

Where Do Loads and Trends Come From?

An overview of how USGS translates monitoring data to management-relevant information

April 27th, 2026

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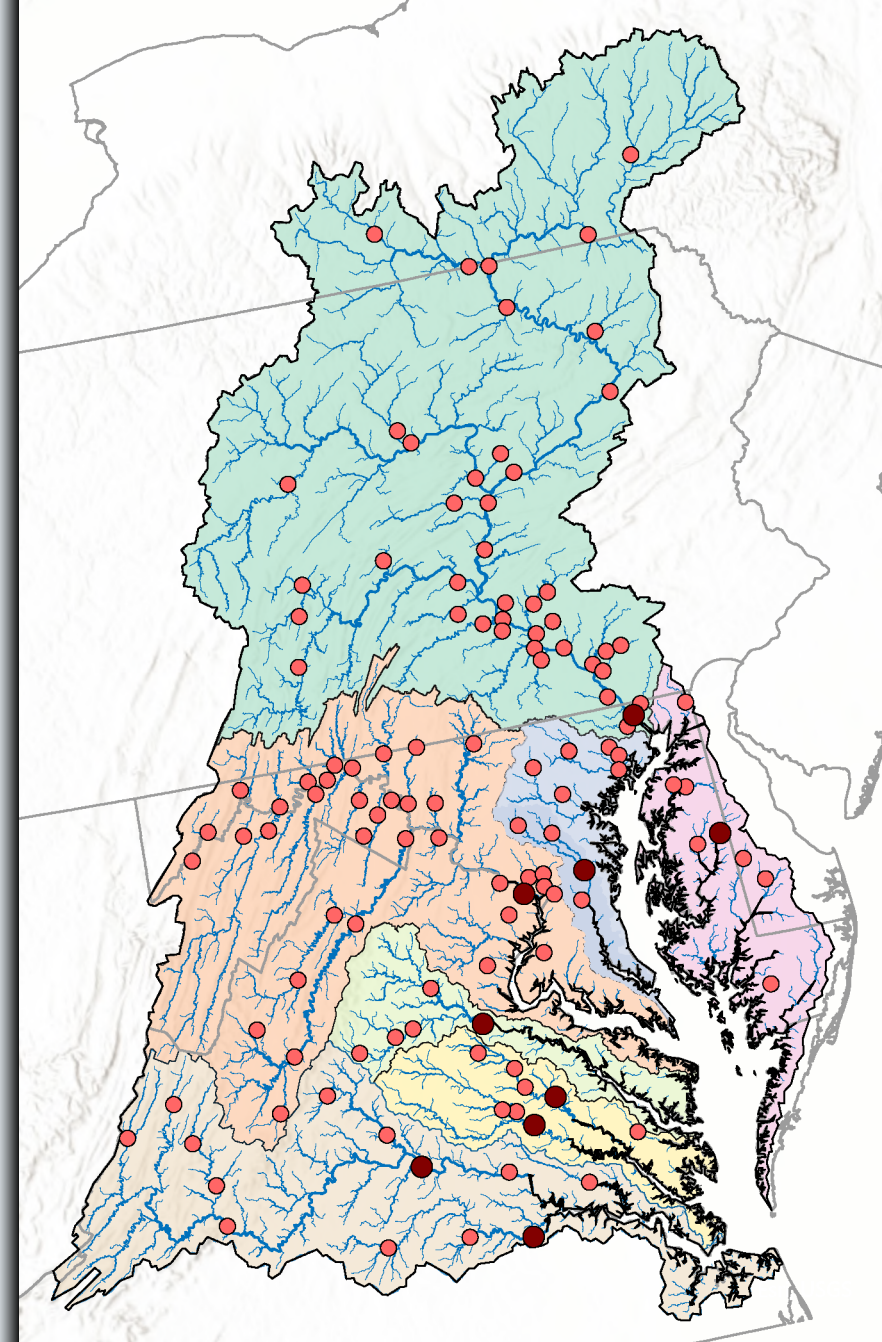
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Loads and trends of nitrogen, phosphorus, and suspended sediment come from monitoring data collected throughout Chesapeake Bay rivers.



Map of NTN monitoring stations.

Monitoring & Modeling Presentations

Today's talk is part of a presentation series about water-quality monitoring and modeling.

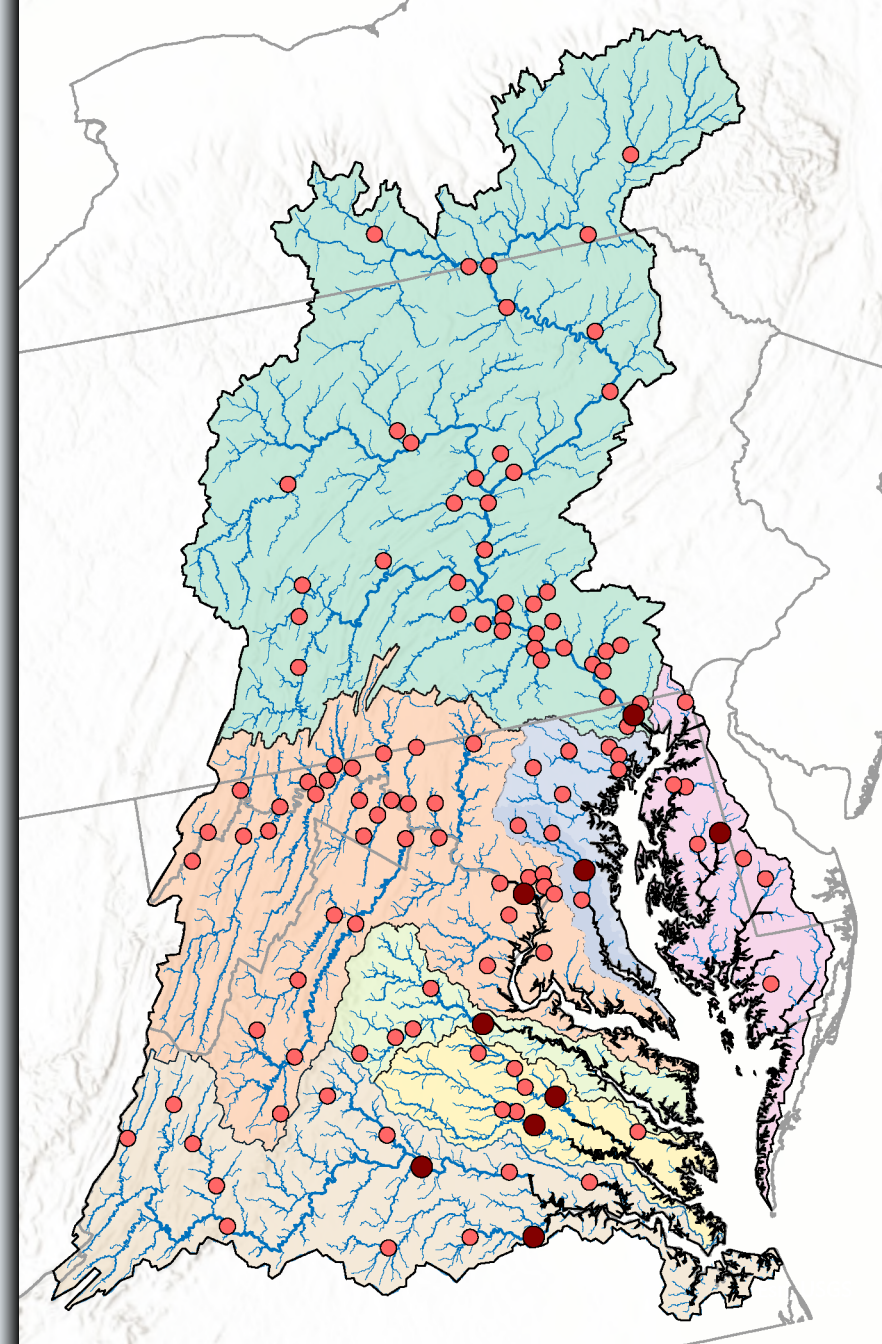
We want your feedback about water-quality loads and trends

January: learn about water-quality load and trend results computed through water year 2024 (Webber)¹

Today: learn how monitoring data are used to compute water-quality loads and trends (Webber & Chanat).

May 18th: learn how we use monitoring data to improve the watershed model and discuss how to further align monitoring/modeling. (Gootman).

Summer 2026: learn about updated water-quality load and trend results, computed through water year 2025 (USGS).



Map of NTN monitoring stations.

Information to Guide Decision Making

The objective of the nontidal monitoring network (NTN) is to compute monitoring-based **loads** and **trends** of nitrogen, phosphorus, and sediment in Chesapeake Bay rivers.

Load: An amount of material delivered over time

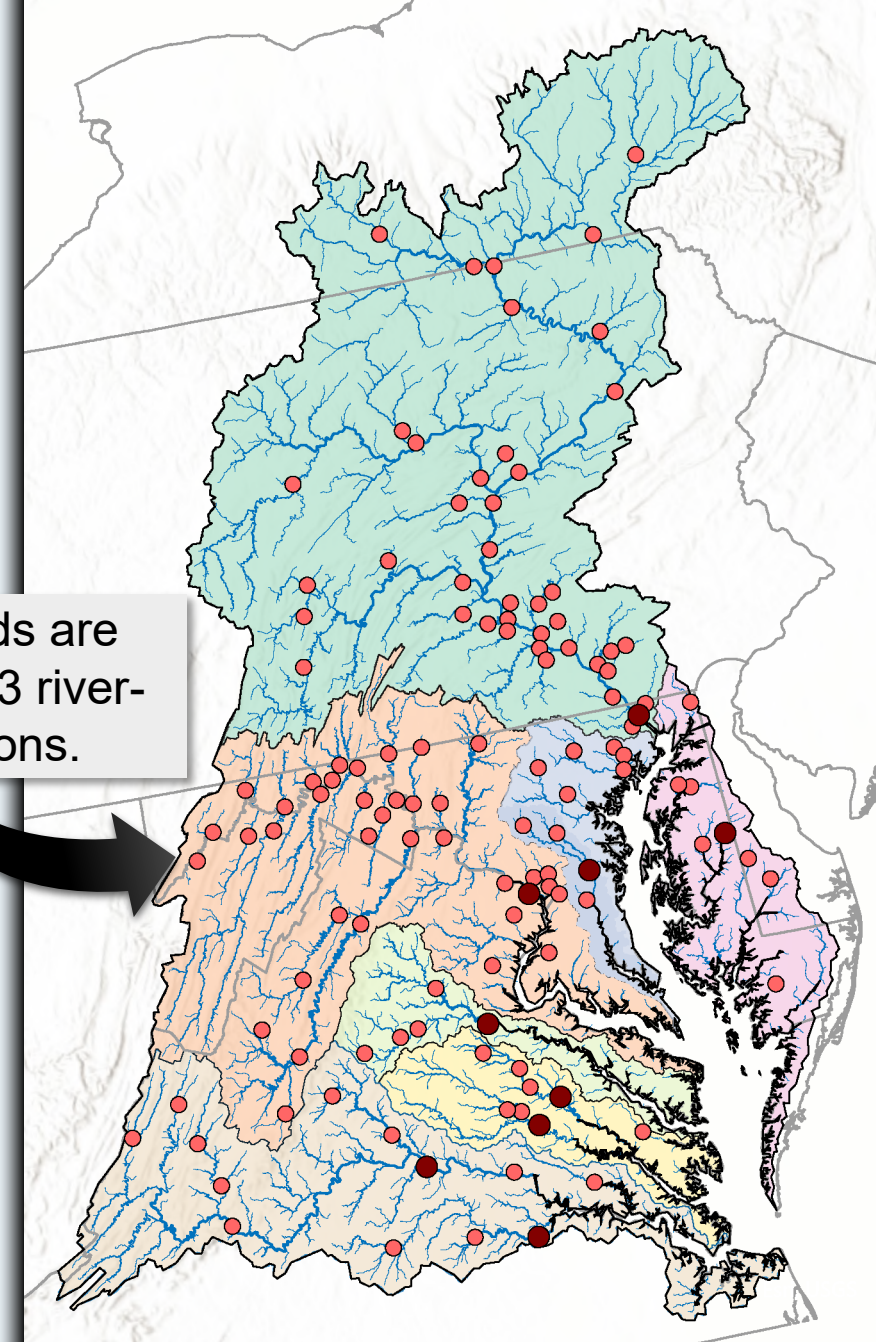
$$\text{Load} = \text{Concentration} * \text{Streamflow}$$

Trend: A change in load over time.

Monitoring-based loads and trends provide critical information used to:

- ✓ Assess progress toward water-quality goals
- ✓ Evaluate the effects of management actions
- ✓ Calibrate and improve water-quality models

Loads and trends are computed at 123 river-monitoring stations.

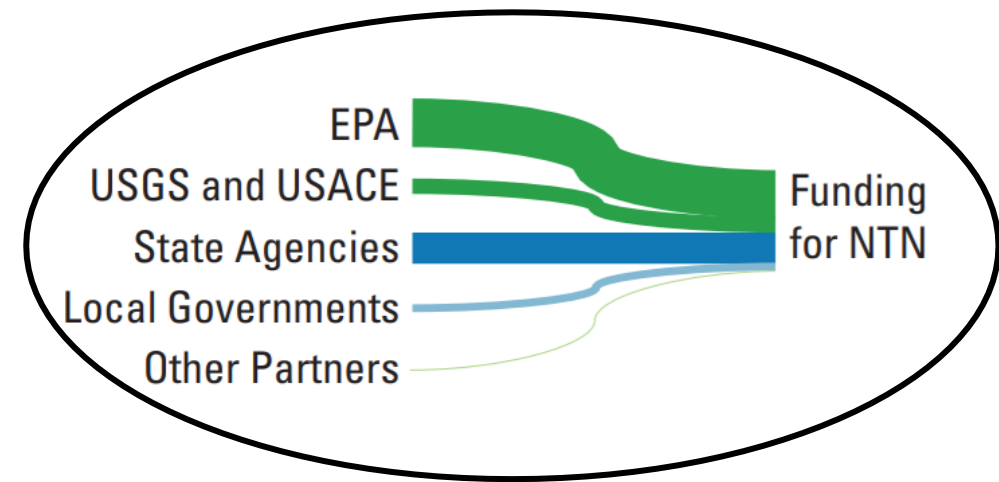


Map of NTN monitoring stations.

A Partnership Approach

The NTN was established in 2004 to provide timely and accurate information about water-quality conditions in the Chesapeake Bay watershed.

Today, 25 different groups support the NTN by funding operations and / or collecting monitoring data



Graphic representing NTN funding sources; thicker lines indicate larger amounts of funding.



A visual representation of the 25 partners who support the NTN. Orange vests represent agencies that collect monitoring data.

USGS collects monitoring data throughout the watershed and leads the computation and communication of load and trend results.

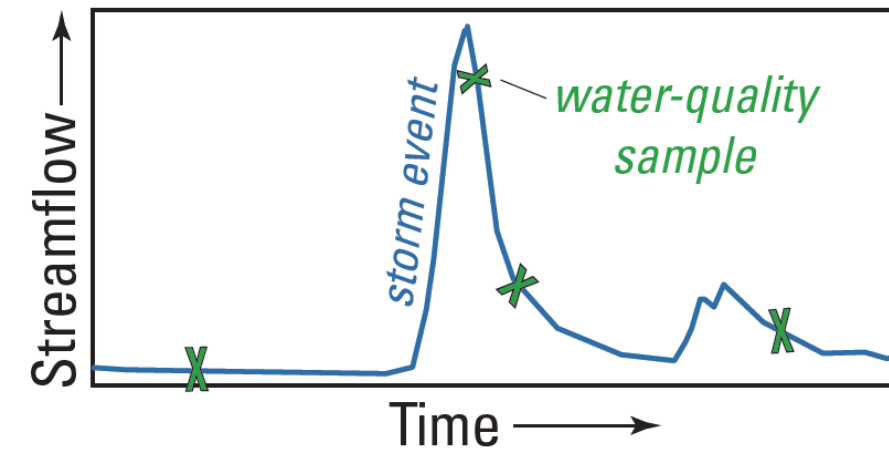
Monitoring-Based Insights

Loads and trends are computed by measuring streamflow and collecting water-quality samples.

Streamflow, the amount of water moving past a station, is reported online every hour.

Water-quality samples of nitrogen, phosphorus, and sediment are collected every month and during storms.

↳ Each year, more than 2,000 water-quality samples are collected from the NTN!



World-class monitoring methods, developed by the USGS, are applied consistently across the NTN.



Photos of USGS measuring streamflow and collecting water-quality samples.

A Watershed-Wide Network

Loads and trends are computed at 123 stations

Stations range in size from less than 1 mi² to about 27,000 mi². Most stations are more than 100 mi².

Water-quality samples have been collected since 1985 at 41 stations, including **9 River Input Monitoring (RIM) stations**.

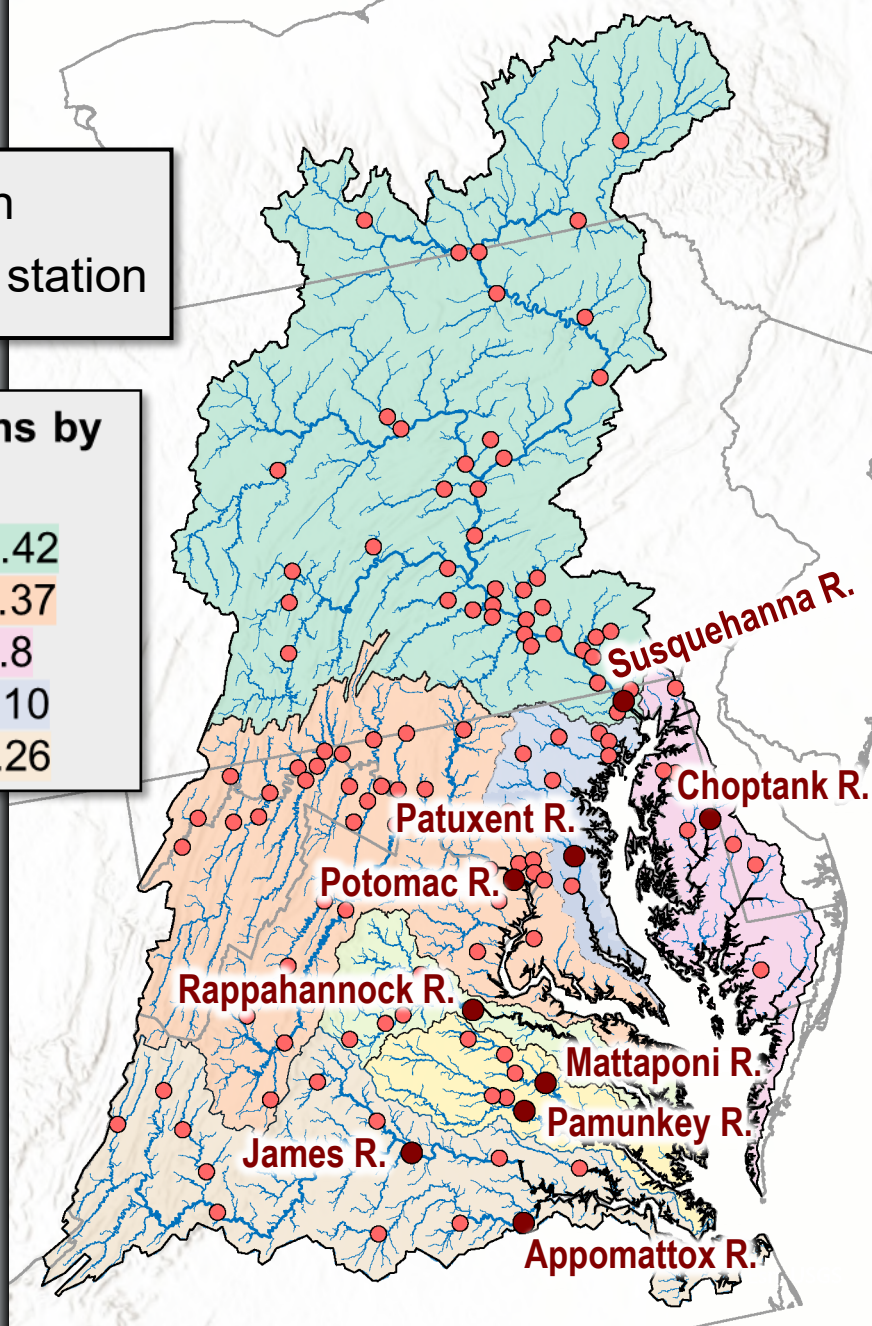
↳ **RIM stations** are located near the tidal boundary on 9 of the largest Chesapeake Bay rivers.

NTN stations have been added over time to meet state and local needs – today, all 123 stations have at least 10 years of data.

● RIM station
● other NTN station

Number of NTN Stations by River Basin

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



Map of NTN monitoring stations with 9 RIM stations labeled.

Timely Information About Loads and Trends

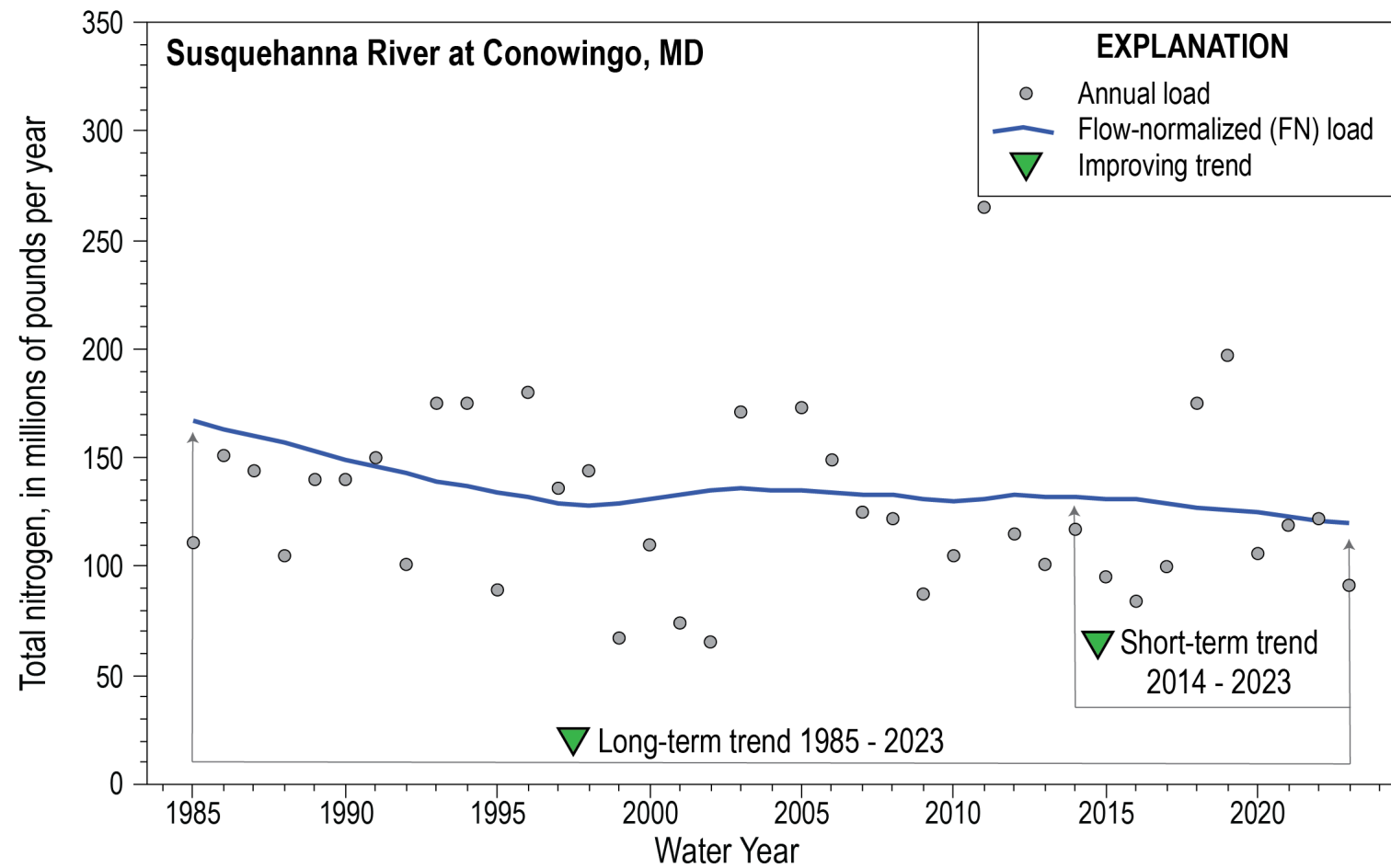
Loads and trends are computed annually at the 9 RIM stations and every-other-year at all NTN stations.

Loads are strongly affected by annual amounts of streamflow.

Flow-normalized (FN) loads remove most year-to-year variability in load associated with streamflow.

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



Time-series plot of TN loads and FN loads from 1985 through 2023 at the Susquehanna River RIM station.

Current Results and Planned Updates

The most recent load and trend results have been published:

- Through water year 2023 at all NTN stations.¹
- Through water year 2024 at the 9 RIM stations.²

Load and trend results are being updated for all NTN stations through water year 2025.

- Results for the 9 RIM stations will be released this summer.
- Results for all stations will be released by the end of the calendar year.

We maintain a project website that provides access to the most recent data, and an interactive summary of results:

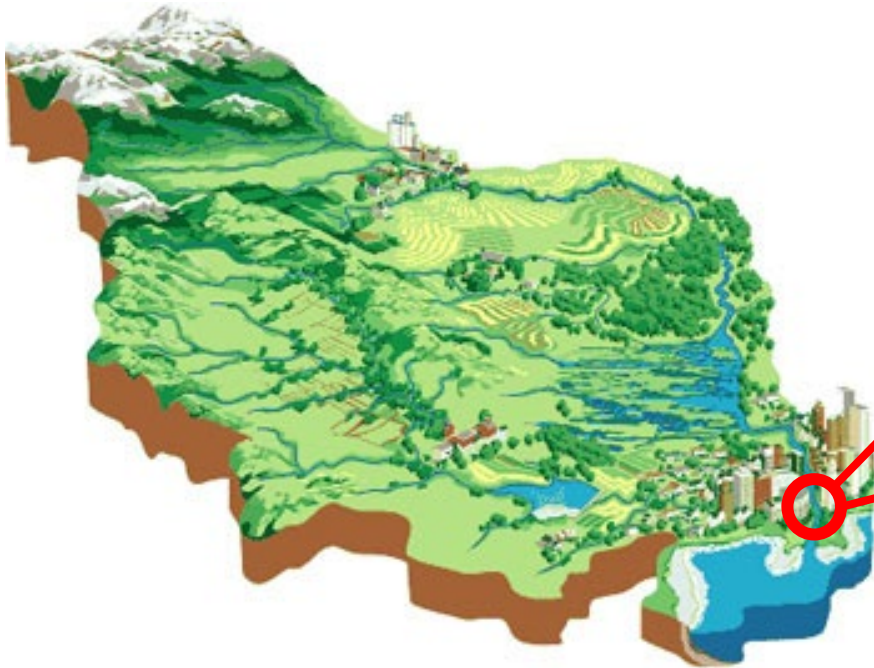
usgs.gov/CB-wq-loads-trends

The screenshot shows the USGS website for Chesapeake Bay Water-Quality Loads and Trends. The page is titled "Chesapeake Bay Water-Quality Loads and Trends" and is categorized under "SCIENCE". It features a navigation menu with links for "SCIENCE", "PRODUCTS", "NEWS", "CONNECT", and "ABOUT". The main content area includes a sub-header "Nontidal Monitoring Network Loads and Trends 2020" and a call to action "Click Here for Interactive Data Analysis and Maps". The page also includes a "Study Area" map and a "Contacts" section.

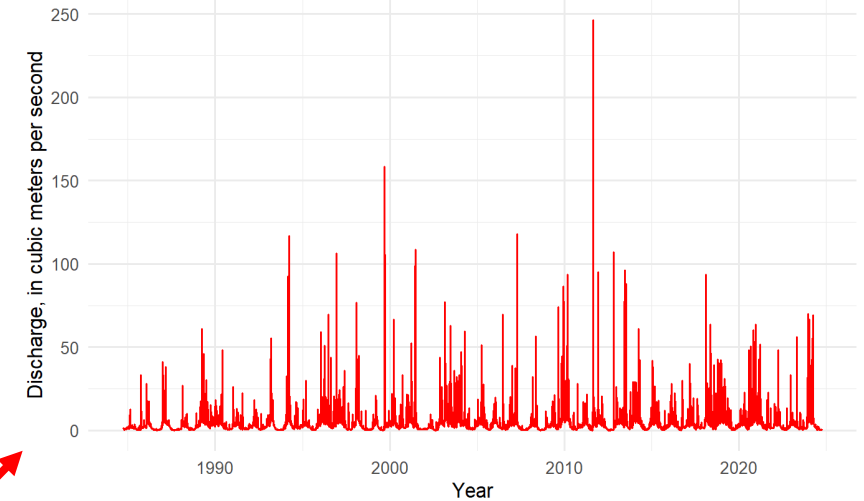
What are the loads in my river? How have loads changed over time in response to management actions?

Continuous daily streamflow, sparse discrete water quality: *our only window into large watershed processes.*

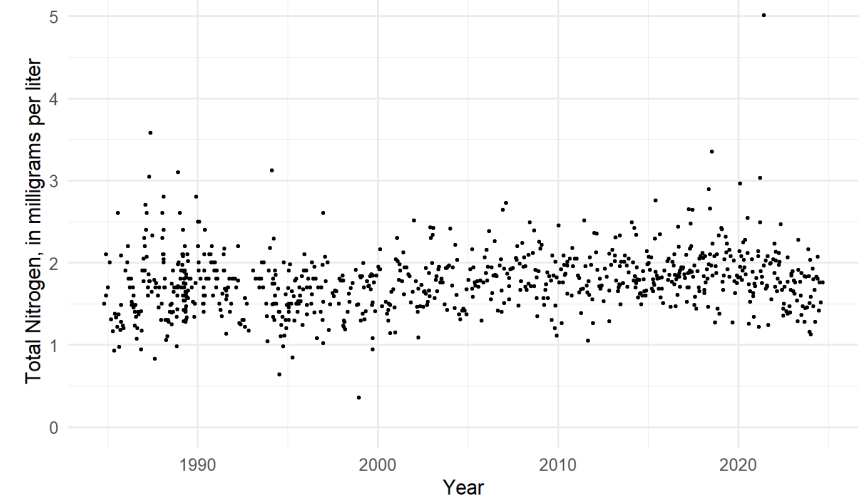
WRTDS was specifically built for the Chesapeake Bay Program to leverage these datasets and answer these questions.



Daily Discharge, 1985-2024
USGS-01491000, Choptank River Near Greensboro, MD



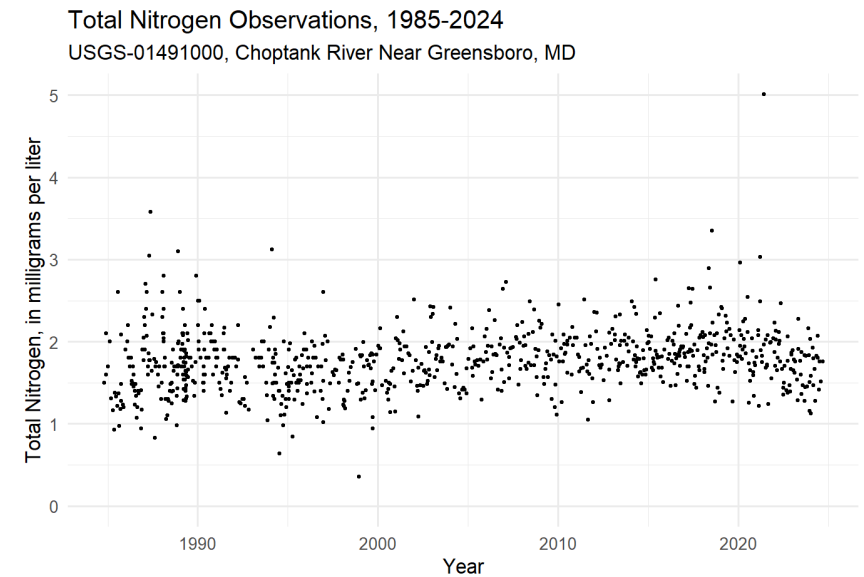
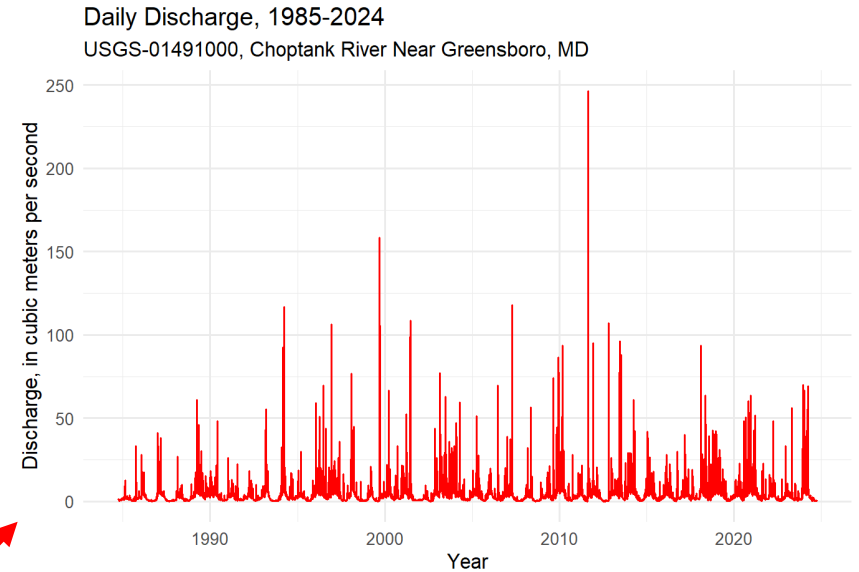
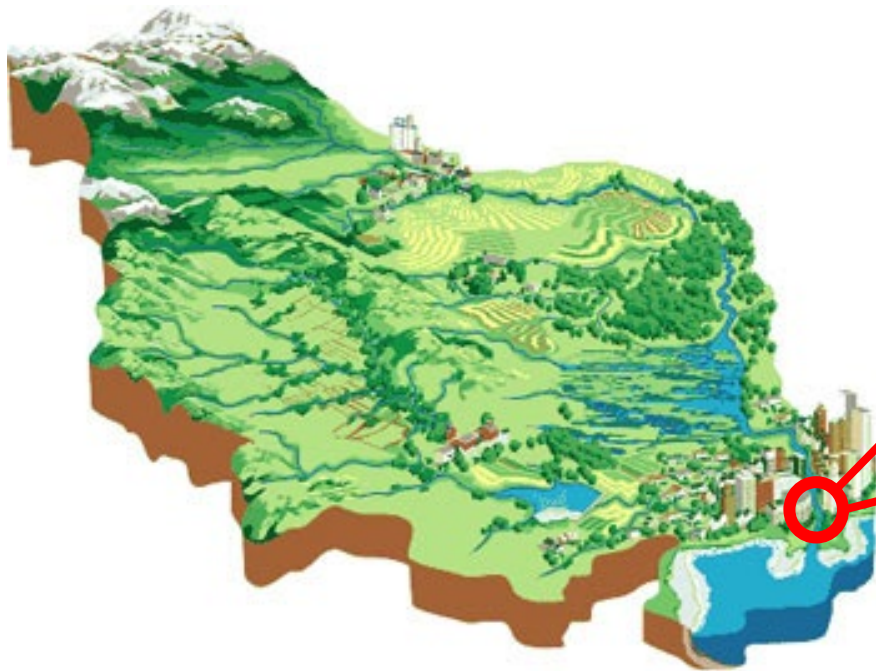
Total Nitrogen Observations, 1985-2024
USGS-01491000, Choptank River Near Greensboro, MD



What are the loads in my river? How have loads changed over time in response to management actions?

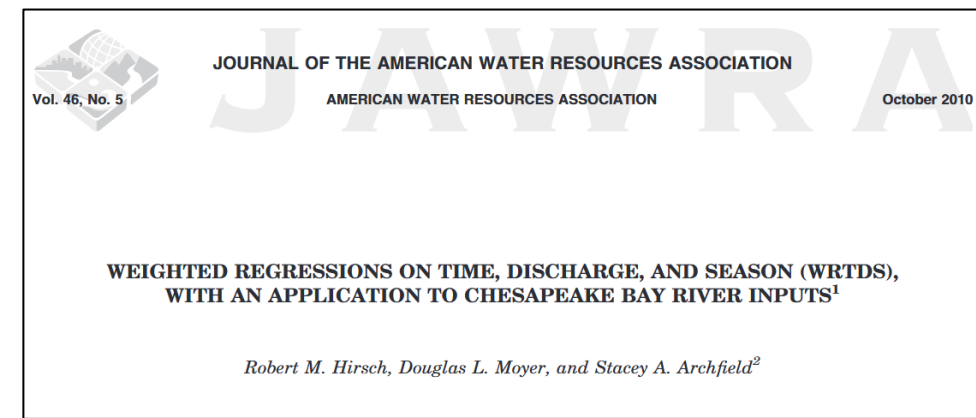
Continuous daily streamflow, sparse discrete water quality: *our only window into large watershed processes.*

WRTDS is an *empirical tool* for interpreting water-quality data

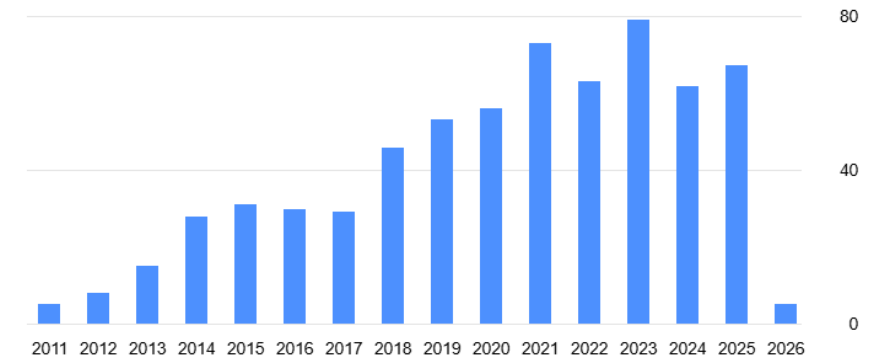


WRTDS was built for the Chesapeake Bay Program and has been applied globally

- Original 2010 WRTDS publication cited 656 times (Scholar)
- 2025 WRTDS bibliography¹:
 - 5 core publications
 - 77 extensions and evaluations
 - 193 regional applications
- Most recent publication by Zhang and others in Nature highlights the widespread use of WRTDS and continued innovations.



× Citations per year



Advancing an adaptable and practical framework to address water quality challenges in a changing world

Qian Zhang, Robert M. Hirsch, Laura A. DeCicco & Jennifer C. Murphy

As water-quality challenges intensify, the widely used Weighted Regressions on Time, Discharge, and Season (WRTDS) method offers an adaptable and practical framework for global water-quality science and management.

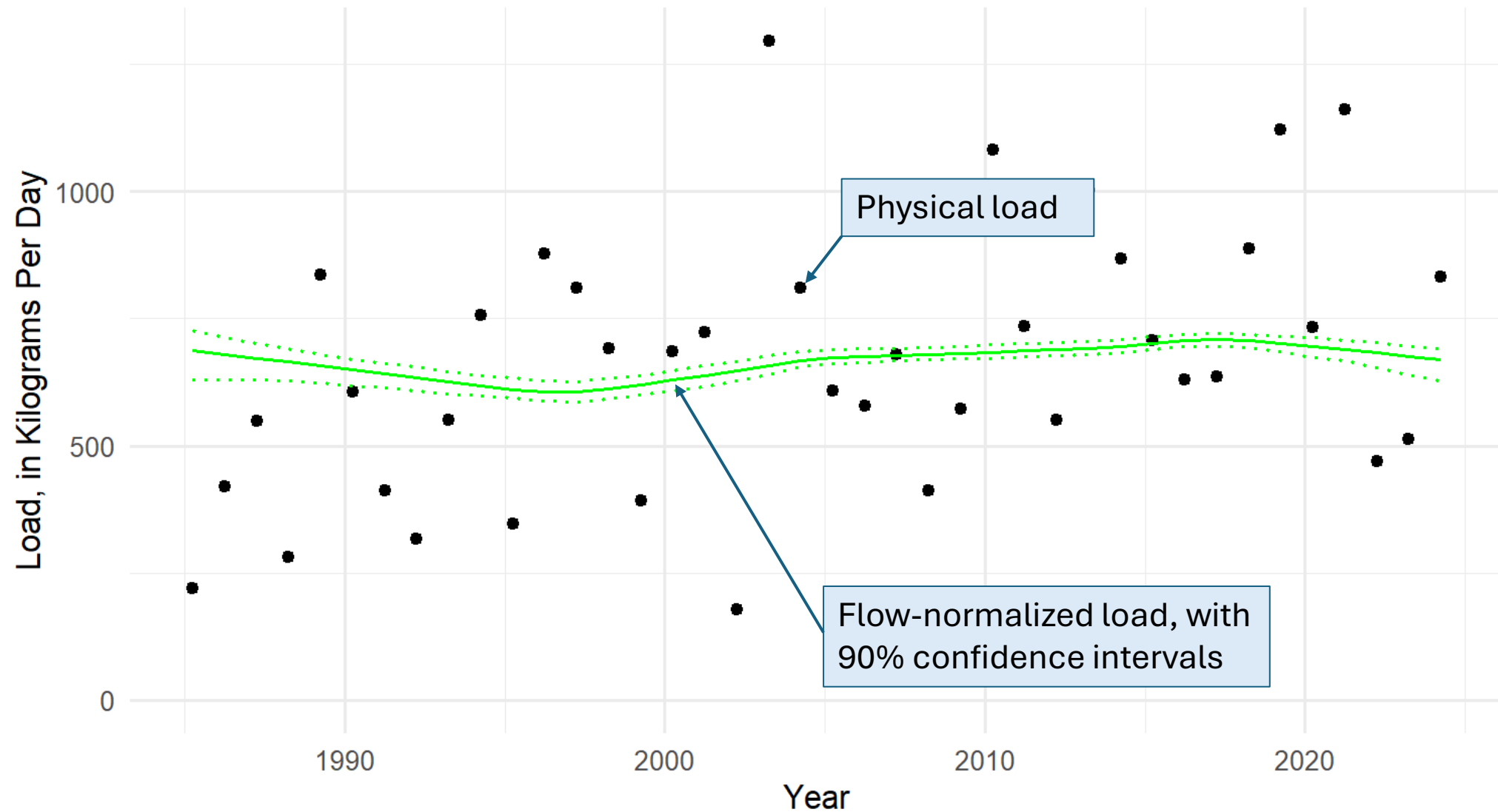
In a rapidly changing world, new challenges underscore the benefit of continued innovation of WRTDS to become a globally unified, state-of-the-art framework for water-quality science. Here, we provide a forward-looking roadmap for the next generation of WRTDS development, focusing on three key themes: advancing the model's framework, integrating new data sources, and establishing community standards.

[Check for updates](#)

Zhang, Q., Hirsch, R.M., DeCicco, L.A. et al. Advancing an adaptable and practical framework to address water quality challenges in a changing world. *Nat Rev Earth Environ* 7, 1–3 (2026). <https://doi.org/10.1038/s43017-025-00753-z>

Total Nitrogen Annual Loads, 1985-2024

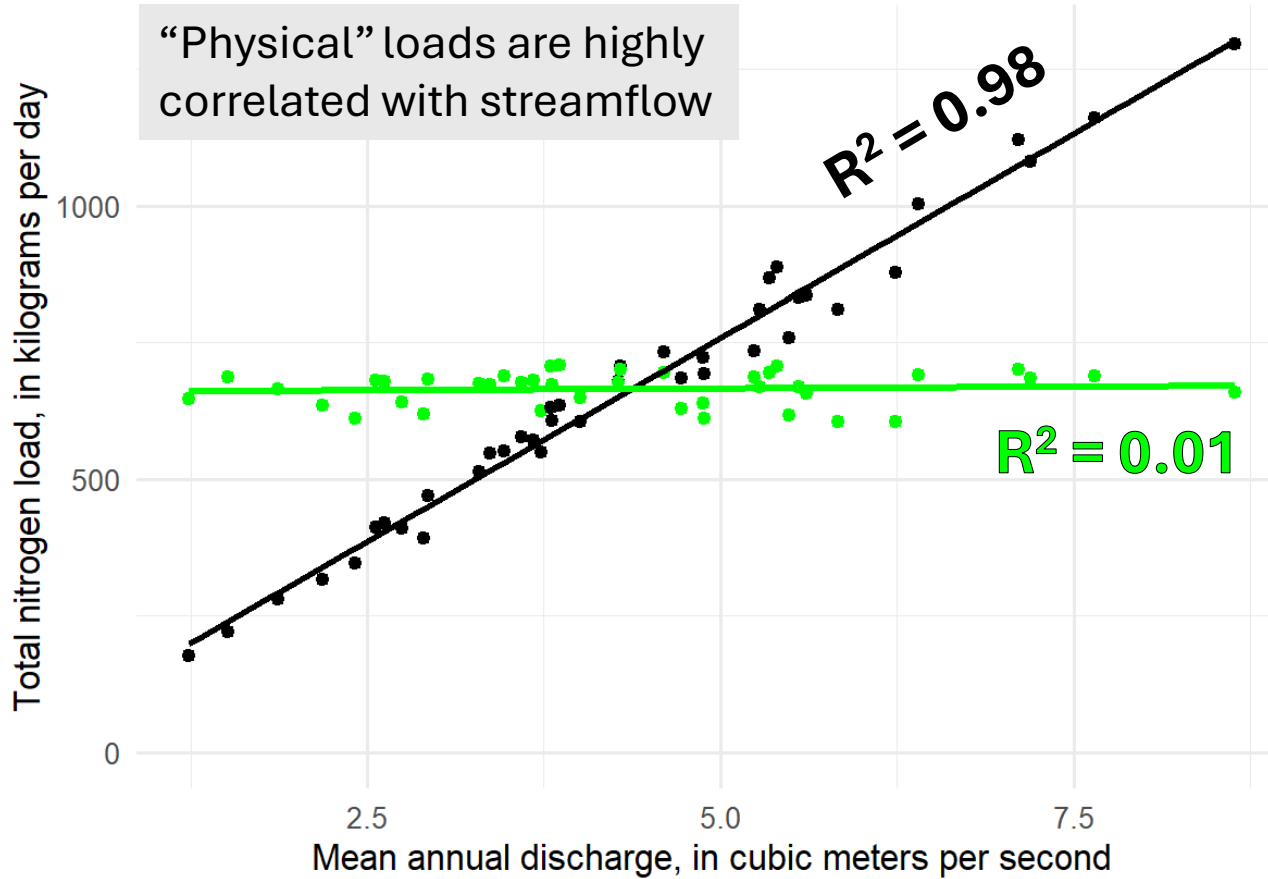
USGS-01491000, Choptank River Near Greensboro, MD



FN loads remove most year-to-year variability caused by streamflow

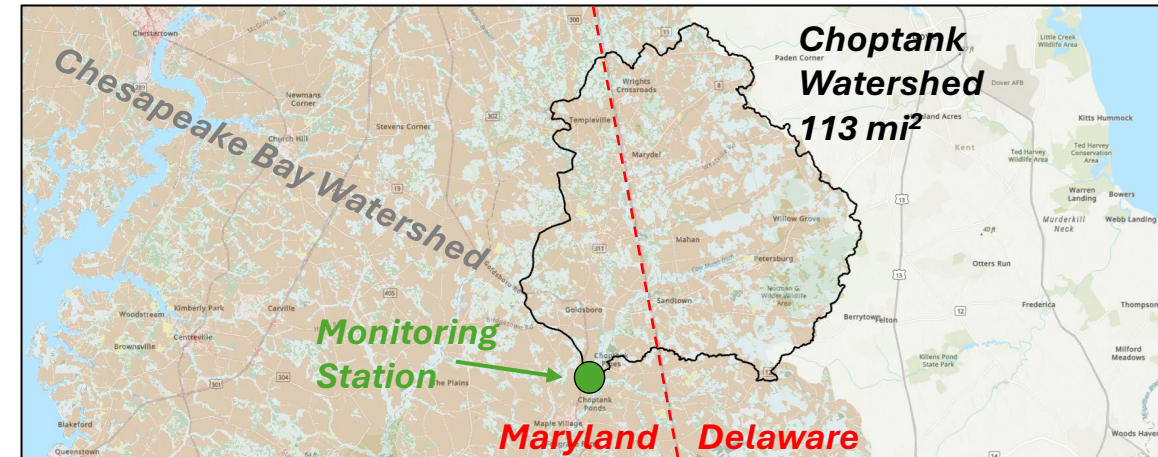
TN Loads versus Annual Discharge, 1985-2024

USGS-01491000, Choptank River Near Greensboro, MD



LoadType

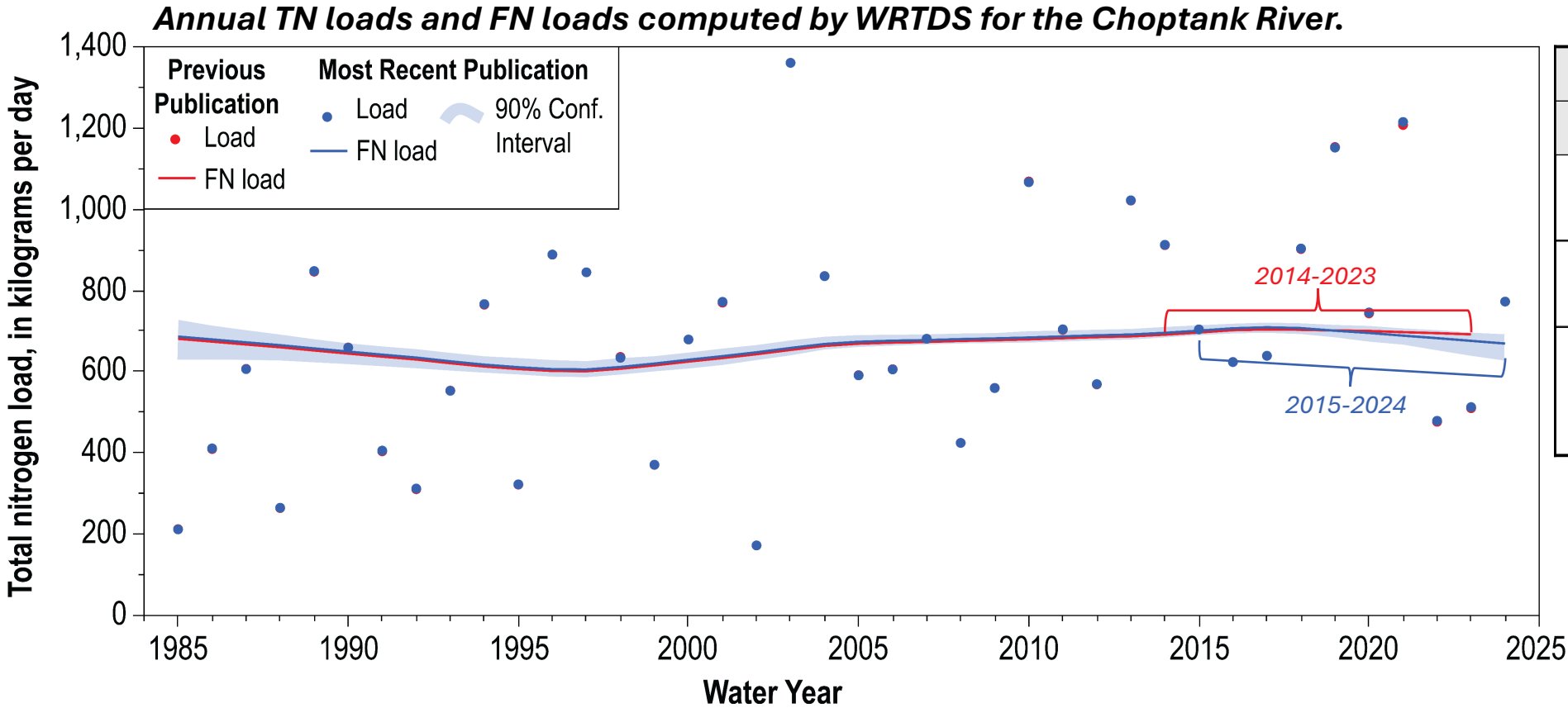
- Physical
- FlowNormalized



Choptank River: Total Nitrogen (TN)

Loads and Trends

Streamflow measurements and discrete water-quality samples have been collected from the Choptank since 1985.



Choptank, TN: 10-Year Trend Result		
Period	2014-2023	2015-2024
Trend Direction	No Trend	Improving
Percent Change	+0.1%	-4.5%
Likelihood of a Downward Trend	0.53 (as likely as not)	0.97 (extremely likely)

Loads and Trends in Chesapeake Bay Nontidal Rivers: an Overview of Methods and Applications

Take Home Messages:

1. WRTDS was developed by the USGS to compute nontidal loads and trends for the Chesapeake Bay Program and has become a widely-adopted approach to assess water-quality conditions across the globe.
2. WRTDS is an empirical statistical tool for letting the water-quality data "speak for themselves".
3. Flow normalization is a core feature of WRTDS that is used to describe trends in load after removing year-to-year streamflow variability. By considering the observed range of flow condition from a station, flow normalized trends represent changes in load associated with watershed conditions, such as management-practice effects.
4. Trends can change direction ("no trend", "improving", "degrading") as new results are computed. These changes result from: (1) a new trend period, (2) a new year of streamflow and water-quality observations, or 3) a response to land management actions, climatic fluctuations or other drivers.