Nitrogen, Phosphorus, and Suspended Sediment:

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

An update through water year 2023

February 19th, 2025

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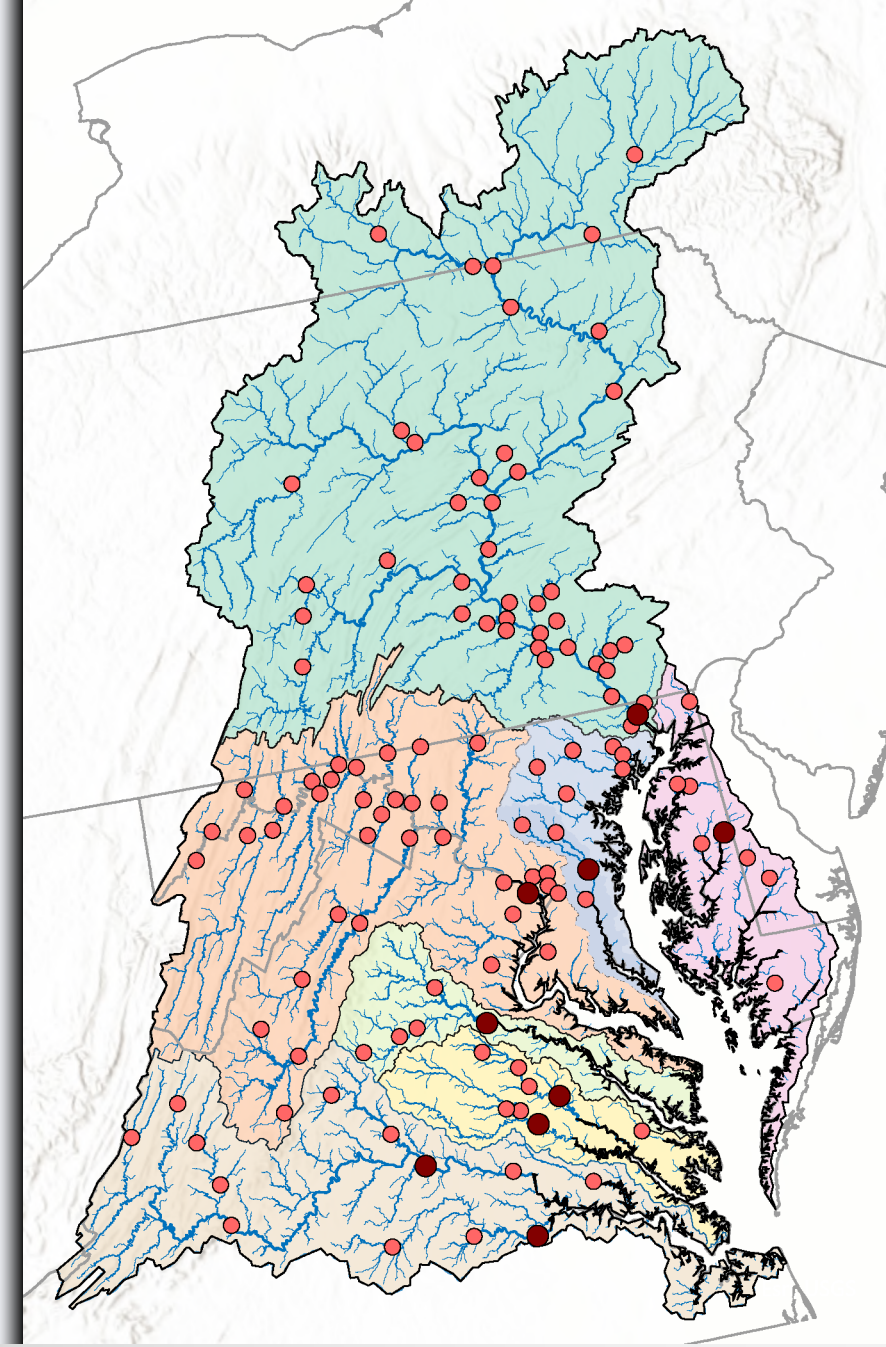
NTN loads and trends were recently computed using monitoring data through water-year 2023.

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



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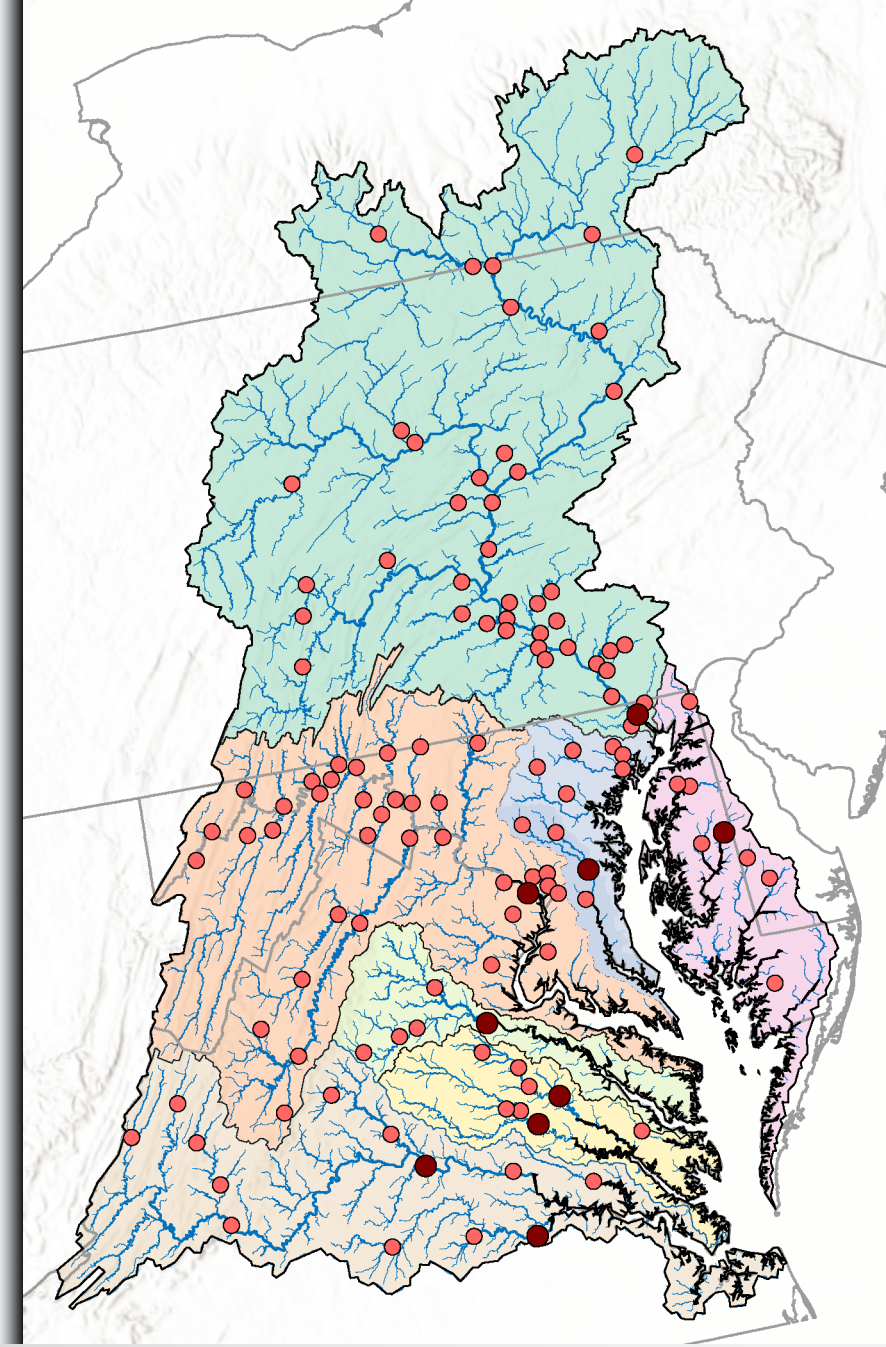


1. **Major Messages**
2. **Monitoring Network and Methods**
3. **Streamflow and Per-Acre Loads (Yields)**
4. **Nutrient and Sediment Trends**
5. **Resources to Learn More**

Major Messages

USGS science for a changing world

Background photo: Collecting a storm sample on the Appomattox River

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.***

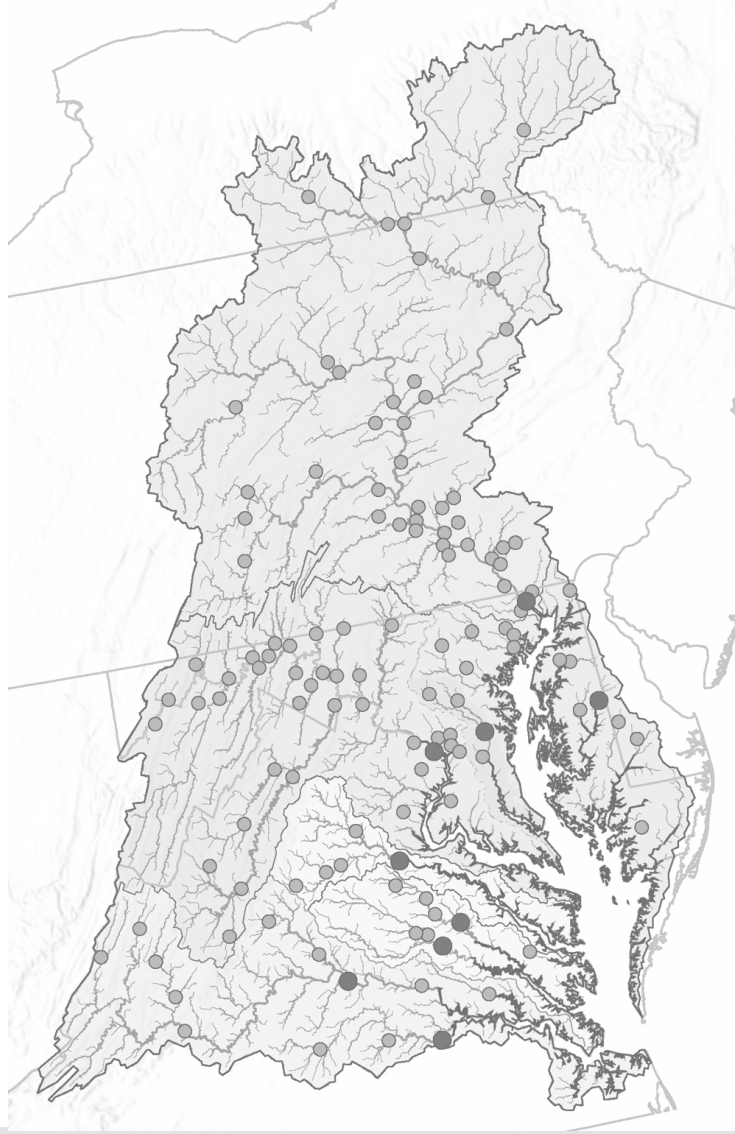
2. Per-acre nutrient and sediment loads are typically highest in agricultural and/or urban watersheds.

3. Most long-term trends[1] 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.



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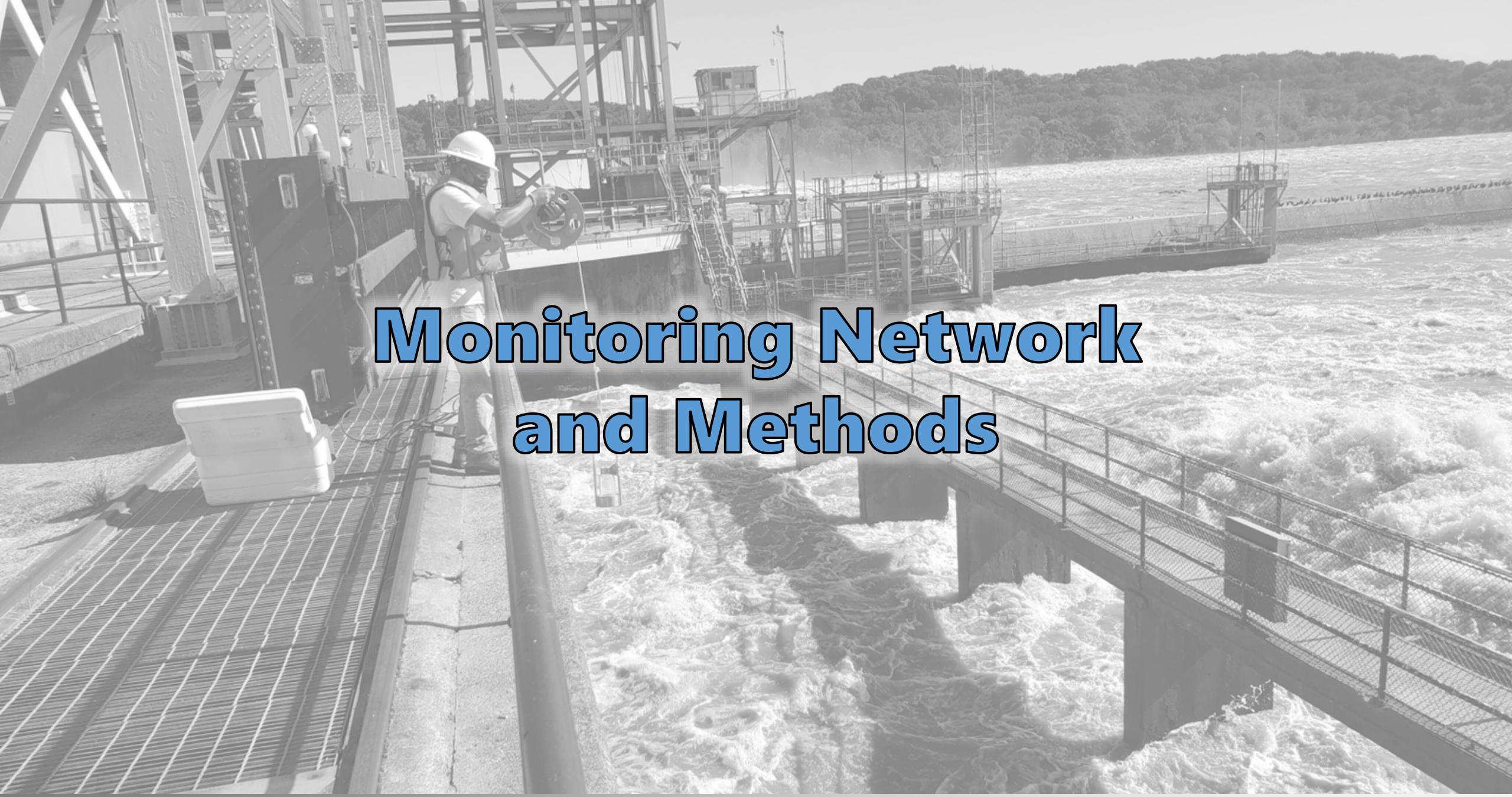
USGS science for a changing world

[1]Long-term trends are computed from sample records that begin before 1990.



Monitoring Network and Methods

USGS science for a changing world

Background photo: Collecting a storm sample on the Susquehanna River at Conowingo Dam

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

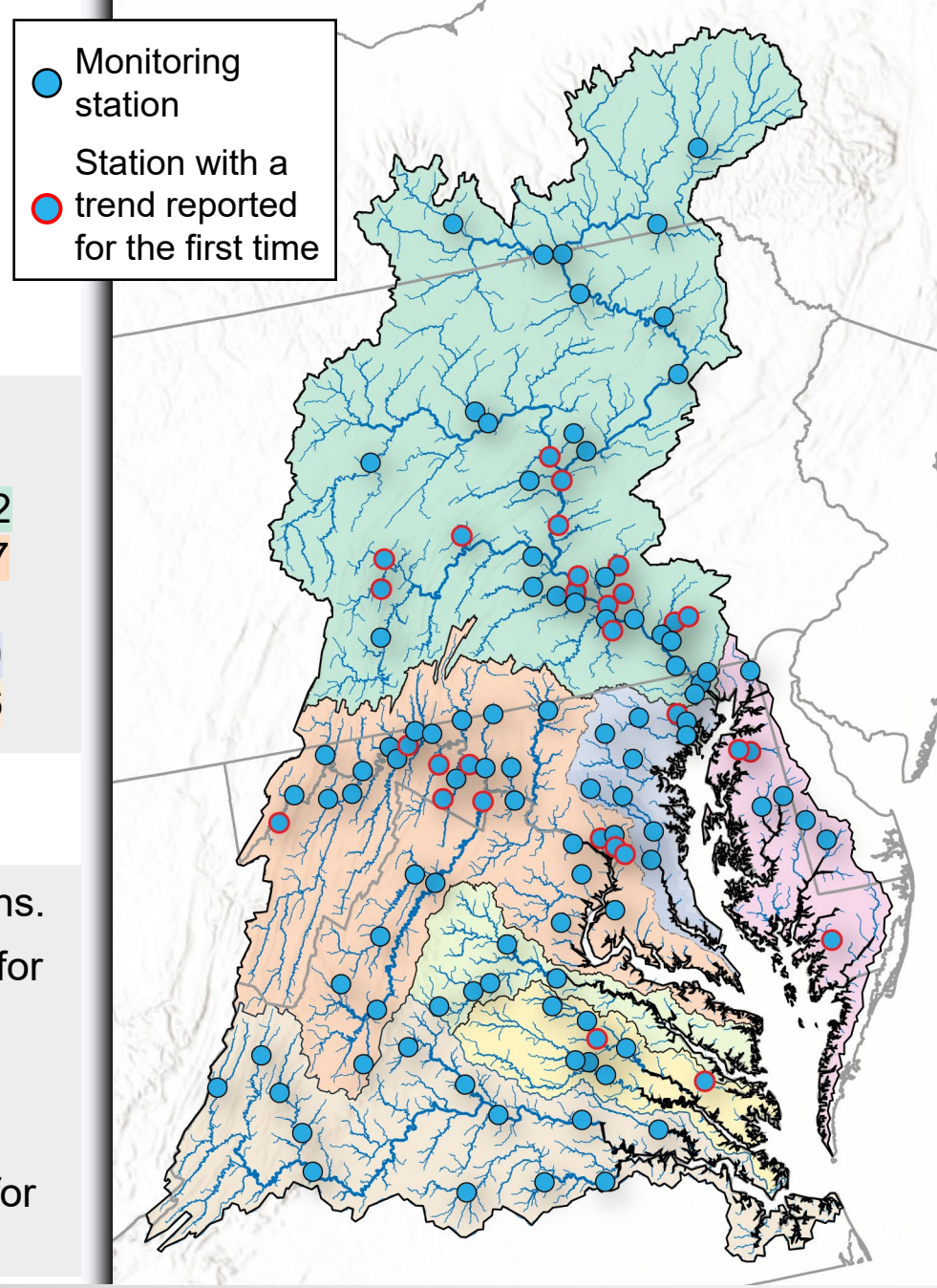
- Susquehanna……...42
- Potomac……37
- Eastern Shore……..8
- MD Western Shore….10
- Rapp. / York / James..26

Loads and trends are computed for five water-quality parameters using WRTDS[1]:

- Total nitrogen (TN)
- Nitrate + nitrite (NOx)
- Total phosphorus (TP)
- Orthophosphate (PO4)
- Suspended sediment (SS)

- **Loads** are computed for 122 stations.
- **Short-term trends[2]** are computed for 120 stations[3].

  31 stations have a trend reported for the first time!
- **Long-term trends[4]** are computed for 43 stations.



USGS science for a changing world

[1]WRTDS: Weighted Regressions on Time Discharge and Season

[2]Short-term trends: 2014 through 2023.

[3]Number of short-term trend stations by parameter: TN and NOx = 120, TP = 105, PO4 = 86, SS = 105.

[4]Long-term trends: < 1990 through 2023.

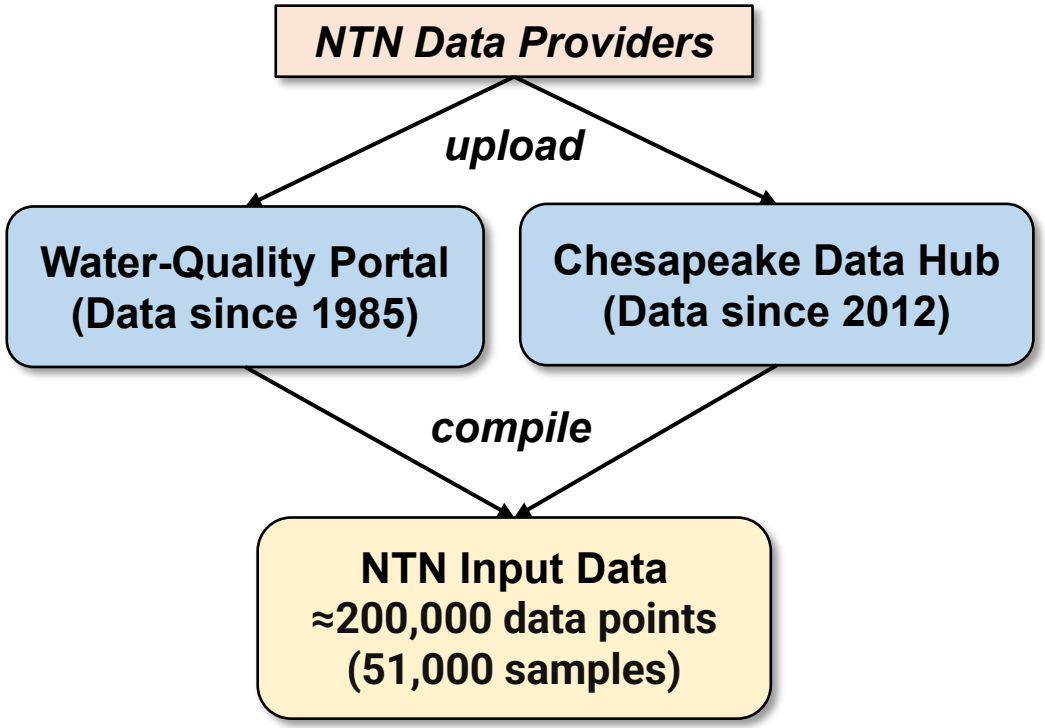
A reproducible set of water-quality samples was built from publicly accessible databases to compute load and trend results

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[1].



Is 51,000 samples a lot?

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

[1]We are publishing a report that will document the methods used to assemble NTN sample dataset. The report will include a data release of the raw NTN samples.

The updated input data compared very well to our previous dataset

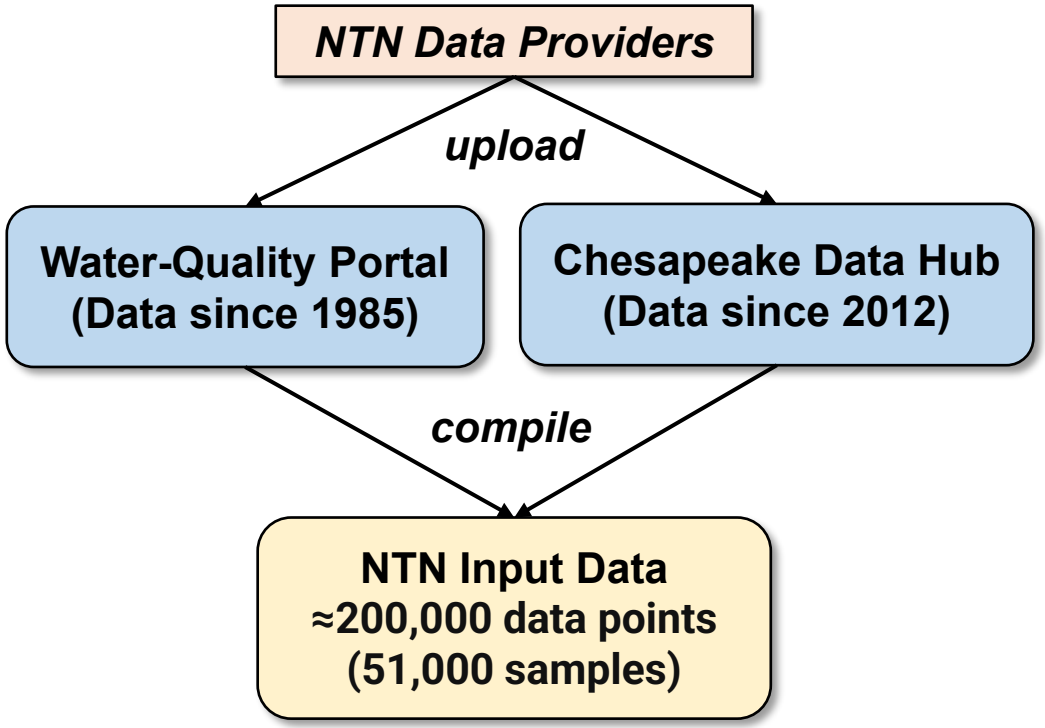
Compared to sample data used previously to compute NTN load and trends (1985 – 2020):

- We found and verified the vast majority of historical sample values in public databases.
- We found previously unused samples in public databases, which increased the total number of samples used to compute loads and trends.

Would the updated input data have changed the previously published NTN load and trend results?

We recomputed NTN trends from 2011 – 2020 using the updated input dataset.

↳ Of more than 300 trend results, ***only two trends*** from 2011 through 2020 would have changed direction using the updated input dataset[1].



Is 51,000 samples a lot?

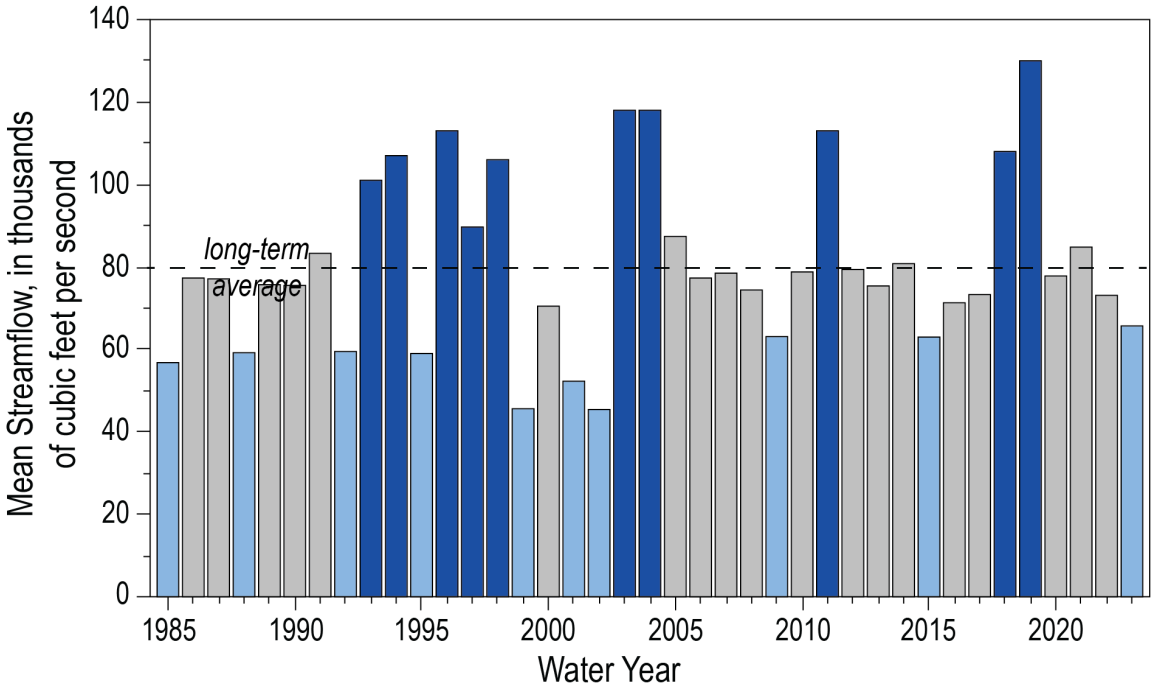
It is an average of about 3.5 NTN samples collected ***every day*** since 1985!

[1]Defined as a change to or from an "increasing" or "decreasing" trend. The TN trend at Susquehanna River Conklin (0150300) and the SS trend at Susquehanna River Danville (01540500) would have changed direction using the updated input dataset.

Streamflow and Per-Acre Loads (Yields)

Streamflow has a large effect on water-quality loads

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

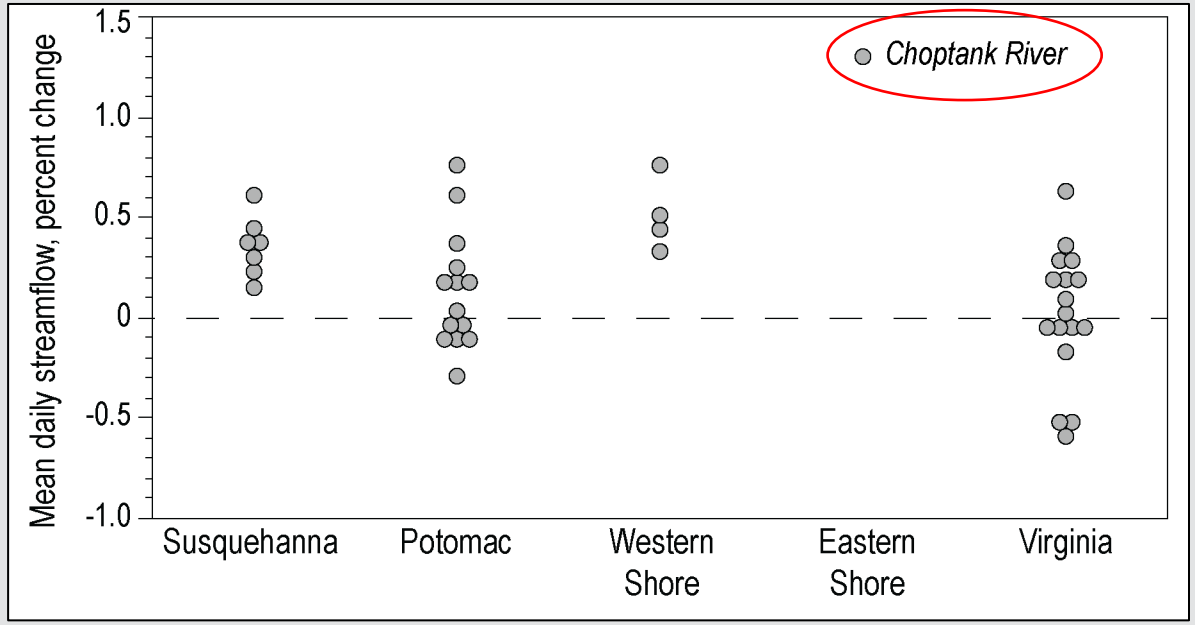


EXPLANATION

- Below 25th percentile of all annual observations
- Between 25th and 75th percentiles of all annual observations
- Above 75th 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.



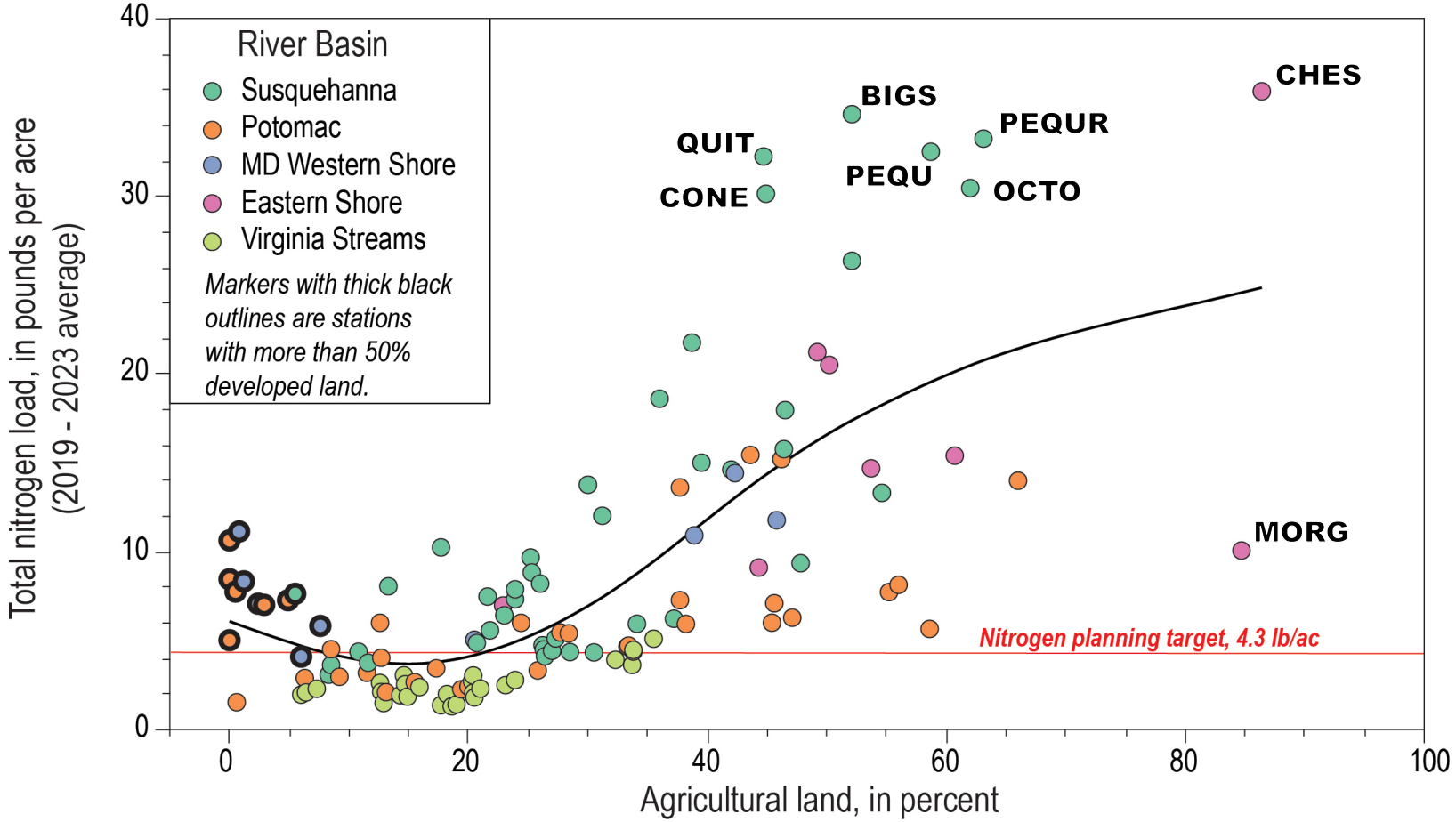
Long-term trends in mean-daily streamflow were only significant at the Choptank River (01491000).

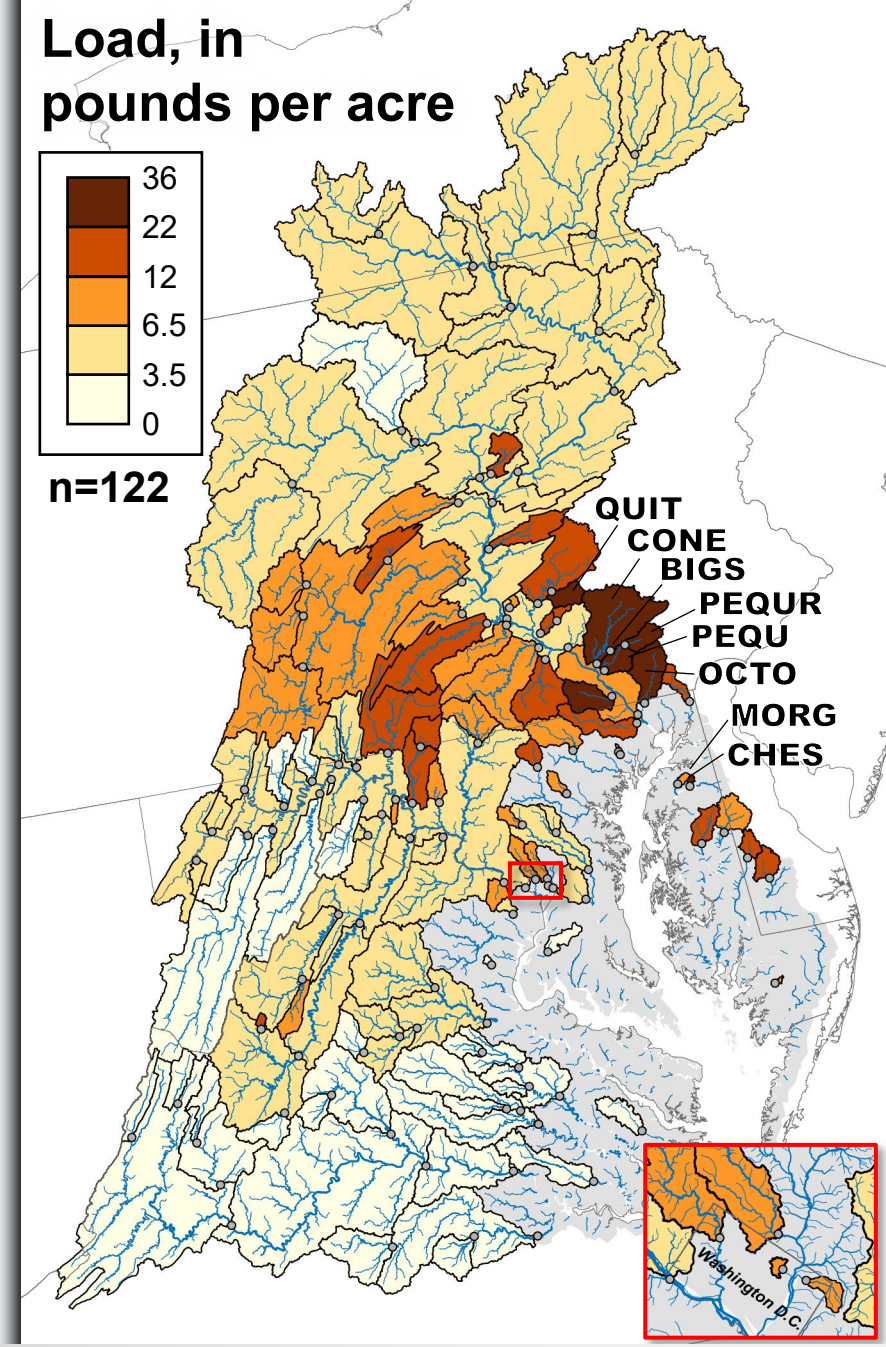
[1]Streamflow entering the Bay estimated from monitored and unmonitored watershed area: www.usgs.gov/centers/chesapeake-bay-activities/science/freshwater-flow-chesapeake-bay

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

Per-acre TN loads are typically highest in **agricultural** watersheds[1].

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





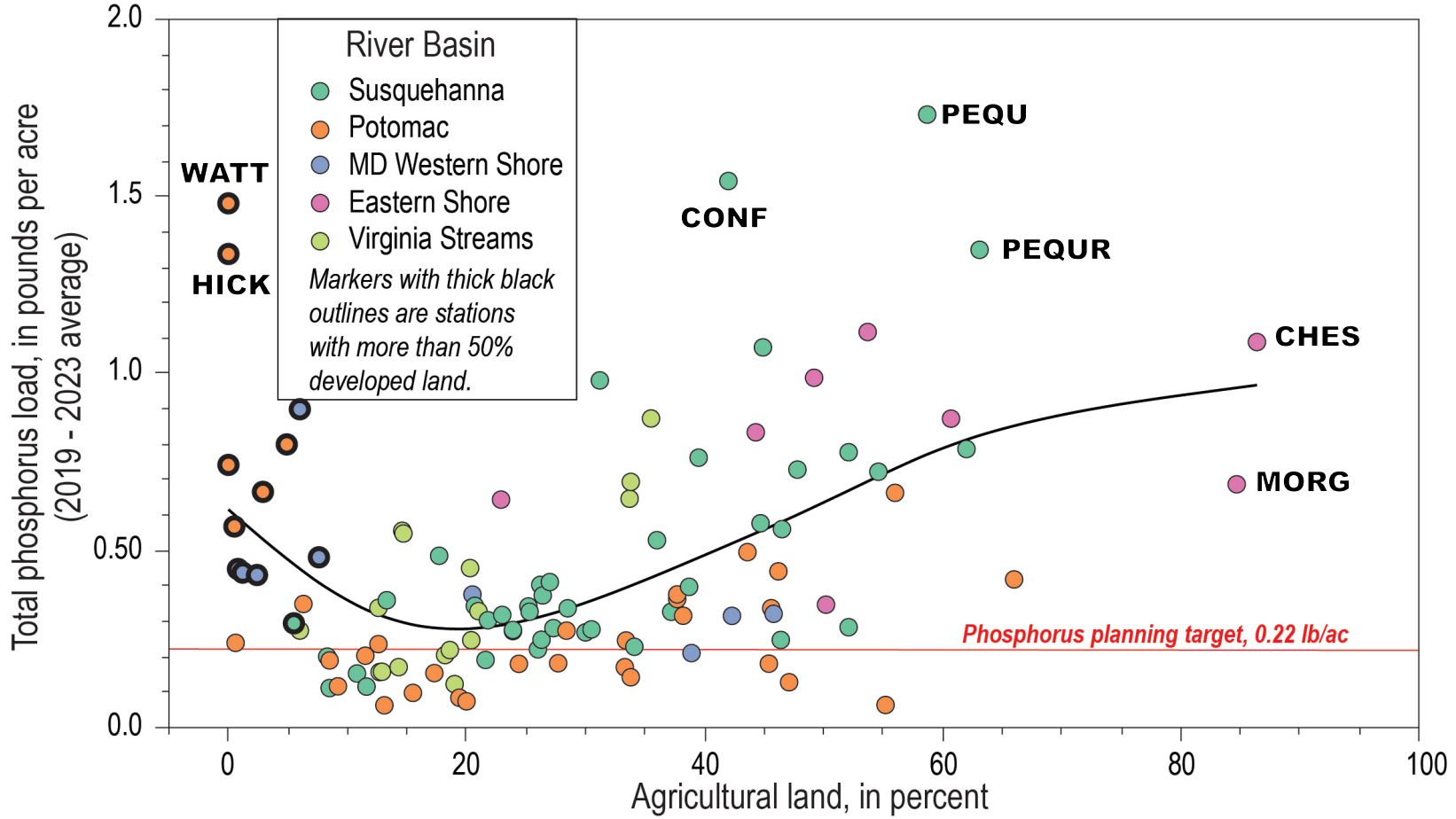
[1]Land use conditions in 2023, from National Land Cover Database: https://doi.org/10.5066/P94UXNTS

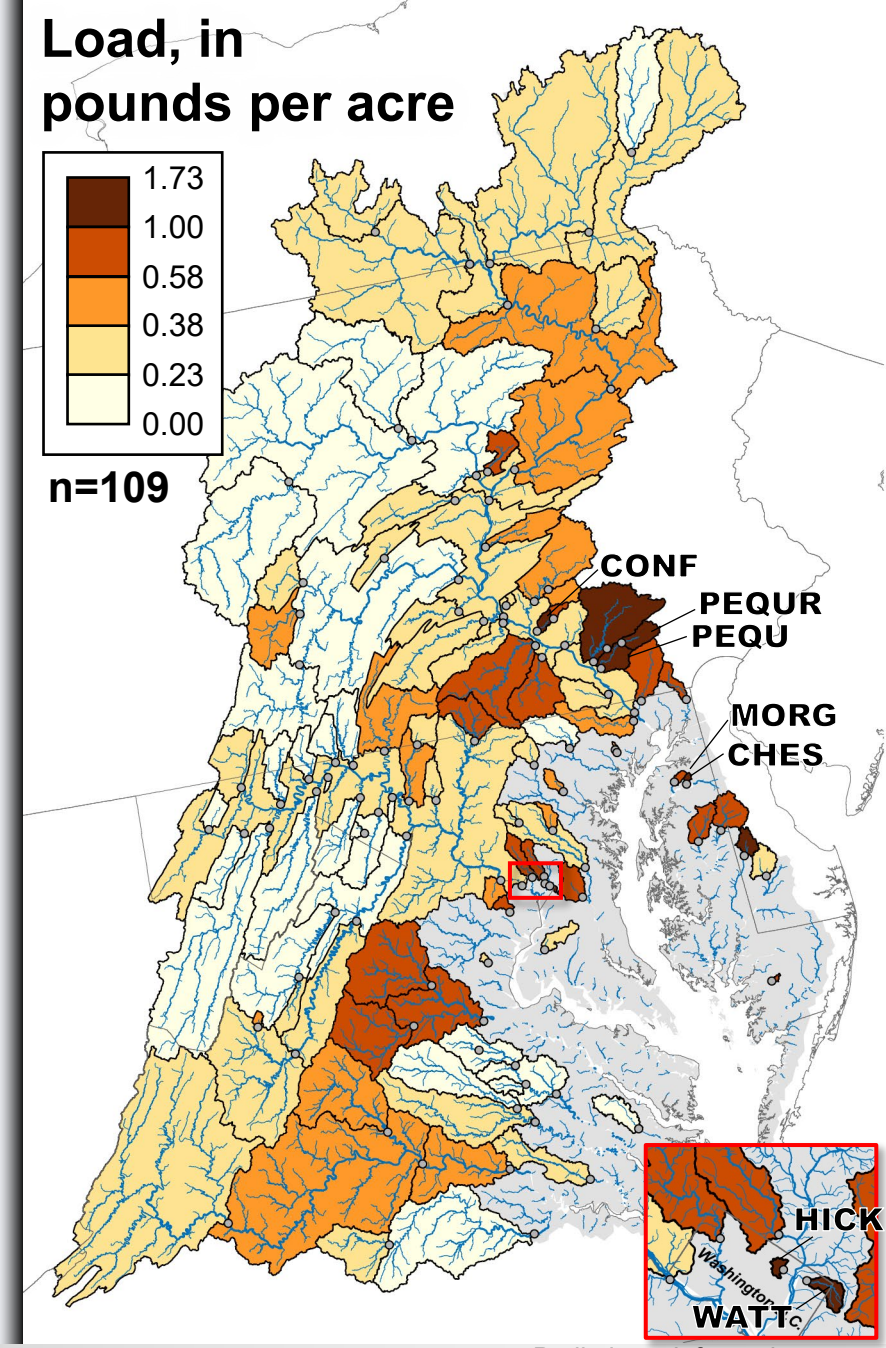
[2]A nitrogen planning target for the Chesapeake Bay watershed was summarized from METRIC: wqs.chesapeakebay.net/metric

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

Per-acre TP loads are typically highest in **developed** and **agricultural** watersheds[1].

75% of stations have a per-acre load that exceeds phosphorus planning target of 0.22 lb/ac[2].





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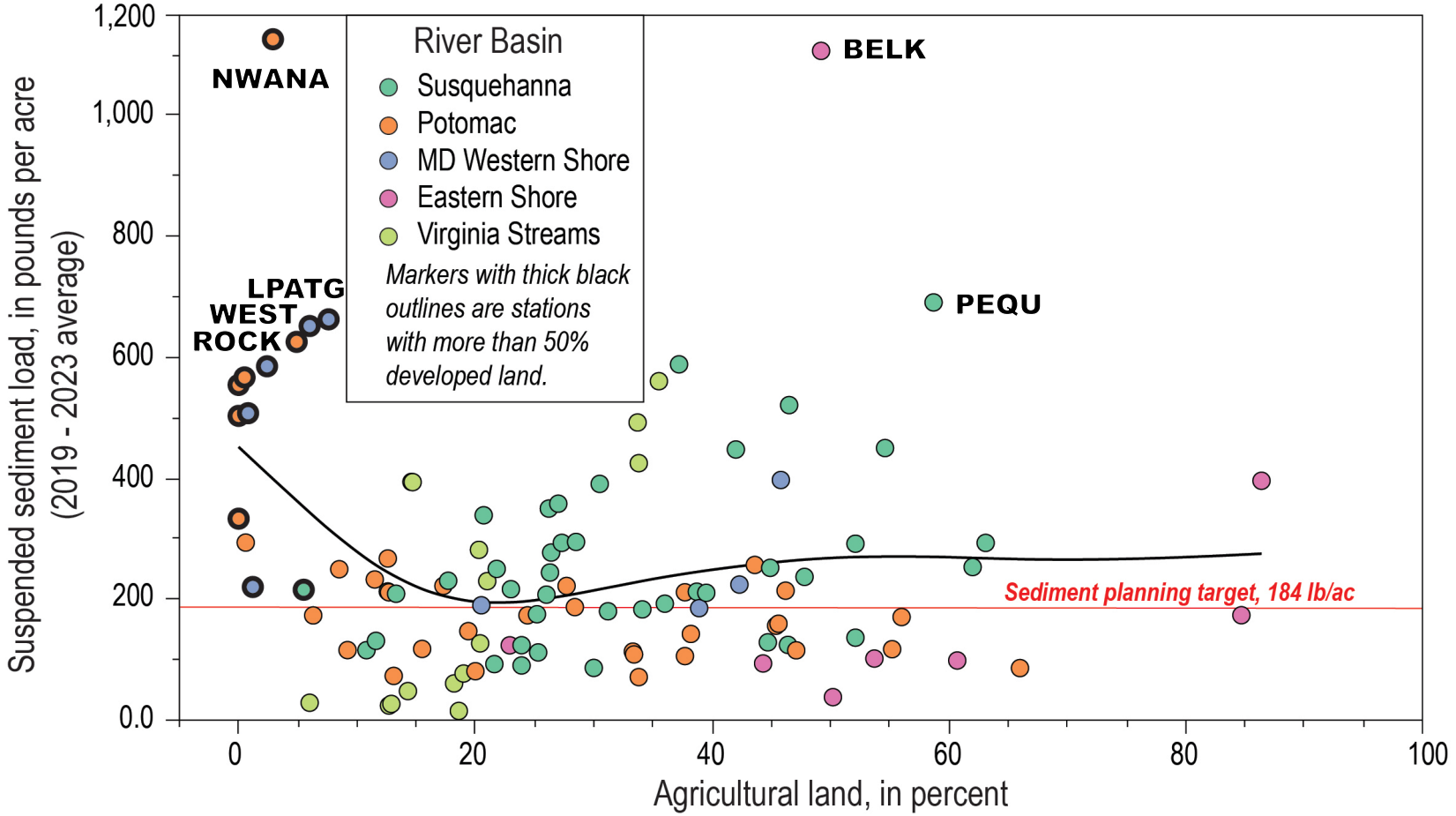
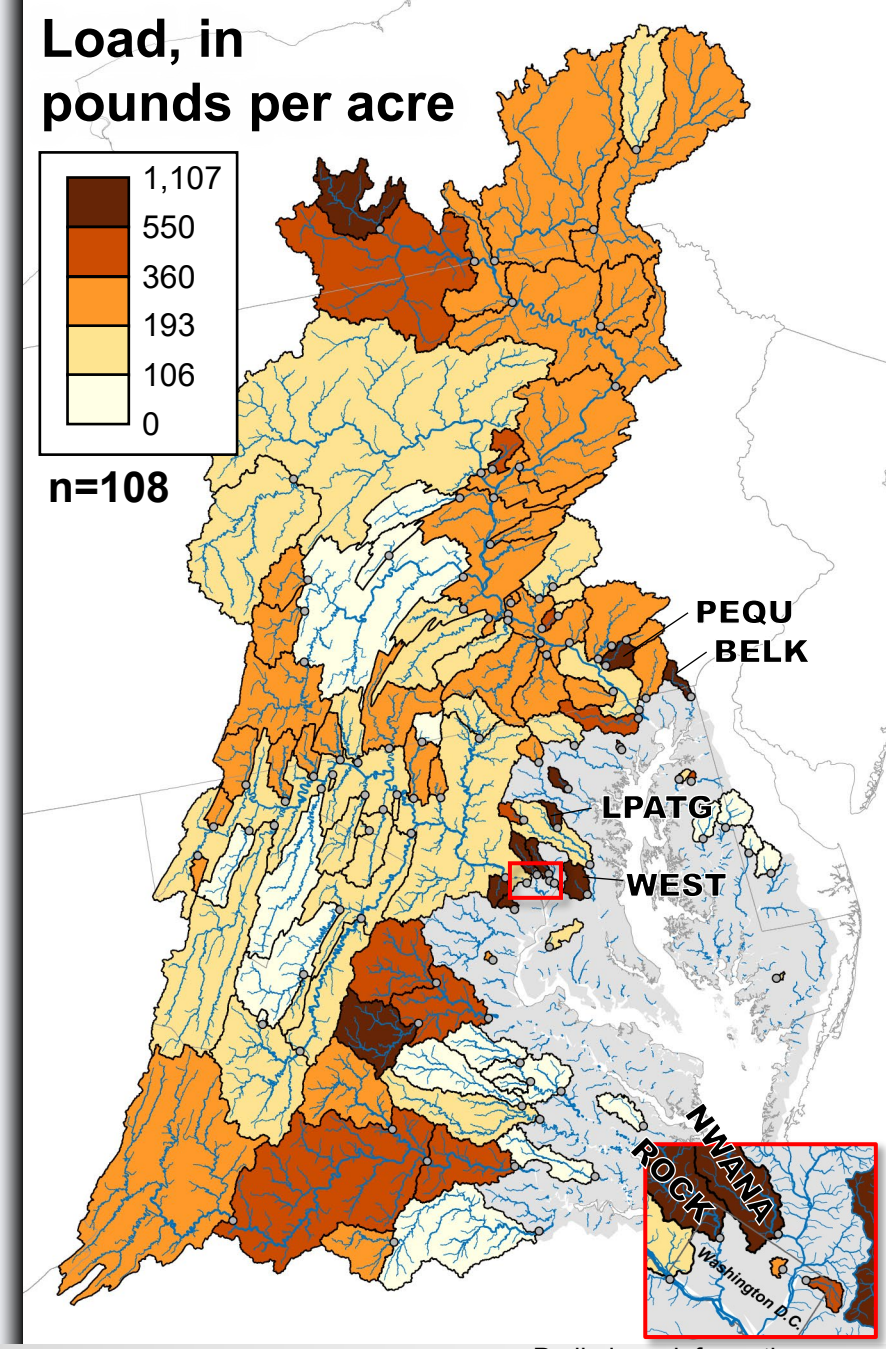
[2]A phosphorus planning target for the Chesapeake Bay watershed was summarized from METRIC: wqs.chesapeakebay.net/metric

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

SS per-acre loads are typically highest in **developed** watersheds[1].

58% of stations have a per-acre load that exceeds a sediment planning target of 184 lb/ac[2].





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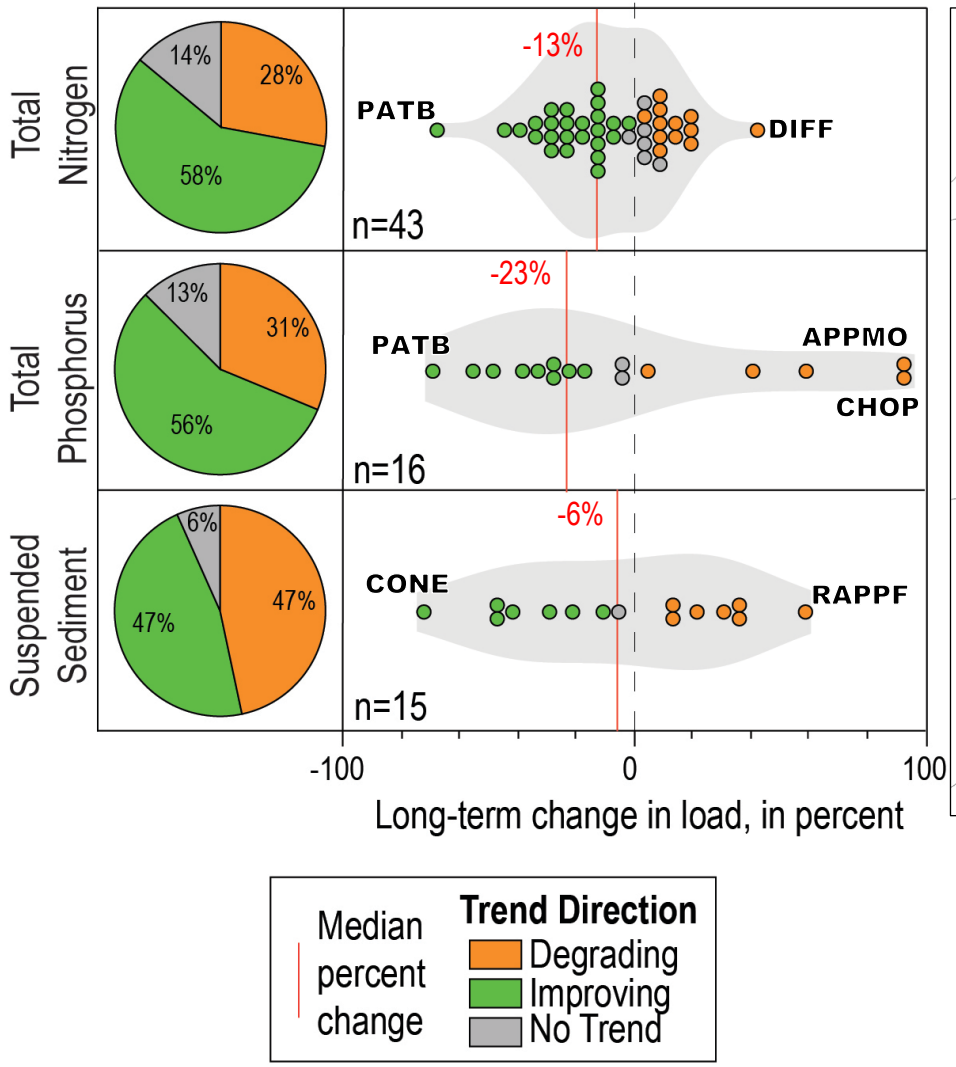
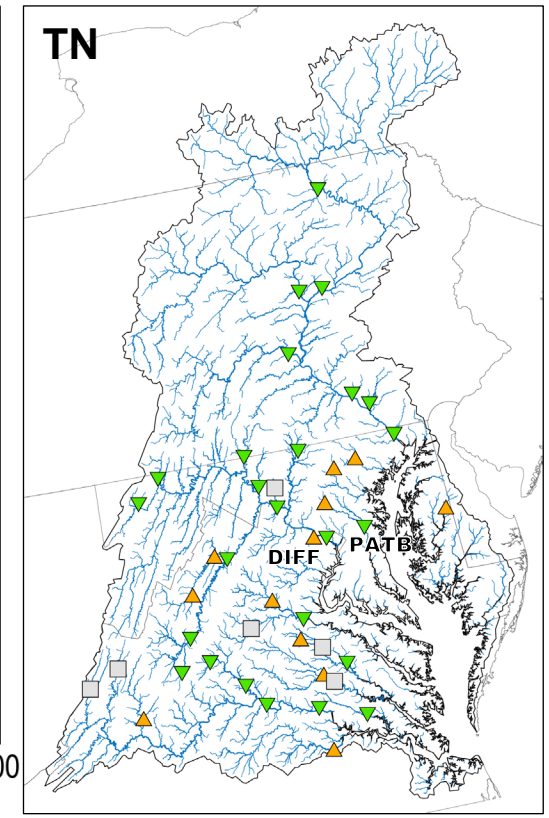
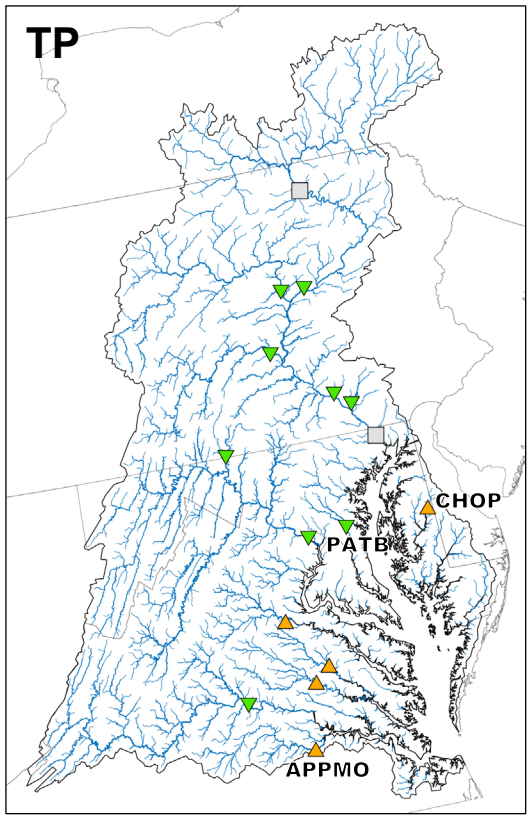
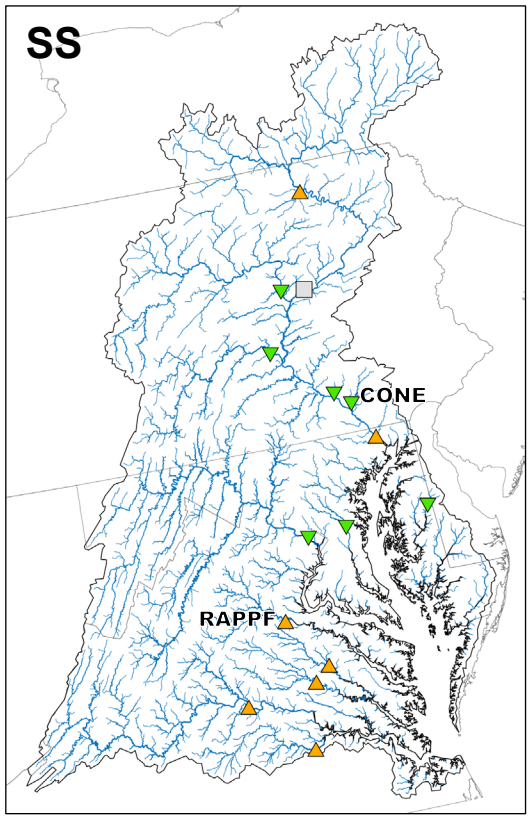
Nutrient and Sediment Trends

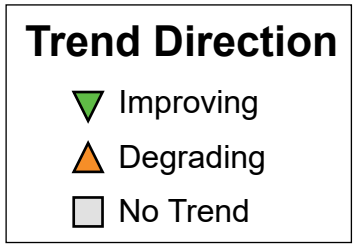
Most long-term[1] nutrient trends improved











[1]Long-term trends are computed from sample records that begin before 1990.

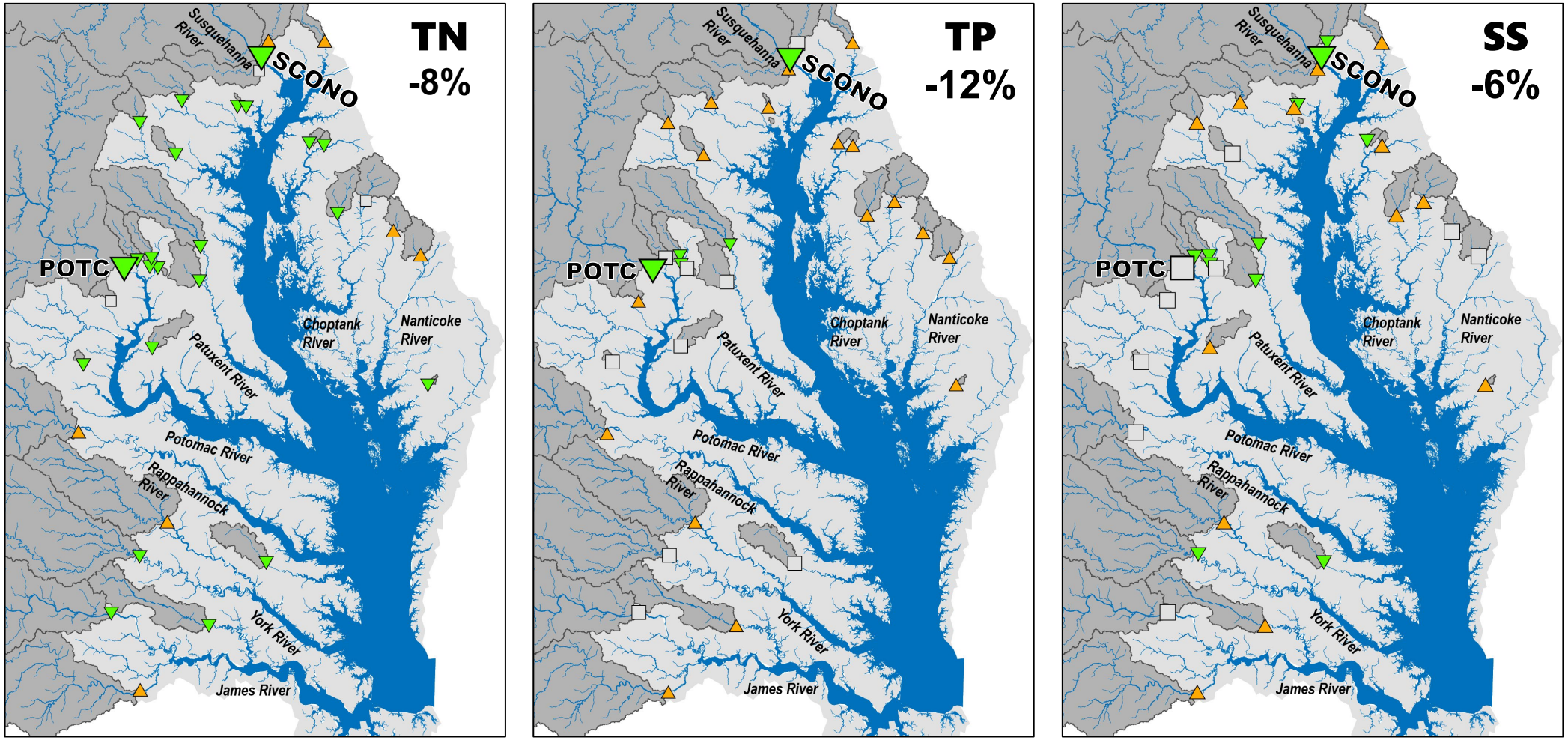
The combined amount of nitrogen, phosphorus, and sediment from NTN stations nearest the Bay all decreased since 2014[1]

The Susquehanna (**SCONO**) and Potomac (**POTC**) rivers contribute about three-quarters of the total load delivered from 33 NTN stations nearest the Bay.

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

Watershed Area
- NTN Watershed
- Chesapeake Bay

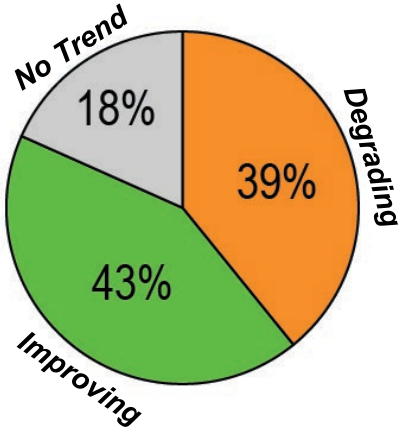
Short-Term Trend Direction
- Improving
- Degrading
- No Trend



[1]Calculated as a change in flow-normalized load from 2014 through 2023 at 33 downstream NTN stations.

Total Nitrogen Trends: 2014 through 2023

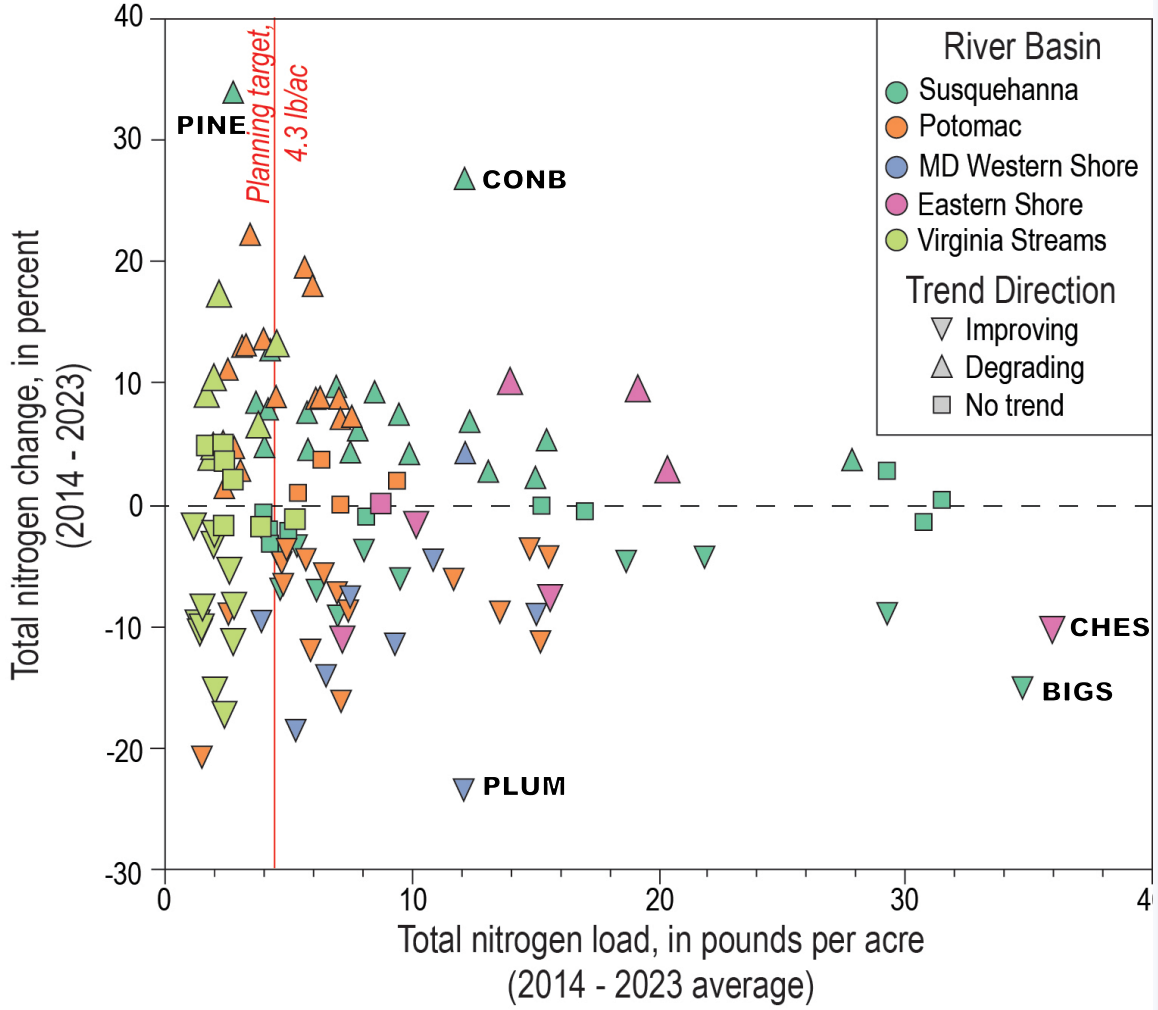
Trends, by Percent of Stations (n=120)

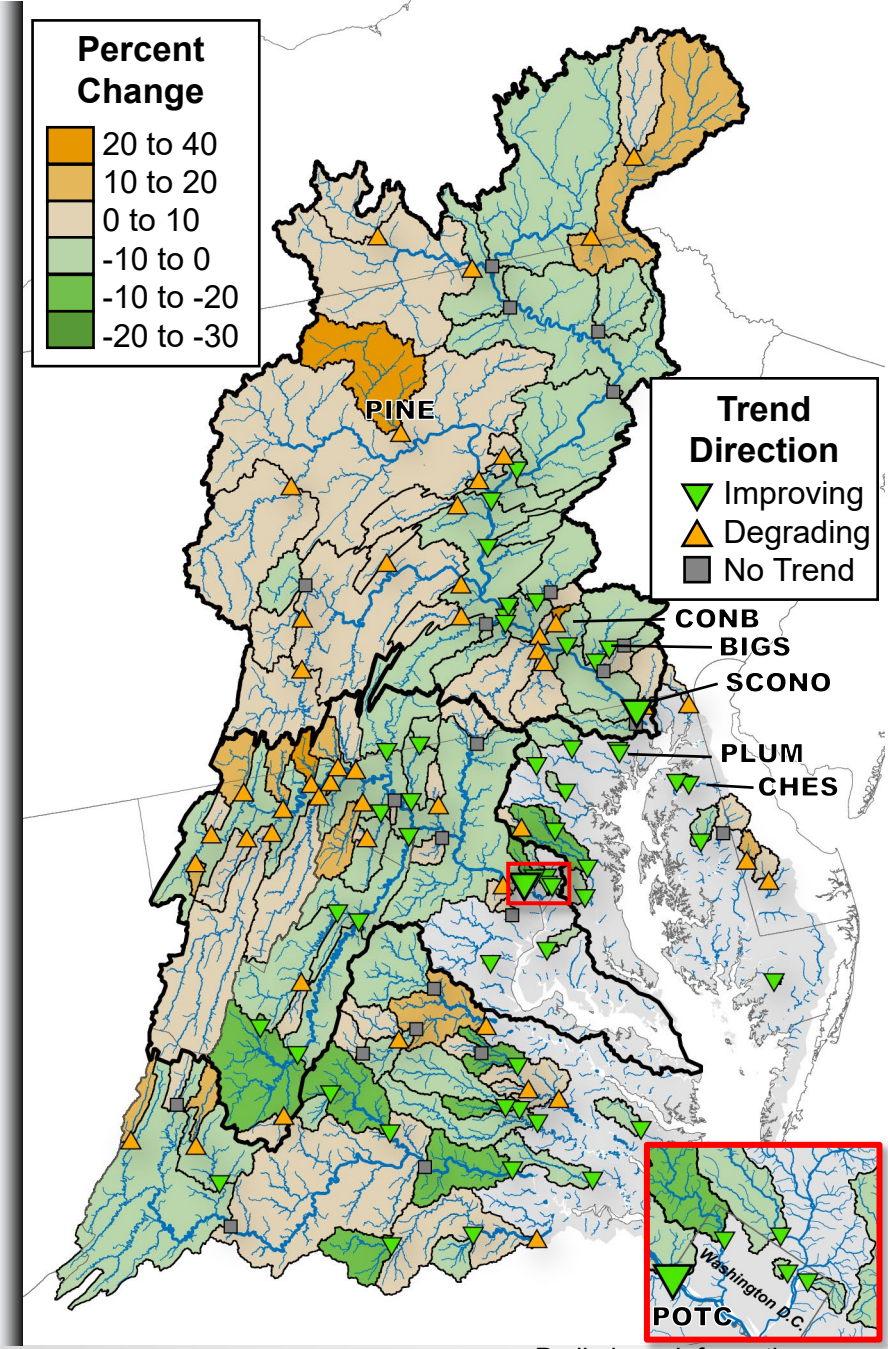


Of the 76 stations that exceed a nitrogen planning target of 4.3 lb/ac[1]:

- **47%** improved
- **36%** degraded
- **17%** have no trend

Median percent change = -0.6%

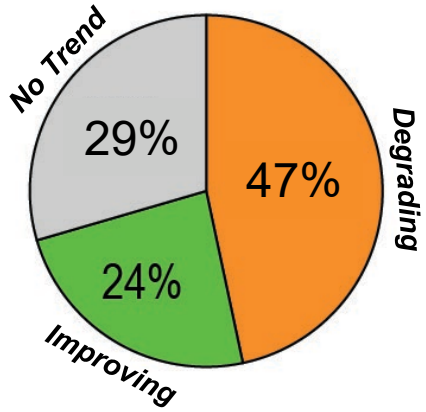




[1]A nitrogen planning target for the Chesapeake Bay watershed was summarized from METRIC: wqs.chesapeakebay.net/metric

Total Phosphorus Trends: 2014 through 2023

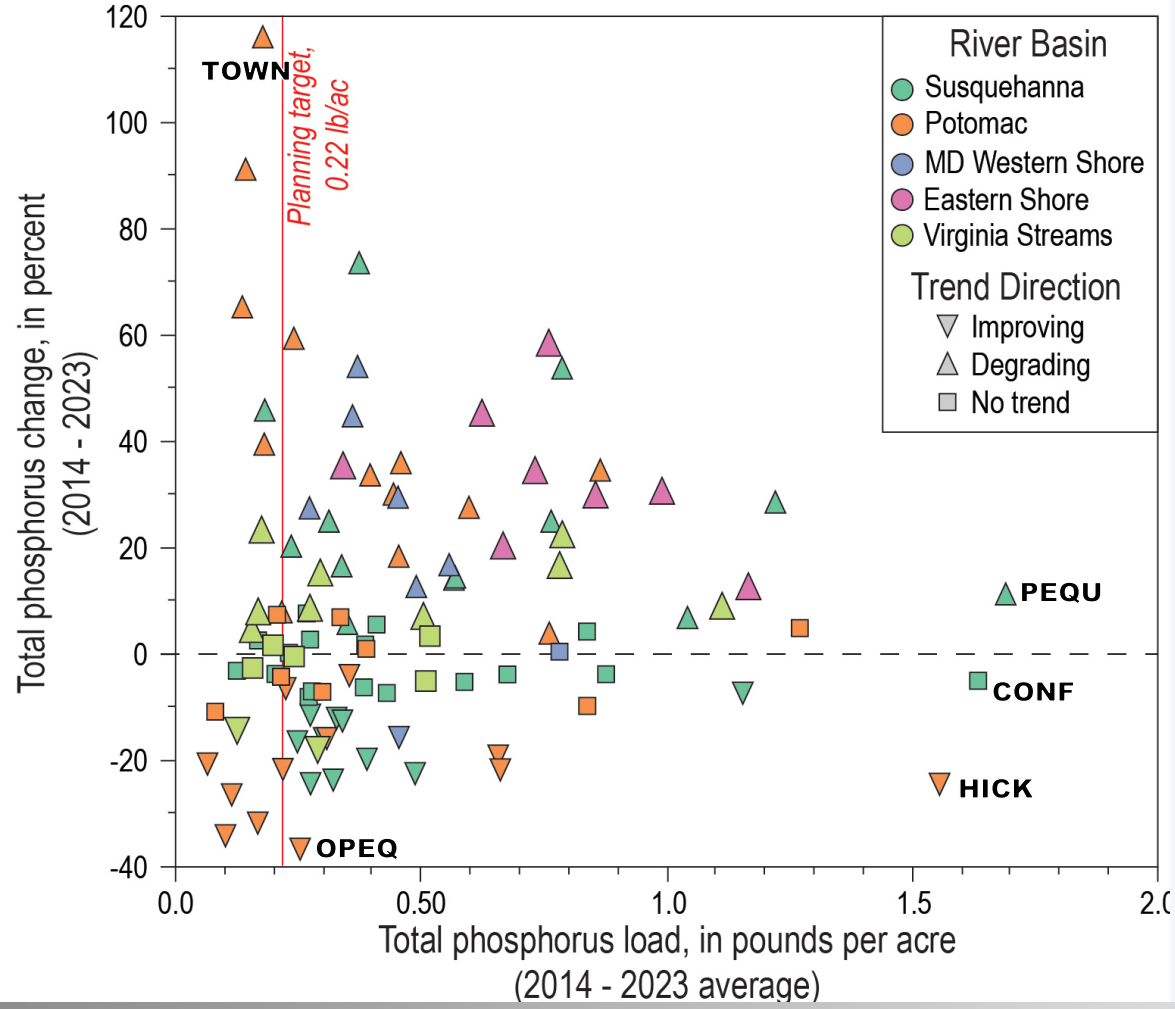
Trends, by Percent of Stations (n=105)

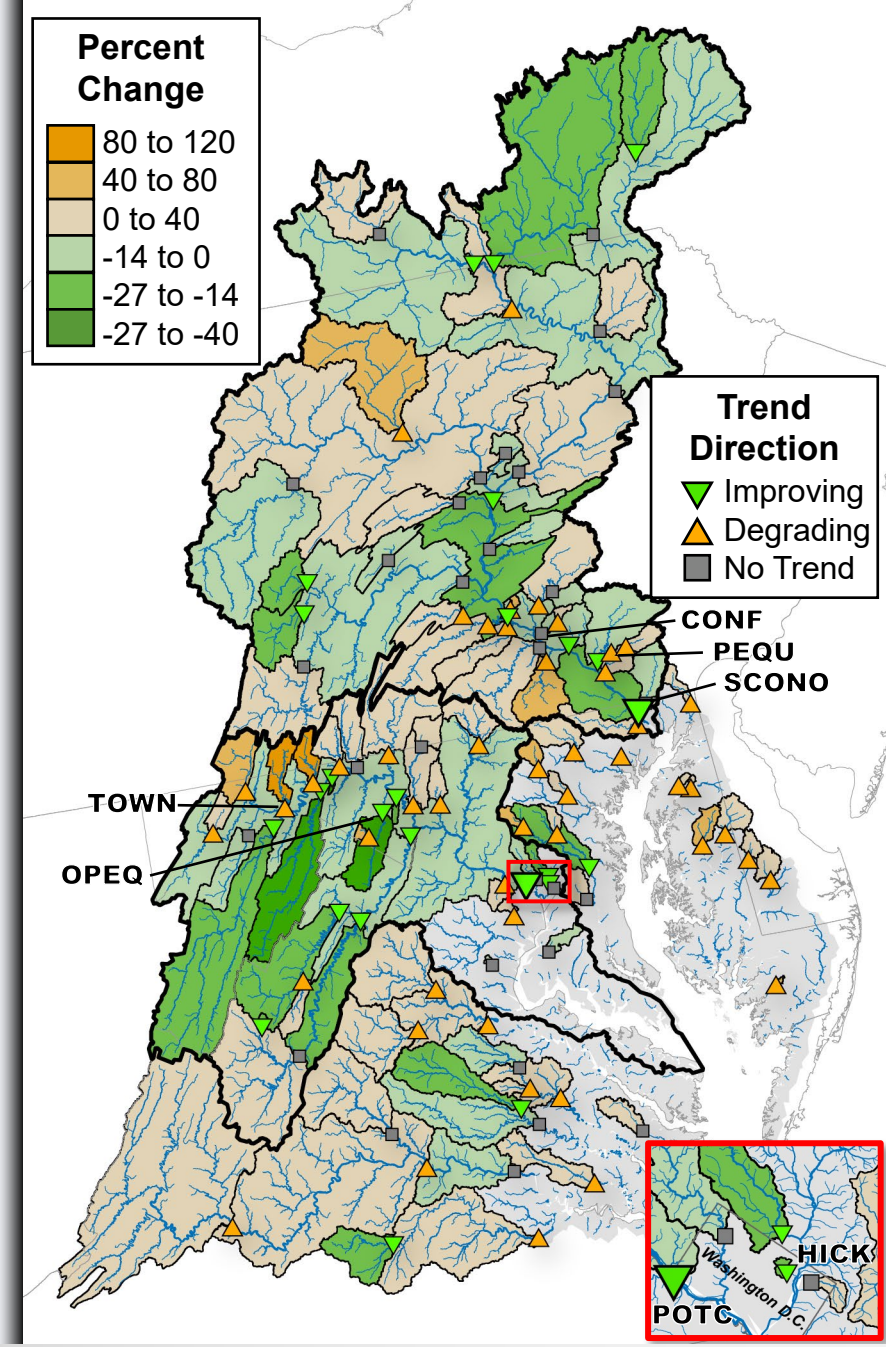


Of the 82 stations that exceed a phosphorus planning target of 0.22 lb/ac[1]:

- **23%** improved
- **49%** degraded
- **28%** have no trend

Median percent change = +4.3%

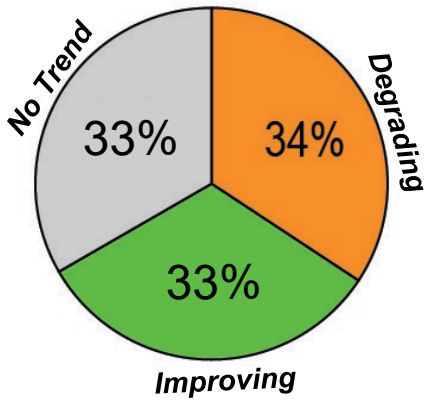




[1]A phosphorus planning target for the Chesapeake Bay watershed was summarized from METRIC: wqs.chesapeakebay.net/metric

Suspended Sediment Trends: 2014 through 2023

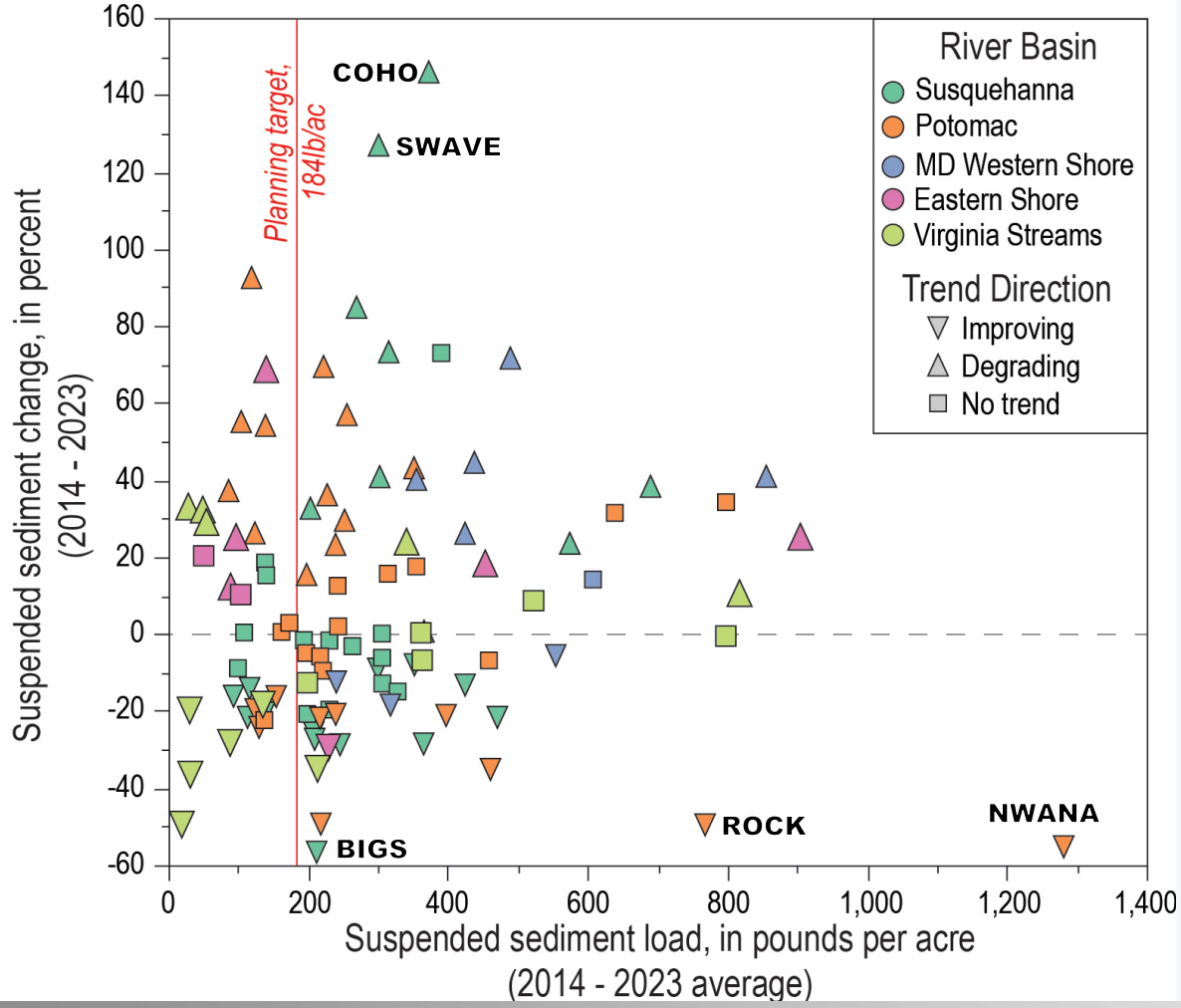
Trends, by Percent of Stations (n=105)

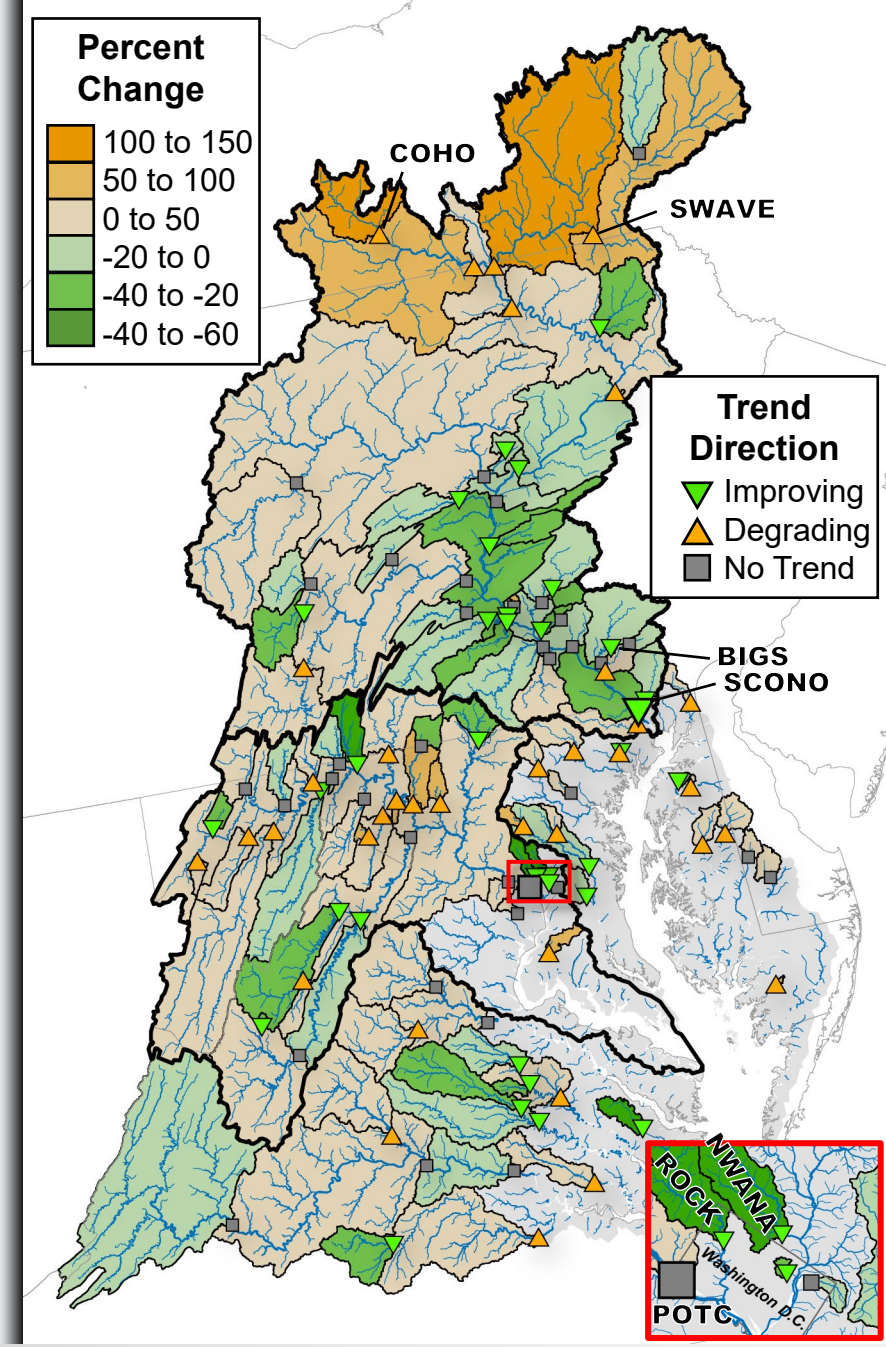


Of the 73 stations that exceed a sediment planning target of 184 lb/ac[1]:

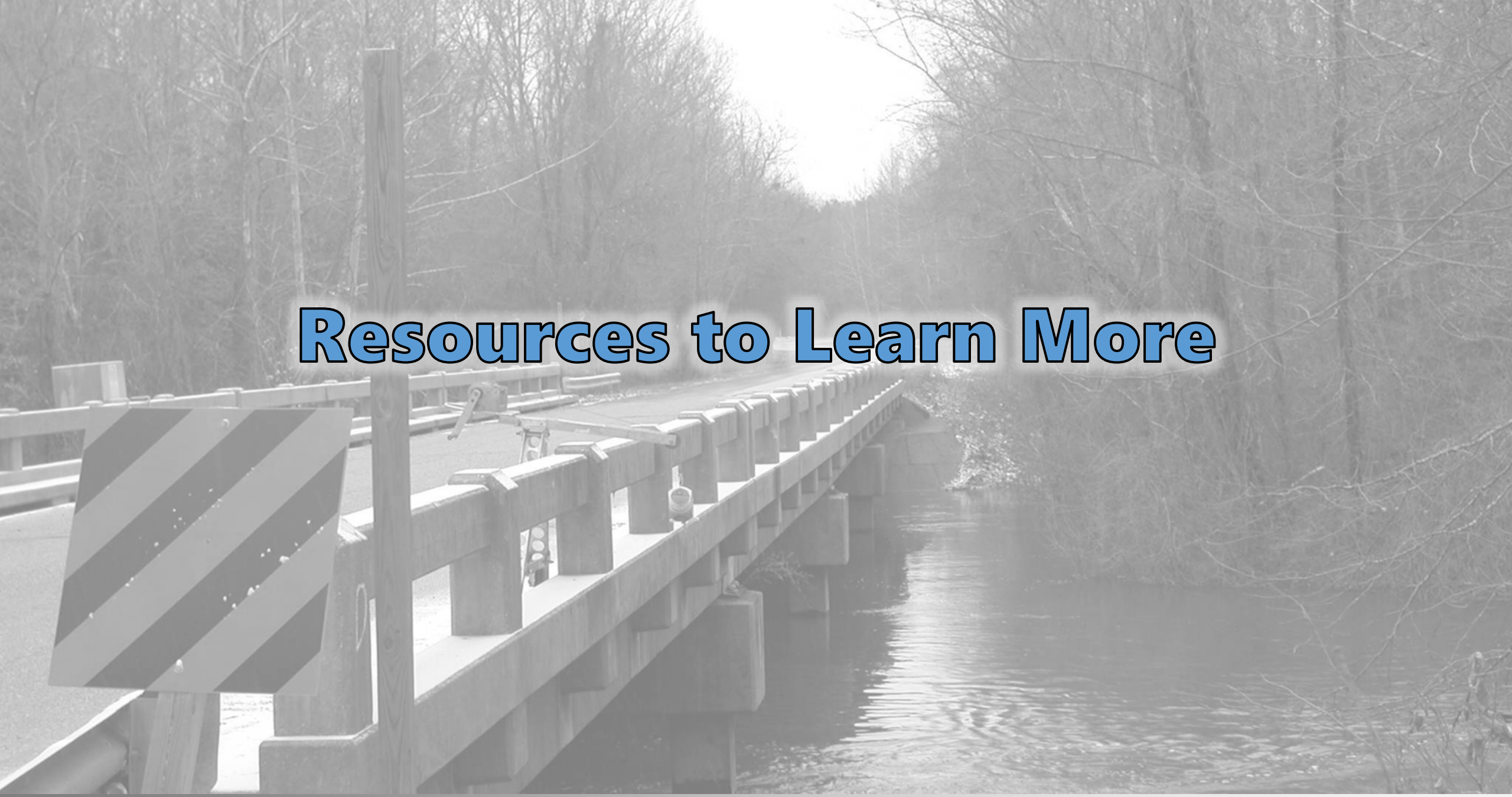
- **30%** improved
- **34%** degraded
- **36%** have no trend

Median percent change = +0.8%





[1]A sediment planning target for the Chesapeake Bay watershed was summarized from METRIC: wqs.chesapeakebay.net/metric



Resources to Learn More

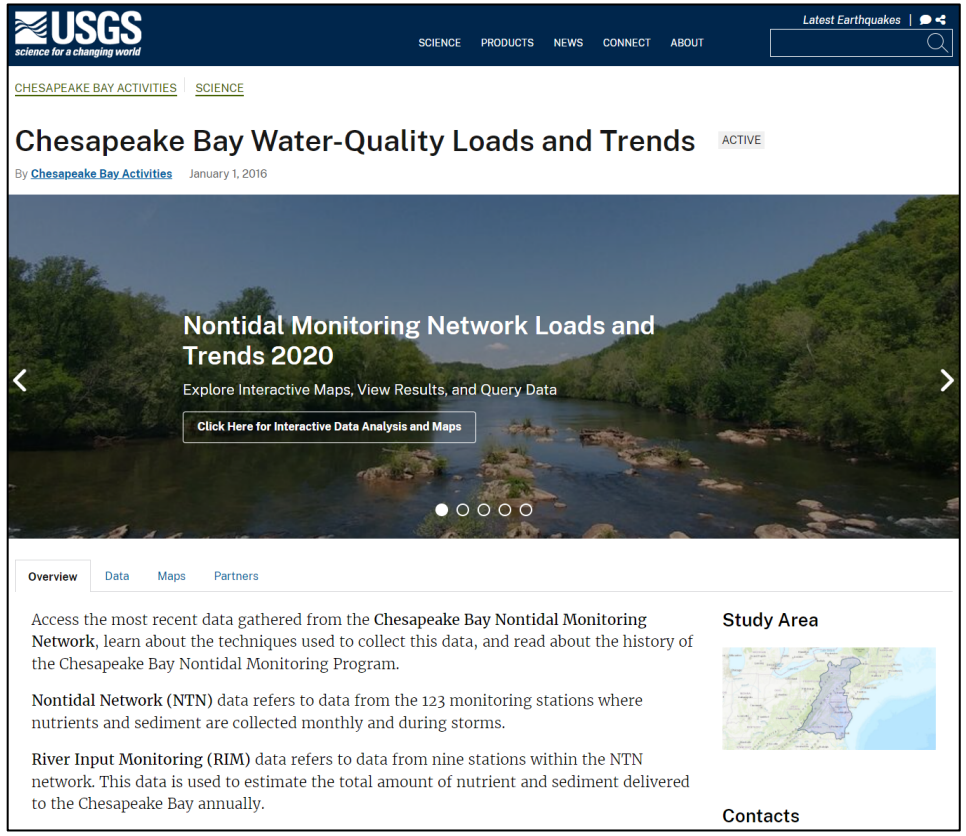
USGS science for a changing world

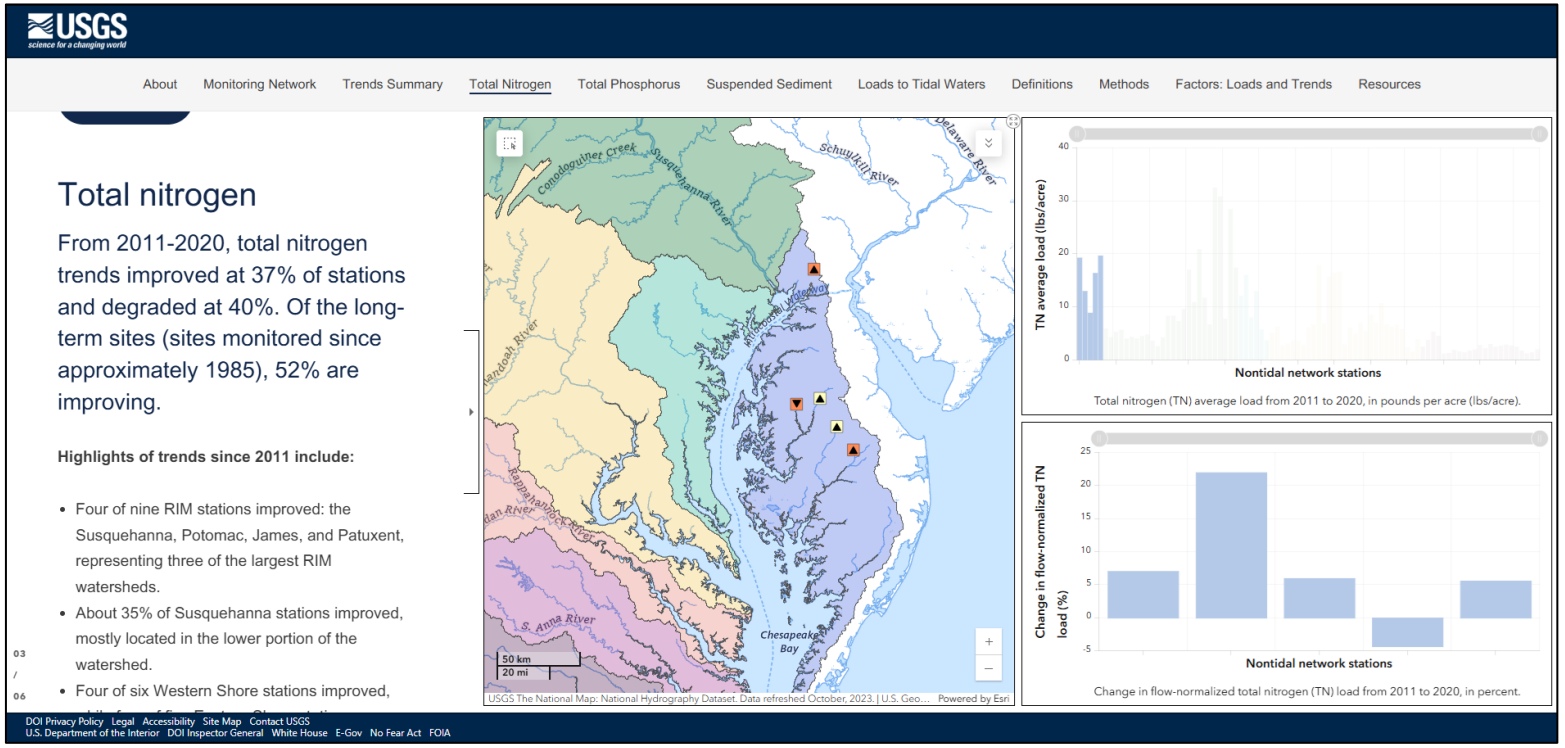
Background photo: stormflow at the Mattaponi River

Resources are available to learn more about NTN results

The project website includes access to the most recent data and a summary of results[1]: 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

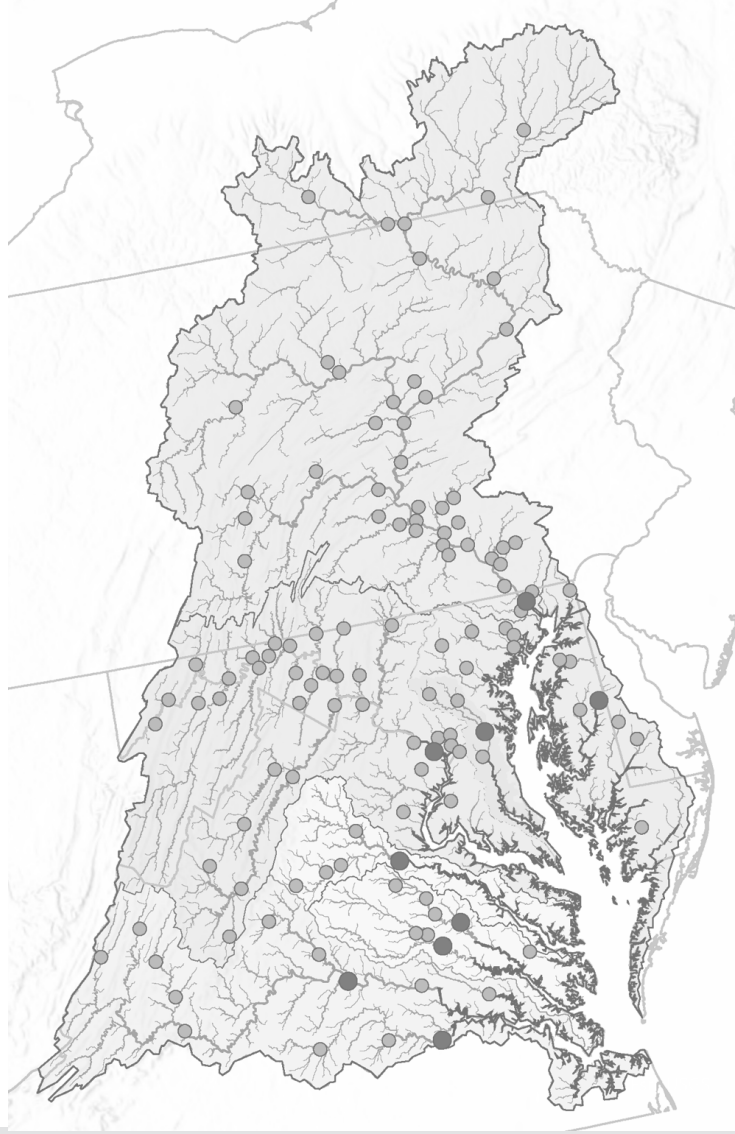




[1]Updated NTN load and trend results will be published to a Science Base data release by the end of next month.

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.



Visit our website to explore these results in more detail: usgs.gov/CB-wq-loads-trends

Jimmy Webber, jwebber@usgs.gov; Chris Mason, camason@usgs.gov;
James Colgin, jcolgin@usgs.gov; Alex Soroka, 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