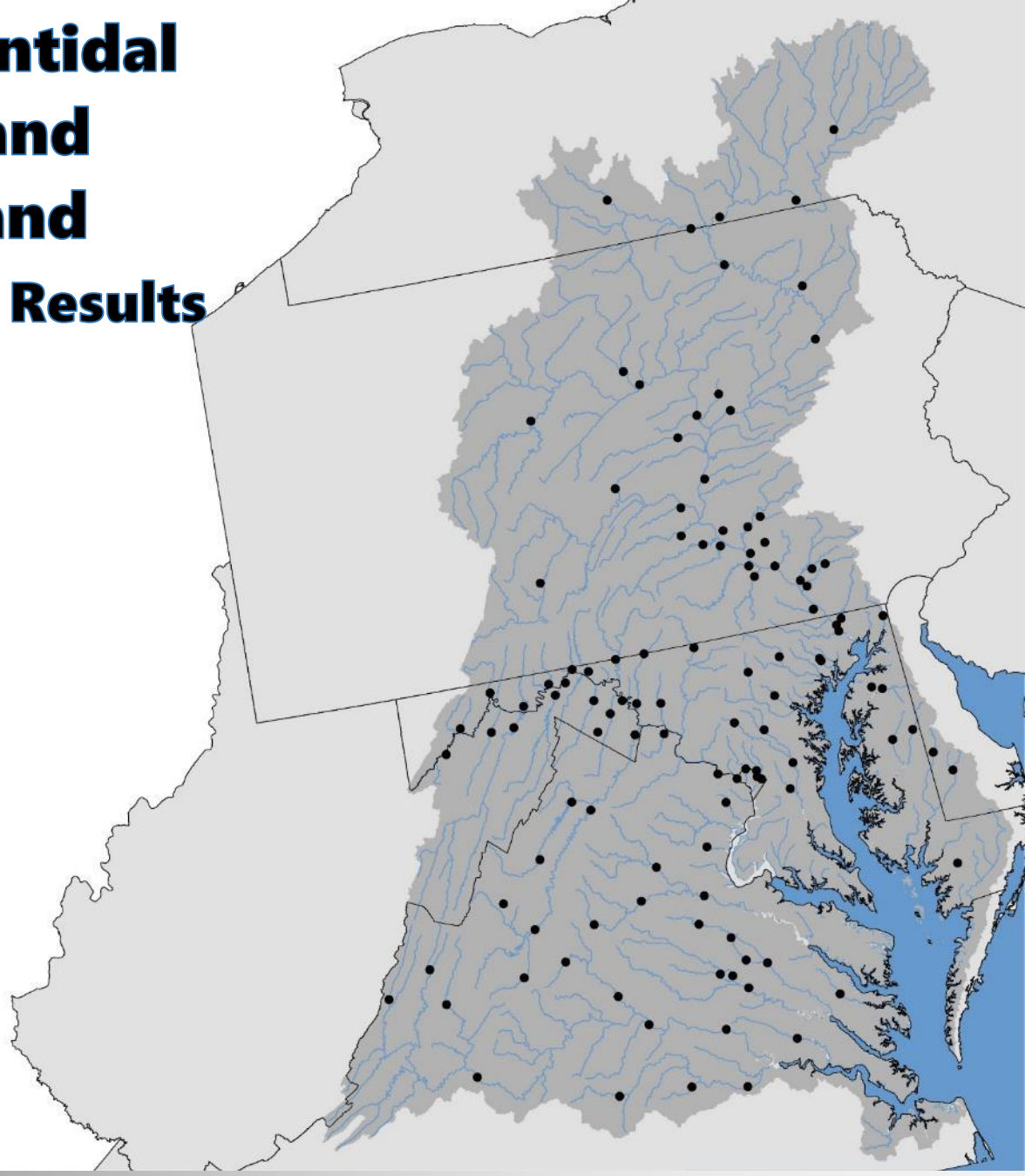
Chesapeake Bay Nontidal Network Nitrogen and Phosphorus Loads and Trends: An Update of Results through 2018



March 23, 2020

Doug Moyer

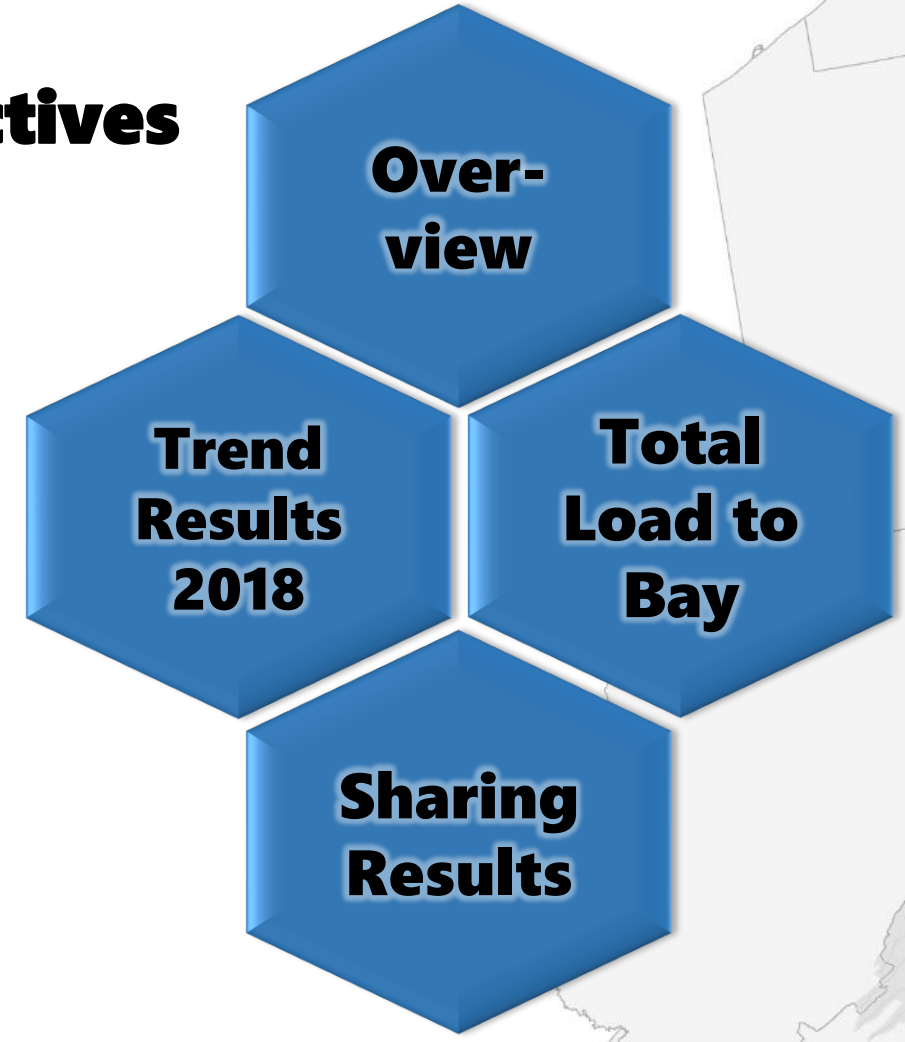
dlmoyer@usgs.gov

Jimmy Webber

jwebber@usgs.gov

Nutrient Loads and Trends in Chesapeake Bay Nontidal Network Streams: An update and presentation of results

Objectives

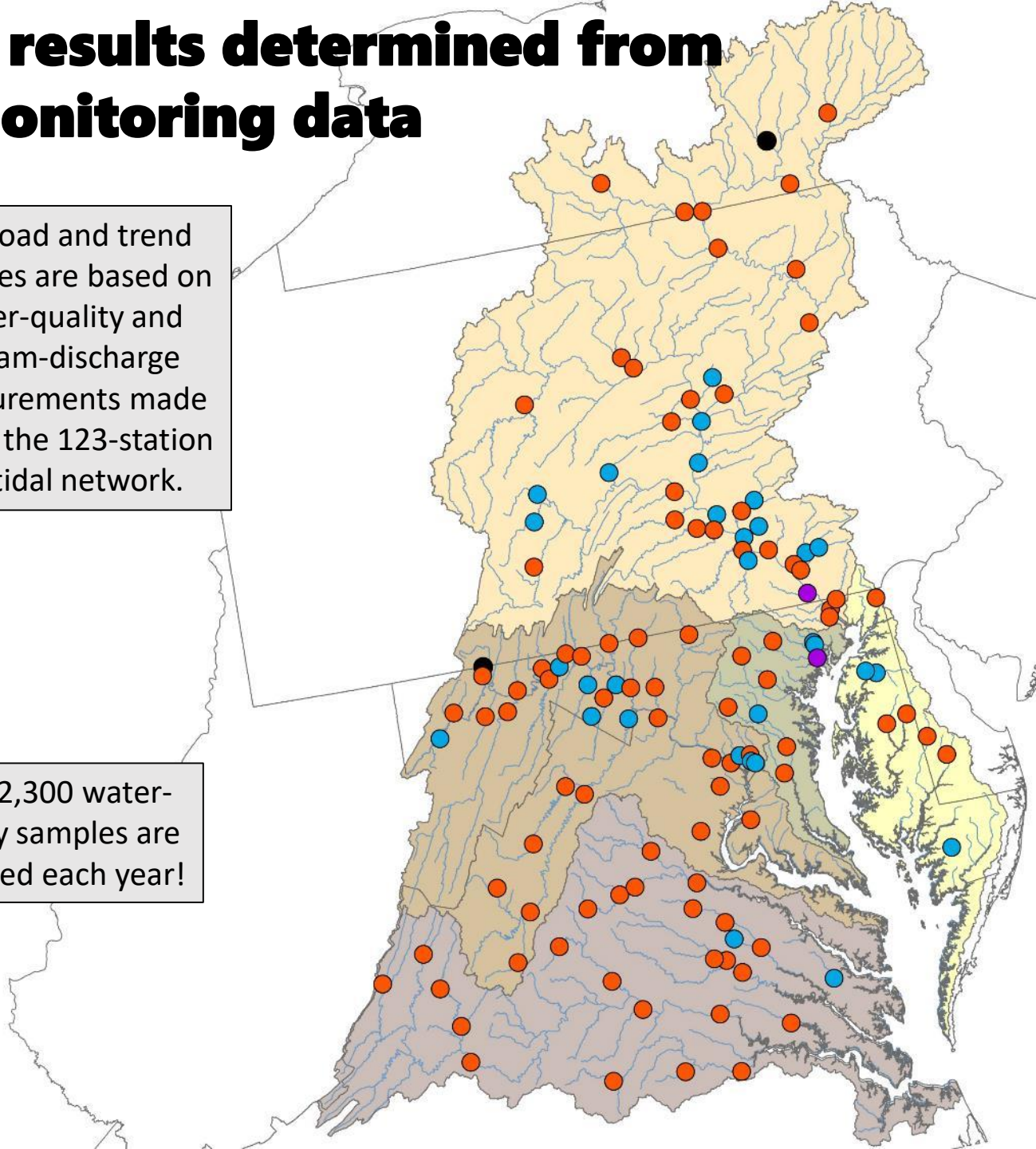


Nutrient Loads and Trends in Chesapeake Bay Nontidal Network Streams: An update and presentation of results

Loads and trend results determined from foundation of monitoring data

Our load and trend analyses are based on water-quality and stream-discharge measurements made across the 123-station nontidal network.

Over 2,300 water-quality samples are collected each year!



USGS
science for a changing world

Loads and trends results determined from foundation of monitoring data

Chesapeake Bay NTN – 123 Stations
NY – SRBC (5)
PA – SRBC(20) and USGS(15)
MD – MD DNR (22) and USGS (9)
DE – DN REC (2)
DC – USGS (4)
WV – USGS (10)
VA – VA DEQ (12) and USGS (24)

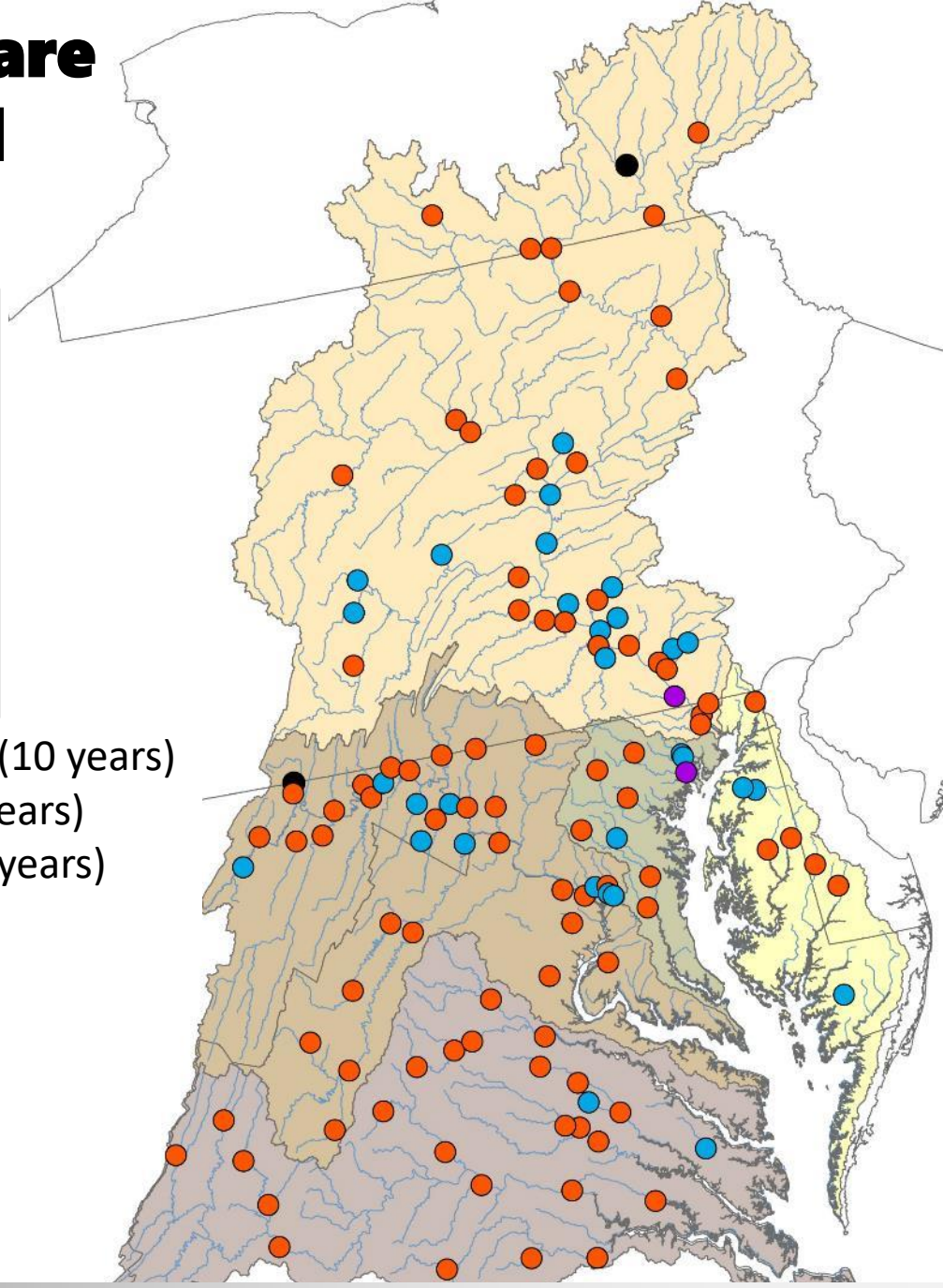
Monitoring would not be possible without the funding support provided by
EPA CBP
USGS
PA DEP, MD DNR, VA DEQ

Funding required per station = ~$50k

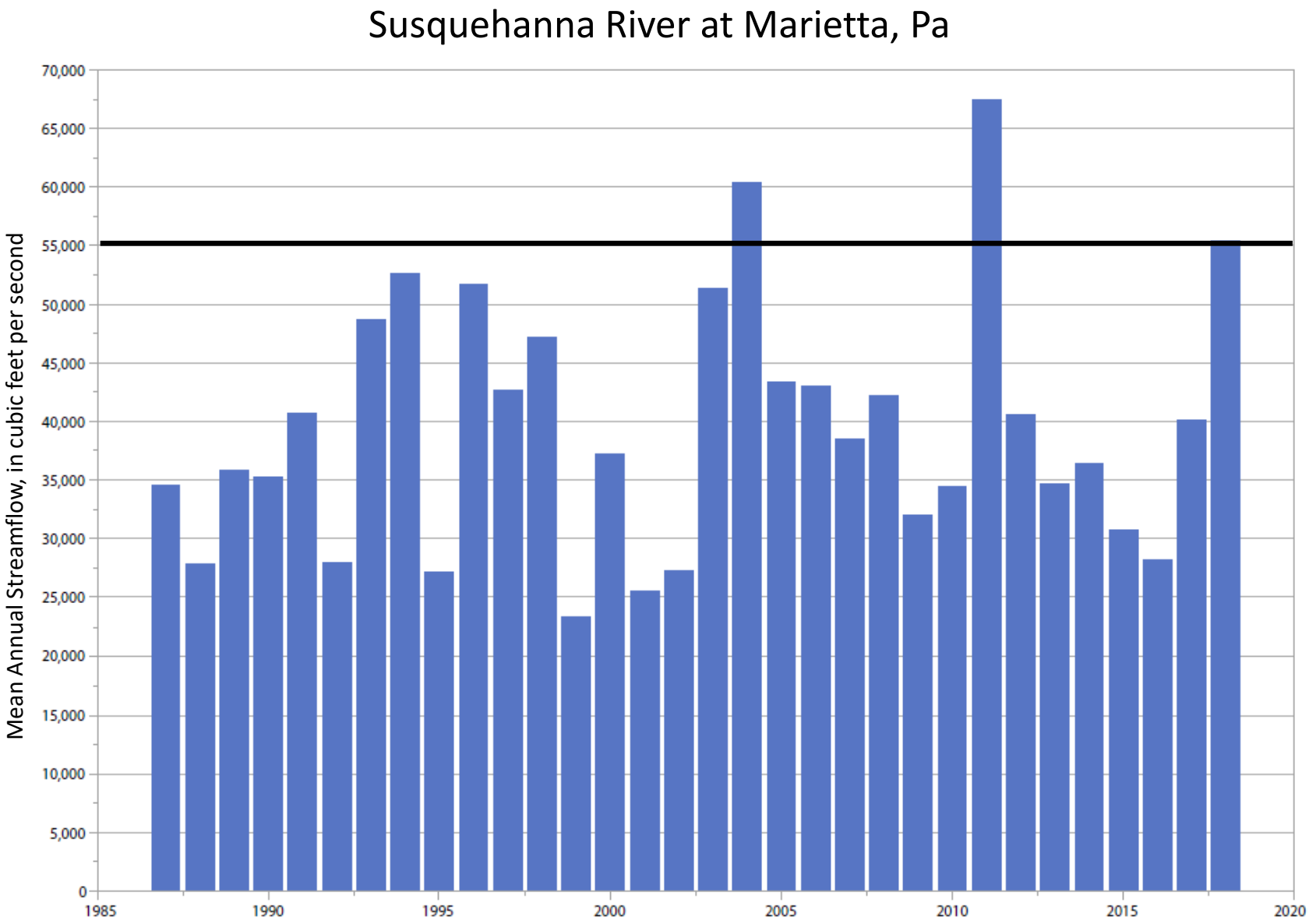
Loads and trend results are available at an increased number of stations

Juris.	N Station	TN		TP		SS	
		Load	Trend	Load	Trend	Load	Trend
NY	6	5	5	5	5	5	5
PA	35	34	20	34	20	34	20
MD	32	30	24	30	23	30	23
DE	2	2	2	2	2	2	2
VA	36	36	34	24	12	24	12
WV	10	10	4	9	4	10	4
DC	4	4	1	4	1	4	1
TOTAL	125	121	90	108	67	109	67

Juris.	Discontinued Stations	New
NY	1	0
PA	0	1
MD	1	1
DE	0	0
VA	0	0
WV	0	0
DC	0	0
TOTAL	2	2

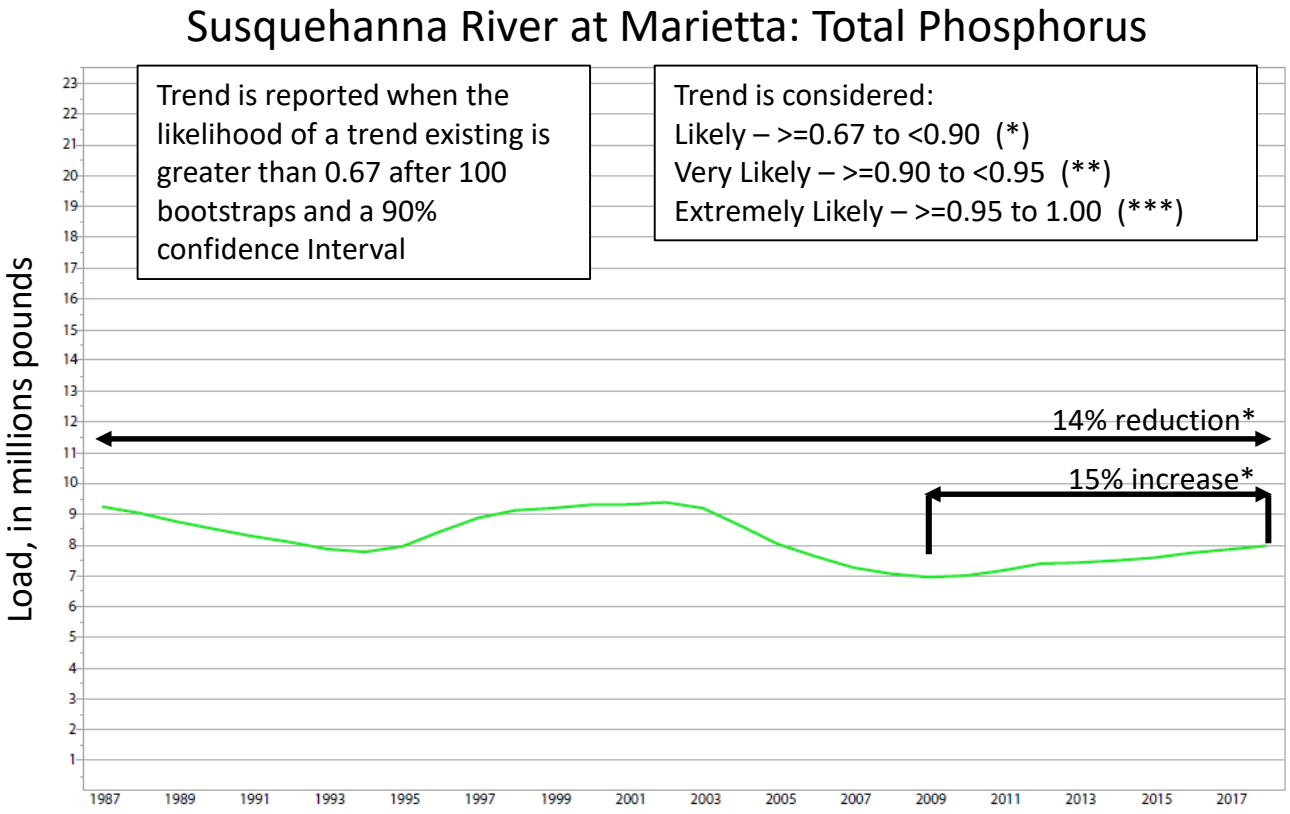


Near Record-High Streamflow in 2018 Provides Valuable Information for our Load and Trend Estimation Method



Load and trend results have been computed through 2018 to provide timely information available for decision making

Flow-normalized loads results by removing most of the hydrologic variability associated with loads. Important for understanding water-quality responses to watershed changes response.



Load and trend results have been computed through 2018 to provide timely information available for decision making

What do we compute/report?

- Trends in flow-normalized load and concentration
  - Long-term - ~1985-2018
  - Short-term – 2009-2018
- Loads and concentration
  - Daily
  - Monthly
  - Annual
- Per-acre Loads (aka. Yields)
  - 10-year average (2009-2018)
  - 5-year average (2014-2018)

Nutrient Loads and Trends in Chesapeake Bay Nontidal Network Streams: An update and presentation of results

USGS
science for a changing world

Summary of nitrogen and phosphorous trends: 2009-2018[2]

Trends in total nitrogen

- 41% of NTN stations showing reductions in nitrogen loading (median change 7%)
- Good news – Majority of improvements occur in agricultural areas of the lower Susquehanna and Potomac.
- 3 of 9 River Input stations are showing reductions in nitrogen loading (Potomac, Patuxent, and James

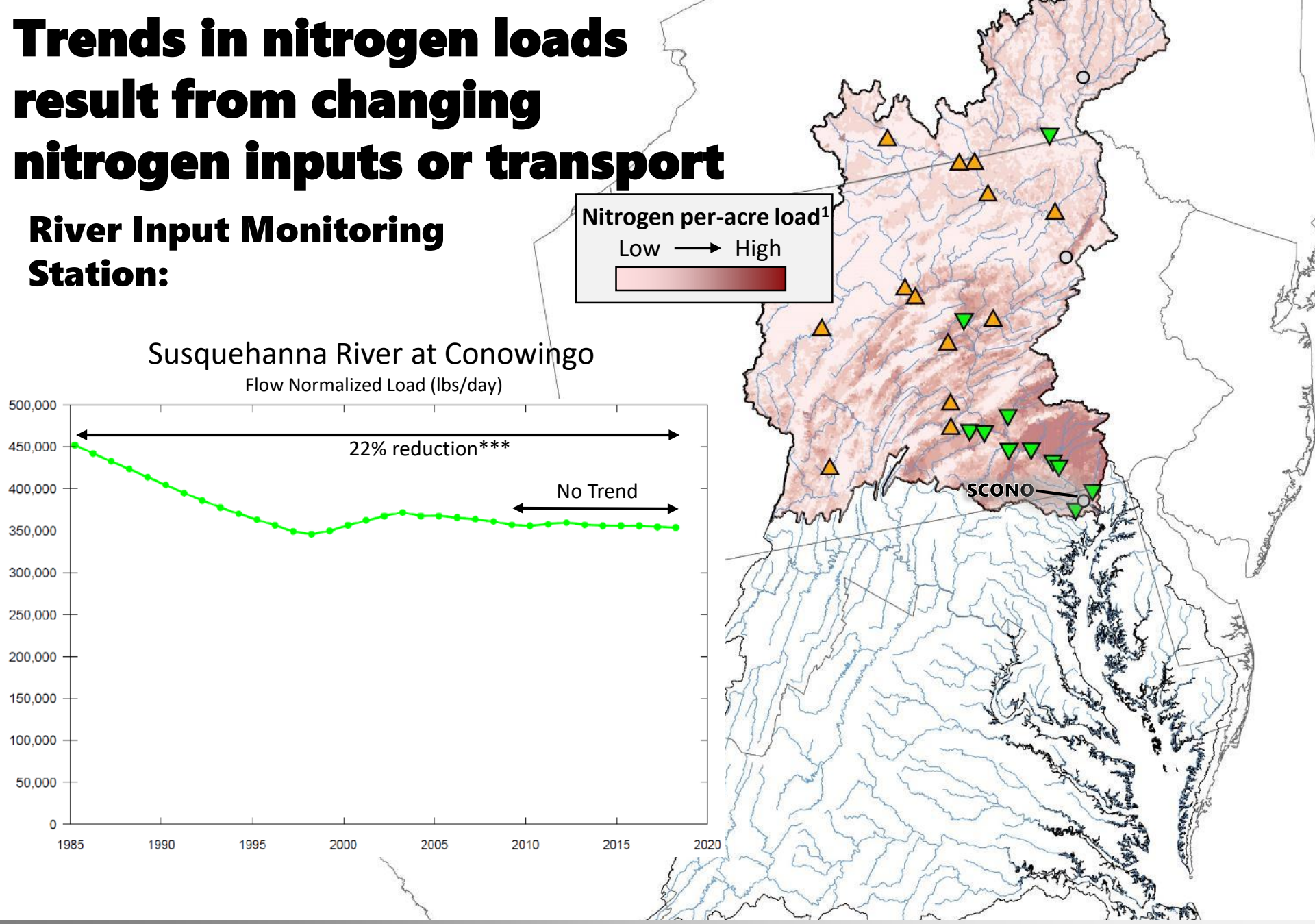
Trends in total phosphorus

- 44% of NTN stations showing reductions in phosphorus loading (median change 15%)
- 12 of 18 stations in the Potomac watershed are showing significant reductions; no stations are showing degradation
- Continued degradation in the high loading areas of the lower Susquehanna and Eastern Shore
- 2 of 9 River Input stations are showing reductions in phosphorus loading (Patuxent and James)
- For trends in suspended-sediment loading, 20 percent of NTN stations are showing reductions
- 2 of 9 River Input stations are showing reductions in suspended-sediment loading (Susquehanna and James)

[2]Moyer and Langland, 2020

Trends in nitrogen loads result from changing nitrogen inputs or transport

River Input Monitoring Station:



Susquehanna River at Conowingo

Flow Normalized Load (lbs/day)

[1]Ator and others, 2011

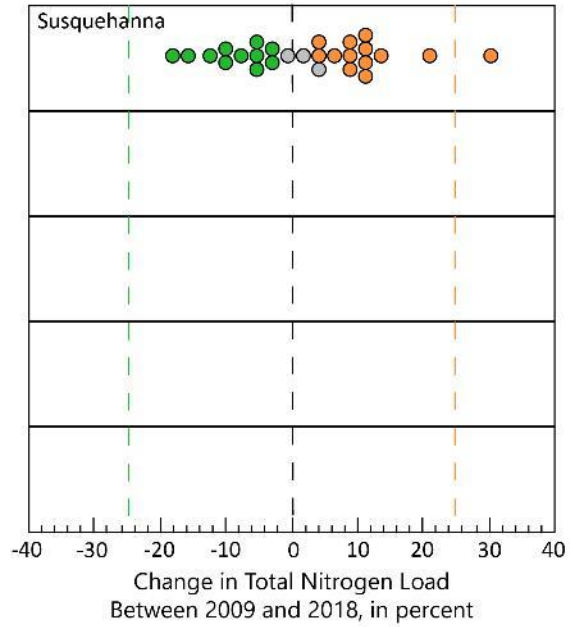
[2]Moyer and Langland, 2020

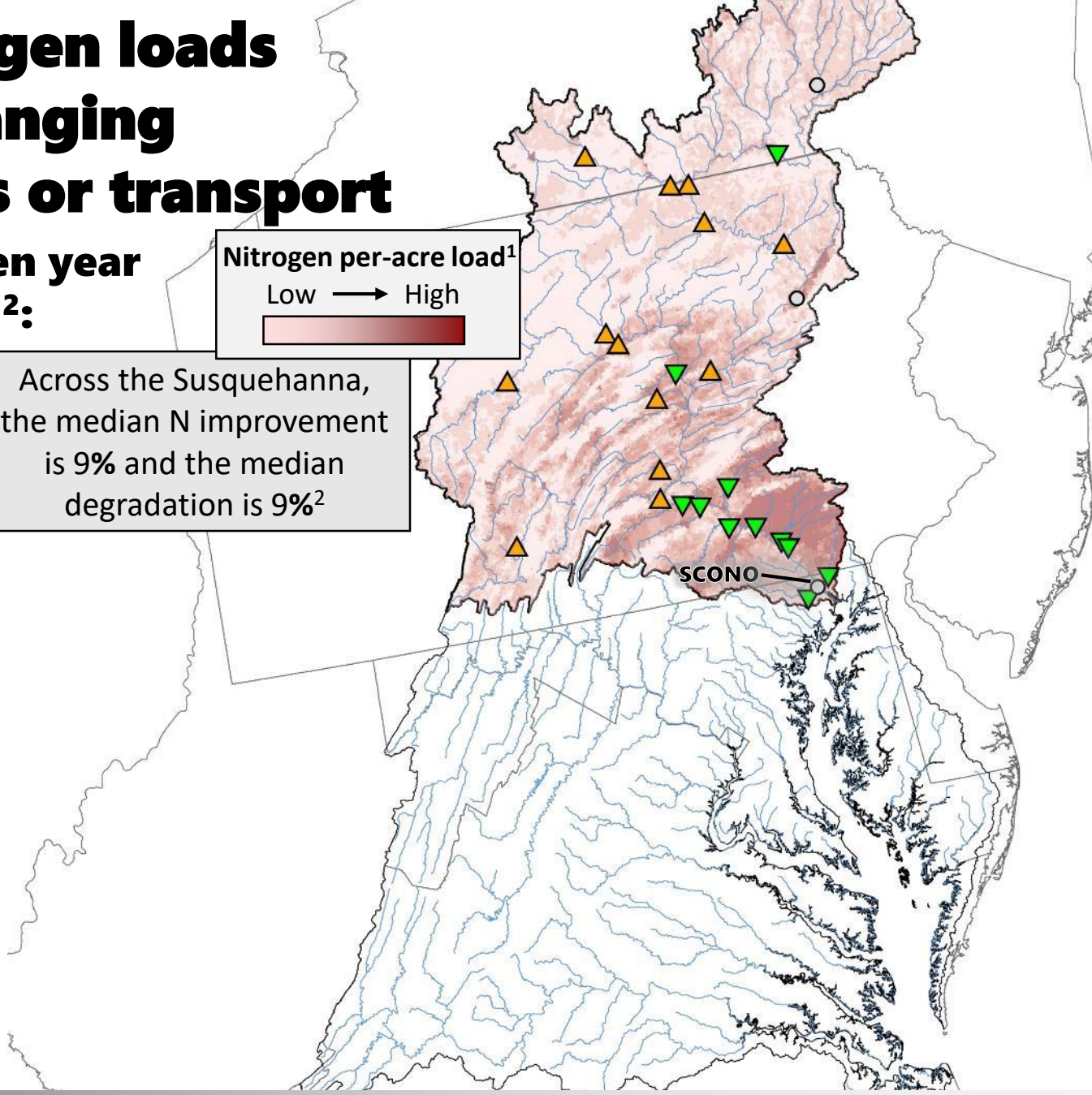
Trends in nitrogen loads result from changing nitrogen inputs or transport

In the most recent ten year period (2009 – 2018)[2]:

Nitrogen loads **(n=27)** have improved at **11**, degraded at **13**, and have no trend at **3** stations[2].

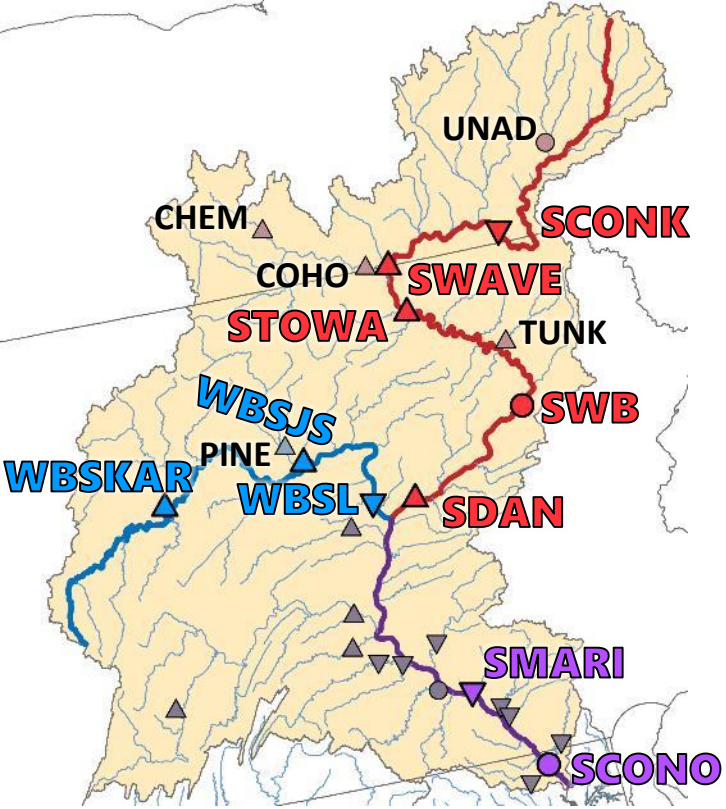
Across the Susquehanna, the median N improvement is **9%** and the median degradation is **9%**[2]

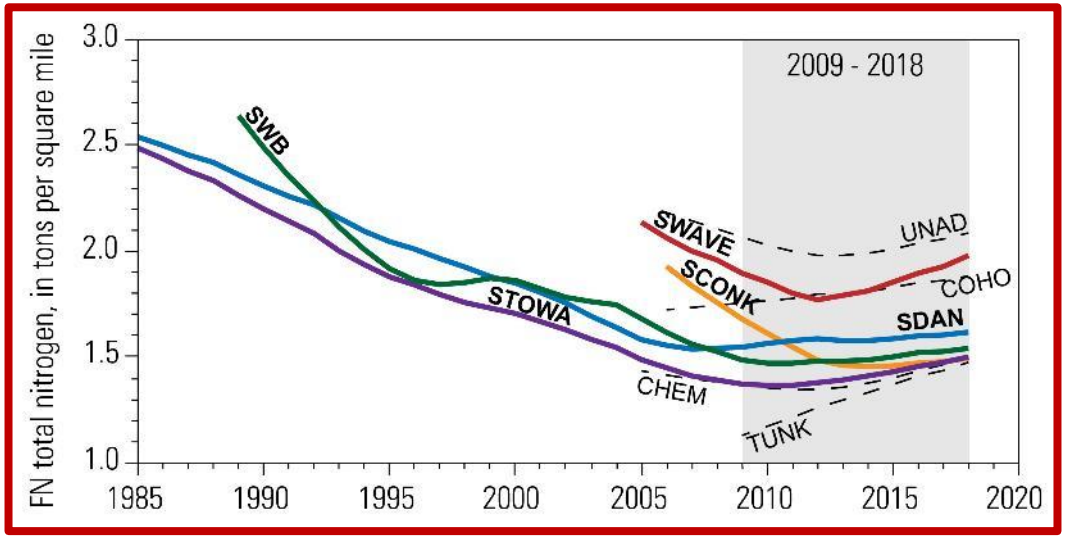


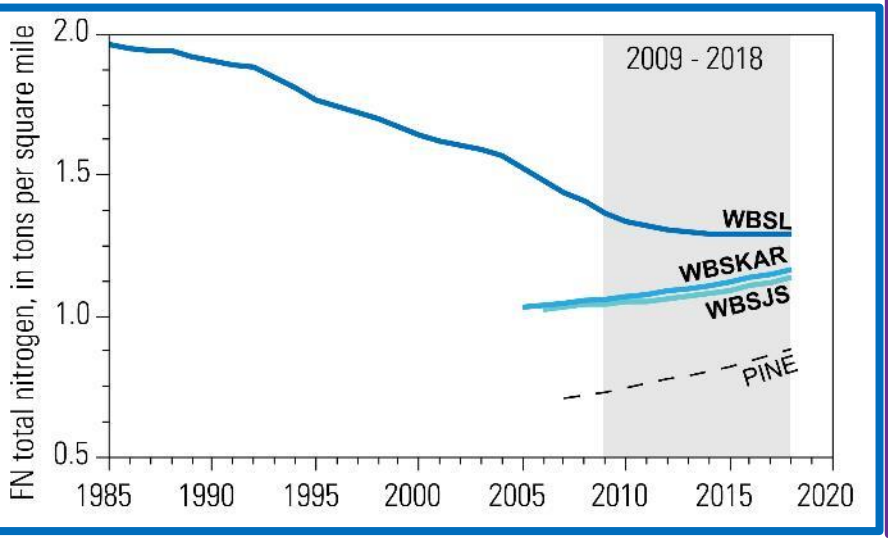


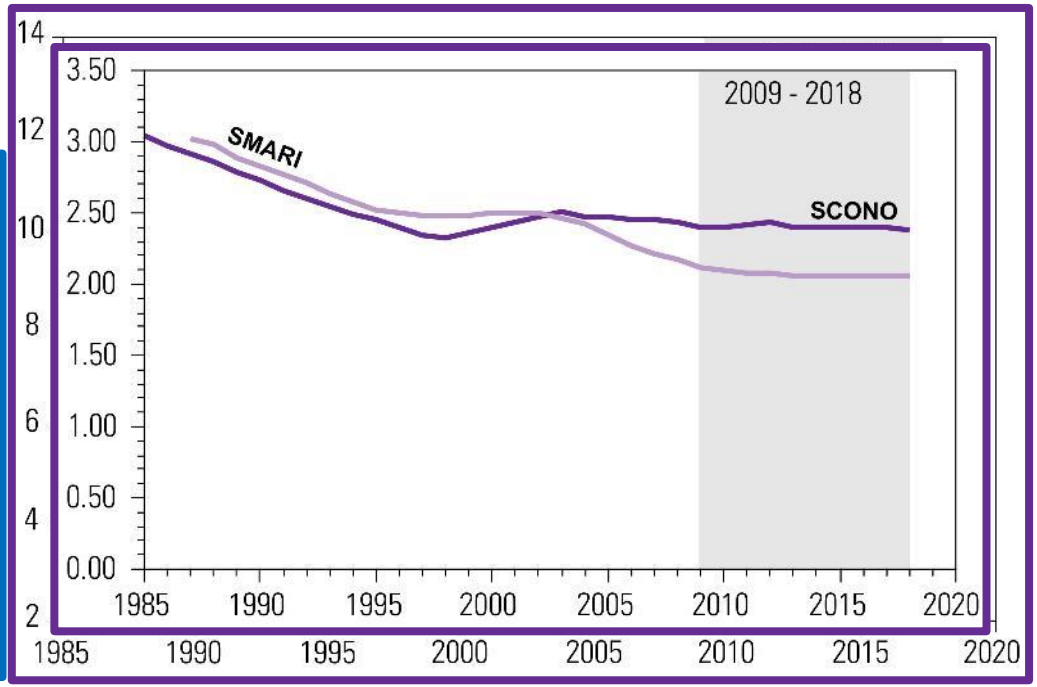
[1]Ator and others, 2011

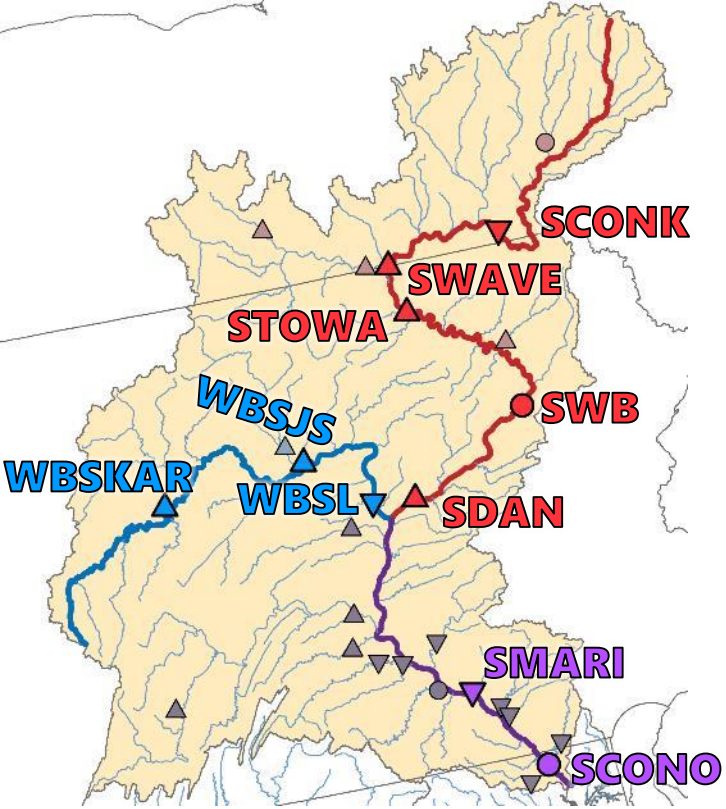
[2]Moyer and Langland, 2020


UNAD
CHEM
SCONK
COHO
SWAVE
STOWA
TUNK
WBSJS
SWB
PINE
WBSKAR
WBSL
SDAN
SMARI
SCONO


FN total nitrogen, in tons per square mile
3.0
2.5
2.0
1.5
1.0
1985
1990
1995
2000
2005
2010
2015
2020
2009 - 2018
SWB
STOWA
SWAVE
SCONK
CHEM
TUNK
UNAD
COHO
SDAN


FN total nitrogen, in tons per square mile
2.0
1.5
1.0
0.5
1985
1990
1995
2000
2005
2010
2015
2020
2009 - 2018
WBSL
WBSKAR
WBSJS
PINE


14
12
10
8
6
4
2
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1985
1990
1995
2000
2005
2010
2015
2020
2009 - 2018
SMARI
SCONO



- What is driving nitrate reductions in lower Susquehanna tributaries?
- How many BMPs are targeting sediment and the retention of particulate nutrients throughout the basin?

- FN yields are decreasing in most lower Susquehanna tributaries
- Yields are typically highest in the lower Susquehanna, with most TN contributed by nitrate
- **SMARI** yields have declined, benefitting from reduced TN contributed by surrounding tributaries.

- FN yields increased in 3/4 WB Susquehanna stations

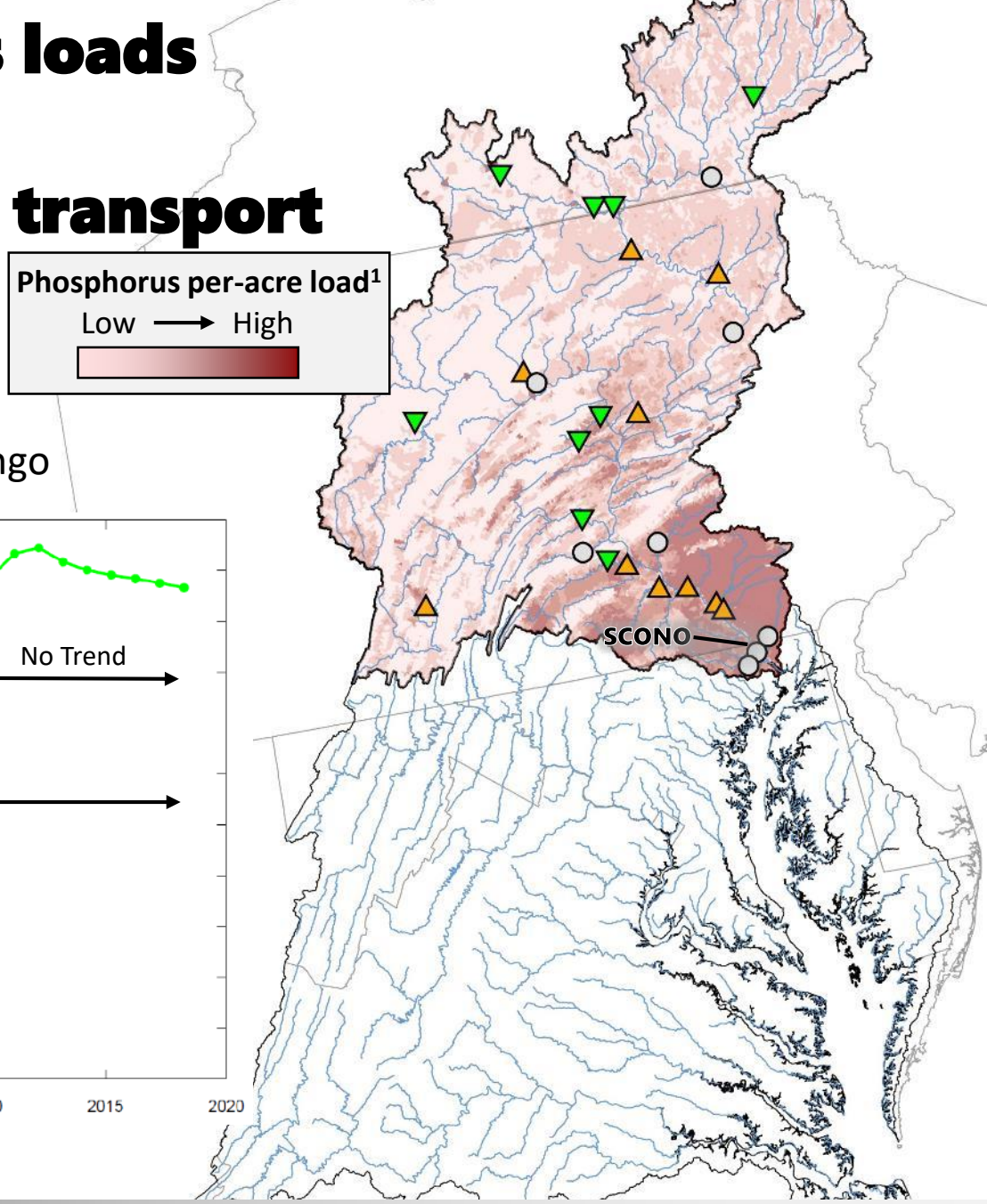
- FN yields increased in 6/9 Upper Susquehanna stations and have been tracking upward in all stations over the past few years.

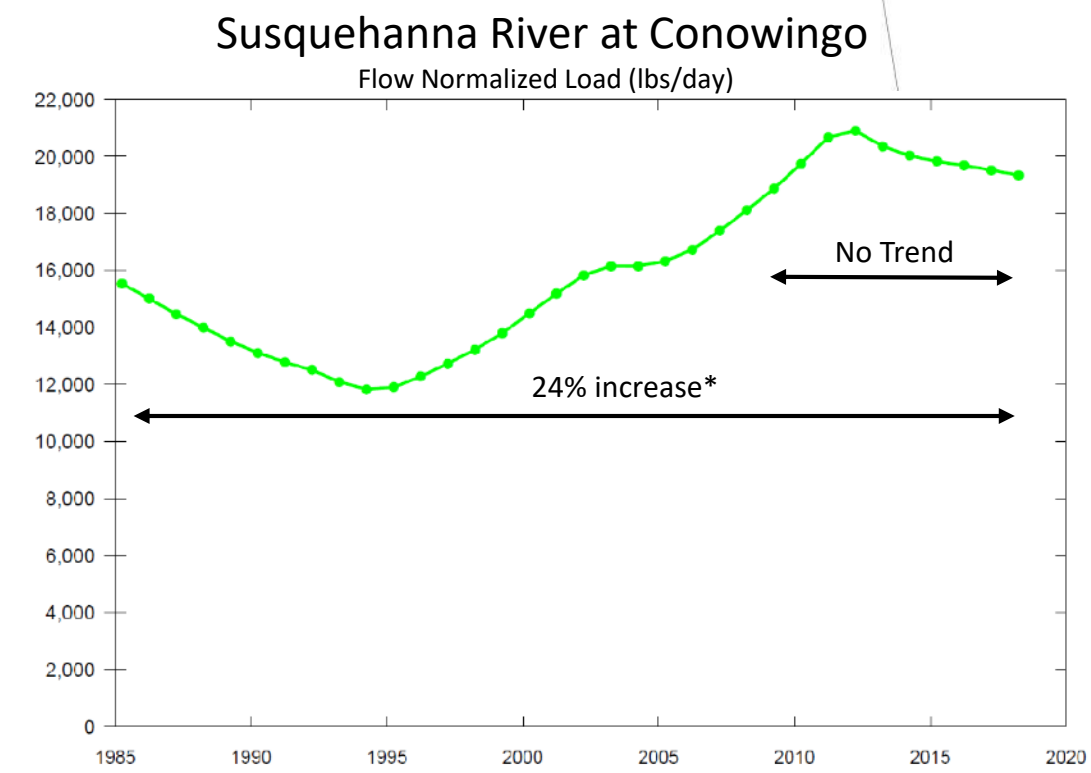
- There is evidence of increased particulate N export in many Upper and West Branch Susquehanna stations:
  - High-flow TN concentrations have increased
  - TN/NO3 ratios have shifted
  - SS export has increased in many stations

- **SDAN** and **WBSL** trends may increase in coming years as a result of increases from upstream contributing areas.
- About 70% of **SMARI** streamflow is from **WBSL** and **SDAN**; increases in these upstream stations will have negative impact on **SMARI** yields.

Trends in phosphorus loads result from changing phosphorus inputs or transport

River Input Monitoring Station:





USGS science for a changing world

[1]Ator and others, 2011

[2]Moyer and Langland, 2020

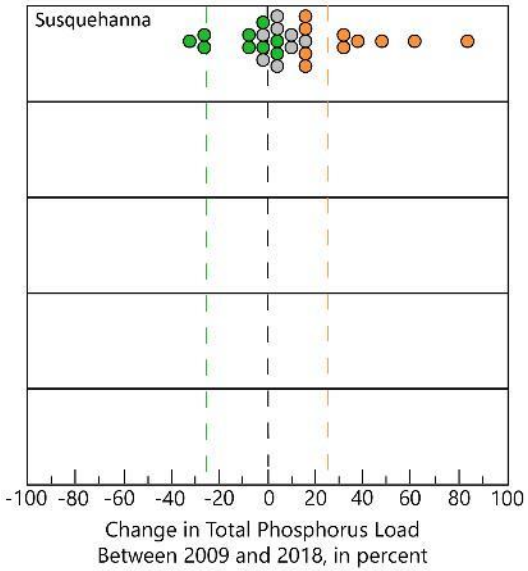
Trends in phosphorus loads result from changing phosphorus inputs or transport

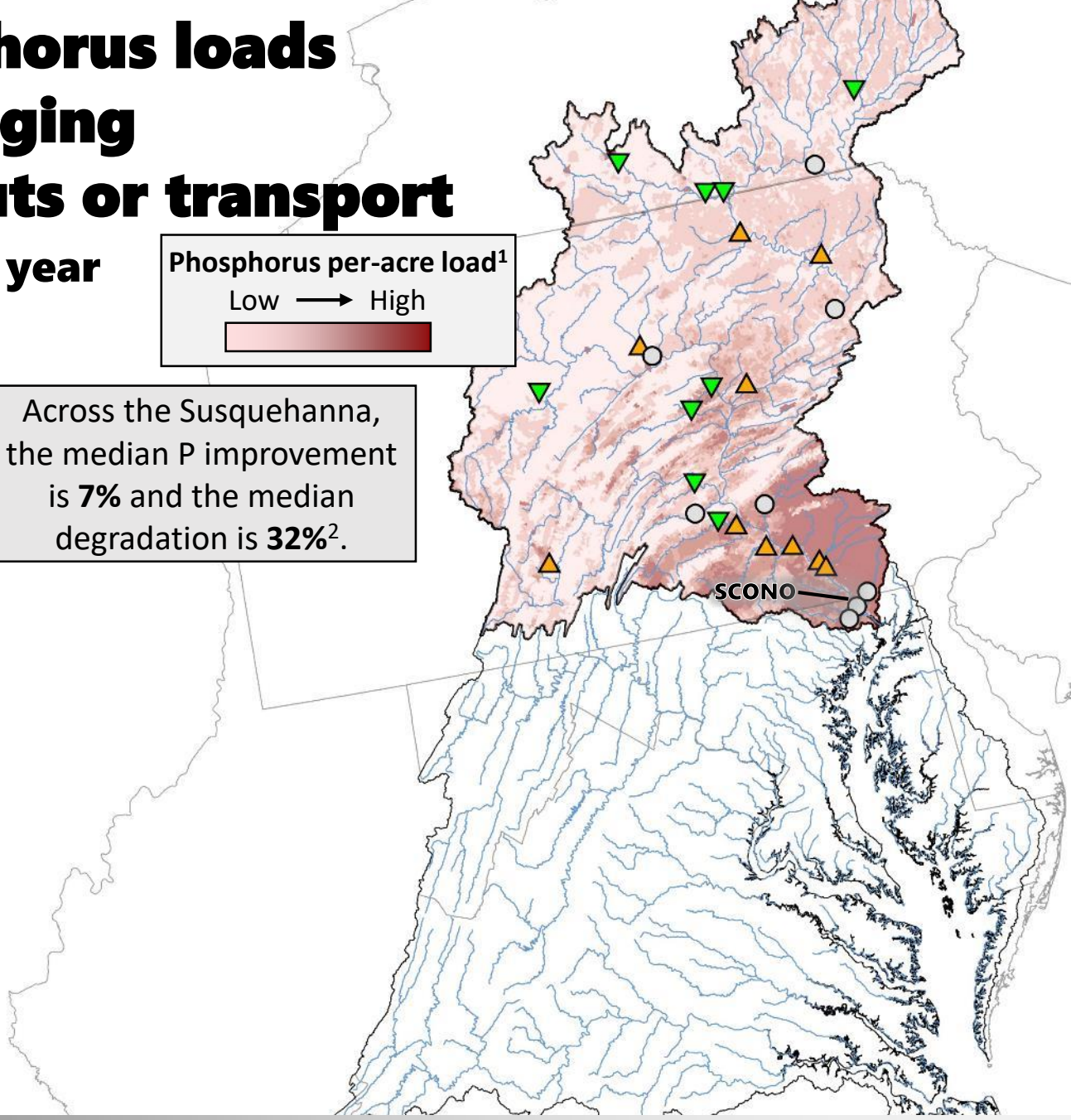
In the most recent ten year period (2009 – 2018)[2]:

Phosphorus per-acre load[1]
Low → High

Phosphorus loads **(n=27)** have improved at **9**, degraded at **10**, and have no trend at **8** stations[2].

Across the Susquehanna, the median P improvement is **7%** and the median degradation is **32%**[2].



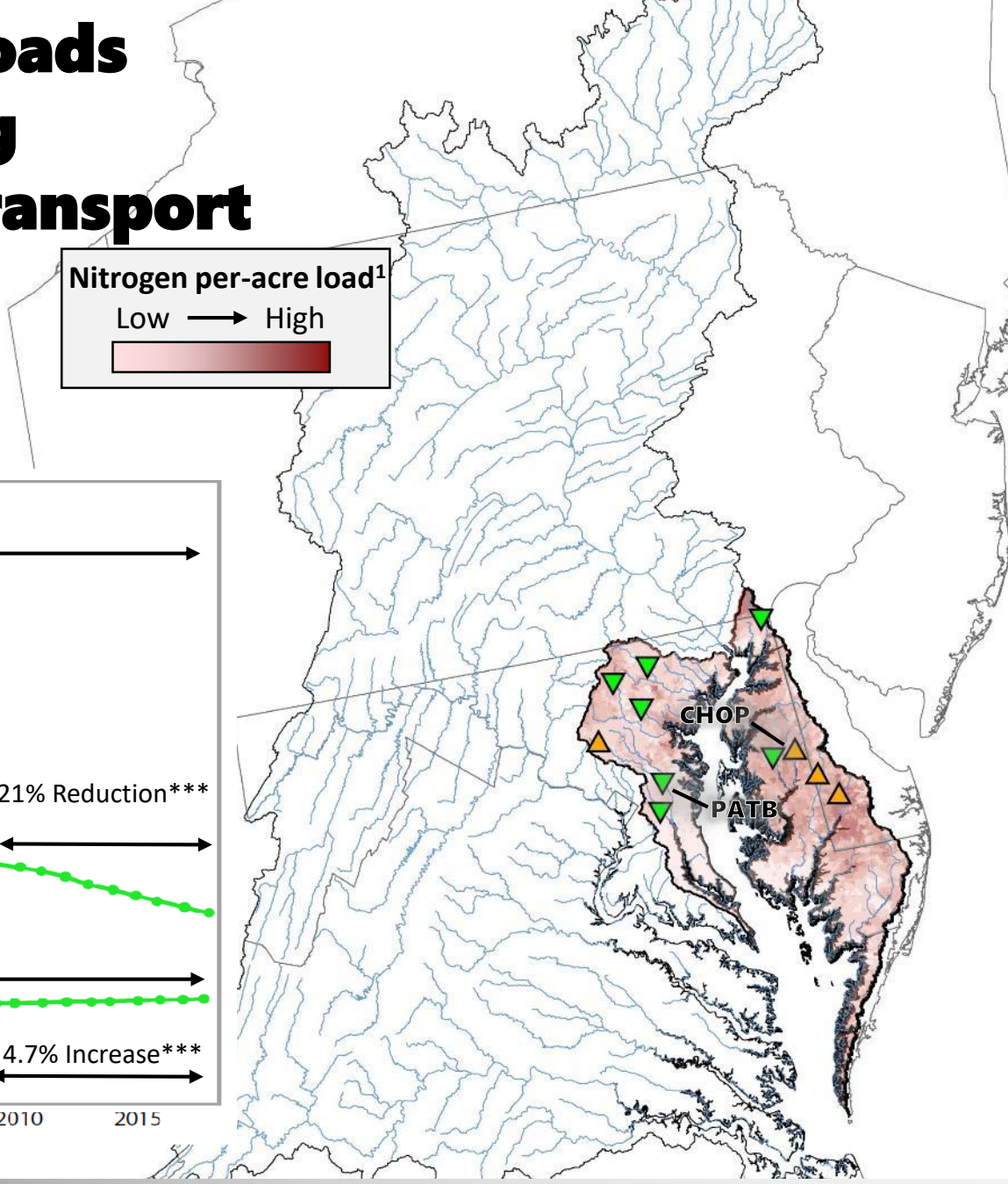


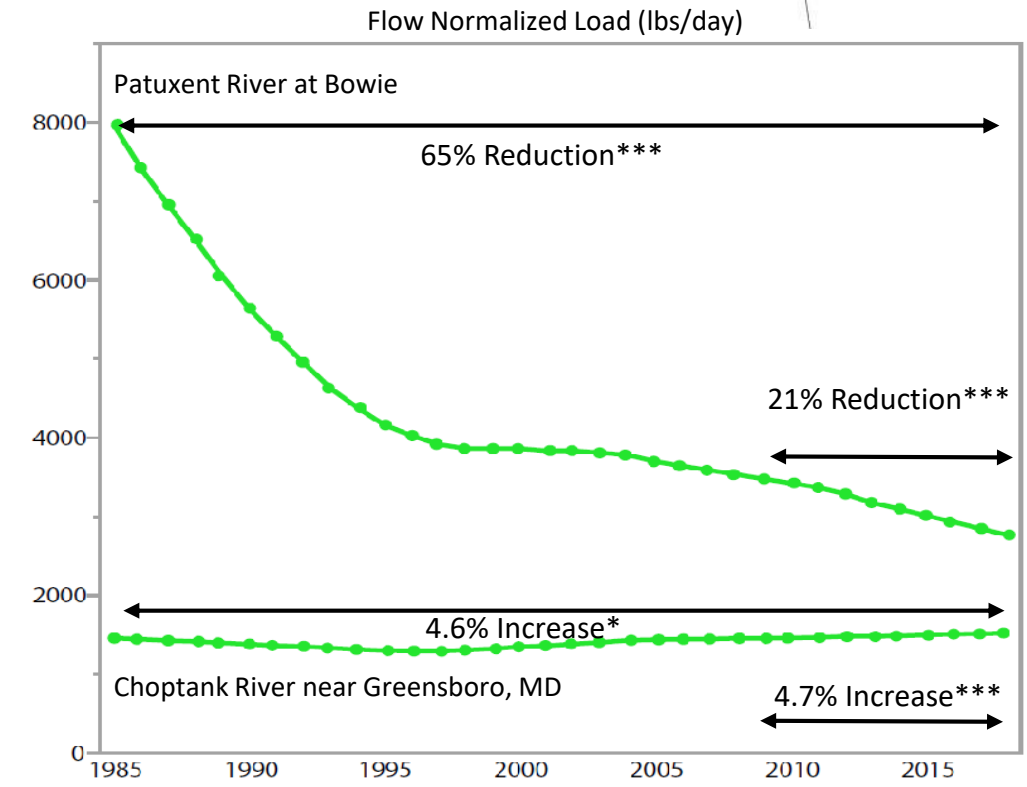
[1]Ator and others, 2011

[2]Moyer and Langland, 2020

Trends in nitrogen loads result from changing nitrogen inputs or transport

River Input Monitoring Stations:





USGS science for a changing world

[1]Ator and others, 2011

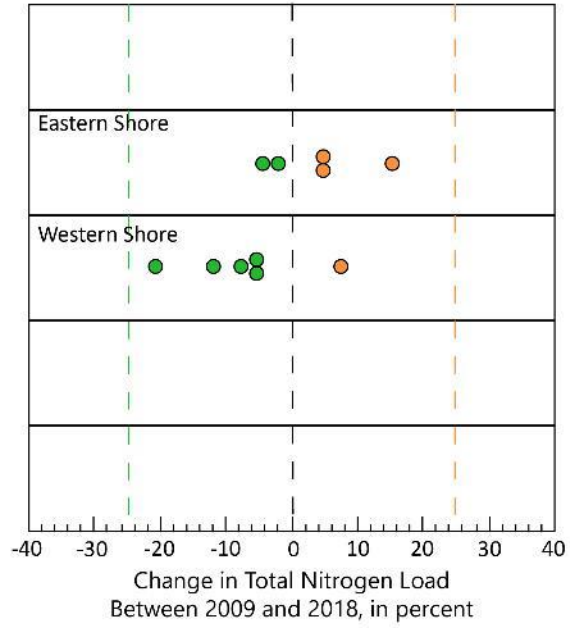
[2]Moyer and Langland, 2020

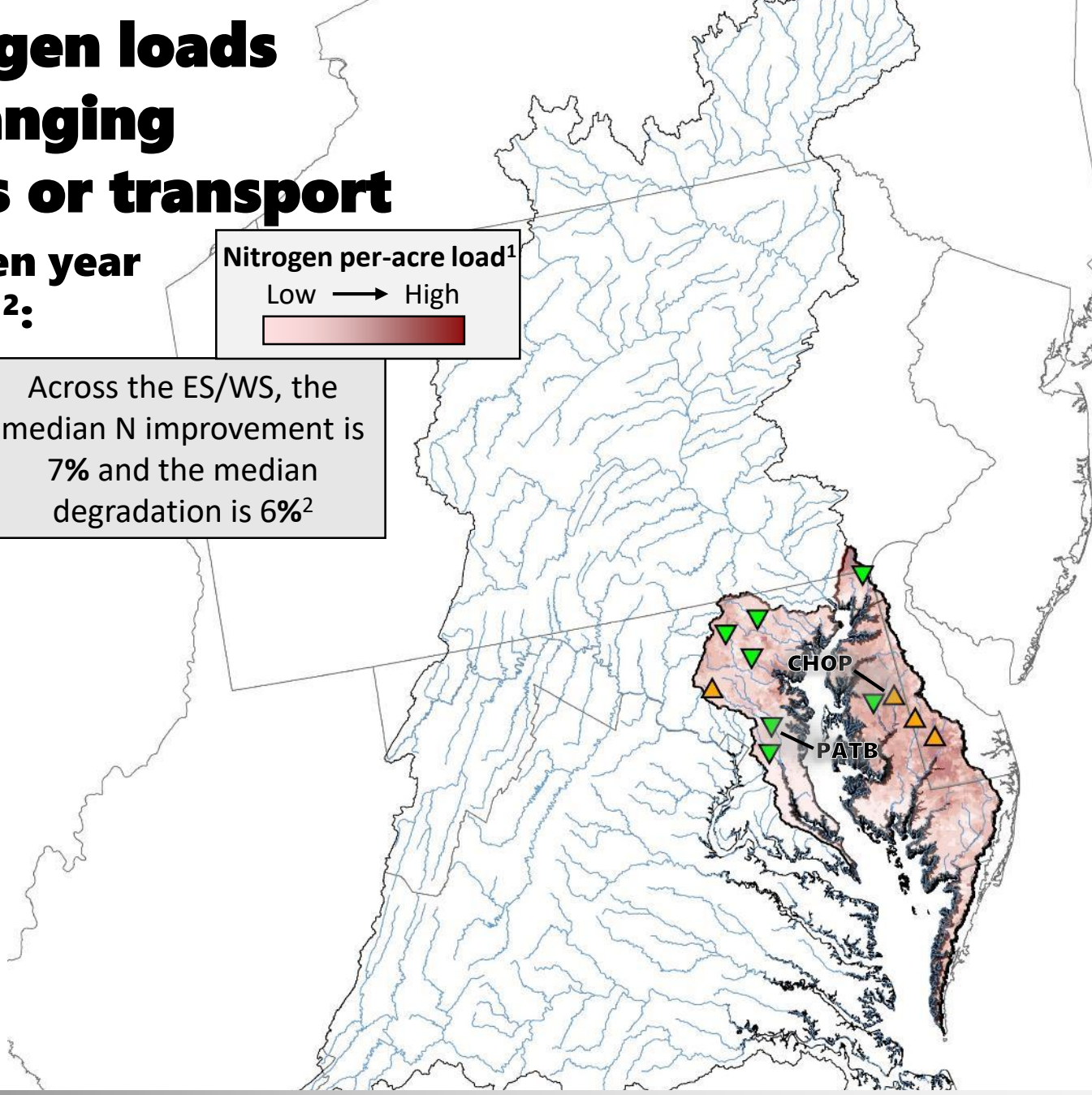
Trends in nitrogen loads result from changing nitrogen inputs or transport

In the most recent ten year period (2009 – 2018)[2]:

Nitrogen loads **(n=11)** have improved at **7 and** degraded at **4** stations[2].

Across the ES/WS, the median N improvement is **7%** and the median degradation is **6%**[2]



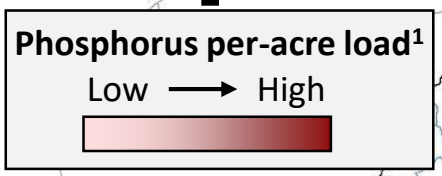


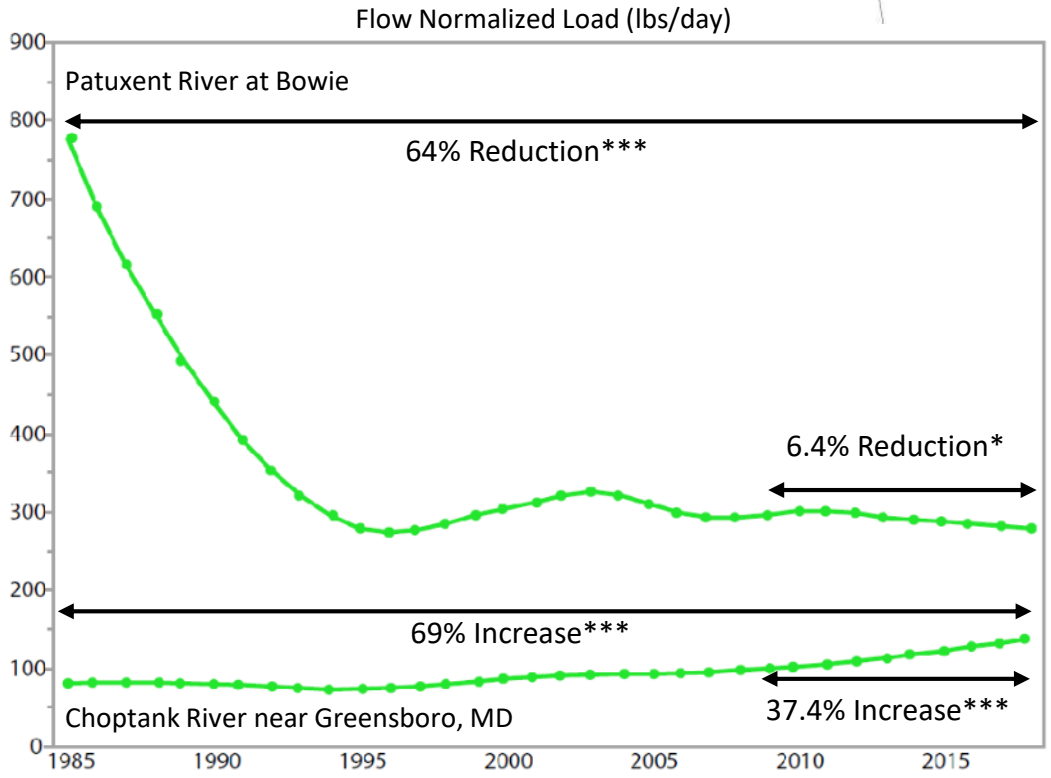
[1]Ator and others, 2011

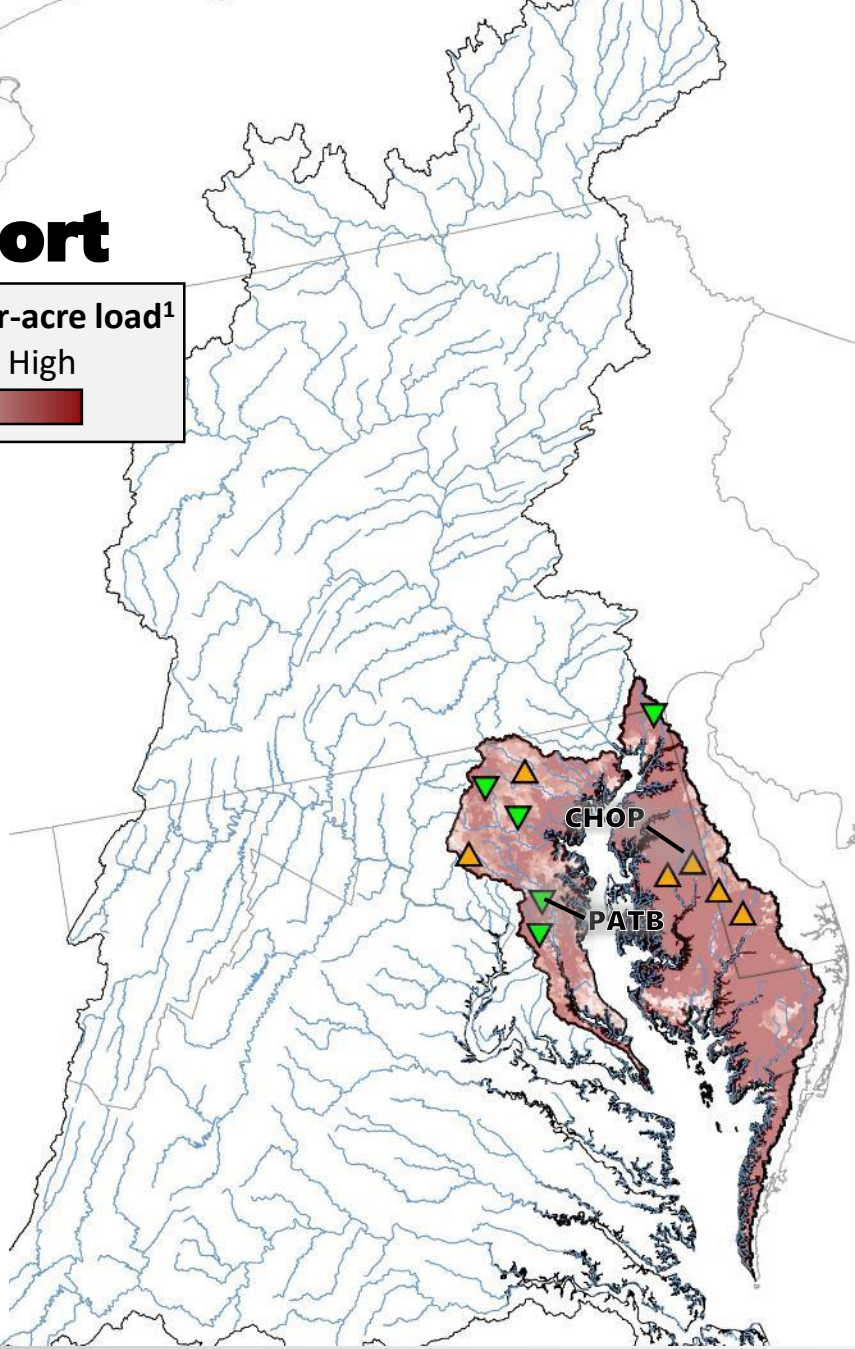
[2]Moyer and Langland, 2020

Trends in phosphorus loads result from changing phosphorus inputs or transport

River Input Monitoring Stations:







USGS science for a changing world

[1]Ator and others, 2011

[2]Moyer and Langland, 2020

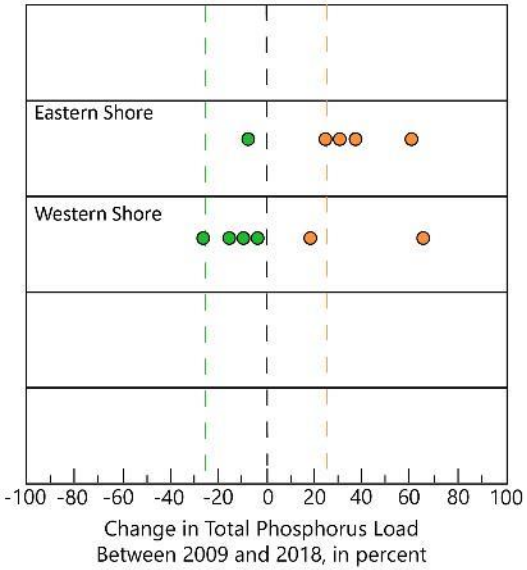
Trends in phosphorus loads result from changing phosphorus inputs or transport

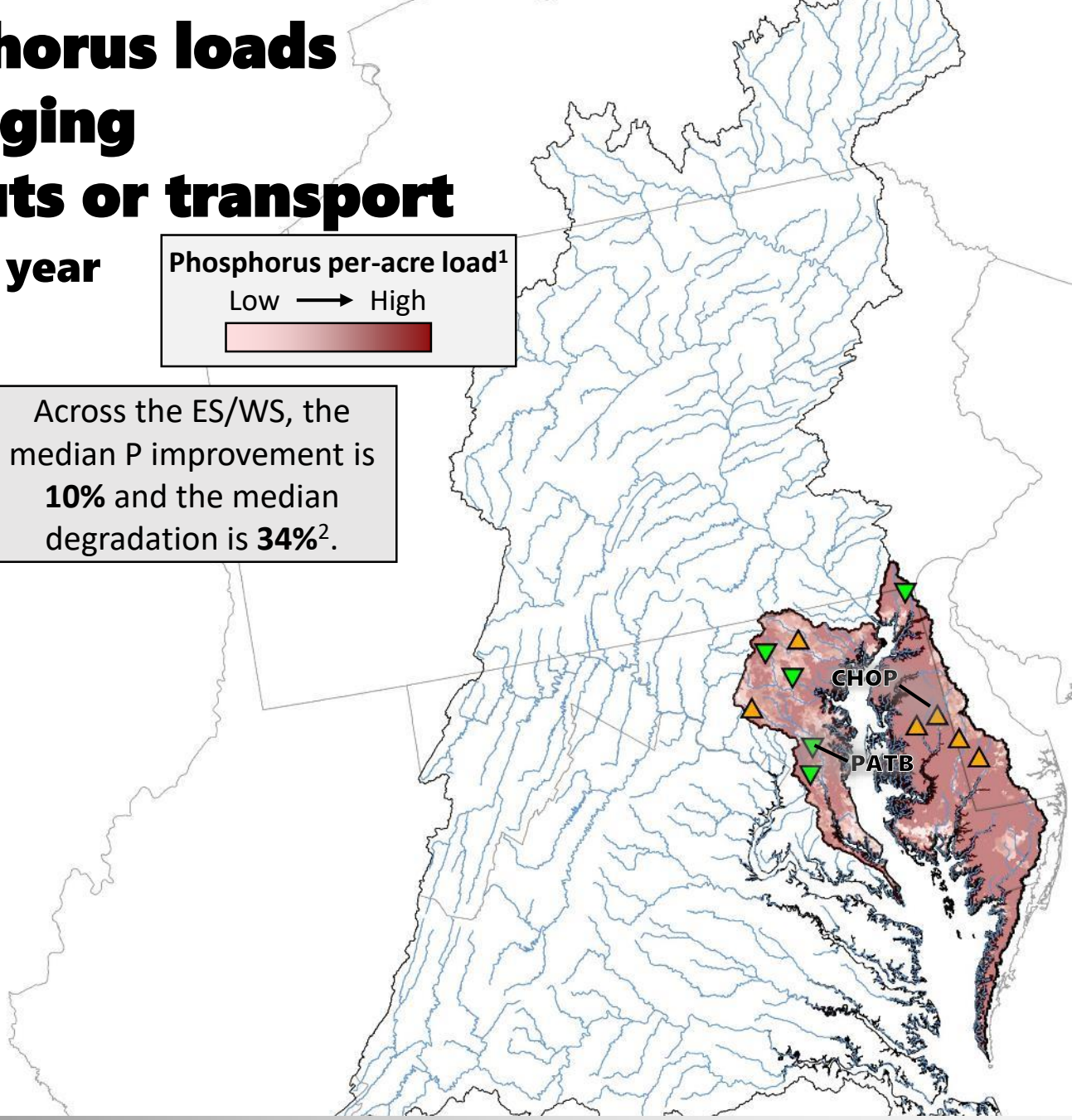
In the most recent ten year period (2009 – 2018)[2]:

Phosphorus per-acre load[1]
Low → High

Phosphorus loads **(n=11)** have improved at **5** and have degraded at **6** stations[2].

Across the ES/WS, the median P improvement is **10%** and the median degradation is **34%**[2].



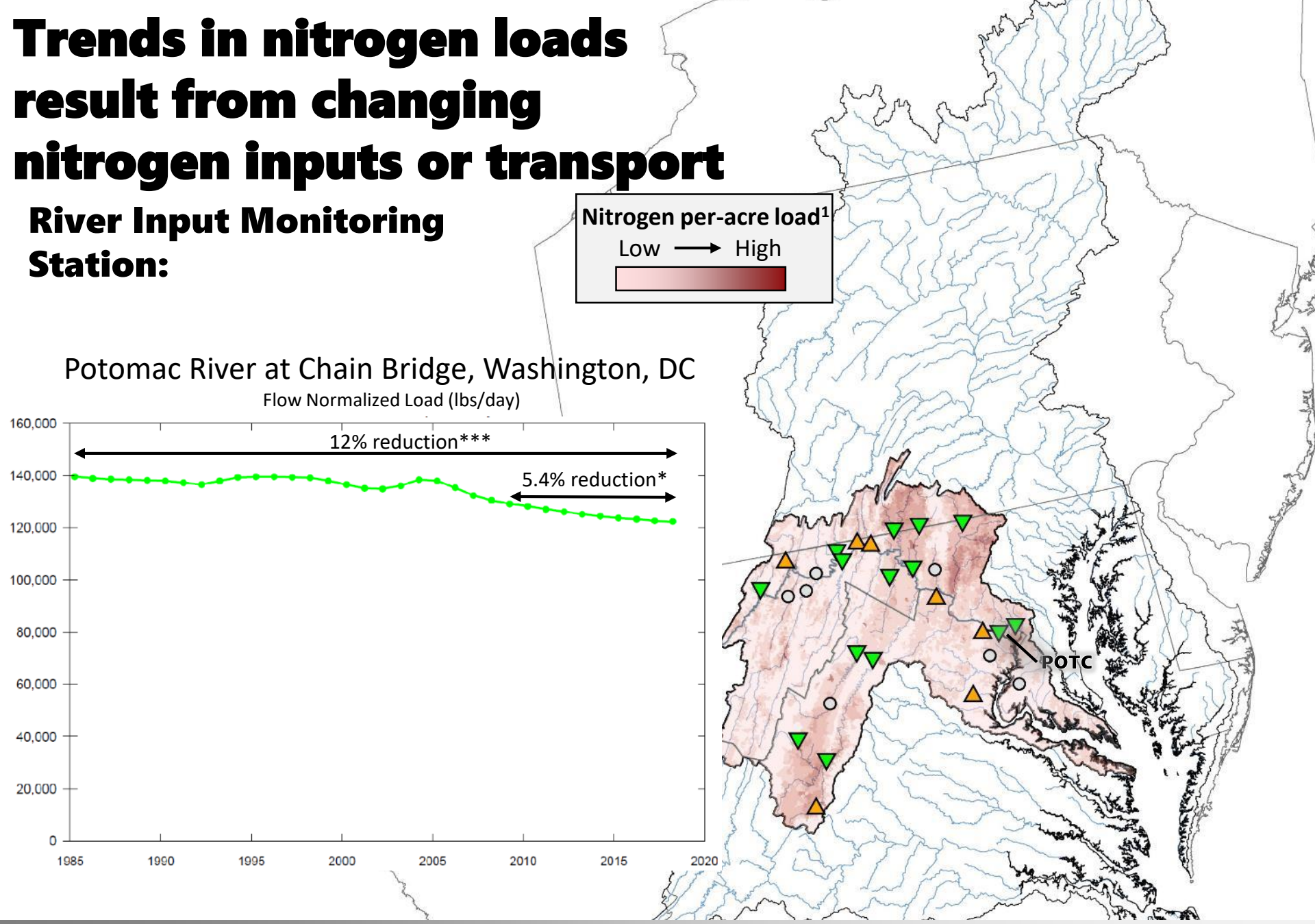


[1]Ator and others, 2011

[2]Moyer and Langland, 2020

Trends in nitrogen loads result from changing nitrogen inputs or transport

River Input Monitoring Station:



Potomac River at Chain Bridge, Washington, DC

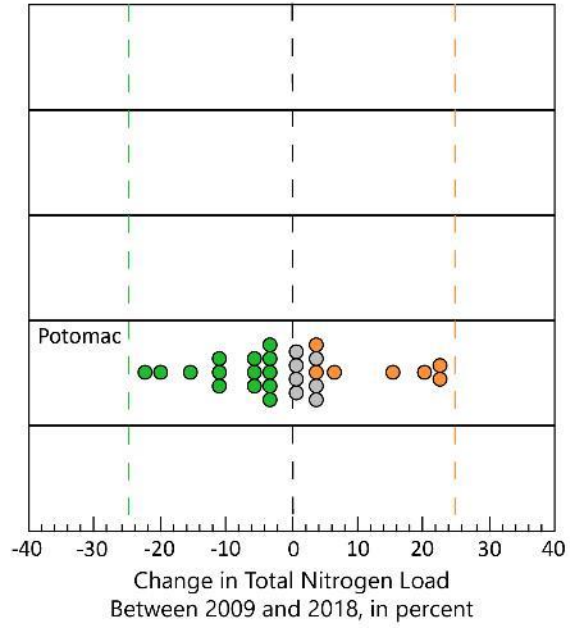
Flow Normalized Load (lbs/day)

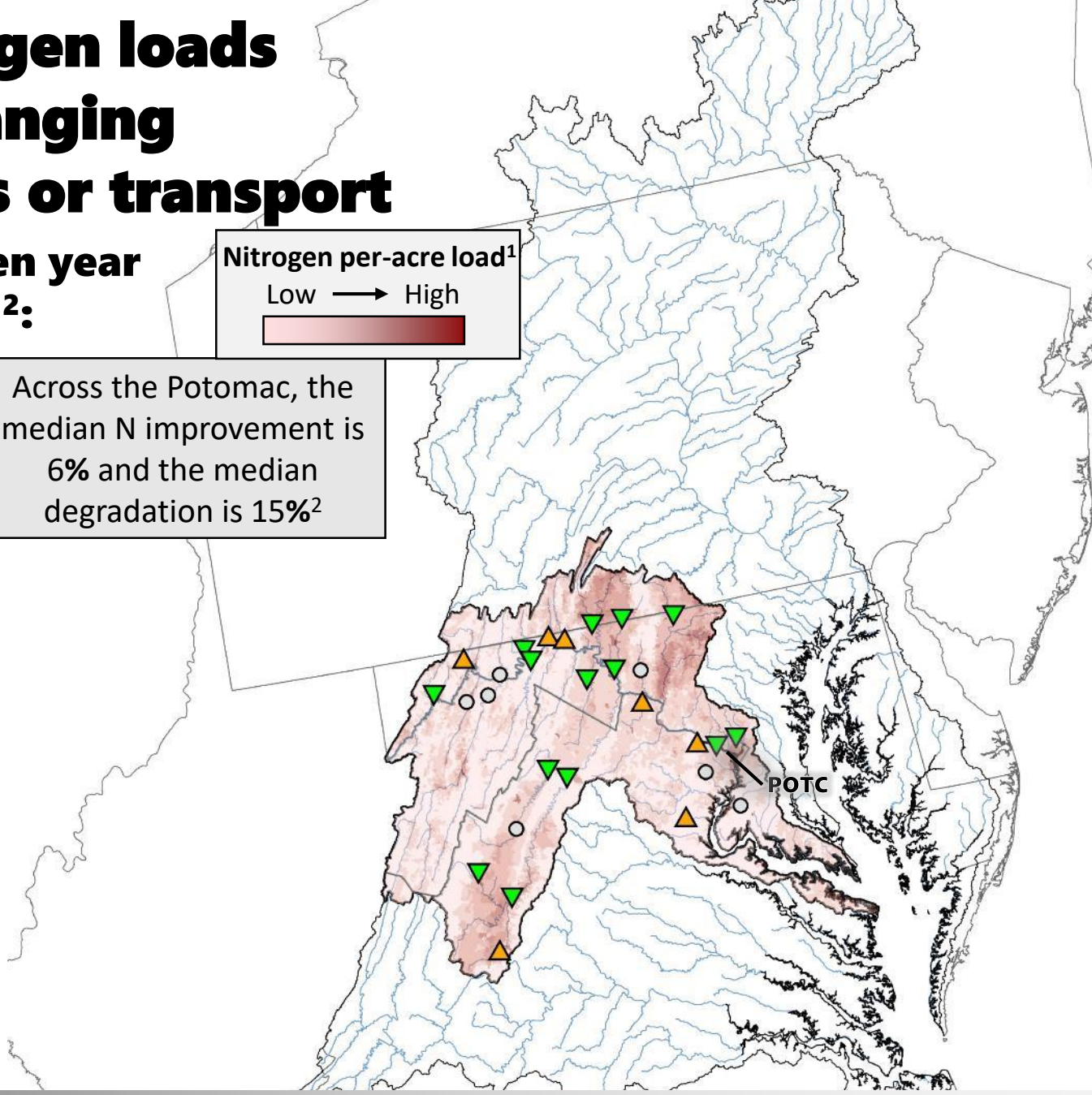
Trends in nitrogen loads result from changing nitrogen inputs or transport

In the most recent ten year period (2009 – 2018)[2]:

Nitrogen loads **(n=28)** have improved at **14,** degraded at **7**, and have no trend at **7** stations[2].

Across the Potomac, the median N improvement is 6**%** and the median degradation is 15**%**[2]



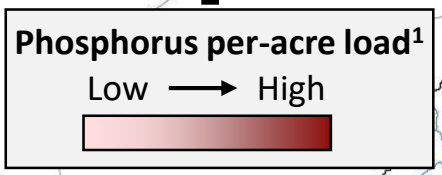


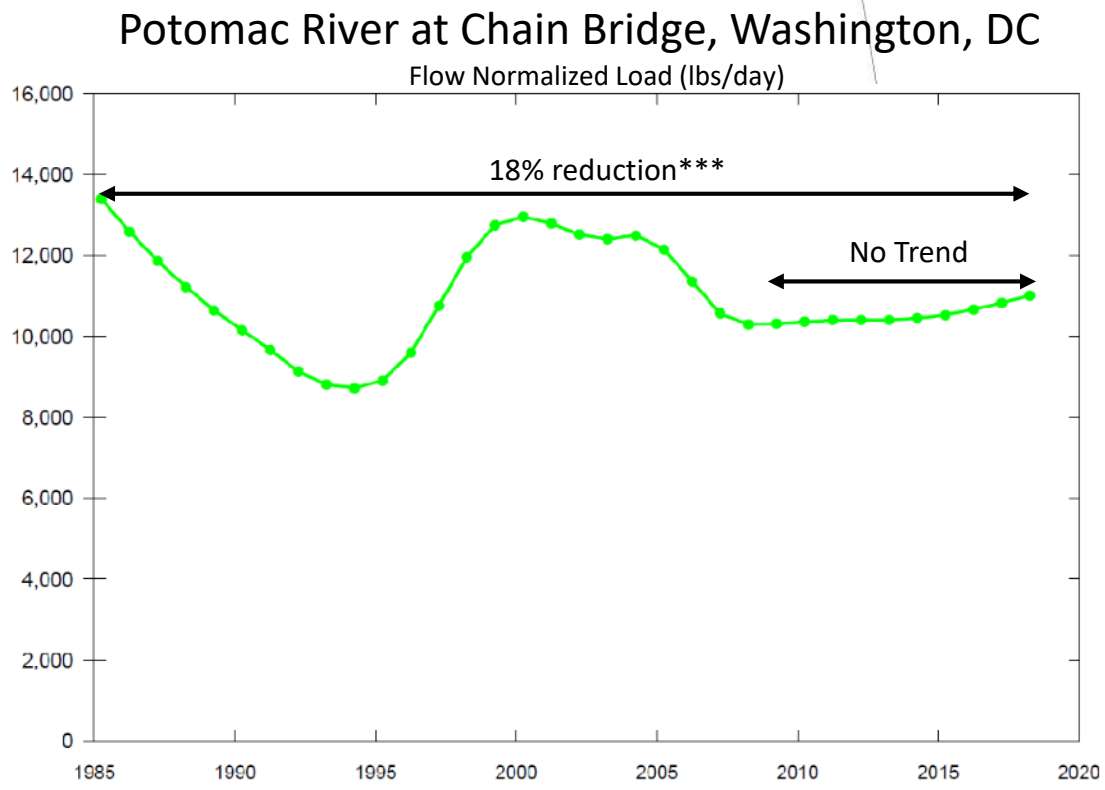
[1]Ator and others, 2011

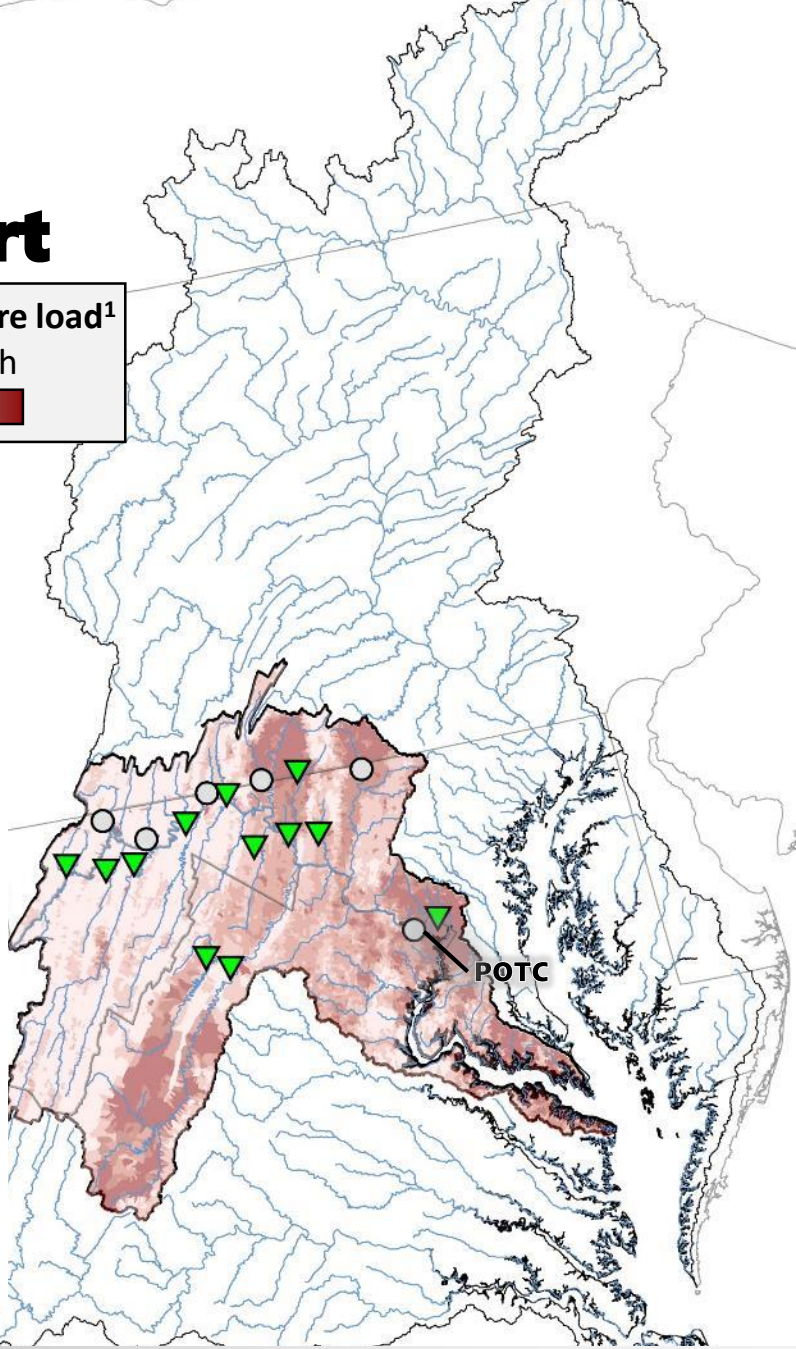
[2]Moyer and Langland, 2020

Trends in phosphorus loads result from changing phosphorus inputs or transport

River Input Monitoring Station:







USGS science for a changing world

[1]Ator and others, 2011

[2]Moyer and Langland, 2020

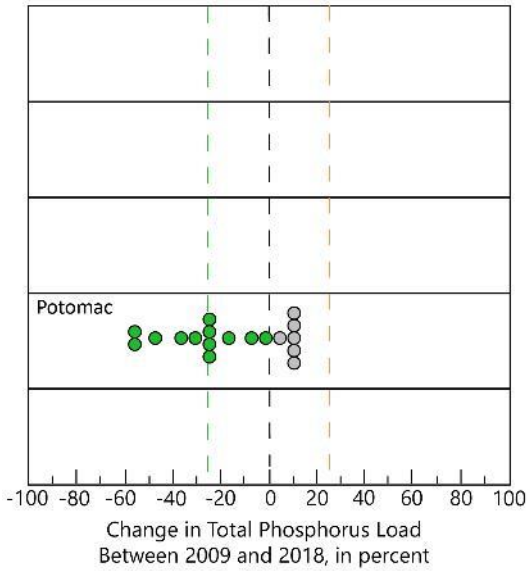
Trends in phosphorus loads result from changing phosphorus inputs or transport

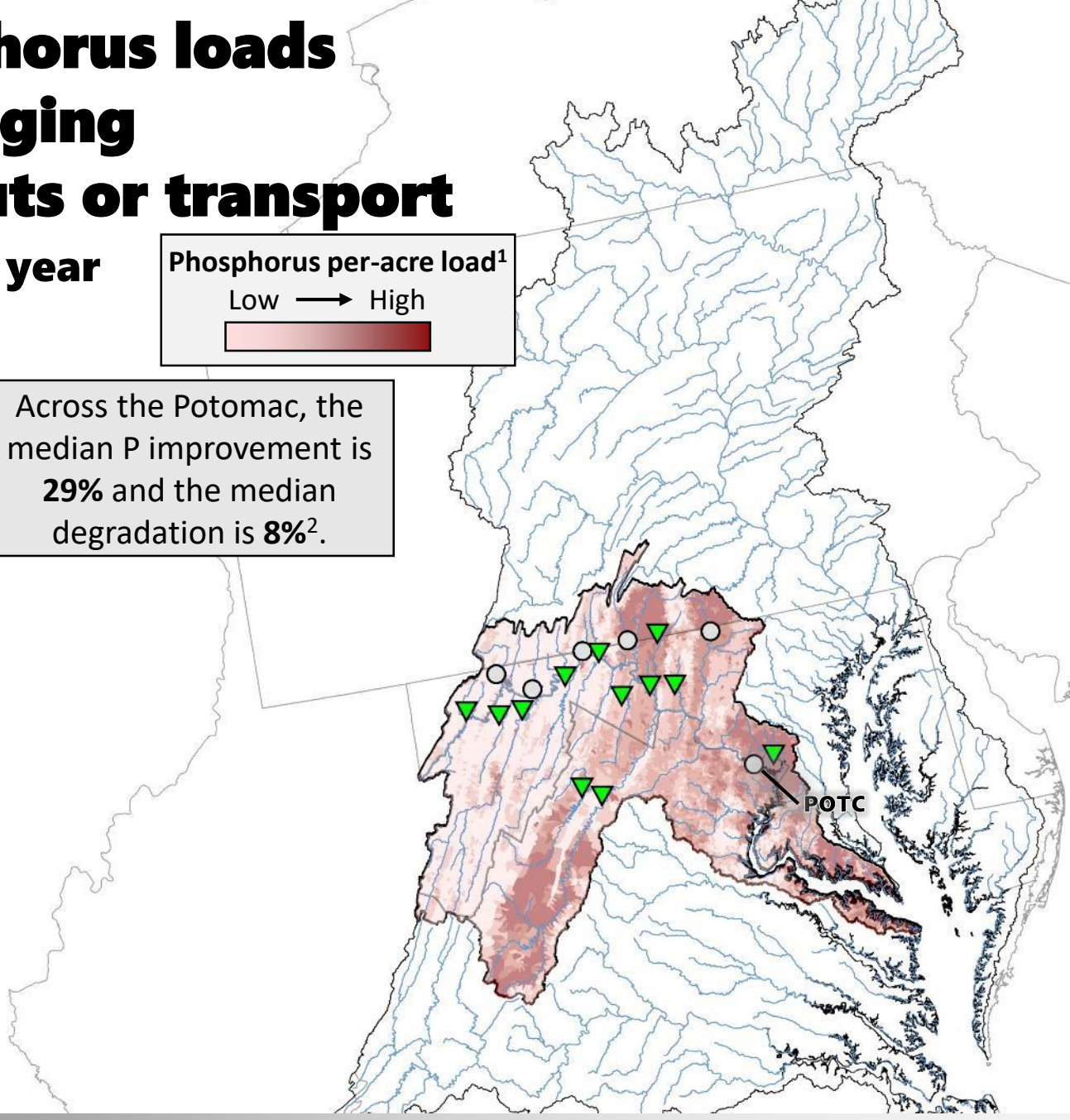
In the most recent ten year period (2009 – 2018)[2]:

Phosphorus per-acre load[1]
Low → High

Phosphorus loads **(n=18)** have improved at **12** and have no trend at **6** stations[2].

Across the Potomac, the median P improvement is **29%** and the median degradation is **8%**[2].





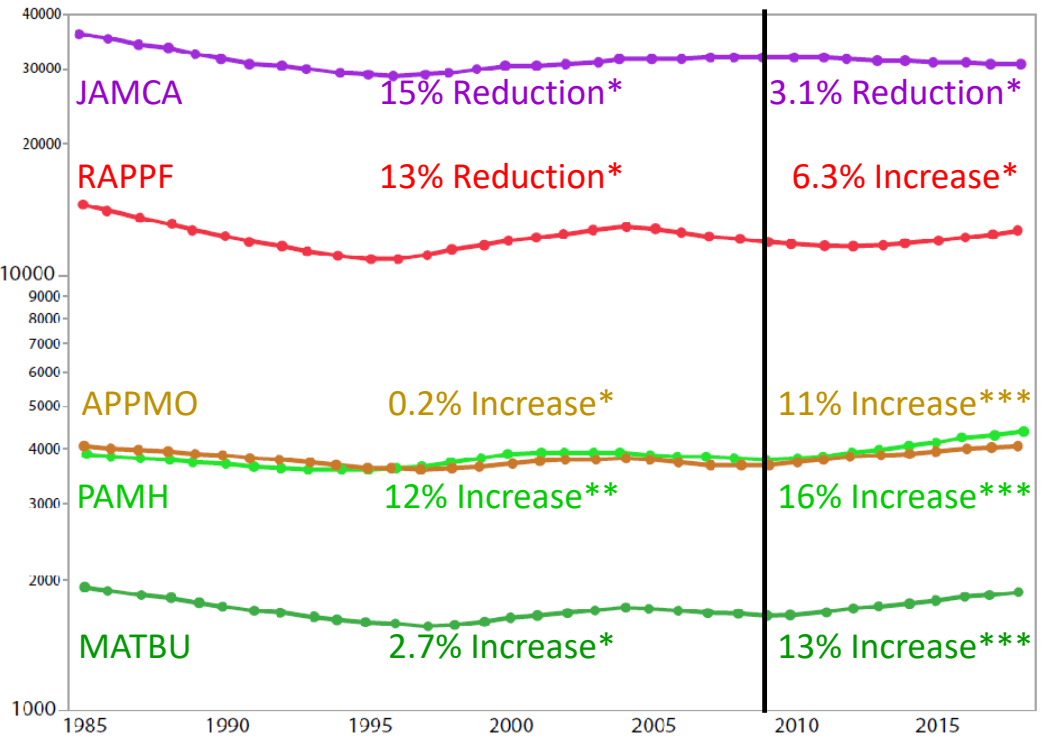
USGS science for a changing world

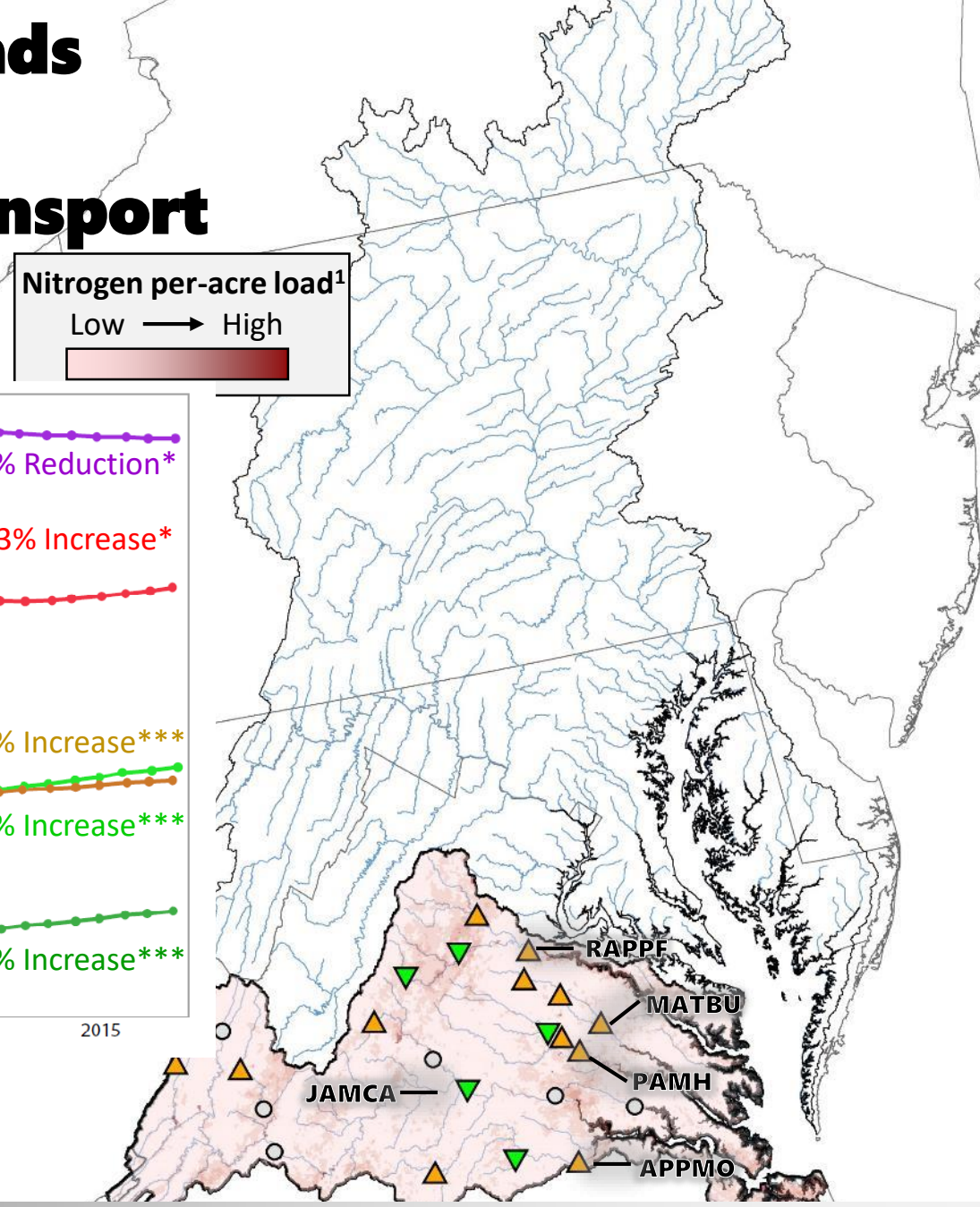
[1]Ator and others, 2011

[2]Moyer and Langland, 2020

Trends in nitrogen loads result from changing nitrogen inputs or transport

River Input Monitoring Stations:





[1]Ator and others, 2011

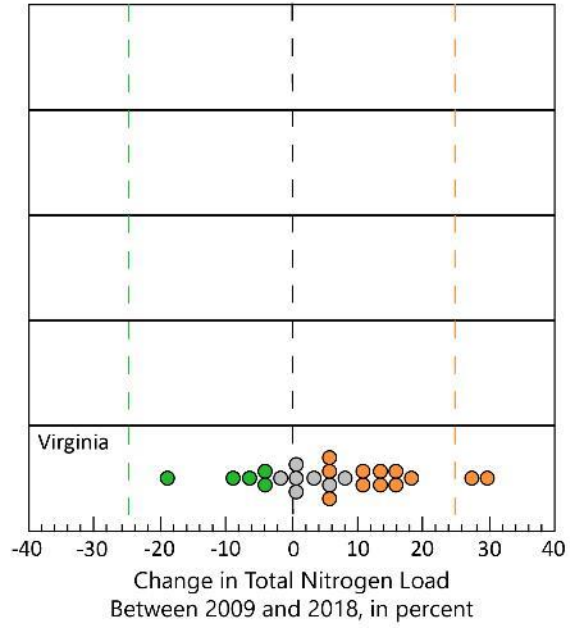
[2]Moyer and Langland, 2020

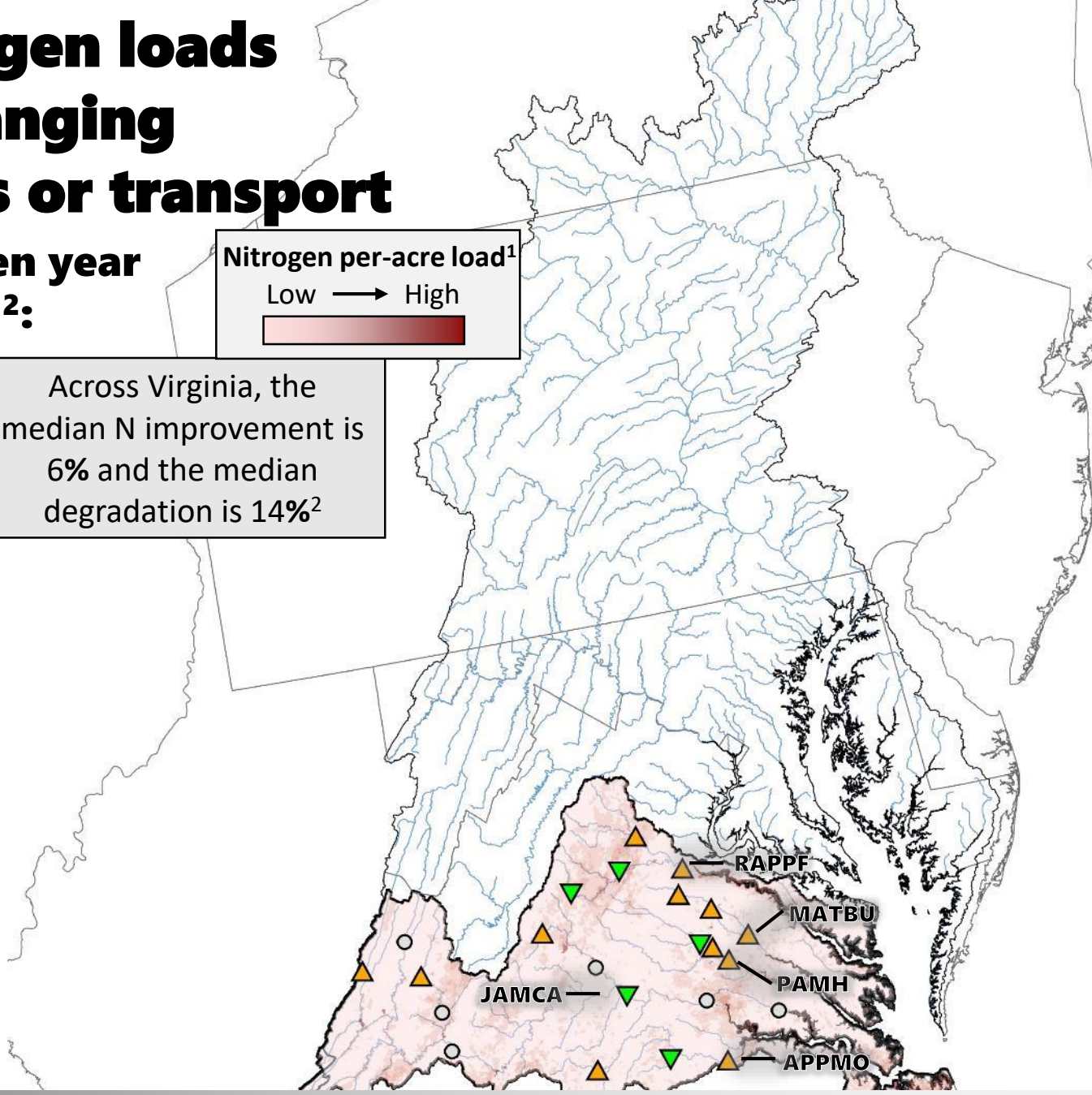
Trends in nitrogen loads result from changing nitrogen inputs or transport

In the most recent ten year period (2009 – 2018)[2]:

Nitrogen loads **(n=24)** have improved at **5**, degraded at **12**, and have no trend at **7** stations[2].

Across Virginia, the median N improvement is **6%** and the median degradation is **14%**[2]



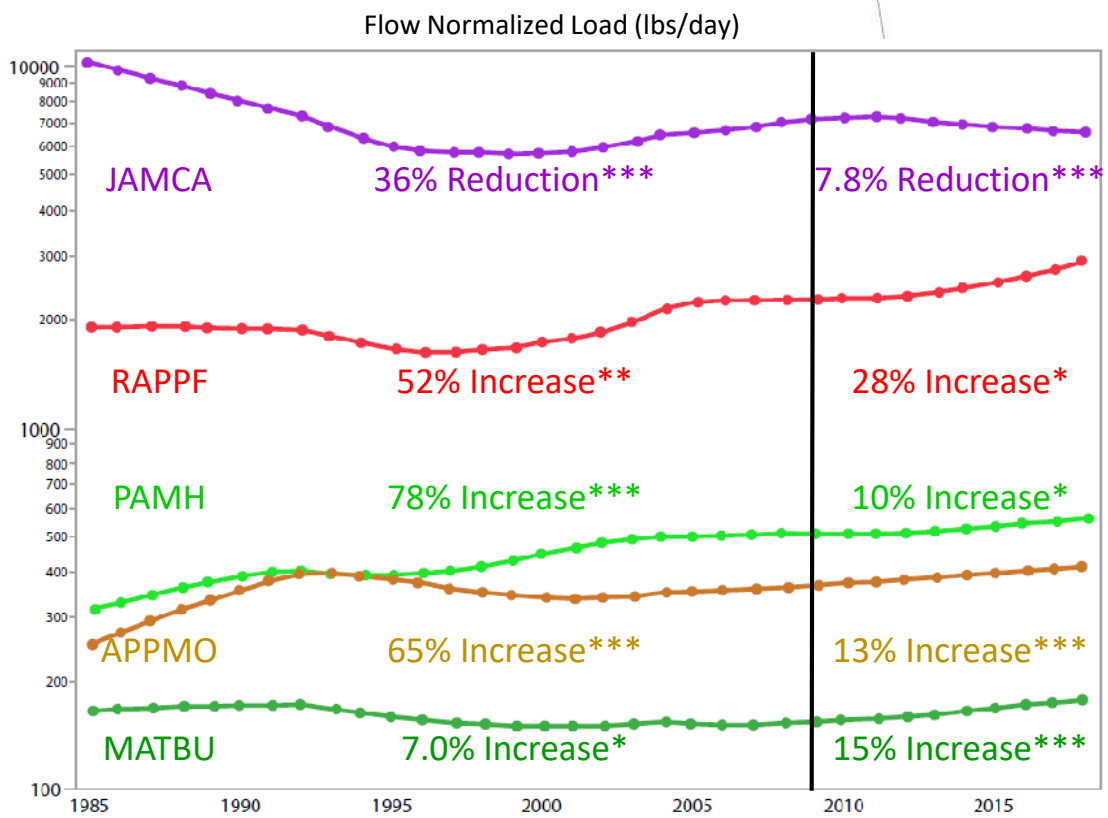


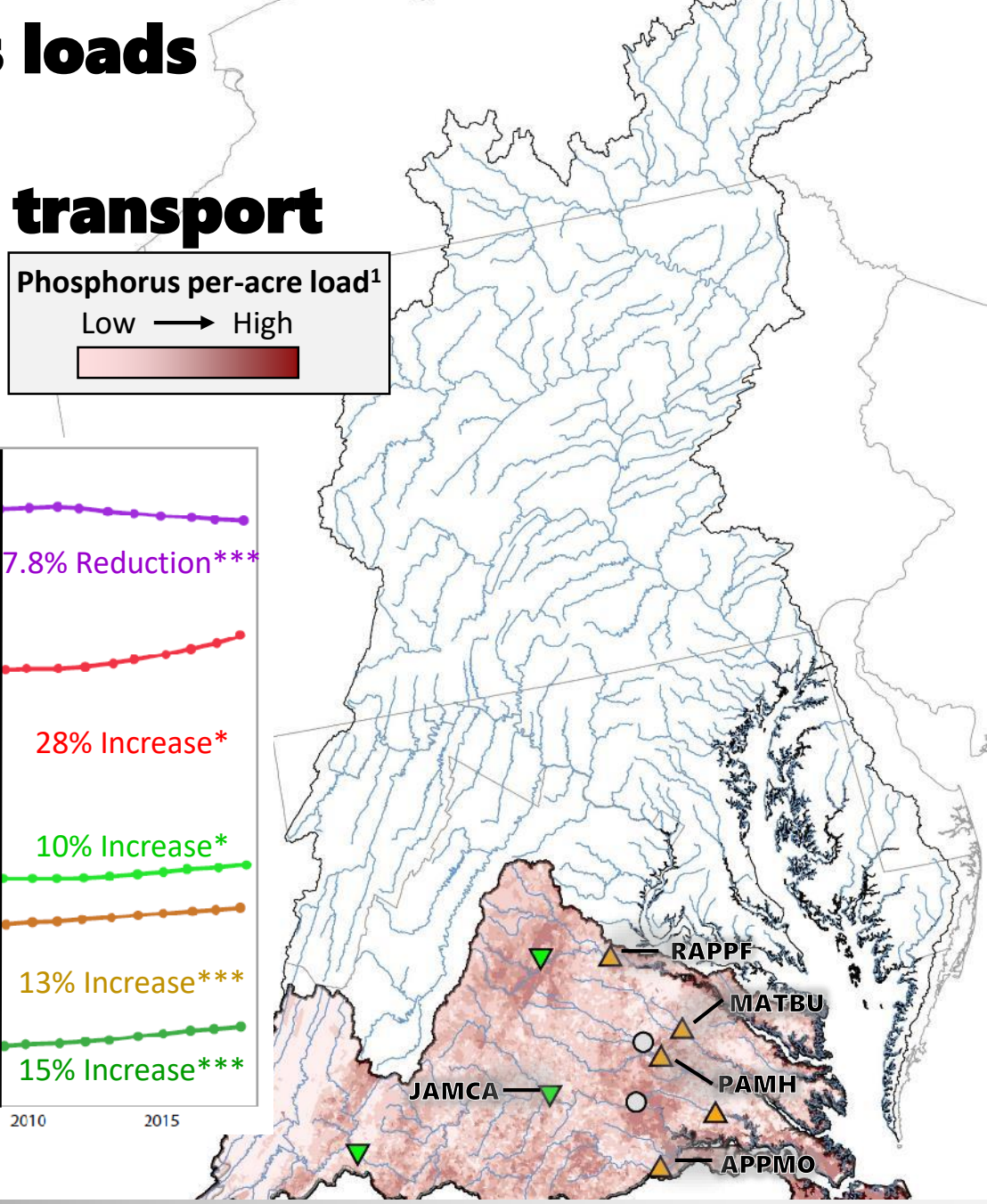
[1]Ator and others, 2011

[2]Moyer and Langland, 2020

Trends in phosphorus loads result from changing phosphorus inputs or transport

River Input Monitoring Stations:





USGS science for a changing world

[1]Ator and others, 2011

[2]Moyer and Langland, 2020

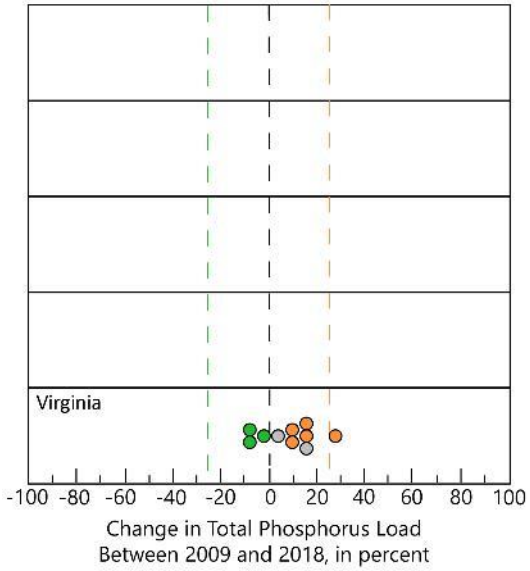
Trends in phosphorus loads result from changing phosphorus inputs or transport

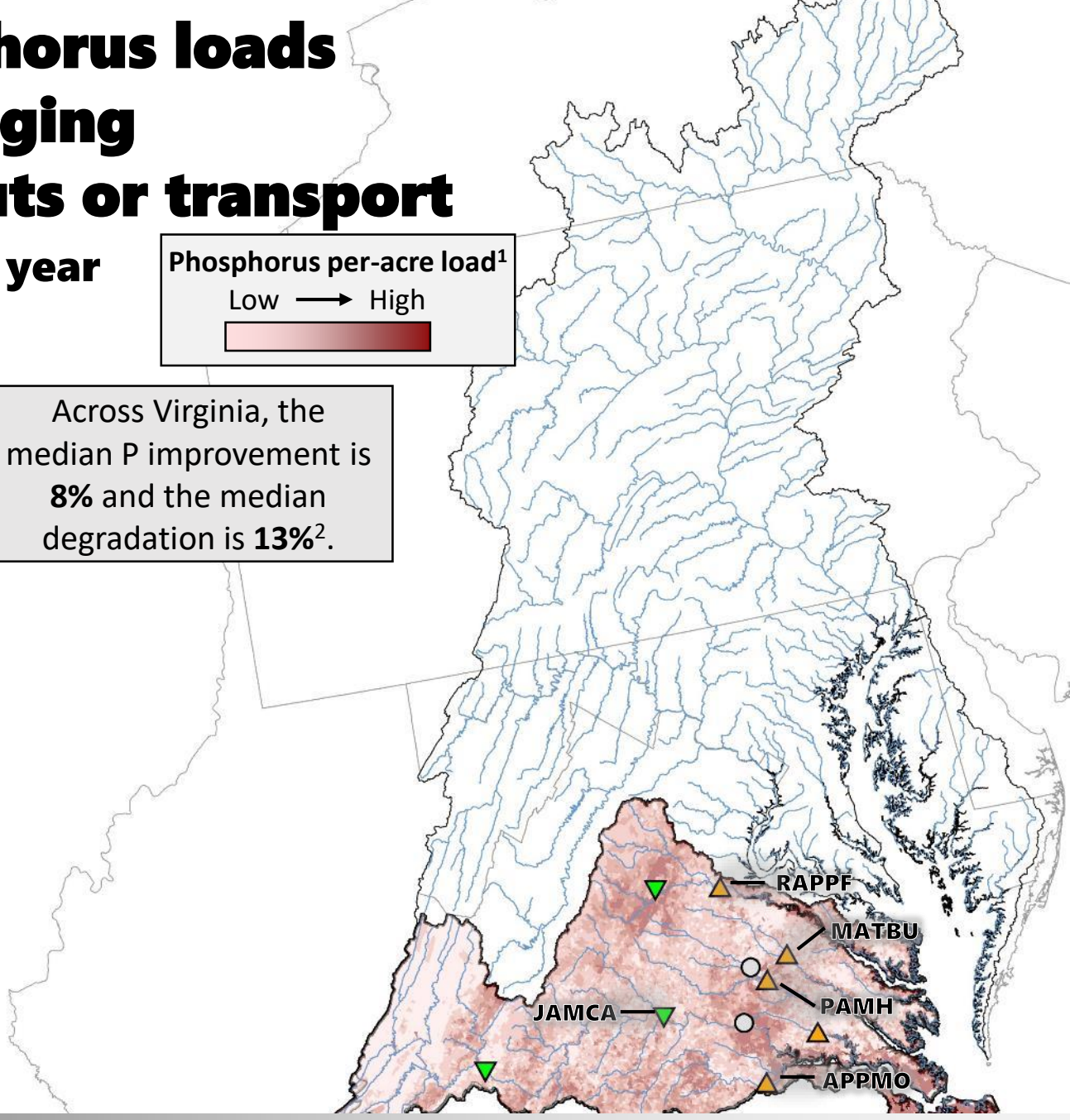
In the most recent ten year period (2009 – 2018)[2]:

Phosphorus per-acre load[1]
Low → High

Phosphorus loads **(n=10)** have improved at **3**, degraded at **5**, and have no trend at **2** stations[2].

Across Virginia, the median P improvement is **8%** and the median degradation is **13%**[2].



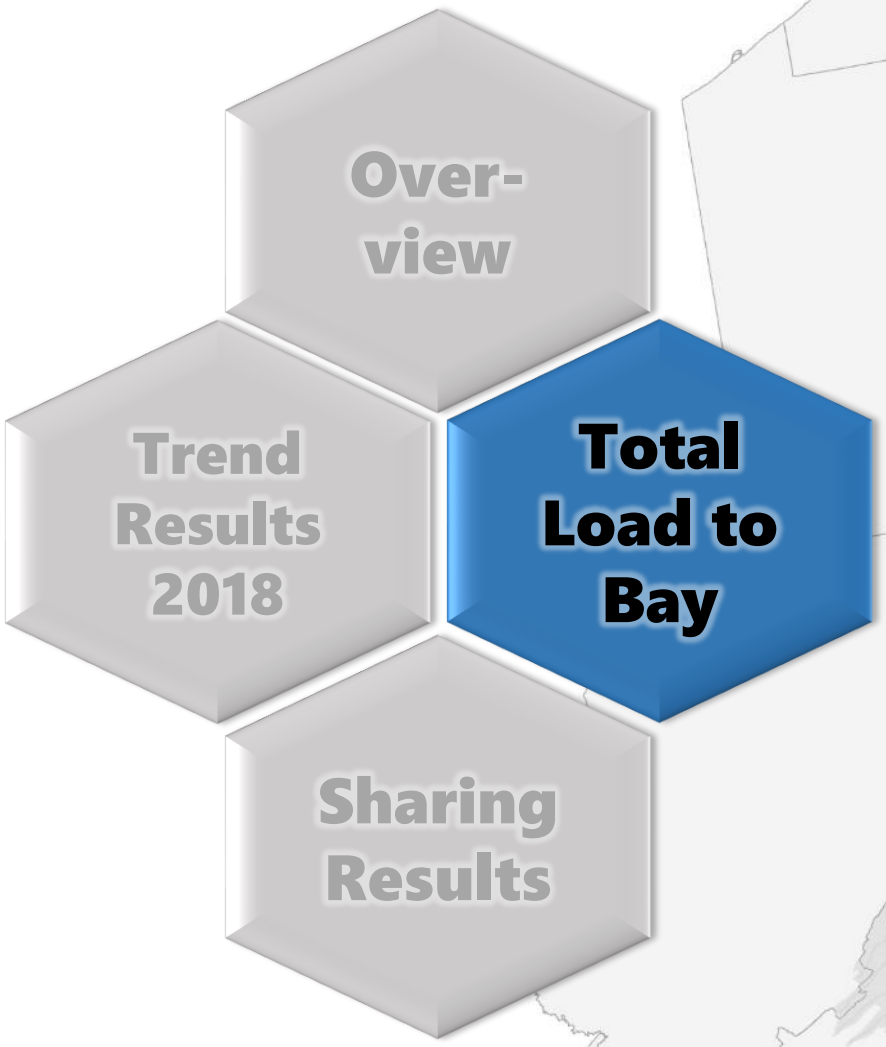


USGS science for a changing world

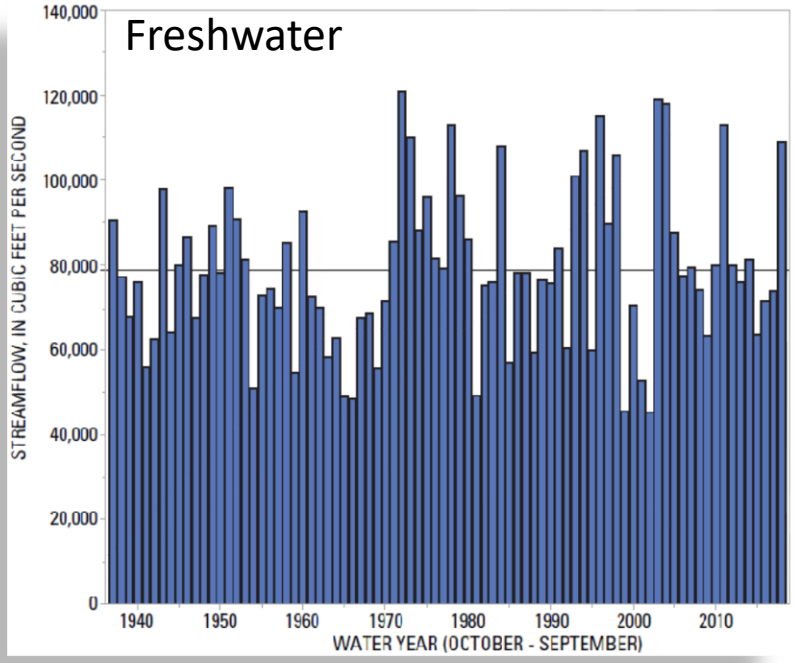
[1]Ator and others, 2011

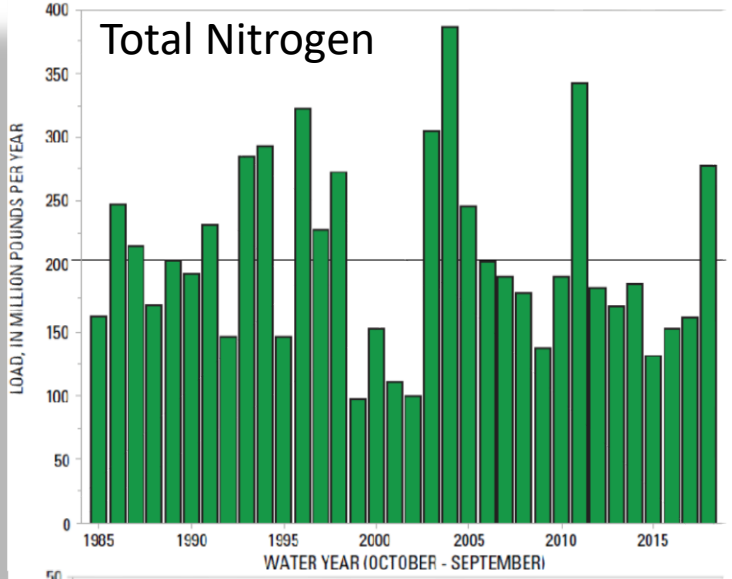
[2]Moyer and Langland, 2020

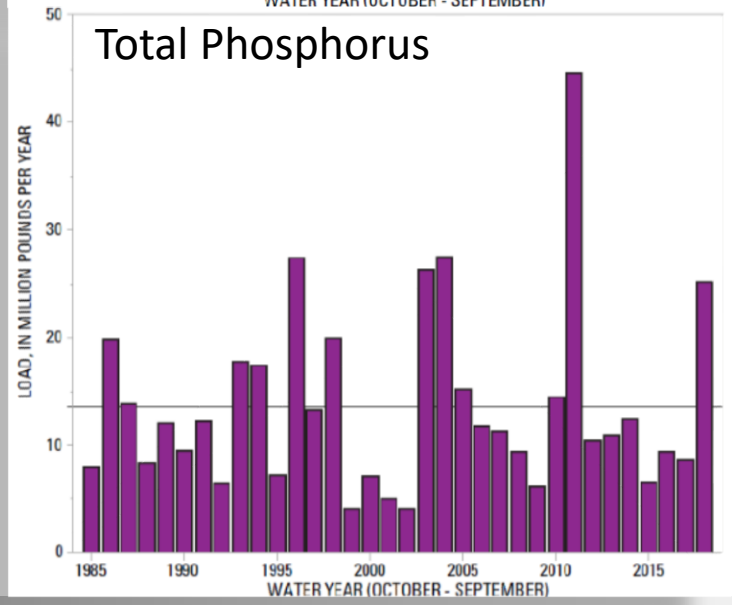
Nutrient Loads and Trends in Chesapeake Bay Nontidal Network Streams: An update and presentation of results



2018 delivery of freshwater flow and total nitrogen and phosphorus loads







2018 Stats

- 5th largest freshwater flow to the bay since 1985 (8th since 1937).
- TN load for 2018 was the 7th largest since 1985.
- TP load for 2018 was the 5th largest since 1985.

USGS science for a changing world

[2]Moyer and Langland, 2020

Nutrient Loads and Trends in Chesapeake Bay Nontidal Network Streams: An update and presentation of results

Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay Nontidal Network stations: Water years 1985-2018

Add View Manage Item

Dates

Publication Date : 2020
Start Date : 1984-10-01
End Date : 2018-09-30

Citation

Moyer, D.L. and Langland, M.J., 2020, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay Nontidal Network stations: Water years 1985-2018: U.S. Geological Survey data release, https://doi.org/10.5066/P931M7FT.

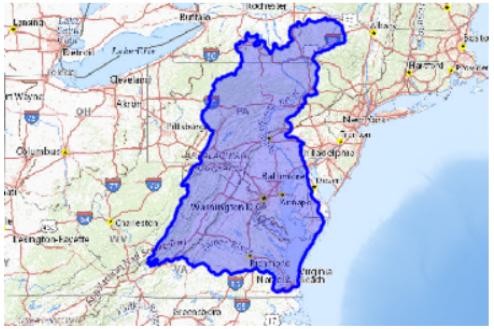
Summary

Nitrogen, phosphorus, and suspended-sediment loads, and changes in loads, in major rivers across the Chesapeake Bay watershed have been calculated using monitoring data from the Chesapeake Bay Nontidal Network (NTN) stations for the period 1985 through 2018. Nutrient and suspended-sediment loads and changes in loads were determined by applying a weighted regression approach called WRTDS (Weighted Regression on Time, Discharge, and Season). The load results represent the total mass of nitrogen, phosphorus, and suspended sediment that was exported from each of the NTN watersheds. To determine the trend in loads, the annual load results are flow normalized to integrate out the year-to-year variability in river discharge. The trend in load is derived from the flow-normalized load timeseries and represents the change in load resulting from changes in sources, delays associated with storage or transport of historical inputs, and (or) implemented management actions. Four data tables are provided that describe nitrogen, phosphorus, and suspended-sediment conditions across the NTN: (1) Annual Loads, (2) Monthly Loads, (3) Trends in Annual Loads, and (4) Average Yield (mass per unit area). Additionally, essential WRTDS Input and Output files are provided. All data tables can be accessed through each respective "Child Item" listed on this page.

Child Items (6)

- Chesapeake Bay Nontidal Network 1985-2018: Annual loads
- Chesapeake Bay Nontidal Network 1985-2018: Average annual yields
- Chesapeake Bay Nontidal Network 1985-2018: Monthly loads
- Chesapeake Bay Nontidal Network 1985-2018: Short- and long-term trends
- Chesapeake Bay Nontidal Network 1985-2018: WRTDS input data
- Chesapeake Bay Nontidal Network 1985-2018: WRTDS output data

Map »



Spatial Services

ScienceBase WMS : https://www.sciencebase.gov/catal

Communities

- USGS Data Release Products

Associated Items

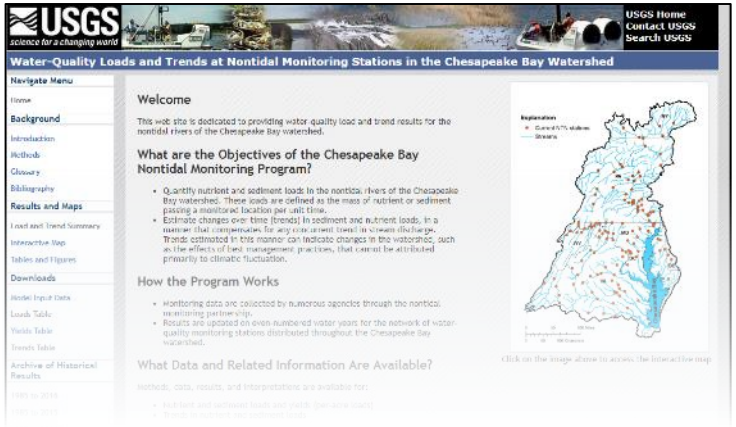
Associate an Item

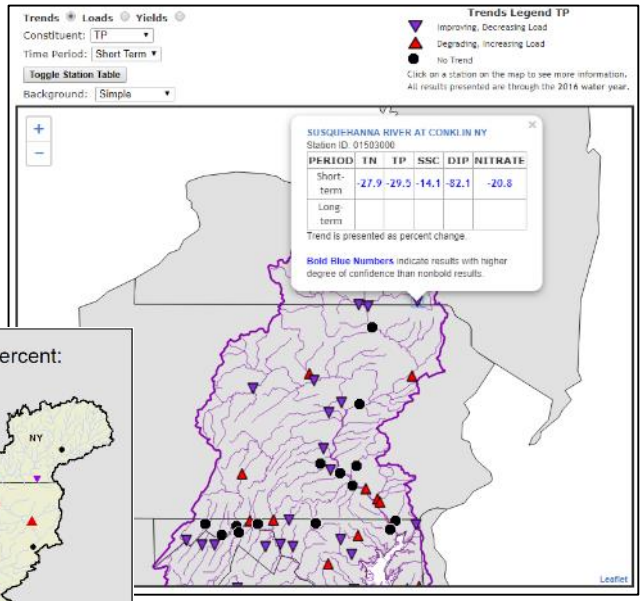
Tags

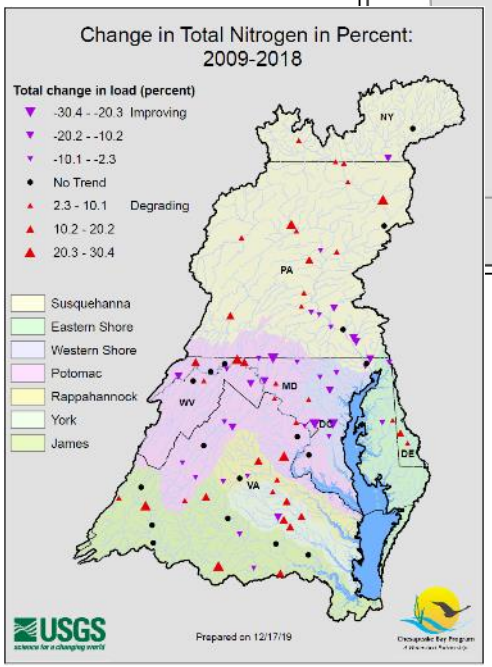
Categories : Data Release - In Progress
Theme : WRTDS, load analysis, nitrogen, nutrients, phosphorus, rivers, suspended sediment, trends, water quality, weighted regression
Place : Chesapeake Bay Watershed, Delaware, Maryland, New York, Pennsylvania, United States, Virginia, Washington DC, West Virginia
Types : Map Service, OGC WFS Layer, OGC WMS

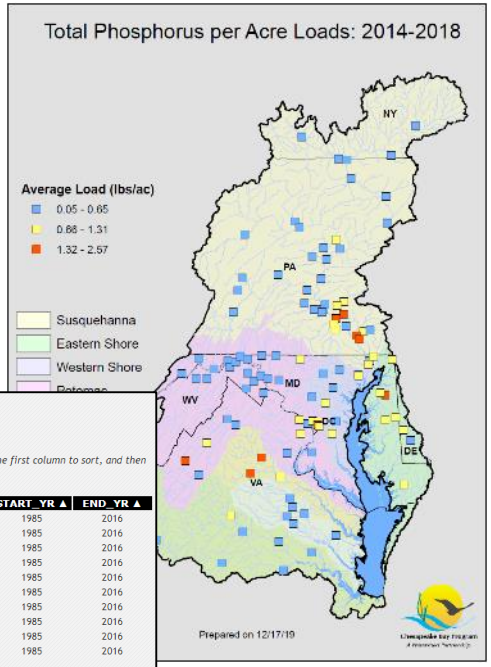
The nontidal monitoring webpage has been updated with 2018 results

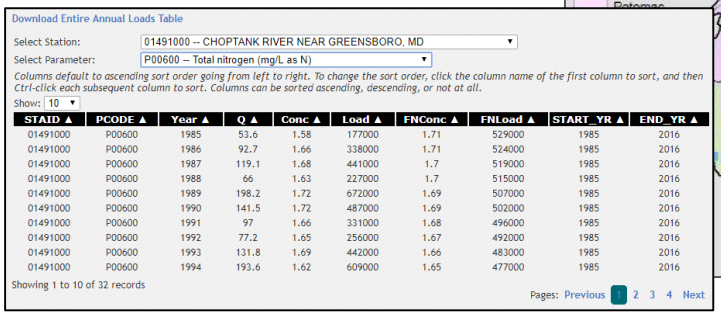
https://cbrim.er.usgs.gov/index.html





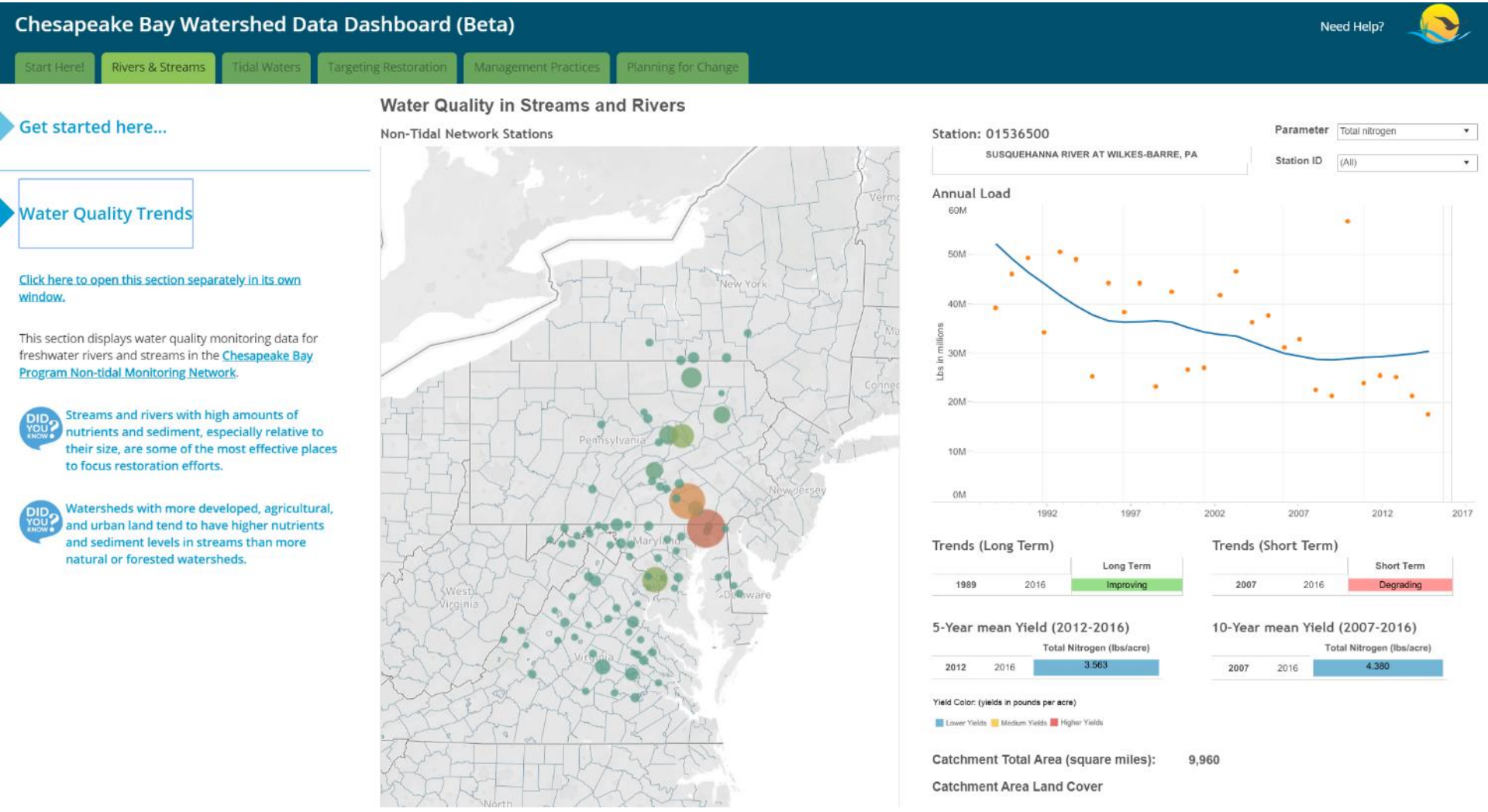






The website contains load and trend results for Total Nitrogen, Nitrate, Total Phosphorus, Orthophosphorus, and Suspended Sediment at individual monitoring stations in graphical or tabular formats.

The Chesapeake Bay Watershed Data Dashboard (Rivers & Streams) page is being updated.



USGS
science for a changing world