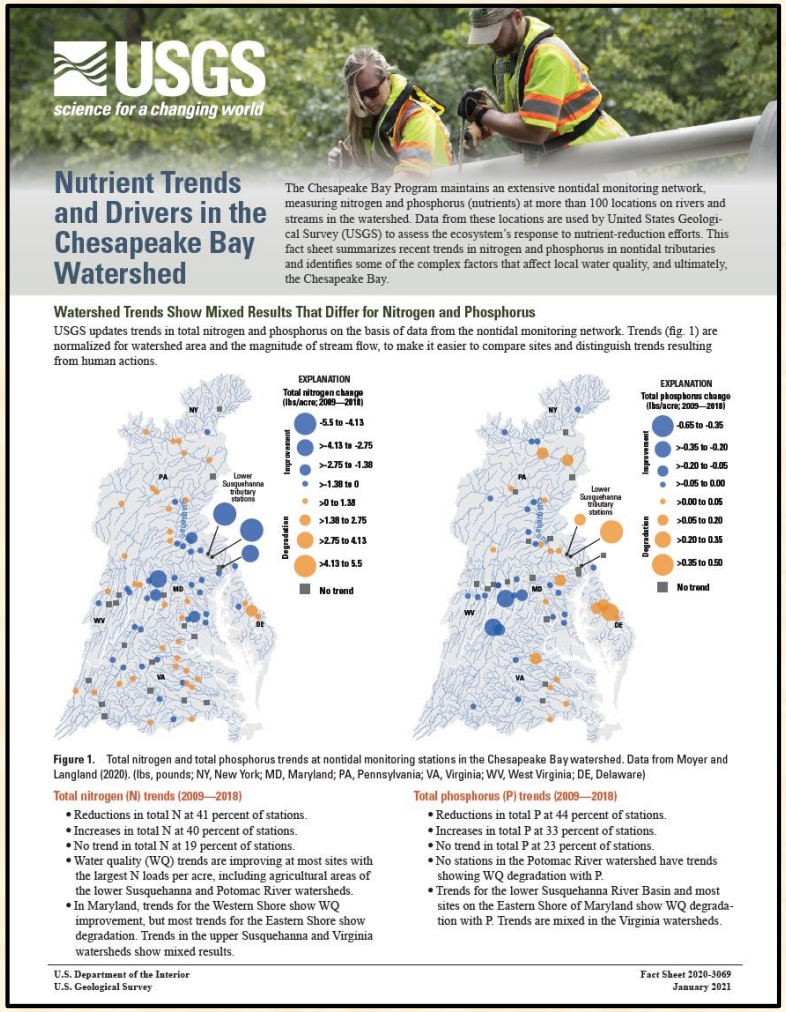
Nutrient Trends and Drivers in the Chesapeake Bay Watershed

Ken Hyer and Scott Phillips

US Geological Survey

January 25, 2021

Based on efforts of many USGS scientists and partners



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The Chesapeake Bay Program maintains an extensive nontidal monitoring network, measuring nitrogen and phosphorus (nutrients) at more than 100 locations on rivers and streams in the watershed. Data from these locations are used by United States Geological Survey (USGS) to assess the ecosystem's response to nutrient-reduction efforts. This fact sheet summarizes recent trends in nitrogen and phosphorus in nontidal tributaries and identifies some of the complex factors that affect local water quality, and ultimately, the Chesapeake Bay.

Watershed Trends Show Mixed Results That Differ for Nitrogen and Phosphorus

USGS updates trends in total nitrogen and phosphorus on the basis of data from the nontidal monitoring network. Trends (fig. 1) are normalized for watershed area and the magnitude of stream flow, to make it easier to compare sites and distinguish trends resulting from human actions.

Figure 1. Total nitrogen and total phosphorus trends at nontidal monitoring stations in the Chesapeake Bay watershed. Data from Moyer and Langland (2020). (lbs, pounds; NY, New York; MD, Maryland; PA, Pennsylvania; VA, Virginia; WV, West Virginia; DE, Delaware)

Total nitrogen (N) trends (2009—2018)

- Reductions in total N at 41 percent of stations.
- Increases in total N at 40 percent of stations.
- No trend in total N at 19 percent of stations.
- Water quality (WQ) trends are improving at most sites with the largest N loads per acre, including agricultural areas of the lower Susquehanna and Potomac River watersheds.
- In Maryland, trends for the Western Shore show WQ improvement, but most trends for the Eastern Shore show degradation. Trends in the upper Susquehanna and Virginia watersheds show mixed results.

Total phosphorus (P) trends (2009—2018)

- Reductions in total P at 44 percent of stations.
- Increases in total P at 33 percent of stations.
- No trend in total P at 23 percent of stations.
- No stations in the Potomac River watershed have trends showing WQ degradation with P.
- Trends for the lower Susquehanna River Basin and most sites on the Eastern Shore of Maryland show WQ degradation with P. Trends are mixed in the Virginia watersheds.

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Fact Sheet 2020-3069
January 2021

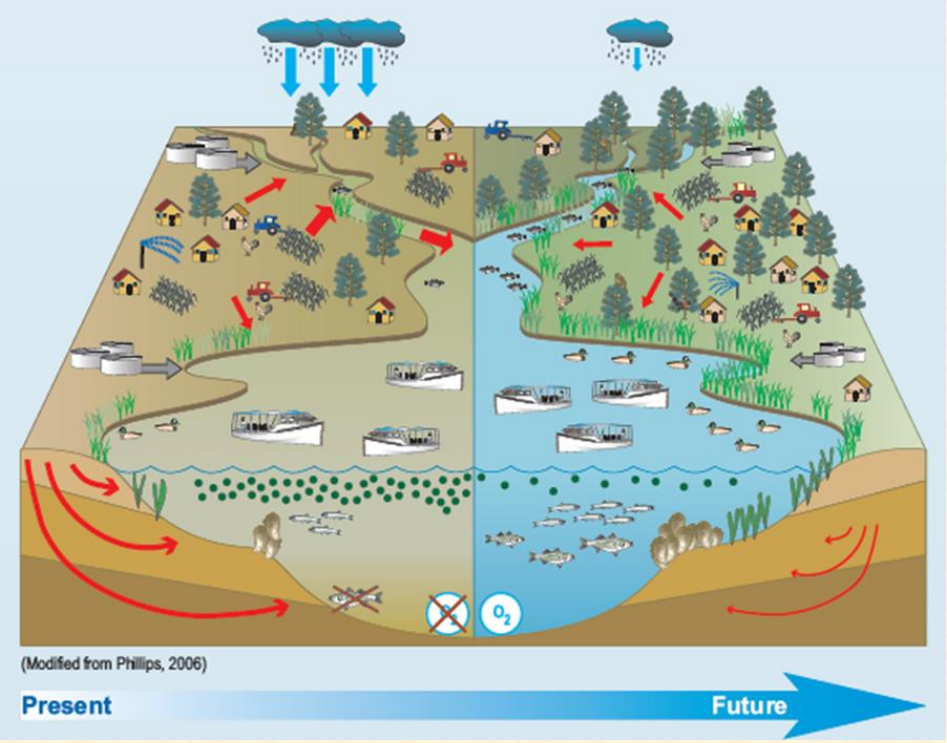
Improving Water Quality

CBP Outcomes:

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

Approach:

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



Purpose of Fact Sheet

- Translate the complex science into an understandable and concise document
- Higher-level managers and policy makers
- Partnership effort: USGS, CBP, UMCES
- Summarize:
  - Updated Trends (2009-2018)
  - Drivers: Wastewater, Atmospheric, Urban, Agricultural, Climate Change
  - Challenges for effective nonpoint nutrient mgt

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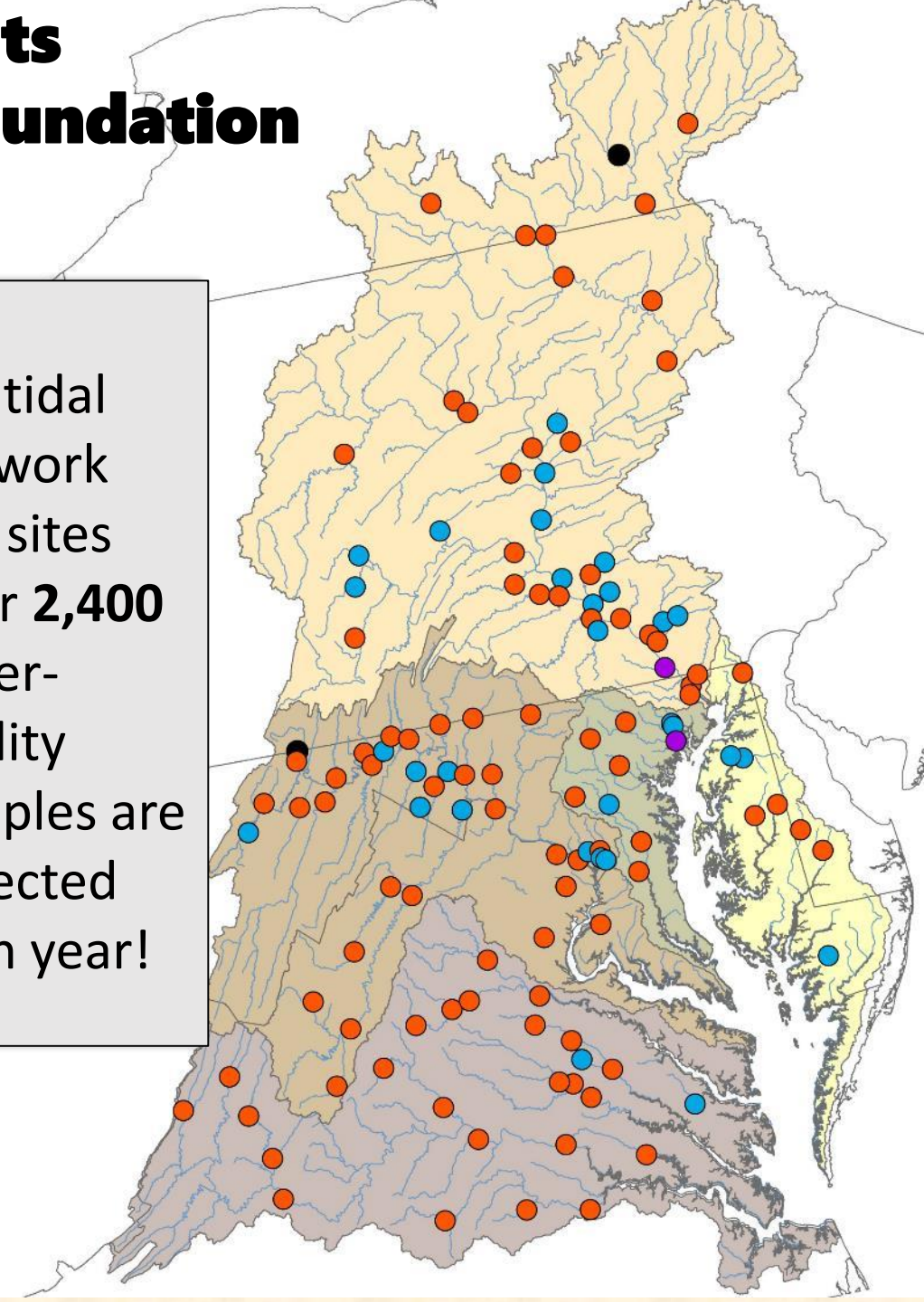
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
INTEGRATION AND APPLICATION NETWORK

Chesapeake Bay Program
Science. Restoration. Partnership.

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!



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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

Watershed nitrogen trends

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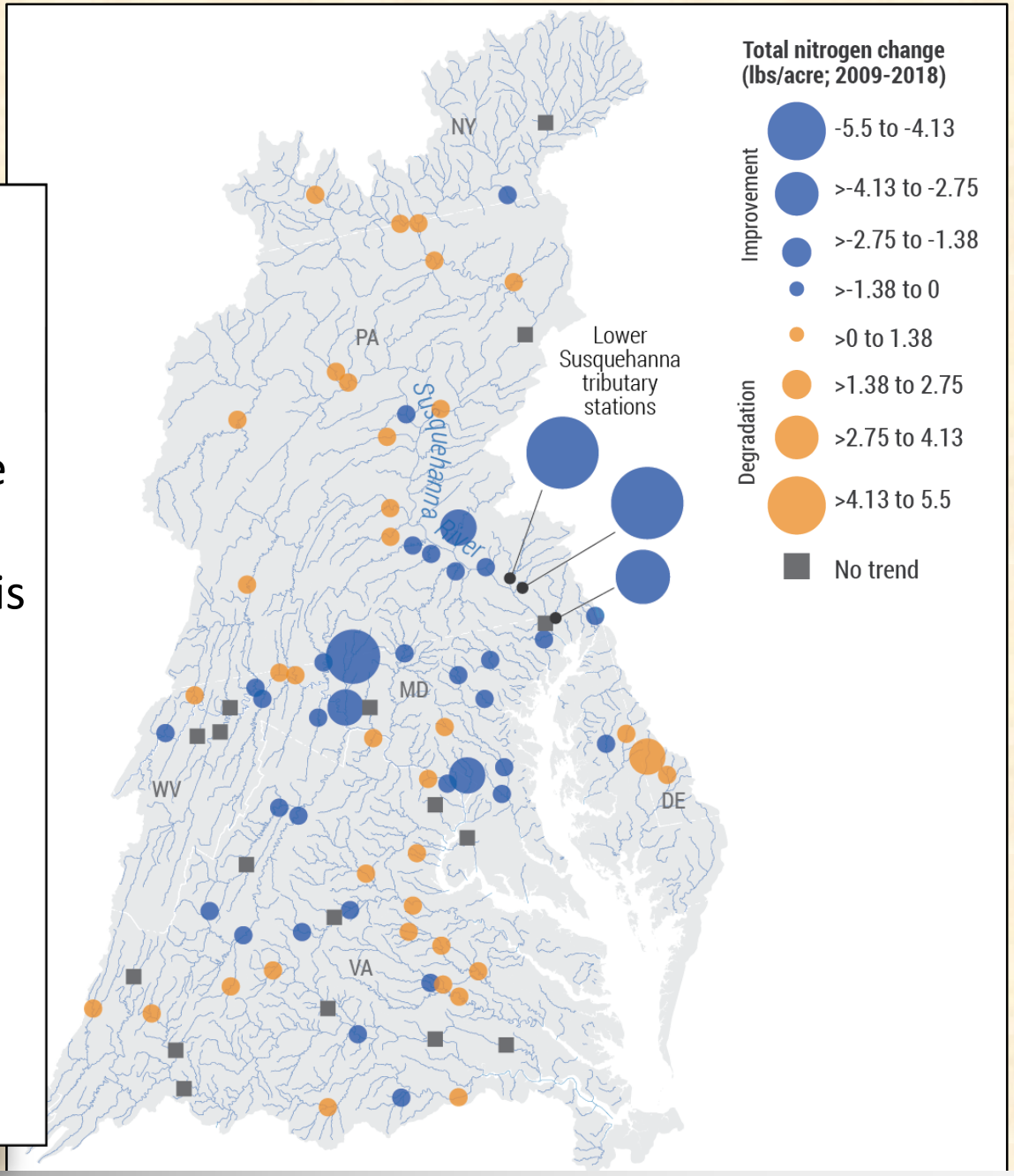

Hyer and others, 2021

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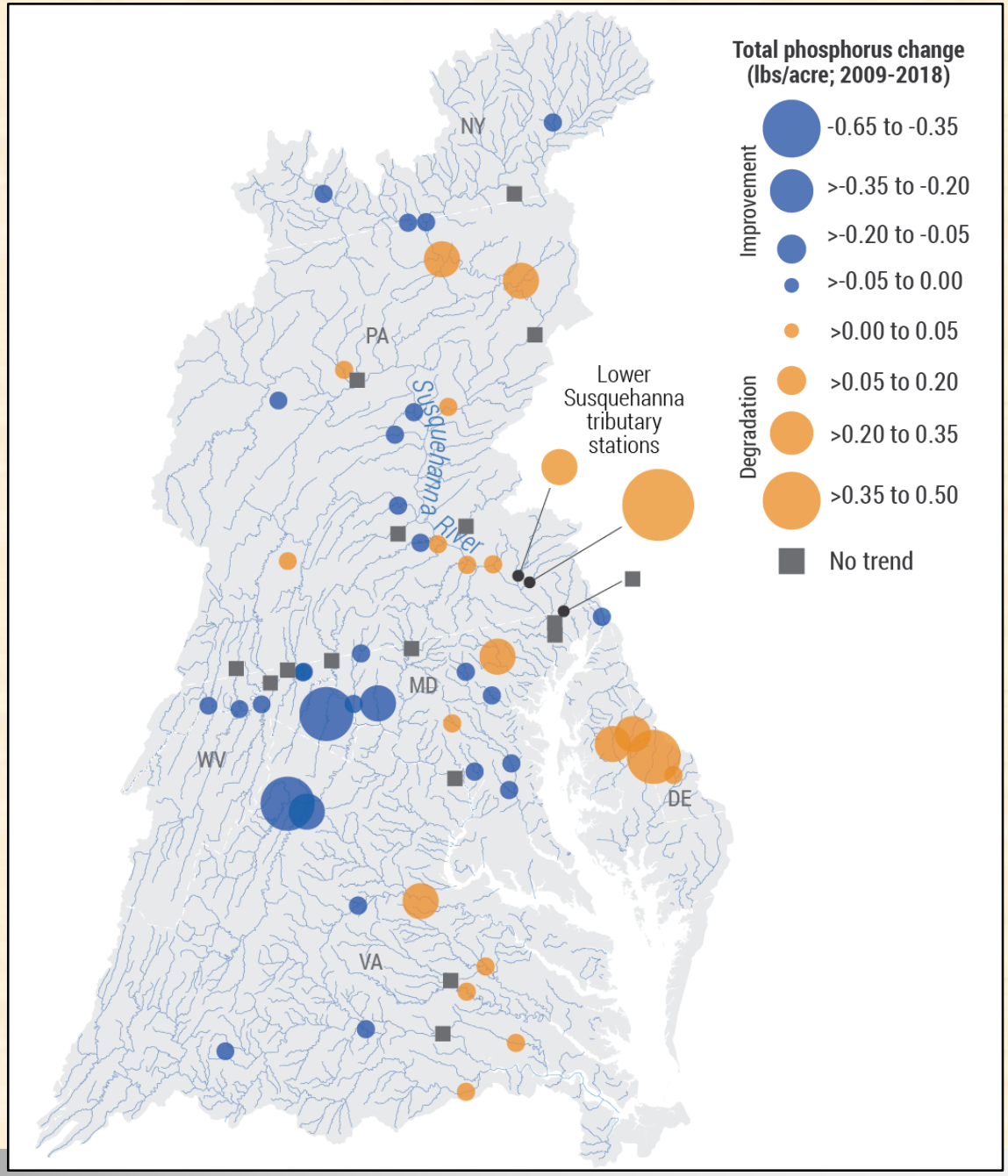
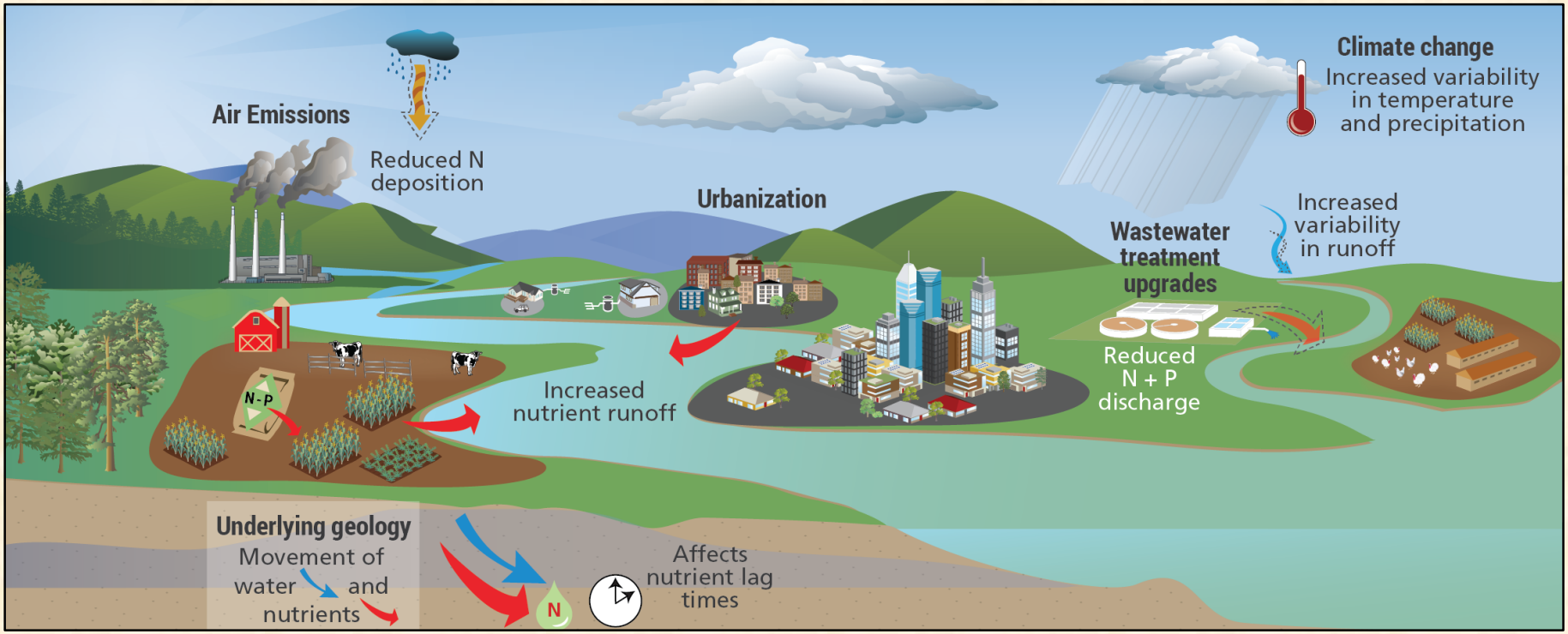


Hyer and others, 2021

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

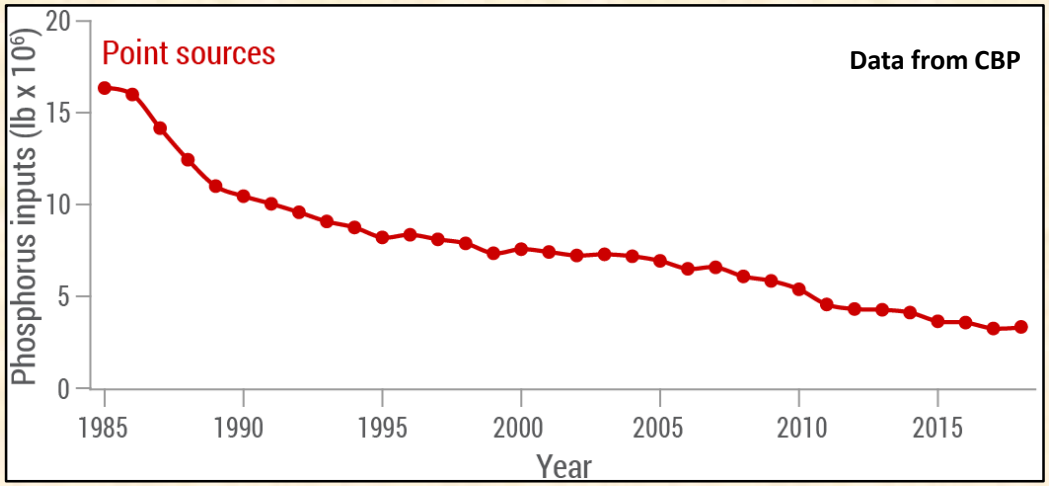
Wastewater and Atmospheric Source Reductions Have Improved Trends

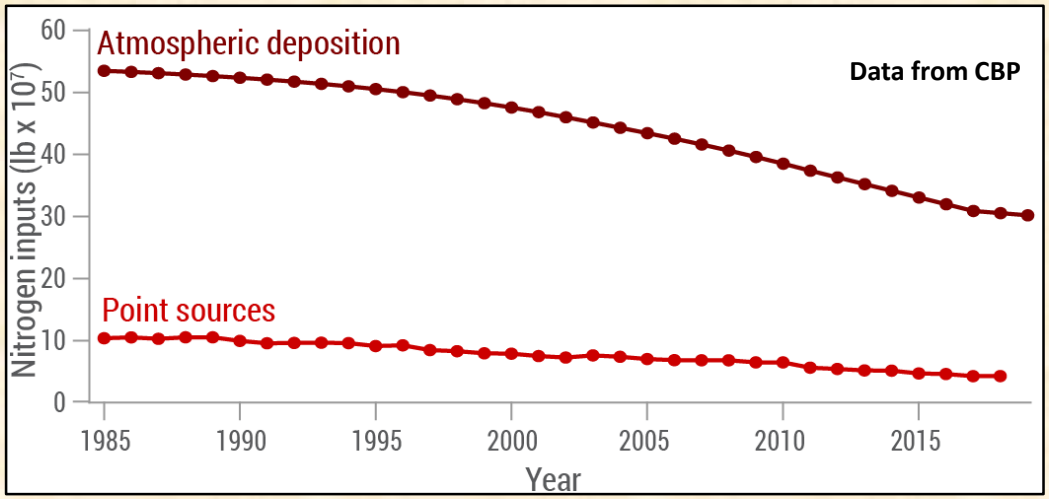
Wastewater point sources

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

Atmospheric deposition

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

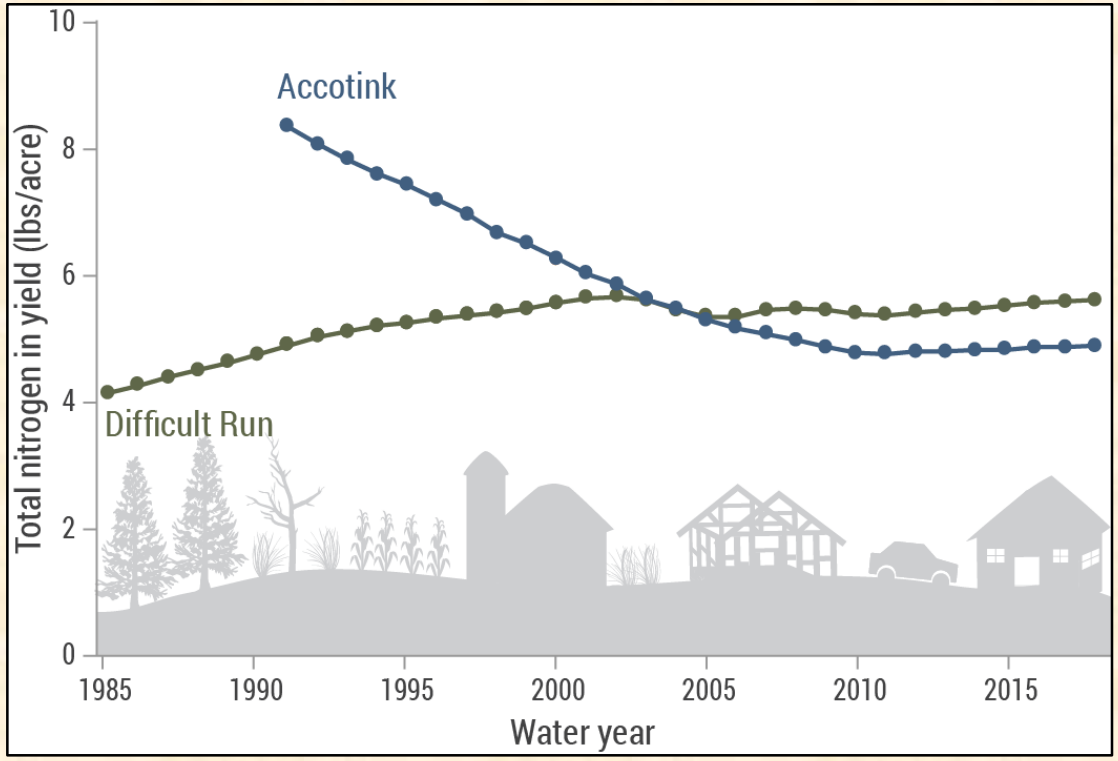




Ator and others 2020

Hyer and others, 2021

Urban Areas: Previous land use affects trends

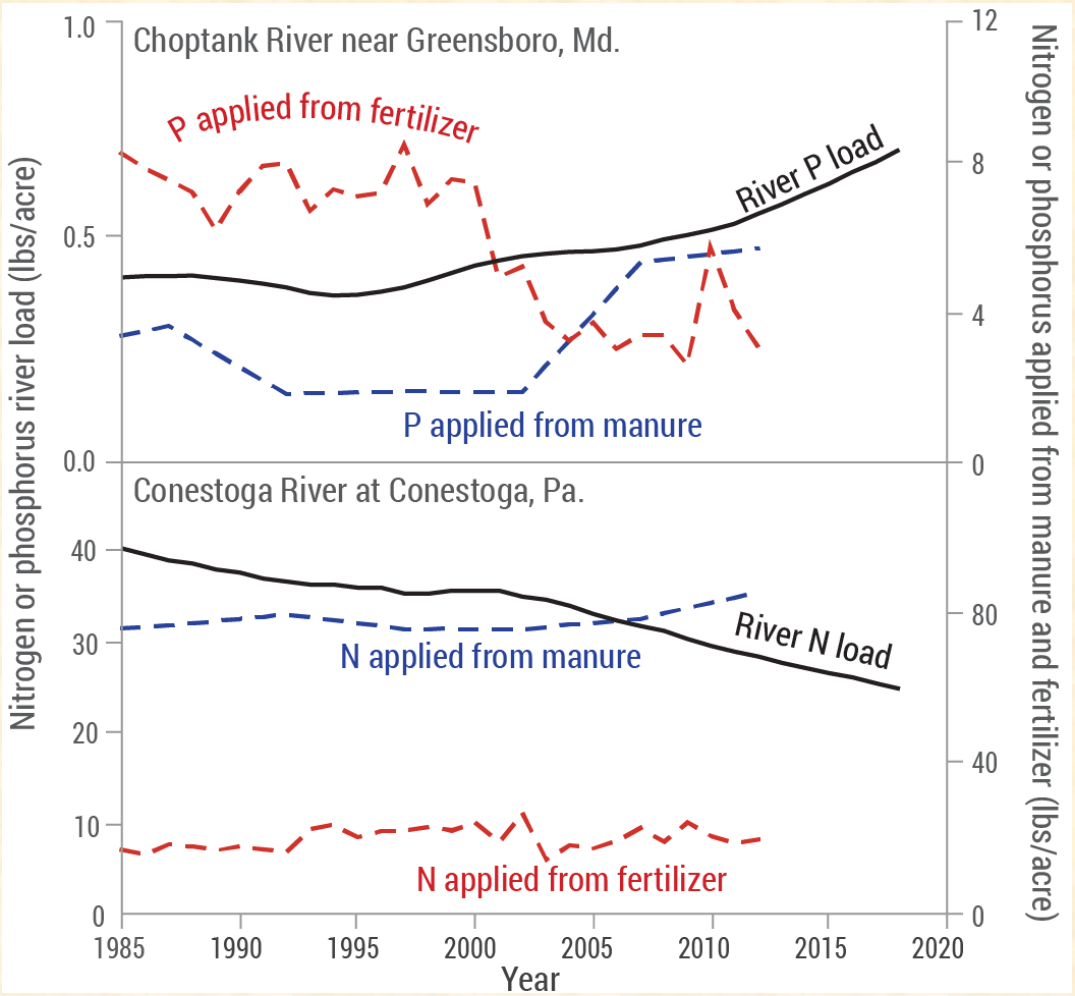


- Urban areas have expanded by 27% since 1992
- Previous land use important
  - Forest to urban: increase nutrient loads.
  - Agricultural to Urban: declines in loads
- Mixed trend results for many sites

Ator and others 2020; Moyer and Langland, 2020; Hyer and others, 2021

Trends in ag watersheds are mixed & 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; Moyer and Langland, 2020; Hyer and others, 2021

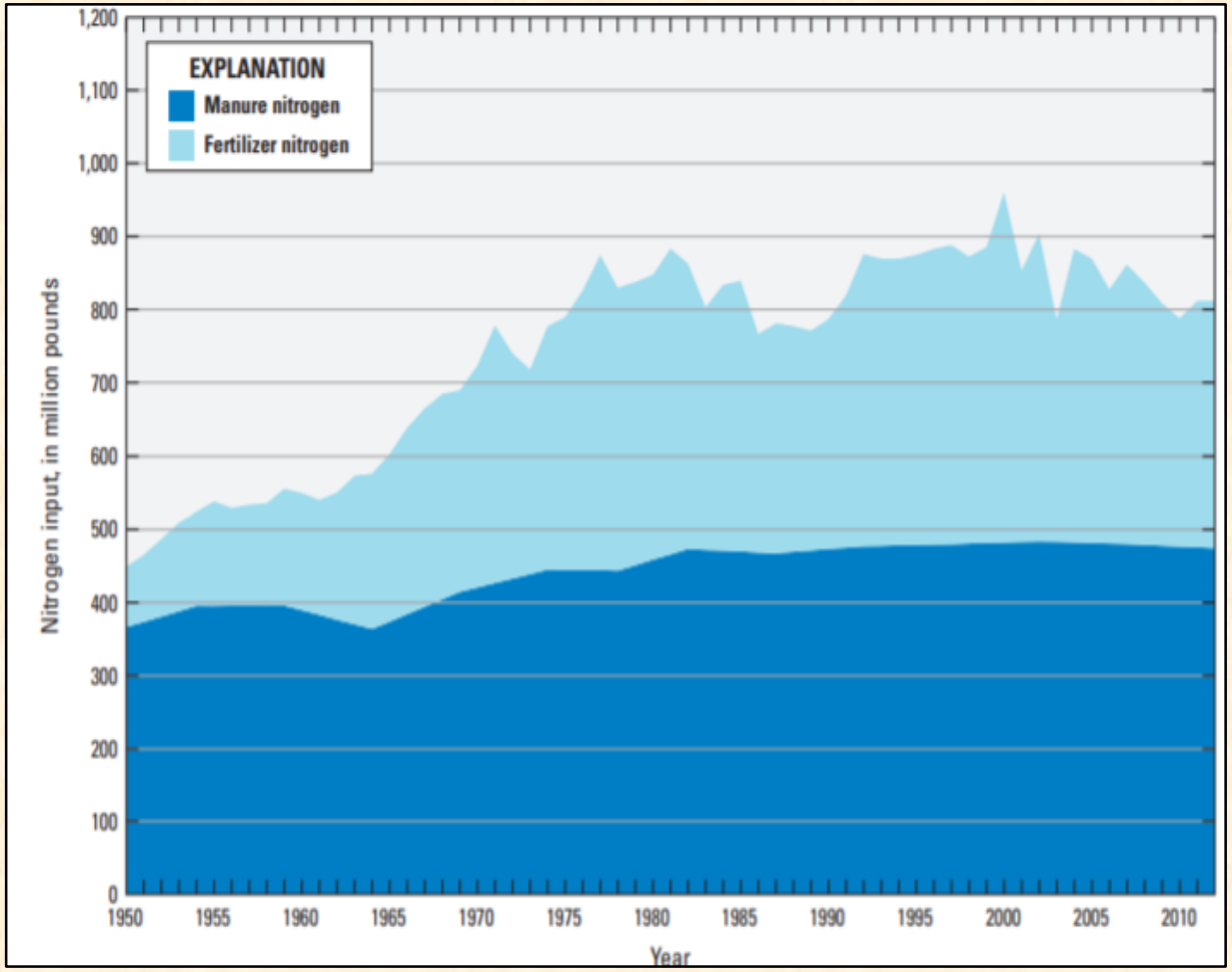
Ag land sources: Manure and Fertilizer

Applications of fertilizer & manure

- Minimal long-term change
- Animal production

Land change:

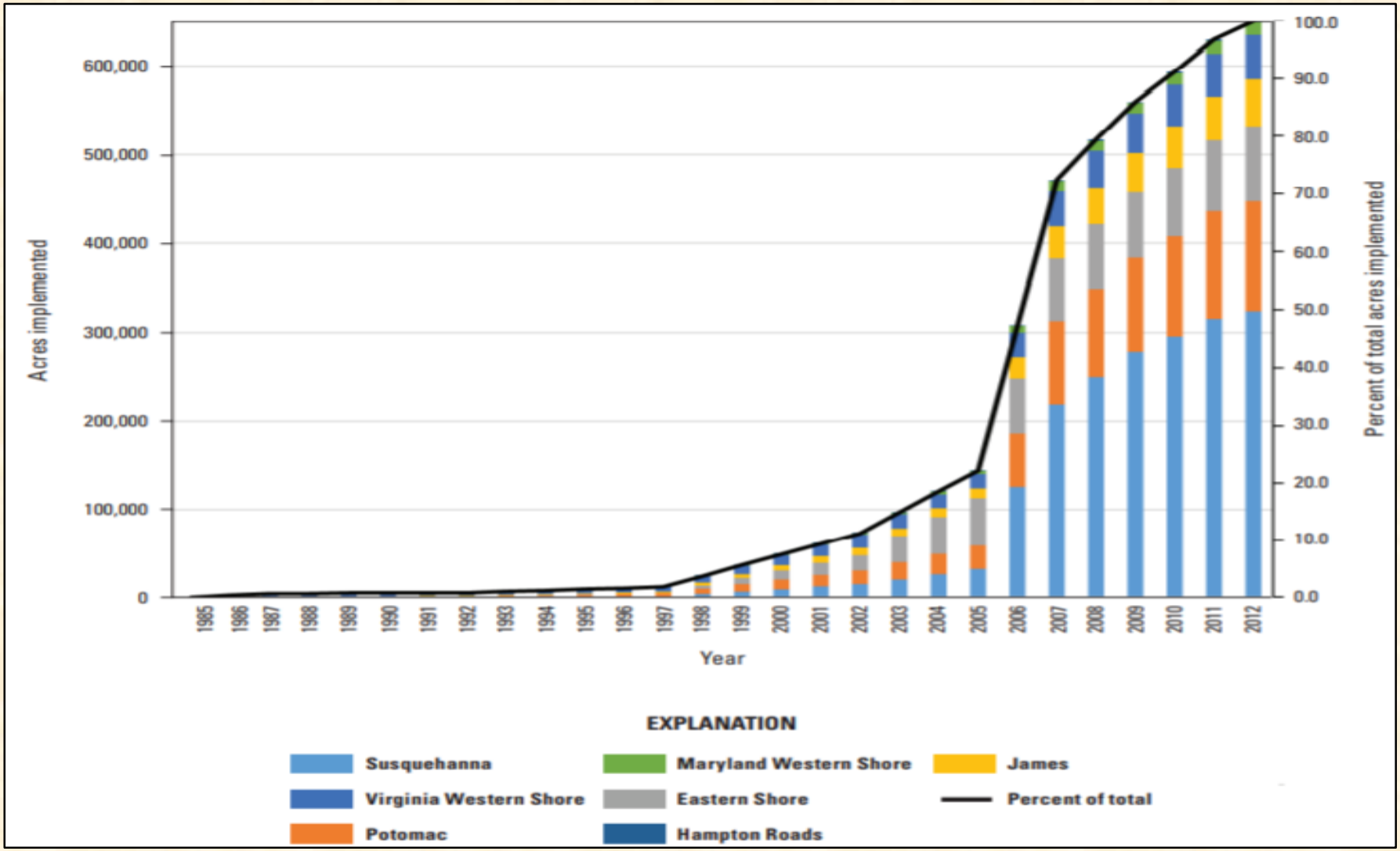
- Increasing crop lands, less pasture



Ator and others 2020;

Keisman and others, 2018

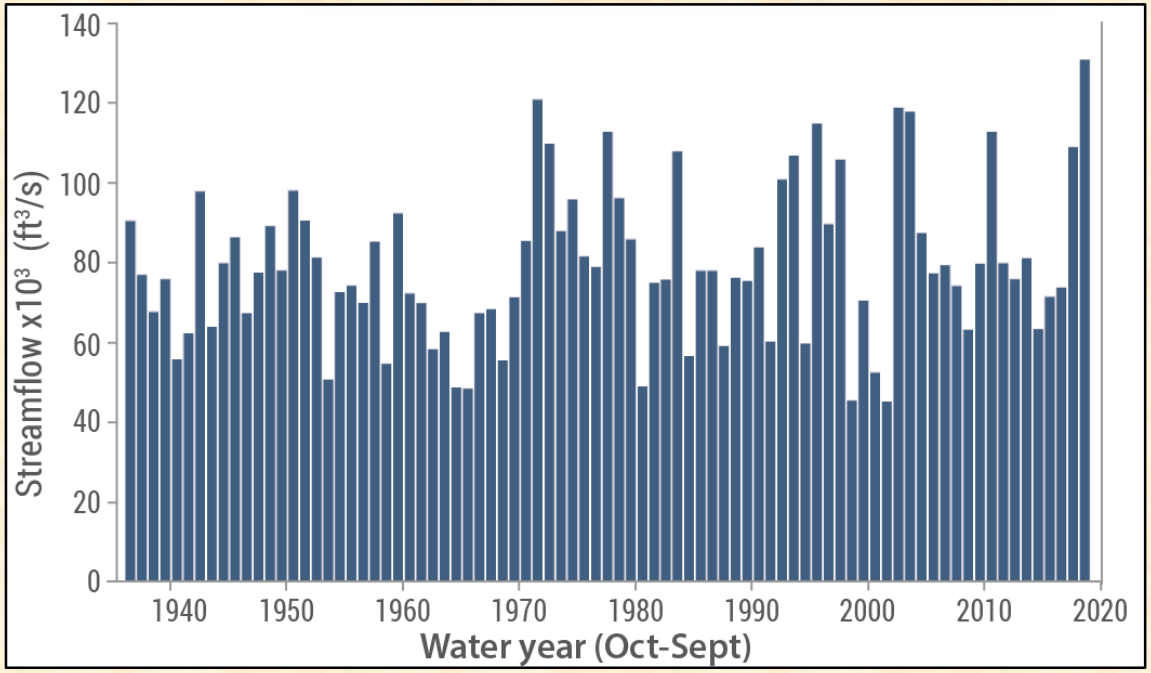
Ag BMPs: Increasing over time



Keisman and others, 2018

Climate change will affect nutrient delivery to the Bay

- Increasing rainfall volume and rising temperatures.
- Annual river flow is more variable
- Affects nutrient and sediment loads to Bay
- Attainment of standards

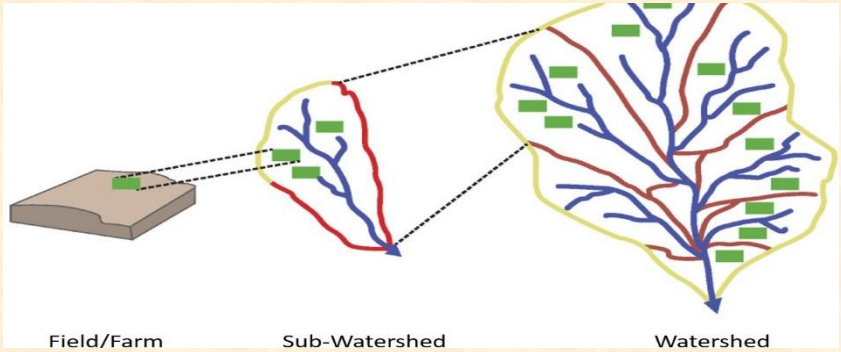


Ator and others 2020; Moyer and Langland, 2020; Hyer and others, 2021

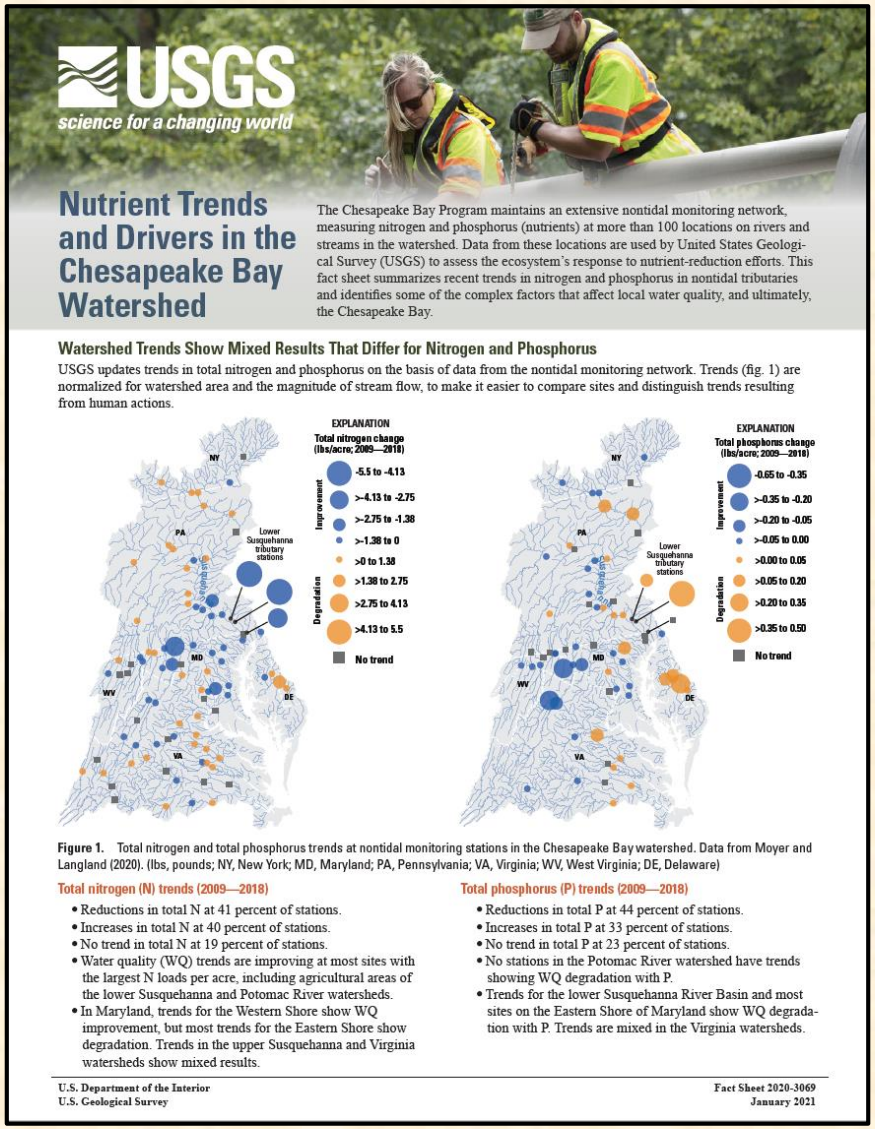
Challenges towards effective management of nonpoint sources

BMP implementation is increasing, but nutrient trends may not always follow expectations:

- Unrealistic expectations
- Competing Factors
- Travel Time
- Insufficient Monitoring



Summary of Messages



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- Mixed results for nitrogen and phosphorus trends
- Point source improvements and reductions in air emissions are improving trends
- Trends in urban watersheds are variable
- Trends in agricultural watersheds are complex
- Nonpoint source reductions are more challenging

Science to inform nutrient reductions efforts

Updated CBP Management Strategy: WIP 2025/Standards Attainment and Monitoring

1. Sustain or enhance monitoring
2. Analysis and reporting of attainment and trends
3. Explaining and communicating trend
4. Relation of water-quality practices to provide benefit to other CBP outcomes (co-benefits)

Contacts and More information

- USGS Chesapeake Studies: https://www.usgs.gov/centers/cba
- New Fact sheet: Hyer and others, 2021:

  https://doi.org/10.3133/fs20203069
- Scott Phillips, USGS Chesapeake Bay Coordinator swphilli@usgs.gov
- Ken Hyer, USGS Chesapeake Bay Assoc Coordinator kenhyer@usgs.gov
- Doug Moyer, Trend updates dlmoyer@usgs.gov
- Story Map

  https://va.water.usgs.gov/storymap/NTN/