Nitrogen, Phosphorus, and Suspended Sediment:

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

An update through water year 2023

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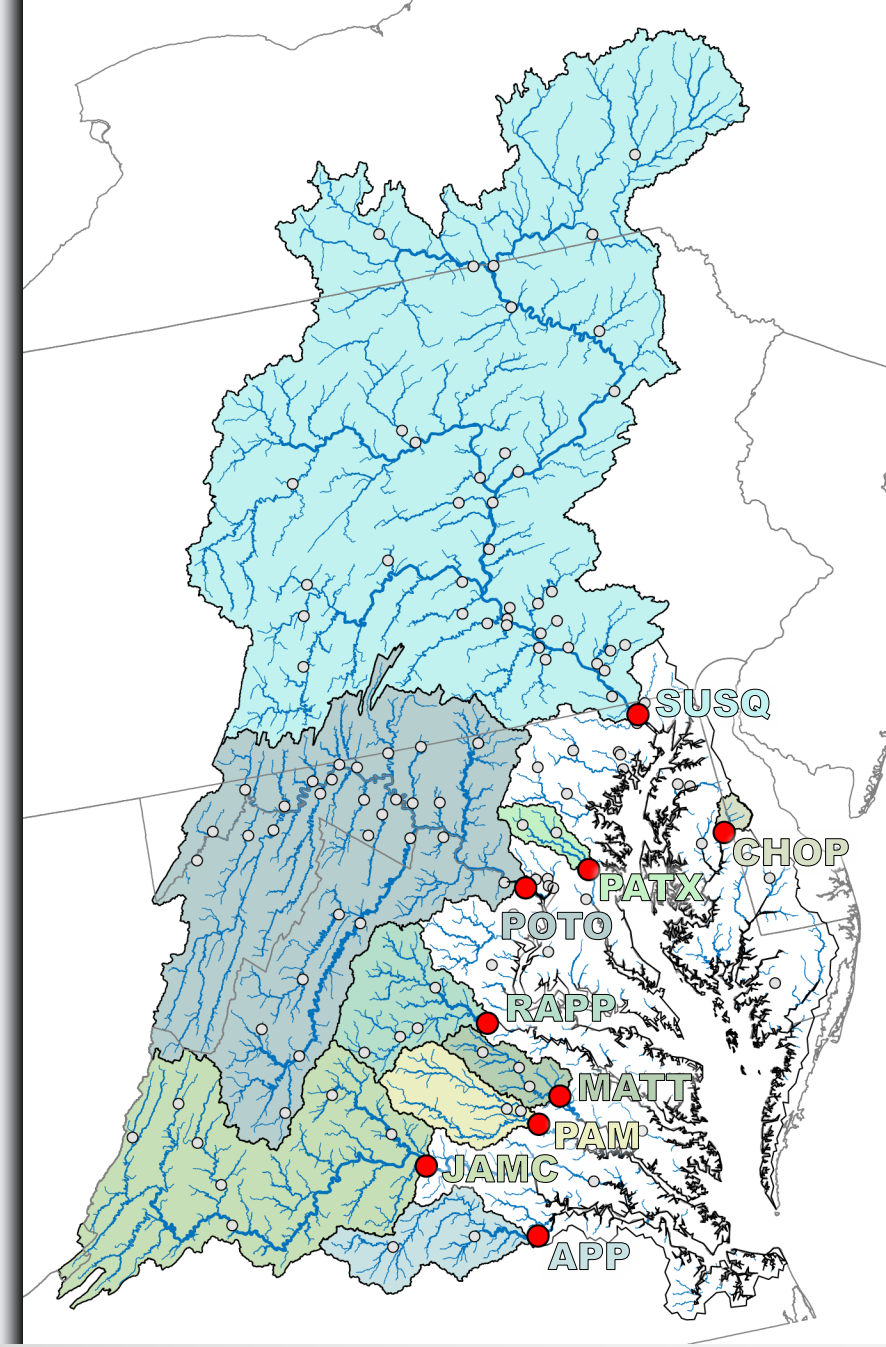
RIM loads and trends were recently released using monitoring data through water-year 2023[1].

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



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[1]Mason, C.A., and Soroka, A.M., 2024, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay River Input Monitoring stations: Water years 1985-2023: U.S. Geological Survey data release, https://doi.org/10.5066/P13QLXFP.

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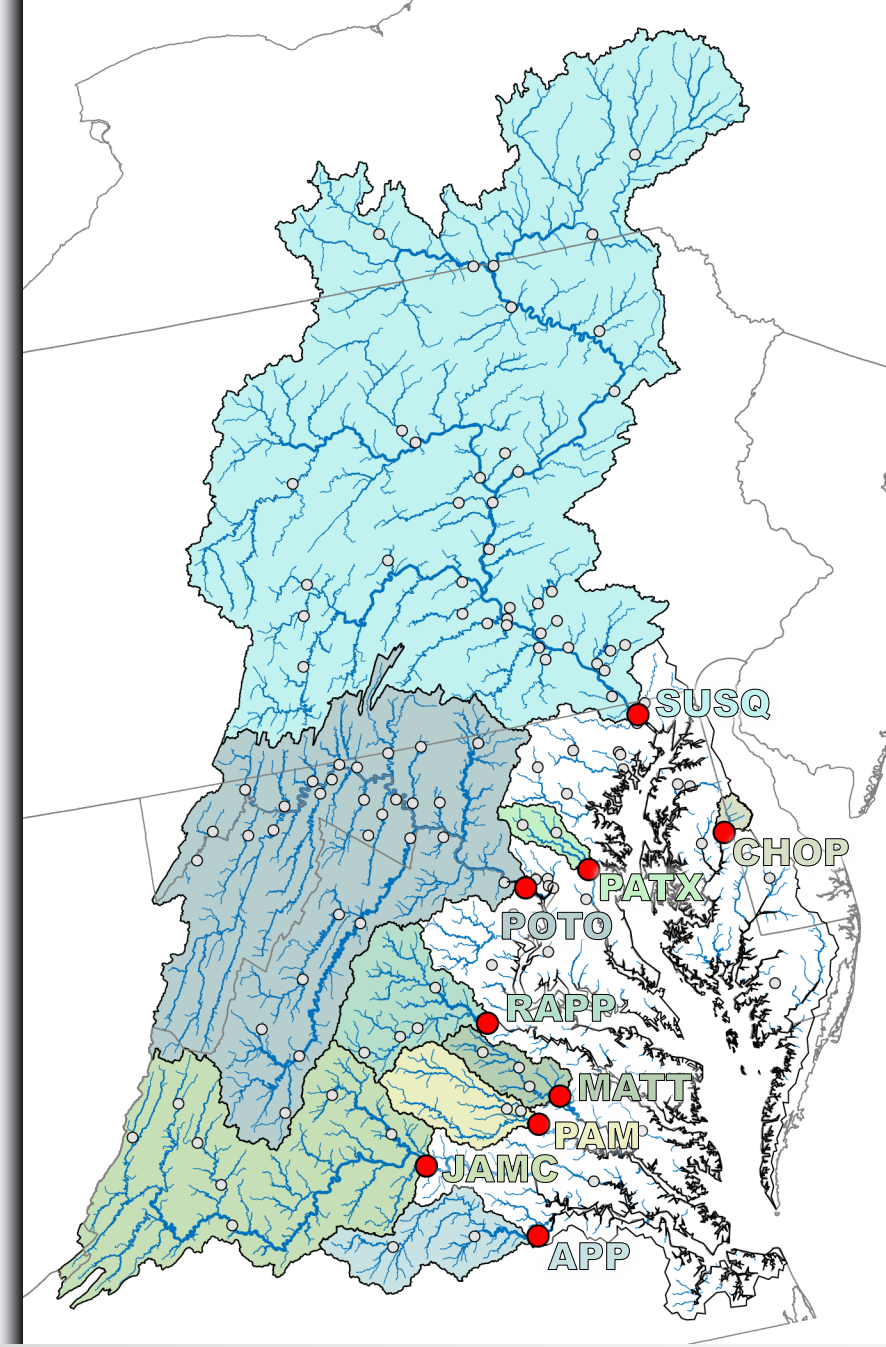
An update through water year 2023

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

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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

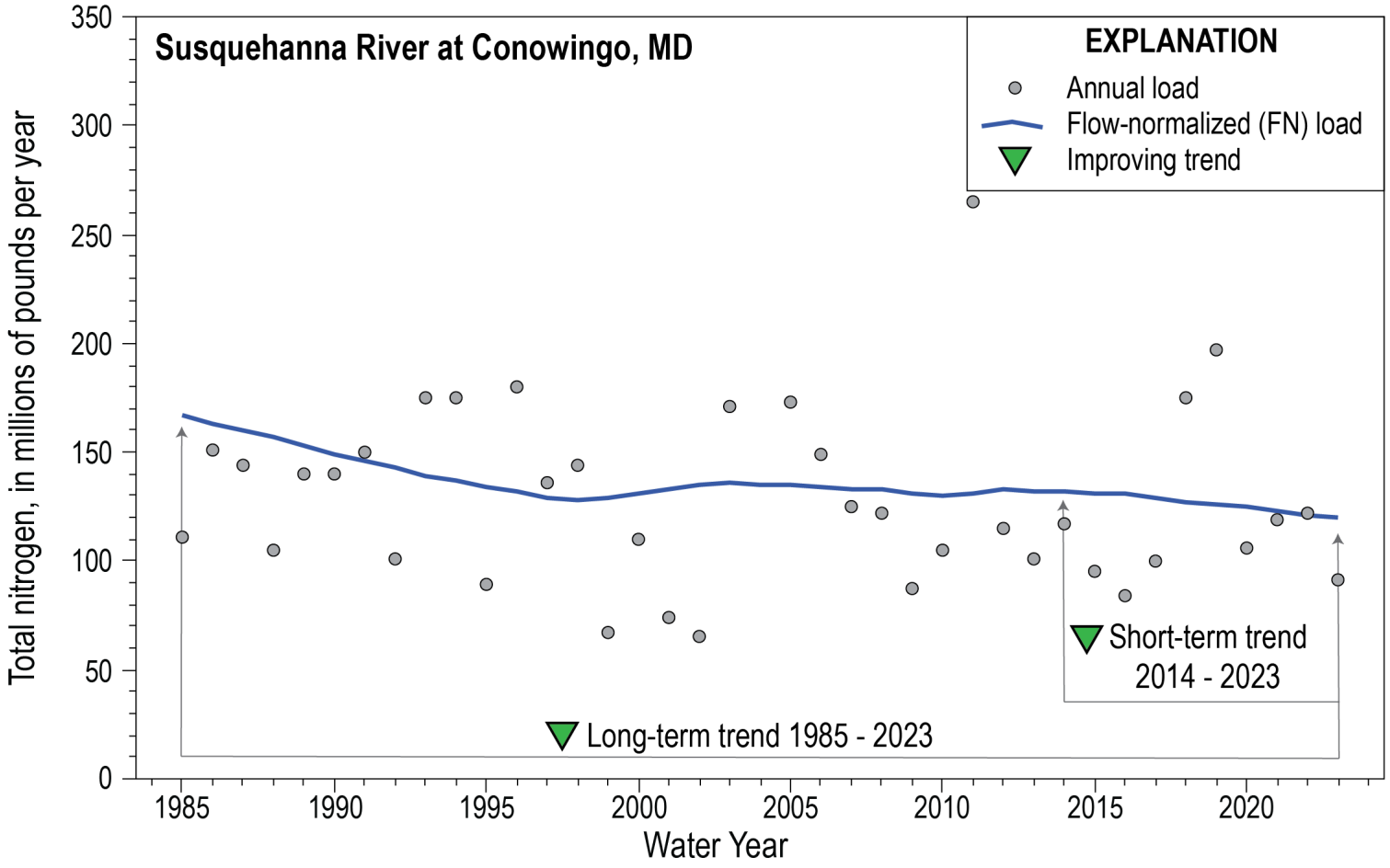
The goal of the RIM network is to compute the **load** and **trend**[1] of nitrogen, phosphorus, and suspended sediment delivered from 9 of the largest watershed tributaries to the Chesapeake Bay.

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.

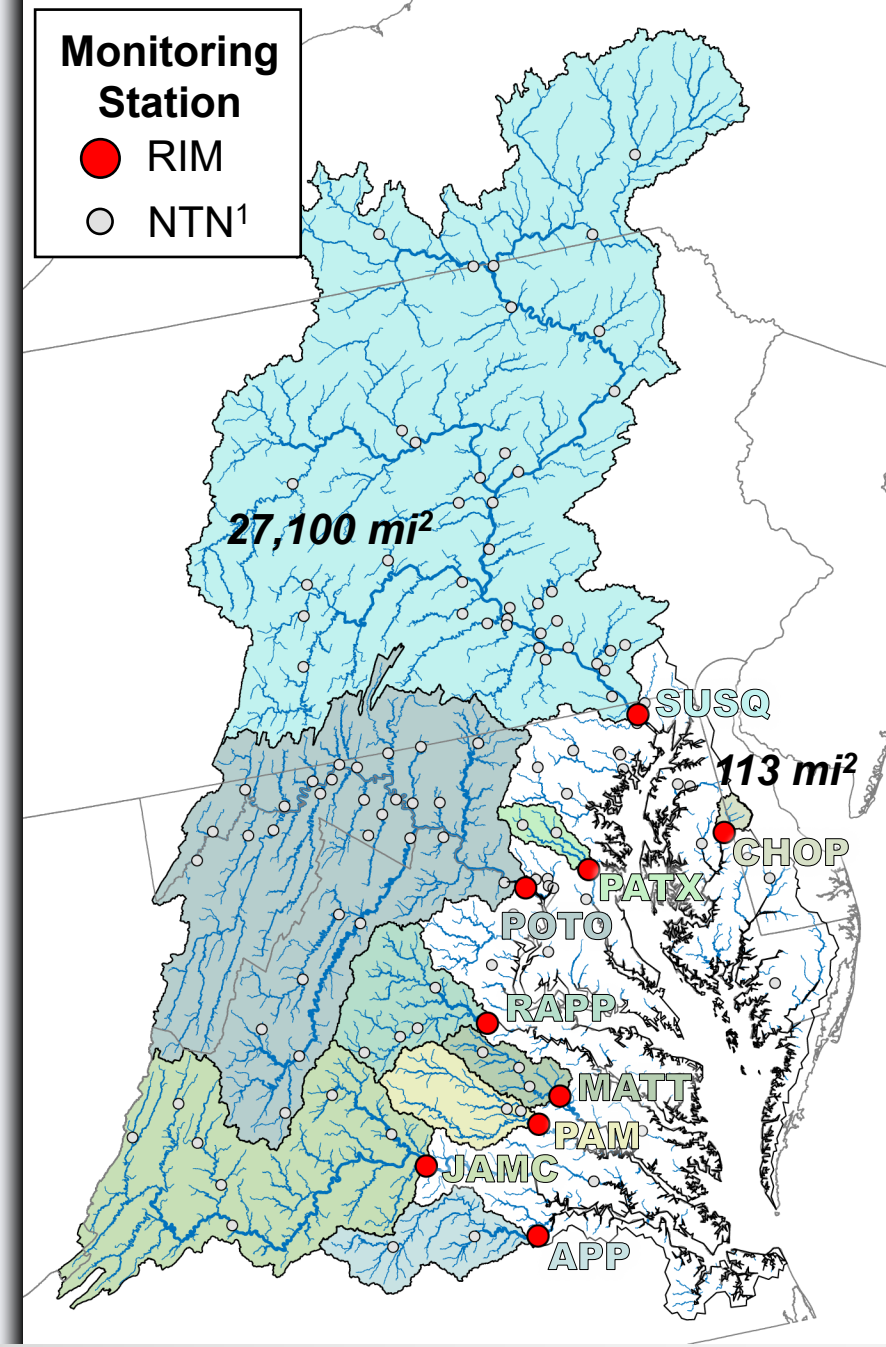
RIM stations represent about 78% of the Chesapeake Bay watershed area

Maryland

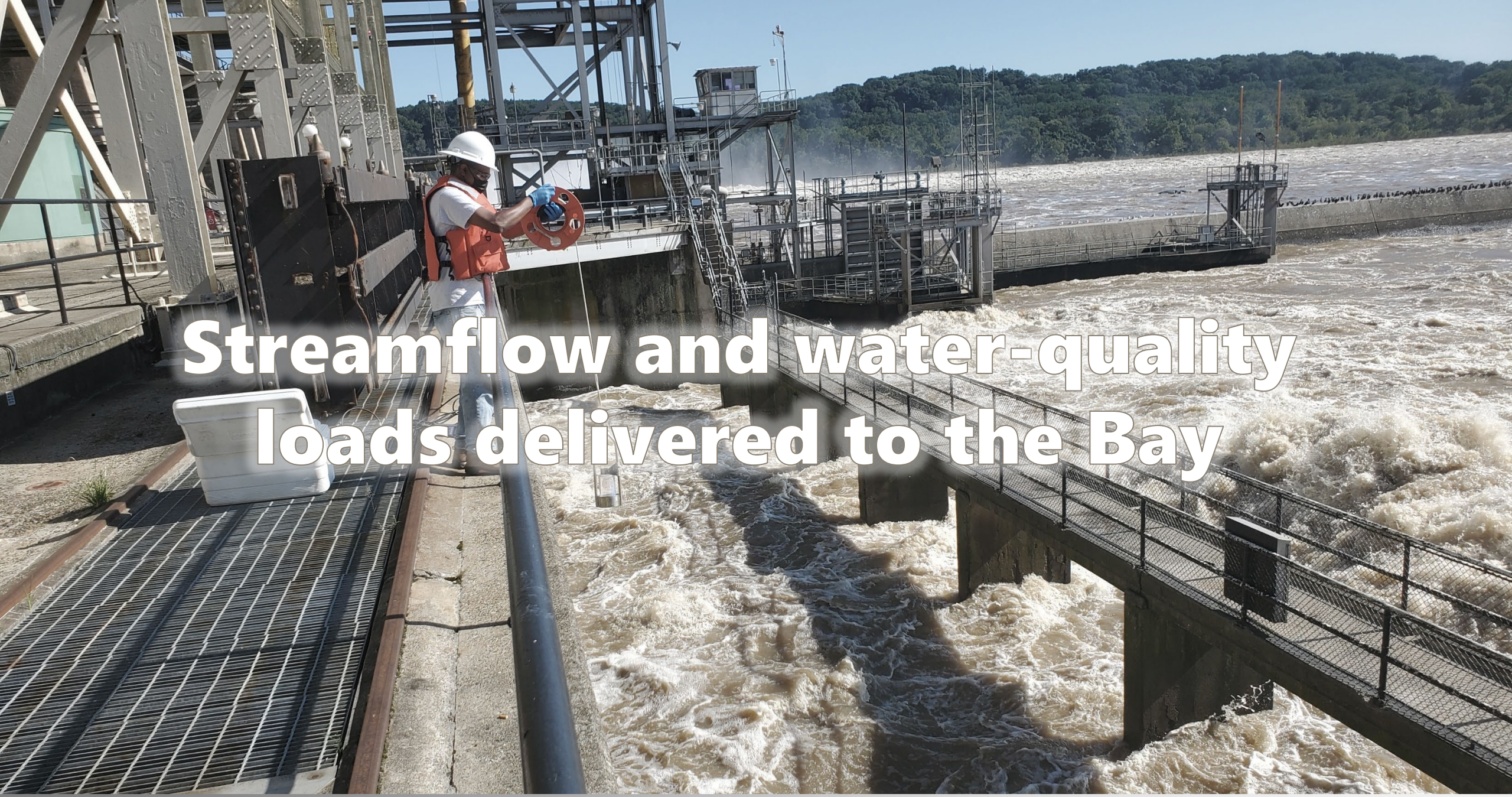
- **SUSQ:** Susquehanna River at Conowingo
- **CHOP:** Choptank River nr Greensboro
- **PATX:** Patuxent River nr Bowie
- **POTO:** Potomac River at Chain Bridge

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 being updated through water year 2023 and will be available in late 2024.



Streamflow and water-quality loads delivered to the Bay

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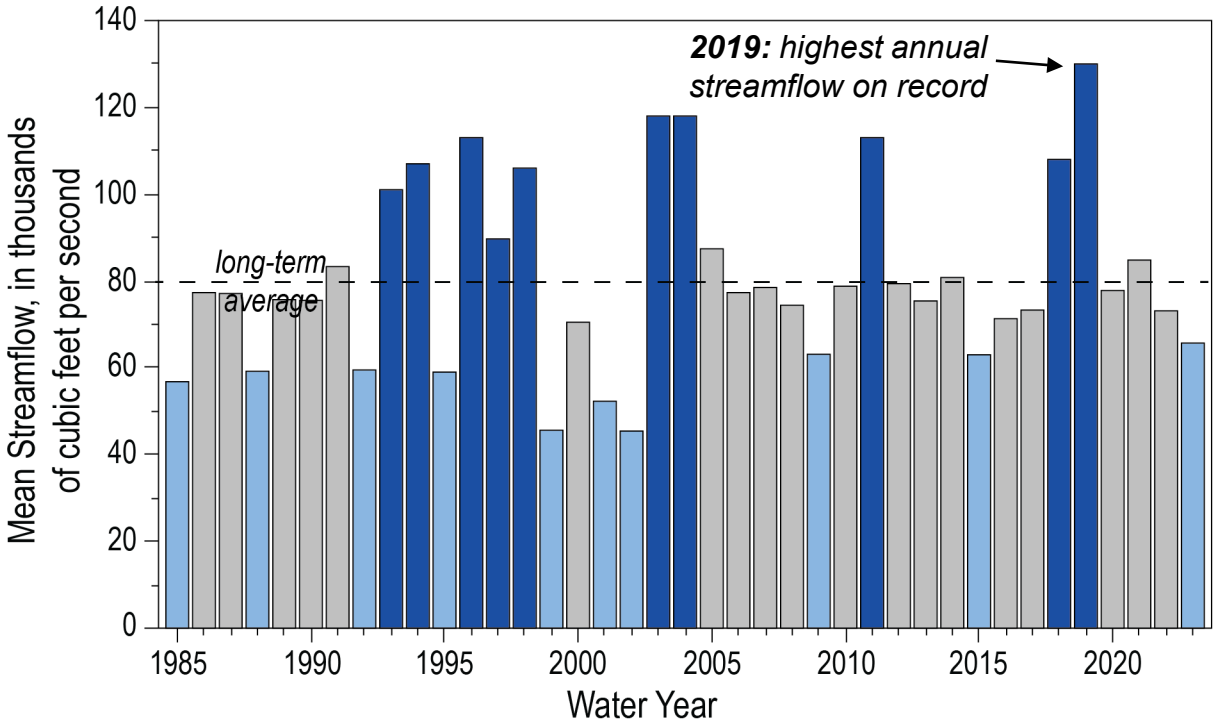
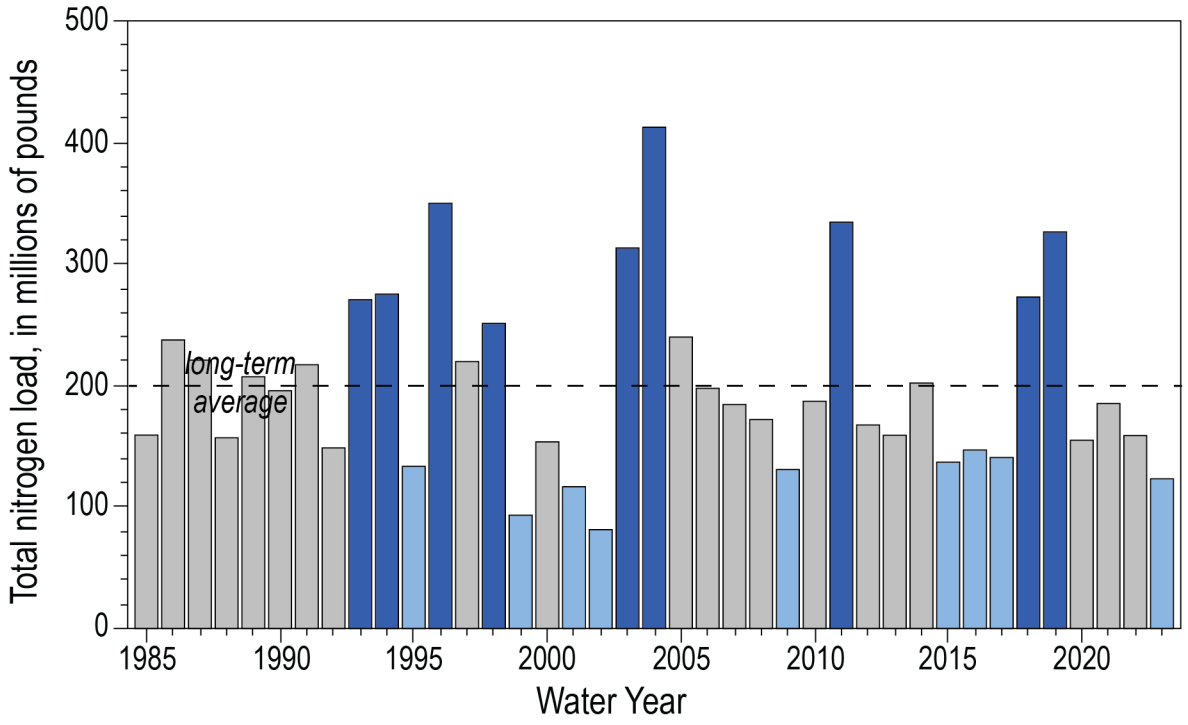
Background photo: Collecting a storm sample on the Susquehanna River at Conowingo Dam

Streamflow and load delivered to the Bay from the watershed was below average in water year 2023

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

This lower amount of streamflow resulted in below-average nutrient and sediment loads delivered to the Bay[2].





EXPLANATION

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

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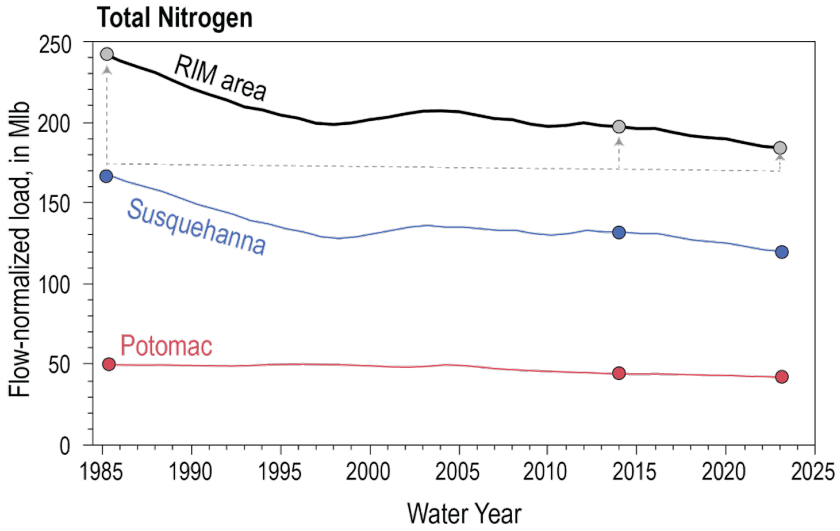
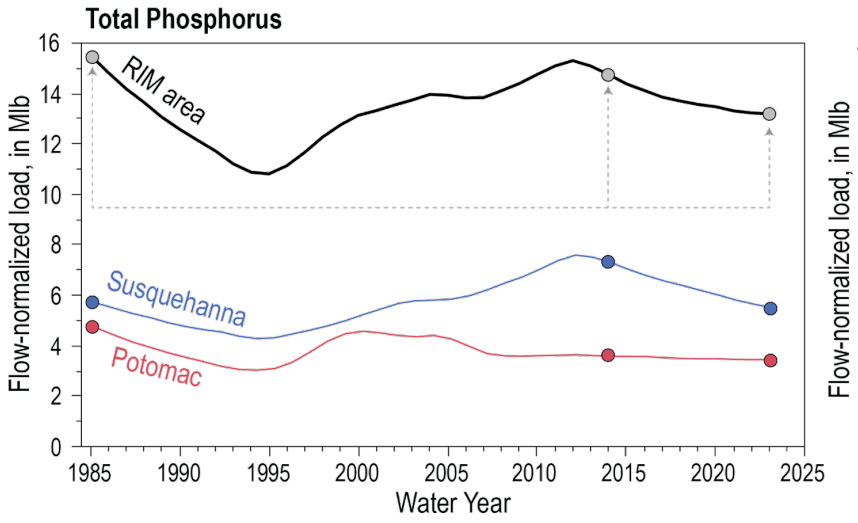
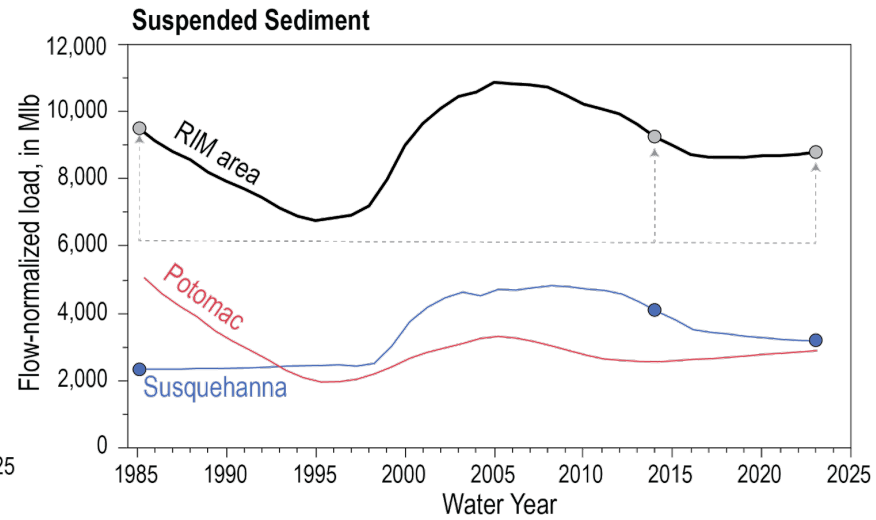
[1]Streamflow entering the Bay estimated from monitored and unmonitored watershed area: www.usgs.gov/centers/chesapeake-bay-activities/science/freshwater-flow-chesapeake-bay

[2]Compared to annual 1985 – 2023 loads in the RIM watershed area.

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







RIM FN total nitrogen loads

-7% from 2014 – 2023
-24% from 1985 – 2023

RIM FN total phosphorus loads

-12% from 2014 – 2023
-15% from 1985 – 2023

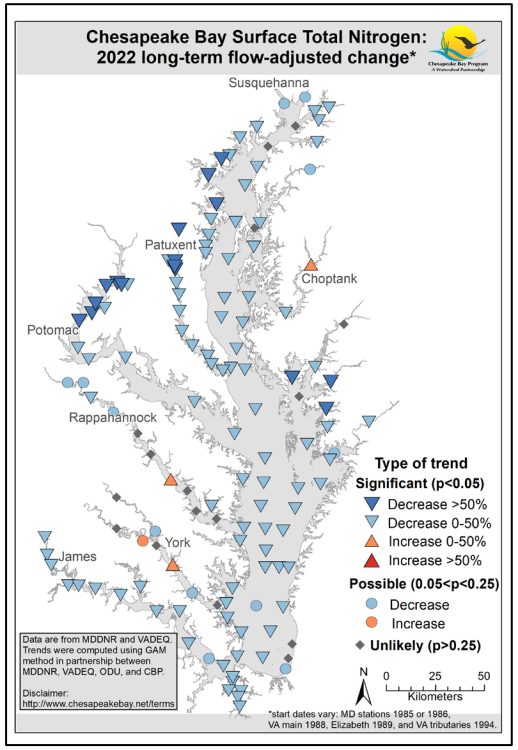
RIM FN suspended sediment loads

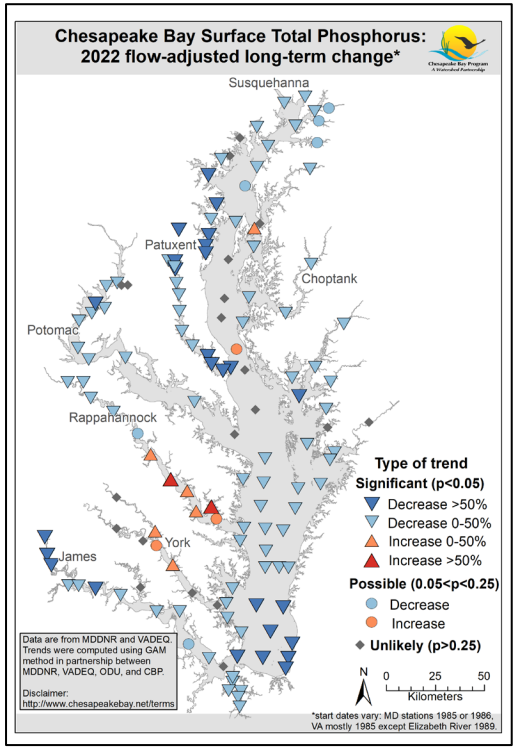
-5% from 2014 – 2023
-8% from 1985 – 2023

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.





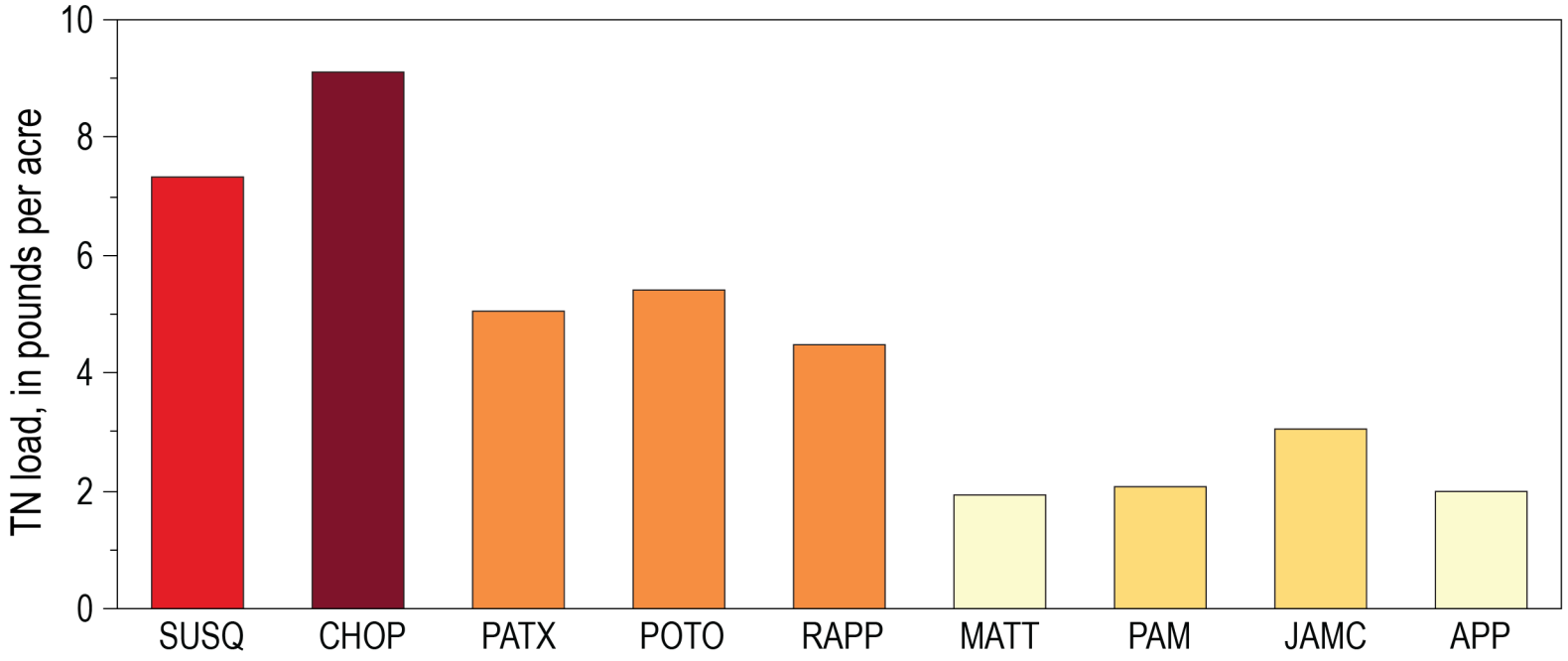
Monitoring data are used to compute water-quality trends in the Bay and tidal areas. These data are available online:
www.chesapeakebay.net/who/group/integrated-trends-analysis-team

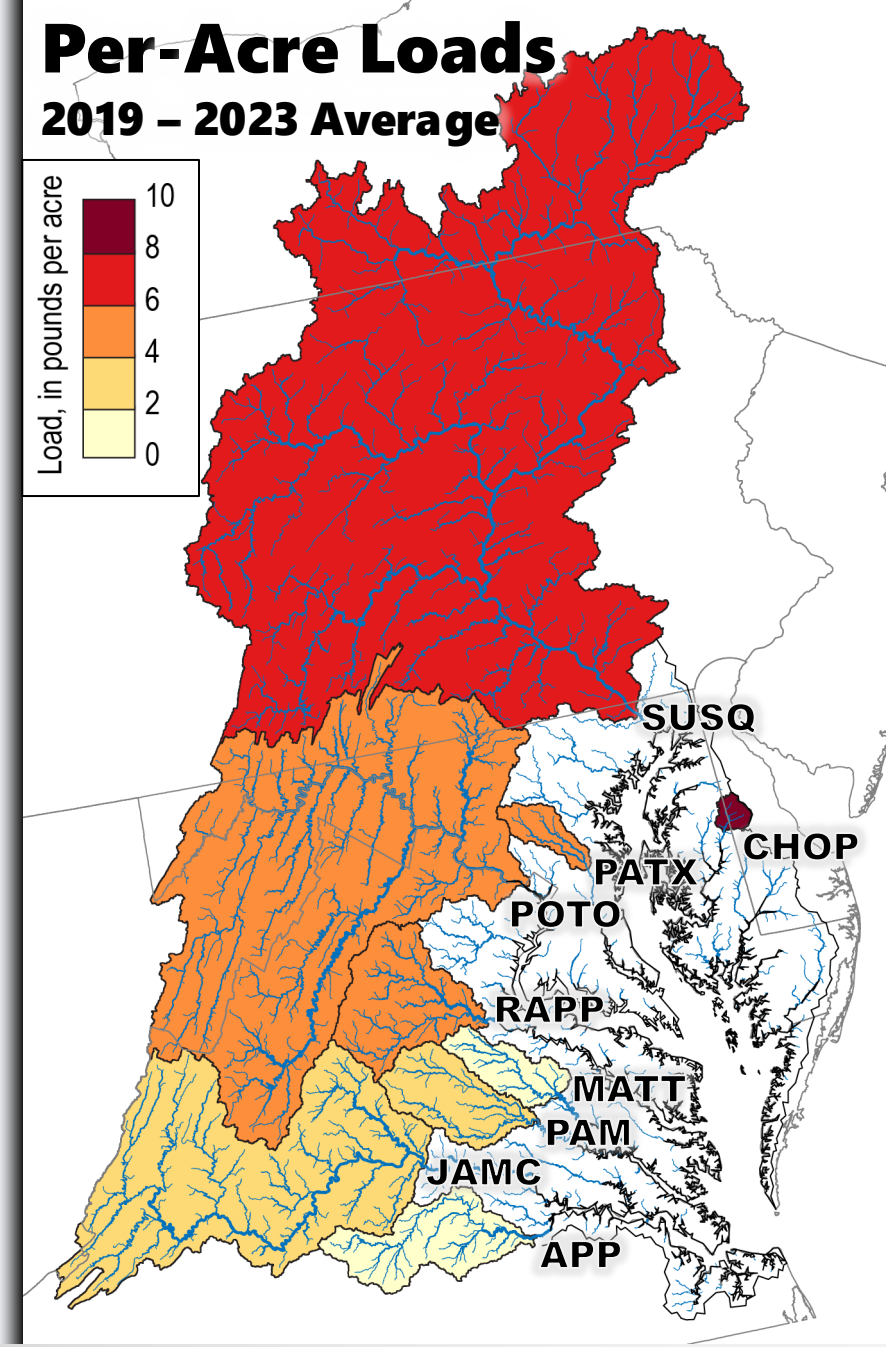
https://landsat.gsfc.nasa.gov/outreach/chesapeake-bay-from-space/

Per-acre loads (yields) at the RIM stations

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

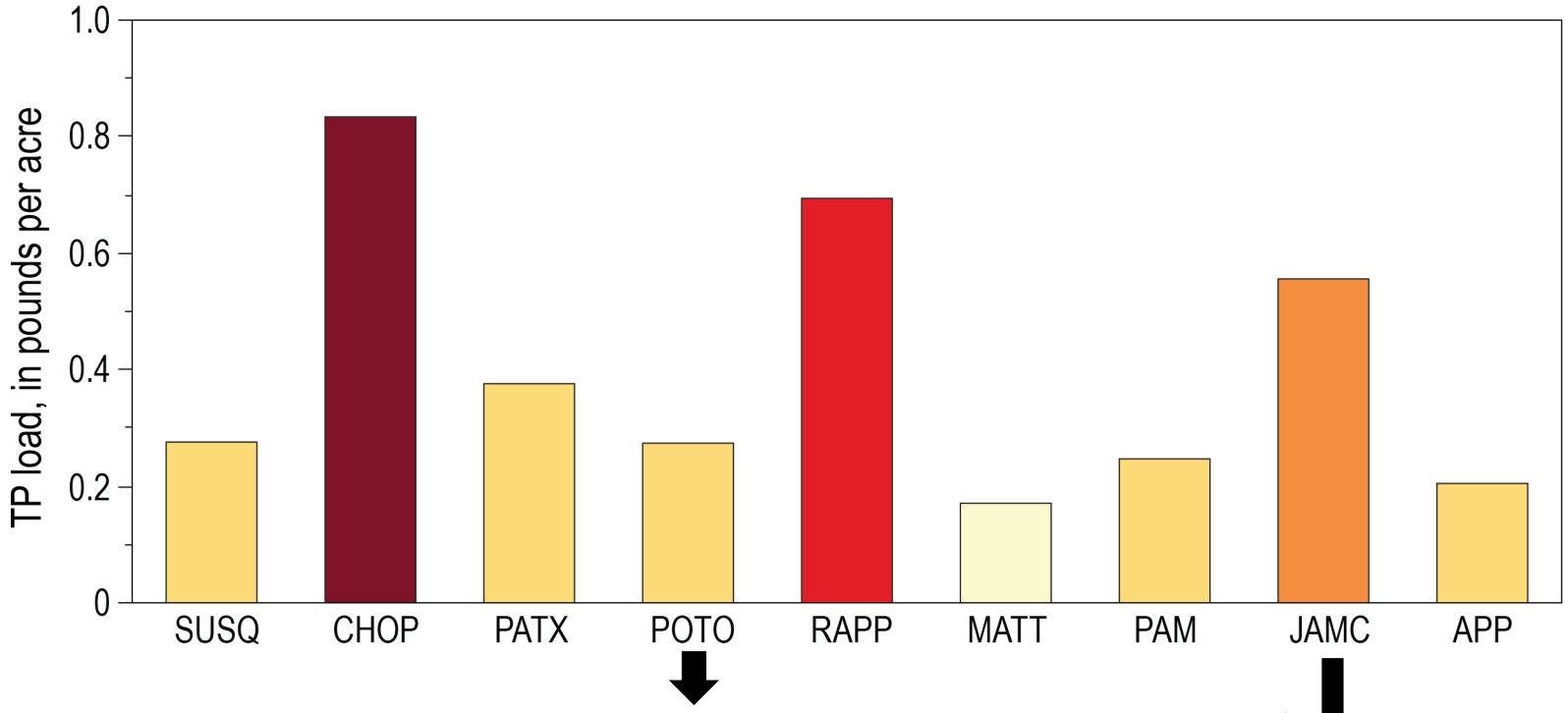
The **Susquehanna** and **Choptank Rivers** have the highest total nitrogen per-acre loads of all RIM stations.



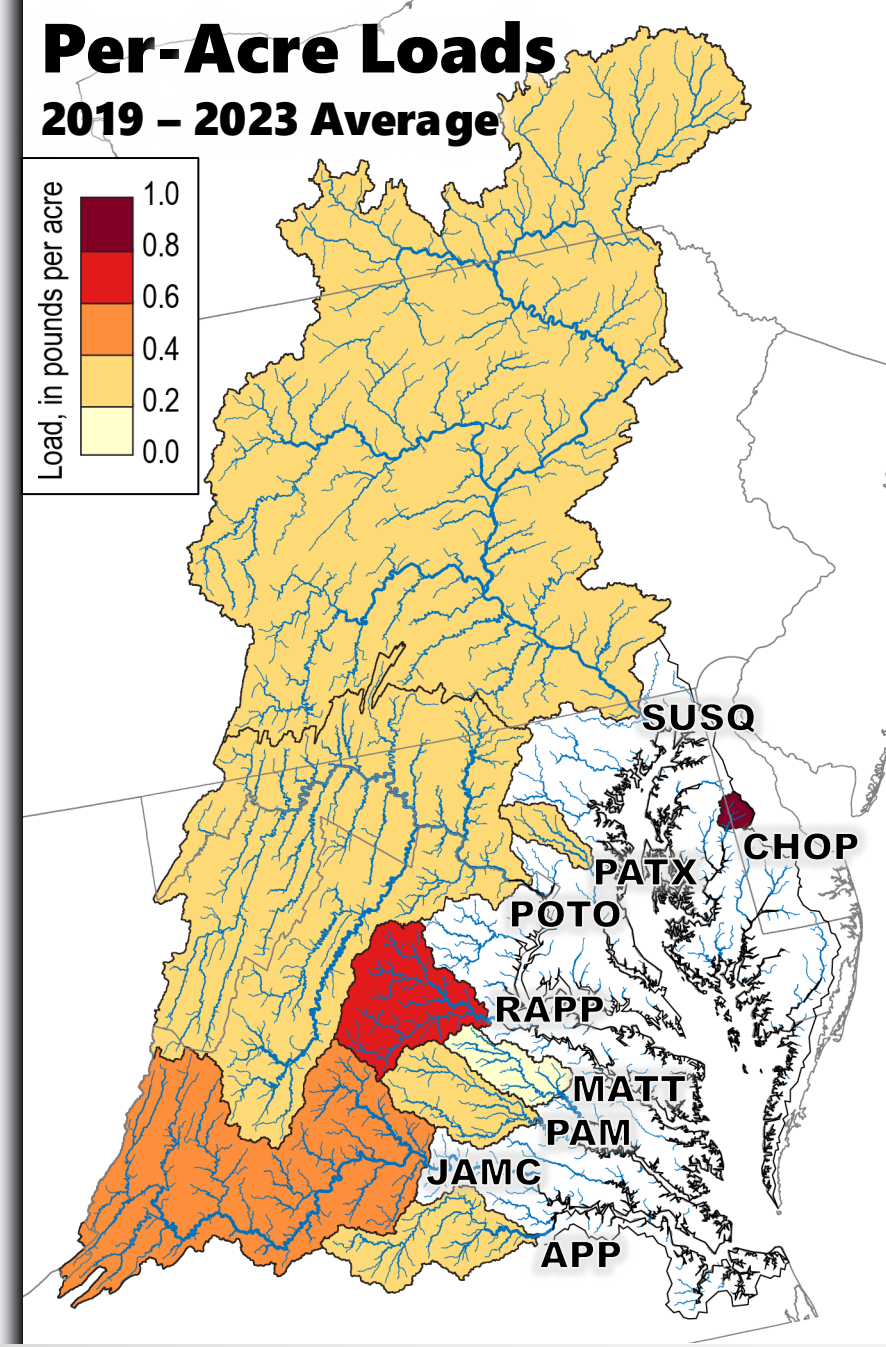


Total Phosphorus:
Per-Acre Loads (2019 – 2023 Average)

The **Choptank** and **Rappahannock Rivers** have the highest total phosphorus per-acre loads of all RIM stations.

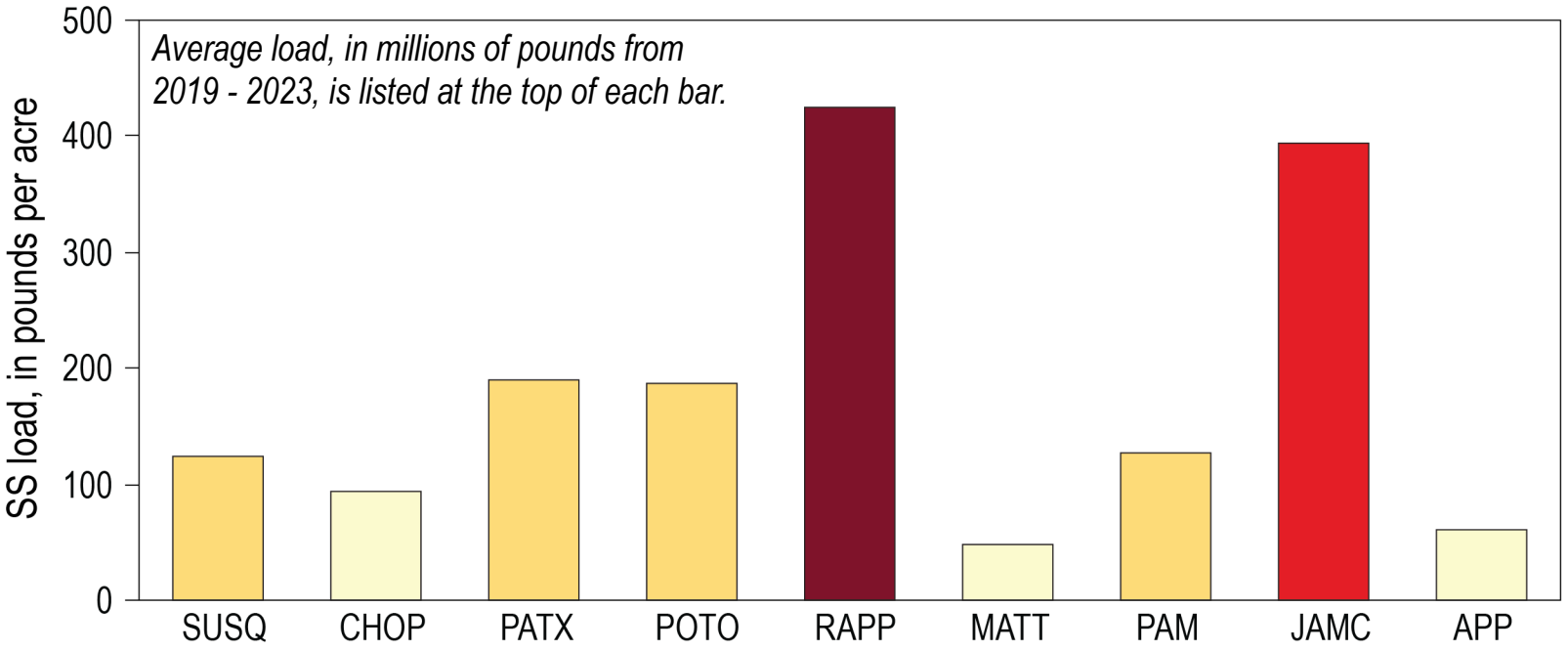


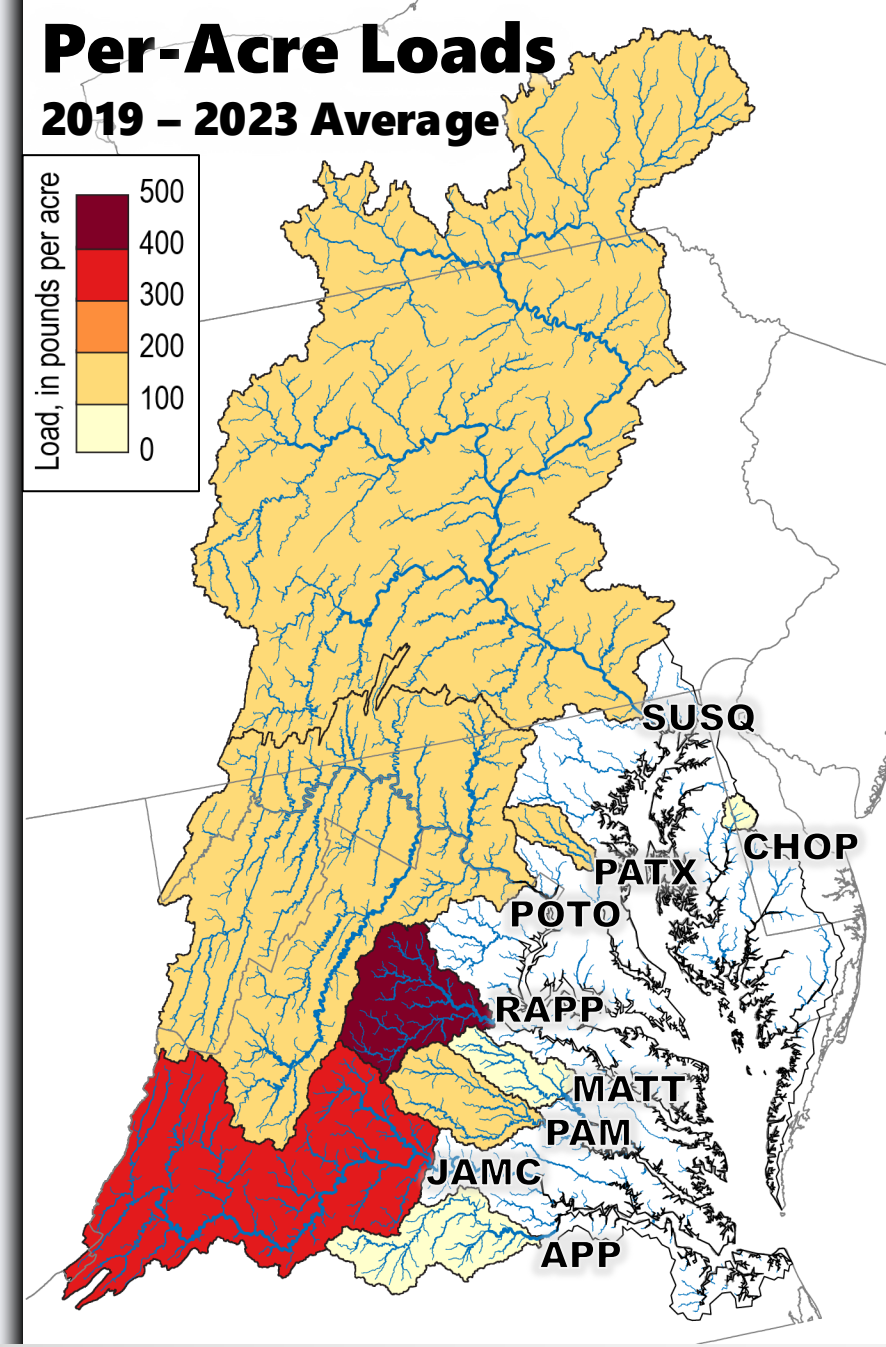
The average TP load from the James River was 2.2 million pounds. This exceeds the TP load from the Potomac River (2.0 million pounds) even though the Potomac River watershed is about twice the size of the James River watershed.



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

The **Rappahannock** and **James Rivers** have the highest suspended sediment per-acre loads of all RIM stations.






Trends at the RIM stations

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

Trend Summary

- 12 trends have improved and 13 have degraded since 1985.
- 10 trends have improved and 11 have degraded since 2014.

Good News

- Most trends improved at the Susquehanna and Potomac.
- All trends improved at the Patuxent.

Recent Areas of Concern

- The Choptank has the highest TP per-acre load and the largest TP short-term percent increase
- Other than the Pamunkey, loads were higher in 2023 than 2014 at all Virginia RIM stations.

	RIM Monitoring Station	Long term: 1985 - 2023			Short term: 2014 - 2023		
		TN	TP	SS	TN	TP	SS
Maryland RIM stations	SUSQ	-28.3%	-2.9%	+35.9%	-9.1%	-24.2%	-21.2%
	CHOP	+1.6%	+90.9%	-21.1%	+0.1%	+34.2%	+13.2%
	PATX	-67.9%	-69.1%	-45.8%	-18.5%	-15.5%	-12.0%
	POTO	-15.4%	-26.1%	-42.5%	-4.4%	-3.9%	+12.8%
Virginia RIM stations	RAPP	-10.9%	+40.7%	+58.8%	+13.2%	+16.3%	+9.9%
	MATT	-5.6%	+4.7%	+12.4%	+3.8%	+7.6%	+33.1%
	PAM	+0.4%	+59.0%	+31.5%	-2.3%	-0.7%	-16.6%
	JAMC	-13.9%	-31.7%	+21.6%	+2.1%	+6.7%	+1.6%
	APPO	+7.7%	+94.2%	+30.8%	+9.0%	+23.0%	+29.9%

Trend Direction Improving Degrading No trend

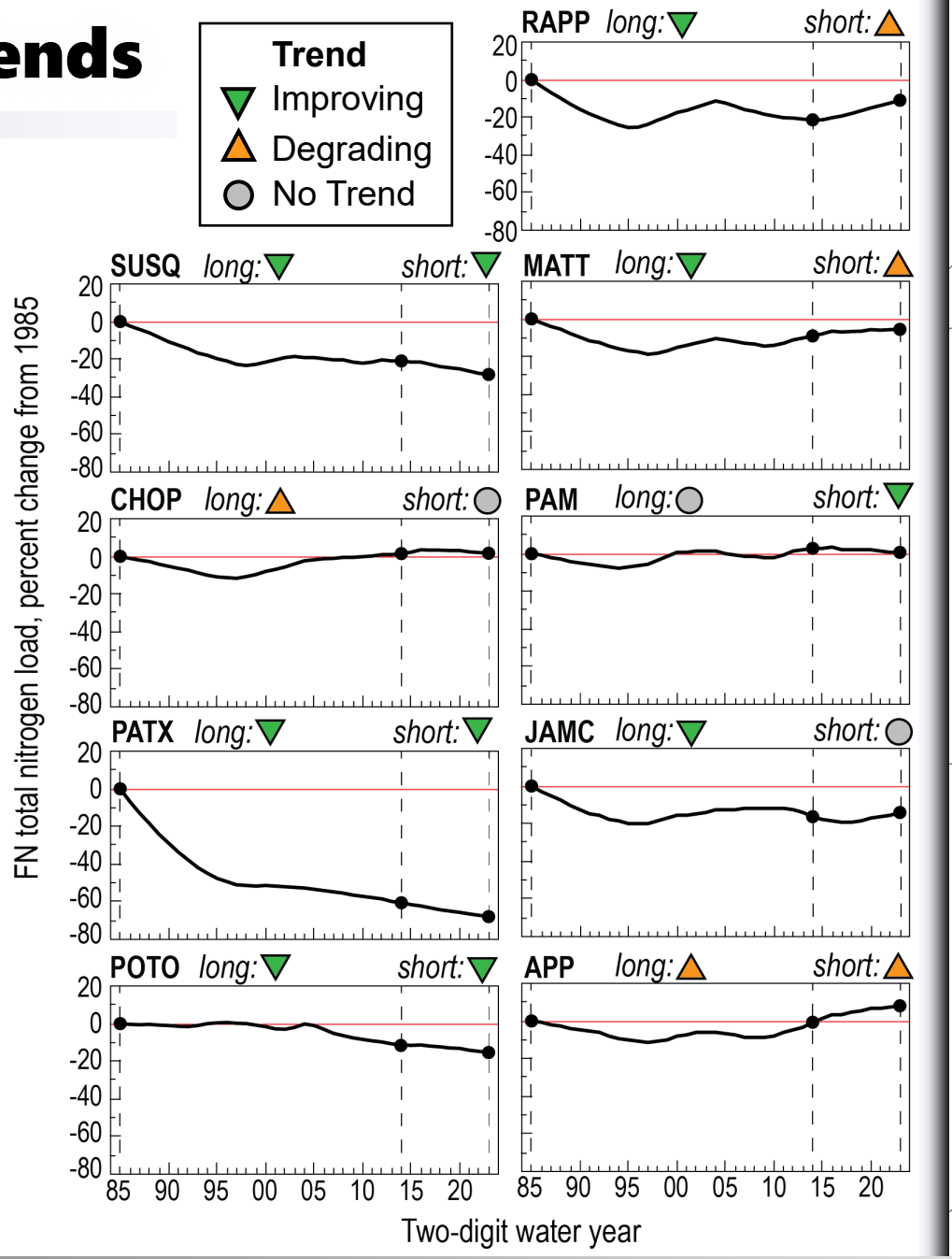
Total Nitrogen Trends

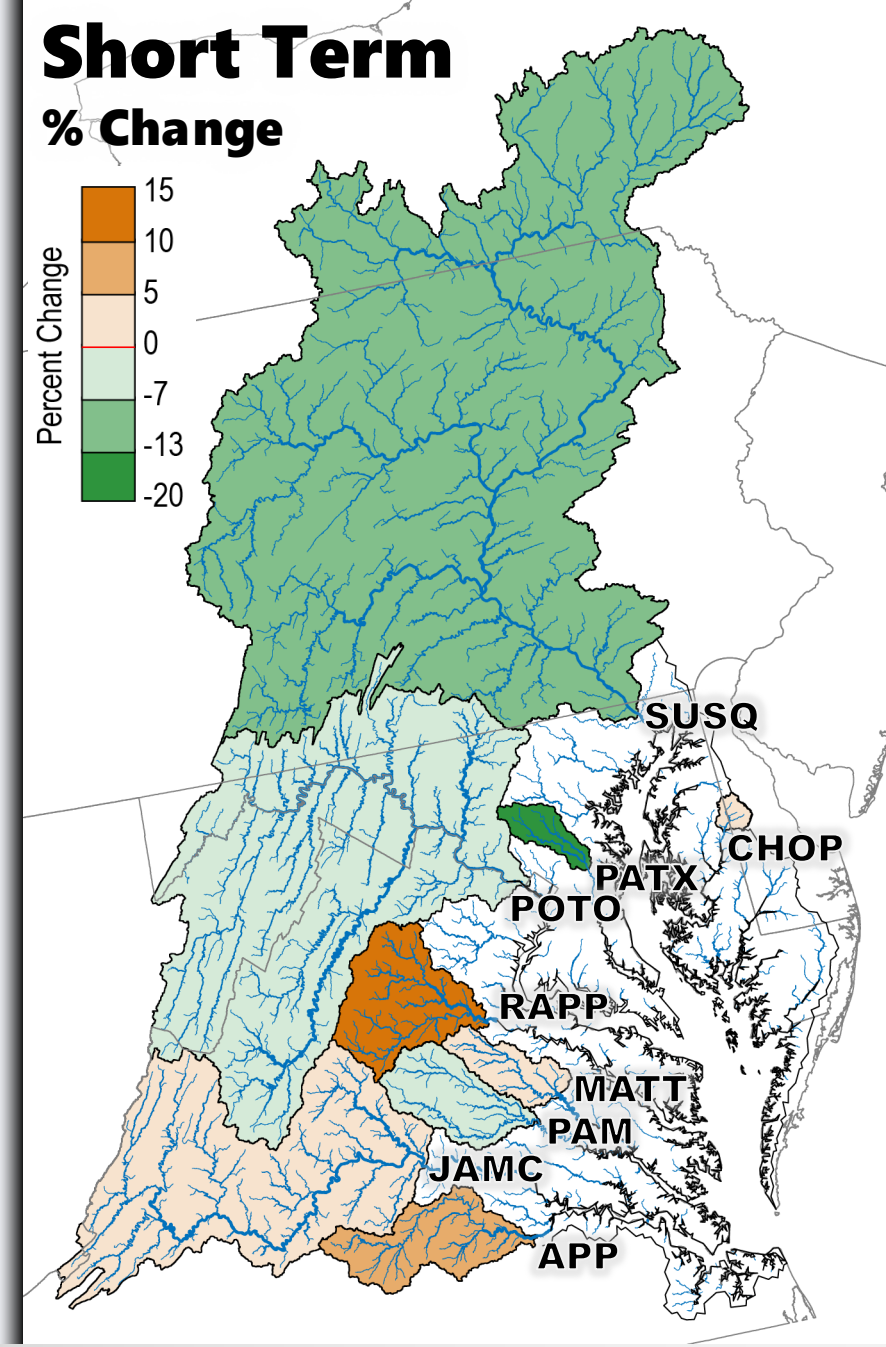
Since 1985:
- 6 stations have improved
- 2 stations have degraded

Since 2014:
- 4 stations have improved
- 3 stations have degraded

The largest percent decrease since 2014 has been at the Patuxent (-18.5%).

The largest percent increases since 2014 have been at the Rappahannock (+13.2%) and the Appomattox (+9.0%).





Total Phosphorus Trends

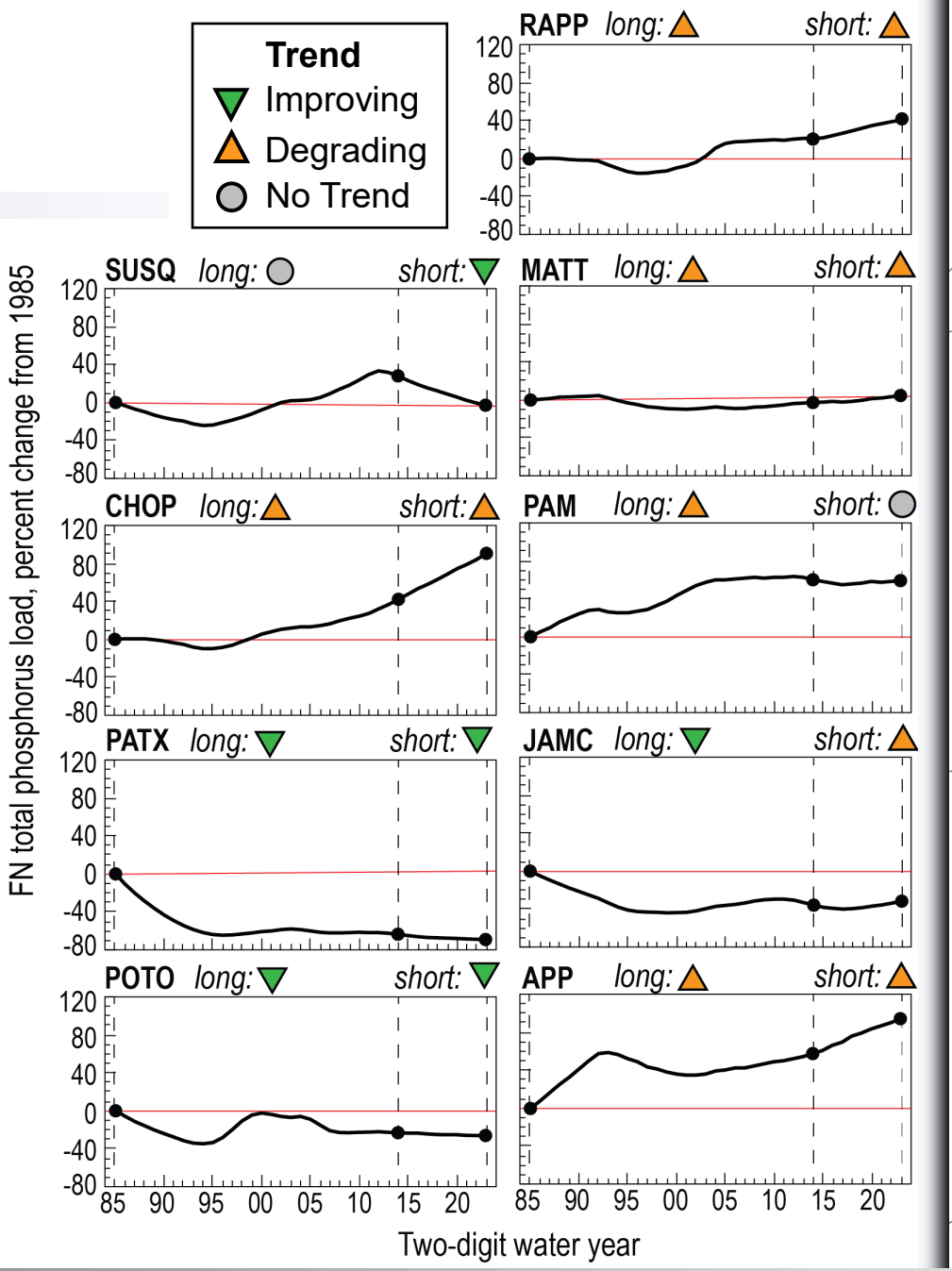
Since 1985:
- 3 stations have improved
- 5 stations have degraded

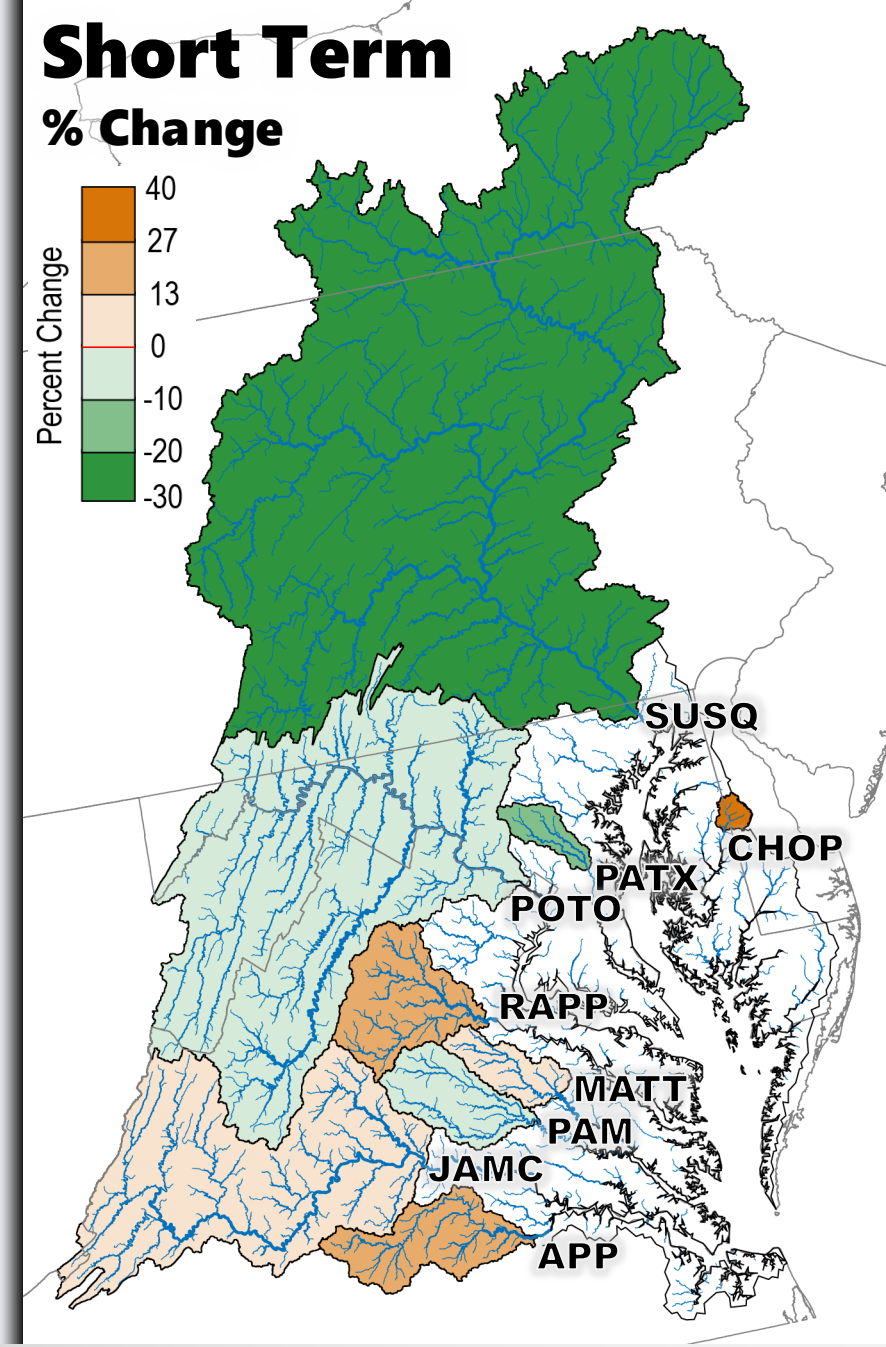
Since 2014:
- 3 stations have improved
- 5 stations have degraded

The largest percent decrease since 2014 has been at the Susquehanna (-24.2%).

The largest percent increases since 2014 have been at the Choptank (+34.2%) and the Appomattox (+23.0%).

→ The Choptank has the highest TP per-acre load.





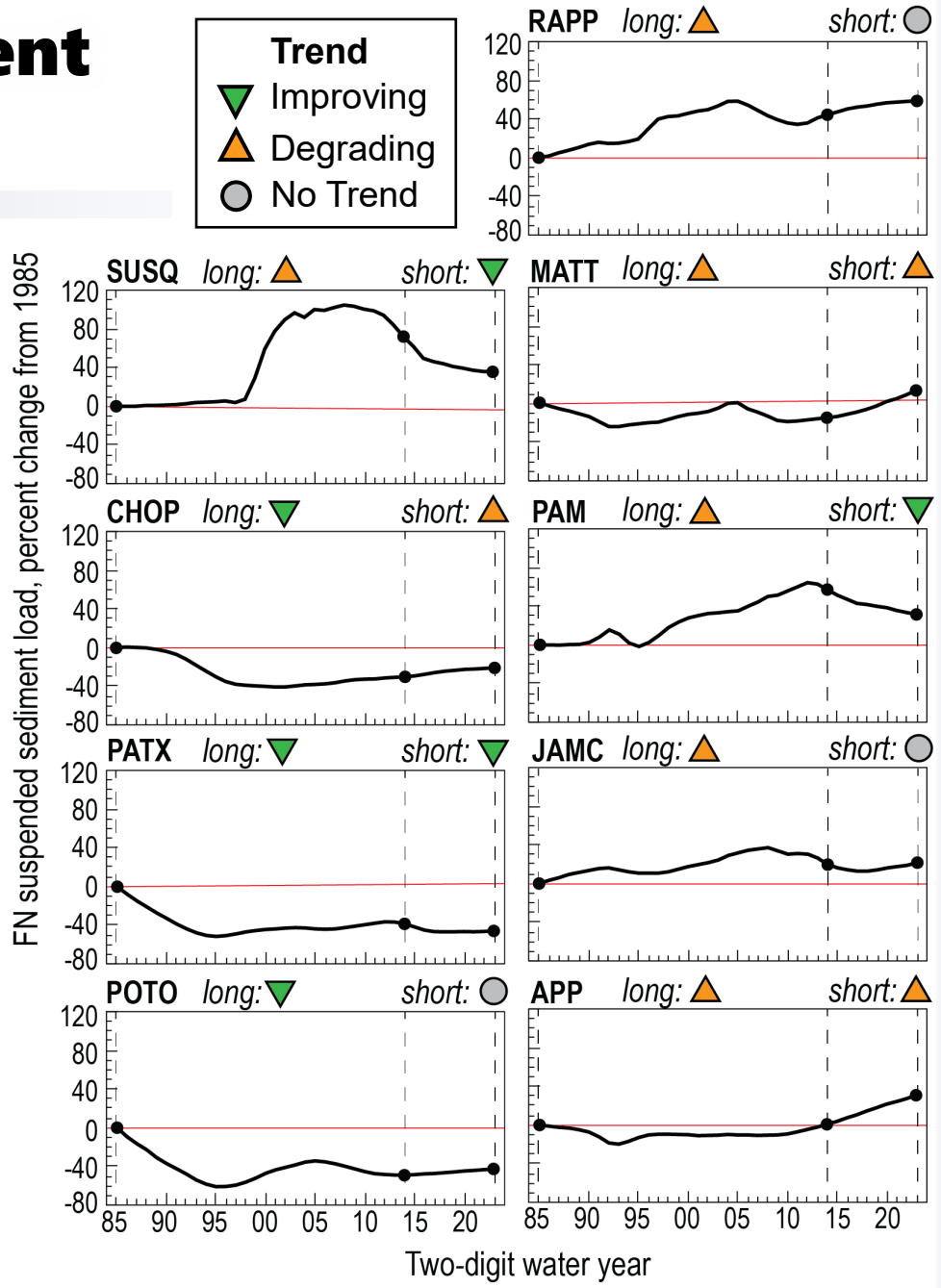
Suspended Sediment Trends

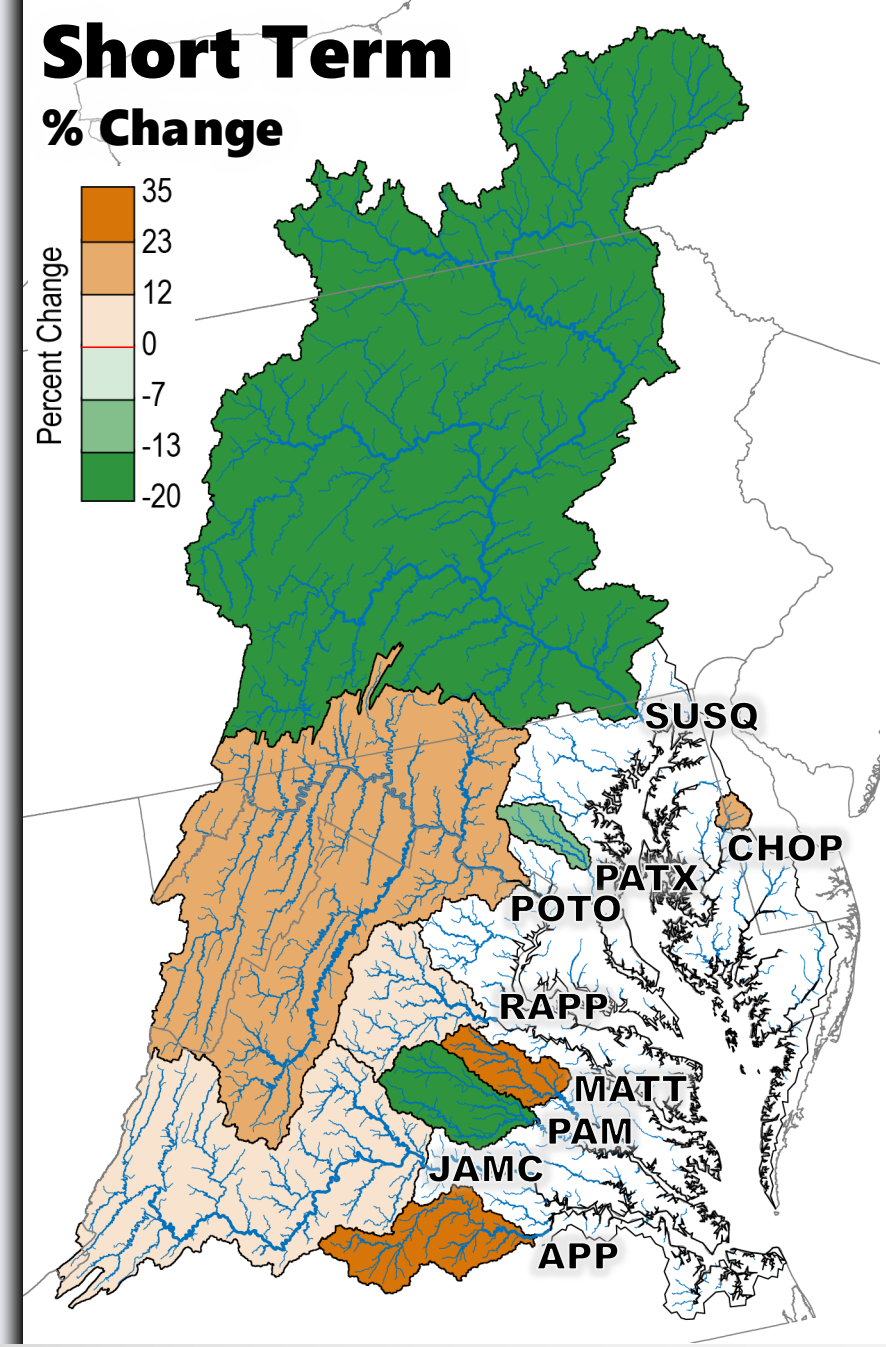
Since 1985:
- 3 stations have improved
- 6 stations have degraded

Since 2014:
- 3 stations have improved
- 3 stations have degraded

The largest percent decrease since 2014 has been at the Susquehanna (-21.2%).

The largest percent increases since 2014 have been at the Mattaponi (+33.1%) and the Appomattox (+29.9%).





Trends and water-quality goals

A new trend period was computed to align with the time frame used in TMDL[1] modeling

Why compute a trend from 1995 through 2023?

Because TMDL[1] planning targets represent modeled load reductions from 1995 that are needed to meet water-quality standards in the Bay.

Therefore, meeting TMDL 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	TMDL Period: 1995 - 2023		
	TN	TP	SS
SUSQ	-10.6%	+27.3%	+29.5%
CHOP	+14.1%	+111.0%	+13.2%
PATX	-38.7%	-14.1%	+11.8%
POTO	-15.6%	+11.0%	+47.4%
RAPP	+19.5%	+63.3%	+33.1%
MATT	+13.8%	+8.2%	+43.9%
PAM	+8.4%	+26.7%	+33.8%
JAMC	+6.8%	+16.2%	+10.1%
APPO	+20.4%	+27.0%	+50.2%

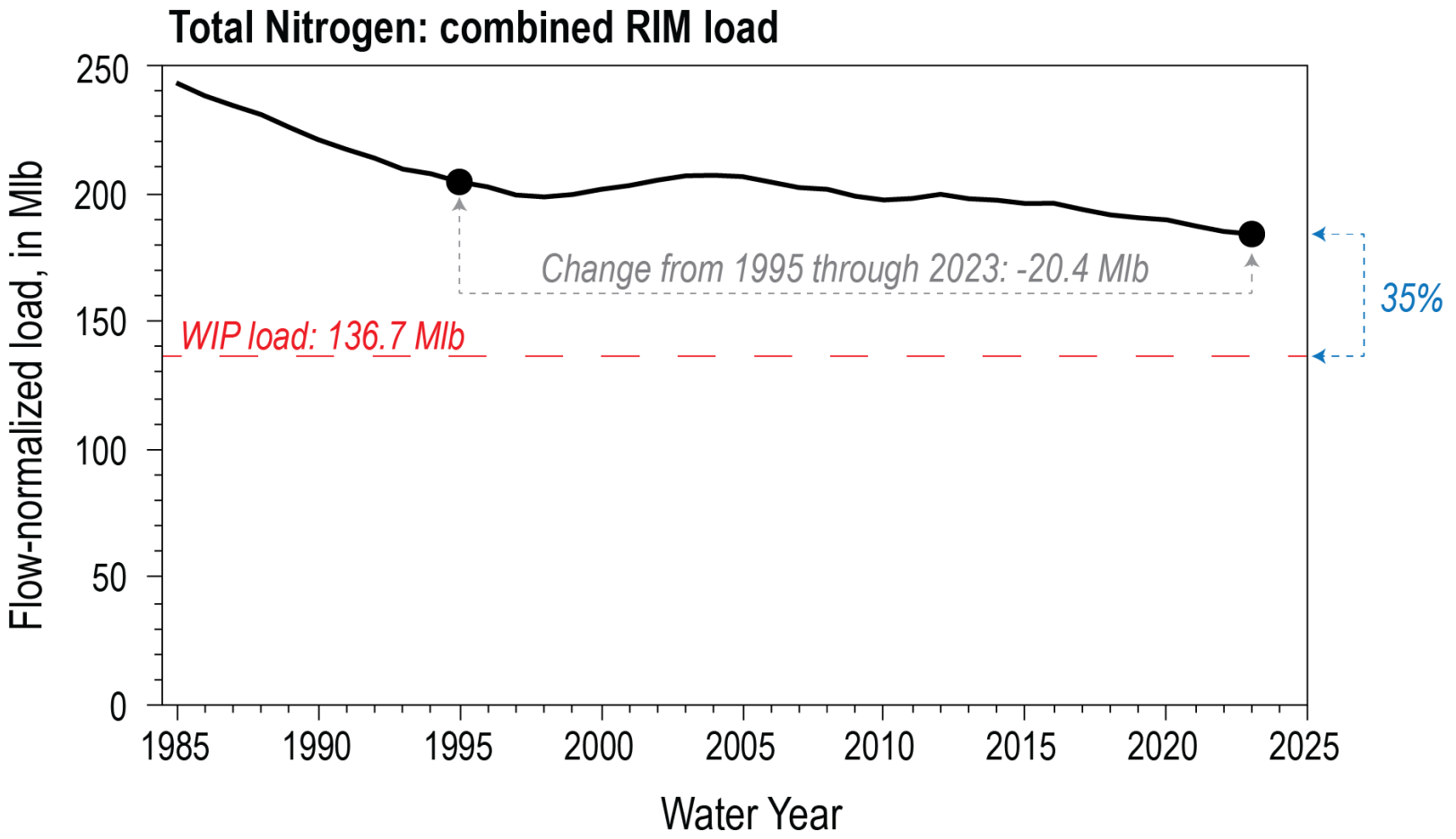
[1]**TMDL** = the 2010 Chesapeake Bay Total Maximum Daily Load

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].

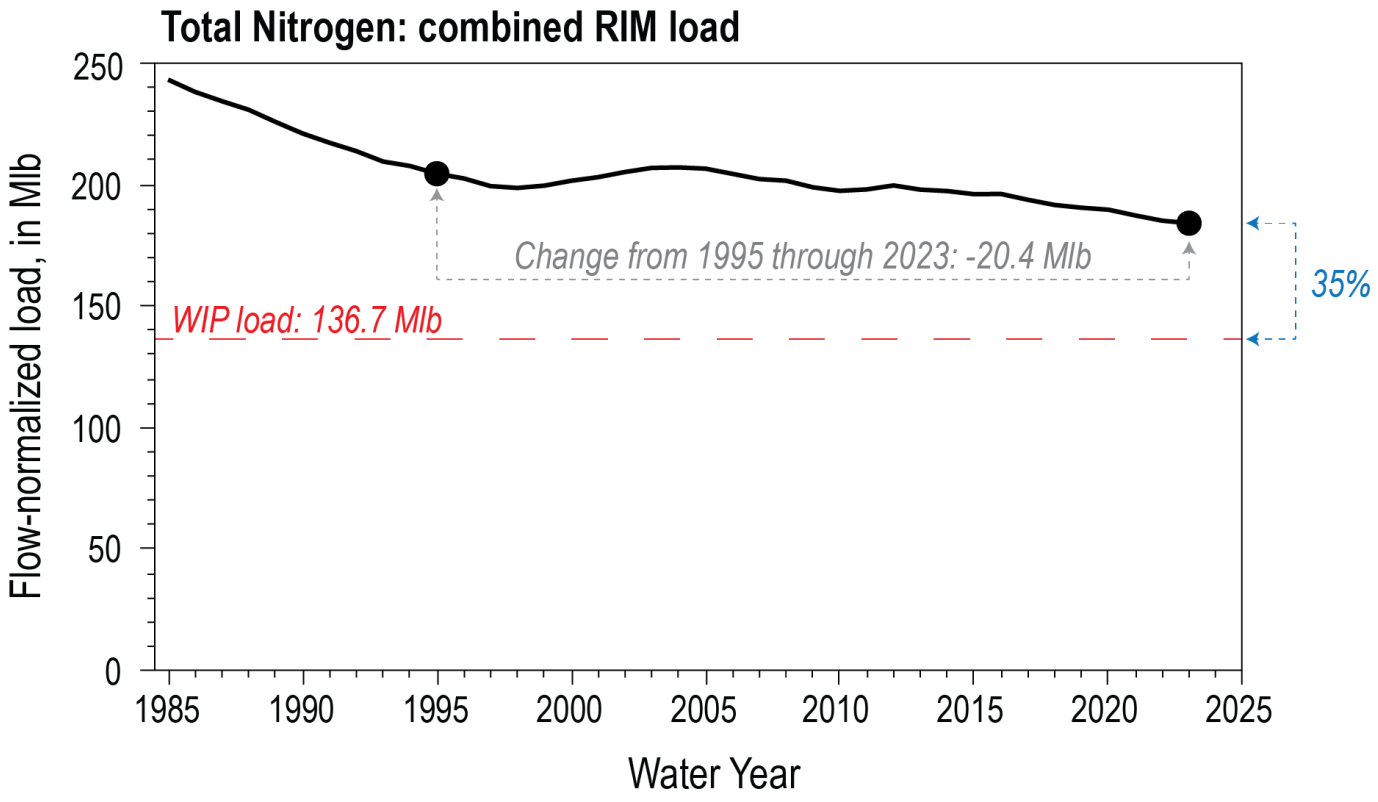
Monitored loads can be compared to WIP loads to assess progress towards meeting water-quality goals.



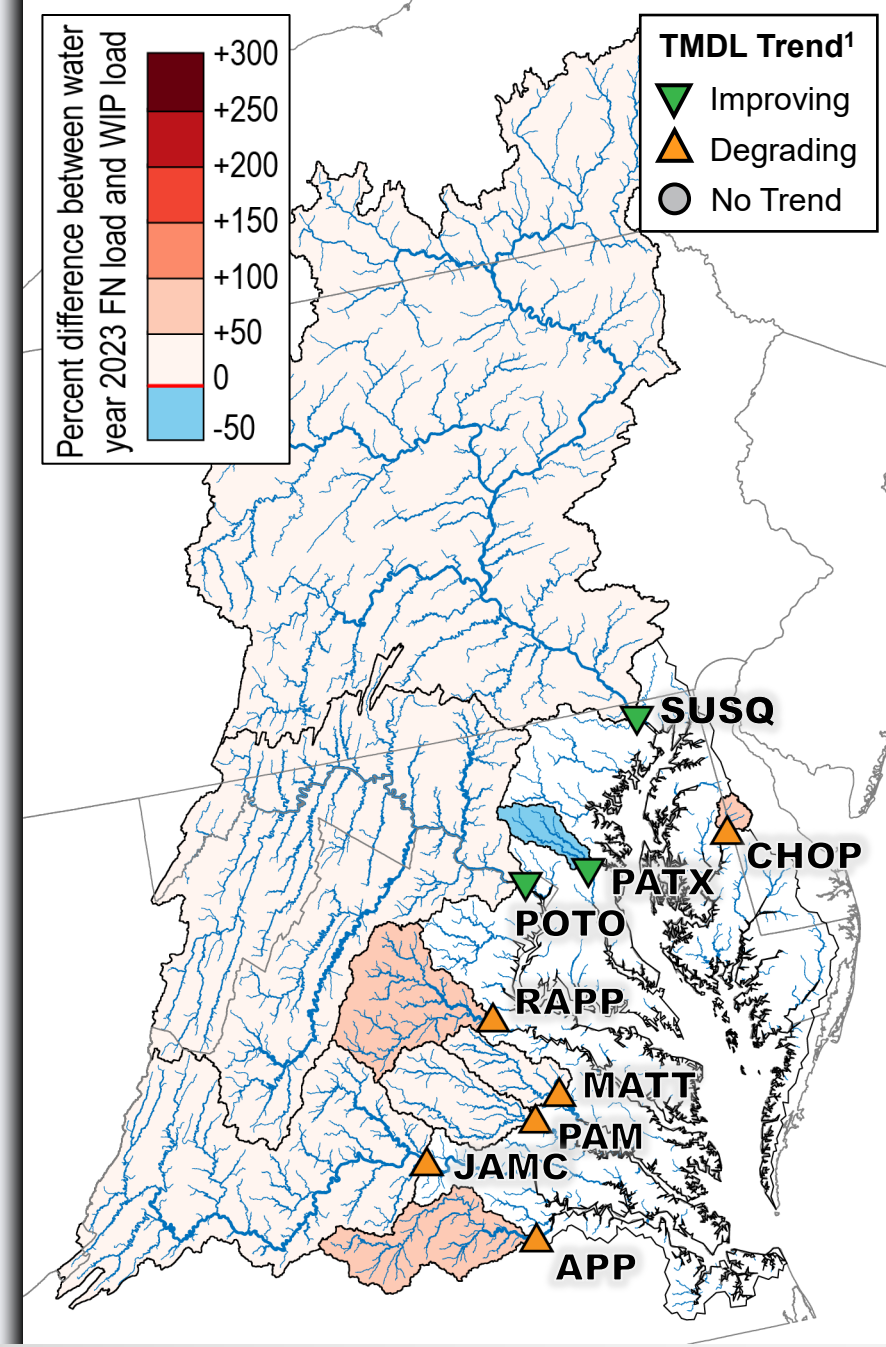
[1]WIP loads were estimated for each RIM watershed and compared against monitored loads, following approaches used by the recently published "METRIC" tool: https://wqs.chesapeakebay.net/metric

Total Nitrogen:
Monitored loads v WIP loads

In water year 2023, the combined RIM load of total nitrogen exceeded the WIP load by **35%**.

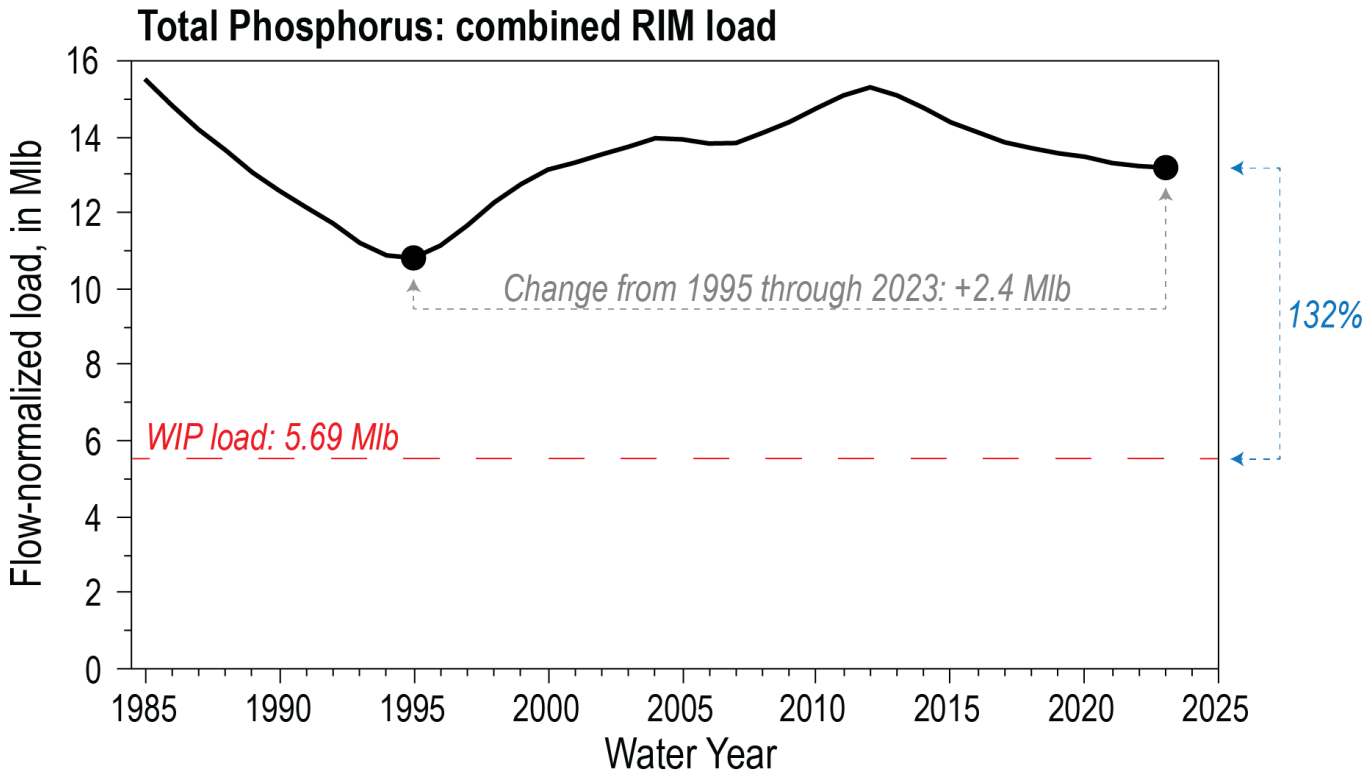


The FN load exceeded the WIP load of total nitrogen in all RIM watersheds except the Patuxent in water year 2023.

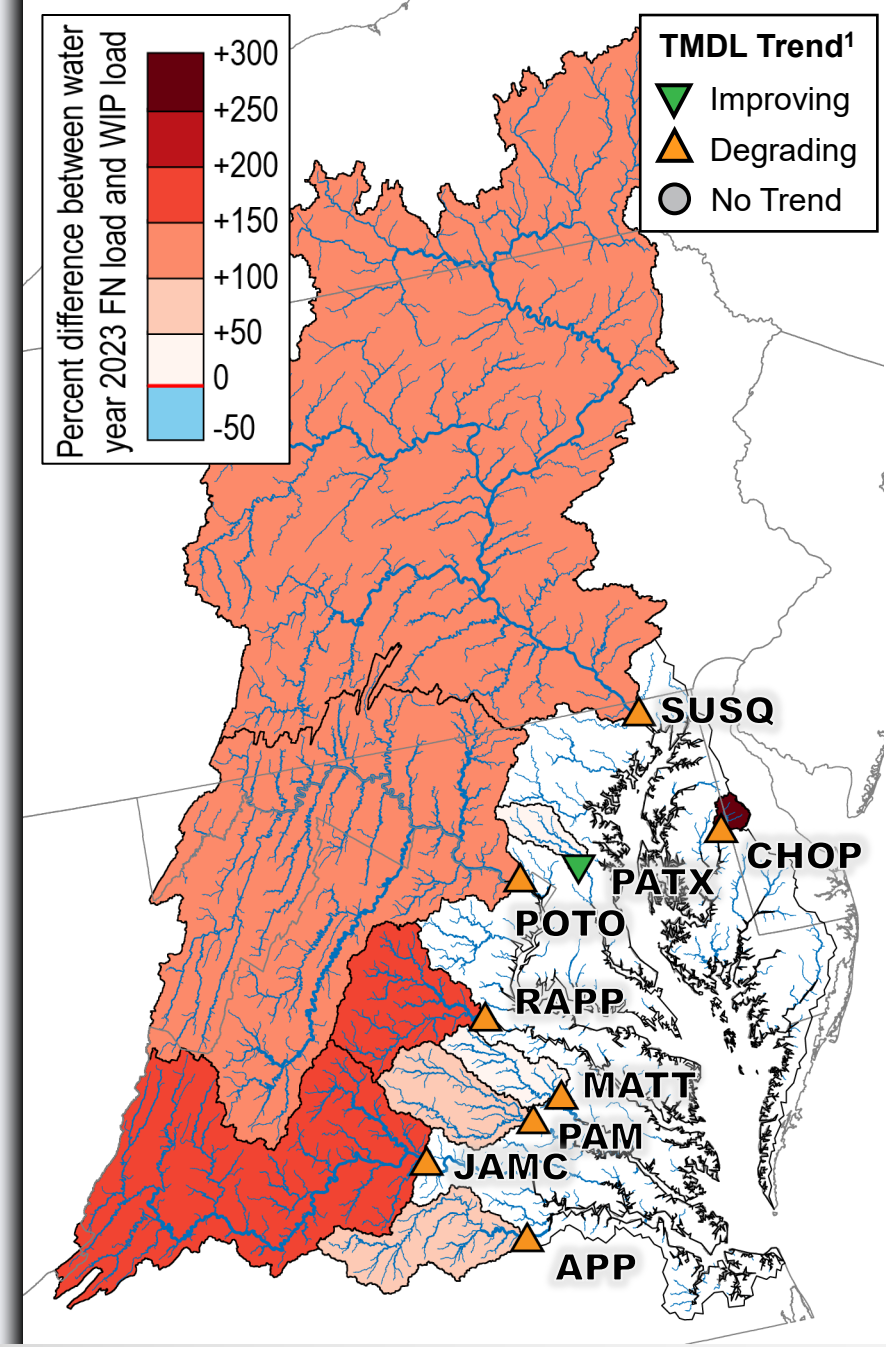


Total Phosphorus:
Monitored loads v WIP loads

In water year 2023, the combined RIM load of total phosphorus exceeded the WIP load by **132%**.

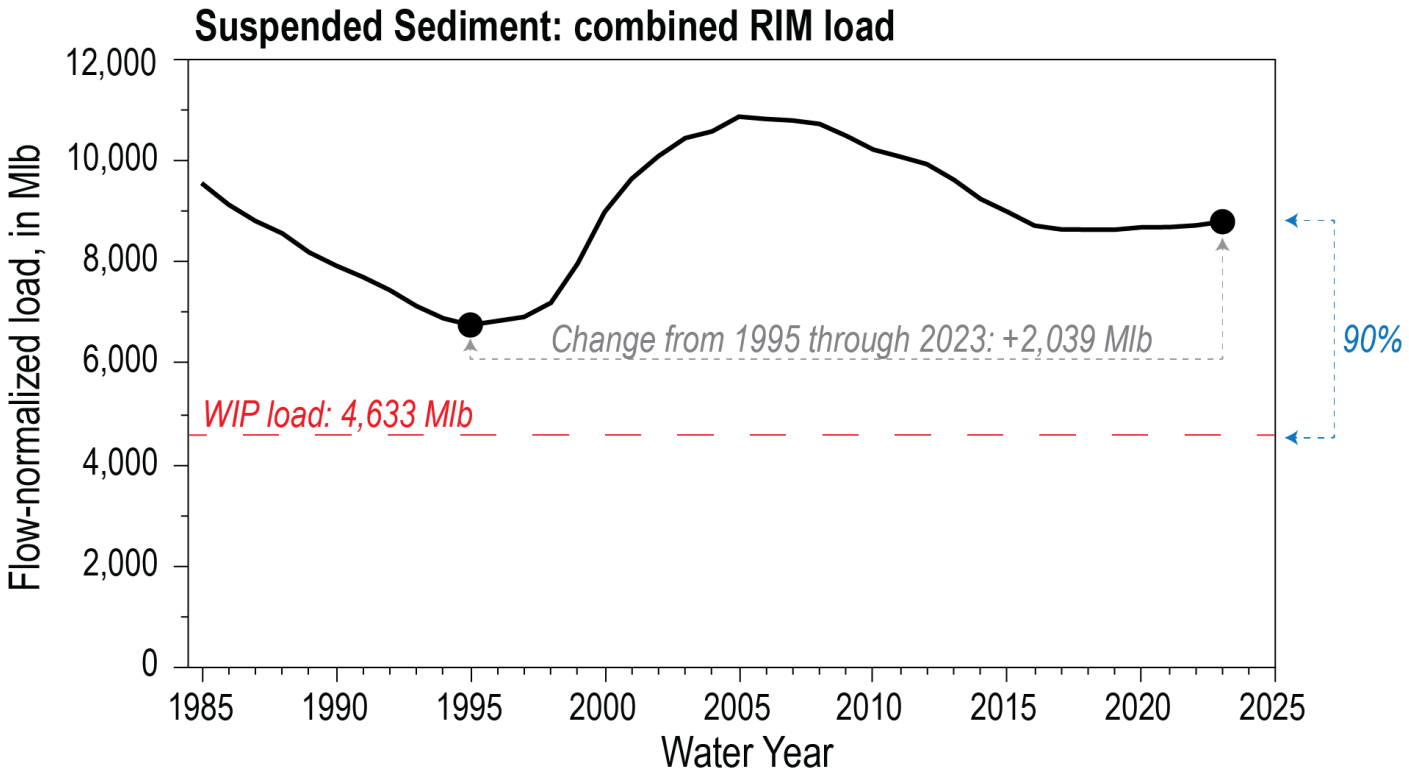


The FN load exceeded the WIP load of total phosphorus in all RIM watersheds in water year 2023.

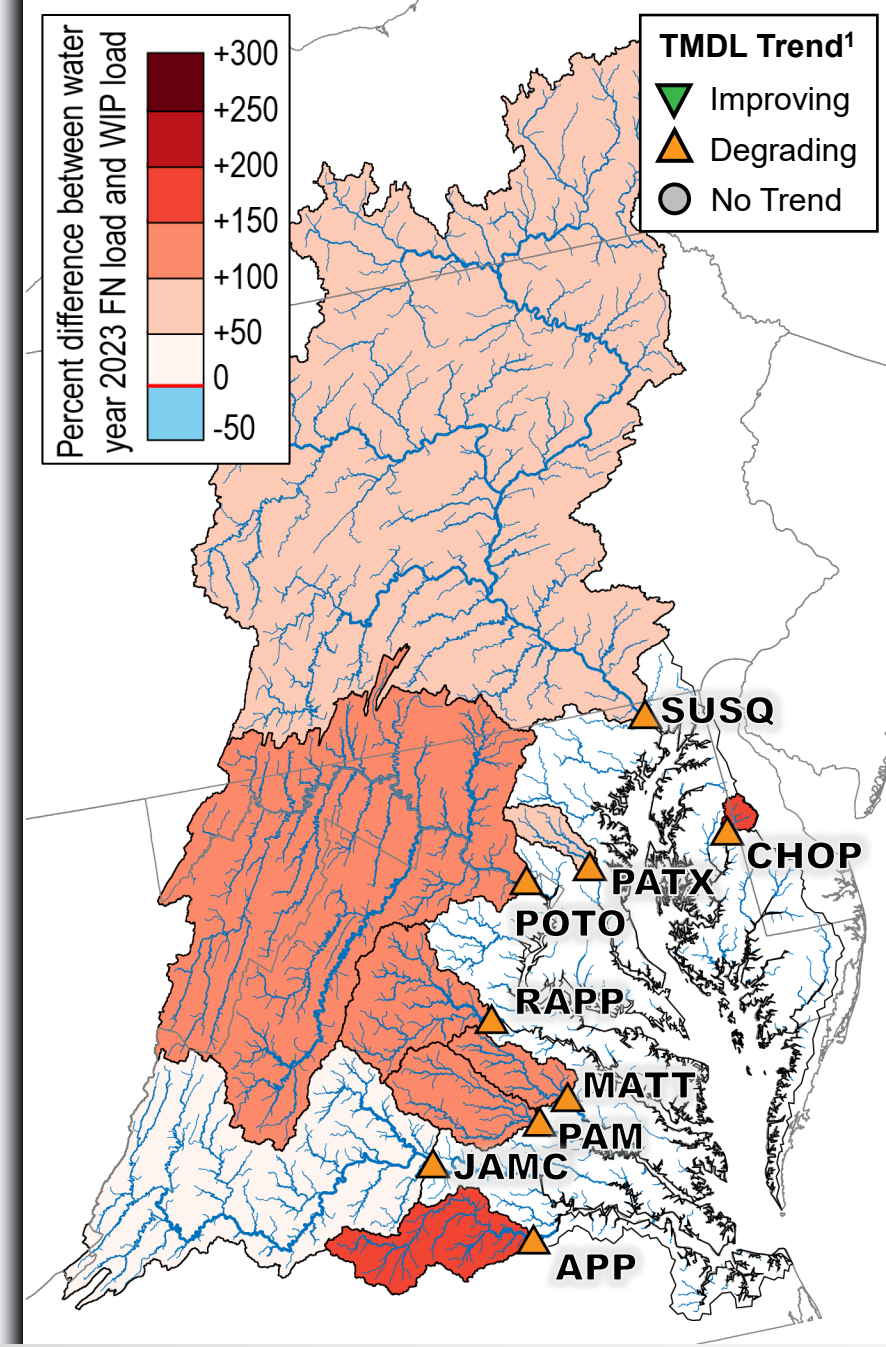


Suspended Sediment: Monitored loads v WIP loads

In water year 2023, the combined RIM load of total phosphorus exceeded the WIP load by **90%**.



The FN load exceeded the WIP load of suspended sediment in all RIM watersheds in water year 2023.



Resources to learn more

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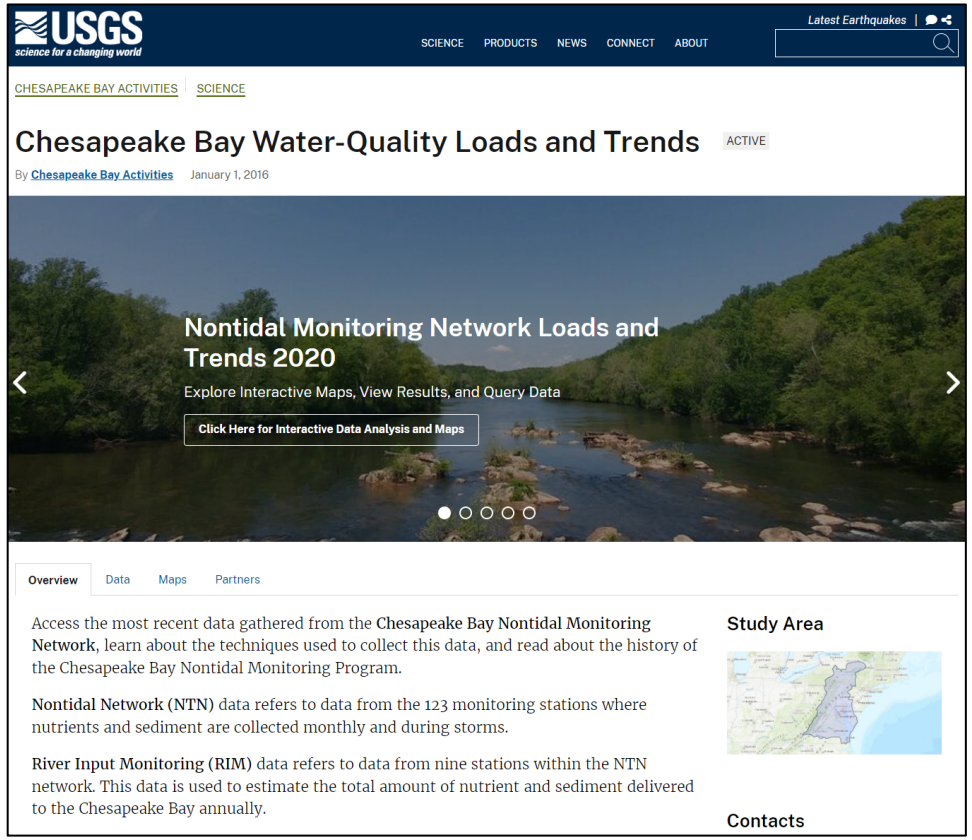
Background photo: stormflow at the Mattaponi River

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!

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Chris Mason, camason@usgs.gov
Alex Soroka, asoroka@usgs.gov

[1]Mason, C.A., and Soroka, A.M., 2024, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay River Input Monitoring stations: Water years 1985-2023: U.S. Geological Survey data release, https://doi.org/10.5066/P13QLXFP.