Open Water Response to Geographic Nutrient Loads

Gary Shenk, Richard Tian, John Wolf

2/19/2019

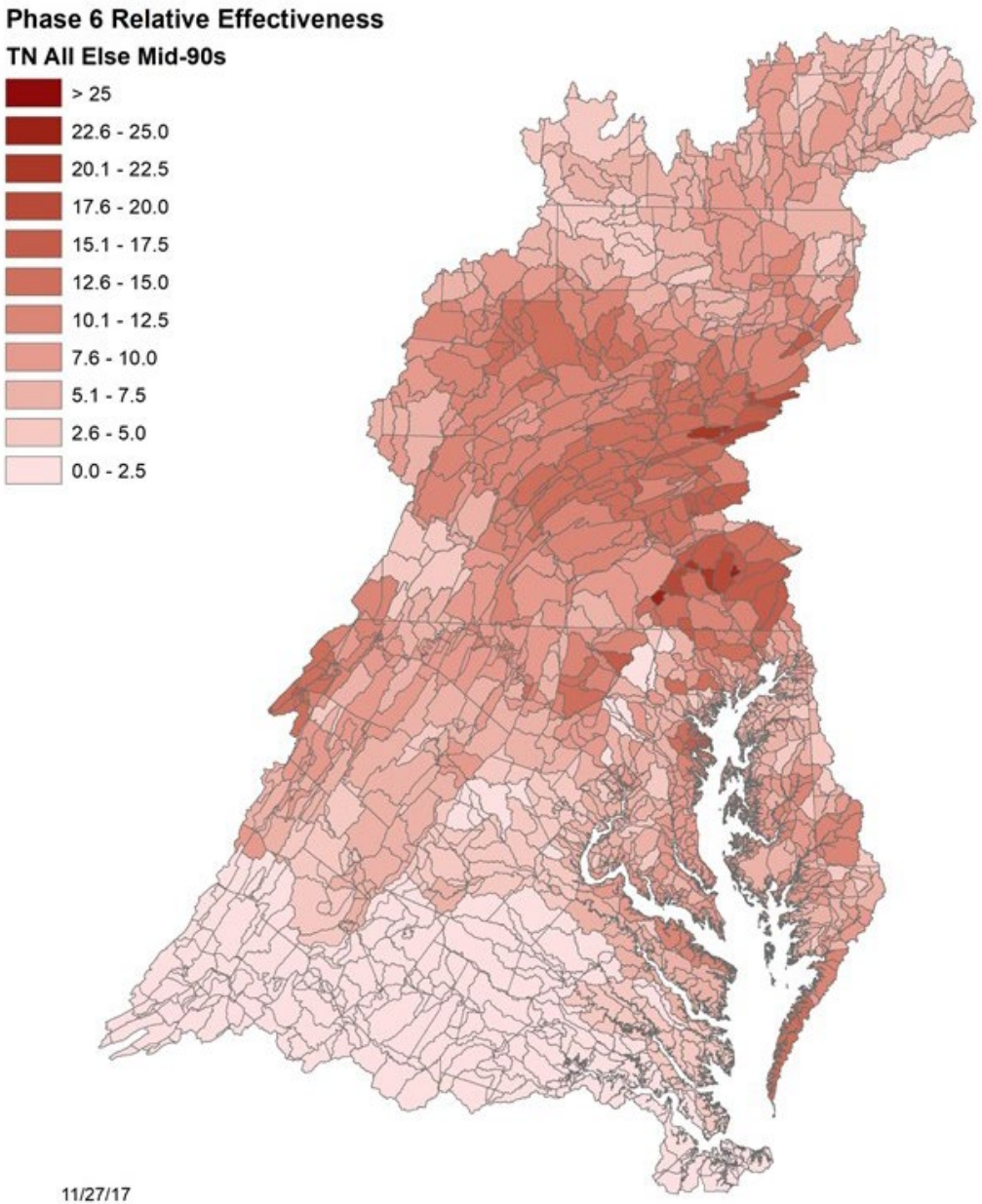
Existing Measure of Relative Effectiveness

Key factors:

Watershed Transport
- Watershed Characteristics
- Travel time
- Existence of impoundments

Position along mainstem bay
- Estuarine circulation

Existence of riverine estuary

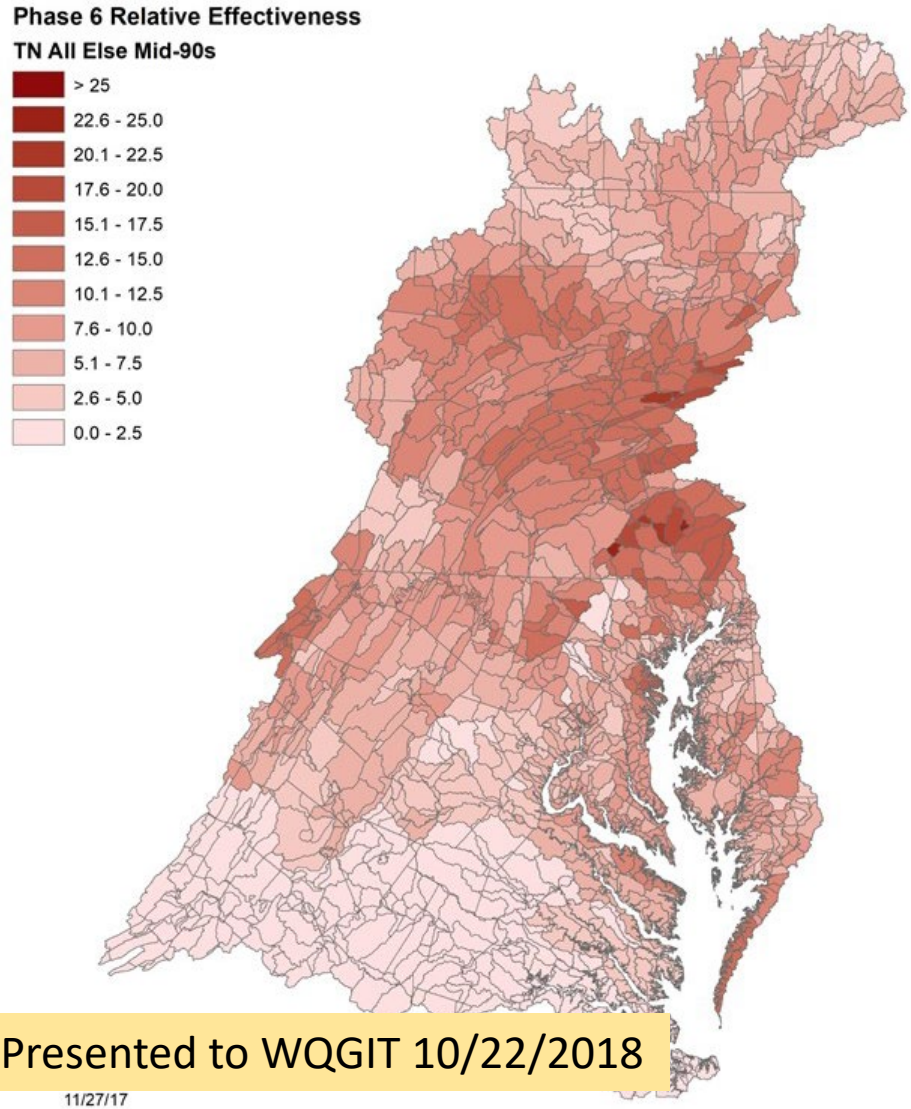


Watershed delivery:
Pound delivered per pound produced
Estuarine delivery
Oxygen reduced per pound delivered
Overall Effectiveness
Oxygen reduced per pound produced

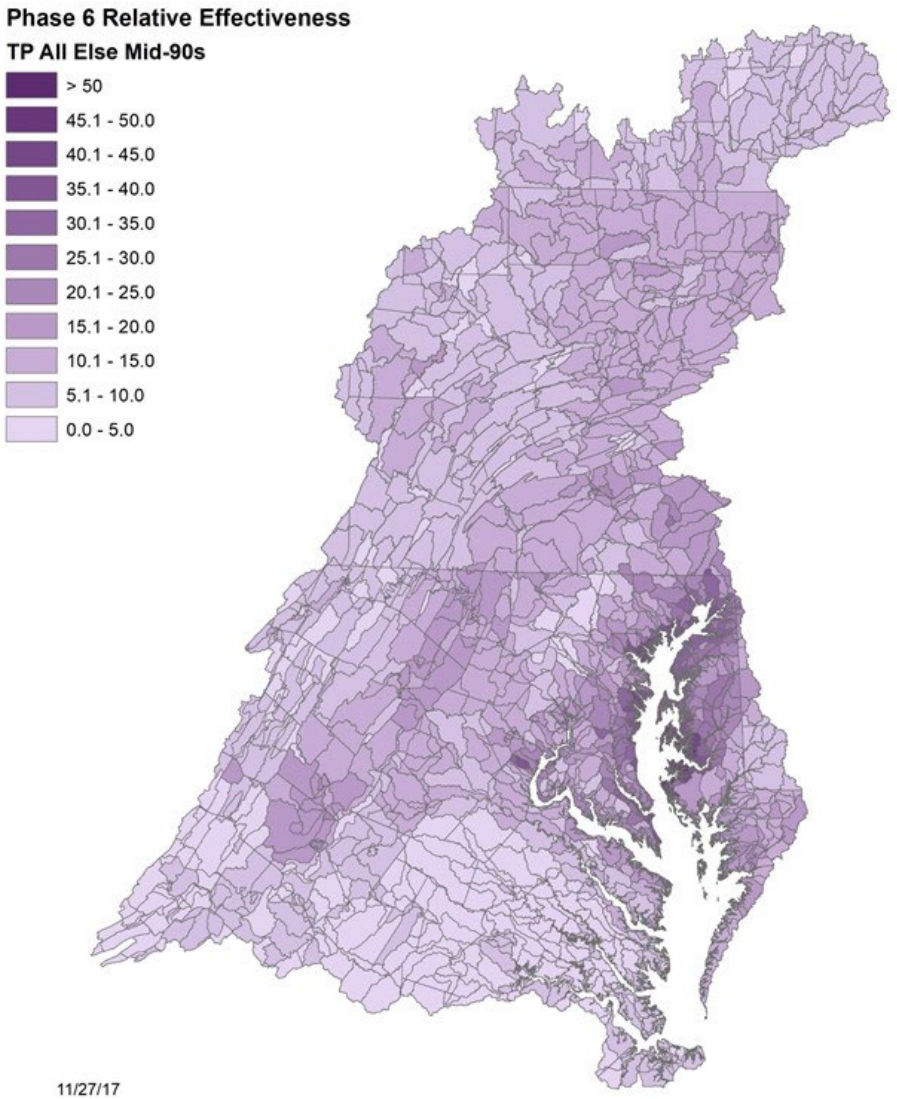
Presented to WQGIT 10/22/2018

Existing Measure of Relative Effectiveness

Nitrogen



Phosphorus

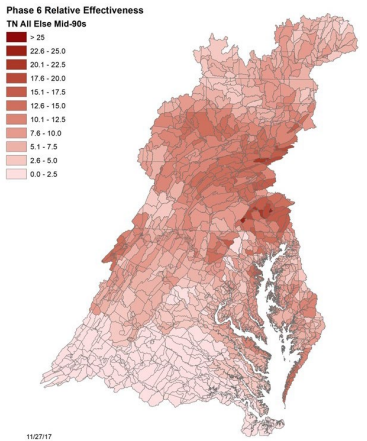


Presented to WQGIT 10/22/2018

Expand to other designated uses

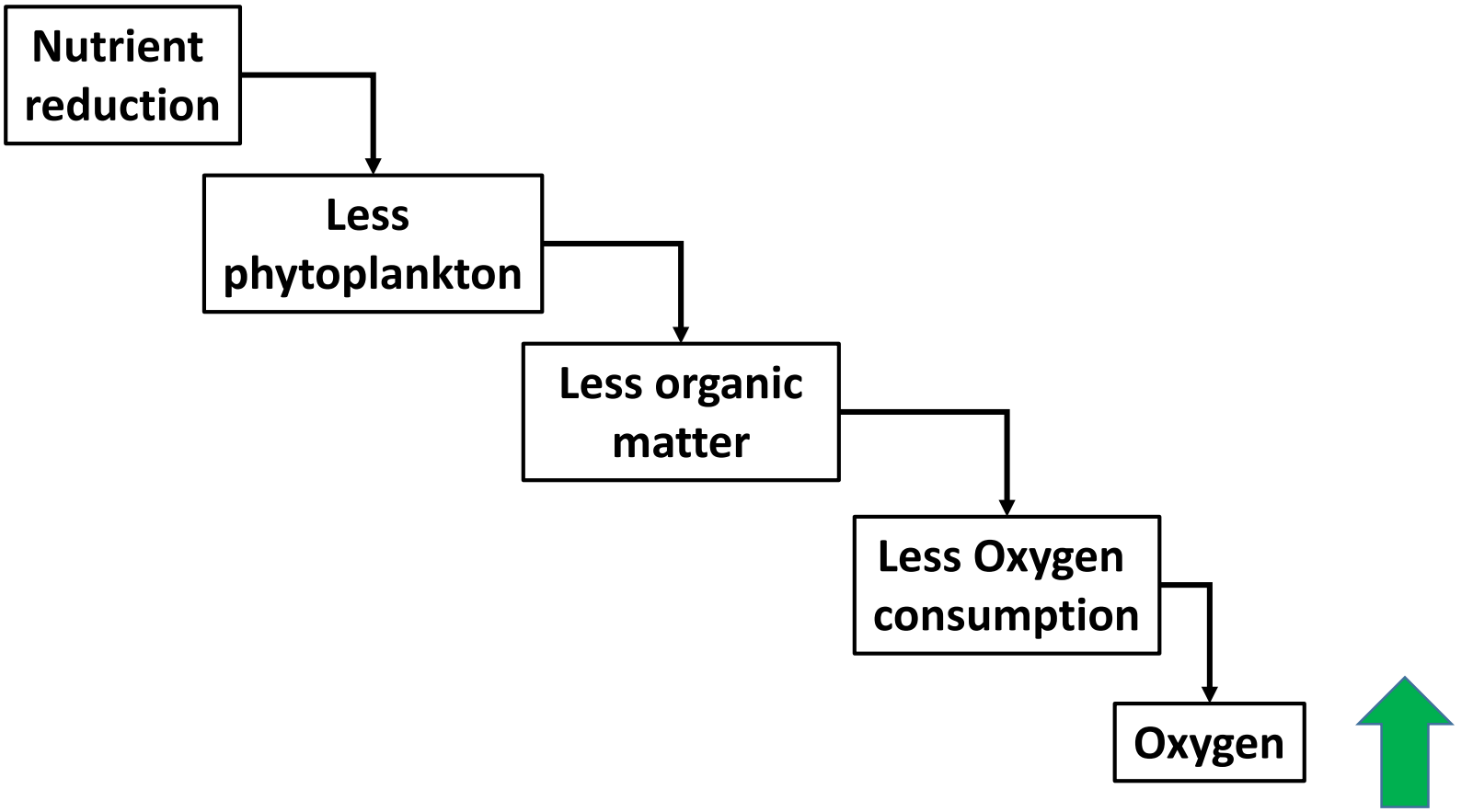
- Existing relative effectiveness for planning targets:
  - Deep Water and Deep Channel
  - CB3MH, CB4MH, CB5MH, POTMH

- Goal is to provide a tool for the partnership to visualize the source of load for each Tidal Segment



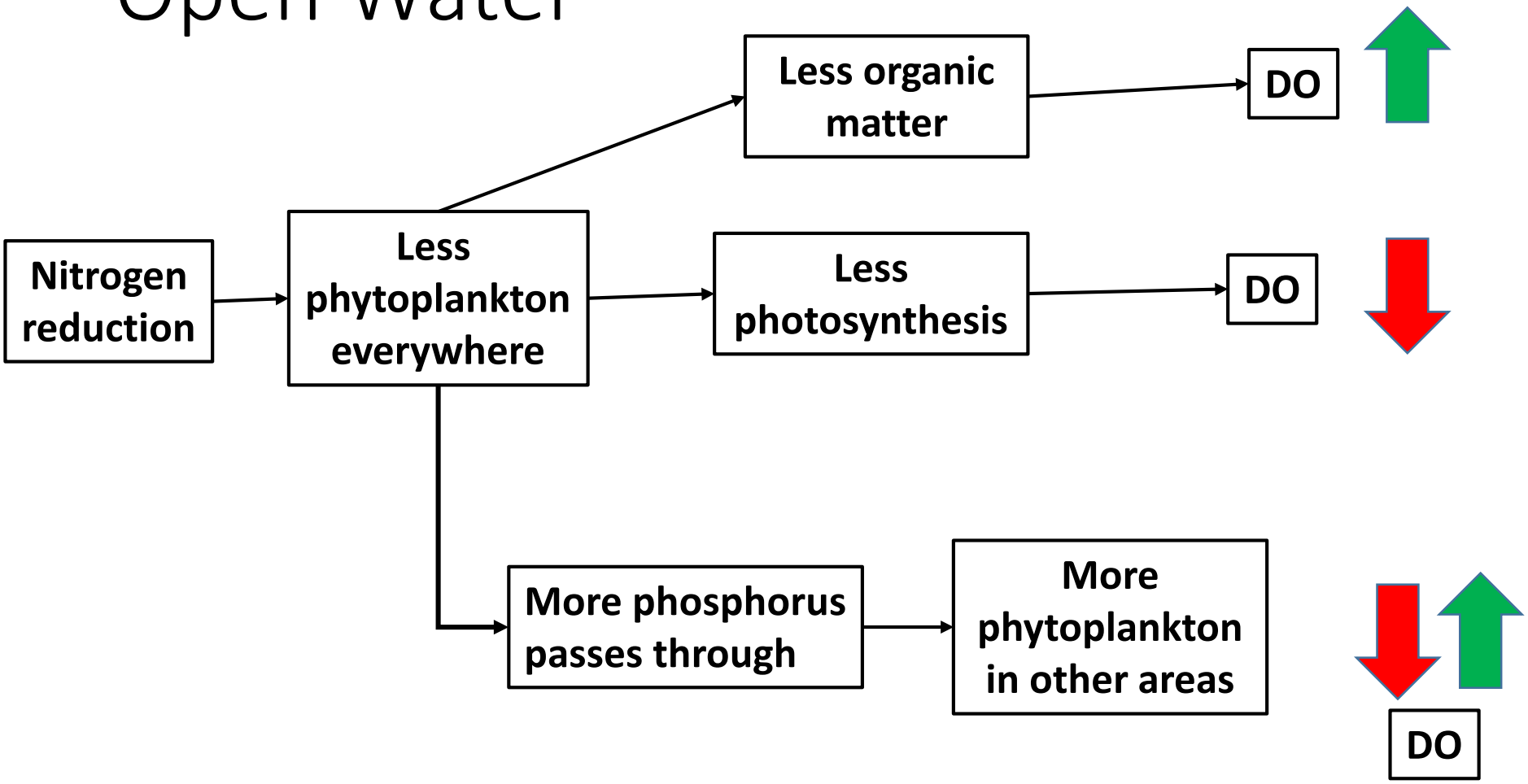
Presented to WQGIT 10/22/2018

Deep Water / Deep Channel



Presented to WQGIT 10/22/2018

Open Water

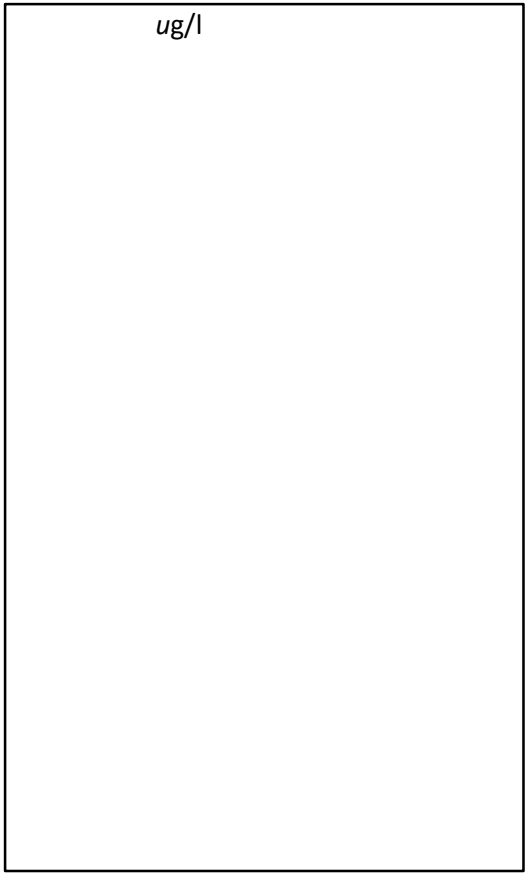


Presented to WQGIT 10/22/2018

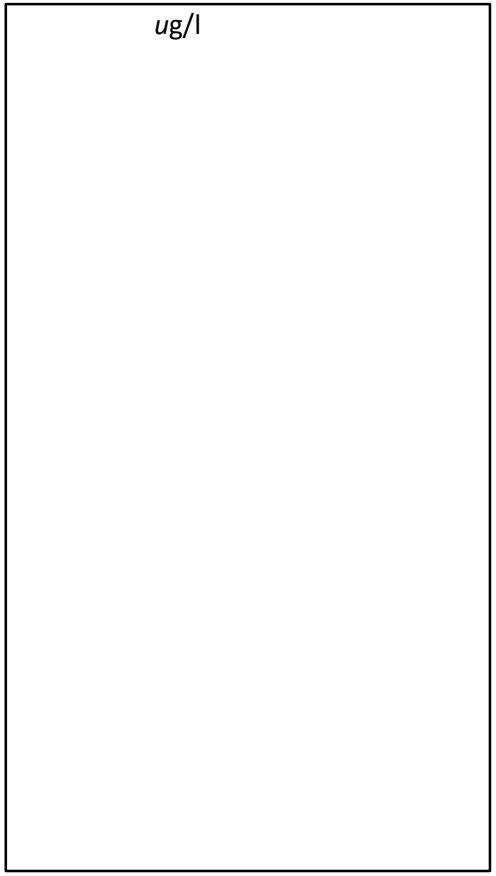
Increase in Susquehanna Loads Effect on Surface Oxygen

- 5 million lbs N increase / 0.5 million lbs P increase

N



P

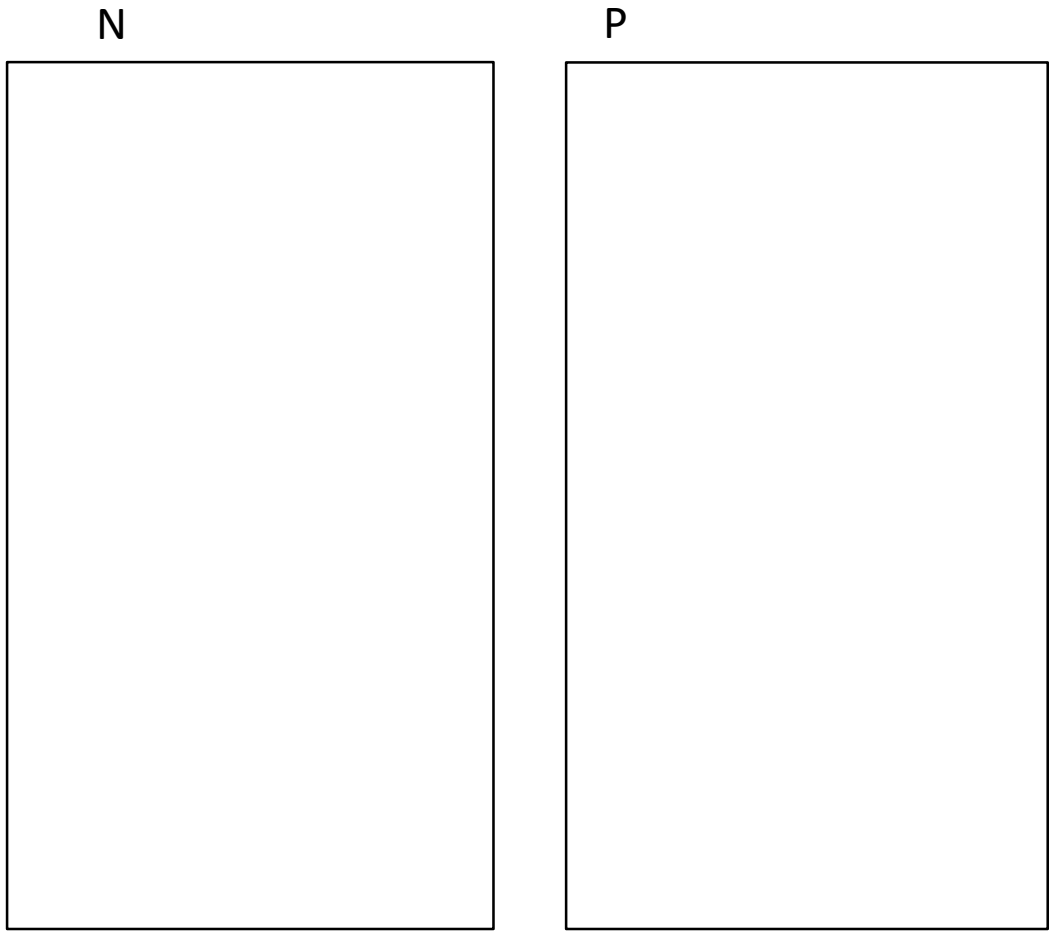


- N-limited areas hurt by N increase
- P-limited areas hurt by P increase
- Dual nutrient control necessary
- Complicated picture – hard to map or calculate

Presented to WQGIT 10/22/2018

Increase in Susquehanna Loads Effect on Chlorophyll

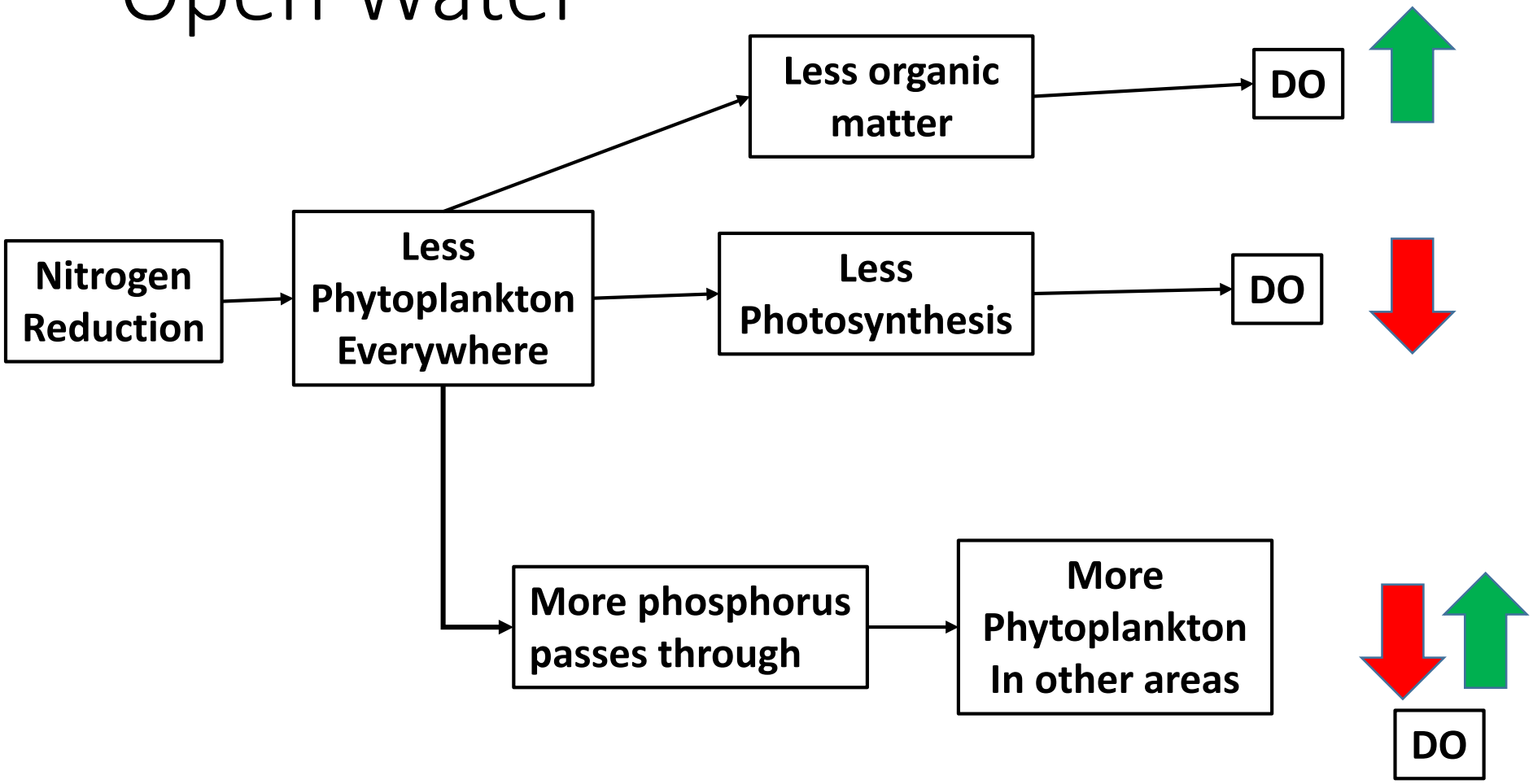
- 5 million lbs N increase / 0.5 million lbs P increase



- N-limited areas hurt more by N increase
- P-limited areas hurt more by P increase
- Dual nutrient control necessary
- Easier to explain

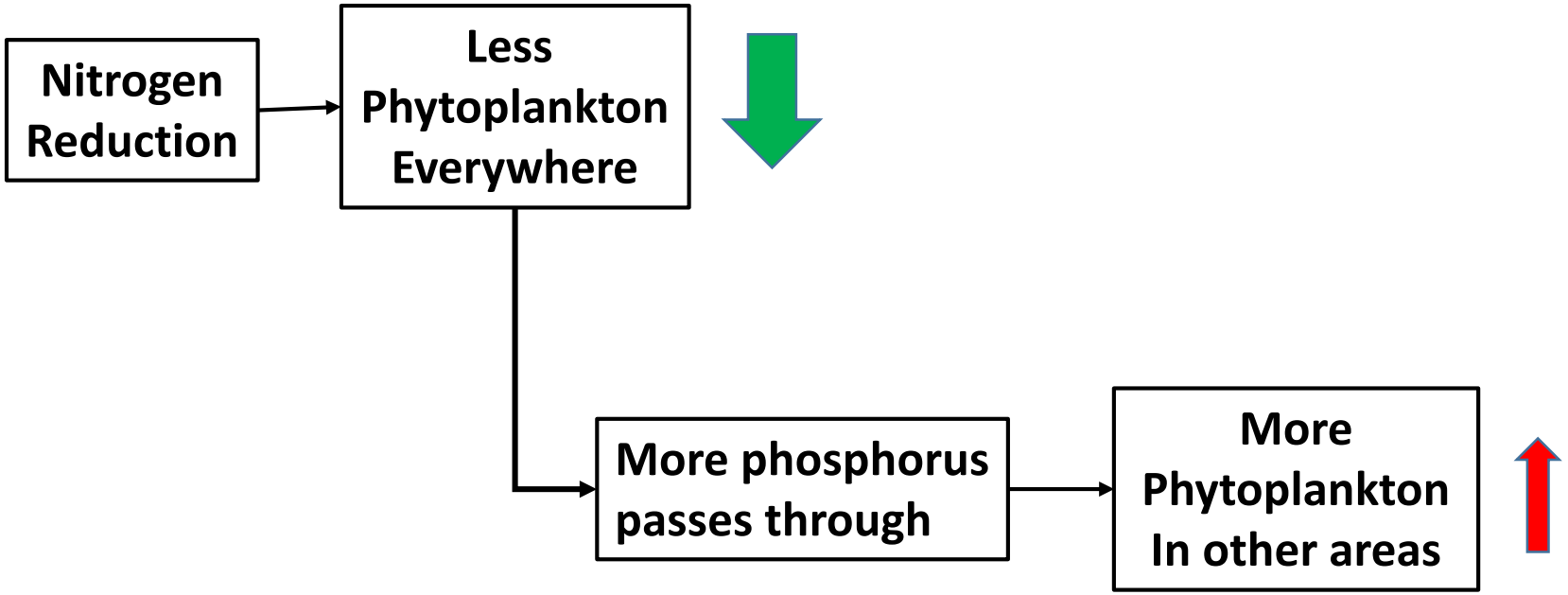
Presented to WQGIT 10/22/2018

Open Water



Presented to WQGIT 10/22/2018

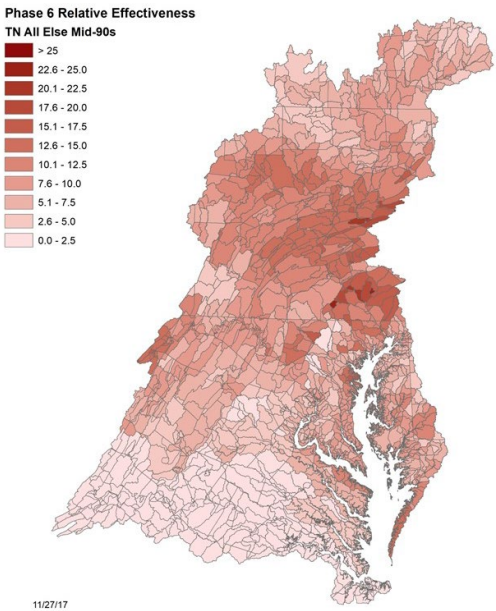
Open Water



Presented to WQGIT 10/22/2018

Implications

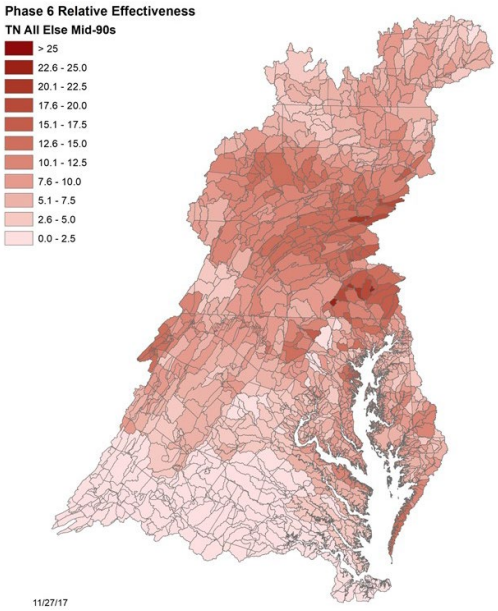
- Open Water dissolved oxygen has a complicated response to single nutrient reduction from a specific area
- Chlorophyll has a much more straightforward response
- Calculations of exchange ratios for a given designated use should not be made
  - Exchange ratios based on DW/DC are still valid
- The Final product will be interactive map of areas contributing to chlorophyll for a given designated use



Presented to WQGIT 10/22/2018

Schedule

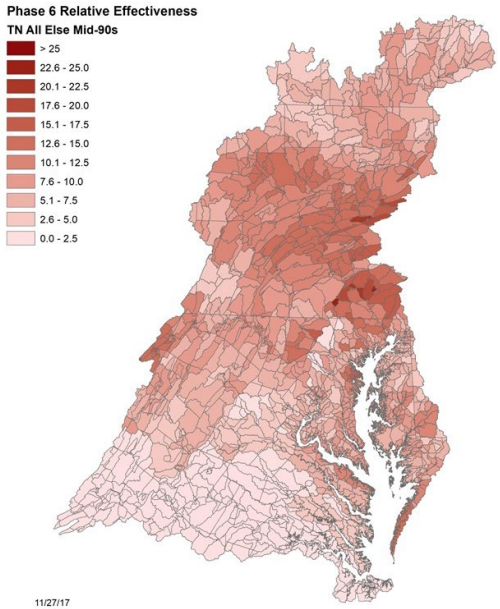
- Nearly 400 WQSTM runs
  - 90 segments (2 have no WQSTM cells)
  - 2 constituents (N and P)
  - 2 sources (PS and NPS)
- Analysis of results
- Development of interface
- Delivery in January 2019



Presented to WQGIT 10/22/2018

Schedule

- Nearly 400 WQSTM runs
  - 90 segments (2 have no WQSTM cells)
  - 2 constituents (N and P)
  - 2 sources (PS and NPS)
- Analysis of results
- Development of interface
- Delivery in ~~January~~ February 2019



Method

- 5 million lbs of N or 0.5 Mlbs/yr P added each year by an annual coefficient to the loads in that CBSEG
- Separate PS and NPS runs
- Change in Chlorophyll concentration to the depth of the long-term surface mixed layer average
- June through September

Georuns Chlorophyl a 2_14_19 f

https://public.tableau.com/profile/john.wolf#!/vizhome/GeorunsChlorophyla2_14_19fixedlegend/Chloro

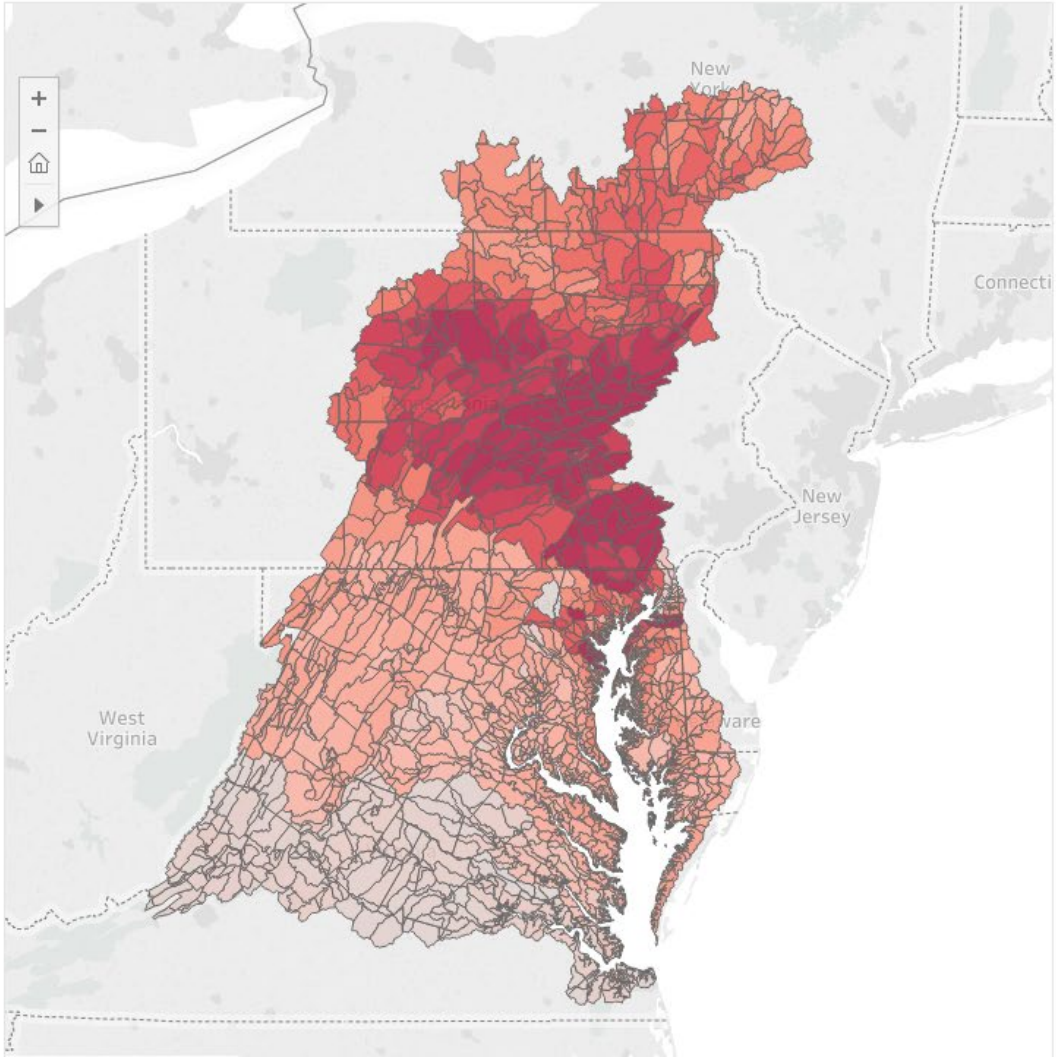
Most Visited | Getting Started | ELMS Home | Login - Learning Center

+ableau public | GALLERY | AUTHORS | BLOG | RESOURCES | ACTIVITY | SIGN IN

John Wolf - Profile

Favorite

Chlorophyl a Georuns 2-14-19



Pollutant (N or P)

- P
- N

Pollutant (N or P)

Source (PS or NPS)

- NPS
- PS

Monitoring Segment (CBSEG)

CB3MH

Total Effectiveness

-100.0 100.0

Georuns Chlorophyl a 2_14_19

https://public.tableau.com/profile/john.wolf#!/vizhome/GeorunsChlorophyla2_14_19fixedlegend/Chloro

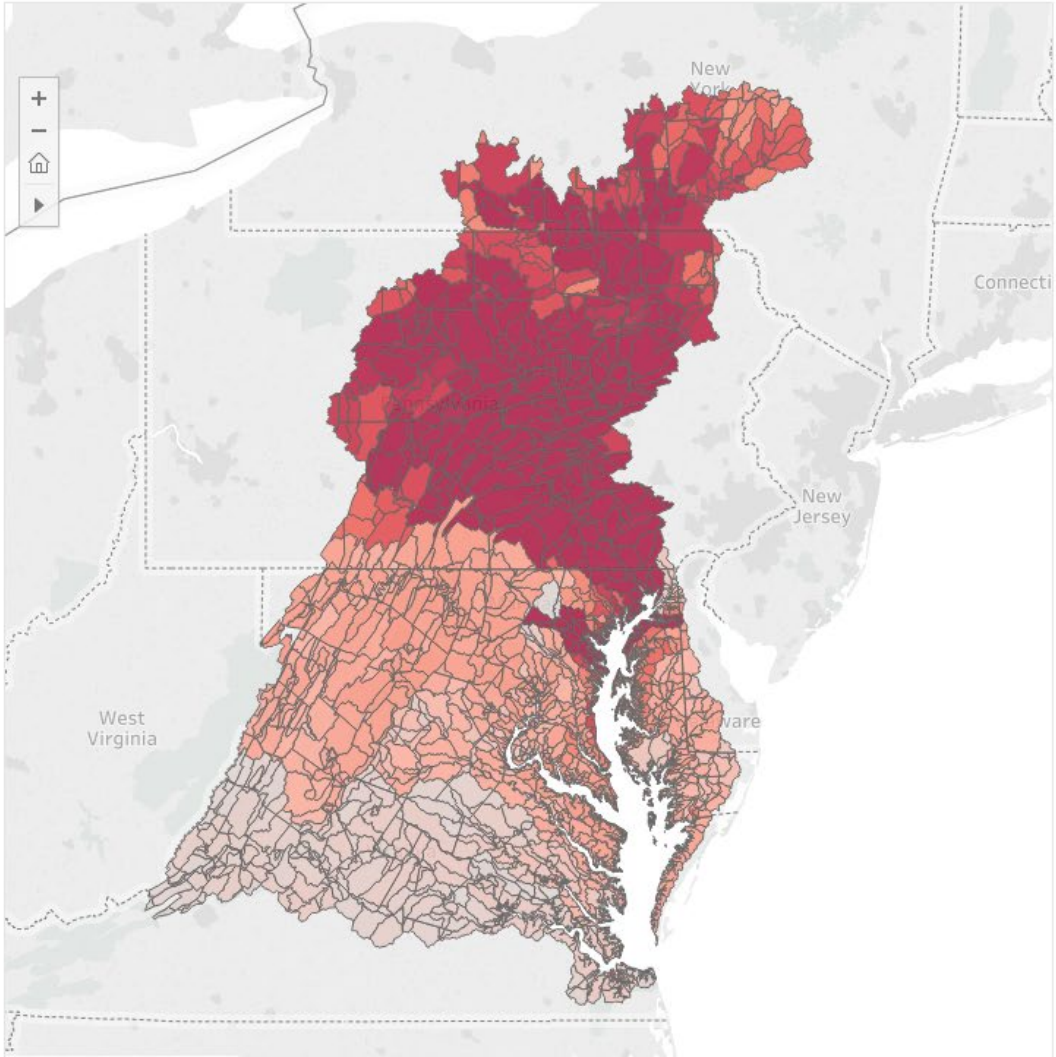
Most Visited | Getting Started | ELMS Home | Login - Learning Center

+ableau public | GALLERY | AUTHORS | BLOG | RESOURCES | ACTIVITY | SIGN IN

John Wolf - Profile

Favorite

Chlorophyl a Georuns 2-14-19



Pollutant (N or P)

- P
- (•) N

Source (PS or NPS)

- NPS
- (•) PS

Monitoring Segment (CBSEG)

CB3MH

Total Effectiveness

-100.0 — 100.0

Georuns Chlorophyl a 2_14_19 f

https://public.tableau.com/profile/john.wolf#!/vizhome/GeorunsChlorophyla2_14_19fixedlegend/Chloro

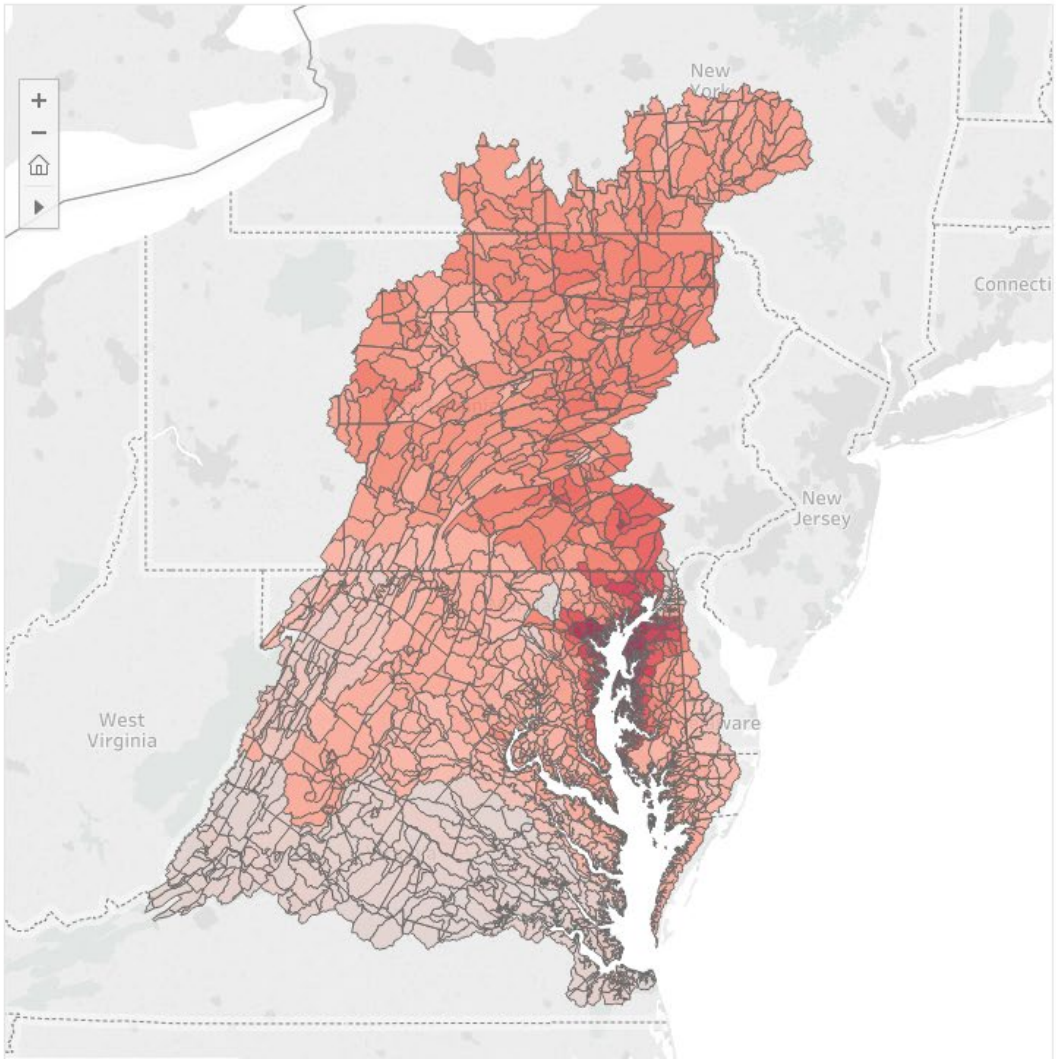
Most Visited | Getting Started | ELMS Home | Login - Learning Center

+ableau public | GALLERY | AUTHORS | BLOG | RESOURCES | ACTIVITY | SIGN IN

John Wolf - Profile

Favorite

Chlorophyl a Georuns 2-14-19



Pollutant (N or P)
- (•) P
- ( ) N

Source (PS or NPS)
- (•) NPS
- ( ) PS

Monitoring Segment (CBSEG)
CB3MH

Total Effectiveness
-100.0 100.0

Georuns Chlorophyl a 2_14_19 f

https://public.tableau.com/profile/john.wolf#!/vizhome/GeorunsChlorophyla2_14_19fixedlegend/Chloro

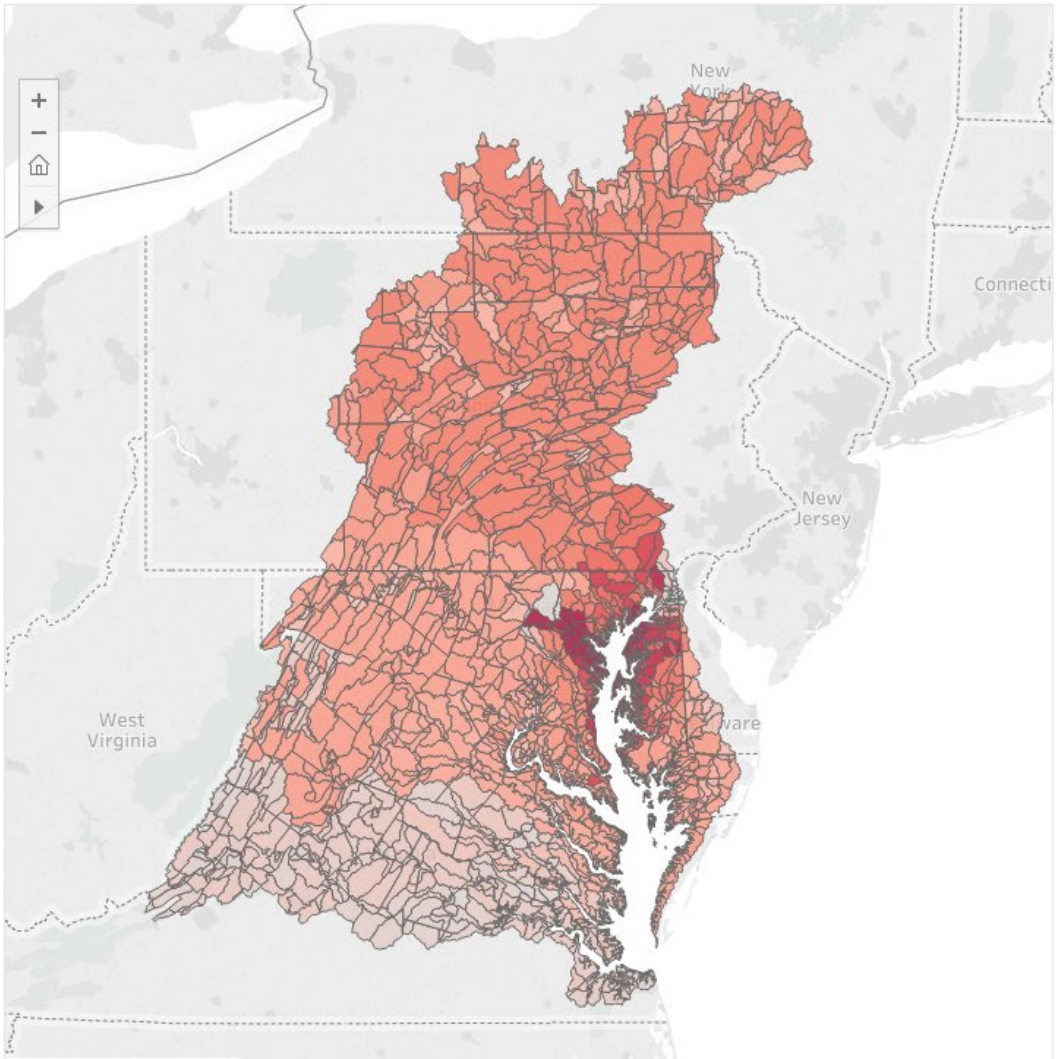
Most Visited | Getting Started | ELMS Home | Login - Learning Center

+ableau public | GALLERY | AUTHORS | BLOG | RESOURCES | ACTIVITY | SIGN IN

John Wolf - Profile

Favorite

Chlorophyl a Georuns 2-14-19



Pollutant (N or P)
- (•) P
- ( ) N

Source (PS or NPS)
- ( ) NPS
- (•) PS

Monitoring Segment (CBSEG)
CB3MH

Total Effectiveness
-100.0 — 100.0

Georuns Chlorophyl a 2_14_19

https://public.tableau.com/profile/john.wolf#!/vizhome/GeorunsChlorophyla2_14_19fixedlegend/Chloro

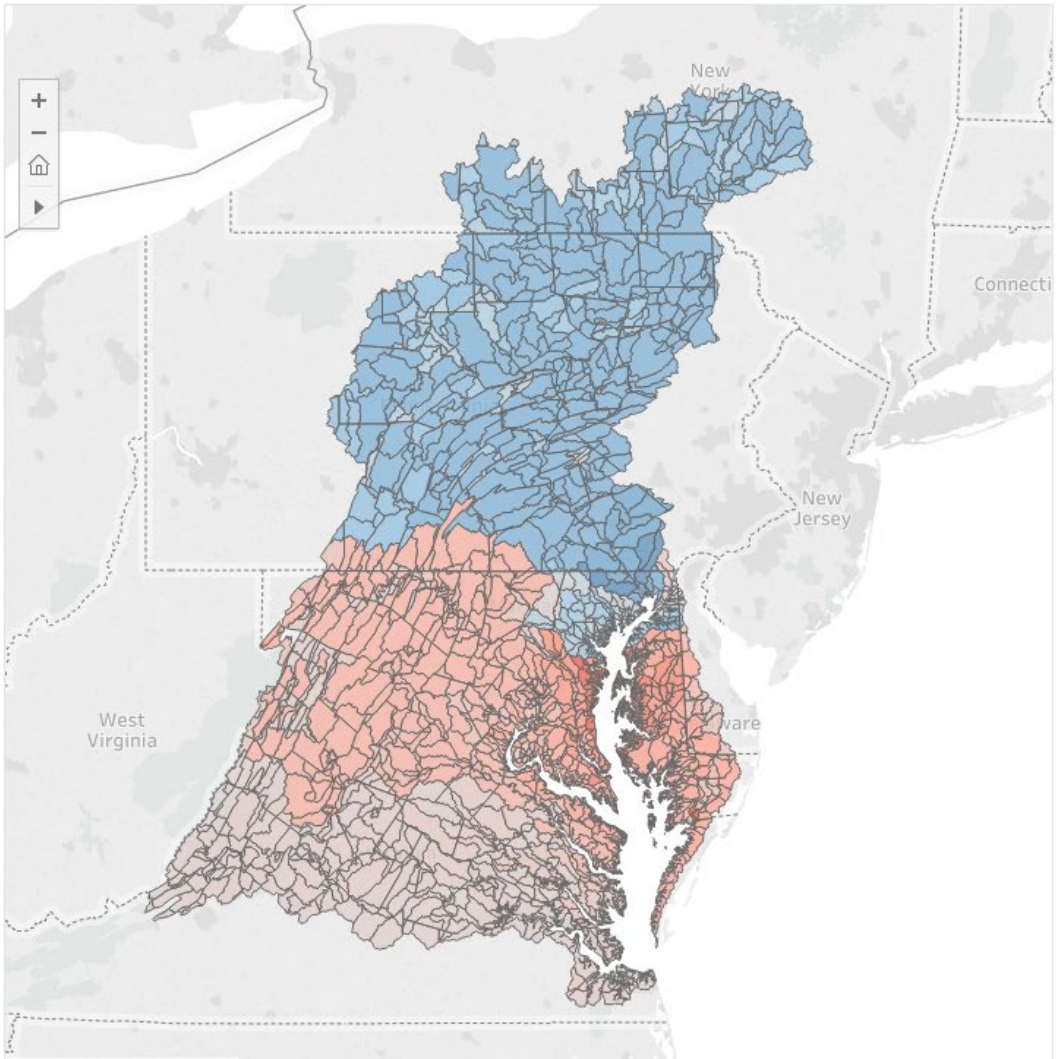
Most Visited | Getting Started | ELMS Home | Login - Learning Center

+ableau public | GALLERY | AUTHORS | BLOG | RESOURCES | ACTIVITY | SIGN IN

John Wolf - Profile

Favorite

Chlorophyl a Georuns 2-14-19



Pollutant (N or P)
- (•) P
- ( ) N

Source (PS or NPS)
- ( ) NPS
- (•) PS

Monitoring Segment (CBSEG)
CB4MH

Total Effectiveness
-100.0 100.0

Georuns Chlorophyl a 2_14_19 f

https://public.tableau.com/profile/john.wolf#!/vizhome/GeorunsChlorophyla2_14_19fixedlegend/Chloro

Most Visited | Getting Started | ELMS Home | Login - Learning Center

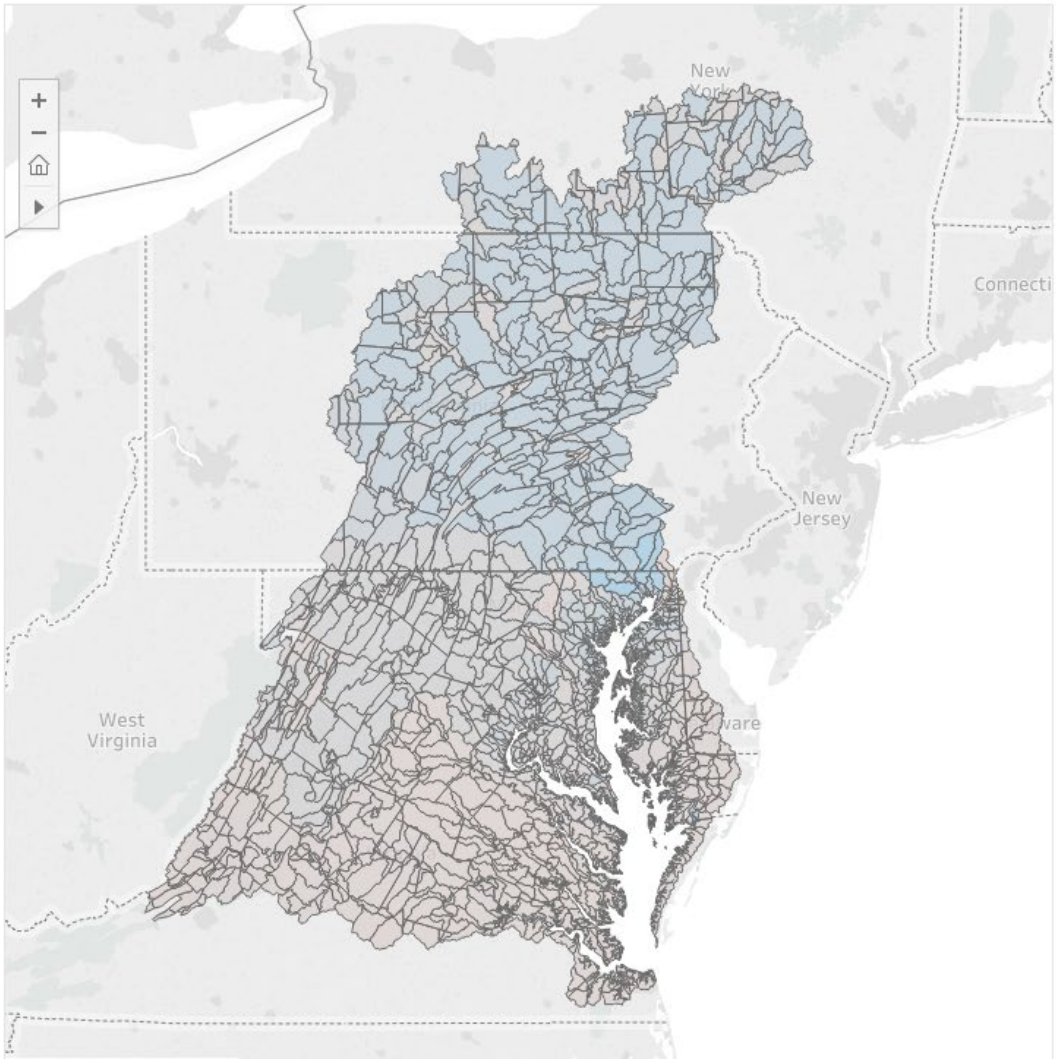
+ableau public

GALLERY AUTHORS BLOG RESOURCES ACTIVITY SIGN IN

John Wolf - Profile

Favorite

Chlorophyl a Georuns 2-14-19



Pollutant (N or P)

- (•) P
- ( ) N

Source (PS or NPS)

- ( ) NPS
- (•) PS

Monitoring Segment (CBSEG)

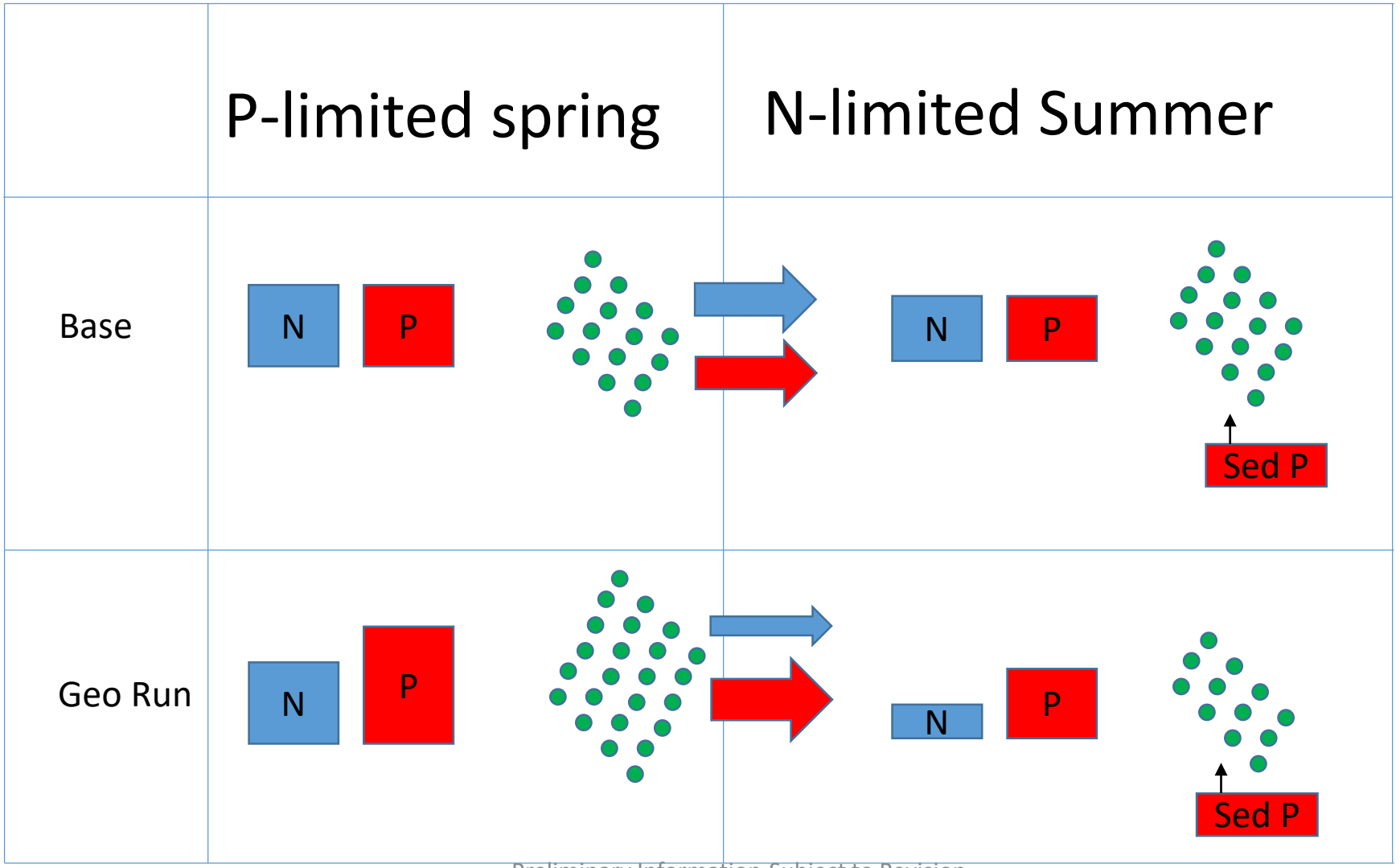
CB8PH

Total Effectiveness

-100.0 100.0

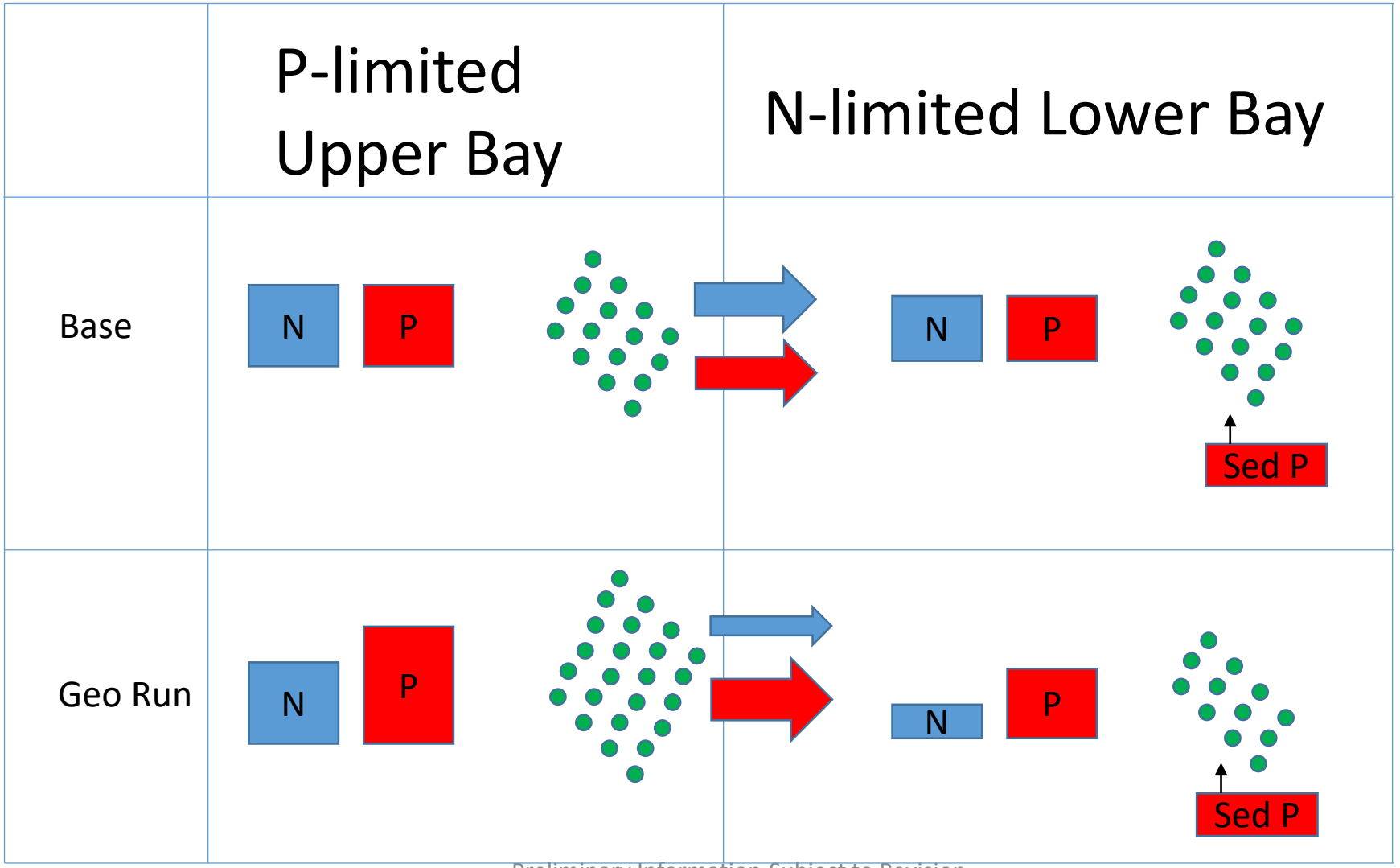
Ideas from Rebecca Murphy, Jeremy Testa, Danny Kaufman and others

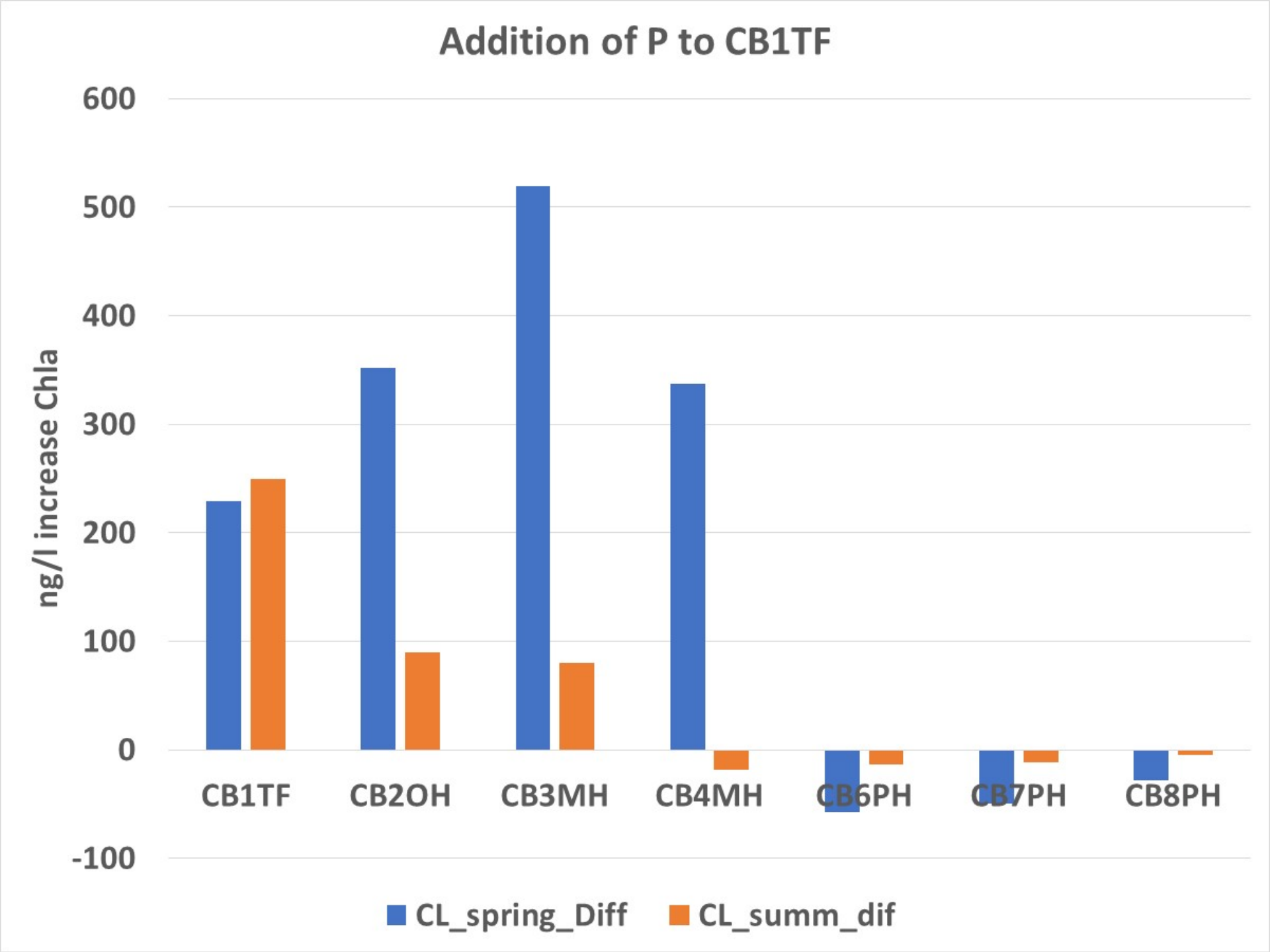
Possible temporal limitation effect



Ideas from Rebecca Murphy, Jeremy Testa, Danny Kaufman and others

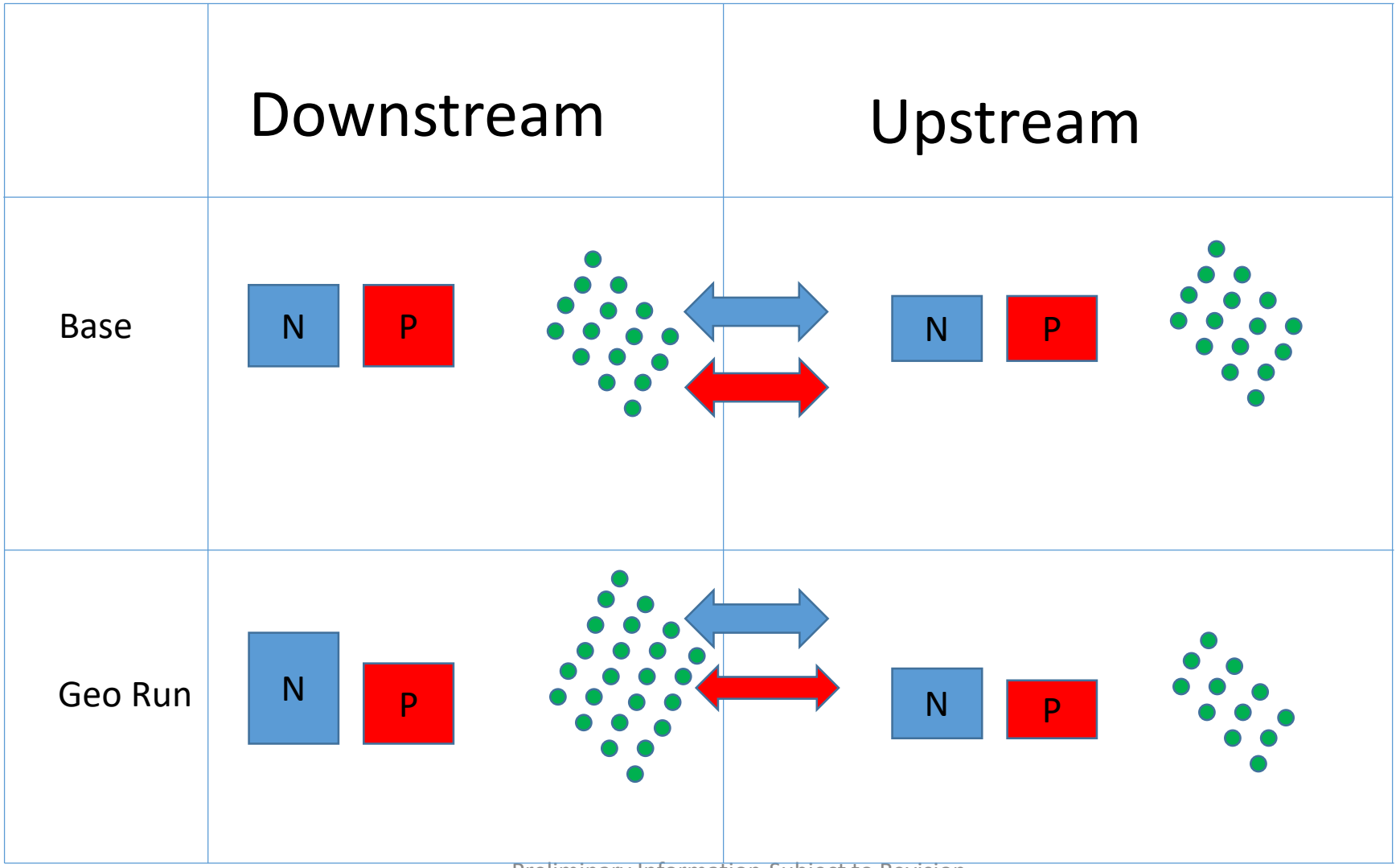
Possible spatial limitation effect



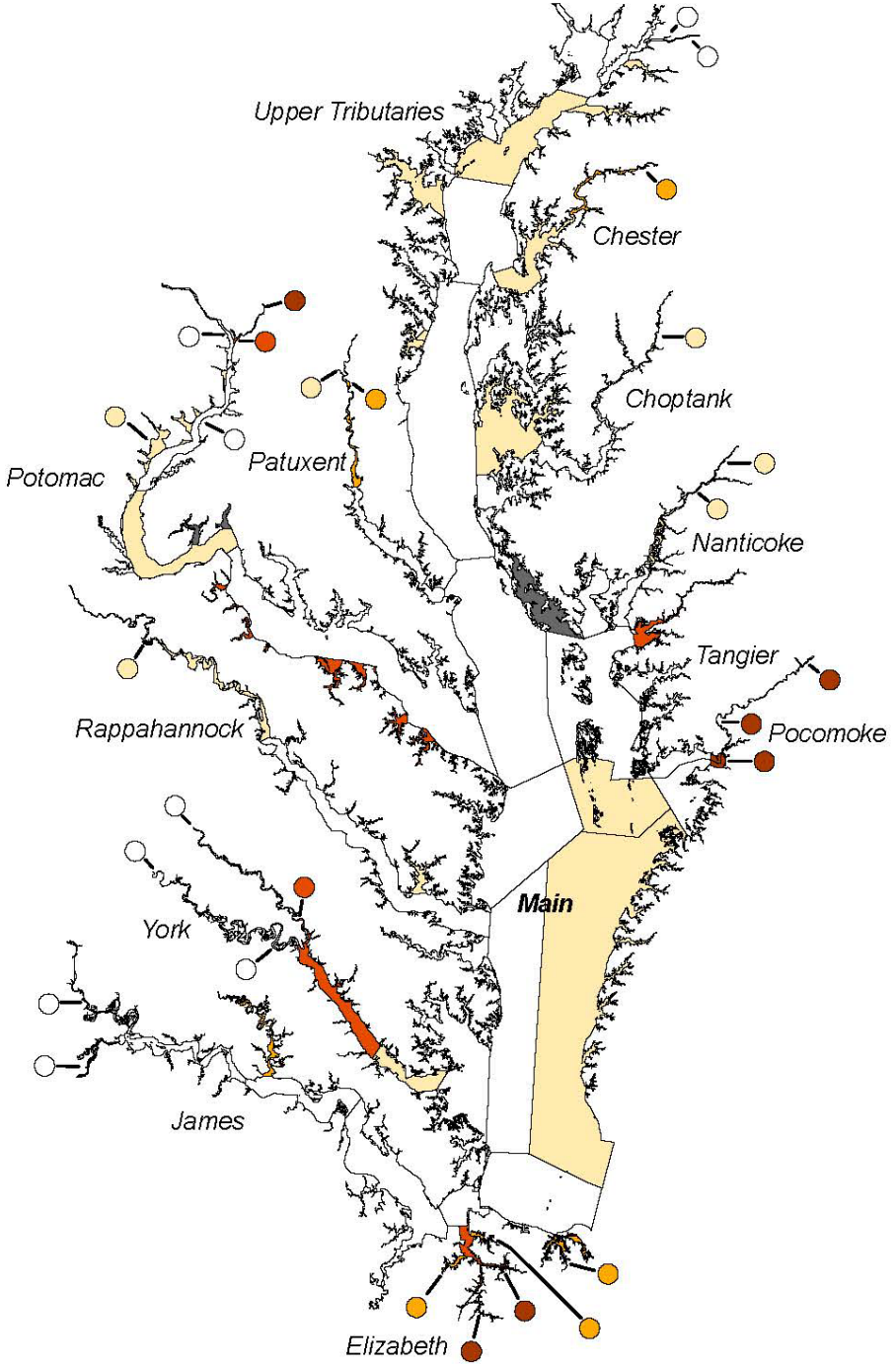

Addition of P to CB1TF
600
500
400
300
200
100
0
-100
ng/l increase Chla
CB1TF
CB2OH
CB3MH
CB4MH
CB6PH
CB7PH
CB8PH
CL_spring_Diff
CL_summ_dif

Ideas from Rebecca Murphy, Jeremy Testa, Danny Kaufman and others

Works for downstream as well

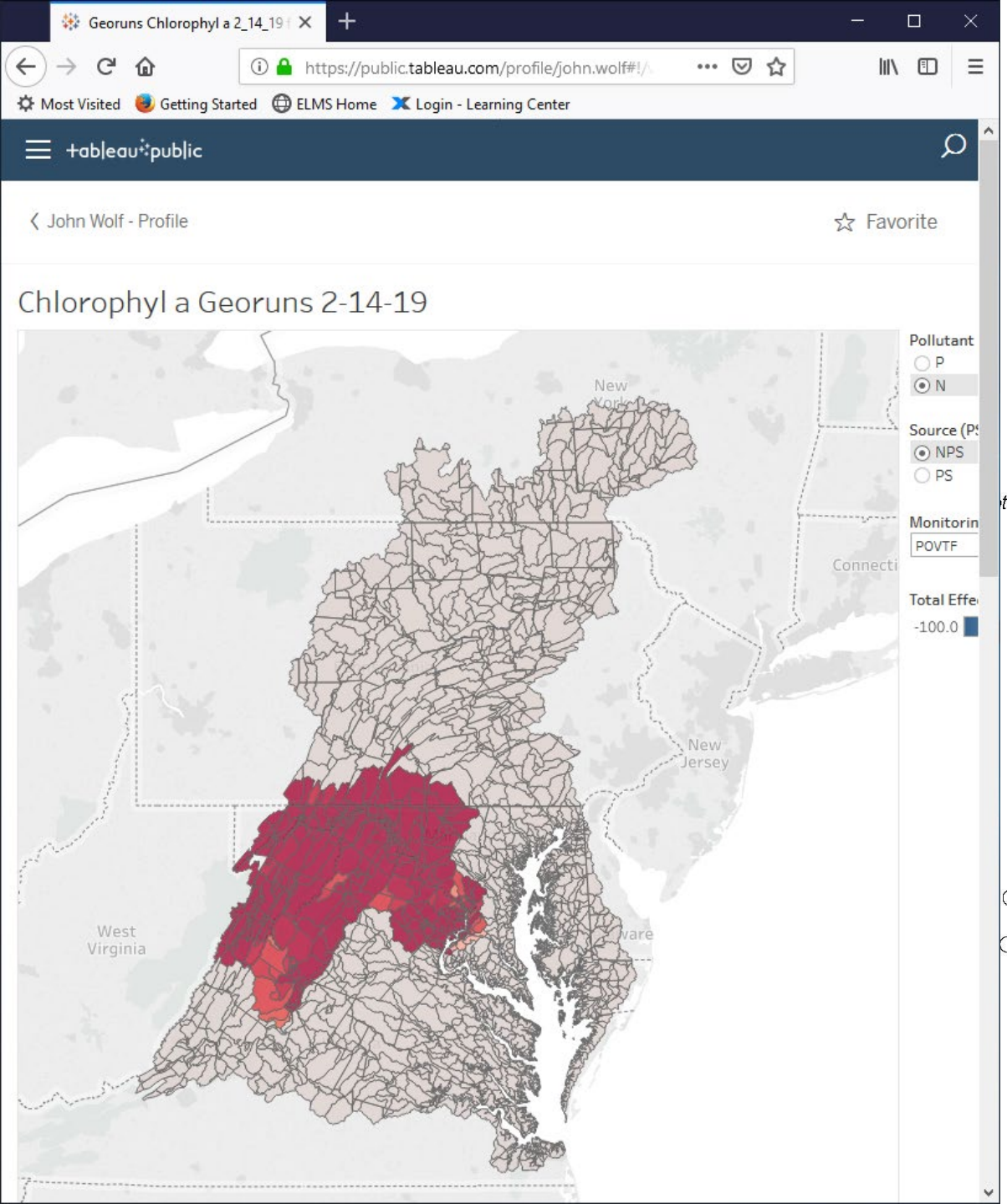


Current Open Water DO Attainment 2014-2016

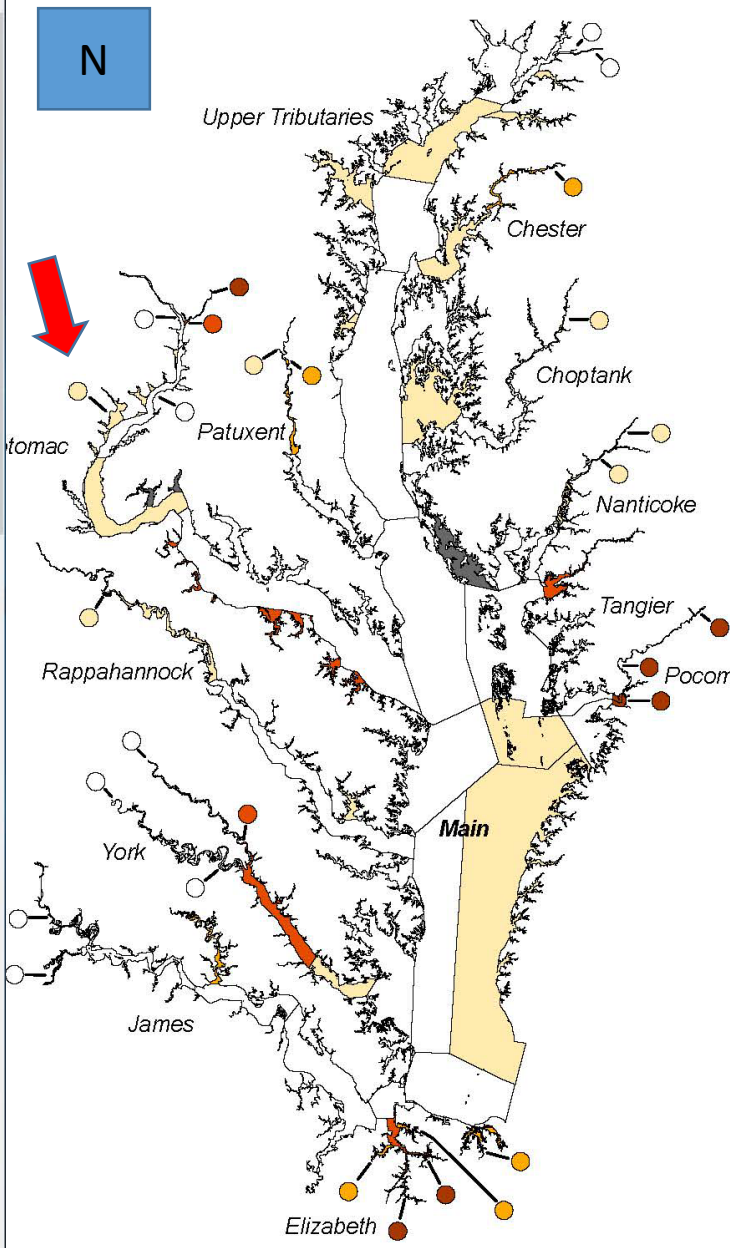


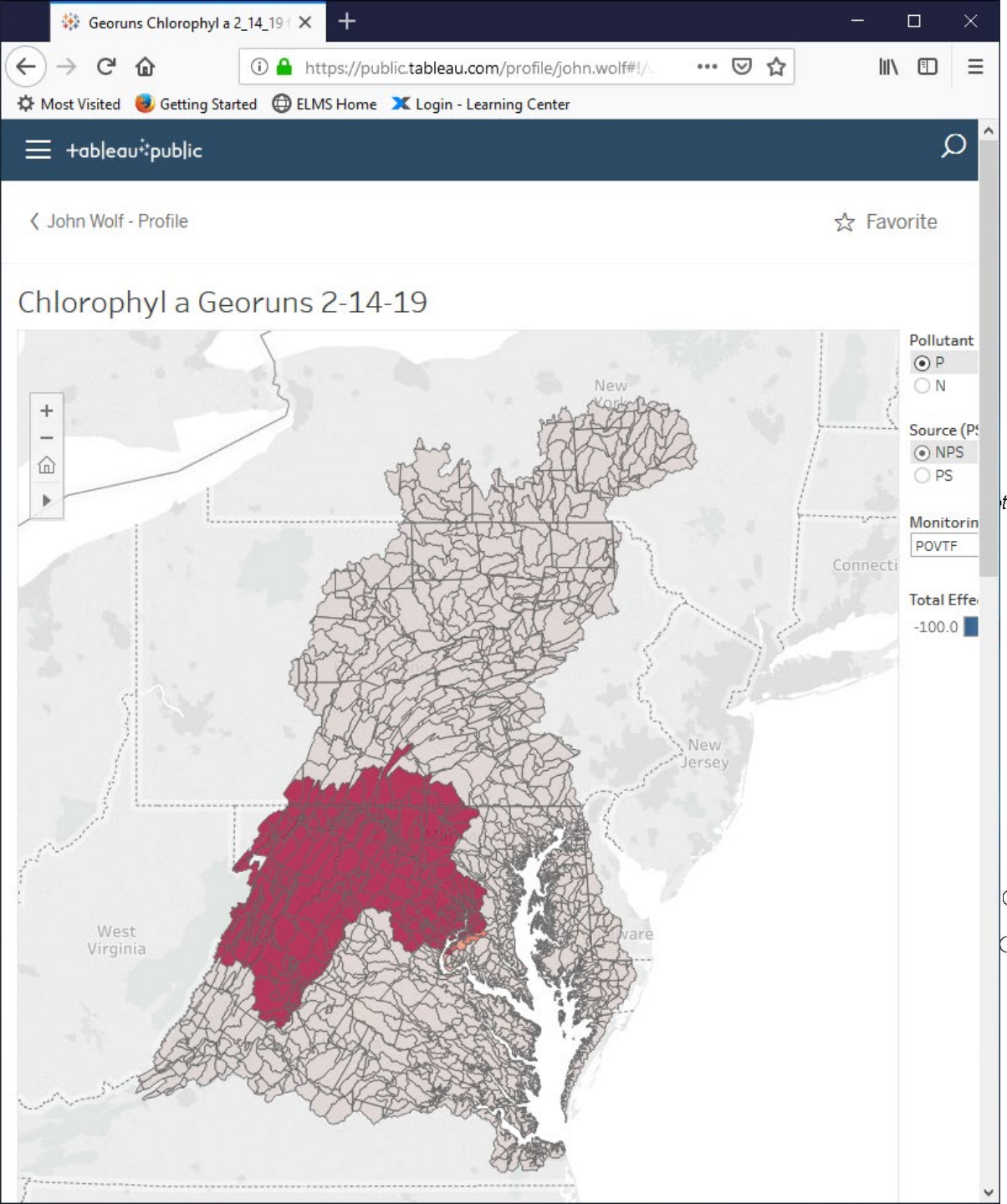
Attainment Deficit (2014-2016)

- No data
- Attaining (no deficit)
- -0.1 to -5%
- -5.1% to -15%
- -15.1% to -25%
- -25.1% to -85%
- Designated use N/A

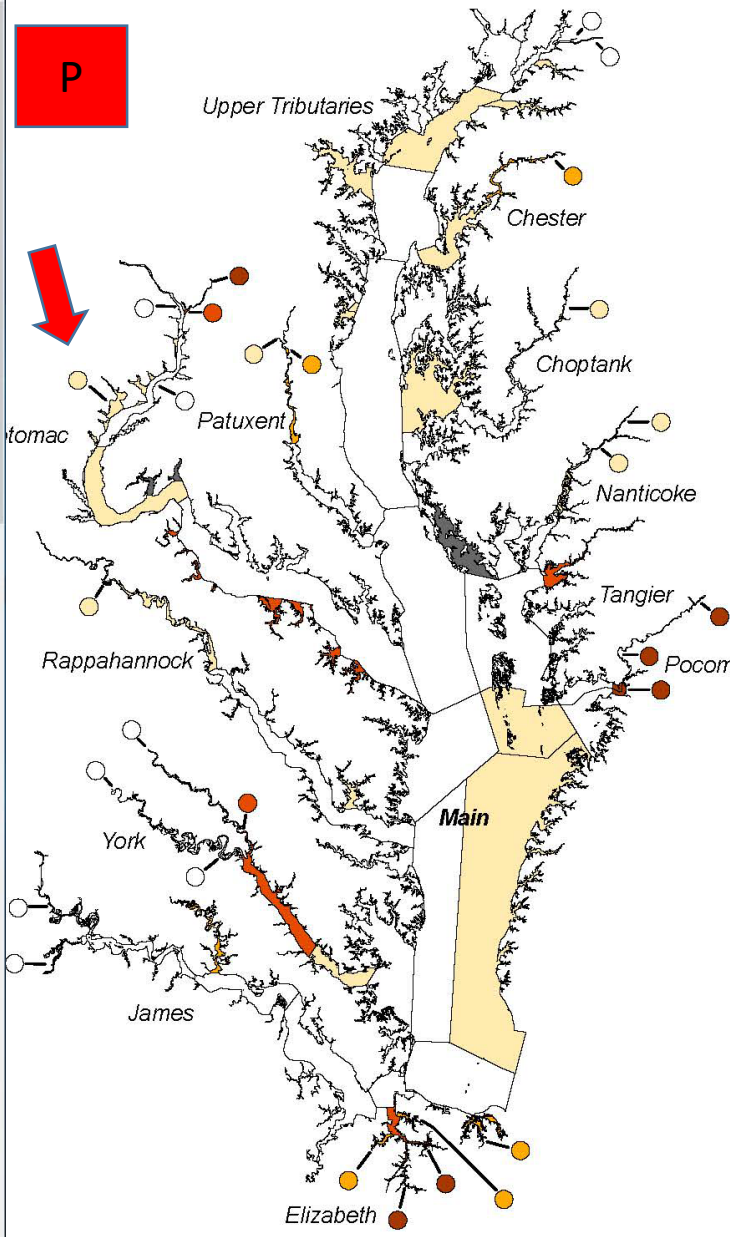


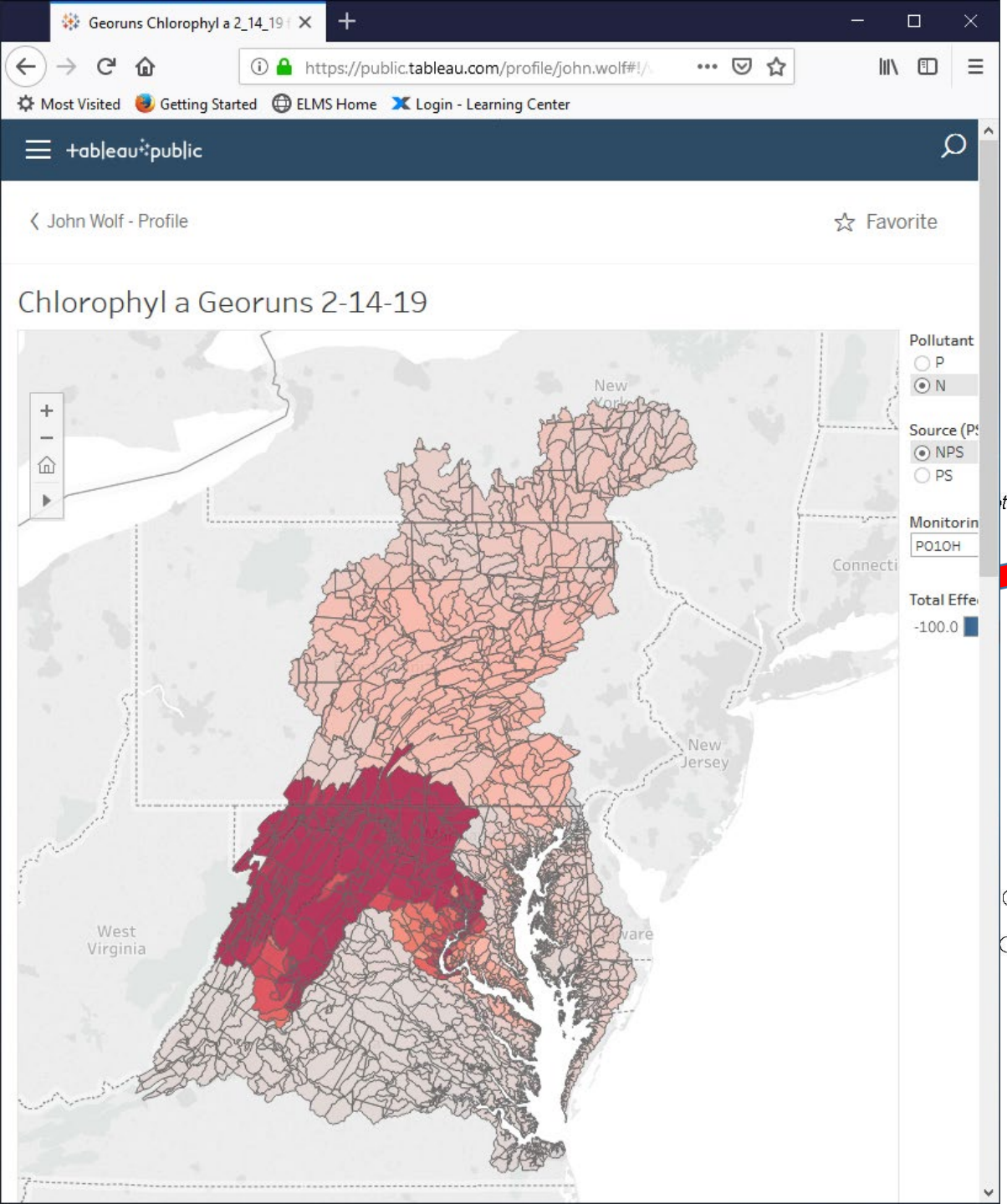
Potomac TF VA



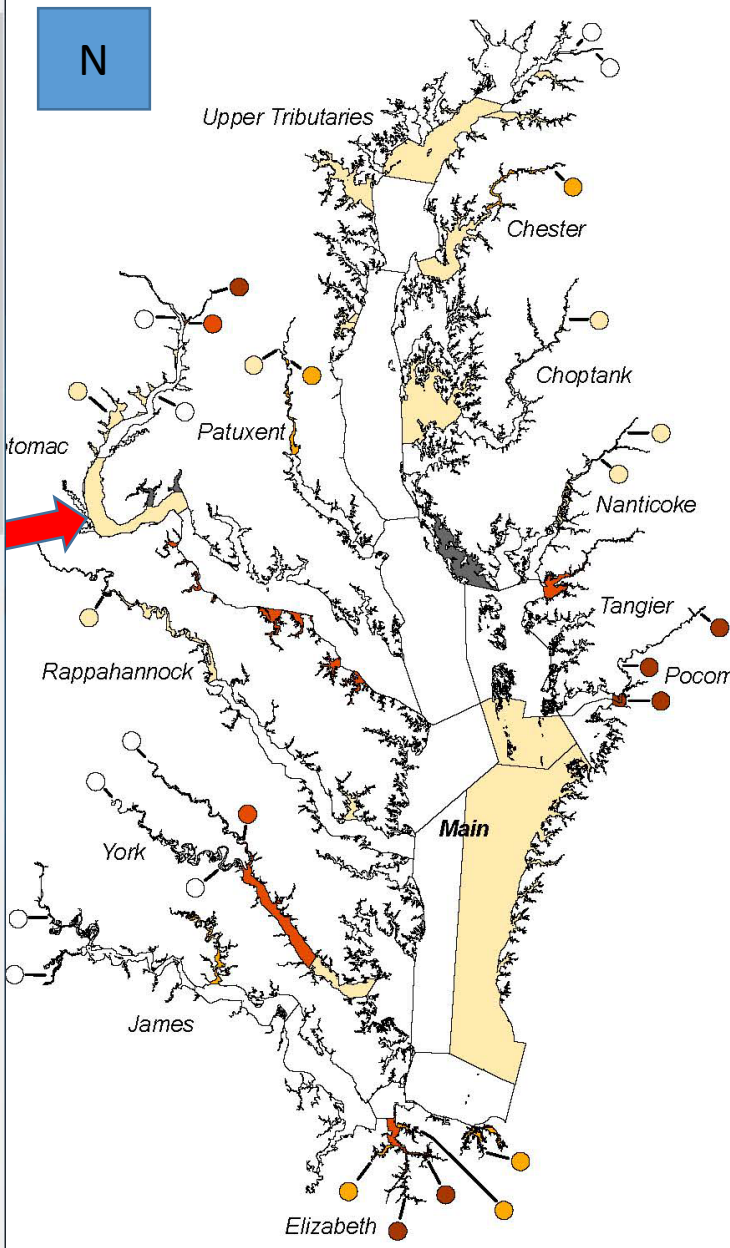


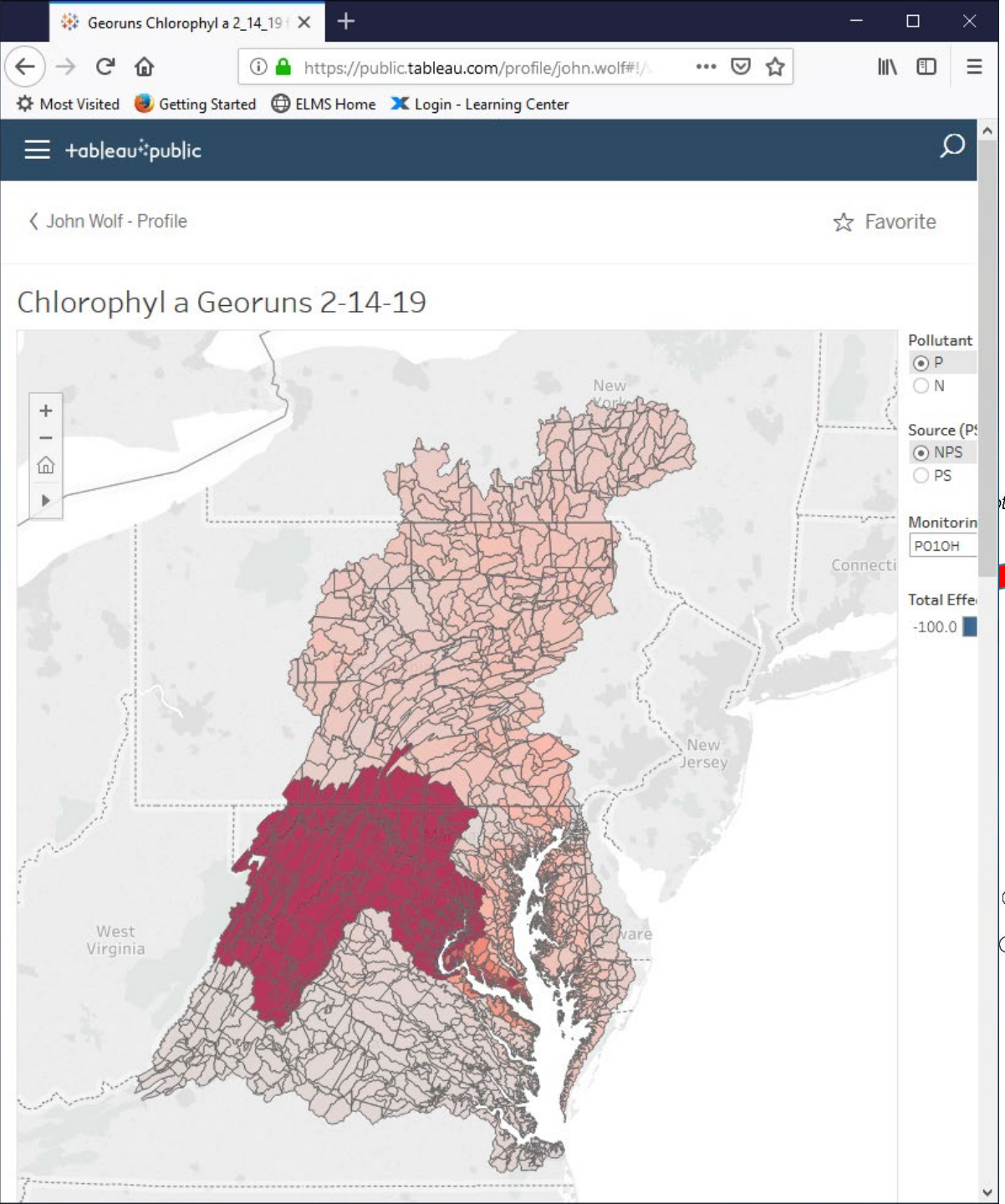
Potomac TF VA



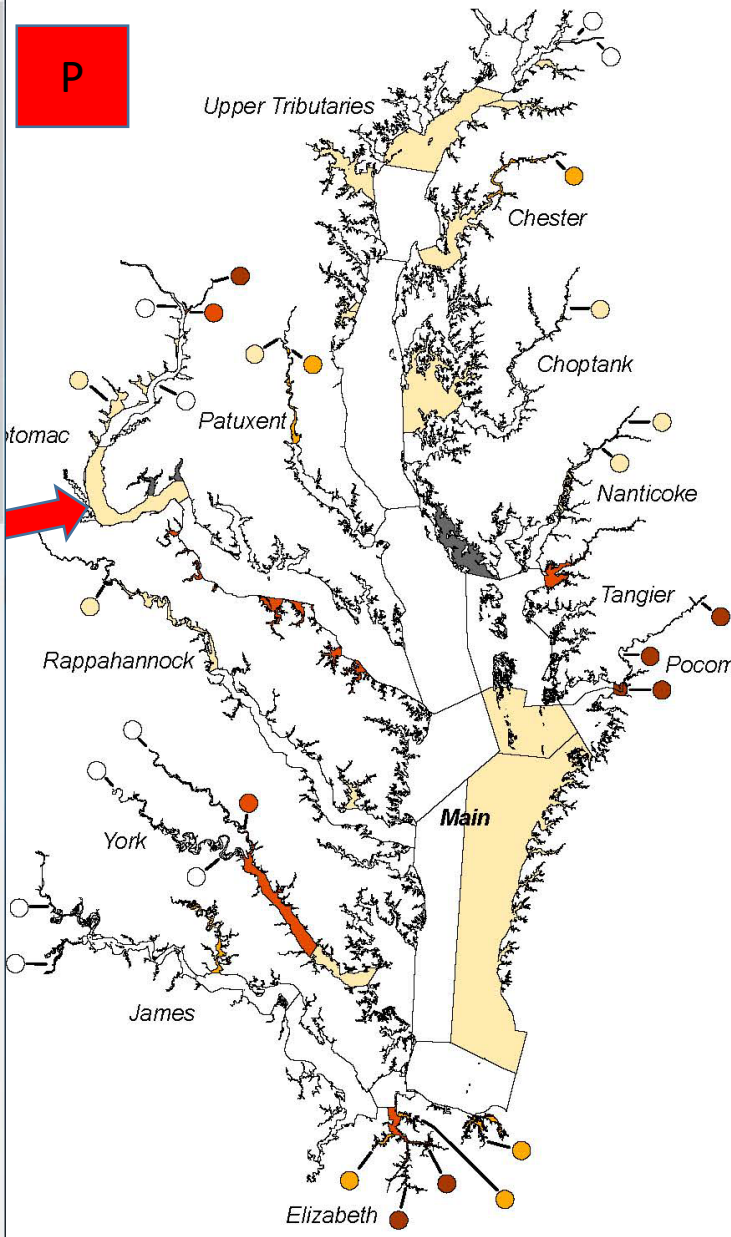


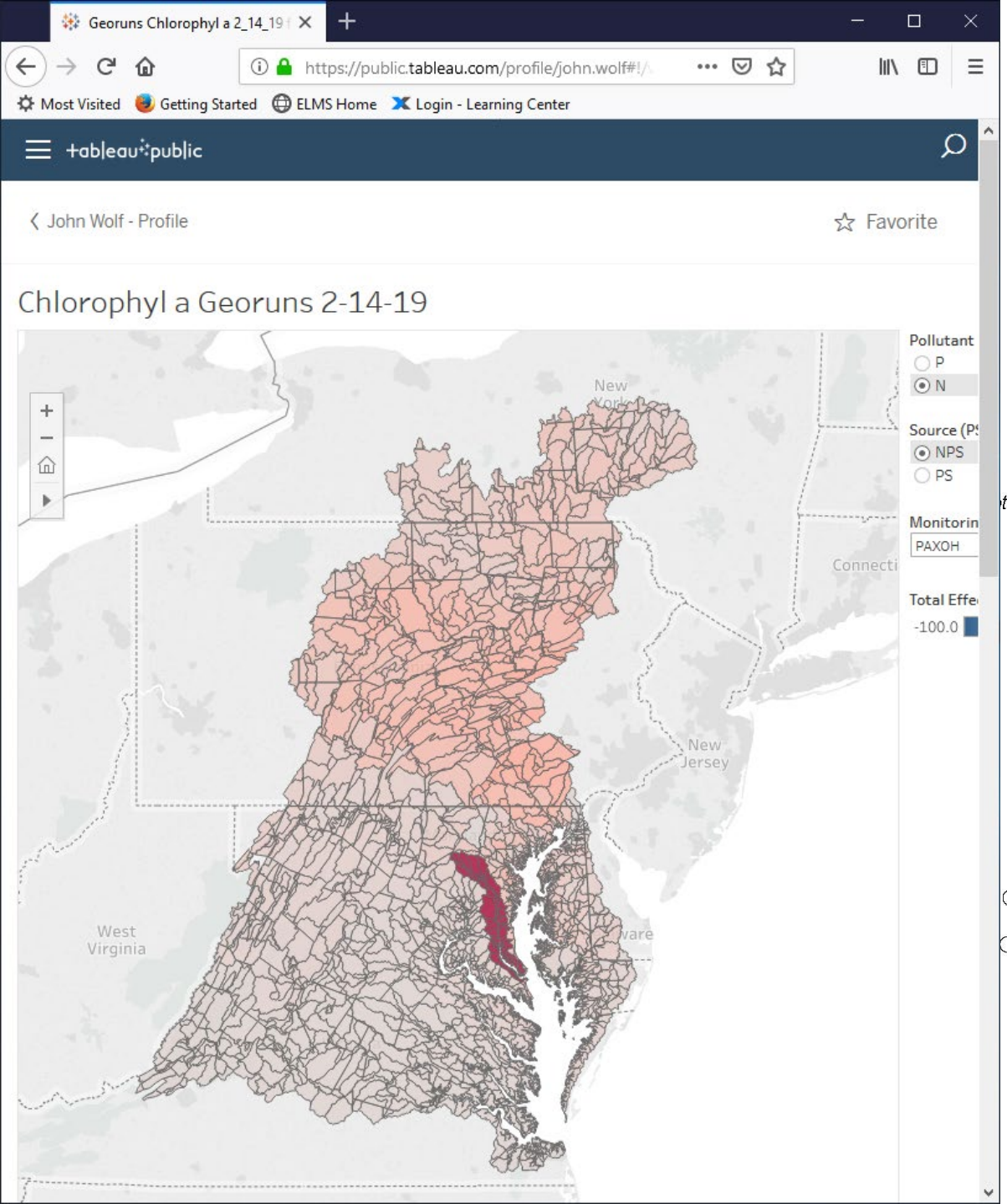
Potomac OH MD



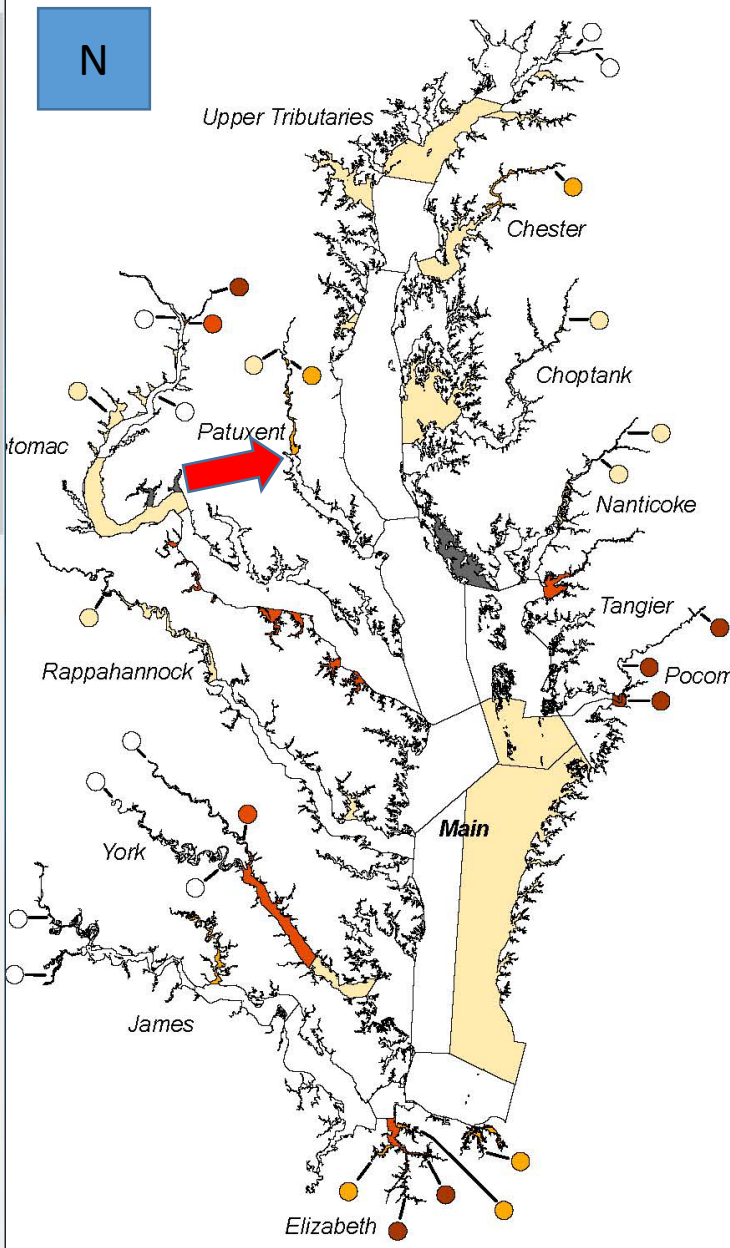


Potomac OH MD





Patuxent OH MD



Georuns Chlorophyl a 2_14_19

https://public.tableau.com/profile/john.wolf#!/

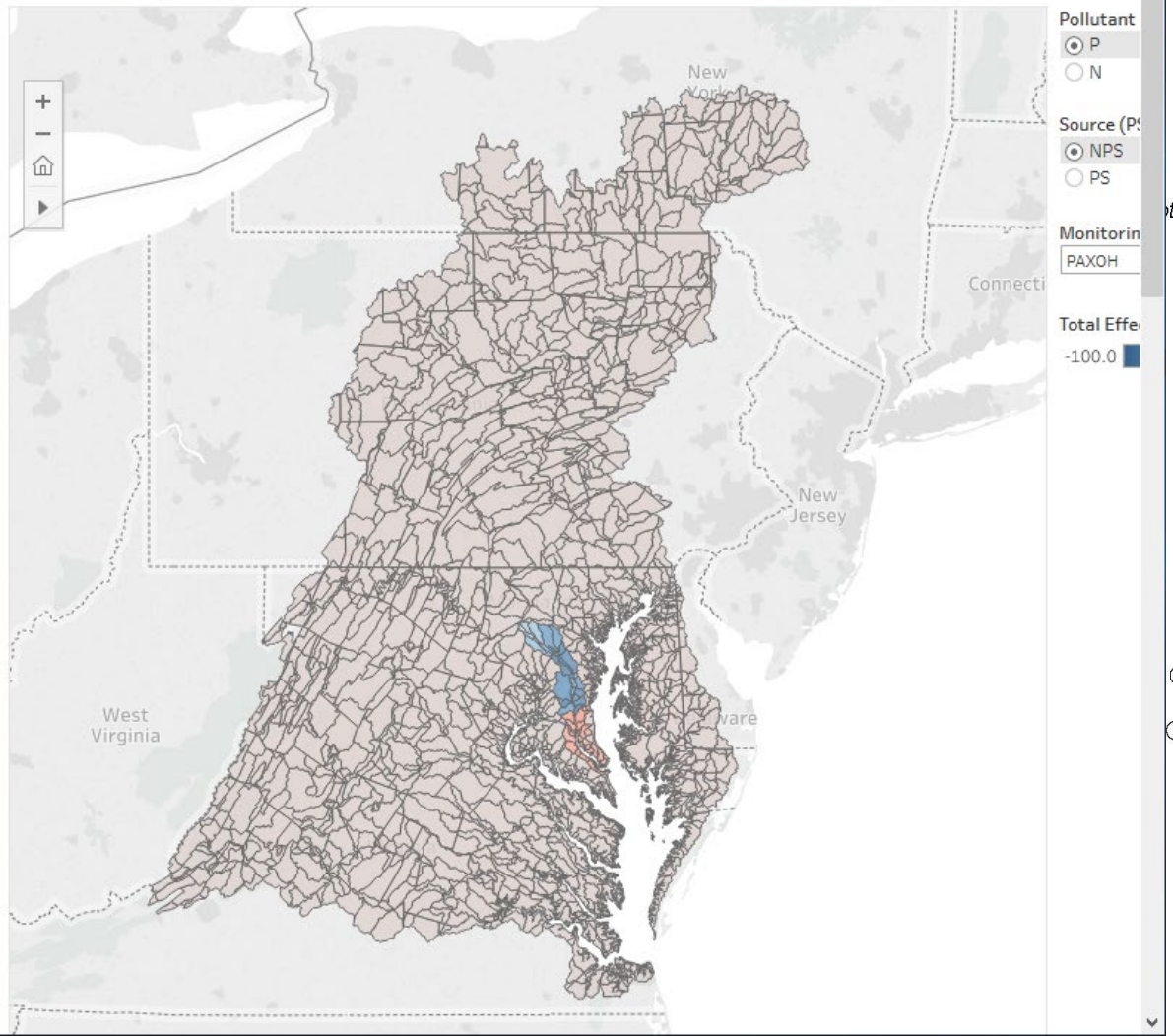
Most Visited | Getting Started | ELMS Home | Login - Learning Center

tableau public

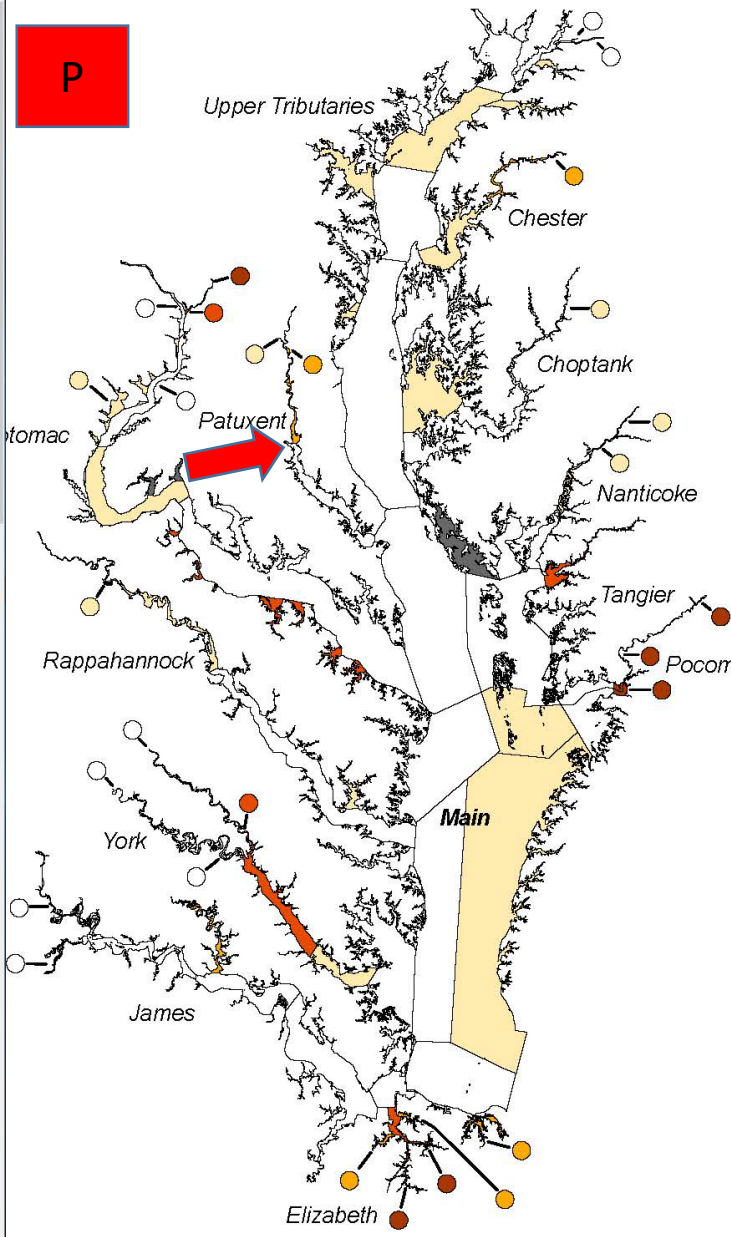
John Wolf - Profile

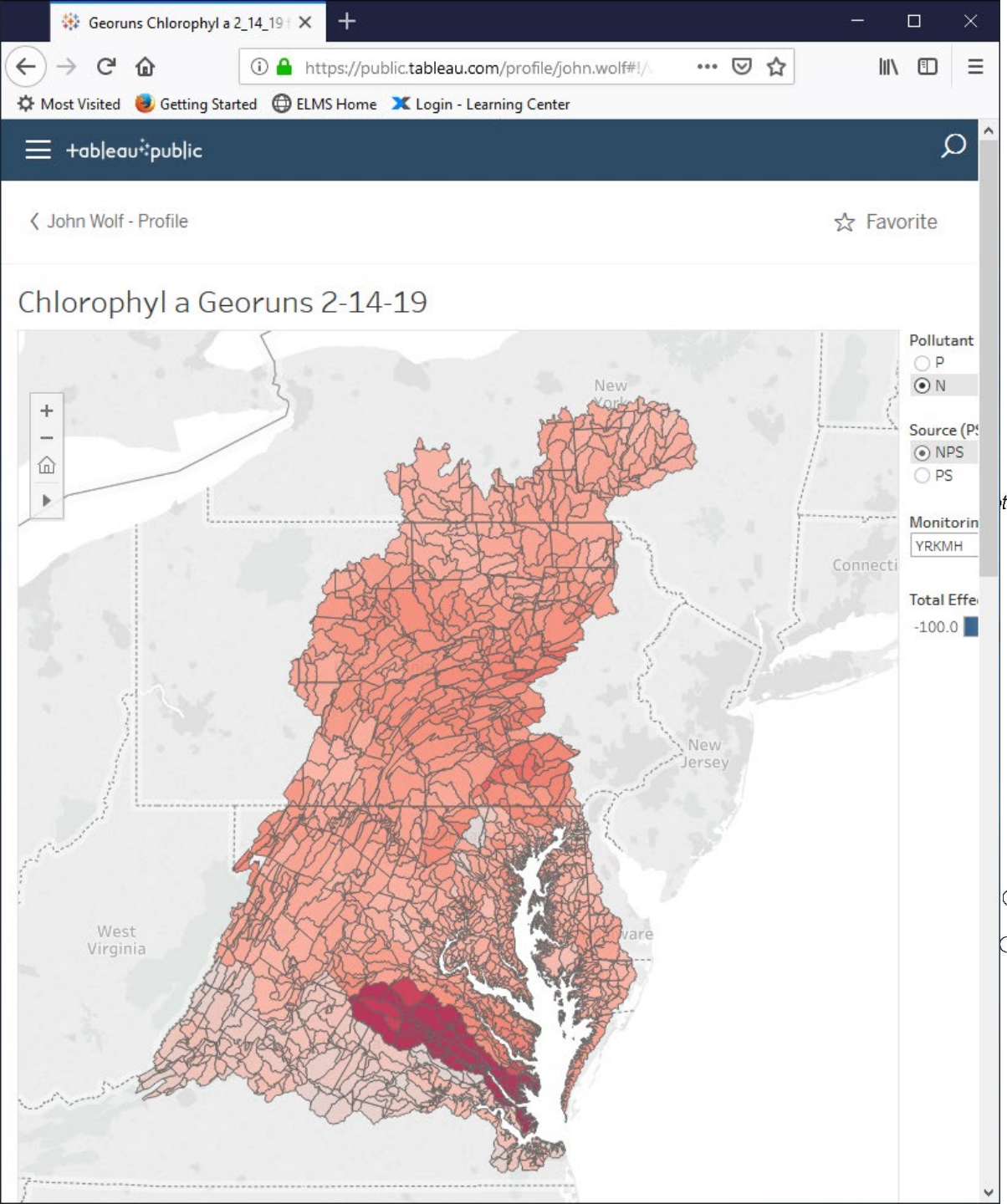
Favorite

Chlorophyl a Georuns 2-14-19

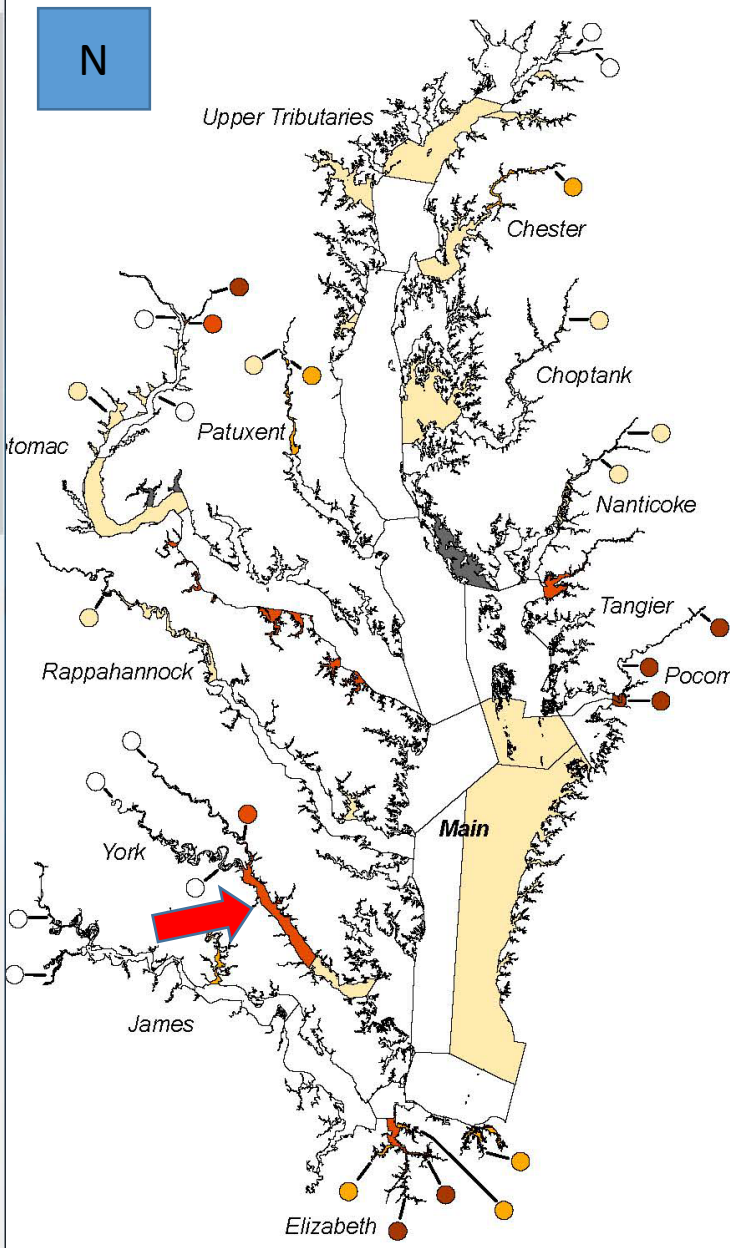


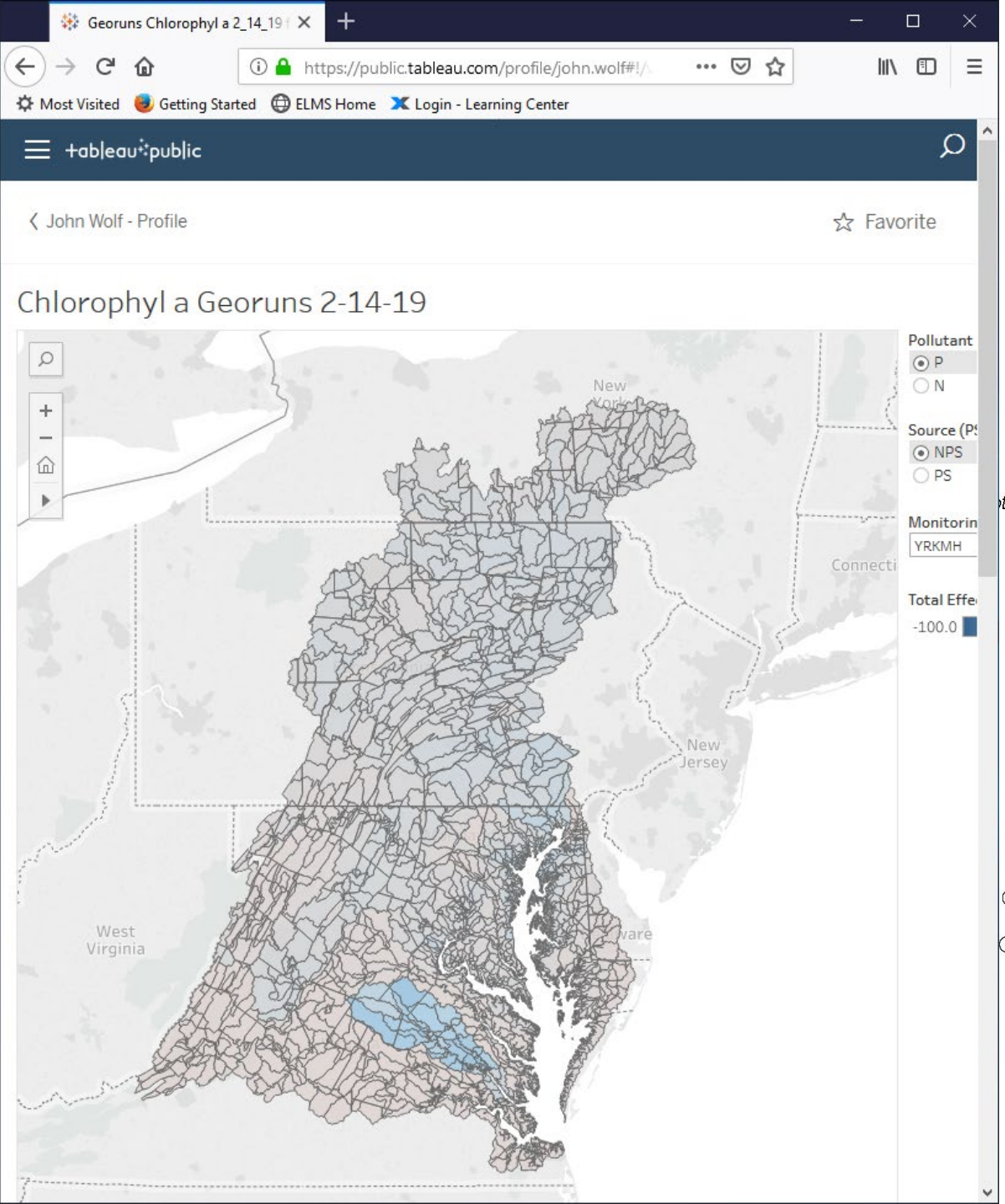
Patuxent OH MD



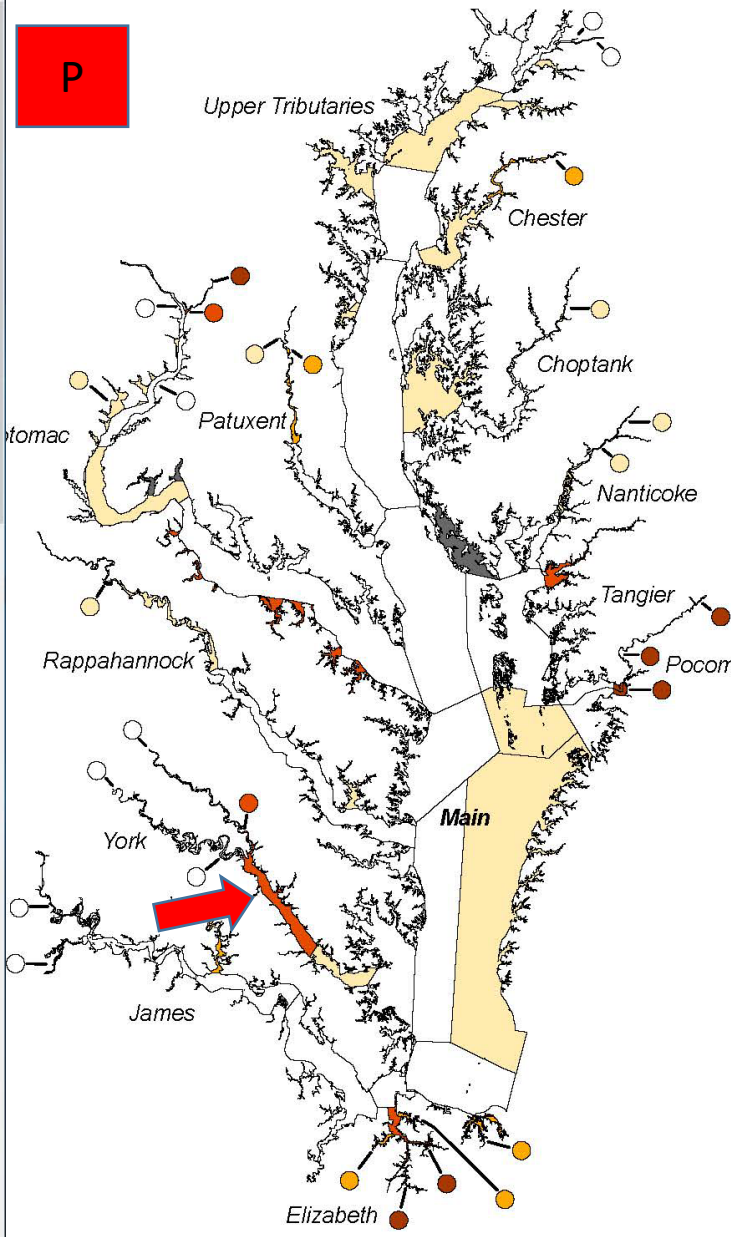

Georuns Chlorophyl a 2_14_19
https://public.tableau.com/profile/john.wolf#!/
Most Visited
Getting Started
ELMS Home
Login - Learning Center
tableau public
John Wolf - Profile
Favorite
Chlorophyl a Georuns 2-14-19
Pollutant
P
N
Source (PS
NPS
PS
Monitorin
YRKMH
Total Effe
-100.0
New York
New Jersey
West Virginia
Connecti

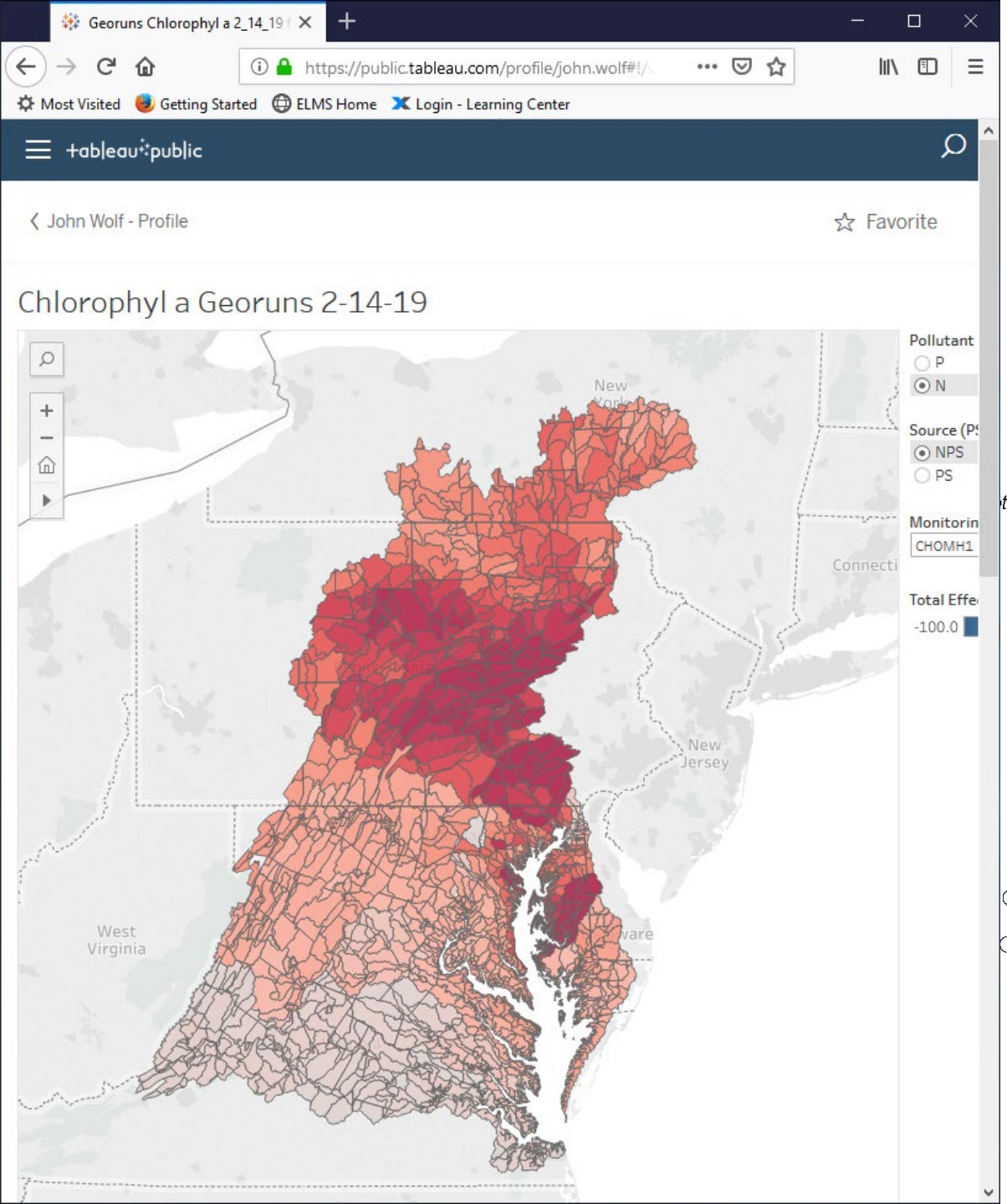
York MH VA


N
Upper Tributaries
Chester
Choptank
Patuxent
Nanticoke
Tangier
Rappahannock
Main
York
James
Elizabeth

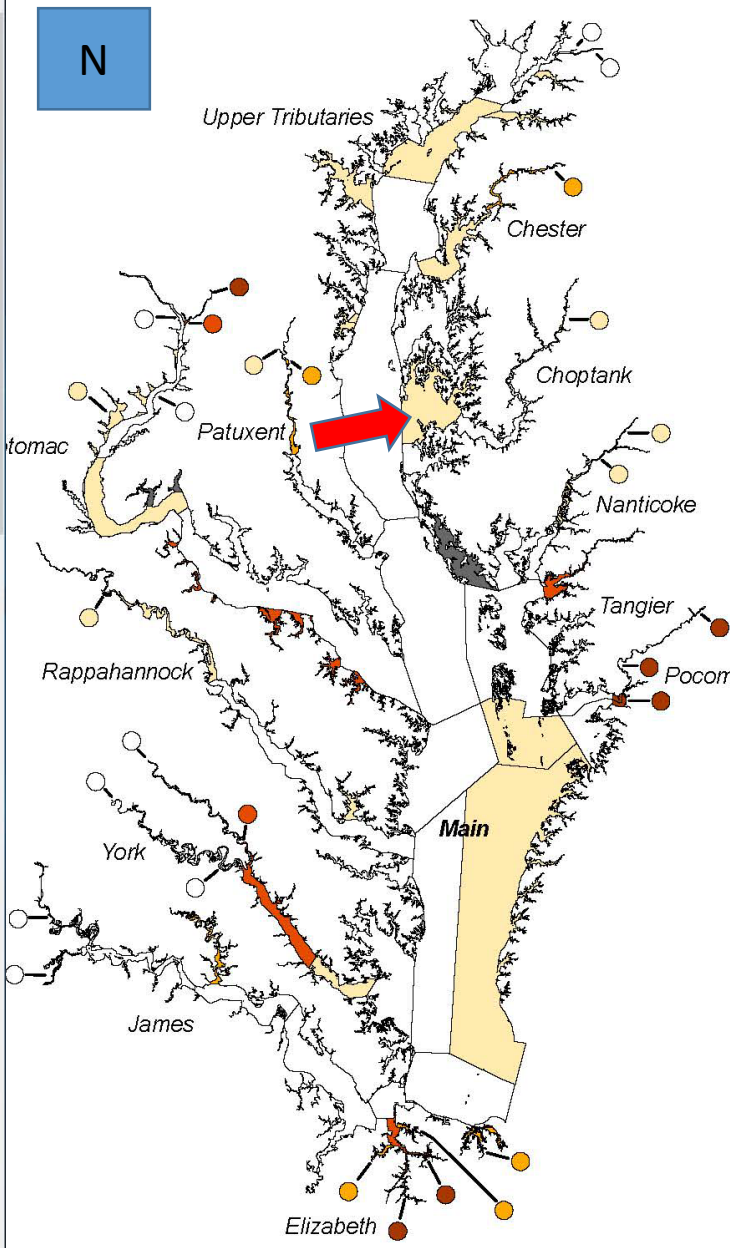

Georuns Chlorophyl a 2_14_19
https://public.tableau.com/profile/john.wolf#!/
Most Visited
Getting Started
ELMS Home
Login - Learning Center
tableau public
John Wolf - Profile
Favorite
Chlorophyl a Georuns 2-14-19
Pollutant
P
N
Source (PS
NPS
PS
Monitorin
YRKMH
Total Effe
-100.0
New York
New Jersey
West Virginia

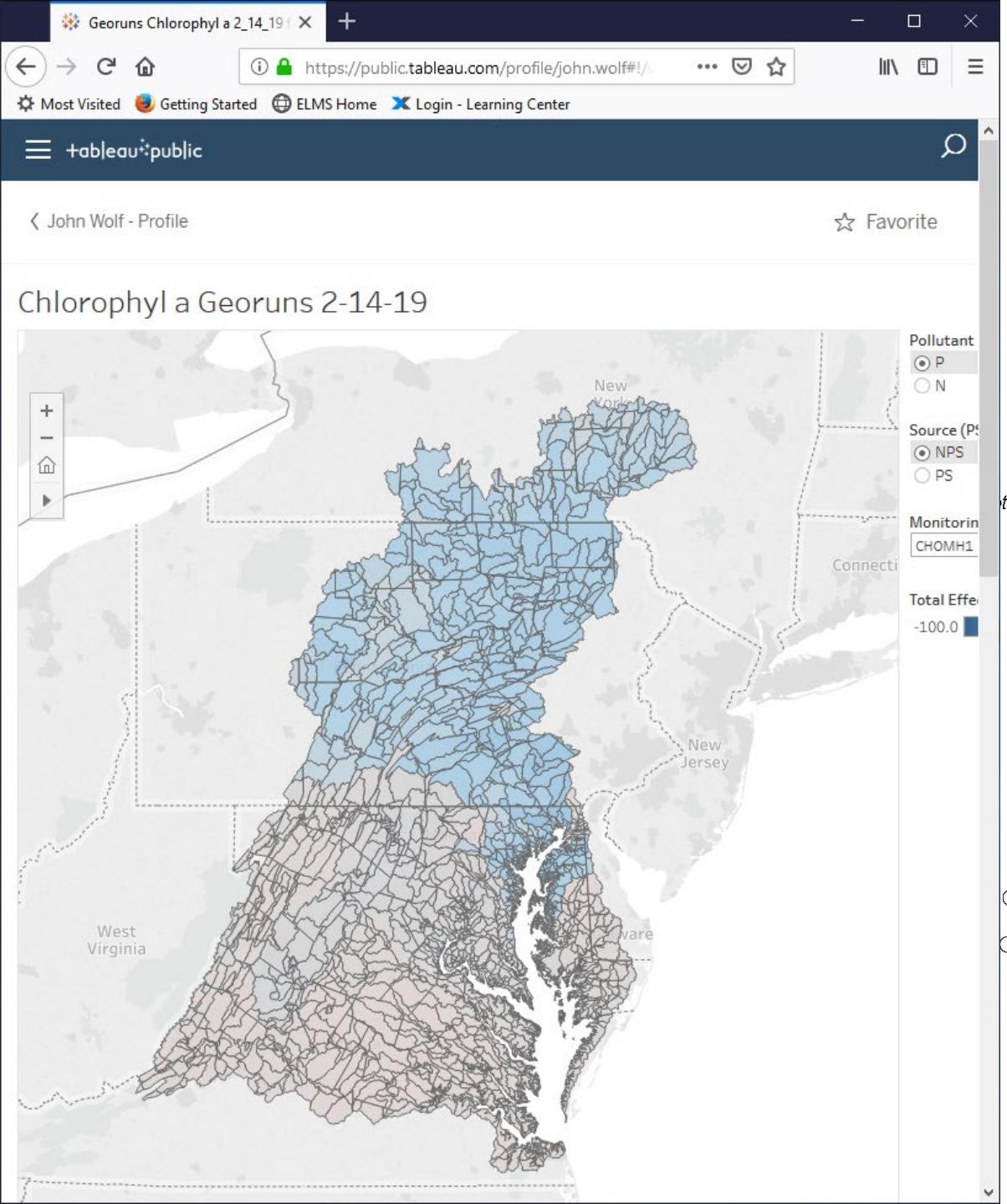
York MH VA


P
Upper Tributaries
Chester
Choptank
Patuxent
Nanticoke
Tangier
Rappahannock
Main
York
James
Elizabeth

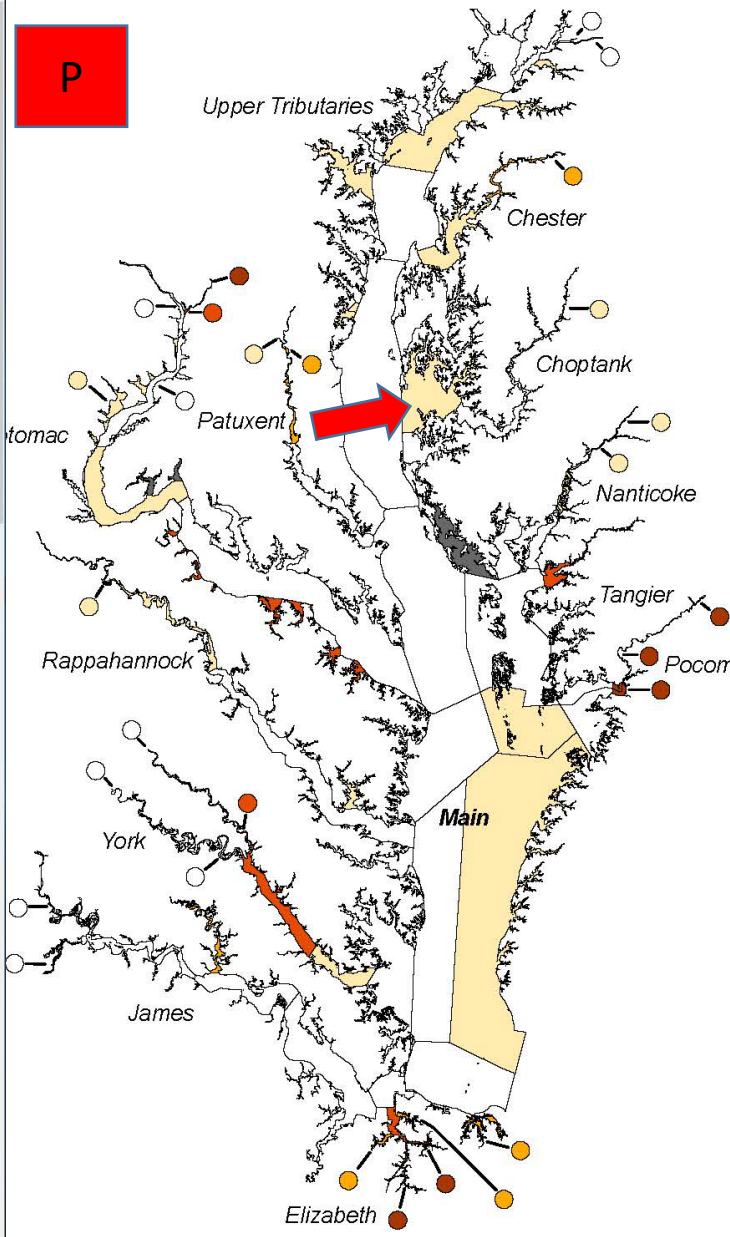


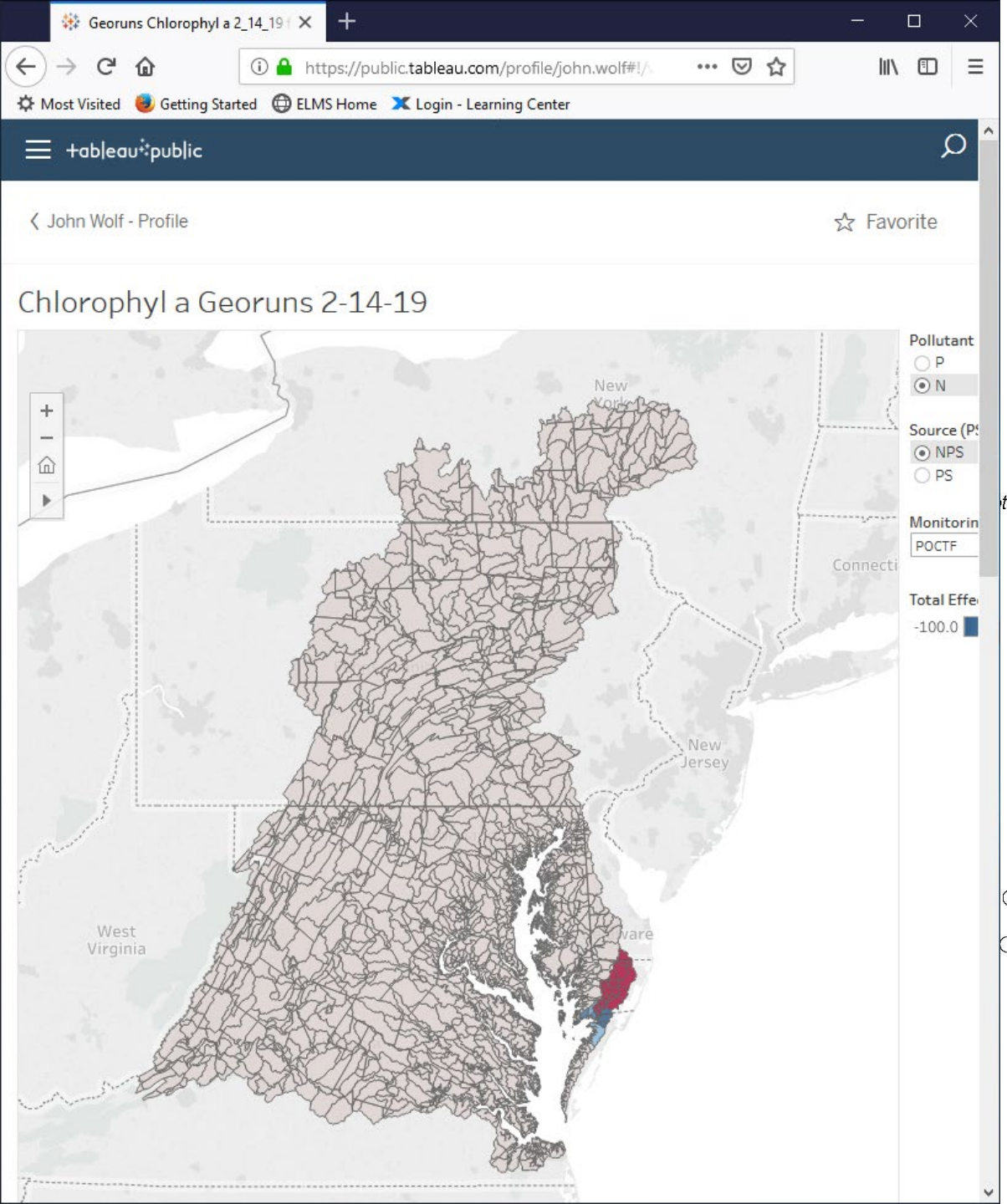
Choptank MH1 MD



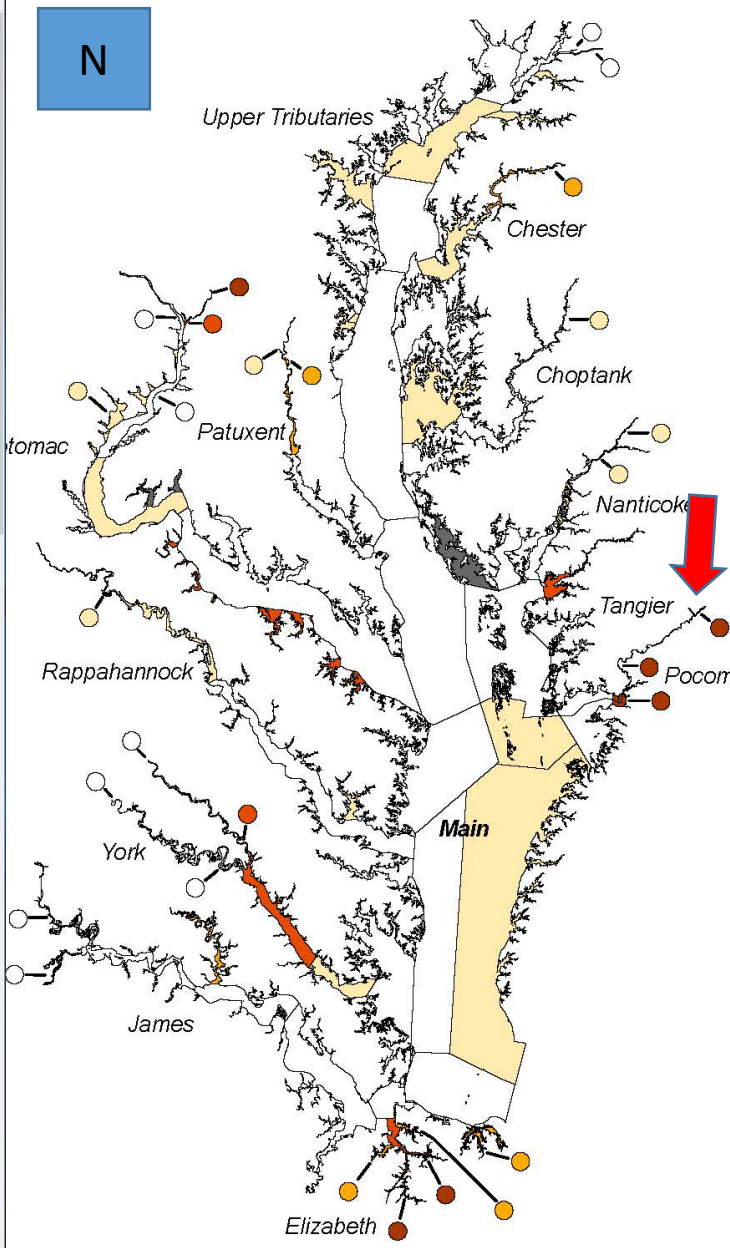


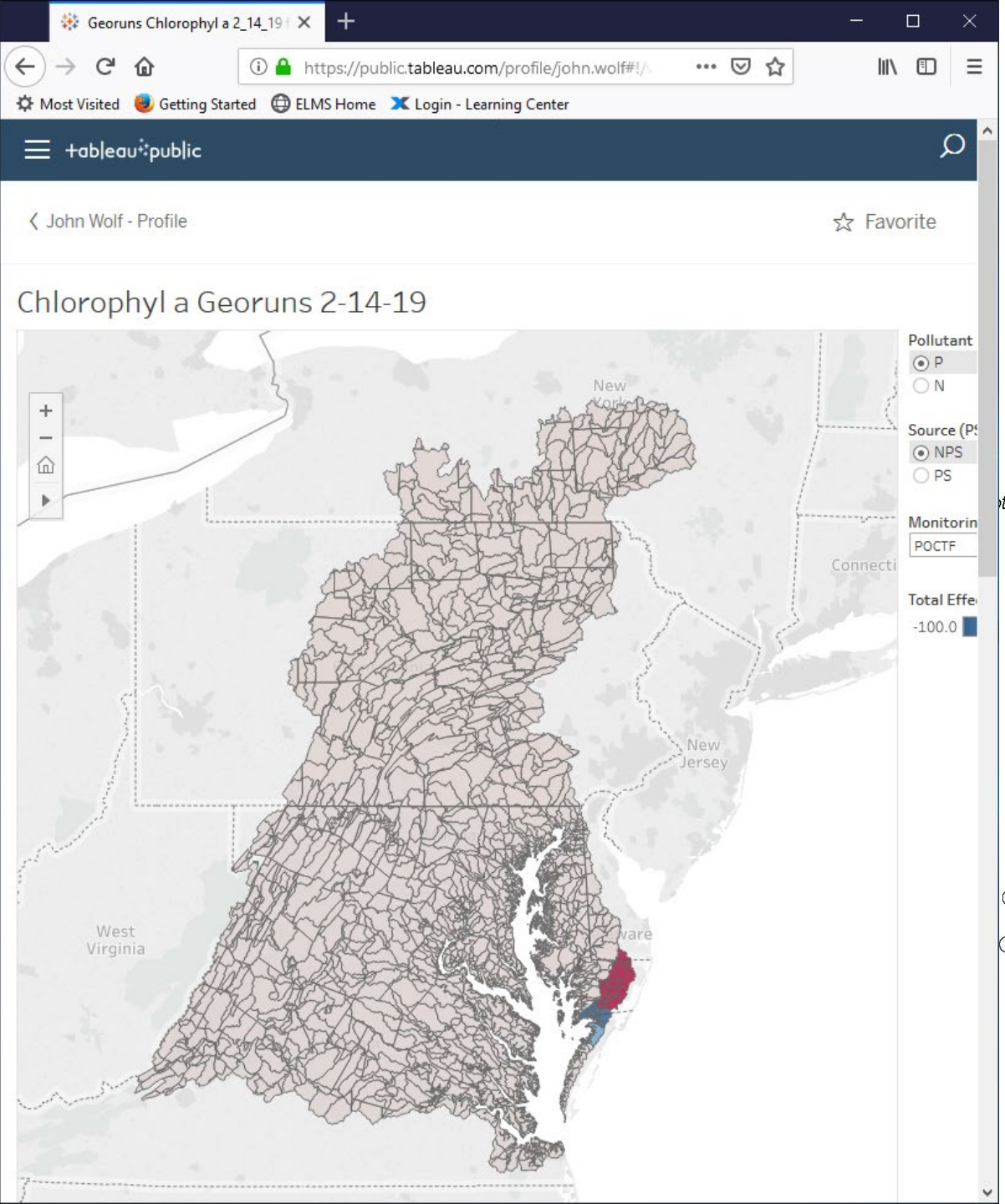
Choptank MH1 MD



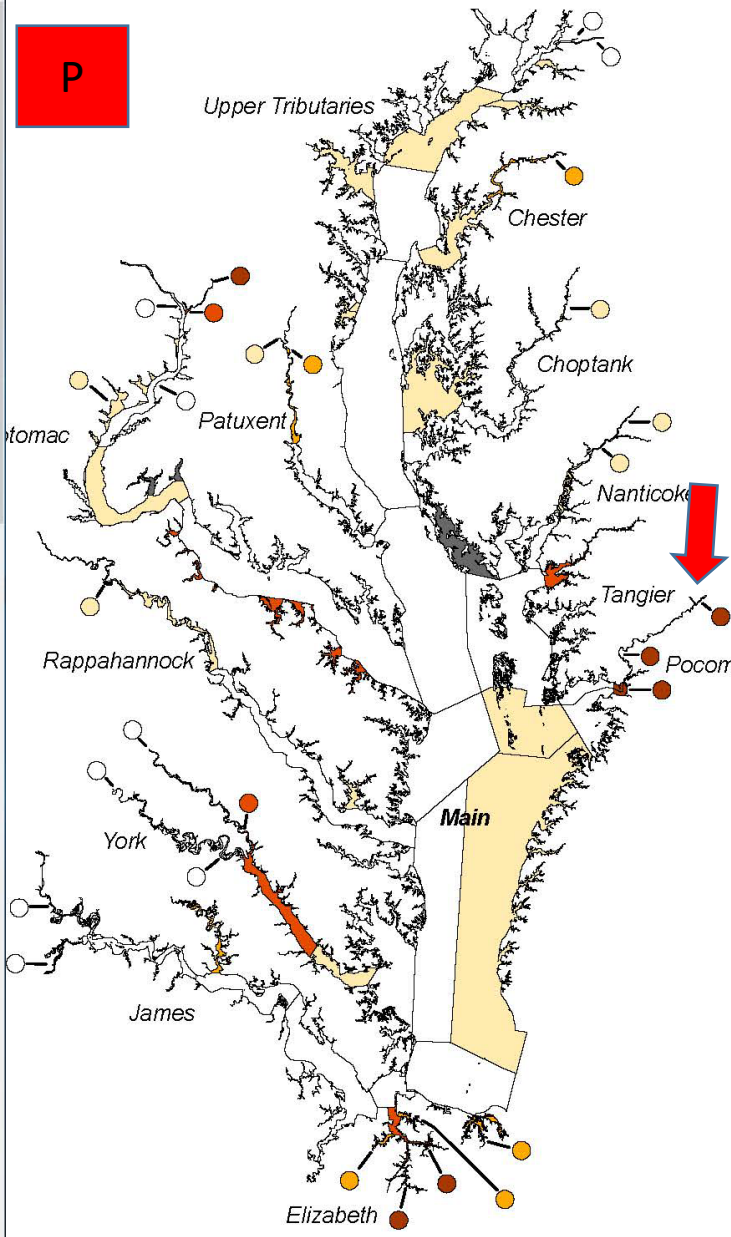


Pocomoke TF MD





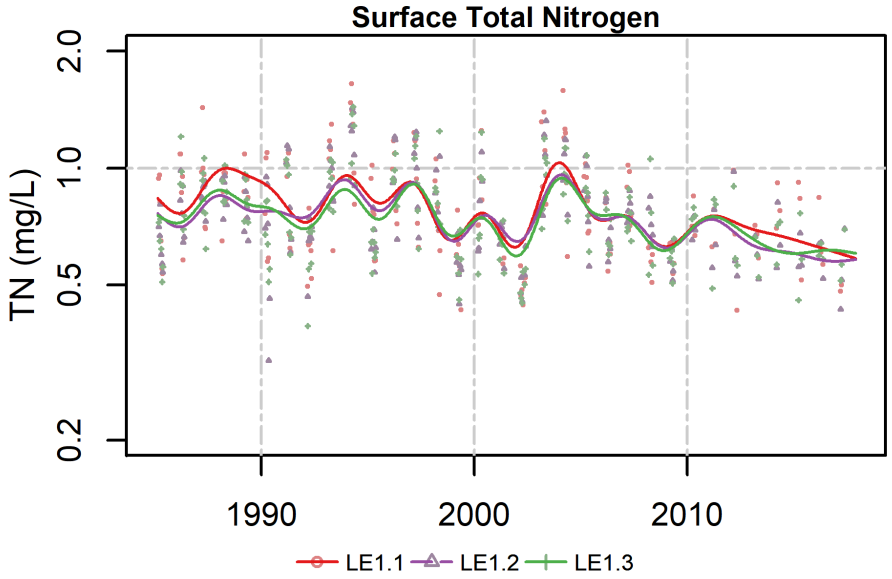
Pocomoke TF MD

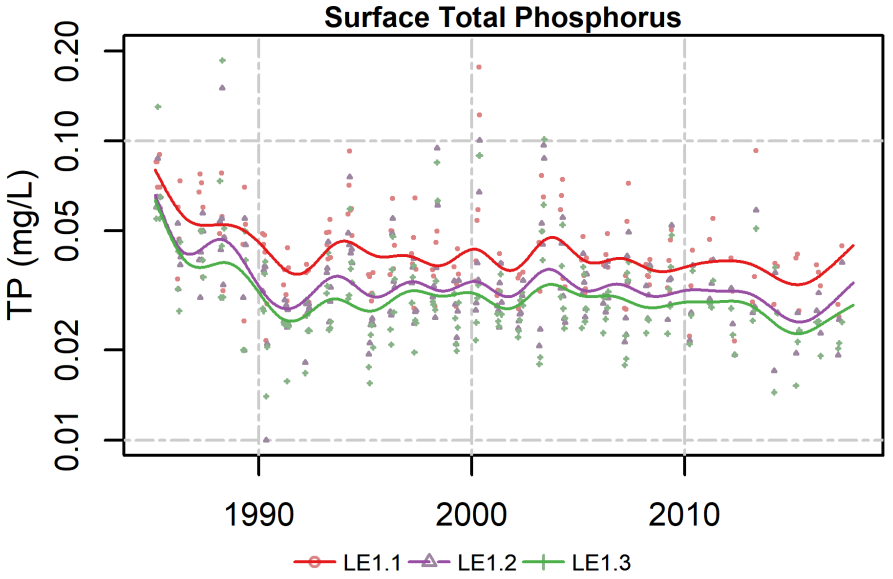


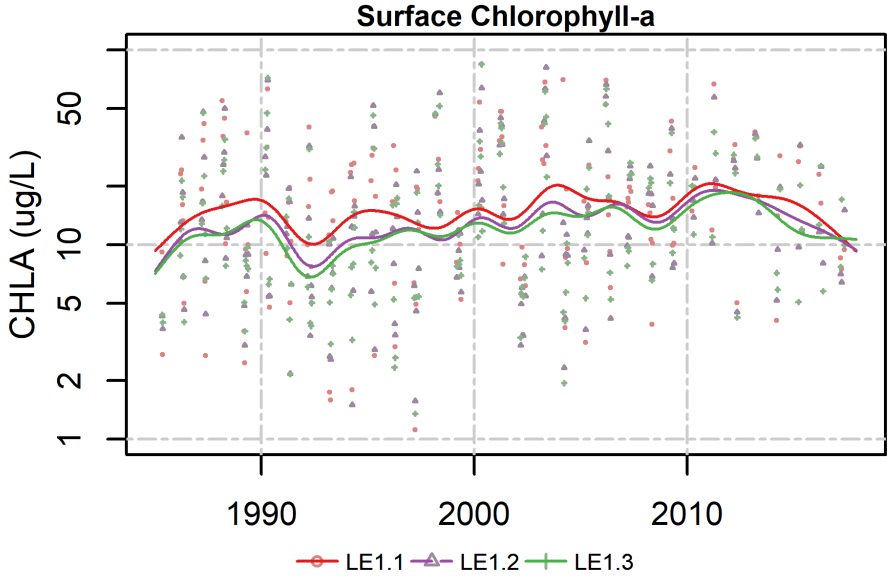
Summary

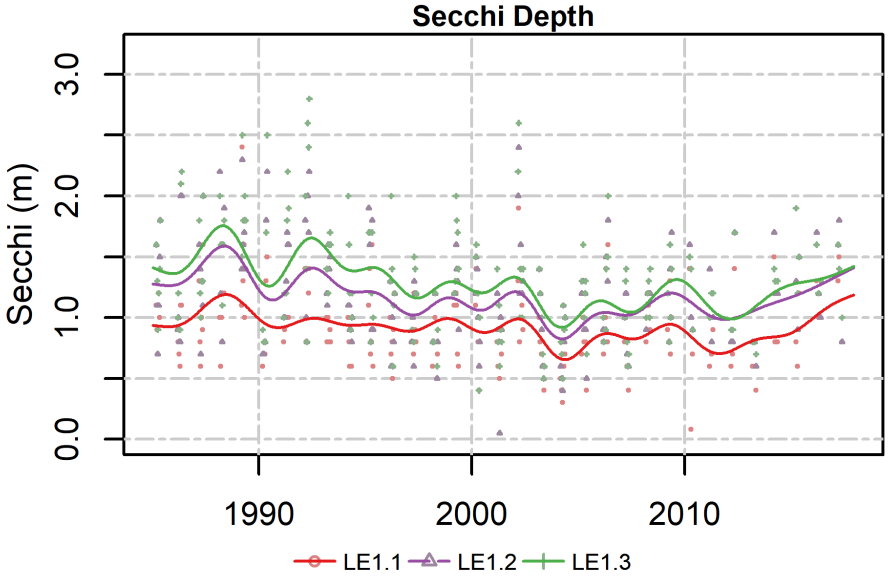
- Promised tool is ready
  - Chlorophyll related to oxygen
  - Visualization only
  - No nutrient exchanges based on these runs
  - Shows primacy of local watersheds to small bays
- Interpretation sometimes difficult
- Invites a lot of interesting scientific questions

Mesohaline Patuxent data and mean model fits for spring (Mar-May)



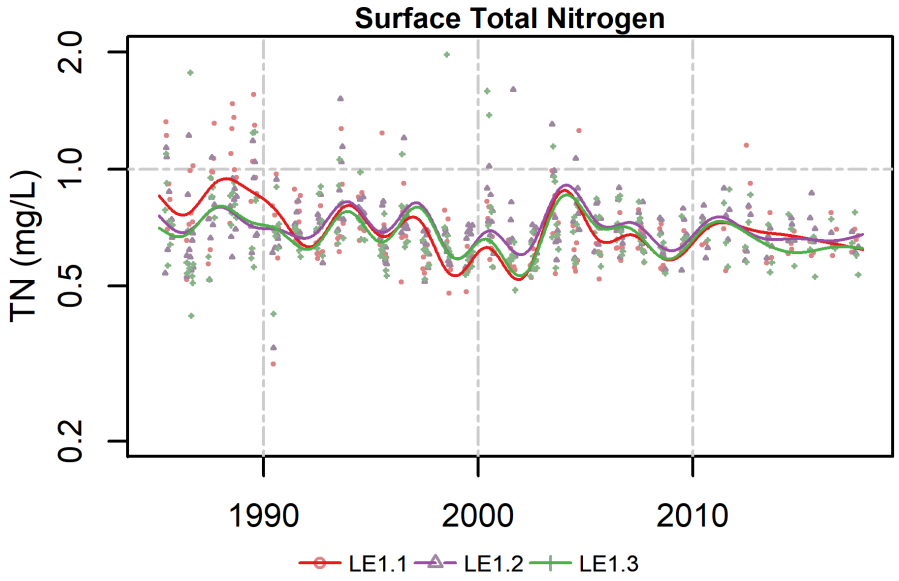


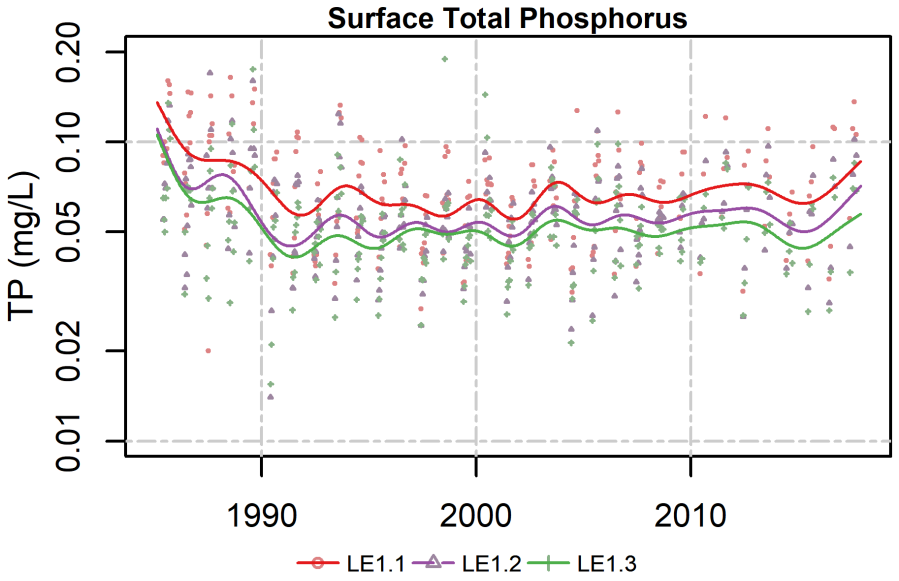


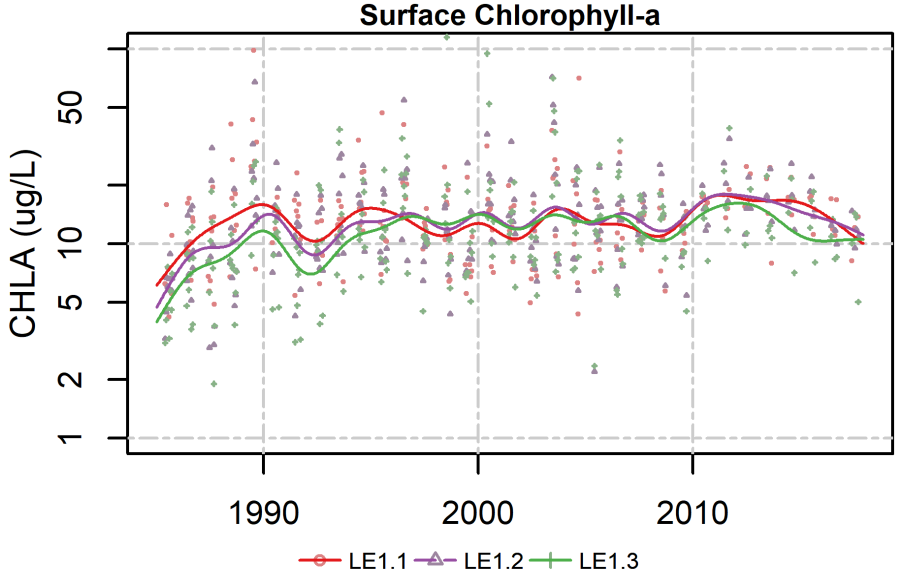


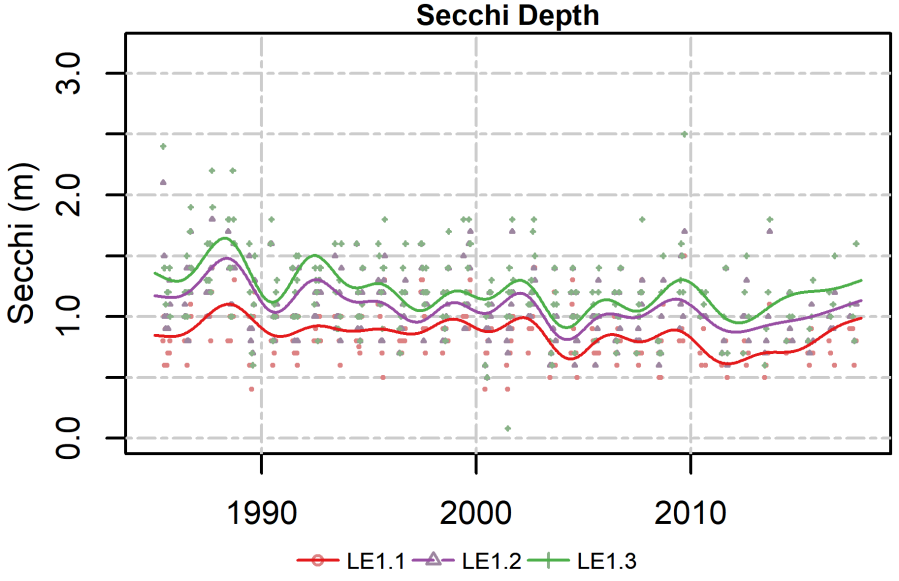
From Rebecca Murphy

Mesohaline Patuxent data and mean model fits for summer (Jun-Sept)









From Rebecca Murphy