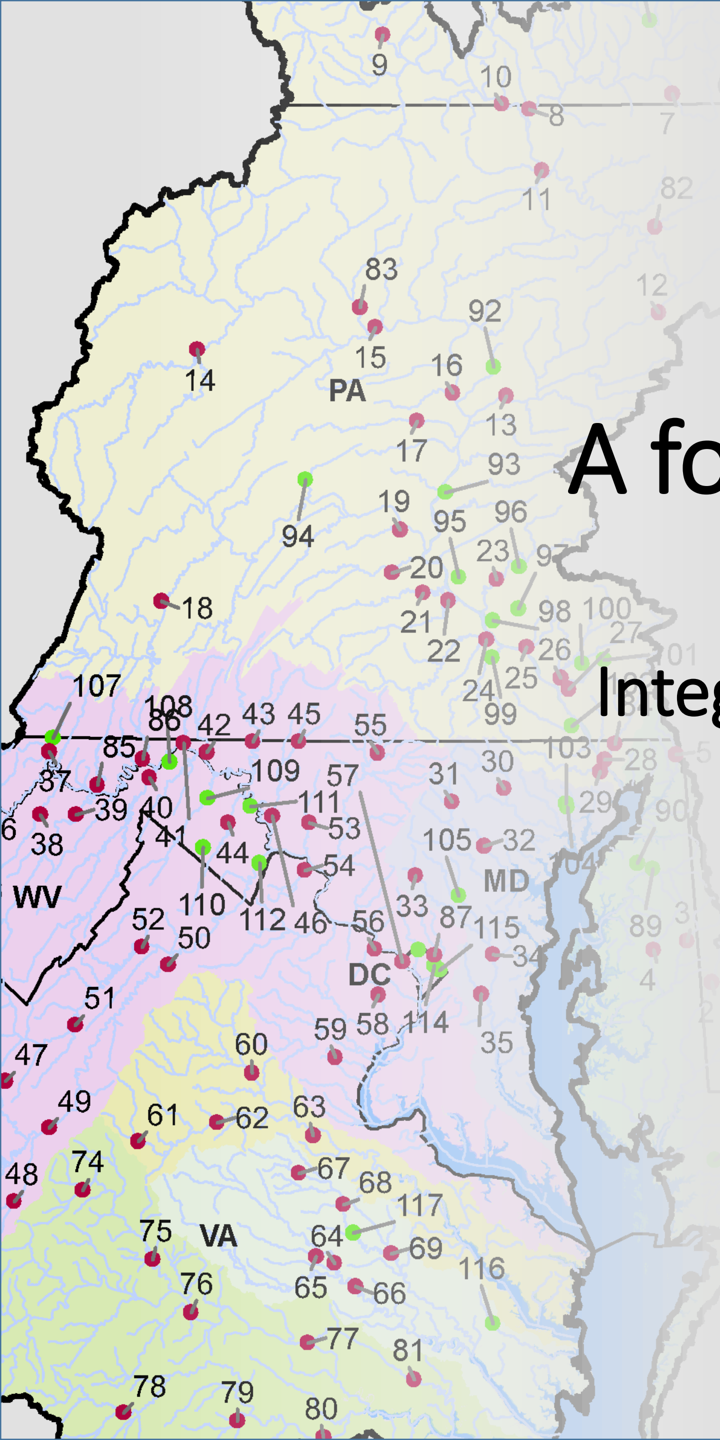


A focused study on the Swatara Creek watershed

Integrating monitoring, modeling, and trends analyses

Emily Trentacoste, PhD

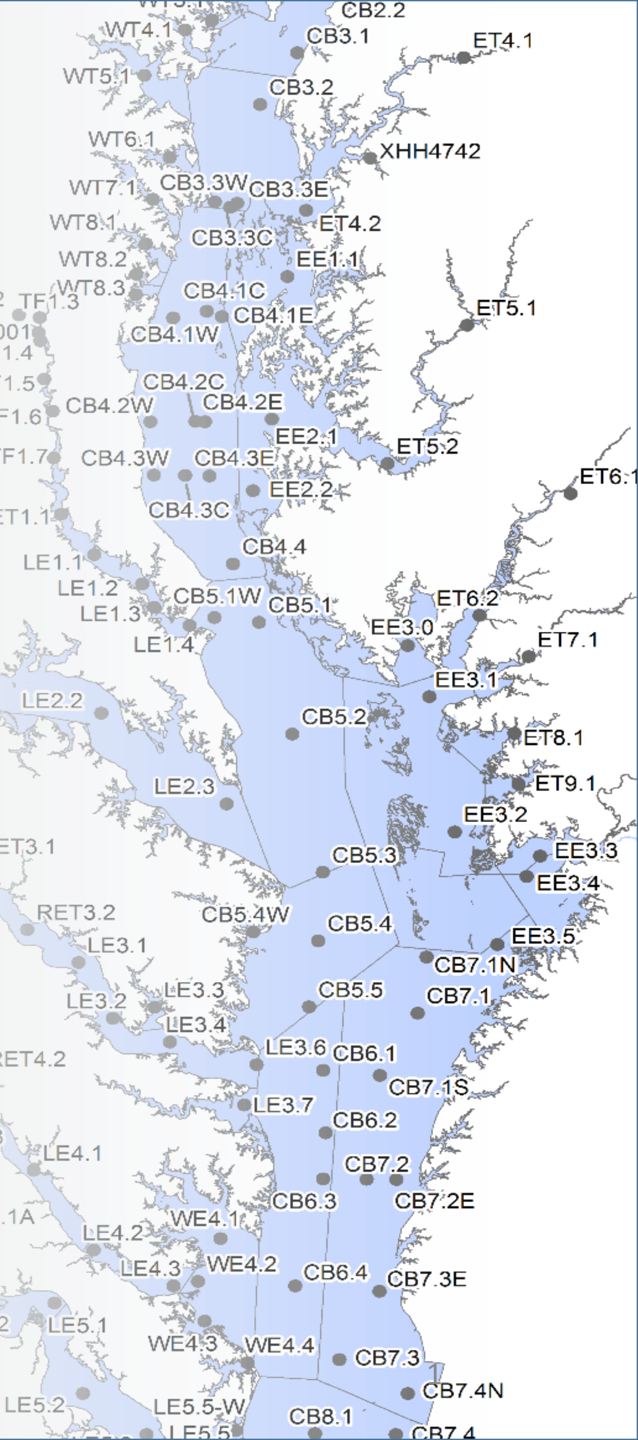
EPA Chesapeake Bay Program Office

Forestry Workgroup

11/1/2017

DRAFT. DO NOT CITE OR DISTRIBUTE.

* References & descriptions of data analyses are described at the end of these slides.



A LOT of new and updated info available…

Monitoring & Trends

Nontidal water quality

Tidal water quality

Tidal attainment

Stream & tidal benthic

Submerged aquatic vegetation

Modeling Tools

CBP Watershed Model

Geographic load distribution

Geographic influence on Bay

BMP progress reports

Synthesis Analyses

USGS Non-tidal Syntheses

-Regional Nitrogen, Phosphorus and Sediment

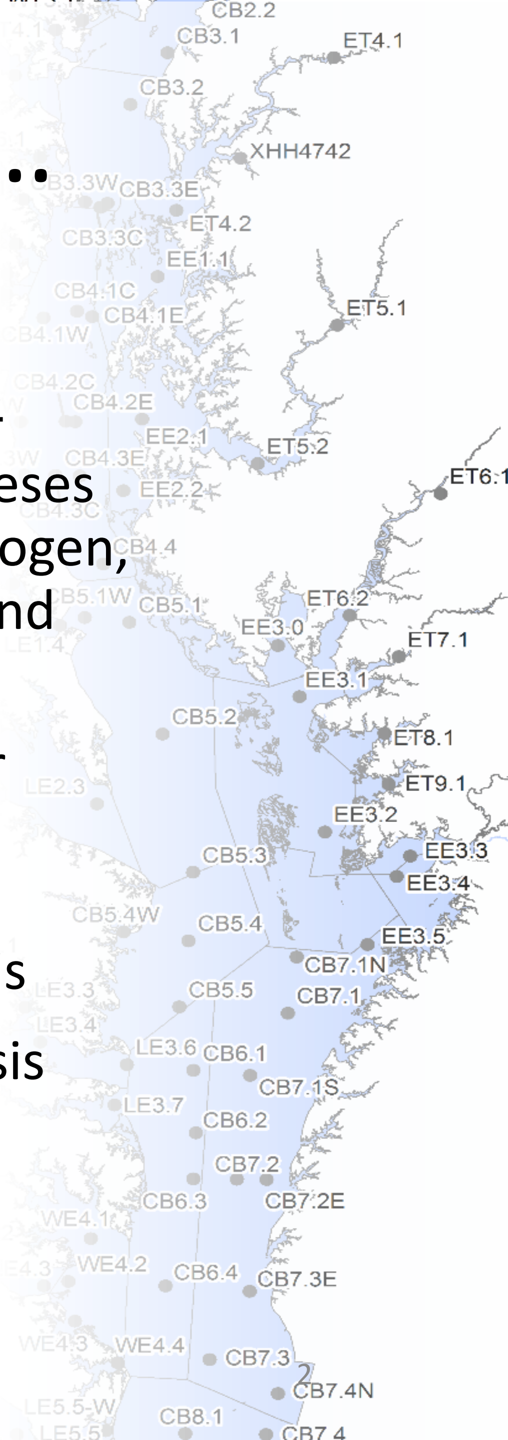
-Groundwater

SAV Syntheses

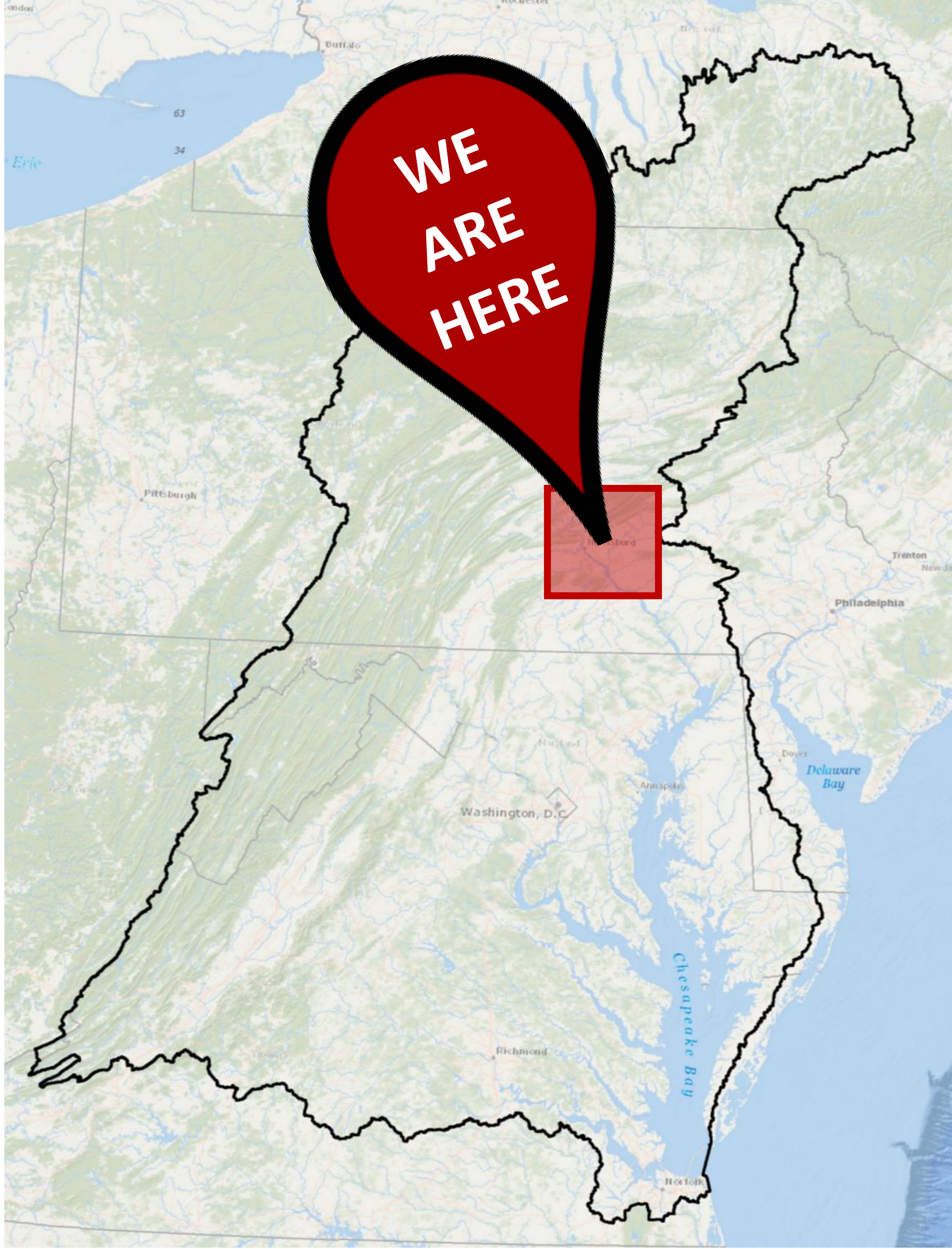
Water Clarity Synthesis

Water Quality Synthesis

…and more to come



Swatara Creek Storyline

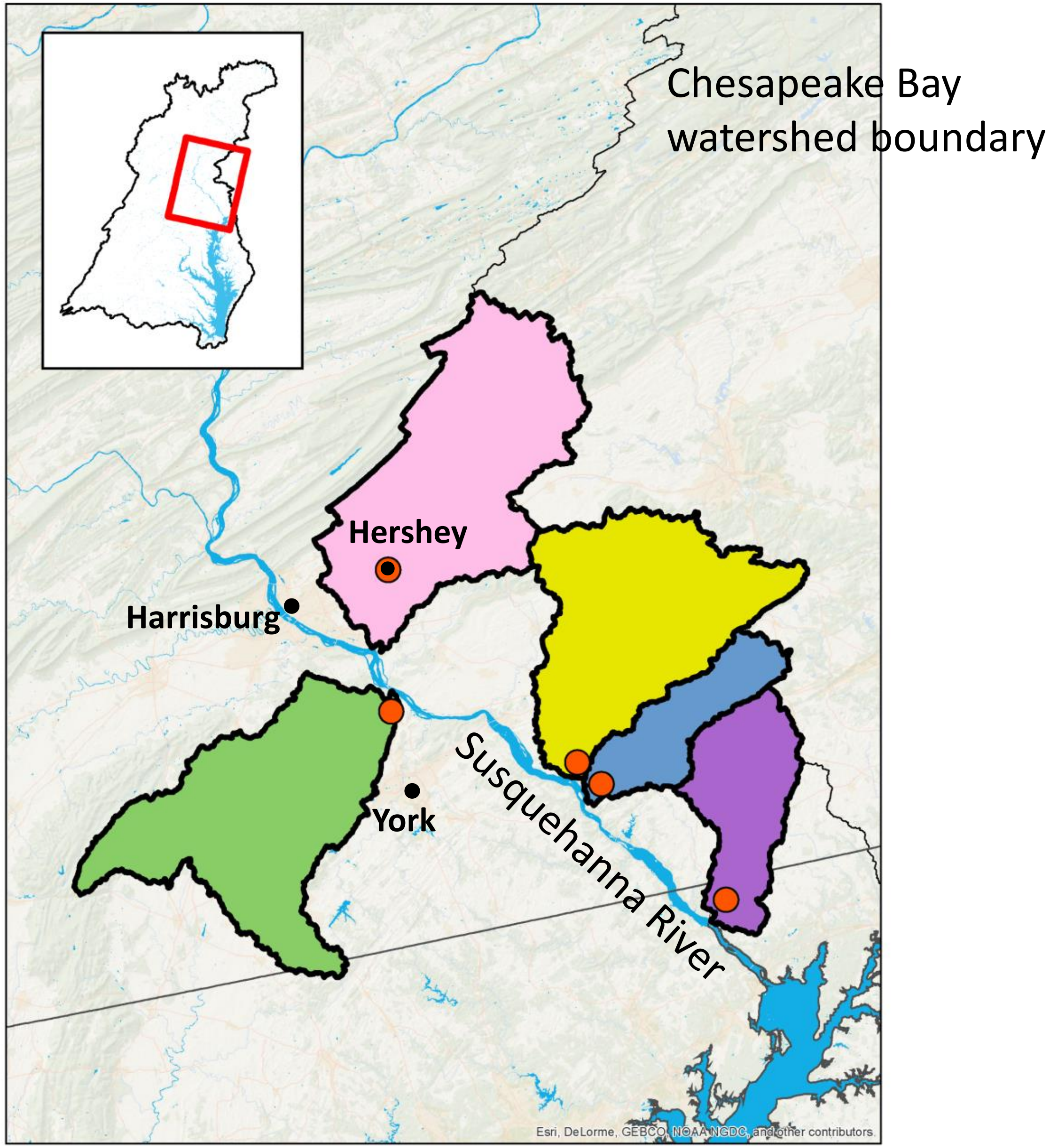


Key Lower Susquehanna Watersheds

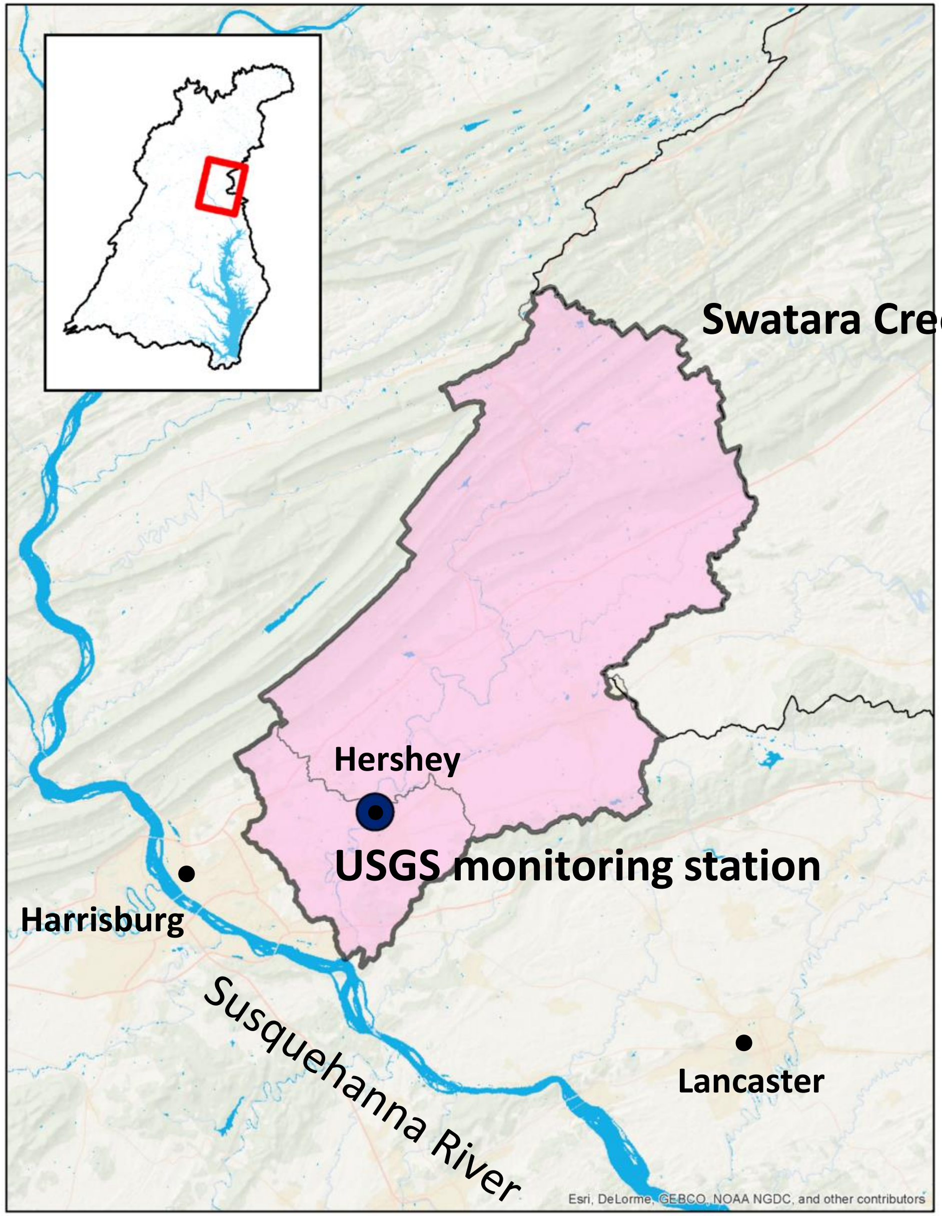
= Water quality monitoring stations

Watersheds

- Swatara Creek
- West Conewago Creek
- Conestoga River
- Pequea Creek
- Octoraro Creek



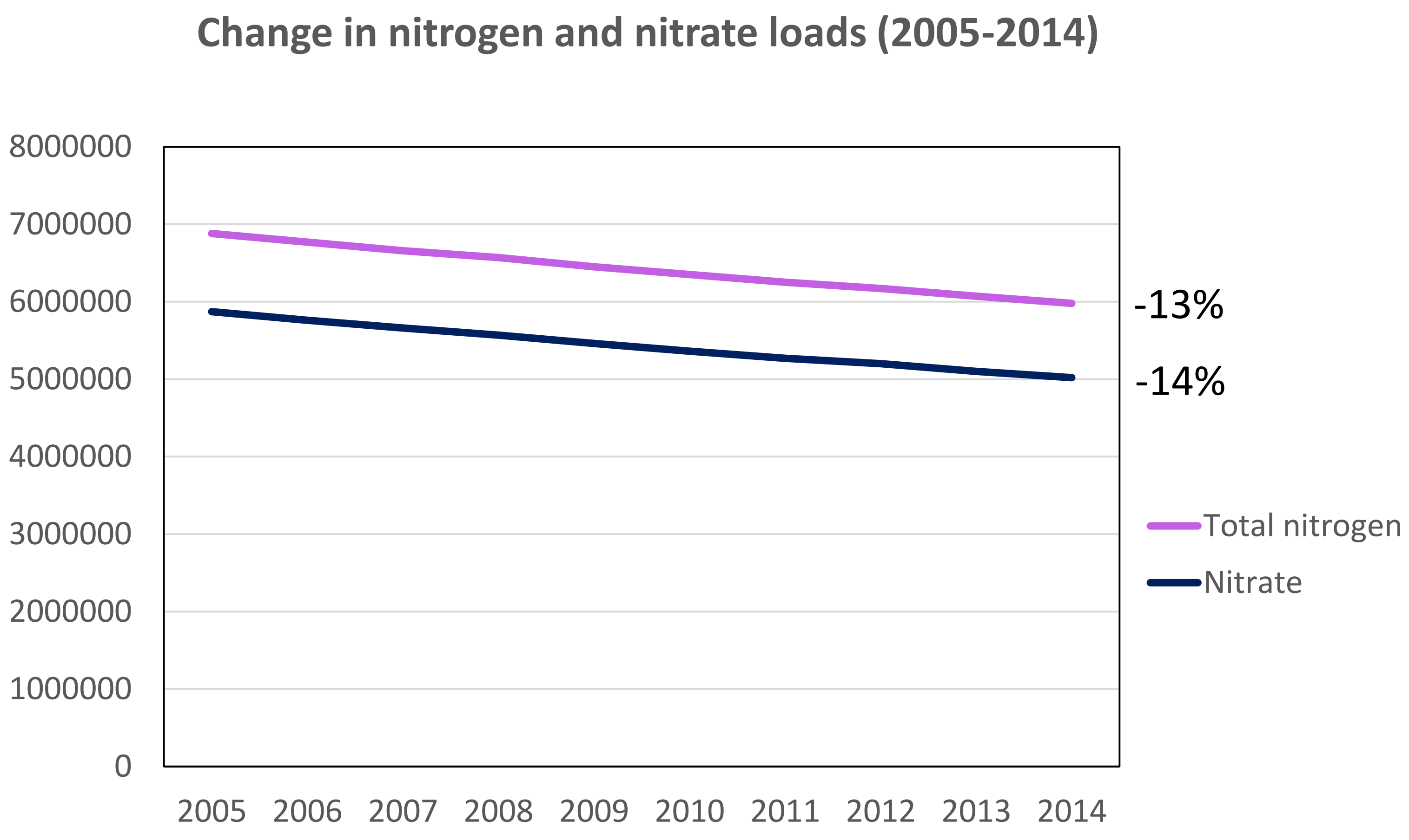
Swatara Creek Watershed



- **Trends**
- **Drivers**
- **Management implications**

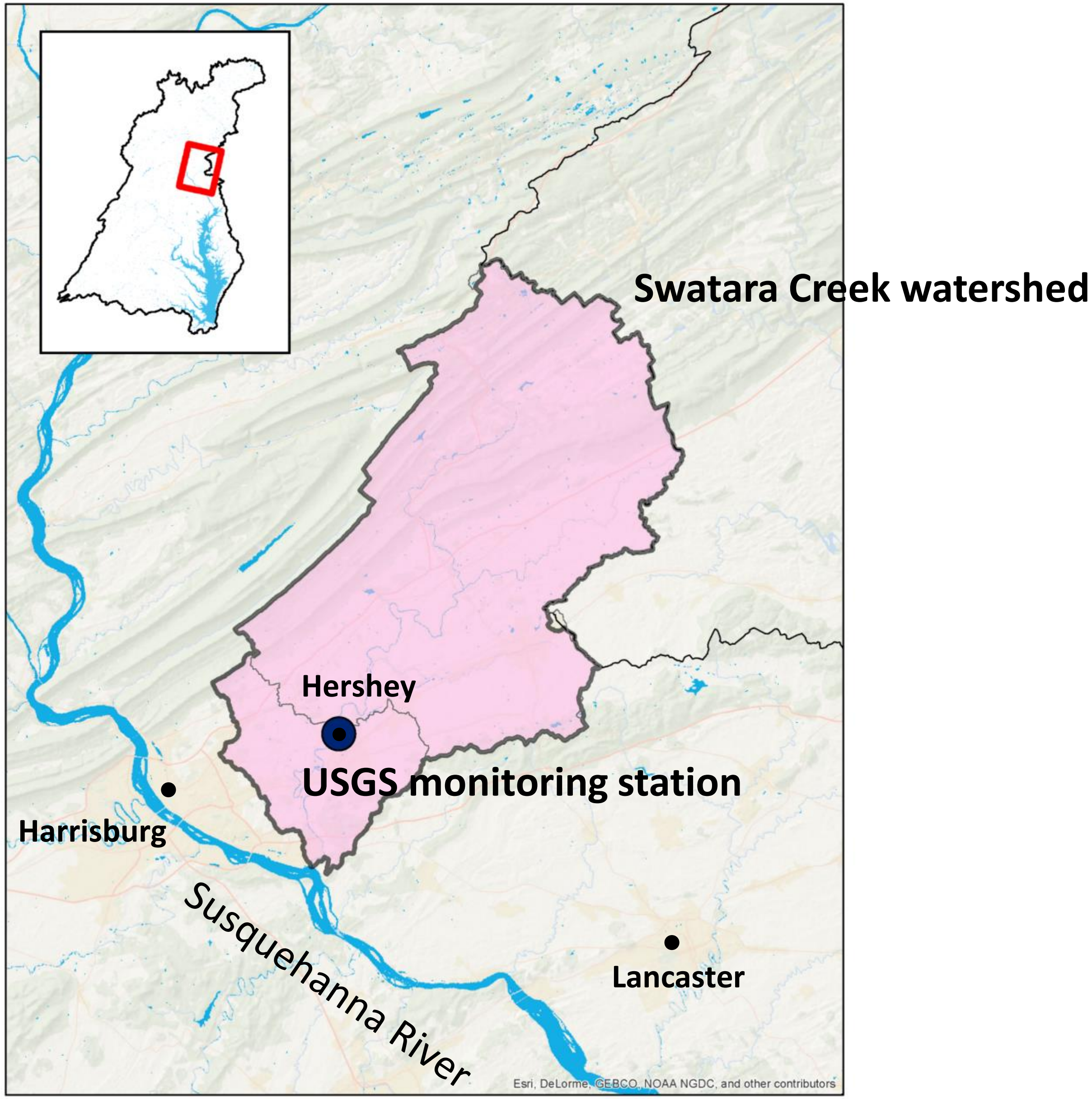
Water Quality Trends in Nitrogen

- **Total nitrogen and nitrate are decreasing**
- **Nitrogen loads are on the higher end for the Chesapeake Bay watershed**



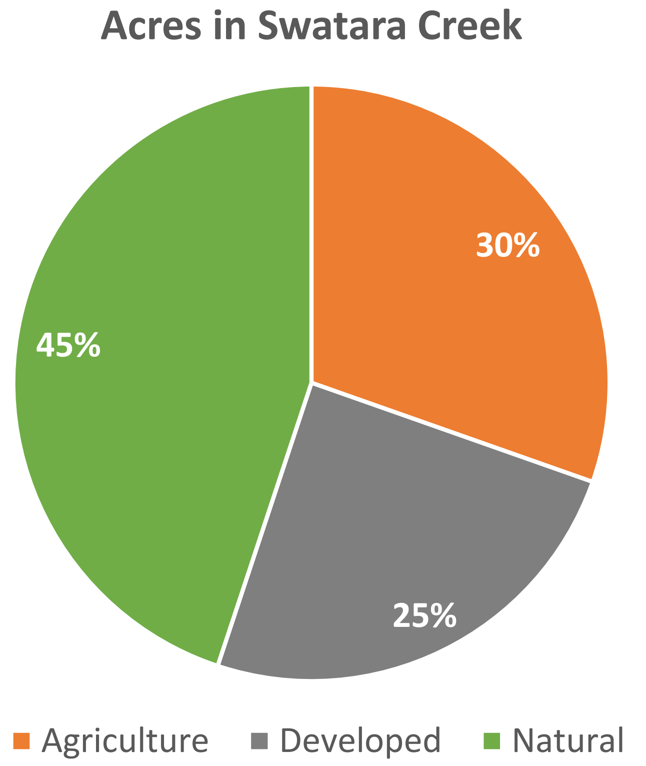
From USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/

Swatara Creek Watershed

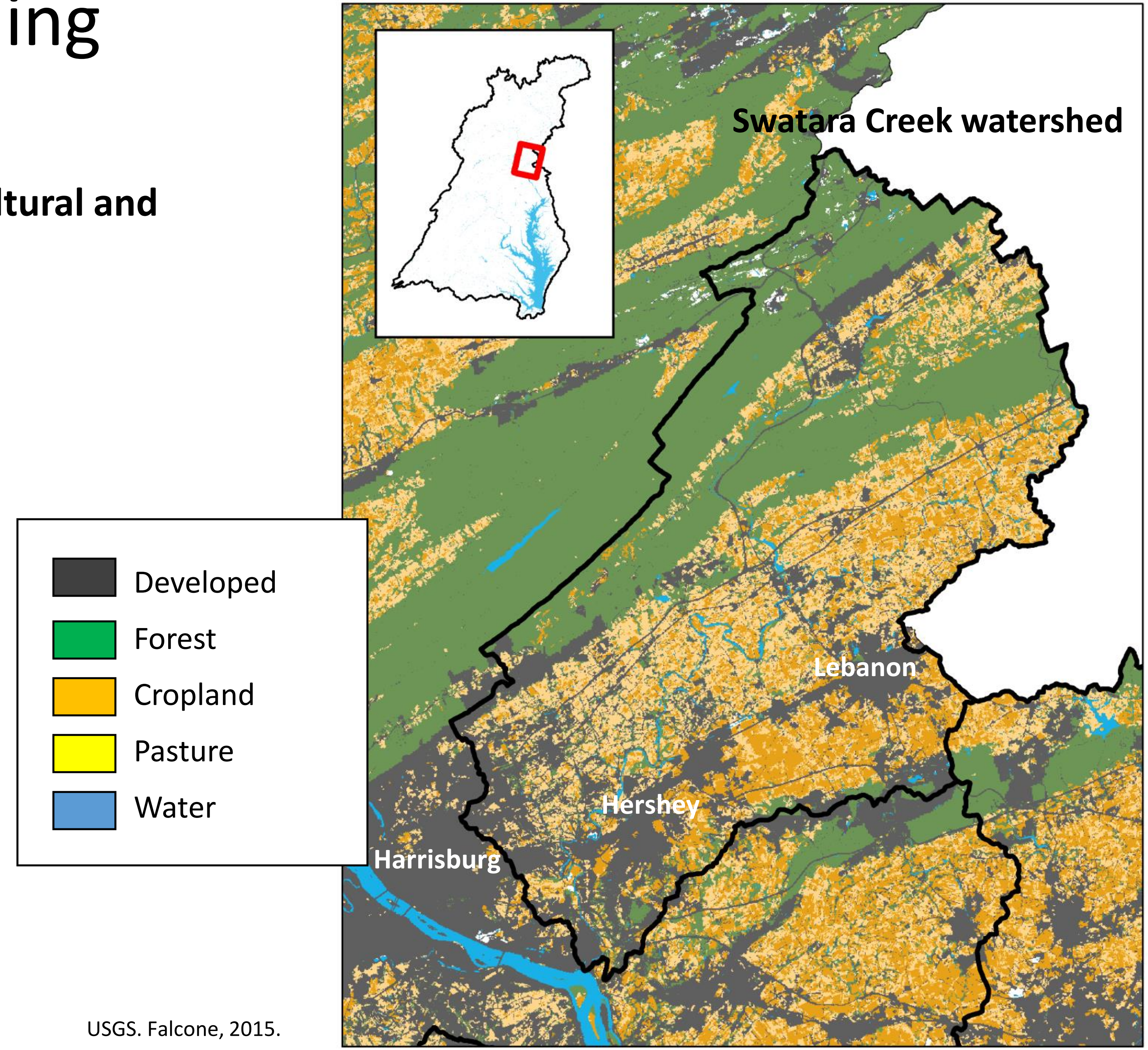


Where is nitrogen coming from?

- **Land-use is a mixture of natural, agricultural and developed**



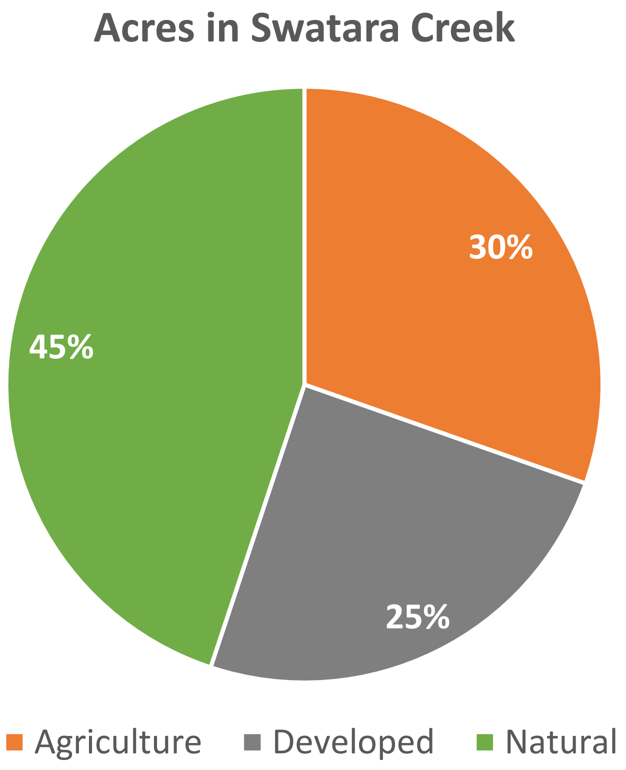
From CBP WSM Phase 6 2013 Progress Report. See data analysis at end of this document.

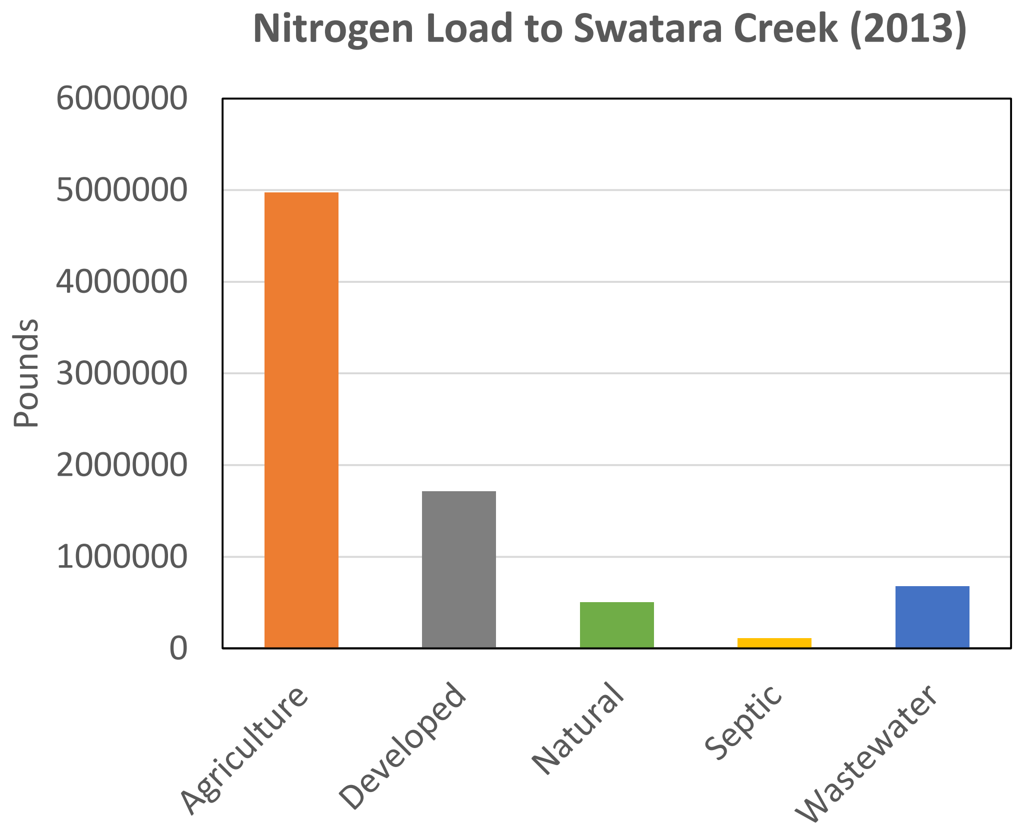


USGS. Falcone, 2015.

Where is nitrogen coming from?

- **Land-use is a mixture of natural, agricultural and developed**
- **The predominant source of nitrogen is agriculture, followed by developed land**





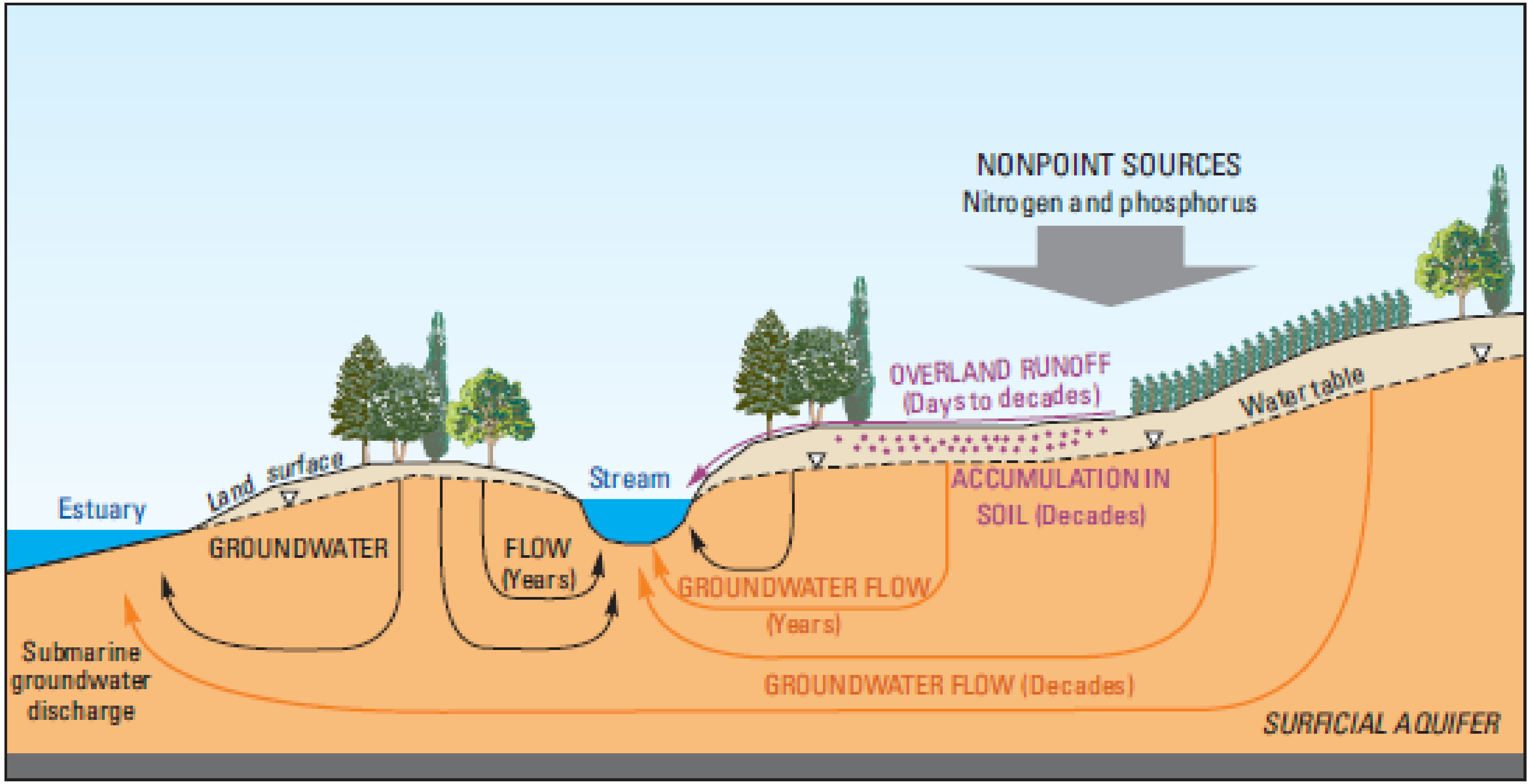
From CBP WSM Phase 6 2013 Progress Report. See data analysis at end of this document.

How is nitrogen reaching streams?

- **Nitrogen reaches streams either from surface runoff or through groundwater (often as nitrate)**
- **A high proportion of nitrate in streams is likely indicative of groundwater sources**

46%

54%



From Ator, S.W., and Denver, J.M., 2015. *USGS Circular 1406*; Bachman, L.J. et al., 1998. *Water Resources Investigations Report 98-4059.*

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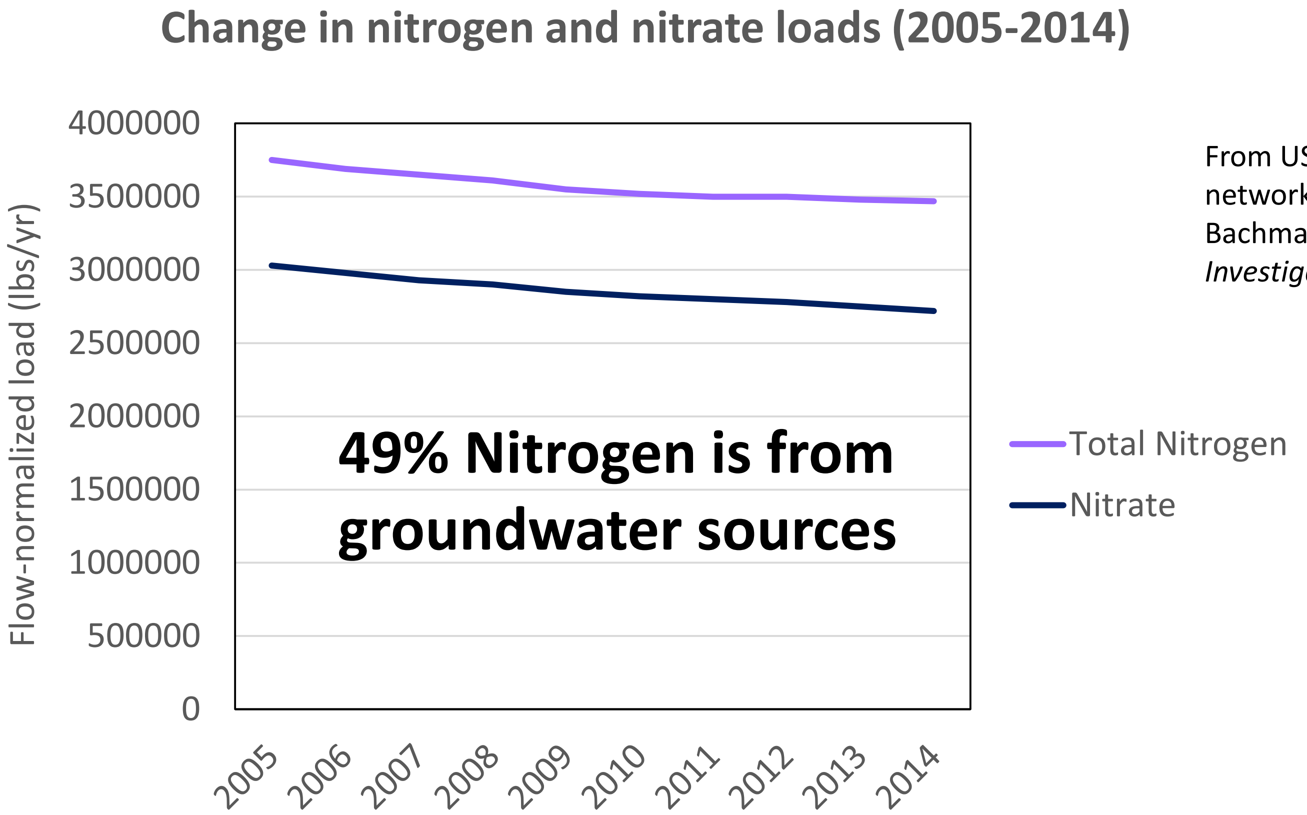
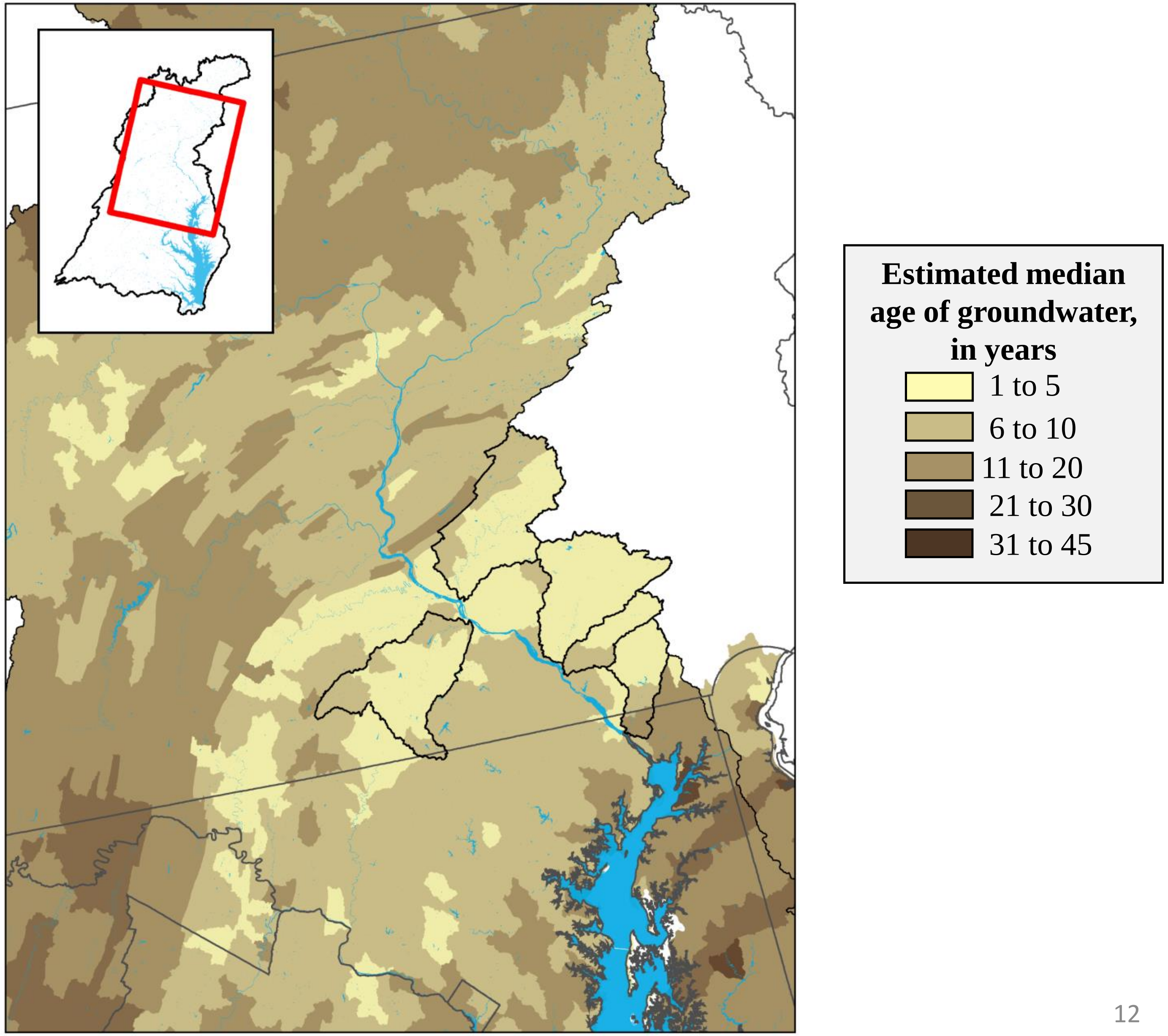


From USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/; Bachman, L.J. et al., 1998. *Water Investigations Report 98-4059.*

How is nitrogen reaching streams?

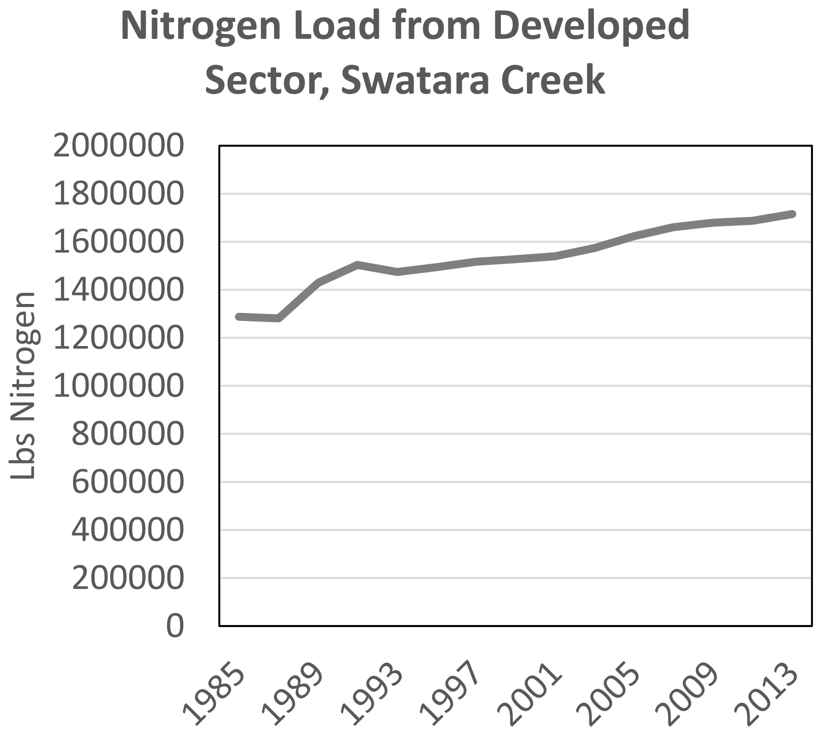
- **Nitrate in groundwater represents a range of ages from recent to decades old**
- **Nitrogen in streams is a reflection of both recent and past nitrogen applications**
- **The median groundwater age in this area is 1-10 years old**



Phase 6 WSM groundwater age estimates. DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

What are drivers behind changes in nitrogen?

- **Loads from developed have increased as development has increased**



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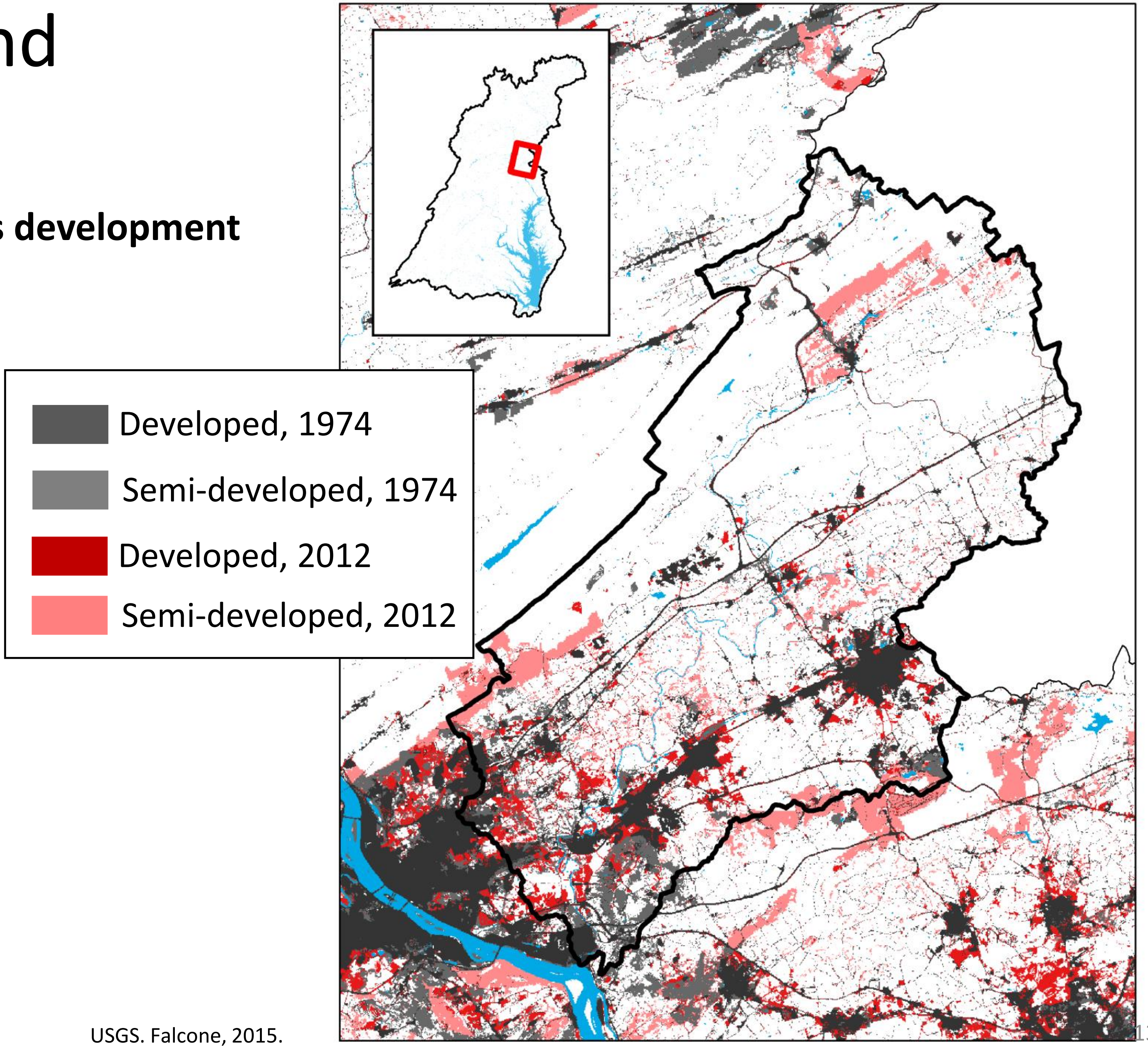
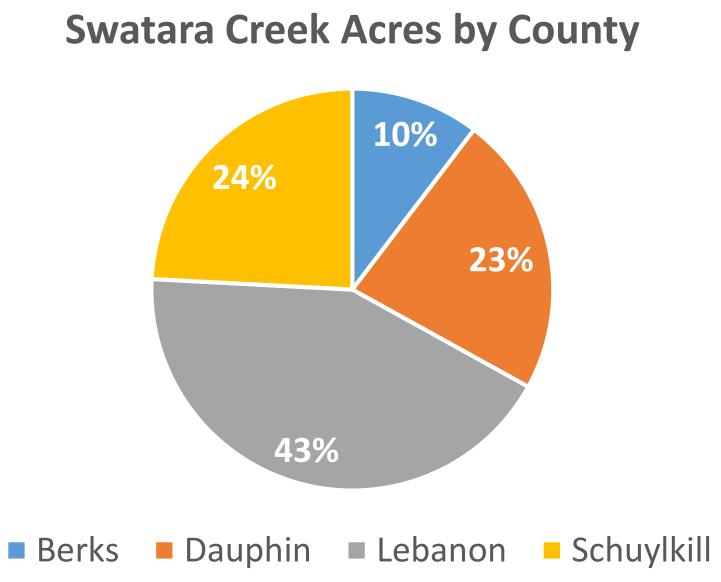
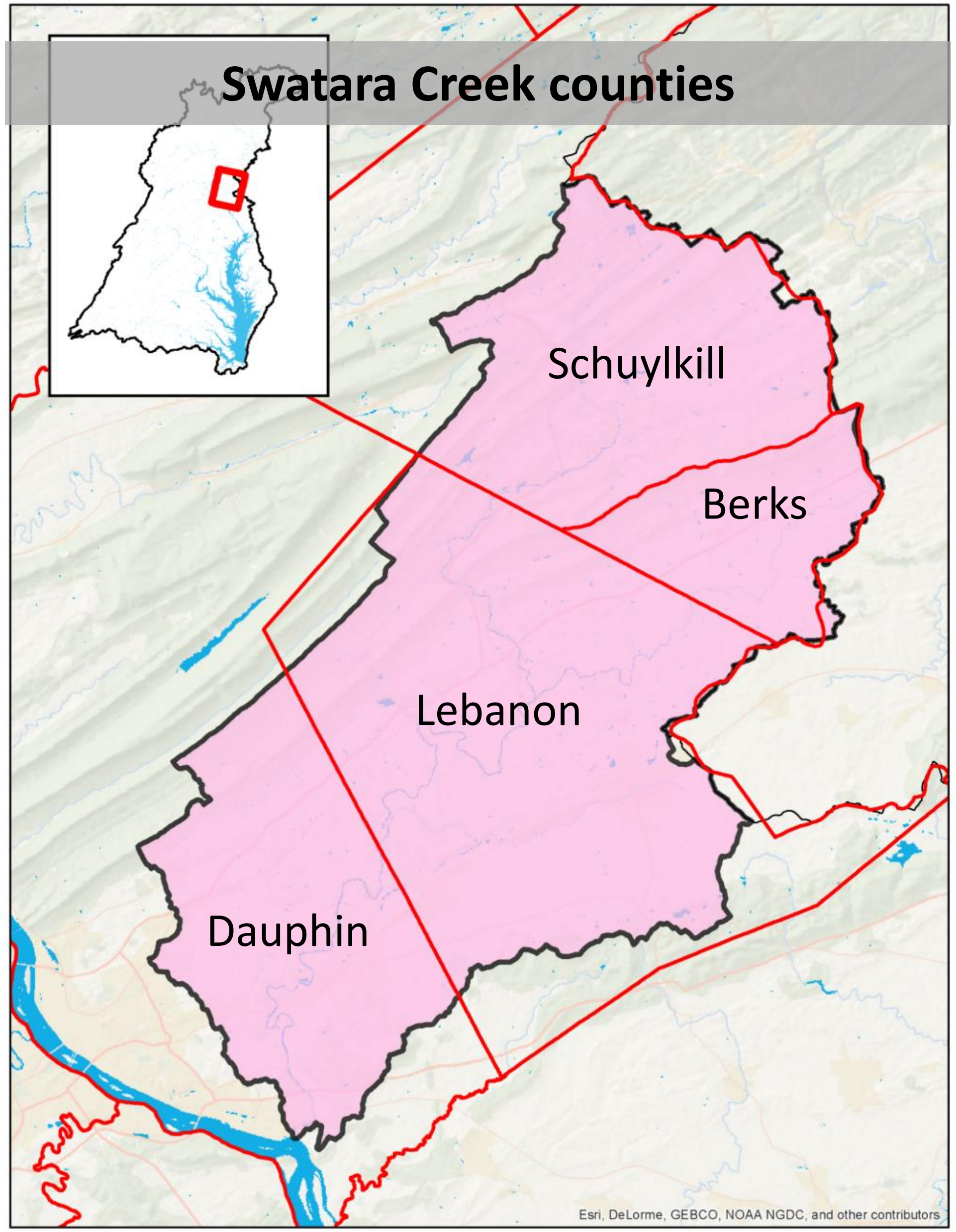


USGS. Falcone, 2015.

What are drivers behind changes in nitrogen?

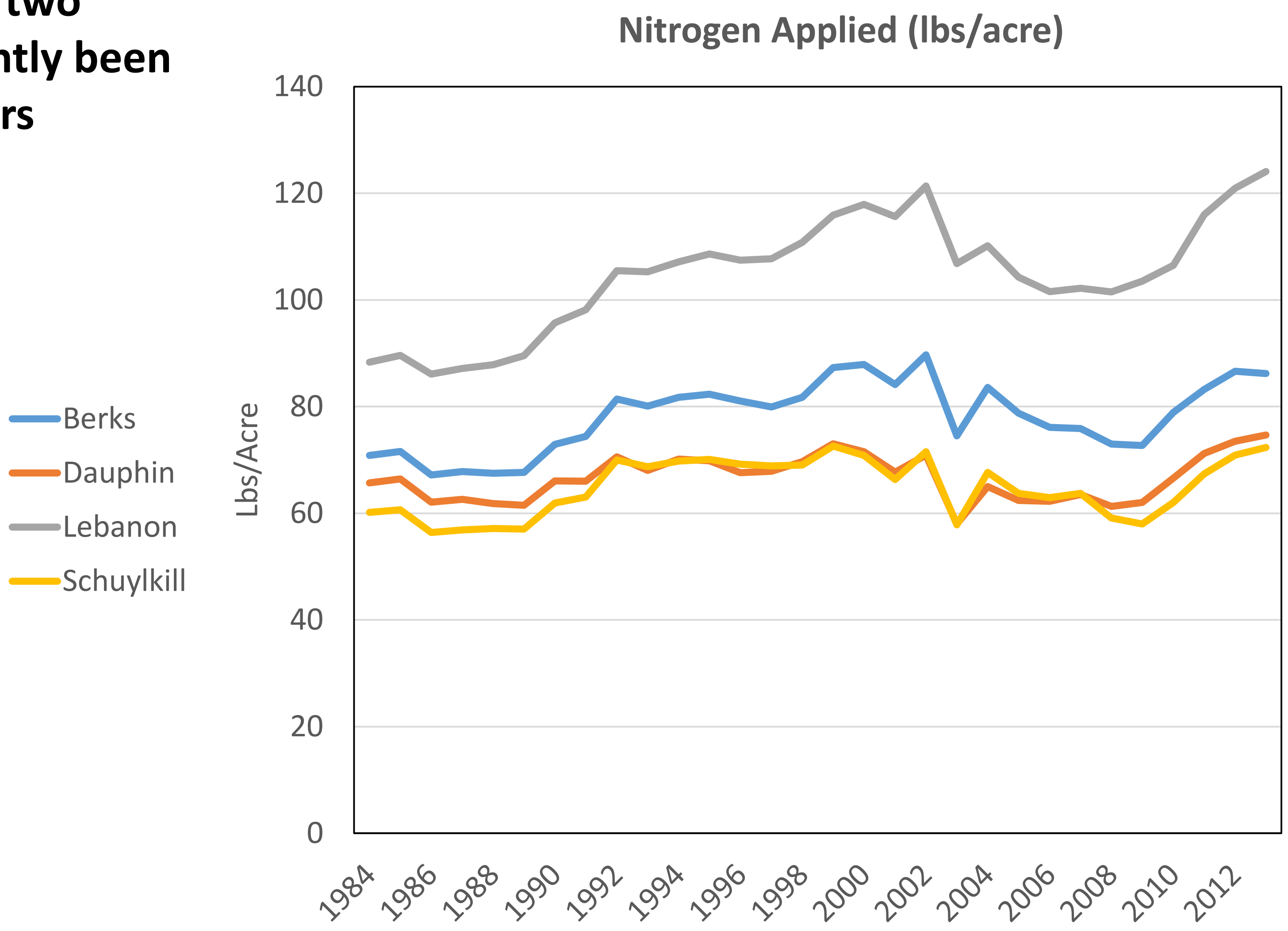
- **The Swatara Creek drainage basin is made of Berks, Dauphin, Lebanon and Schuylkill Counties**
- **Lebanon County has most area**





How have nitrogen inputs changed?

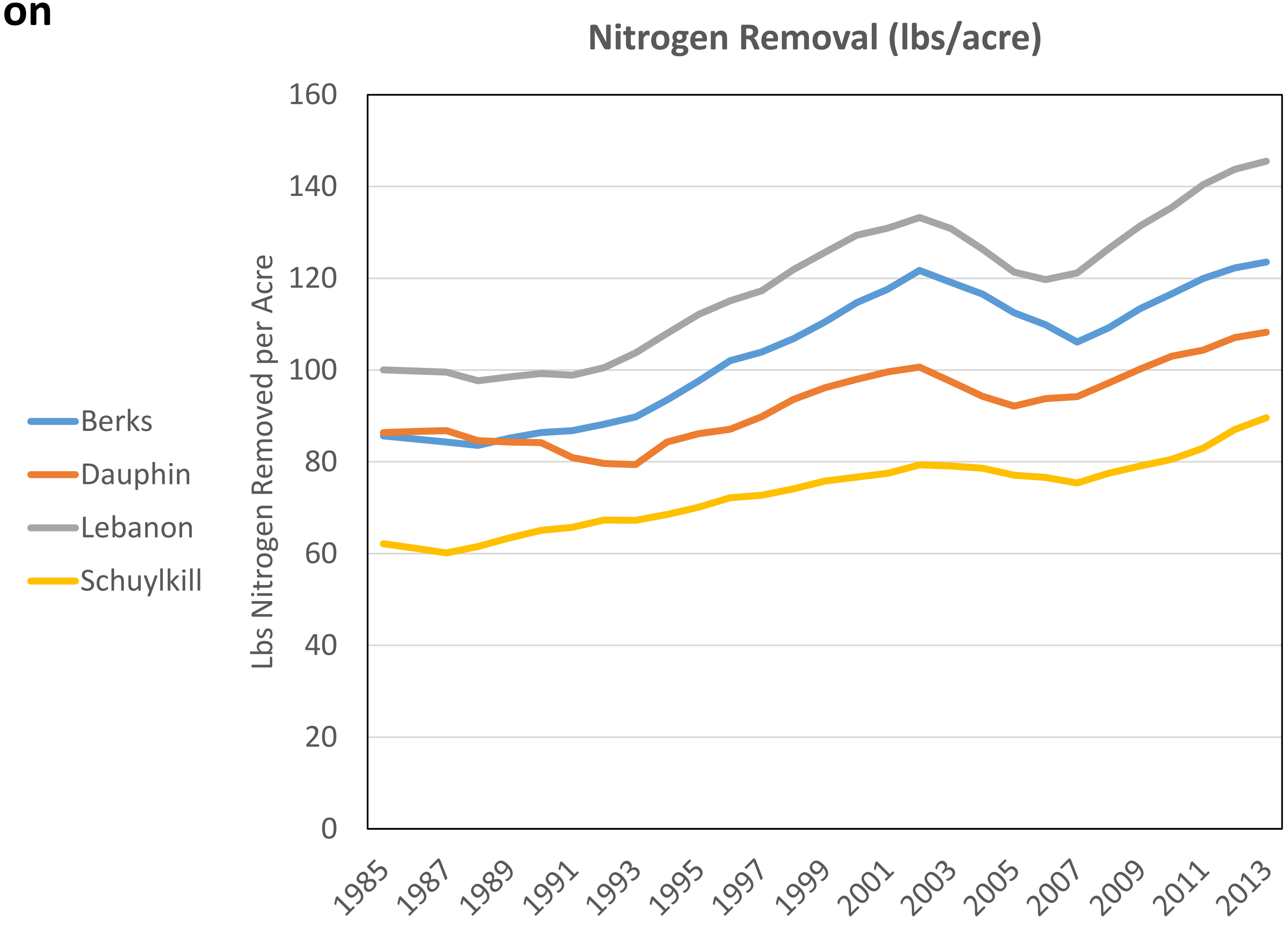
- **Nitrogen inputs on agriculture have decreased over the last two decades, but have recently been increasing in recent years**



From CBP WSM Phase 6 inputs; https://mpa.chesapeakebay.net/Phase6DataVisualization.html

How has nitrogen removal changed?

- **Removal of nitrogen in crops often mirrors nitrogen input on agriculture**



From CBP WSM Phase 6 inputs; https://mpa.chesapeakebay.net/Phase6DataVisualization.html

Where to focus efforts geographically?

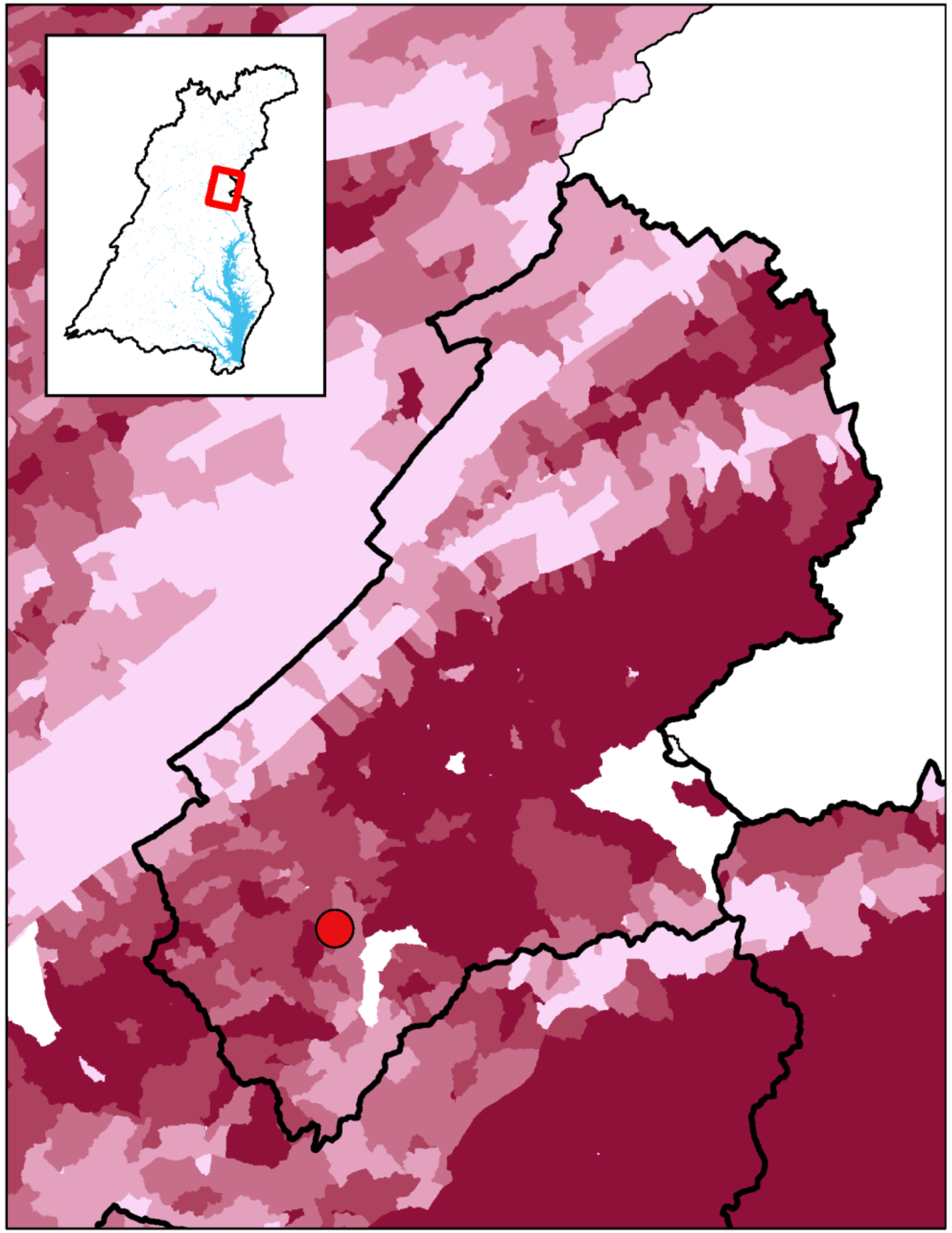
- **Certain areas of the watershed are higher loading than others**
- **These can be the more effective areas to focus restoration efforts**

Total nitrogen yield to local waters in lbs/acre

- <5
- 5 to 10
- 10 to 15
- 15 to 20
- 20 to 25
- >25

Average Total Nitrogen yield (2005-2014) in lbs/acre

- 0 to 6.88
- 6.89 to 13.8
- 13.9 to 33.4



Modified from Jimmy Webber, USGS, using Ator, S. et al, 2011.

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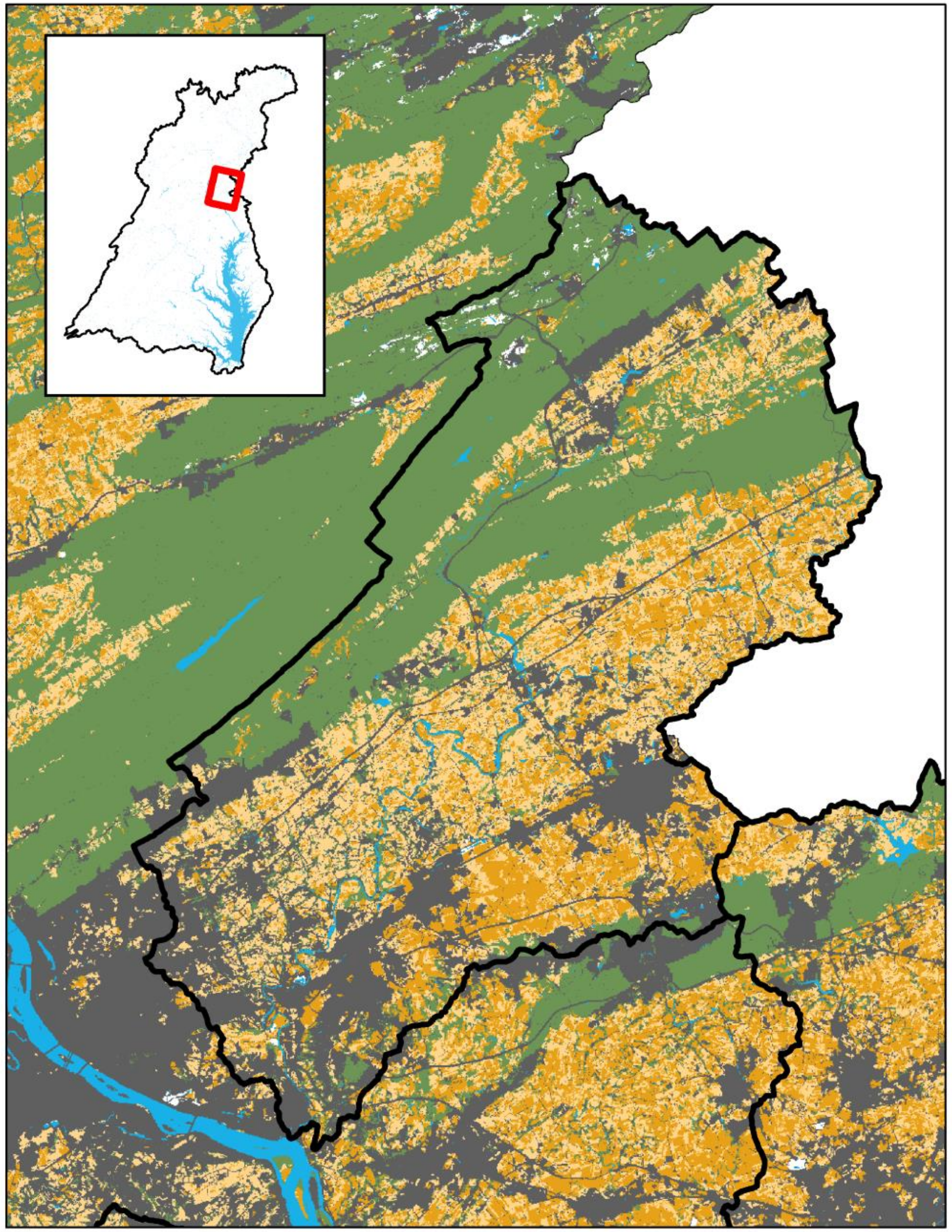

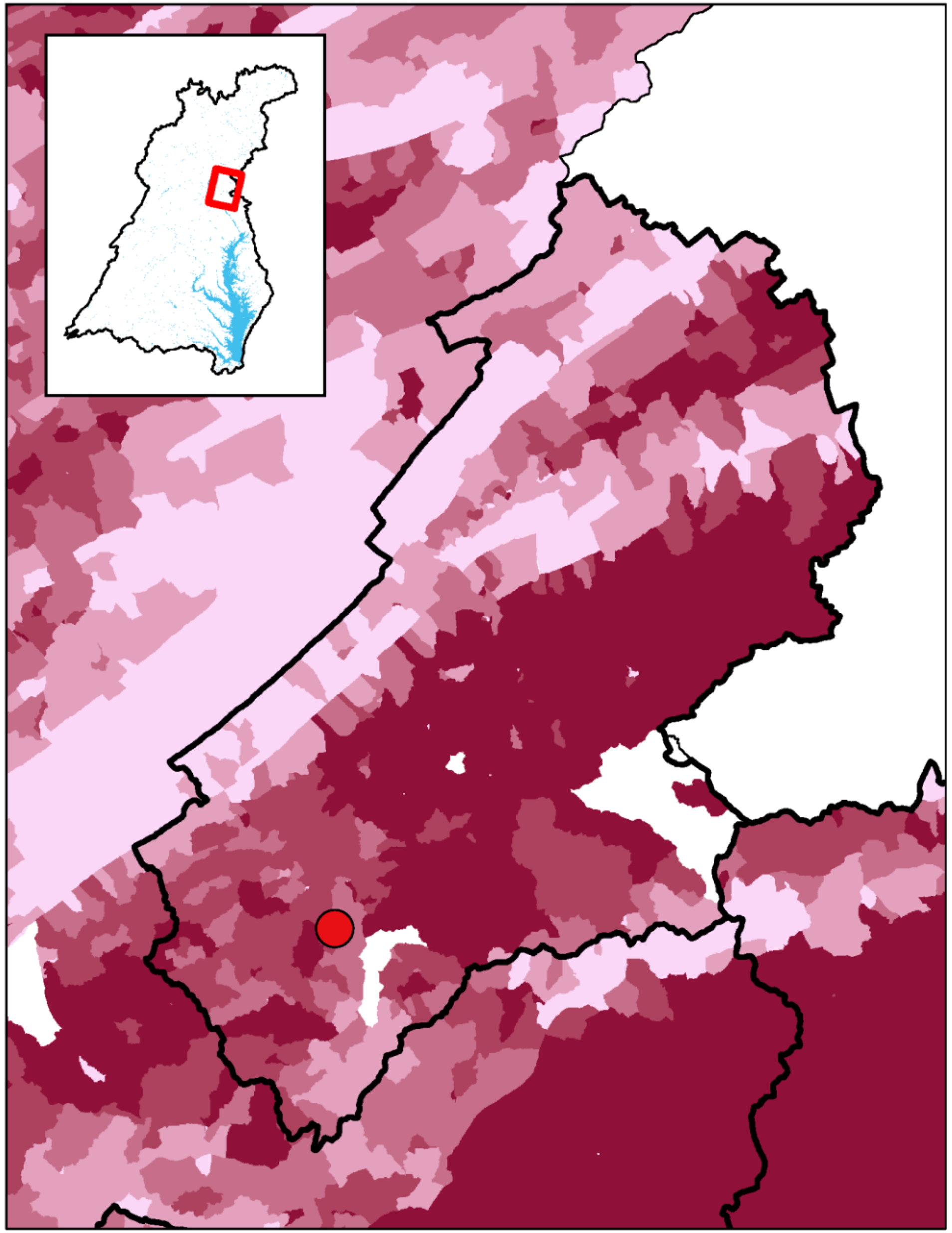

Modified from Jimmy Webber, USGS, using Ator, S. et al, 2011; Falcone, et al. 2015.

Where to focus efforts geographically?

- **Geology makes the groundwater (and therefore streams) in some areas especially vulnerable to high nitrogen inputs**
- **These areas can be the most effective to focus practices for nitrate in groundwater**

Vulnerable geology

(Areas underlain by carbonate rocks or coarse coastal sediments)

Average Total Nitrogen yield (2005-2014) in lbs/acre

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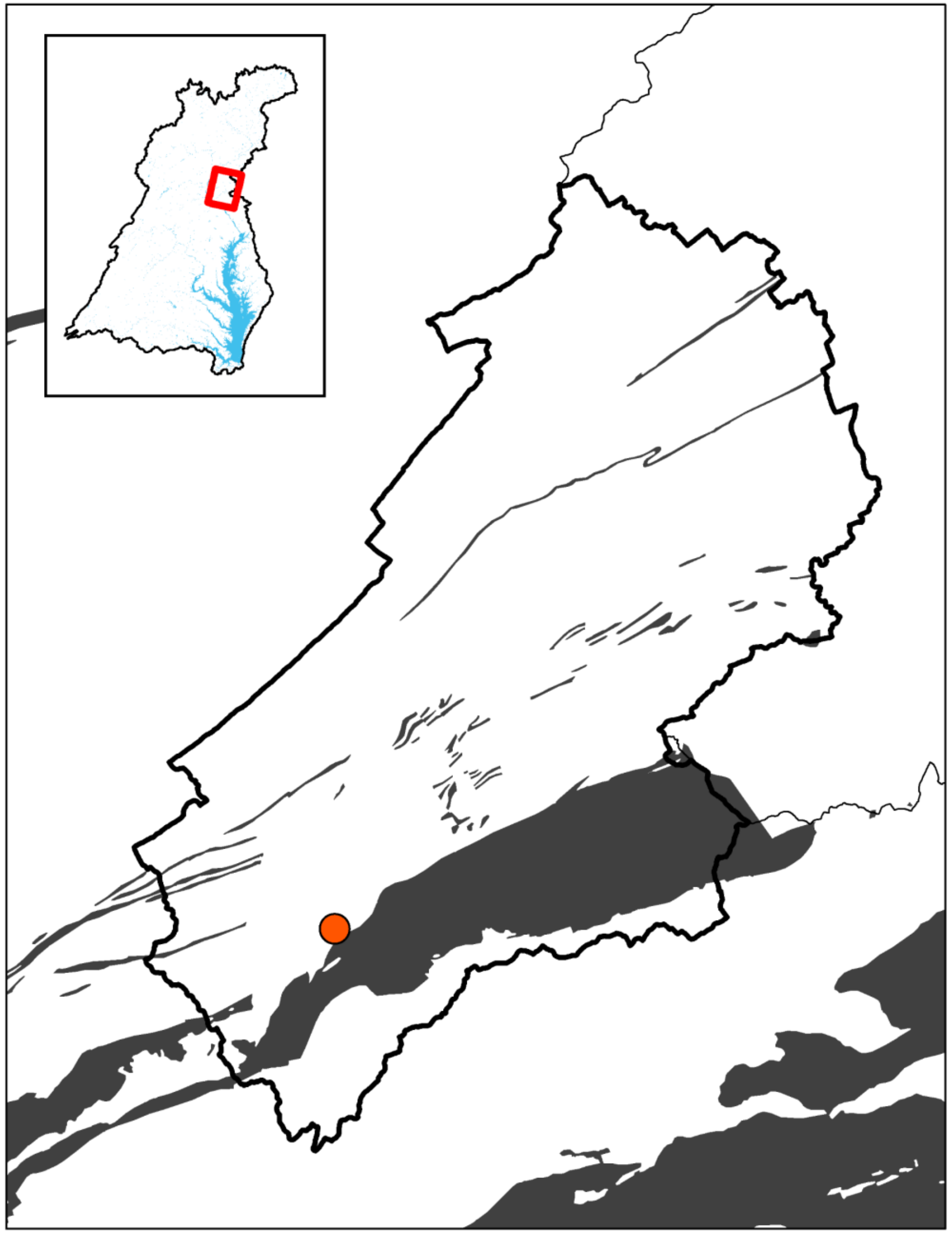

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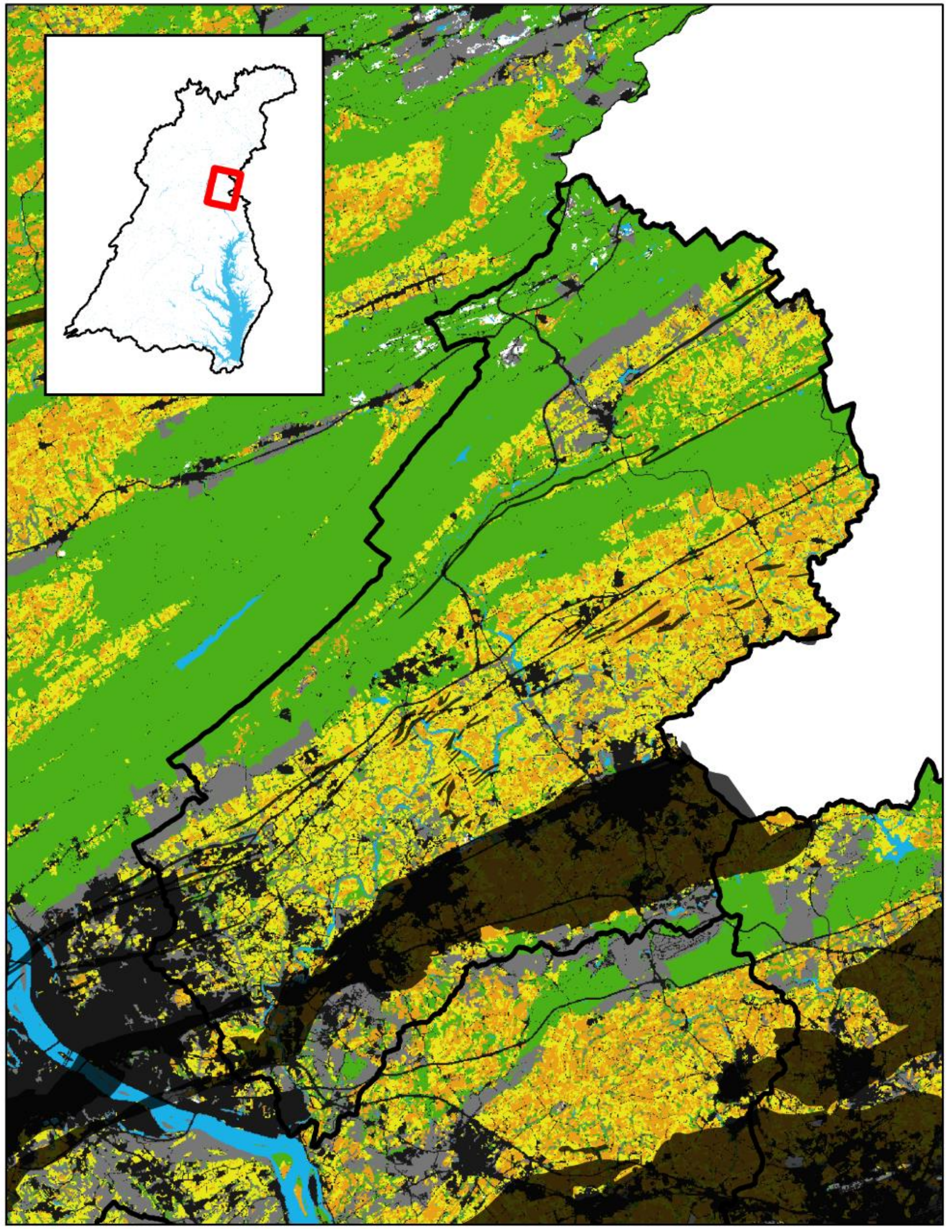

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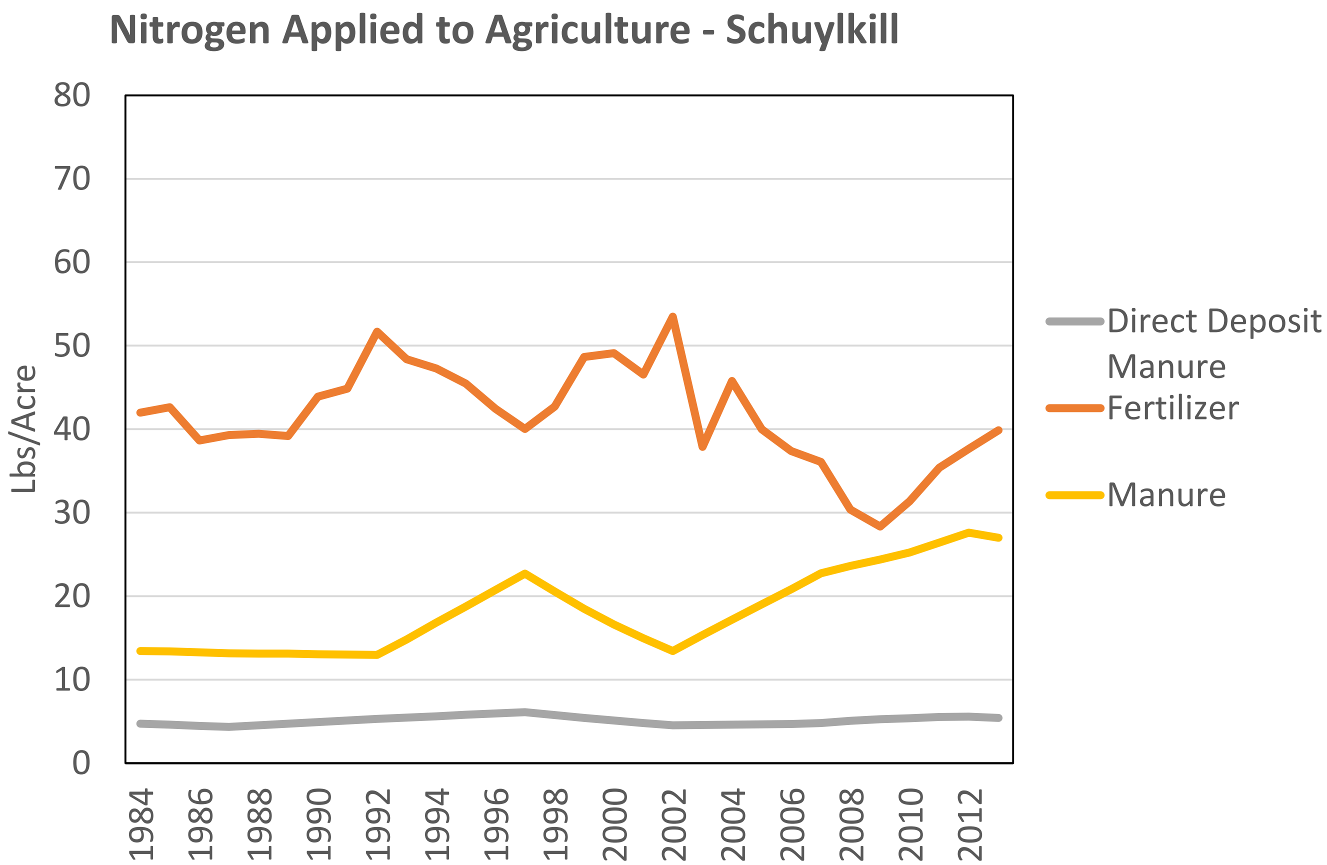
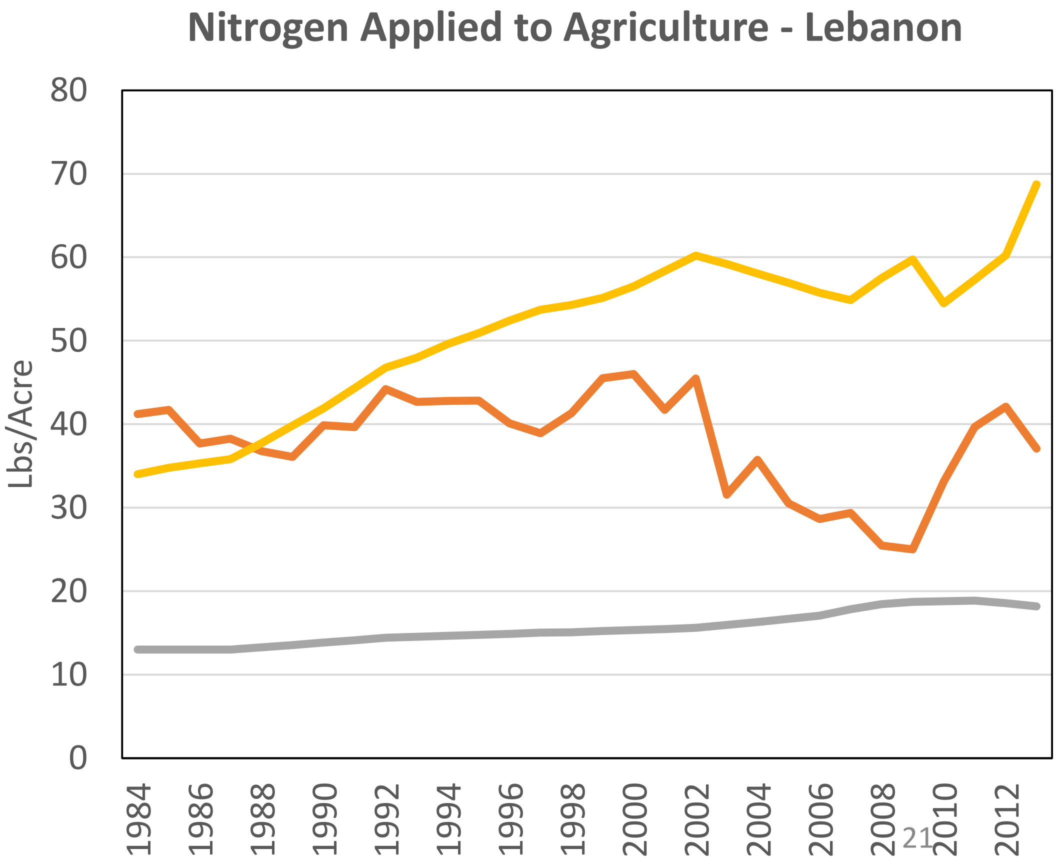
Where to focus efforts geographically?

- **Loads and practices can differ between counties**
- **For example, Lebanon county has more intense application of nitrogen per acre, and increasing application of manure, correlating to animal production**

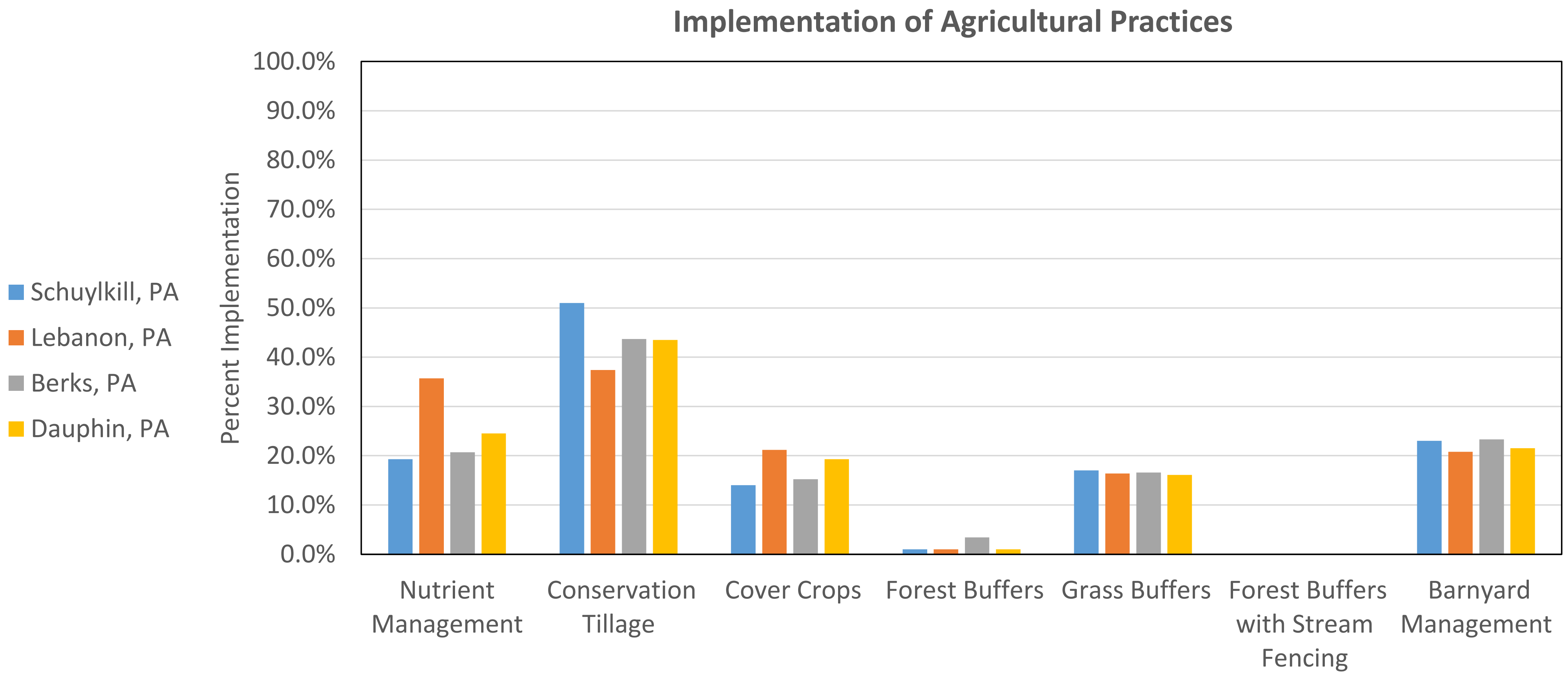
From CBP WSM Phase 6 inputs; https://mpa.chesapeakebay.net/Phase6DataVisualization.html





What practices to focus on?

- **The highest loading sources are different types of cropland and barnyards**
- **Effective practices for these sources can include buffers, barnyard management, and cover crops**



Phase 6 WSM 2013 BMP Progress Report

*Percent implementation = acres with practice implemented out of acres available for practice

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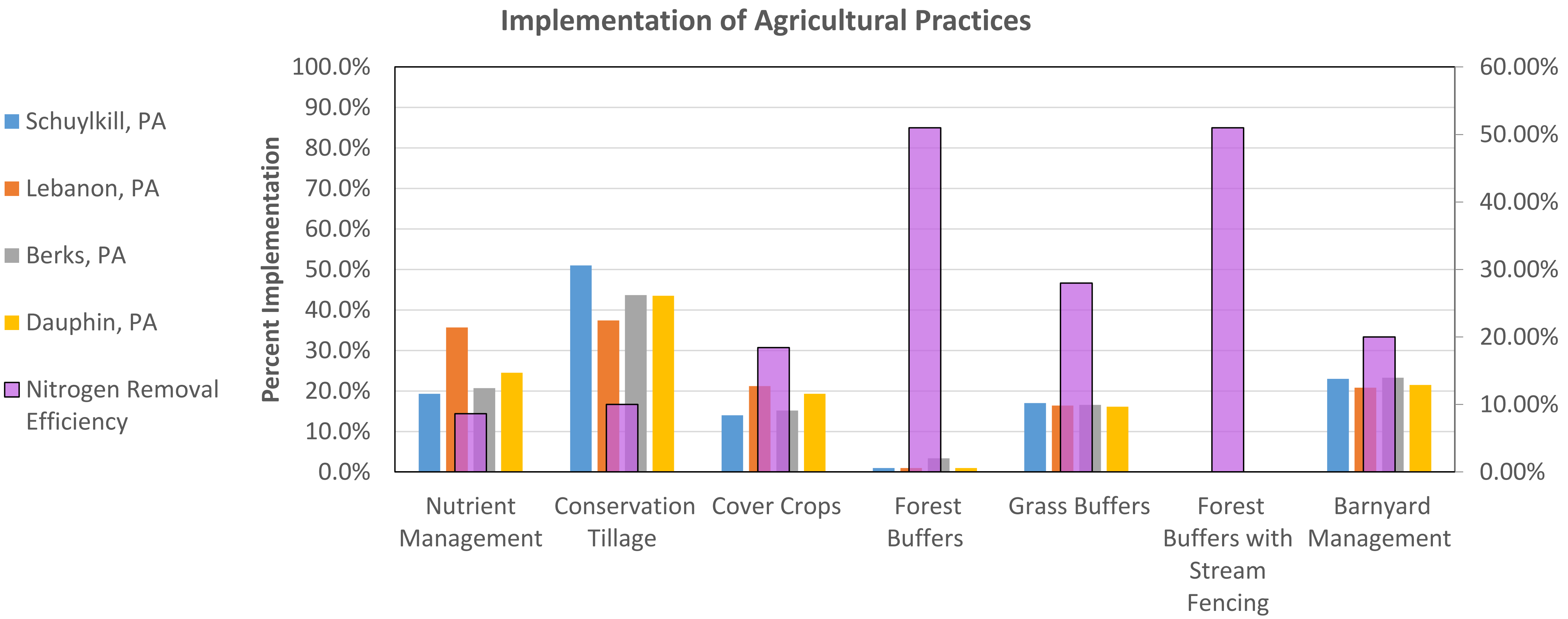
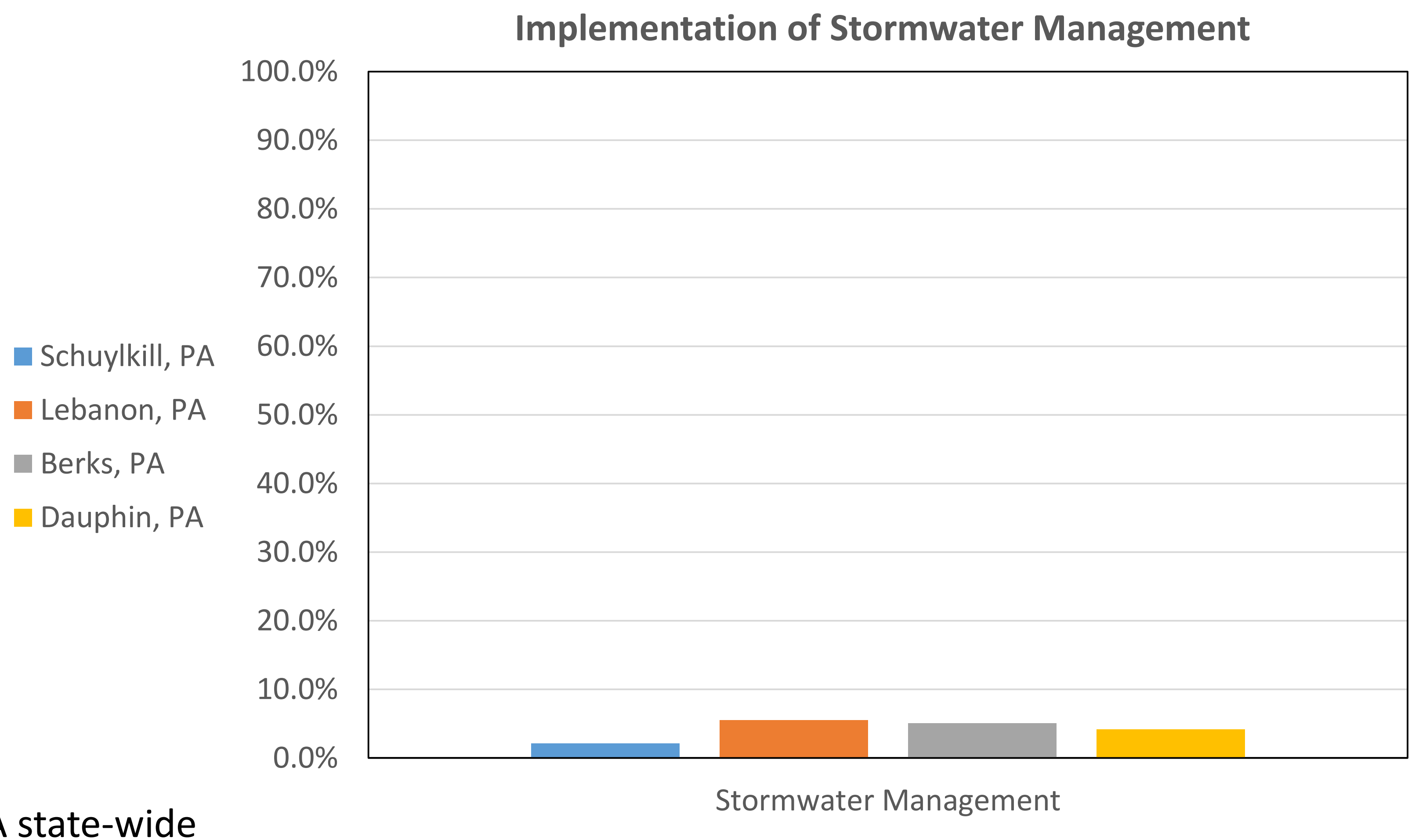


Phase 6 WSM 2013 BMP Progress Report

What practices to focus on?

- **Loads from developed land are not insignificant in these areas and are increasing**
- **Stormwater management will be important to address issues associated with increasingly developed areas**

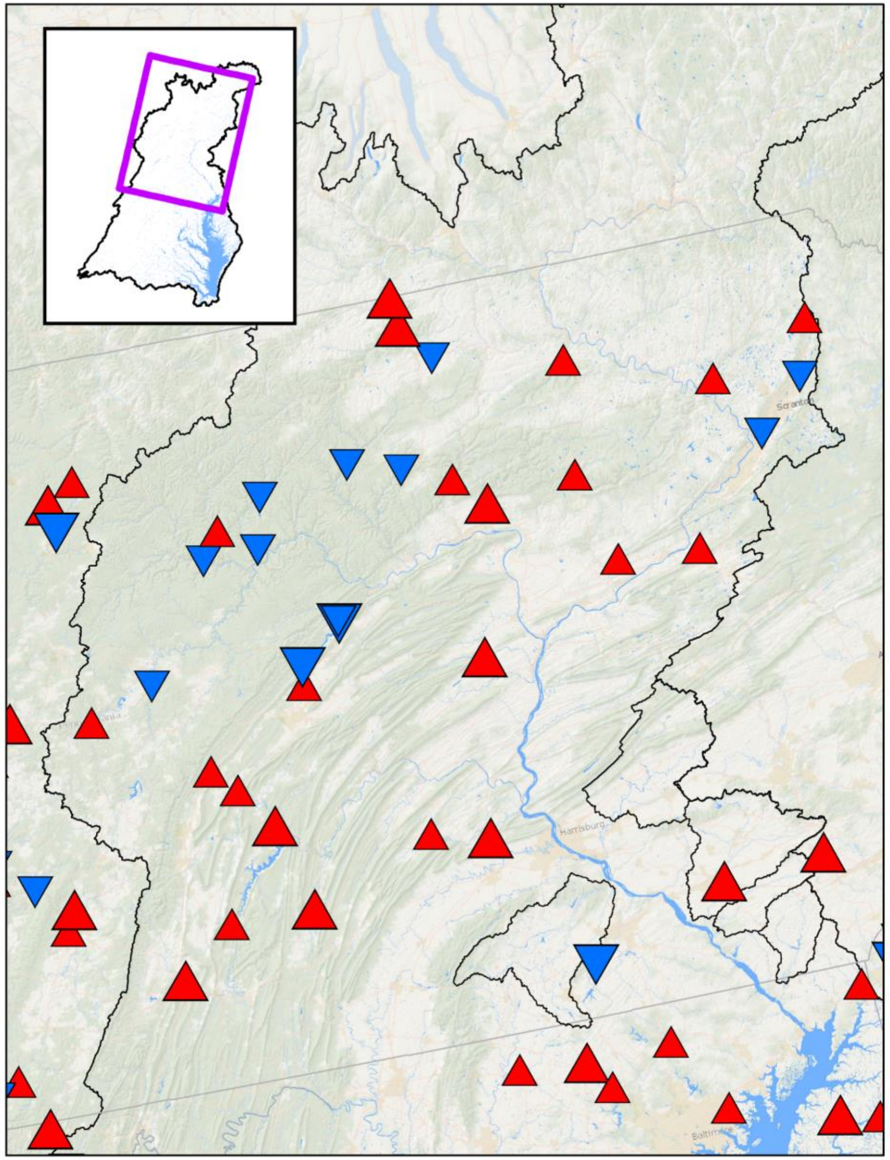


PA state-wide implementation (2013) 2.9%

Phase 6 WSM 2013 BMP Progress Report

And it's not just about water quality…

- **Local waters benefit from the same conservation and restoration practices that help the Bay**
- **For example, stream temperatures are rising across the region, which impacts native fish species such as brook trout**



Temperature Trends

Increasing

Decreasing

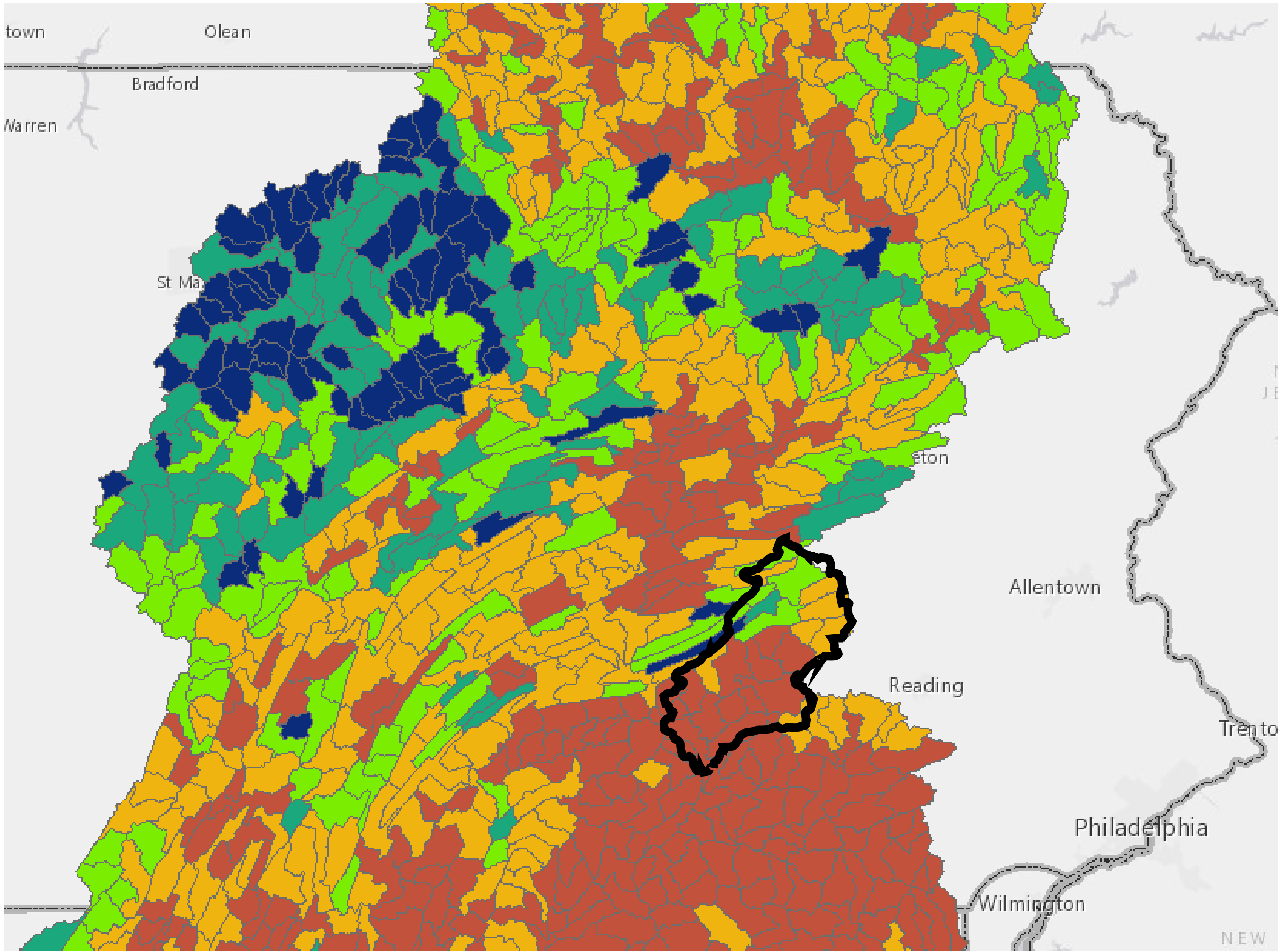
*larger symbol represents trend is significant

Modified from Rice, K. & Jastram, J.D., 2015.

And it’s not just about water quality…

- **These areas contain watersheds that have low predicted occurrence of Brook Trout due to a combination of factors such as habitat and natural and anthropogenic stressors**

Predicted Likelihood of Brook Trout Occurrence



Predicted Likelihood of Occurrence

- Low
- Moderately Low
- Moderate
- Moderately High
- High

Fish Habitat Decision Support Tool;
http://www.fishhabitattool.org/

A LOT of new and updated info available…

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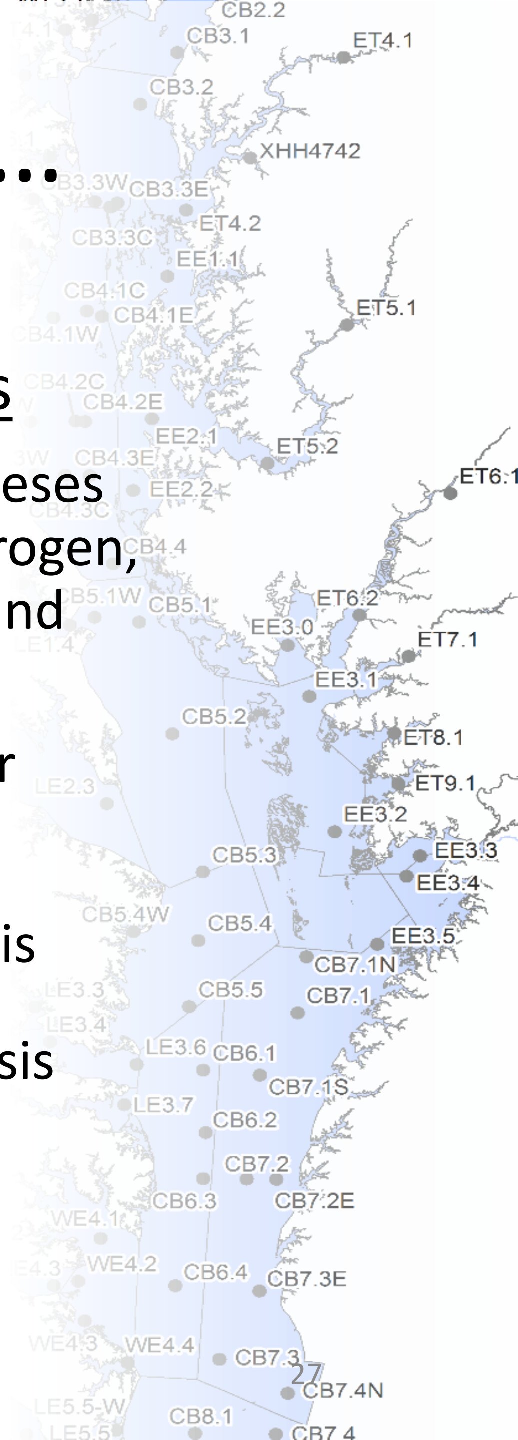
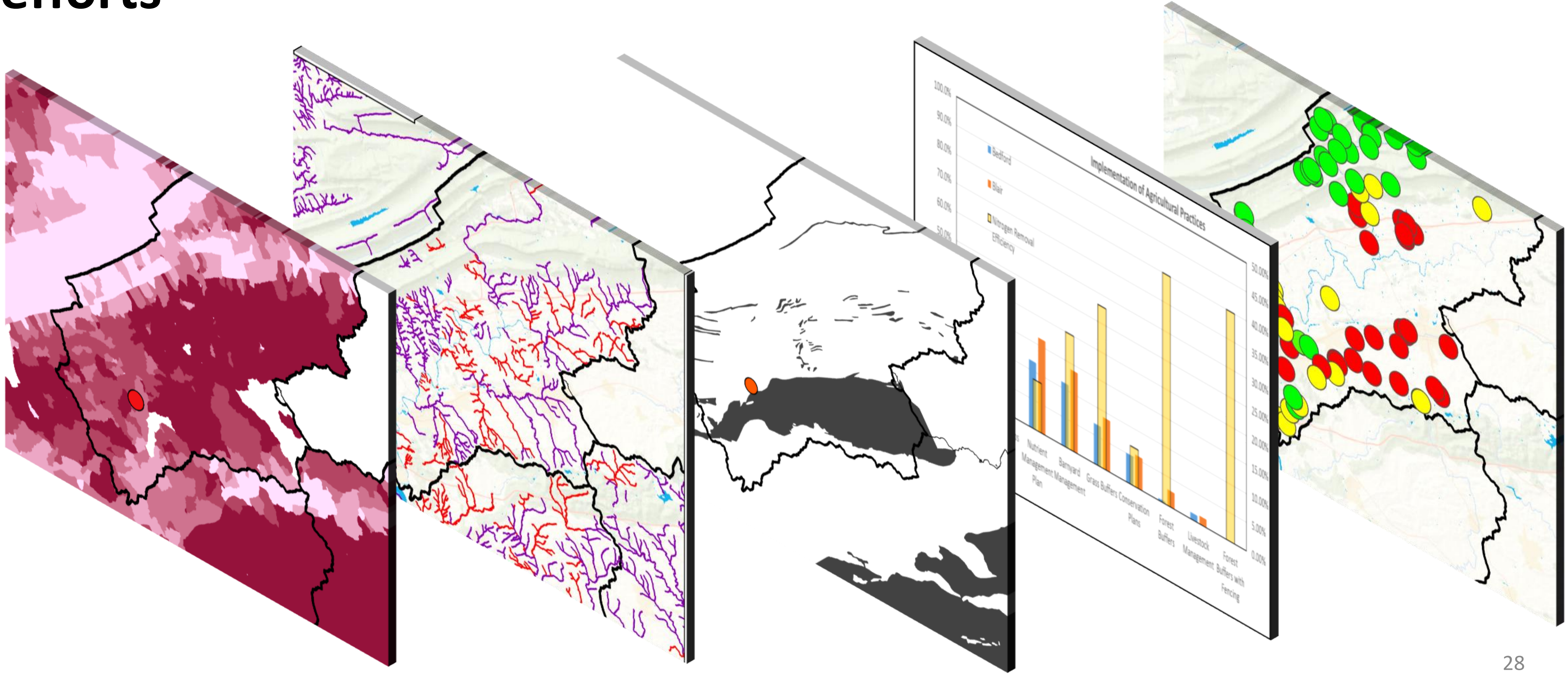
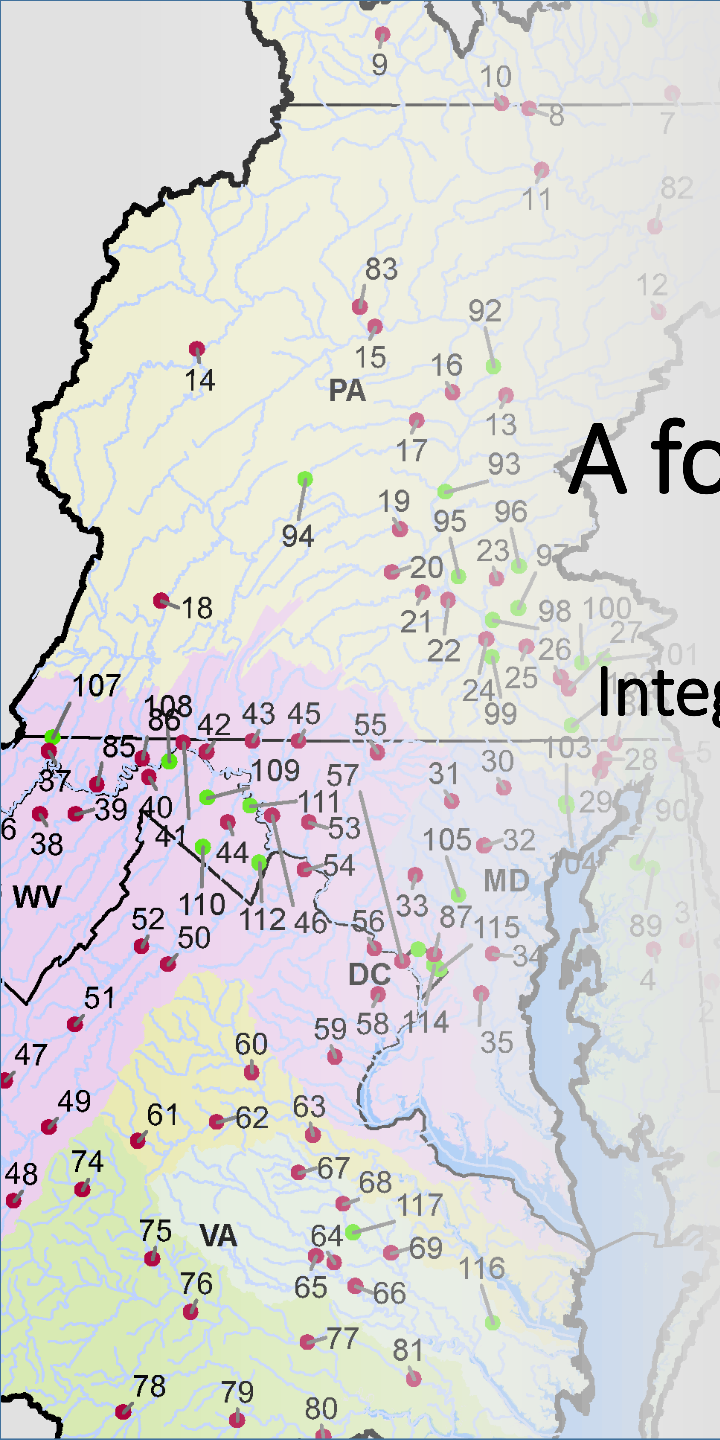


A LOT of new and updated info available…

…that can be integrated together to answer questions and inform efforts





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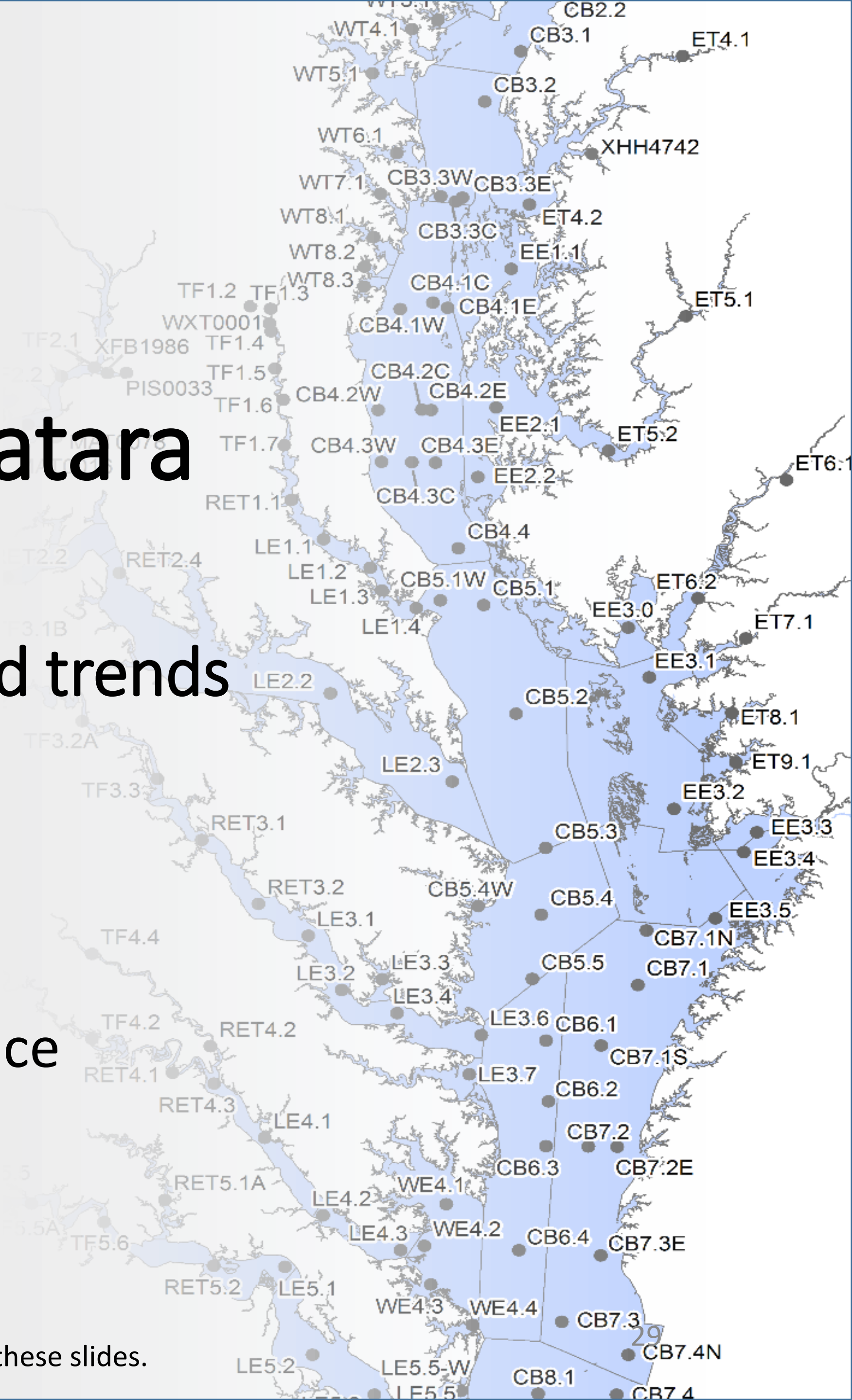

References

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Bachman, L.J., Lindsey, B., Brakebill, J., & Powars, D.S. 1998. Ground-water discharge and base-flow nitrate loads of nontidal streams, and their relation to a hydrogeomorphic classification of the Chesapeake Bay watershed, Middle Atlantic Coast: U.S. Geological Survey Water Resources Investigations Report 98-4059, 77 p., http://

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Brakebill, J.W. & Kelley, S.K., 2000. Hydrogeomorphic Regions in the Chesapeake Bay Watershed. U.S. Geological Water –Resources Investigations report 00-424. Map.(Also available at https://water.usgs.gov/lookup/getspatial?hgmr).

Ator, S.W., Denver, J.M. Krantz, D.E. Newell, W.L., Martucci, S.K., 2005. A Surficial Hydrogeologic Framework for the Mid-Atlantic Coastal Plain. U.S. Geological Survey Professional Paper 1680. 49 p. (Also available at https://pubs.usgs.gov/pp/2005/pp1680/#pdf).

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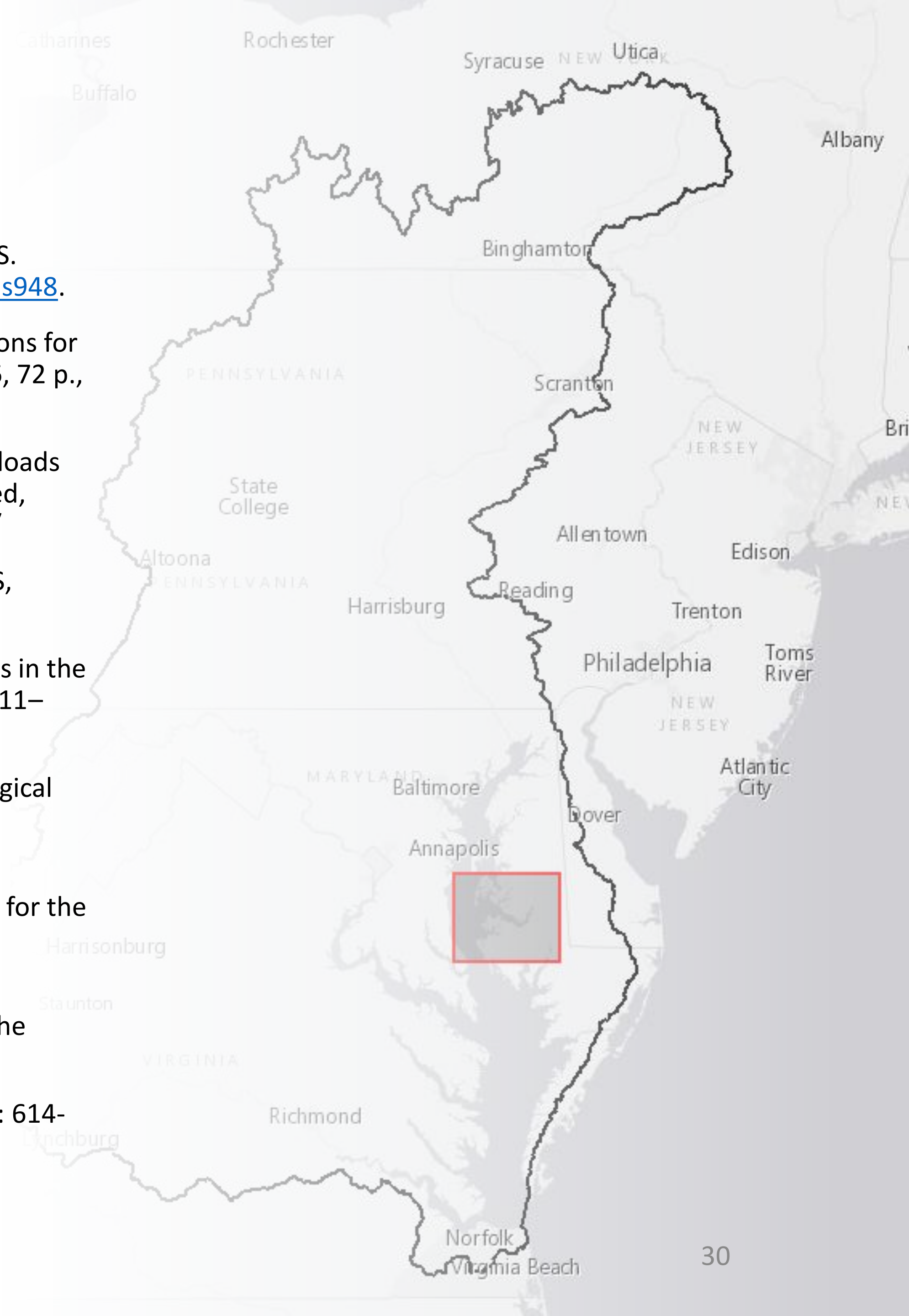

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Smith, Z., C. Buchanan, and A. Nagel. 2017. Refinement of the Basin-Wide Index of Biotic Integrity for Non-Tidal Streams and Wadeable Rivers in the Chesapeake Bay Watershed. ICPRB Report 17-02. Interstate Commission on the Potomac River Basin. Available online at www.potomacriver.org.

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Chesapeake Bay Program Cross-GIT Mapping Project: http://gis.chesapeakebay.net/intergit/overview.html. Visualization tool: https://gis.chesapeakebay.net/mpa/scenarioviewer/.

Data Analysis

Land area and loads by source sector from monitoring station basins:

Drainage basins for the USGS stations were taken from USGS. Drainage basins were matched to their land-river segments using ArcGIS (also available on the CBP Watershed Model Segmentation Viewer available off CAST (http://gis.chesapeakebay.net/modeling/). For each land-river segment, total acreage, acreage by individual land-use, and loads by individual land-use were downloaded from Phase 6 CAST 2013 Progress Run (http://cast.chesapeakebay.net). Acreage and loads were aggregated for individual land-uses within each source sector.

Nitrogen applications:

Nitrogen applications by county and source (lbs/acre/yr) over time were obtained from the Phase 6 Model Calibration Inputs graphical interface available at https://mpa.chesapeakebay.net/Phase6DataVisualization.html.

BMP implementation by practice and county:

BMP percent implementation was obtained from Phase 6 CAST 2013 BMP Summary Report from http://cast.chesapeakebay.net. Percent implementation is defined as the percent of total acres credited out of the total acres of land-use available for a practice.

Nitrogen effectiveness values for individual agricultural BMPs were obtained from the Phase 6 Watershed Model Source Data, available on Phase 6 CAST (http://cast-beta.chesapeakebay.net/Home/SourceData). Nitrogen effectiveness values for individual agricultural BMPs were averaged by BMP type for the geologic region.