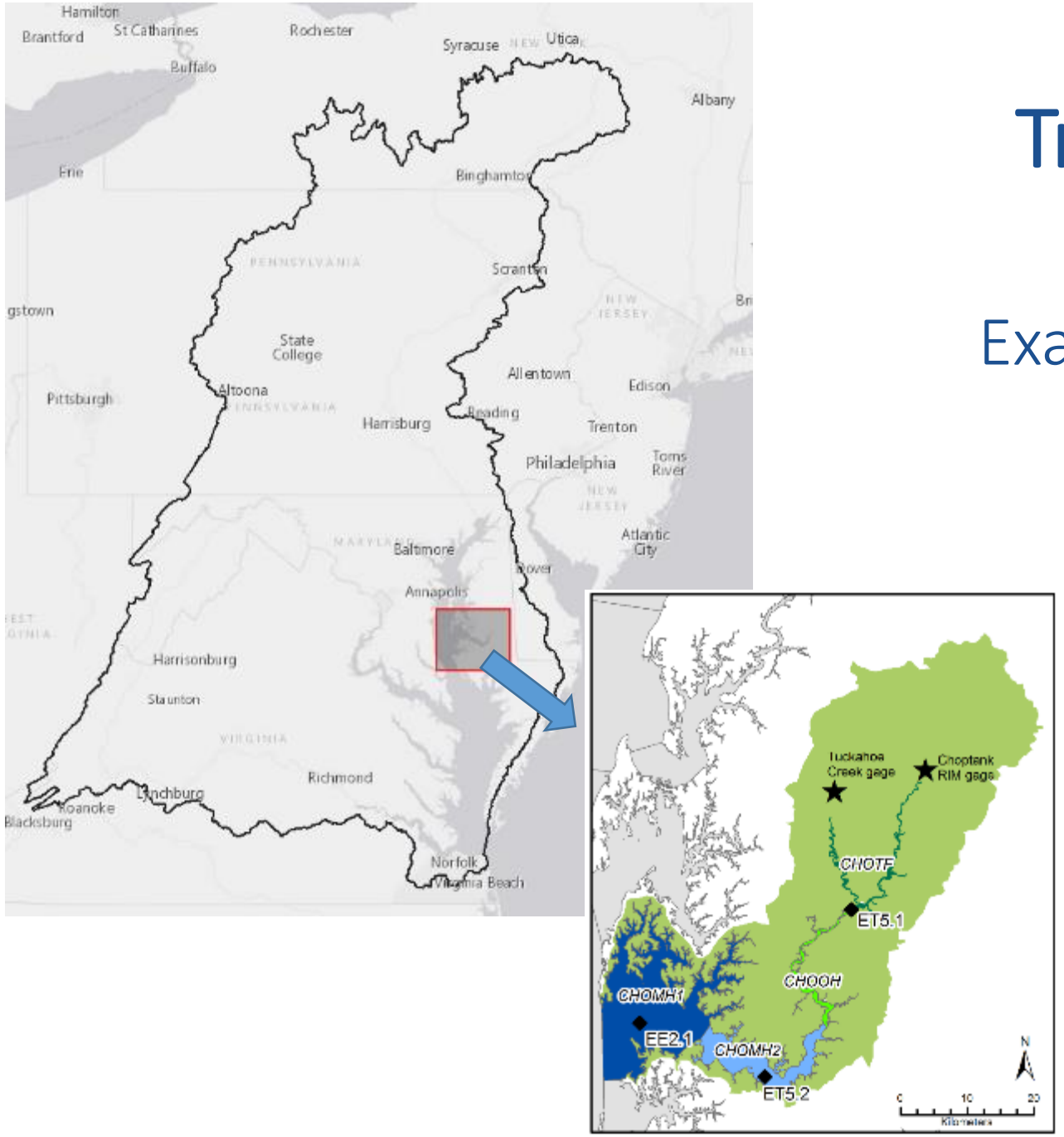


Tributary Summary Reports and Syntheses

Example concept for Choptank River

Rebecca Murphy[1], Emily Trentacoste[2], and Jeni Keisman[3]

STAC Integrating Findings to Explain Water Quality Change

Dec. 13, 2017

[1]UMCES at CBP; [2]U.S. EPA; [3]USGS

Synthesis pieces used here

MD water quality data:
MDDNR team

Water quality criteria evaluations:
Richard Tian and Qian Zhang (UMCES), Peter Tango (USGS)

MD tidal trends:
Renee Karrh (MDDNR) (and helpful review)

MD BMP data:
Greg Sandi (MDDNR) and Jeff White (MDDNR)

Buffer analysis:
Lindsey Gordon (CRC CBP)

GAM method:
Elgin Perry, Jon Harcum (TT), Mike Lane (ODU), Renee Karrh (MDDNR), Jeni Keisman (USGS), Rebecca Murphy (UMCES)

SAV data:
JJ Orth and Dave Wilcox (VIMS)

Nontidal loads:
Doug Moyer (USGS)

USGS Non-tidal Synthesis pieces:
Joel Blomquist, Jimmy Webber, Judy Denver, Scott Ator, Greg Noe, Gopal Bhatt (CBP)

Pull together: your groups' findings, existing research, trends

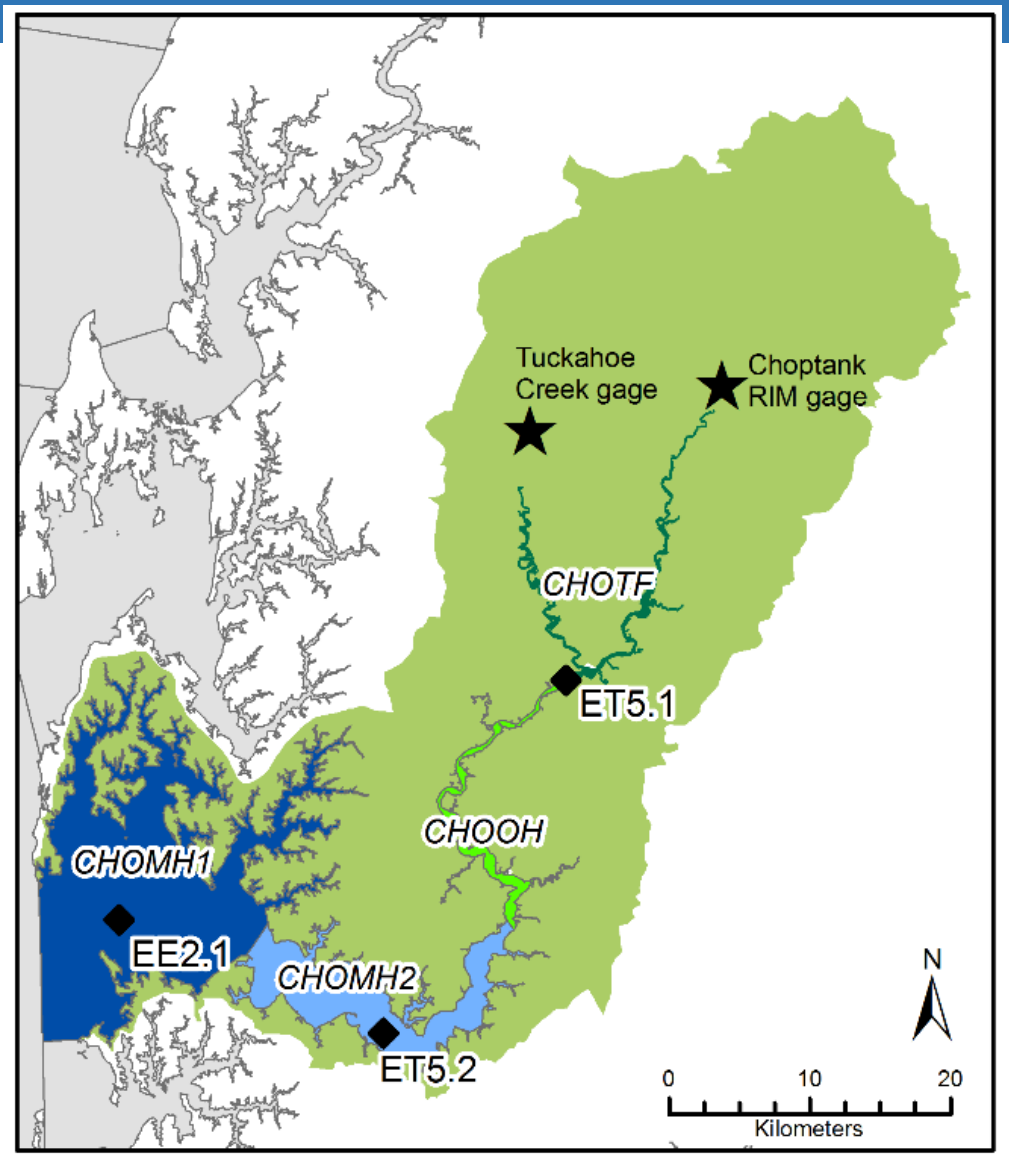
To address segment-by-segment:

<u>Tidal</u>

1. How are water quality criteria and DO concentrations related?
2. What is impacting DO concentrations?
3. What should we expect for the future of meeting water quality criteria?

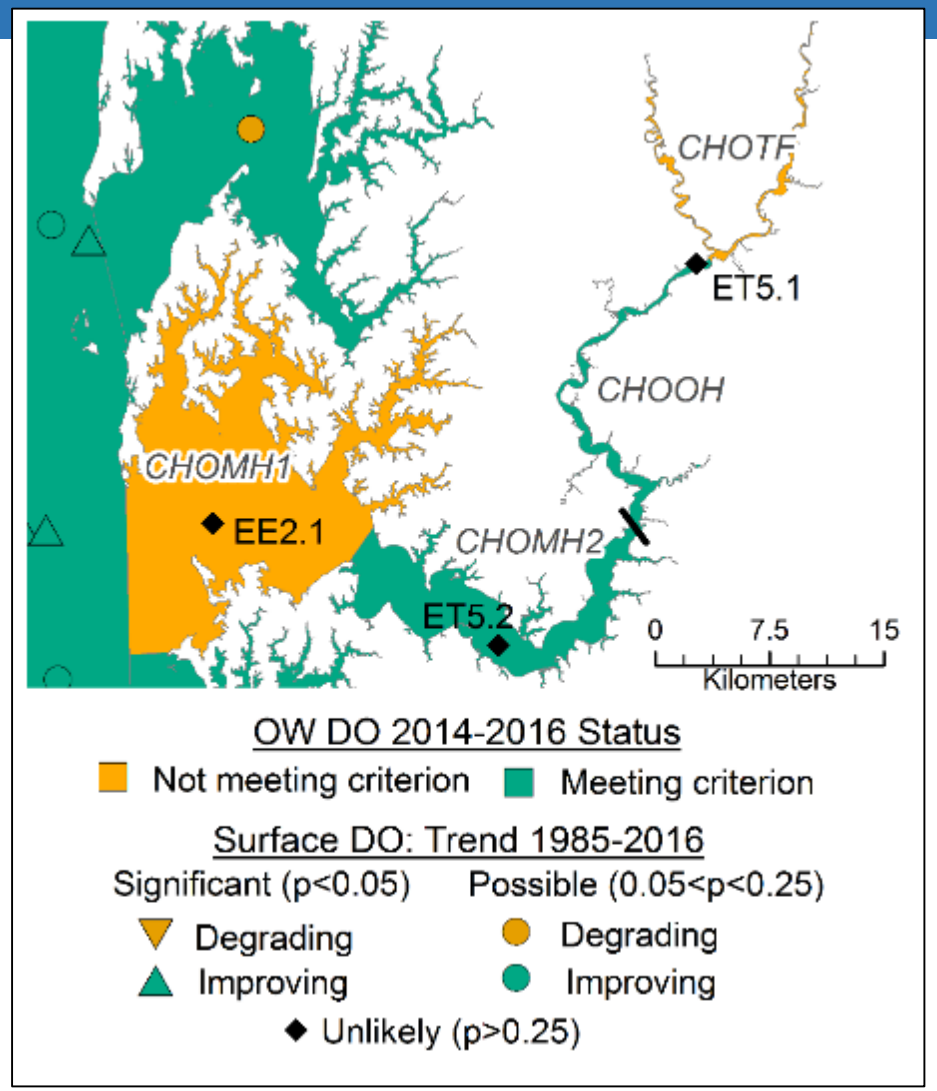
<u>Watershed</u>

1. What are the sources and drivers behind water quality?
2. Have we been addressing these issues thus far?
3. What are our opportunities moving forward?



Yes/No of water quality criteria

Summer open water 30-day mean DO criterion status and surface DO trends



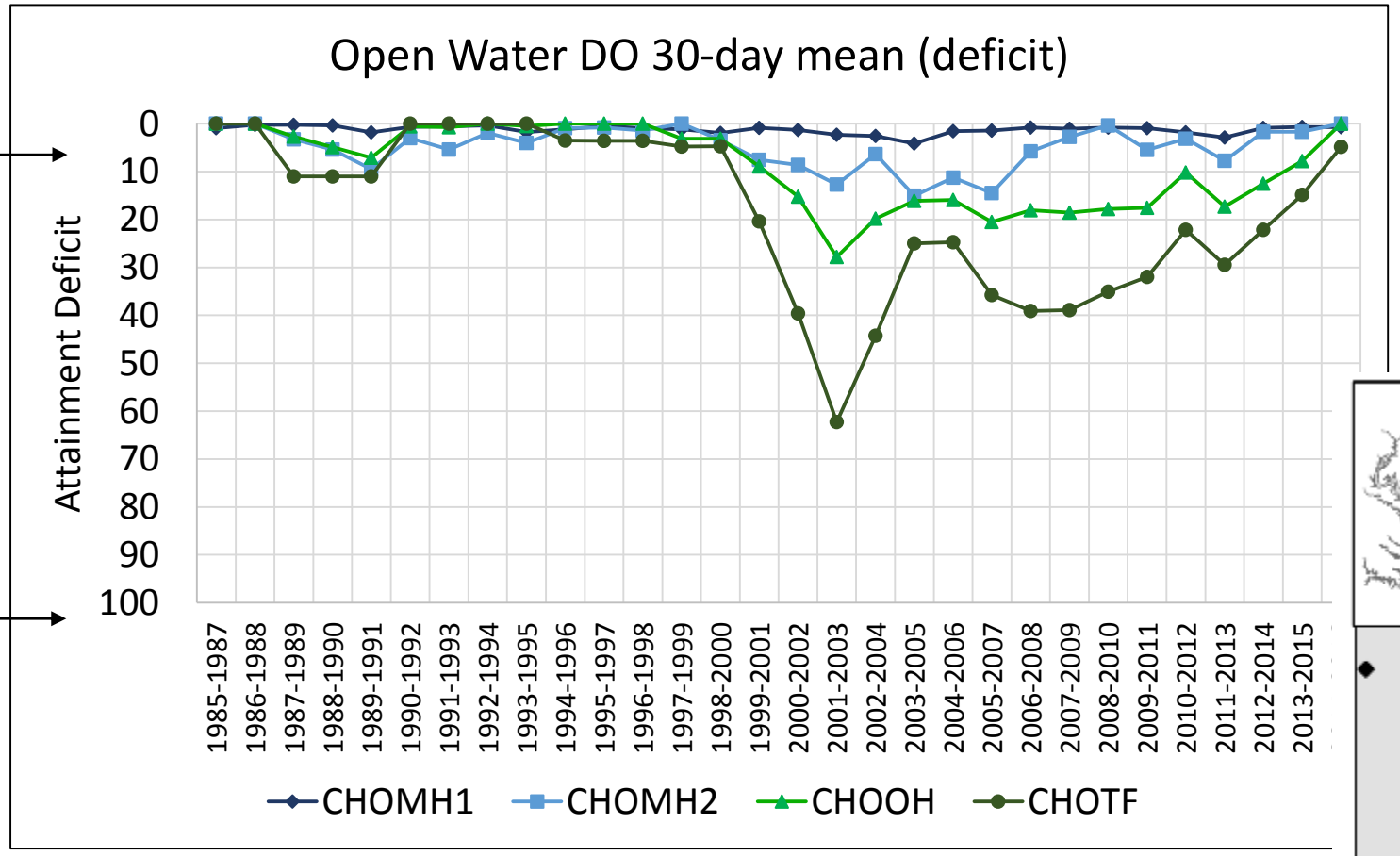
Data from MDDNR, status computed by Richard Tian, UMCES

Choptank: Record of segments meeting water quality criteria

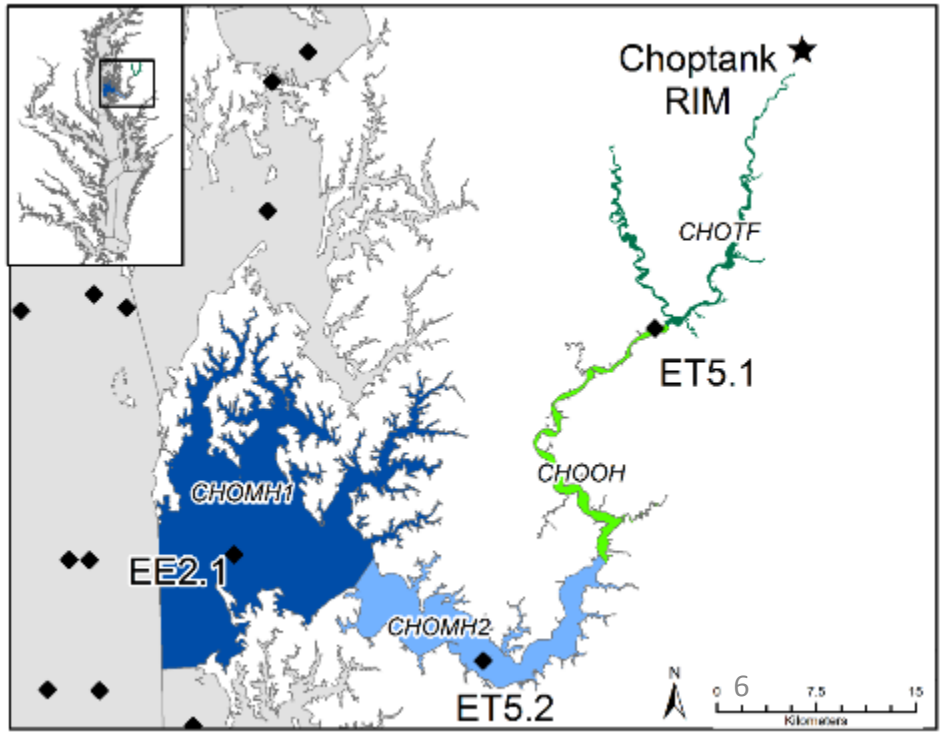
For 3-year periods, indicates if criteria was met (green shaded) or not met (blank)

DU	Segment	1985-1987	1986-1988	1987-1989	1988-1990	1989-1991	1990-1992	1991-1993	1992-1994	1993-1995	1994-1996	1995-1997	1996-1998	1997-1999	1998-2000	1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	2013-2015	2014-2016
Open Water	CHOTF																														
	CHOOH																														
	CHOMH2																														
	CHOMH1																														

Choptank “attainment deficit” for Open Water (DO 30-day)

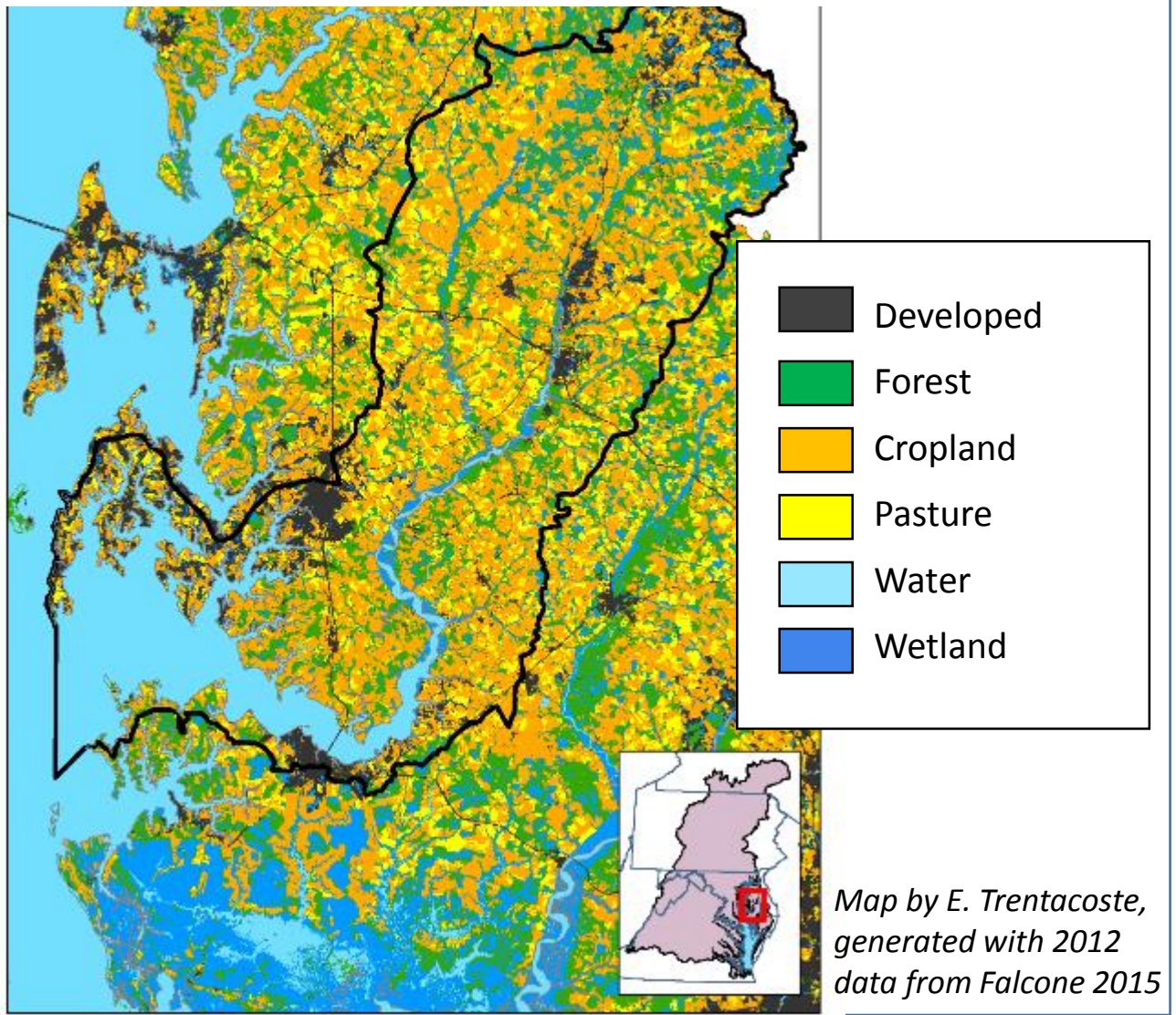


Computed by Qian Zhang, UMCES



Start to develop explanations

1. Keep the context of the whole watershed

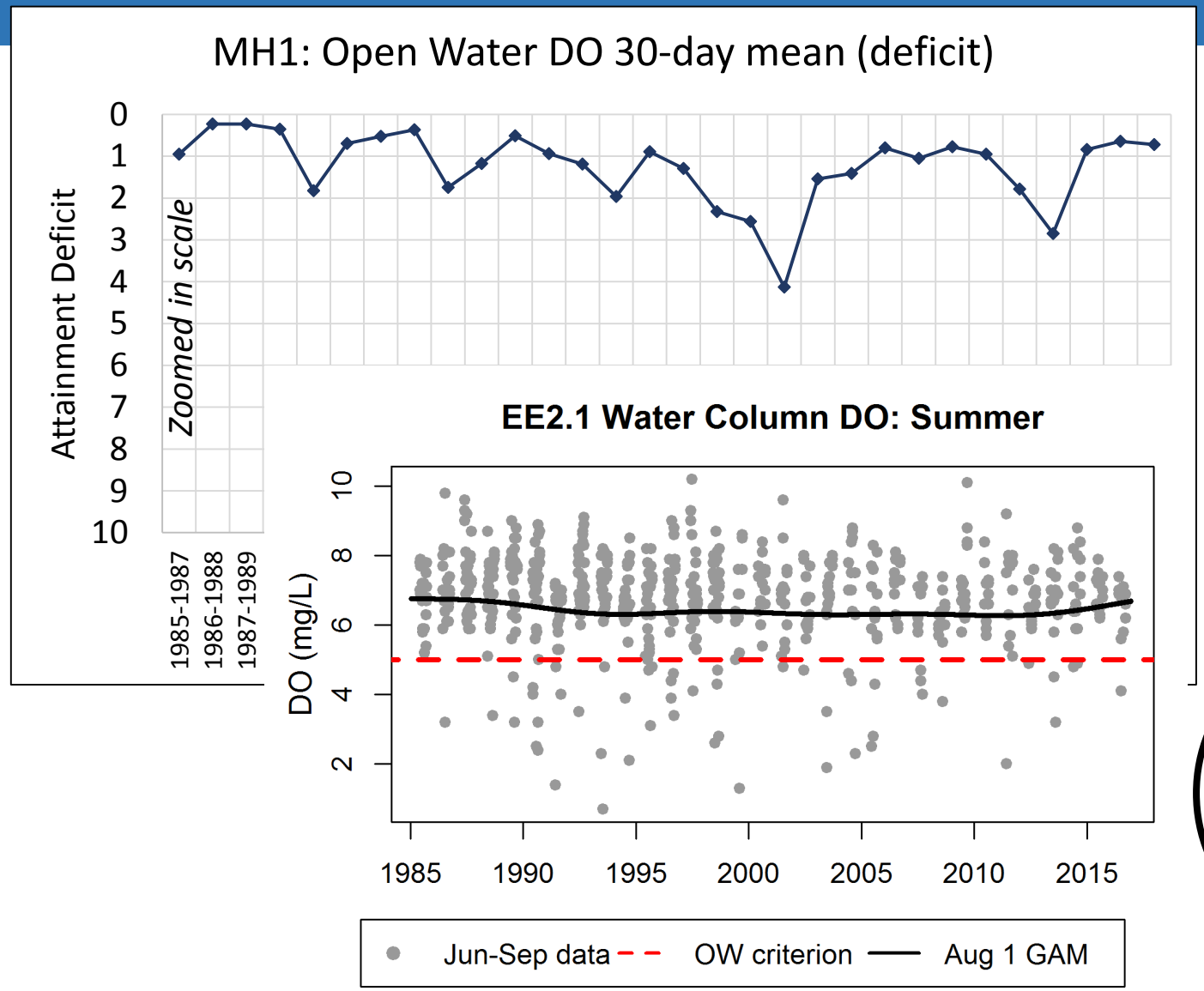


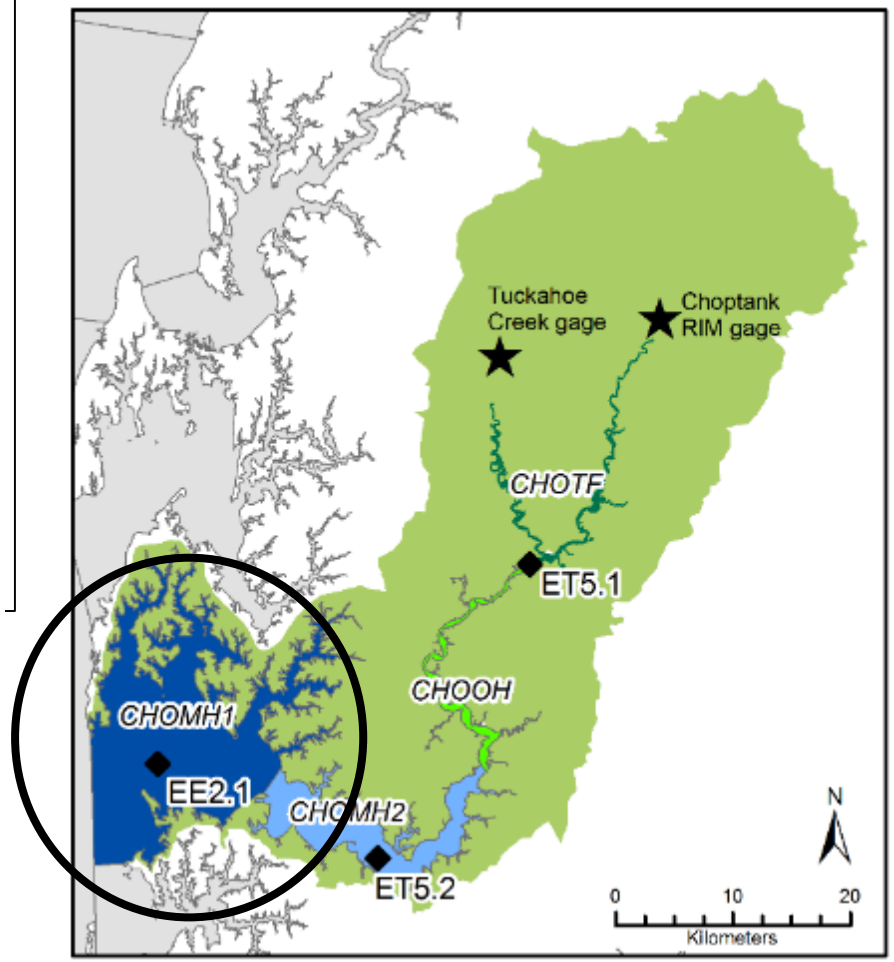
Map by E. Trentacoste, generated with 2012 data from Falcone 2015

2. But zoom-in and examine by segment:

- DO patterns in relation to attainment deficit
- Proximate nutrient sources and unique segment characteristics
- Nutrient concentrations in tidal waters
- SAV and clarity trends
- Physical and climate forces

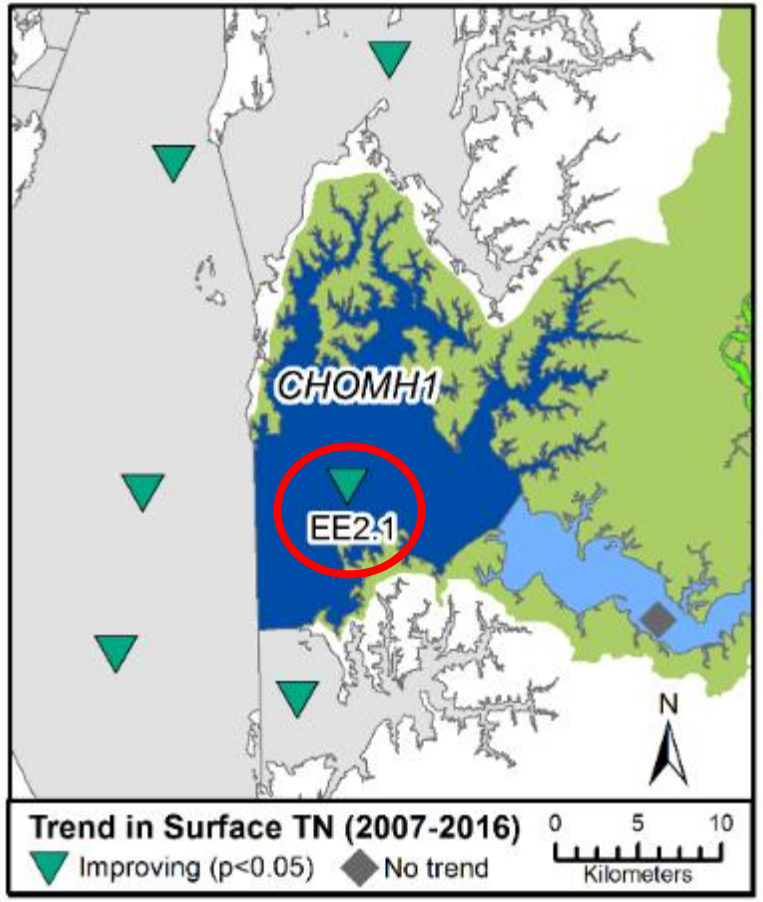
Lower Choptank: Mesohaline 1





CHOMH1: Proximate sources

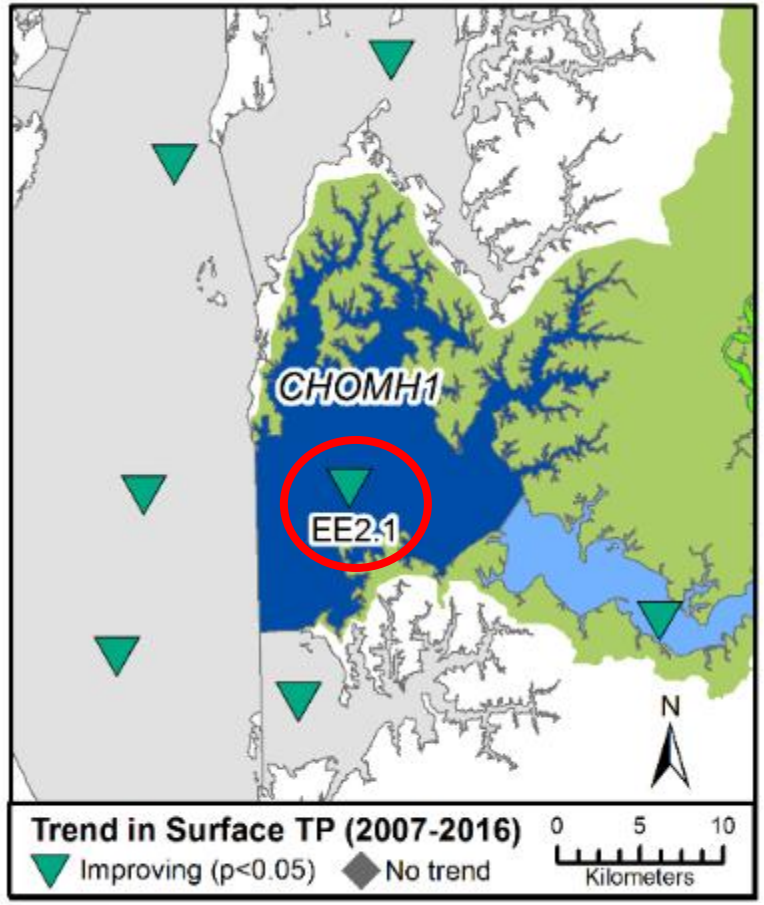
TN trends 2007-2016



From trends run by Renee Karrh, MDDNR

- Upstream sources are likely playing a role
- Mainstem Chesapeake Bay influence as well
- Almost all surrounding tidal nutrient concentrations are decreasing

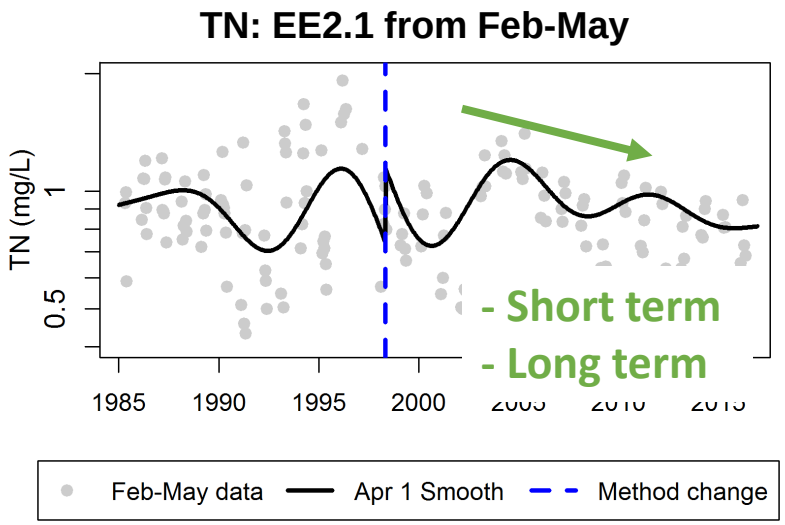
TP trends 2007-2016

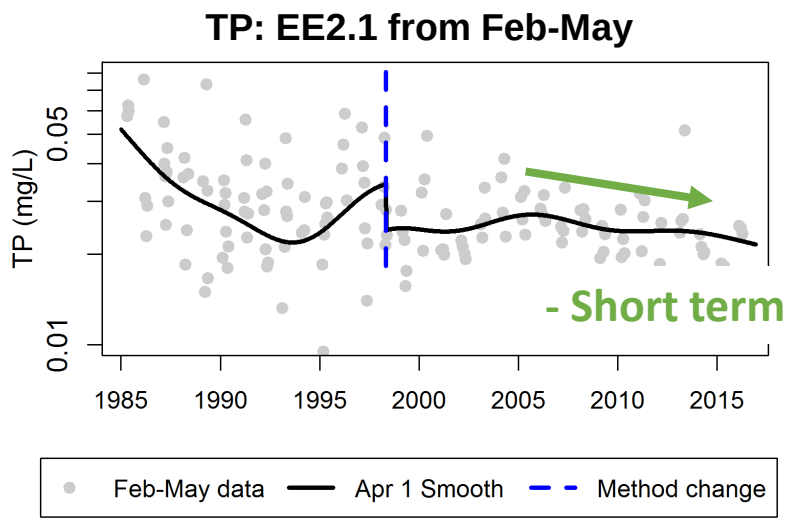


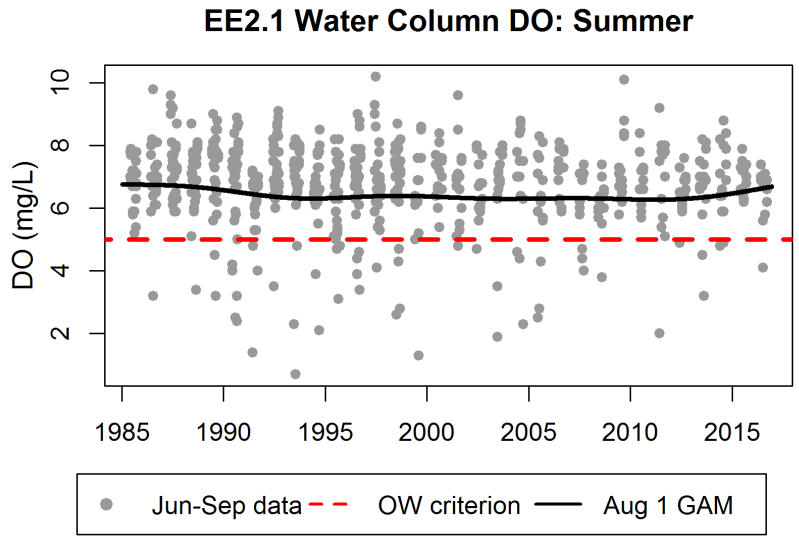
From trends run by Renee Karrh, MDDNR

Note: these are annual trends

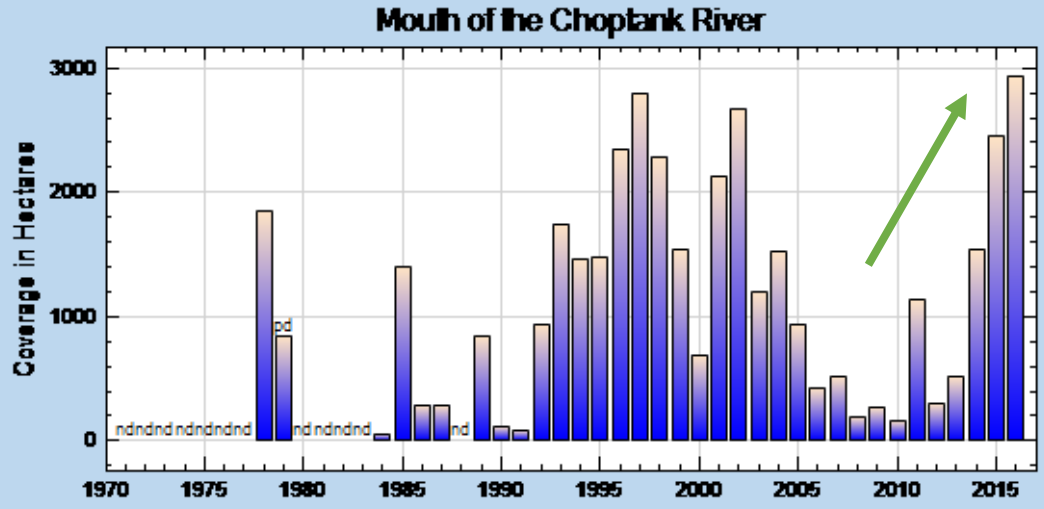
1) CHOMH1 Nutrients in tidal waters







3) CHOMH1 SAV re-appearance in last few years

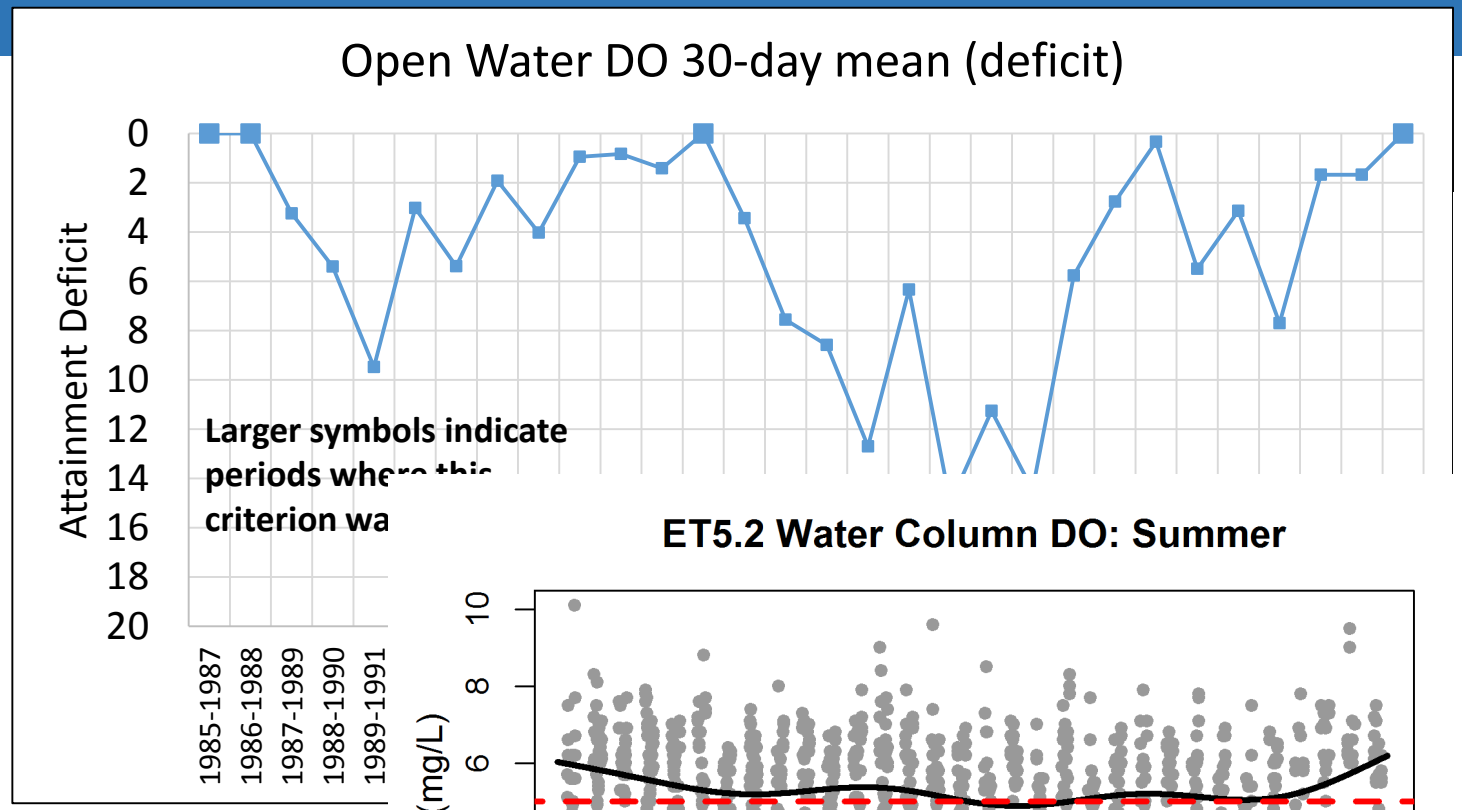


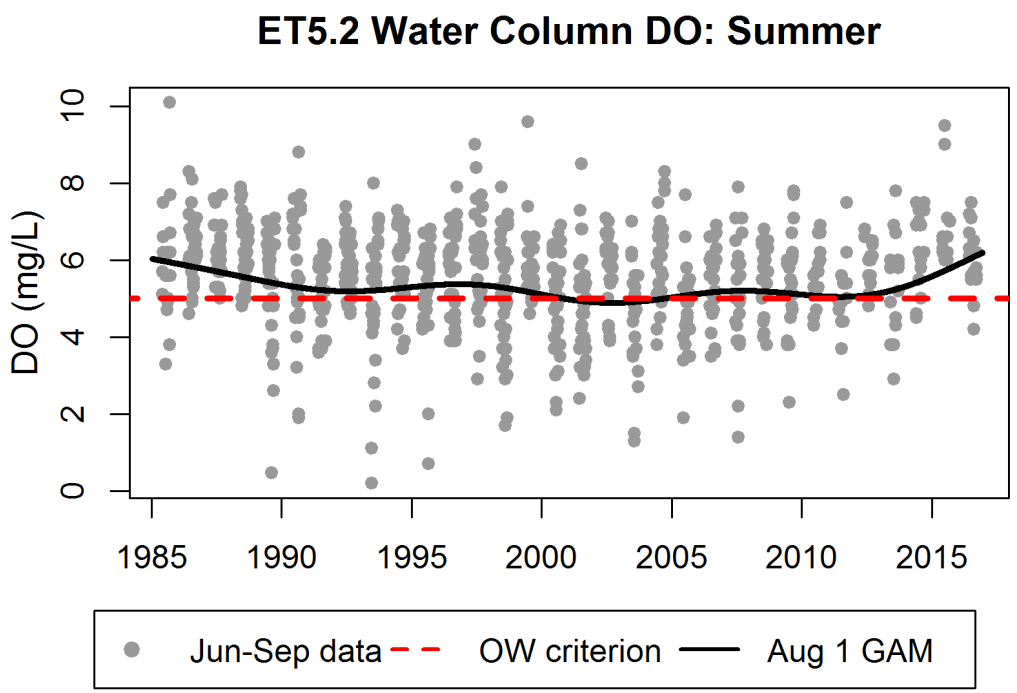
Source: VIMS

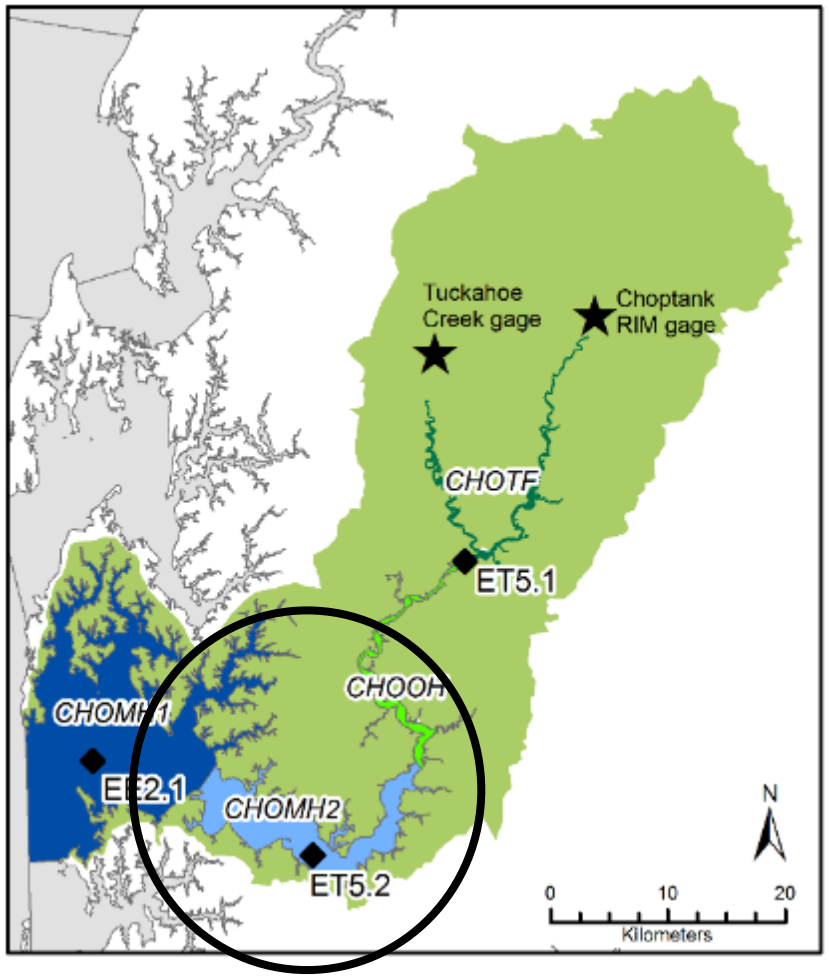
Take home points:

- Tidal nutrient improvements are promising.
- SAV improvement in last few years is a hopeful sign for the ecosystem.
- If positive conditions continue, DO and WQ criteria status expected to improve.

Middle: Mesohaline 2

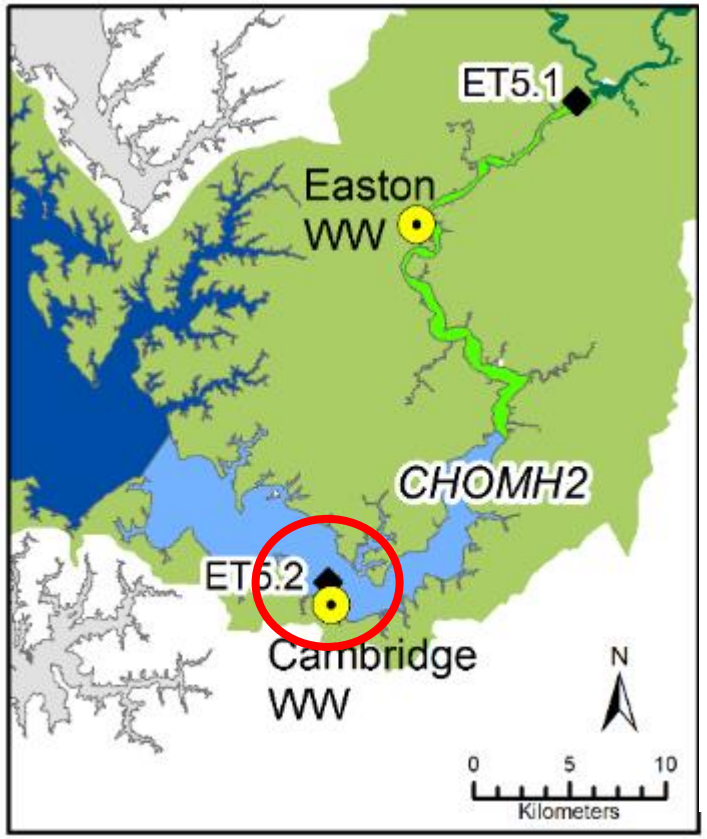


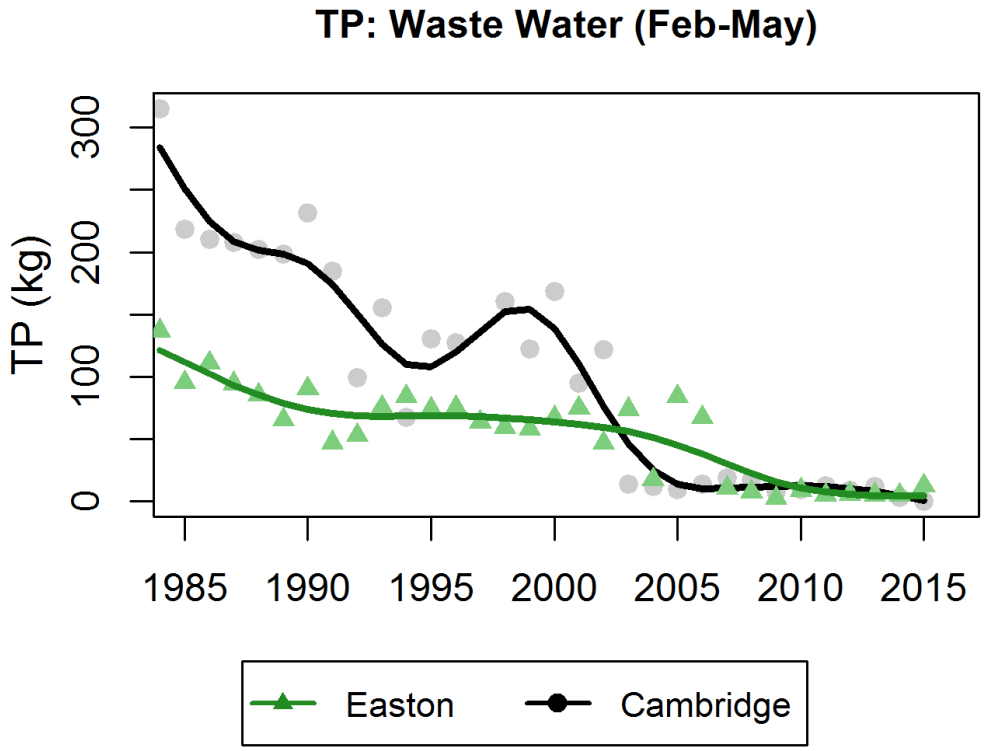




CHOMH2: Proximate sources

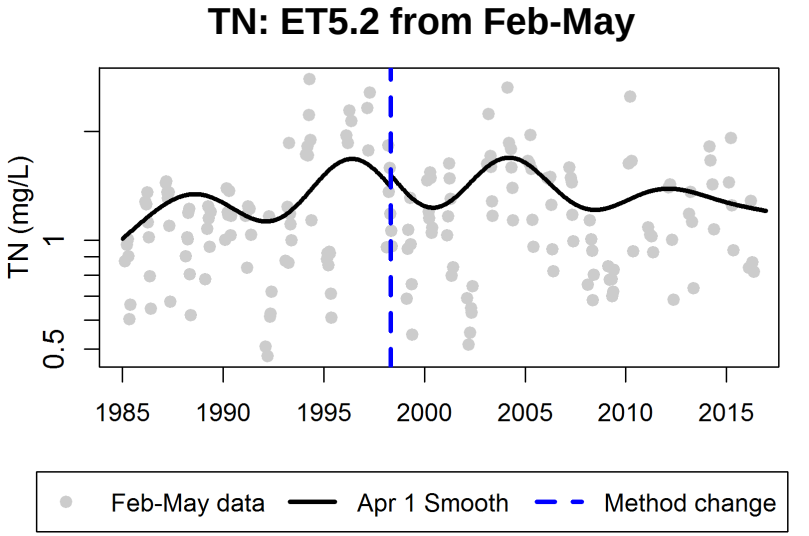
- Watershed nonpoint loads are the largest portion of the nutrient inputs.
- But an evaluation of tidal nutrients and sources (Whitall et al. 2010) demonstrated that P-inputs from WW sources are influential in tidal Choptank nutrient concentrations.
- Wastewater reductions to this segment have been dramatic, *although a small portion of overall watershed input.*

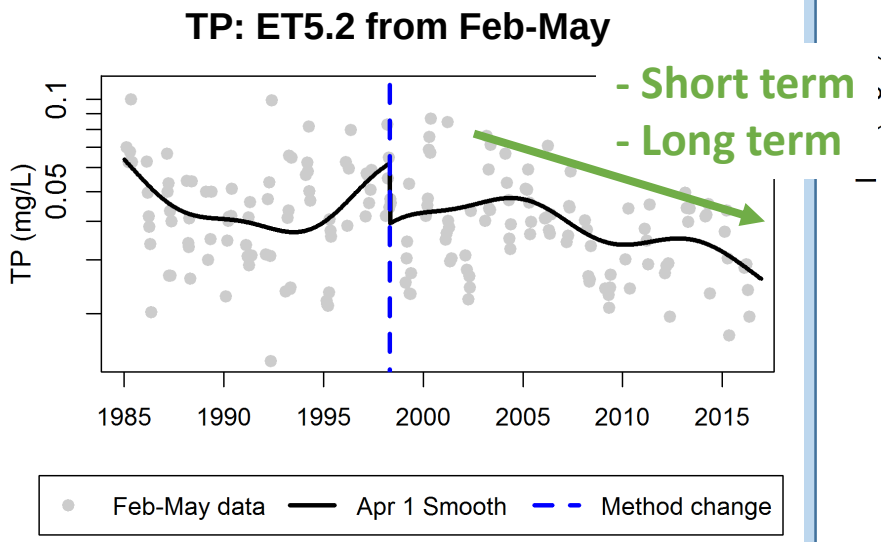




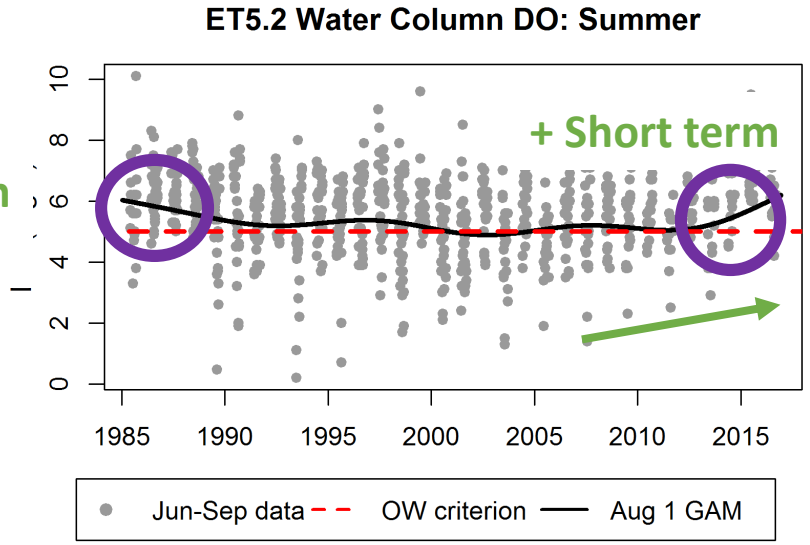
High TP 1997 load of 519 kg from Cambridge not plotted
Source: CBP Point Source Database

1) CHOMH2: Nutrients in tidal waters

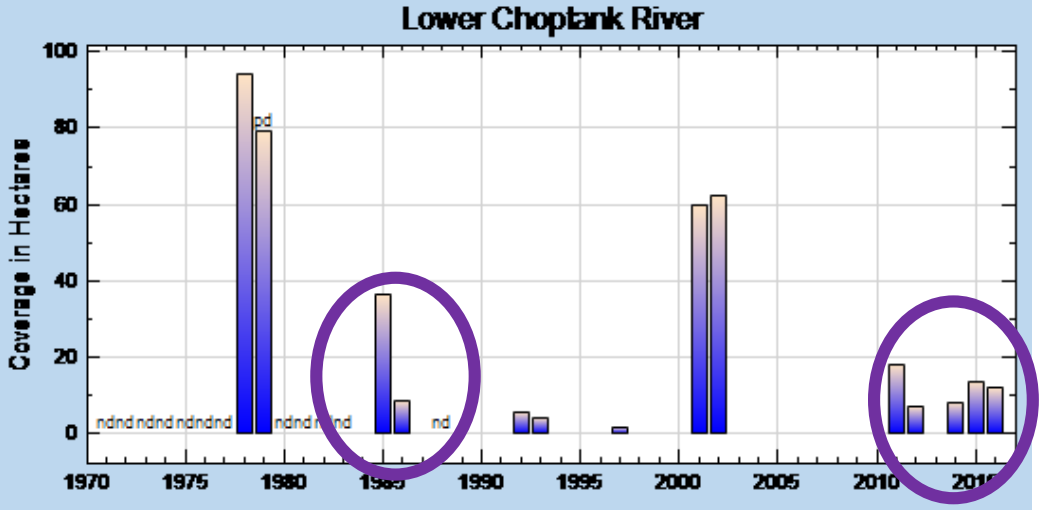




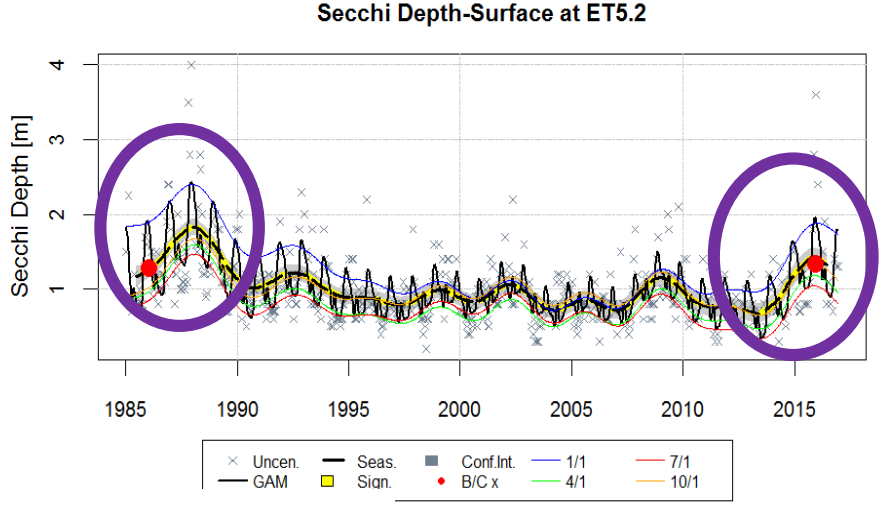
- Short term
- Long term



2) CHOMH2: Water clarity and SAV



Source: VIMS

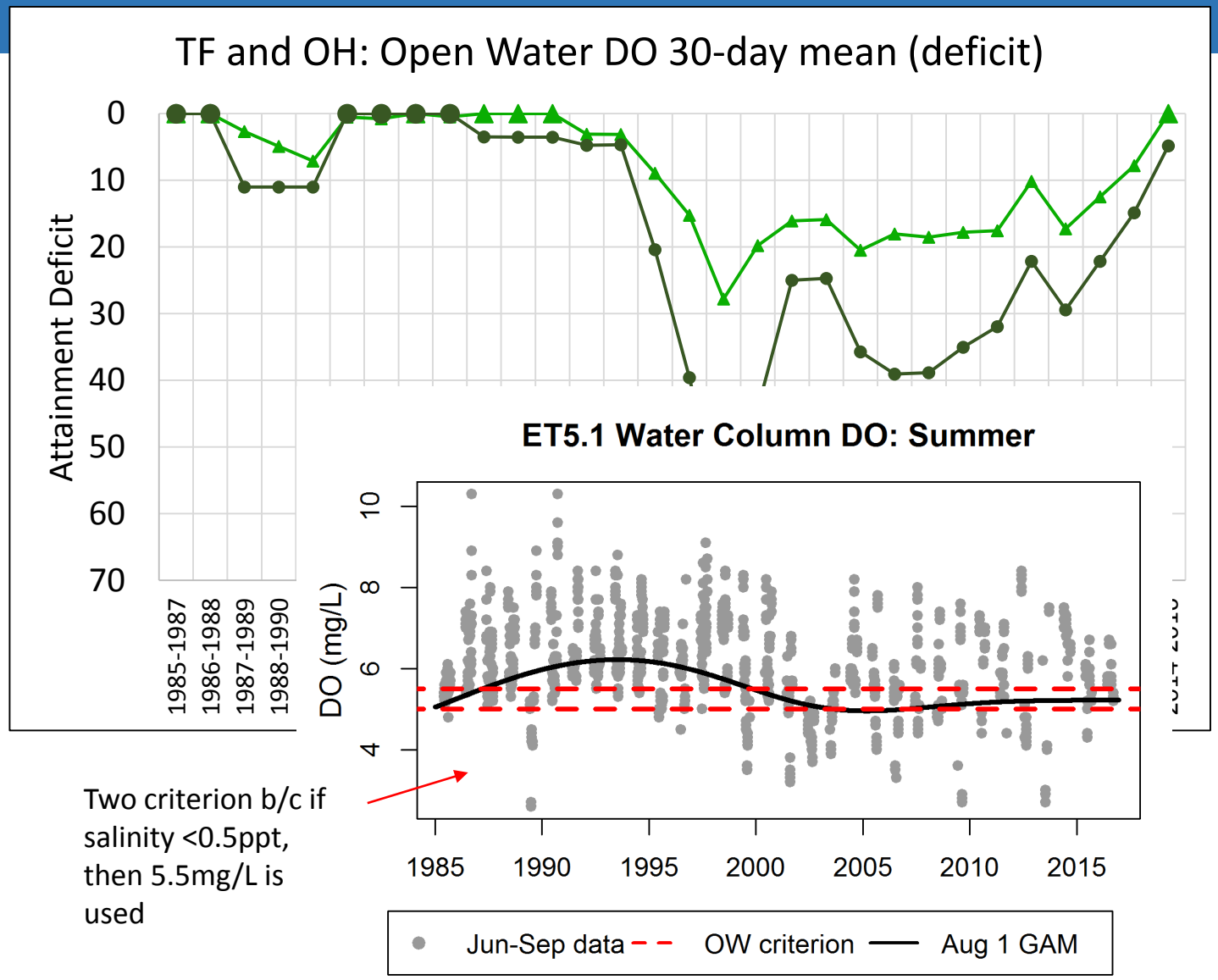


Source: R Karrh, MDDNR

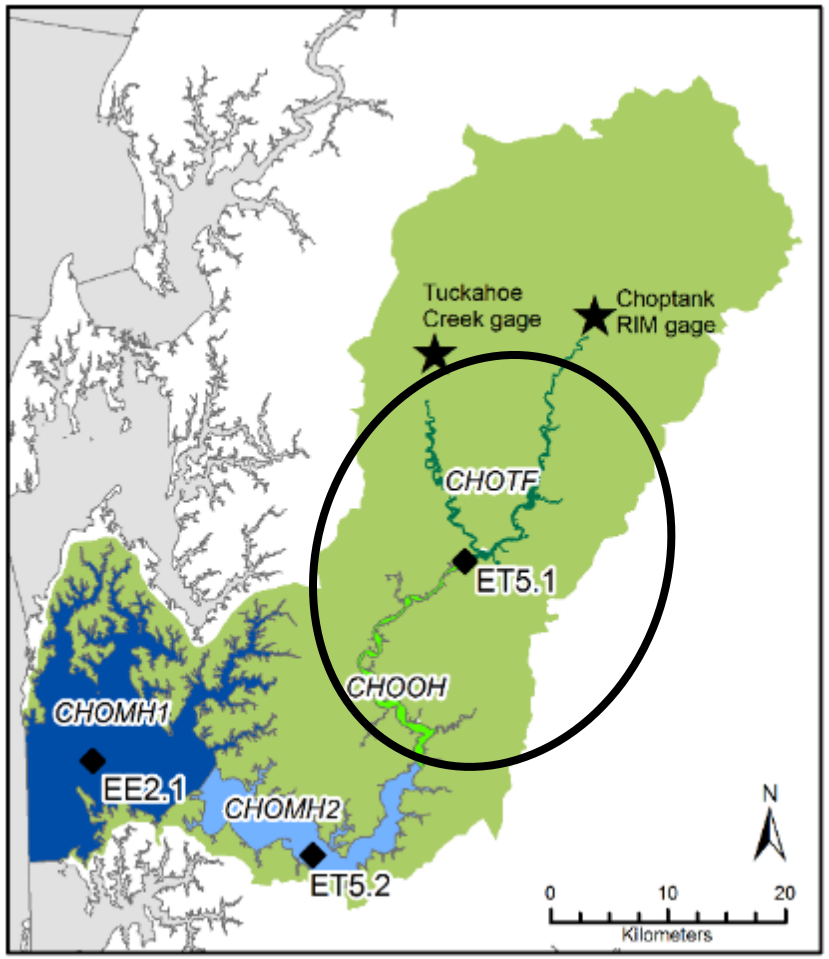
Take home points:

- Tidal TP improvements are consistent with WW loads.
- Recent SAV, secchi, DO, and TP patterns could all be associated through positive feedbacks.

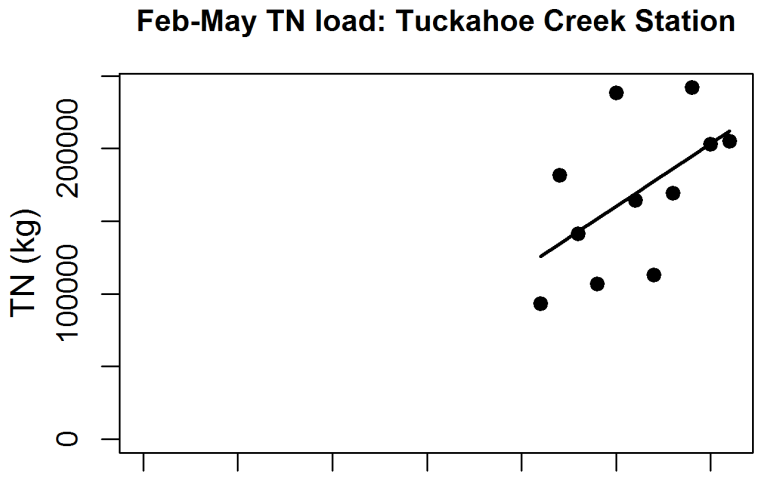
Tidal Fresh and Oligohaline

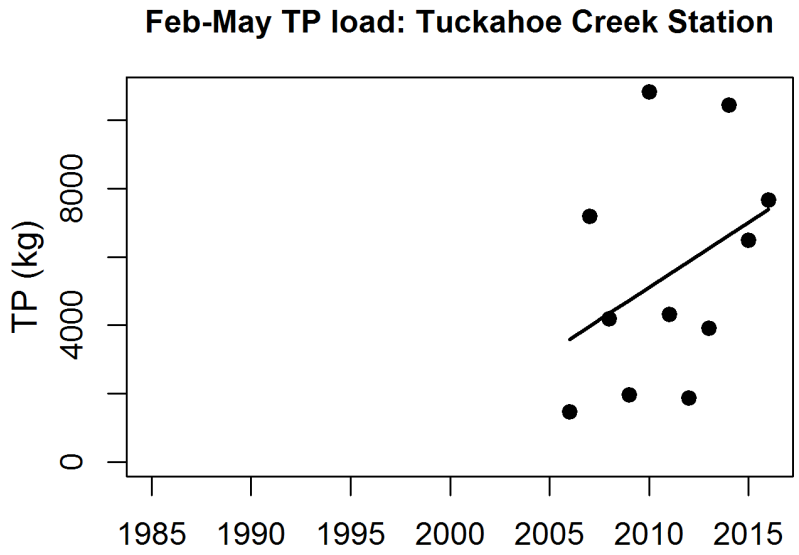


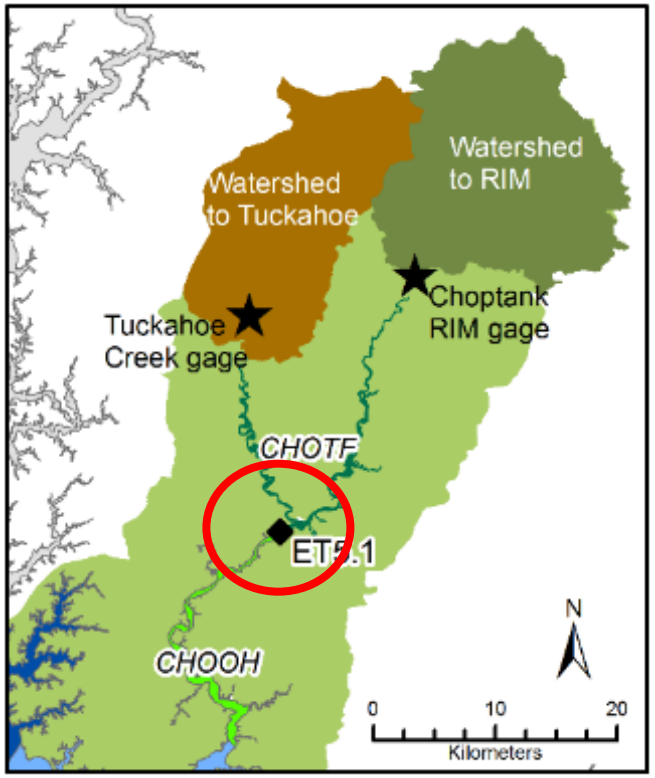
Two criterion b/c if salinity <0.5ppt, then 5.5mg/L is used

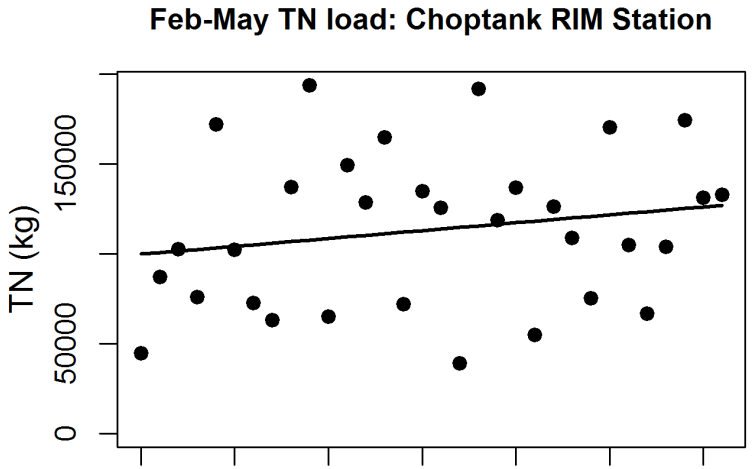


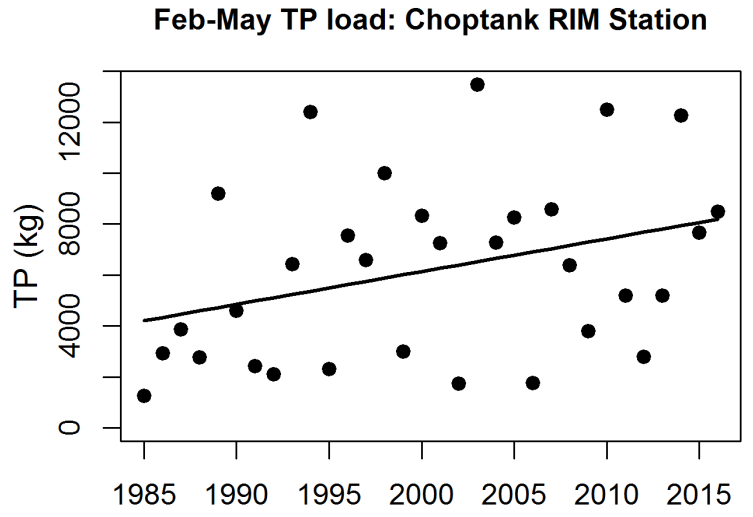
CHOTF and CHOOH: Proximate sources





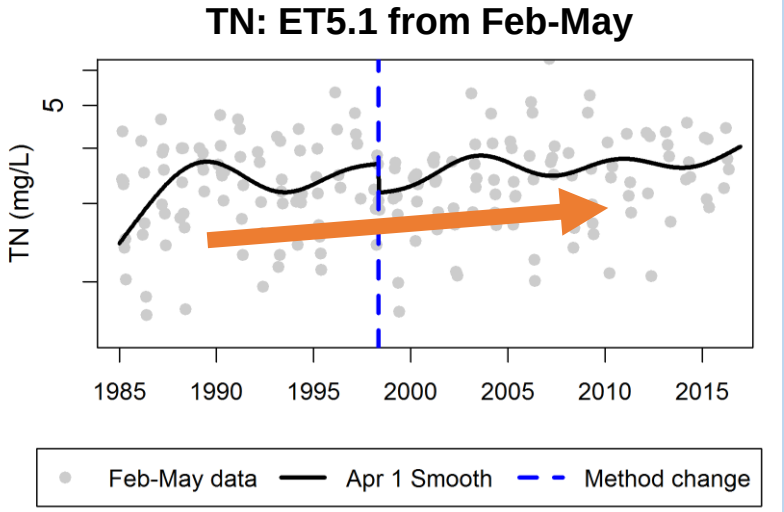


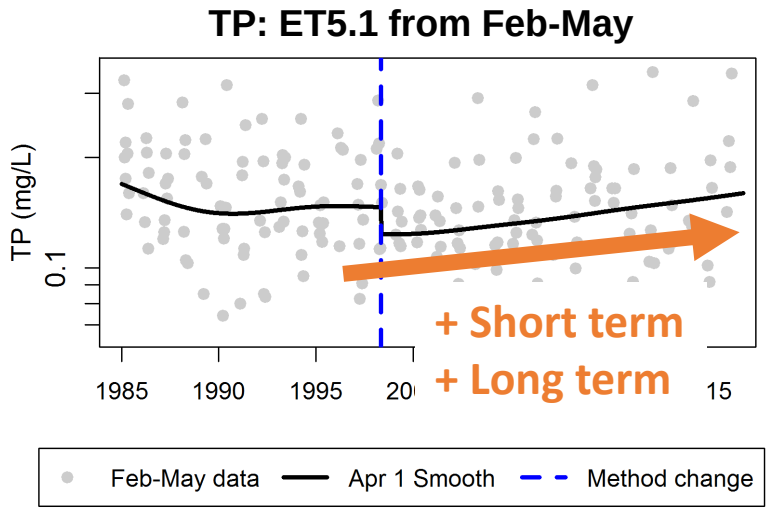


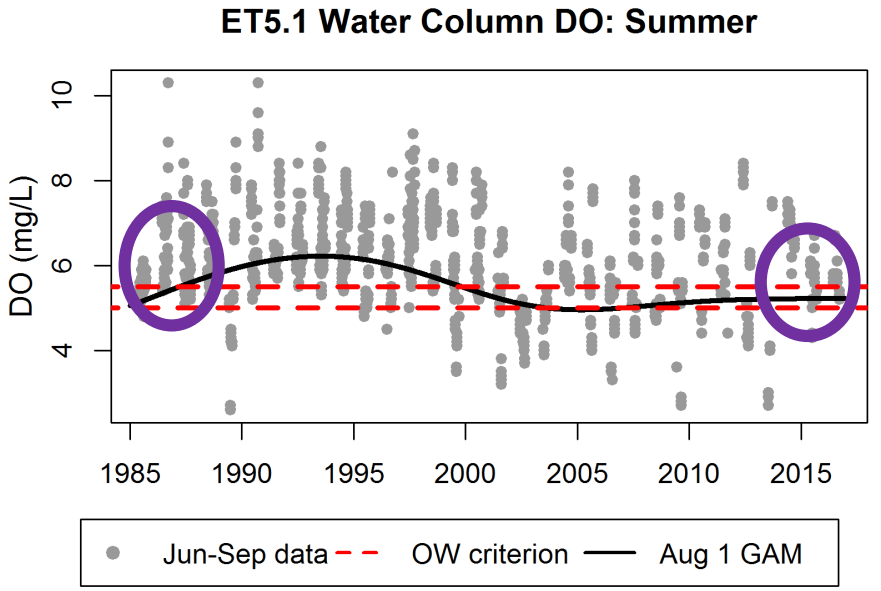


Source: Monthly loads from D Moyer, USGS.
Notes: Loads NOT flow-normalized. They are the sum of the total loads for four months.

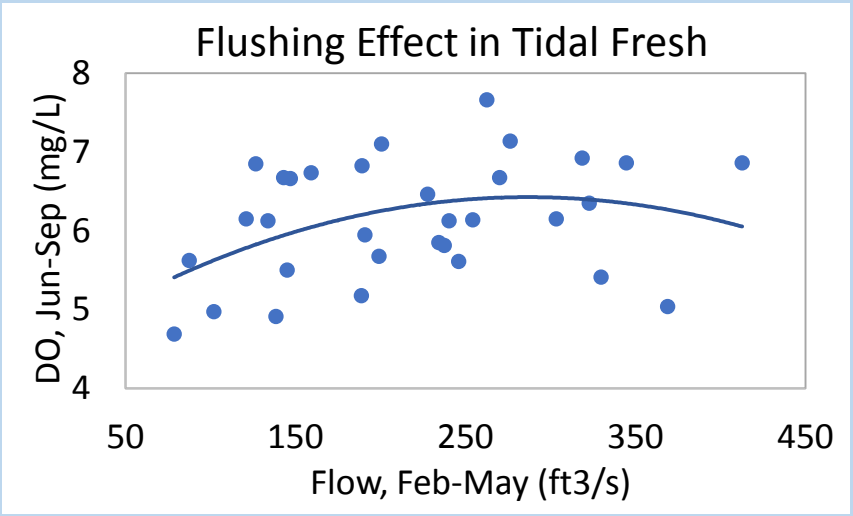
1) CHOTF and CHOOH: Nutrients in the tidal waters:

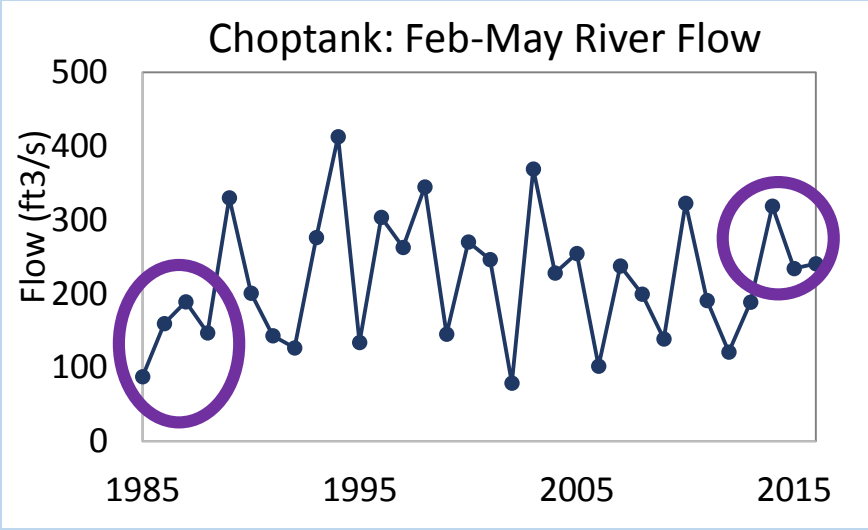






2) CHOTF/OH: Consider strong physical control (and light limitation).





Take home points:

- A long-term increase in nutrient loads is apparent in increasing tidal nutrient concentrations and shape of DO pattern.
- Recent few years are promising, but they may be a result of higher than average flow.

Tidal Choptank Summary

What can we do?

1. Continue to reduce nutrients and encourage SAV growth
2. Focus on both phosphorus and nitrogen
3. Even though lower Choptank is influenced somewhat by the mainstem, controlling local sources is most important in this system

Support from existing research

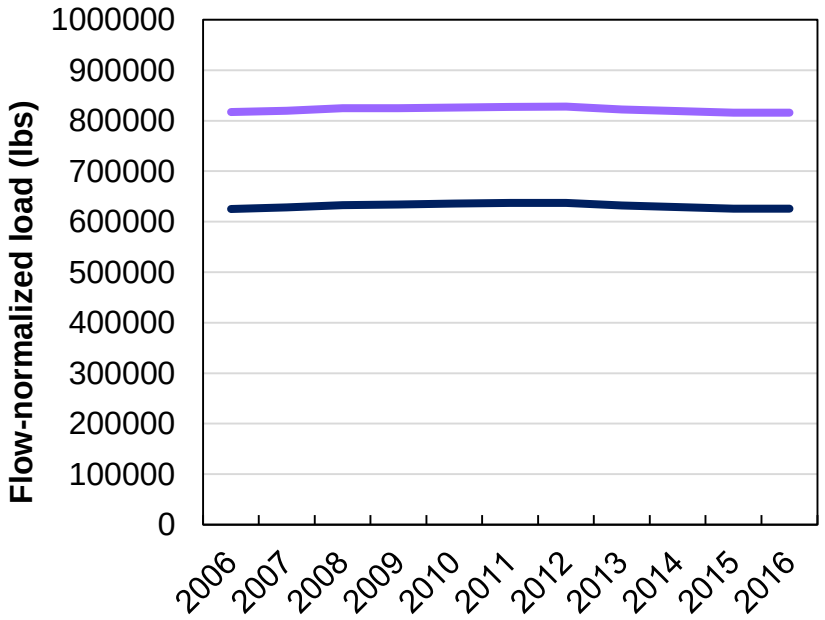
→ Long-term analysis of the water quality data and loads directly attributed increasing chlorophyll-a, declining water clarity, and declining DO concentrations to increasing nutrient loads from the watershed (Fisher et al. 2006)

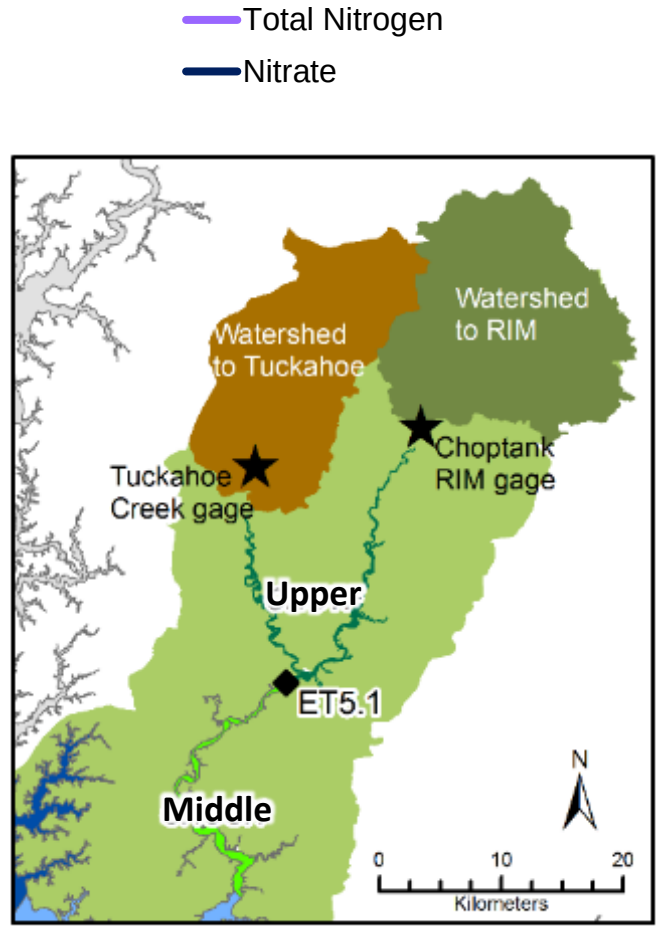
→ The tidal Choptank river varies between N and P limitation. Appeared more N limited in late fall to early spring; in summer, P-limitation is more common. (Whitall et al 2010; Fisher et al. 1999)

→ Although hypoxic water occasionally enters from the mainstem, the shallow sill at the mouth prevents this from being a common source of low-DO water (Fisher et al. 2006)

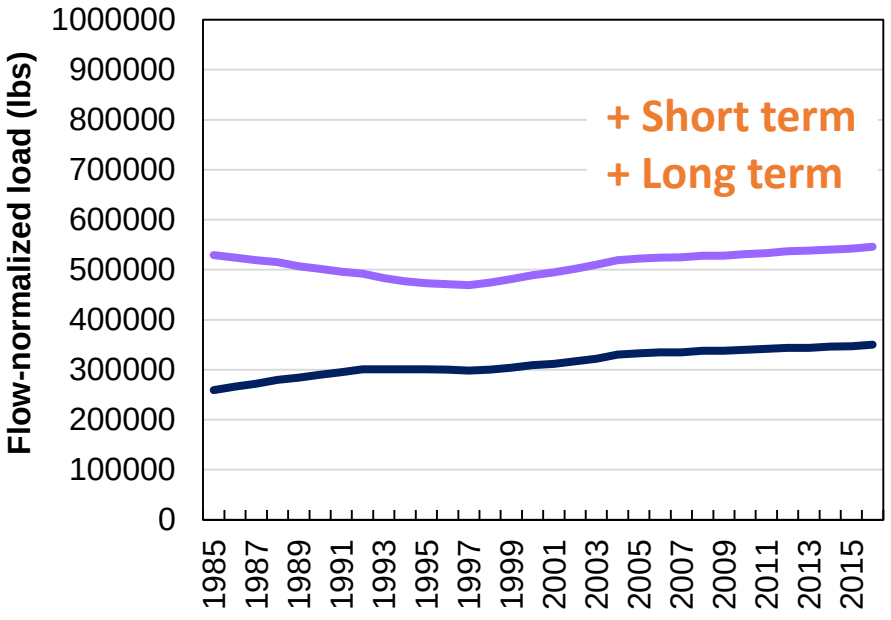
Watershed Loads

Tuckahoe Creek: Nitrogen Load

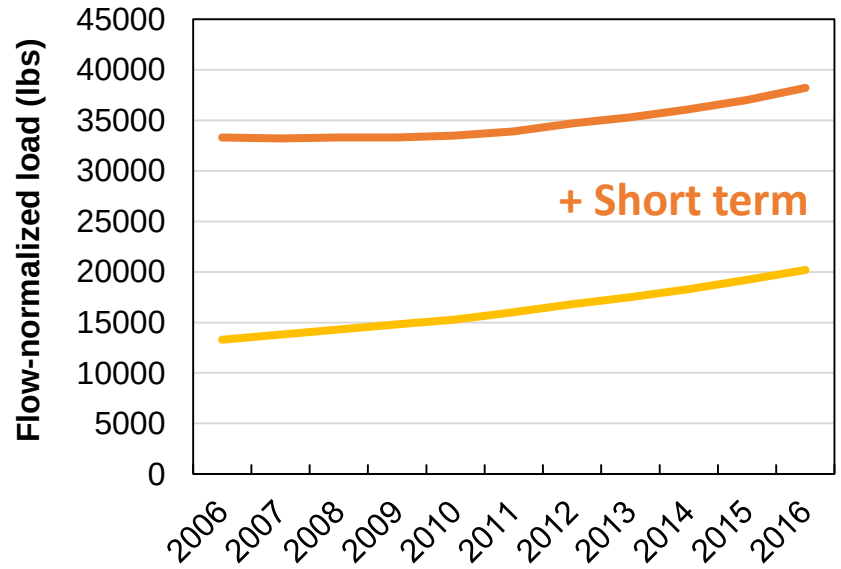




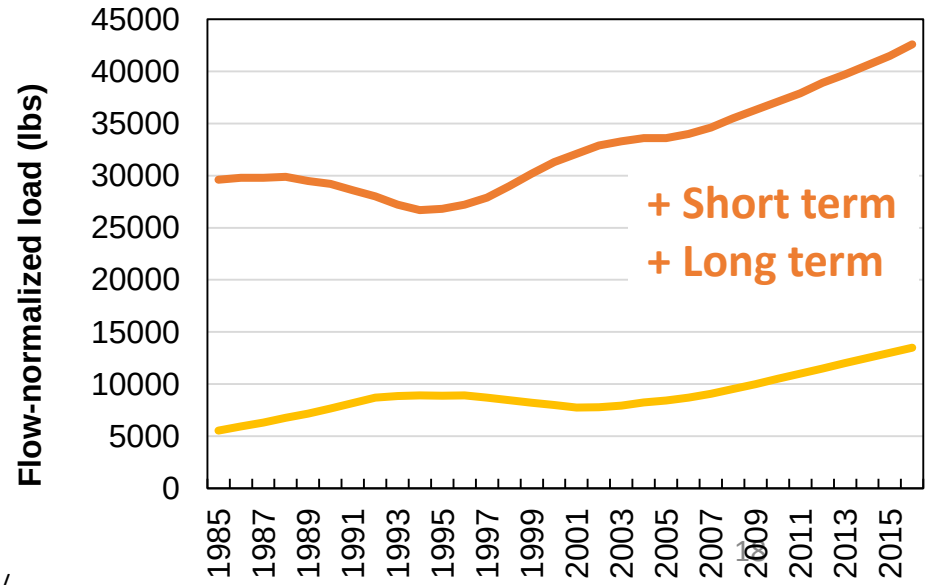
Choptank @ Greensboro: Nitrogen Load



Tuckahoe Creek: Phosphorus Load



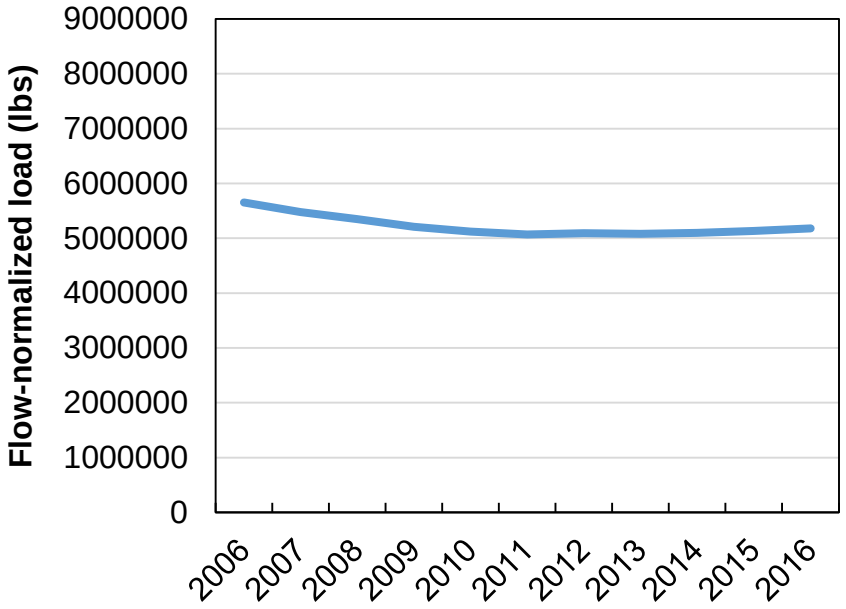
Choptank @ Greensboro: Phosphorus Load



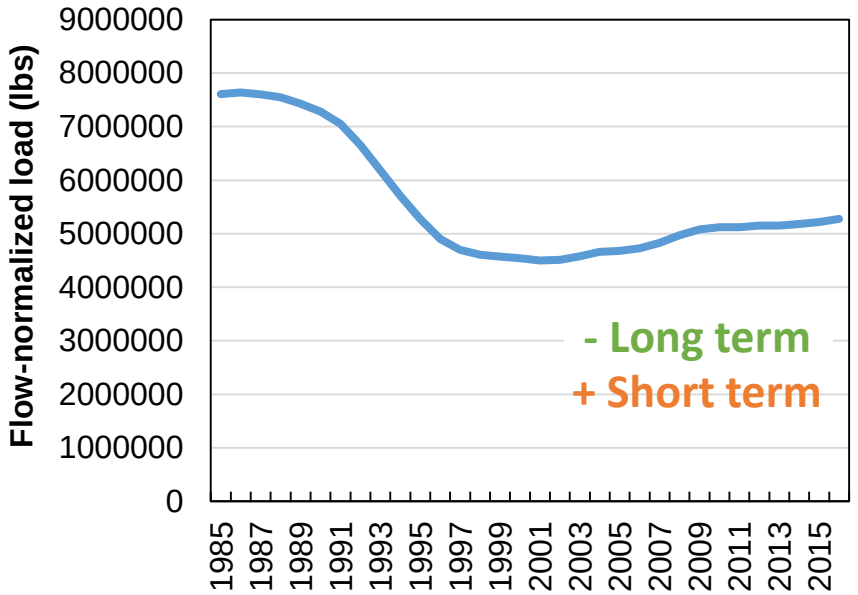
USGS Chesapeake Bay Non-tidal Network: https://cbrim.er.usgs.gov/

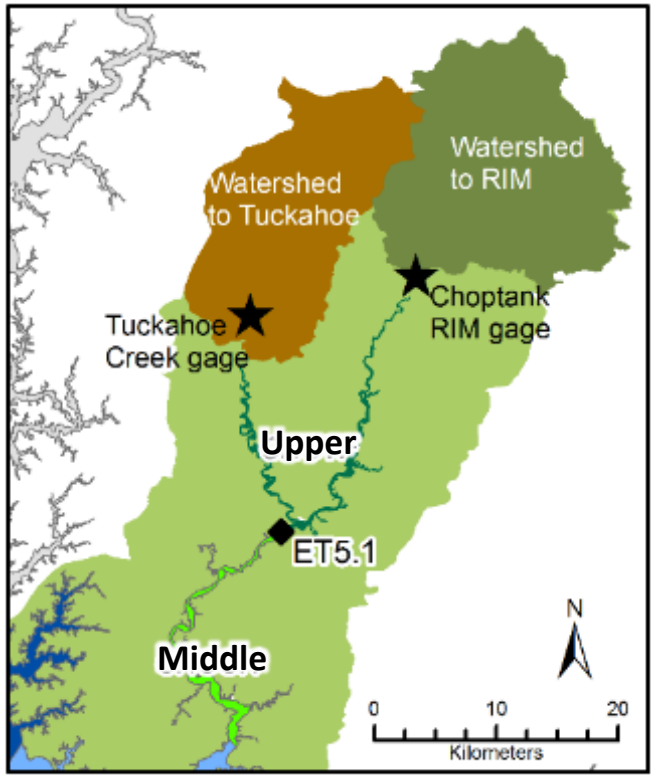
Watershed Loads

Tuckahoe Creek: Sediment Load

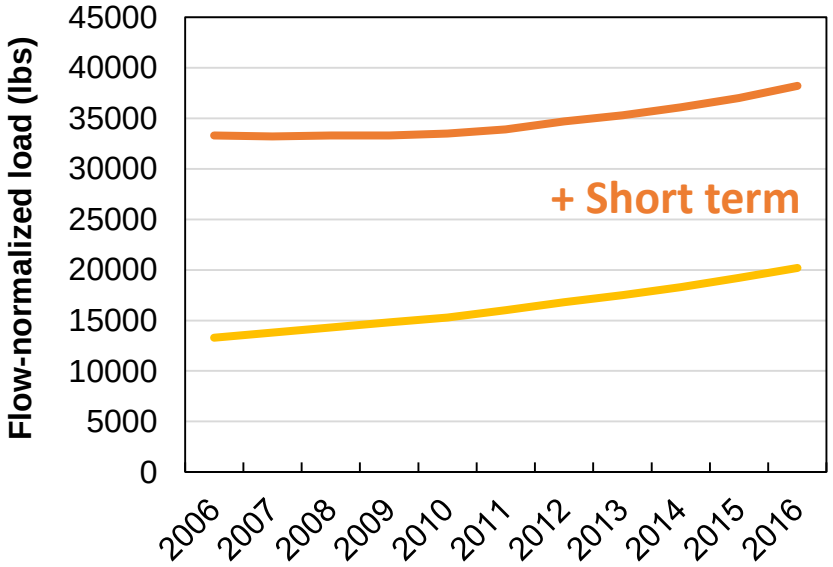


Choptank @ Greensboro: Sediment Load

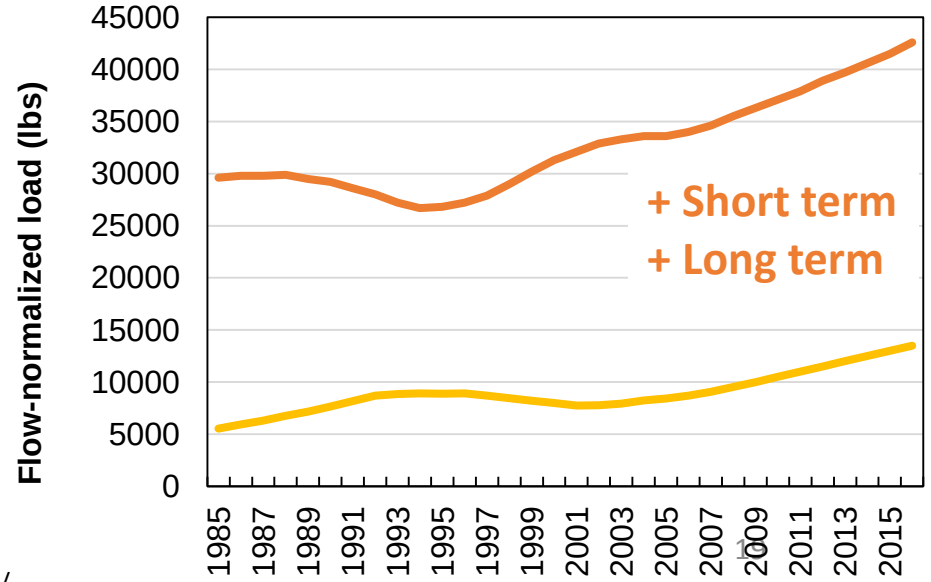




Tuckahoe Creek: Phosphorus Load



Choptank @ Greensboro: Phosphorus Load



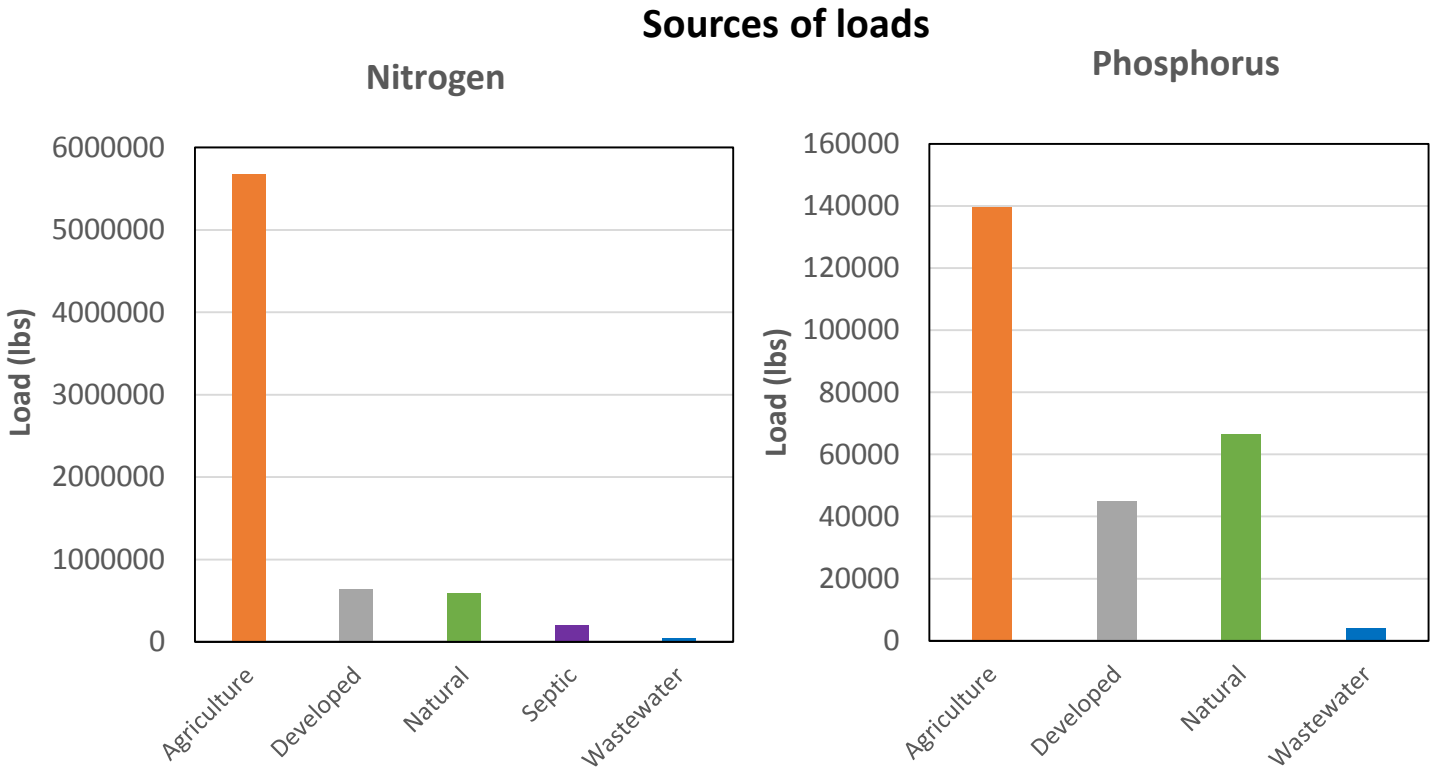
Total Phosphorus

Orthophosphorus

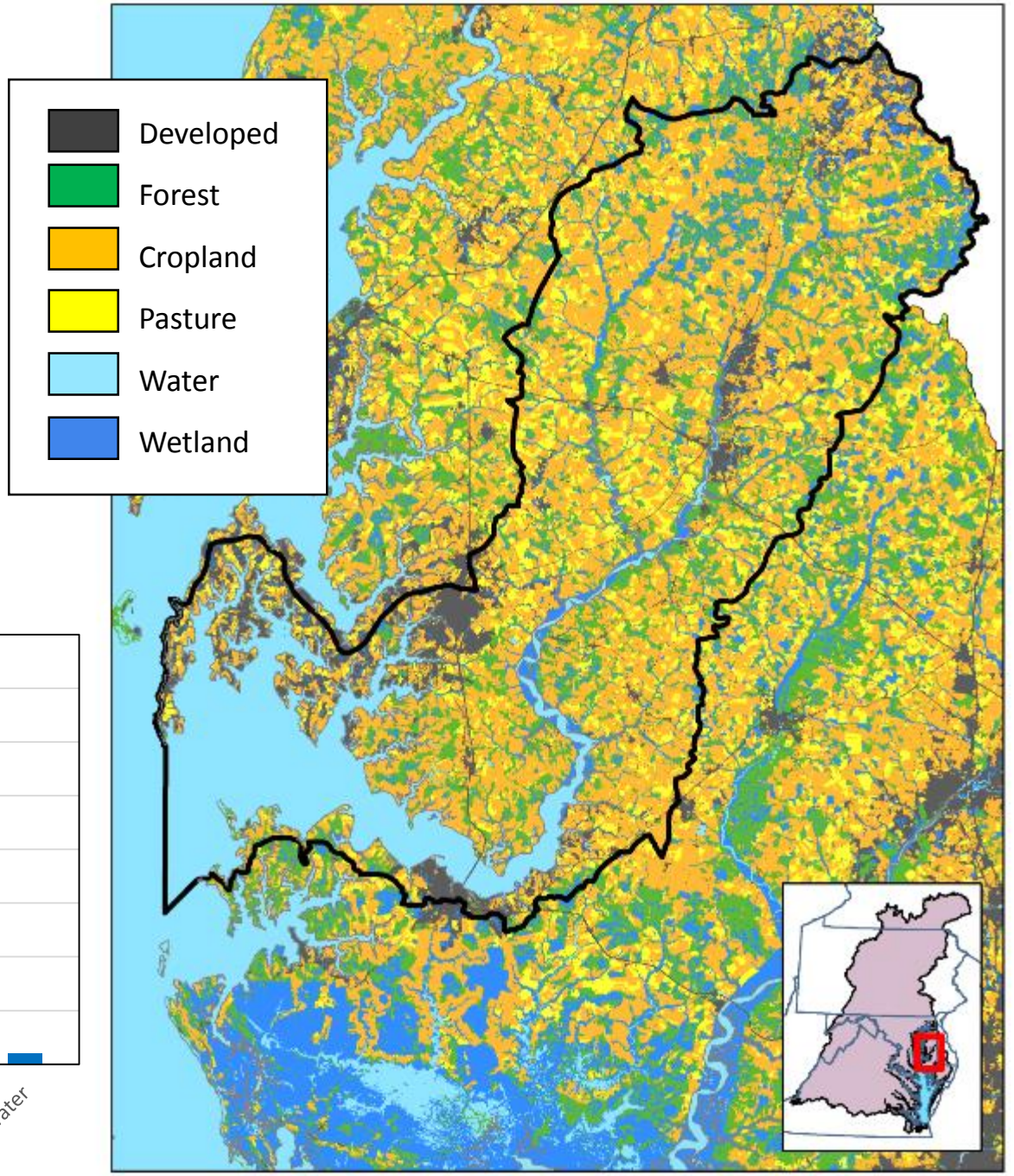
USGS Chesapeake Bay Non-tidal Network: https://cbrim.er.usgs.gov/

Where do nutrients and sediment come from in the watershed?

- Nutrient and sediment loads come primarily from agriculture, specifically cropland
- Different localities can have unique issues



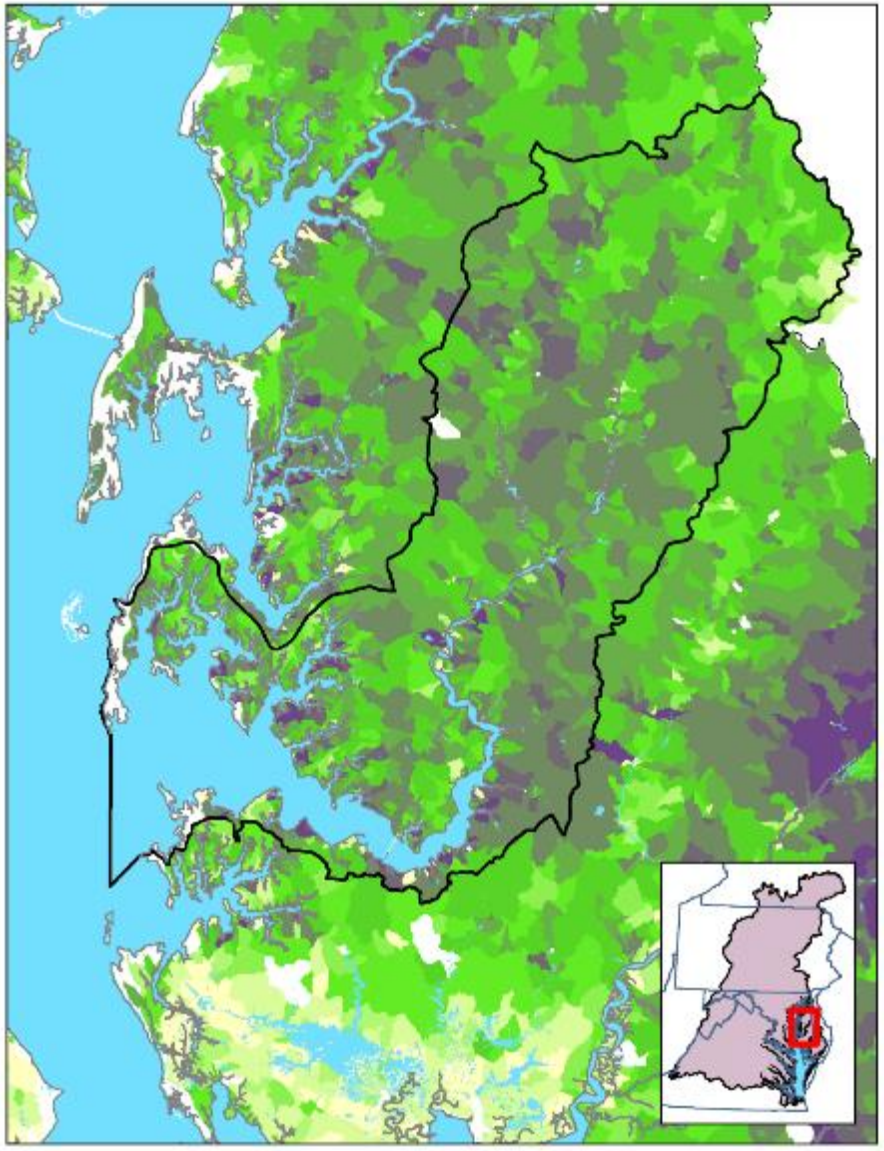
Chesapeake Bay Phase 6 Program Watershed Model. Draft 2016 Progress.



Map data from Falcone, J.A., 2015.

Loads in the watershed are tied to land use and geology

Nitrogen



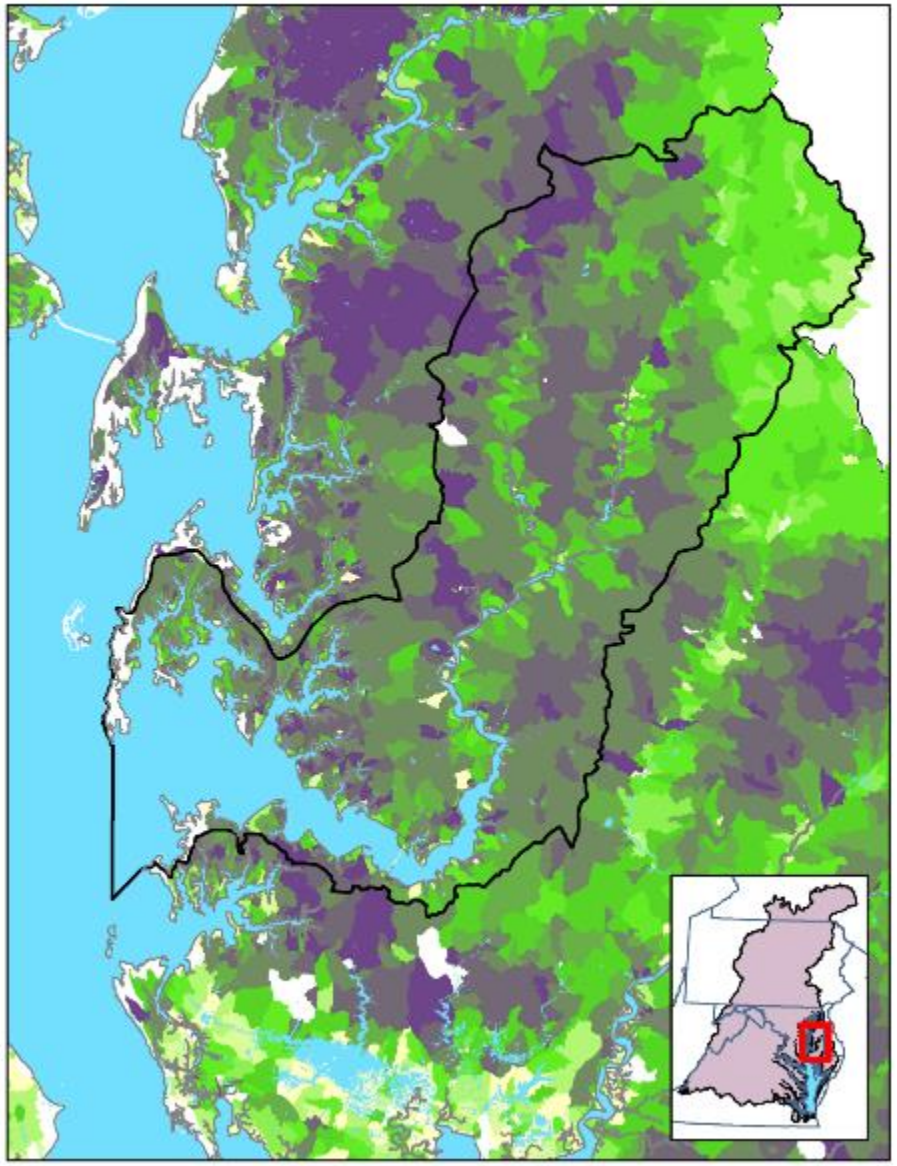
USGS SPARROW model

Estimated annual yield to local streams (lbs/acre)

Nitrogen	Phosphorus
< 2	< 0.5
2 to 3	0.05 to 0.1
3 to 4	0.1 to 0.2
4 to 5	0.2 to 0.3
5 to 7	0.3 to 0.5
7 to 10	0.5 to 0.8
10 to 14	0.8 to 1
14 to 17	1 to 1.5
17 to 22	1.5 to 2.0
>22	>2.0

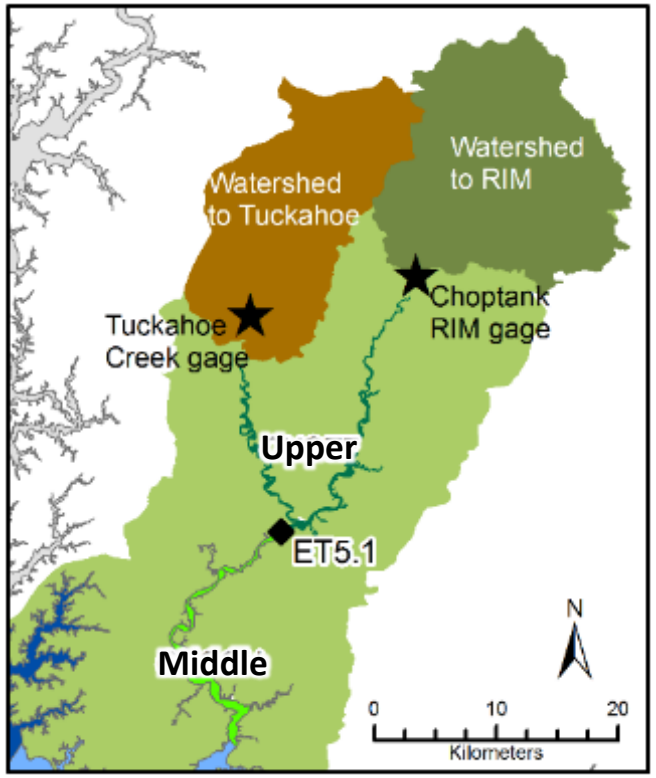
Map data from Ator, S.W. et al., 2011.
Maps modified from Ator, S.W. & Denver, J.M., 2015.

Phosphorus



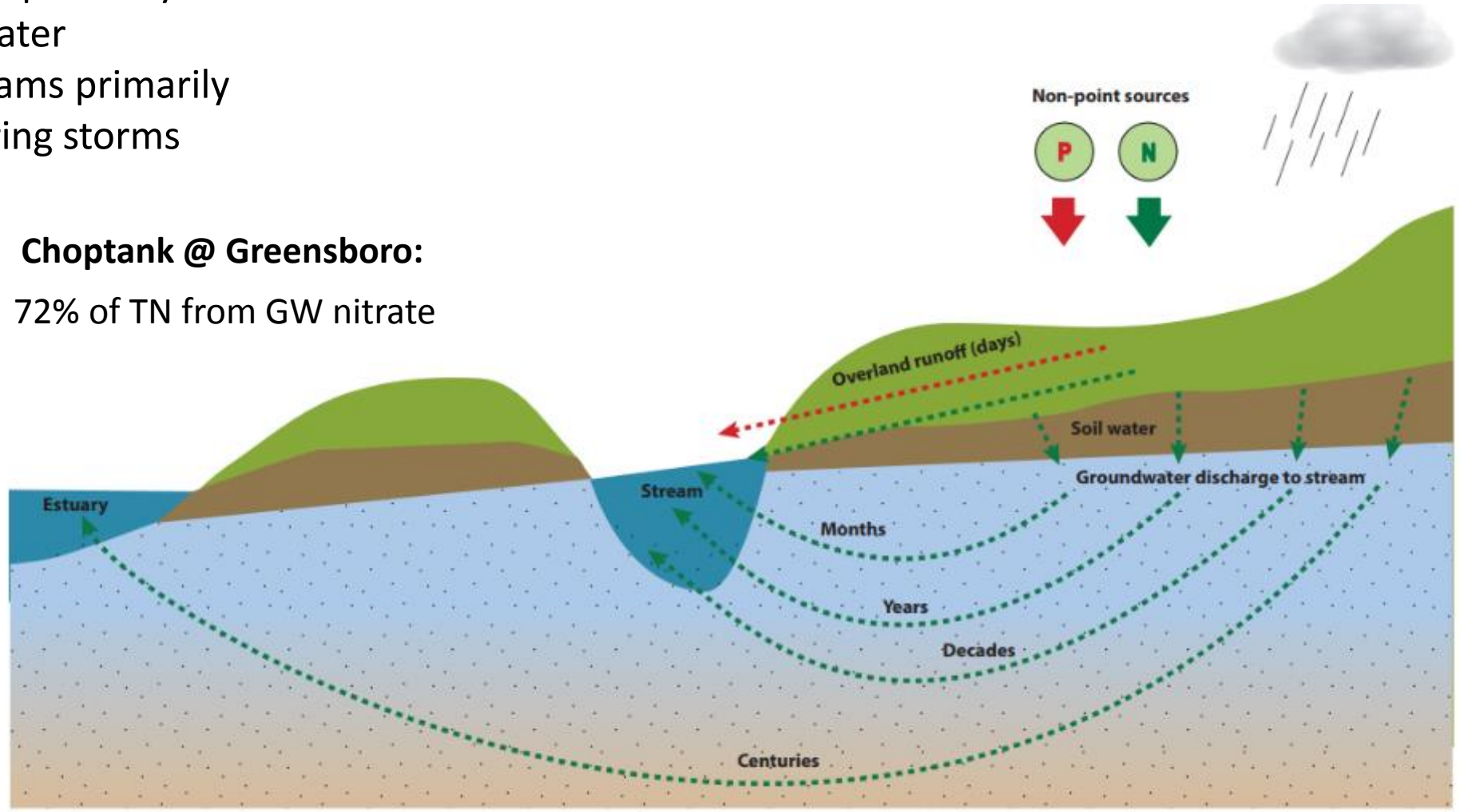
The transport of nutrients matters

- Nitrogen reaches streams primarily as nitrate through groundwater
- Phosphorus reaches streams primarily from overland runoff during storms



Choptank @ Greensboro:

72% of TN from GW nitrate

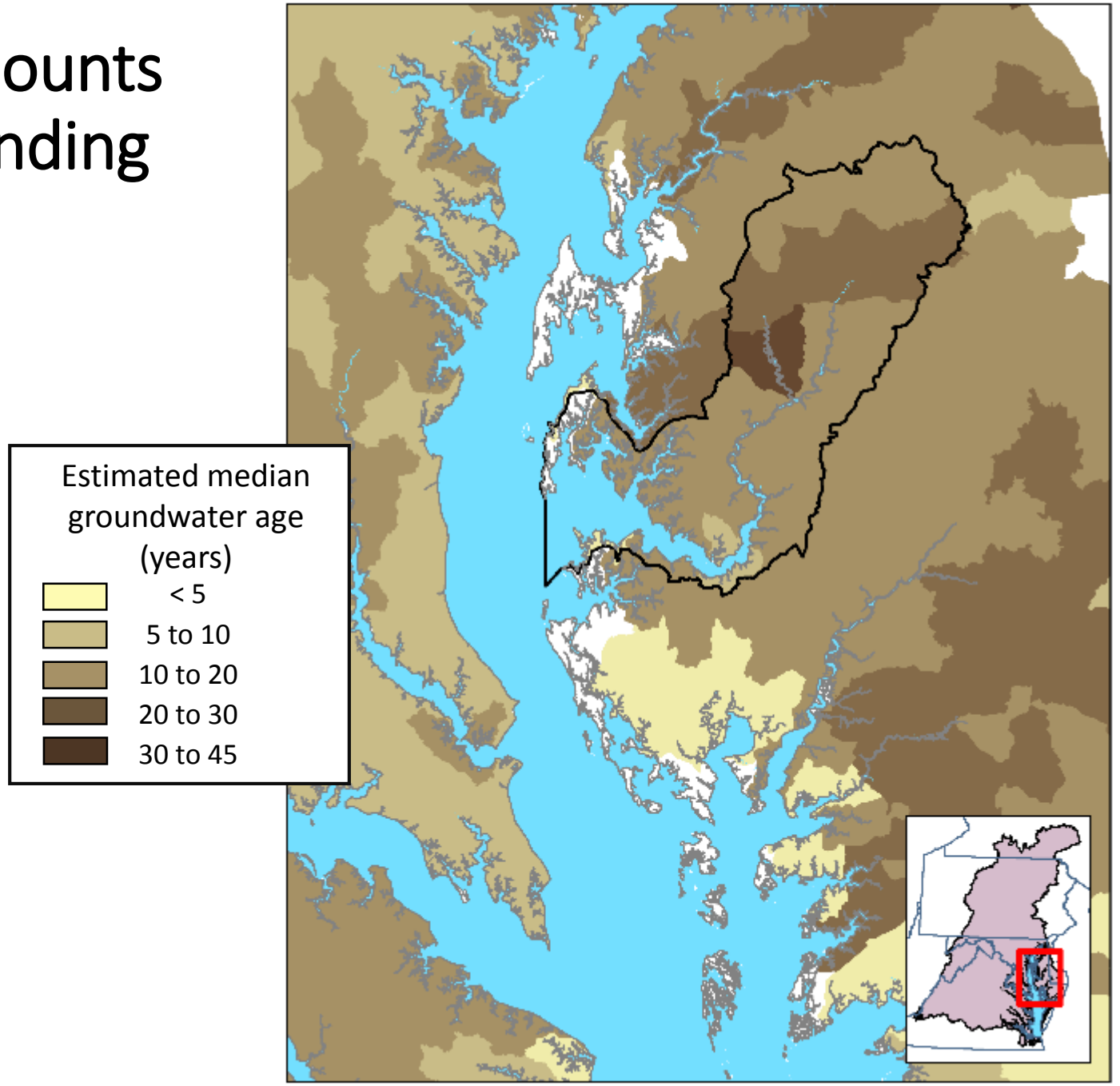


Ator, S.W. & Denver, J.M., 2015.
Bachman, L.J., et al., 1998.

Diagram from Lyerly, A.L. et al., 2014.

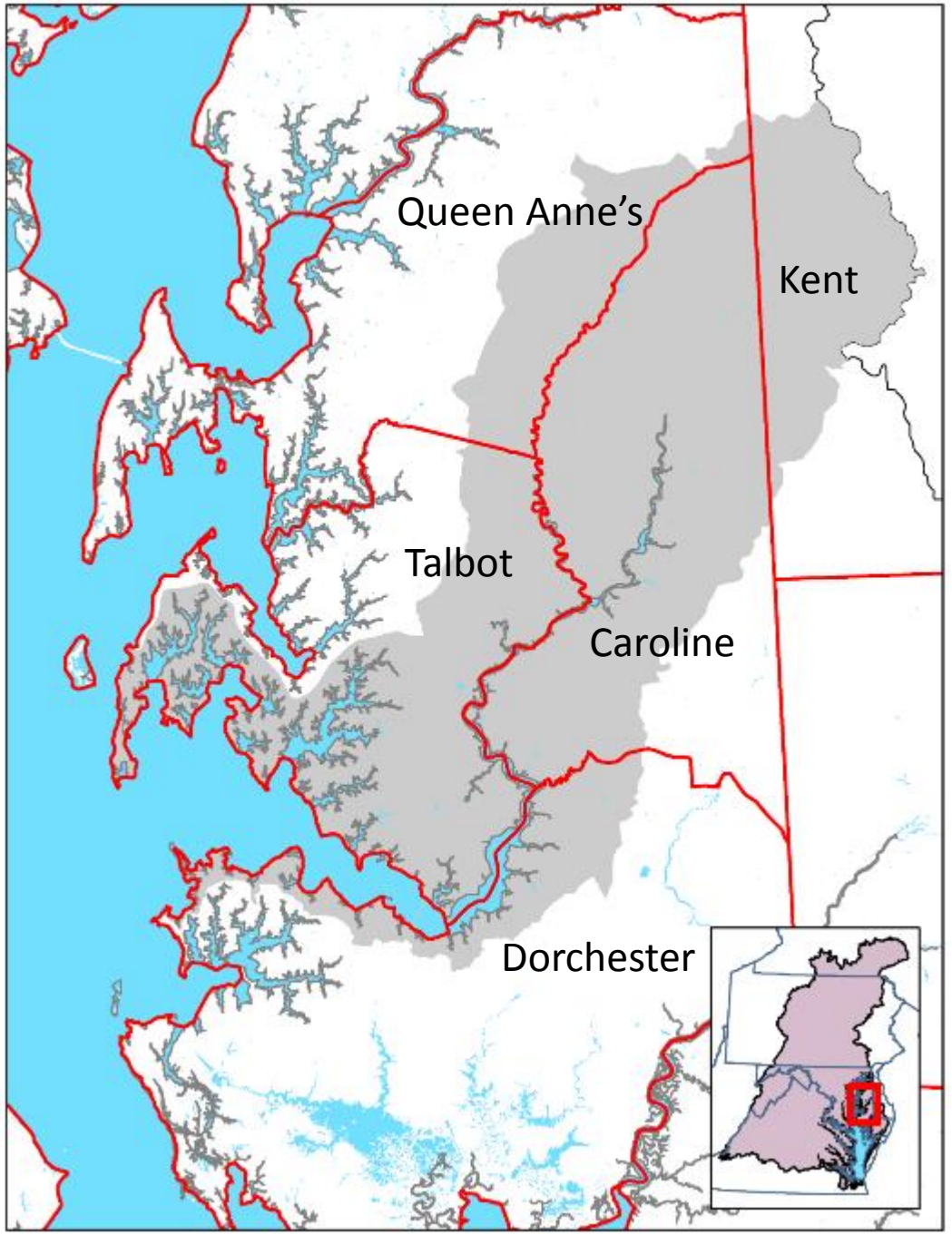
Groundwater takes varying amounts of time to reach streams depending on location

- Nitrate in groundwater represents a range of ages from recent to decades old
- Benefits from management actions will manifest in both the short and long term



Phase 6 Watershed Model groundwater age estimates.
DRAFT from Ghopal Batt, Chesapeake Bay Program.

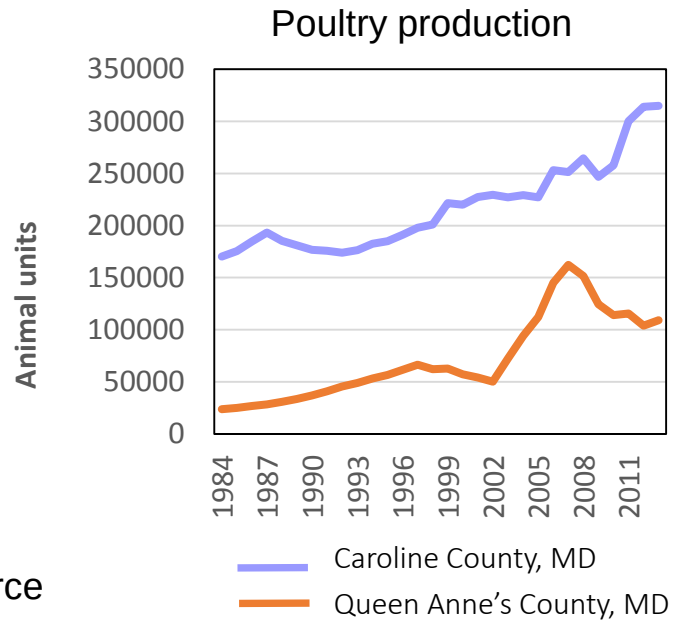
Sources, drivers, and impacts can differ between counties

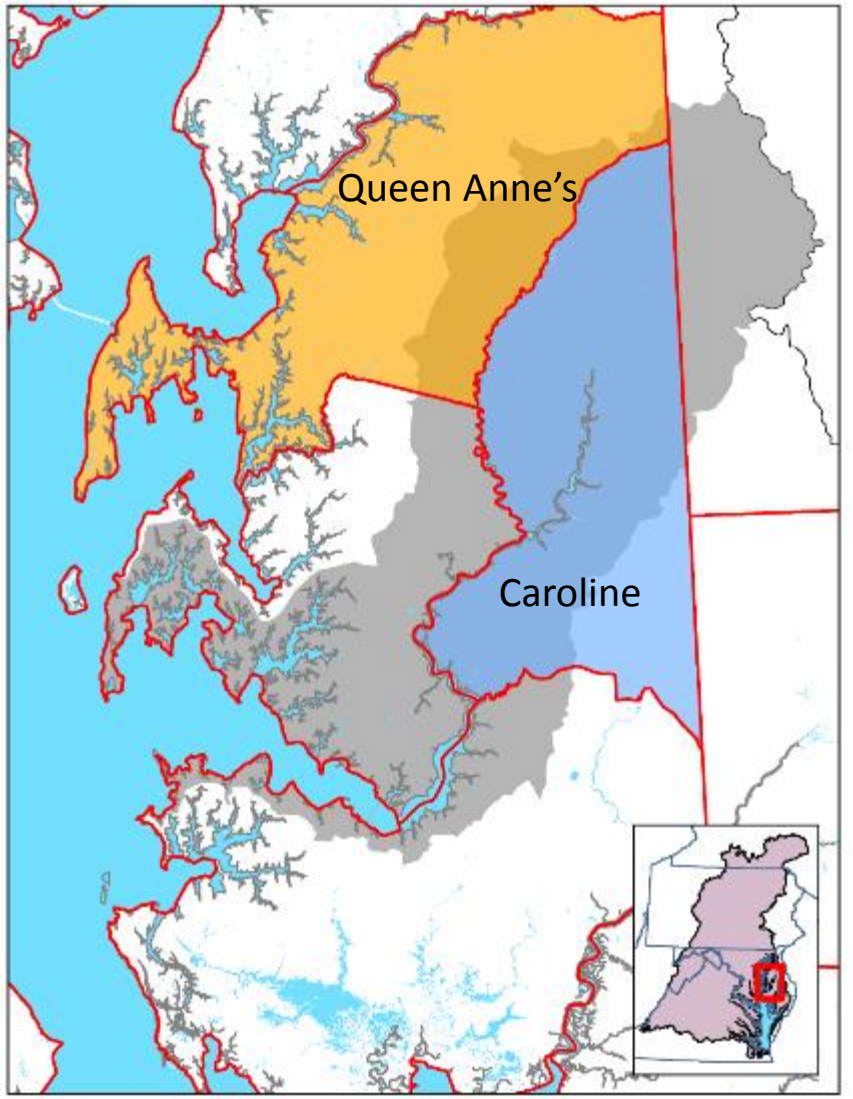


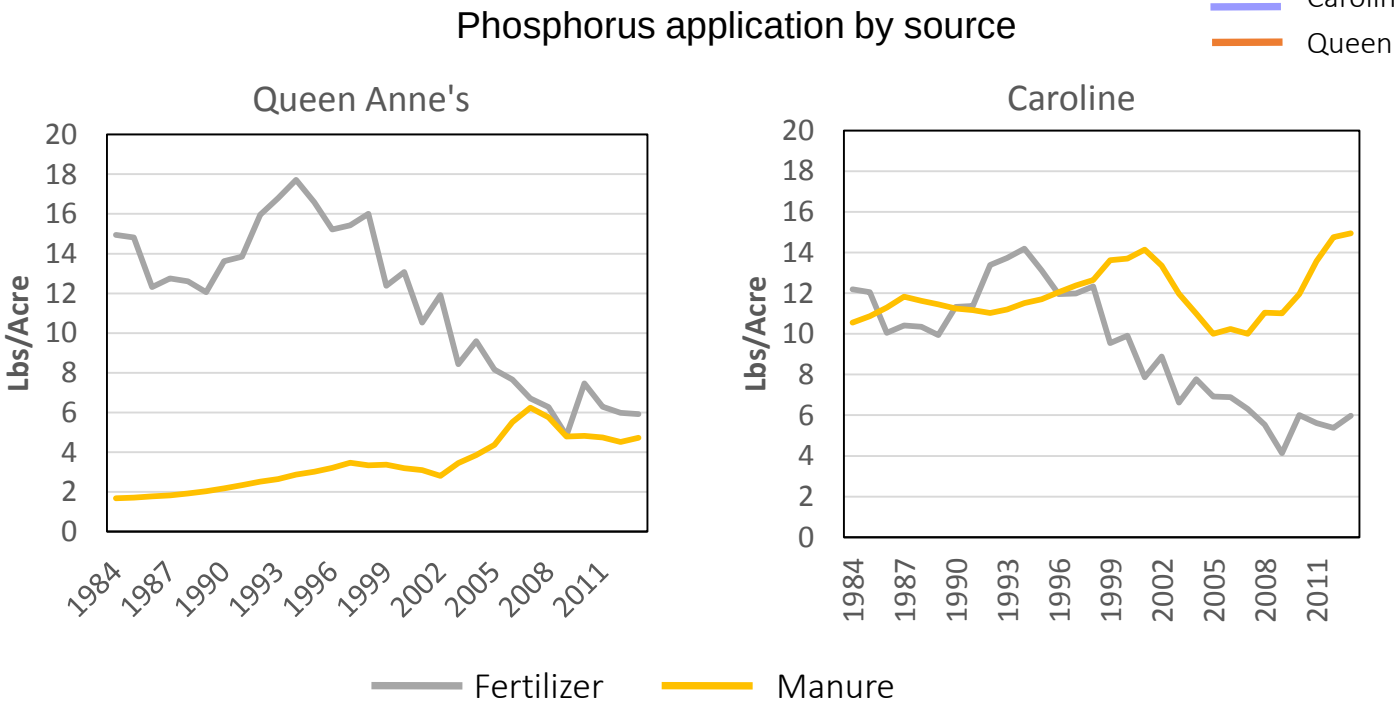
Sources, drivers, and impacts can differ between counties

Example: Queen Anne's & Caroline

- Different agricultural production
- Different application practices
- Different impact on soils & streams







Chesapeake Bay Phase 6 Program Watershed Model Inputs.
http://cast.chesapeakebay.net

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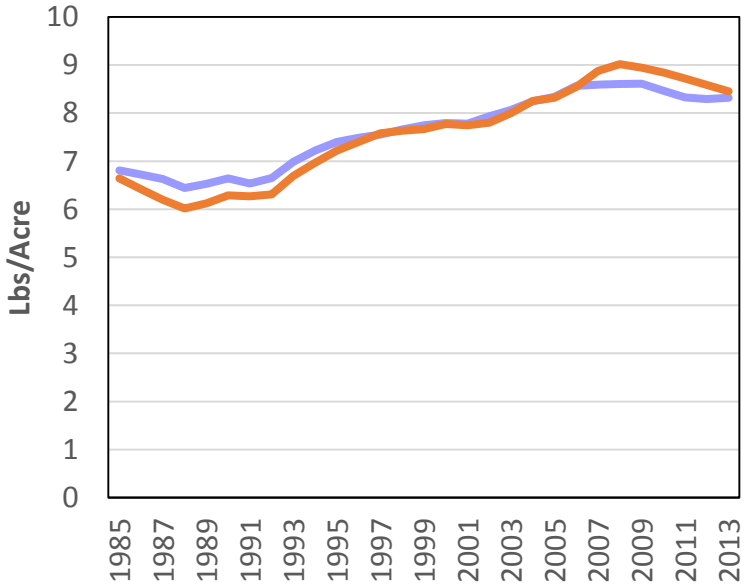
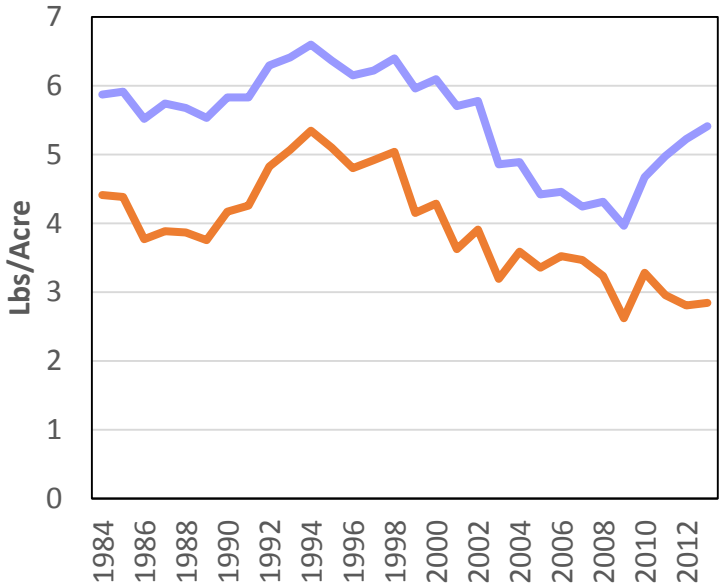
Phosphorus removed in crops

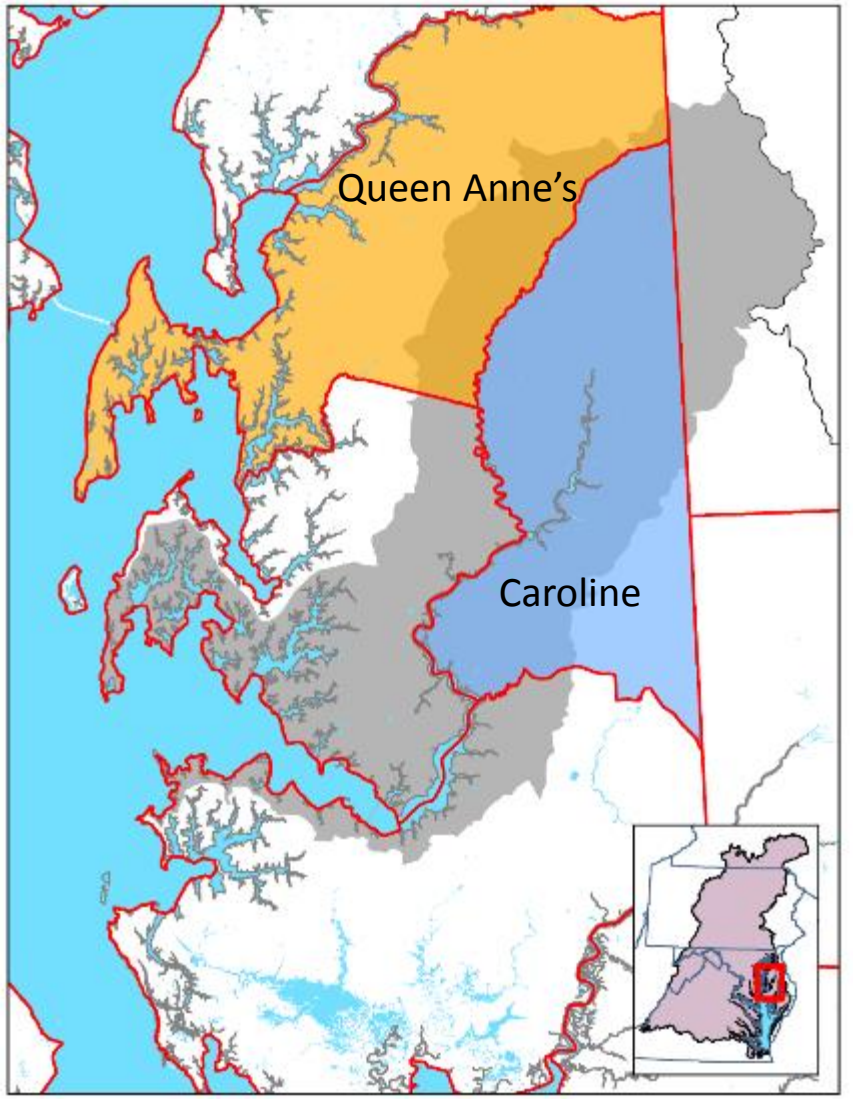


Phosphorus applied to crops



Caroline County, MD

Queen Anne's County, MD



Chesapeake Bay Phase 6 Program Watershed Model.
http://cast.chesapeakebay.net

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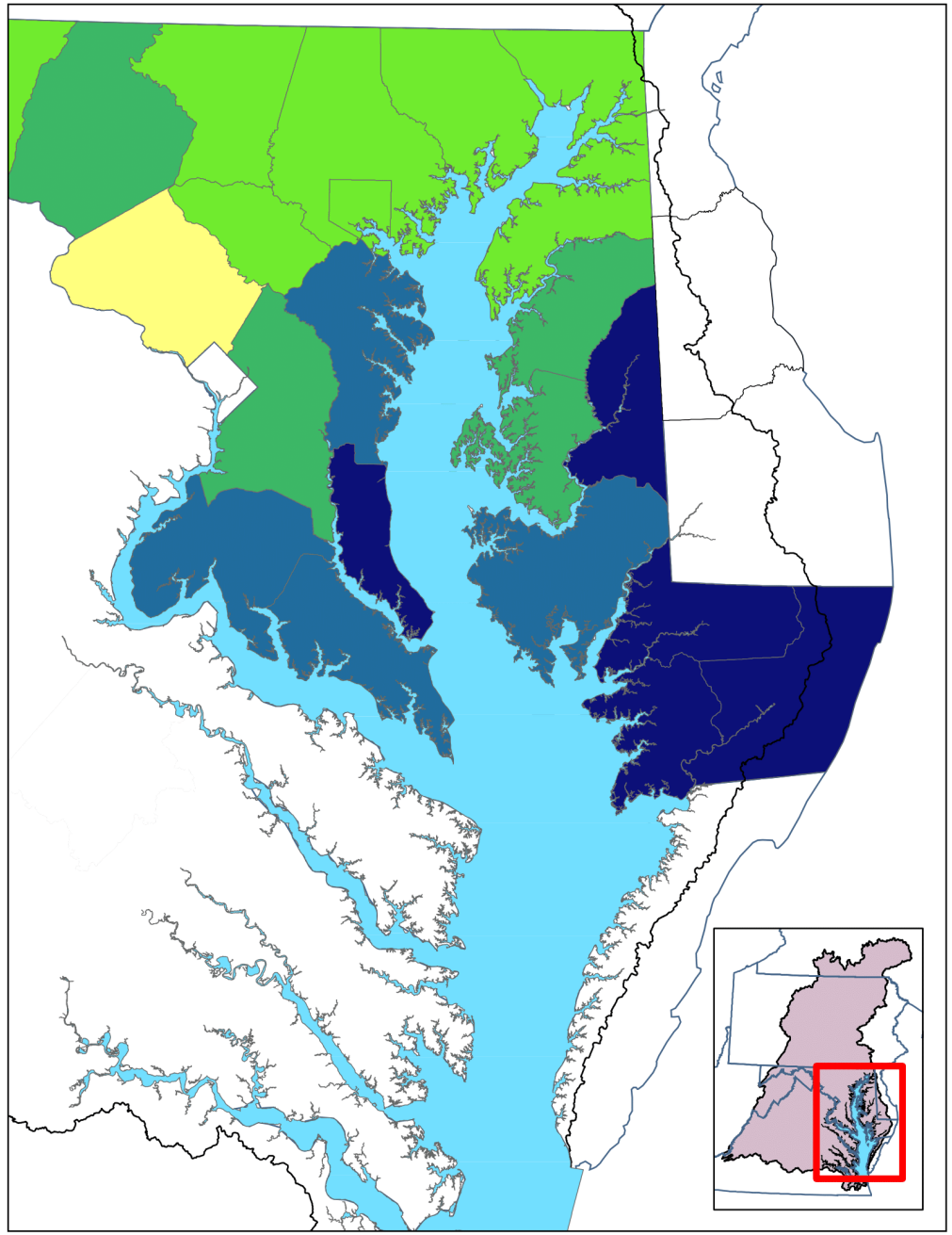
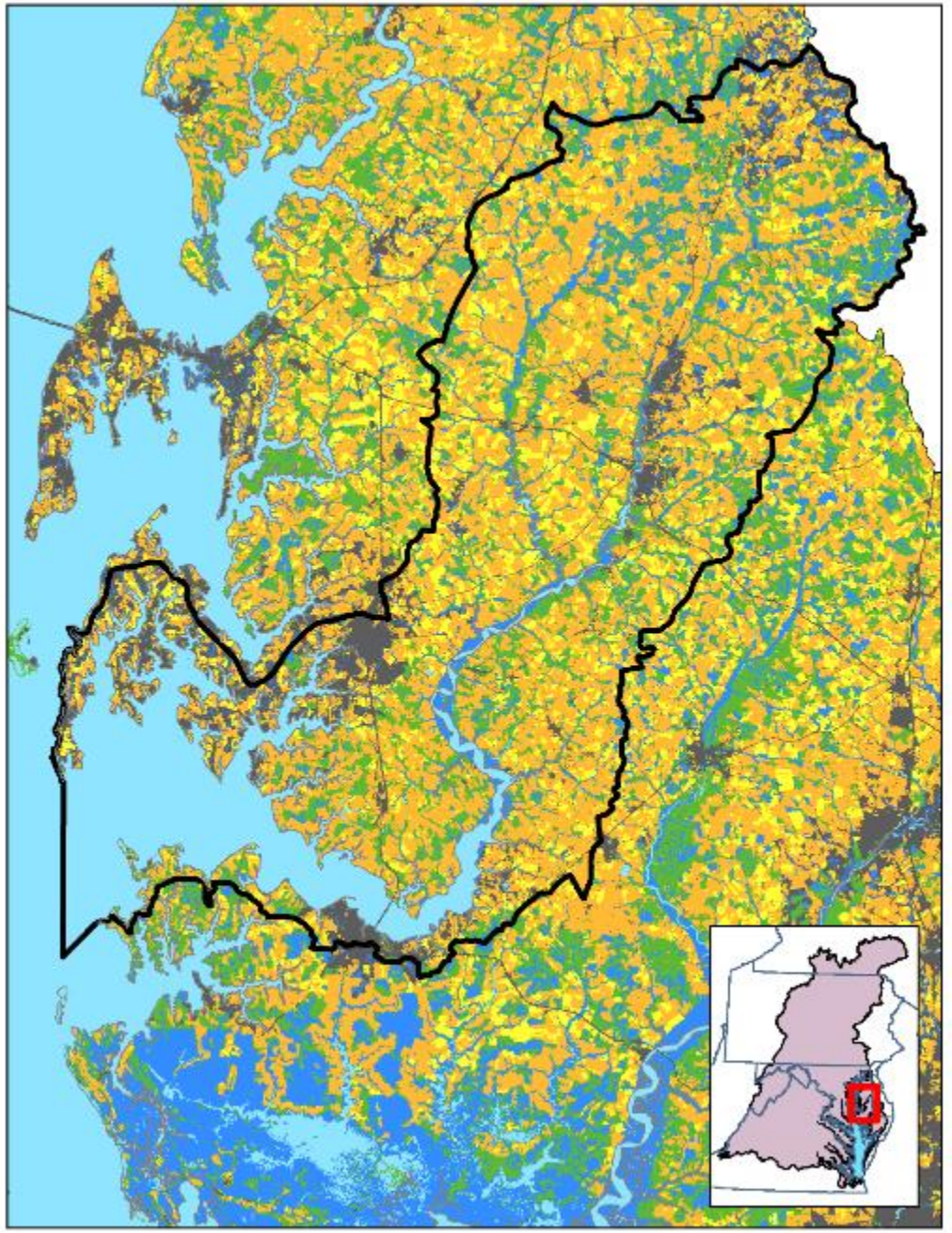
Fertility Index Value of Maryland Counties



Maryland Department of Agriculture
Phosphorus Management Tool
http://mda.maryland.gov/Pages/PMT.aspx

Making the management connection:

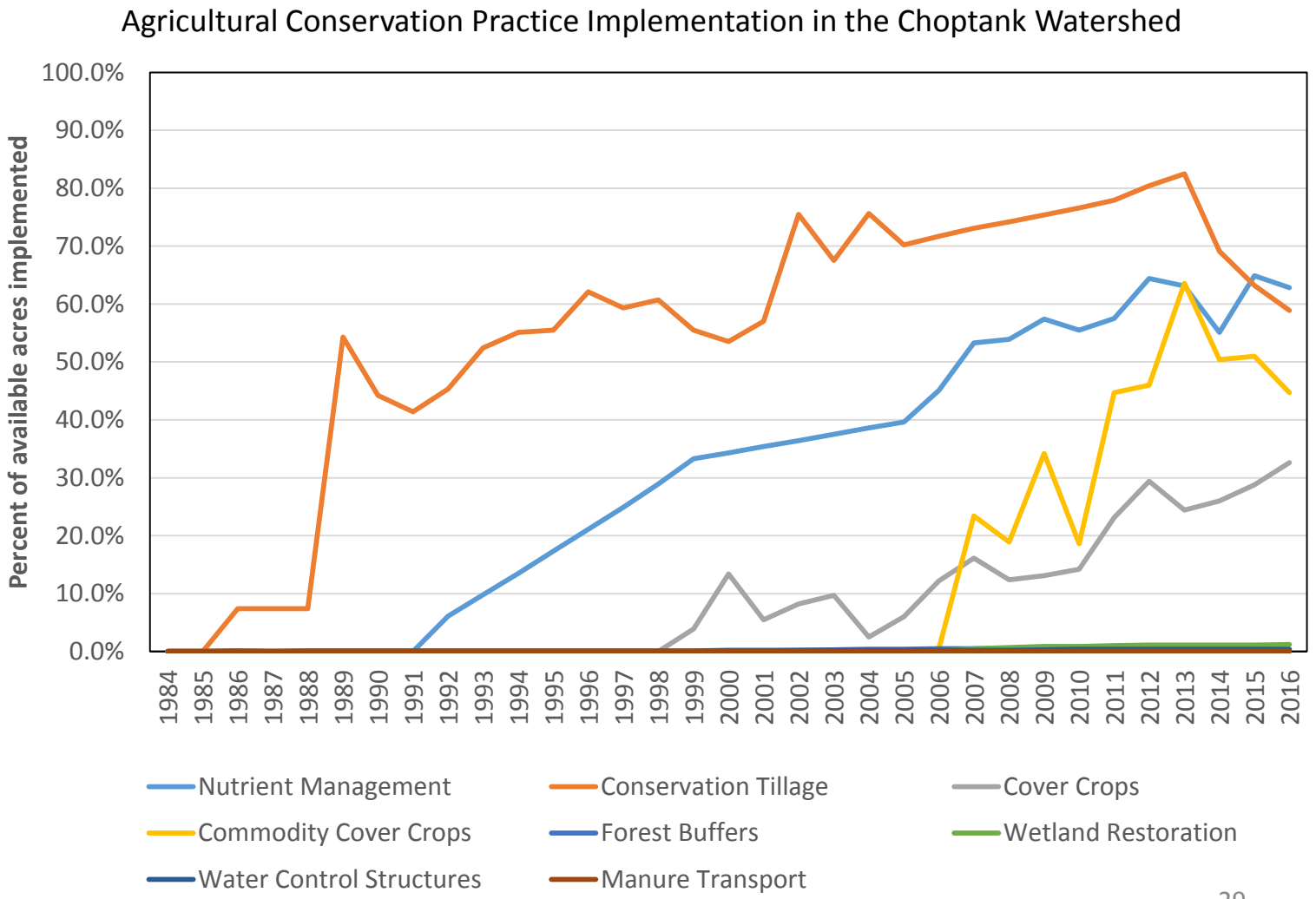
What have we done so far and what are the opportunities moving forward?



Map data from Falcone, J.A., 2015.

What practices address the issues in the Choptank? Have we been implementing them?

- Conservation tillage has been the longest and most widely implemented practice
- Major issues are nitrogen in groundwater, soil phosphorus, and overland runoff of sediment and phosphorus
- Effective practices could be cover crops, forest buffers, water control structures, manure transport, wetland restoration, appropriate nutrient management



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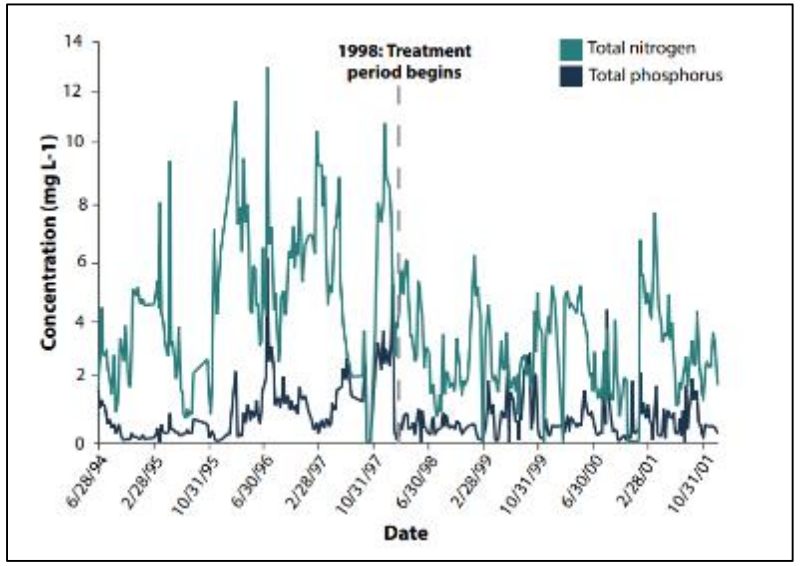
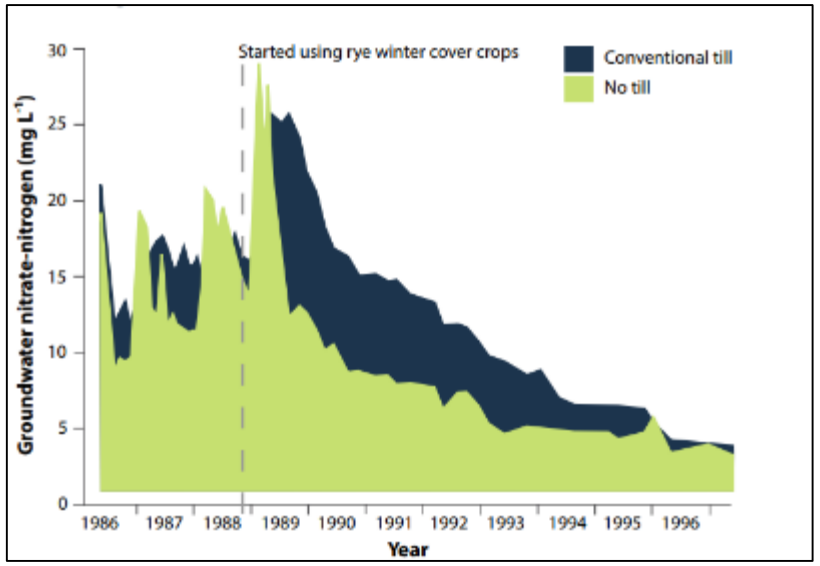
Decrease in stream nitrogen with cover crops and manure transport



Pocomoke River

Decrease in groundwater nitrate with cover crops



Wye River

Chesapeake Bay Phase 6 Program Watershed Model Draft 2016 Progress. http://cast.chesapeakebay.net

Lyerly, C.M. et al., 2015.

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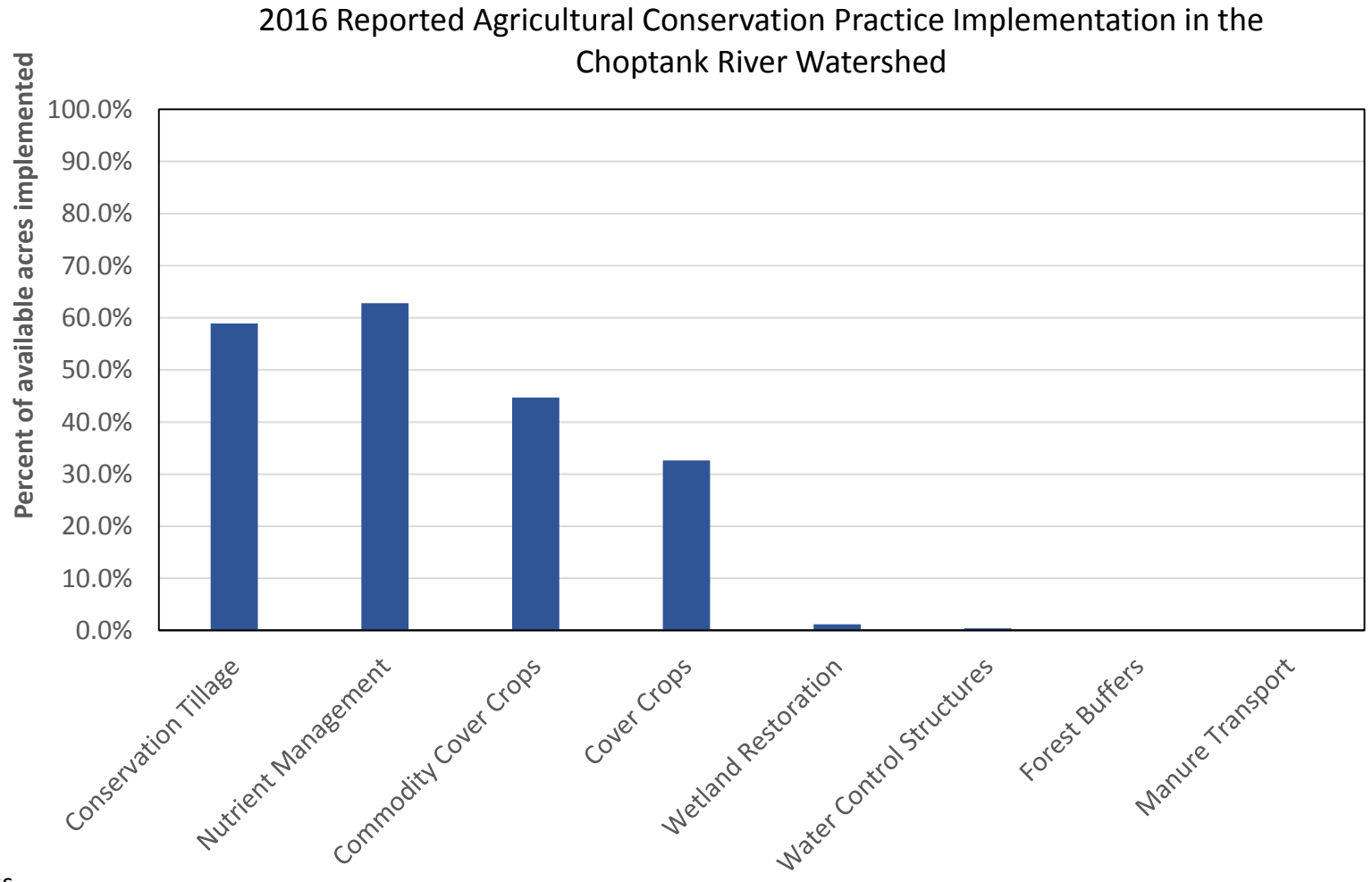

Chesapeake Bay Phase 6 Program Watershed Model Draft 2016 Progress. http://cast.chesapeakebay.net

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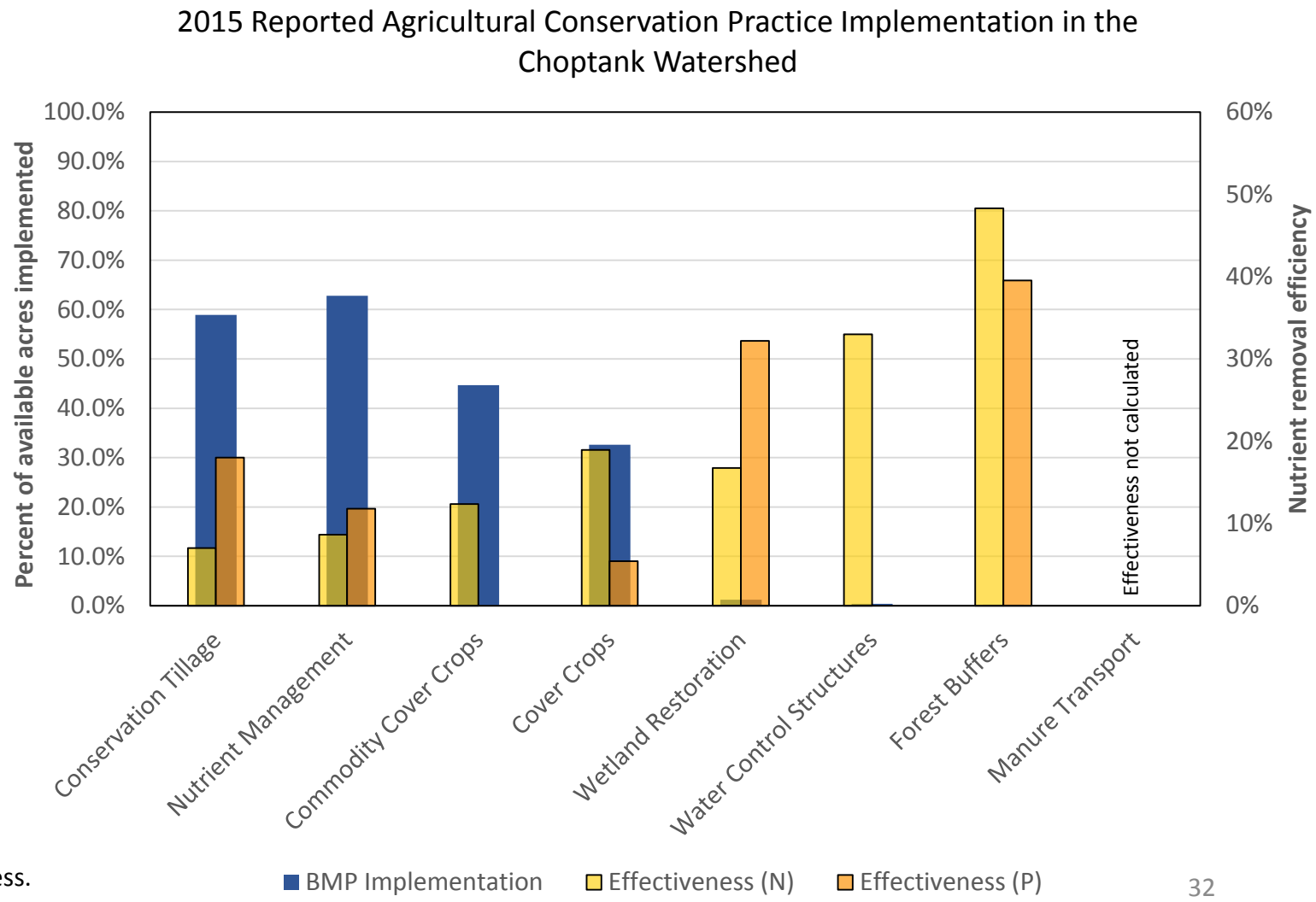
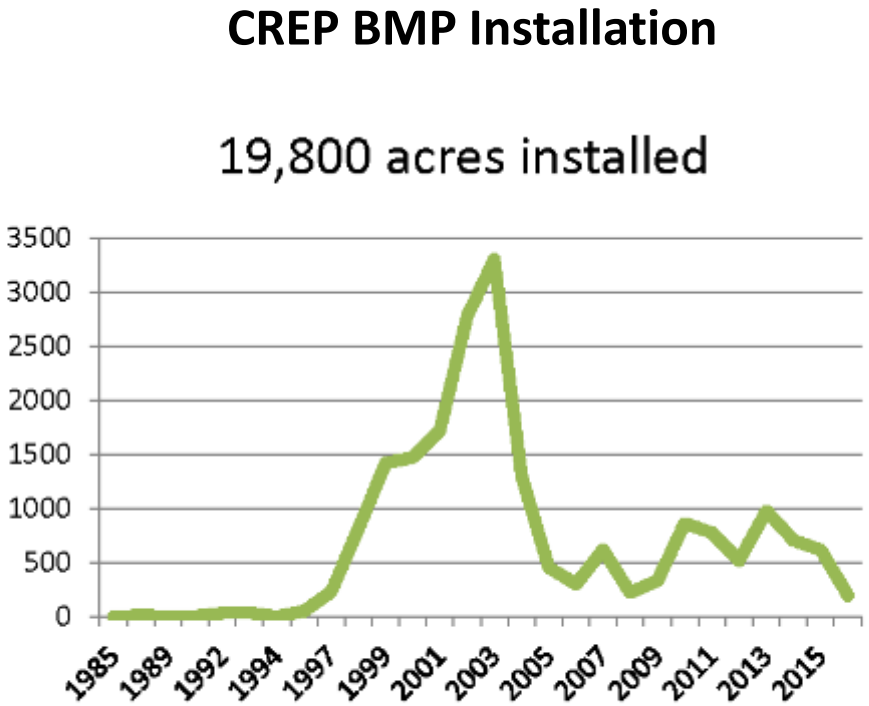
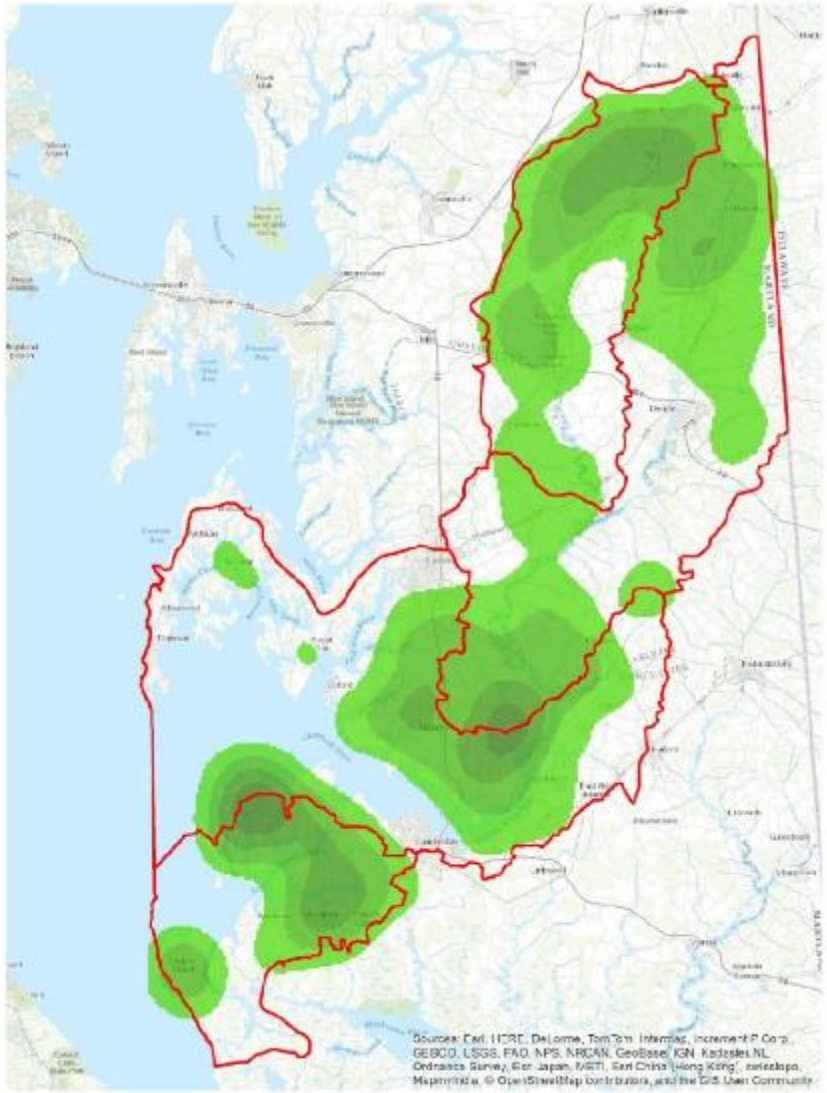


Chesapeake Bay Phase 6 Program Watershed Model Draft 2016 Progress. http://cast.chesapeakebay.net

What practices address the issues in the Choptank? Have we been implementing them?

CREP BMP Installation in Choptank (Maryland)

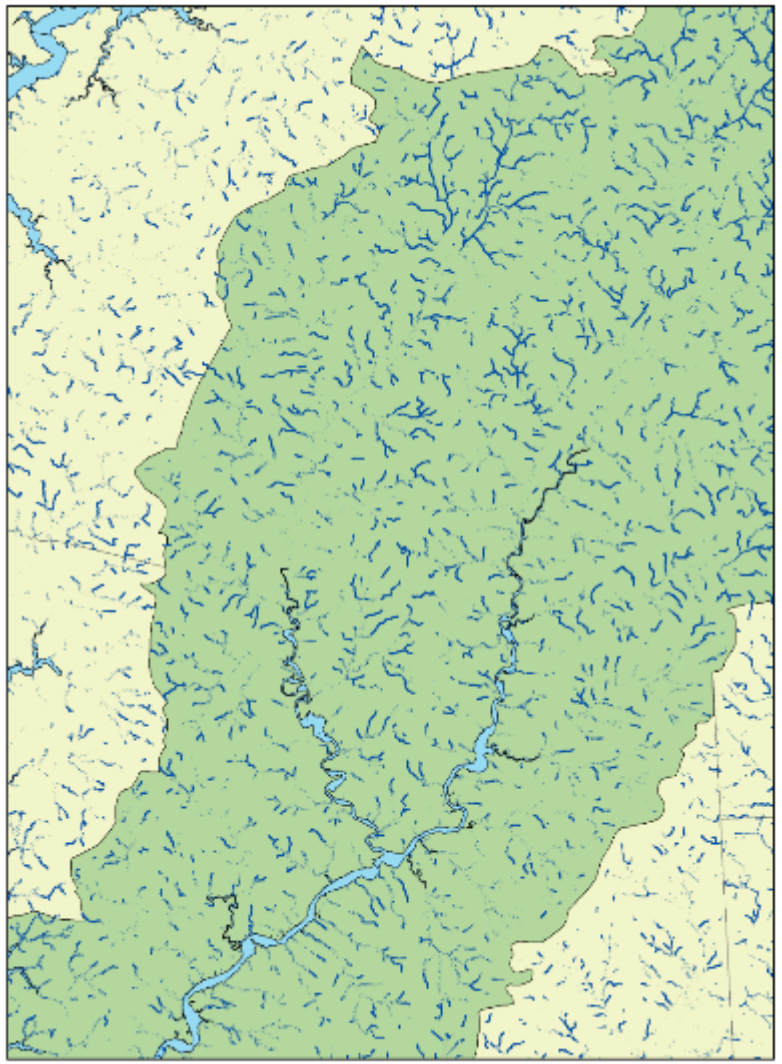




Graph and map from Jason Keppler, MDA, 2016 Choptank Symposium

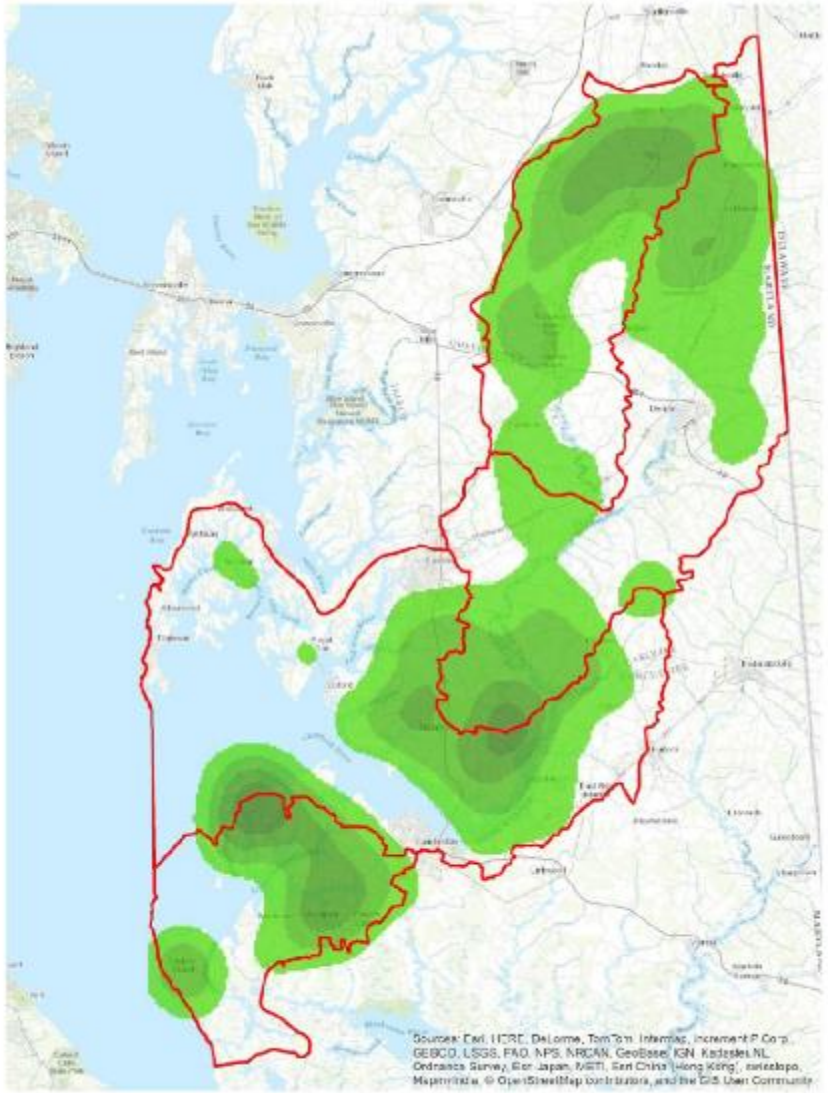
What practices address the issues in the Choptank? Have we been implementing them?

Bufferable land within 30m of streams



Data from Lindsey Gordon, CRC CBP

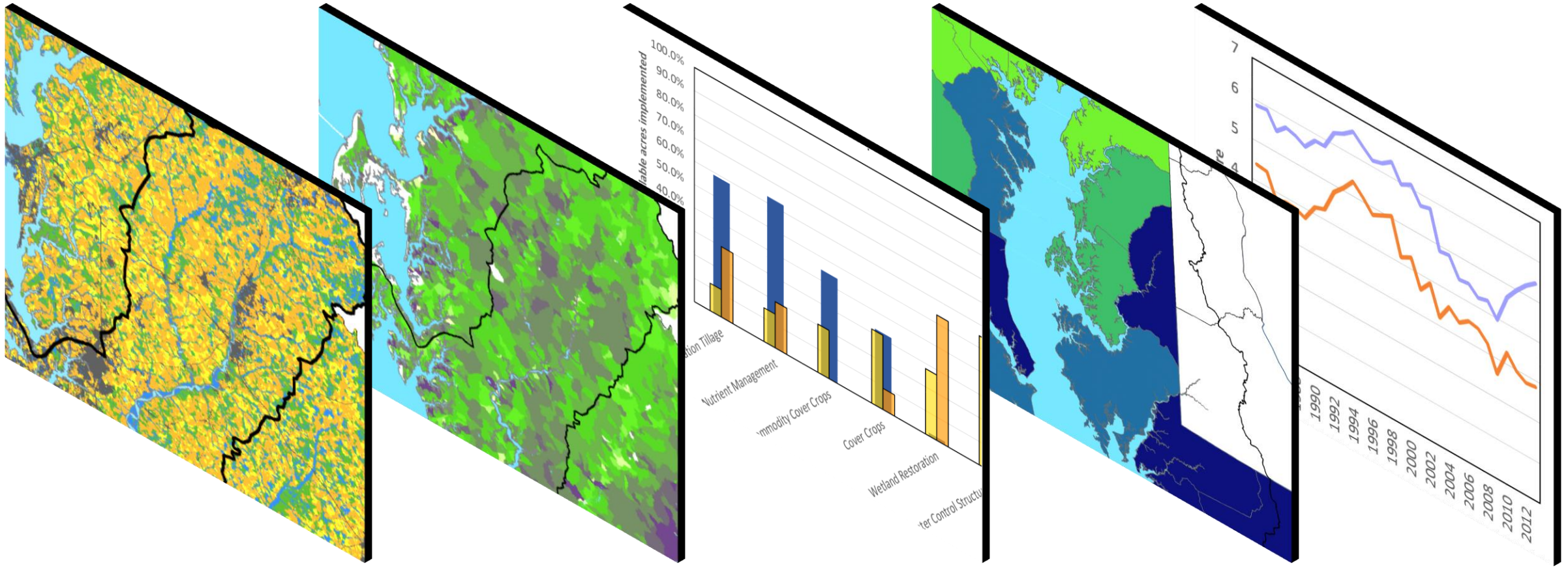
CREP BMP Installation in Choptank (Maryland)



Map from Jason Keppler, MDA, 2016 Choptank Symposium

A LOT of new and updated info available…

…that can be used together to inform management and restoration efforts



Choptank Watershed Summary

Key Takeaways

1. Heterogeneity of watershed and practices means one size doesn't fit all for restoration efforts
2. The current science **can** help to inform management and restoration efforts
3. We have useful information for focusing restoration efforts spatially, by practices, by county, and by sector

Thank you

For more information :

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Emily Trentacoste, USEPA -- trentacoste.emily@epa.gov
Jeni Keisman, USGS – jkeisman@usgs.gov

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