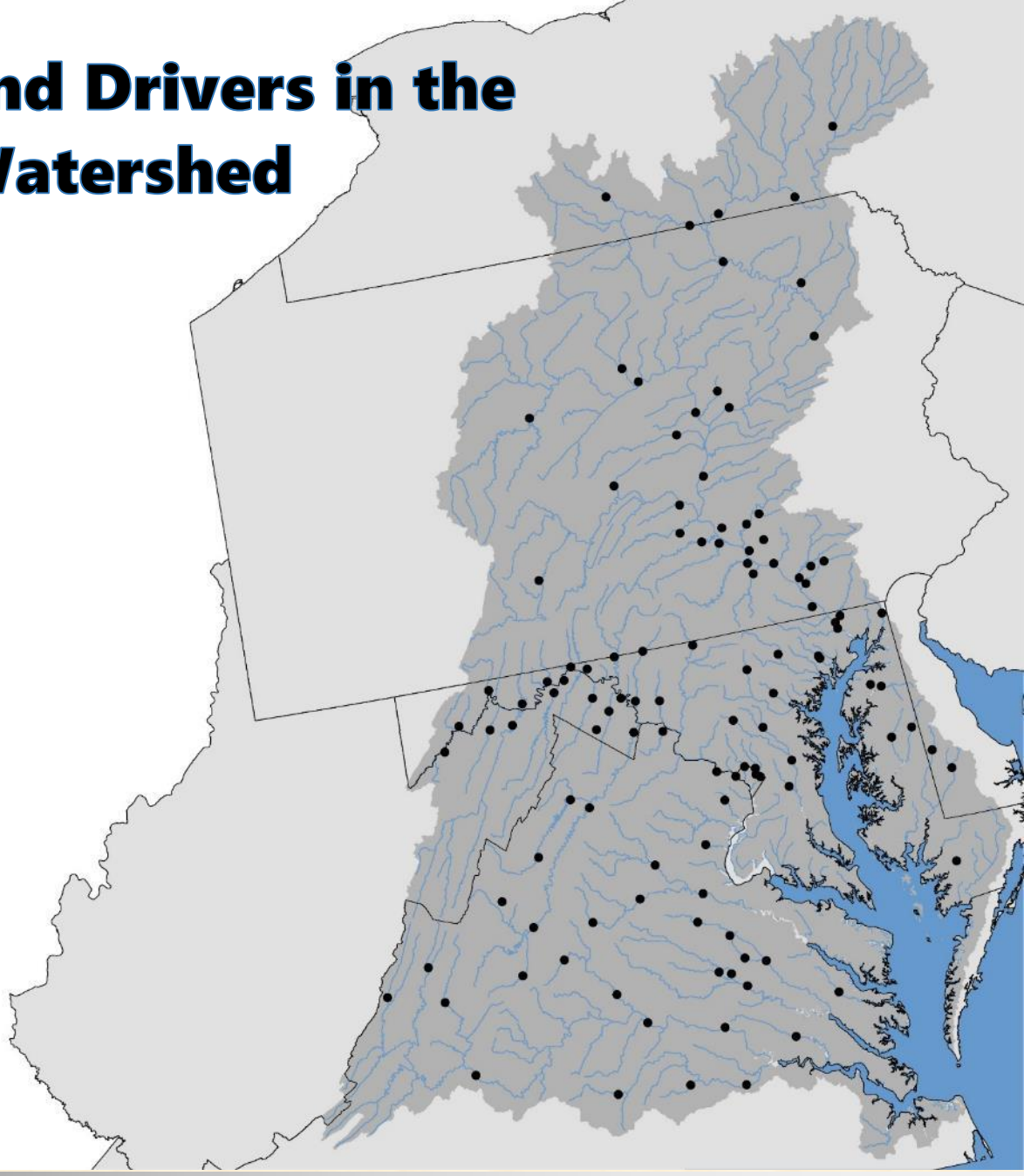
Nutrient Trends and Drivers in the Chesapeake Bay Watershed



Scott Phillips

US Geological Survey

September 11, 2020

Based on efforts of many USGS scientists and partners

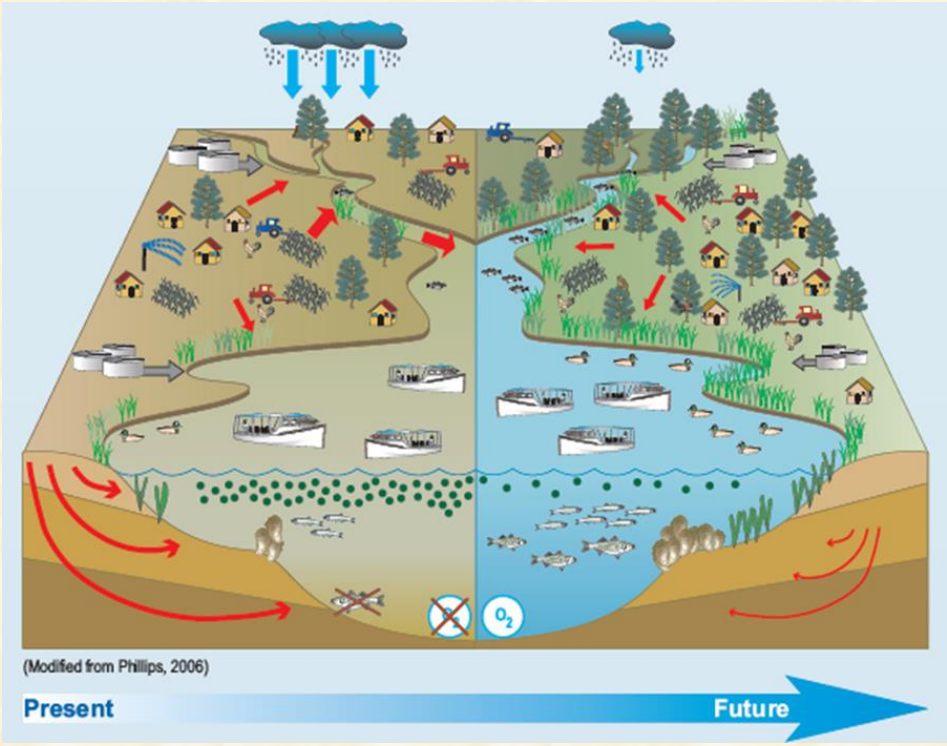
Improving Water Quality

CBP Outcomes:

- Attain DO and clarity standards
- Reduce nutrients and sediment (TMDL)

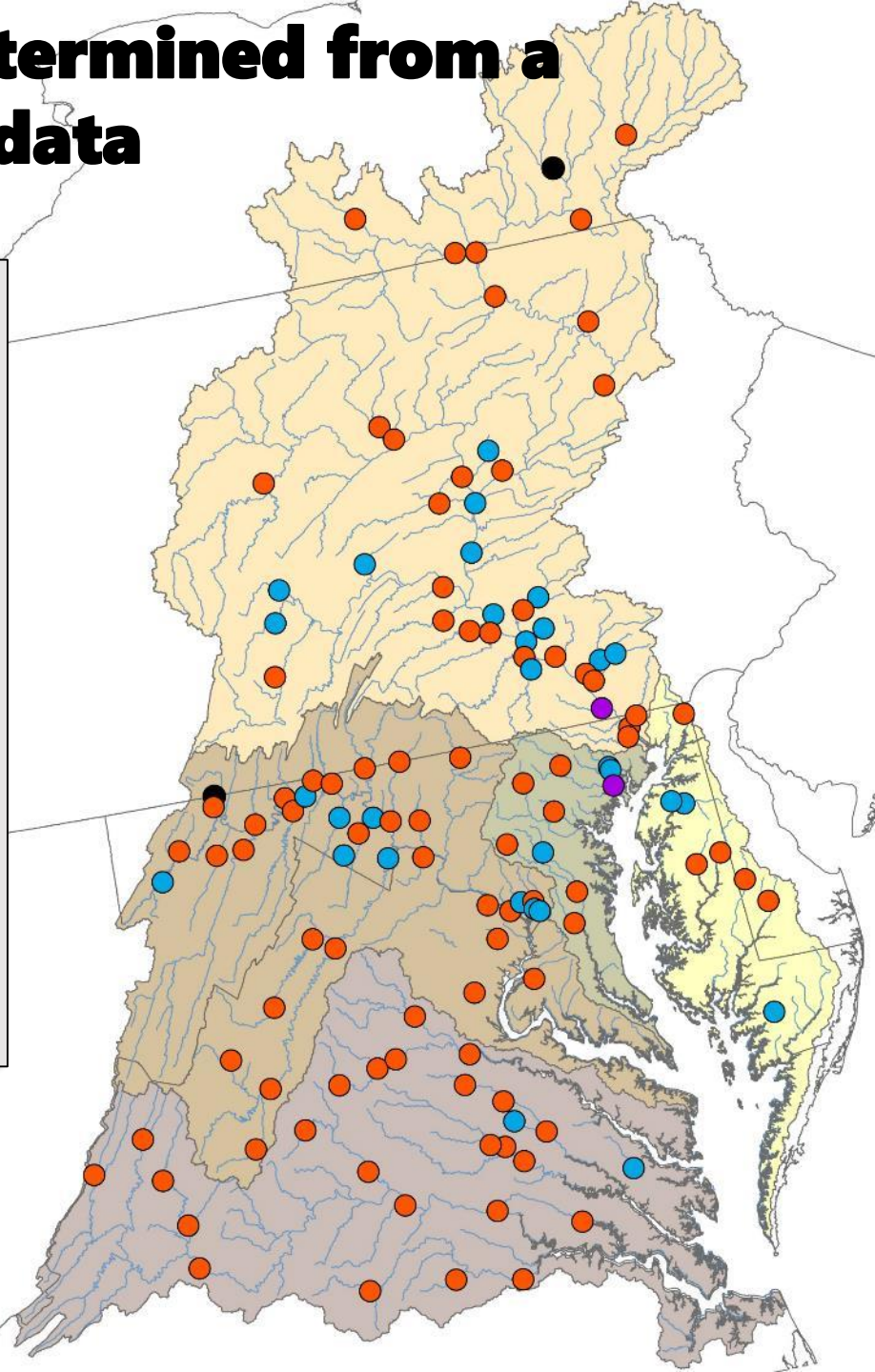
Approach:

- WIPs
- Practices in place by 2025
- Watershed nutrient trends
- Attain DO and clarity/SAV standards



Loads and trend results determined from a foundation of monitoring data

- CBP Nontidal Network
- 123 sites
- Over **2,400** water-quality samples are collected each year!

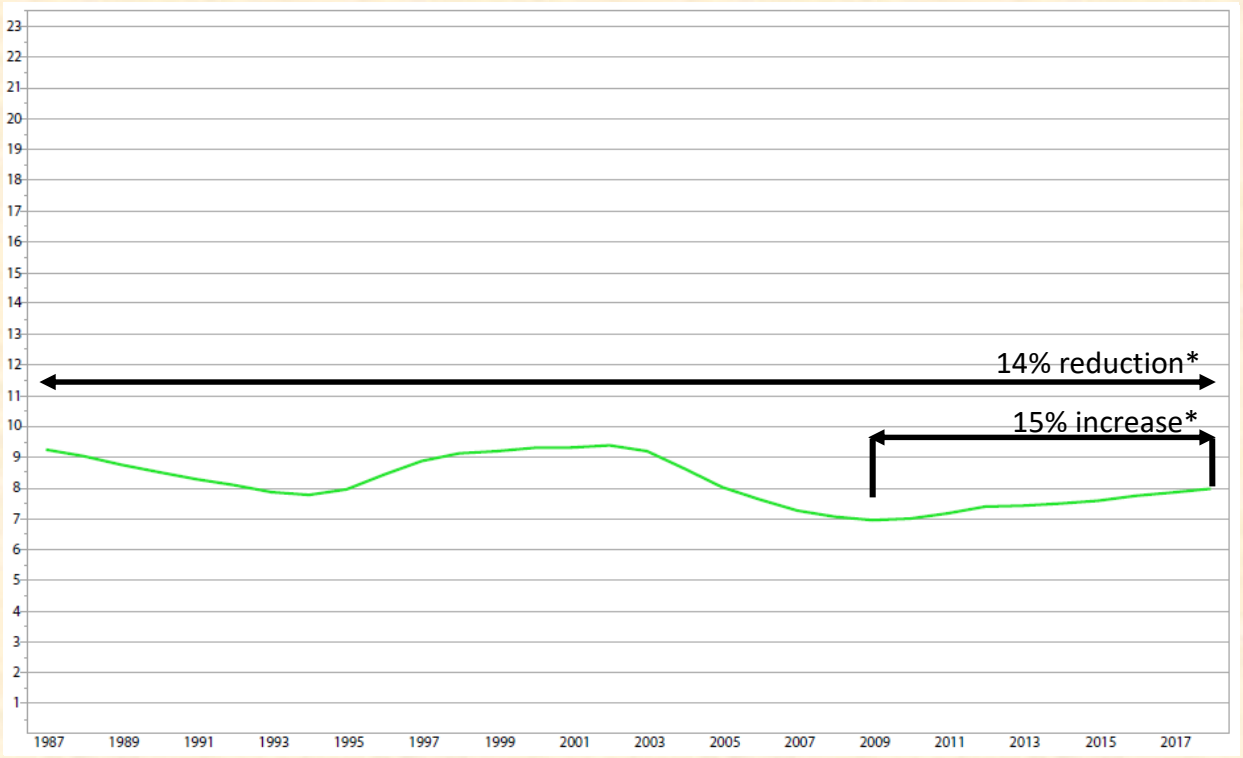


USGS
science for a changing world

Annual Rivers Loads and Trends

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

Susquehanna River at Marietta: Total Phosphorus



Trend is reported when:
Likely – >=0.67 to <0.90 (*)
Very Likely – >=0.90 to <0.95 (**)
Extremely Likely – >=0.95 to 1.00 (***)

Mixed Results for Nutrient Trends (2009-2018)

Nitrogen summary:

1. 41% improving, 40% degrading
2. High loading sites are almost all improving
3. Lower Susquehanna is improving
4. Western Shore is improving, Eastern Shore is a challenge
5. Mixed results throughout other portions of the watershed

Phosphorus summary:

1. 44% improving and 32% degrading
2. Potomac River is improving
3. Mixed response in Virginia watersheds and other areas

Downstream estuary response:

1. Still only meeting 40% of standards attainment

[2]Moyer and Langland, 2020

Watershed nitrogen and phosphorous trends

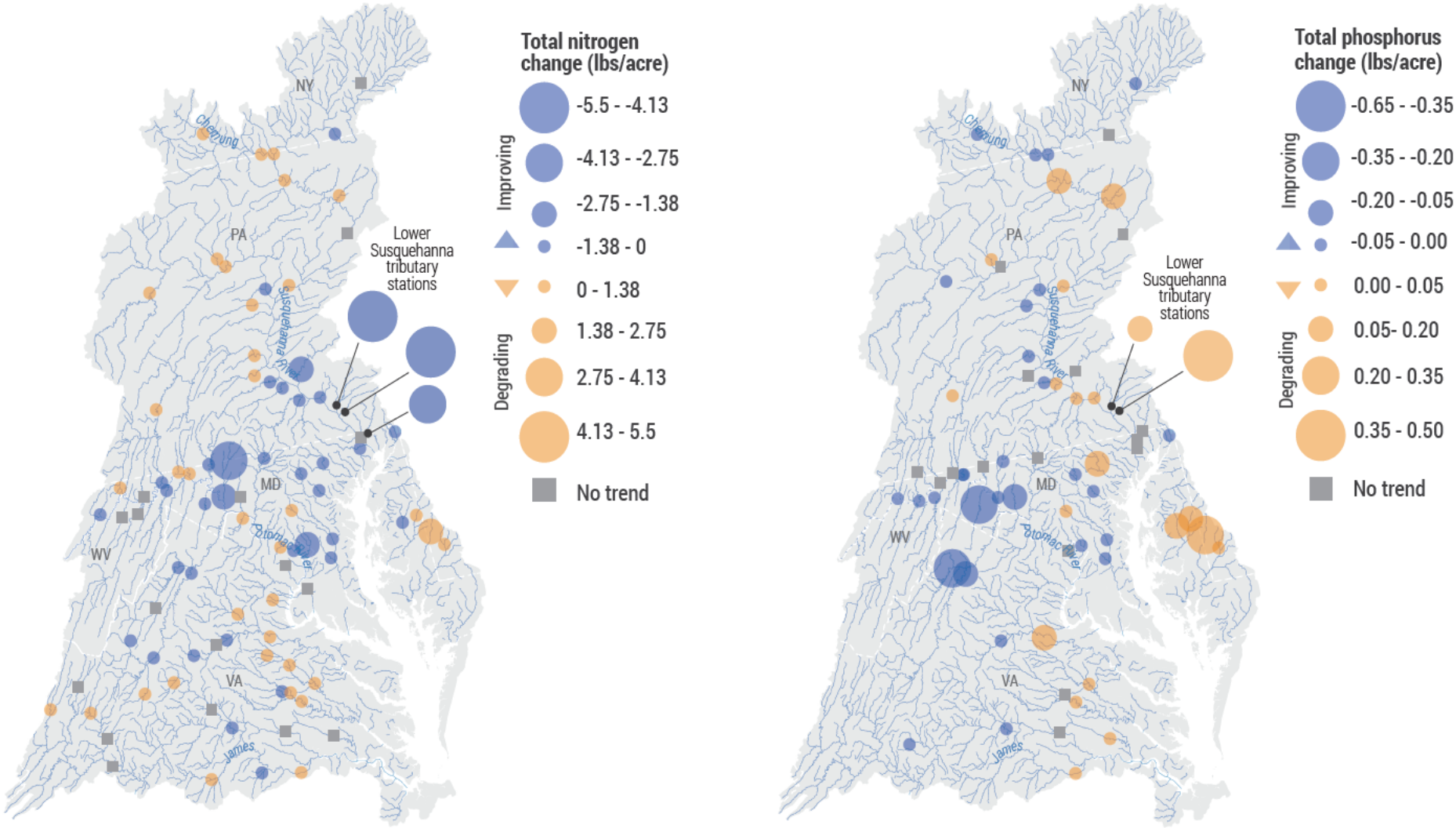


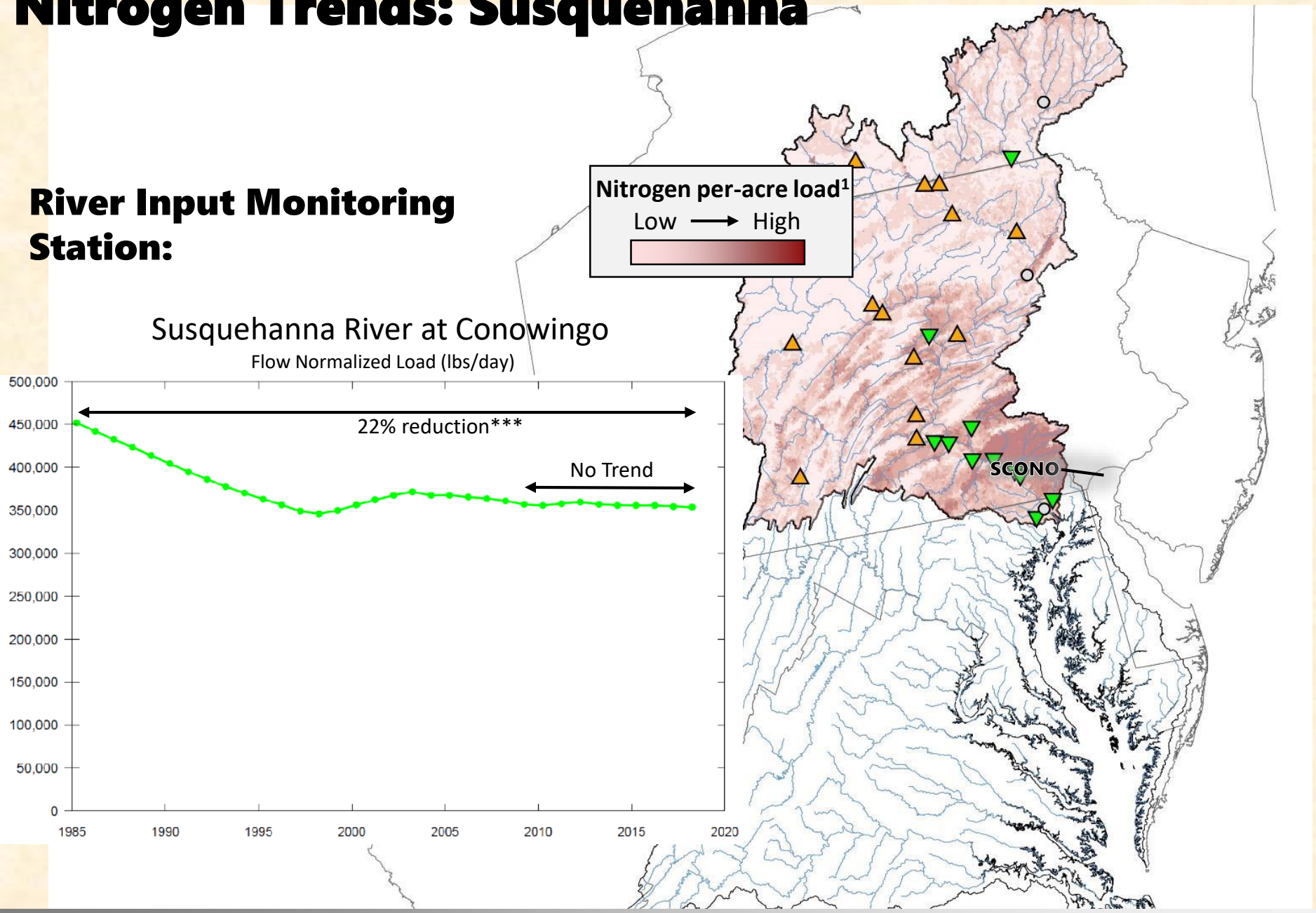
Figure 1. Total nitrogen and total phosphorus trends at nontidal monitoring stations in the Chesapeake Bay watershed. Data from Moyer and Langland, 2020.

Total nitrogen (N) trends (2009-2018)

Total phosphorus (P) trends (2009-2018)

Nitrogen Trends: Susquehanna

River Input Monitoring Station:

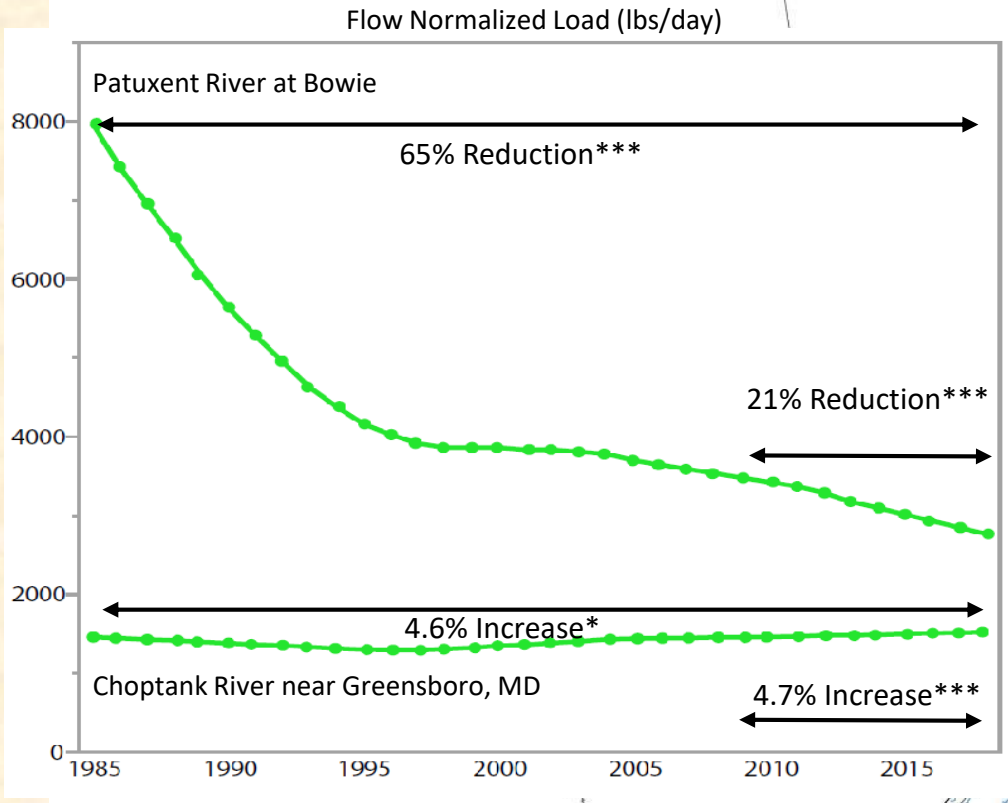


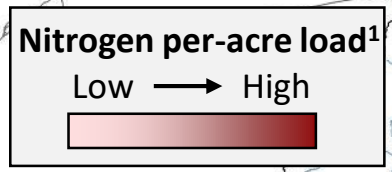
[1]Ator and others, 2011

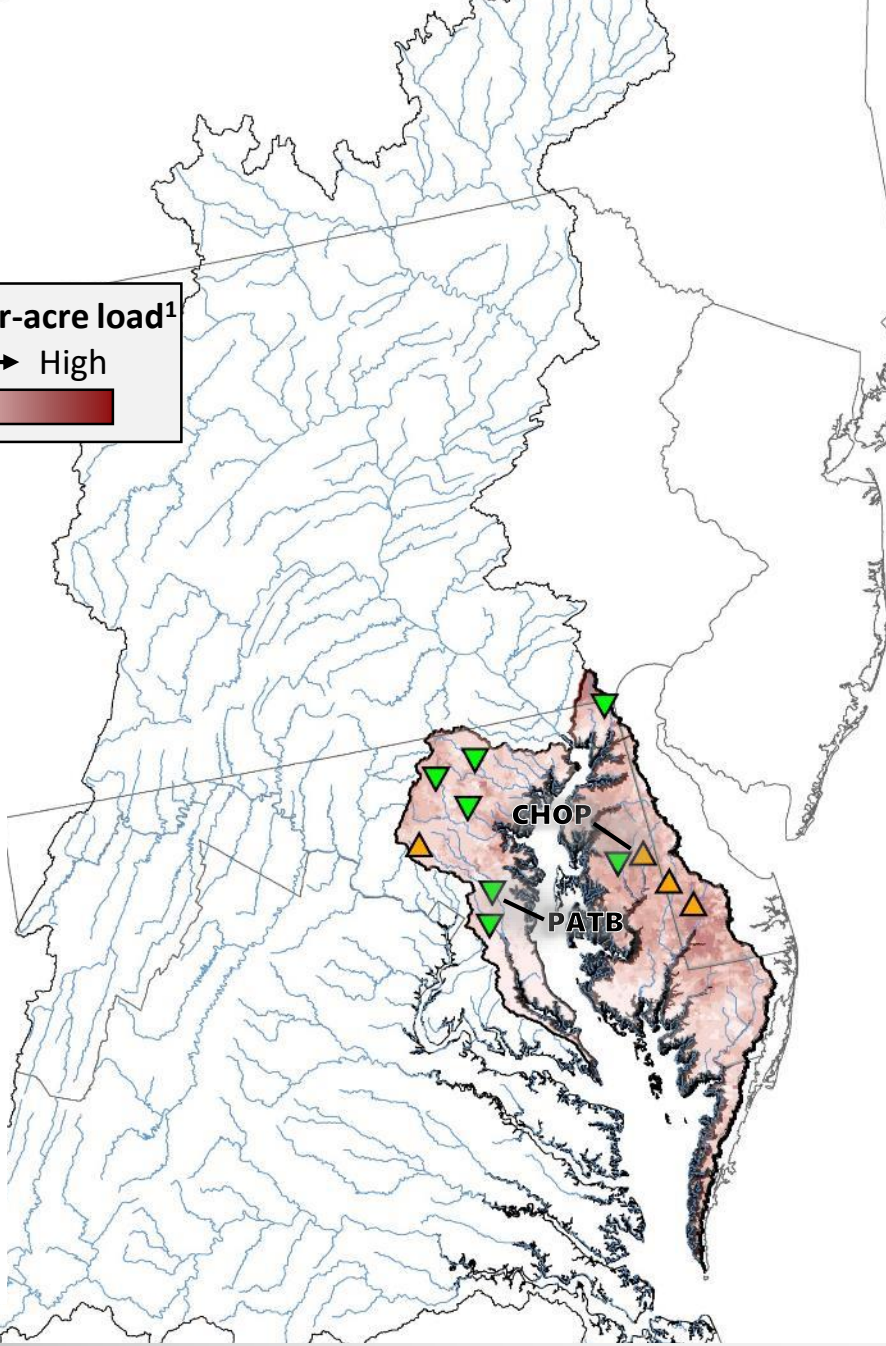
[2]Moyer and Langland, 2020

Nitrogen trends: Urban and Ag areas in MD

River Input Monitoring Stations:







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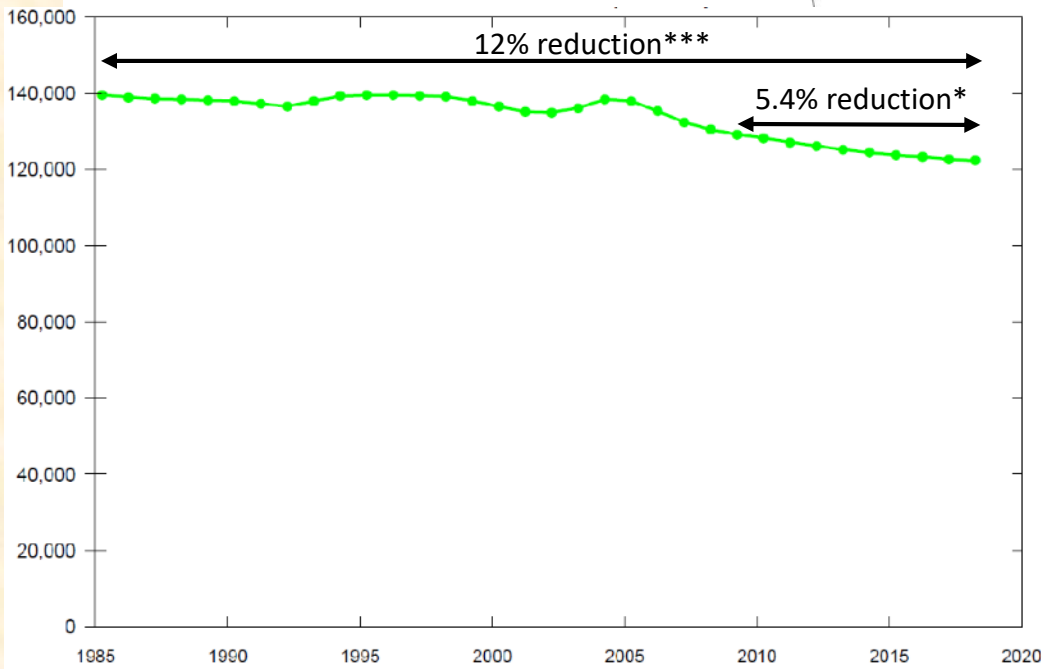
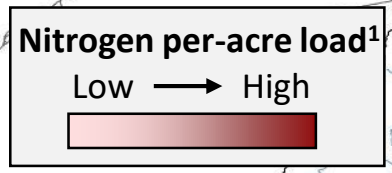
[1]Ator and others, 2011

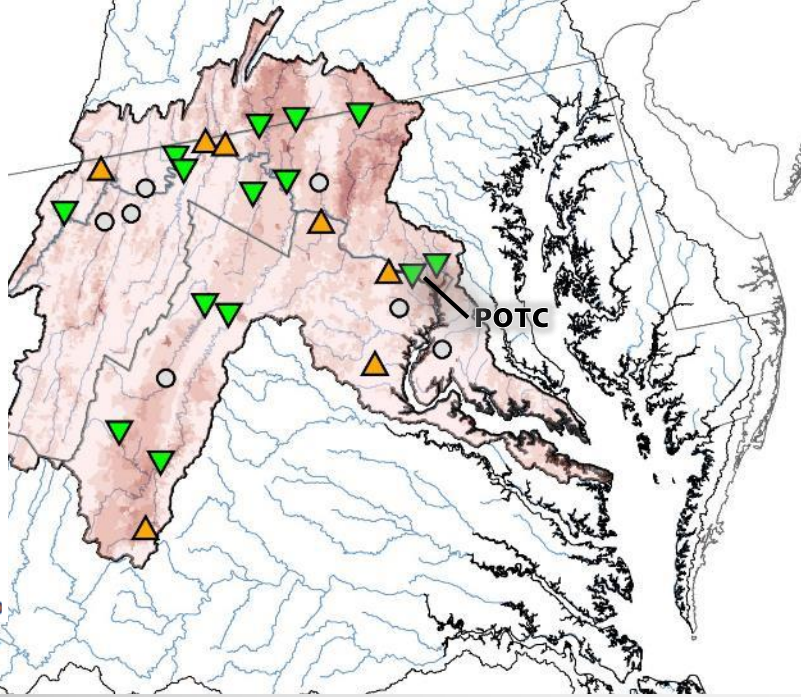
[2]Moyer and Langland, 2020

Trends in nitrogen: Potomac River

River Input Monitoring Station:





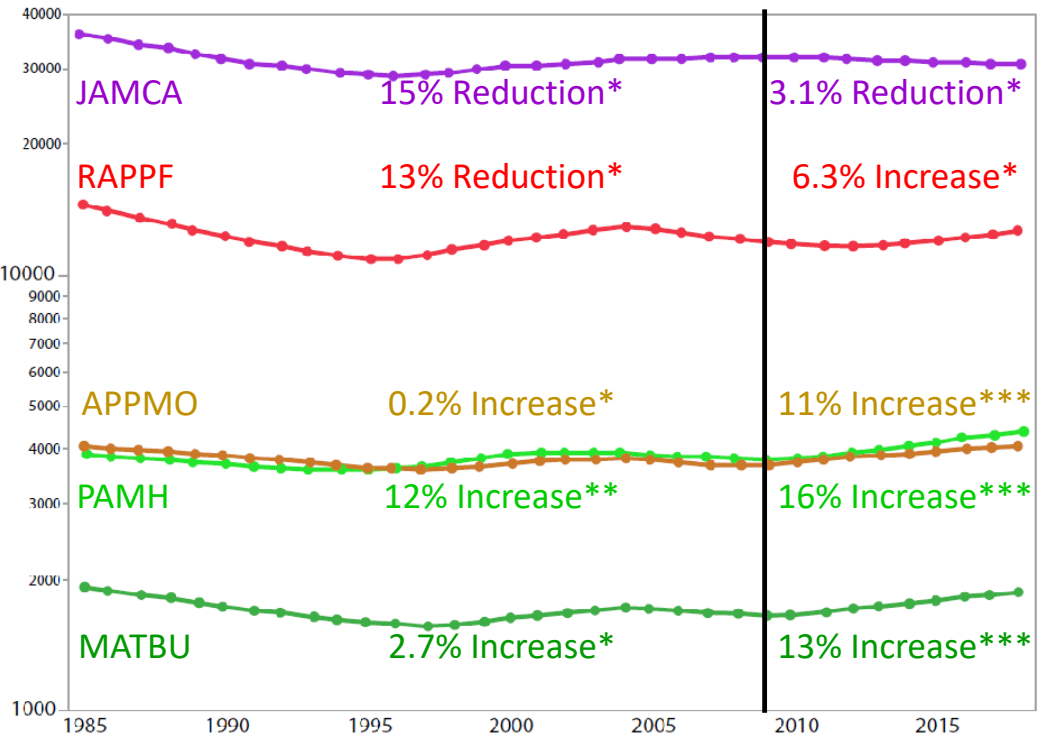


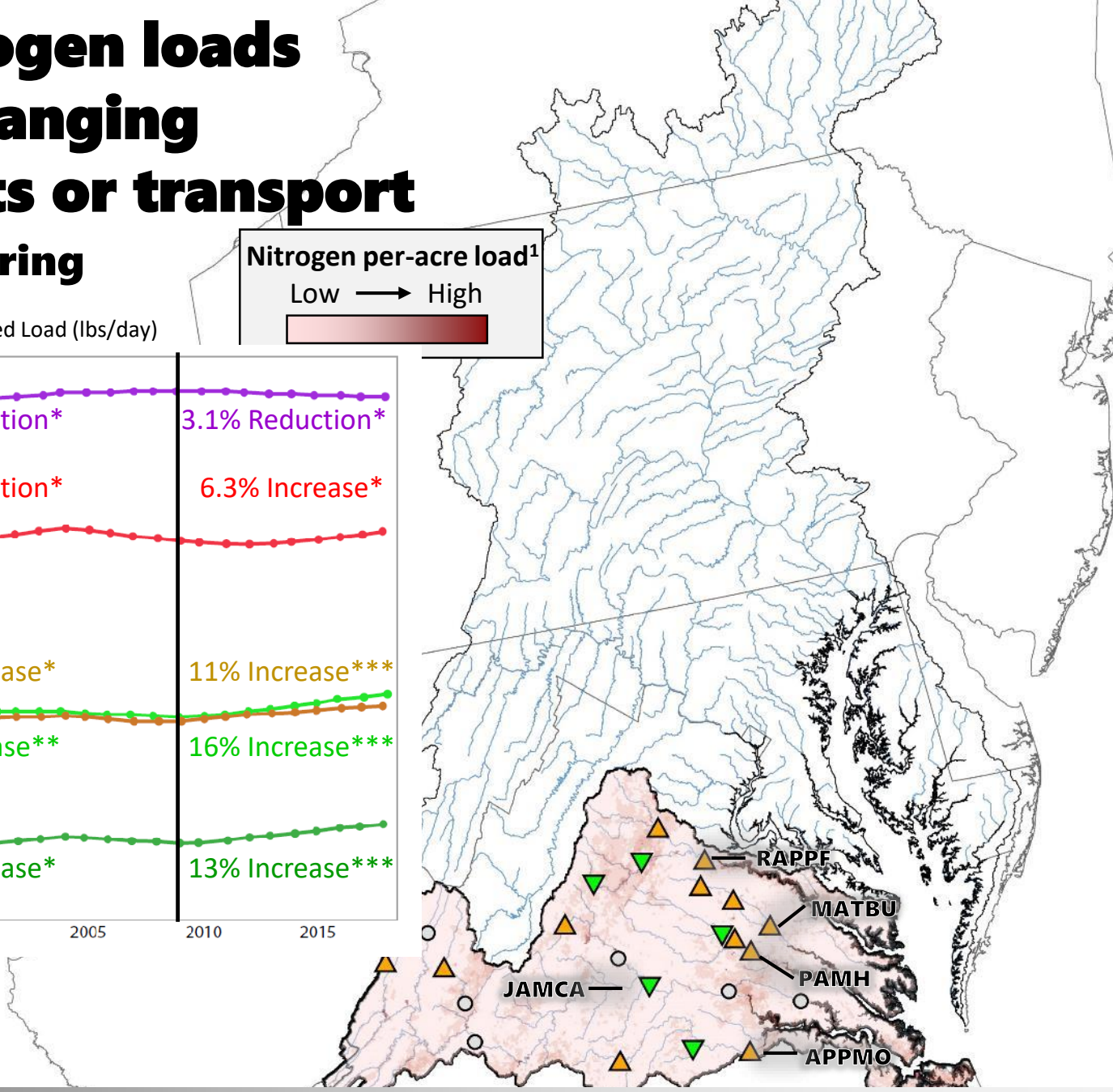
[1]Ator and others, 2011

[2]Moyer and Langland, 2020

Trends in nitrogen loads result from changing nitrogen inputs or transport

River Input Monitoring Stations:

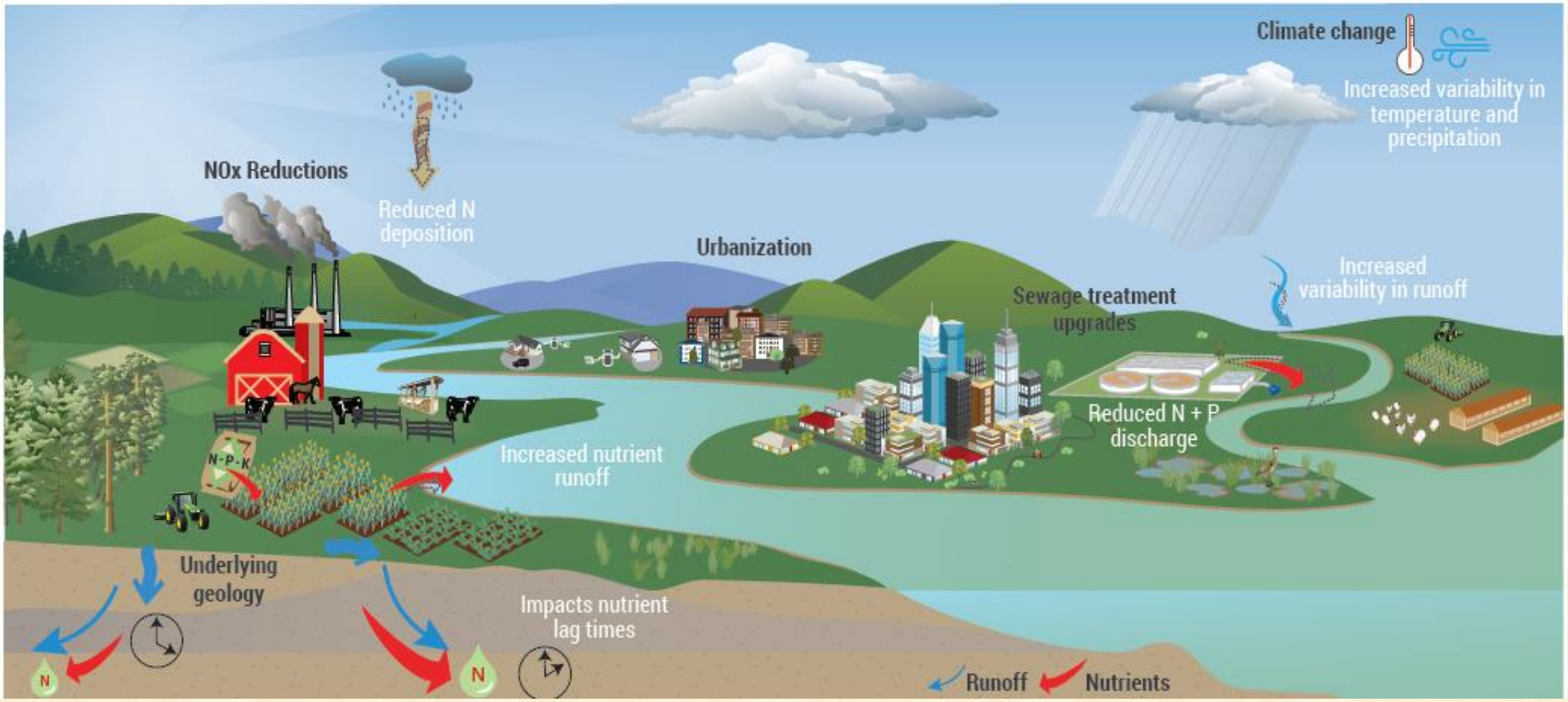




[1]Ator and others, 2011

[2]Moyer and Langland, 2020

Factors: Nutrient Sources, BMPs, and Transport



Sources:

Wastewater

Air deposition

Urban development

Agricultural lands

BMPs:

Reduction

Retention

Transport:

Loss during travel

Legacy Nutrients

Climate Change

USGS and UMCES, in review

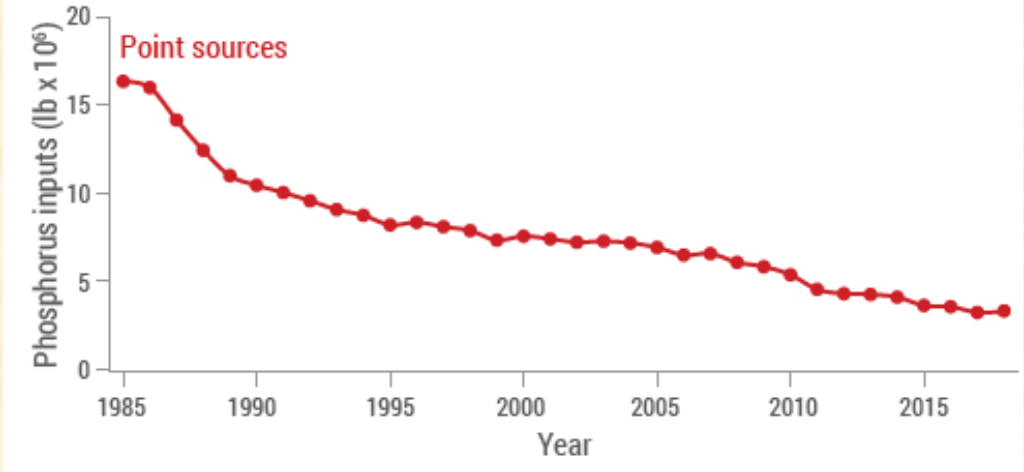
Wastewater and Atmospheric Reductions Have Improved Trends

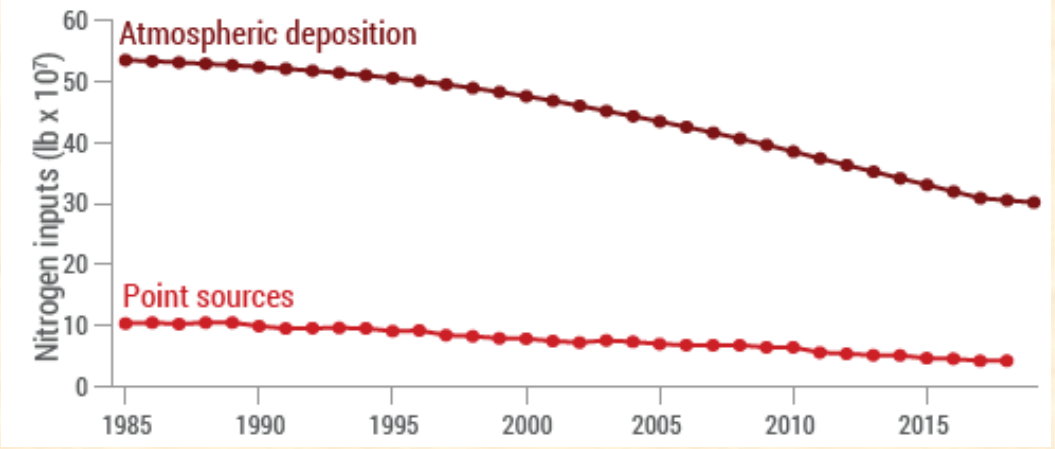
<u>Wastewater point sources</u>

- Upgrades to treatment plants
- Largest reduction of P and N inputs to Bay
- Improved local water
- Increasing population

<u>Atmospheric deposition</u>

- Air emissions reduced
  - Explain 13-14% reduction of N to the Bay



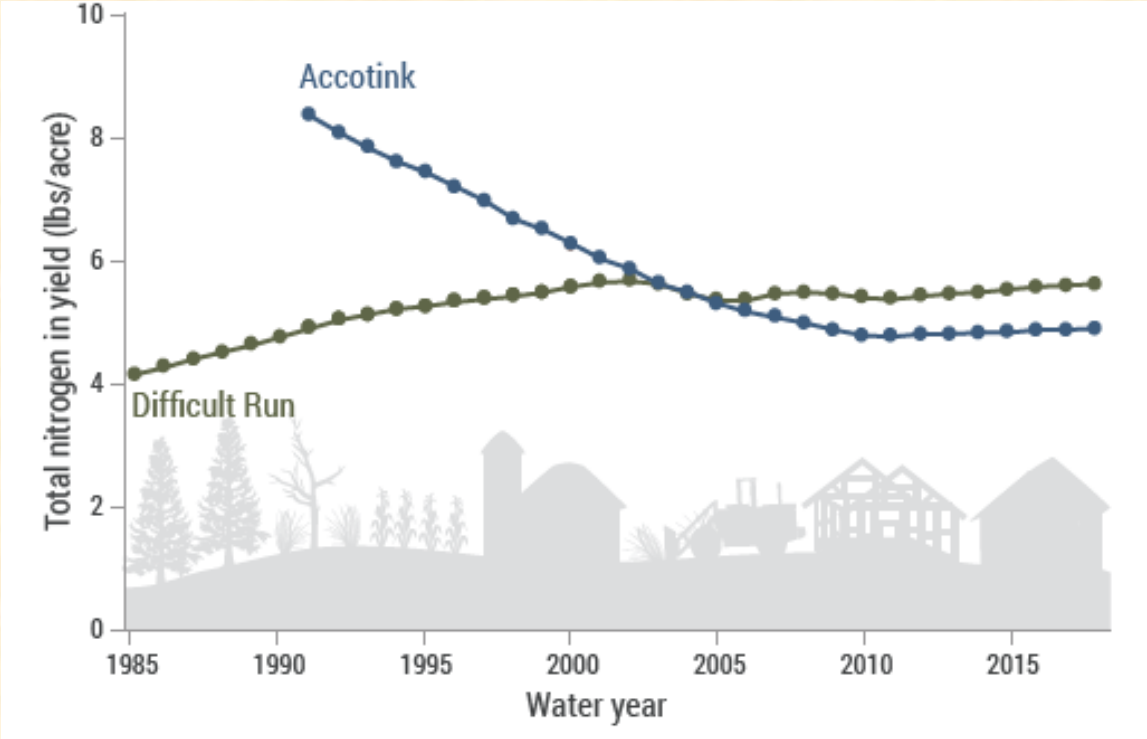


Ator and others 2020

USGS and UMCES, in review

Data from CBP

Urban Areas: Previous land use affects trends



- Urban areas have expanded by 27% since 1992
- Previous land use important
- Forest to urban: increase nutrient loads.
- Agricultural to Urban: declines in loads
- Overall decline in N; P uncertain

Ator and others 2020;
Moyer and Langland, 2020

USGS and UMCES, in review

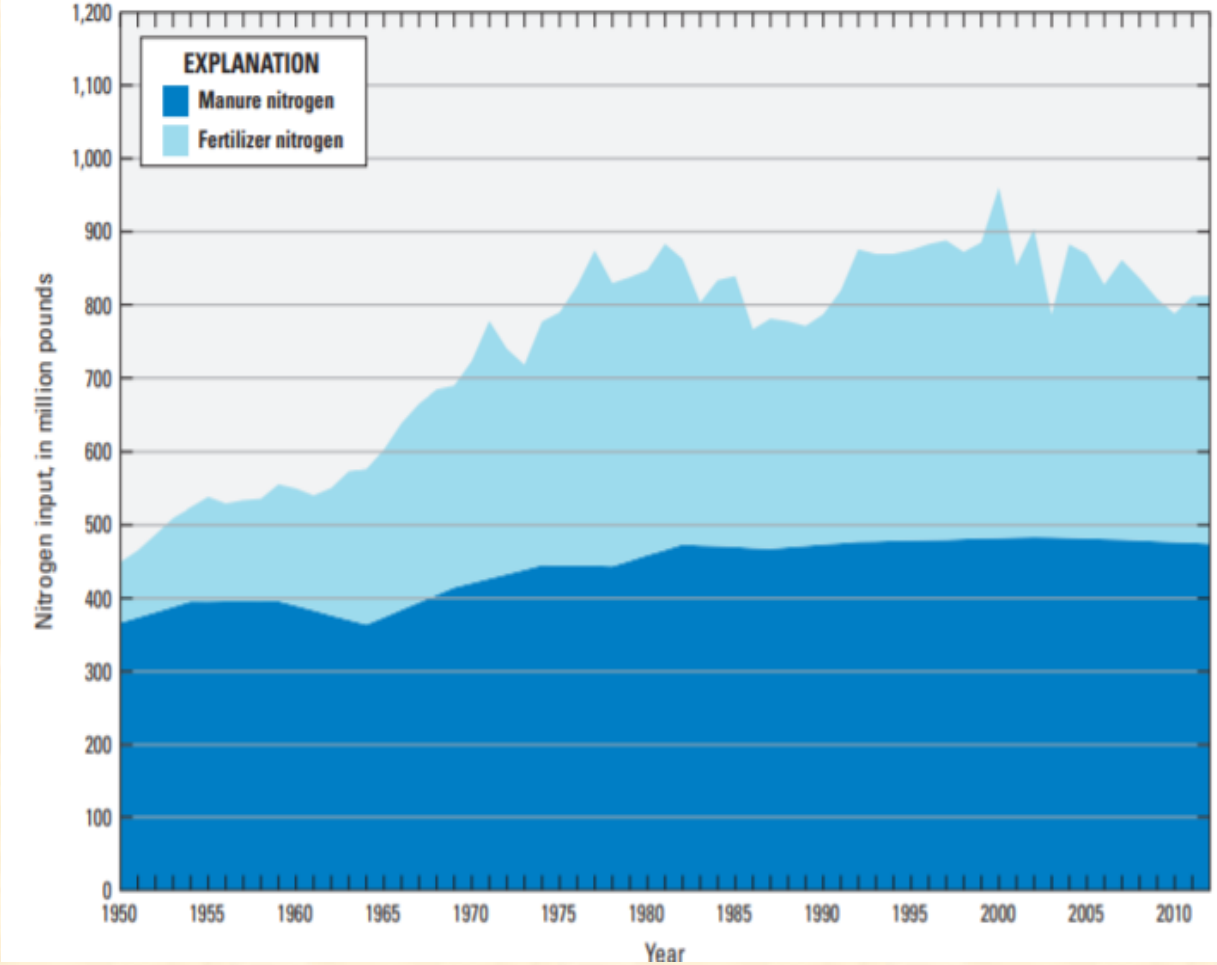
Ag Lands: Manure and Fertilizer

Applications of fertilizer and manure

- Minimal long-term change
- Animal production

Land change:

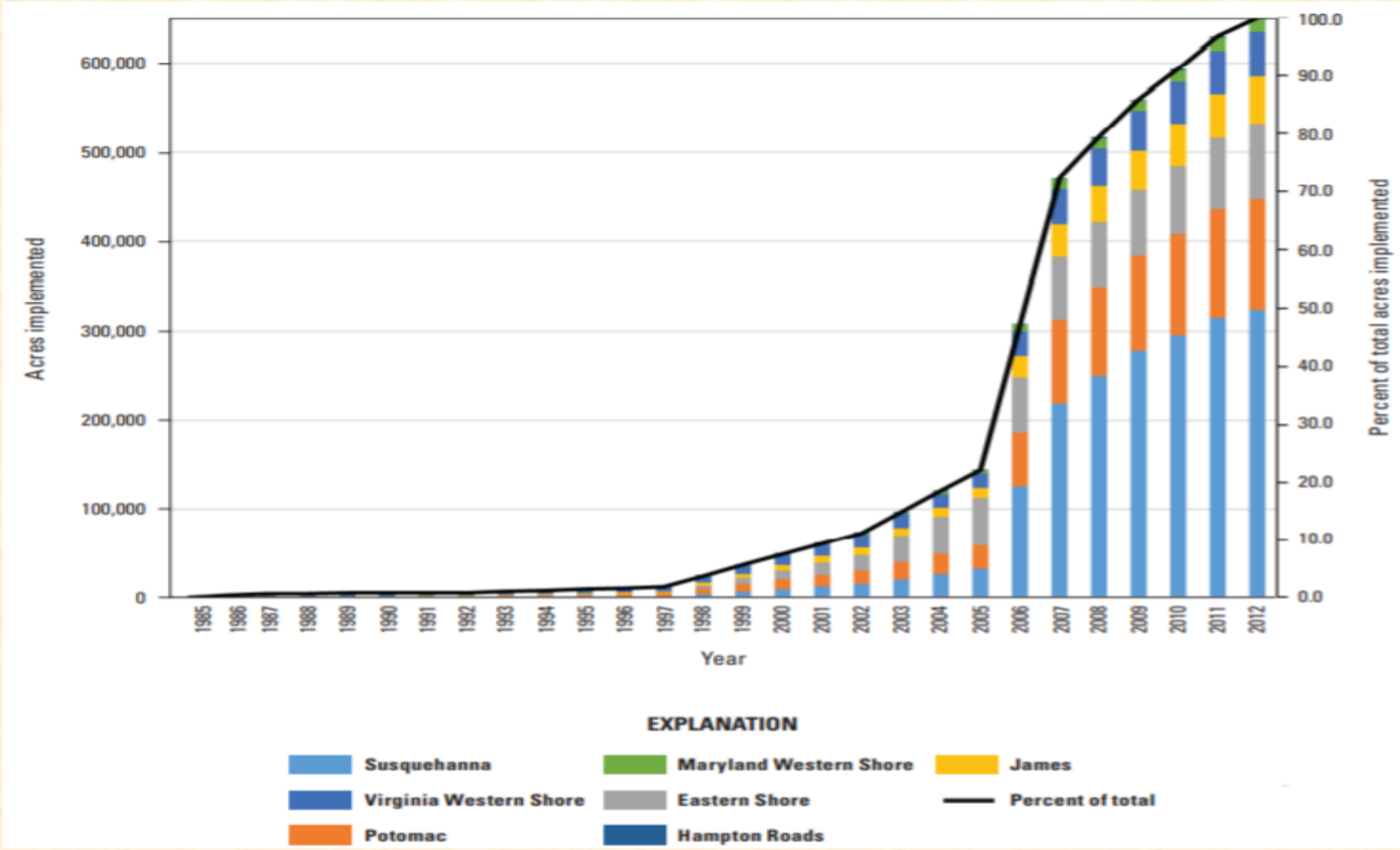
- Increasing crop lands, less pasture



Ator and others 2020;

Keisman and others, 2018

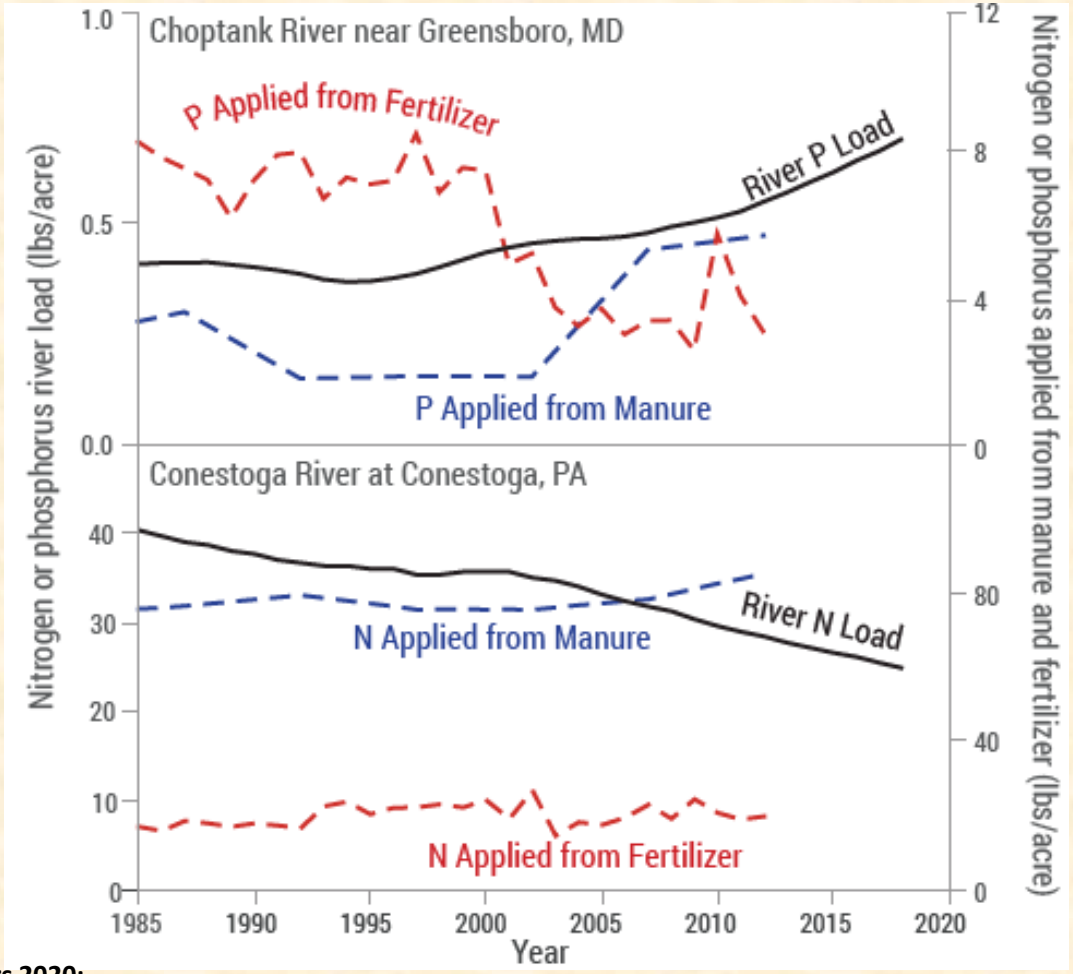
Ag BMPs: Increasing over time



Keisman and others, 2018

Rivers trends in agricultural watersheds affected by multiple factors

- Types and effectiveness of BMPs
- Inputs can offset BMP reductions
- Legacy nutrients
  - Nitrogen in groundwater
  - P in soils & streams
- Lag time



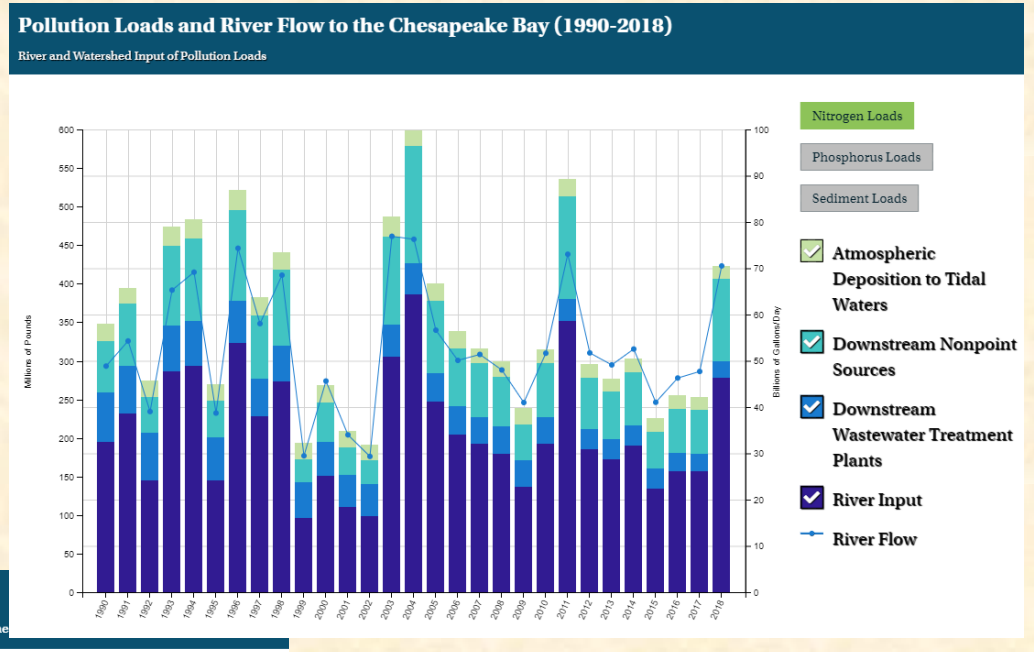
Ator and others 2020;

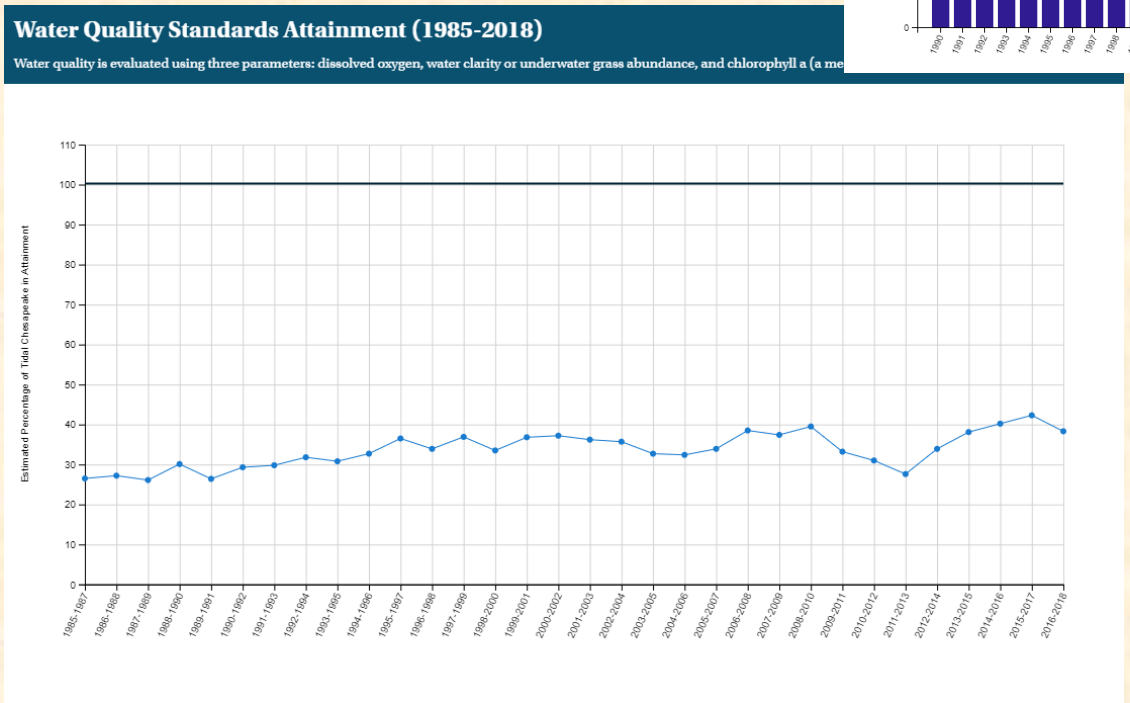
Keisman and others, 2018

Loads to the Bay and Estuary Response

- Total loads to Bay
- Standards attainment

Total Nitrogen





Source: EPA, CBP Chesapeake Progress, 2020

Management Implications

- Investments in point source improvements
  - WWTP upgrades provides the greatest reduction of nutrient loads
  - Most rapid improvements in water quality
  - Nitrogen improvements from air emission reduction
- Nonpoint source reductions are more challenging
- Urban lands
  - Appears to be declines in N; P uncertain
  - Storm-water controls
- Agricultural lands
  - Little overall change in N and P inputs
  - BMPs are increasing and focus of Phase III WIPs
  - Water-quality improvements affected by multiple factors
- Only 40% attainment of water-quality standards in Bay
- Monitor and explain response to restoration efforts

Next steps and more information

1. Sustain and enhance monitoring
2. Partnering with local entities to explain patterns in load/trend throughout the watershed.
3. Connecting the watershed inputs to the estuary response (SAV, clarity, dissolved oxygen).

Contacts and More information

- USGS Chesapeake Studies: https://www.usgs.gov/centers/cba
- Scott Phillips, USGS Chesapeake Bay Coordinator swphilli@usgs.gov
- Doug Moyer, Trend updates dlmoyer@usgs.gov
- Story Map https://va.water.usgs.gov/storymap/NTN/