Nitrogen, Phosphorus, and Suspended Sediment:

Loads and Trends Measured from the Chesapeake Bay River Input Monitoring (RIM) Network

An update through water year 2024

Jimmy Webber, jwebber@usgs.gov

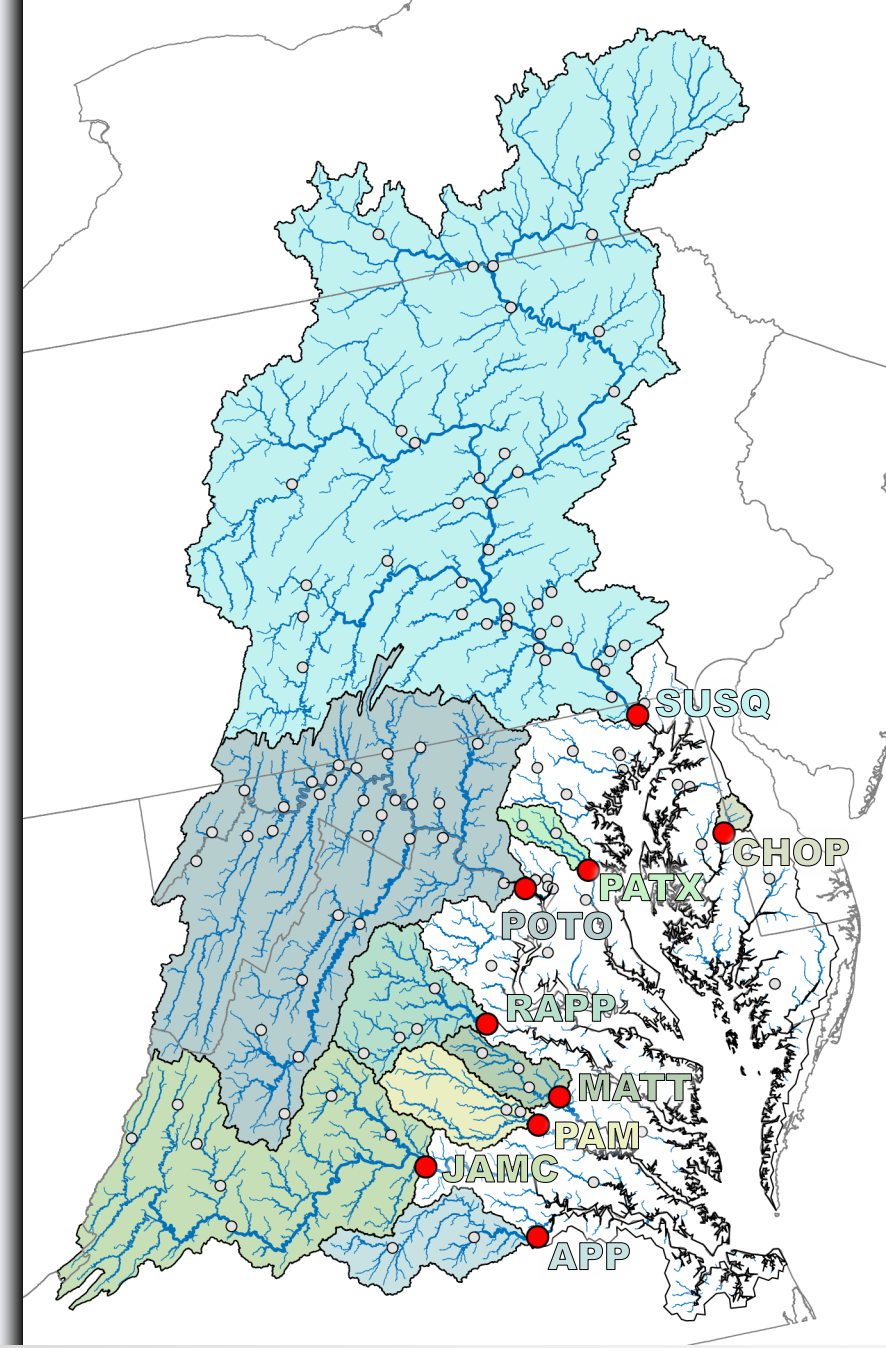
Chris Mason, camason@usgs.gov

Alex Soroka, asoroka@usgs.gov

Doug Moyer, dlmoyer@usgs.gov

RIM loads and trends were recently released using monitoring data through water-year 2024[1].

This presentation will summarize the updated RIM nutrient and sediment loads and trends.



USGS science for a changing world

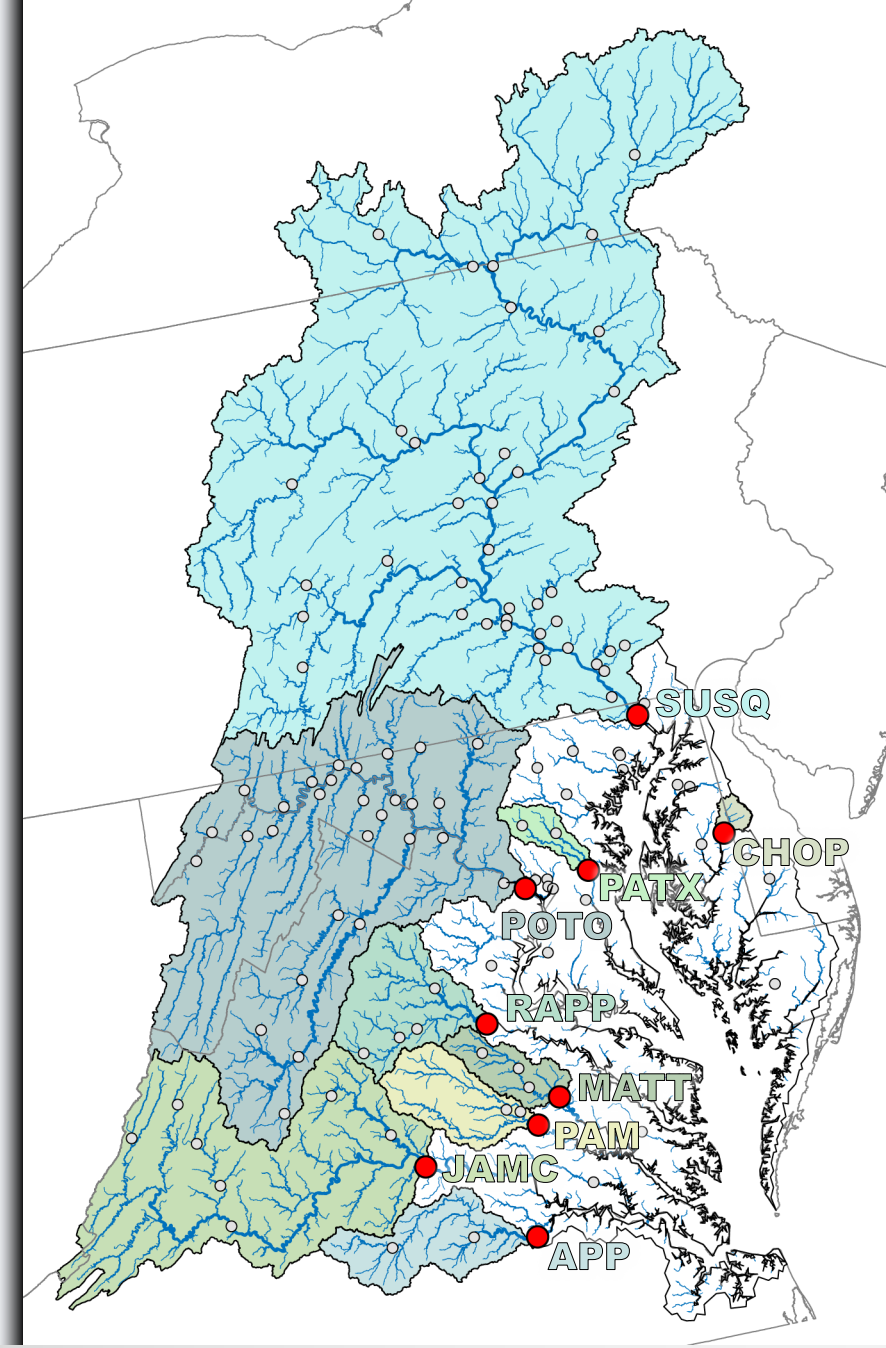
[1]Mason, C.A., and Soroka, A.M., 2025, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay River Input Monitoring stations: Water years 1985-2024: U.S. Geological Survey data release, https://doi.org/10.5066/P14CG4D8.

Nitrogen, Phosphorus, and Suspended Sediment:

Loads and Trends Measured from the Chesapeake Bay River Input Monitoring (RIM) Network

An update through water year 2024

1. Overview of the RIM network
2. Streamflow and water-quality loads delivered to the Bay
3. Per-Acre Loads (“Yields”) at the RIM stations
4. Trends at the RIM stations
5. Trends and water-quality goals
6. Resources to learn more



Overview of the RIM network

USGS science for a changing world

Background photo: Collecting a storm sample on the Appomattox River

The RIM network is used to assess water-quality conditions in the Chesapeake Bay watershed to inform management decisions

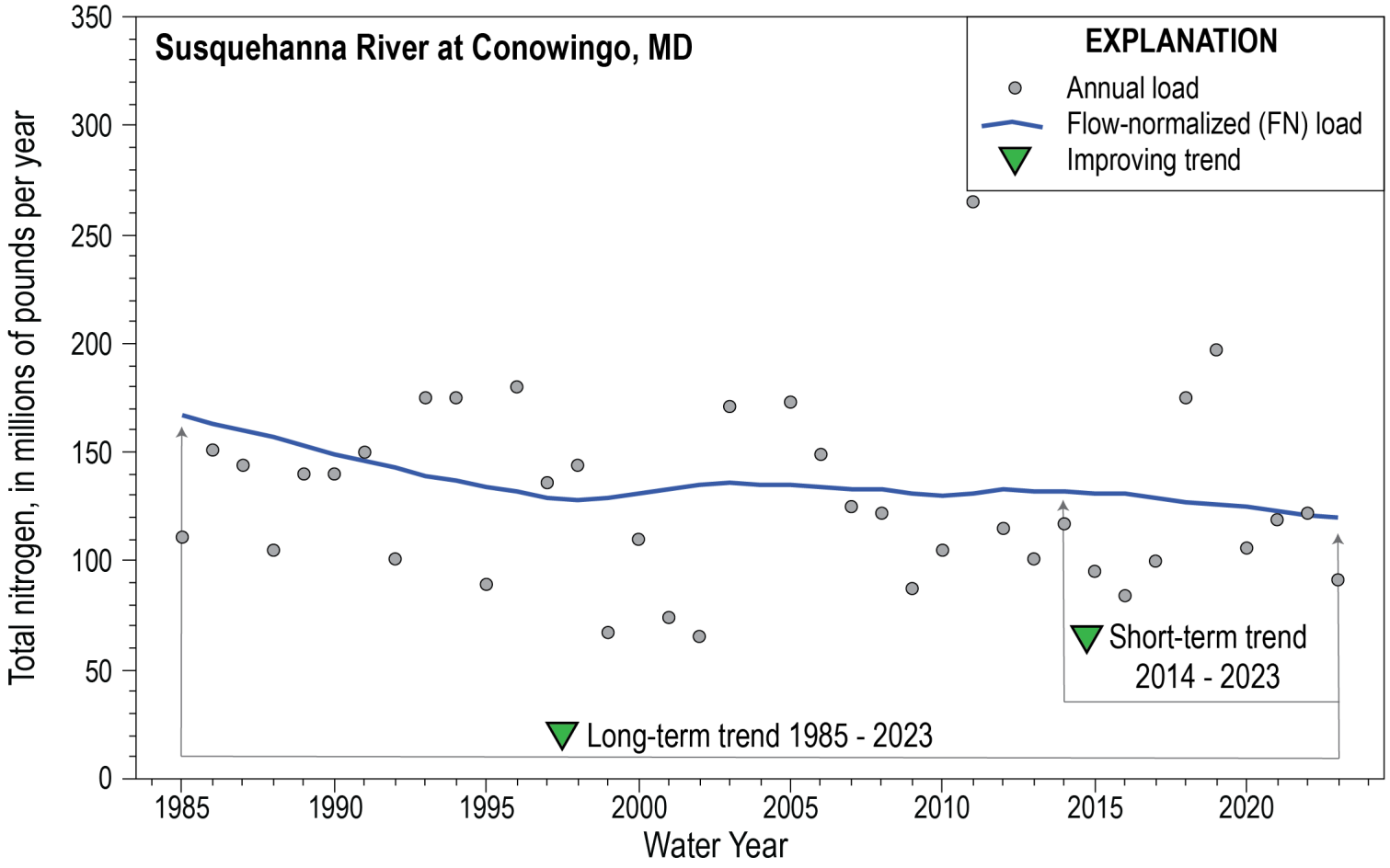
The goal of the RIM network is to compute the **load** and **trend**[1] of nitrogen, phosphorus, and suspended sediment delivered from 9 of the largest watershed tributaries to the Chesapeake Bay.

Load is the total amount of nutrients or sediment that is delivered over a time period (annually).

Flow-normalized (FN) loads remove most of the hydrologic variability associated with loads.

Trends are changes in FN load over time.

- **"Improving"** = a decrease over time
- **"Degrading"** = an increase over time
- **"No trend"** = no meaningful change over time



[1]Loads and trends are computed using WRTDS (Weighted Regressions on Time, Discharge, and Season).

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

The USGS collects monthly and storm-targeted water-quality samples from the 9-station RIM network.

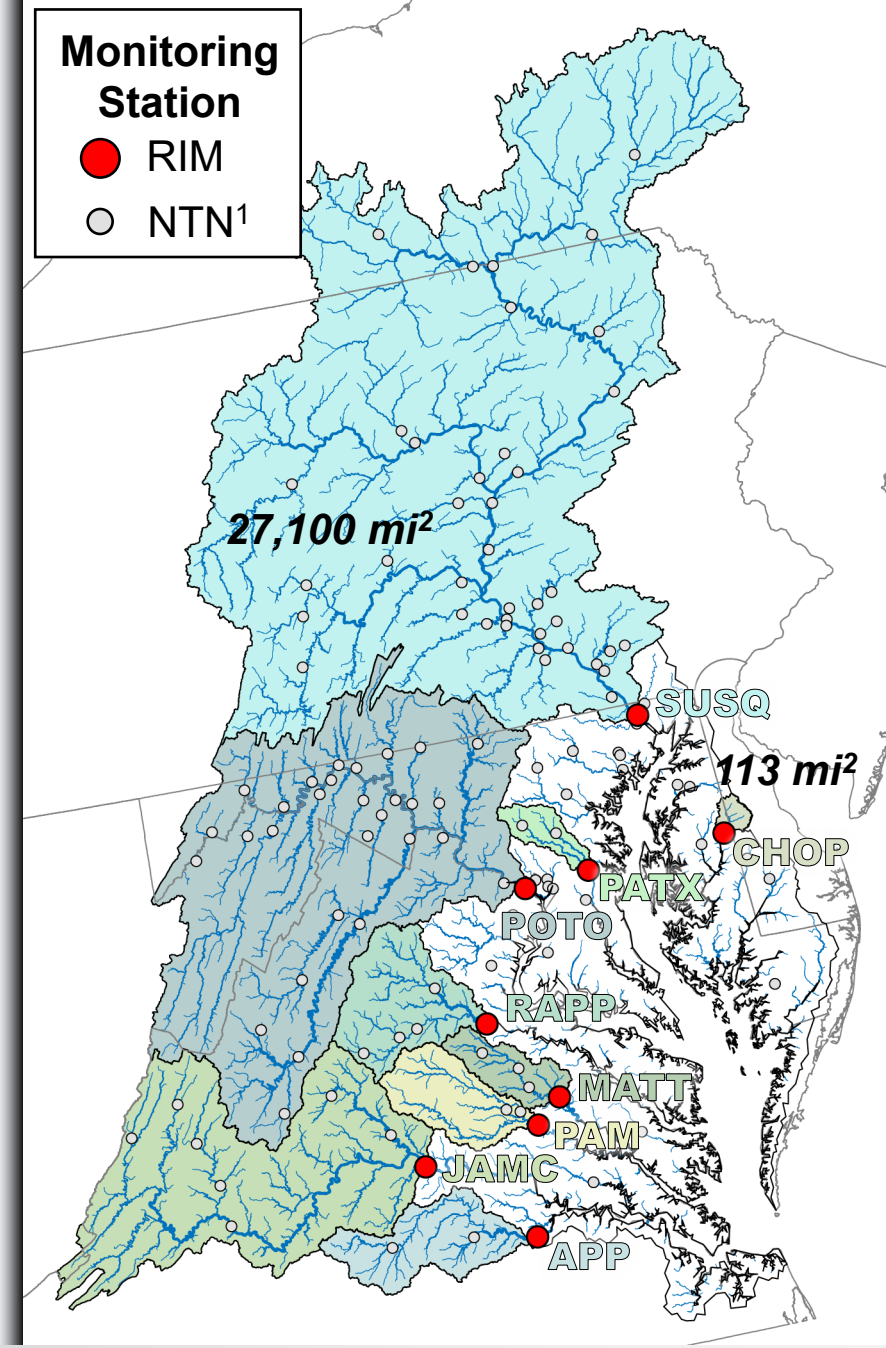
RIM stations represent about 78% of the Chesapeake Bay watershed area

Maryland

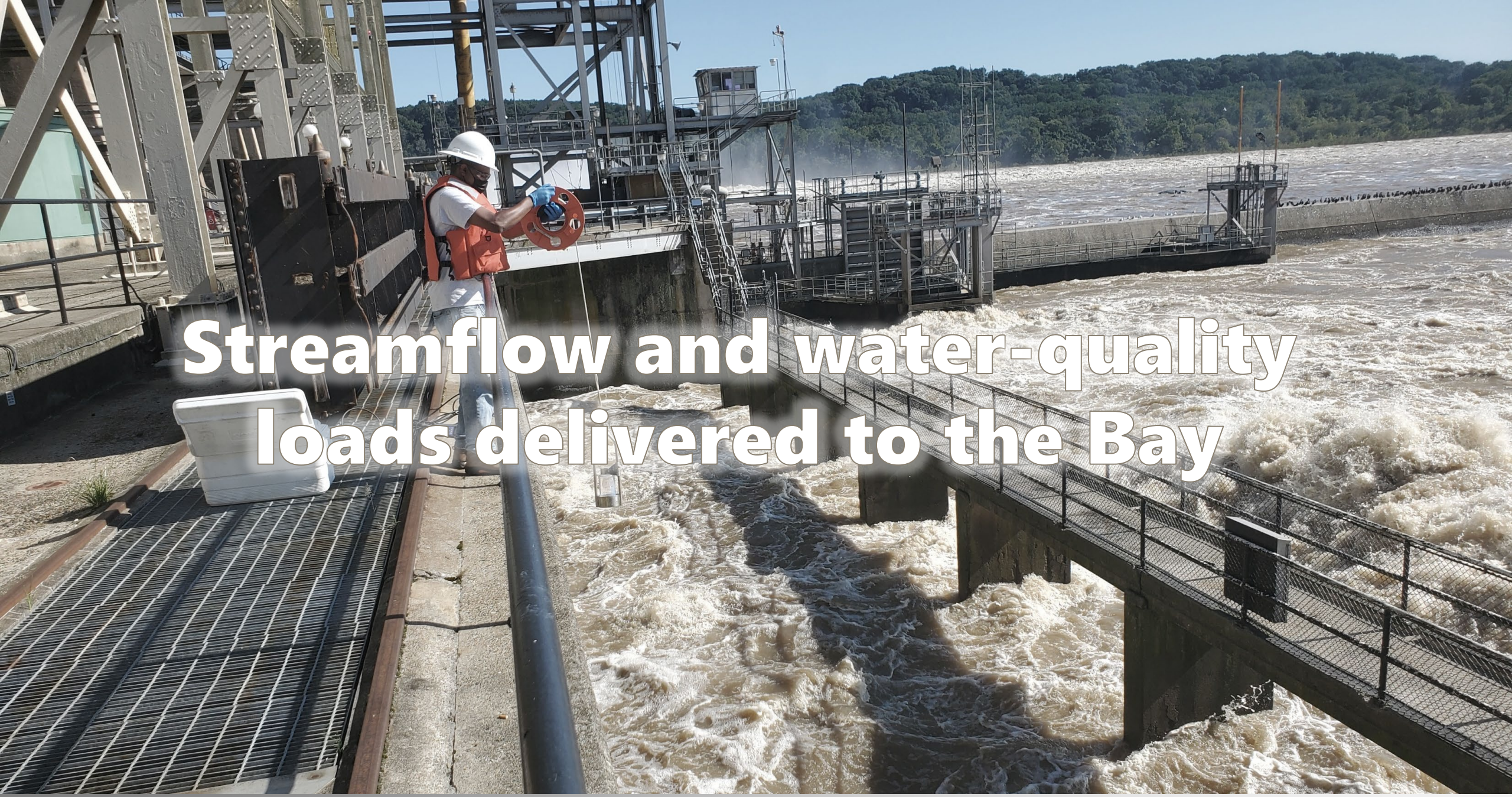
- **SUSQ:** Susquehanna River at Conowingo
- **CHOP:** Choptank River nr Greensboro
- **PATX:** Patuxent River nr Bowie
- **POTO:** Potomac River at Chain Bridge

Virginia

- **RAPP:** Rappahannock River nr Fredricksburg
- **MATT:** Mattaponi River nr Beulahville
- **PAM:** Pamunkey River nr Hanover
- **JAMC:** James River at Cartersville
- **APP:** Appomattox River at Matoaca



[1]NTN loads and trends are available through water year 2023: https://doi.org/10.5066/P13P4TWR.



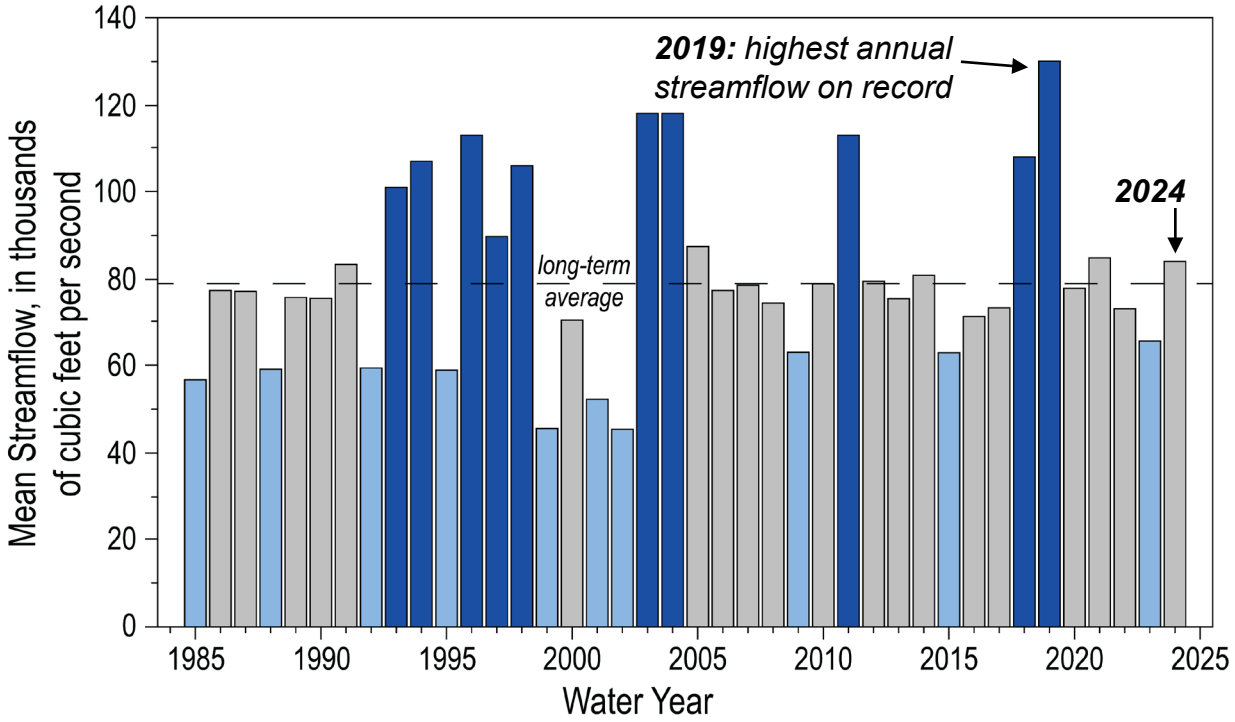
Streamflow and water-quality loads delivered to the Bay

USGS science for a changing world

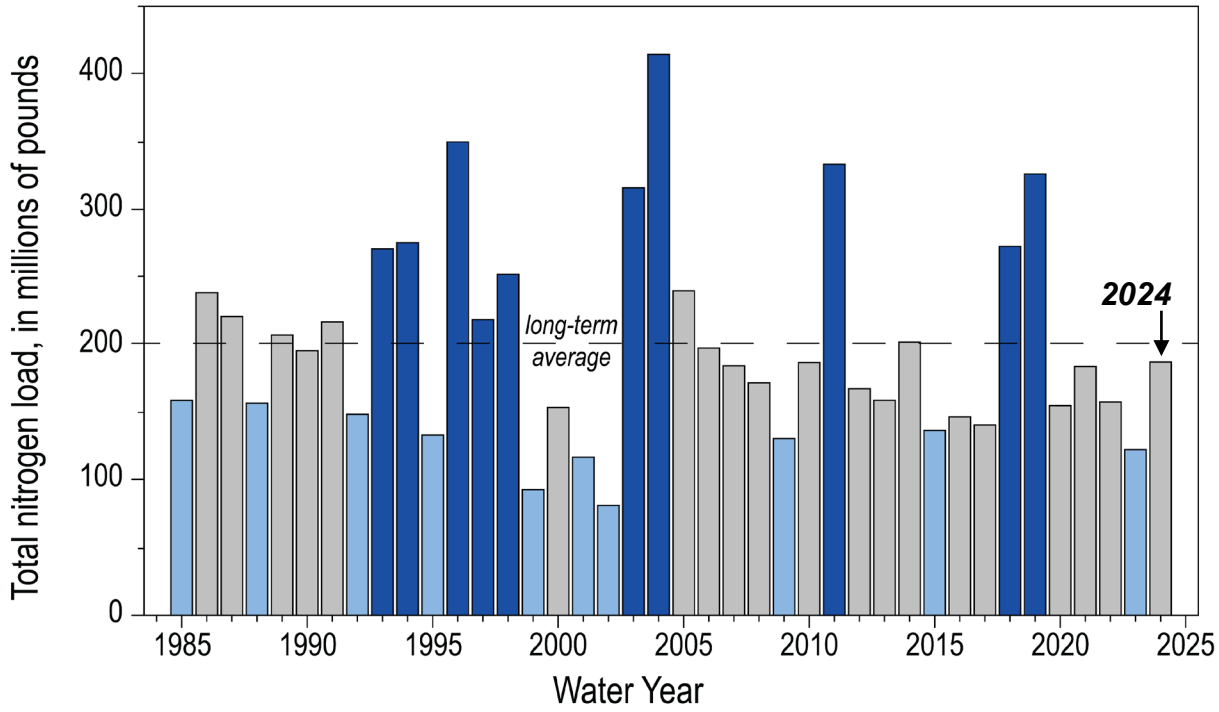
Background photo: Collecting a storm sample on the Susquehanna River at Conowingo Dam

In 2024, above average streamflow delivered below-average loads

The estimated annual-mean streamflow entering the Bay[1] in water year 2024 was about **4% higher** than the long-term average[2].



Loads of TN, NOx, TP, PO4, and SS from the RIM watershed in 2024 were **less** than long-term average[2] loads.



EXPLANATION

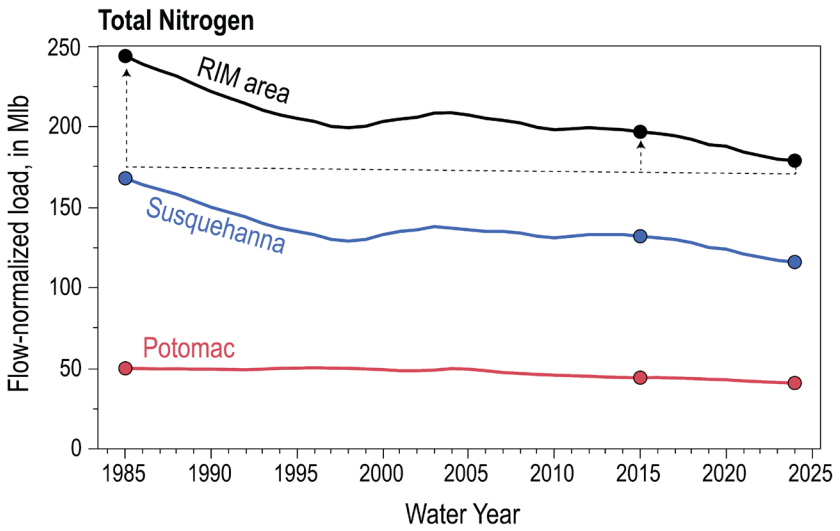
- Below 25th percentile of all annual observations
- Between 25th and 75th percentiles of all annual observations
- Above 75th percentile of all annual observations

USGS science for a changing world

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

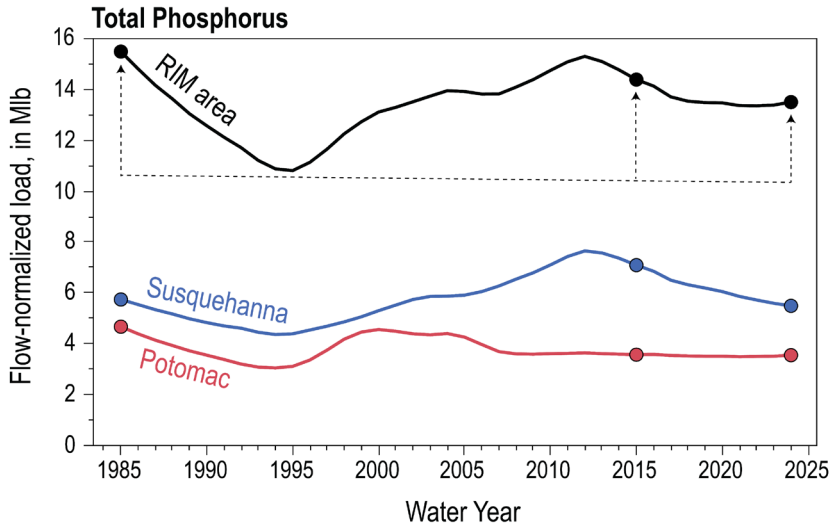
[2]Long-term average = 1985 – 2024.

FN nutrient and sediment loads have decreased from the RIM watershed area over time



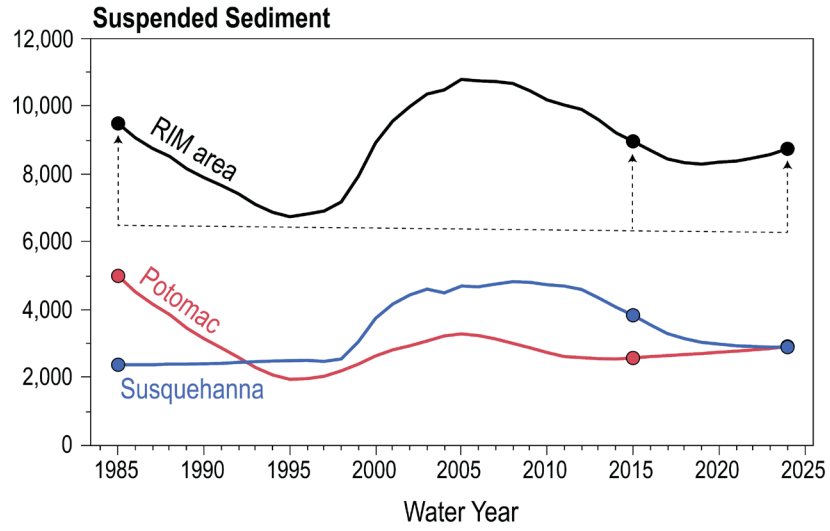
RIM FN total nitrogen loads

-9% from 2015 – 2024
-33% from 1985 – 2024



RIM FN total phosphorus loads

-6% from 2015 – 2024
-14% from 1985 – 2024



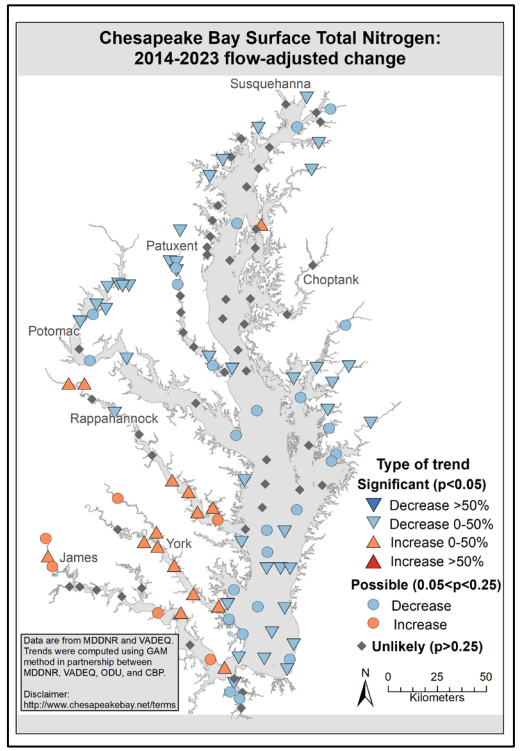
RIM FN suspended sediment loads

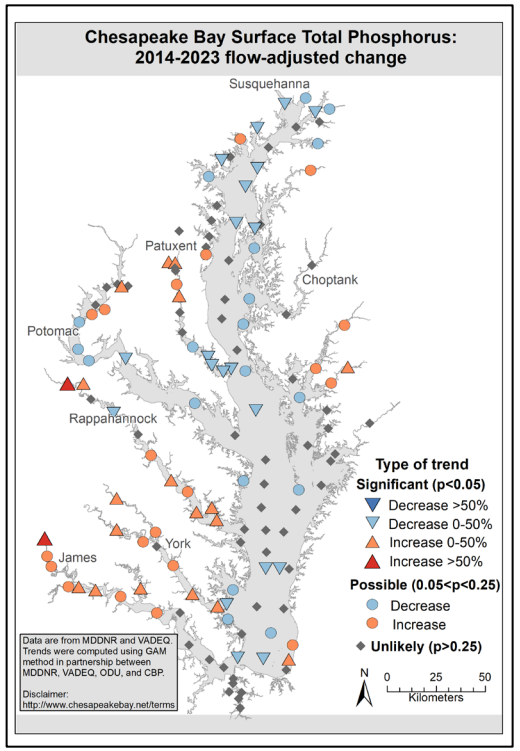
-3% from 2015 – 2024
-8% from 1985 – 2024

The Susquehanna and Potomac are the largest RIM watersheds. FN loads from these two stations typically represent 70 – 90% of the total RIM FN load.

Freshwater flow from RIM tributaries affects the water-quality of tidal areas

Although the Susquehanna and Potomac commonly deliver most of the nutrient and sediment load to the Bay, freshwater flow from all tributaries affects the water quality of the Bay and local tidal areas.





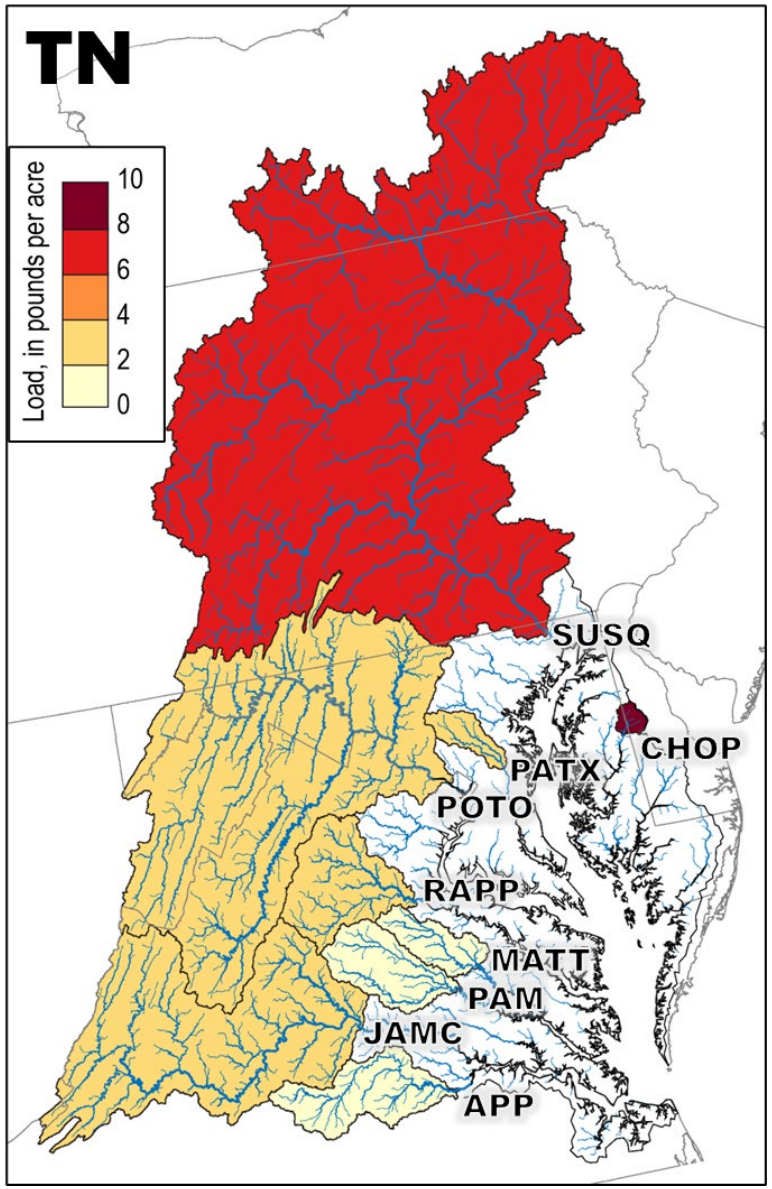
Monitoring data are used to compute water-quality trends in the Bay and tidal areas. These data are available online:
www.chesapeakebay.net/who/group/integrated-trends-analysis-team

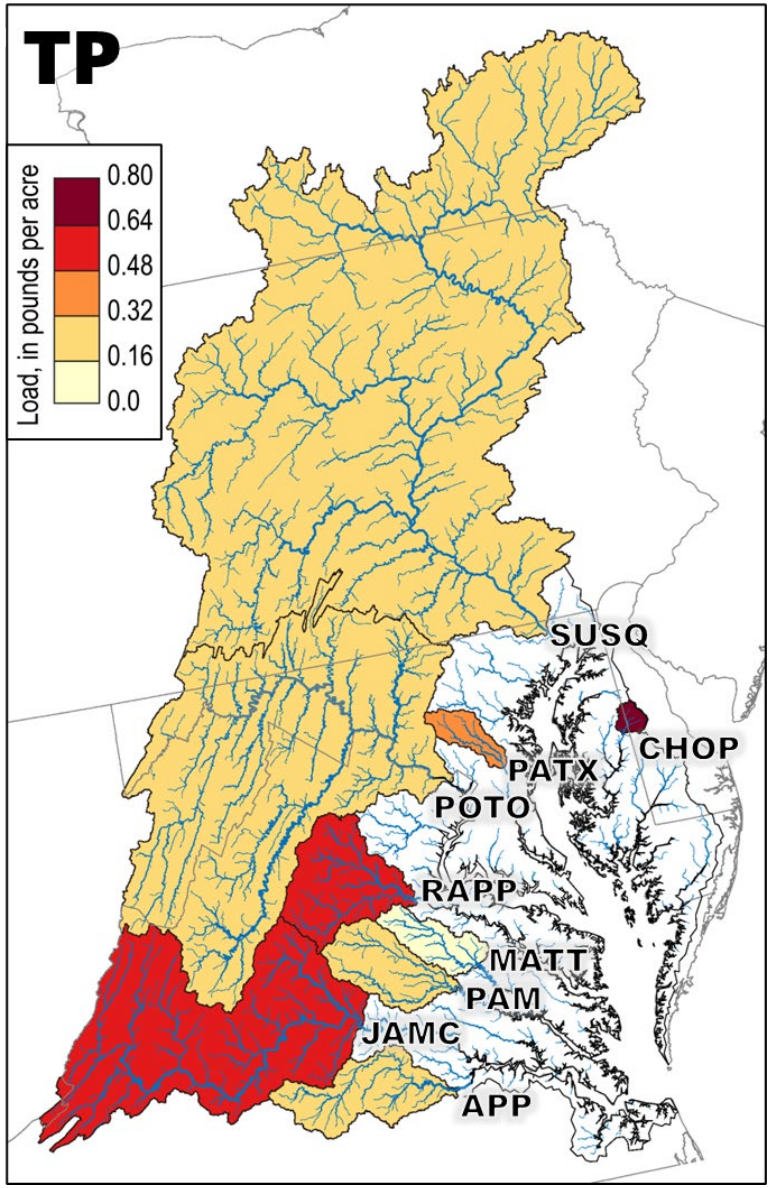
USGS science for a changing world

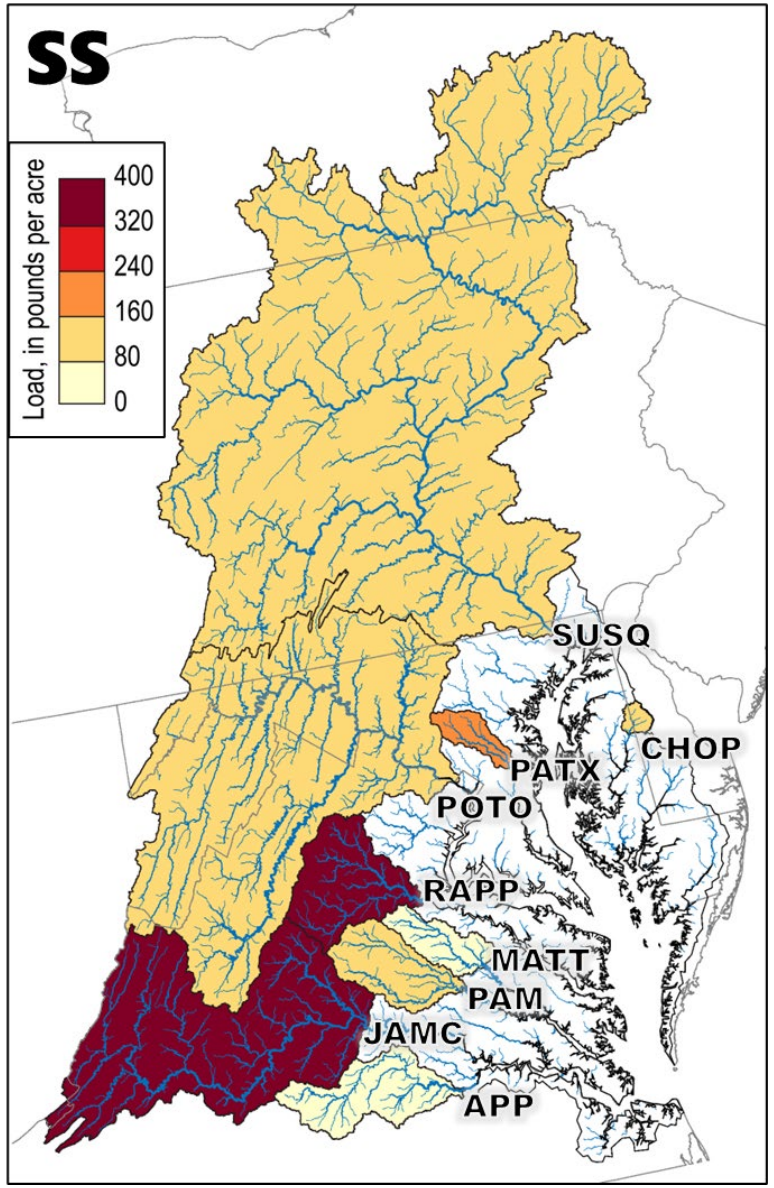
https://landsat.gsfc.nasa.gov/outreach/chesapeake-bay-from-space/

Per-acre loads (yields) at the RIM stations

Per-Acre Loads: 2020 – 2024 Average (most recent 5 years of data)








Trends at the RIM stations

The RIM network has a similar number of improving and degrading trend results

Trend Summary

- 13 trends have improved and 11 have degraded since 1985.
- 8 trends have improved and 12 have degraded since 2015.

Good News

- All trends improved at Susquehanna since 2015.
- TN trends improved at all MD RIM stations since 2015.

Concerns

- The Choptank has the highest TP per-acre load and a large TP increase since 2015.
- Other than the Pamunkey, loads were higher in 2024 than 2015 at all Virginia RIM stations.

	RIM Monitoring Station	Long term: 1985 - 2024			Short term: 2015 - 2024		
		TN	TP	SS	TN	TP	SS
Maryland RIM stations	SUSQ	-31.2%	-4.6%	+21.5%	-12.4%	-22.8%	-24.8%
	CHOP	-2.5%	+77.4%	-34.3%	-4.5%	+20.2%	-7.5%
	PATX	-69.5%	-66.8%	-44.0%	-21.0%	-5.5%	-4.5%
	POTO	-18.4%	-24.3%	-41.7%	-7.6%	-1.0%	+13.1%
Virginia RIM stations	RAPP	-15.6%	+31.2%	+50.0%	+7.3%	+7.6%	+1.7%
	MATT	-6.4%	+6.4%	+8.6%	+1.7%	+8.9%	+26.9%
	PAM	-1.3%	+59.2%	+36.3%	-3.9%	+1.0%	-9.9%
	JAMC	-8.0%	-22.1%	+40.3%	+11.2%	+25.8%	+20.9%
	APPO	+6.4%	+99.5%	+44.2%	+5.4%	+23.4%	+38.9%

Trend Direction Improving Degrading No trend

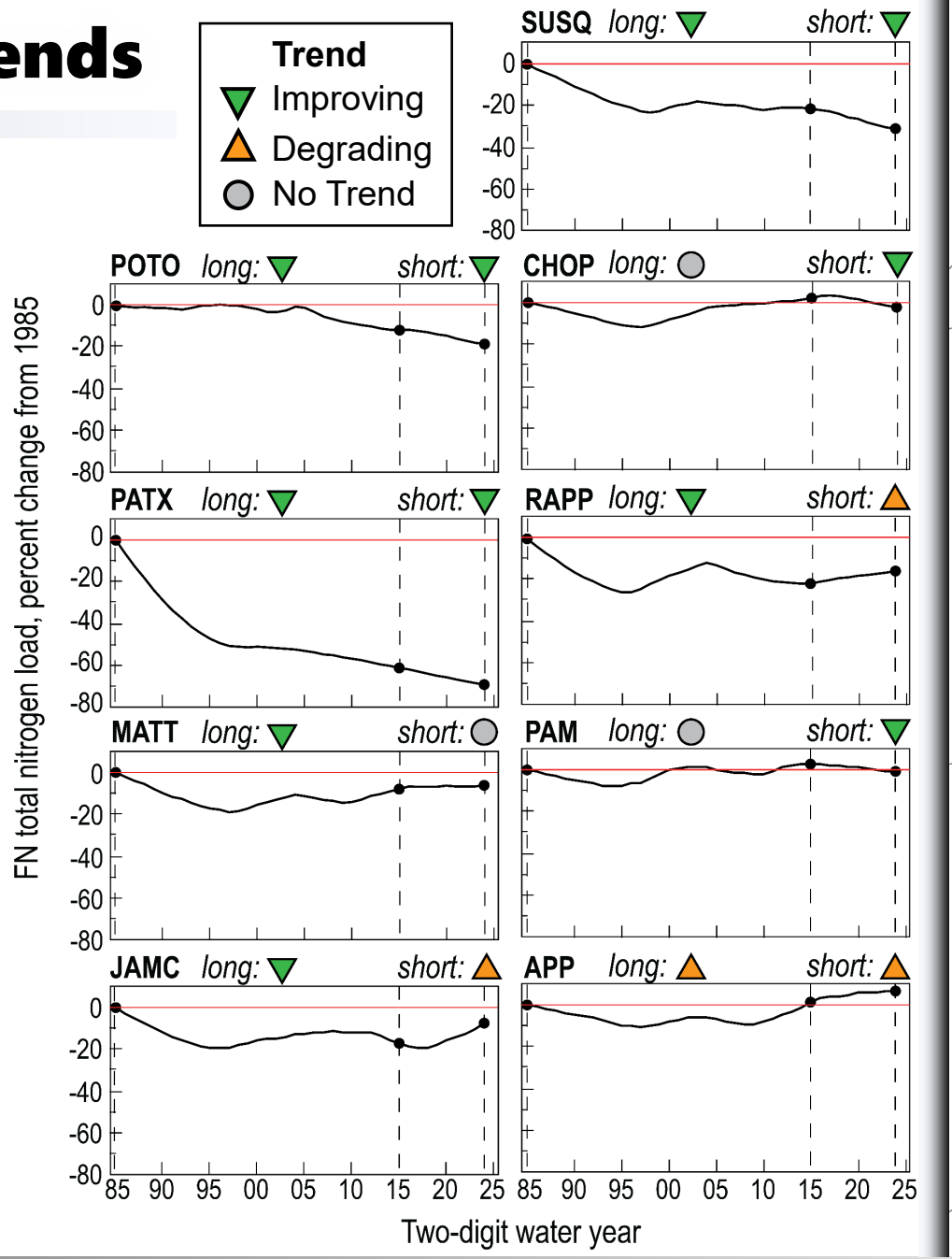
Total Nitrogen Trends

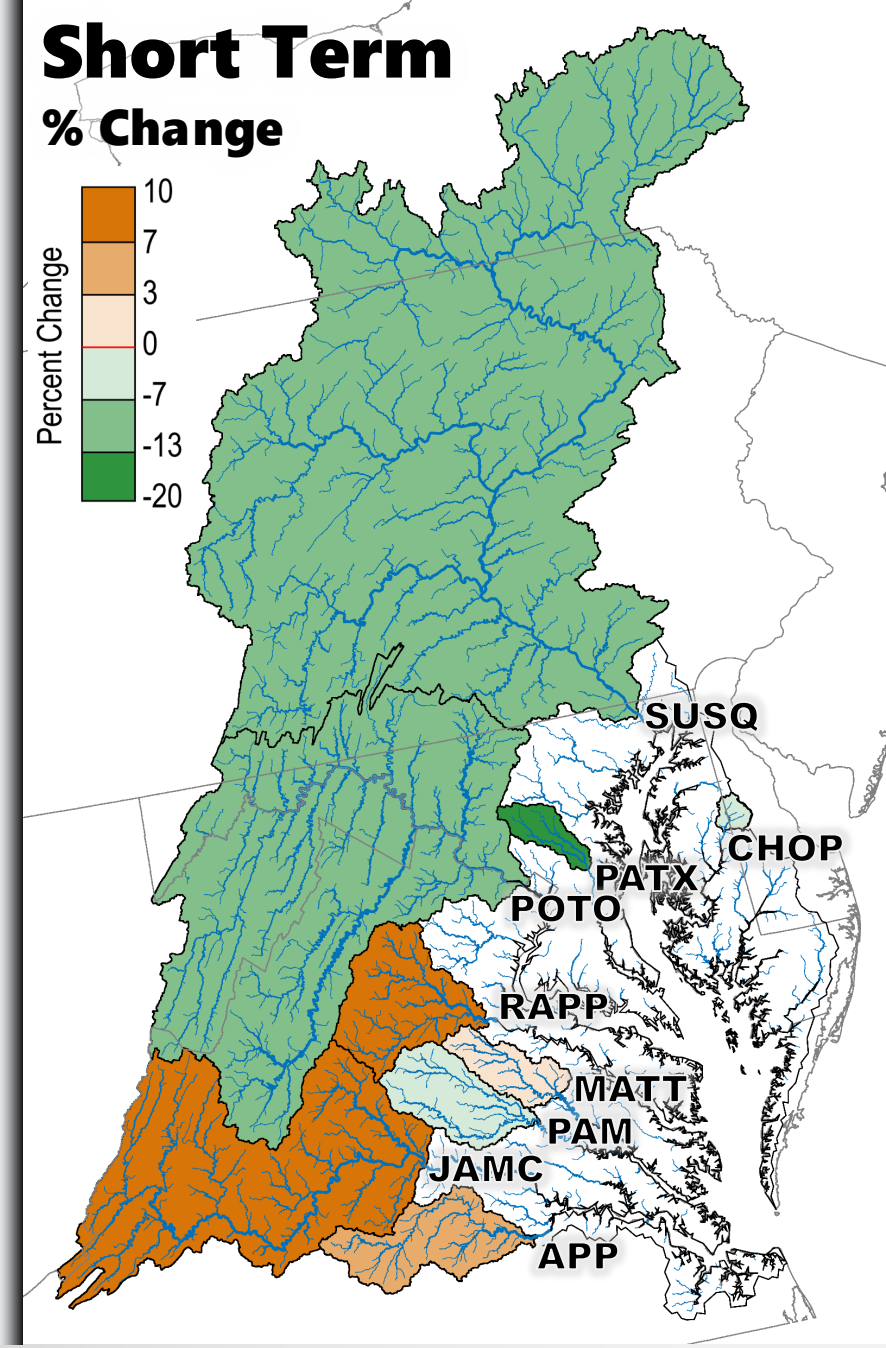
Since 1985:
- 6 stations have improved
- 1 station has degraded
- 2 stations have no trend

Since 2015:
- 5 stations have improved
- 3 stations have degraded
- 1 station has no trend

The largest percent decrease since 2015 has been at the Patuxent River (-21.0%).

The largest percent increase since 2015 has been at the James River (+11.2%).





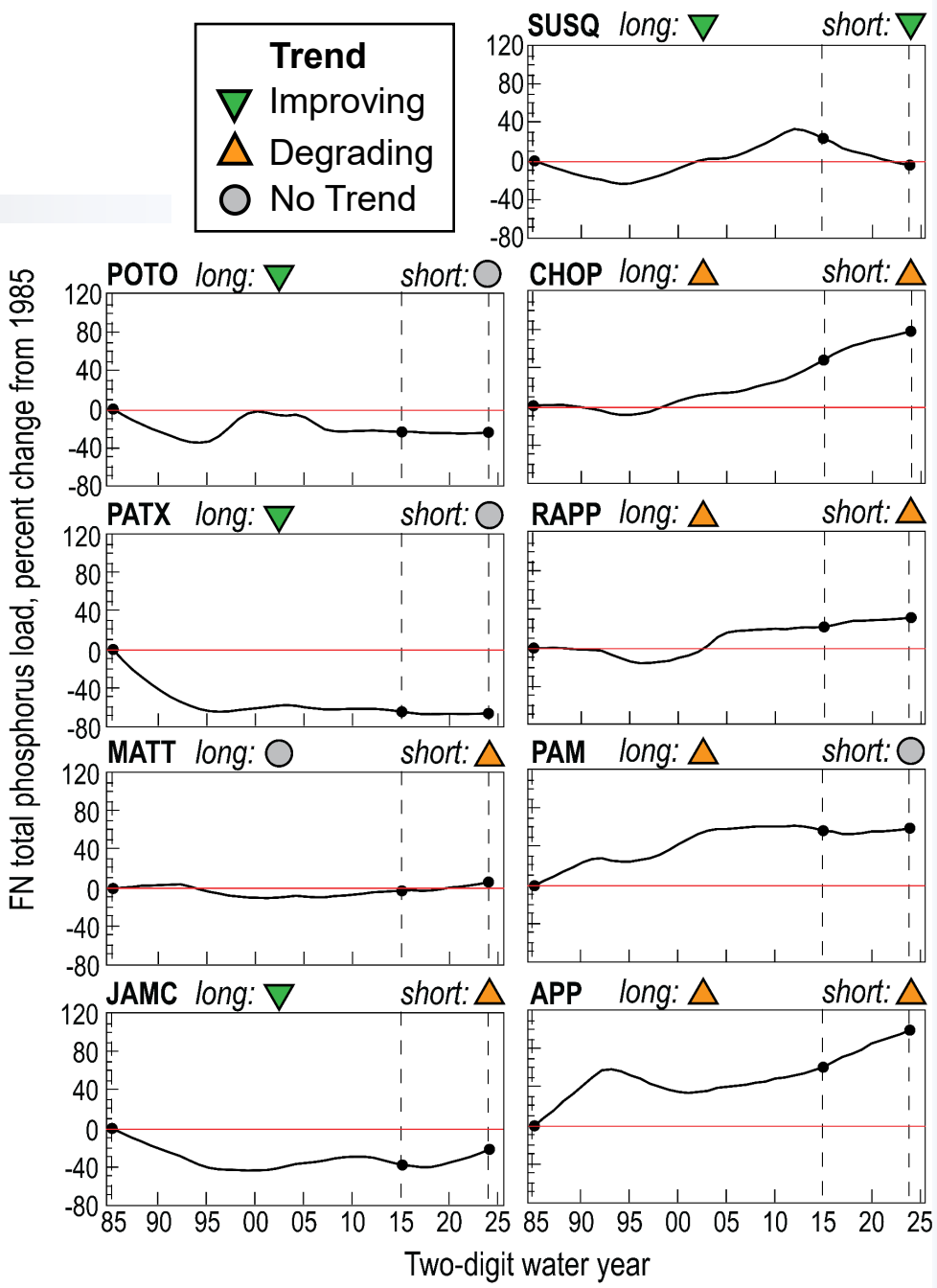
Total Phosphorus Trends

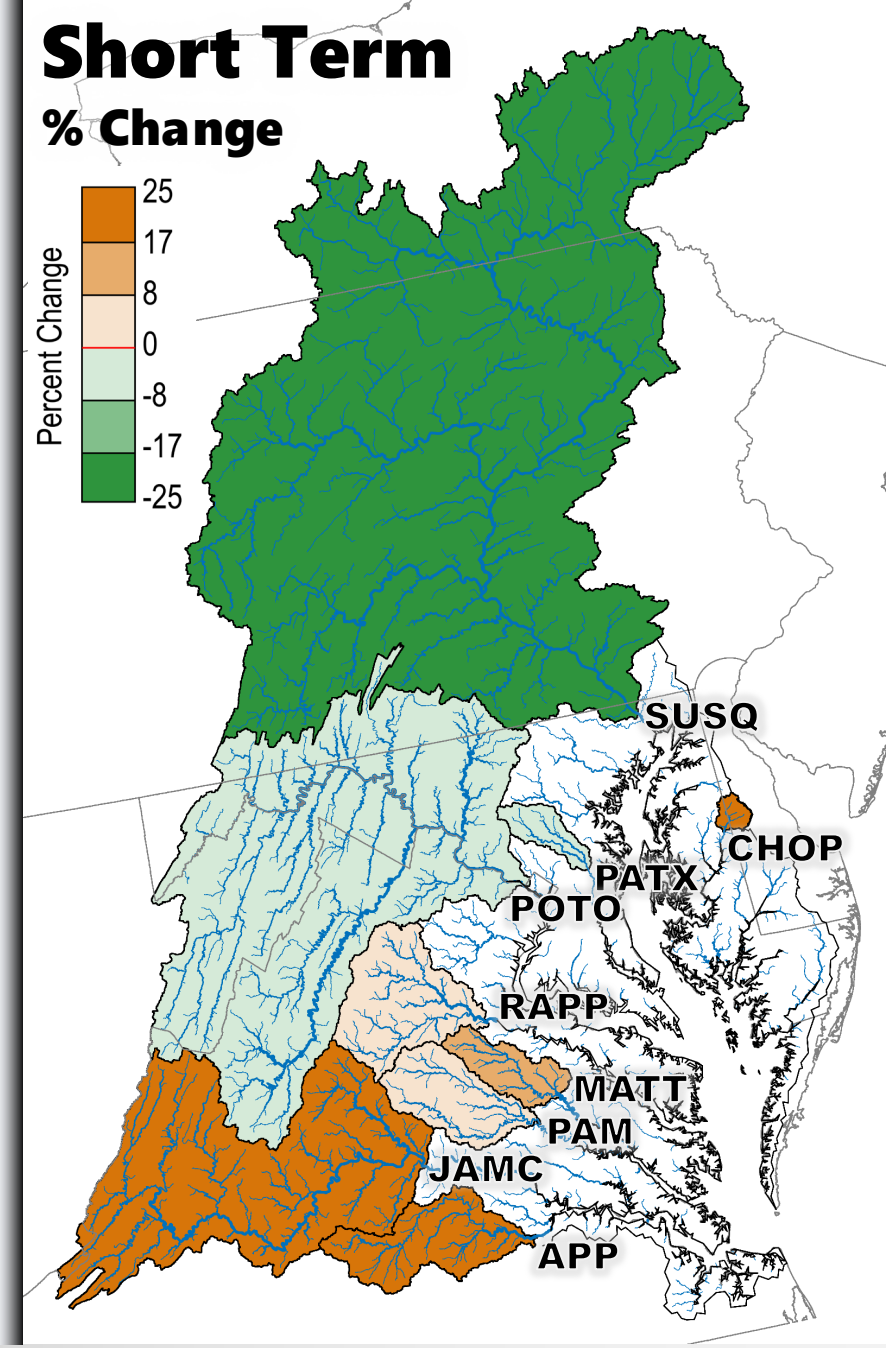
Since 1985:
- 4 stations have improved
- 4 stations have degraded
- 1 station has no trend

Since 2015:
- 1 station has improved
- 5 stations have degraded
- 3 stations have no trend

The largest percent decrease since 2015 has been at the Susquehanna River (-22.8%).

The largest percent increase since 2015 has been at the James River (+25.8%).





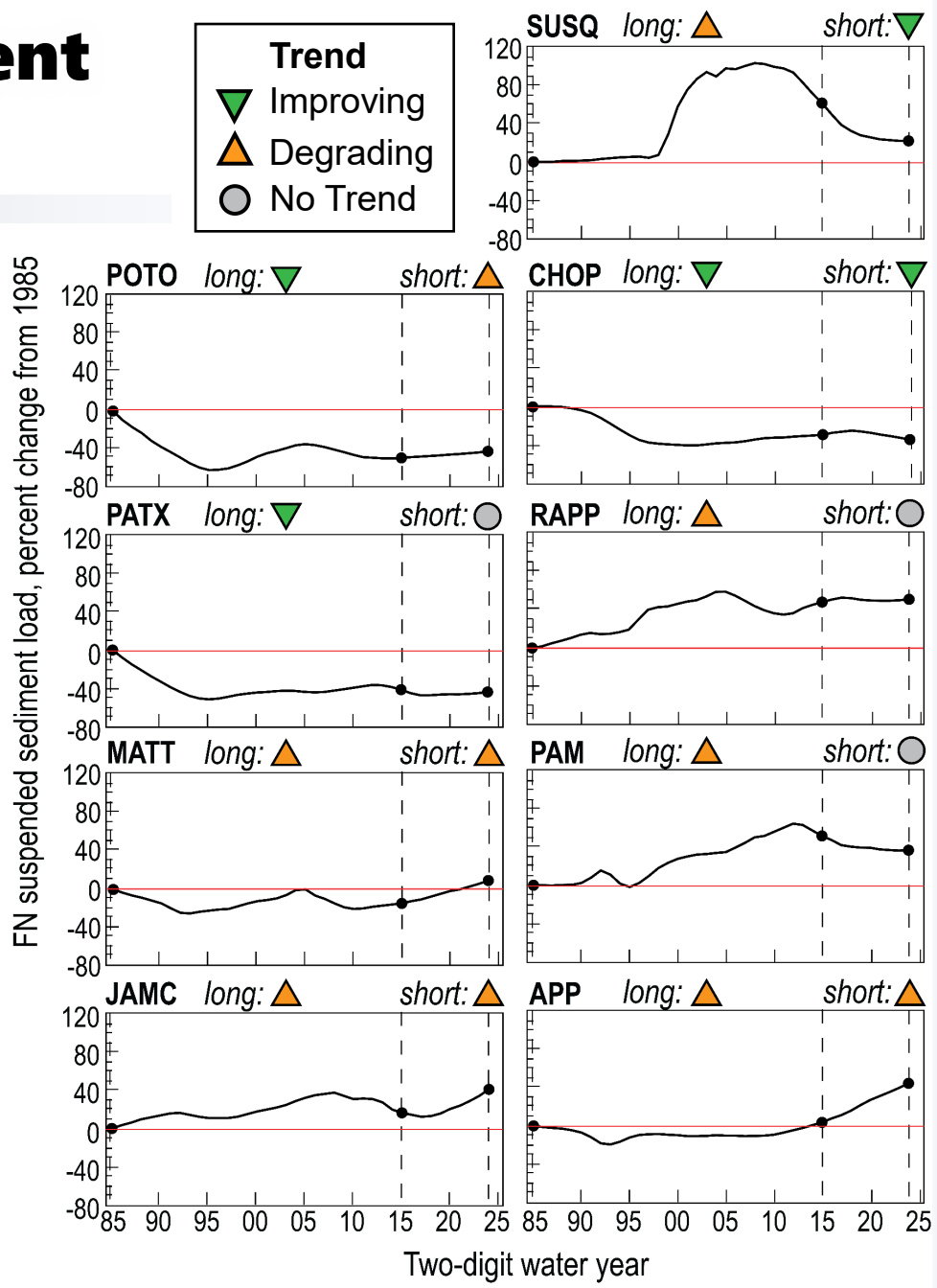
Suspended Sediment Trends

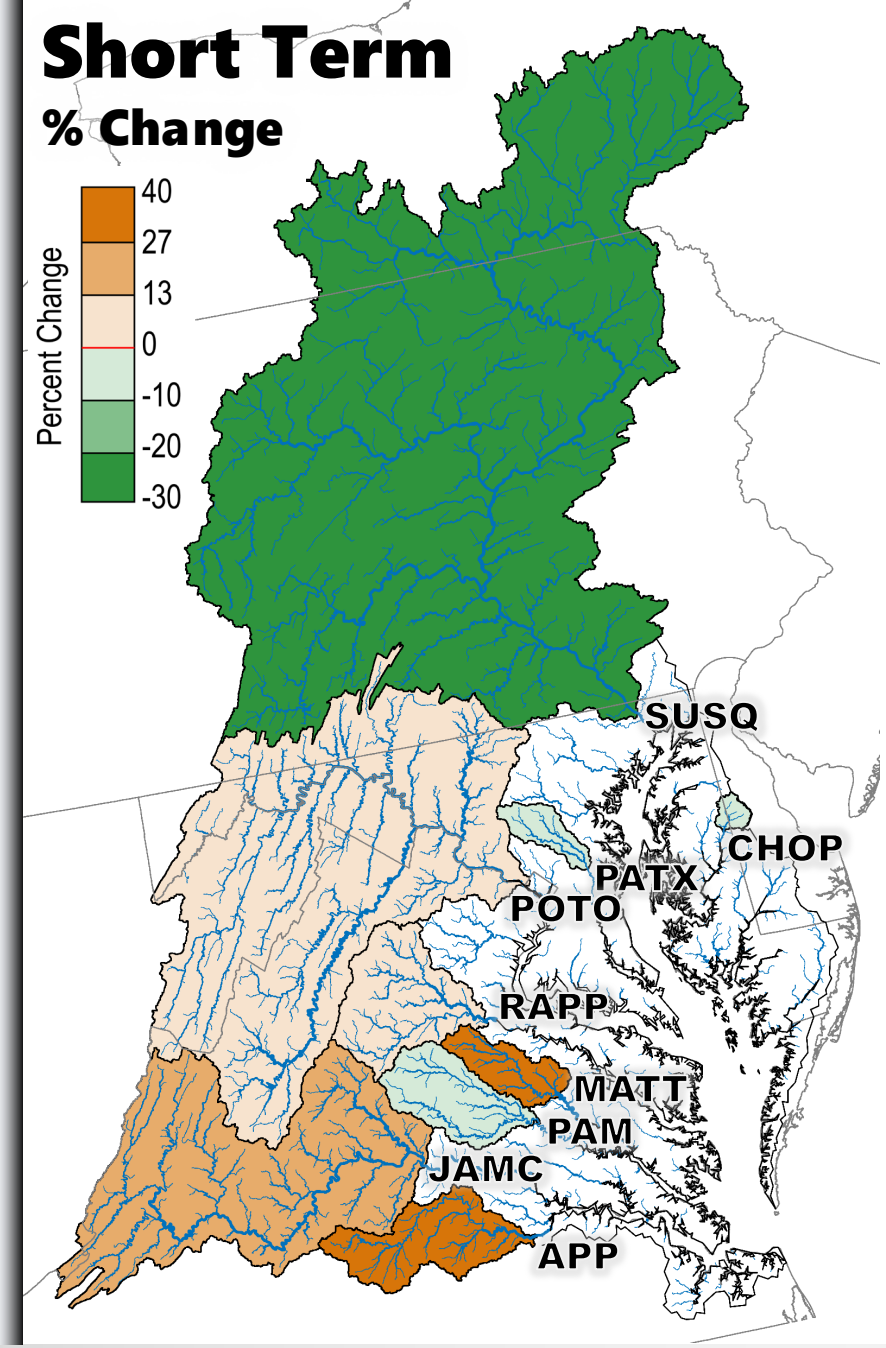
Since 1985:
- 3 stations have improved
- 6 stations have degraded

Since 2015:
- 2 stations have improved
- 4 stations have degraded
- 3 stations have no trend

The largest percent decrease since 2015 has been at the Susquehanna (-24.8%).

The largest percent increase since 2015 have been at the Appomattox River (+38.9%).





Trends and water-quality goals

Nutrient and sediment trends were computed from 1995 through 2024

Why?

Because nutrient and sediment planning targets represent modeled load reductions from 1995 that are needed to meet water-quality standards in the Bay.

Therefore, meeting planning targets in the RIM watersheds likely requires an "improving" trend relative to loads in 1995.

Most nutrient and sediment loads increased since 1995

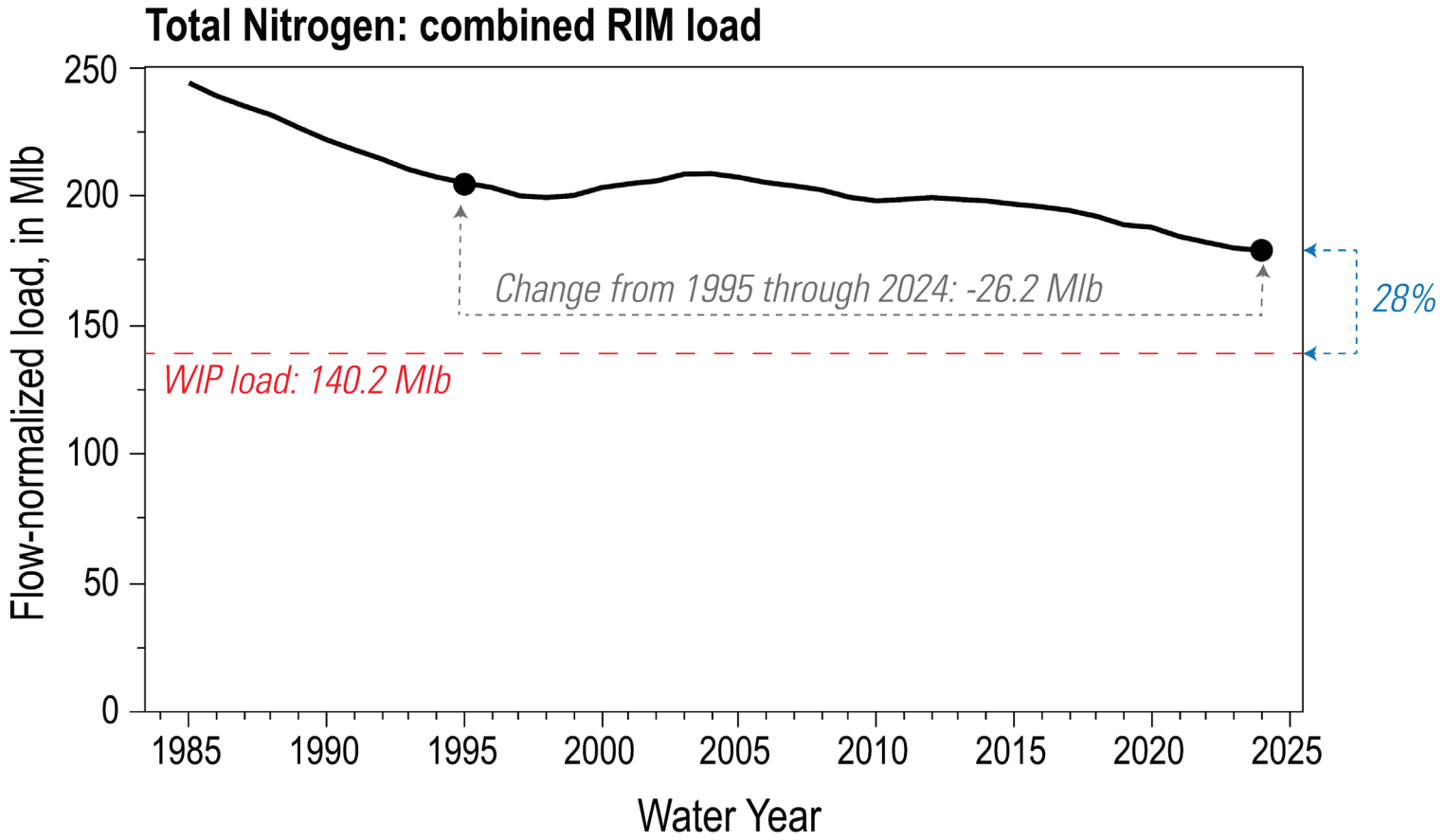
RIM Monitoring Station	Trend Period: 1995 - 2024		
	TN	TP	SS
SUSQ	-14.3%	24.9%	15.6%
CHOP	9.5%	96.1%	-6.8%
PATX	-41.9%	-7.4%	15.6%
POTO	-18.6%	13.7%	49.4%
RAPP	13.4%	52.4%	26.2%
MATT	12.9%	10.0%	39.2%
PAM	6.9%	27.0%	38.7%
JAMC	14.0%	32.4%	26.8%
APPO	18.4%	30.5%	64.1%

Monitored loads can evaluate progress towards meeting water-quality goals

Chesapeake Bay jurisdictions have submitted watershed implementation plans (WIPs) that describe conservation efforts to meet nutrient planning targets.

The Chesapeake Bay Program's watershed model estimates the expected load if WIPs are fully implemented (the "WIP load")[1].

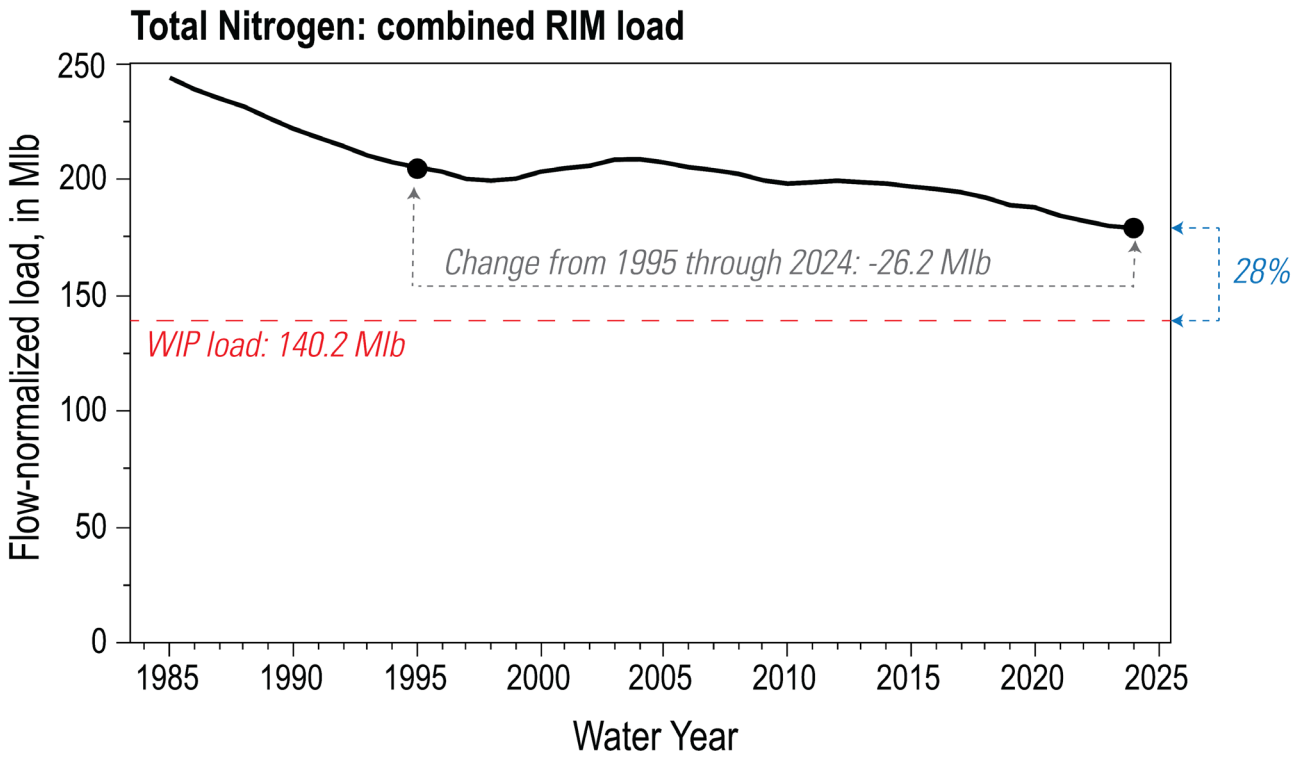
Monitored loads can be compared to WIP loads to assess progress towards meeting water-quality goals.



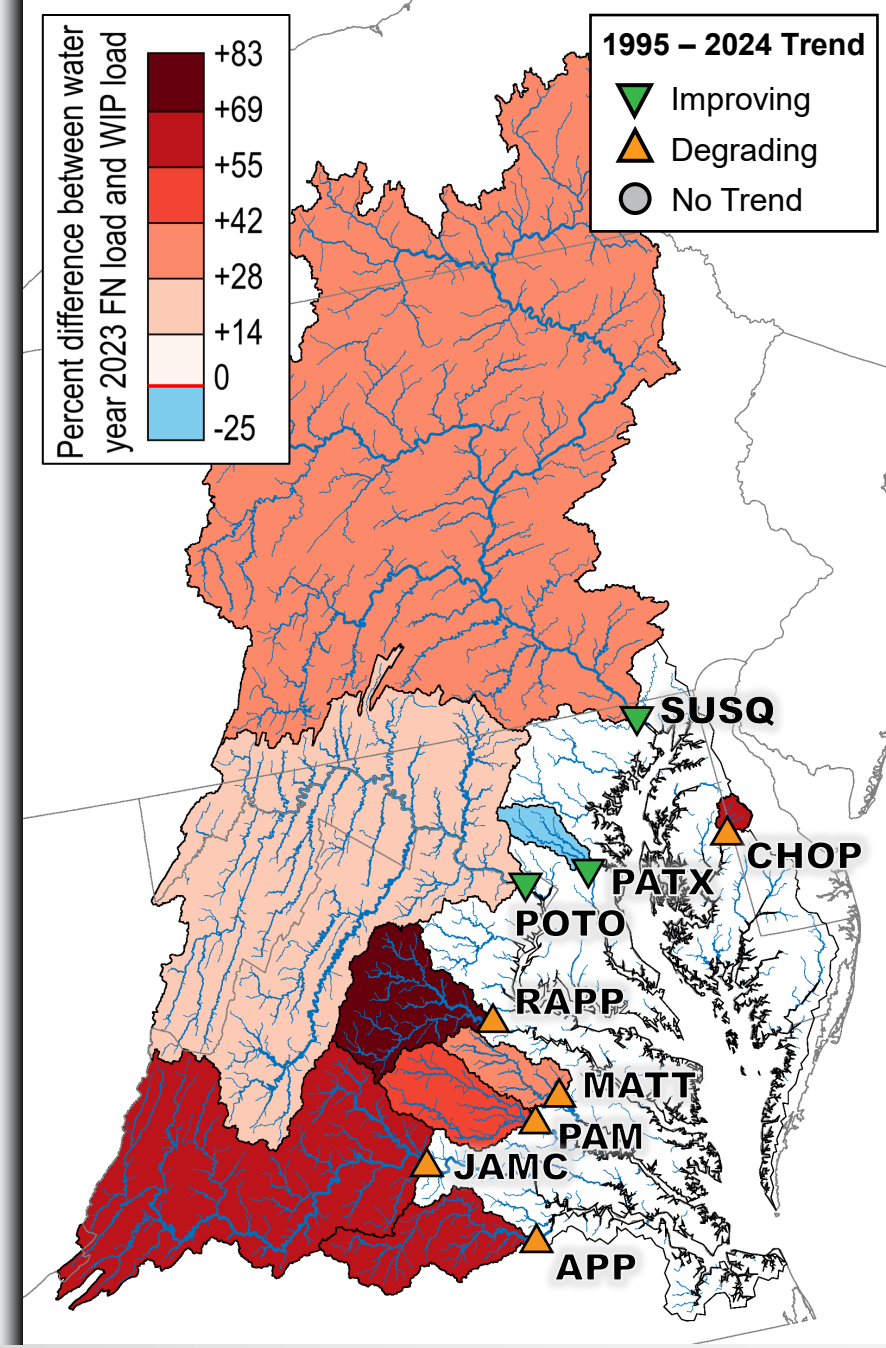
[1]WIP loads were estimated for each RIM watershed and compared against monitored loads, following approaches used by the recently published "METRIC" tool: https://wqs.chesapeakebay.net/metric

Total Nitrogen:
Monitored loads v WIP loads

In water year 2024, the combined RIM load of total nitrogen exceeded the WIP load by **28%**.

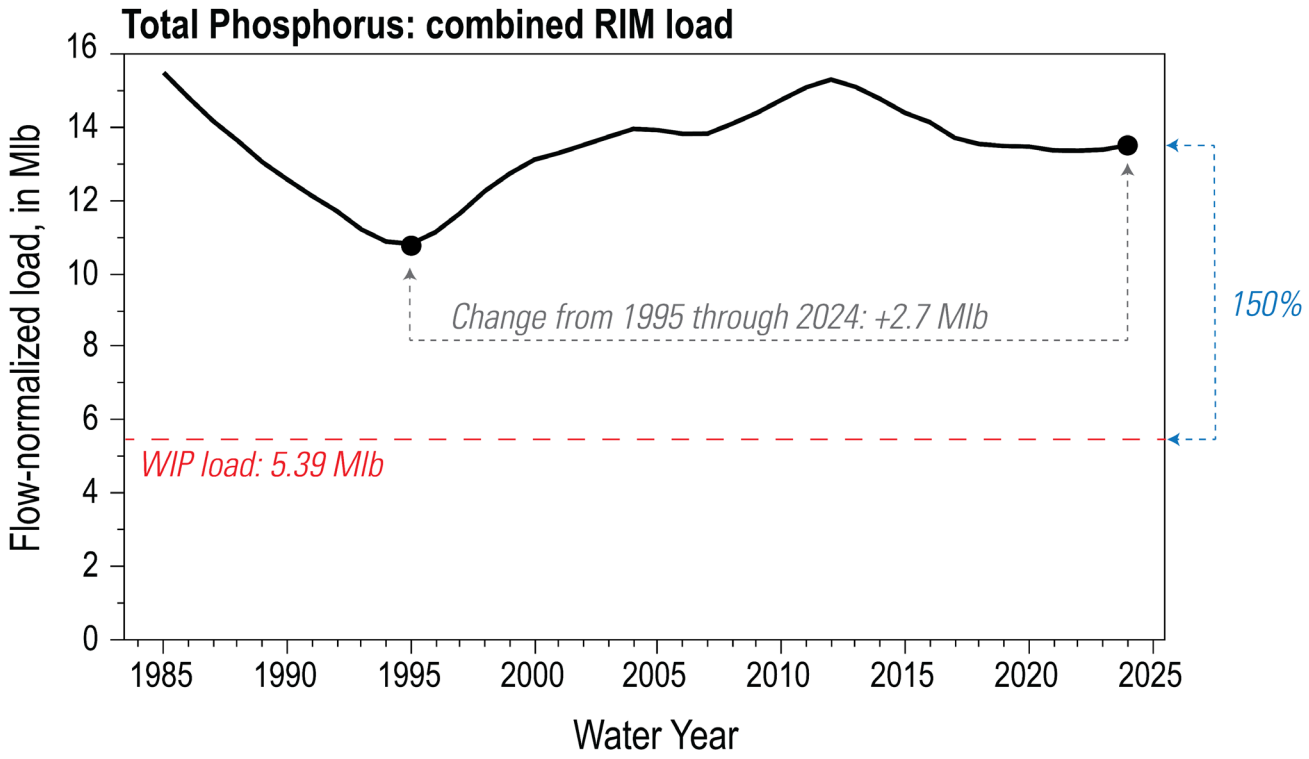


The FN load exceeded the WIP load of total nitrogen in all RIM watersheds except the Patuxent in water year 2024.

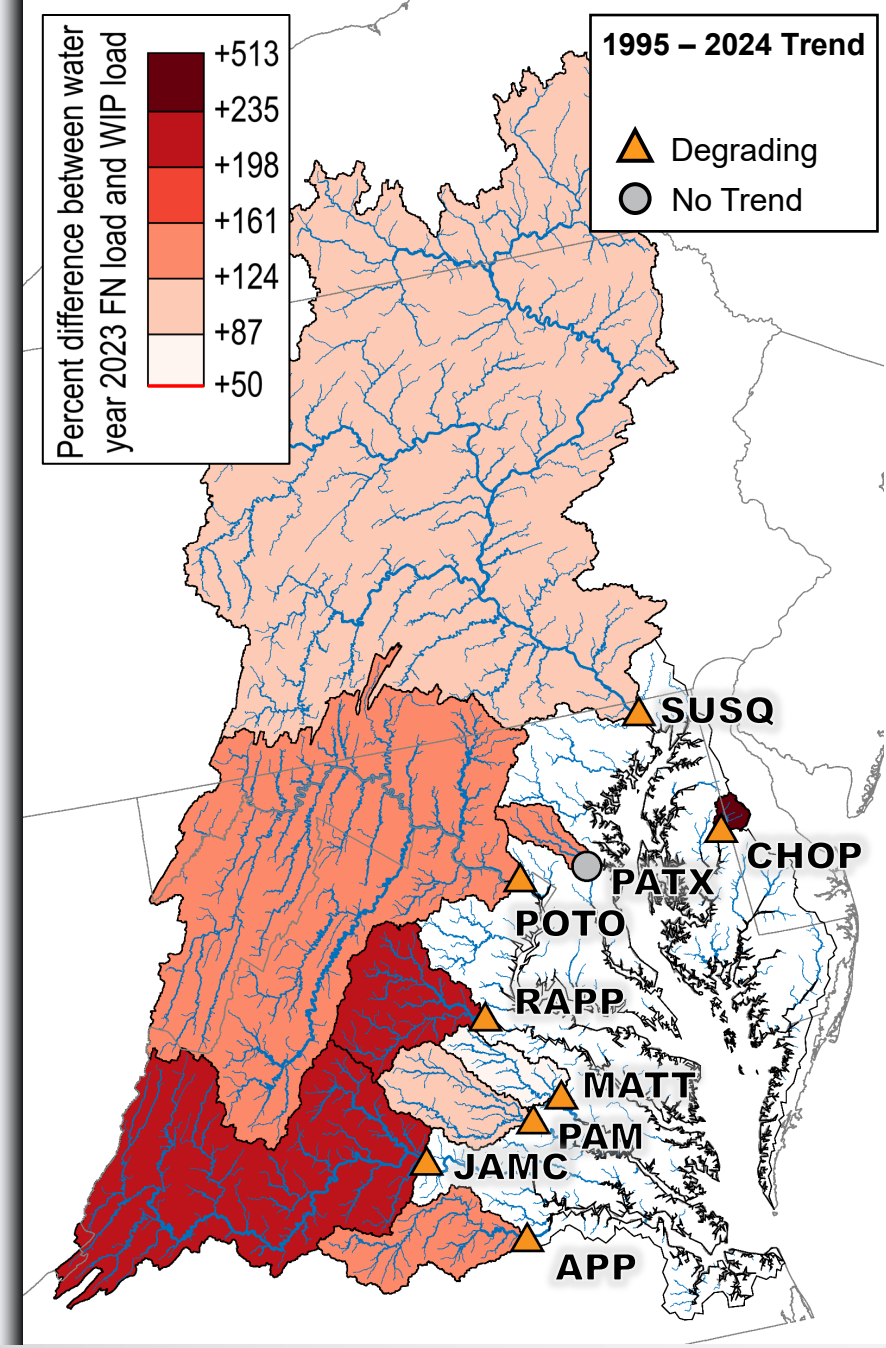


Total Phosphorus:
Monitored loads v WIP loads

In water year 2024, the combined RIM load of total phosphorus exceeded the WIP load by **150%**.

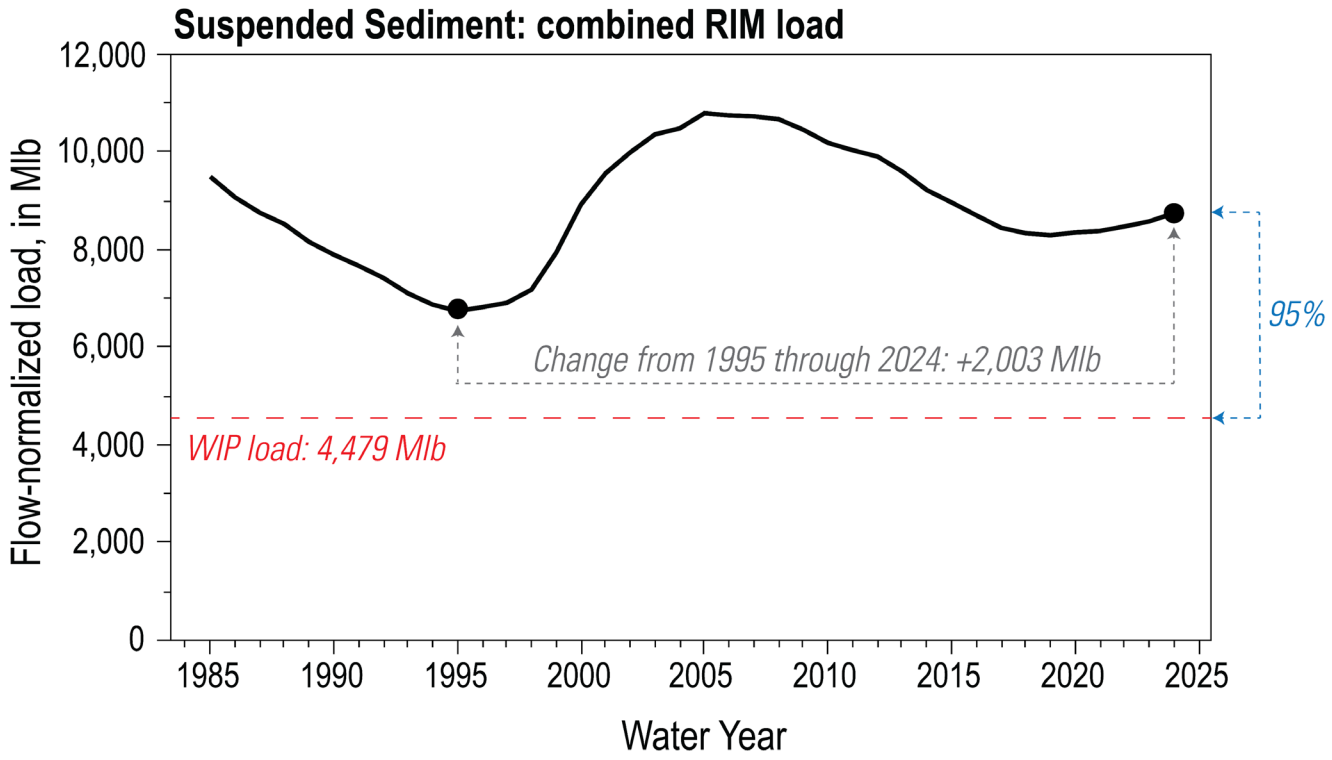


The FN load exceeded the WIP load of total phosphorus in all RIM watersheds in water year 2024.

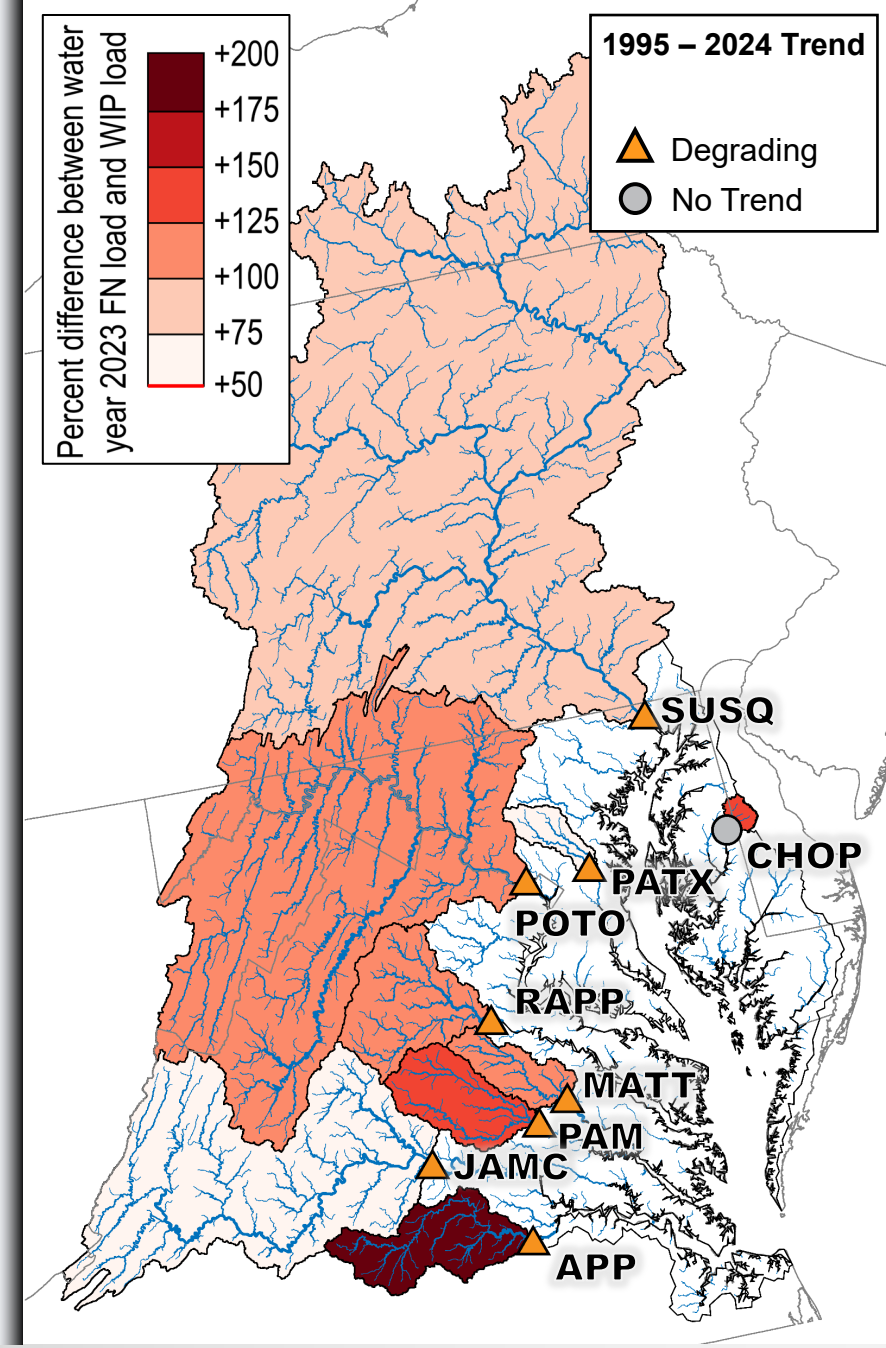


Suspended Sediment: Monitored loads v WIP loads

In water year 2024, the combined RIM load of total phosphorus exceeded the WIP load by **95%**.



The FN load exceeded the WIP load of suspended sediment in all RIM watersheds in water year 2024.



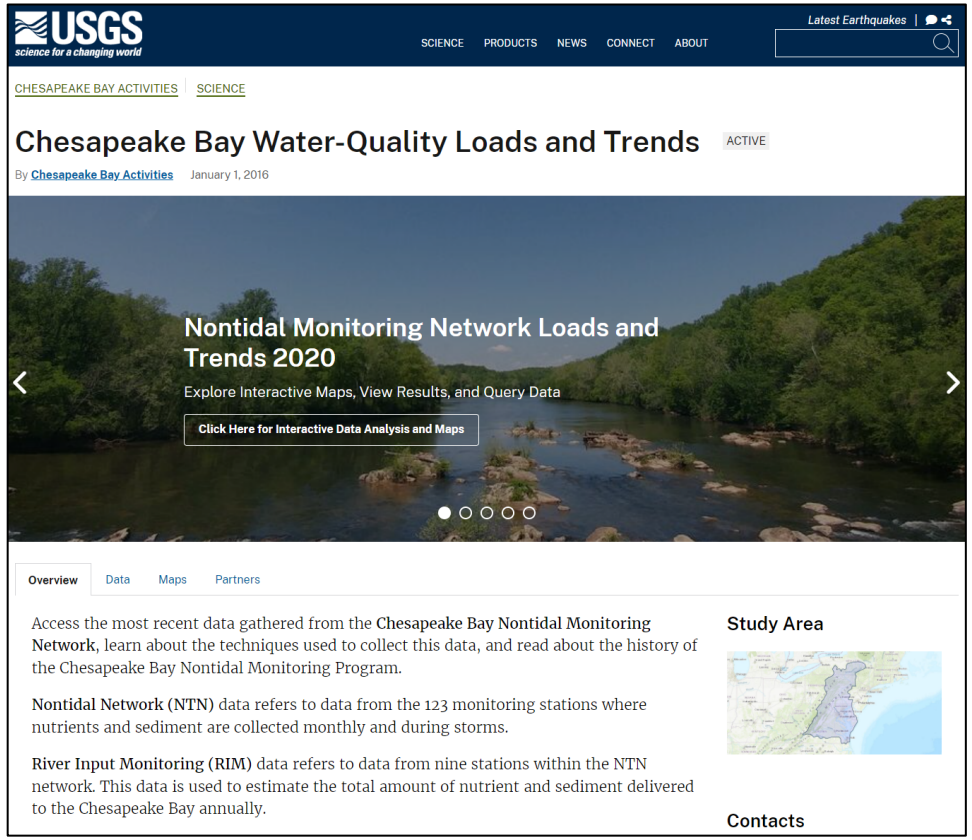
Resources to learn more

USGS science for a changing world

Background photo: stormflow at the Mattaponi River

Resources are available to learn more about these results

The project website includes access to the most recent data[1] and a summary of results: www.usgs.gov/CB-wq-loads-trends



The USGS works with Chesapeake Bay partners to evaluate and explain water-quality monitoring data.

What has caused the recent water-quality improvements in the Susquehanna?

Why are phosphorus loads high and increasing in the Choptank?

Why are sediment loads high and increasing in the James and Rappahannock?

Are management practices reducing water-quality loads?

Has reservoir scouring and infill affected loads in the Susquehanna and Appomattox?

We want to hear from you. Your questions inform our research!

Jimmy Webber, jwebber@usgs.gov
Chris Mason, camason@usgs.gov
Alex Soroka, asoroka@usgs.gov
Doug Moyer, dlmoyer@usgs.gov

[1]Mason, C.A., and Soroka, A.M., 2025, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay River Input Monitoring stations: Water years 1985-2024: U.S. Geological Survey data release, https://doi.org/10.5066/P14CG4D8.