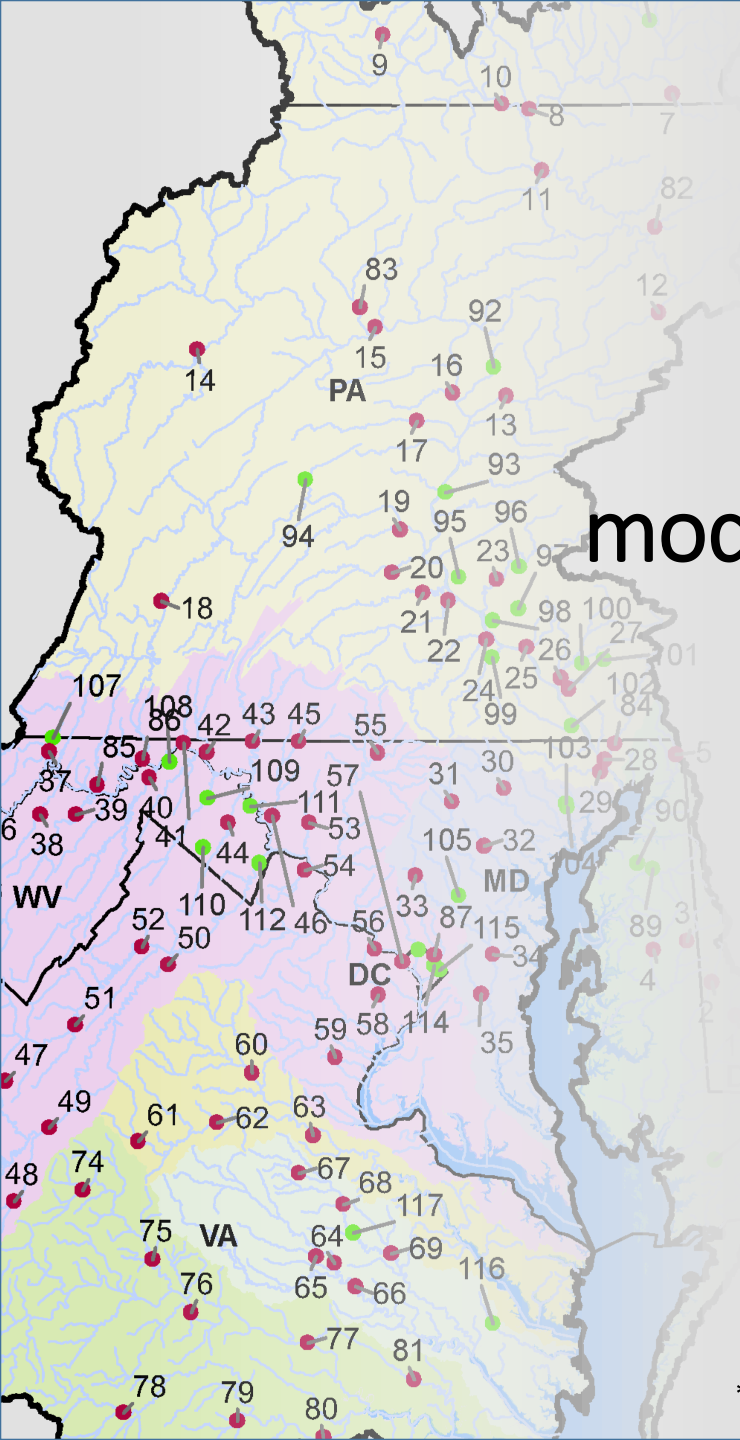


Incorporating monitoring, modeling and trends analyses into management decisions: a Choptank River example

Emily Trentacoste, PhD
EPA Chesapeake Bay Program

WQGIT Meeting

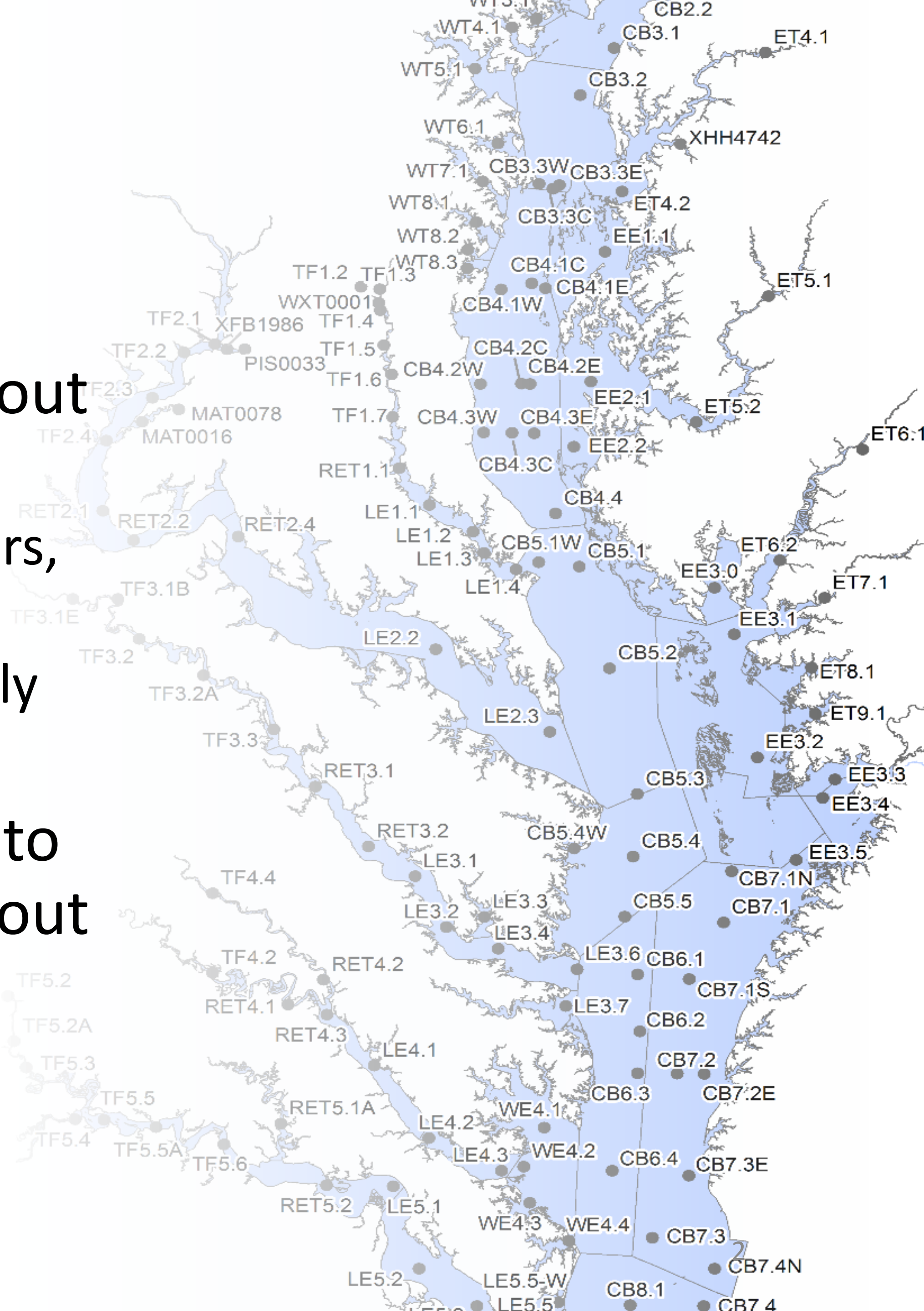
7/10/2017

DRAFT. DO NOT CITE OR DISTRIBUTE.

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

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



A LOT of data 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

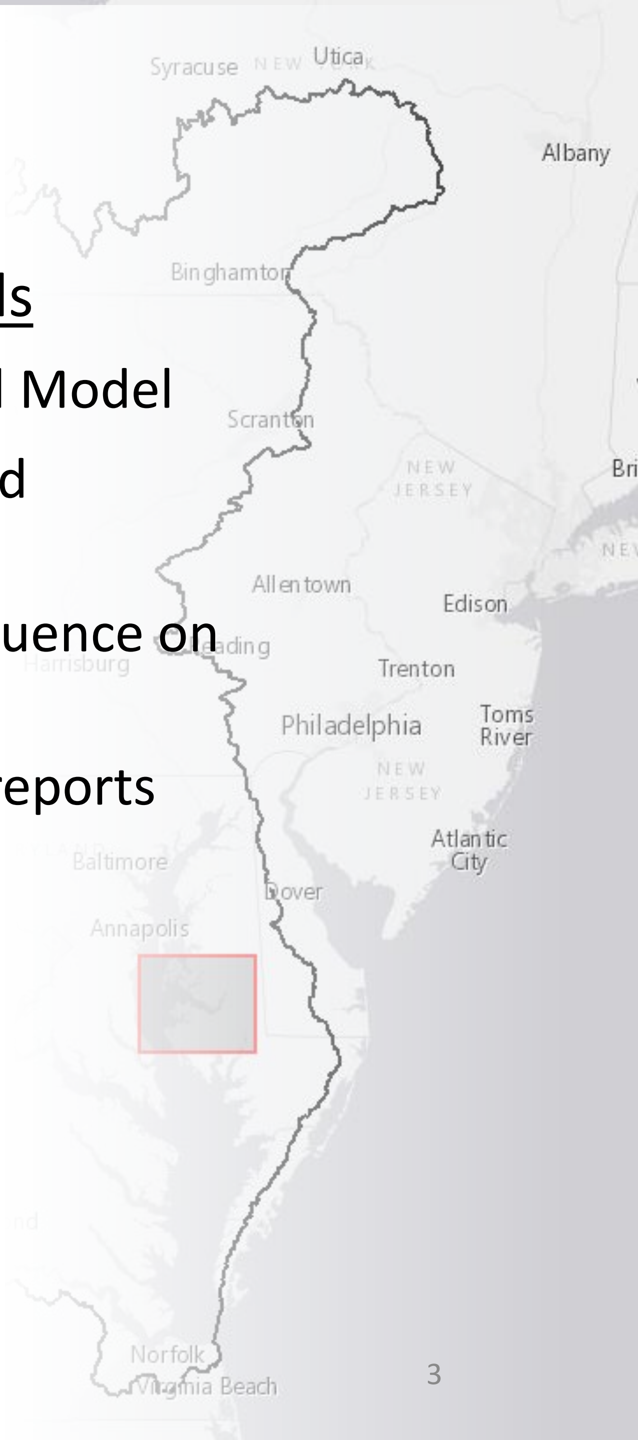
CBP Watershed Model

Geographic load distribution

Geographic influence on Bay

BMP progress reports

…and more to come



Storyline Development

Monitoring & Trends Data

Monitoring, Trends & Explanations:
What is happening in this watershed?
What are the sources and drivers?
What is the explanation behind a trend?

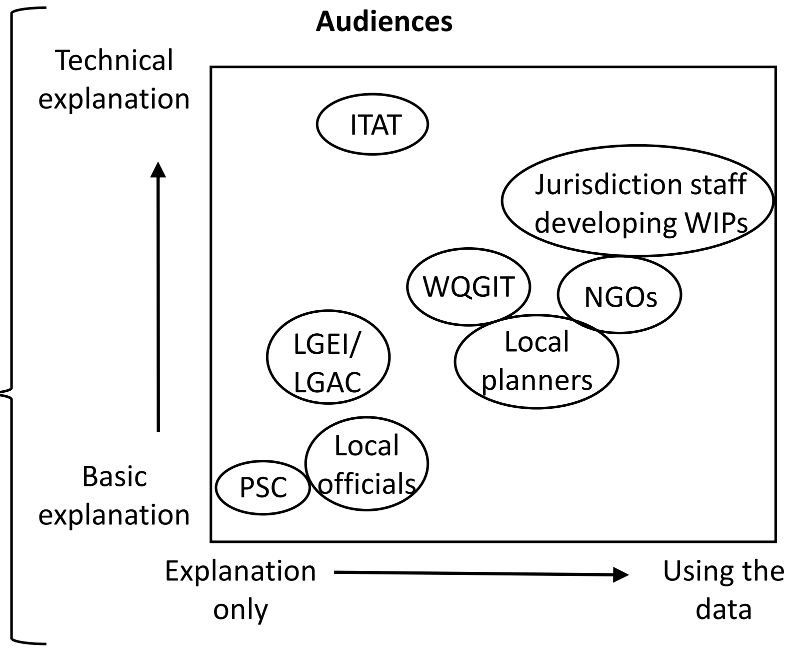
Modeling data

Synthesis Analyses

Programmatic Implications
What has or hasn't been working, and where?
What types of adjustments are necessary (source sector, geography, etc.)?
How can those adjustments be realized (shifts in BMP implementation, etc.)?

BMPs/practices

Communication
Who needs to know this information and why?
In what form do they want to see it?
When do they need to see it?



Storyline Products
Storyline templates
Data visualization tools for users
Data layers for users
Training/guidance on use

Data Visualization/Tools

Framework
What information was used in the different steps above?
Where and in what format is it available?
How will different users interact with the information?
How can we best guide users?

Choptank River Storyline

Questions for WQGIT

- Are example stories useful for demonstrating data and information available and how to use? Would you like to see more?
- Most of this information is available watershed-wide, but what are you most likely to use?
- How would you like to interact with the information?
    - E.g. storyline templates, trainings, online platform for downloading, visualization tools

Storyline Development

Monitoring & Trends Data

Modeling data

Synthesis Analyses

Monitoring, Trends & Explanations:
What is happening in this watershed?
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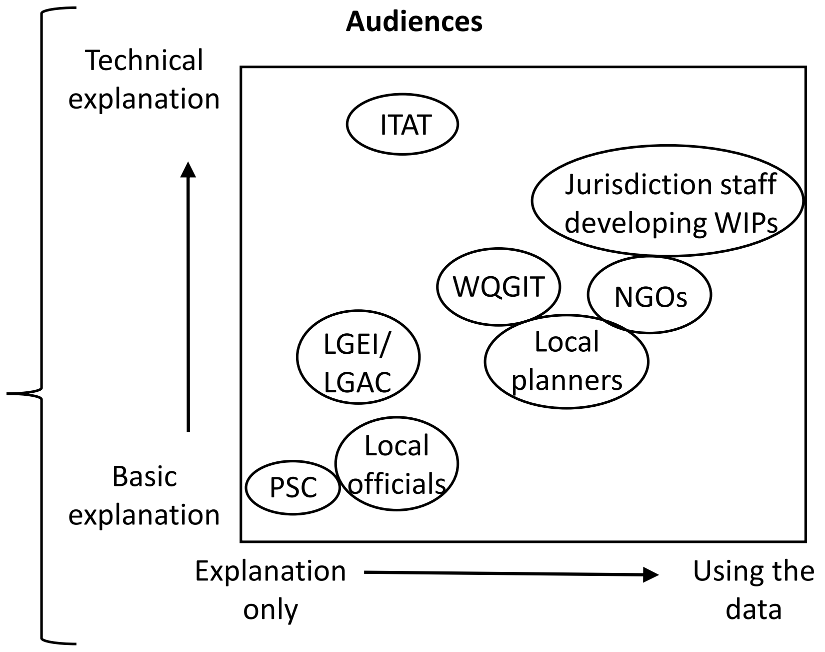

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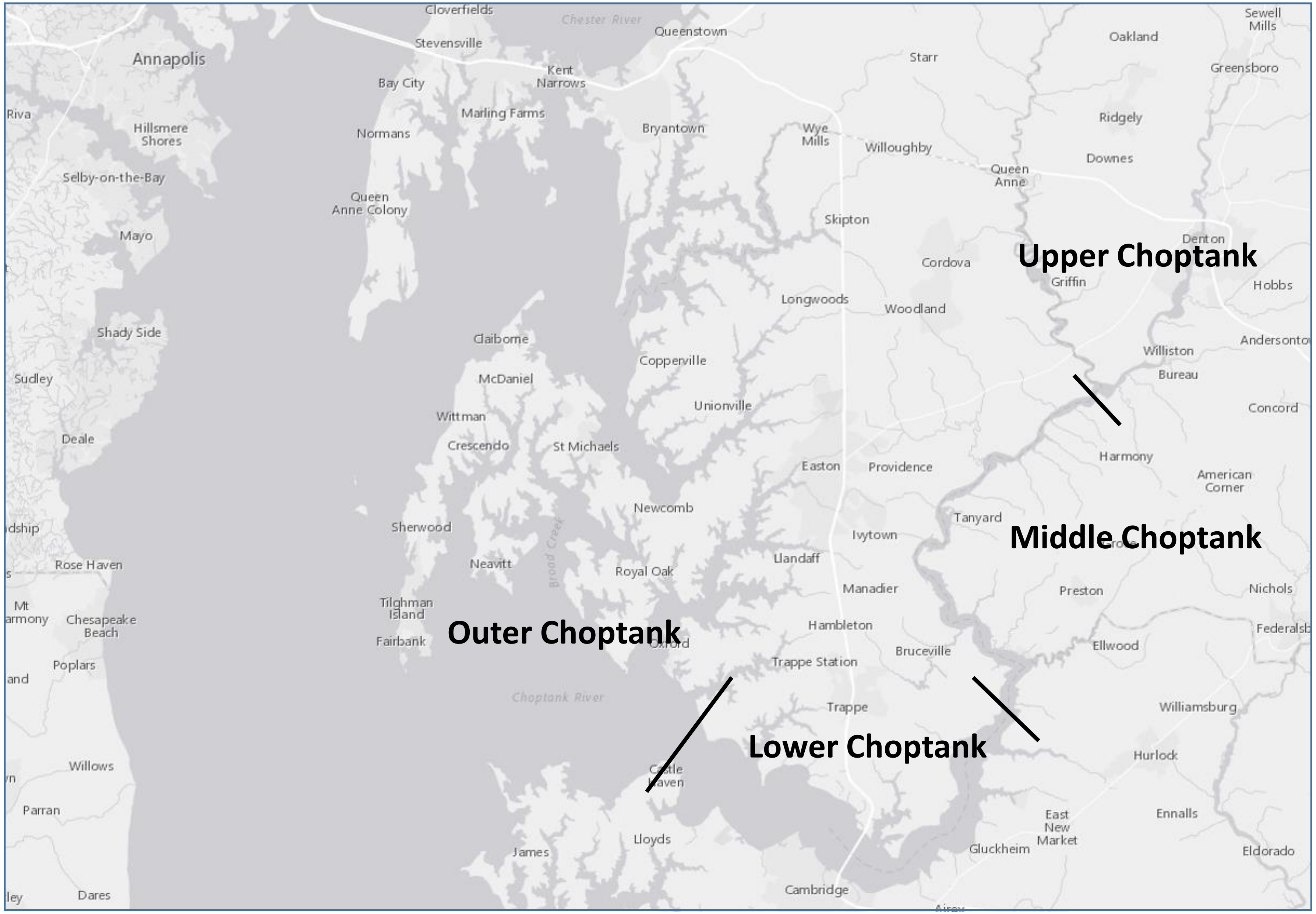
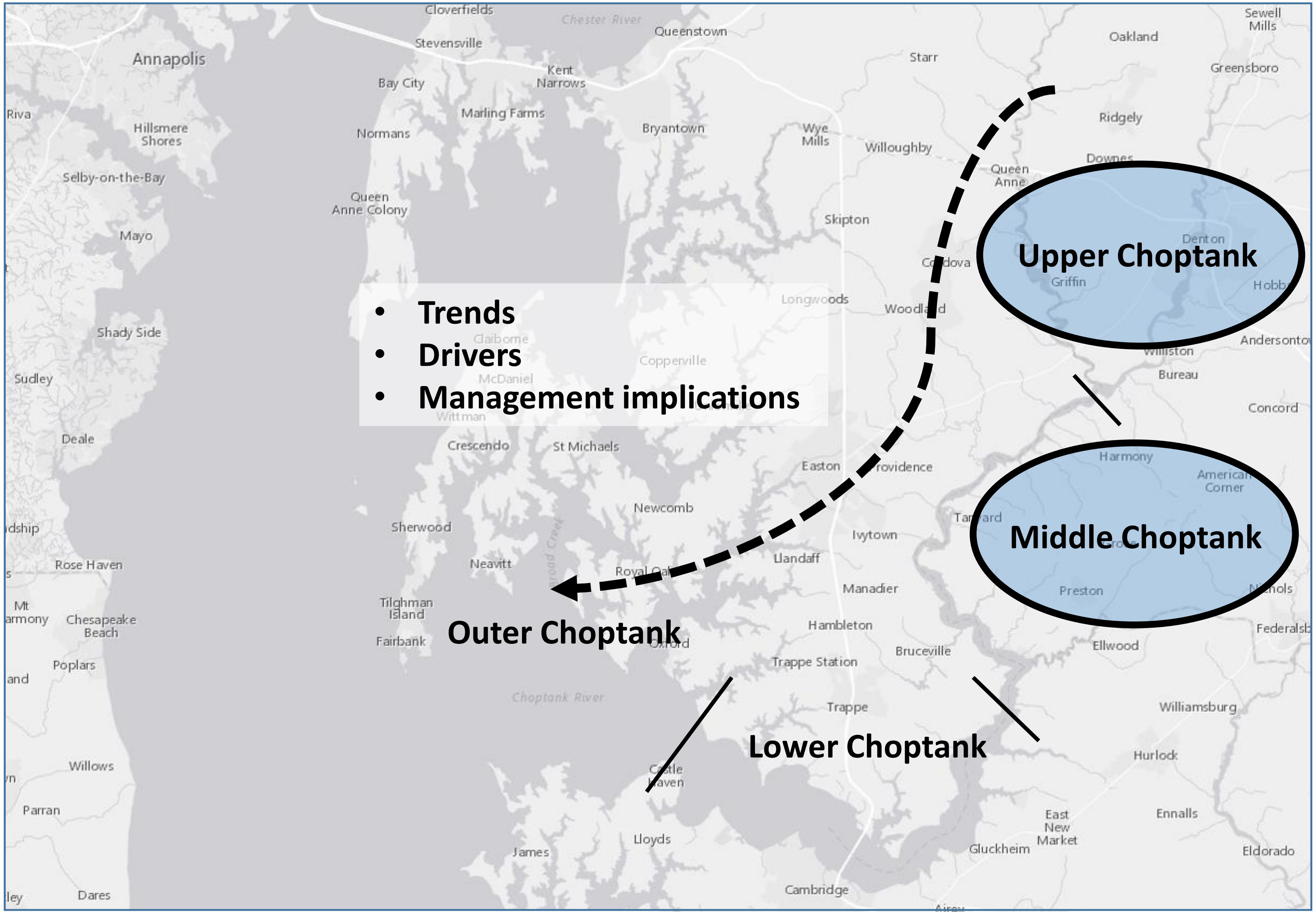
Choptank River



Choptank River Storyline



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

Storyline Development

Monitoring & Trends Data

Monitoring, Trends & Explanations:
What is happening in this watershed?
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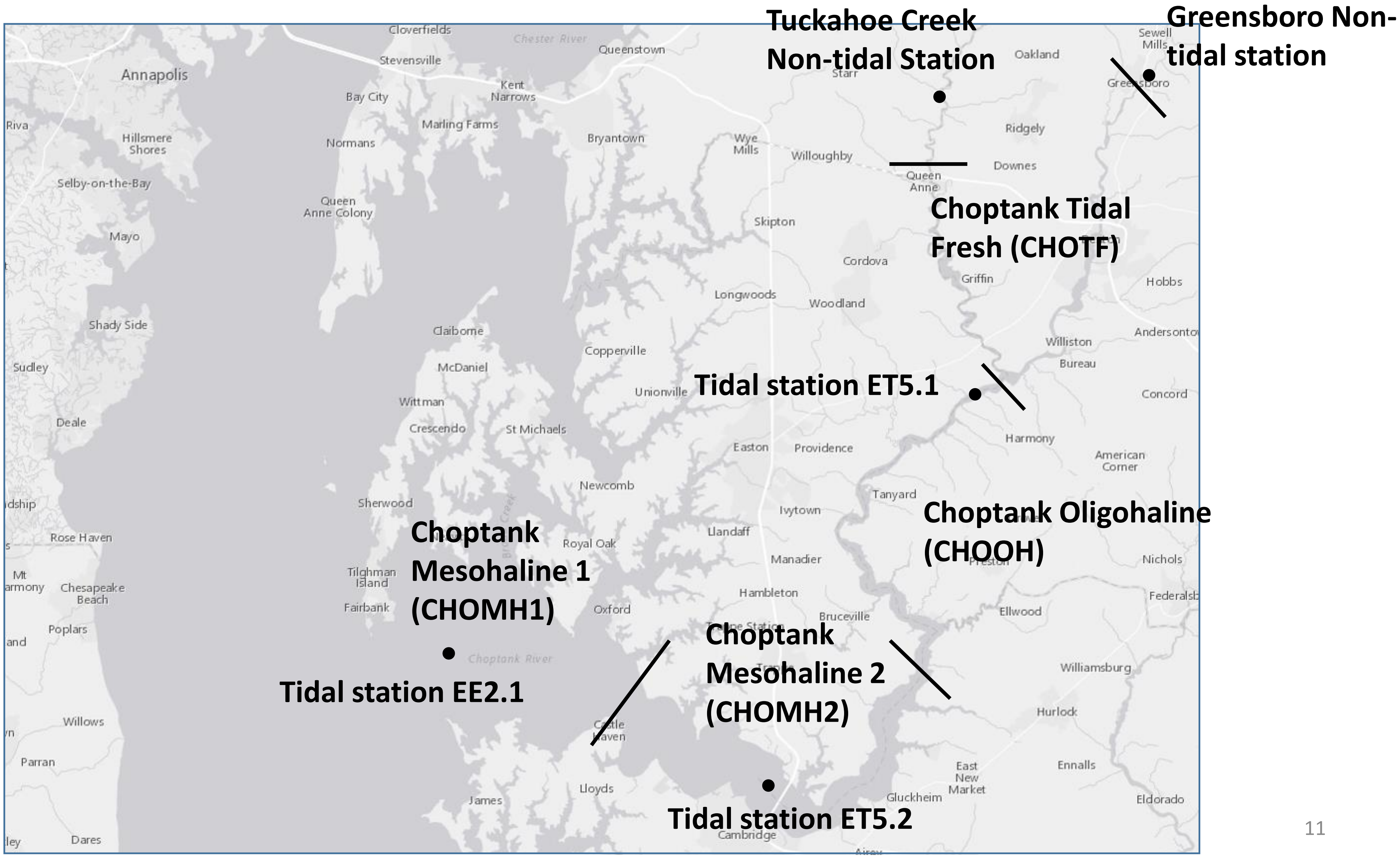
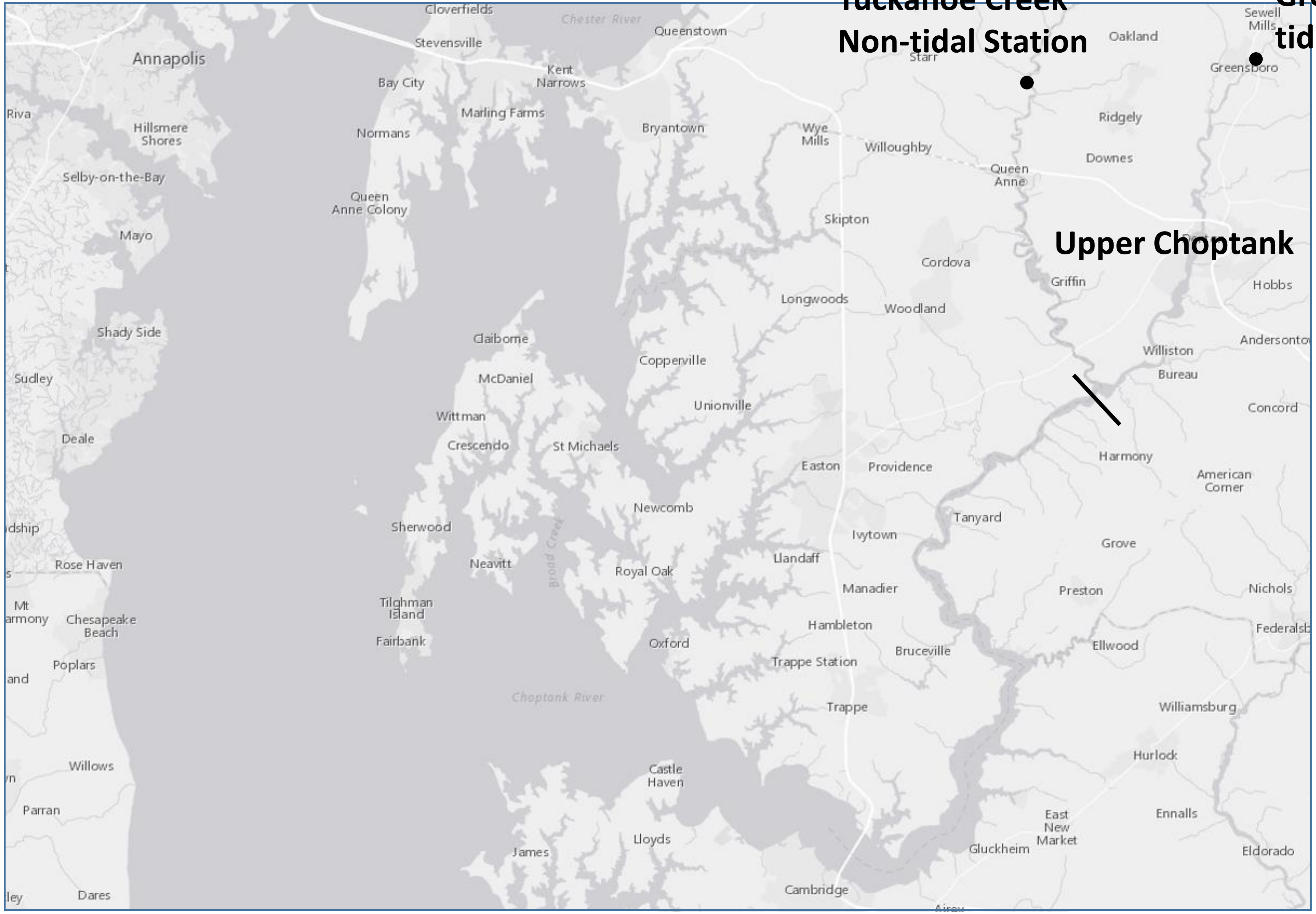
What is the explanation behind a trend?

Choptank River Monitoring



Choptank River Monitoring



USGS Non-tidal Network

Nitrogen and nitrate are increasing at the Upper Choptank non-tidal stations

EXPLANATION

Improving

Degrading

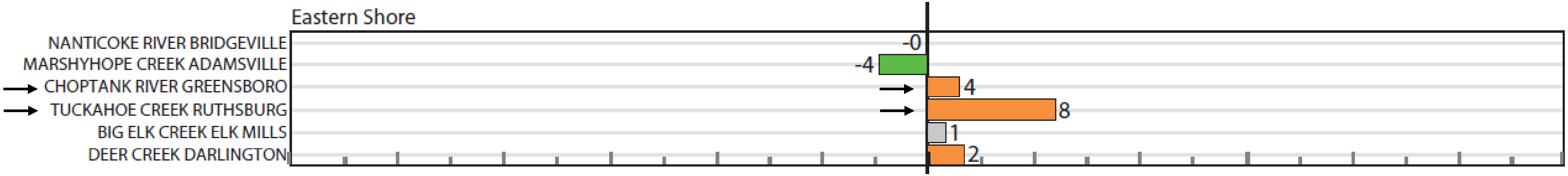
No Trend

Improving or degrading trends classified as likelihood estimates greater than or equal to 66%

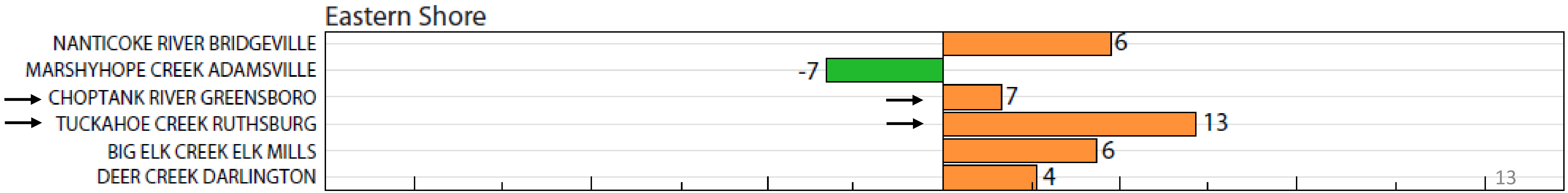
*The number next to each bar represents the total percent change in total nitrogen yield over the specified time period.

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

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



Change in Nitrate per acre loads (2005-2014)



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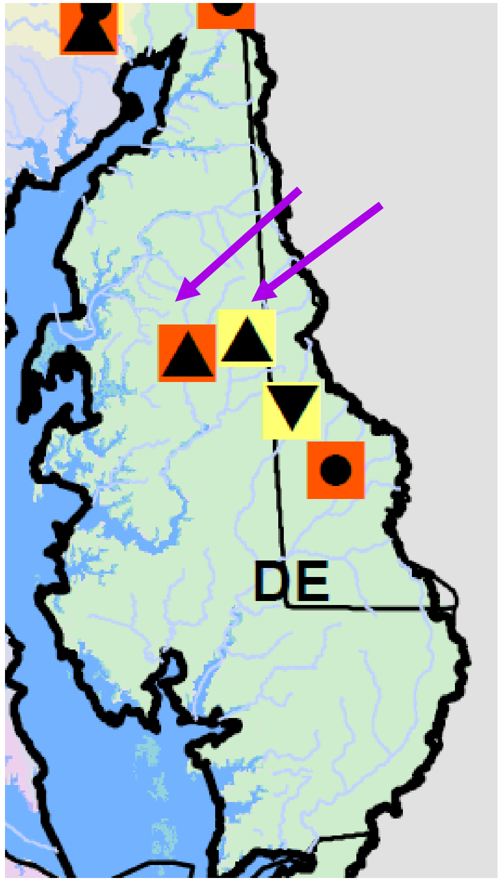

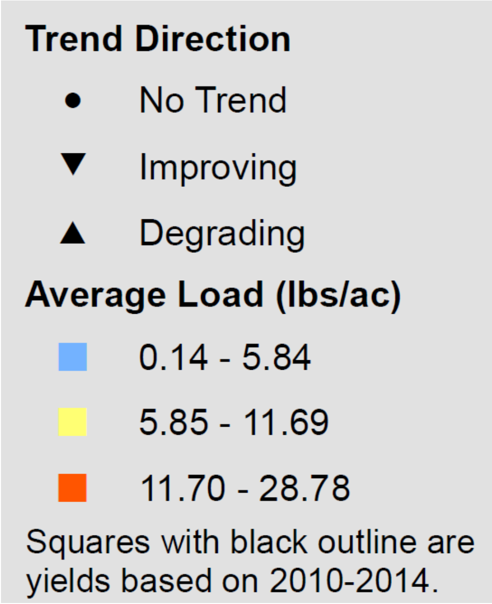

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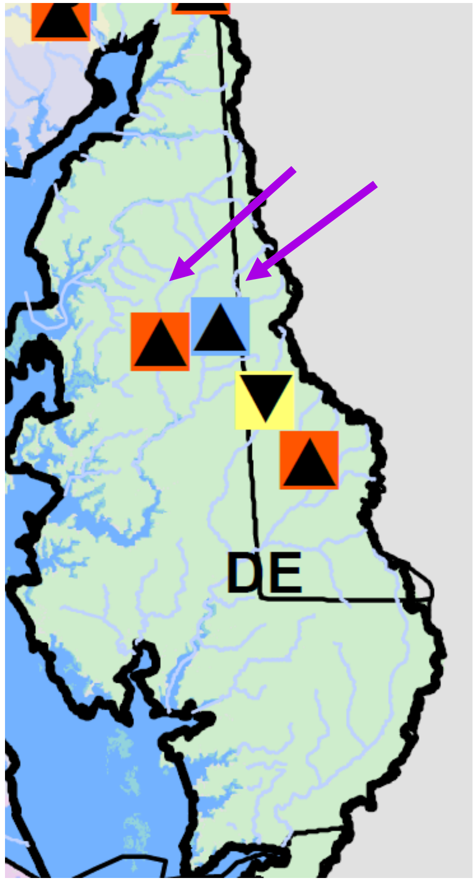

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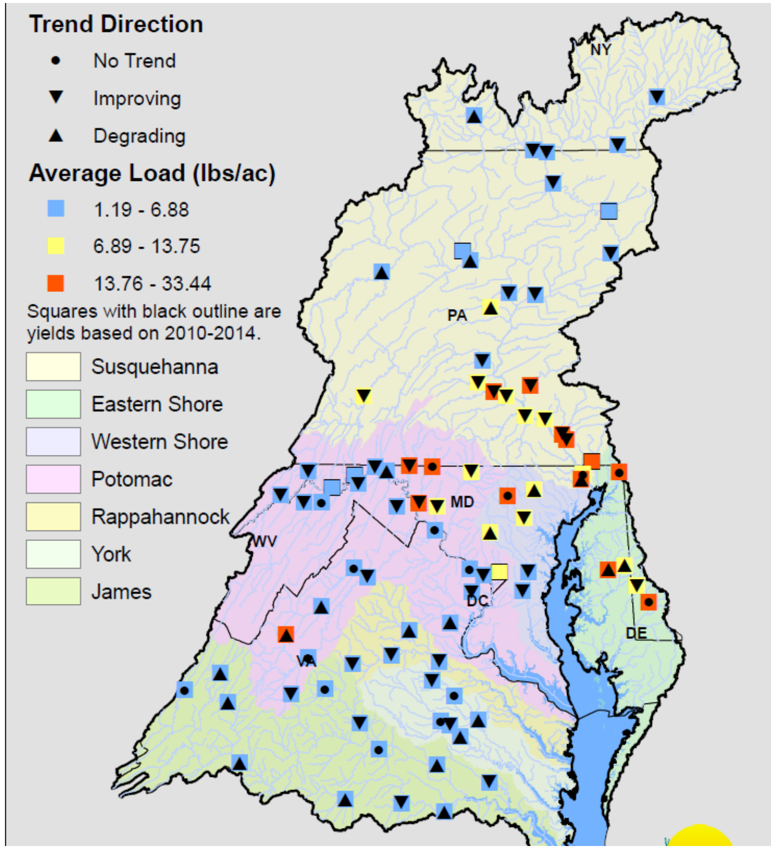

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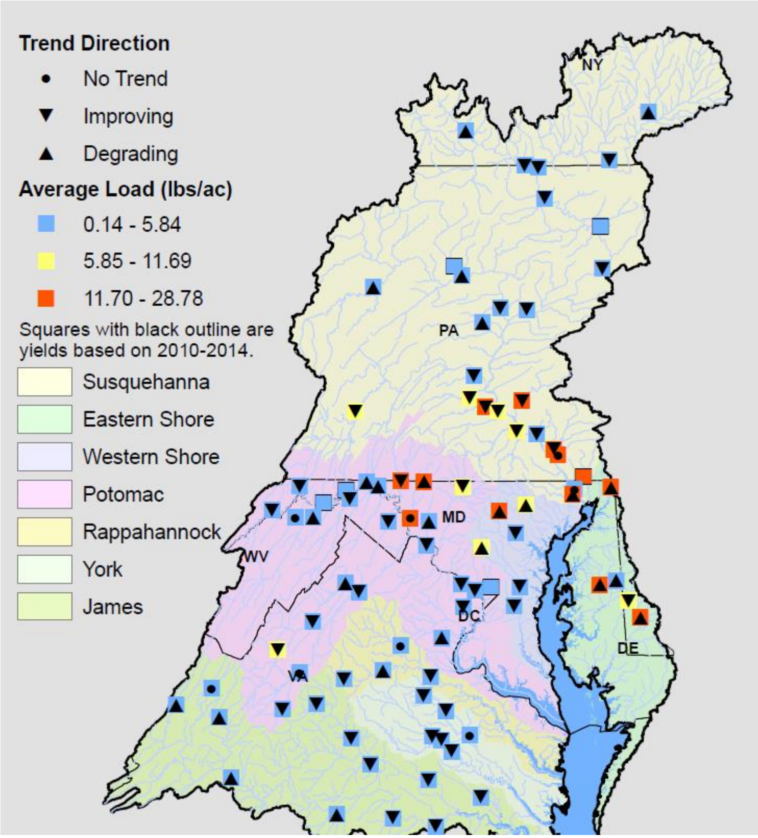


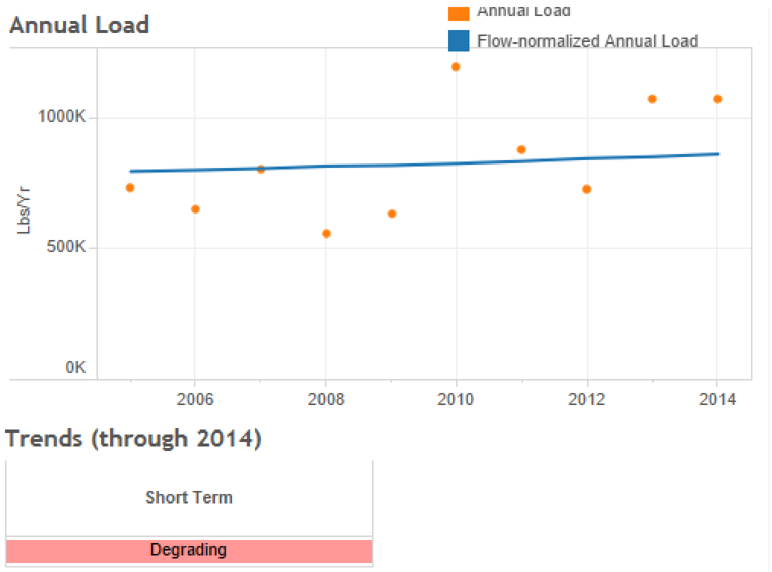
From USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/

USGS Non-tidal Network

Nitrogen and nitrate are increasing at the Upper Choptank non-tidal stations

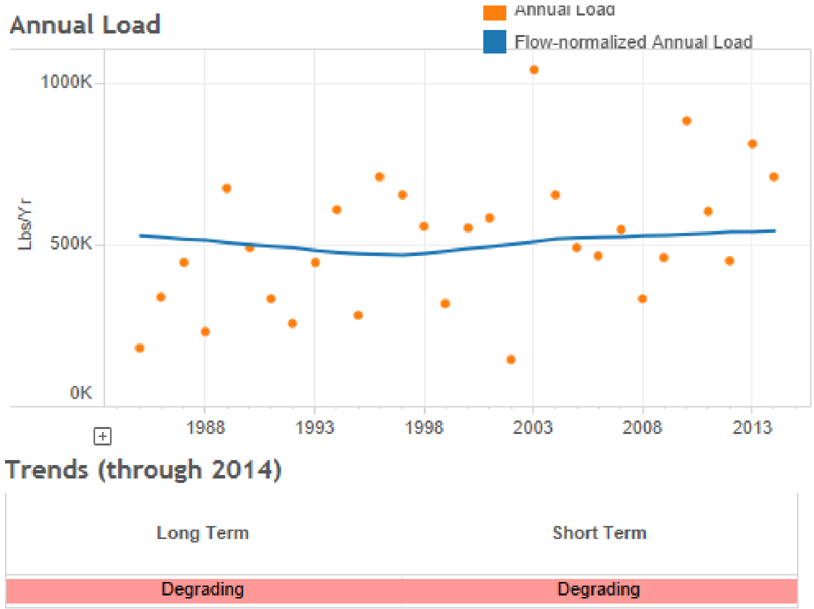
Tuckahoe Creek Station

Total Nitrogen



Greensboro Station

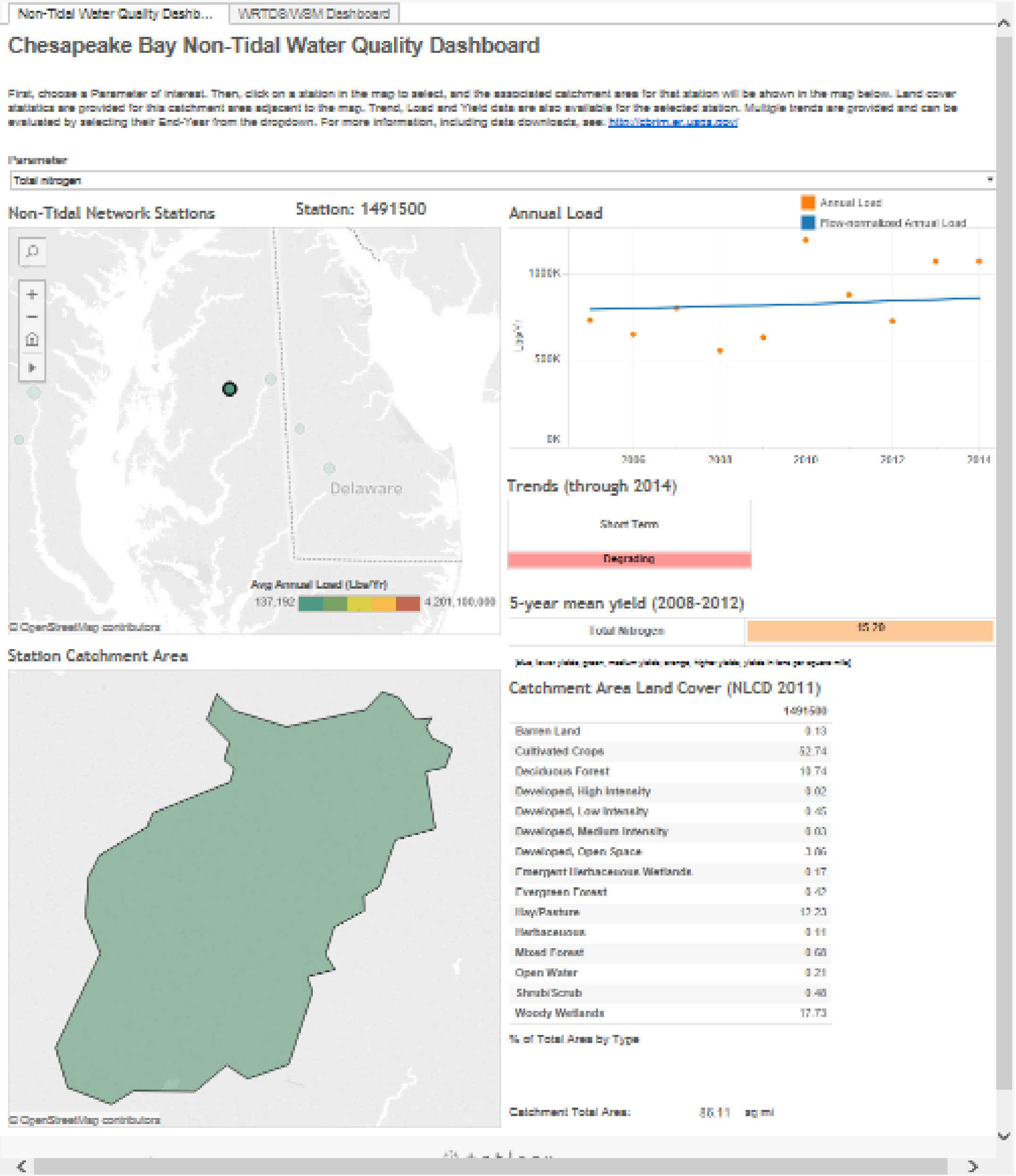
Total Nitrogen



From CBP Non-tidal Dashboard, in development.

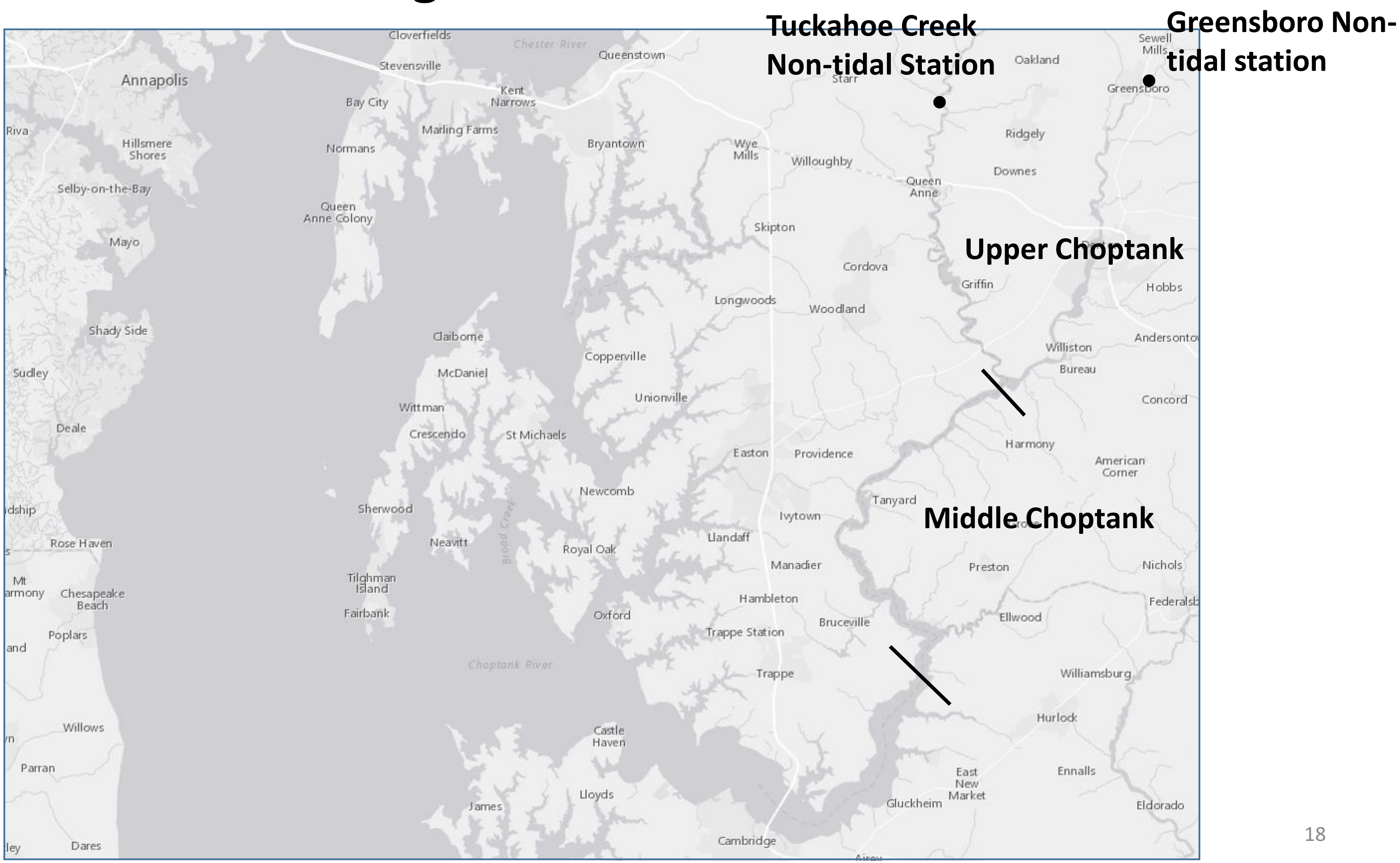
USGS Non-tidal Network

Nitrogen and nitrate are increasing at the Upper Choptank non-tidal stations



From CBP Non-tidal Dashboard, in development.

Choptank River Monitoring



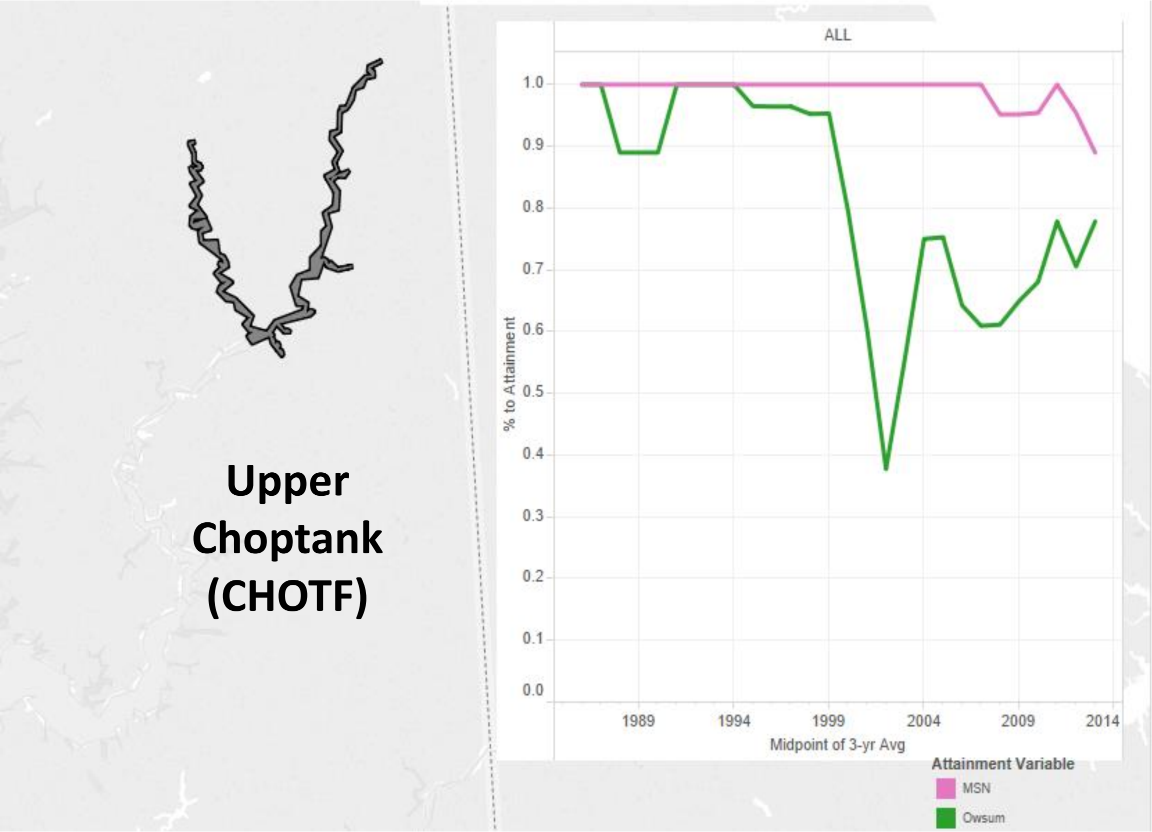
Tidal Segment Attainment

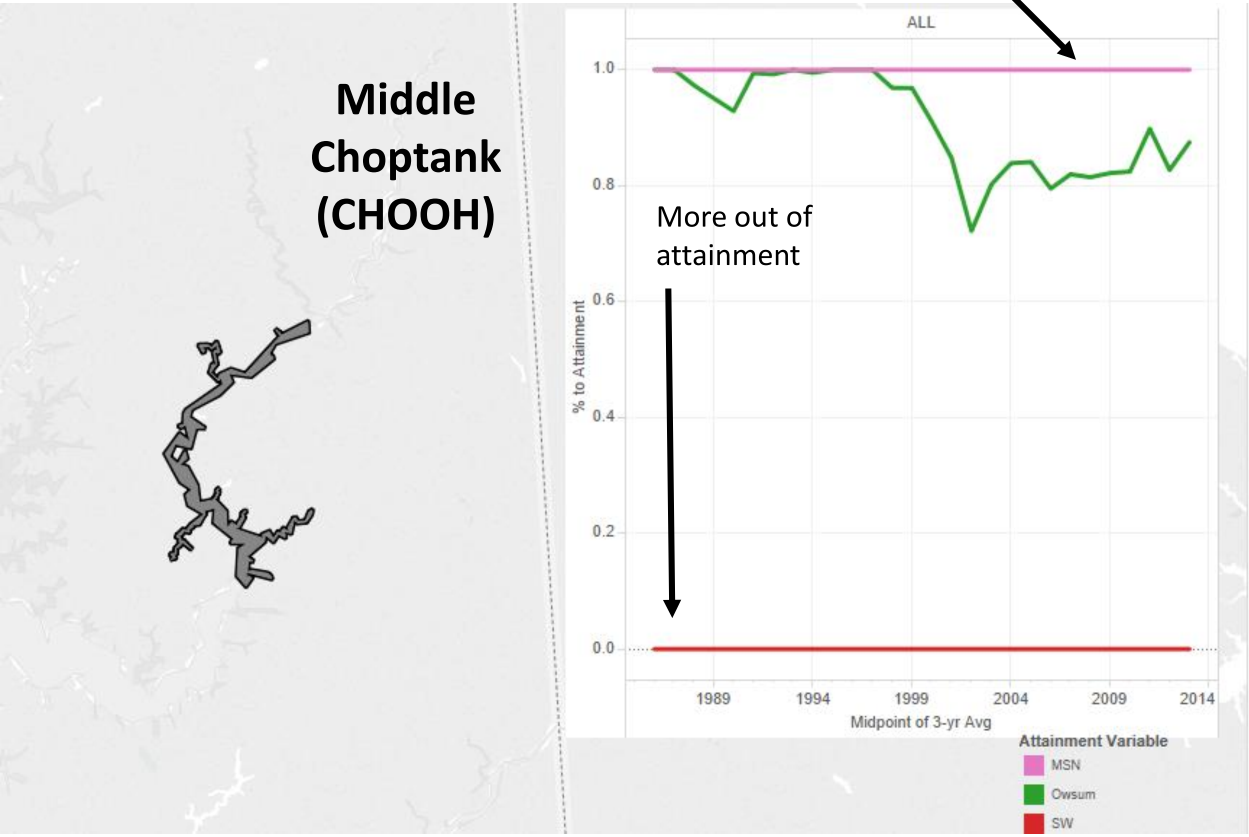
- **Tidal segments are not attaining Open Water Dissolved Oxygen (OW DO) criteria and show degrading trends**

Designated use attainment

Migratory/spawning/nursery
Open water
Submerged Aquatic Vegetation (SAV)

1.0 = attainment





From CBP Tidal Dashboard, in development.

Trends Summary

- Nitrogen trends are degrading in the non-tidal monitoring stations
- Of the two stations, Tuckahoe Creek has higher loads
- Neither the Upper or Middle Choptank are attaining for Open Water Dissolved Oxygen criteria
- These tidal segments have been getting more out of attainment over time

Storyline Development

Monitoring & Trends Data

Monitoring, Trends & Explanations:
What is happening in this watershed?
What are the sources and drivers?
What is the explanation behind a trend?

Modeling data

Synthesis Analyses

USGS Non-tidal Network

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

Tuckahoe Creek Station

USGS Non-tidal Network

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Tuckahoe Creek Station

USGS Non-tidal Network

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

Greensboro Station

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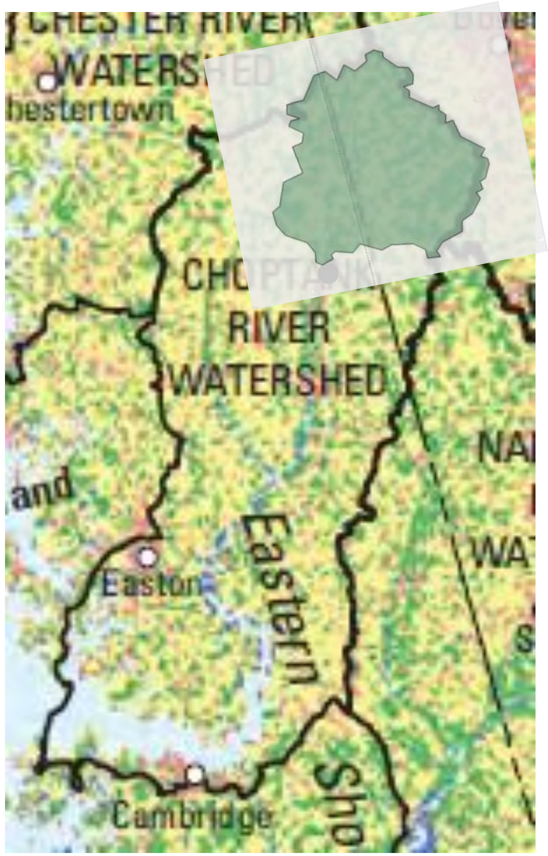
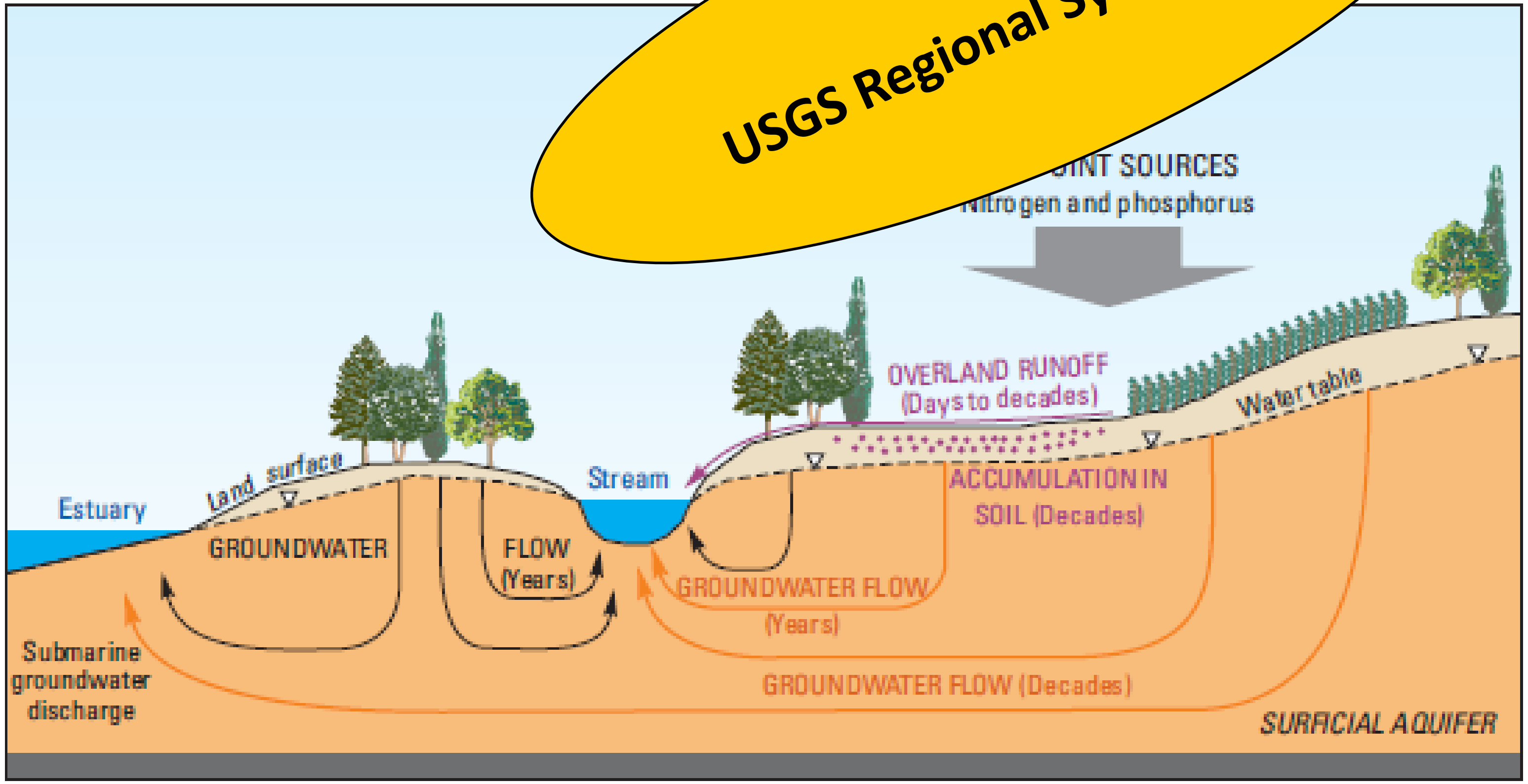


How is nitrogen reaching streams?

- **Nitrogen reaches streams primarily as nitrate through groundwater (in these areas)**

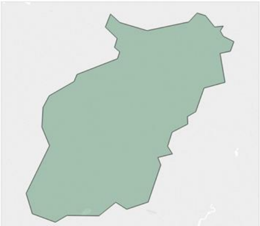
USGS Regional Synthesis

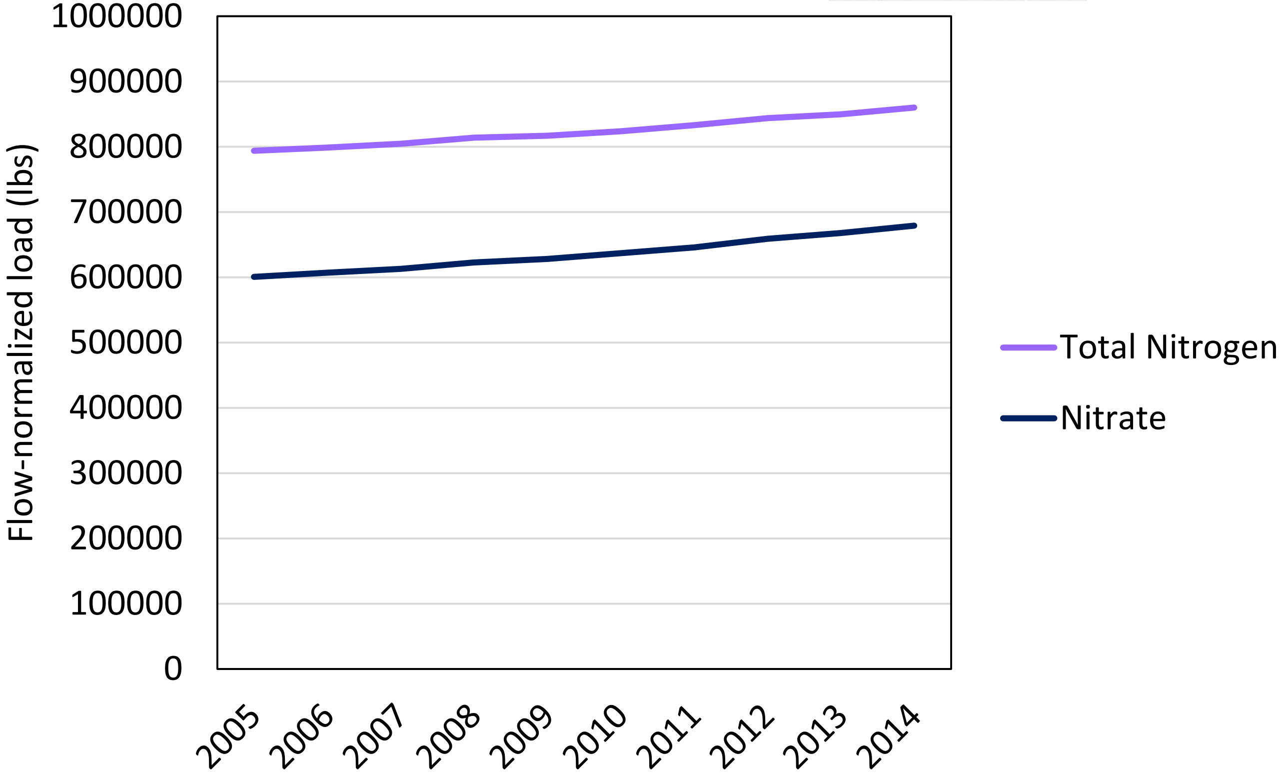


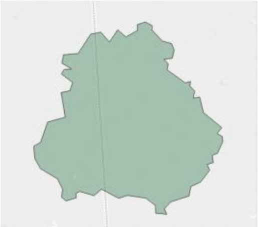
From Ator, S.W., and Denver, J.M., 2015. *USGS Circular 1406.*

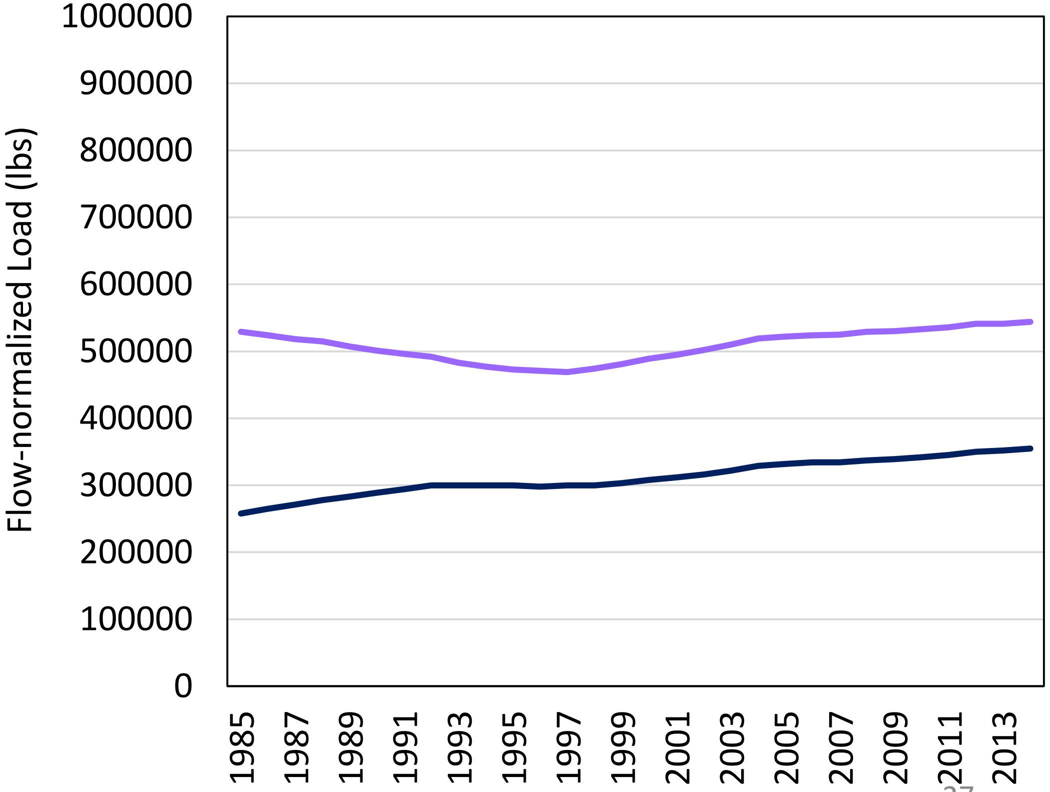
How is nitrogen reaching streams?

- Nitrogen reaches streams primarily as nitrate through groundwater (in these areas)
- **Nitrate is primarily driving nitrogen load increase**



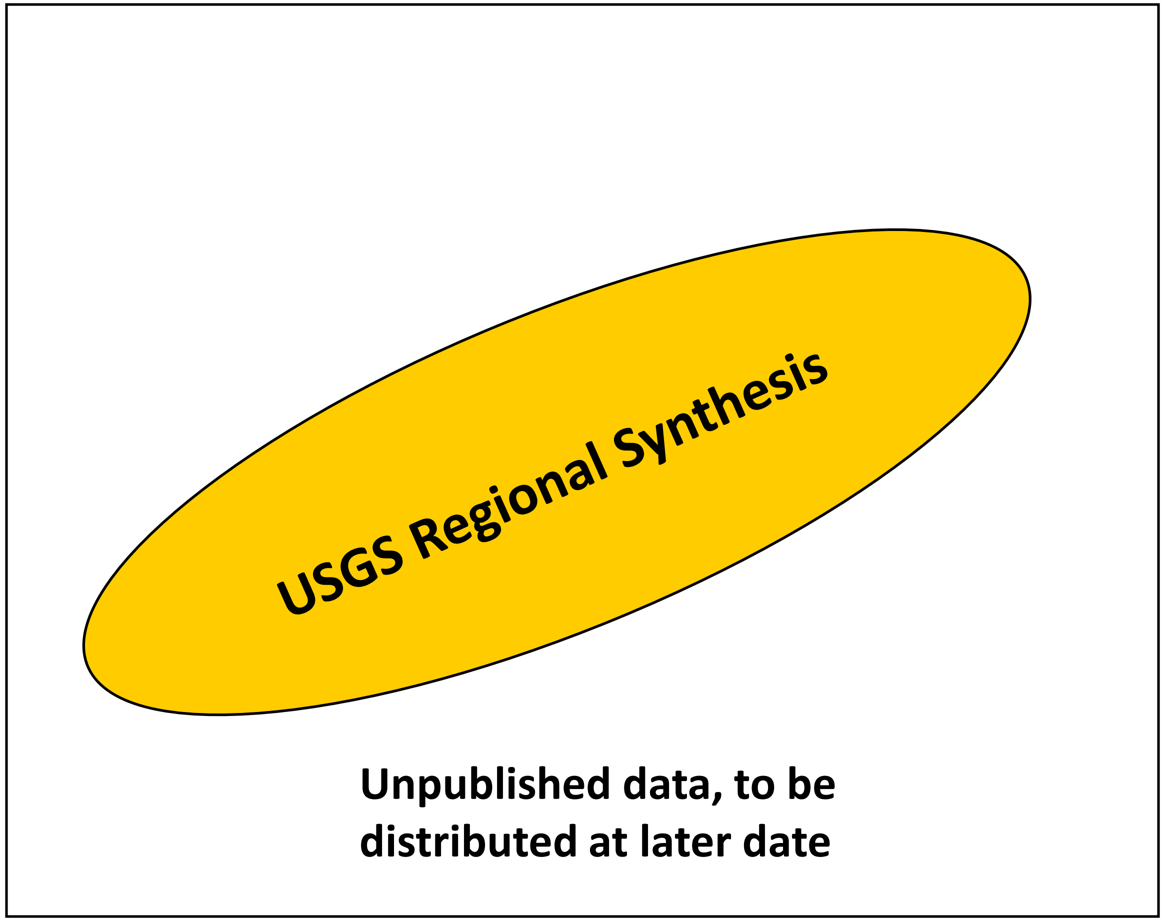






How is nitrogen reaching streams?

- Nitrate from groundwater is primarily driving load increase
- **Nitrogen in streams represents a range of groundwater ages**
- **Nitrogen in streams represents both recent and past applications**



DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

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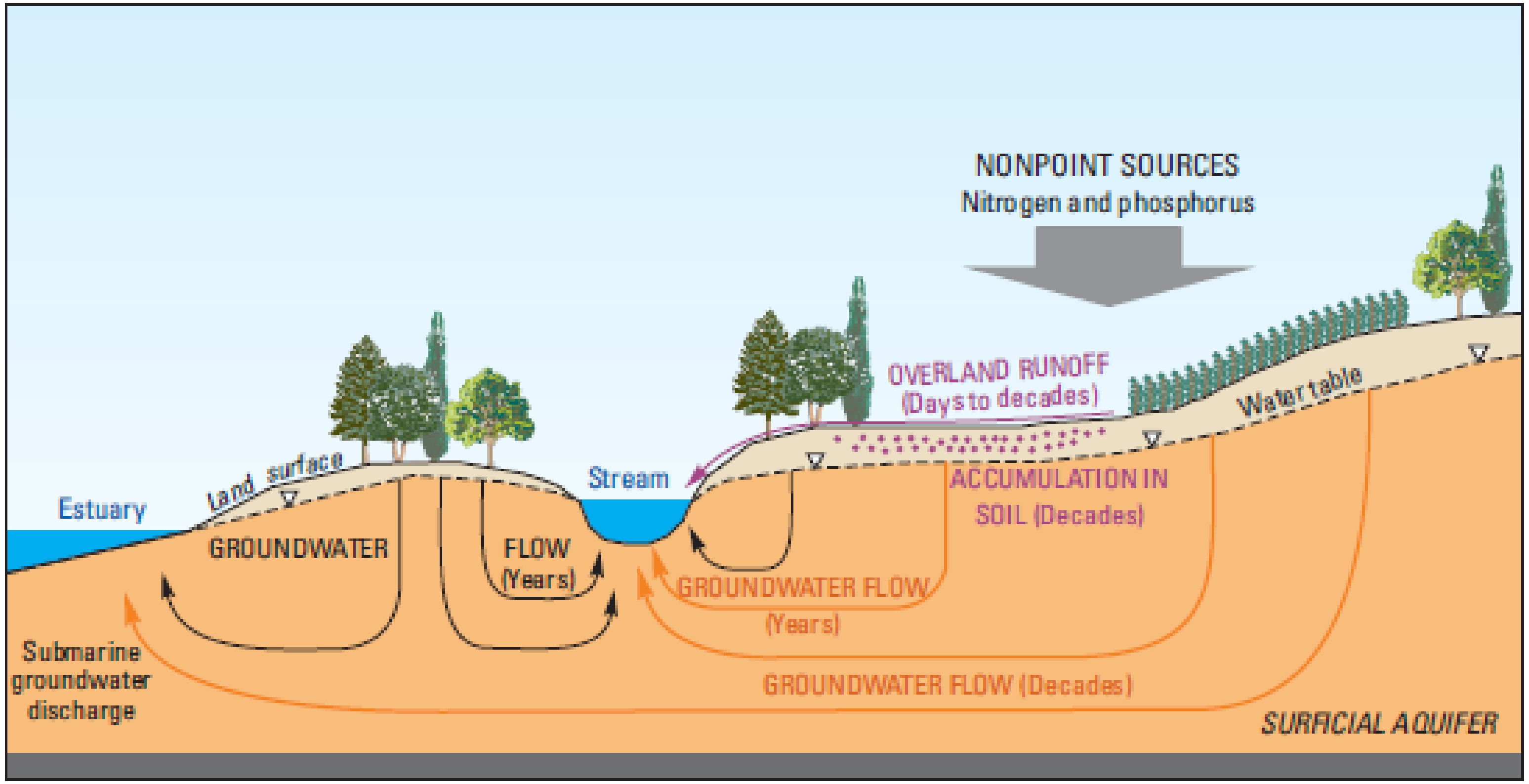

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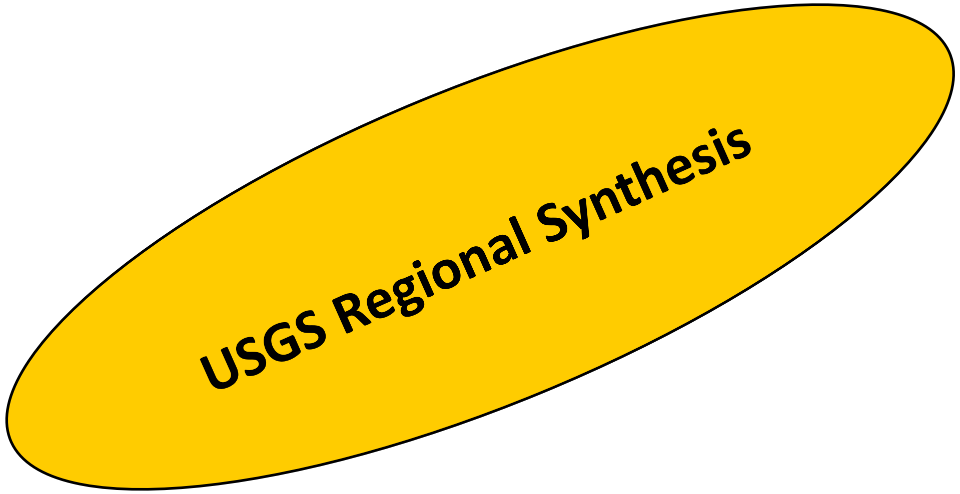
USGS Regional Synthesis: Groundwater ages vary throughout the watershed



Unpublished data, to be distributed at later date

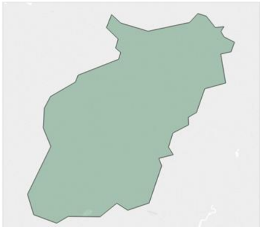
DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

Where is nitrogen coming from?

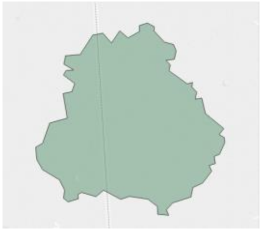
Land-use

- Agricultural land-use drives nutrient loads
- Loads are primarily from low-till cropland

Tuckahoe Creek

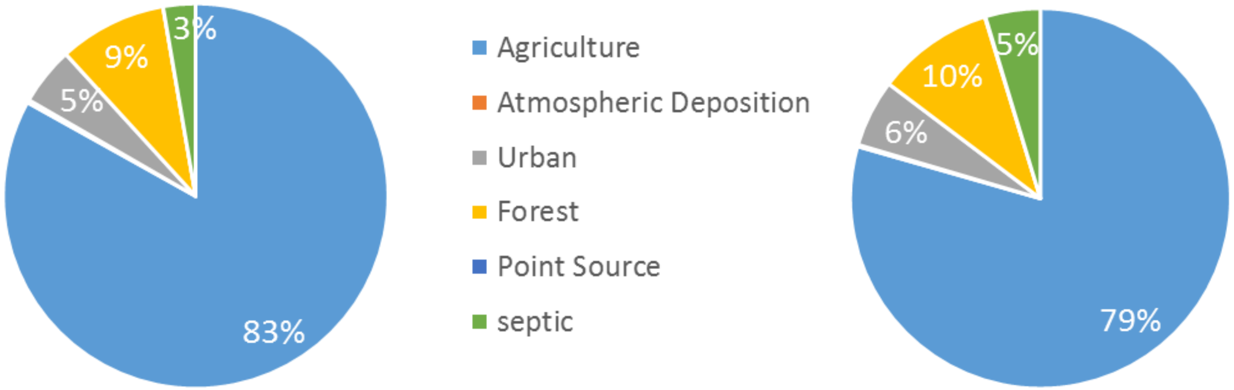


Greensboro



Proportion of land area by source sector

Nitrogen loads from monitoring station's drainage area



From CBP WSM Phase 5.3.2 2015 Progress. See data analysis at end of this document.

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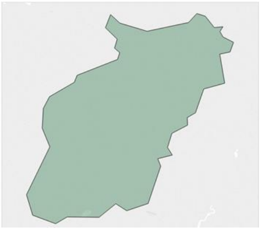
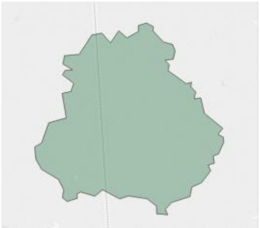
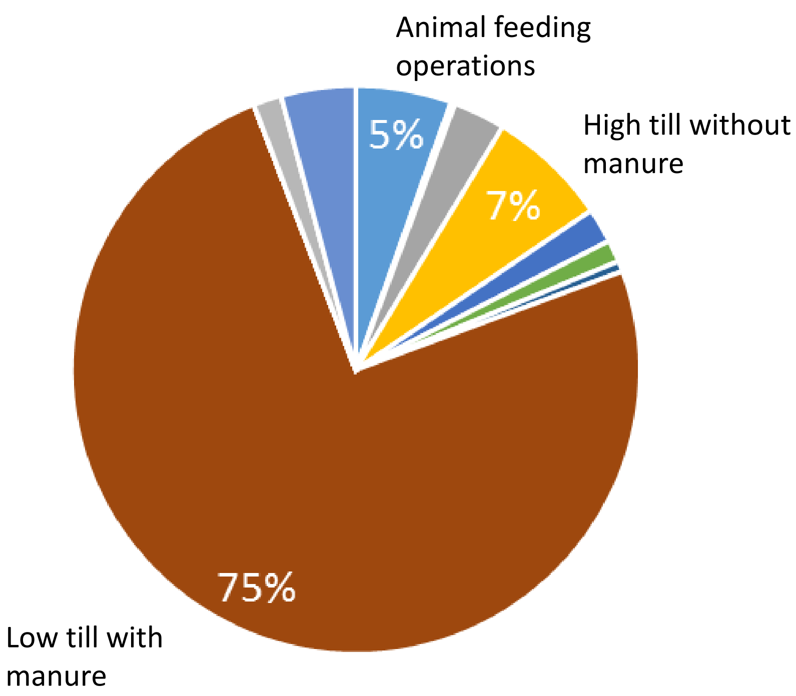
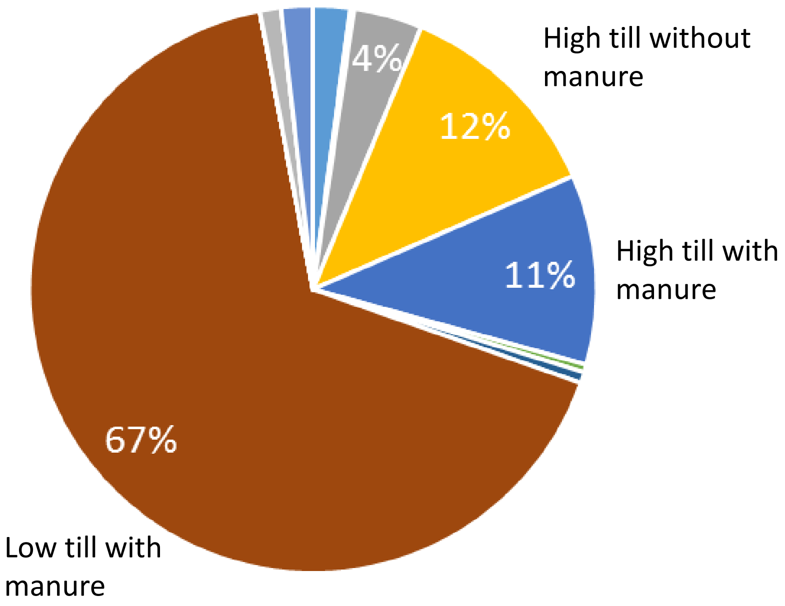




Relative acres of agricultural land-use





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Land-use

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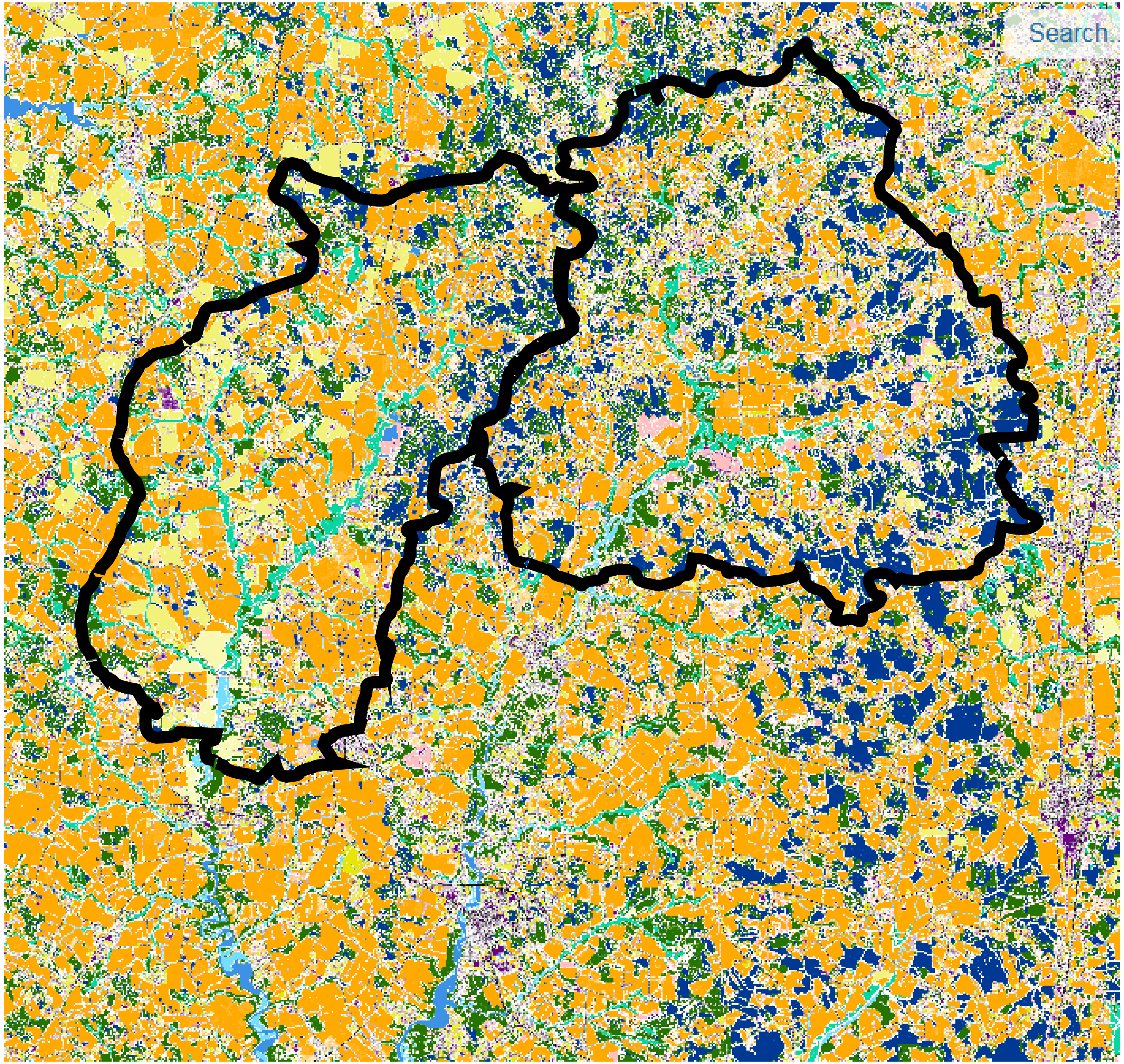
Impervious Roads
Impervious Non-Roads
Tree Canopy Over Impervious
Tree Canopy Over Turf Grass
Turf Grass
Mixed Open
→ Forest
Tidal Wetland
Non-tidal Floodplain Wetland
→ Non-tidal Other Wetland
Open Water
→ Cropland
Pasture

Tuckahoe Creek **Greensboro**



Chesapeake Bay Phase 6 Land-use Viewer:
https://chesapeake.usgs.gov/phase6/map

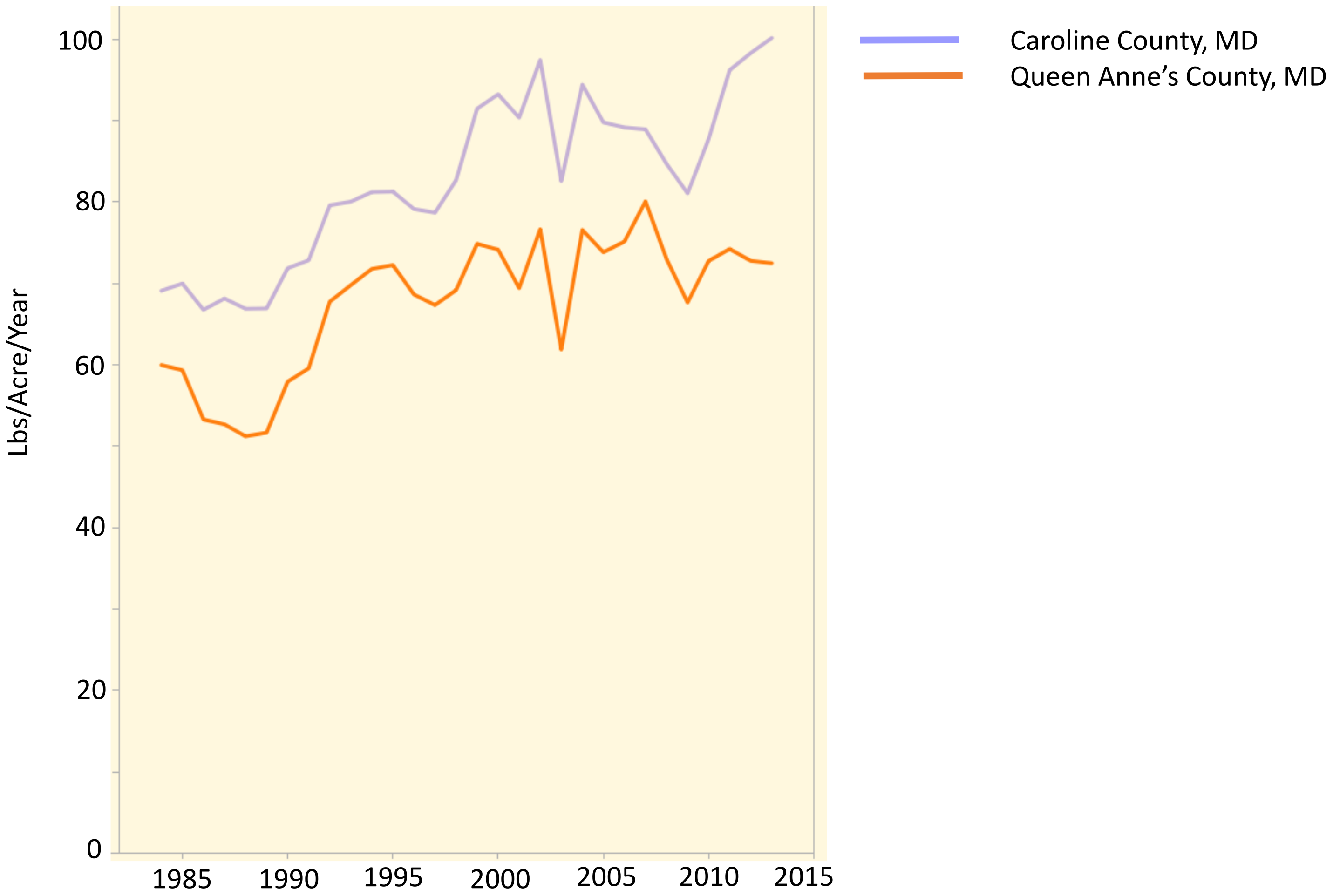
Nitrogen inputs

- Nitrogen in streams represents both recent and past applications
- **Nitrogen applications have increased in these watersheds over decades**

Tuckahoe Creek: Caroline & Queen Anne's counties, MD

Greensboro: Caroline County, MD & Kent County, DE

Nitrogen (lbs/acre/year) applied

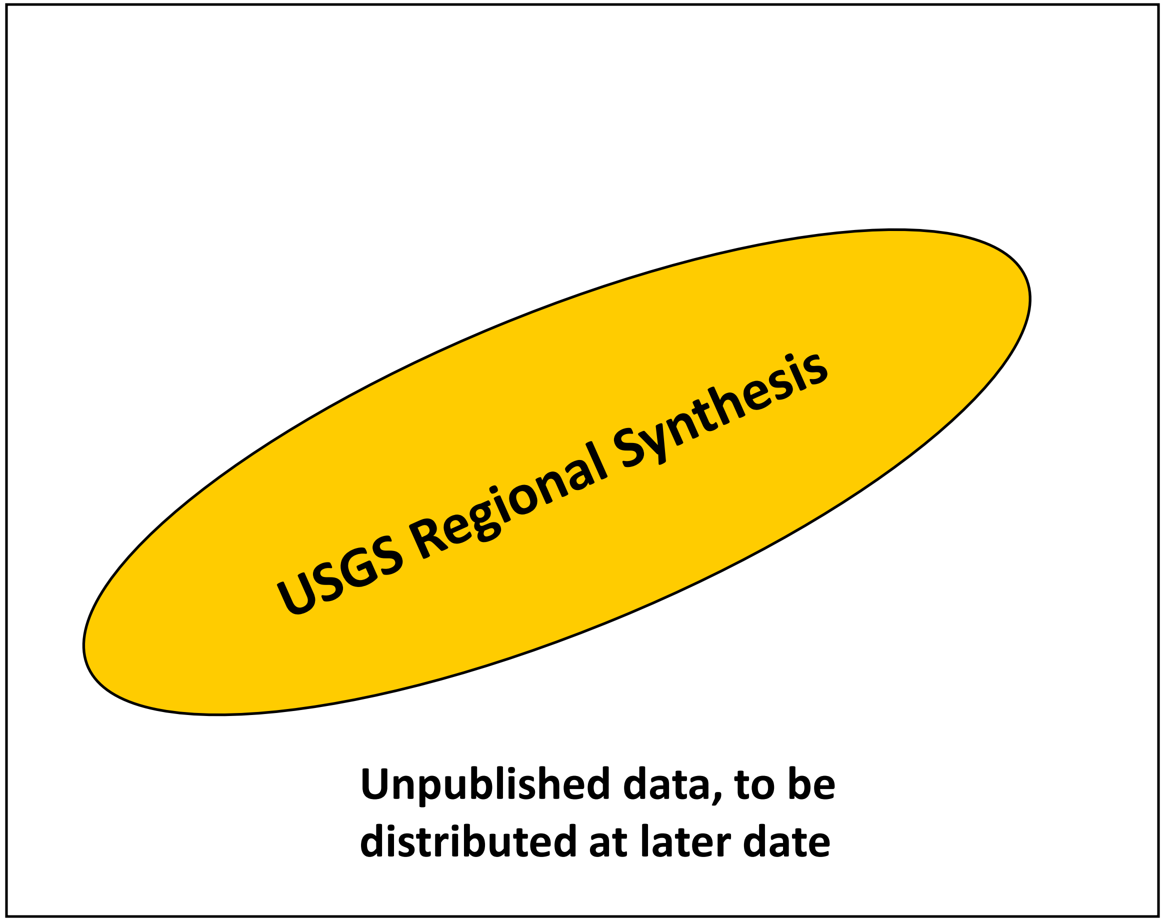


From CBP WSM Phase 6 inputs; https://mpa.chesapeakebay.net/Phase6DataVisualization.html

Nitrogen yields

- Nitrogen in streams represents both recent and past applications
- Nitrogen applications have increased in these watersheds over decades
- **Nitrogen yields have been increasing from cropland in these areas**

Change in nitrogen yield from cropland, 1992-2012, Decadal SPARROW



Scott Ator, unpublished. USGS. DO NOT CITE OR DISTRIBUTE.

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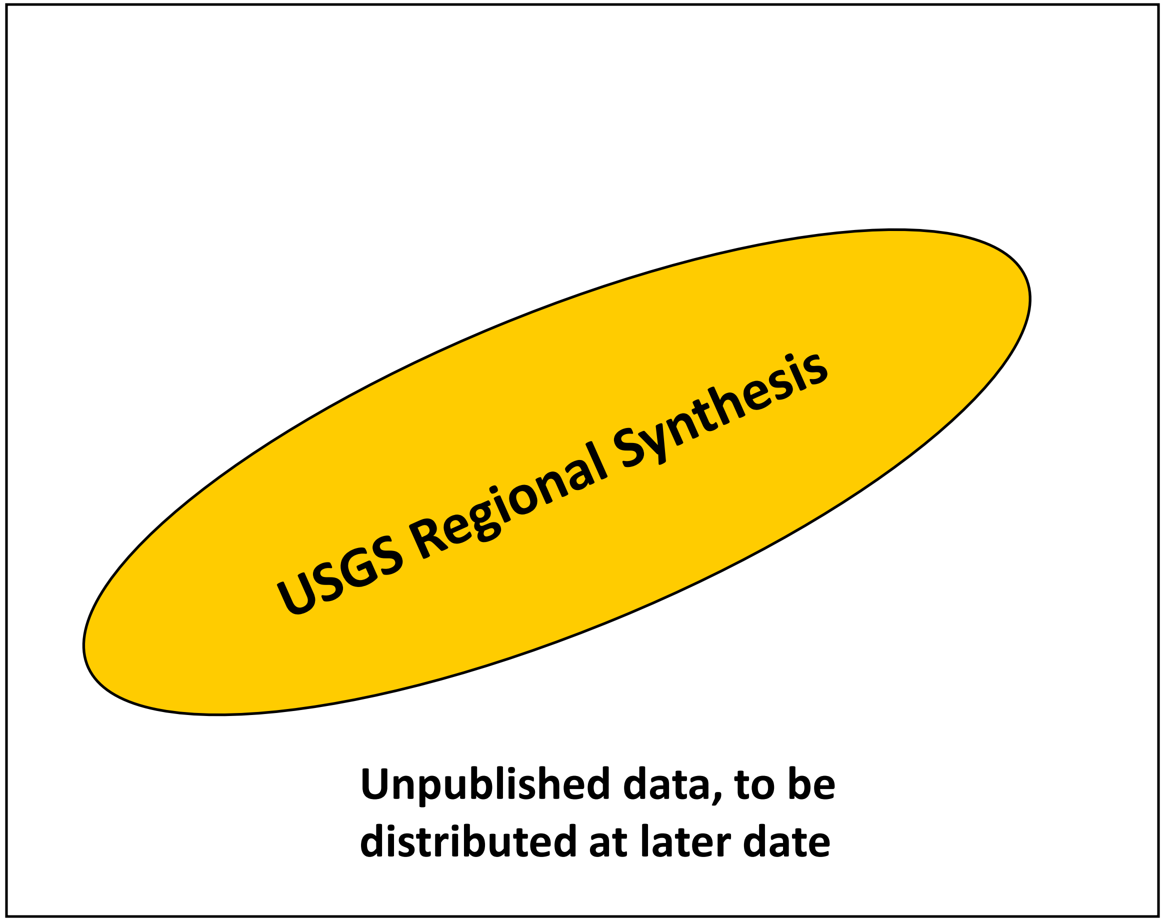


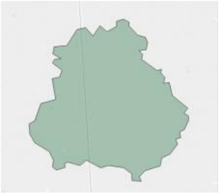
Scott Ator, unpublished. USGS. DO NOT CITE OR DISTRIBUTE.

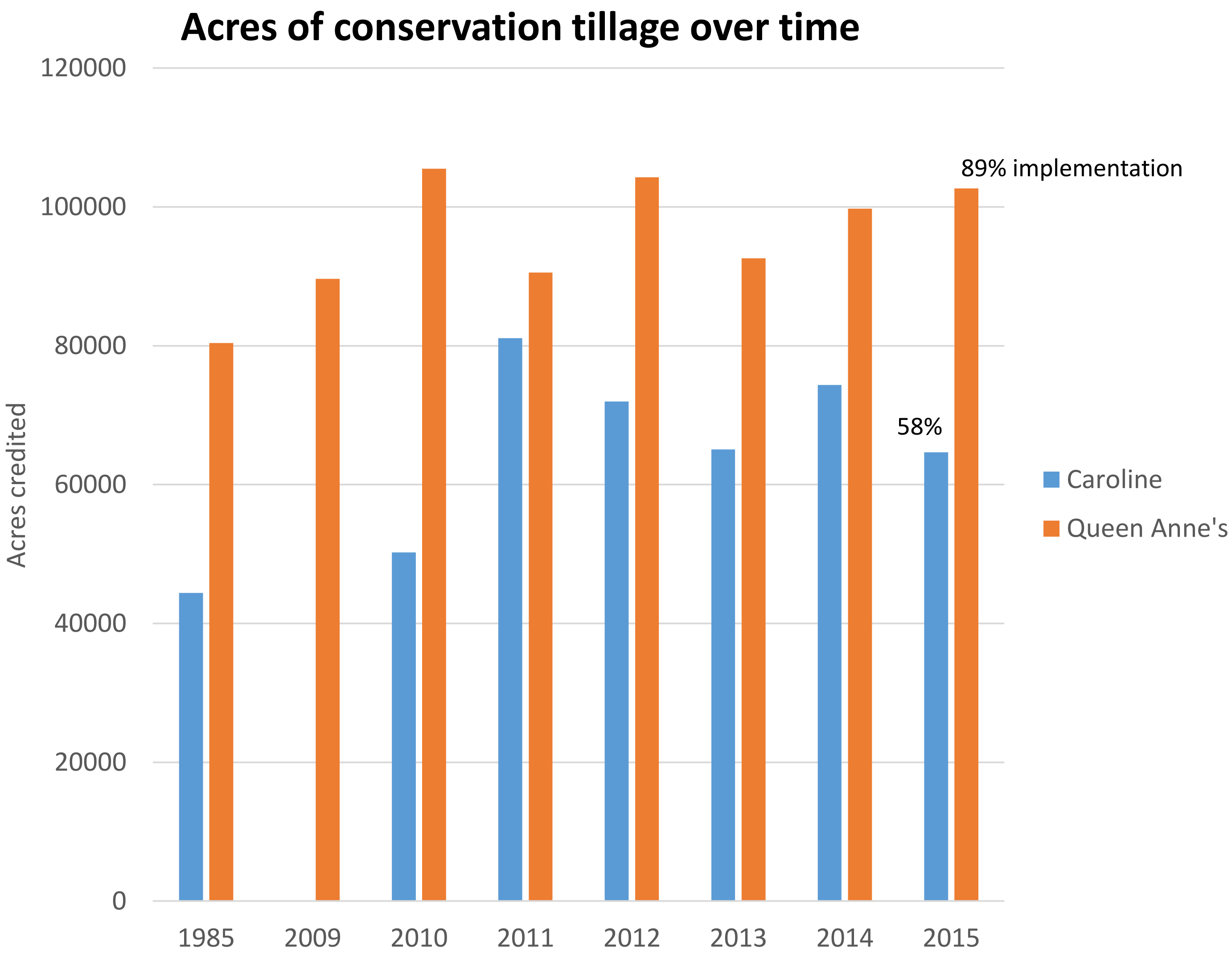
BMP Implementation

Some highly implemented conservation practices can actually drive nitrogen into groundwater

Tuckahoe Creek: Caroline & Queen Anne's counties, MD

Greensboro: Caroline County, MD & Kent County, DE





From MD credited BMP Progress reports. See data analysis at end of this document.

What is driving non-attainment in tidal areas?

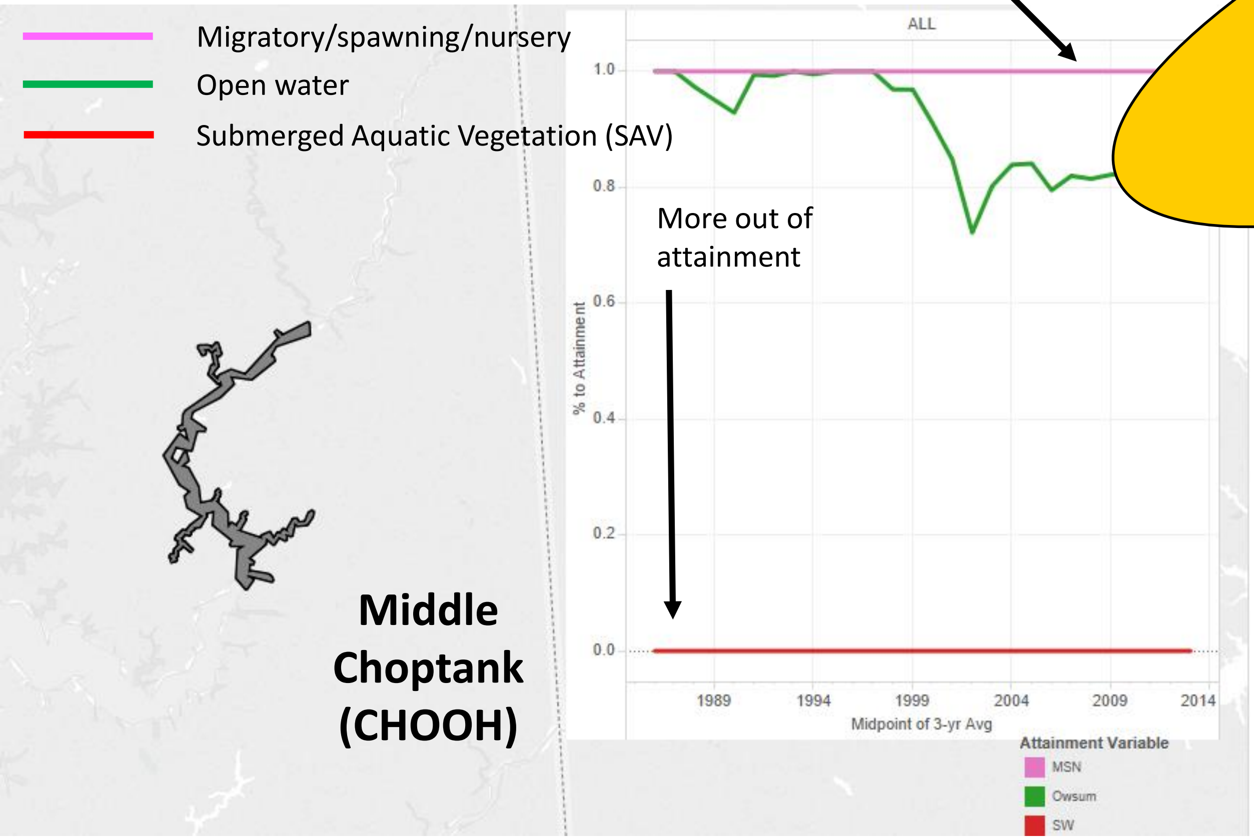
- Degrading summer DO drives non-attainment
- Increasing nutrients drive down DO

Summer DO is de[...] Middle

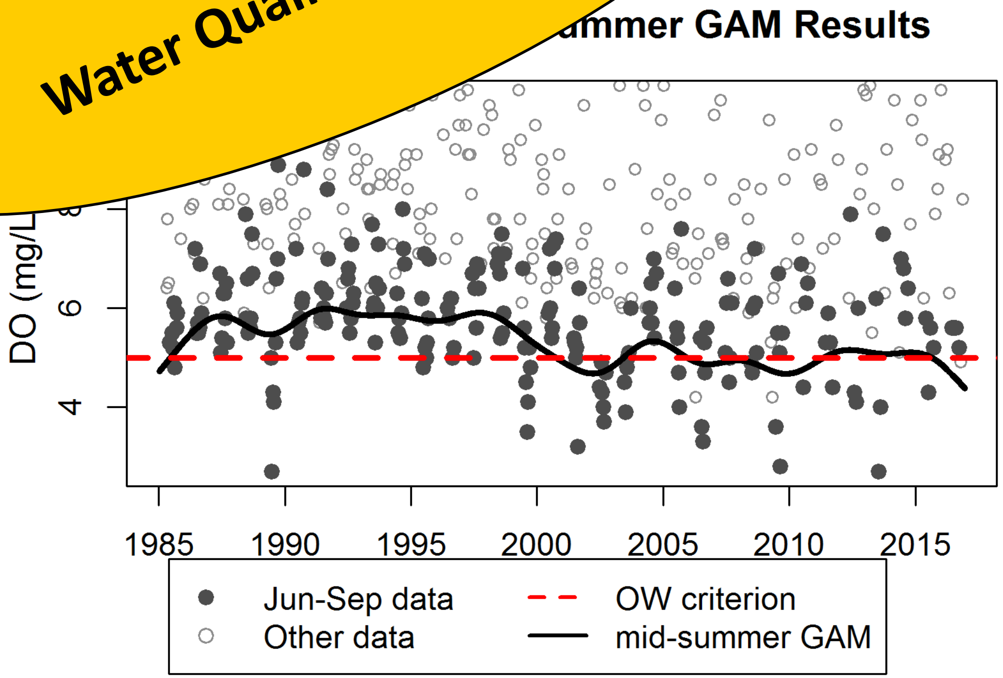
Water Quality Synthesis

1.0 = attainment

Designated use attainment



From CBP Tidal Dashboard, in development.



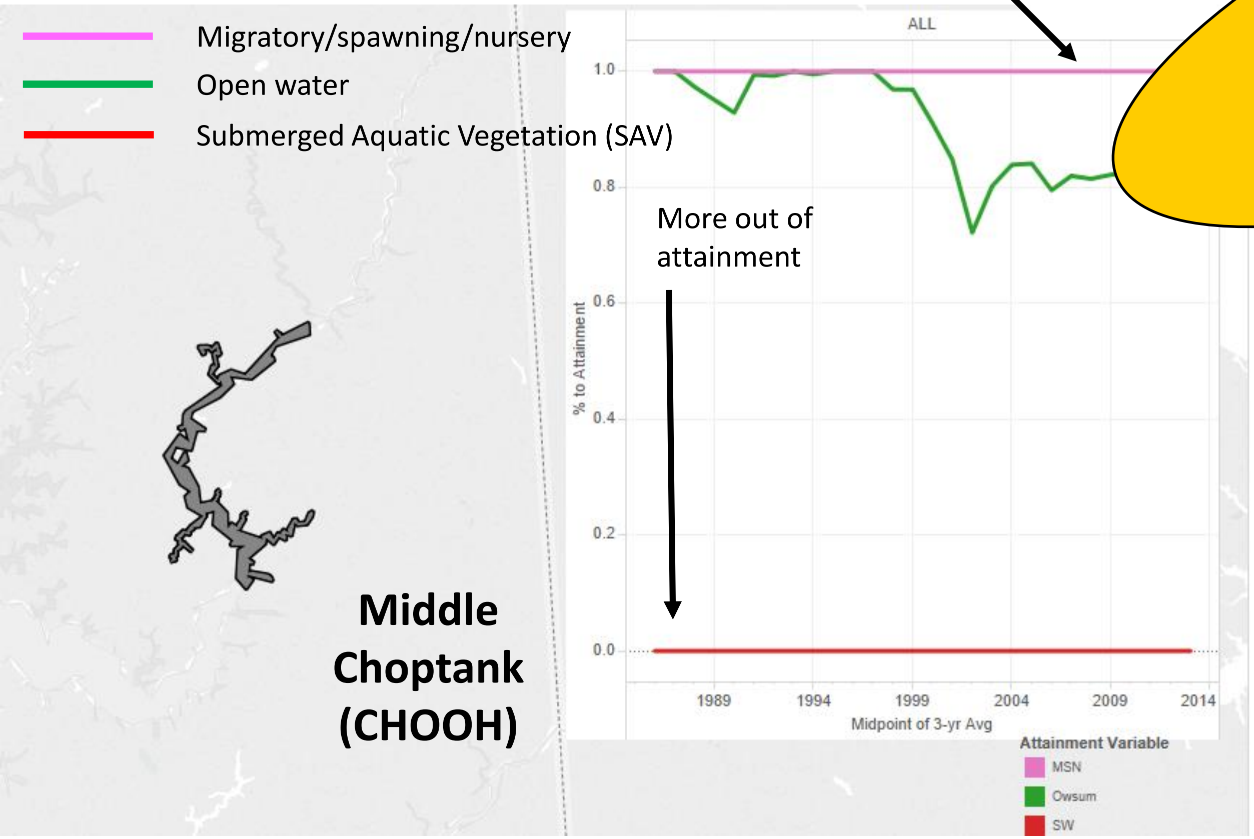
Rebecca Murphy, UMCES, unpublished. DO NOT CITE OR DISTRIBUTE.

What is driving non-attainment?

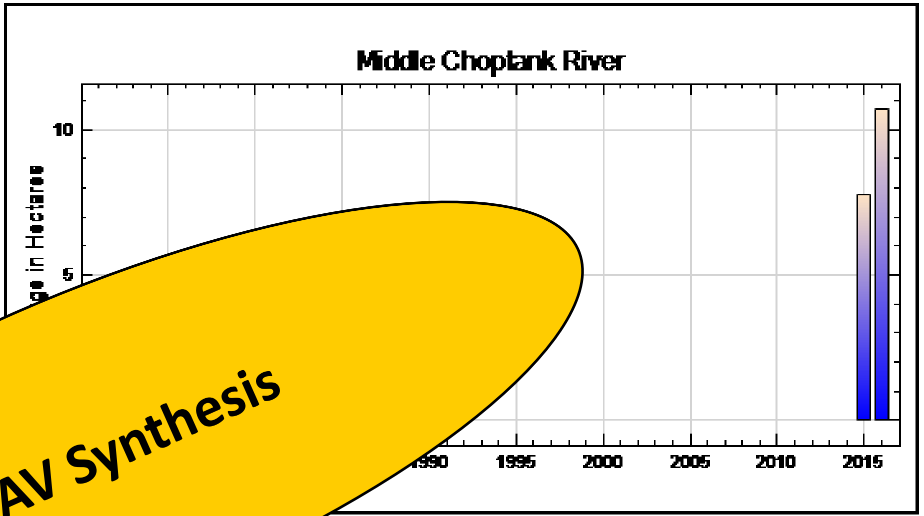
- SAV is strongly and negatively influenced by high nutrients in this part of the Bay
- Presence of any SAV improves chance of recovery
- May be a threshold of nutrients for recovery

Designated use attainment

1.0 = attainment

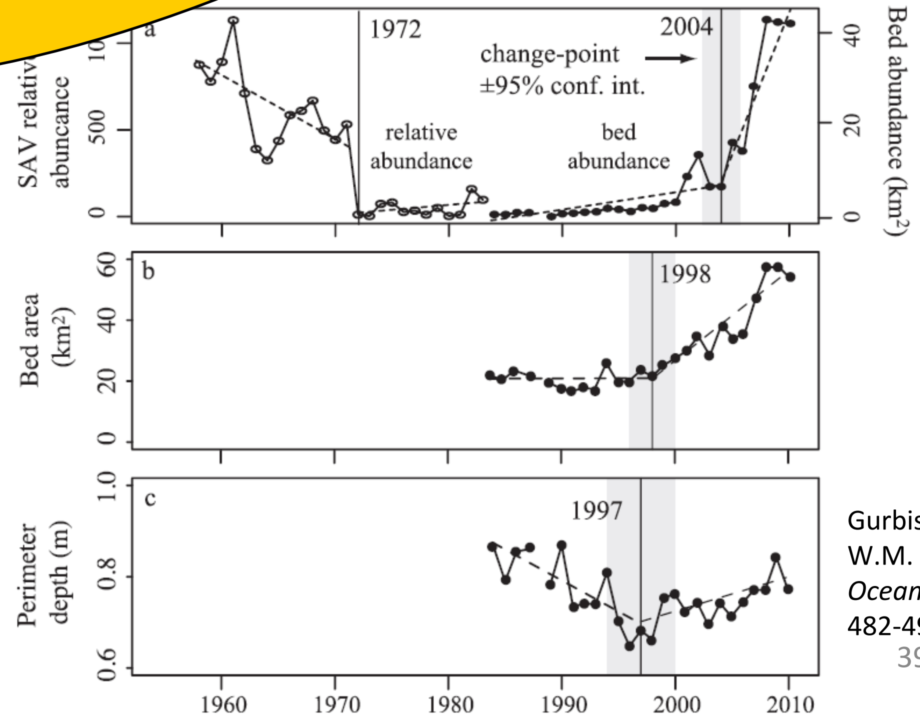


SAV trends in Middle Choptank



SAV Synthesis

ver quickly with right conditions



Gurbiscz, C. & Kemp, W.M. 2014. *Limnol. Oceanogr.* 59(2): 482-494.

Drivers Summary

- Nitrogen fate and transport characteristics make these areas especially vulnerable to high inputs
- Nitrogen loads are primarily from agricultural cropland
- Nitrogen inputs to the land have been increasing
- Declining summer DO is driving non-attainment in tidal waters

Storyline Development

Monitoring & Trends Data

Monitoring, Trends & Explanations:
What is happening in this watershed?
What are the sources and drivers?
What is the explanation behind a trend?

Modeling data

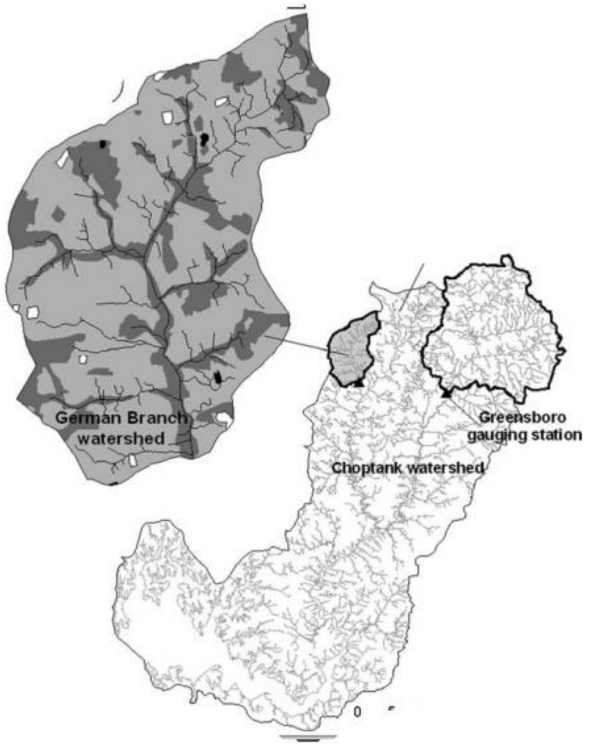
Synthesis Analyses

Programmatic Implications
What has or hasn't been working, and where?
What types of adjustments are necessary (source sector, geography, etc.)?
How can those adjustments be realized (shifts in BMP implementation, etc.)?

BMPs/practices

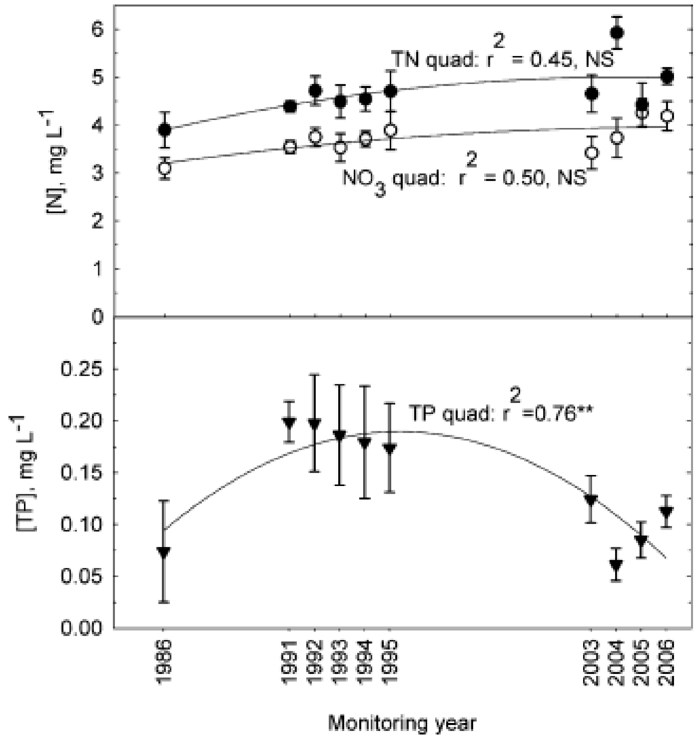
BMP Implementation: has it worked?

- **Certain areas are potentially responding to focused implementation of BMPs**
- **The German Branch of the Tuckahoe Creek watershed shows a slower increase in nitrogen**



Sutton et al., 2008. *Water Air Soil Poll.* 199(1):353-369.

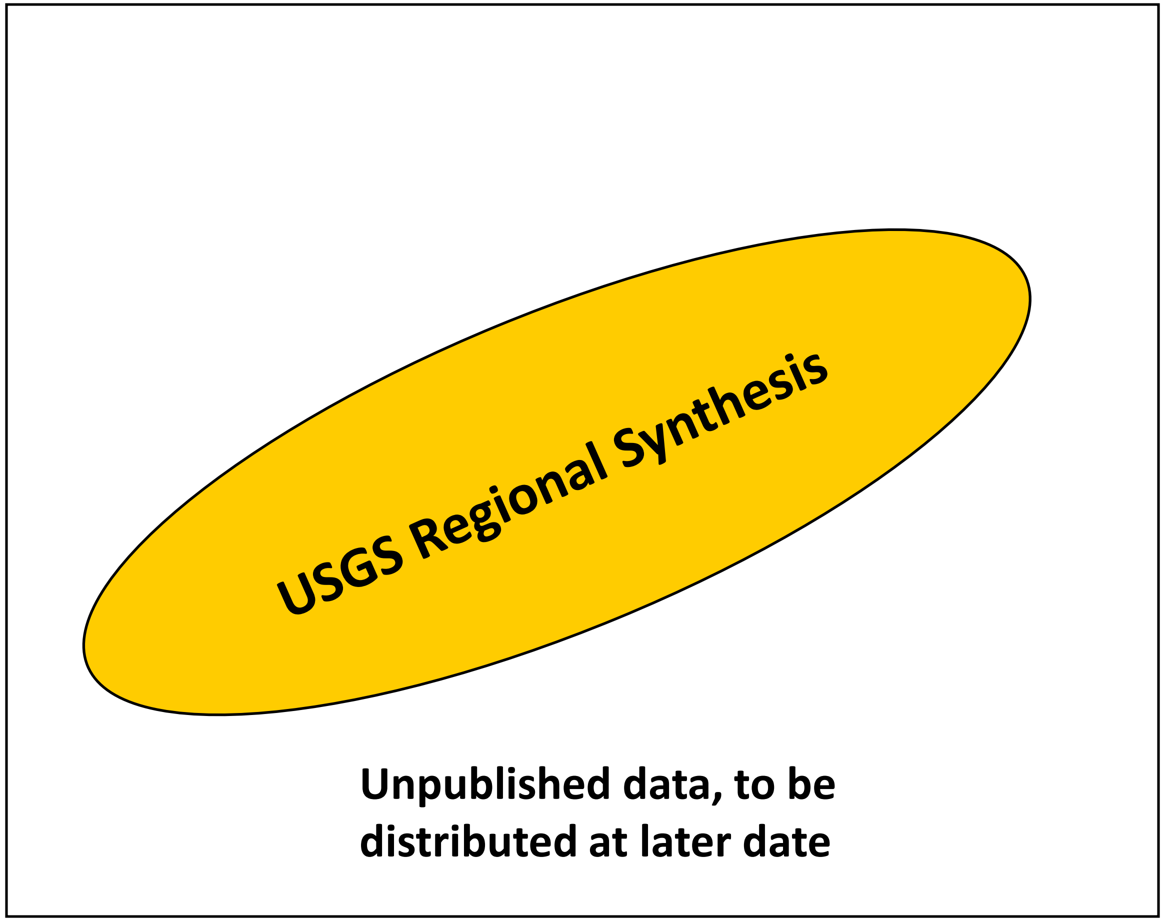
Decreased P and slowed N increases in German Branch



	Rate of change (mg L^{-1} $year^{-1}$)		
Sampling periods	TN	NO3-N	TP
1986 to 1990s	0.09*	0.08**	0.01
1990s to 2000s	0.04	0.02	−0.008***

Where to focus (regionally)?

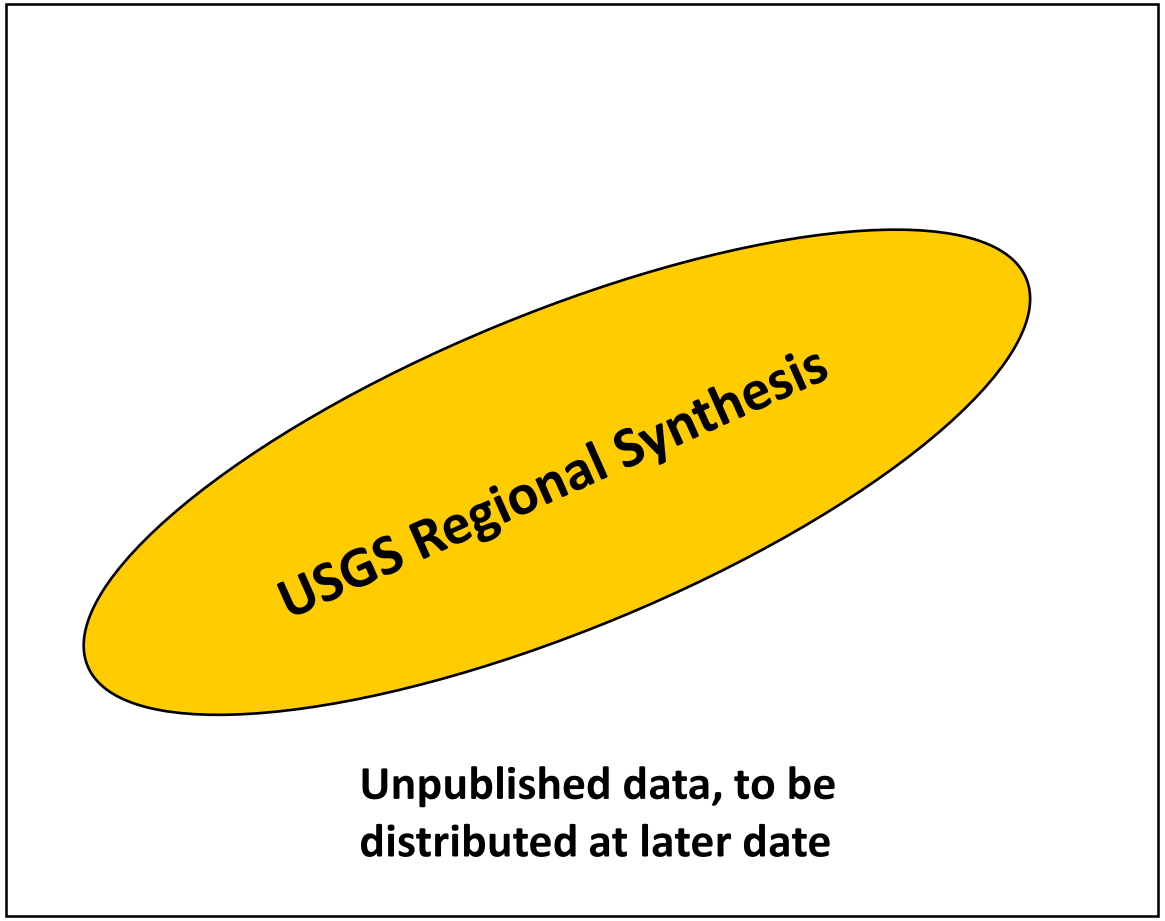
Certain areas of the watershed are higher loading than others



DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

Where to focus (locally)?

Certain areas of these sub-watersheds are higher loading than others



DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

Where to focus (regionally)?

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

USGS Regional Synthesis

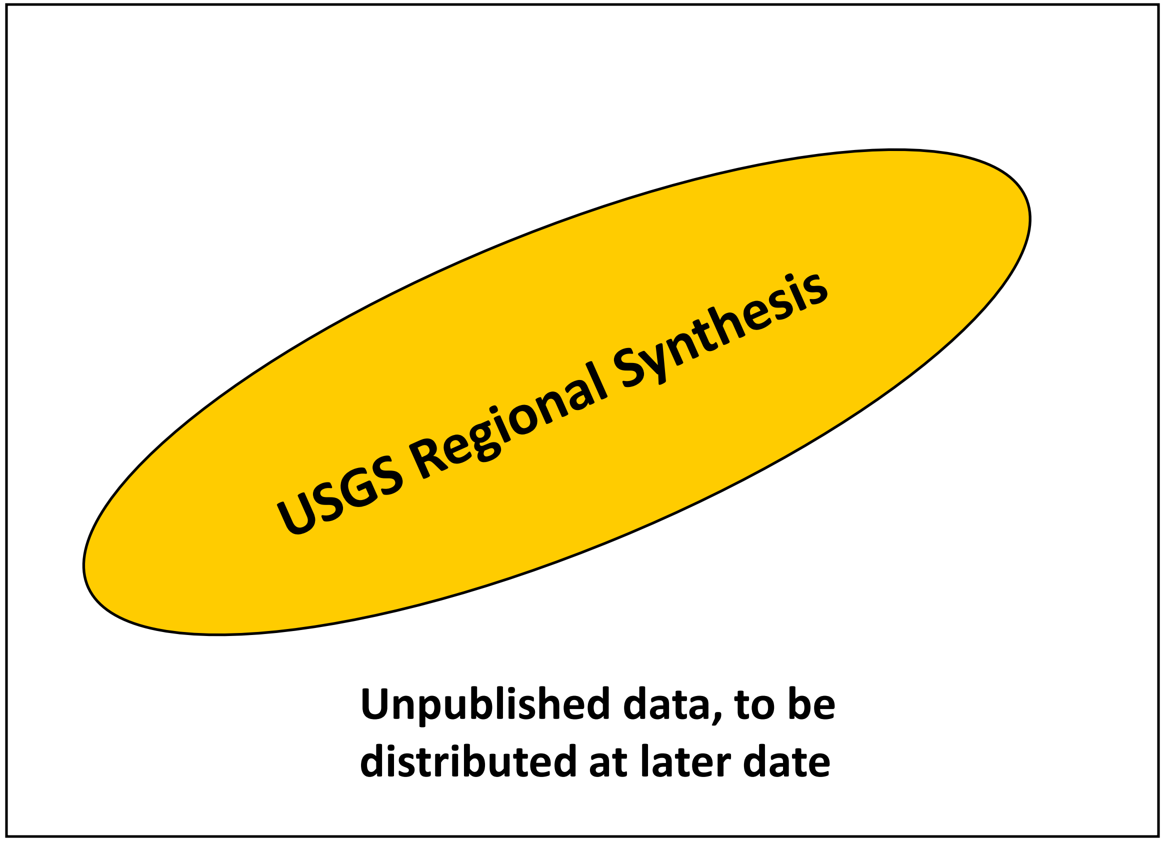
Unpublished data, to be distributed at later date

DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

Where to focus (locally)?

The geology in the Choptank area makes the groundwater (and therefore streams) especially vulnerable to high nitrogen inputs

USGS Regional Synthesis: Carbonate and Coarse Coastal Plain areas have efficient movement of nitrogen to groundwater

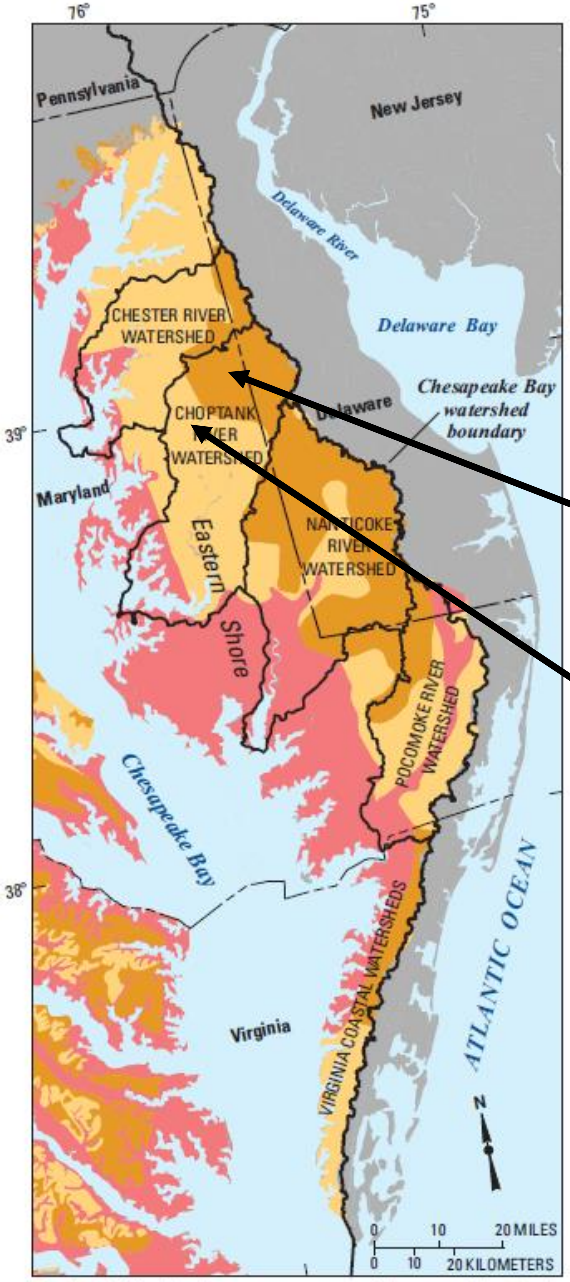


DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

Where to focus (locally)?

Even within sub-watersheds, fate and transport of nitrogen can differ greatly based on setting

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



Different colors represent different settings that impact denitrification and transport of nitrogen to groundwater

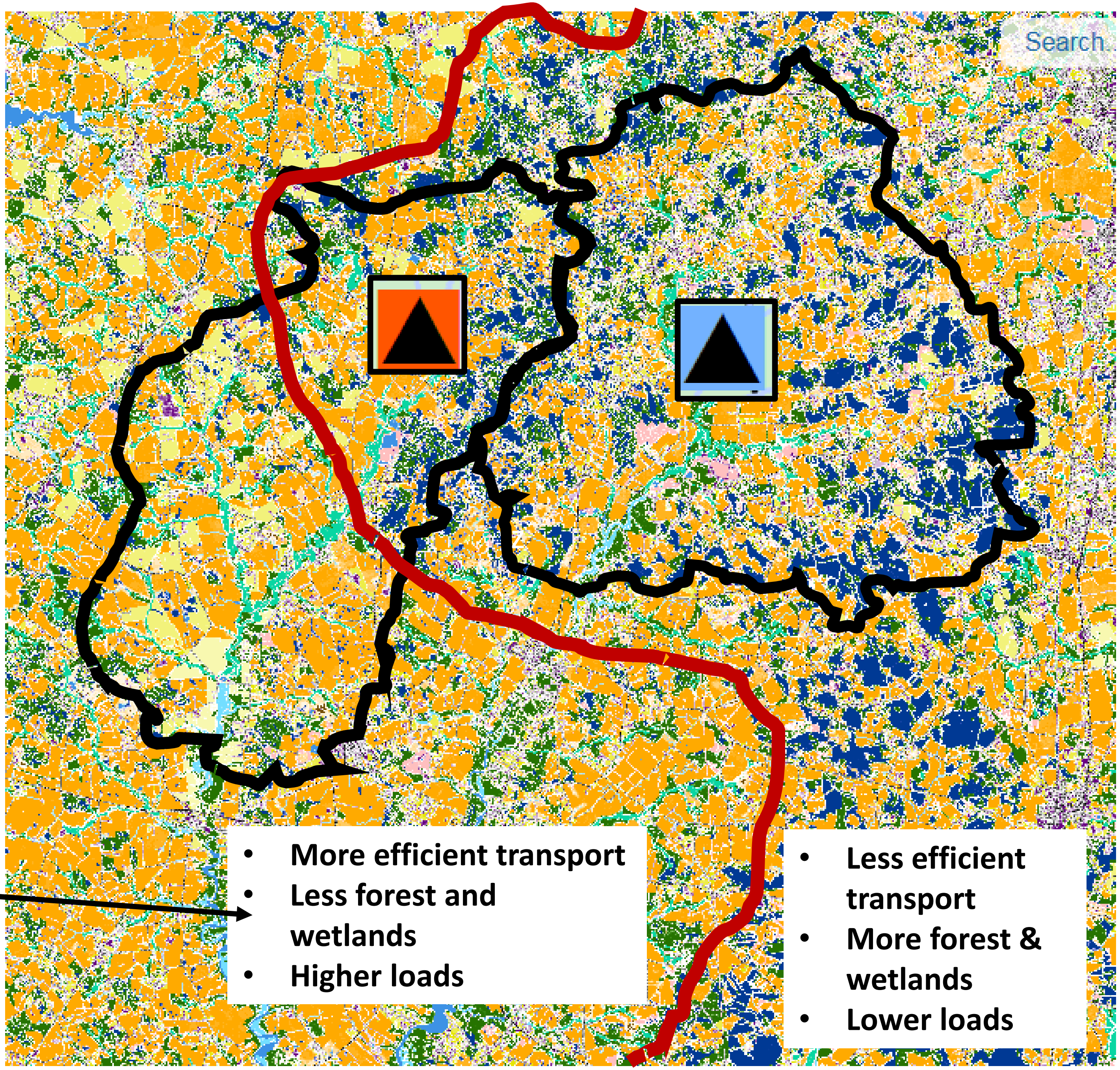
Associated with lower loads, less efficient transport to groundwater

Associated with higher loads, more efficient transport to groundwater

Where to focus?

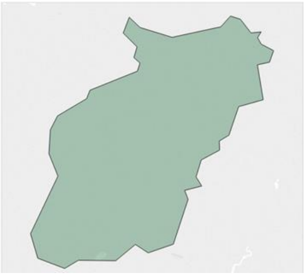
- Even within sub-watersheds, fate and transport of nitrogen can differ greatly based on setting
- Setting of Tuckahoe Creek contributes to higher loads
- Setting impacts the effectiveness of BMPs

Controlling inputs to groundwater is especially important in this area, but proper BMPs can be more effective

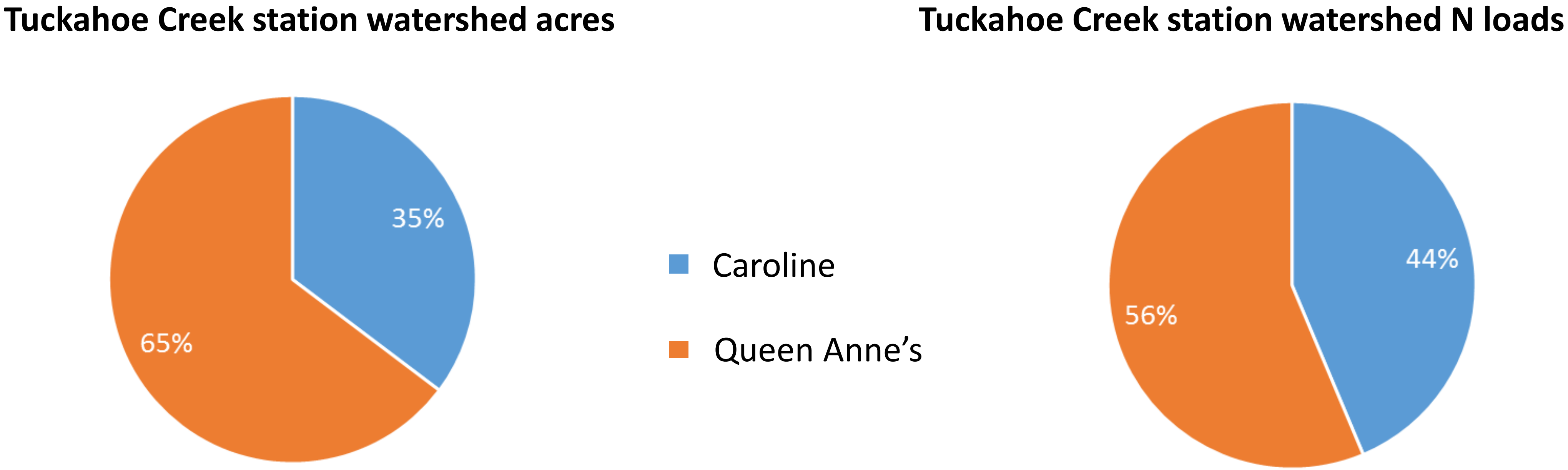


Where to focus (locally)?

- Loads and practices can differ between counties within watersheds
- Caroline county delivers a disproportionate amount of the load compared to its area

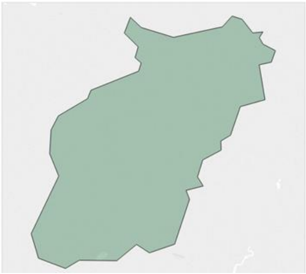


Tuckahoe Creek



From CBP WSM Phase 5.3.2 2015 Progress. See data analysis at end of this document.

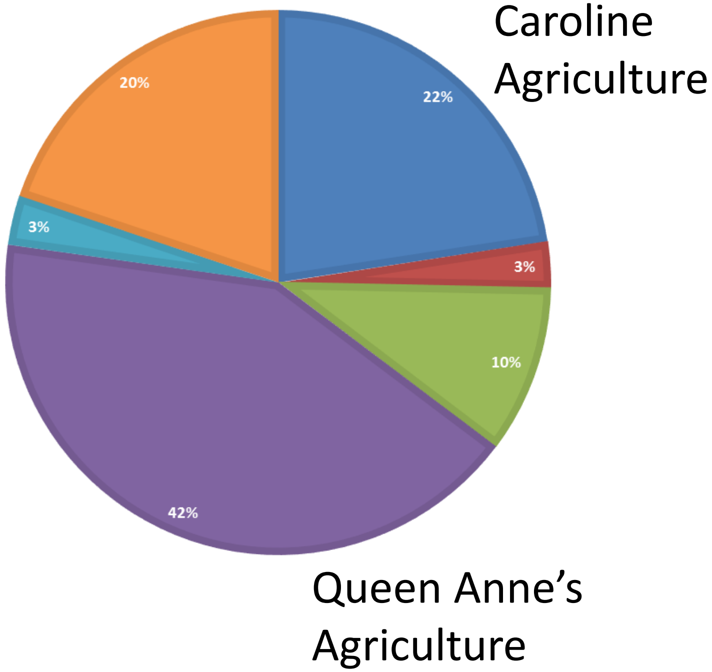
Where to focus (locally)?



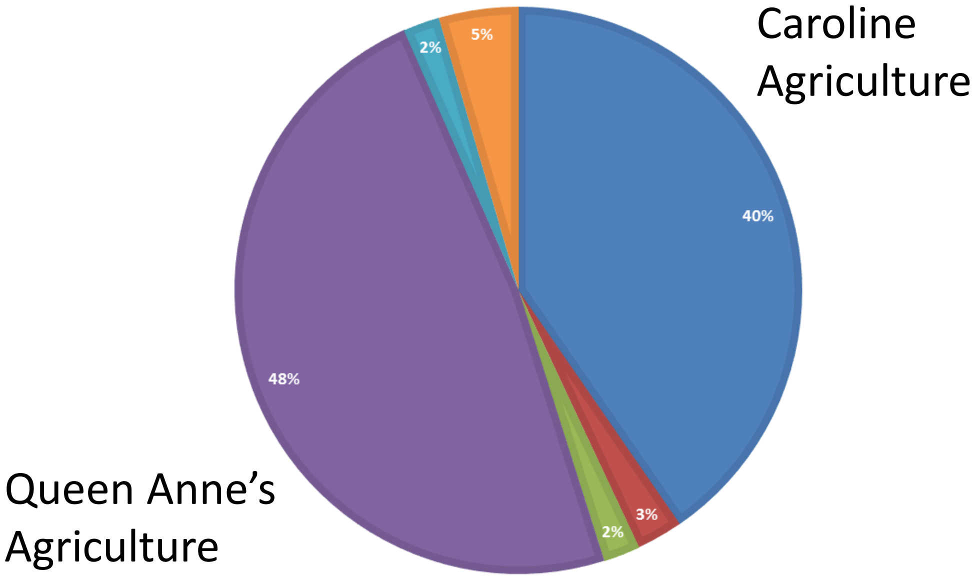
Tuckahoe Creek

- Loads and practices can differ between counties within watersheds
- Caroline county delivers a disproportionate amount of the load compared to its area

Tuckahoe Creek station watershed acres by land-use



Tuckahoe Creek station watershed N loads by land-use



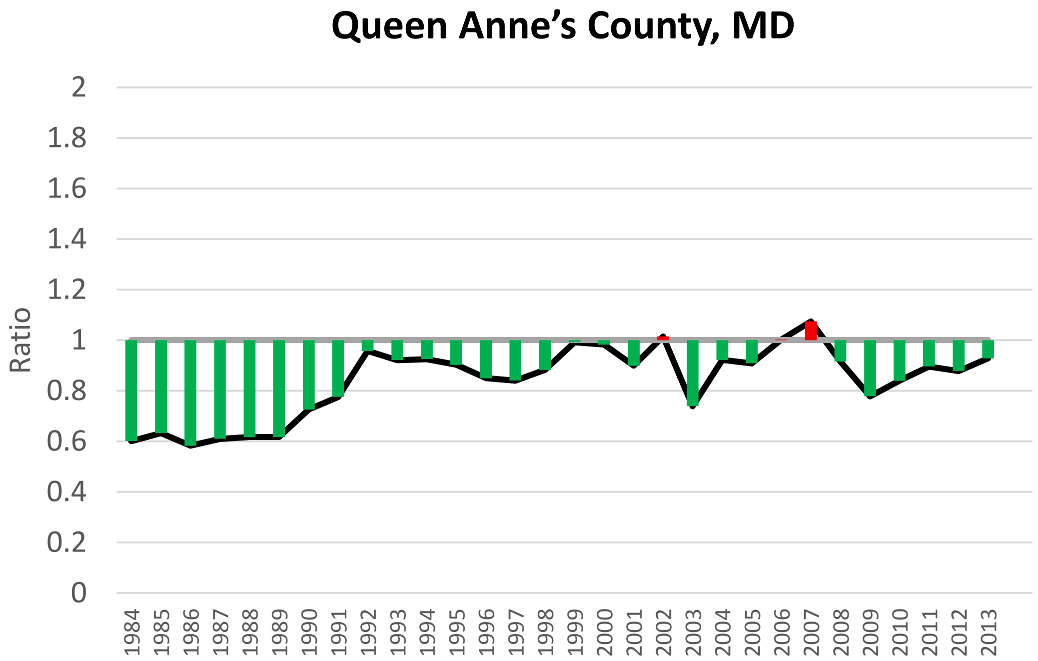
From CBP WSM Phase 5.3.2 2015 Progress. See data analysis at end of this document.

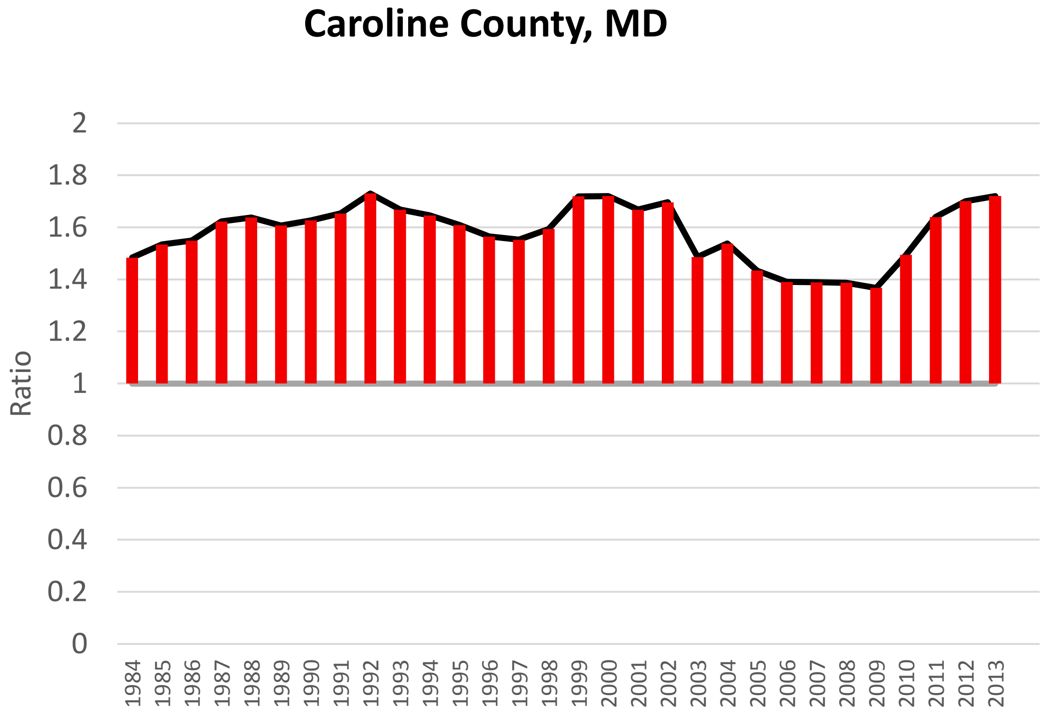
Where to focus (locally)?

- Loads and practices can differ between counties within watersheds
- Caroline county delivers a disproportionate amount of the load compared to its area

Ratio of Nitrogen applied to crop application goal

Crop application goal reflects expected application per acre for any producer with a nutrient management plan



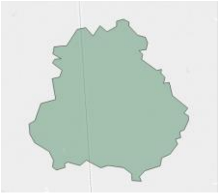


From CBP WSM Phase 6 inputs. See data analysis at end of this document.

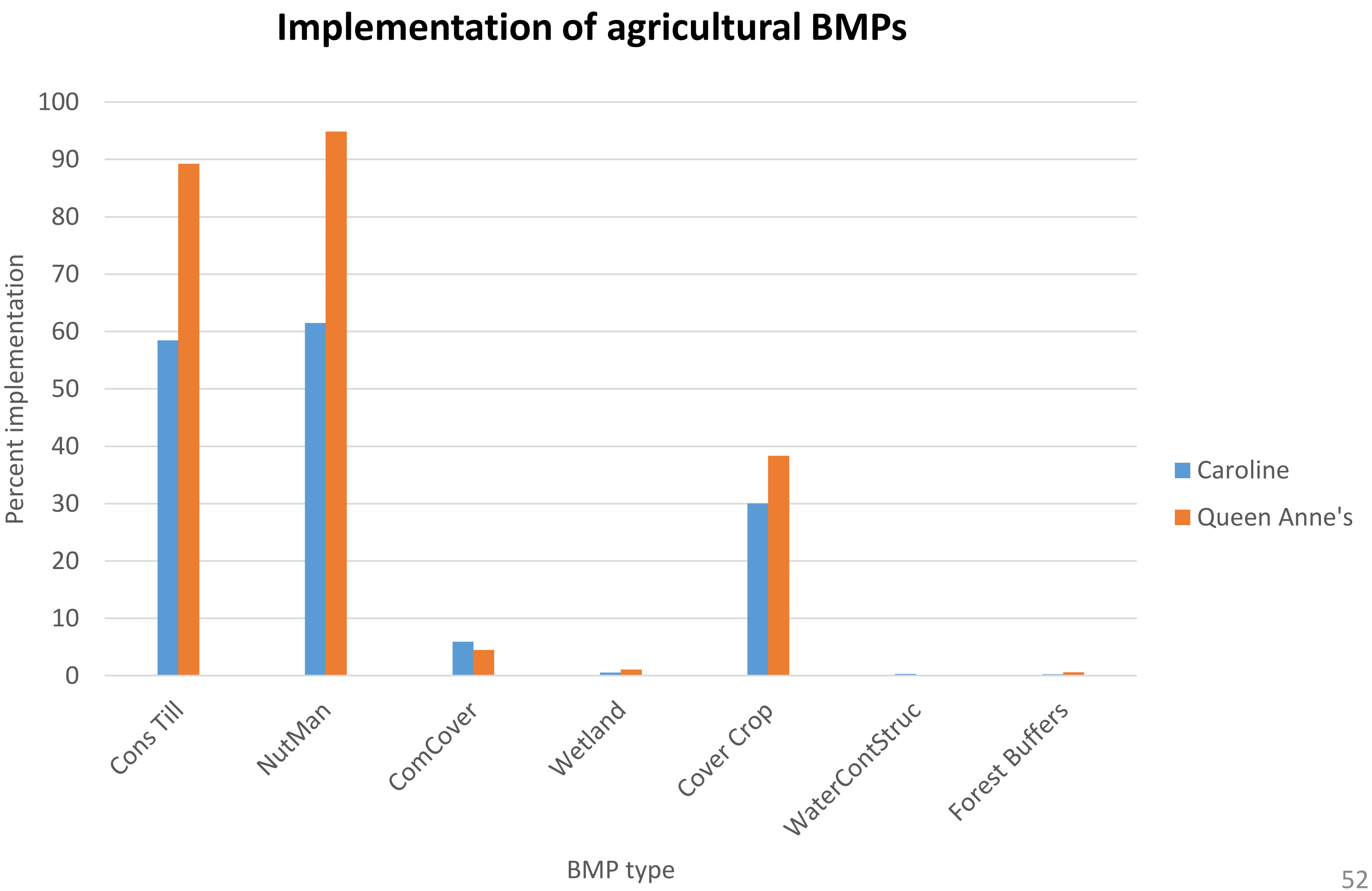
Where to focus (locally)?

Tuckahoe Creek: Caroline & Queen Anne's counties, MD

Greensboro: Caroline County, MD & Kent County, DE



- **Loads and practices can differ between counties within watersheds**
- **BMPs have higher implementation in Queen Anne's county than Caroline**

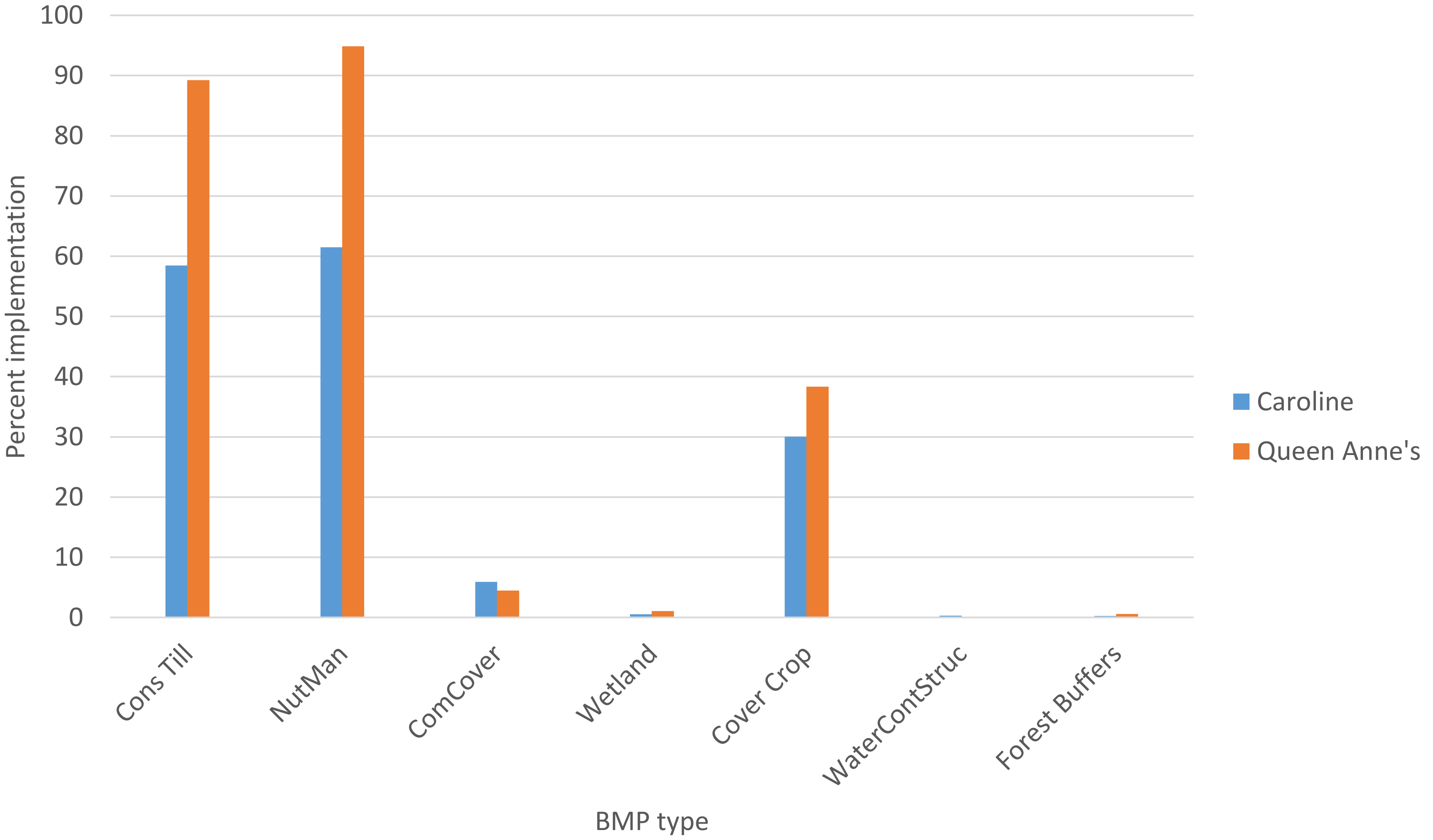


From 2015 MD credited BMP Progress. See data analysis at end of this document.

What types of BMPs?

- **Because nitrate in groundwater is the primary source of nitrogen in streams, BMPs that mitigate nitrogen in groundwater or decrease nutrient applications can be effective**
- **Can include cover crops, forest buffers, wetland restoration, water control structures**

Implementation of agricultural BMPs and their effectiveness at removing nitrogen



From 2015 MD credited BMP Progress. See data analysis at end of this document.

MD state-wide percent implementation	74%	70%	9%	0.6%	33%	0.2%	1.5%

What types of BMPs?

- Because nitrate in groundwater is the primary source of nitrogen in streams, BMPs that mitigate nitrogen in groundwater or decrease nutrient applications can be effective
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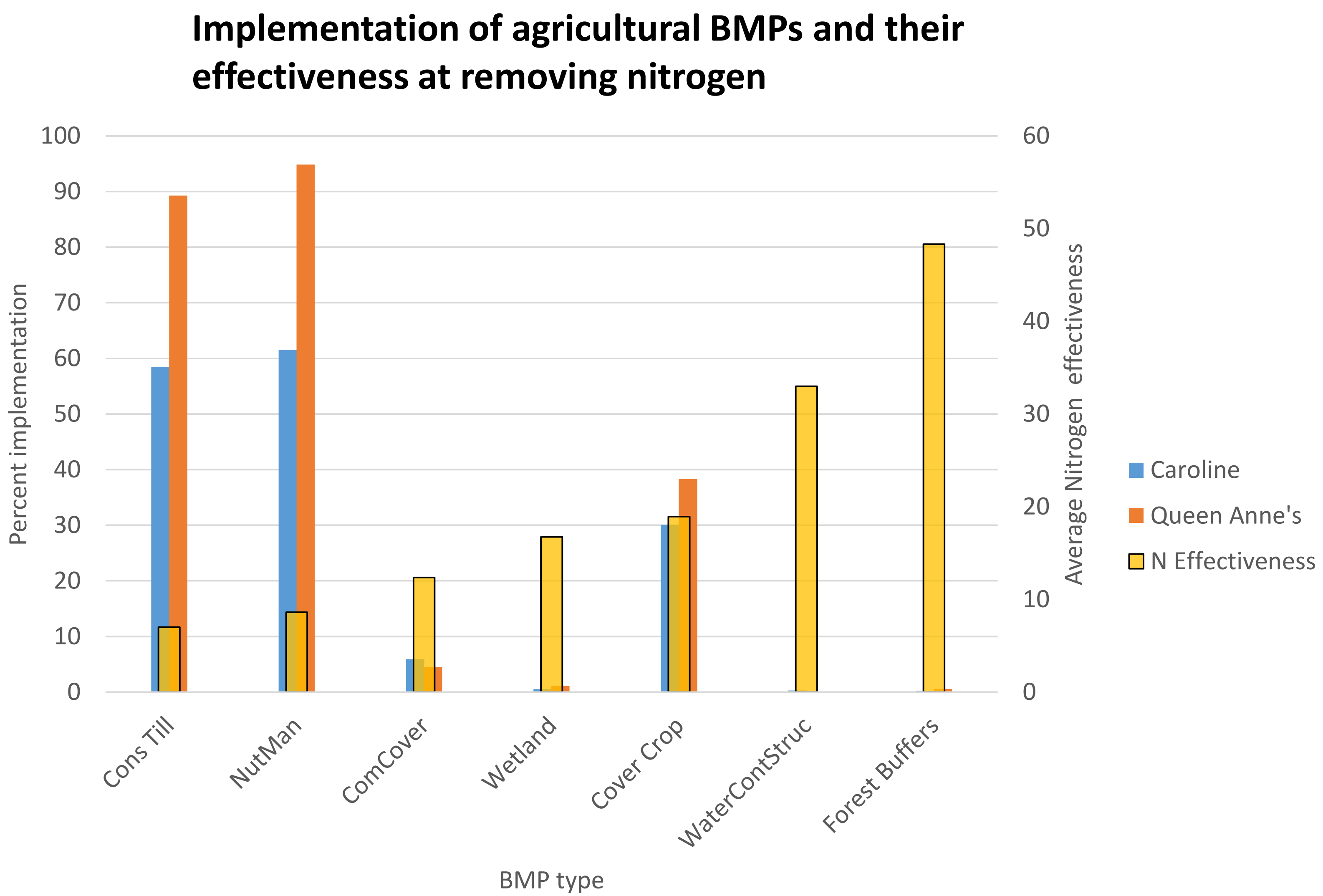


From 2015 MD credited BMP Progress and Phase 6 WSM Documentation. See data analysis at end of this document.

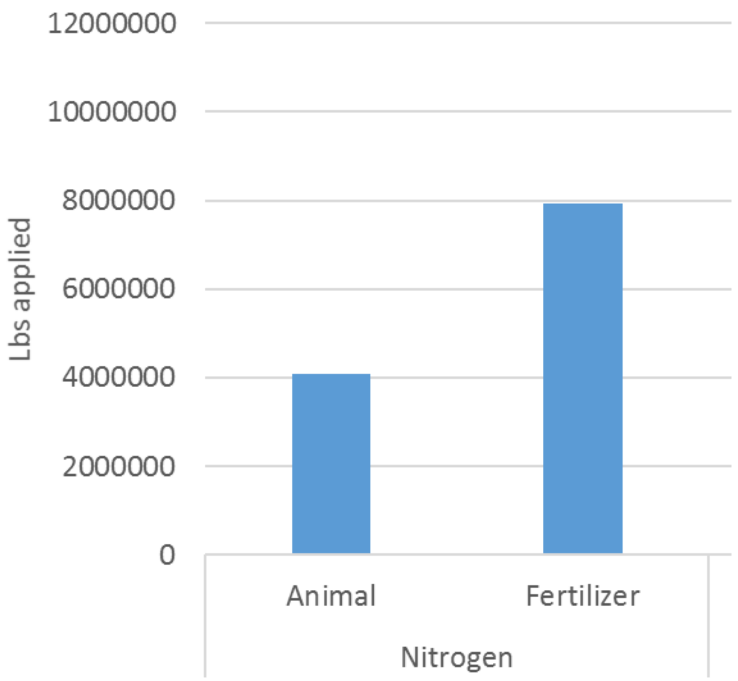
MD state-wide percent implementation	74%	70%	9%	0.6%	33%	0.2%	1.5%
MD Phase II WIP 2025	81%	97%	0%	0.8%	44%	1.4%	1.6%

What types of BMPs: Nutrient management

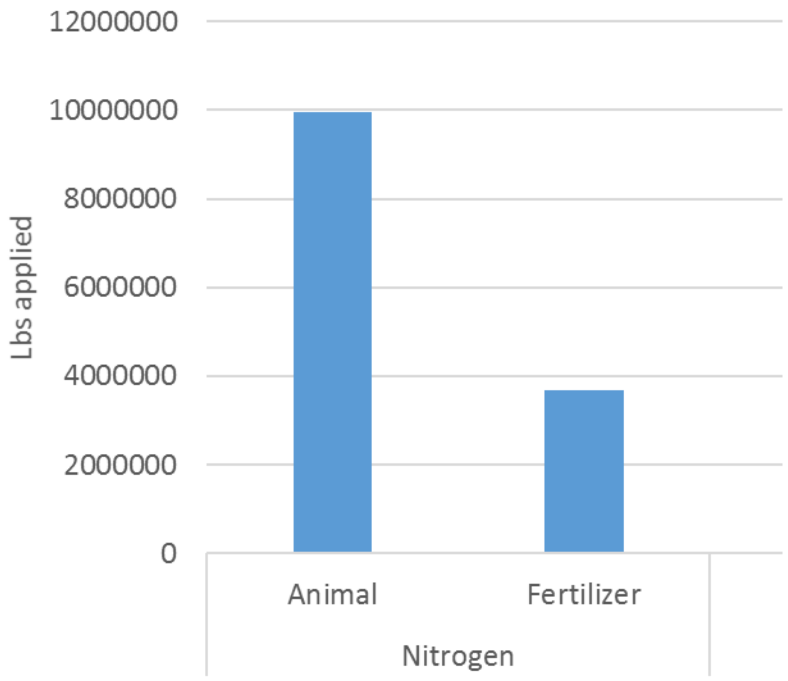
Counties apply nutrients differently, which can be taken into account when developing BMPs

Nitrogen (lbs) applied in 2015

Queen Anne’s County, MD



Caroline County, MD

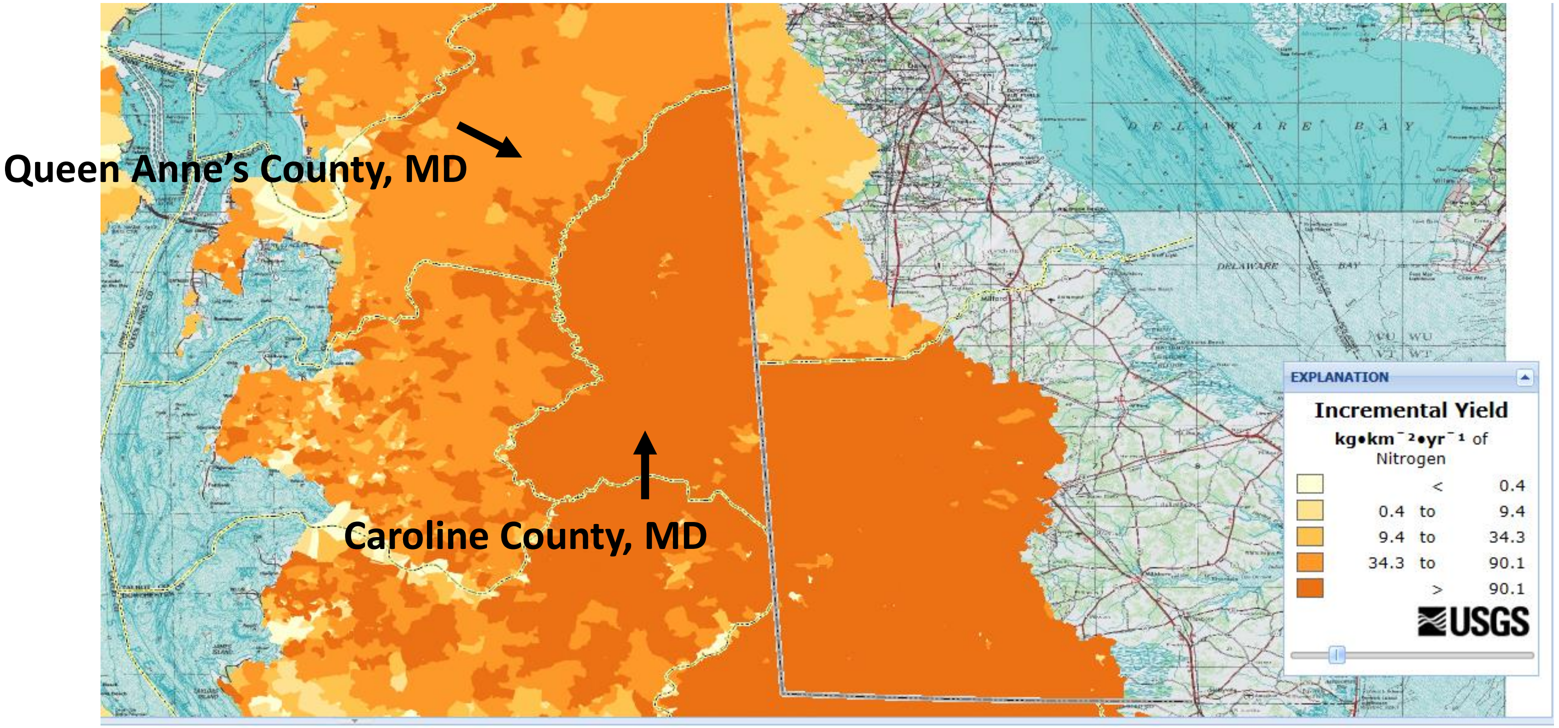


From CBP WSM Phase 5.3.2 2015 Progress. See data analysis at end of this document.

What types of BMPs: Nutrient management

Counties apply nutrients differently, which can be taken into account when developing BMPs

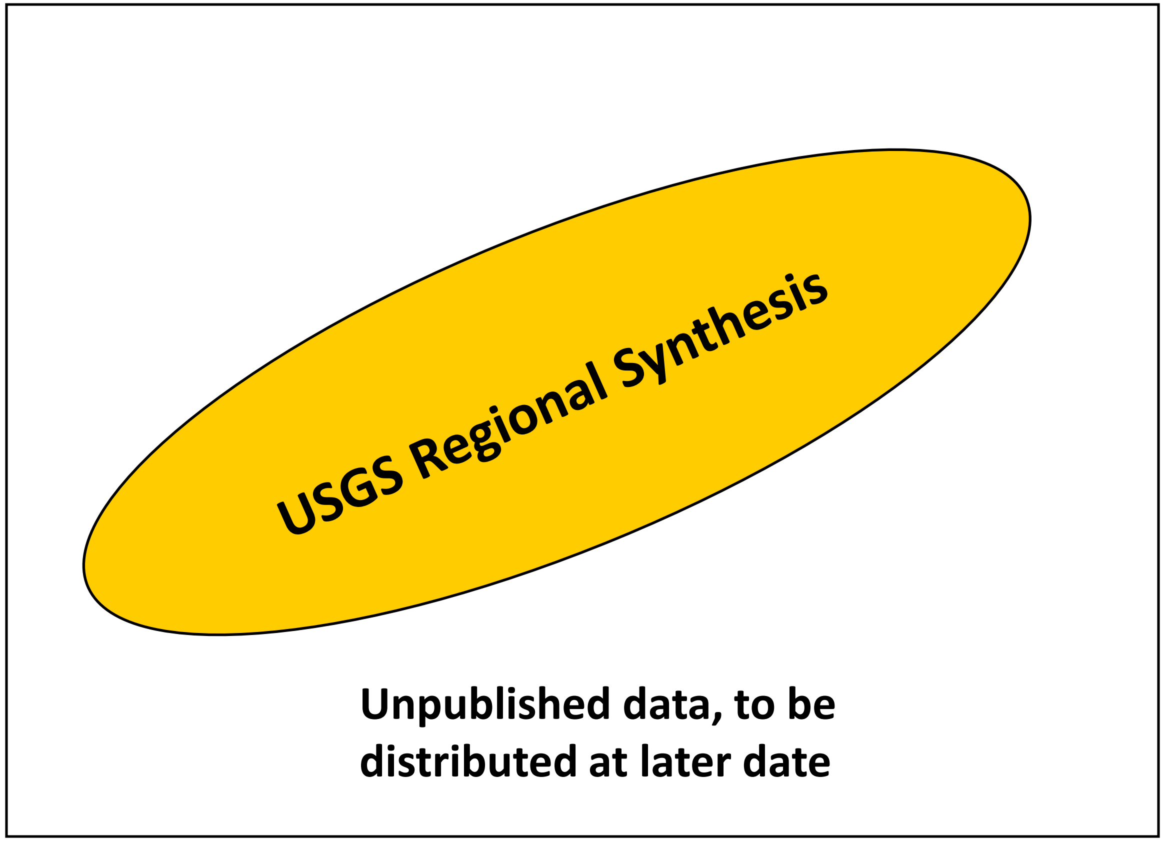
SPARROW modeled Nitrogen yield from Manure



From USGS Chesapeake Bay Nitrogen SPARROW Decision Support Tool. https://cida.usgs.gov/sparrow/

Choptank River in context of the Bay

The Choptank River, and these watersheds, can be effective areas for managing nitrogen loads to the Bay



DRAFT from Jimmy Webber, USGS. DO NOT CITE OR DISTRIBUTE.

Where to focus for the tidal waters?

Relative influence of Bay watershed on DO in Upper Choptank

The Choptank River's watershed is the most effective place to manage to influence dissolved oxygen attainment in its tidal waters

Unpublished data, to be distributed at later date

DRAFT from John Wolf. CBP
WSM geographic isolation runs.
DO NOT CITE OR DISTRIBUTE.

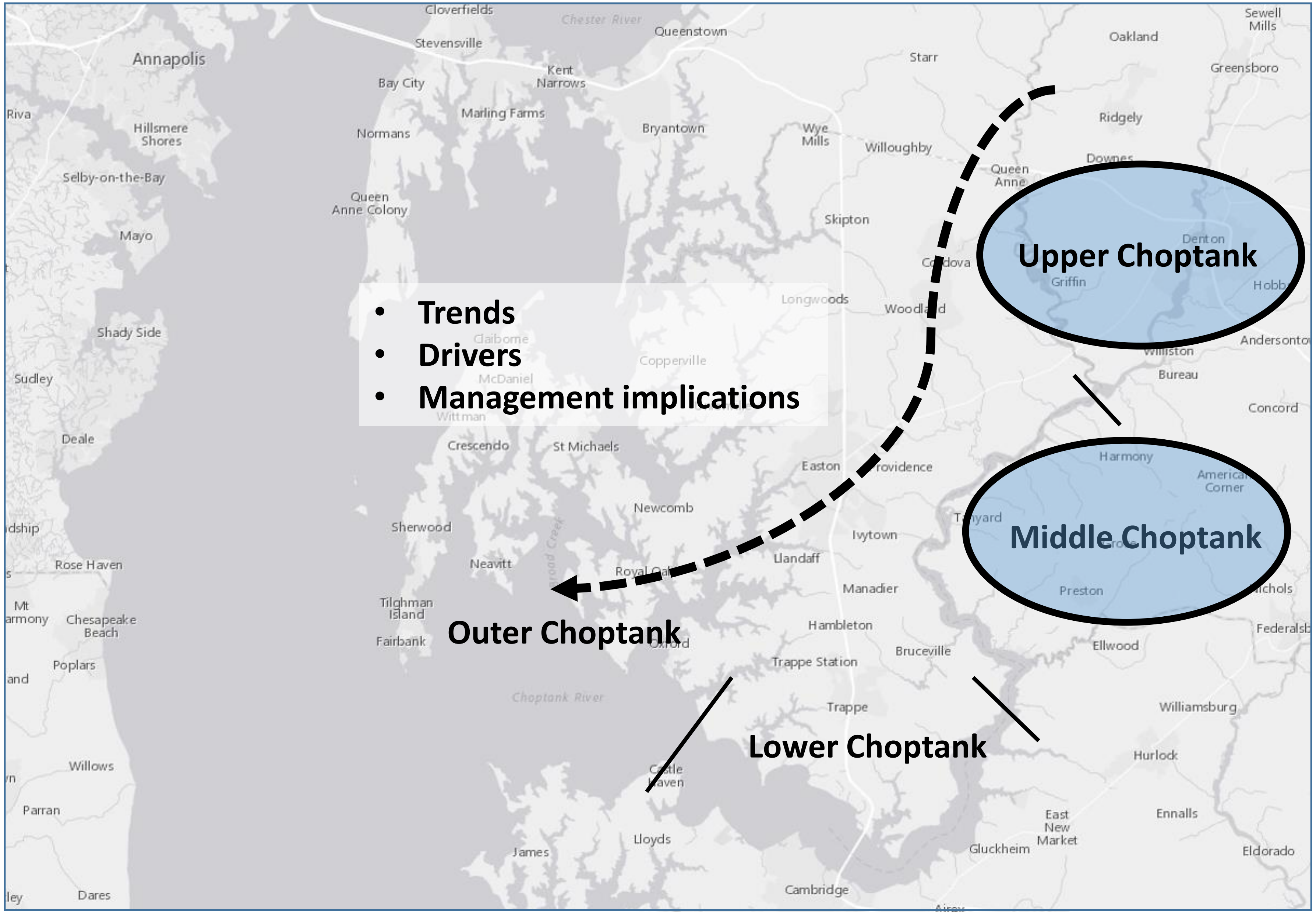
Management Implications Summary

- BMPs can have an impact on nutrients in these areas
- Certain parts of the non-tidal watersheds can be more effective for nitrogen management through BMPs
- Applications, practices and loads can vary greatly between counties
- BMPs that mitigate nitrate in groundwater and control nutrient applications are especially important in these areas
- The Choptank River's immediate watershed is the most effective area to influence attainment in its tidal waters

Choptank River Storyline

- Degrading nitrogen trends are driven by increased nutrient inputs over decades
- Degrading nutrient trends are driving tidal waters further out of attainment
- Mitigation of groundwater nitrogen and nutrient application are especially important in this area
- The immediate Choptank River watershed is the most effective place to influence attainment in its tidal waters
- The setting in which practices are implemented makes a large difference
- The Choptank is an effective area for MD to reduce nutrient loads to the Bay

Choptank River Storyline



Storyline Development

Monitoring & Trends Data

Modeling data

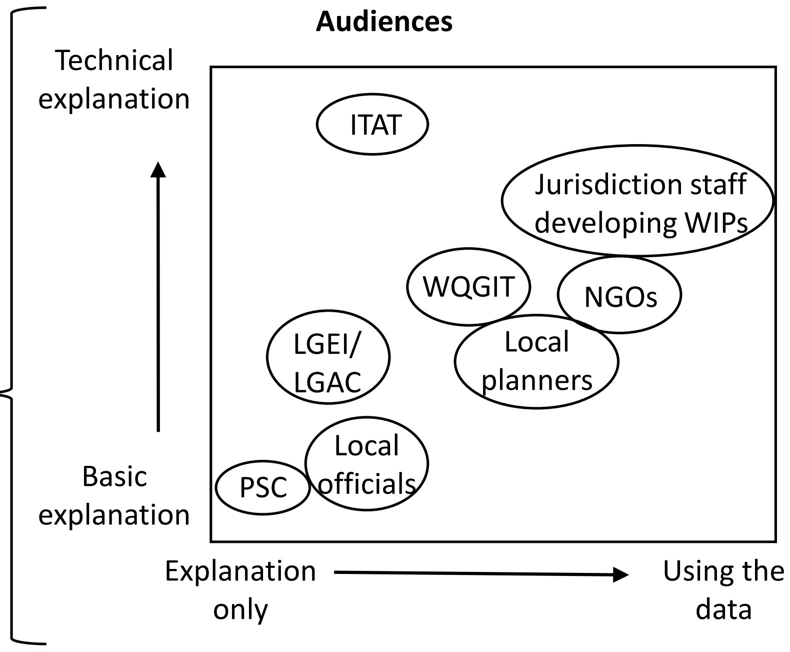
Synthesis Analyses

Monitoring, Trends & Explanations:
What is happening in this watershed?
What are the sources and drivers?
What is the explanation behind a trend?

Programmatic Implications
What has or hasn't been working, and where?
What types of adjustments are necessary (source sector, geography, etc.)?
How can those adjustments be realized (shifts in BMP implementation, etc.)?

BMPs/practices

Communication
Who needs to know this information and why?
In what form do they want to see it?
When do they need to see it?

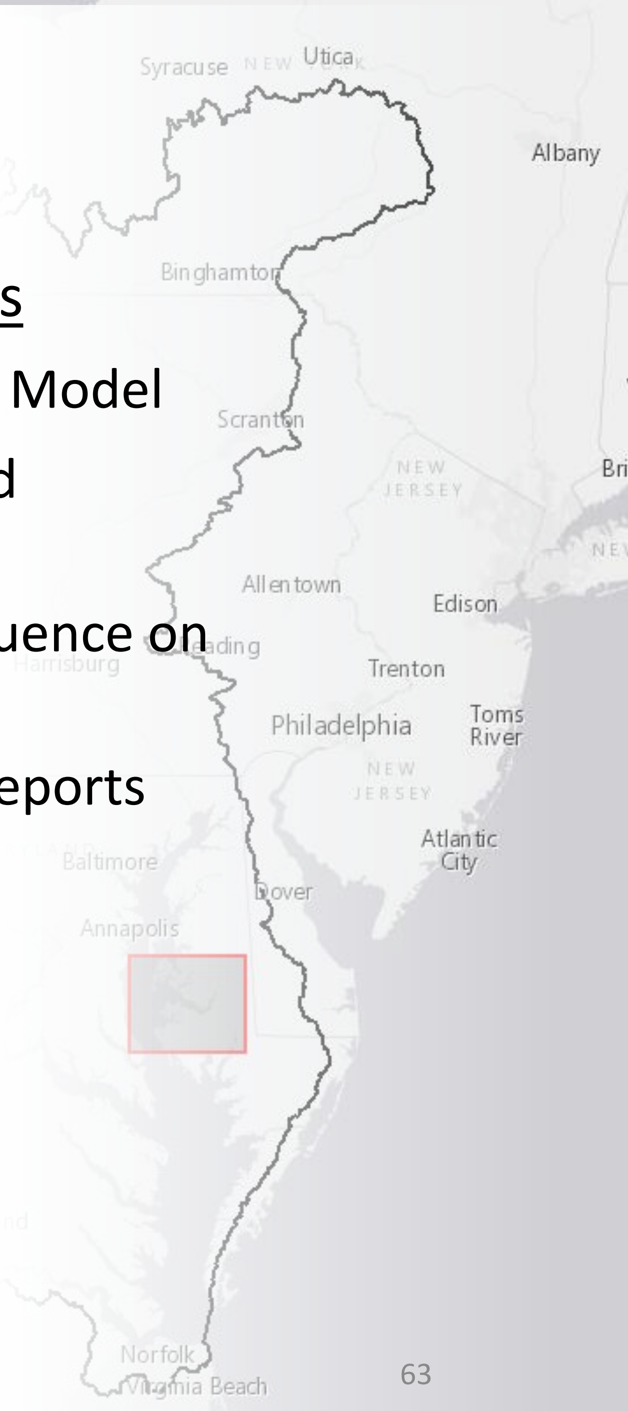


Storyline Products
Storyline templates
Data visualization tools for users
Data layers for users
Training/guidance on use

Data Visualization/Tools

Framework
What information was used in the different steps above?
Where and in what format is it available?
How will different users interact with the information?
How can we best guide users?

A LOT of data already 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

Questions for WQGIT

- Are example stories useful for demonstrating data and information available and how to use? Would you like to see more?
- Most of this information is available watershed-wide, but what are you most likely to use?
- How would you like to interact with the information?
    - E.g. storyline templates, trainings, online platform for downloading, visualization tools

References

Slide 13-15: USGS Chesapeake Bay non-tidal network: https://cbrim.er.usgs.gov/

Slide 16-17: CBP Non-tidal dashboard (in development): https://public.tableau.com/profile/bryan.chastain#!/vizhome/CBPNon-TidalV6/Non-TidalWaterQualityDashboard

Slide 219: CBP Tidal dashboard (in development): https://public.tableau.com/profile/bryan.chastain#!/vizhome/CBPDataVizTableauV7/MonitoringStationsOnly

Slide 28, 30, 35, 43-46, 57: Explaining nitrogen loads and trends in Chesapeake Bay tributaries: an interim report. Jimmy Webber, USGS, unpublished.

Slide 35-36: Application of SPARROW models to understanding nitrogen and phosphorus trends in Chesapeake Bay tributaries, 1992-2012. Scott Ator, USGS, unpublished.

Slide 26-29, 47: 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*.

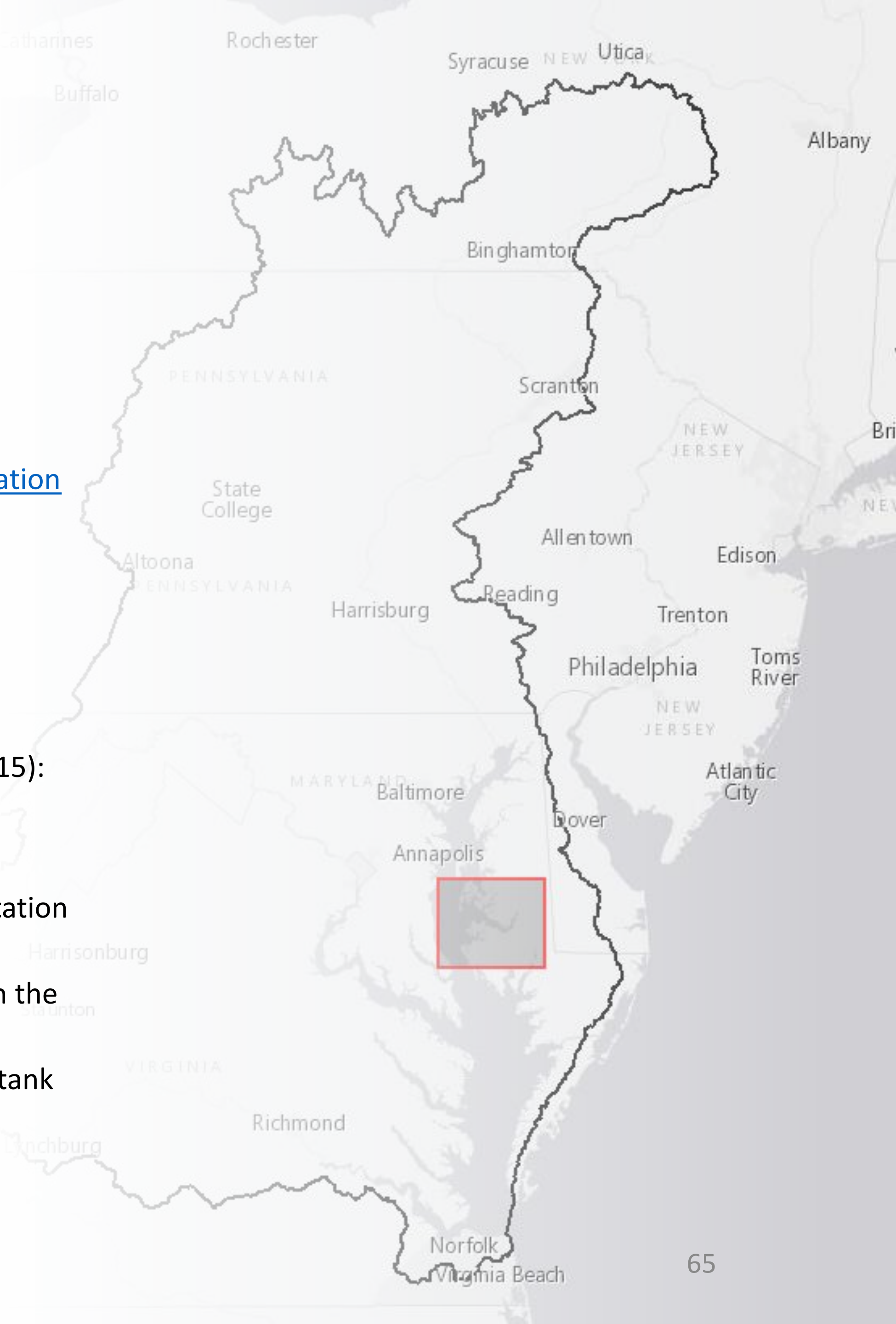
Slide 38: Summer DO GAM Results. Rebecca Murphy, UMCES, unpublished.

Slide 39: SAV Charts. William & Mary Virginia Institute of Marine Science Submerged Aquatic Vegetation (http://web.vims.edu/bio/sav/index.html)

Slide 39: 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 42: Sutton, A.J., et al. 2009. Historical changes in water quality at German Branch in the Choptank River Watershed. *Water, Air and Soil Pollution*. 199(1): 353-369.

Slide 56: USGS Chesapeake Bay Nitrogen SPARROW Decision Support Tool. https://cida.usgs.gov/sparrow/.



Data Analysis

Slide 27: Nitrogen and nitrate loads downloaded from https://cbrim.er.usgs.gov/.

Slide 31-32: Land area by source sector from monitoring station basins:

Drainage basins for the USGS stations were taken from the Tableau Nontidal Dashboard. Drainage basins were matched to their land-river segments using 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 through Phase 5 BayTAS (https://baytas.chesapeakebay.net/) from WSM outputs of the most recent progress runs available (2015) on the Phase 5.3.2 model. Acreage and loads were aggregated for individual land-uses within each source sector. Loads represent those from land-use only. Wastewater and septic were not included in these charts, however, they make up <5% of the load in each basin.

Slide 34: Nitrogen applications:

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

Slide 37, 52-54: BMP implementation over time by county:

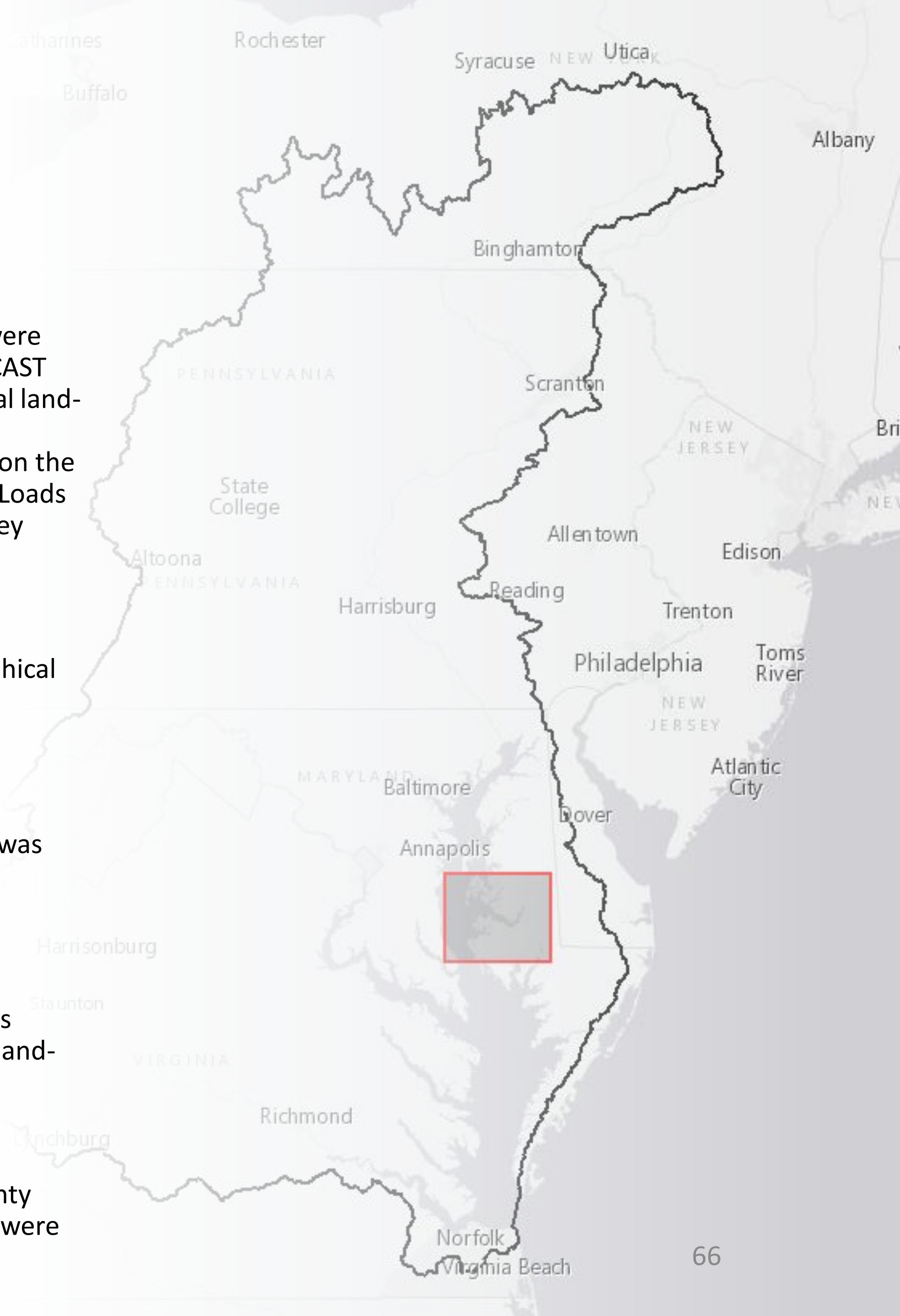
BMP credited acres were obtained from Credited vs. Submitted BMP Report of Maryland-submitted BMP Progress reports, downloaded from BayTAS (https://baytas.chesapeakebay.net/). Percent implementation was obtained from Maryland's submitted 2015 Milestone, from Phase 5 CAST (http://www.casttool.org/), downloaded as the BMP and Cost File.

Slide 49-50: Acres & loads by county in monitoring station basins:

Acres and loads for each individual land-use were obtained for land-river segments from the Detailed Loads Report for Maryland 2015 Progress from BayTAS (https://baytas.chesapeakebay.net/). Acres and loads for land-river segments comprising the Tuckahoe Creek station basin were aggregated.

Slide 51: Ratio of nitrogen to applied crop application goal:

Ratios of nitrogen applied to crop application goal were obtained for individual land uses over time by county from the Phase 6 Graphical Inputs (https://mpa.chesapeakebay.net/Phase6DataVisualization.html). Ratios were averaged for all agricultural land uses for each year in each county.



Data Analysis (continued)

Slide 54: BMP implementation was obtained as described above. 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: Conservation Tillage (excluding HR Till), Nutrient Management Plans, Commodity Cover Crops, Wetland Restoration, Cover Crops, Water Control Structures and Forest Buffers.

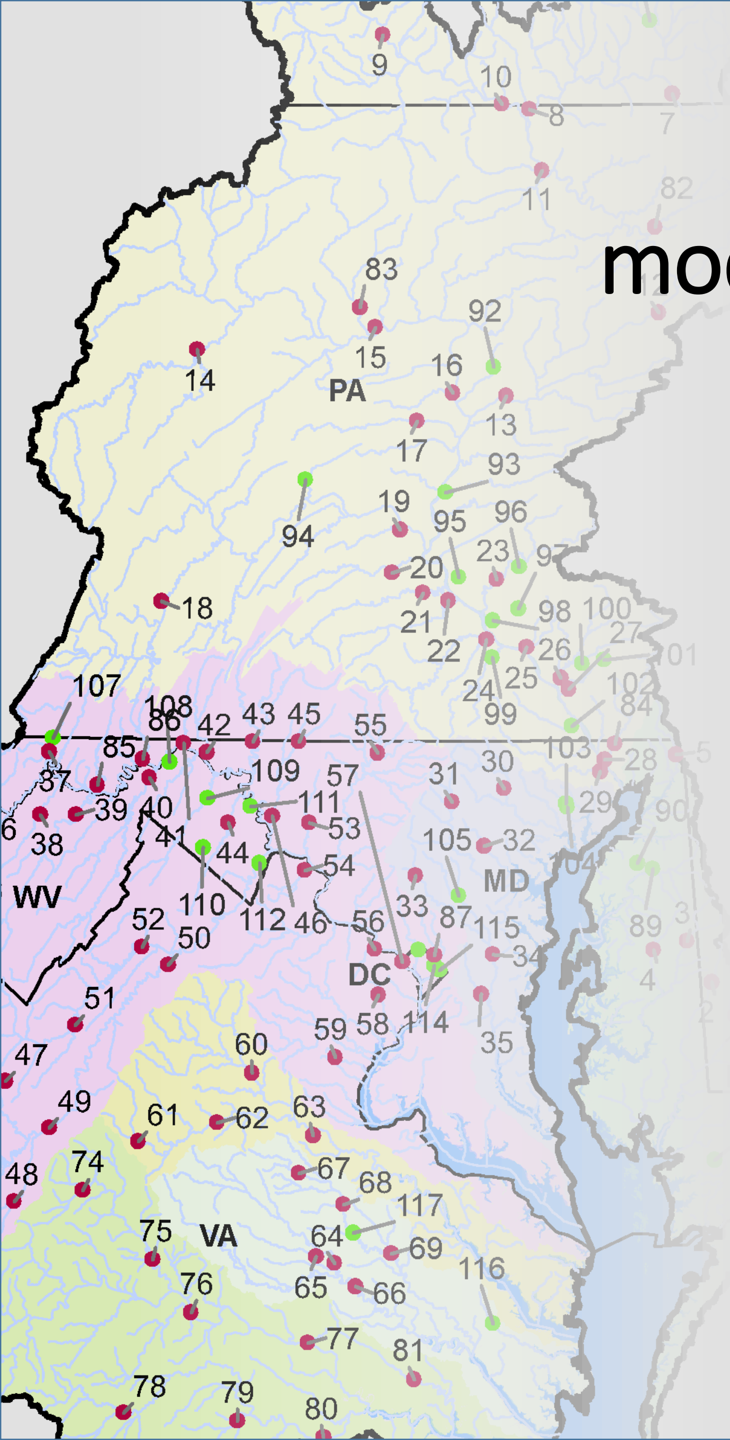
Slide 55: Nitrogen application by source and by county:

Nitrogen application by county was obtained from the 2015 Maryland Base Conditions Report from BayTAS (https://baytas.chesapeakebay.net/). Nutrient types (fertilizer or animal) were aggregated for agricultural land uses in each county.

Slide 58: Relative influence of Bay watersheds on tidal segment:

For the Choptank Tidal Fresh segment, relative total effect (% of all total effects) of each land-river segment in the Chesapeake Bay watershed are shown spatially. Total effect was determines as follows:

Estuarine effectiveness for nitrogen was determined by performing a series of Bay Water Quality Model scenarios on the Phase 5 model that individually varied fall line loads for each major river basin while holding others constant and then predicted the change in DO concentration during the summer criteria assessment period in each tidal segment. Estuarine effectiveness is reported as change in DO (µg/L) per million pounds nitrogen reduced. Riverine effectiveness was determined by using the Bay Watershed Model to estimate the attenuation and loss of nitrogen loads between their original input point and their delivery to tidal waters. Riverine effectiveness (i.e. delivery factor) is reported as delivered to Bay loads over edge-of-stream loads . Total effect of a land-river segment is its riverine effectiveness multiplied by the estuarine effectiveness of its major river basin multiplied by the loads coming from that land-river segment (according to the 2015 Progress runs on the Phase 5.3.2 model). Relative total effect of one land-river segment is its percentage of the sum of total effects of all land-river segments in the Bay.



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

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Emily Trentacoste, PhD

EPA Chesapeake Bay Program

WQGIT Meeting

7/10/2017