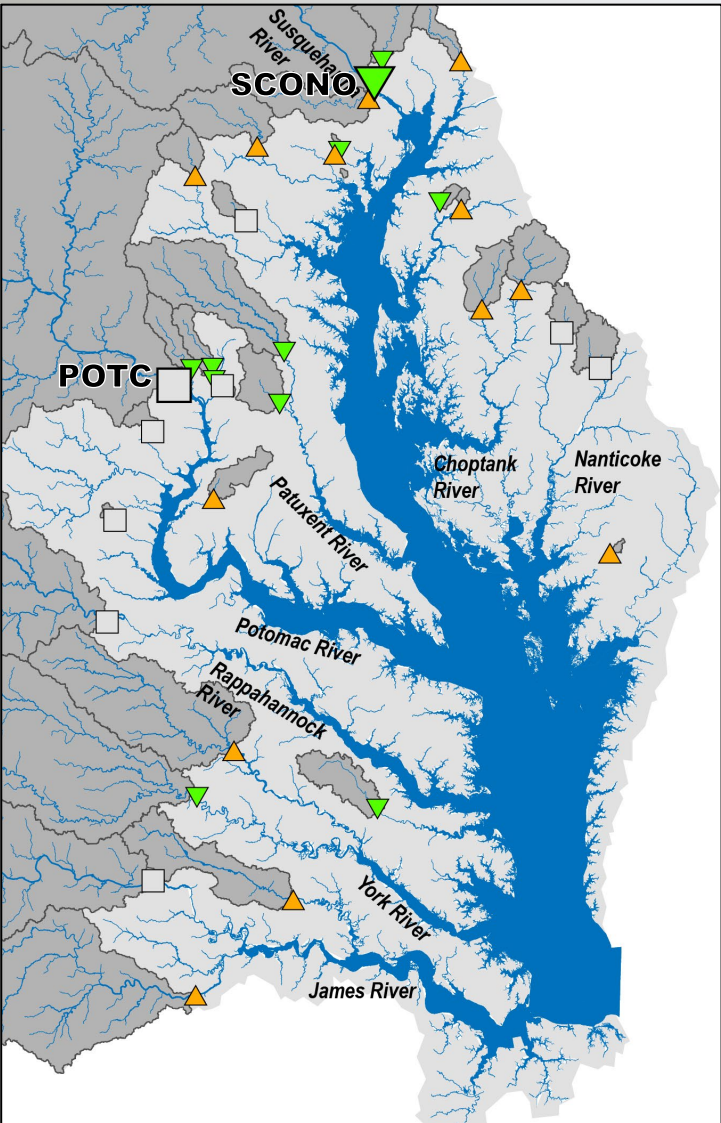
The NTN monitored area is about **81%** of the Chesapeake Bay watershed area.

### Watershed Area

- NTN Watershed
- Chesapeake Bay

### NTN Trend: SS, 2014 - 2023

- Improving
- Degrading
- No Trend



### Tidal Trend: TSS, 2014/15 – 2022/23, Non-linear with Flow Adjustment Surface, Annual

- Significant increase
- Possible increase
- Unlikely
- Possible decrease
- Significant decrease

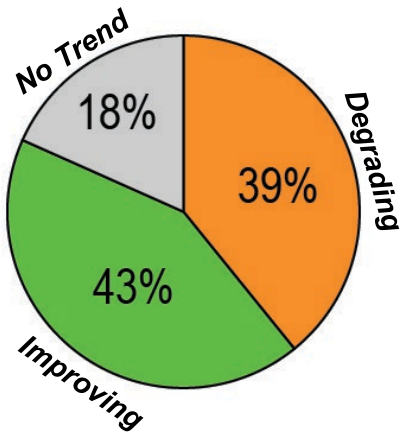
[baytrends.chesapeakebay.net](https://baytrends.chesapeakebay.net)

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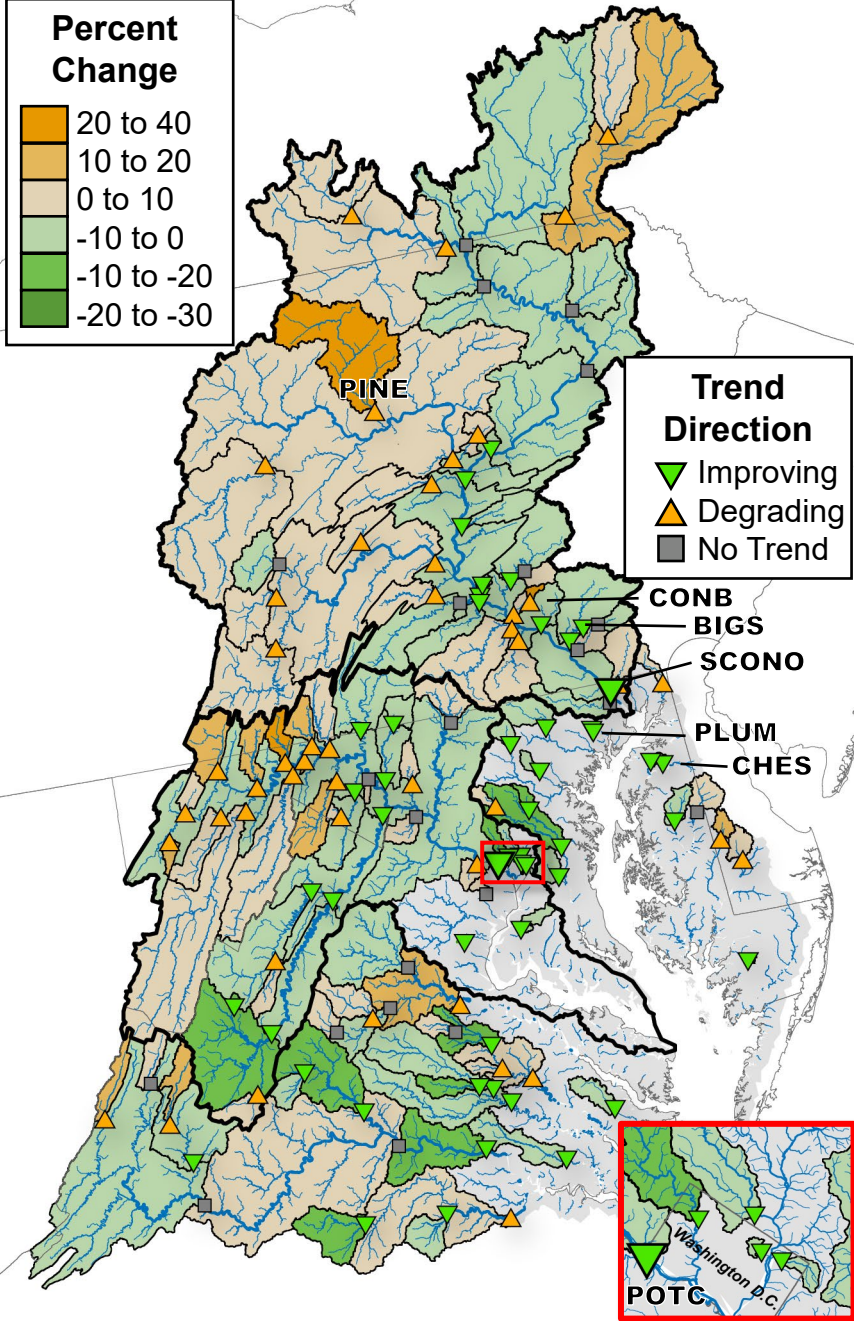
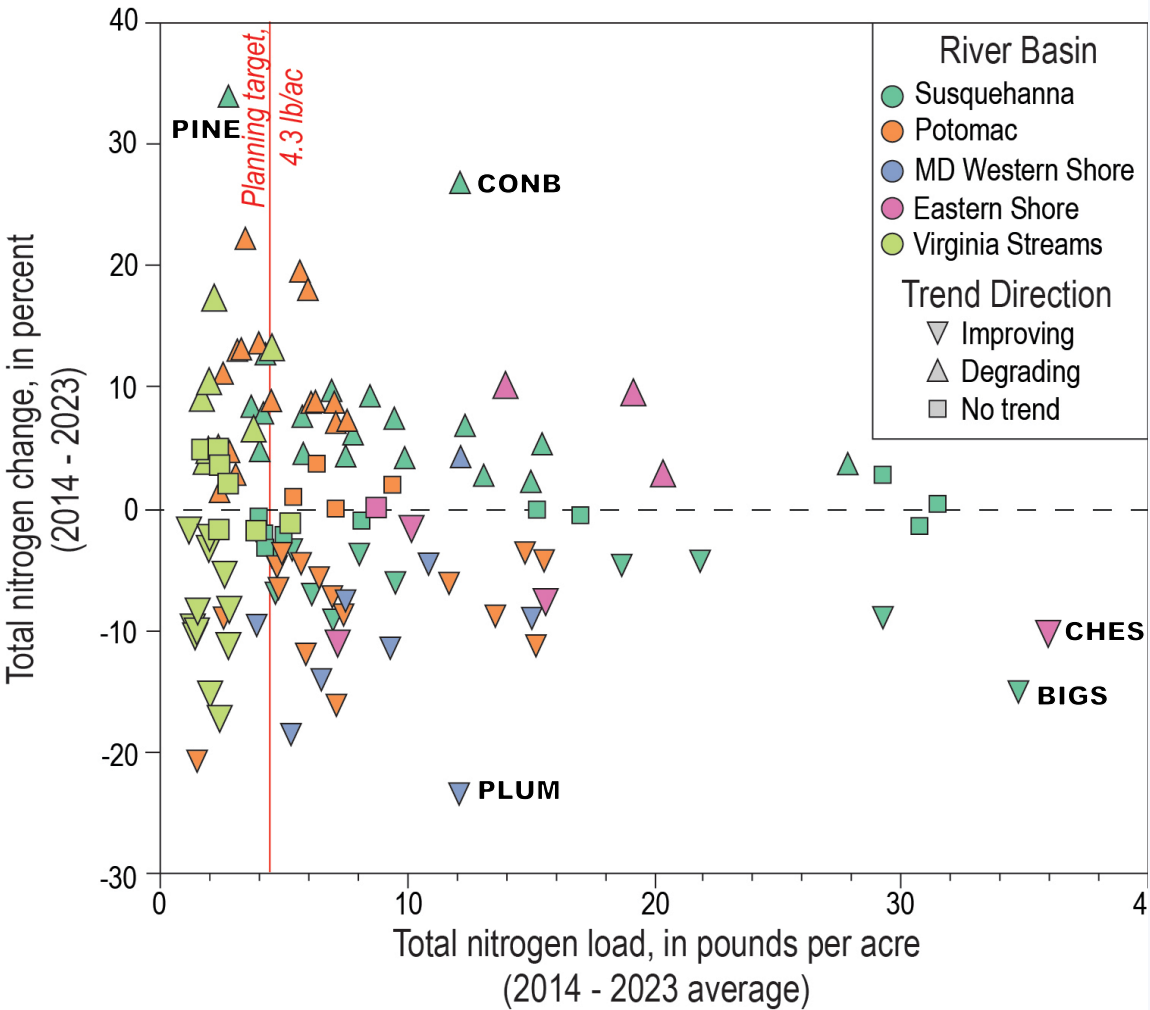


# Total Nitrogen Trends: 2014 through 2023

Trends, by Percent  
of Stations (n=120)

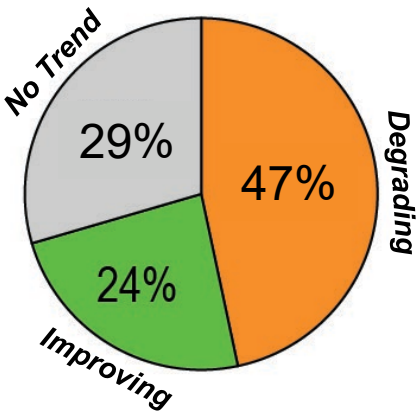


Median percent change = -0.6%

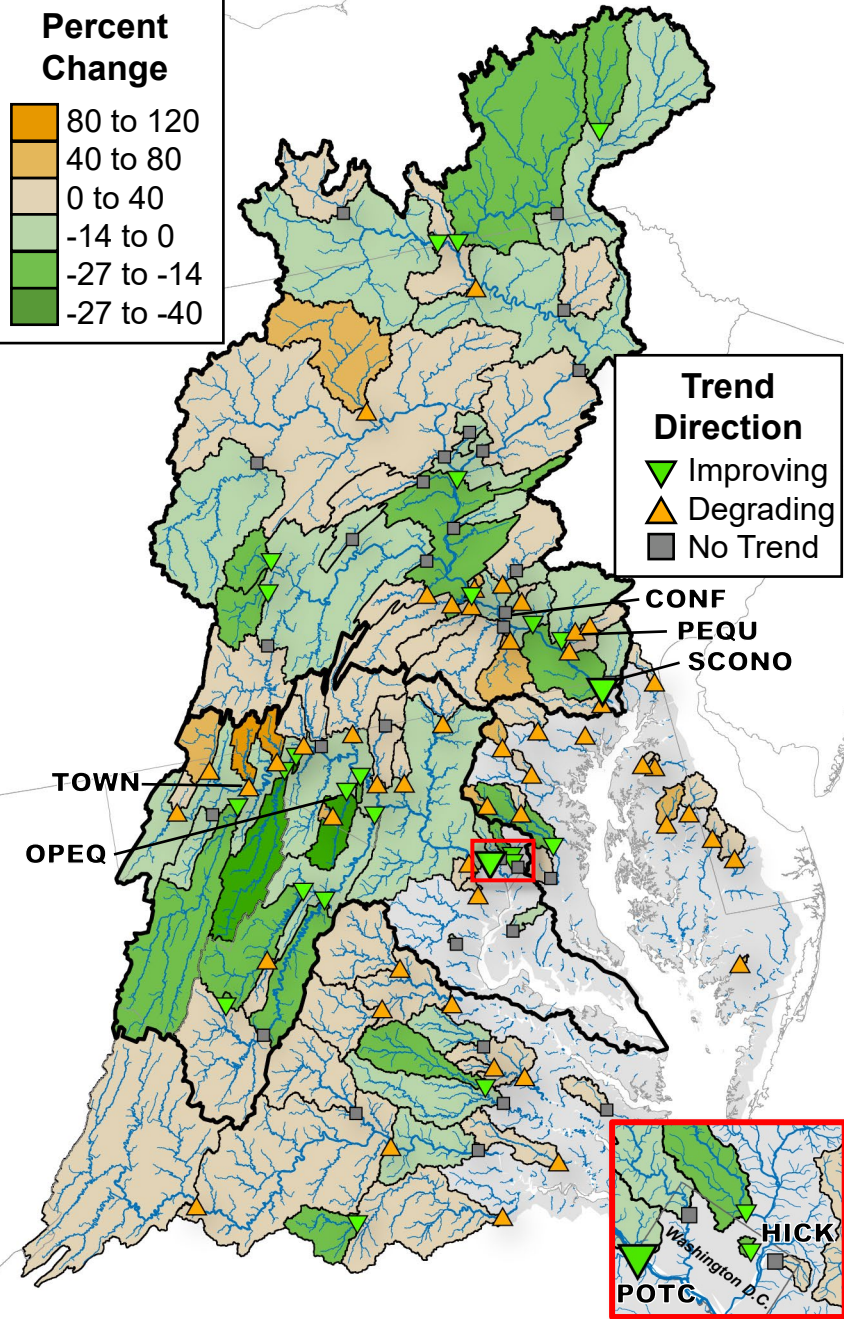
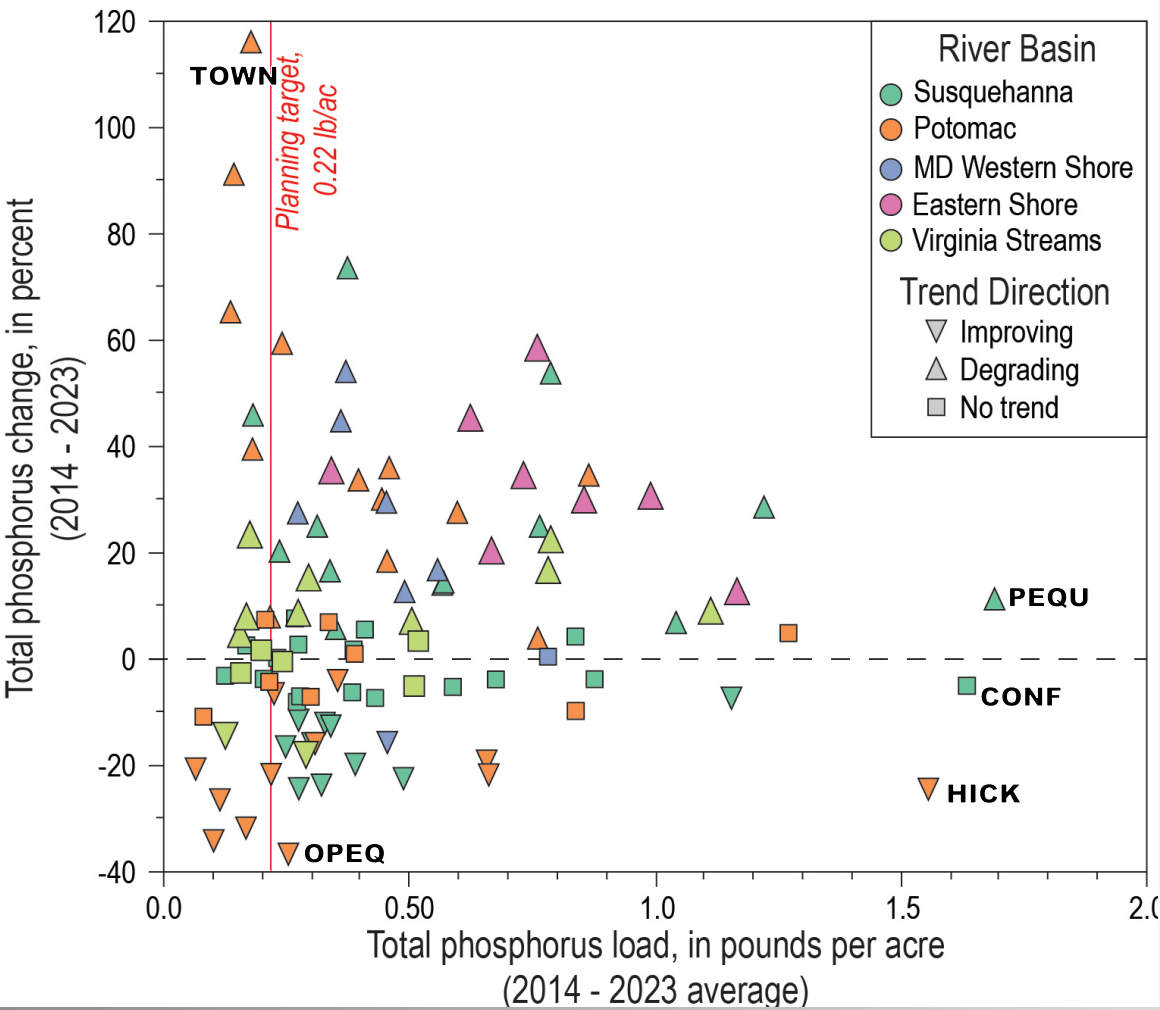


# Total Phosphorus Trends: 2014 through 2023

Trends, by Percent  
of Stations (n=105)



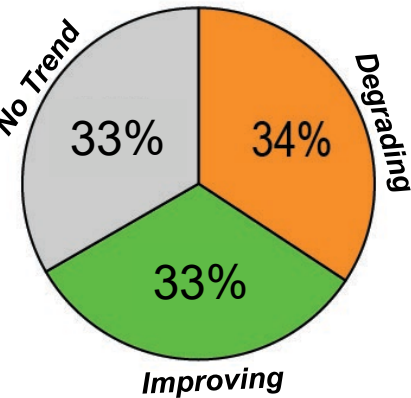
Median percent change = +4.3%



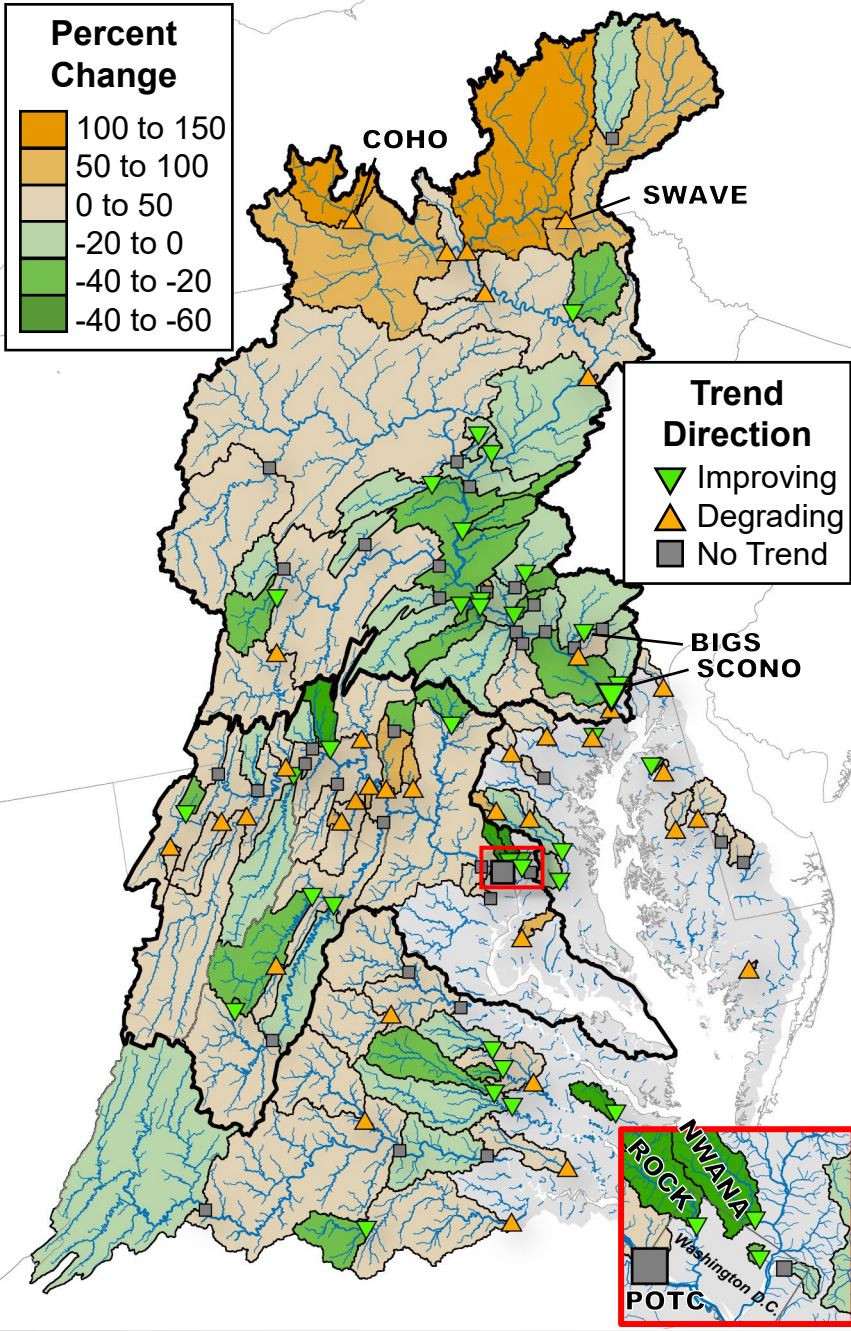
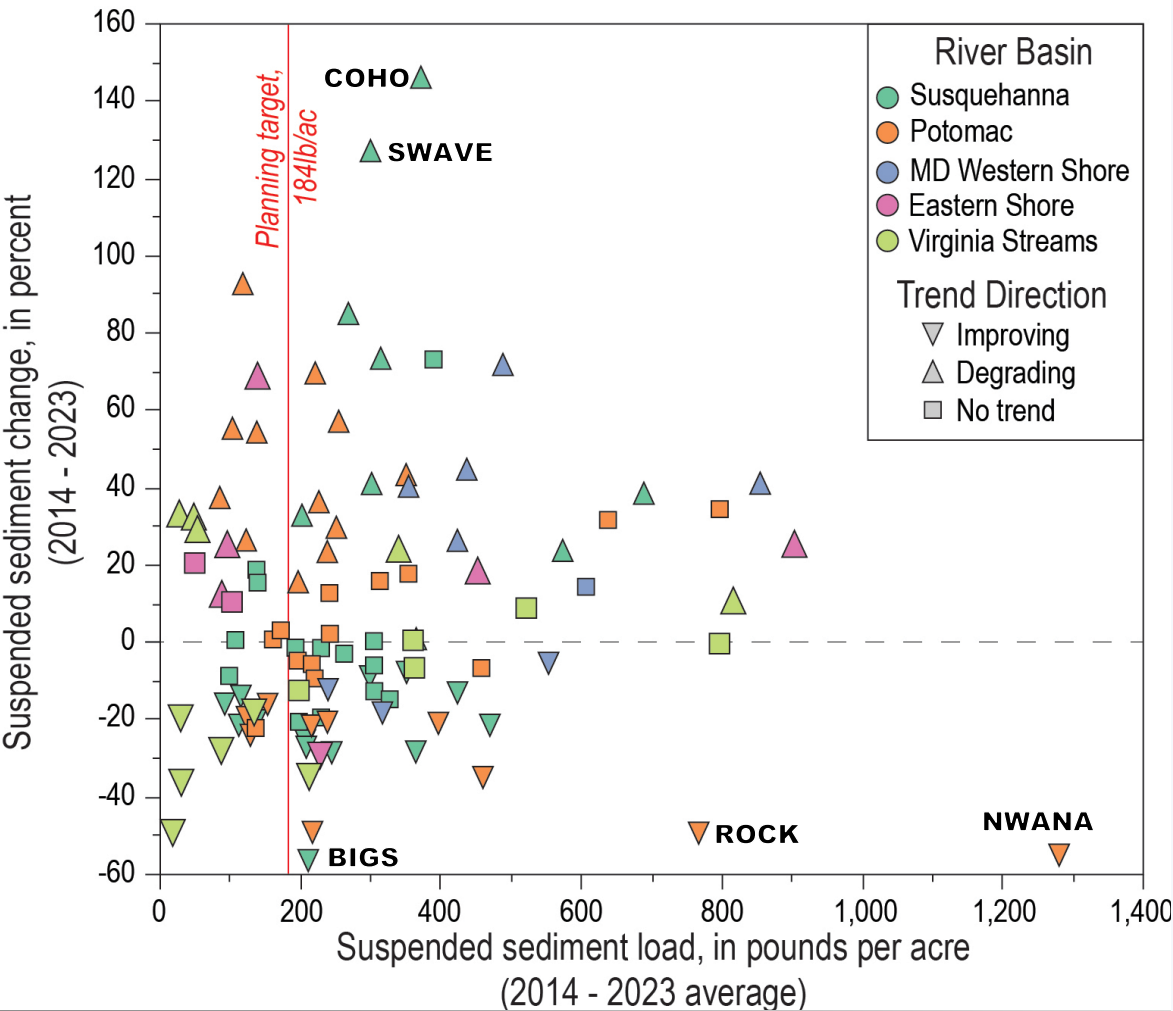


# Suspended Sediment Trends: 2014 through 2023

Trends, by Percent of Stations (n=105)



Median percent change = +0.8%




# Resources to Learn More



## Resources are available to learn more about NTN results


The project website includes access to the most recent data and a summary of results: [usgs.gov/CB-wq-loads-trends](https://usgs.gov/CB-wq-loads-trends)

We will be updating an interactive geonarrative, where users can explore results at individual stations in greater detail:  
[va.water.usgs.gov/geonarratives/ntn](https://va.water.usgs.gov/geonarratives/ntn)



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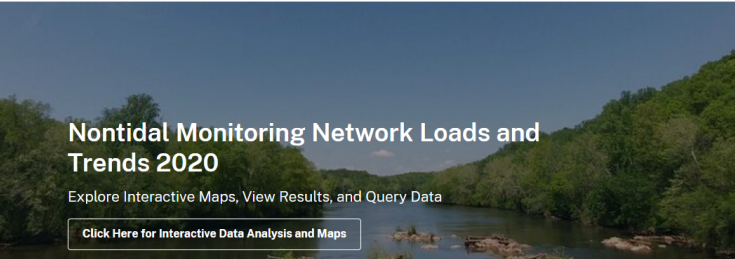
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# Chesapeake Bay Water-Quality Loads and Trends

ACTIVE

By [Chesapeake Bay Activities](#)
January 1, 2016



## Nontidal Monitoring Network Loads and Trends 2020

Explore Interactive Maps, View Results, and Query Data

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Access the most recent data gathered from the **Chesapeake Bay Nontidal Monitoring Network**, learn about the techniques used to collect this data, and read about the history of the Chesapeake Bay Nontidal Monitoring Program.


**Nontidal Network (NTN)** data refers to data from the 123 monitoring stations where nutrients and sediment are collected monthly and during storms.

**River Input Monitoring (RIM)** data refers to data from nine stations within the NTN network. This data is used to estimate the total amount of nutrient and sediment delivered to the Chesapeake Bay annually.

### Study Area



### Contacts



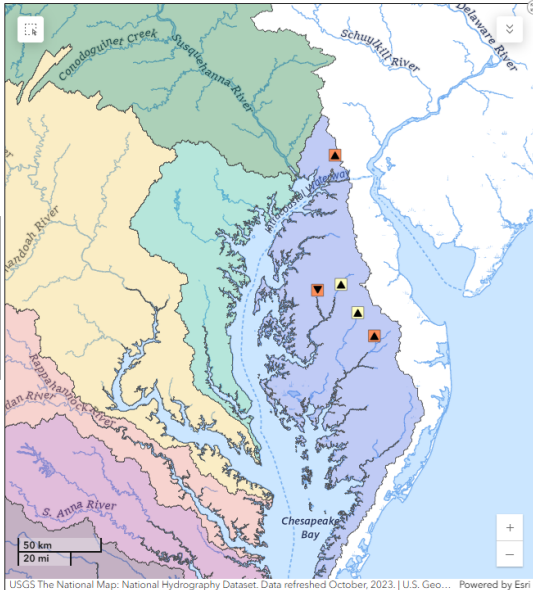
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[Trends Summary](#)
[Total Nitrogen](#)
[Total Phosphorus](#)
[Suspended Sediment](#)
[Loads to Tidal Waters](#)
[Definitions](#)
[Methods](#)
[Factors: Loads and Trends](#)
[Resources](#)

# Total nitrogen

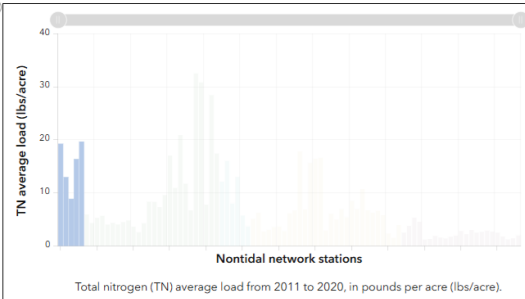
From 2011-2020, total nitrogen trends improved at 37% of stations and degraded at 40%. Of the long-term sites (sites monitored since approximately 1985), 52% are improving.

Highlights of trends since 2011 include:

- Four of nine RIM stations improved: the Susquehanna, Potomac, James, and Patuxent, representing three of the largest RIM watersheds.
- About 35% of Susquehanna stations improved, mostly located in the lower portion of the watershed.
- Four of six Western Shore stations improved,



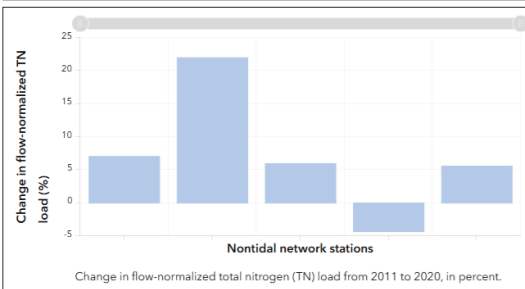
USGS The National Map: National Hydrography Dataset, Data refreshed October, 2023 U.S. Geo... Powered by Esri



TN average load (lbs/acre)

Nontidal network stations

Total nitrogen (TN) average load from 2011 to 2020, in pounds per acre (lbs/acre).



Change in flow-normalized TN load (%)

Nontidal network stations

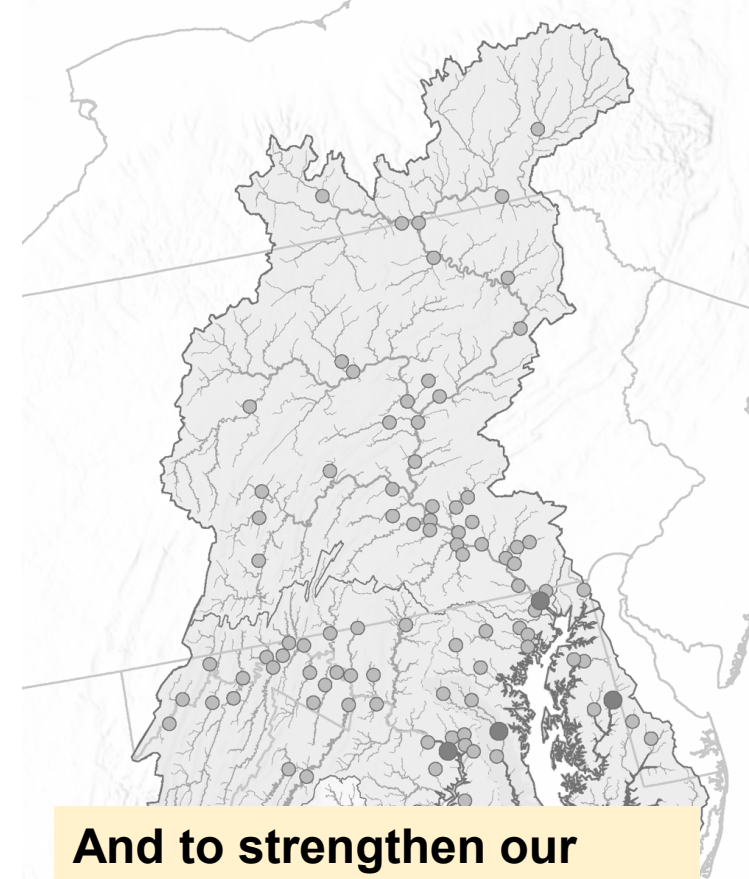
Change in flow-normalized total nitrogen (TN) load from 2011 to 2020, in percent.

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Mason, C.A., Colgin, J.E., Webber, J.S., and Soroka, A.M., 2025, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay Nontidal Network stations: Water years 1985-2023: U.S. Geological Survey data release, <https://doi.org/10.5066/P13P4TWR>.

# Major Messages: NTN Loads and Trends

1. Loads and trends have been calculated through water year 2023 using reproducible and accurate water-quality datasets.  
***The quality of NTN data has never been better.***
2. Per-acre nutrient and sediment loads are typically highest in agricultural and/or urban watersheds.
3. Most long-term trends of total nitrogen (n=43) and total phosphorus (n=16) ***improved***.
4. The combined amounts of nitrogen, phosphorus, and sediment from NTN stations nearest the Bay all ***decreased*** since 2014.
5. Improving short-term trends (2014 – 2023) of total nitrogen, total phosphorus, and suspended sediment were detected at ***less than half*** of all stations.
6. The USGS will continue to work with Chesapeake Bay partners to evaluate and explain these observed water-quality patterns.



**And to strengthen our understanding about the effects of nontidal river loads on tidal water-quality conditions!**

**Visit our website to explore these results in more detail:**  
**[usgs.gov/CB-wq-loads-trends](https://usgs.gov/CB-wq-loads-trends)**

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James Colgin, [jcolgin@usgs.gov](mailto:jcolgin@usgs.gov); Alex Soroka, [asoroka@usgs.gov](mailto:asoroka@usgs.gov)



# Station Dictionary

The following NTN short station names are used throughout this presentation.

Short Name	Station ID	Station Name
APPMO	02041650	APPOMATTOX RIVER AT MATOACA, VA
BELK	01495000	BIG ELK CREEK AT ELK MILLS, MD
BIGS	015765195	BIG SPRING RUN NEAR MYLIN CORNERS, PA
CHES	01493112	CHESTERVILLE BRANCH NEAR CRUMPTON, MD
CHOP	01491000	CHOPTANK RIVER NEAR GREENSBORO, MD
COHO	01529500	COHOCTON RIVER NEAR CAMPBELL NY
CONB	01573695	CONEWAGO CREEK NEAR BELLAIRE, PA
CONE	01576754	CONESTOGA RIVER AT CONESTOGA, PA
CONF	01573710	CONEWAGO CREEK NEAR FALMOUTH, PA
DIFF	01646000	DIFFICULT RUN NEAR GREAT FALLS, VA
HICK	01651770	HICKEY RUN AT NEW YORK AVE AT WASHINGTON, DC
LPATG	01593500	LITTLE PATUXENT RIVER AT GUILFORD, MD
MORG	01493500	MORGAN CREEK NEAR KENNEDYVILLE, MD
NWANA	01651000	NW BR ANACOSTIA RIVER NR HYATTSVILLE, MD
OCTO	01578475	OCTORARO CREEK NEAR RICHARDSMERE, MD

Short Name	Station ID	Station Name
OPEQ	01616500	OPEQUON CREEK NEAR MARTINSBURG, WV
PATB	01594440	PATUXENT RIVER NEAR BOWIE, MD
PEQU	01576787	PEQUEA CREEK AT MARTIC FORGE, PA
PEQUR	01576767	PEQUEA CREEK NEAR RONKS, PA
PINE	01549700	PINE CREEK BL L PINE CREEK NEAR WATERVILLE, PA
PLUM	01581752	PLUMTREE RUN NEAR BEL AIR, MD
POTC	01646580	POTOMAC RIVER AT CHAIN BRIDGE, AT WASHINGTON, DC
QUIT	01573160	QUITTAPAHILLA CREEK NEAR BELLEGROVE
RAPPF	01668000	RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA
ROCK	01648010	ROCK CREEK AT JOYCE ROAD, WASHINGTON, DC
SCONO	01578310	SUSQUEHANNA RIVER AT CONOWINGO, MD
SWAVE	01515000	SUSQUEHANNA RIVER NEAR WAVERLY NY
TOWN	01609000	TOWN CREEK NEAR OLDTOWN, MD
WATT	01651800	WATTS BRANCH AT WASHINGTON, DC
WEST	01594526	WESTERN BRANCH AT UPPER MARLBORO, MD