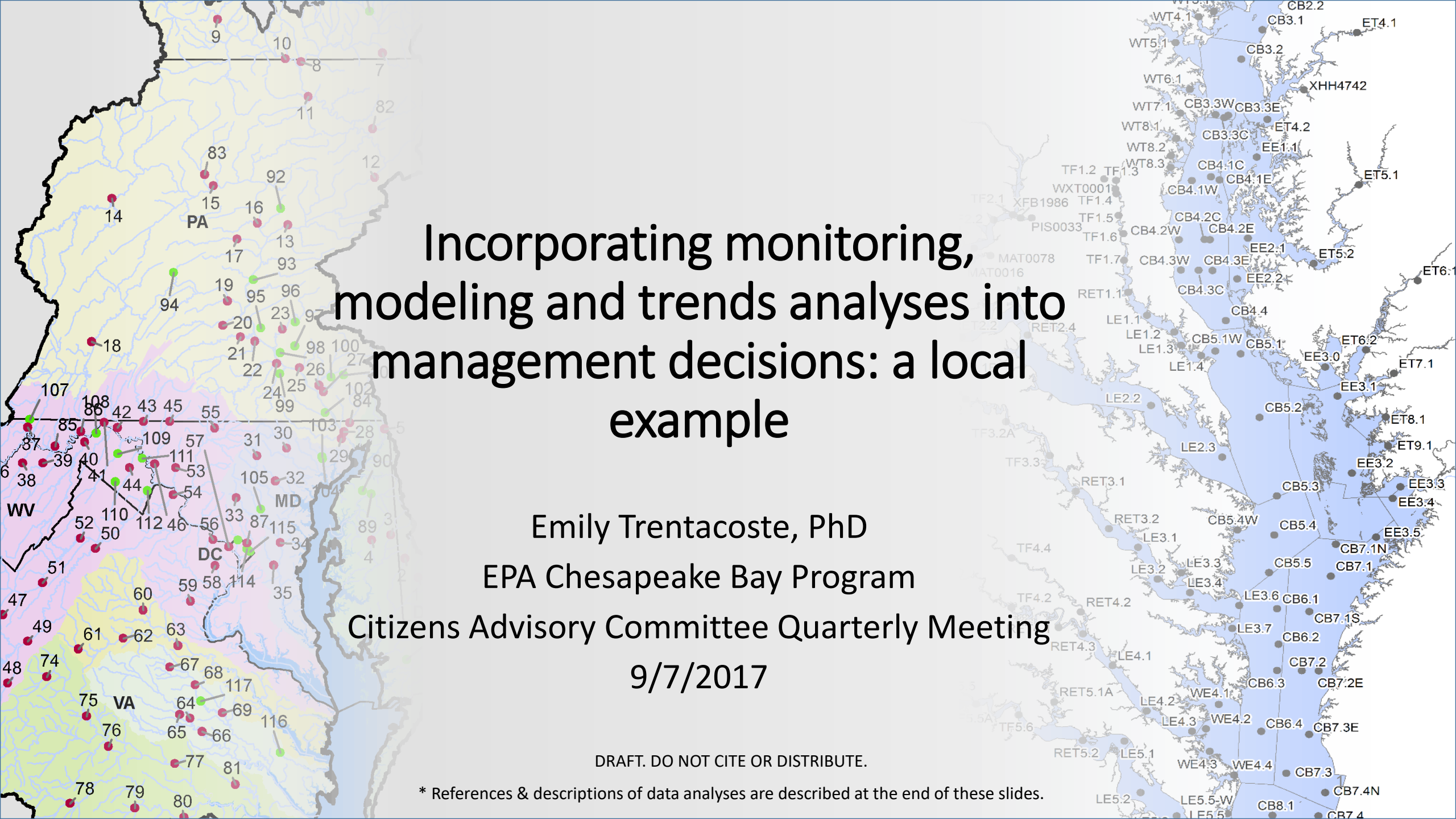


Incorporating monitoring, modeling and trends analyses into management decisions: a local example

Emily Trentacoste, PhD

EPA Chesapeake Bay Program

Citizens Advisory Committee Quarterly Meeting

9/7/2017

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 DO NOT CITE OR DISTRIBUTE.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

Synthesis Analyses

USGS Non-tidal Syntheses

-Regional Nitrogen

-SPARROW models

-Groundwater models

SAV Syntheses

Water Clarity Synthesis

Water Quality Synthesis

Modeling Tools

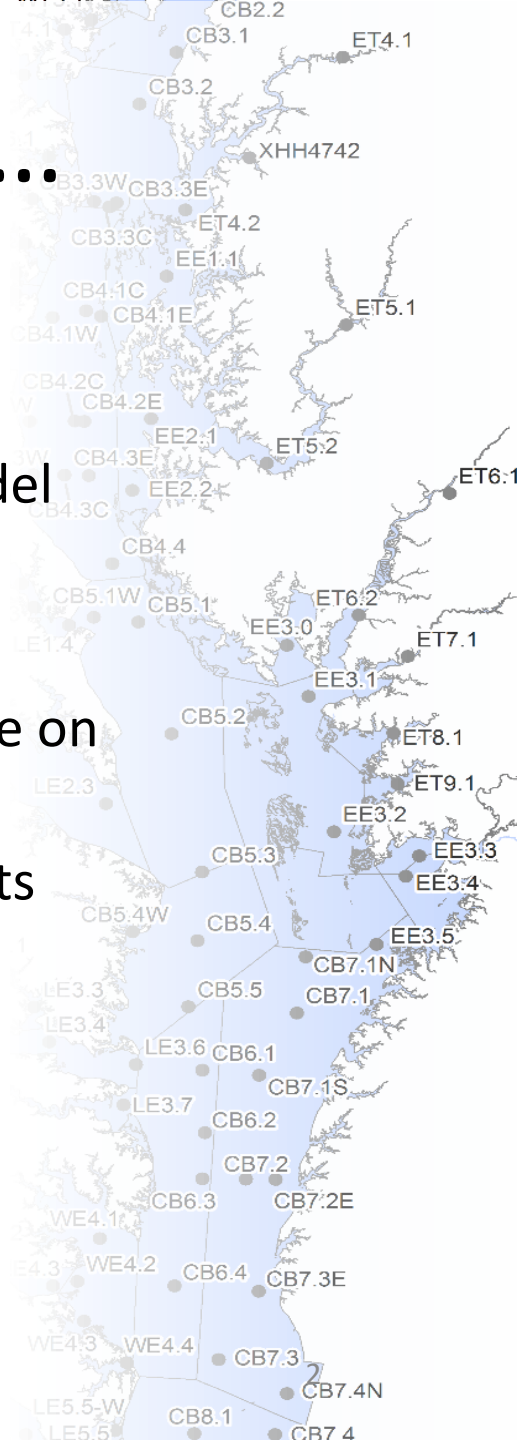
CBP Watershed Model

Geographic load distribution

Geographic influence on Bay

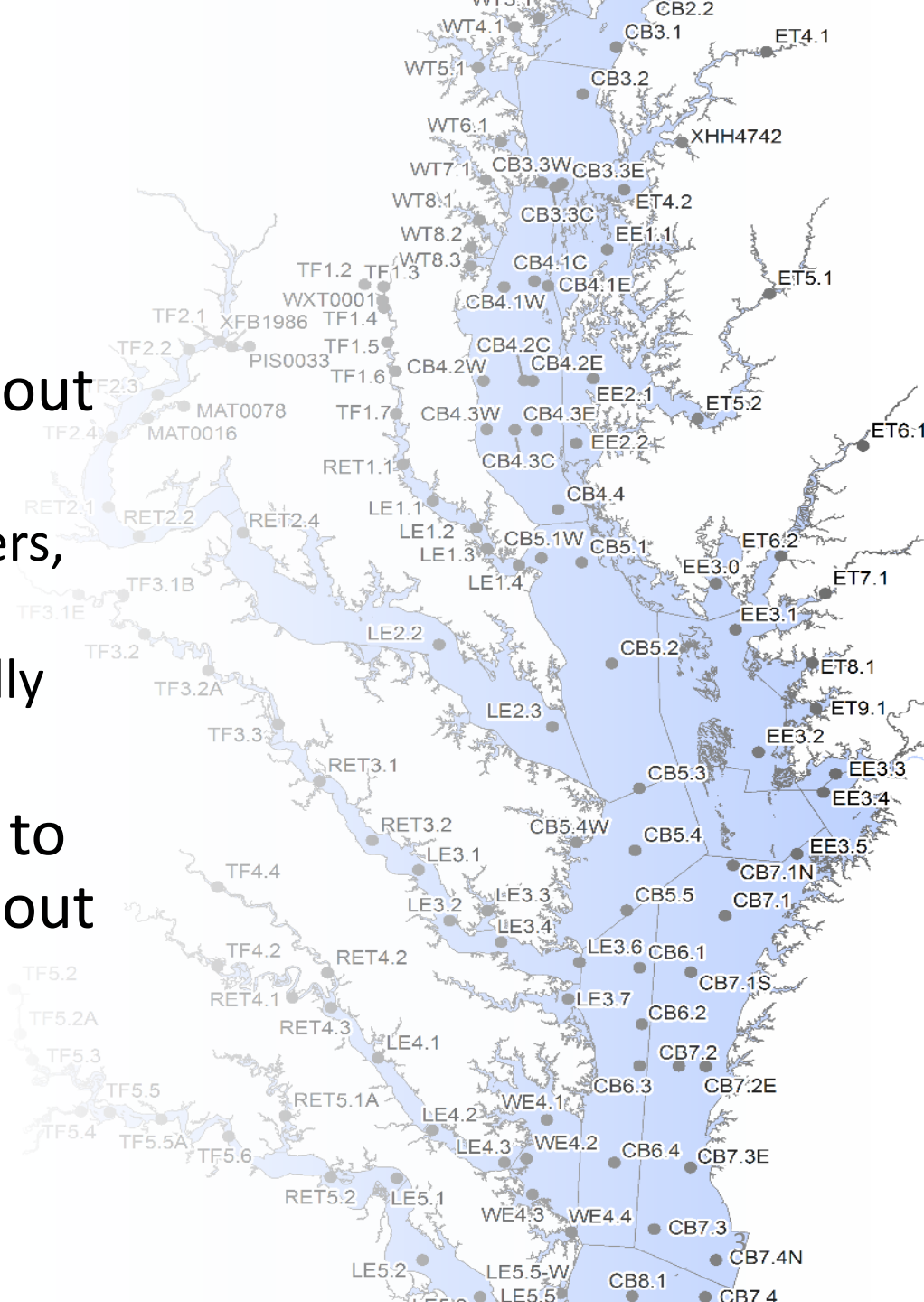
BMP progress reports

…and more to come



Storylines Concept

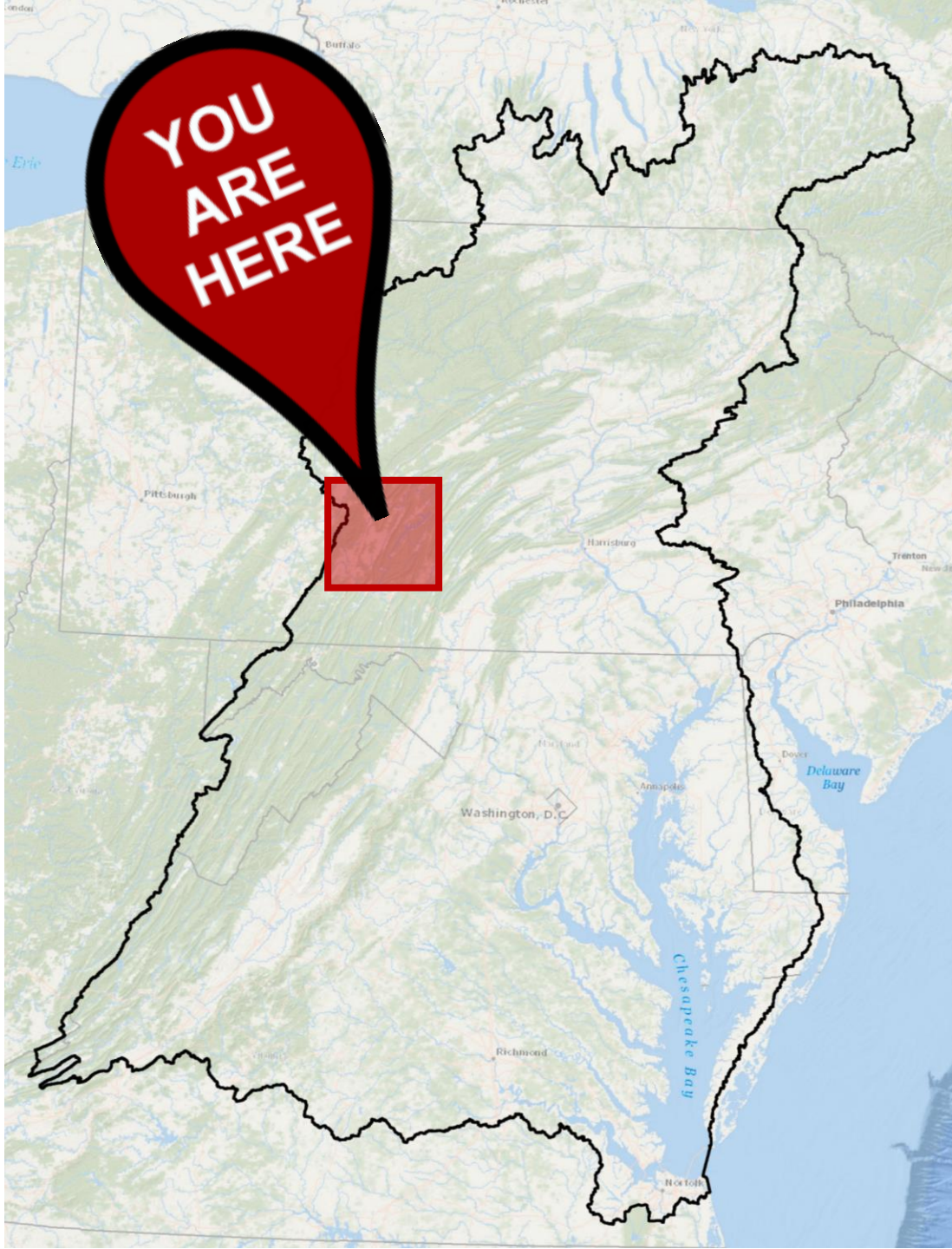
- Identify storylines in specific areas throughout the watershed and tidal areas and:
  - Synthesize data available on trends, their drivers, and explanations
  - Determine management implications, especially for Phase III WIP development
- Disseminate process and information used to empower partners to do the same throughout their jurisdictions



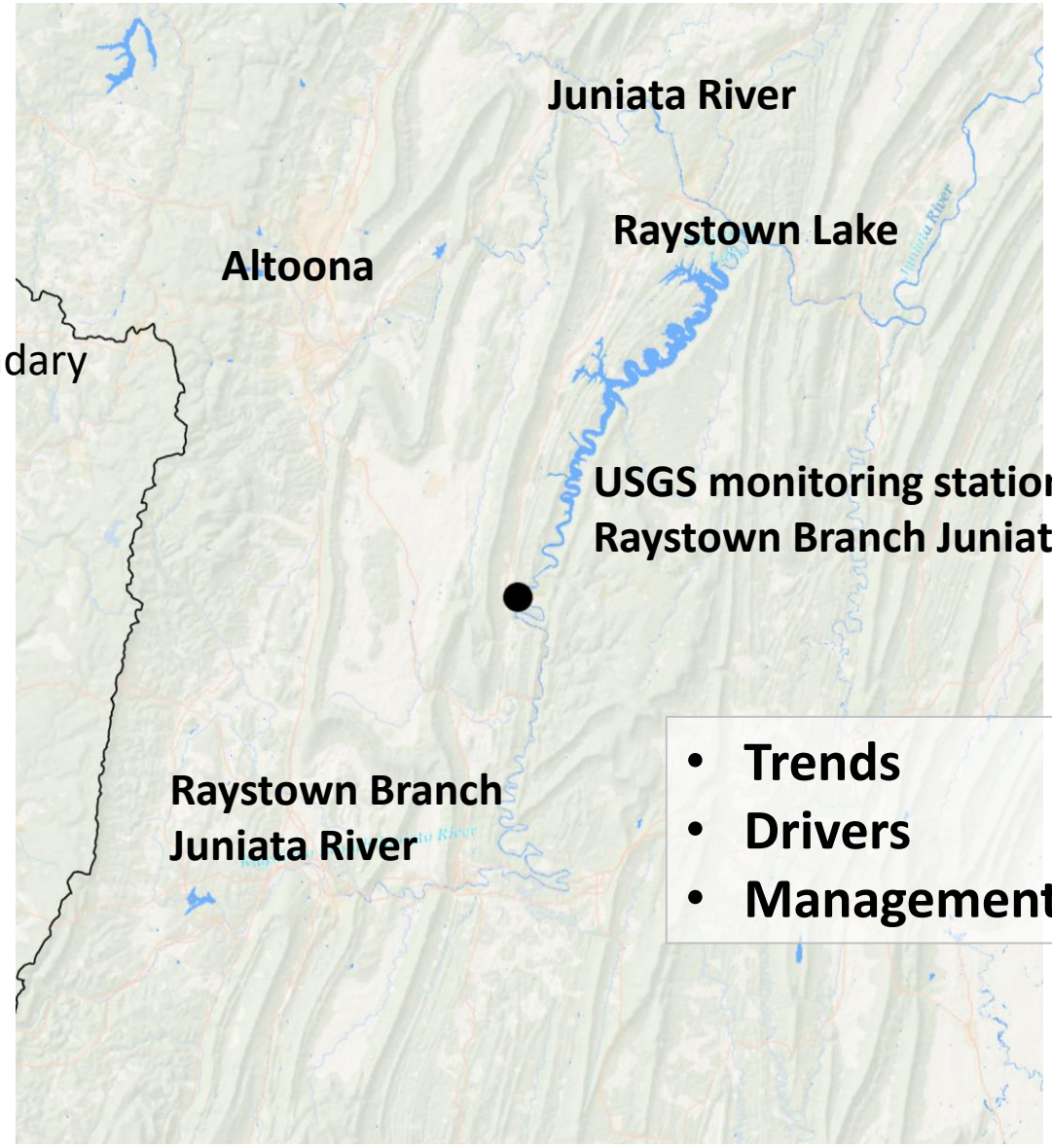
To Keep in Mind…

- Most of the data are available watershed-wide
- Are example stories useful for demonstrating data and information available and how to use it?
- How would you like to access and use the data and information available for your own communities?

A Raystown Branch Storyline

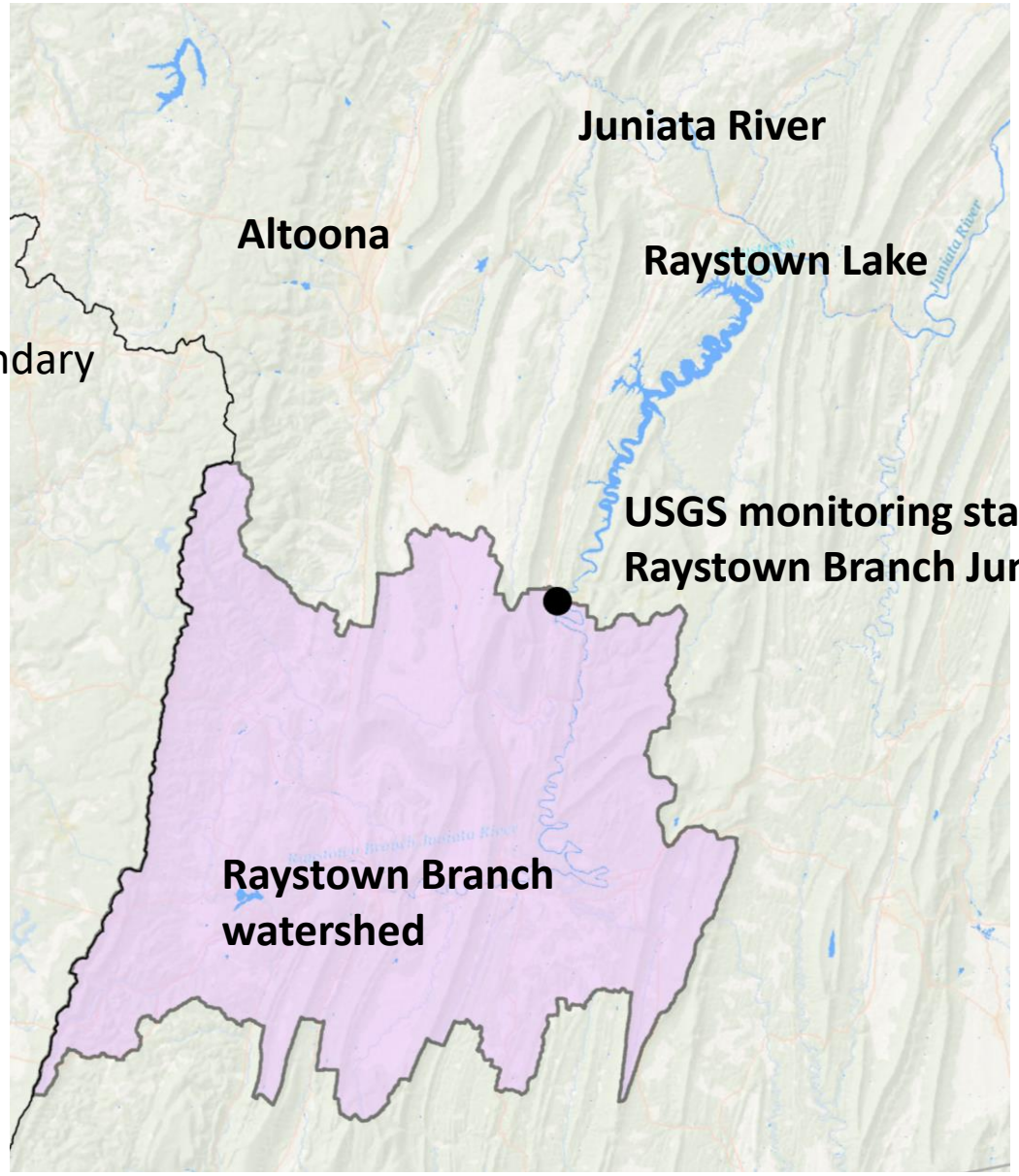


Raystown Branch Juniata River



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

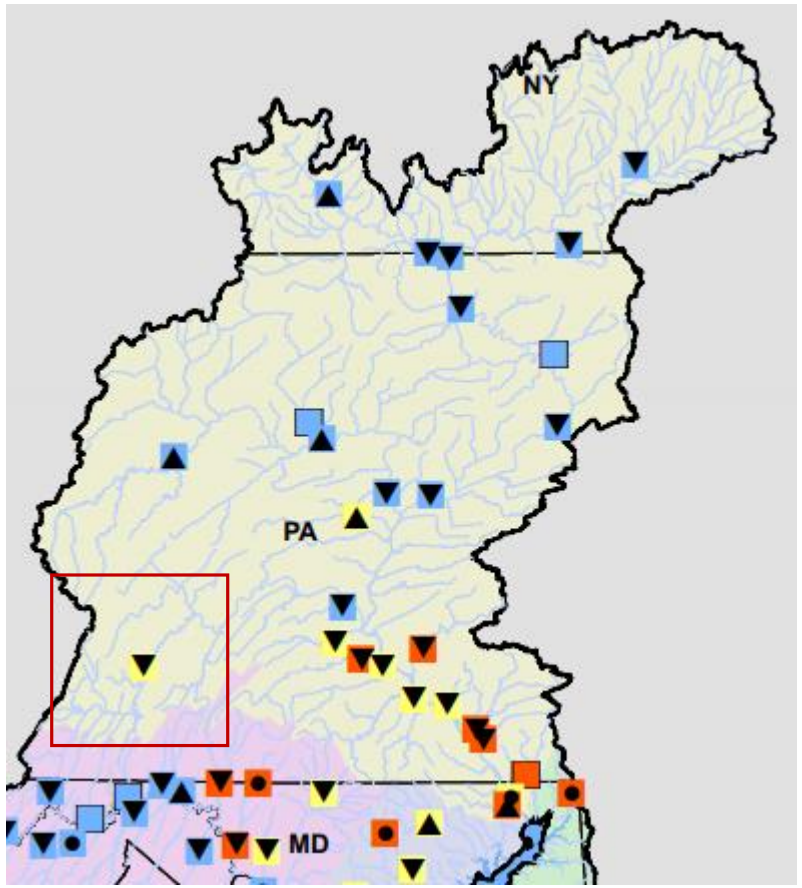
Raystown Branch Juniata River



Water Quality Trends in Nitrogen

- **Total nitrogen and nitrate are decreasing**
- **Nitrogen loads are mid-range for the Chesapeake Bay watershed**

Change in Total Nitrogen per acre loads (2005-2014)



Trend Direction

- No Trend
- Improving
- Degrading

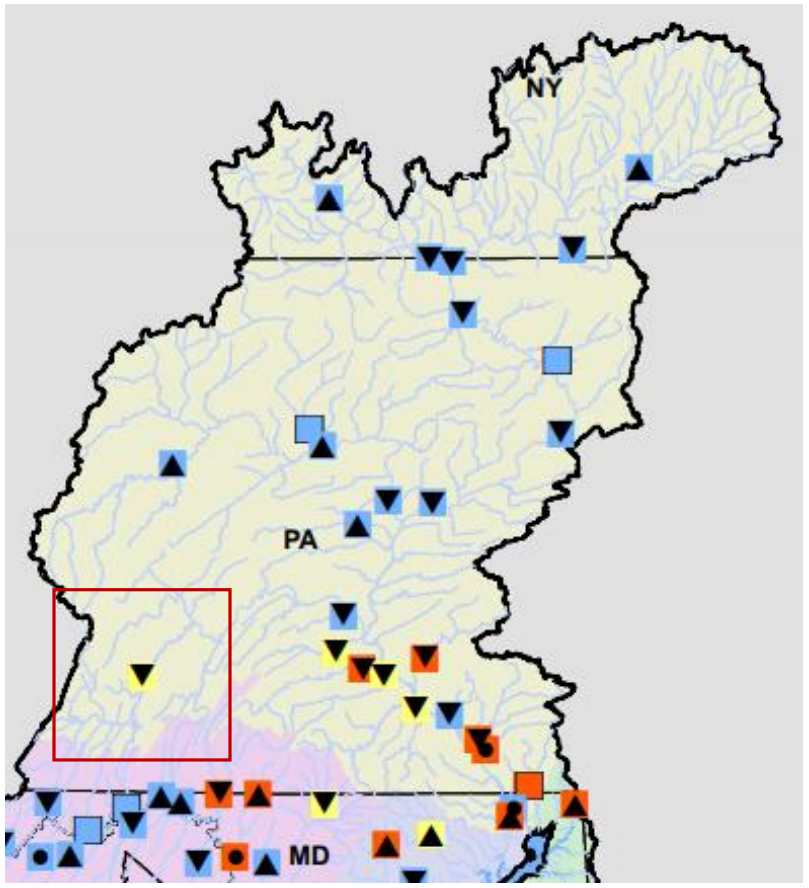
Average Load (lbs/ac)

- 0.14 - 5.84
- 5.85 - 11.69
- 11.70 - 28.78

Squares with black outline are yields based on 2010-2014.

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

Change in Nitrate per acre loads (2005-2014)



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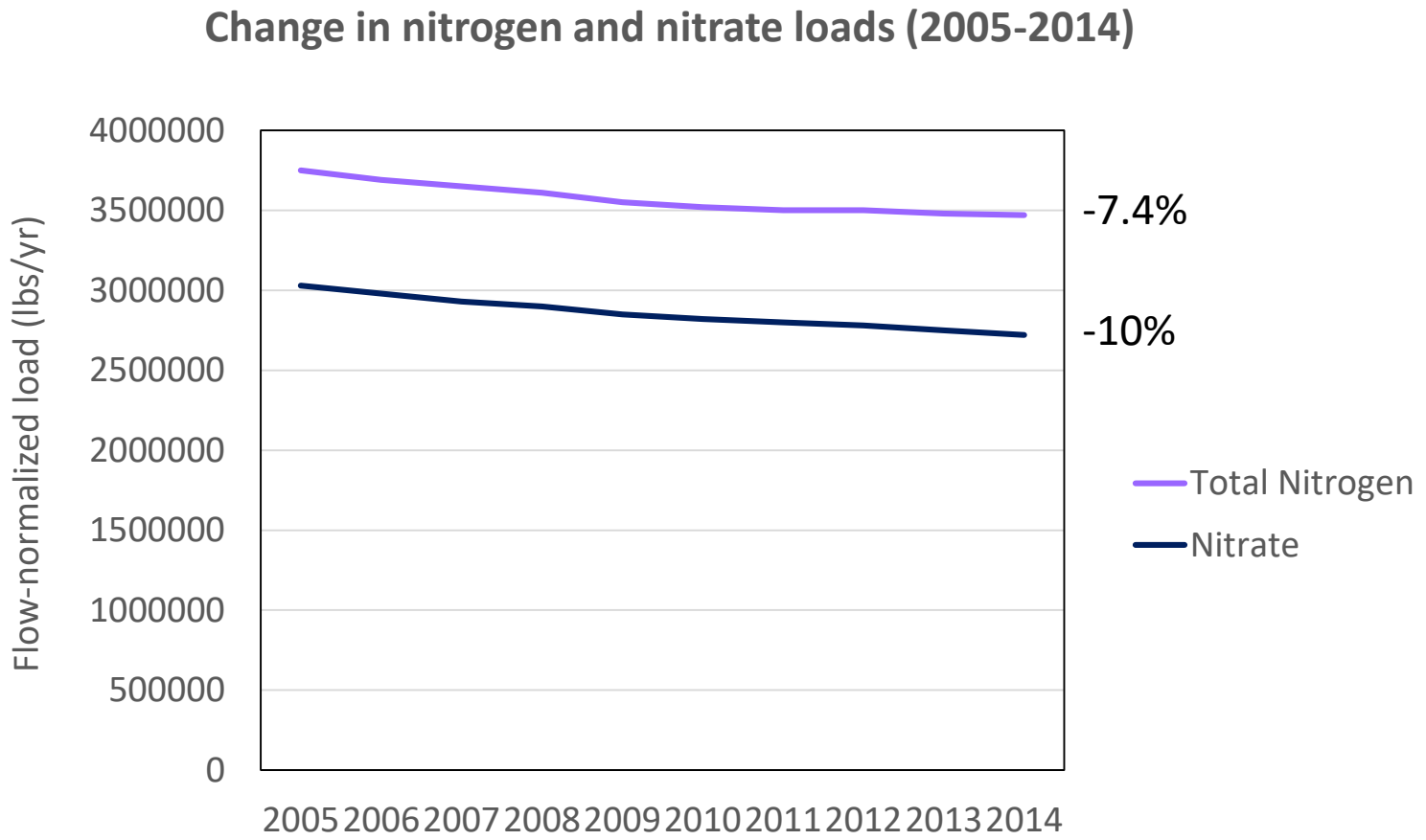
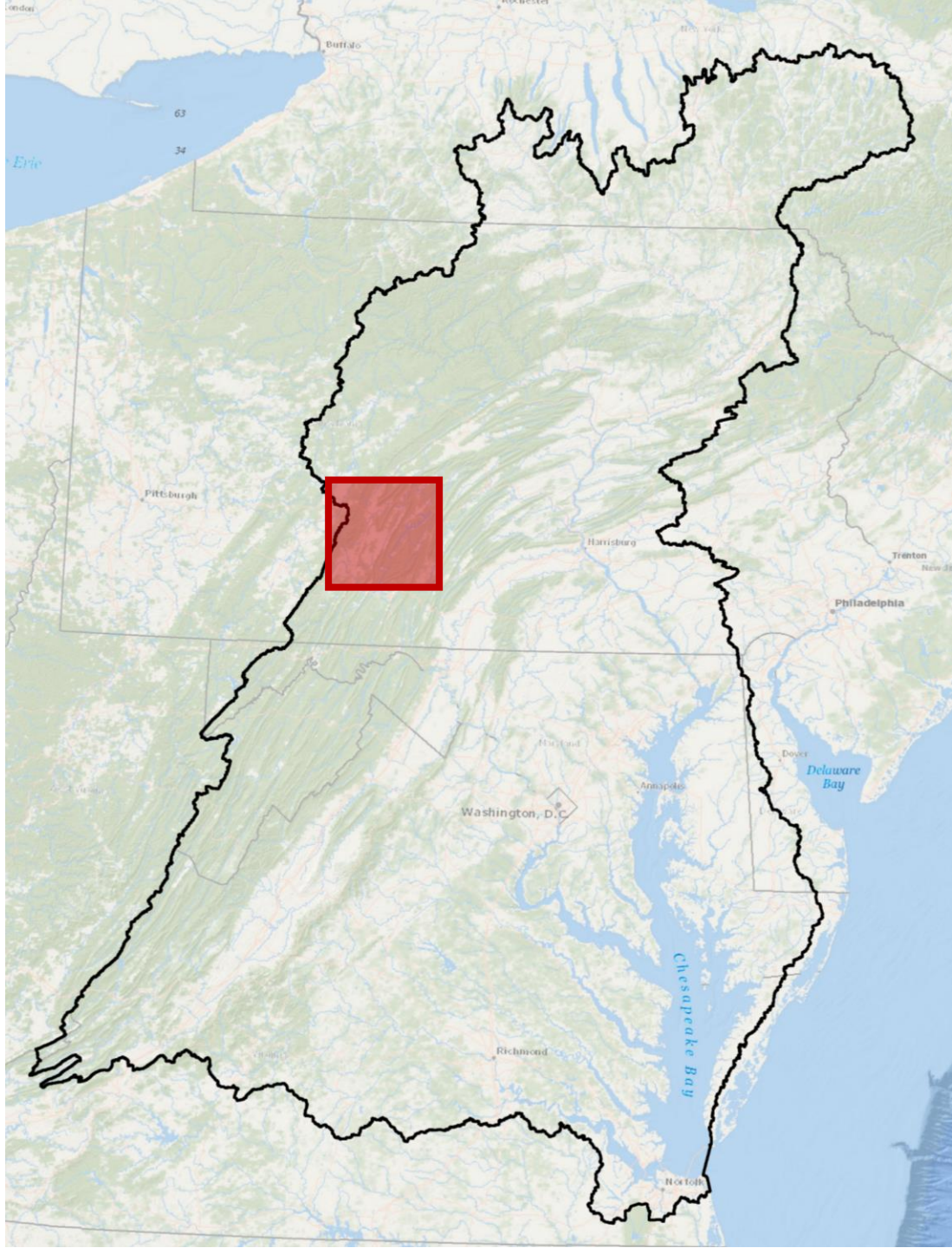


From USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/

Status & Trends Summary

- Total nitrogen and nitrate trends are improving at Raystown Branch
- Raystown Branch is in the middle tier of monitoring stations for nitrogen loads (lbs/acre)
- Raystown Branch is in the mid-range for percent total nitrogen reduction (2005-2014)



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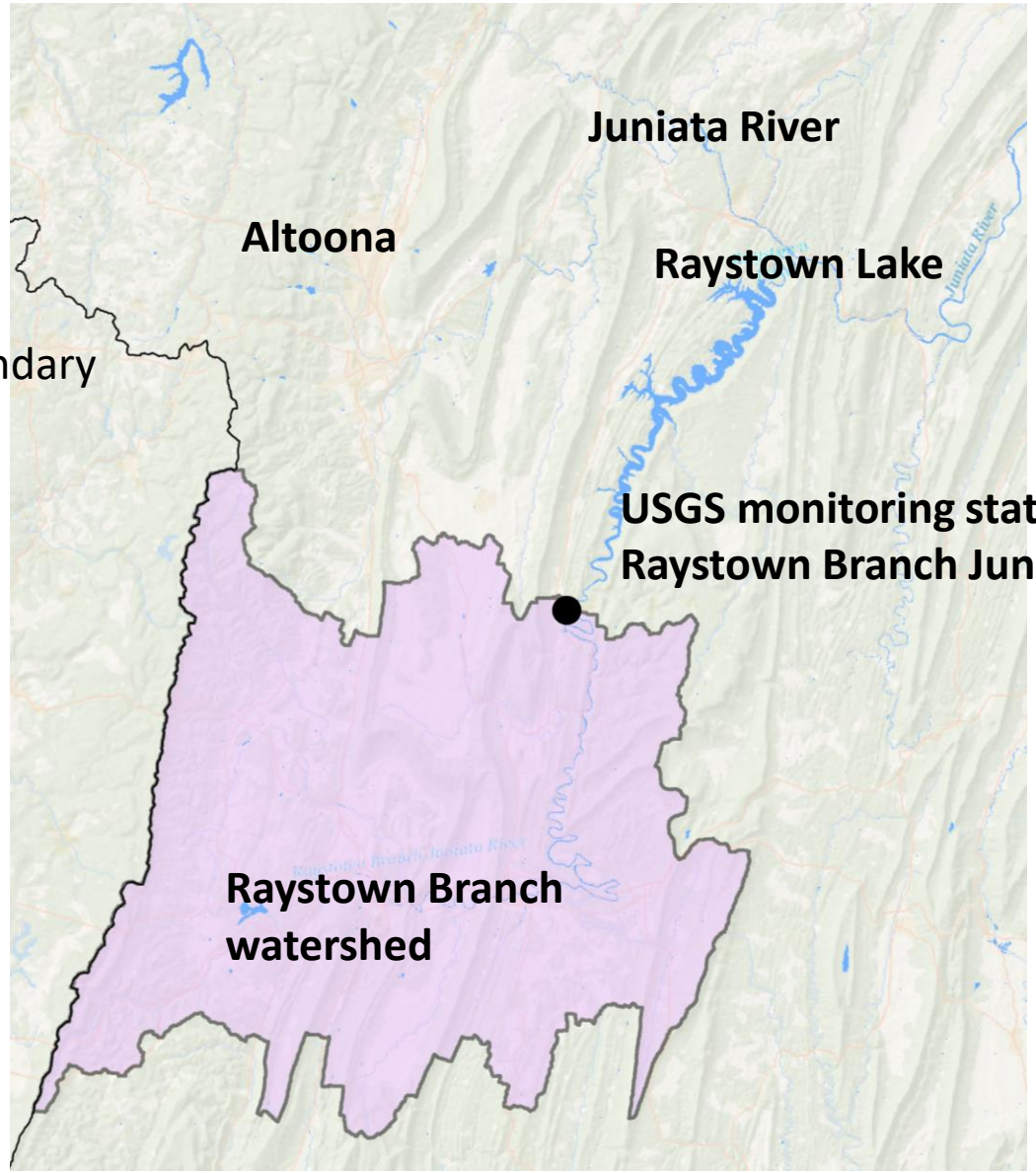
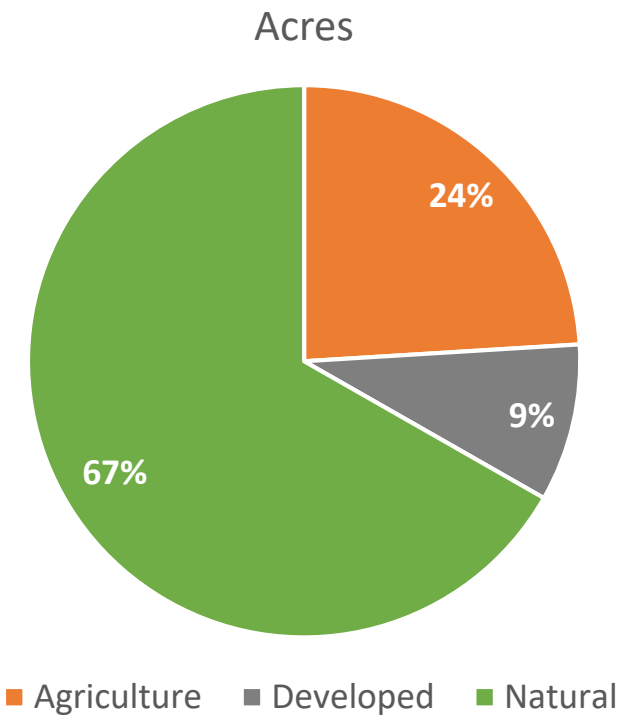
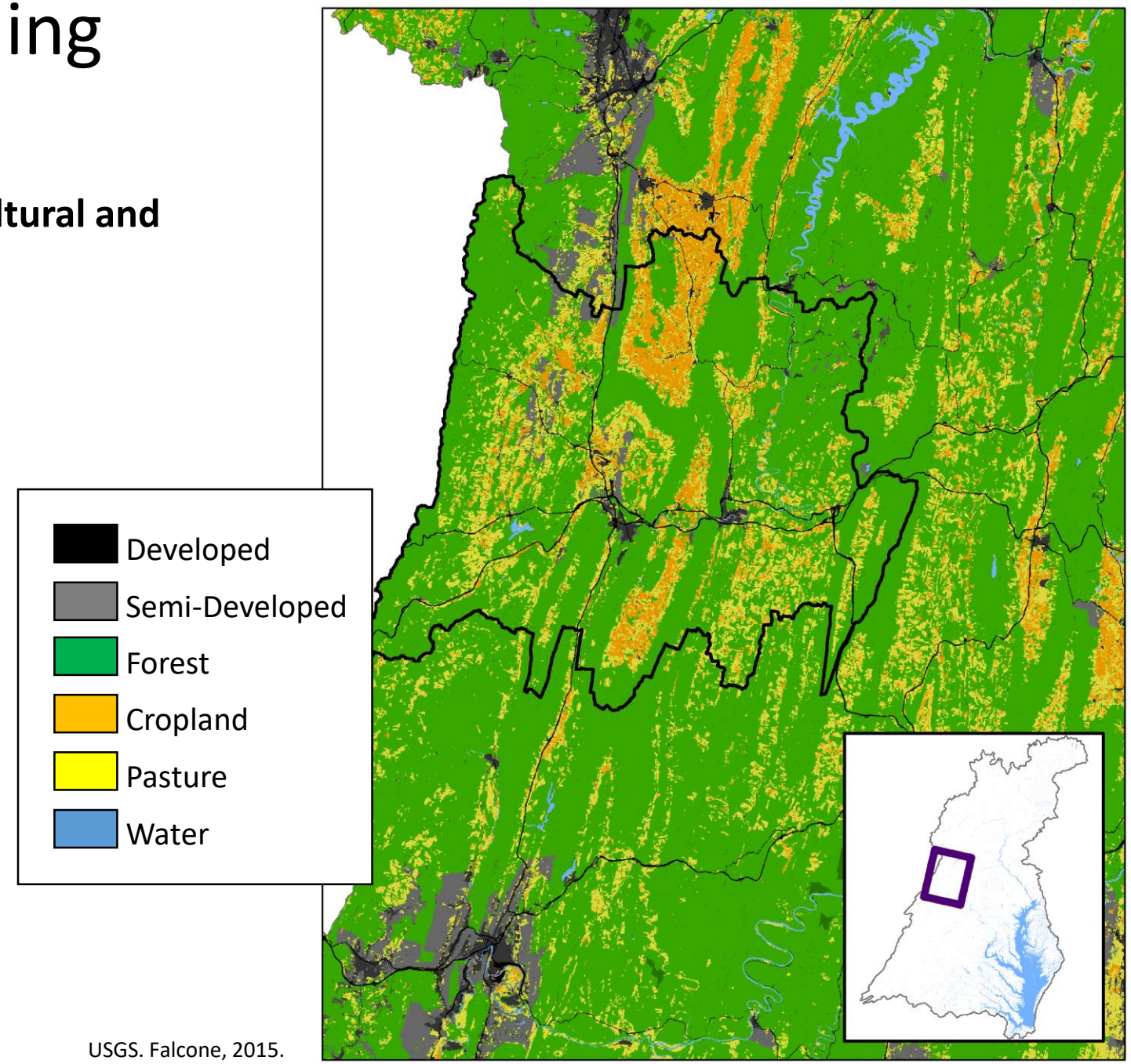


Where is nitrogen coming from?

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



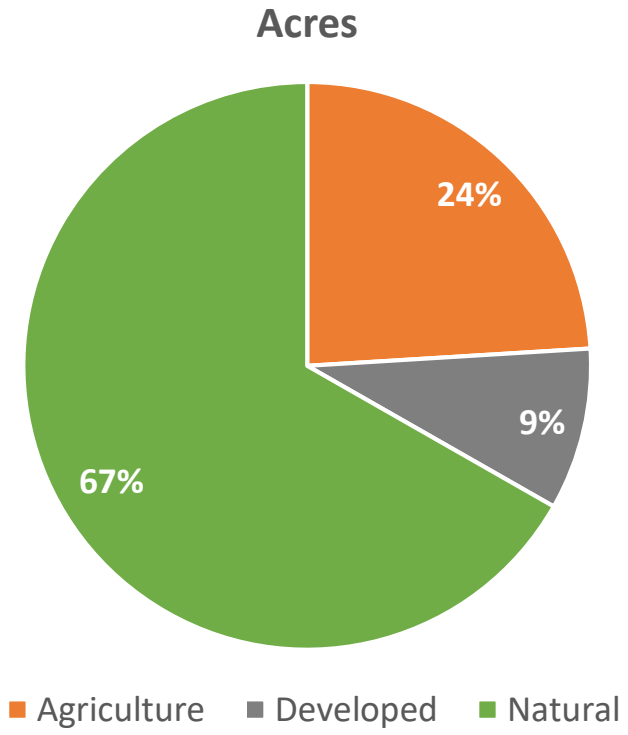


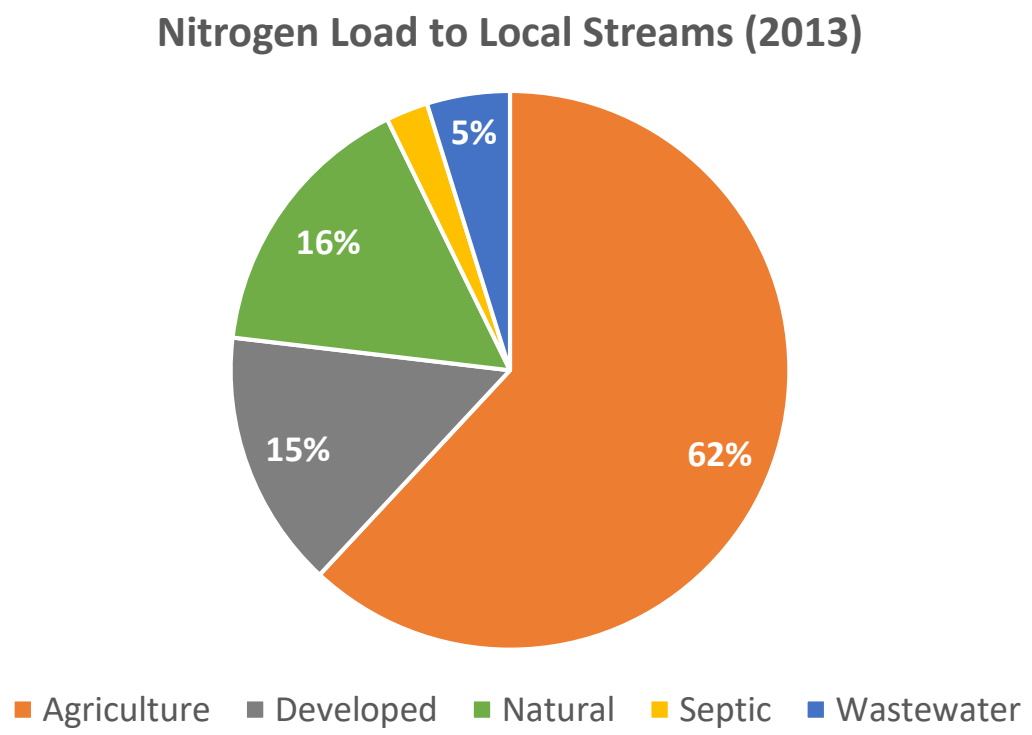
From CBP WSM Phase 6 2013 Progress Report. See data analysis at end of this document.

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**





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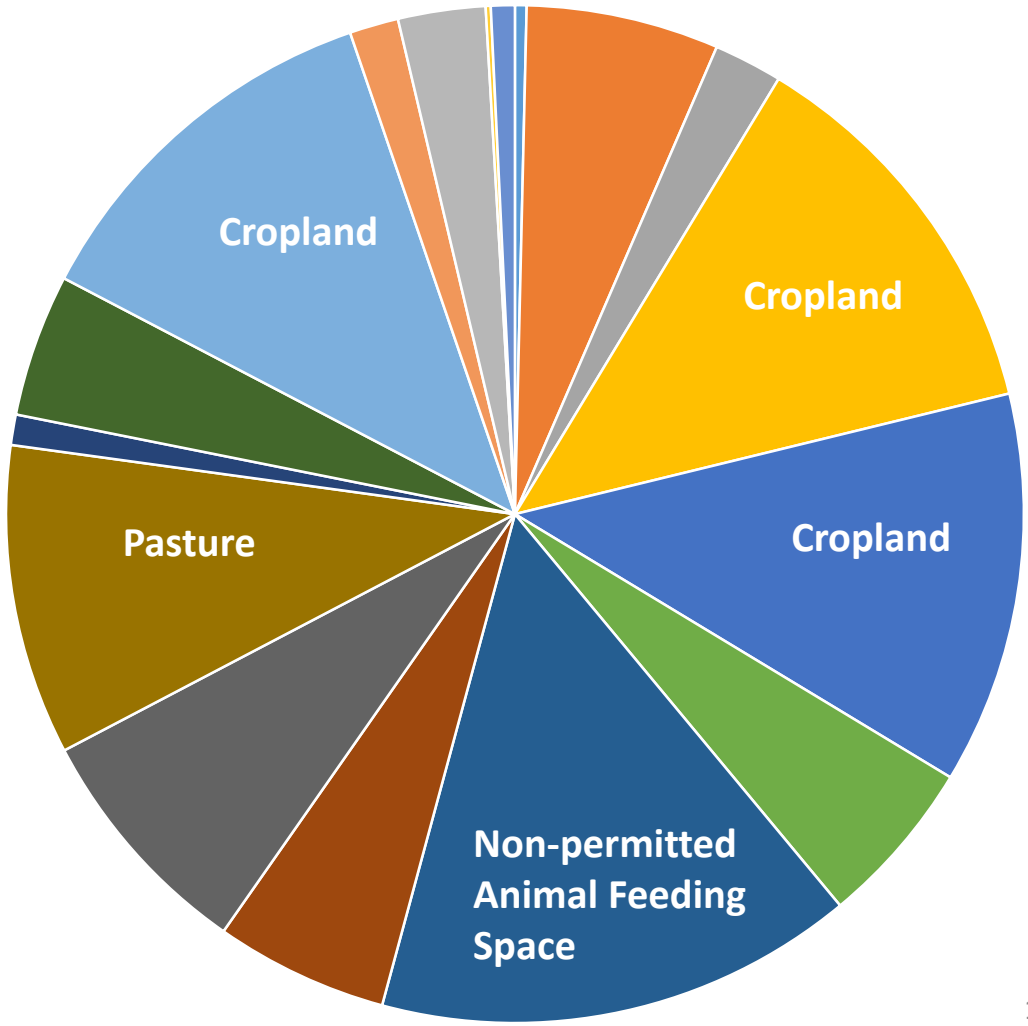

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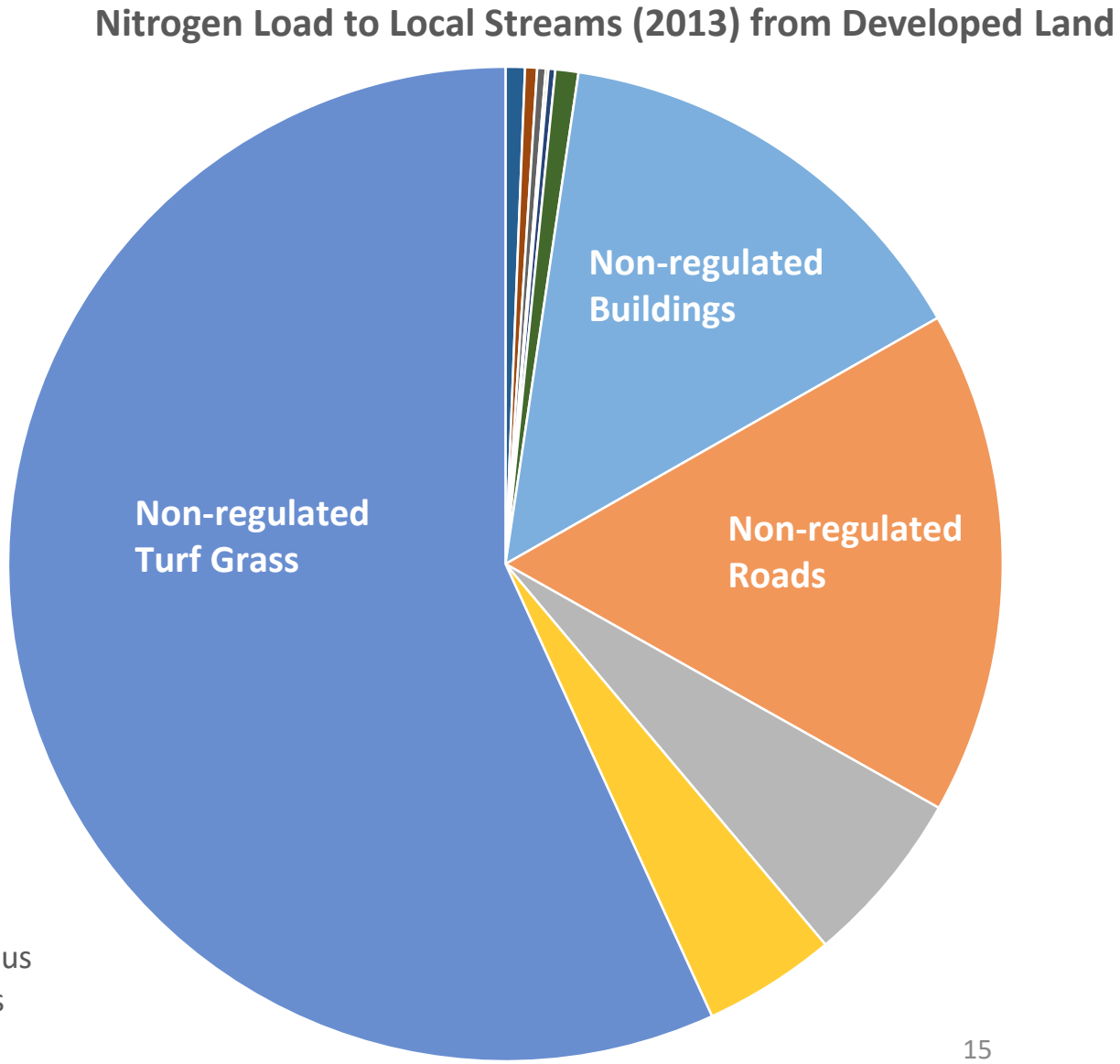


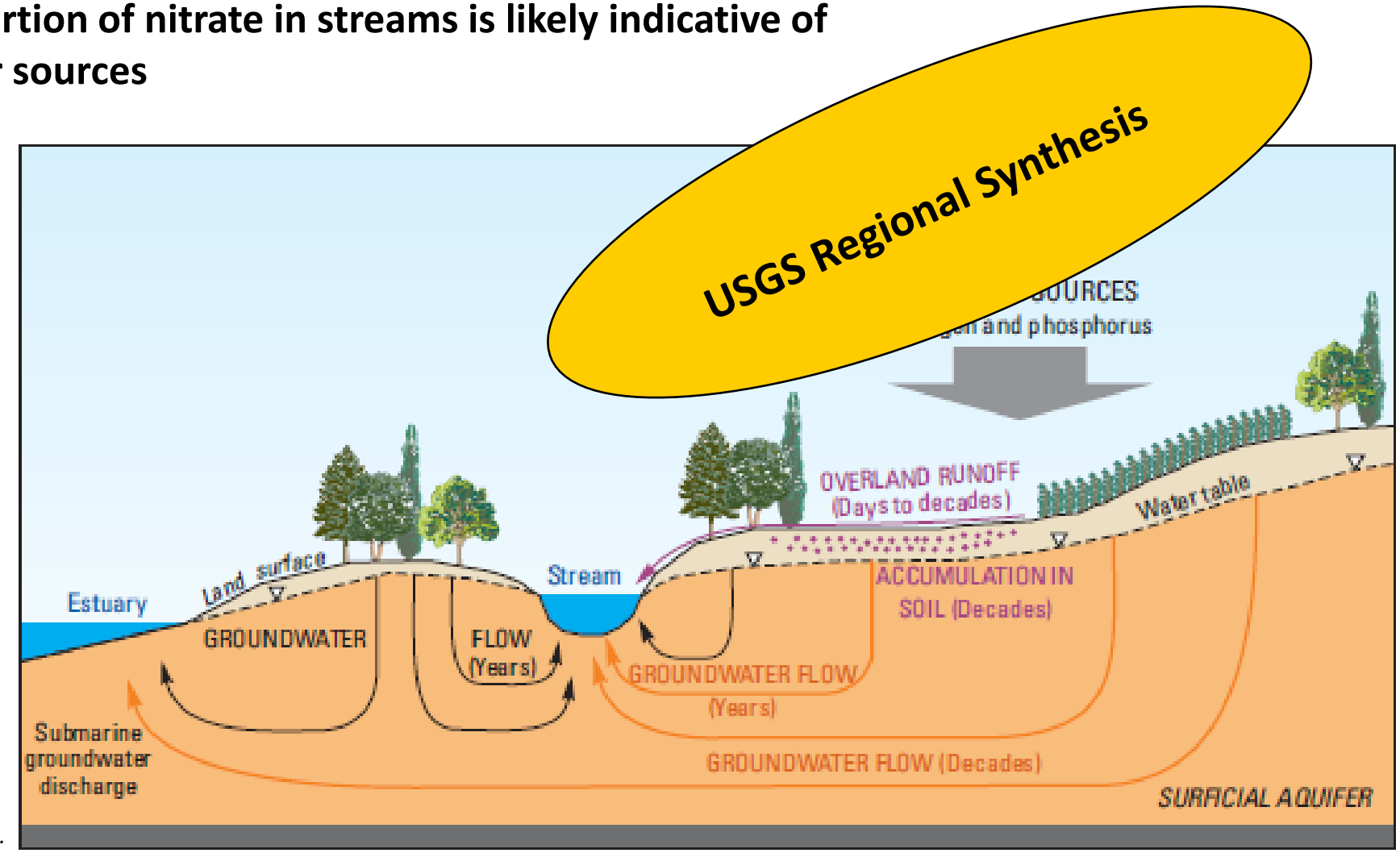
From CBP WSM Phase 6 2013 Progress Report. See data analysis at end of this document.

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**

50%

50%



From Ator, S.W., and Denver, J.M., 2015. *USGS Circular 1406.*

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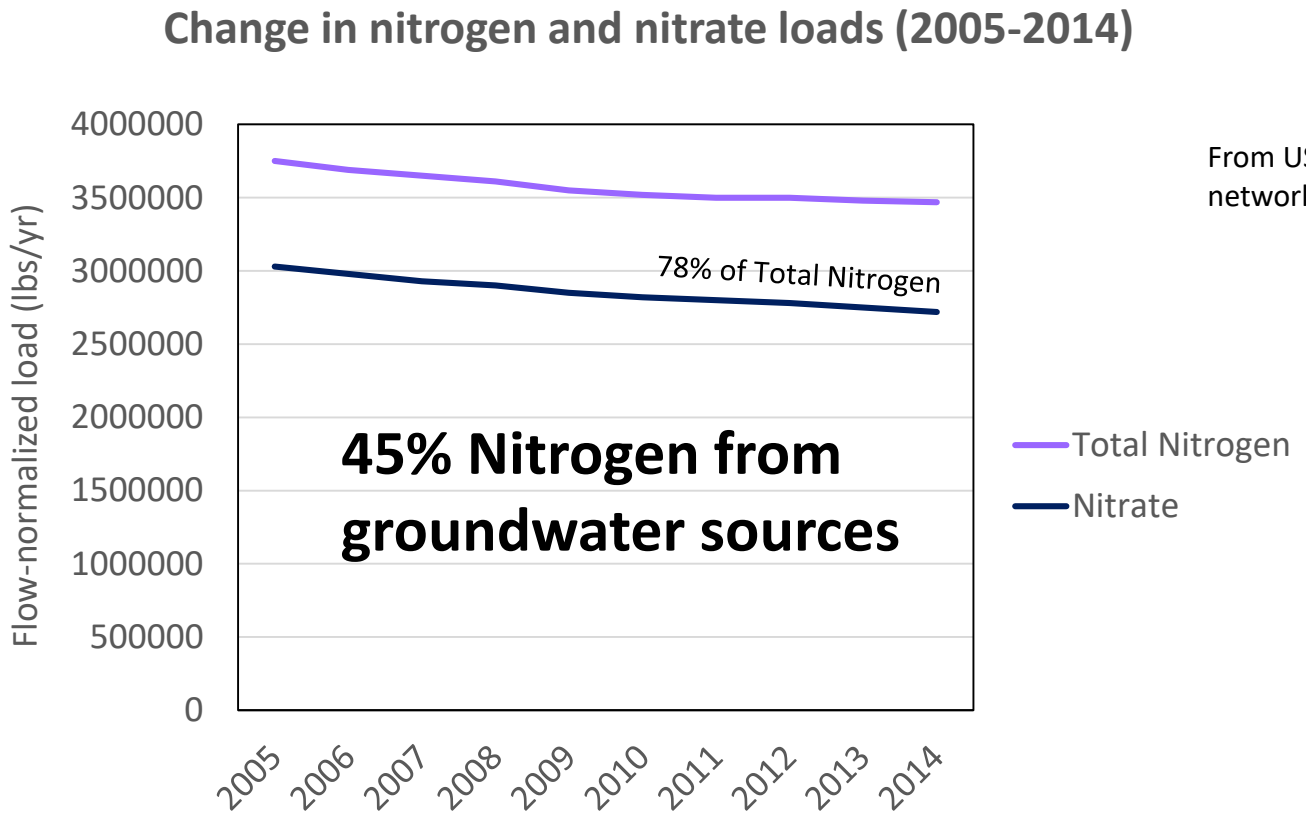
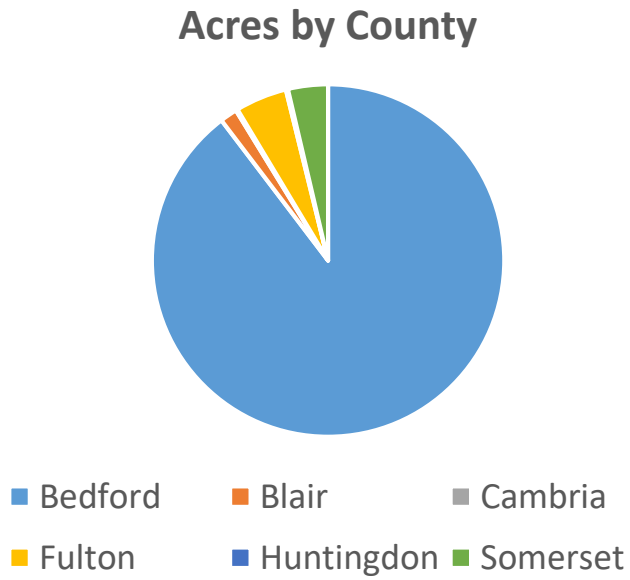
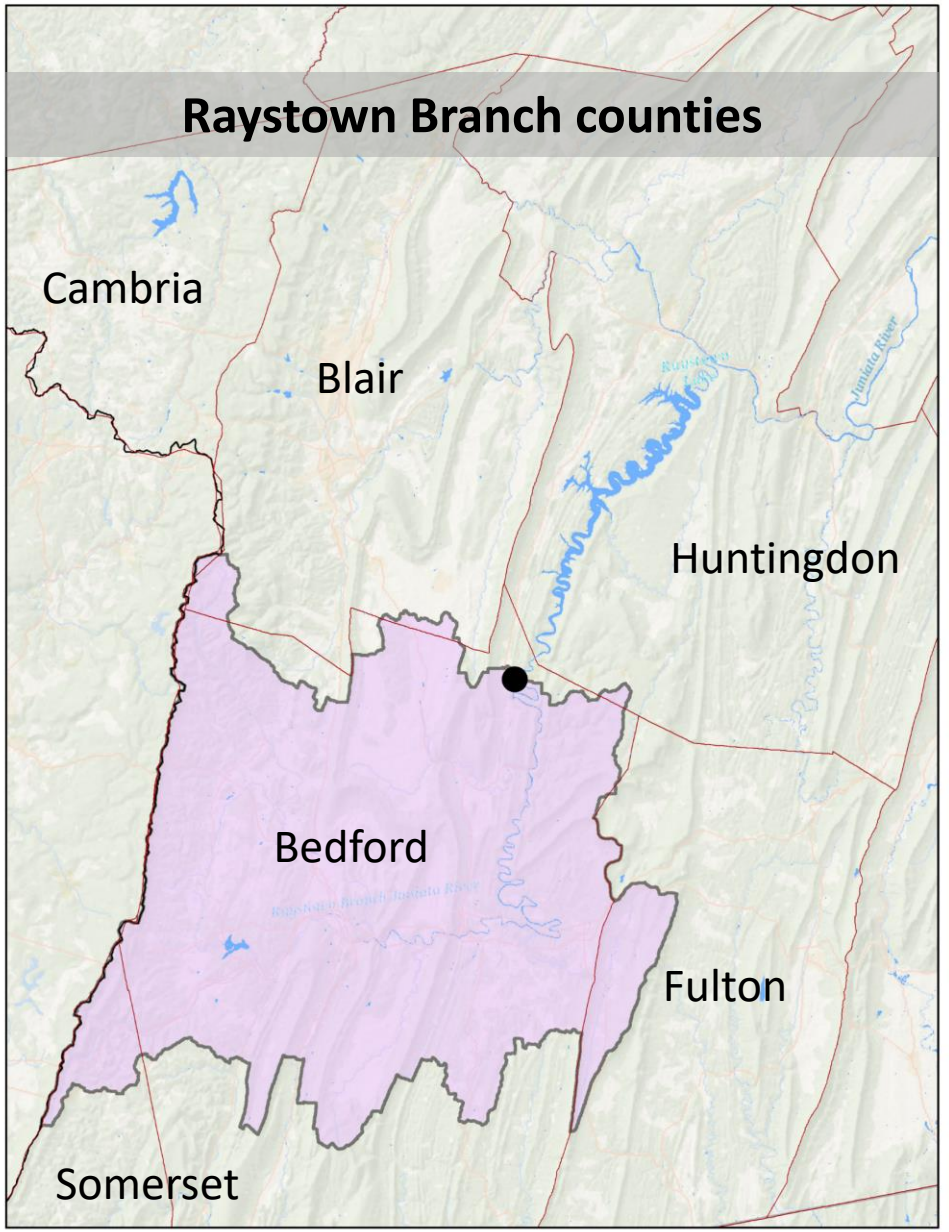


From USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/

What are drivers behind changes in nitrogen?

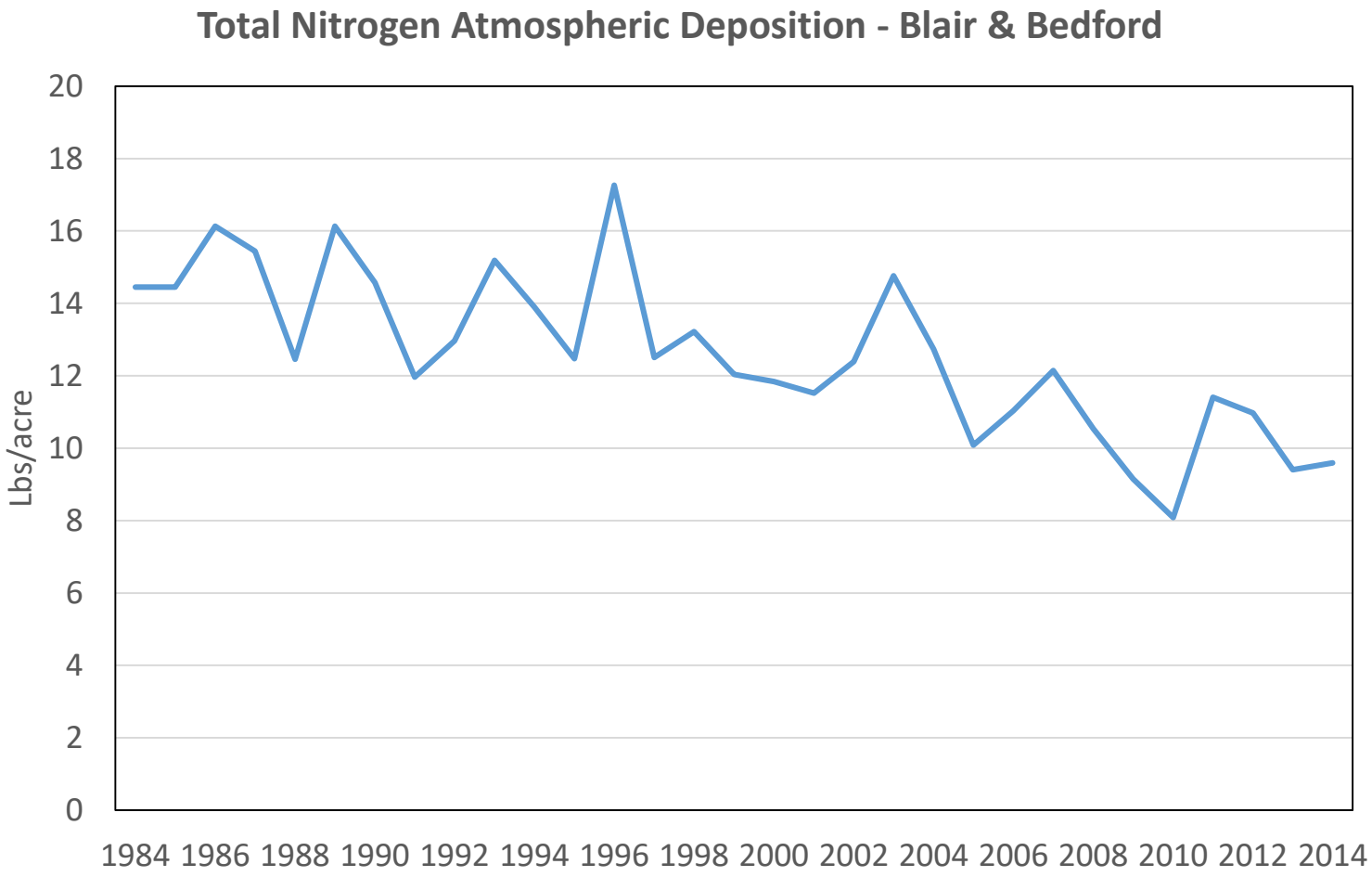
- **The Raystown Branch drainage basin is made up mostly by Bedford County**
- **Also going to look at Blair County**





How have nitrogen inputs changed?

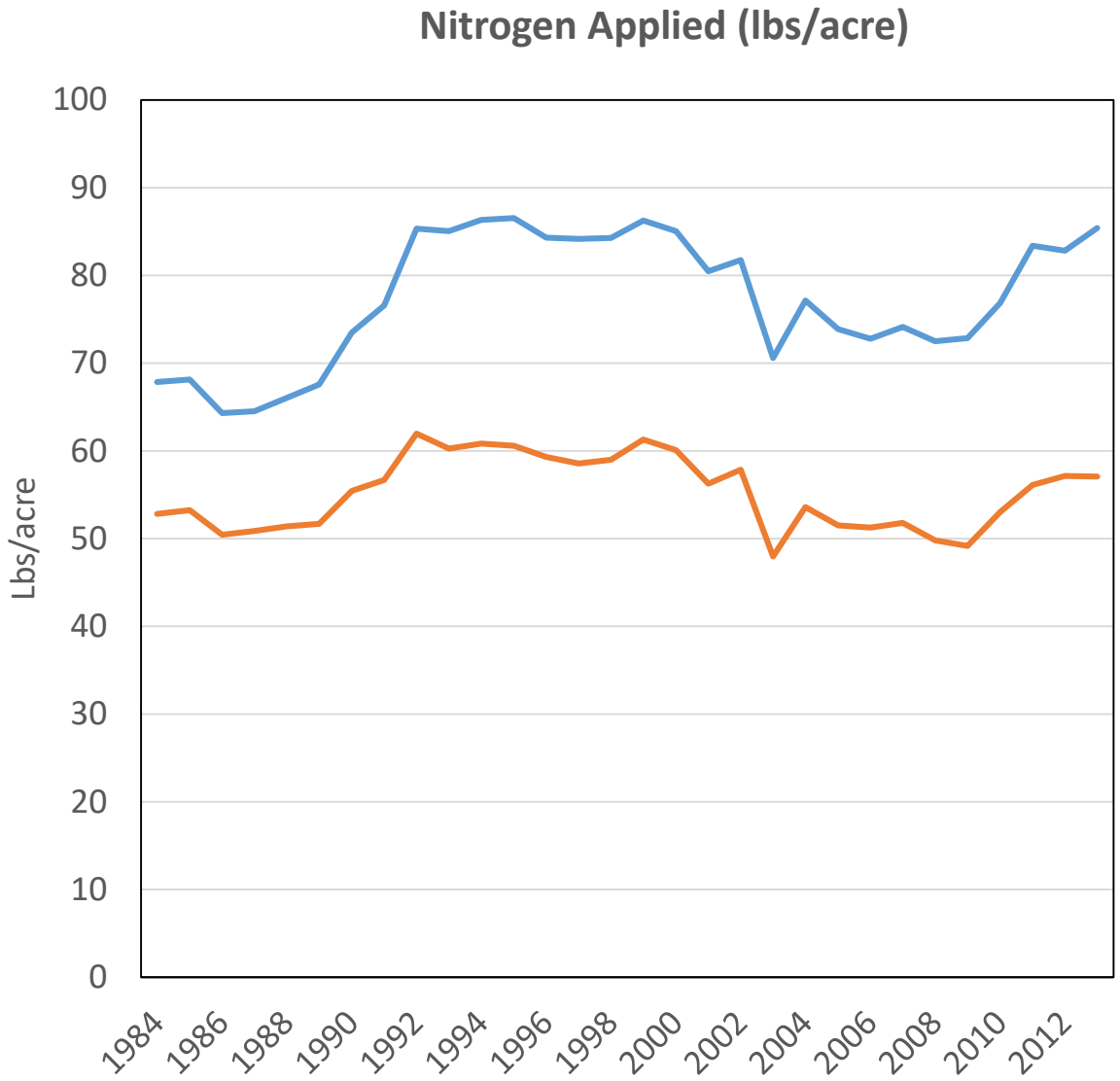
- **Nitrogen inputs from atmospheric deposition have decreased**



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

How have nitrogen inputs changed?

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



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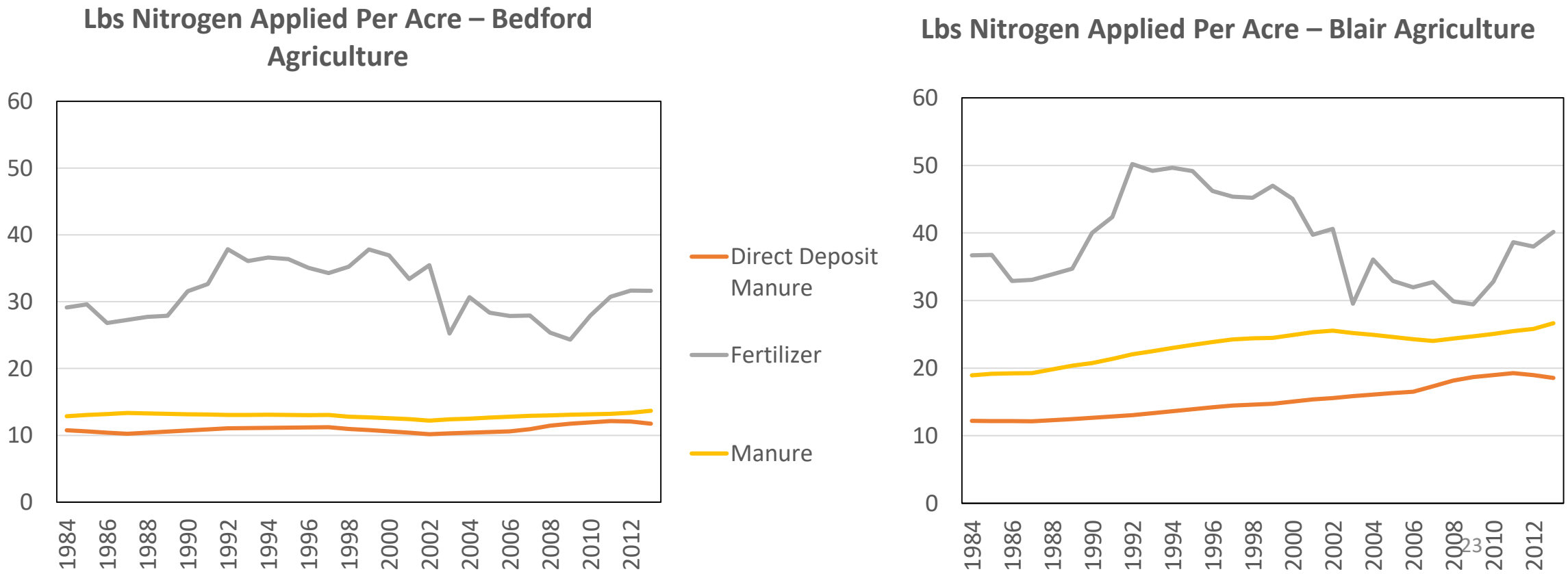
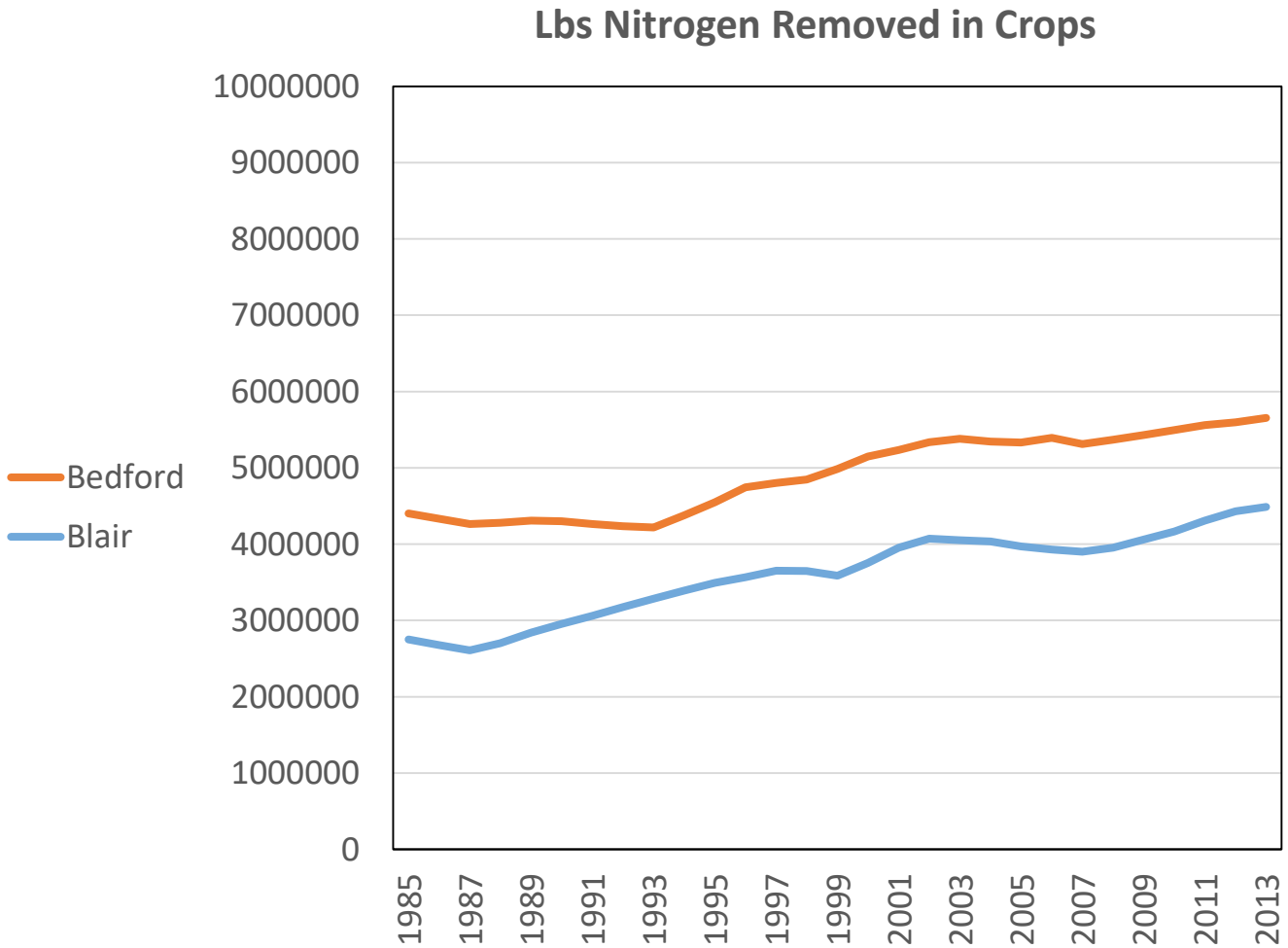
- Nitrogen inputs on agriculture have decreased over the last few decades, but have recently been increasing in the past few years
- **Decrease in nitrogen inputs has been driven by decrease in fertilizer**



How have nitrogen inputs changed?

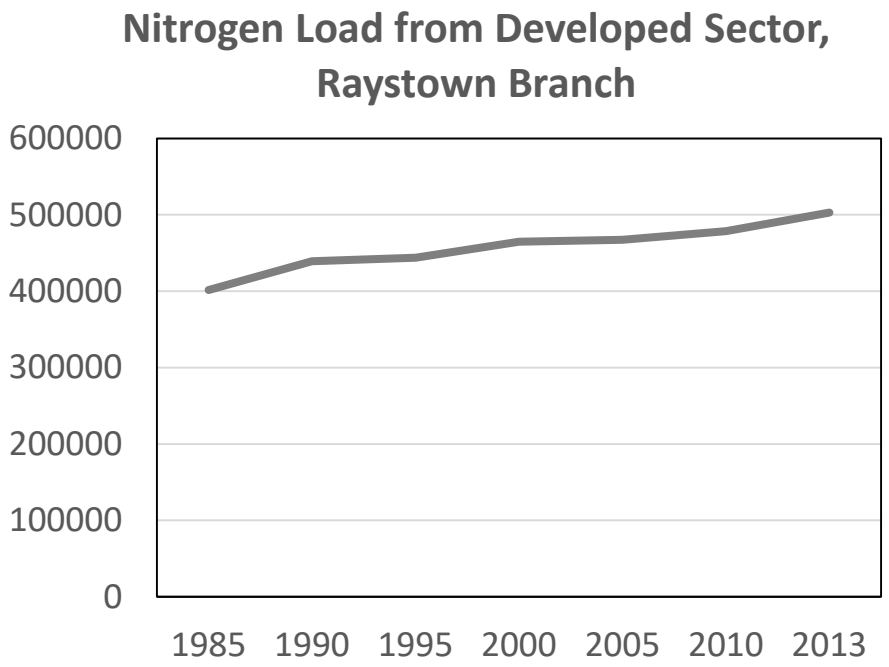
- **Crop production has continued to increase, even during times of decreased nitrogen application**

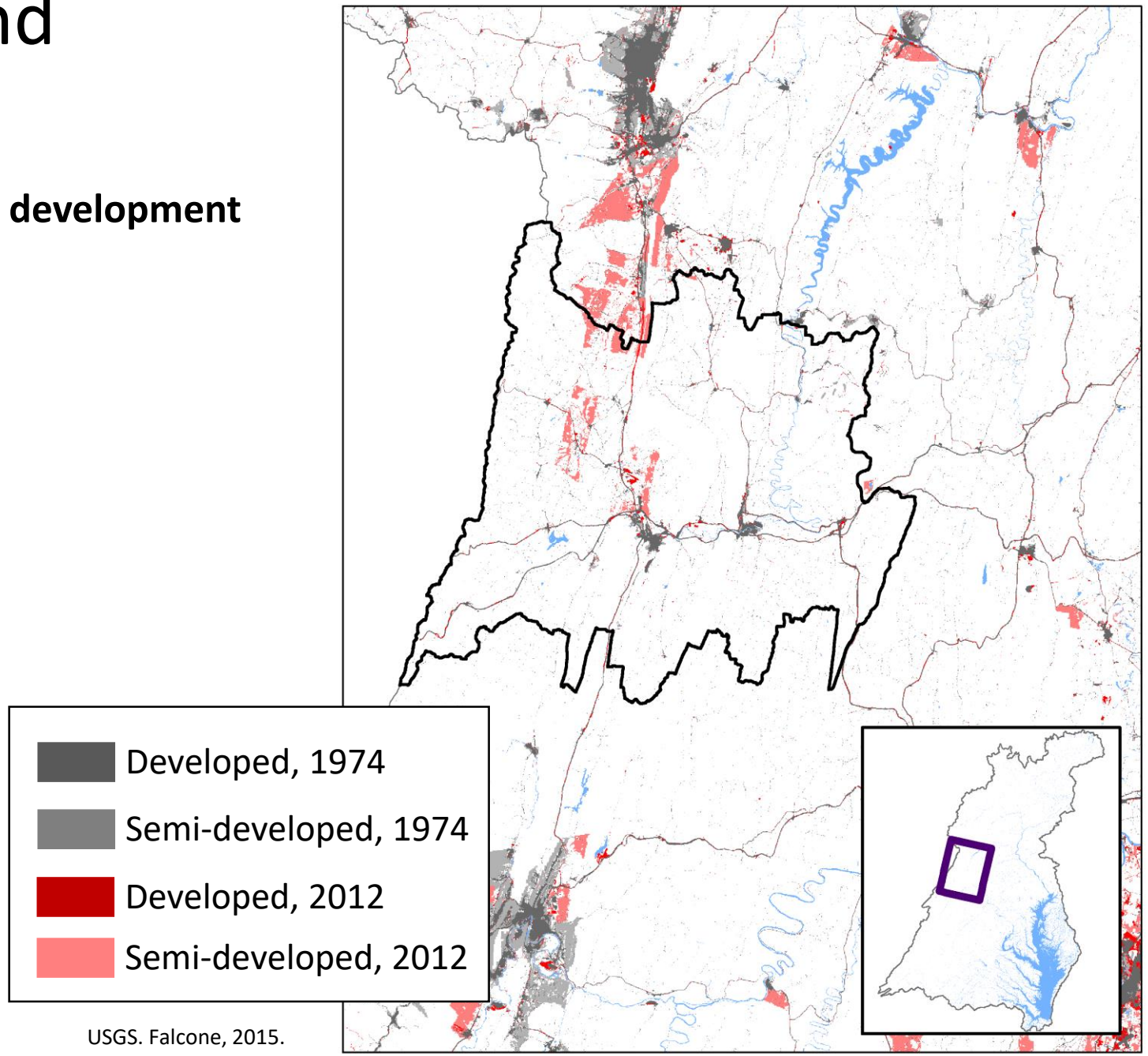


From CBP WSM Phase 6 input data, available on request.

What are drivers behind changes in nitrogen?

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



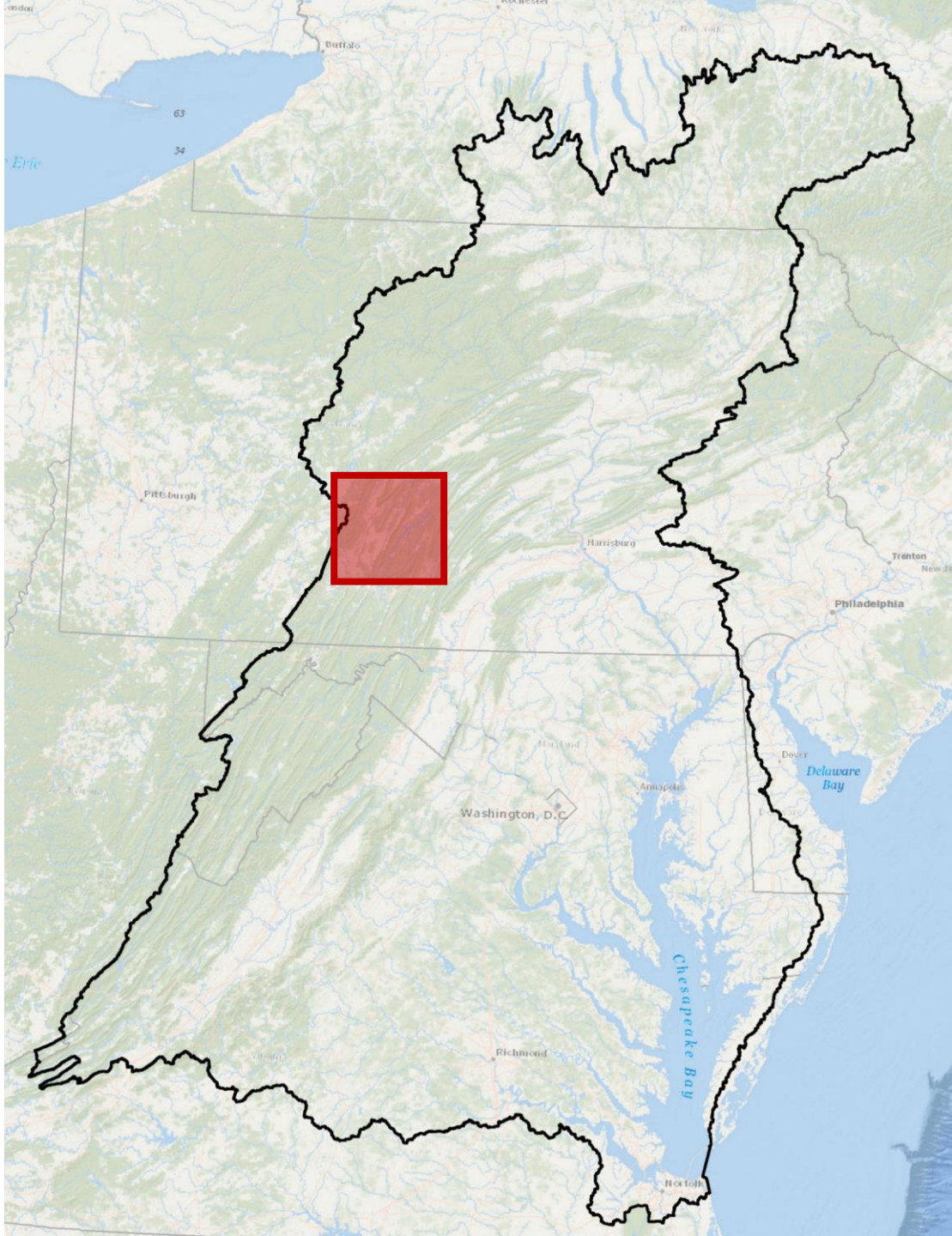


From CBP WSM Phase 6 Progress Reports. See data analysis at end of this document.

USGS. Falcone, 2015.

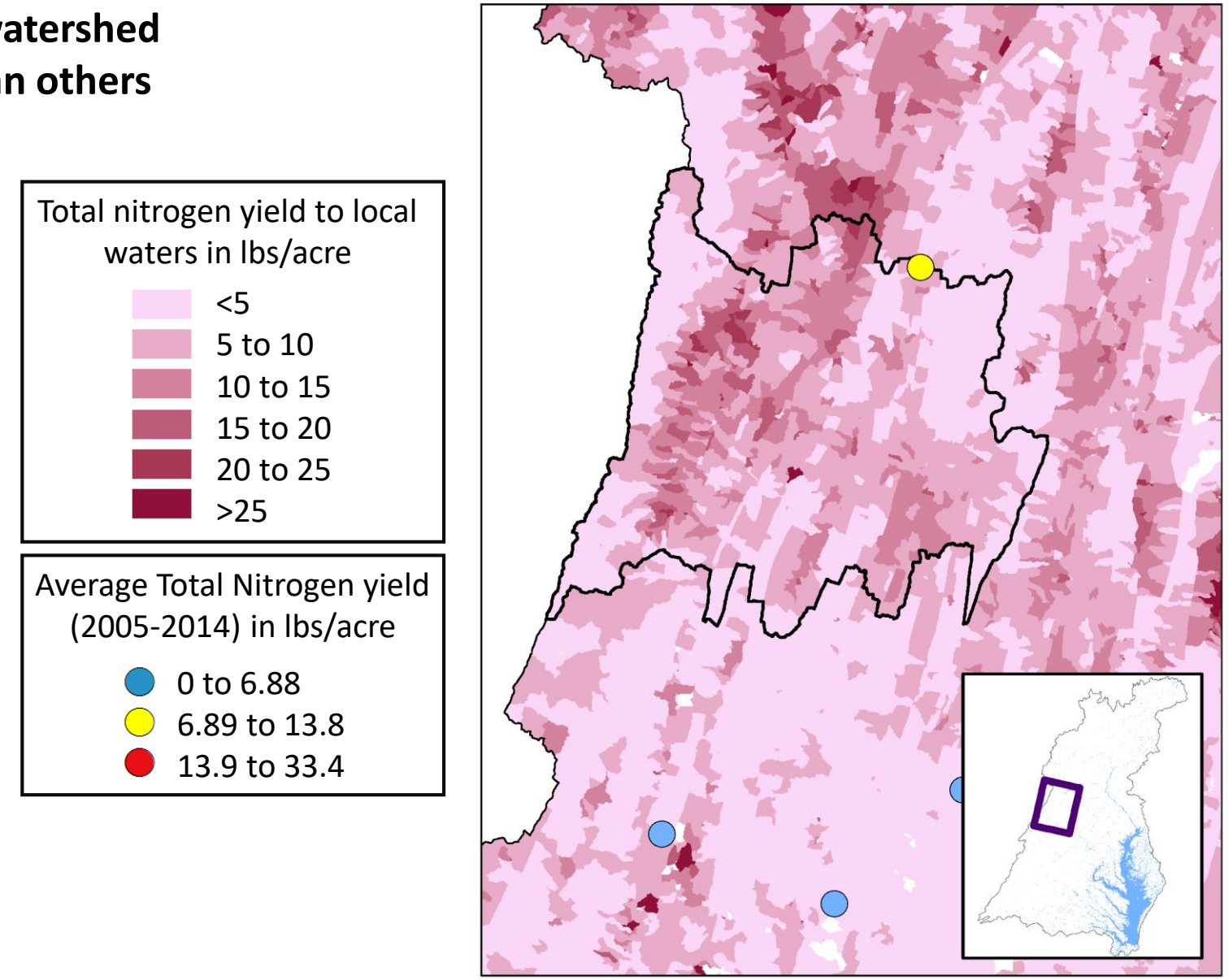
Drivers Summary

- Nitrogen loads come from mixed sources, predominantly agriculture
- Nitrogen reaches streams primarily as nitrate from both groundwater and surface runoff
- Nitrogen in streams reflects recent and past inputs
- Agricultural inputs have decreased over the past few decades, but have recently been increasing
- Inputs from developed land have been increasing



Where to focus efforts geographically?

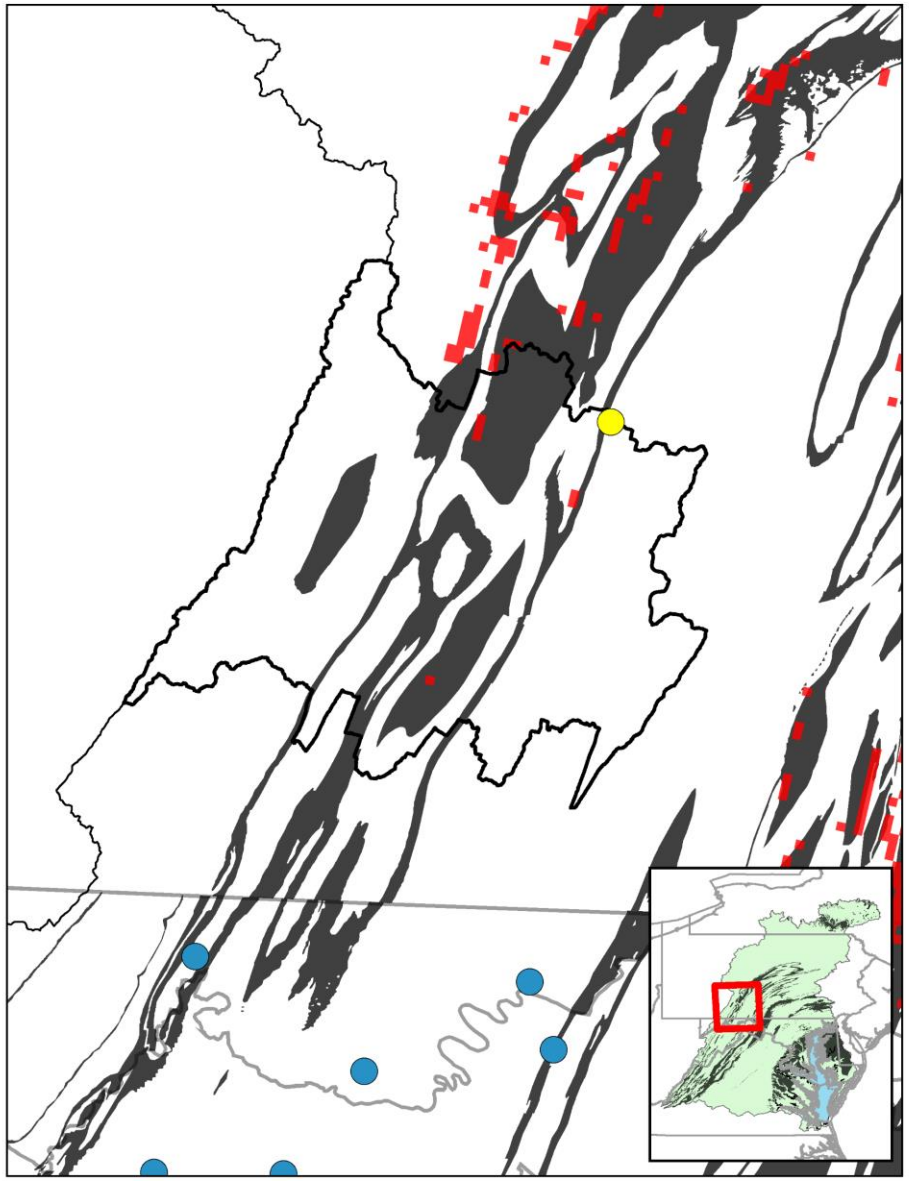
- **Certain areas of the watershed are higher loading than others**



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

Where to focus efforts geographically?

- **Geology makes the groundwater (and therefore streams) in some areas especially vulnerable to high nitrogen inputs**



Vulnerable geology
(Areas underlain by carbonate rocks or coarse coastal sediments)

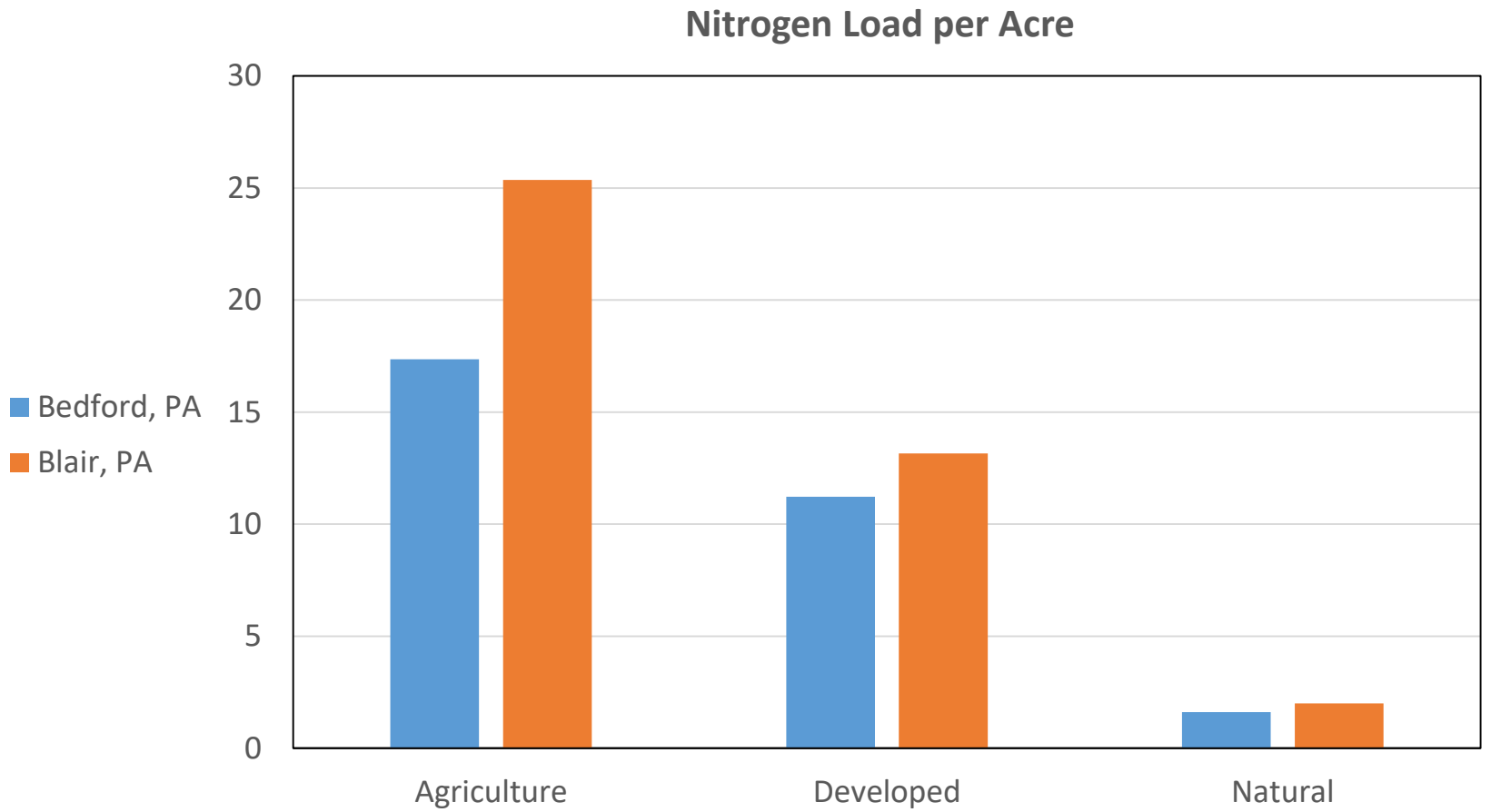
Average Total Nitrogen yield (2005-2014) in lbs/acre
- 0 to 6.88
- 6.89 to 13.8
- 13.9 to 33.4

Modeled groundwater nitrate >10 mg/L

Modified from Jimmy Webber, USGS, using Brakebill, JW 2000, Ator, S. et al. 2005 and Nolan & Hitt, 2006. DO NOT CITE OR DISTRIBUTE.

Where to focus efforts geographically?

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



From CBP WSM Phase 6 2013 Progress Run.
http://cast.chesapeakebay.net

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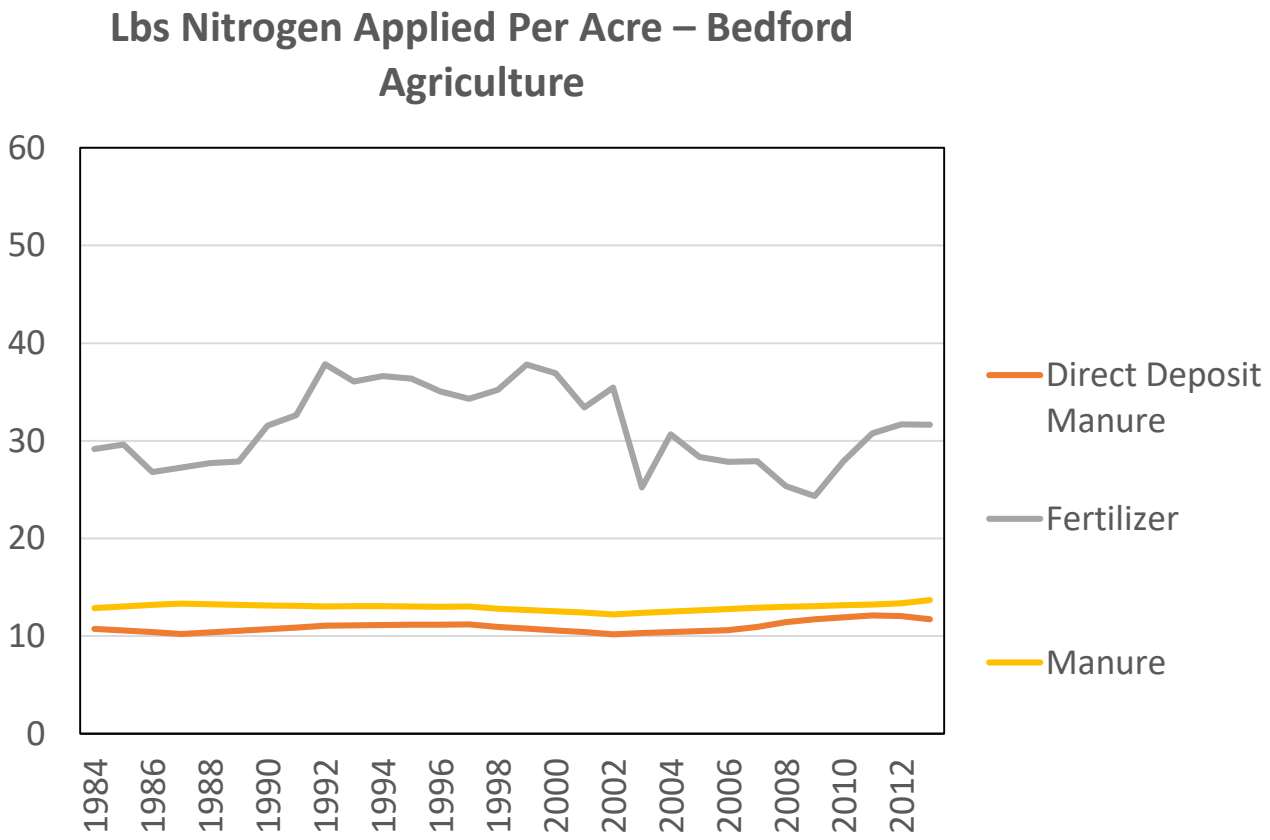

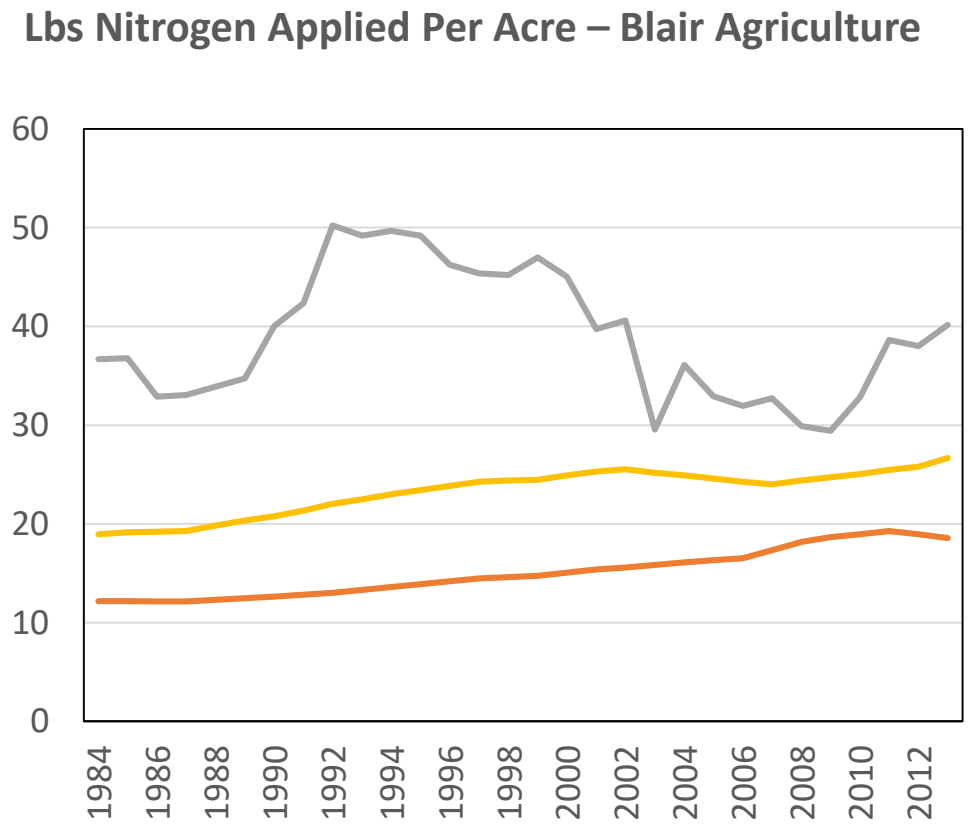

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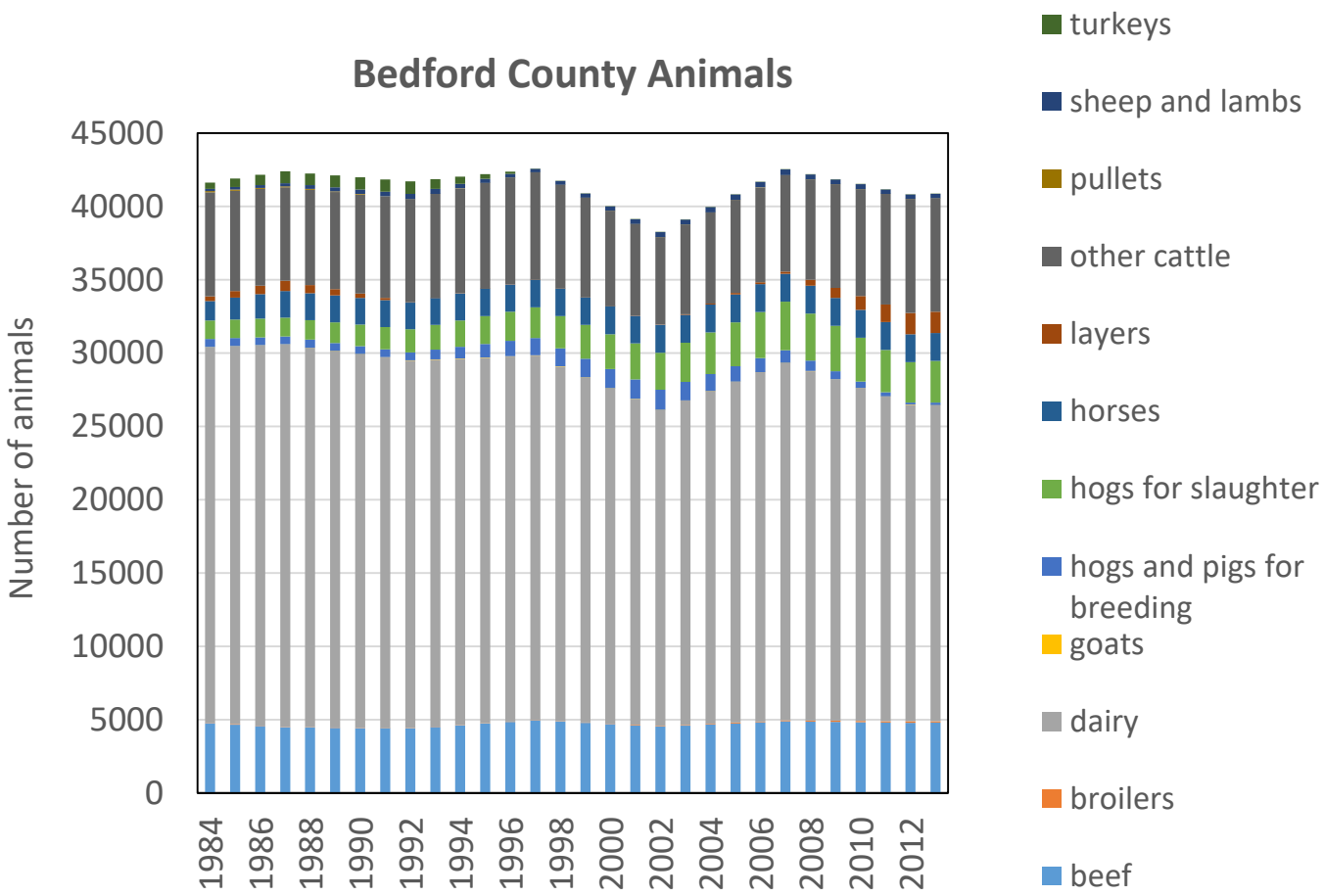
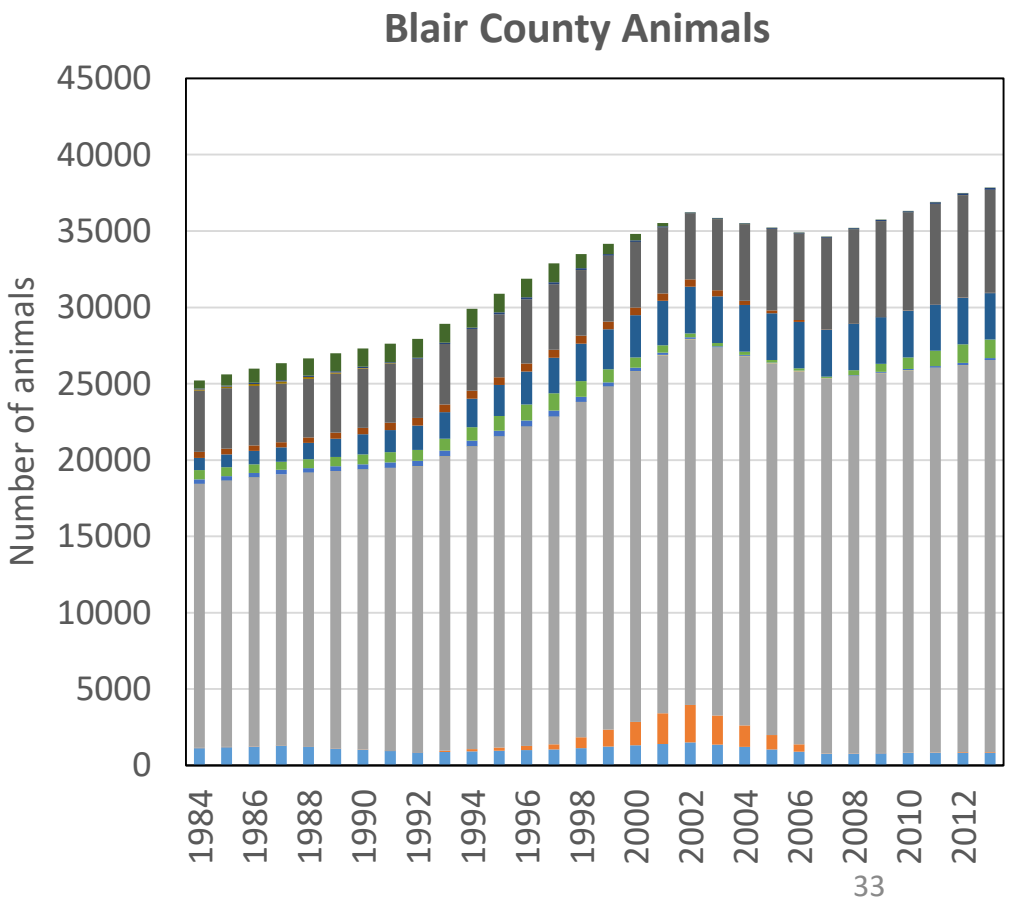
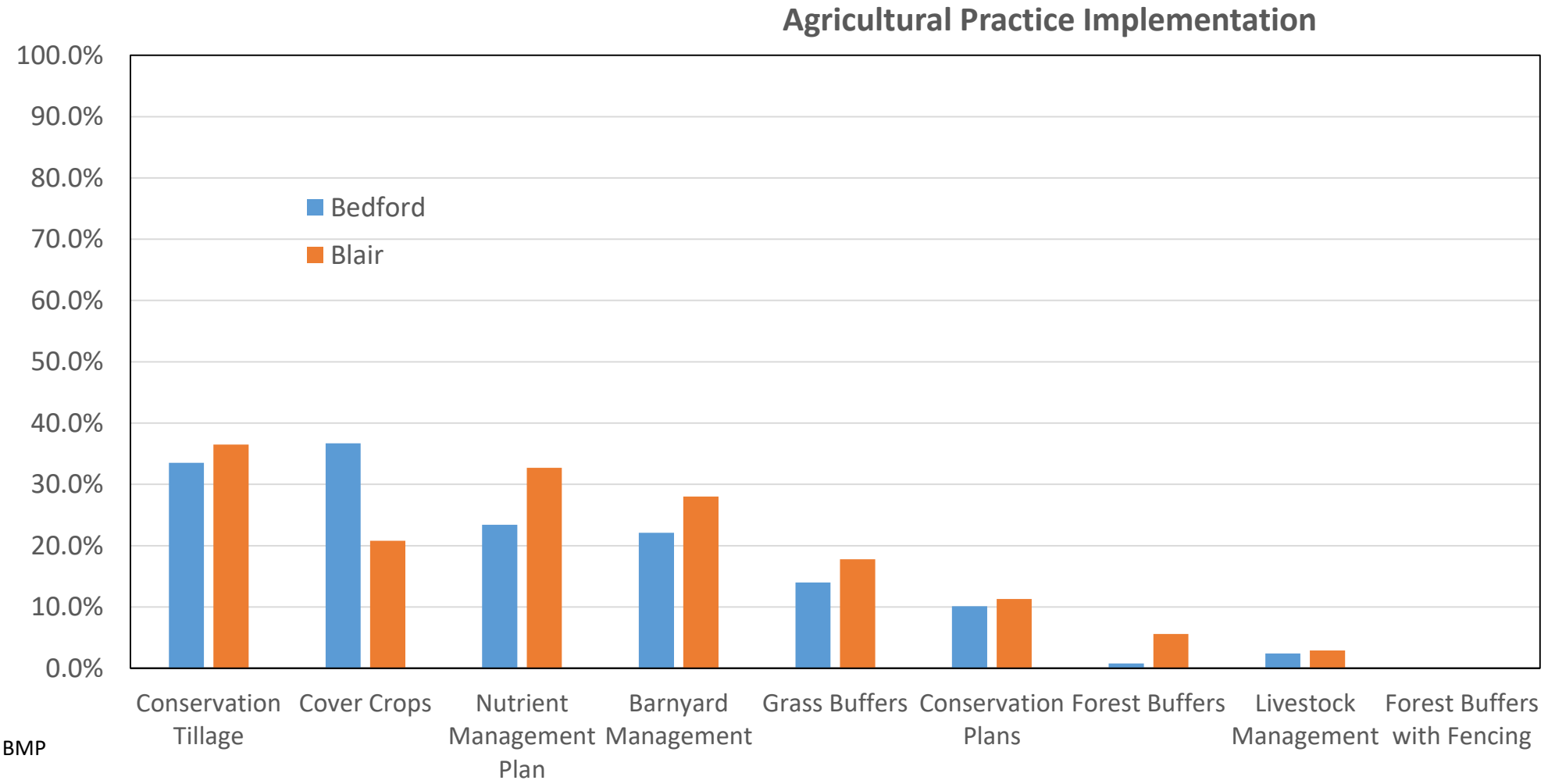




What practices to focus on?

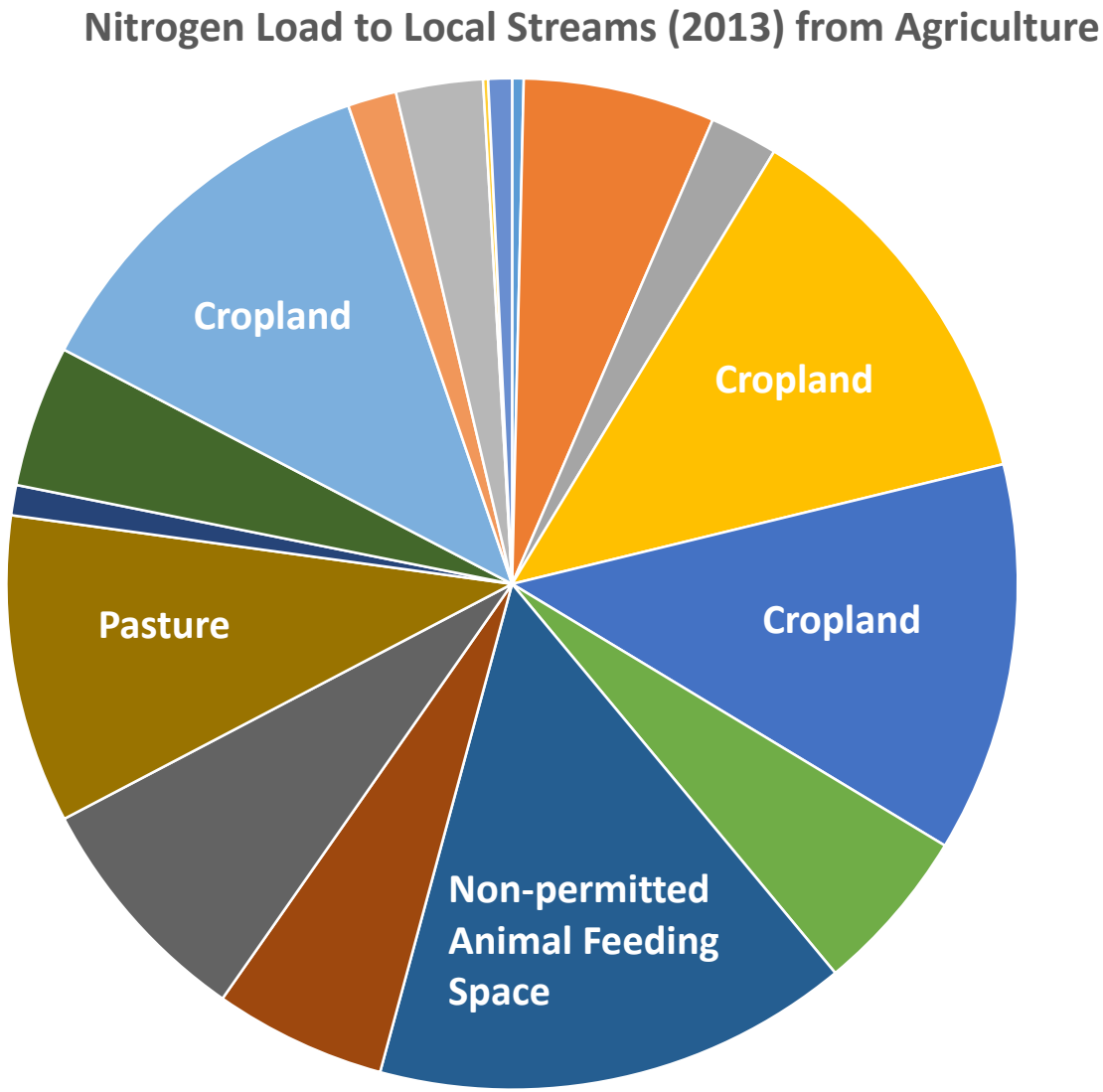
- **For nitrate from groundwater, effective practices keep nitrogen from getting into groundwater, or mitigate nitrate in groundwater**
- **For surface nitrogen, effective practices reduce nitrogen inputs or keep nitrogen from running into streams**



From CBP WSM Phase 6 BMP Summary Report 2013.

What practices to focus on?

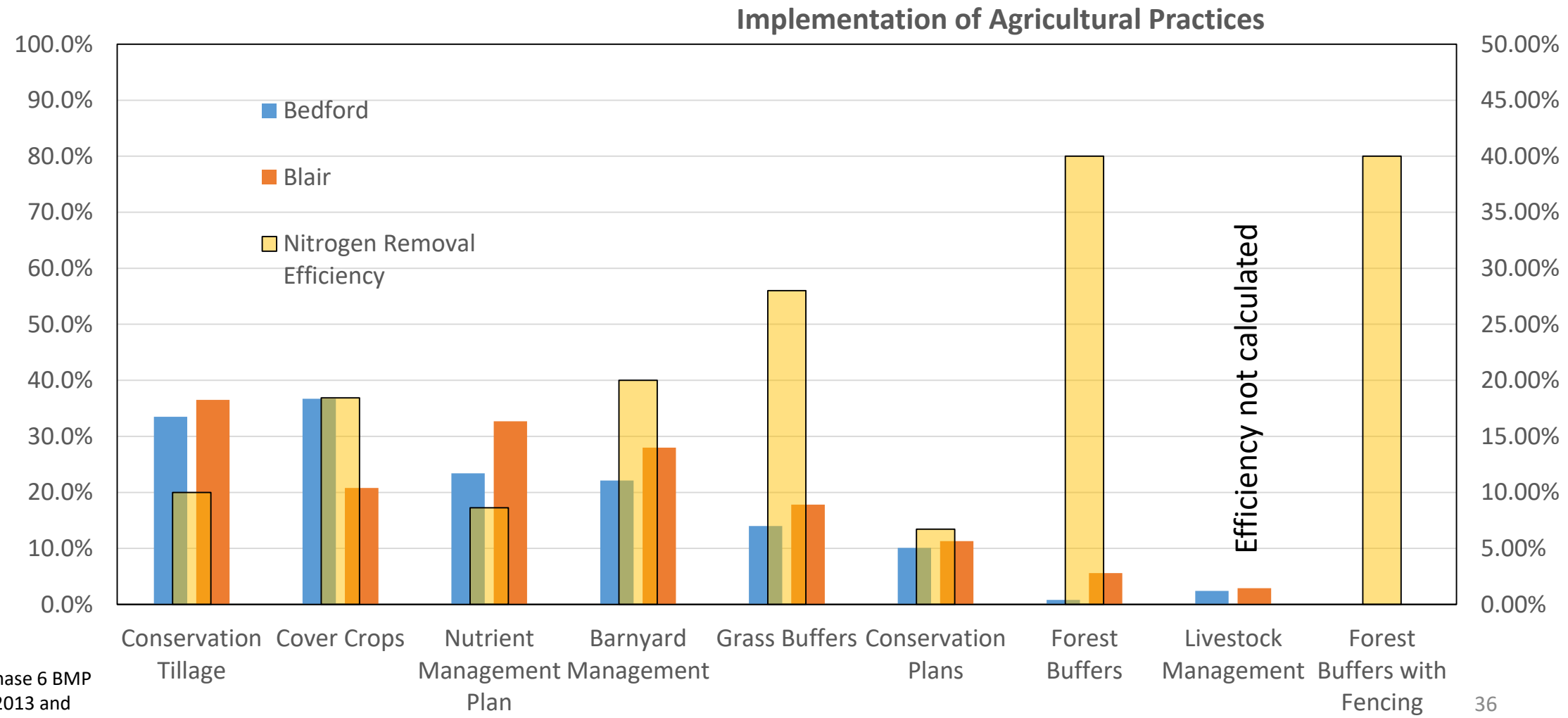
- **The highest loading sources are cropland, animal feeding operations, and pasture**



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

What practices to focus on?

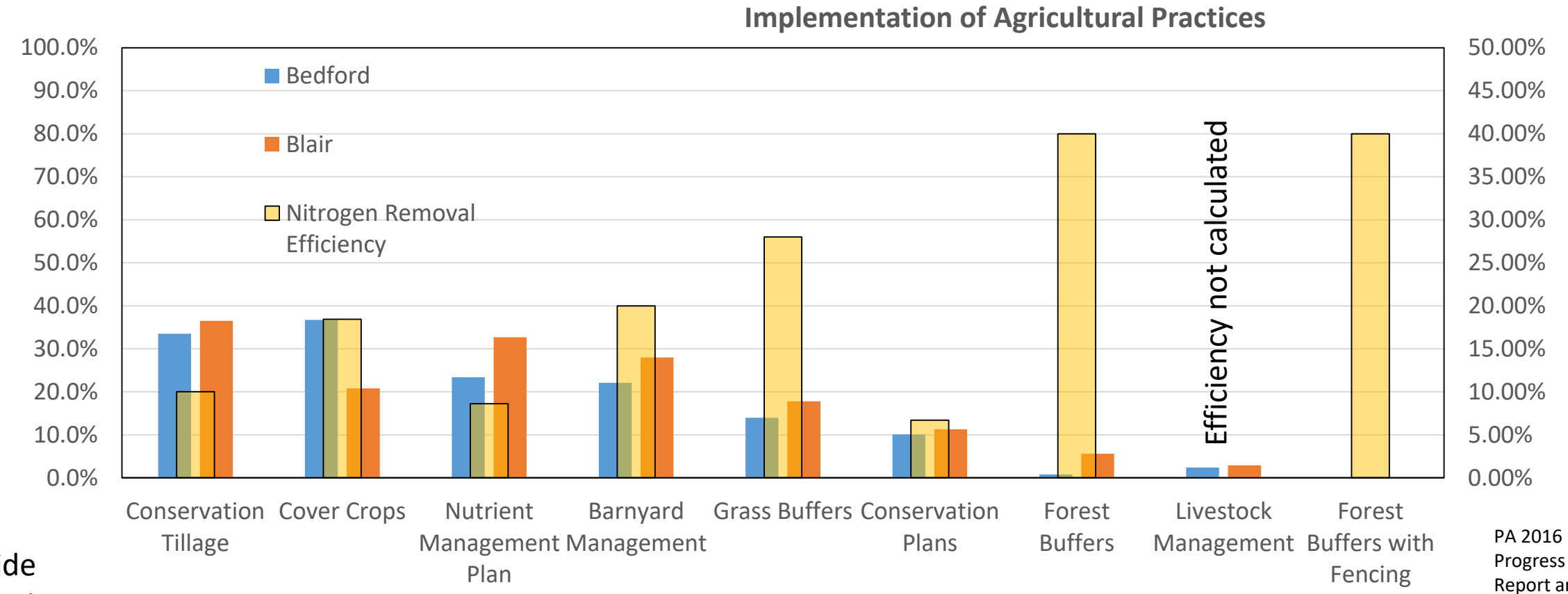
- The highest loading sources are cropland, animal feeding operations, and pasture
- **Effective practices for these sources can include buffers, barnyard management, and cover crops**



From CBP WSM Phase 6 BMP Summary Report 2013 and Phase 6 Documentation.

What practices to focus on?

- **These areas are keeping pace with Pennsylvania state-wide implementation for many effective practices**
- **There may be room for adjustments in the Phase III WIP to better address nitrogen issues in these areas**

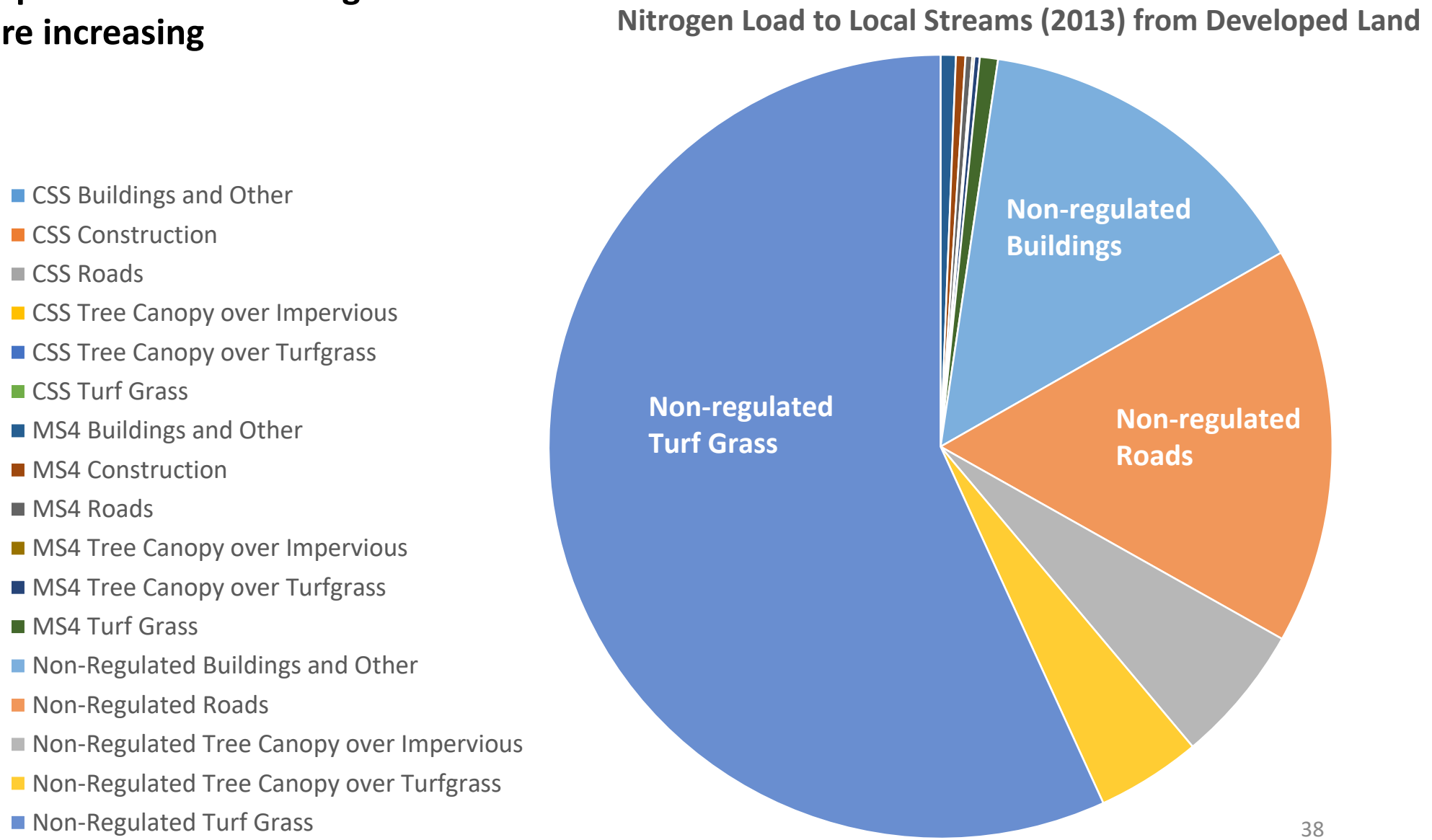


	Conservation Tillage	Cover Crops	Nutrient Management Plan	Barnyard Management	Grass Buffers	Conservation Plans	Forest Buffers	Livestock Management	Forest Buffers with Fencing
PA state-wide implementation	73%	9%	31%	20%	0.2%	59%	2%	60%	0%
PA Phase II WIP 2025	96%	43%	95%	66%	1.4%	96%	4.7%	60%	28%

PA 2016 Progress Report and PA Phase II WIP.

What practices to focus on?

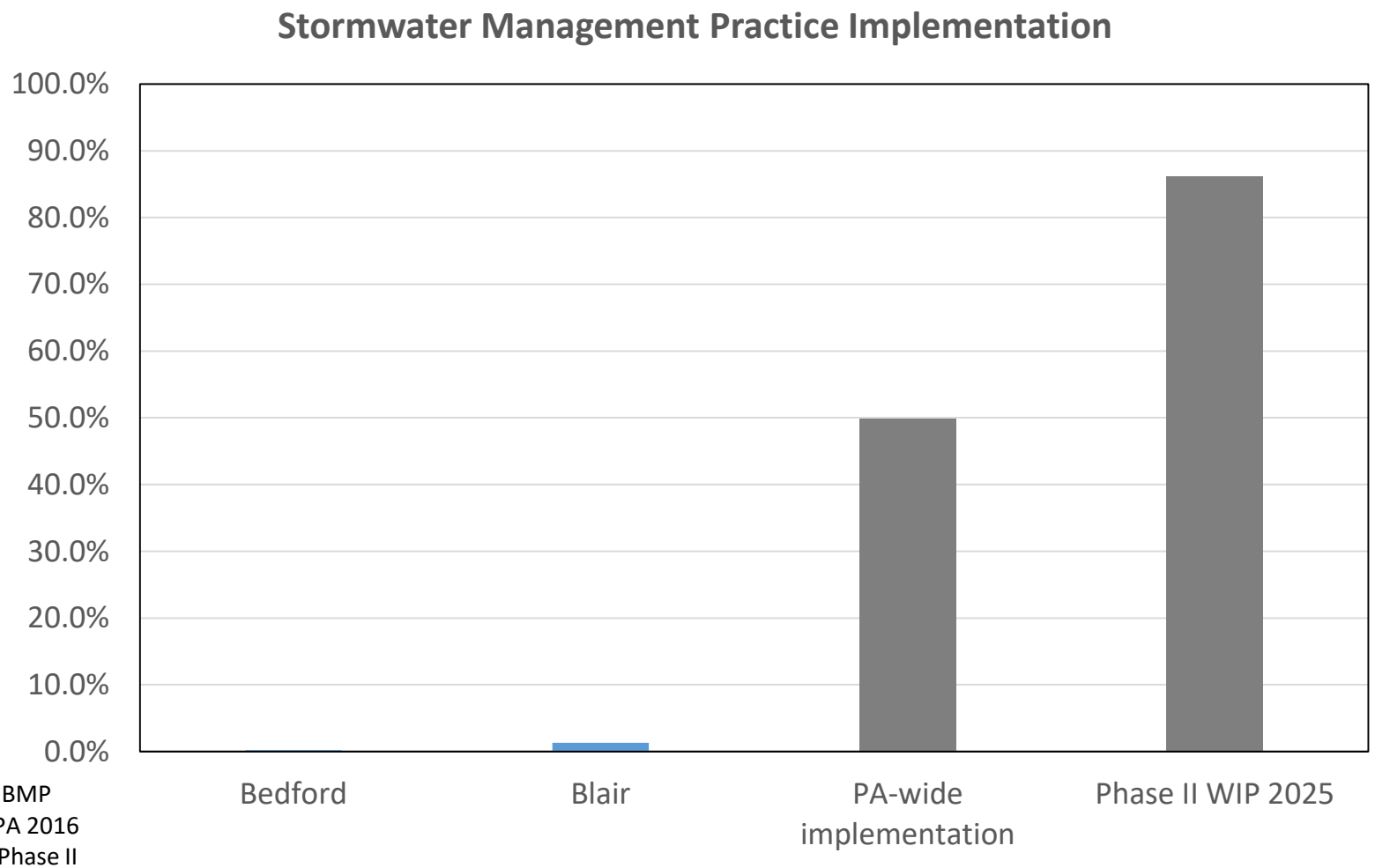
- **Loads from developed land are not insignificant in these areas and are increasing**



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

What practices to focus on?

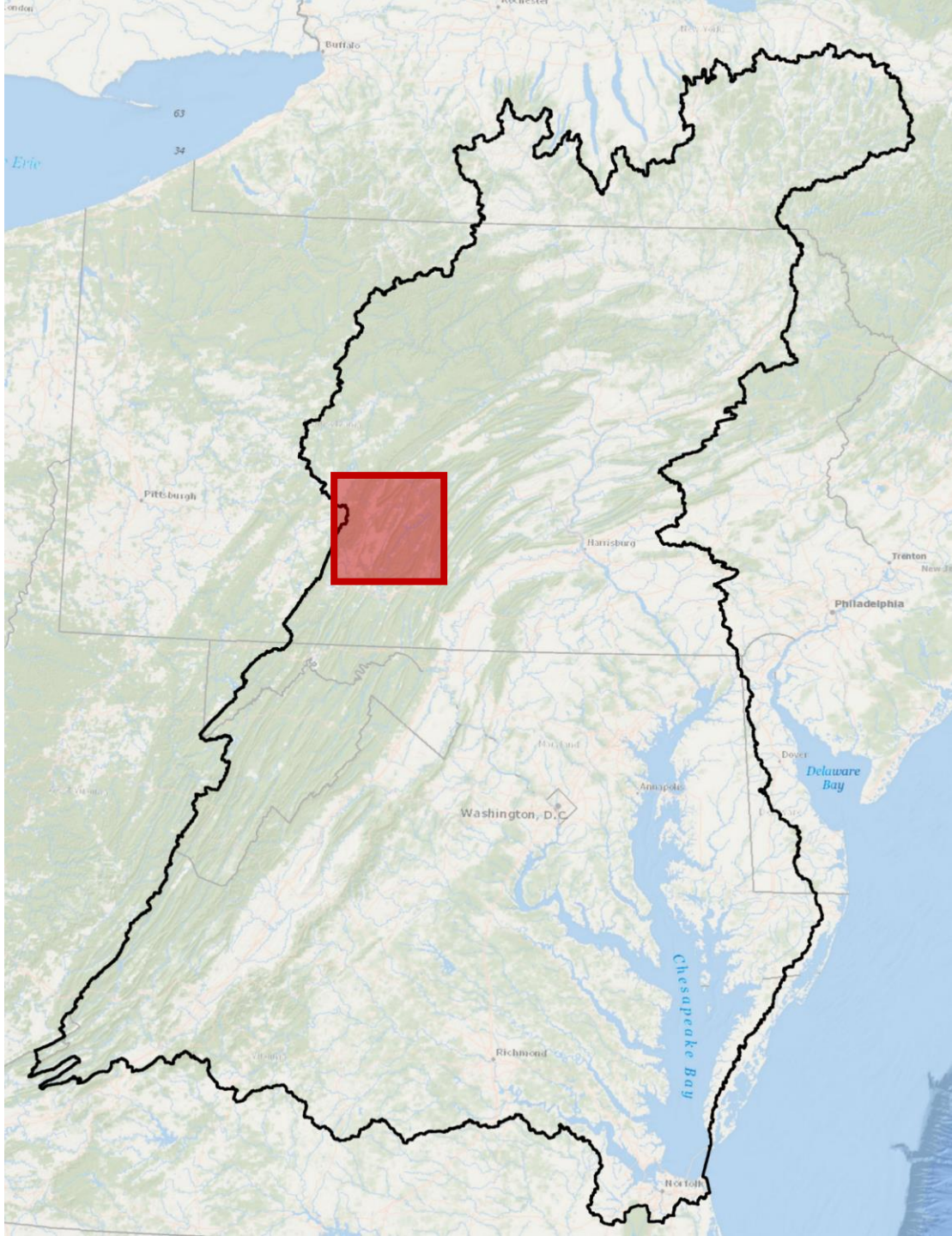
- **Loads from developed land are not insignificant in these areas and are increasing**
- **Stormwater management will be important to address issues associated with increasingly developed areas**



From CBP WSM Phase 6 BMP Summary Report 2013. PA 2016 Progress Report and PA Phase II WIP.

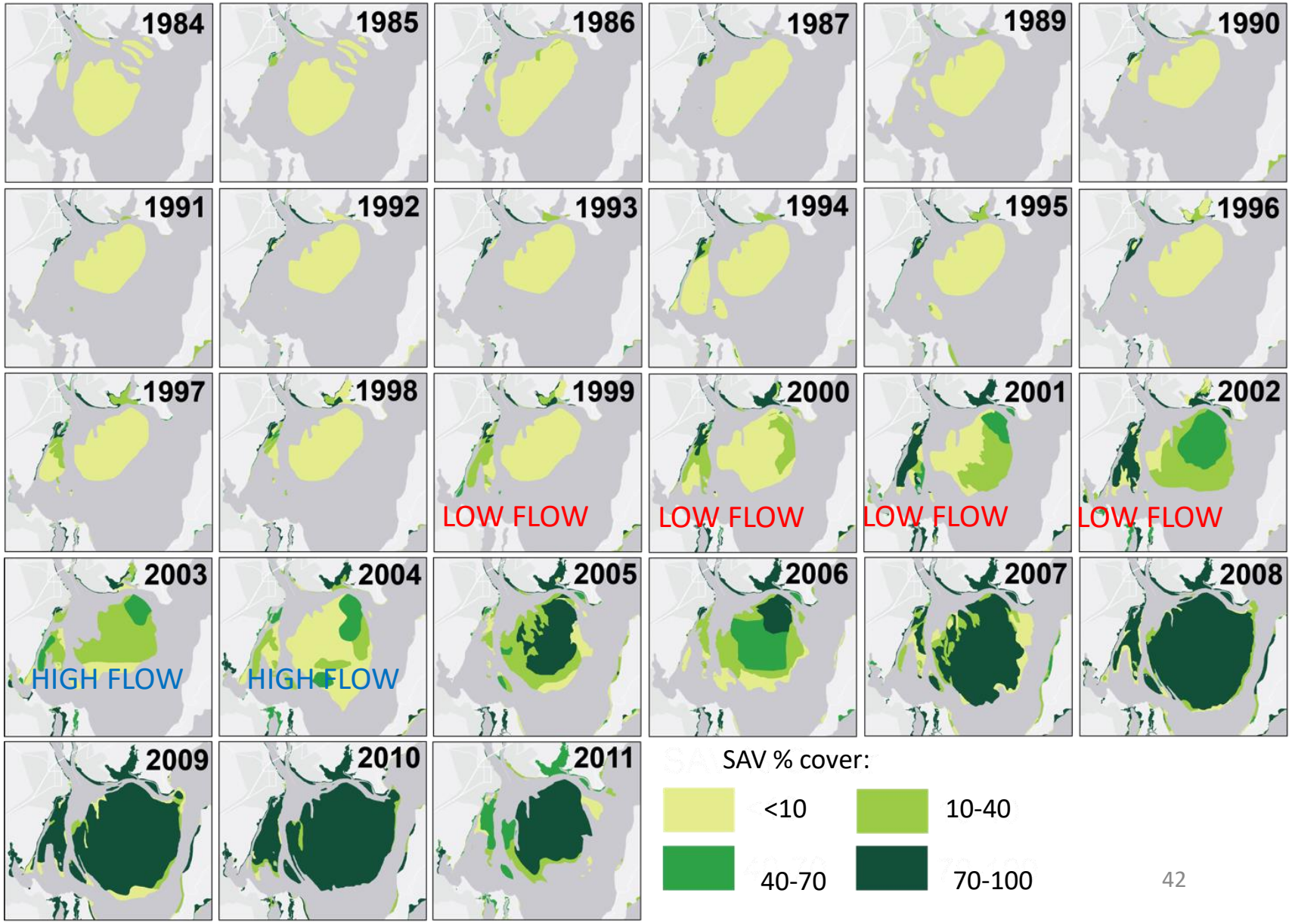
Management Implications Summary

- Certain geographic areas within this region can be more effective to target based on loads and geology
- Counties differ in their practices, which should be taken into account when focusing efforts
- In these areas, practices such as cover crops, forest buffers, and barnyard control can be effective
- Stormwater practices will be important to address increasing development



Restoration in Pennsylvania is helping the Bay

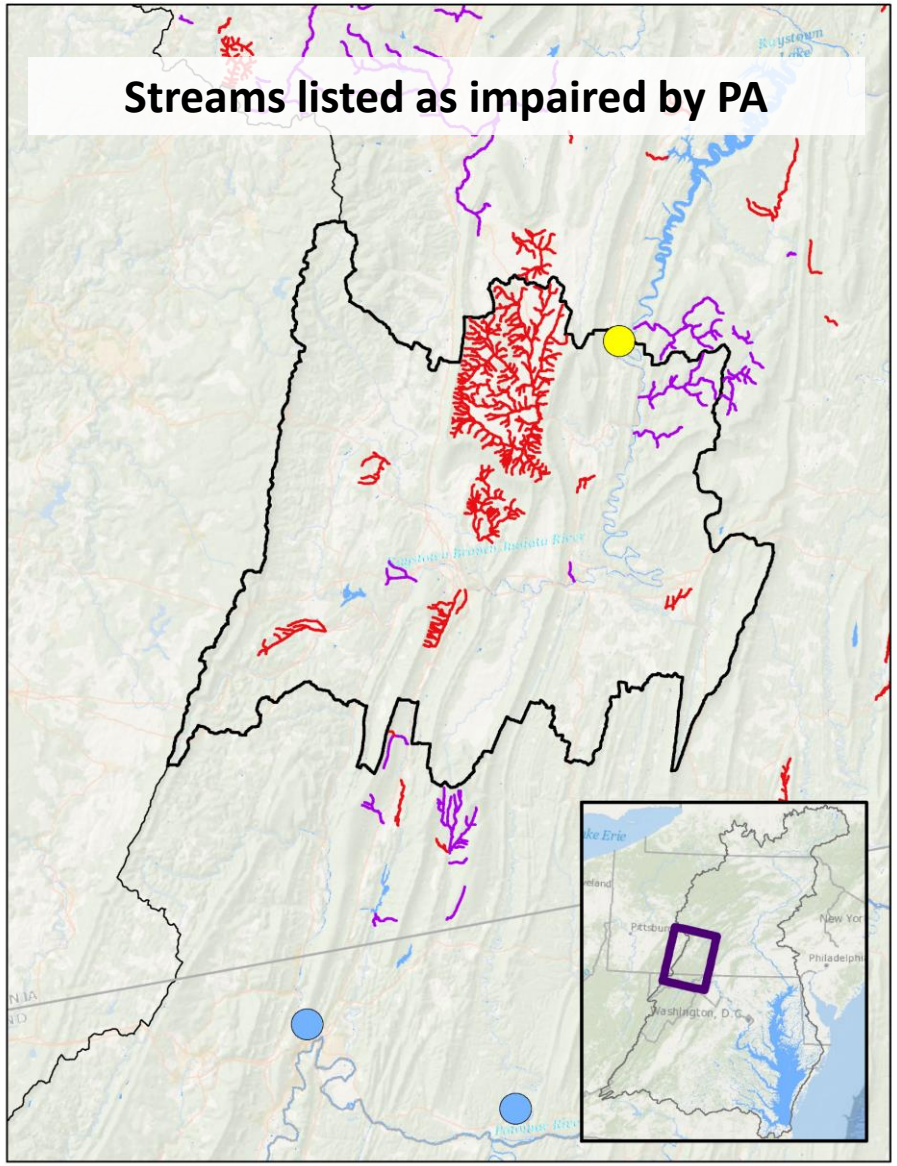
- **Submerged Aquatic Vegetation recovery and resilience have drastically improved in the Susquehanna Flats due to a combination of reduced nutrients and low flow years**



Gurbisz, C. & Kemp, W.M. 2014. *Limonol. Oceanogr.* 59(2):483-494.

But it’s not just about the Bay…

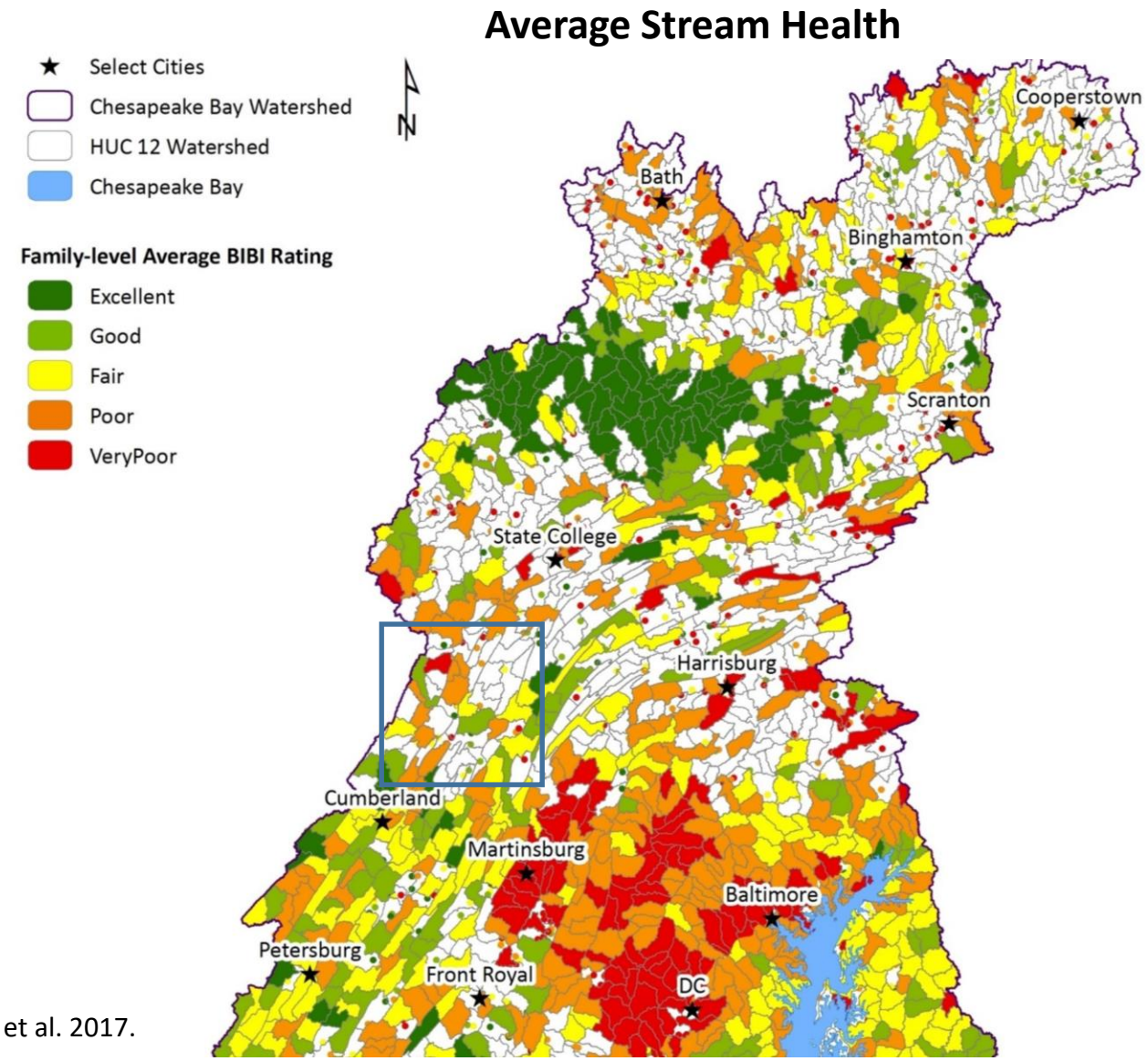
- **Many local streams are impaired due to a variety of problems**
- **In this area, impairment is often due to agricultural sources**



From PA 303(d) impaired waters list. See References section at end of document.

And it’s not just about water quality…

- **Stream health in this area ranges from good to very poor, with presence of many watersheds with poor stream health**

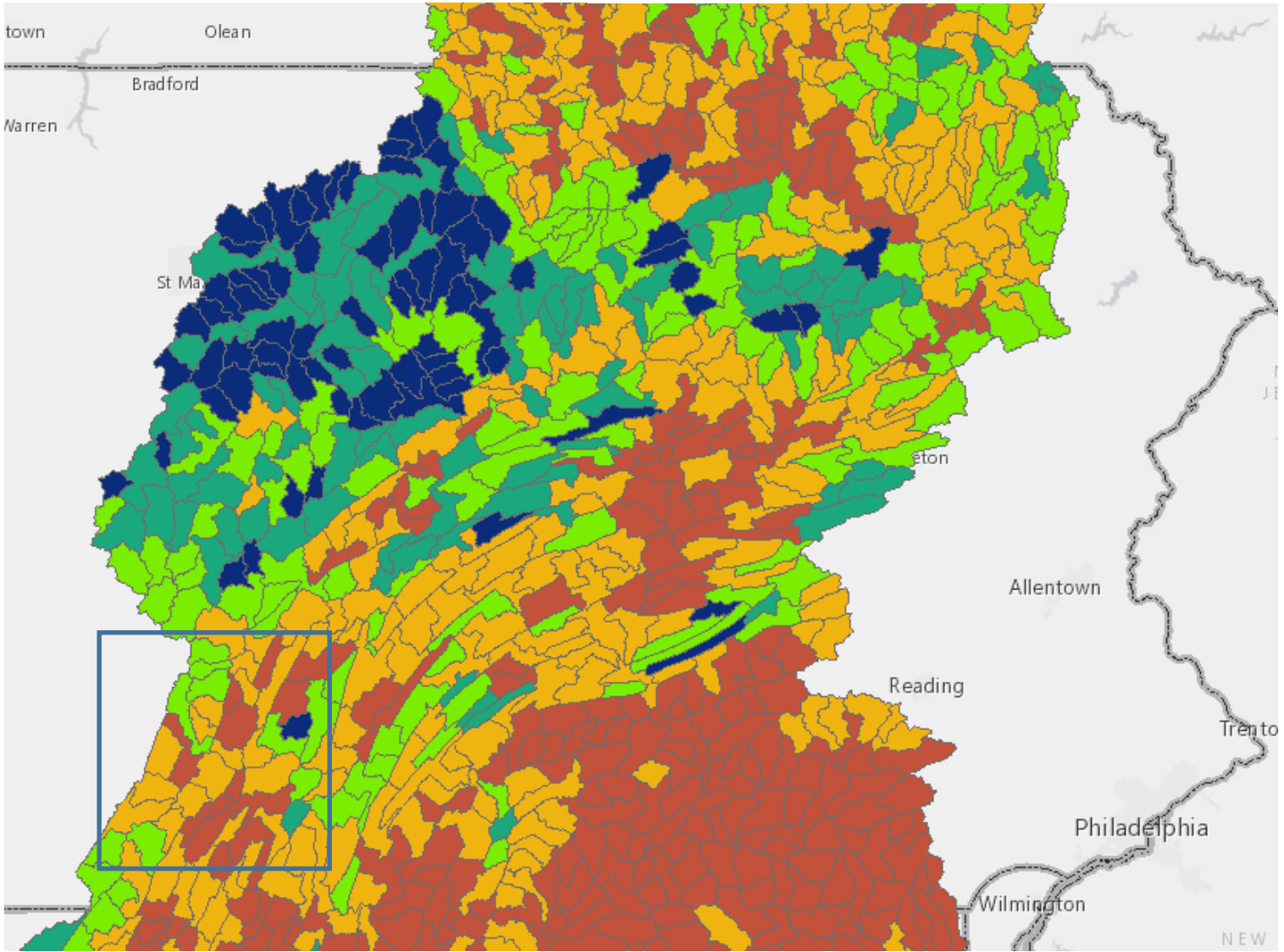


Smith, Z.C. et al. 2017.

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



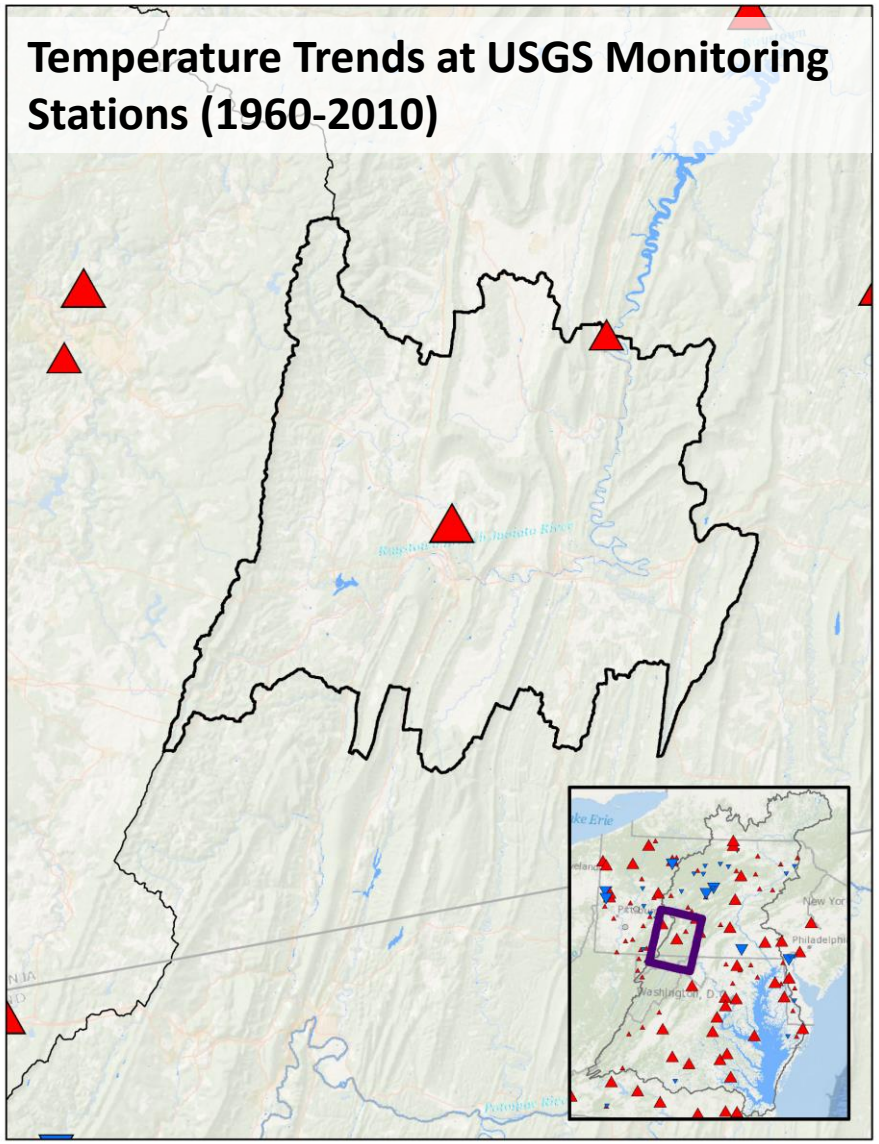
Predicted Likelihood of Occurrence

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

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

And it’s not just about water quality…

- **Stream temperatures are rising across the region, which impact native fish species such as brook trout**



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

A LOT of new and updated info available…

Monitoring & Trends

Nontidal water quality

Tidal water quality

Tidal attainment

Stream & tidal benthic

Submerged aquatic vegetation

Synthesis Analyses

USGS Non-tidal Syntheses

-Regional Nitrogen

-SPARROW models

-Groundwater models

SAV Syntheses

Water Clarity Synthesis

Water Quality Synthesis

Modeling Tools

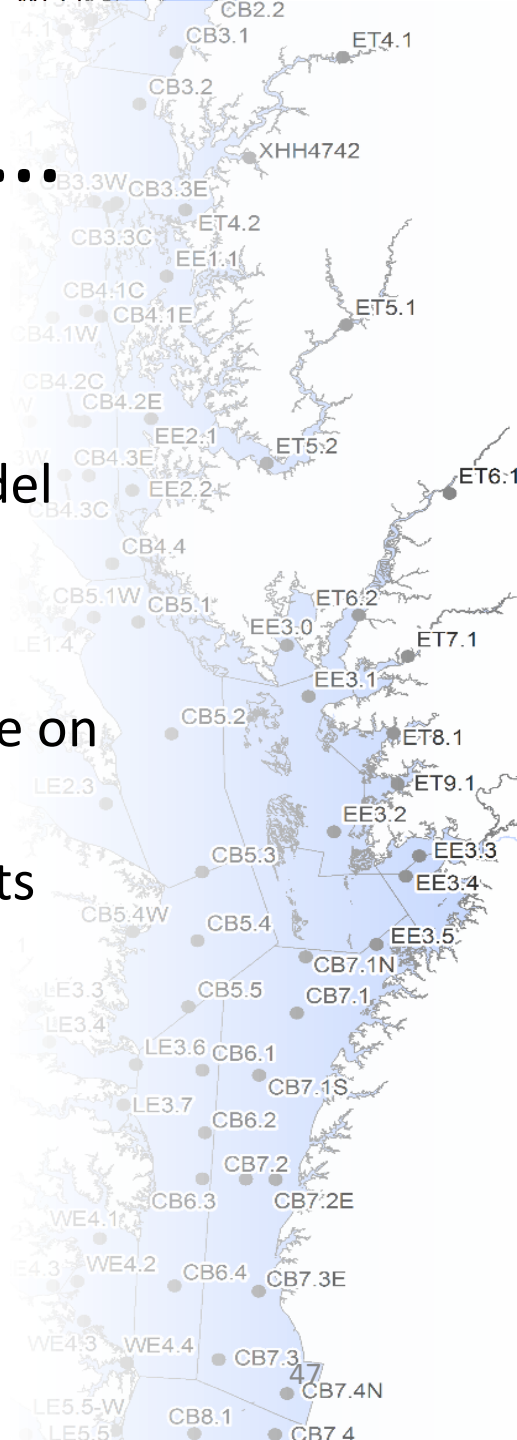
CBP Watershed Model

Geographic load distribution

Geographic influence on Bay

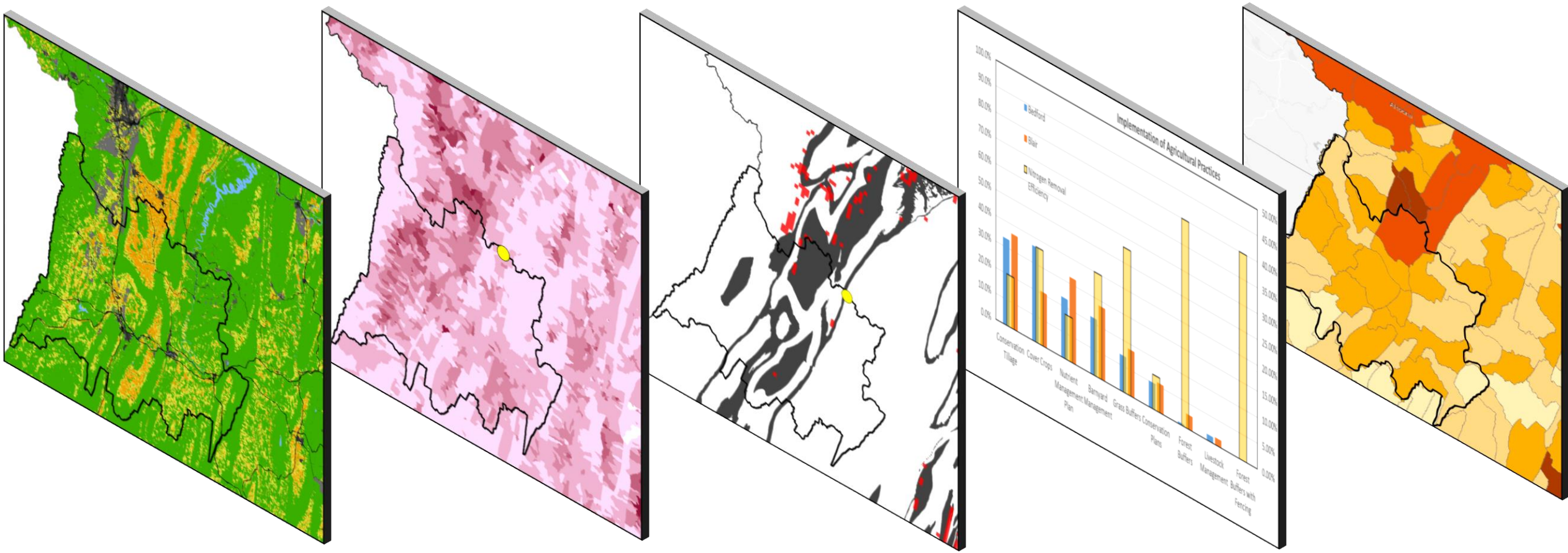
BMP progress reports

…and more to come



A LOT of new and updated info available…

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



To Keep in Mind…

- Most of the data are available watershed-wide
- Are example stories useful for demonstrating data and information available and how to use it?
- How would you like to access and use the data and information available for your own communities?

Incorporating monitoring, modeling and trends analyses into management decisions: a Choptank River example

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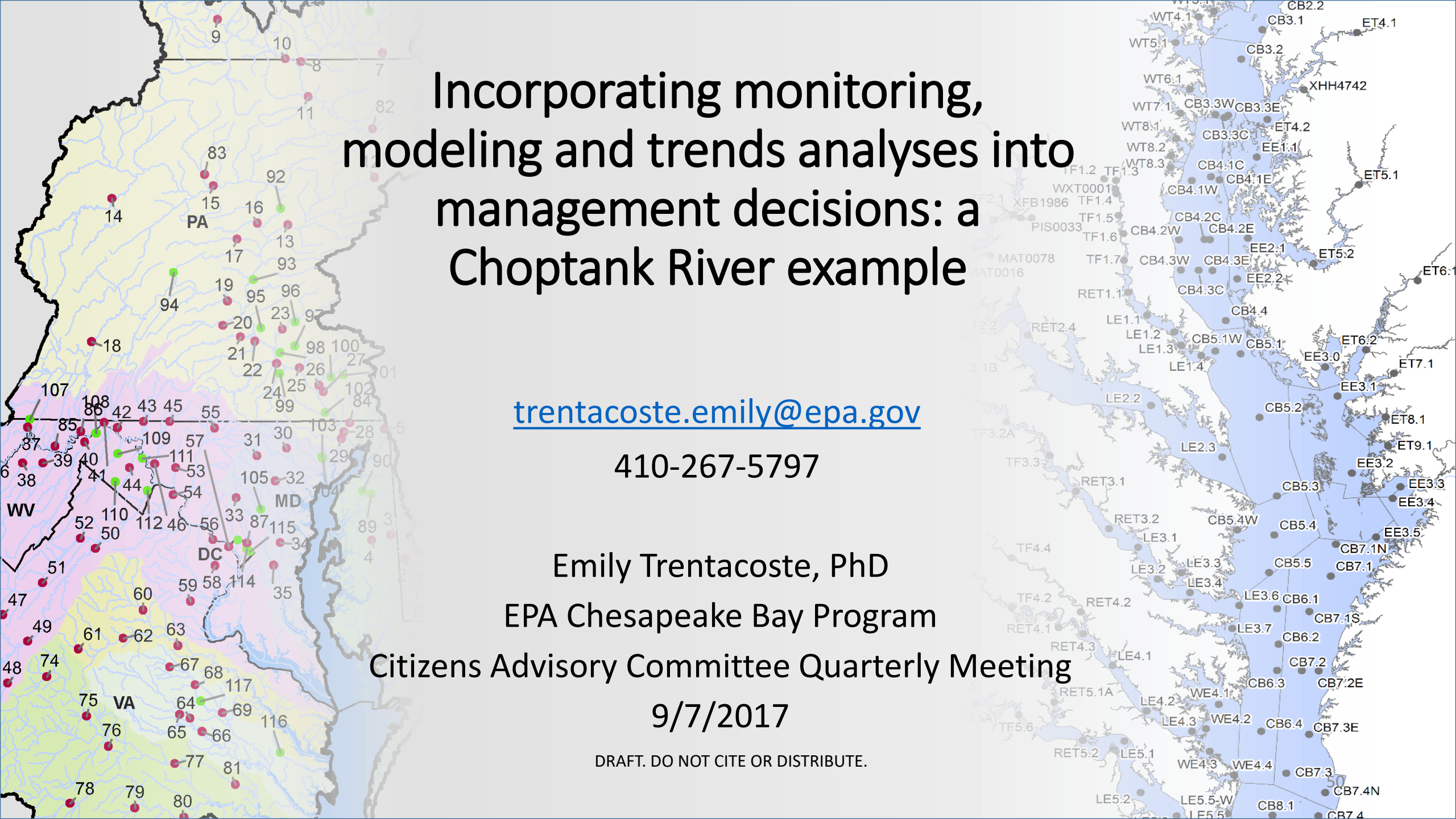
EPA Chesapeake Bay Program

Citizens Advisory Committee Quarterly Meeting

9/7/2017

DRAFT. DO NOT CITE OR DISTRIBUTE.



References

Slide 8-10, 18: USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/

Slide 13, 26: Falcone, J.A., 2015, U.S. conterminous wall-to-wall anthropogenic land use trends (NWALT), 1974–2012: U.S. Geological Survey Data Series 948, 33 p. plus appendixes 3–6 as separate files, http://dx.doi.org/10.3133/ds948.

Slide 17: Ator, S.W., and Denver, J.M., 2015, Understanding nutrients in the Chesapeake Bay watershed and implications for management and restoration—the Eastern Shore (ver. 1.2, June 2015): U.S. Geological Survey Circular 1406, 72 p., *http://dx.doi.org/10.3133/cir1406*.

Slide 19-20, 28, 30: Explaining nitrogen loads and trends in Chesapeake Bay tributaries: an interim report. Jimmy Webber, USGS, unpublished. DO NOT CITE OR DISTRIBUTE.

Slide 29: Ator, S.W., Brakebill, J.W., and Blomquist, J.D., 2011, Sources, fate, and transport of nitrogen and phosphorus in the Chesapeake Bay watershed—An empirical model: U.S. Geological Survey Scientific Investigations Report 2011–5167, 27 p. (Also available at http://pubs.usgs.gov/sir/2011/5167/.)

Slide 31: 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).

Slide 31: 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).

Slide 31: Nolan, B.T. & Hitt, K.J., 2006. Vulnerability of Shallow Groundwater and Drinking-Water Wells to Nitrate in the United States. *Environ. Sci. & Technol.* 40(24): 7834-7840.

Slide 41: Testa, J. et al., 2017. Ecological Forecasting and the Science of Hypoxia in Chesapeake Bay. *BioScience* 67(7): 614-626.

References

Slide 42: Gurbisz, C. & Kemp, W.M. 2014. Unexpected resurgence of a large submersed plant bed in the Chesapeake Bay: Analysis of time series data. *Limnology & Oceanography*. 59(2): 482-494.

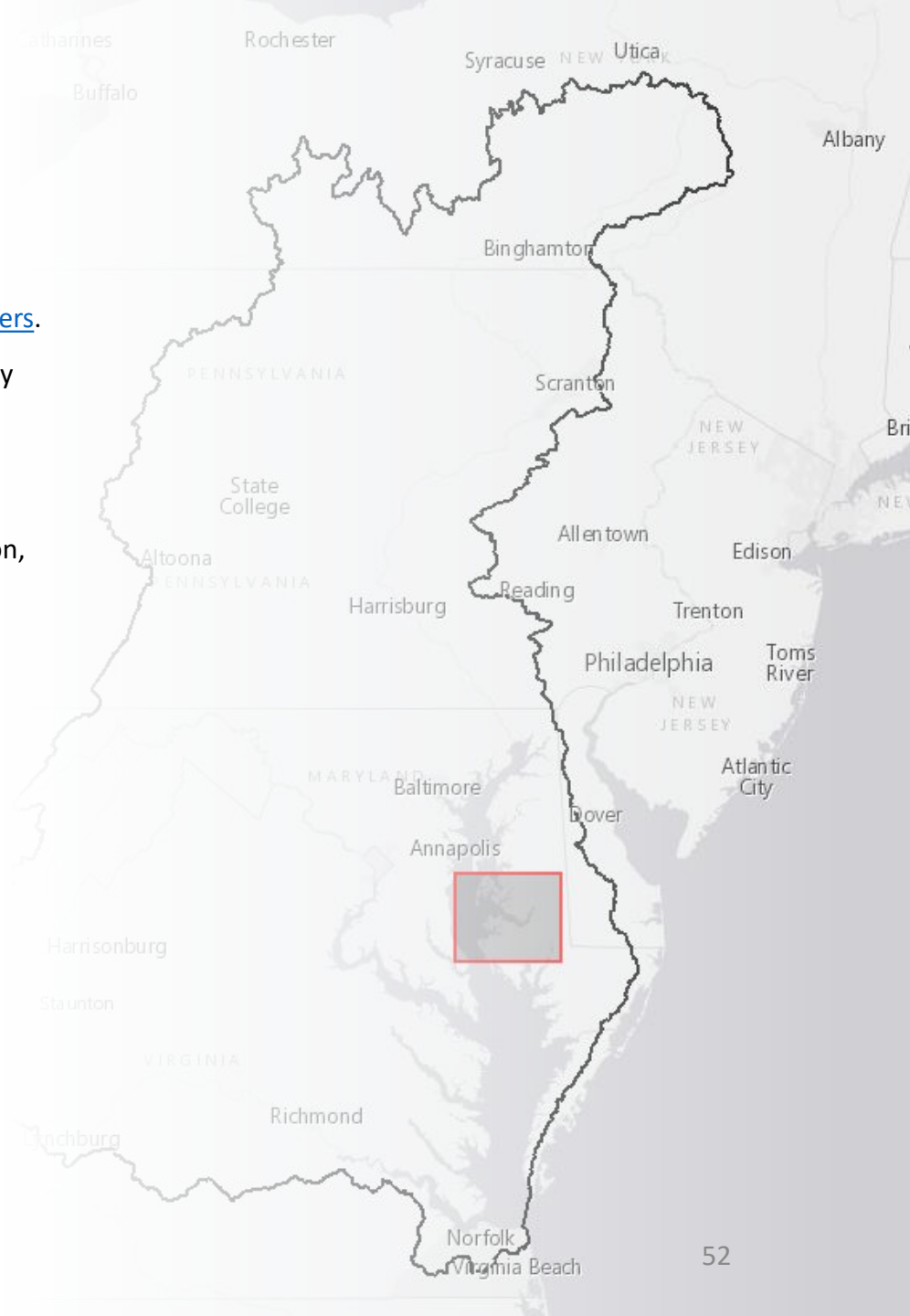
Slide 43: 303(d) Listed Impaired Waters NHDPlus Indexed Data Set. U.S. Environmental Protection Agency. Available at https://www.epa.gov/waterdata/waters-geospatial-data-downloads#303dListedImpairedWaters.

Slide 44: 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.

Slide 45: Fish Habitat Decision Support Tool. http://www.fishhabitattool.org/.

Slide 46: Rice, K. & Jastram, J.D., 2015. Rising air and stream-water temperatures in Chesapeake Bay Region, USA. *Climatic Change* 128(1-2): 127-138. Also available at https://chesapeake.usgs.gov/streamtempfeature12-14.html.

Slide 47: Chesapeake Bay Program Cross-GIT Mapping Project: http://gis.chesapeakebay.net/intergit/overview.html. Visualization tool: https://gis.chesapeakebay.net/mpa/scenarioviewer/.



Data Analysis

Slide 13-16, 26, 35, 38: 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.

Slide 23-24: 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.

Slide 34, 36-37, 39: 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.

Slide 36-37: 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.