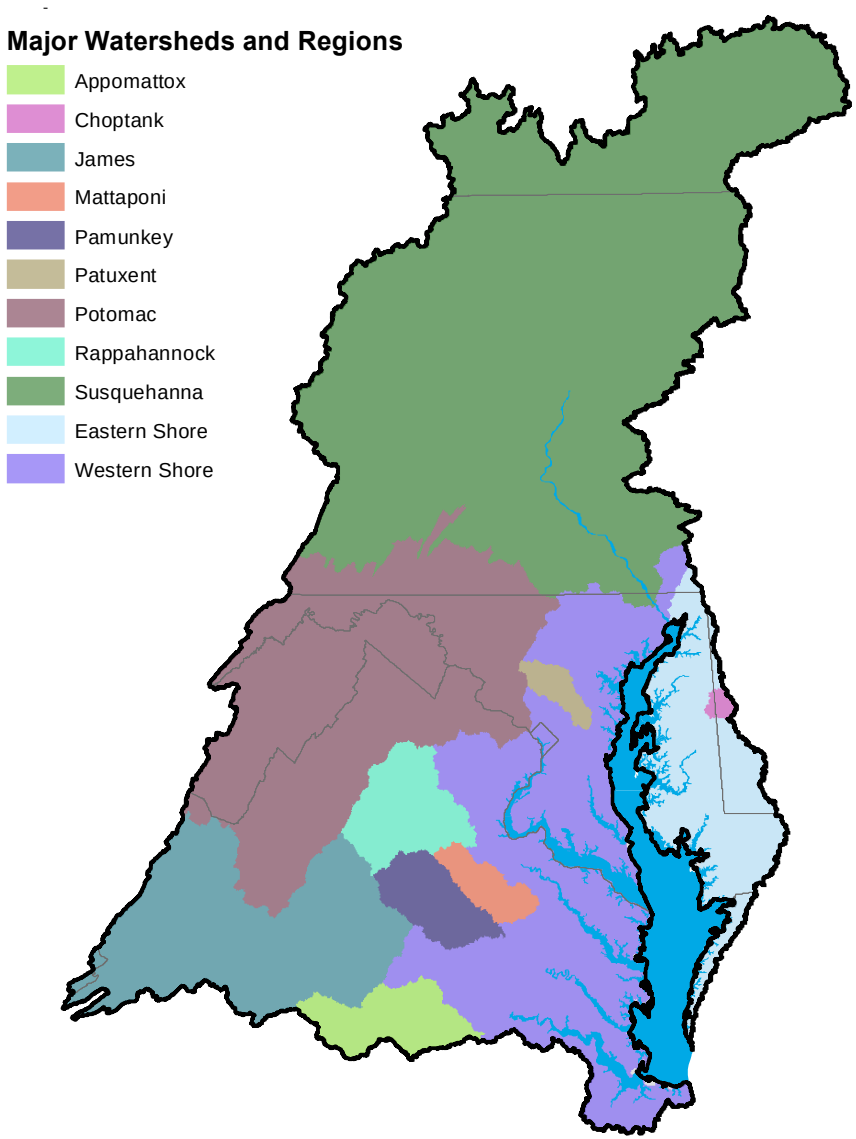
A History of Nutrient and Sediment Inputs to Chesapeake Bay: 1985-2016

A summary of three decades of monitoring and coordinated restoration in the Chesapeake Watershed



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- Modeling team
- Others

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Outline

- Overview of Nutrient delivery to Chesapeake Bay
- Sources of Nitrogen and Phosphorus
- Watershed Change and Restoration actions
- Observed changes in Nutrient and Sediment Loads
- Summary

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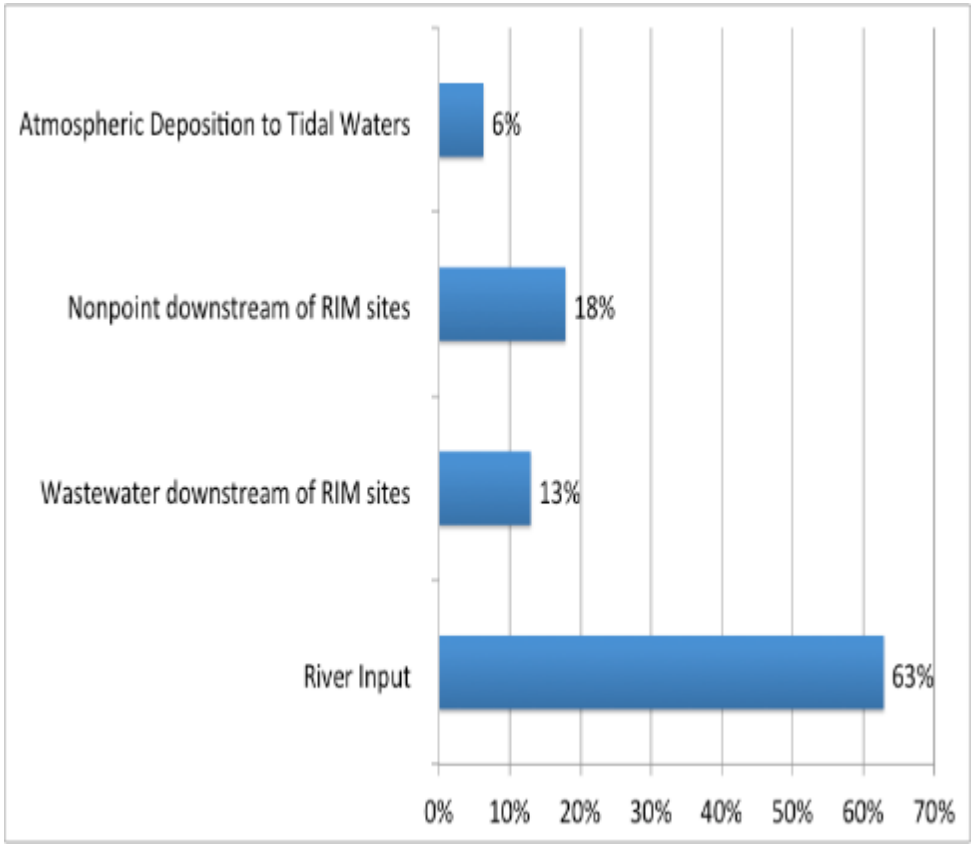
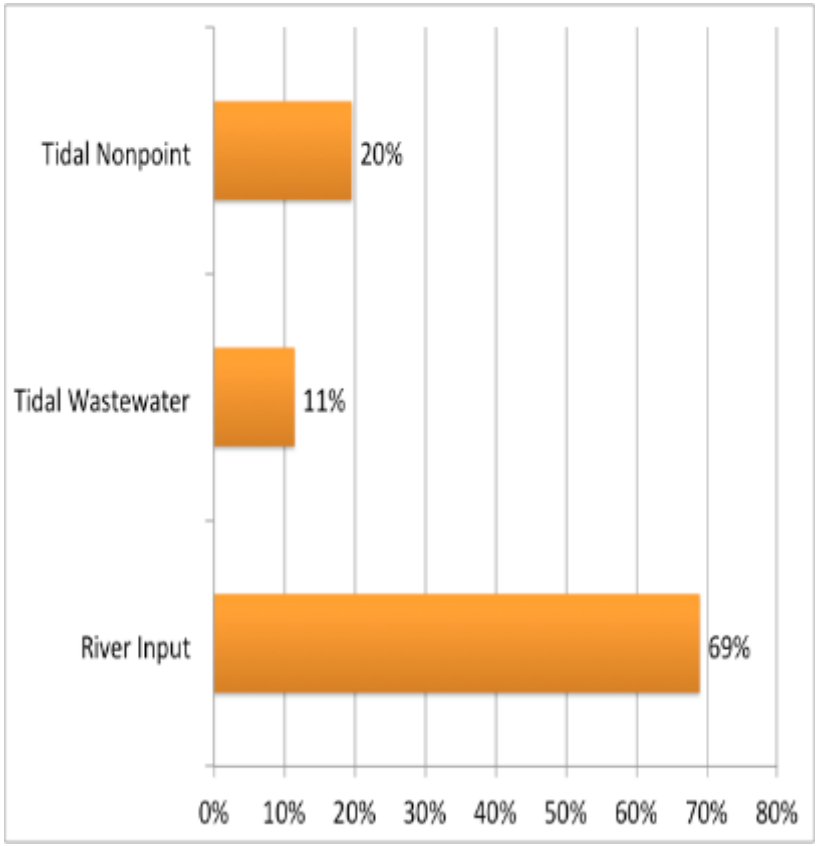
Nutrient Sources to Chesapeake Bay

Nitrogen



Phosphorus



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SPATIAL SOURCES OF NUTRIENT LOADS

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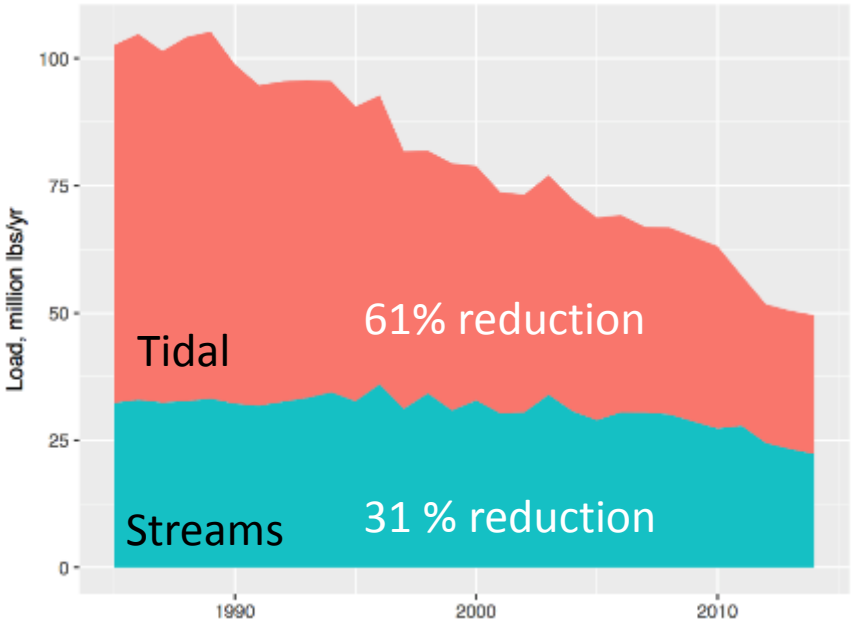
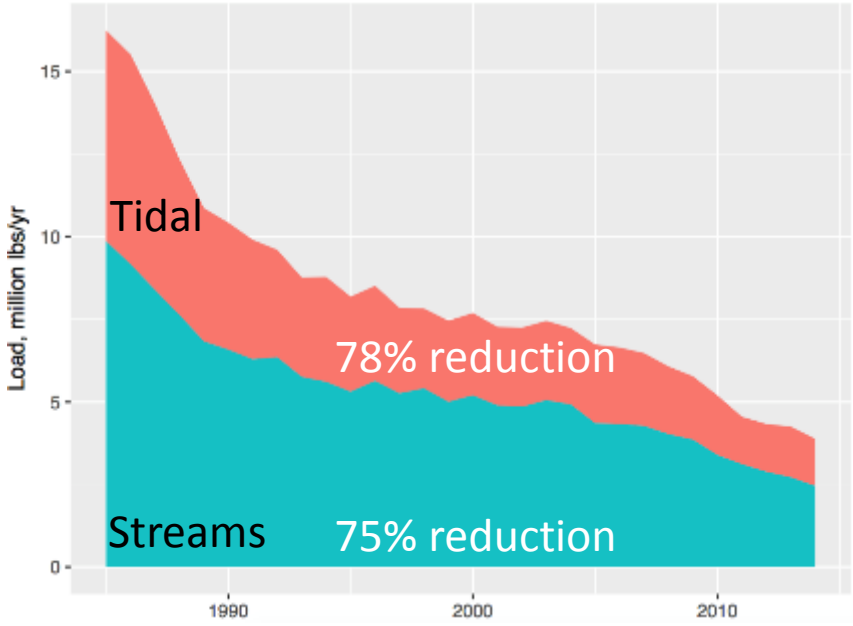
Point Source Changes

Nitrogen



Phosphorus



Downstream from Stream Monitoring

Upstream from Stream Monitoring

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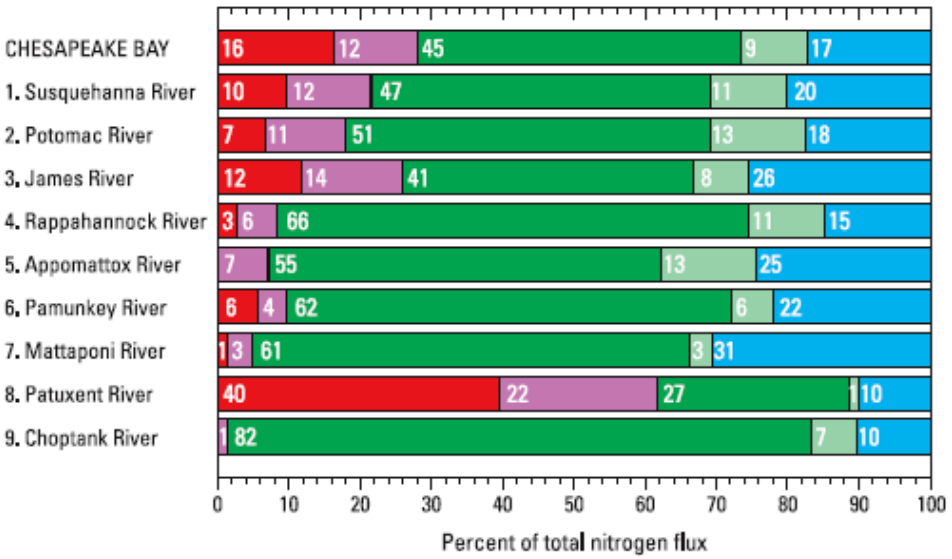
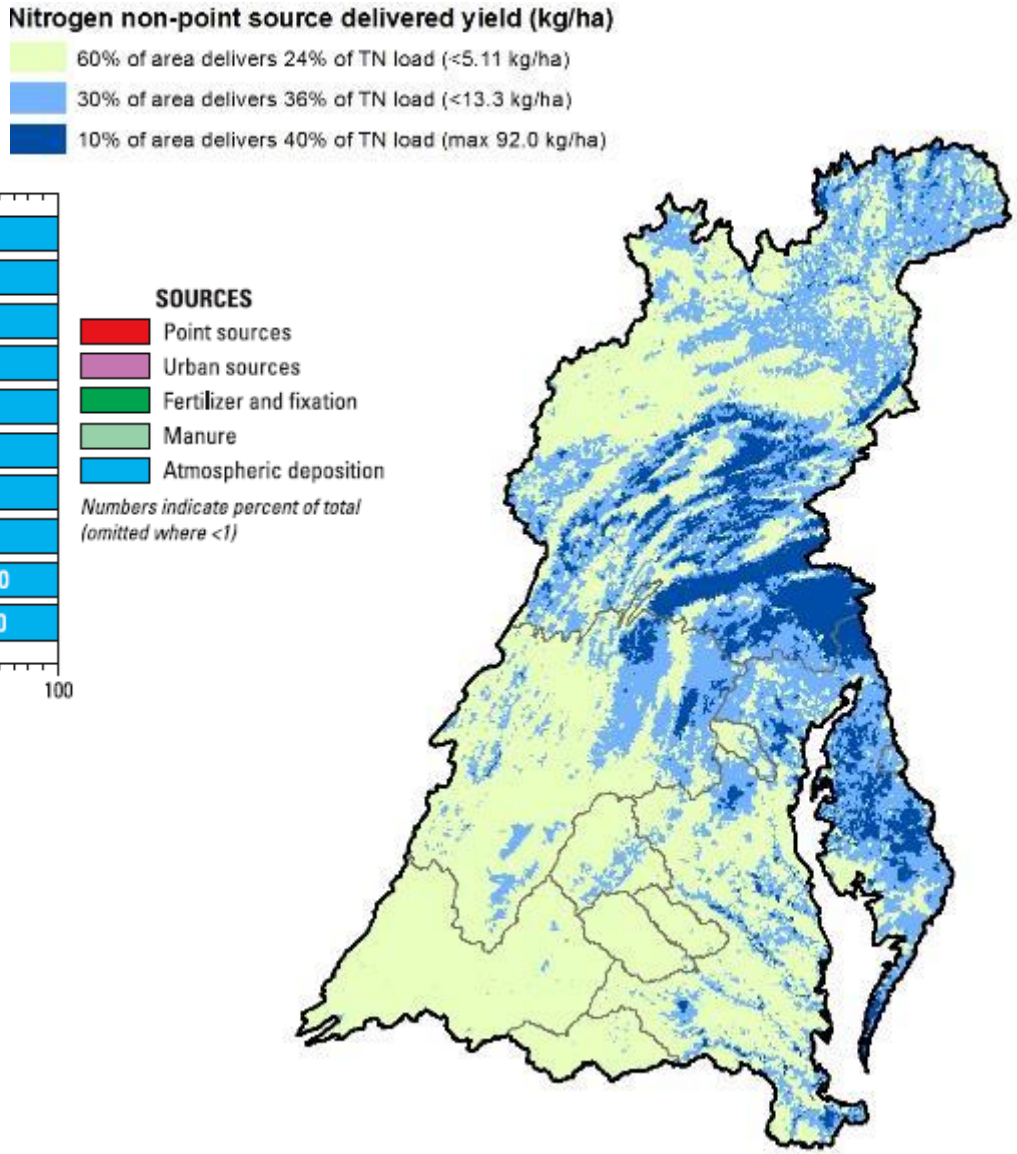
Nitrogen Sources





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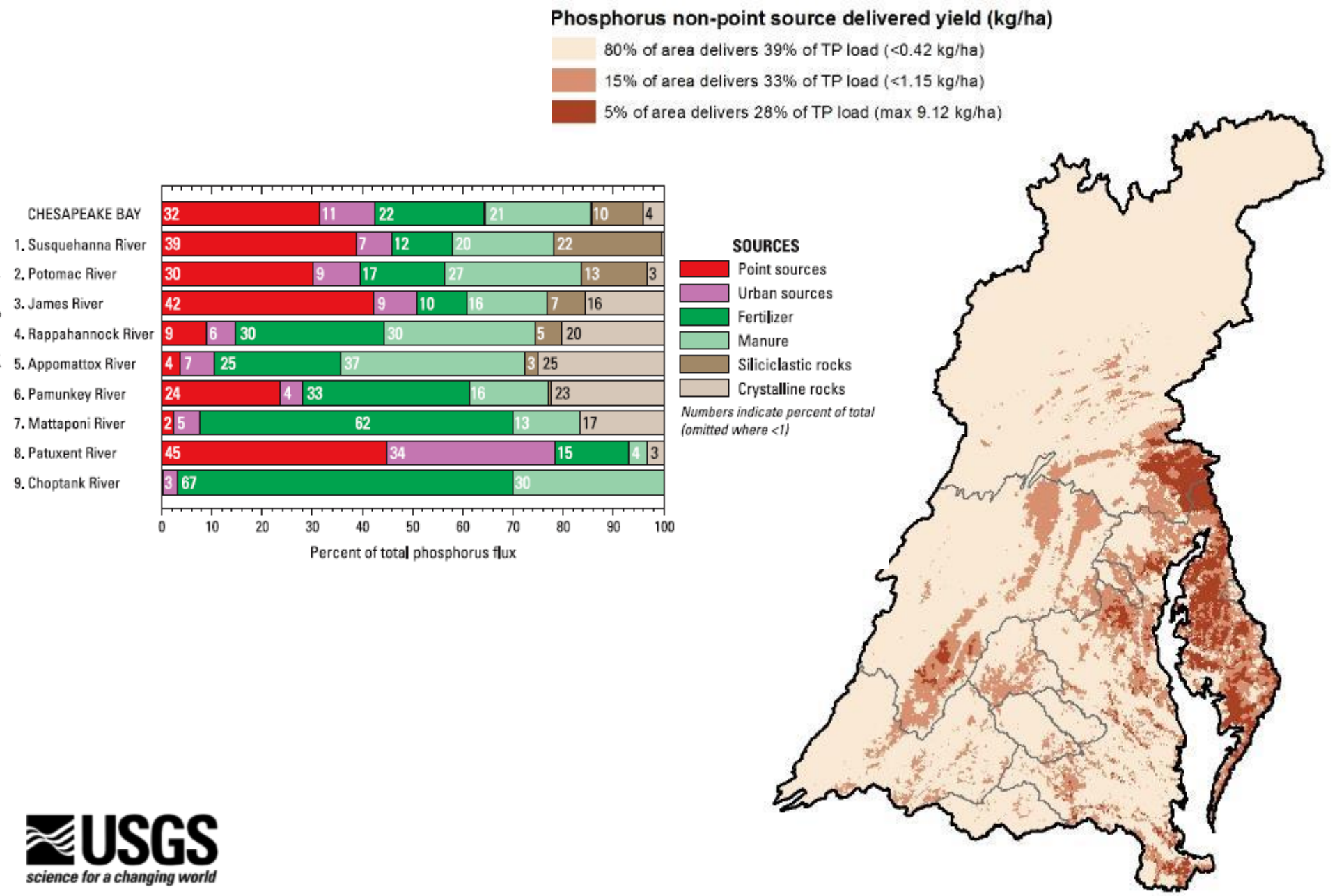
Phosphorus Sources



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WATERSHED CHANGE AND RESTORATION ACTIONS

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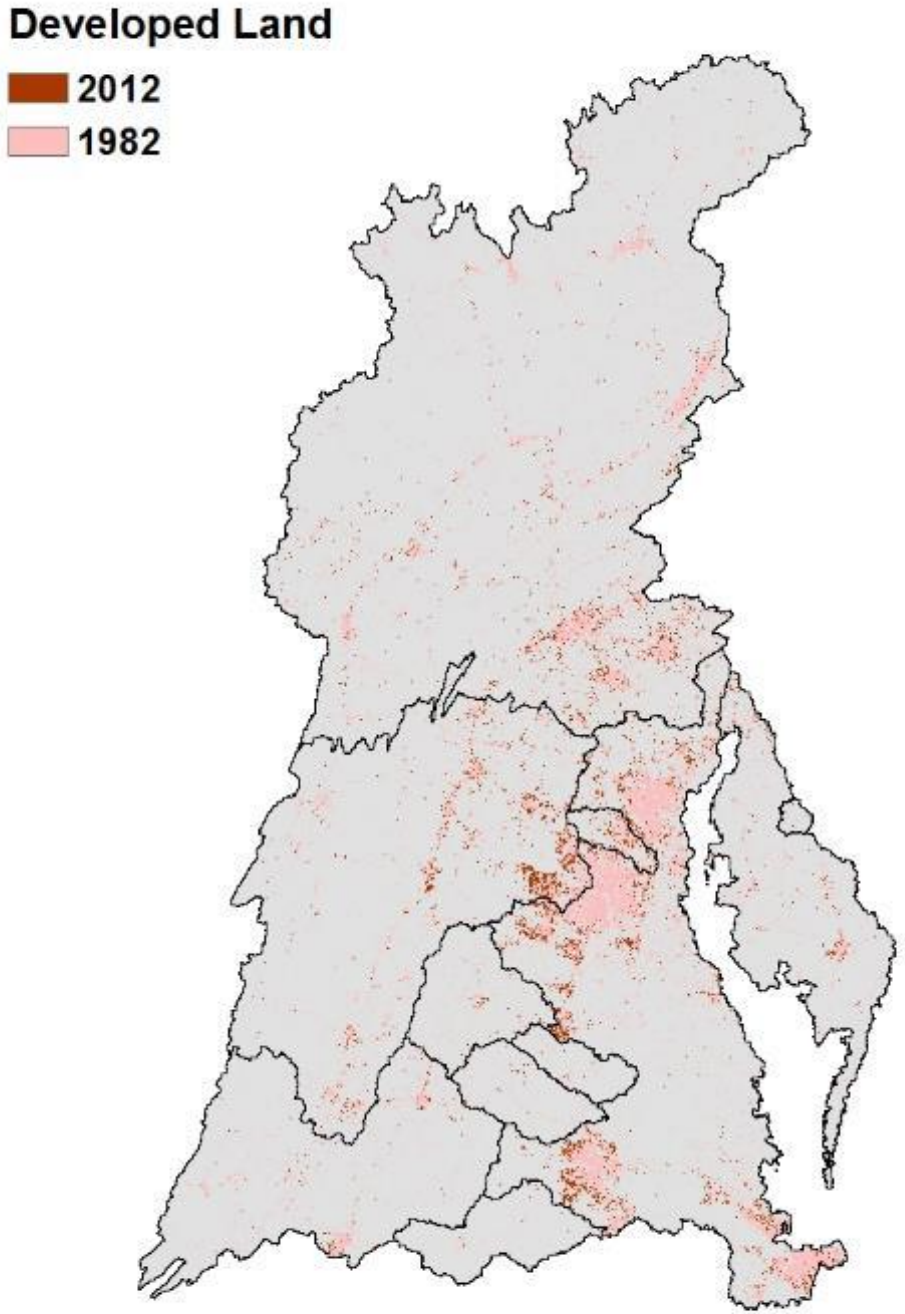
Urbanization



SOURCE: U.S. Conterminous Wall-to-Wall Anthropogenic Land Use Trends (NWALT), 1974–2012

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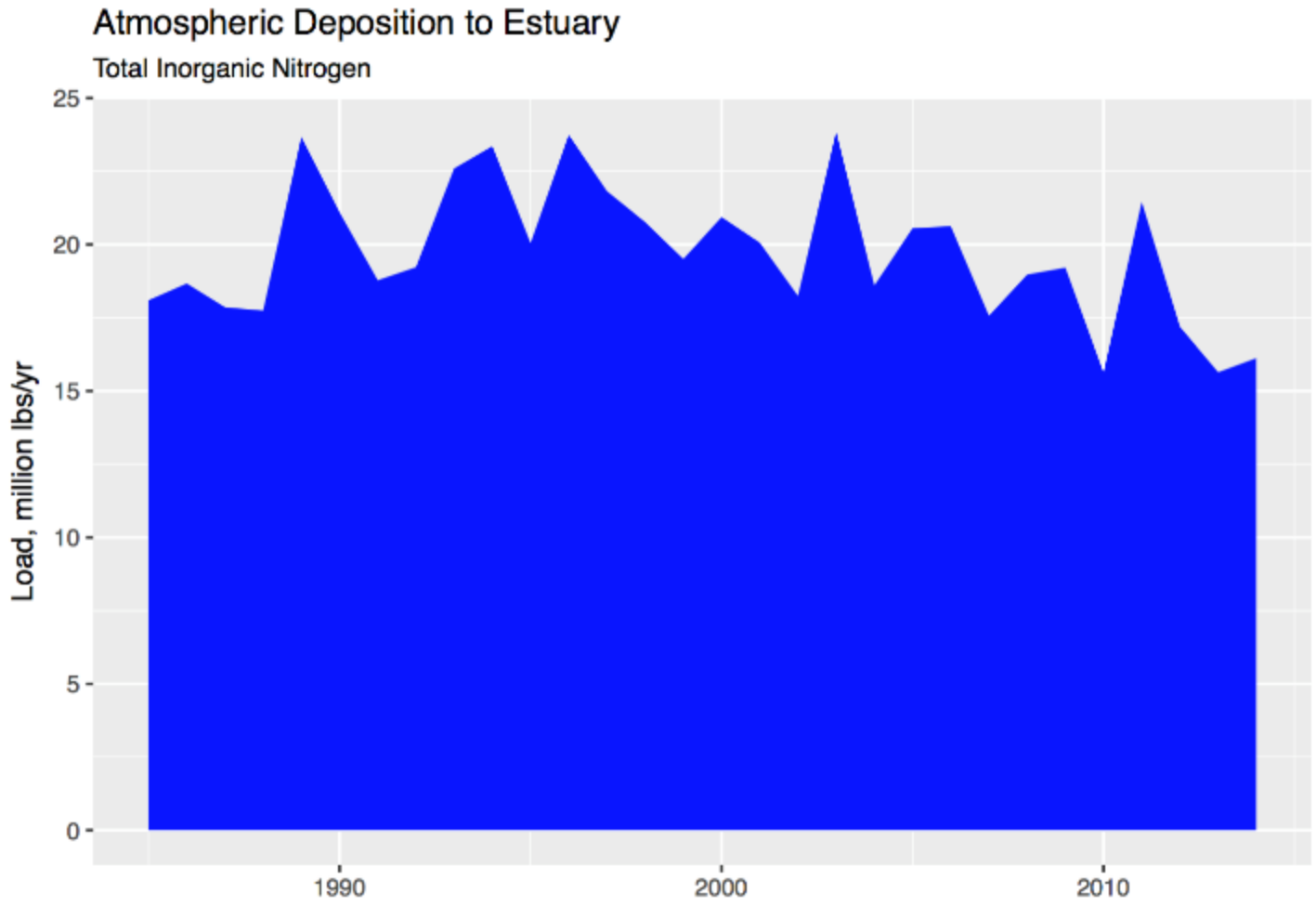

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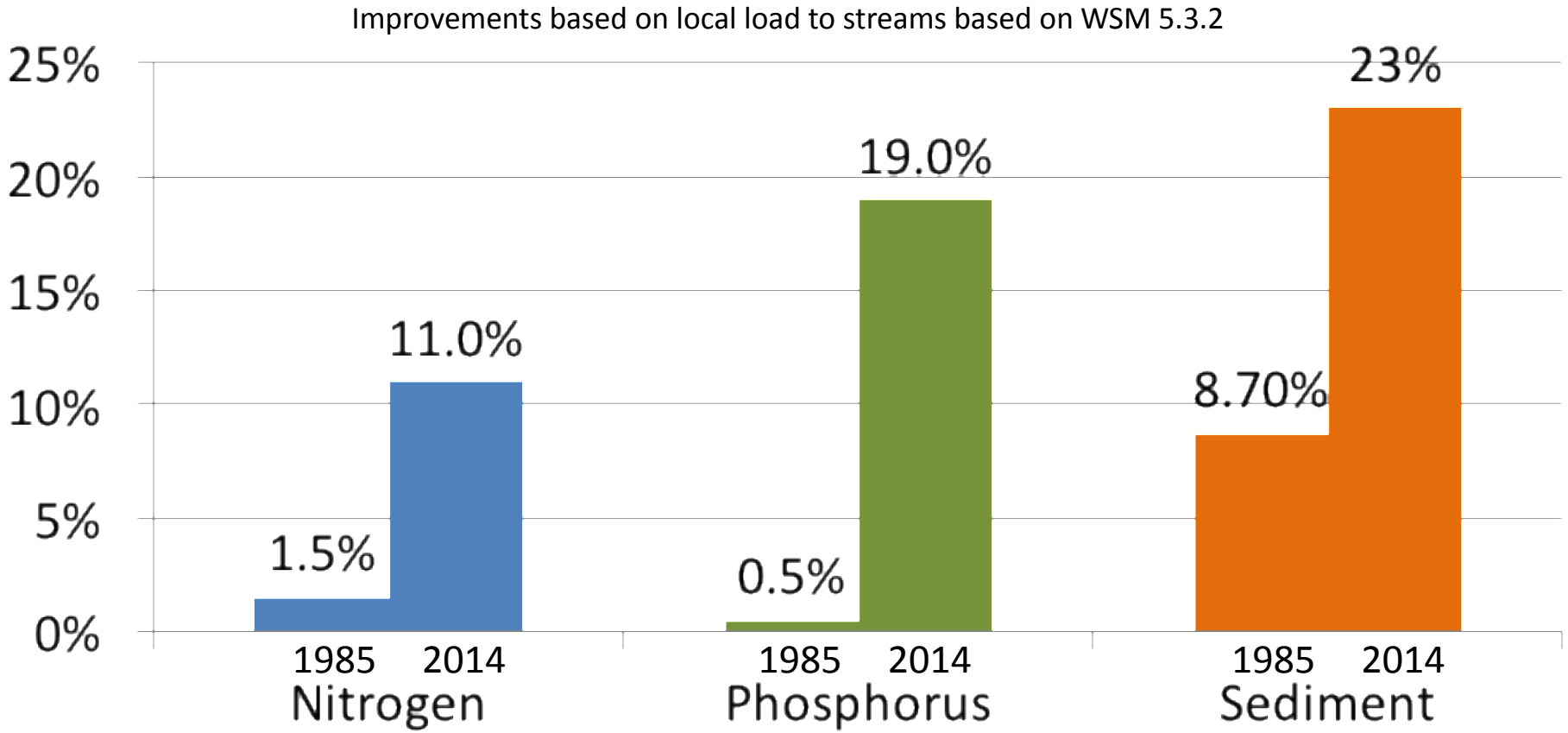
Expected Total Nutrient and Sediment Reduction Due to Agricultural and Developed BMPs



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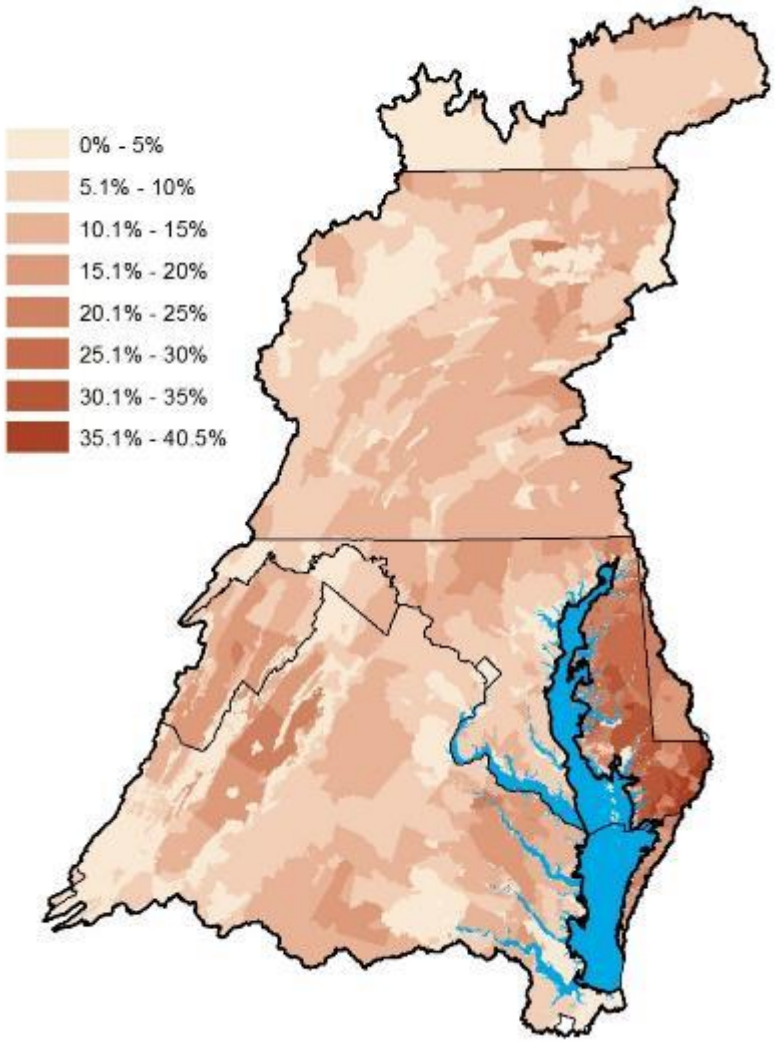
CBP WSM Expected Nitrogen loads Reduction
(edge of stream)

2012



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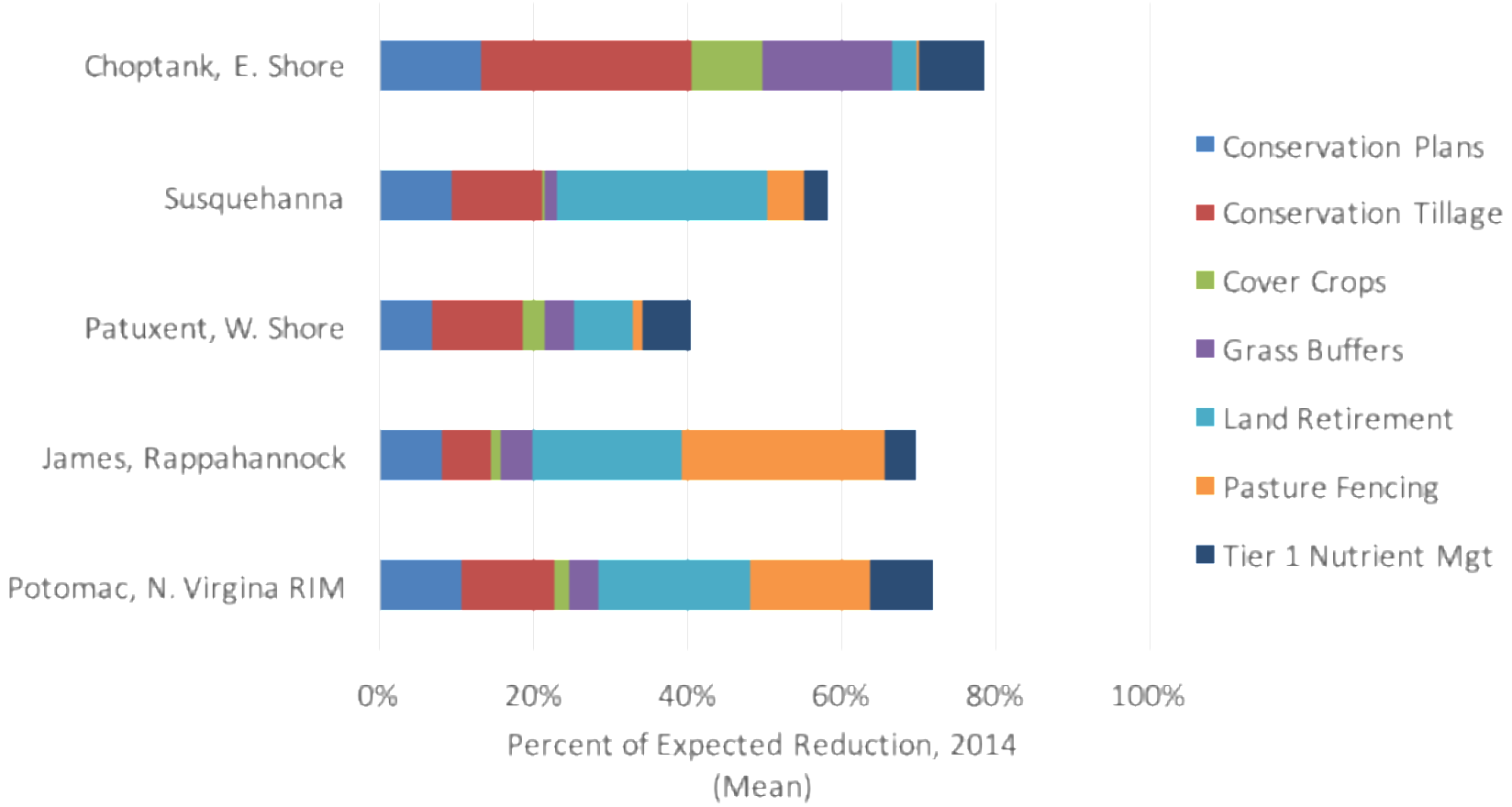
Nitrogen Management



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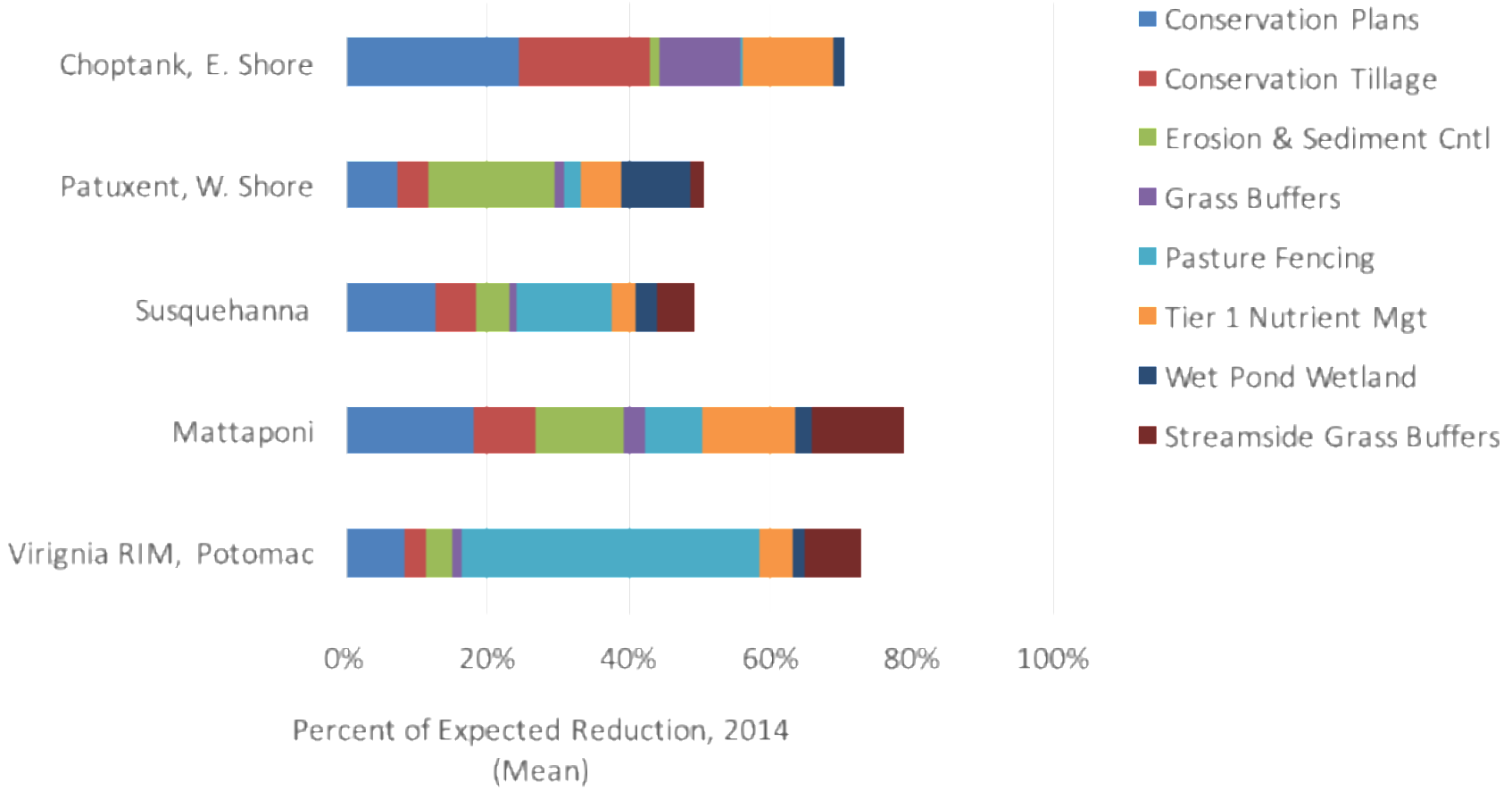
Phosphorus Management



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HYDROLOGIC CONTROLS

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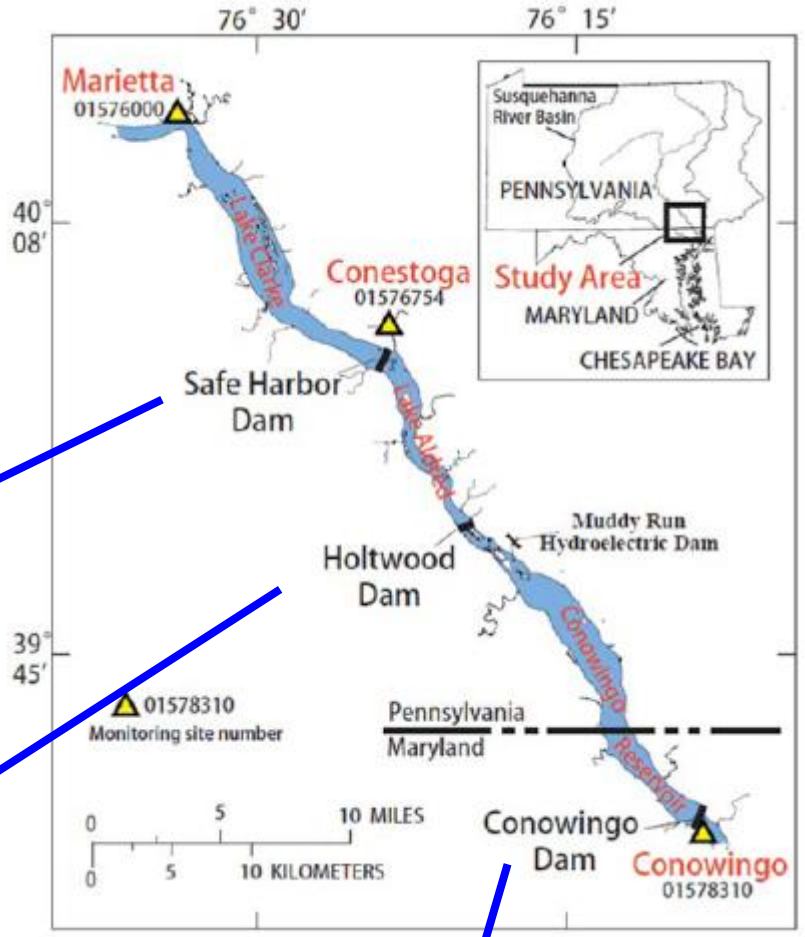
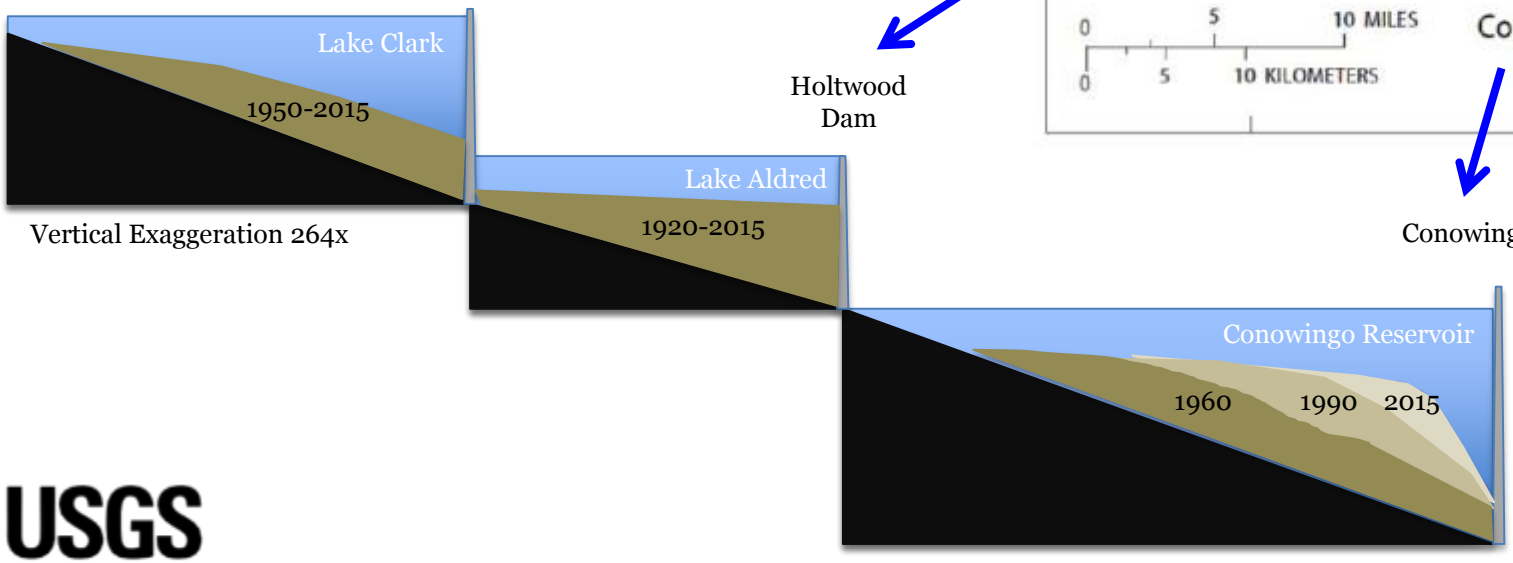
Three Reservoirs in the Lower Susquehanna

The System of Reservoirs has been filling over time.





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Source: Langland and Blomquist, USGS, personal communication

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HISTORY OF MEASURED LOADS TO CHESAPEAKE BAY

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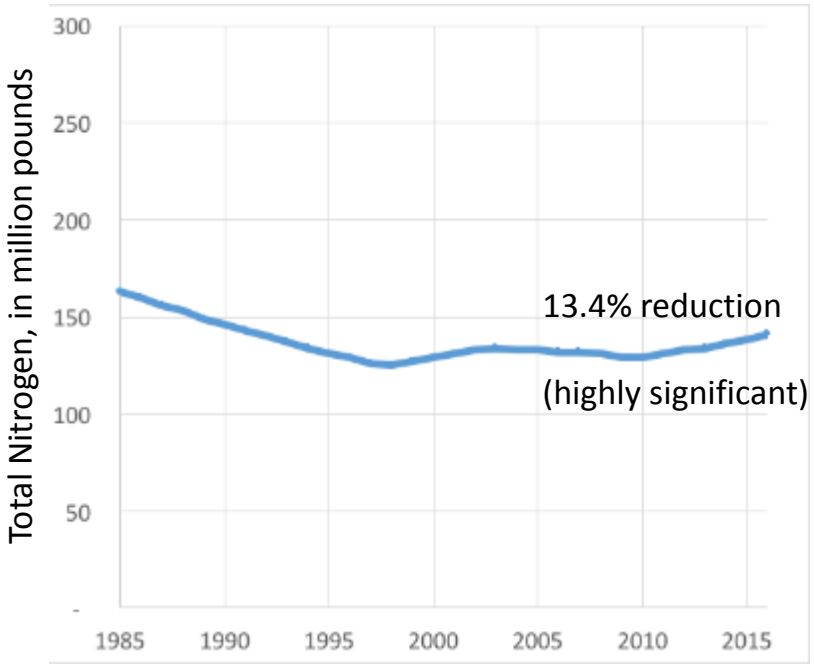
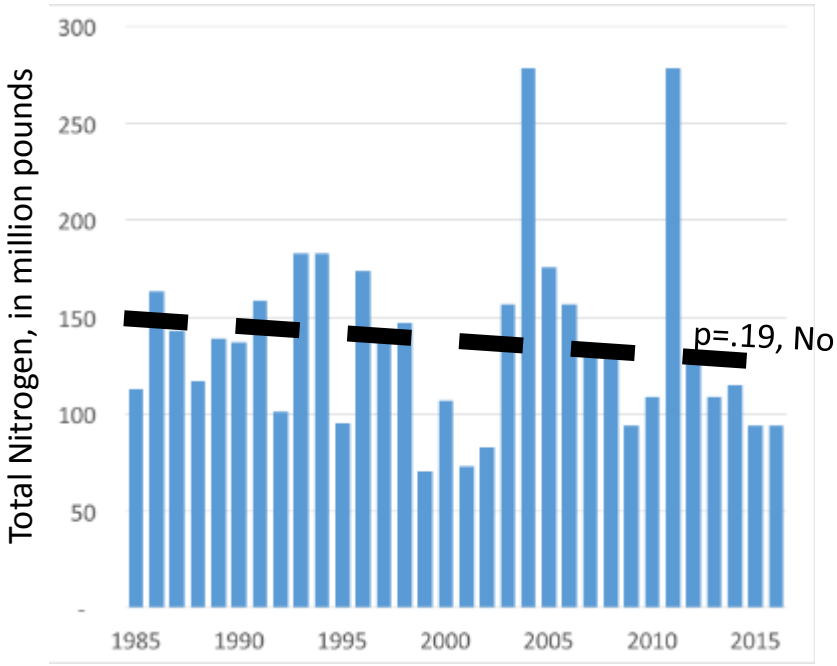
Two ways to evaluate change in load:

Susquehanna River at Conowingo, Md.
Total Nitrogen

Flow –Normalized Load



True Condition Load



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Summary of Changes in Load:

From the Watershed and to Chesapeake Bay

Flow-Normalized Load, (WY 1985-2016)

Station	Total Nitrogen	Total Phosphorus	Sediment
Choptank	UP	UP	DN
Susquehanna	DN	UP	UP
Patuxent	DN	DN	DN
Potomac	DN	DN	DN
Rappahannock	DN	UP	UP
Pamunkey	-	UP	UP
Mattaponi	DN	-	-
James	DN	DN	UP
Appomattox	-	UP	-
M_NTCBW	**DN**	**UP**	**UP**
No change (-)	2	1	2
Improving (DN	6	3	3
Degrading (UP)	1	5	4

True Condition Load, (WY 1985-2016)

Station	Total Nitrogen	Total Phosphorus	Sediment
Choptank	UP	UP	-
Susquehanna	-	-	-
Patuxent	DN	-	UP
Potomac	-	-	-
Rappahannock	-	-	-
Pamunkey	-	-	-
Mattaponi	-	-	-
James	-	DN	-
Appomattox	-	-	-
M_NTCBW	**-**	**-**	**-**
No change (-)	7	7	8
Improving (DN	1	1	0
Degrading (UP)	1	1	1

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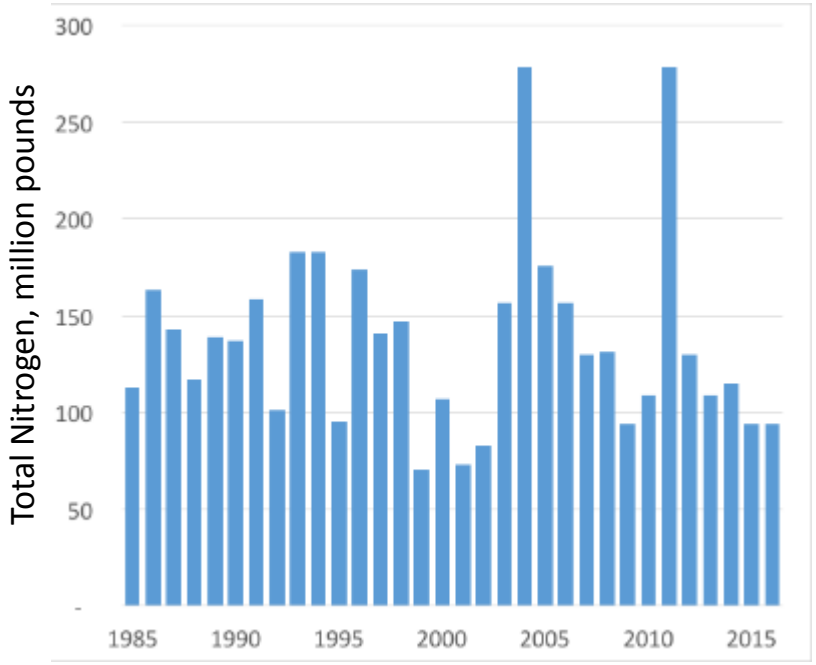
Load vs. Flow Weighted Concentration Trend

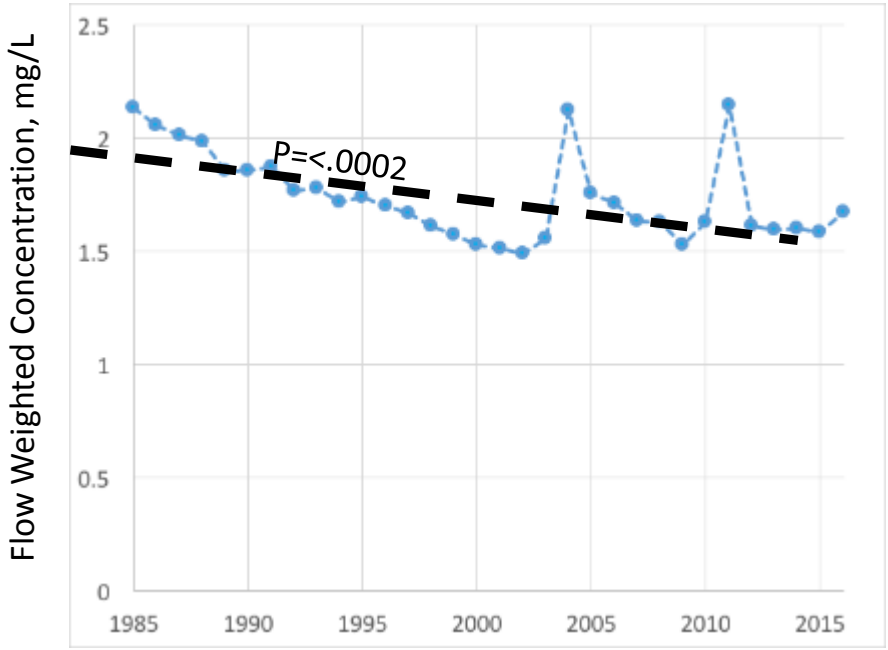
Susquehanna River at Conowingo, Md.

$$\text{Flow-Weighted Concentration} = \frac{\text{True Condition Load}}{\text{Annual Flow}}$$

True Condition Load



Flow-Weighted Concentration



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Summary of Inputs to Chesapeake Bay:

True Condition vs. Flow-Weighted Concentration

True Condition Load, (WY 1985-2016)

Station	Total Nitrogen	Total Phosphorus	Sediment
Choptank	UP	UP	-
Susquehanna	-	-	-
Patuxent	DN	-	UP
Potomac	-	-	-
Rappahannock	-	-	-
Pamunkey	-	-	-
Mattaponi	-	-	-
James	-	DN	-
Appomattox	-	-	-
M_NTCBW	-	-	-
No change (-)	7	7	8
Improving (DN	1	1	0
Degrading (UP)	1	1	1

Flow-Weighted Concentration, (WY 1985-2016)

Station	Total Nitrogen	Total Phosphorus	Sediment
Choptank	UP	UP	-
Susquehanna	DN	-	-
Patuxent	DN	DN	-
Potomac	DN	-	-
Rappahannock	-	-	-
Pamunkey	-	UP	UP
Mattaponi	-	-	-
James	DN	DN	-
Appomattox	-	-	-
M_NTCBW	DN	-	-
No change (-)	4	5	8
Improving (DN	4	2	0
Degrading (UP)	1	2	1

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SUMMARY

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Findings: take home messages

- Nitrogen
  - Nonpoint source nitrogen inputs to the bay are disproportionately contributed from the Southern Susquehanna basin and Eastern Shore regions. Susquehanna loadings are expected to have a significant impact on main-Bay conditions, while the Eastern shore tidal tributaries are receiving elevated nitrogen loadings.
  - Flow-normalized loads show wide scale improvements in the watershed.
  - Wastewater improvements and atmospheric deposition appear to be among the greater causes of decreases, with only small effects of nonpoint source controls
  - Choptank continues to increase– indicating a broader pattern across the Eastern Shore
  - Observed changes are not (yet?) similar to expected effects of current BMP implementation levels
  - True condition loads show 7 stations with no change!
    - Choptank increasing
    - Patuxent decreasing
  - Flow-weighted concentrations decreasing to tidal waters– should we expect decreased primary productivity? – Particularly in tidal fresh systems

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Findings: take home messages

- Phosphorus
  - Locations of principal nonpoint phosphorus to Chesapeake differ from nitrogen—
    - Suggest separate strategies for N and P.
    - Note that some P strategies are bad for N
  - Flow Normalized loads (FNL) show significant reductions to Patuxent Potomac and James
    - Strongly linked to point-source reductions
    - Significant reductions in Dissolved orthophosphate (P04)
  - FNL increasing at 5 stations
    - Choptank: coincident with increases in PO4 suggesting a change in this system– What does this tell us about the Eastern shore and its embayment
    - Susquehanna: coincident with Conowingo reaching equilibrium
  - Phosphorus detergent ban and wastewater improvements appear to have a great effect.
  - True Condition Loads (TCL) show no change at 7 of 9 sites—
    - Choptank increasing– Is this happening elsewhere on the Easter Shore?
    - Decreasing to the James– Reductions are greater than the variability driven by hydrology!?!?!
  - Flow-Weighted Concentrations
    - No change at Susquehanna, Potomac and 3 Virginia tributaries.
    - Increasing at Choptank and Pamunkey
    - Decreasing at Patuxent ant James
  - Conowingo reservoir no longer provides a significant trap for phosphorus–
    - Average annual loads have increases
    - Management strategies are being adjusted to accommodate

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