Water-Quality Results from Four Chesapeake Bay Showcase Watersheds:

Monitoring and Analysis Designed to Assess and Inform Restoration

April 21st, 2016

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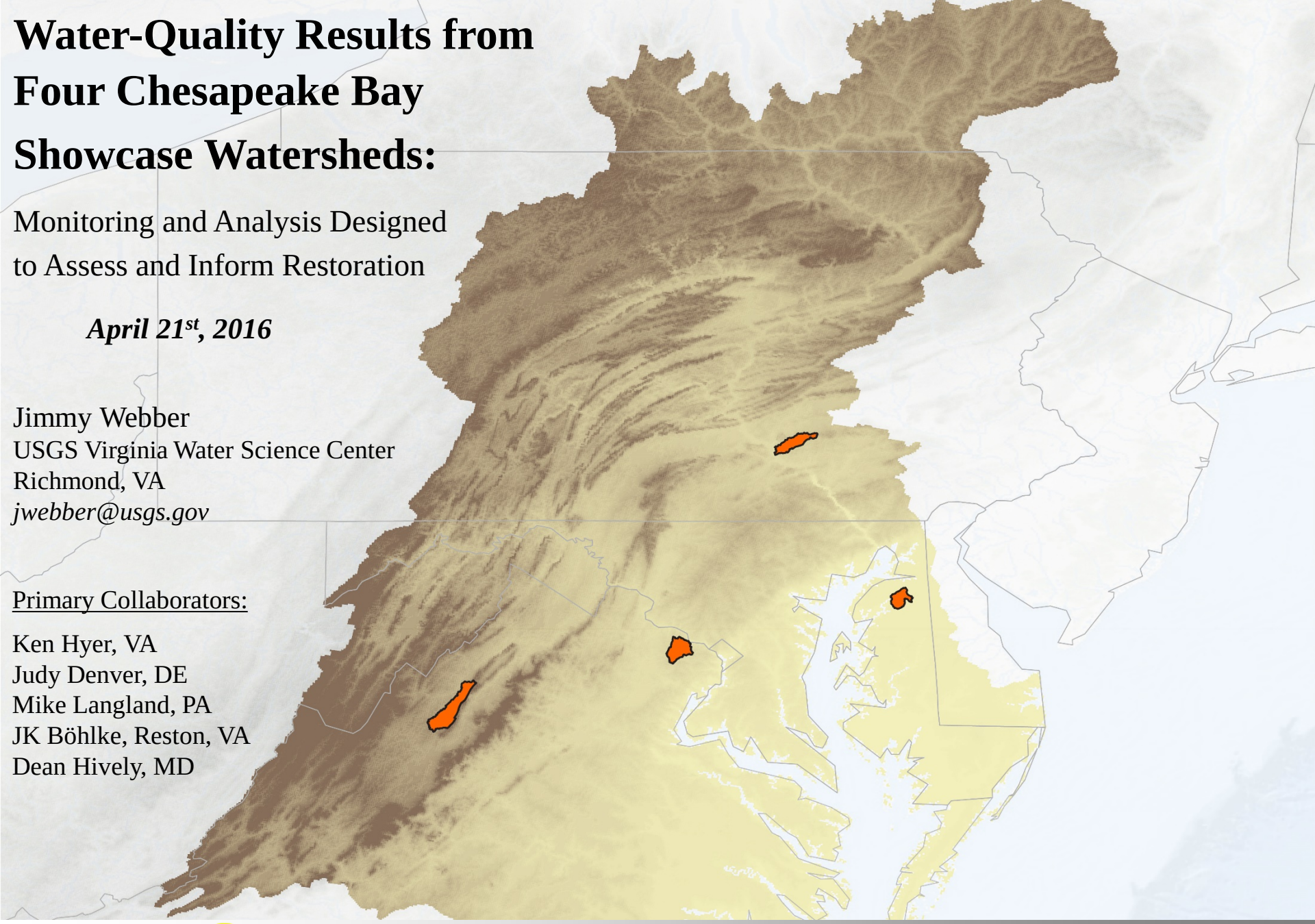

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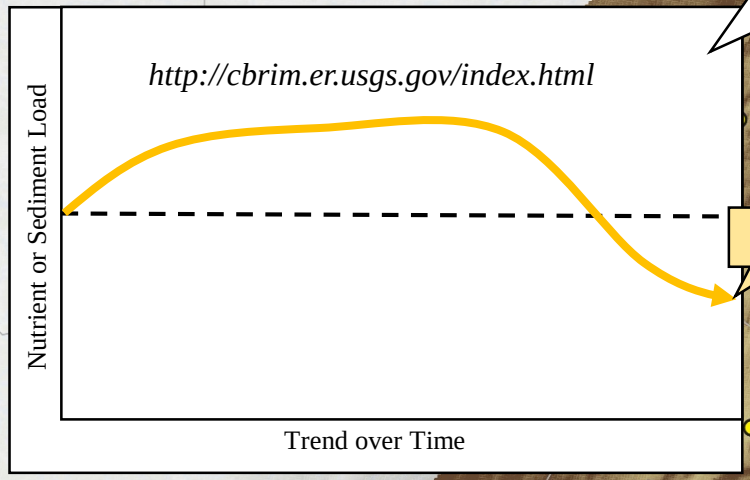
USDA

Water-Quality Results from Four Chesapeake Bay Showcase Watersheds:

Impetus for this process-level work

Non-tidal network monitoring location

How is the water quality of rivers and estuaries responding to restoration actions and changing land use?



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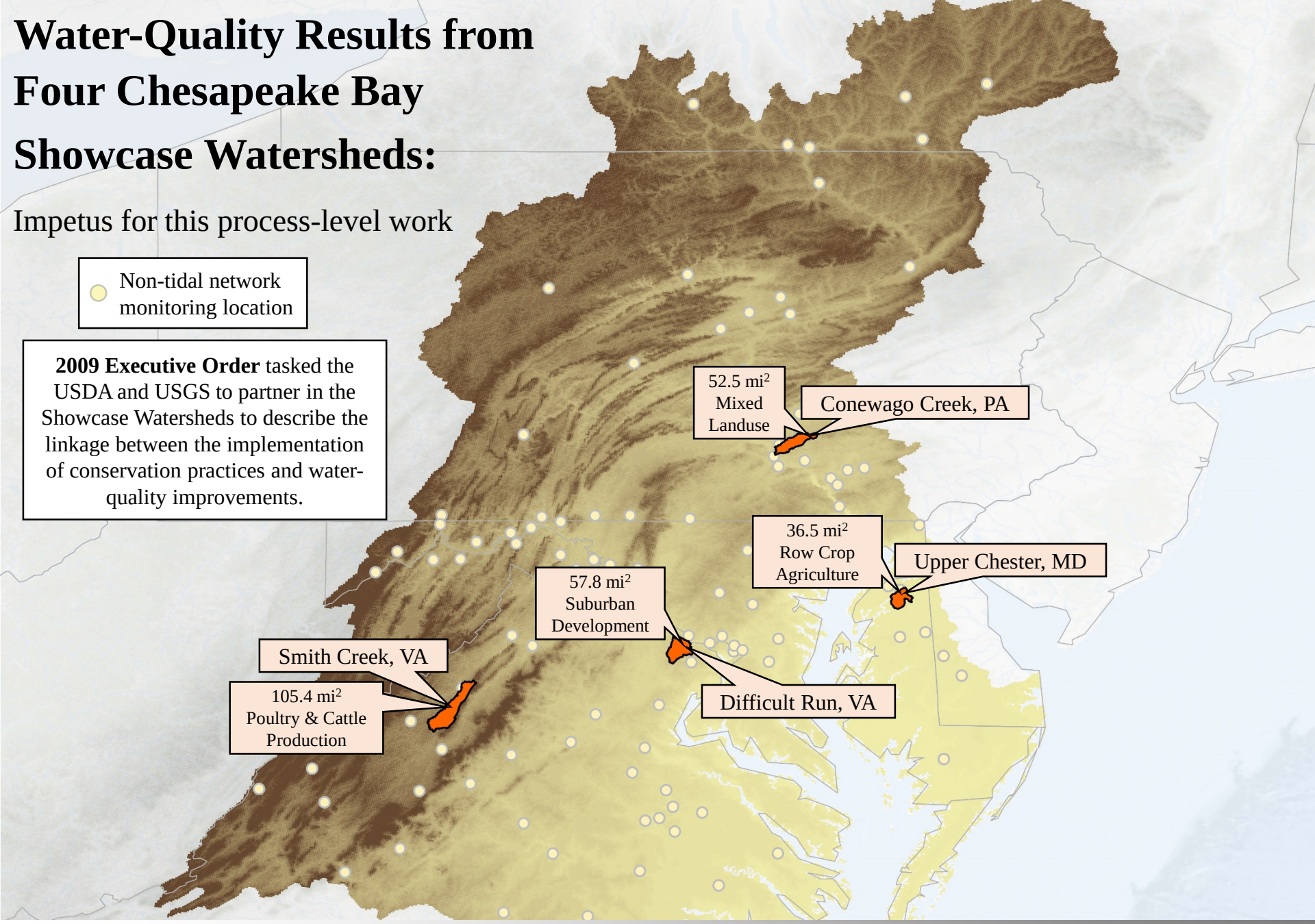

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Impetus for this process-level work

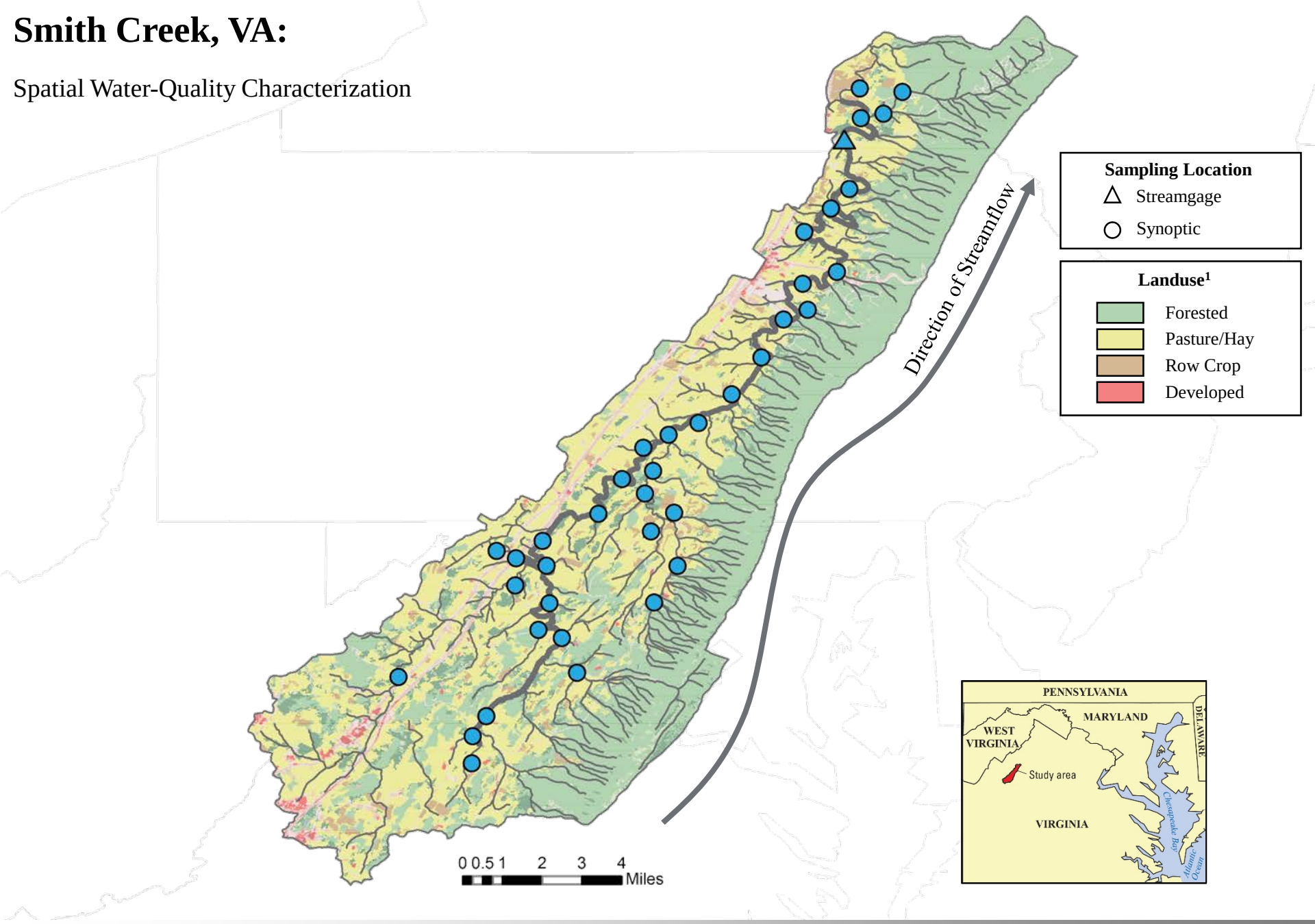
Non-tidal network monitoring location

2009 Executive Order tasked the USDA and USGS to partner in the Showcase Watersheds to describe the linkage the implementation of conservation practices and water-quality improvements.

Benefits	Challenges
We can isolate different basin types	**High cost for such intensive monitoring**
We can potentially resolve specific sources of sediment and nutrients	**How to transfer knowledge of individual basins to a regional scale?**
Enhanced spatial resolution can reveal nutrient and sediment "hot spots"	**How to link water-quality response to BMP implementation?**

Smith Creek, VA:

Spatial Water-Quality Characterization



[1]Landuse from NLCD 2011

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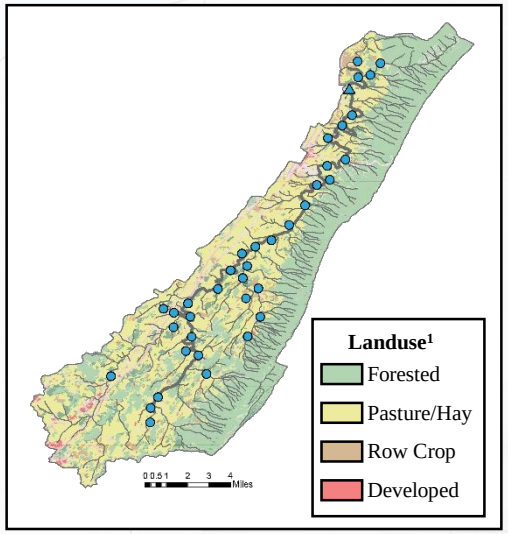

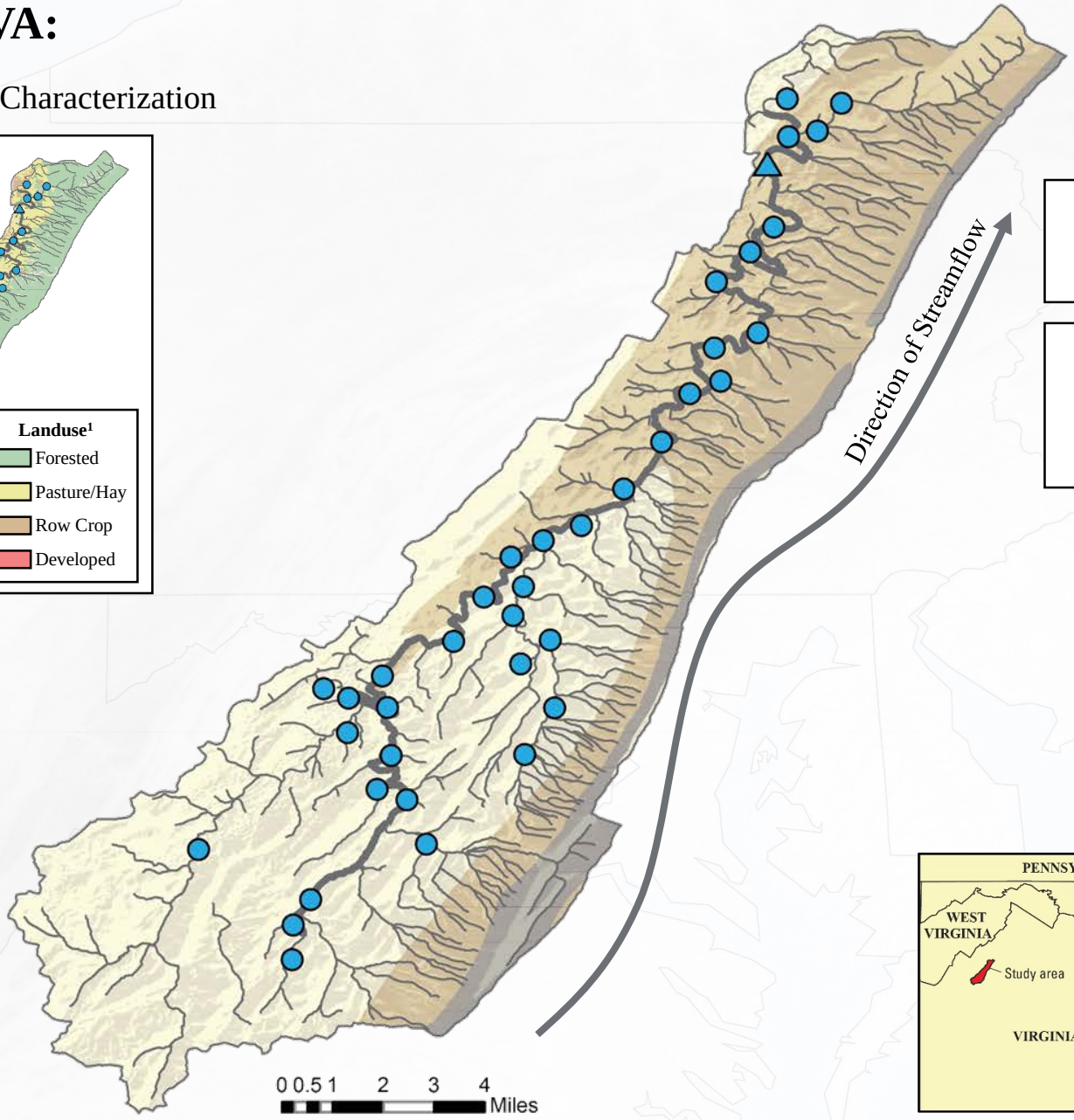

Sampling Location

△ Streamgage

○ Synoptic

Geology[2]

Limestone

Shale

Other

USGS science for a changing world

[1]Landuse from NLCD 2011

[2]Geology from Dicken and others (2005)

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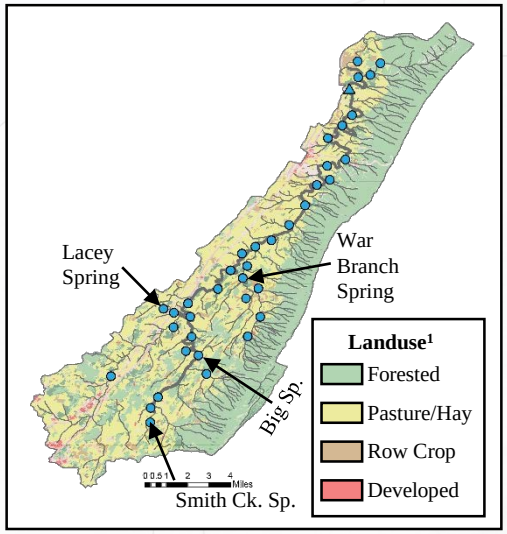

Lacey Spring

War Branch Spring

Big Spring

Smith Creek Spring

Direction of Streamflow

0 0.5 1 2 3 4 Miles

Sampling Location

Streamgage

Synoptic

Geology[2]

Limestone

Shale

Other

Sinkhole[3]

USGS science for a changing world

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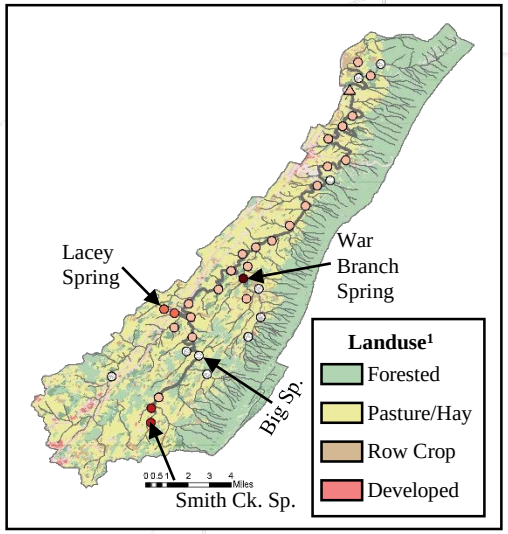

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Direction of Streamflow

0 0.5 1 2 3 4 Miles

Sampling Location
- Streamgage
- Synoptic

Geology[2]
- Limestone
- Shale
- Other
- Sinkhole[3]

Total Nitrogen, in milligrams per liter[4]
- 0.0 to 2.0
- 2.1 to 4.0
- 4.1 to 6.0
- 6.1 to 8.0
- 8.1 to 10.0

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[1]Landuse from NLCD 2011

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[4]Total nitrogen concentrations from May 2013 synoptic sampling event.

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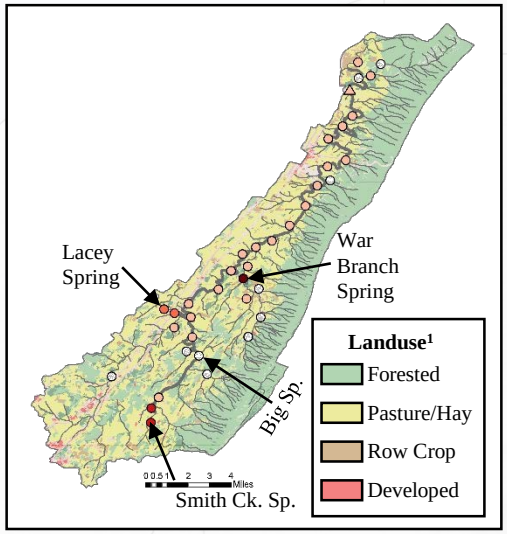

Total Nitrogen, in pounds per day[4]

- 0 to 150
- 151 to 300
- 301 to 450
- 451 to 600
- 601 to 750

Lacey Spring

War Branch Spring

Big Spring

Smith Creek Spring

0 0.5 1 2 3 4 Miles

Sampling Location

- Streamgage
- Synoptic

Geology[2]

- Limestone
- Shale
- Other
- Sinkhole[3]

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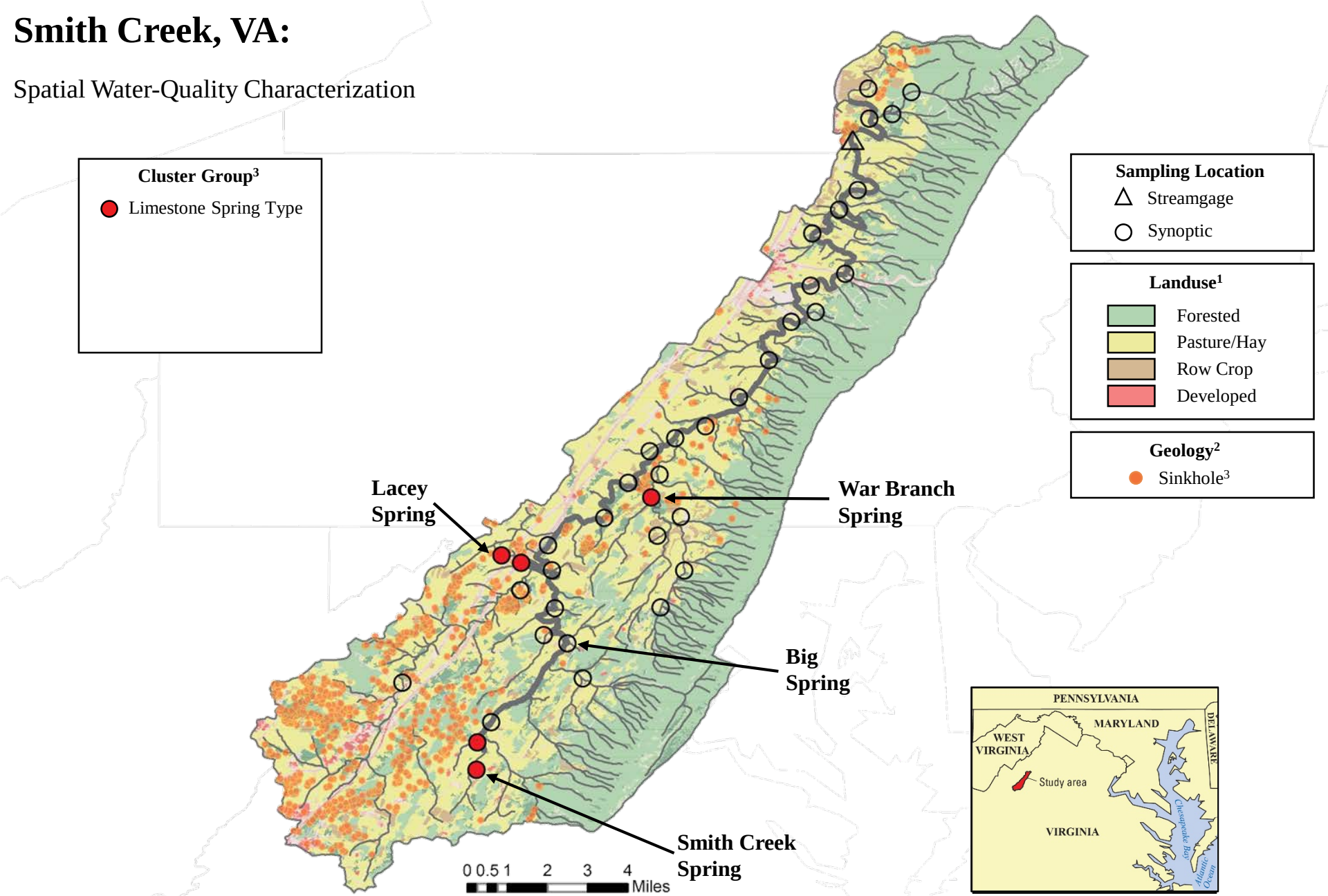

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[3]Cluster groups assigned to samples during May 2013 synoptic sampling event.

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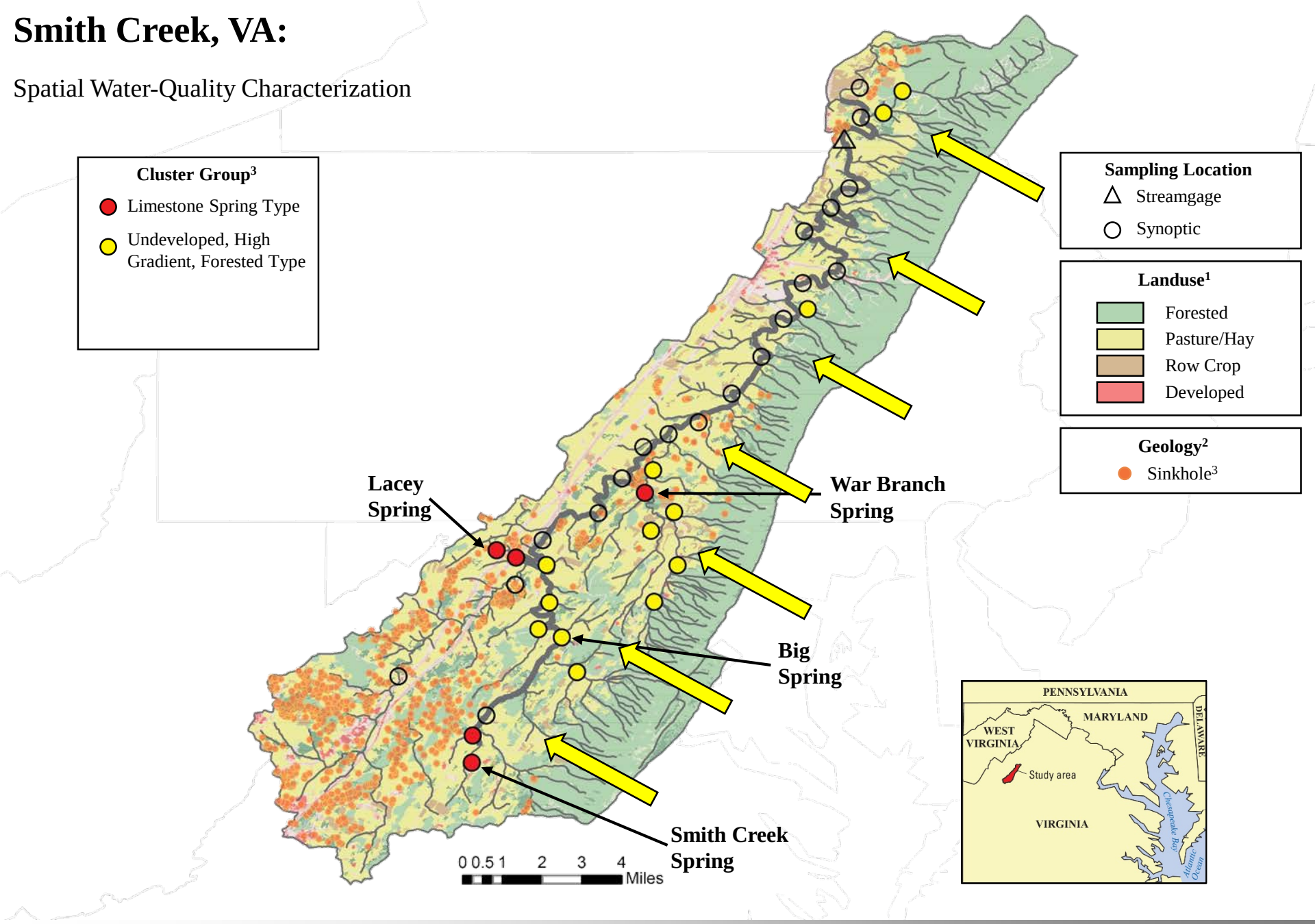

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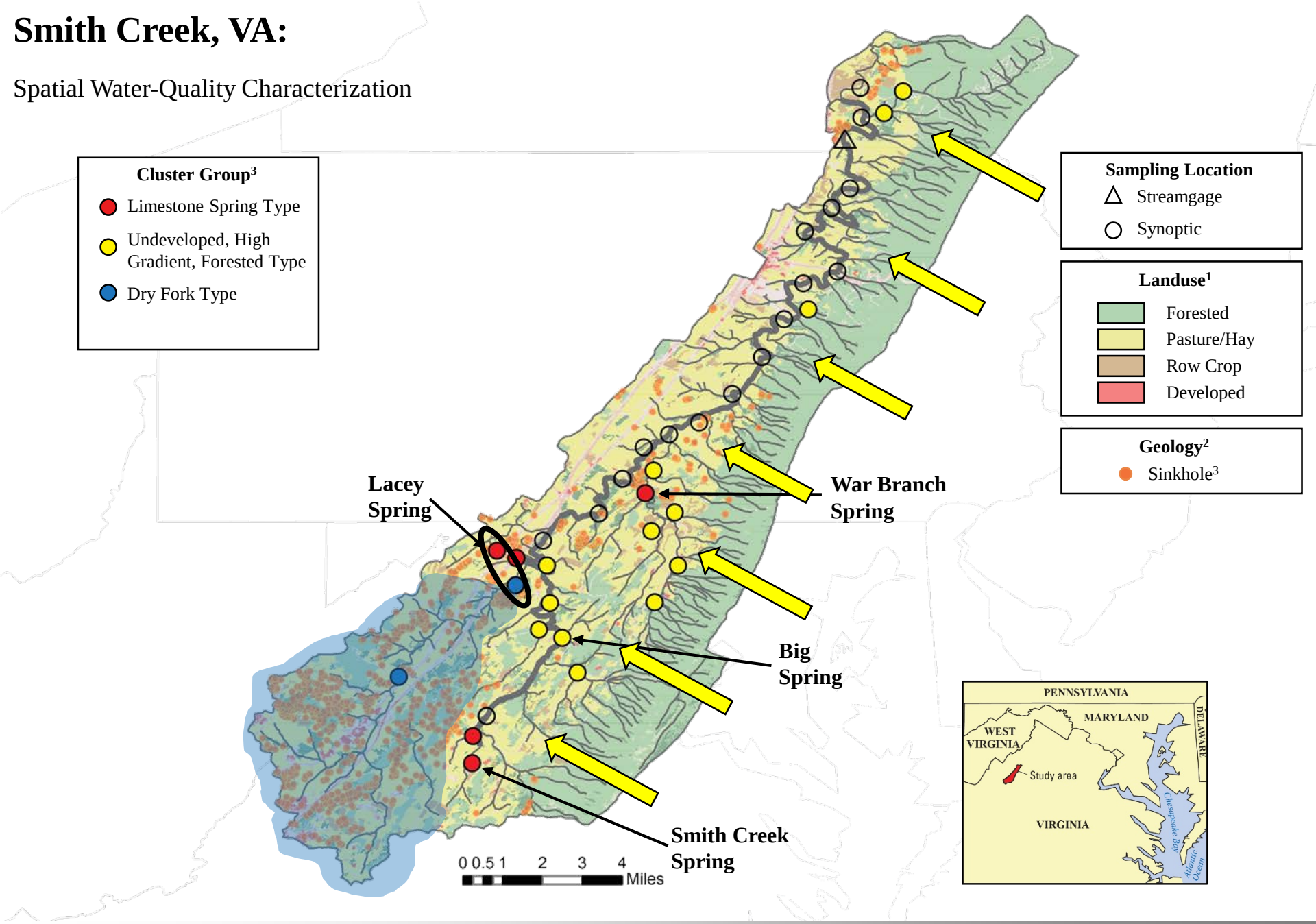

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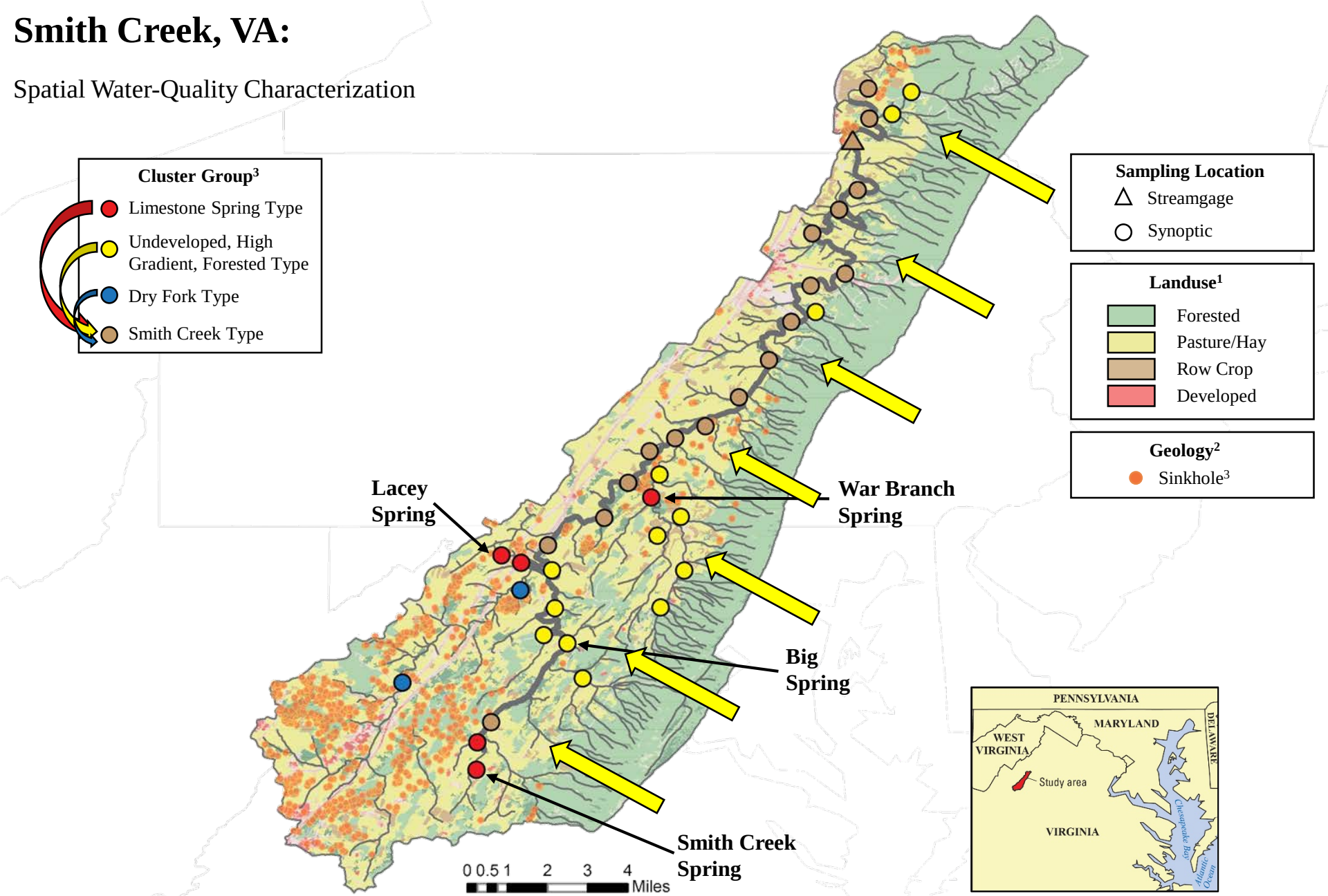

USGS science for a changing world

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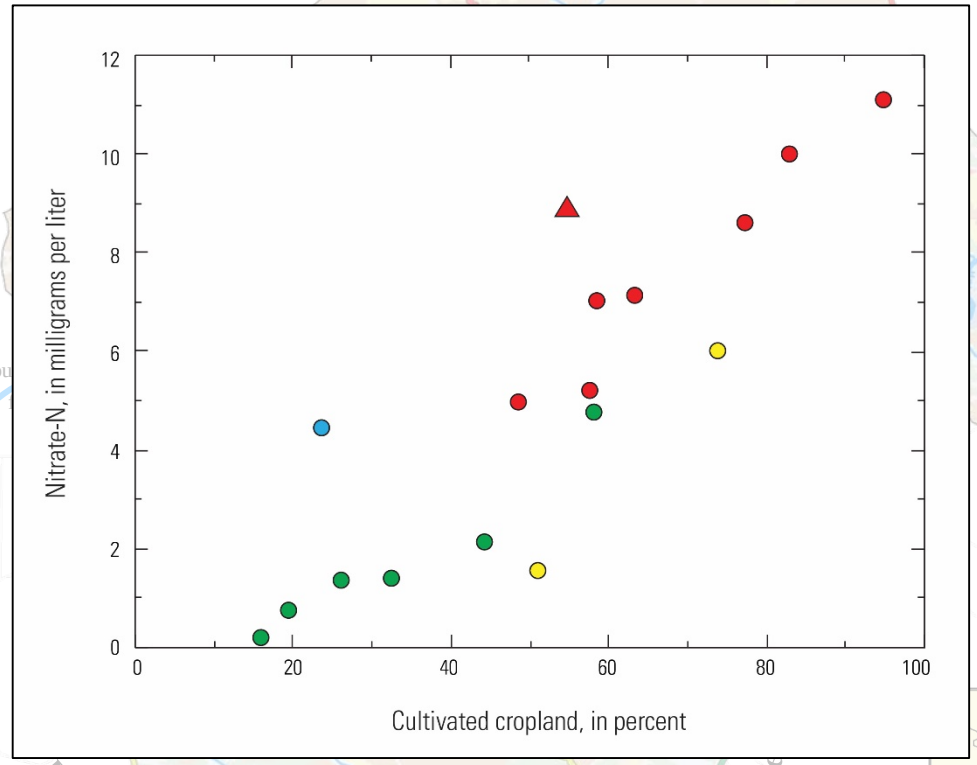
Upper Chester, MD:

Spatial Water-Quality Characterization



Sampling Location

- Streamgage
- Synoptic

Landuse[1]

- Forested
- Pasture/Hay
- Row Crop
- Developed

Cluster Group[2]

- Oxic, high agriculture type
- Anoxic, low agriculture type
- Northern, high total phosphorus type
- High-NaCl type

Chesterville Branch

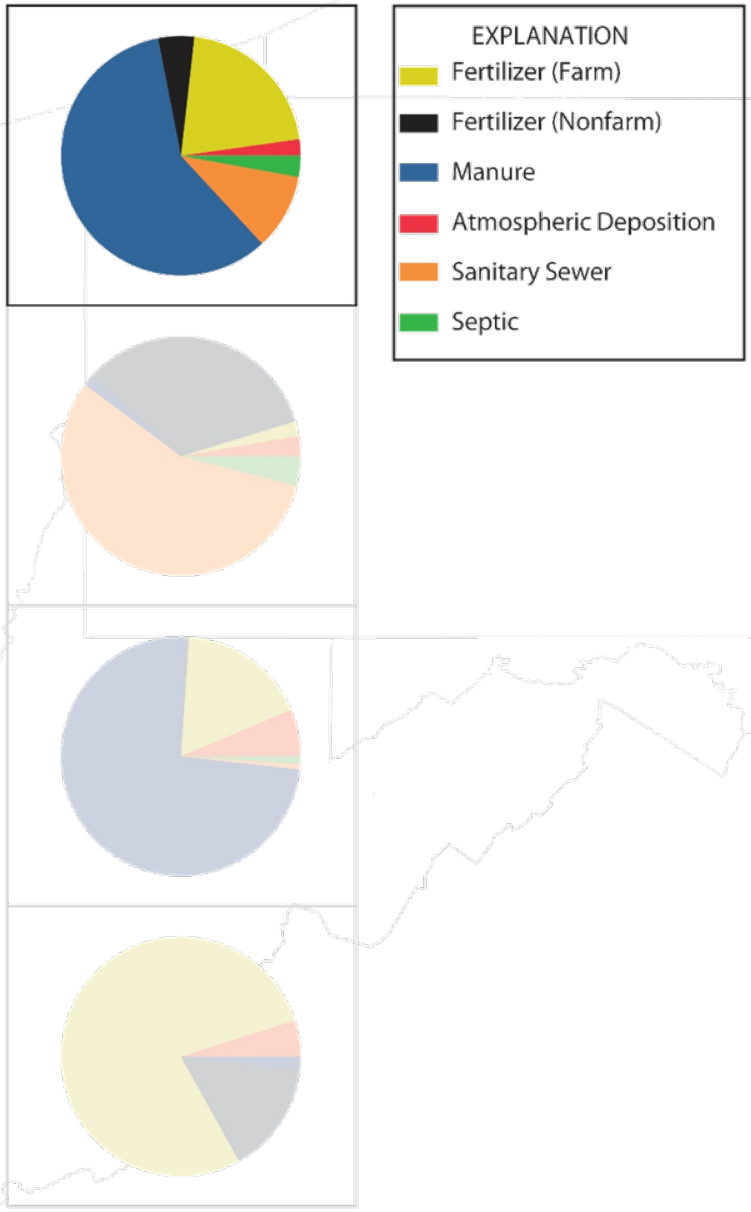
Foreman Branch

0 0.5 1 2 Miles

[1]Landuse from NLCD 2011

[2]Cluster groups assigned to samples during April 2013 synoptic sampling event.

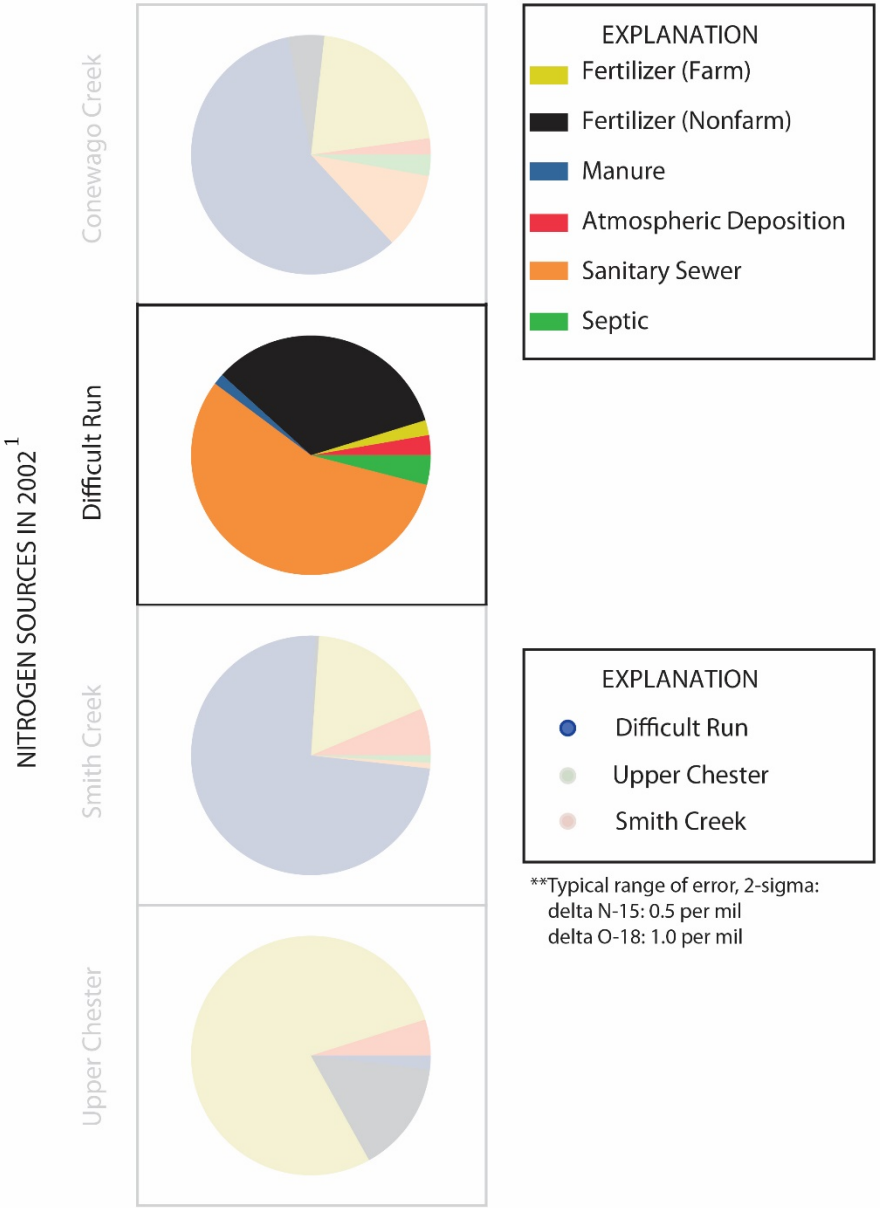
Nitrogen Sources: Conewago Creek, PA

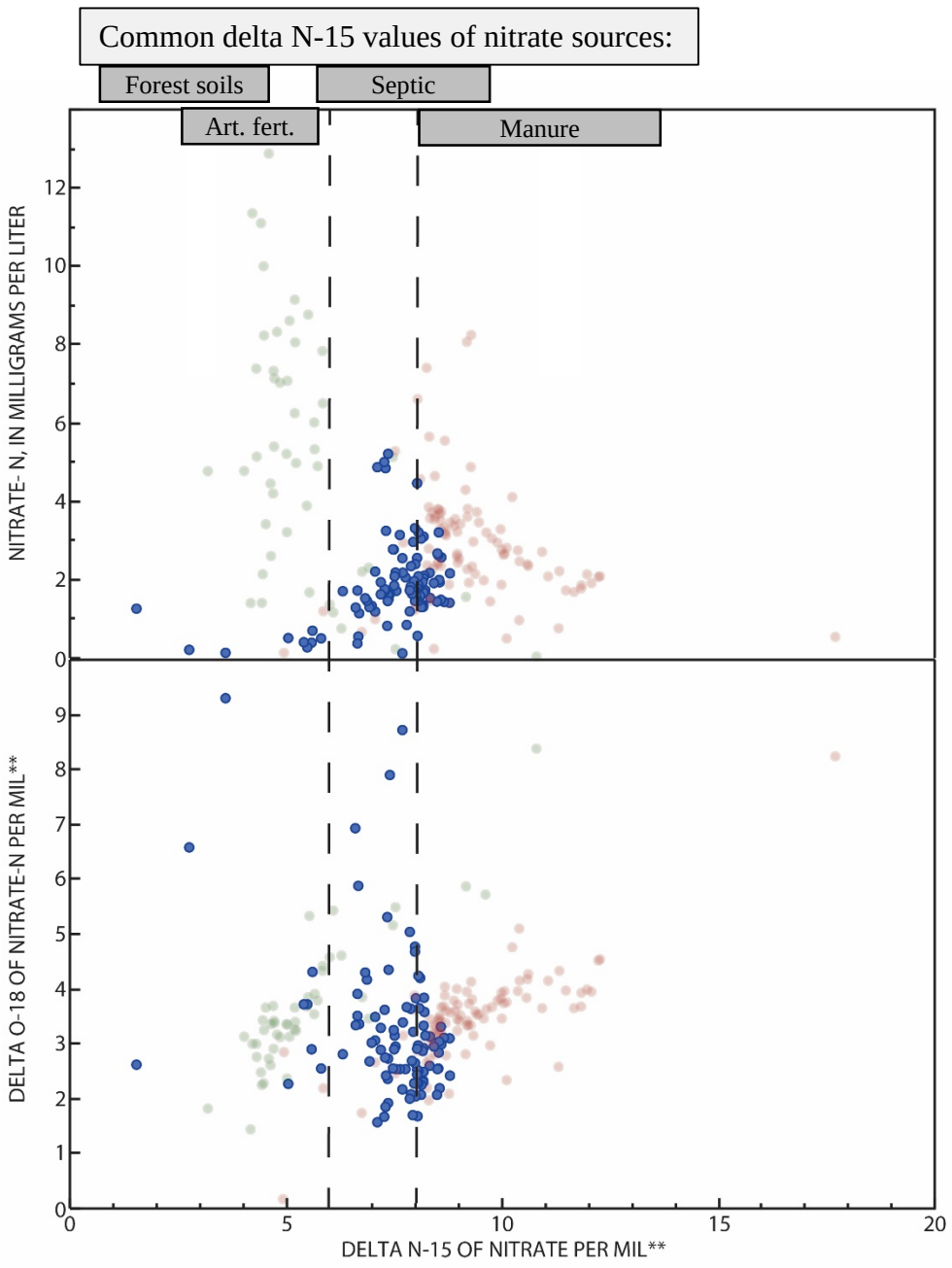


NITROGEN SOURCES IN 2002[1]

[1]Sources derived from county-based landuse estimates from 2002. Conewago Creek is an average of Dauphin and Lebanon Counties (PA), Difficult Run is based on Fairfax County (VA), Smith Creek is an average of Shenandoah and Rockingham Counties (VA), Upper Chester is an average of Kent and Queen Anne's Counties (MD).

Nitrogen Sources: Difficult Run, VA





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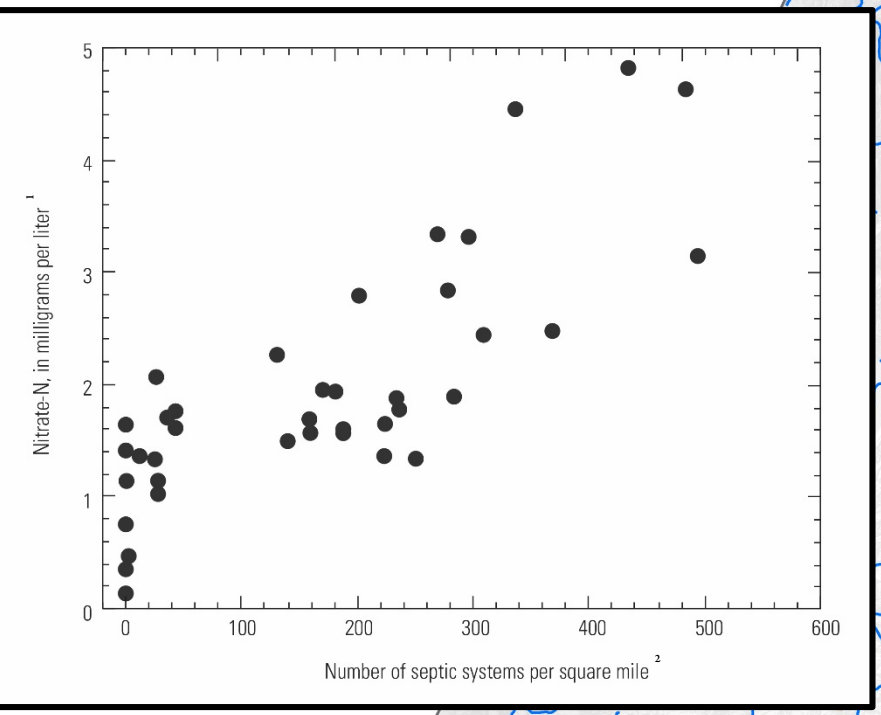

Conventional Septic System [2]

Alternative Septic System [2]

Nitrate-N, in mg/L [1]

0.0 – 1.0

1.1 – 2.0

2.1 – 3.0

3.1 – 4.0

4.1 – 5.0

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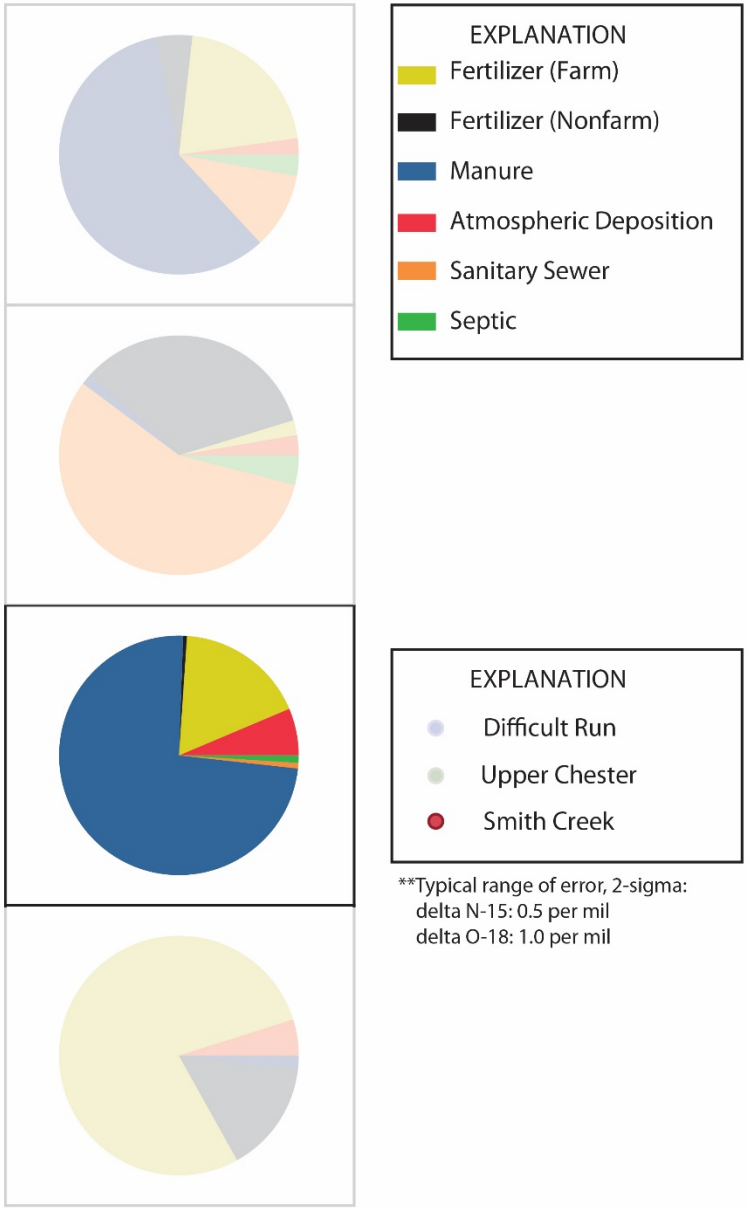
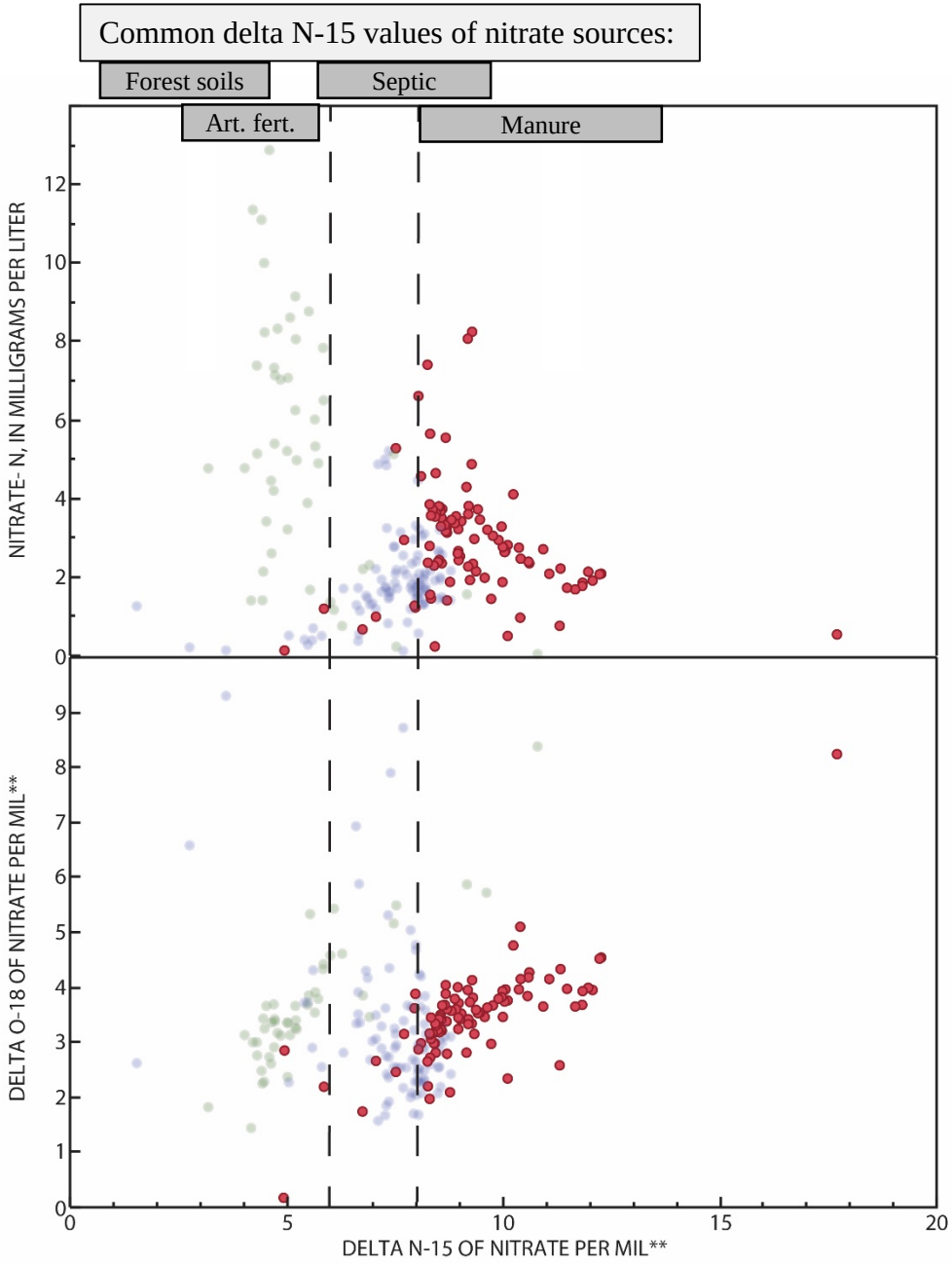
[1]Nitrate-N data based on the average of 6 synoptic events between 2011 and 2015.

[2]GIS data of properties served by septic systems provided by Fairfax County, May 2015.

Nitrogen Sources: Smith Creek, VA





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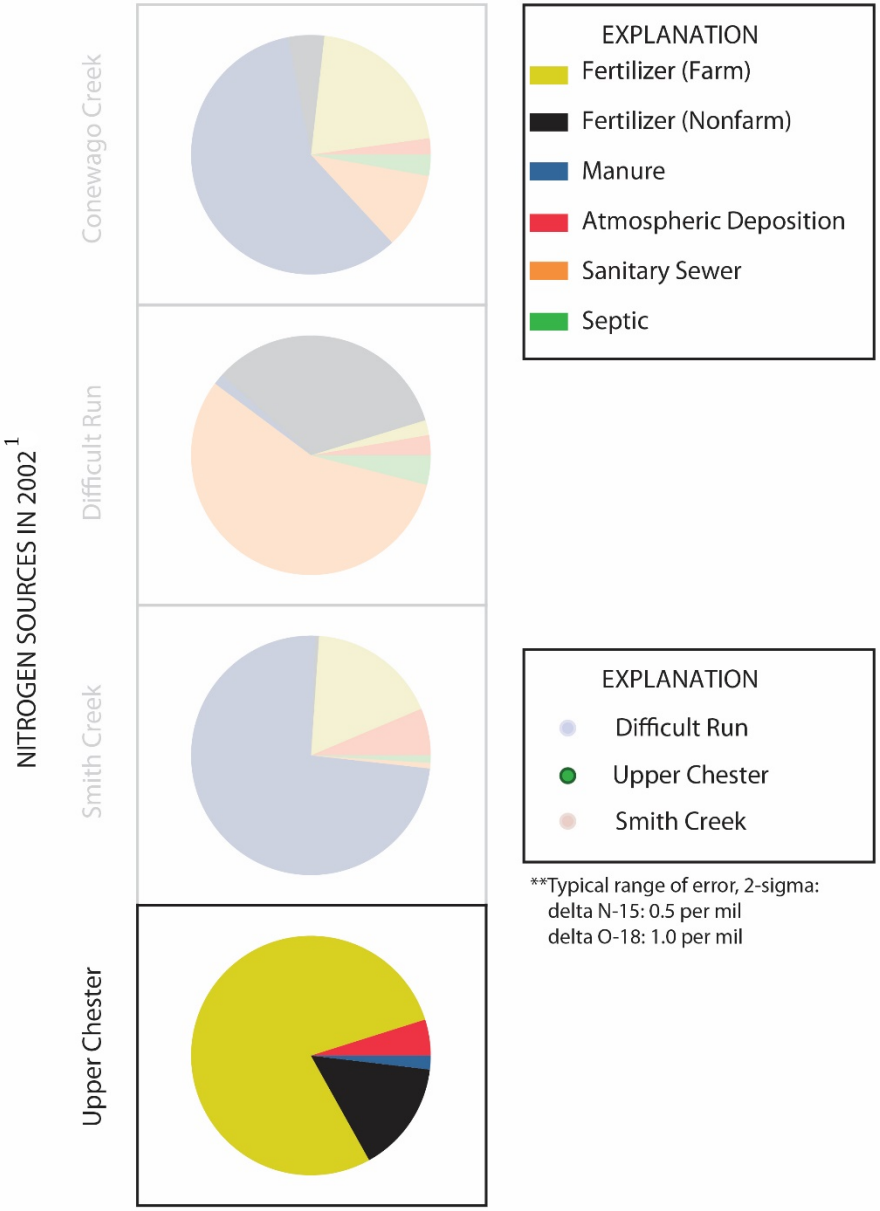
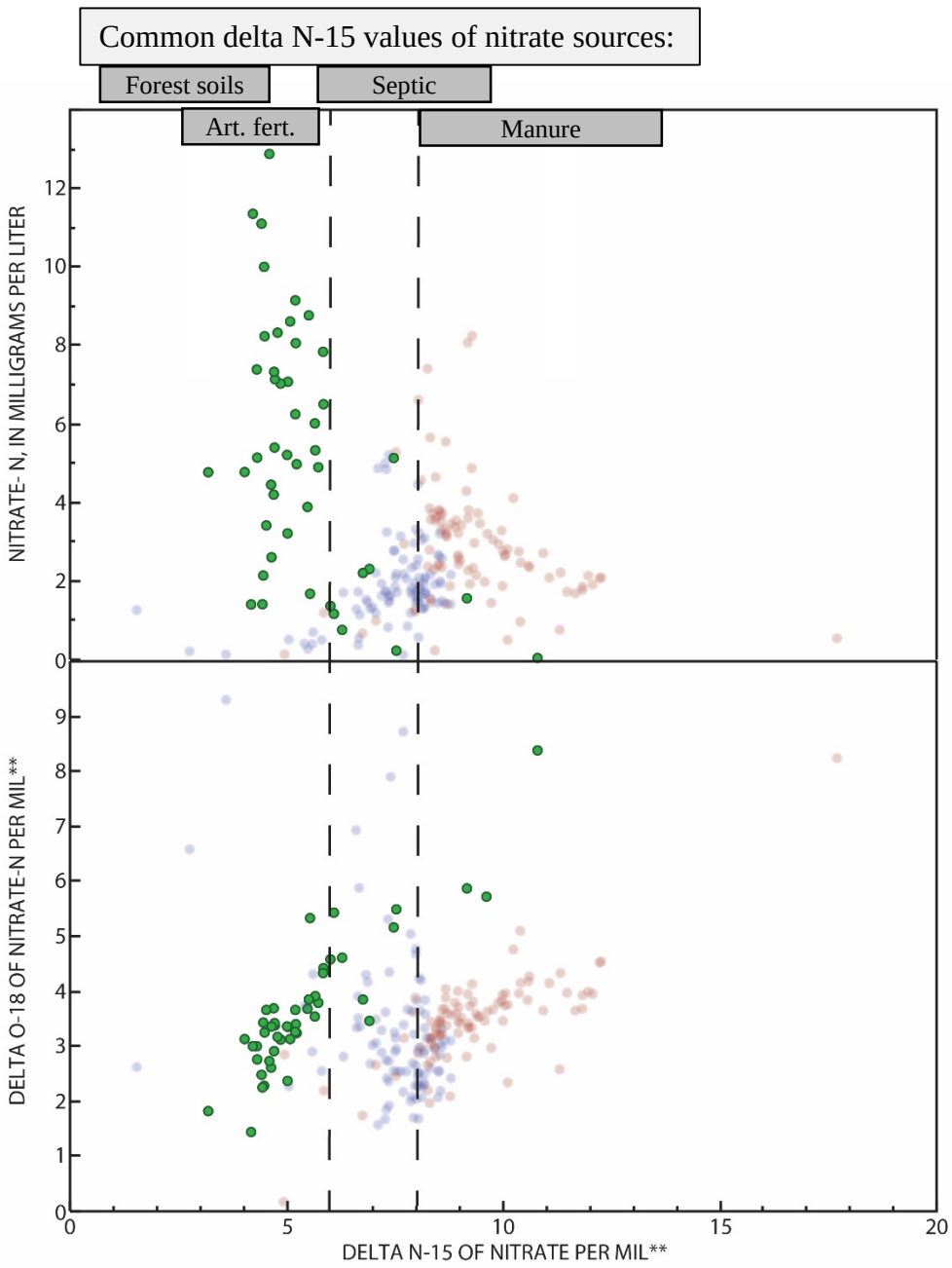
Nitrogen Sources: Upper Chester, MD





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Detecting Change Over Time

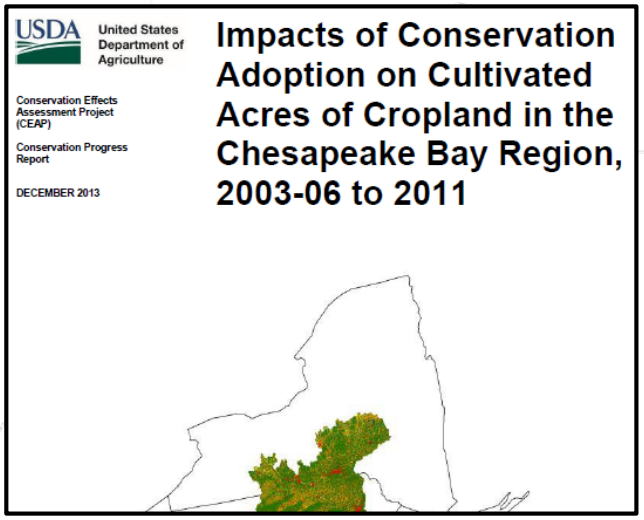
Increased Conservation Practices

Total number of federally funded conservation practices implemented annually within the Showcase Watersheds.

Watershed	2007	2008	2009	2010	2011	2012	2013	Total
Conewago Creek	131	50	110	90	122	86	93	682
Smith Creek	292	66	99	117	202	312	316	1,404
Upper Chester	179	106	103	189	193	264	79	1,113

Vs.

Increased Inputs?



Manure Application Rate: 25% increase[1]

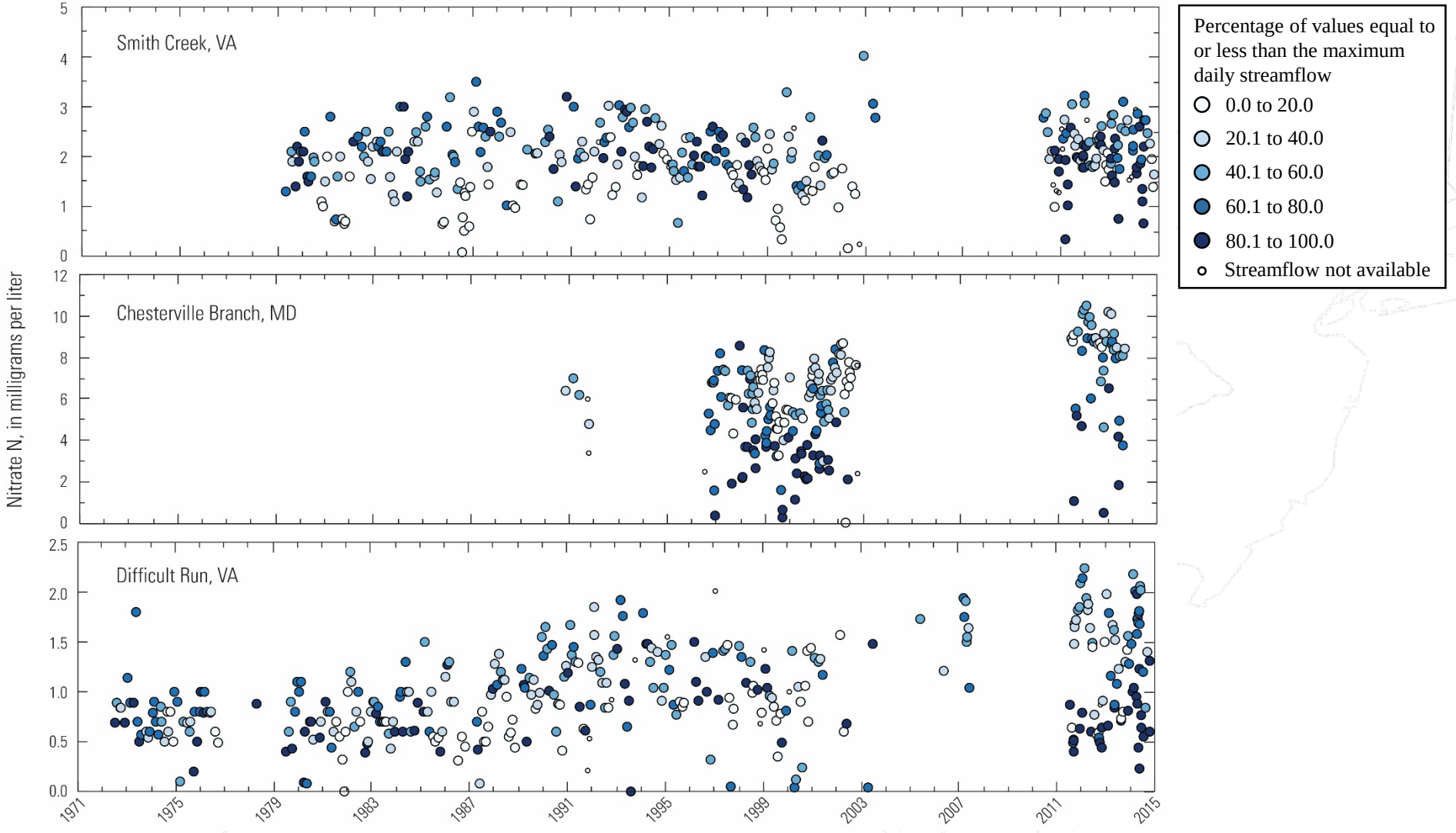
Commercial Fertilizer Application Rate: 9% increase[1]

Appropriate nitrogen application rate: 9% decrease[1]

USGS science for a changing world

[1]U.S. Department of Agriculture, Natural Resources Conservation Service, 2013, Impacts of conservation adoption on cultivated acres of cropland in the Chesapeake Bay region, 2003–06 to 2011: 113 p.

Detecting Change Over Time



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Lessons Learned

Intensive water-quality sampling has resulted in a relatively strong understanding of:

- Spatial Variability in Water Chemistry
- Nitrogen Transport Processes
- Nitrogen Sources
  - Manure in Smith Creek
  - Inorganic commercial fertilizer in the Upper Chester River
  - A mixture of sources that likely includes septic effluent in Difficult Run

Observed empirical nitrate concentrations indicate that conditions are not yet improving

- Implementation of conservation practices may be offset by increased nitrogen inputs.
- These empirical data are critical for validating and improving various regional modeling tools such as the Chesapeake Bay Program's Watershed model, and the USGS SPARROW model.

Future Directions

- Evaluate phosphorus sources and transport processes
- Understand the relation between BMP implementation and changes in water-quality
- Regionalize results to the Chesapeake Bay watershed