Comprehensive Measurements of Rate Processes and Water Quality on the Potomac Estuary, August 2010

University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
CHESAPEAKE BIOLOGICAL LABORATORY

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Casey Sperling, Eva Bailey, Mike Owens, Melissa Day,
Meghann Niesen, & Michael Pennino

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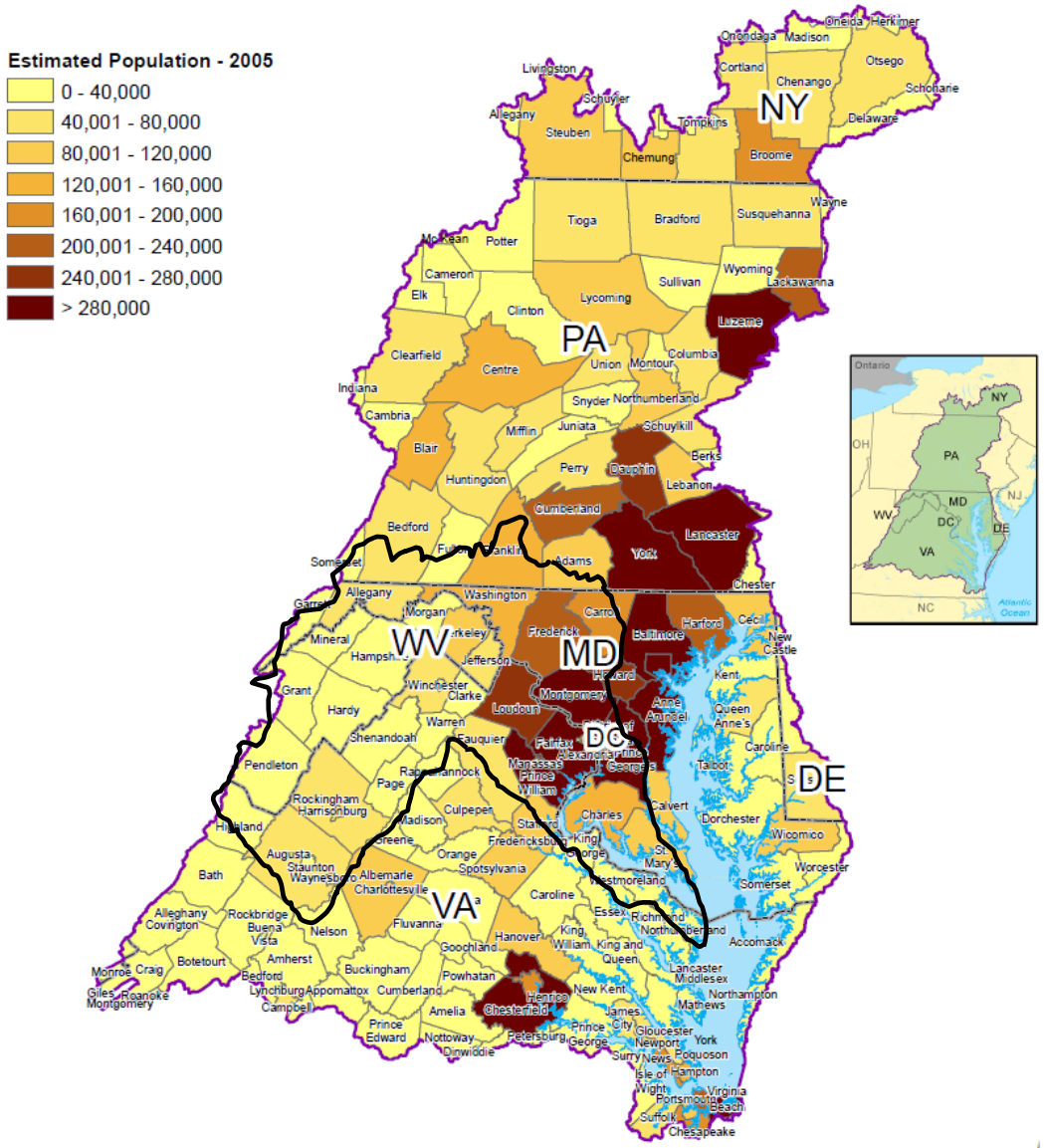
Population (2005)

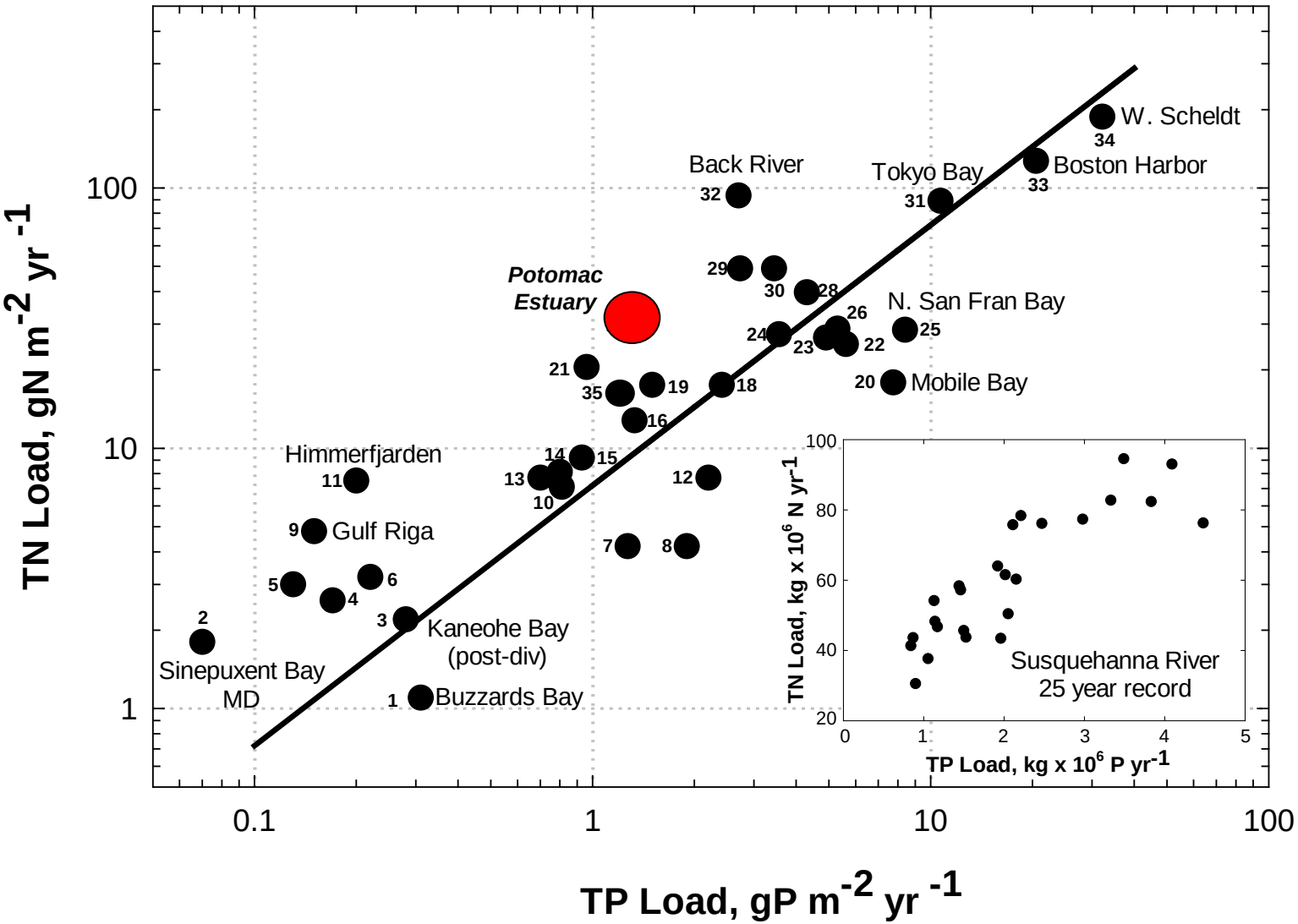
Chesapeake Bay Watershed Counties

Chesapeake Bay Program
A Watershed Partnership



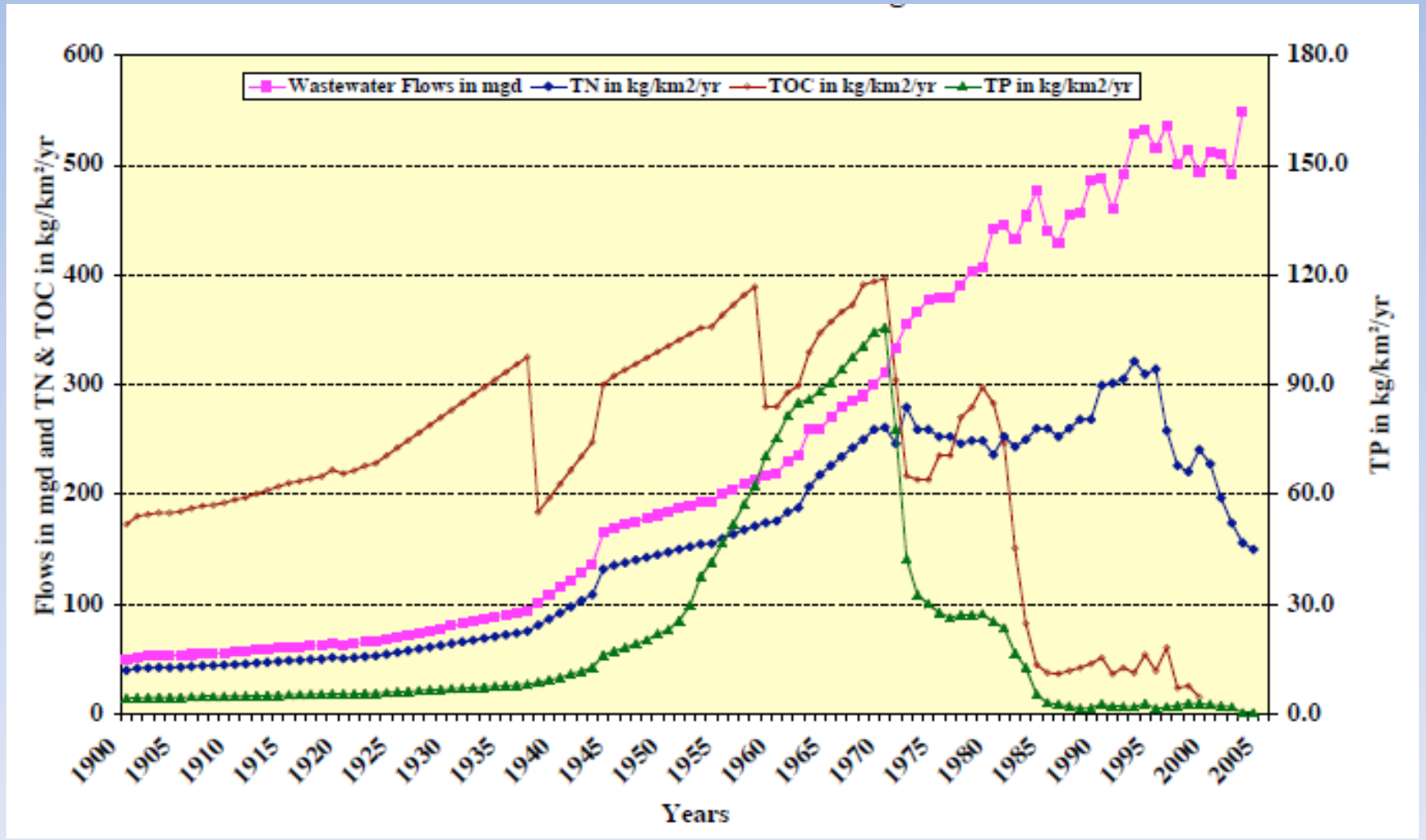
Created by JW, 2/13/08

UTM Zone 18N, NAD 83

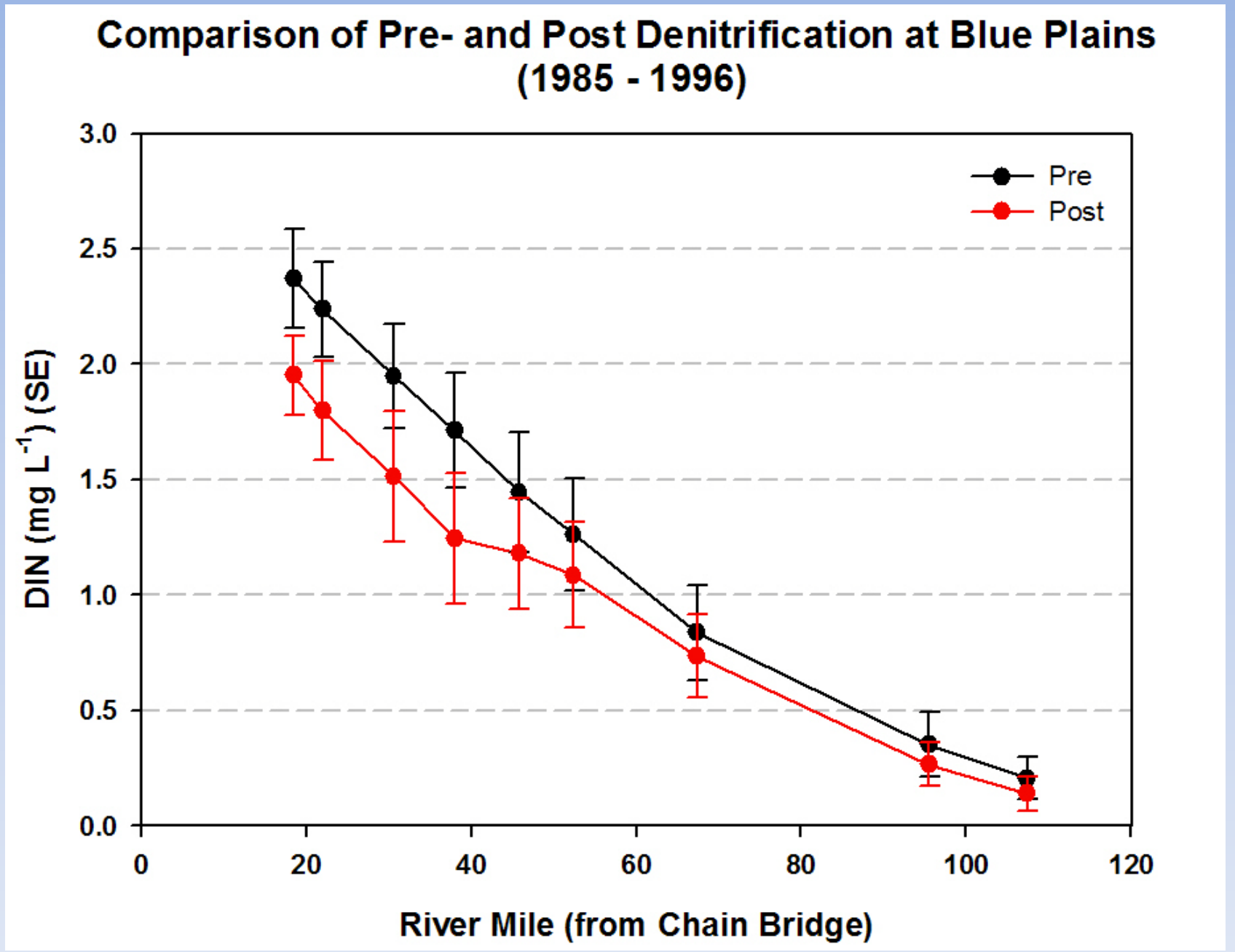


Courtesy Boynton Lab Group

Potomac Estuary Tidal WWTP Discharge Nutrient Trends



Jaworski Treatise



Courtesy Boynton Lab Group

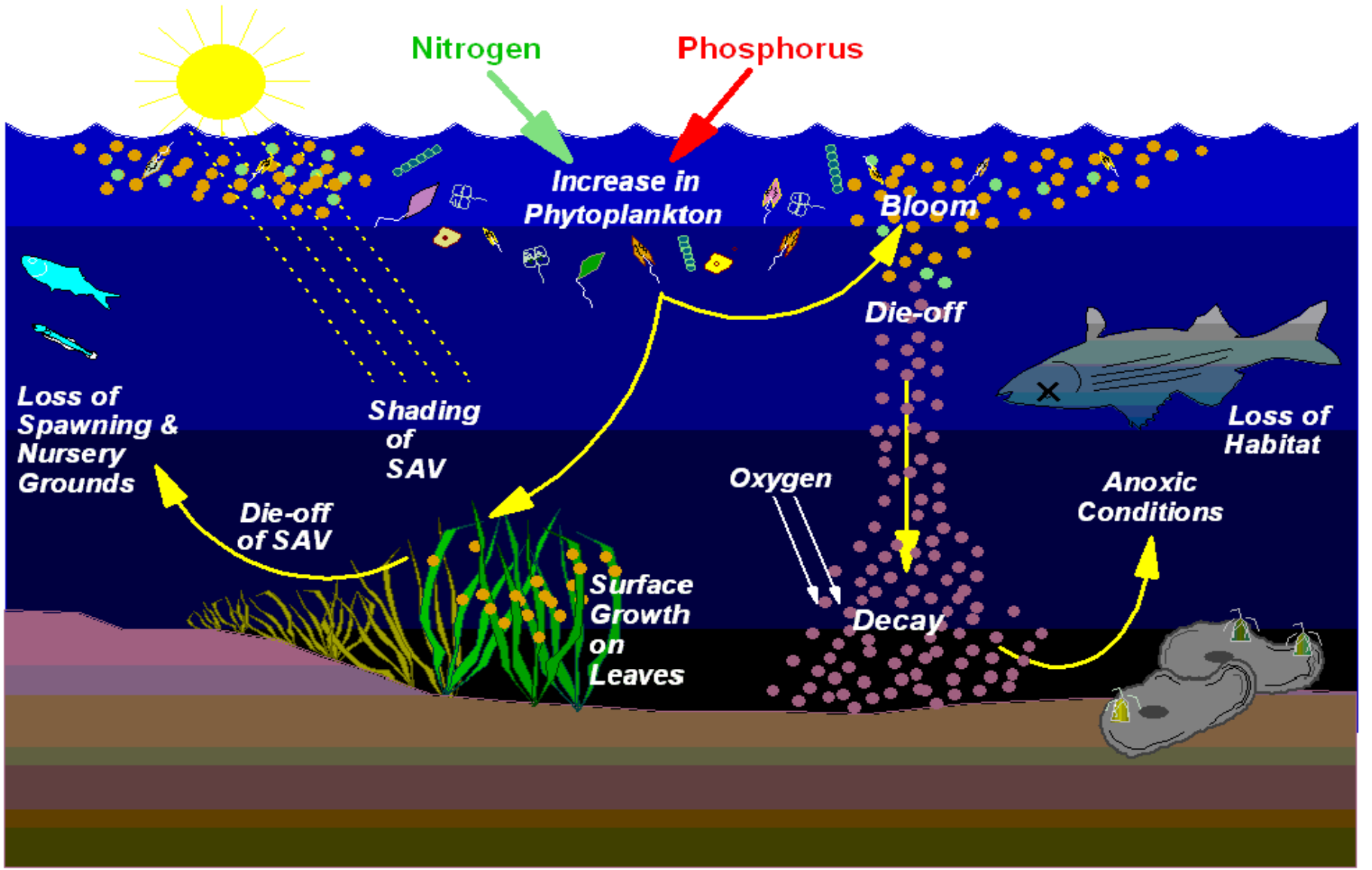
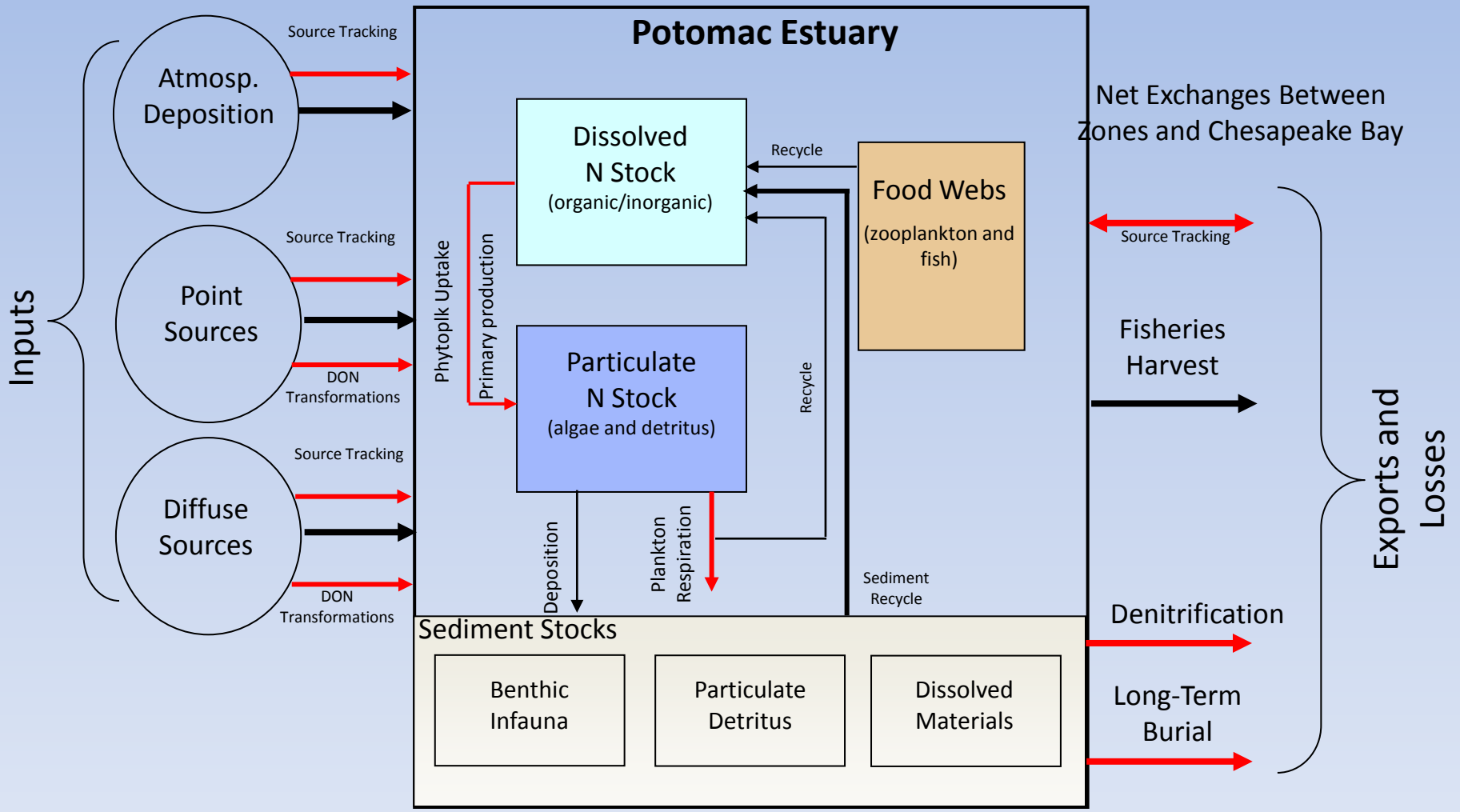


Image courtesy Boynton Lab Group

Conceptual Diagram of Nitrogen Mass Balance for Potomac Estuary



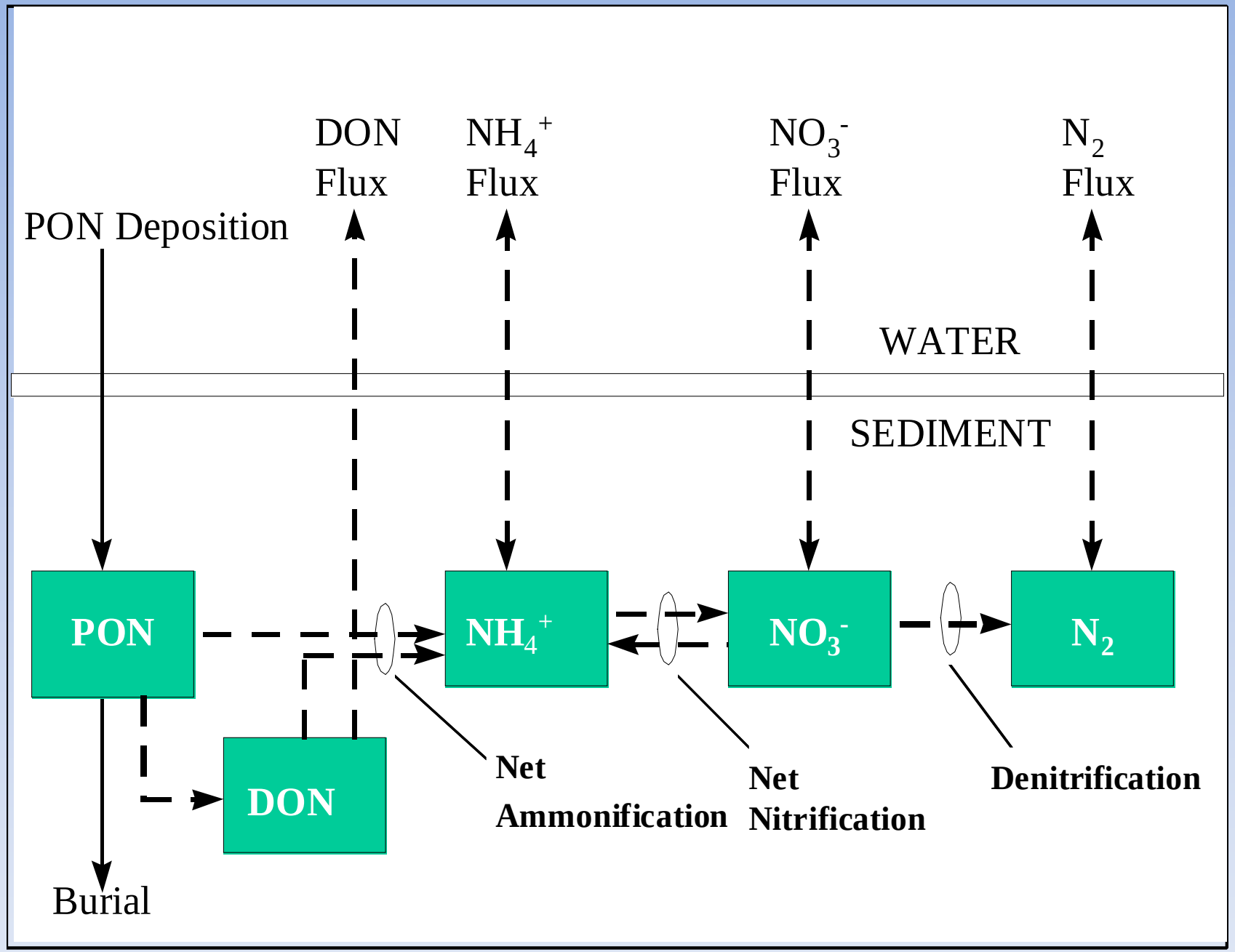
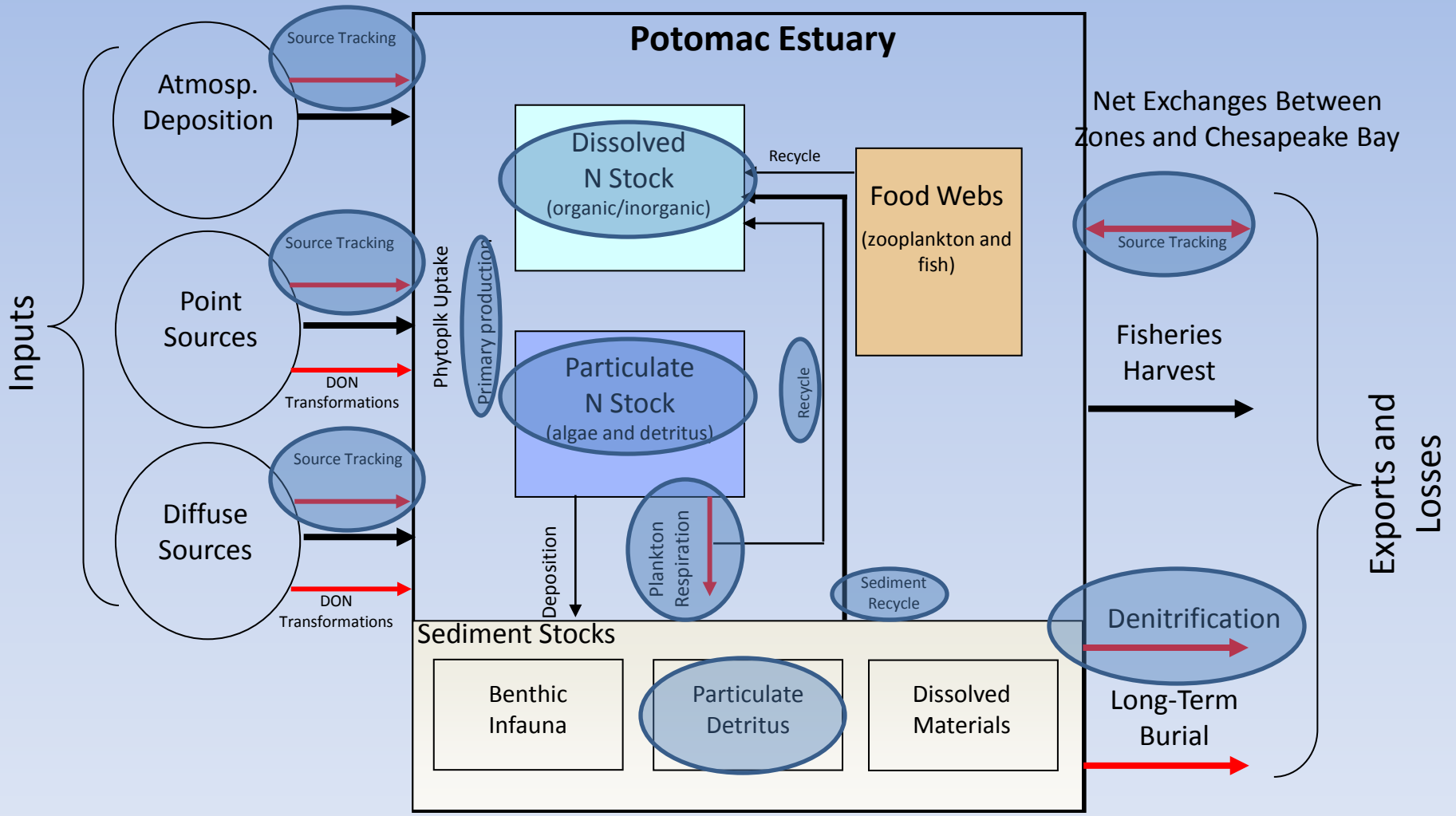


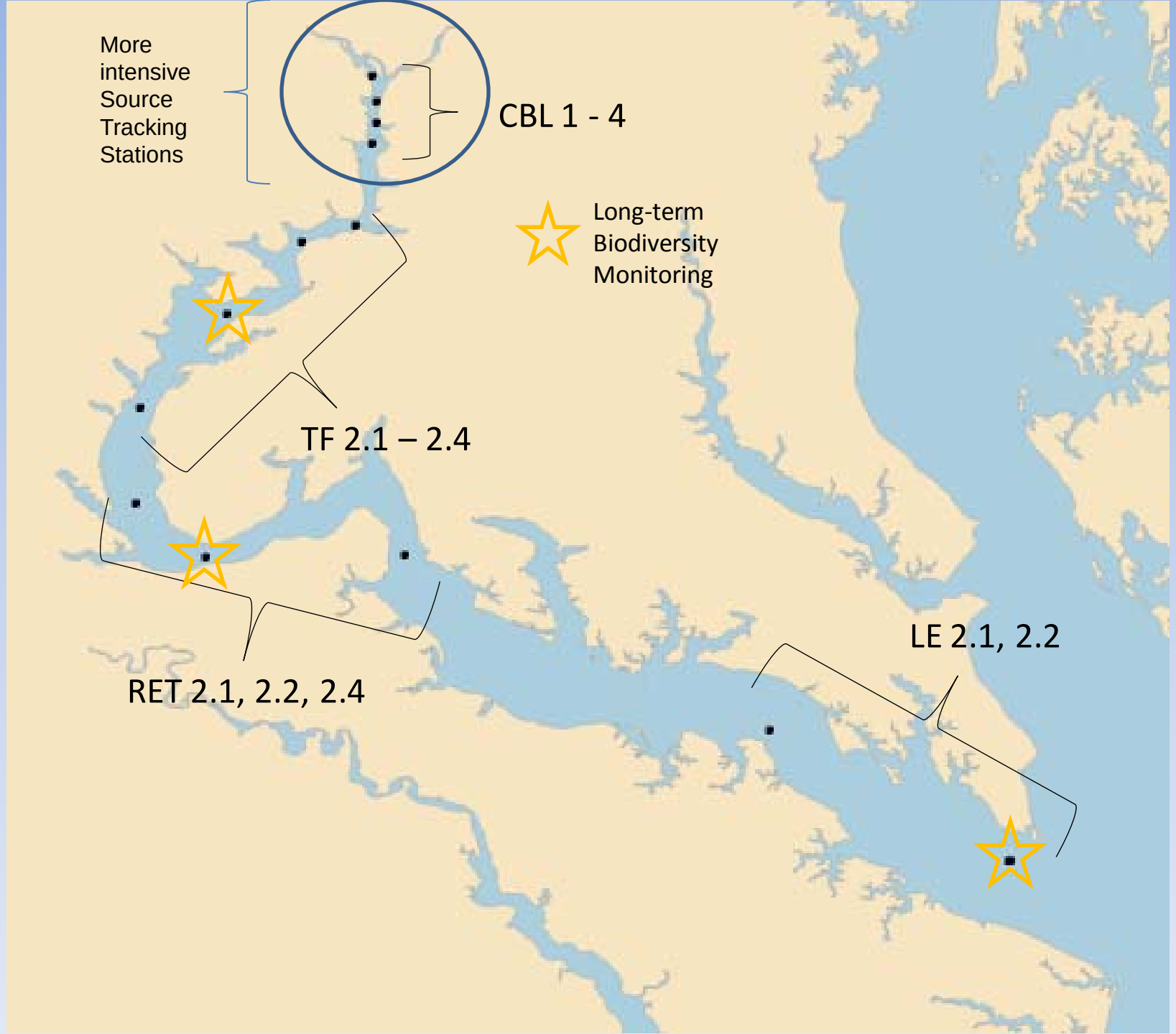
Image courtesy J Cornwell


Potomac Estuary
Inputs
Atmosp. Deposition
Source Tracking
Point Sources
Source Tracking
DON Transformations
Diffuse Sources
Source Tracking
DON Transformations
Phytoplk Uptake
Primary production
Dissolved N Stock
(organic/inorganic)
Recycle
Food Webs
(zooplankton and fish)
Particulate N Stock
(algae and detritus)
Recycle
Deposition
Plankton Respiration
Sediment Recycle
Sediment Stocks
Benthic Infauna
Particulate Detritus
Dissolved Materials
Net Exchanges Between Zones and Chesapeake Bay
Source Tracking
Fisheries Harvest
Denitrification
Long-Term Burial
Exports and Losses

Monitoring of Potomac Water Quality Supported by DC WATER Includes:

Monthly

- Local Cruises Between Gravelly Point and Fort Washington
- Measurements using MD DNR Monthly Cruise collected water
  - light attenuation, salinity, pH, temperature
  - dissolved and particulate nutrients, dissolved oxygen
  - primary production, respiration, chl a, HPLC pigments
  - DNA, taxonomy by microscopy
  - source tracking using eem's and stable isotopes


More intensive Source Tracking Stations
CBL 1 - 4
Long-term Biodiversity Monitoring
TF 2.1 – 2.4
RET 2.1, 2.2, 2.4
LE 2.1, 2.2

Monitoring of Potomac Water Quality Supported by DC WATER Includes:

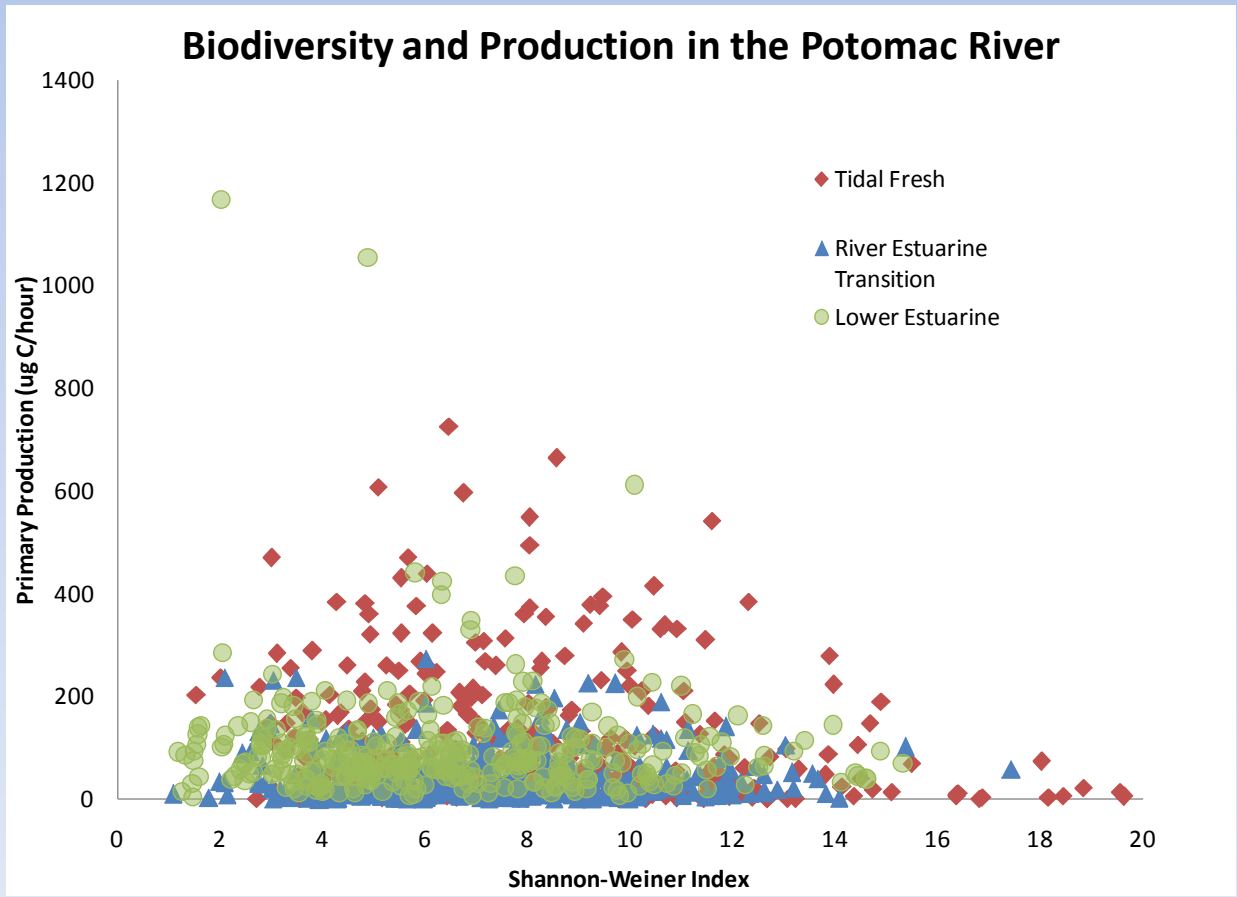
Rachel Carson Cruise

- light attenuation, salinity, pH, temperature
- dissolved and particulate nutrients, dissolved oxygen
- primary production, respiration, chl a, HPLC pigments
- DNA, taxonomy by microscopy
- source tracking using fluorescence indicators and stable isotopes
- ***Sediment flux measurements: denitrification, sediment oxygen demand, NH_4^+ and NO_2/NO_3 fluxes***
- ***sediment nutrient concentrations, sediment***

Graduate Student Research

Meghann Niesen, M.S. candidate UMCES-CBL

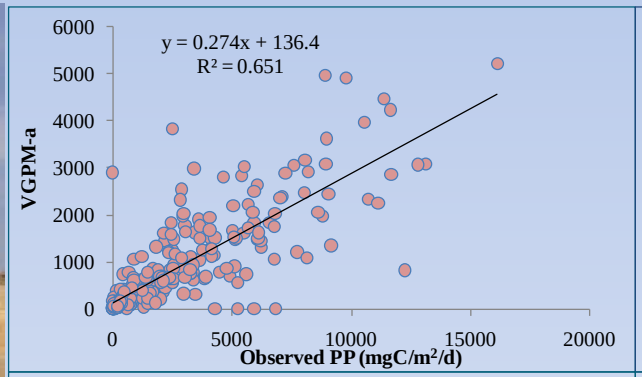
1. *Are primary production rates influenced by biodiversity in the Potomac?*
2. *How do molecular approaches compare with microscopic identification when measuring metrics of biodiversity?*

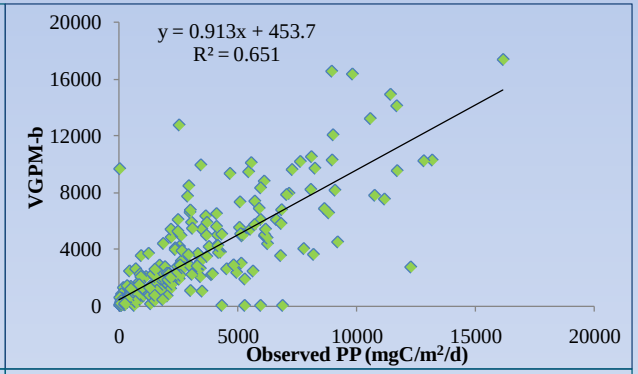


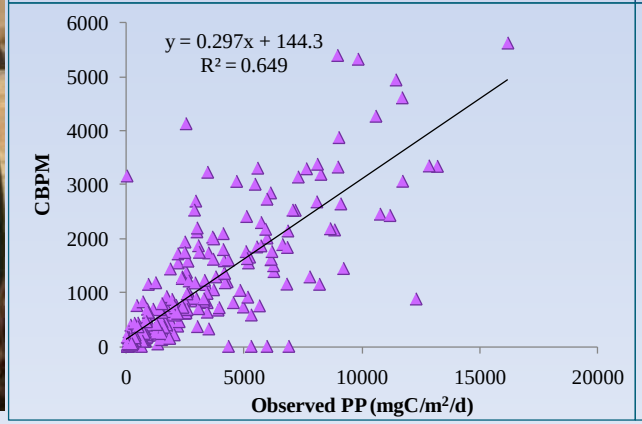
Graduate Student Research

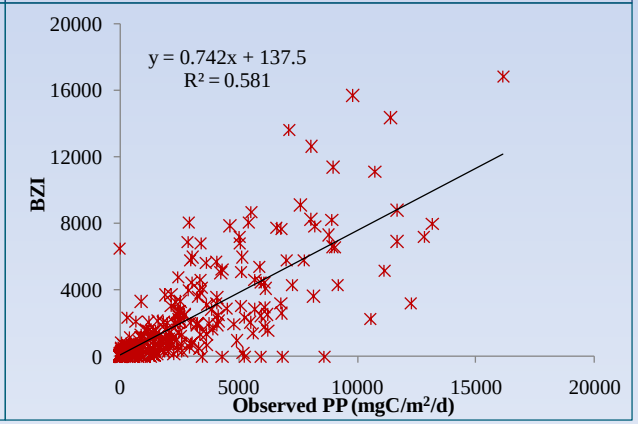
Katherine Ziombra, M.S. candidate UMCES-CBL

1. *What models of primary production are effective in the tidal fresh Potomac?*
2. *How have patterns of water column nitrogen concentrations changed in the context of management actions at the Blue Plains Wastewater Treatment Plant?*





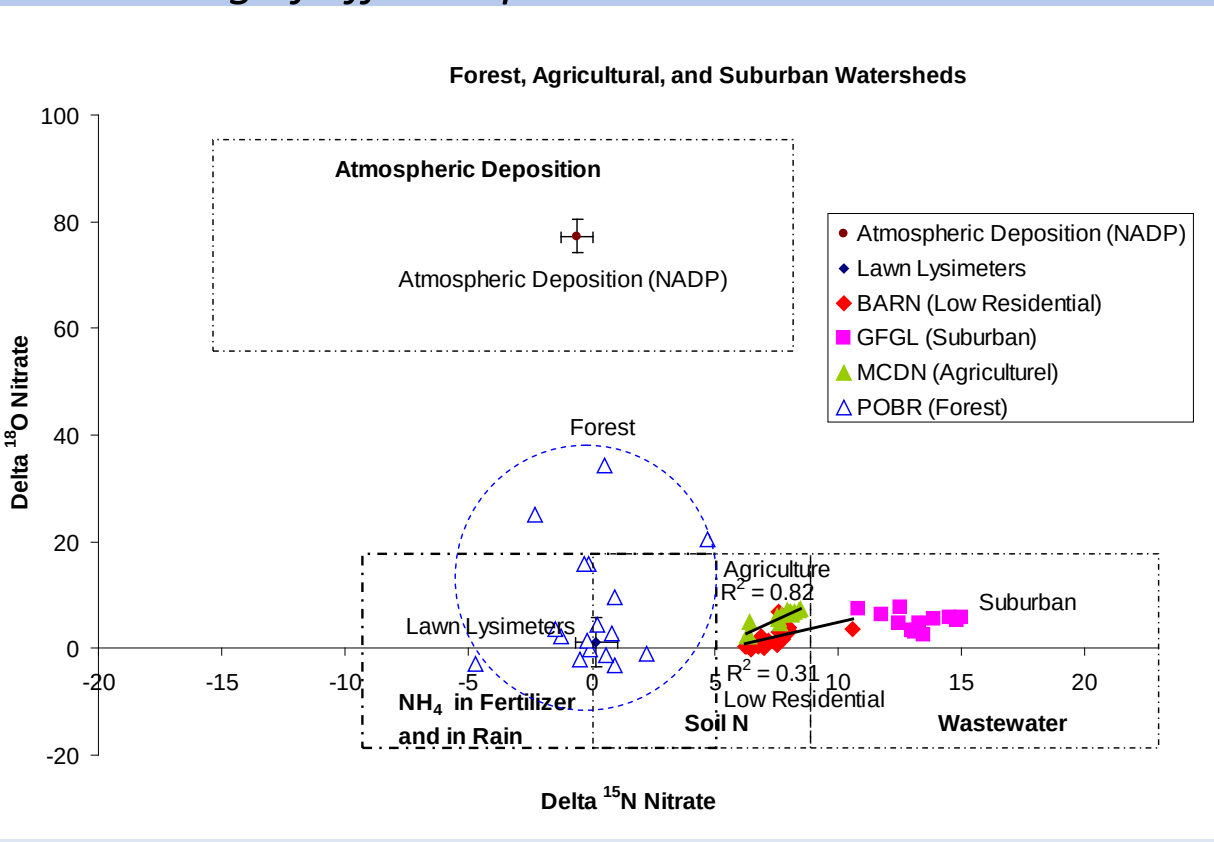




Graduate Student Research

Michael Pennino, PhD candidate UMBC

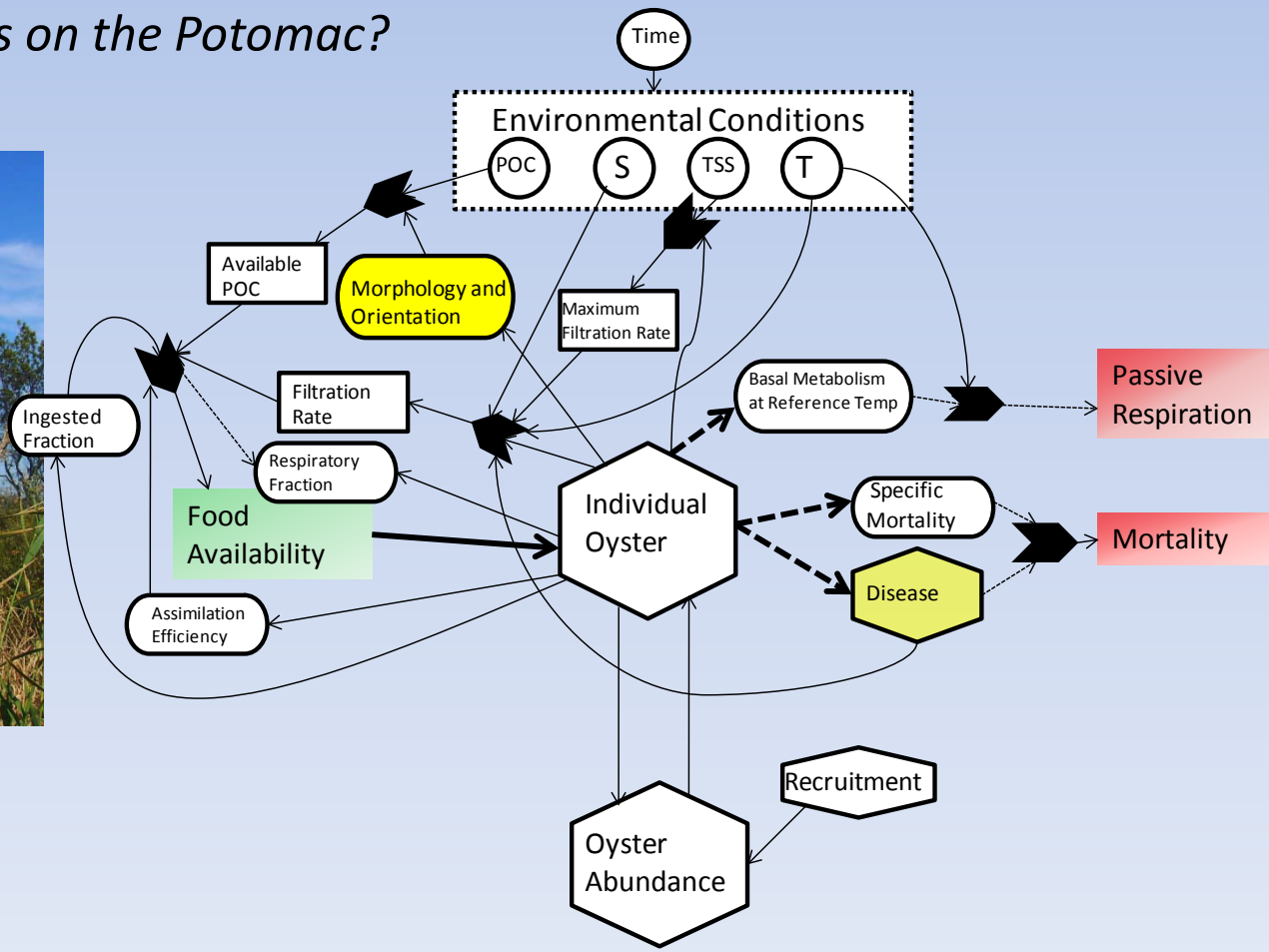
1. *Can a combination of δN15 and δO18 stable isotopic tracers be used for source tracking of Blue Plains wastewater effluent in the Potomac?*
2. *Will excitation emission matrices and associated fluorescence indices complement isotopic tracers for improved modeling of effluent plumes?*



Graduate Student Research

Melinda Forsyth, M.S. candidate UMCES-CBL

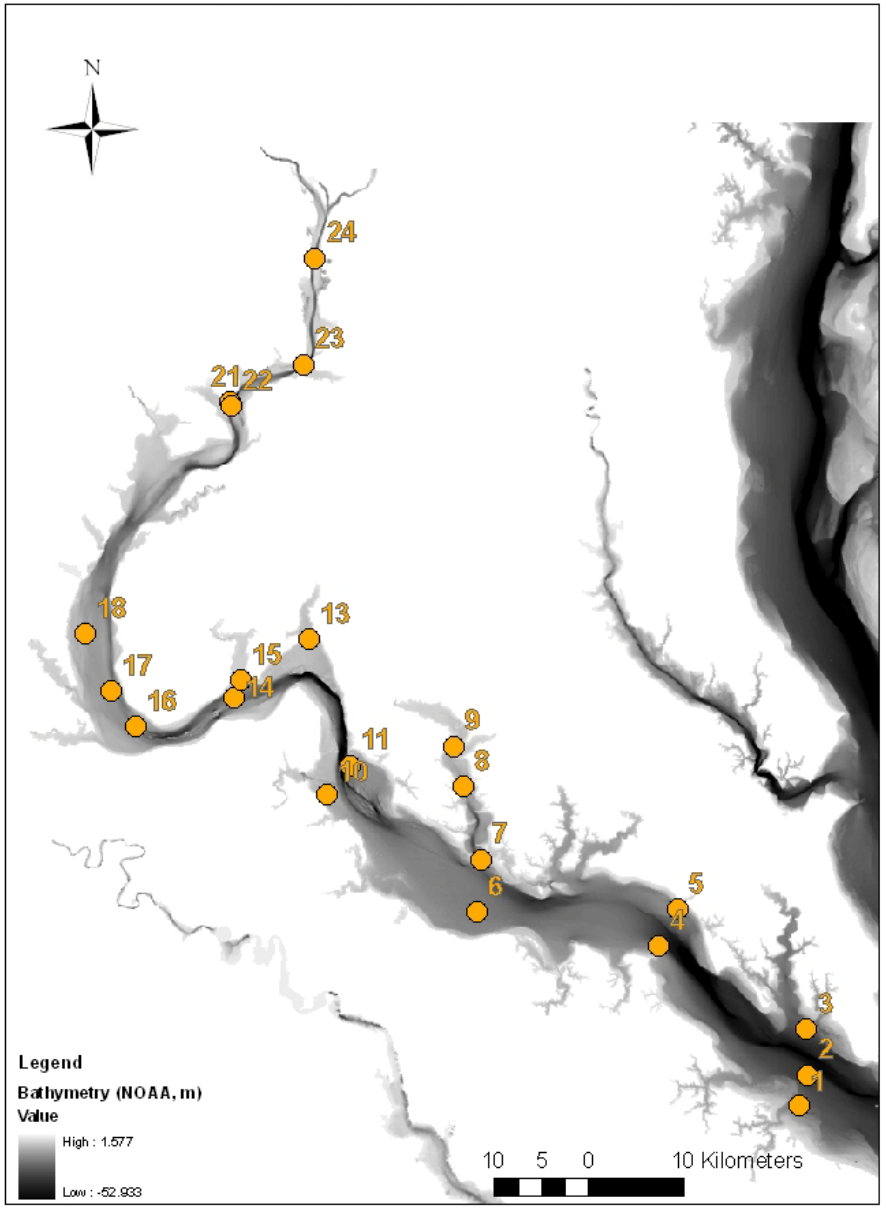
1. *Do oyster morphology and orientation affect particle capture and, ultimately, oyster growth?*
2. *Can an individual-based bioenergetic oyster model incorporating morphology inform restoration efforts on the Potomac?*




RACHEL CARSON

August 9-12, 2010

- Four Principal Investigators: Harris, Boynton, Kaushal, Cornwell
- Most comprehensive measurements of estuarine rate processes and water quality made at one time
- Successful measurements and execution of all cruise objectives



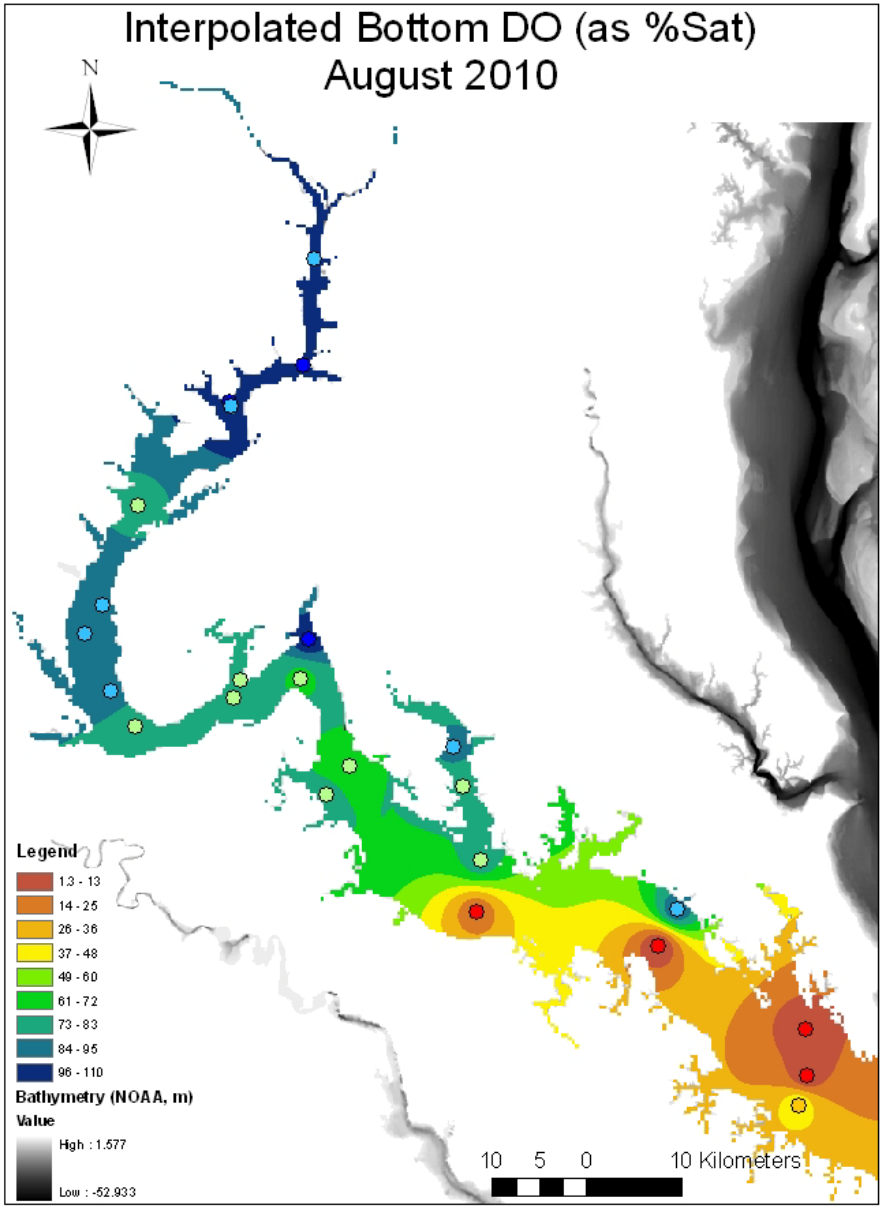
Preliminary Results August 2010 Cruise

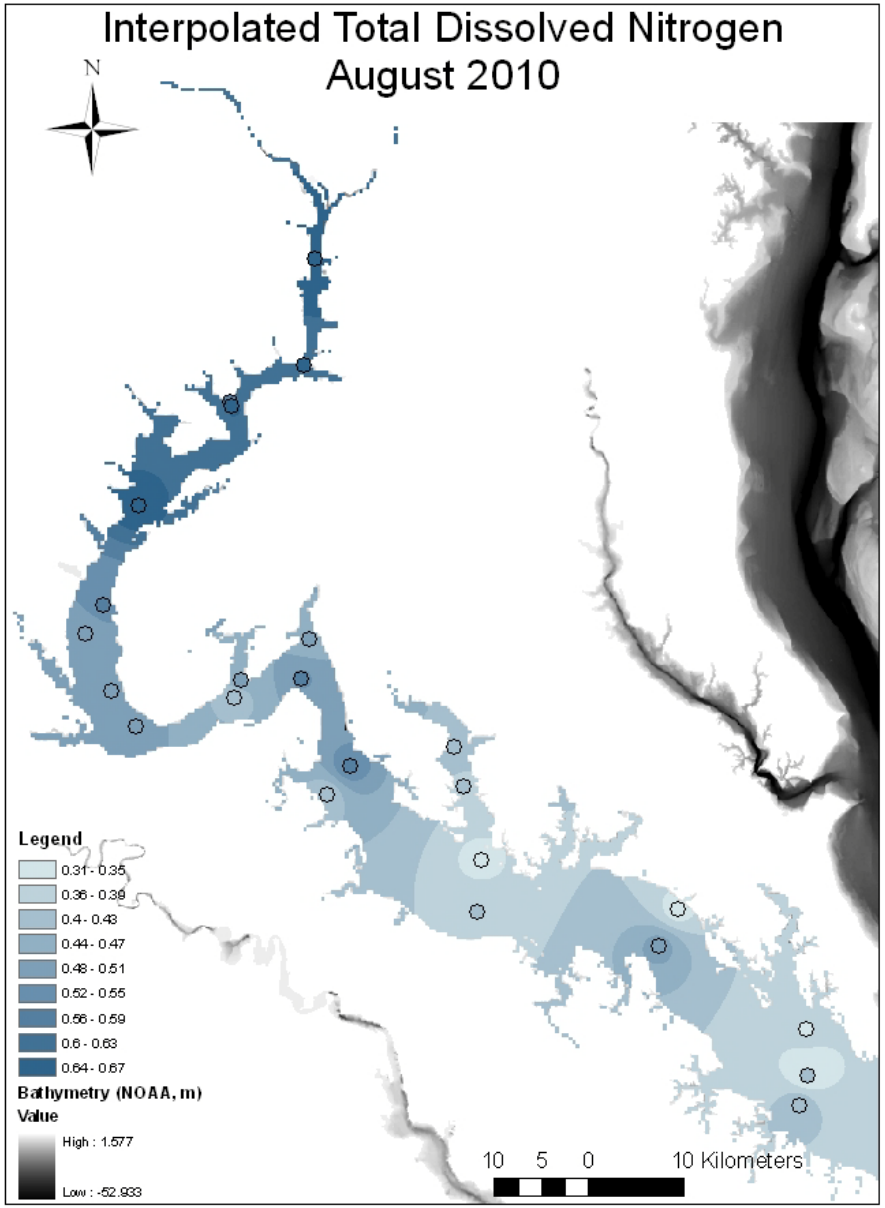
Water Column Sampling:

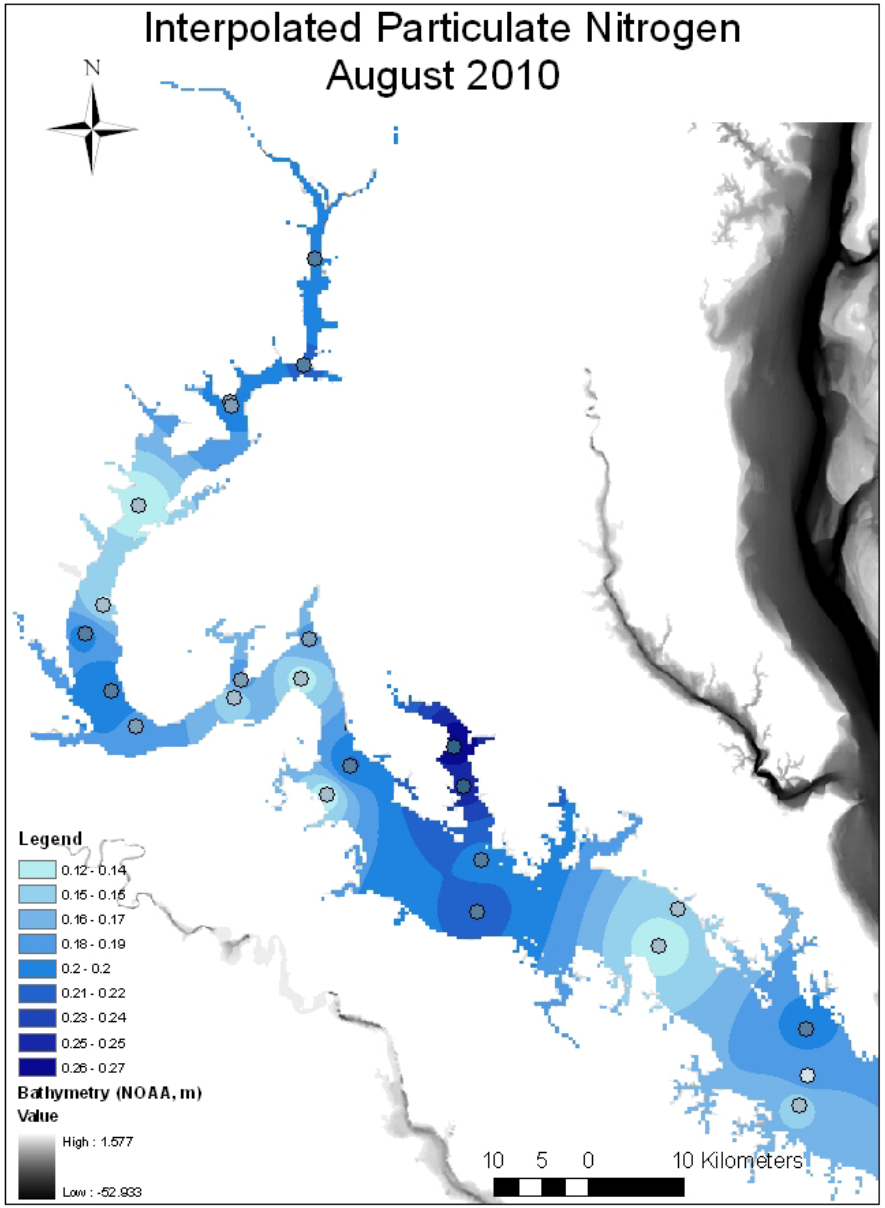
- *Surface*
- *Below pycnocline*
- *Bottom water*

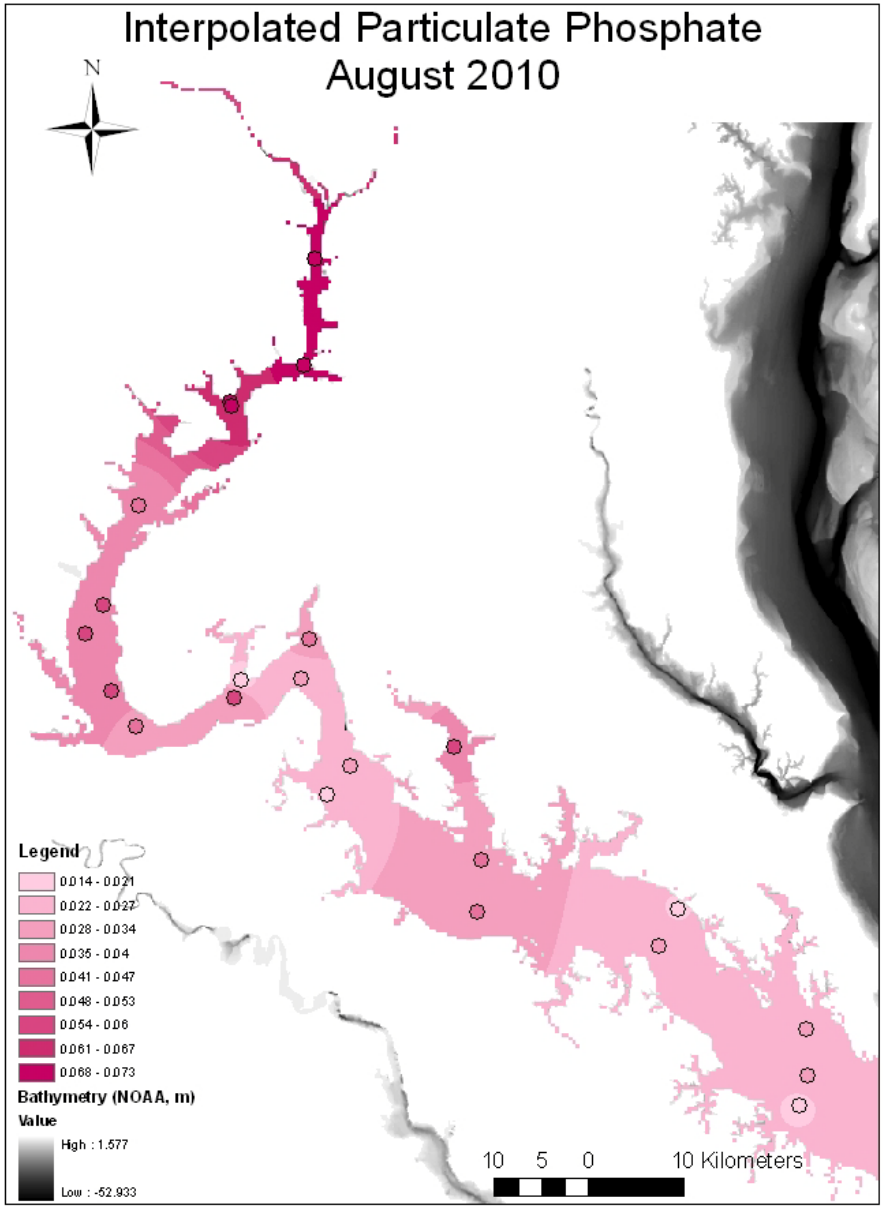
Sediment Cores for

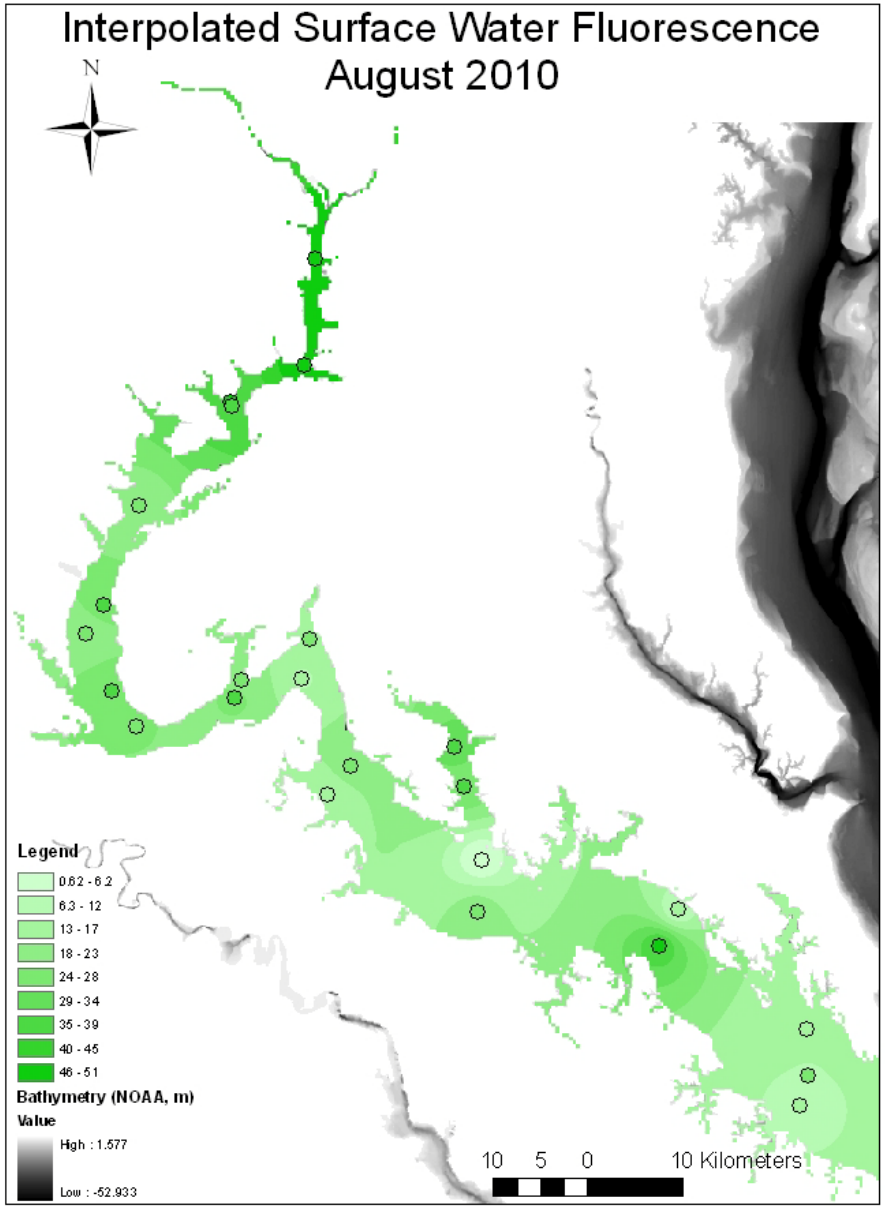
- *Nutrient fluxes*
- *Denitrification*
- *Sediment Oxygen Demand*

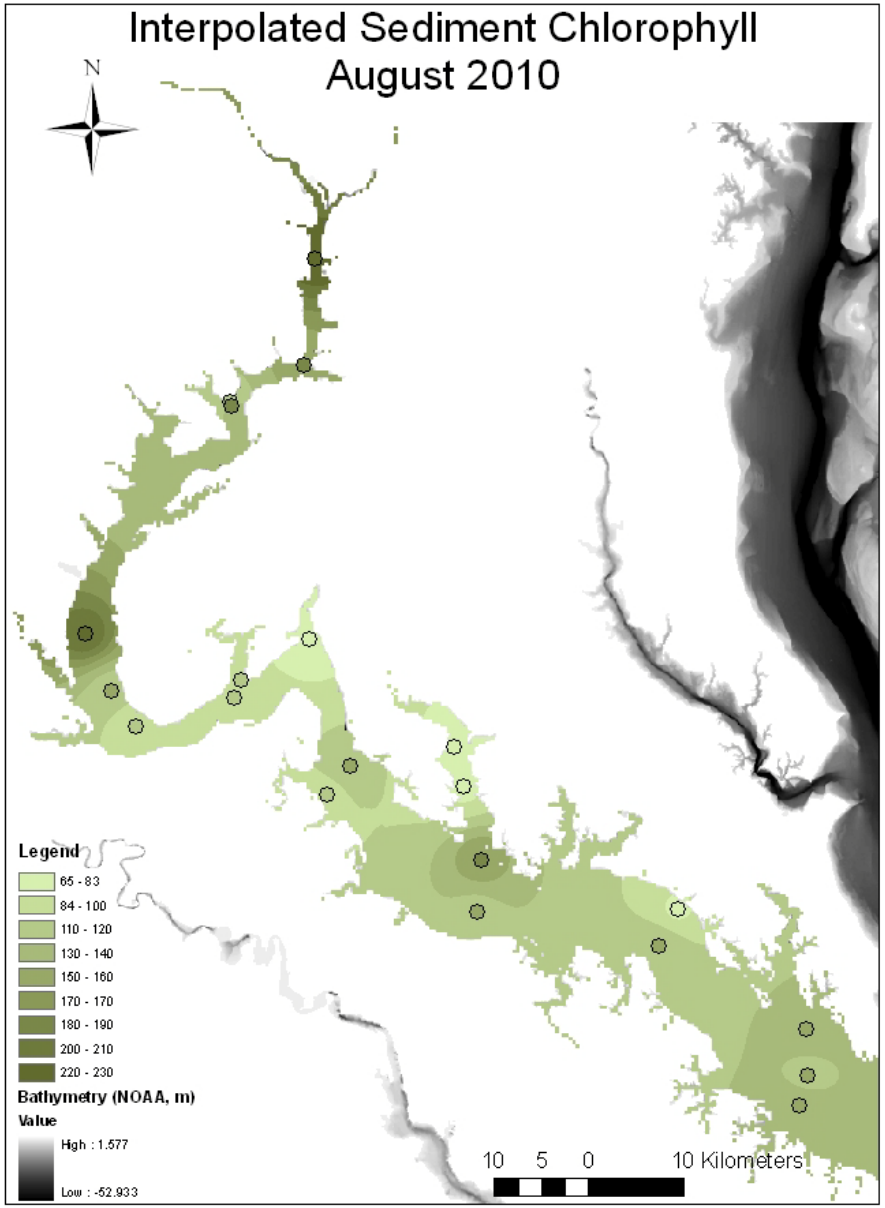


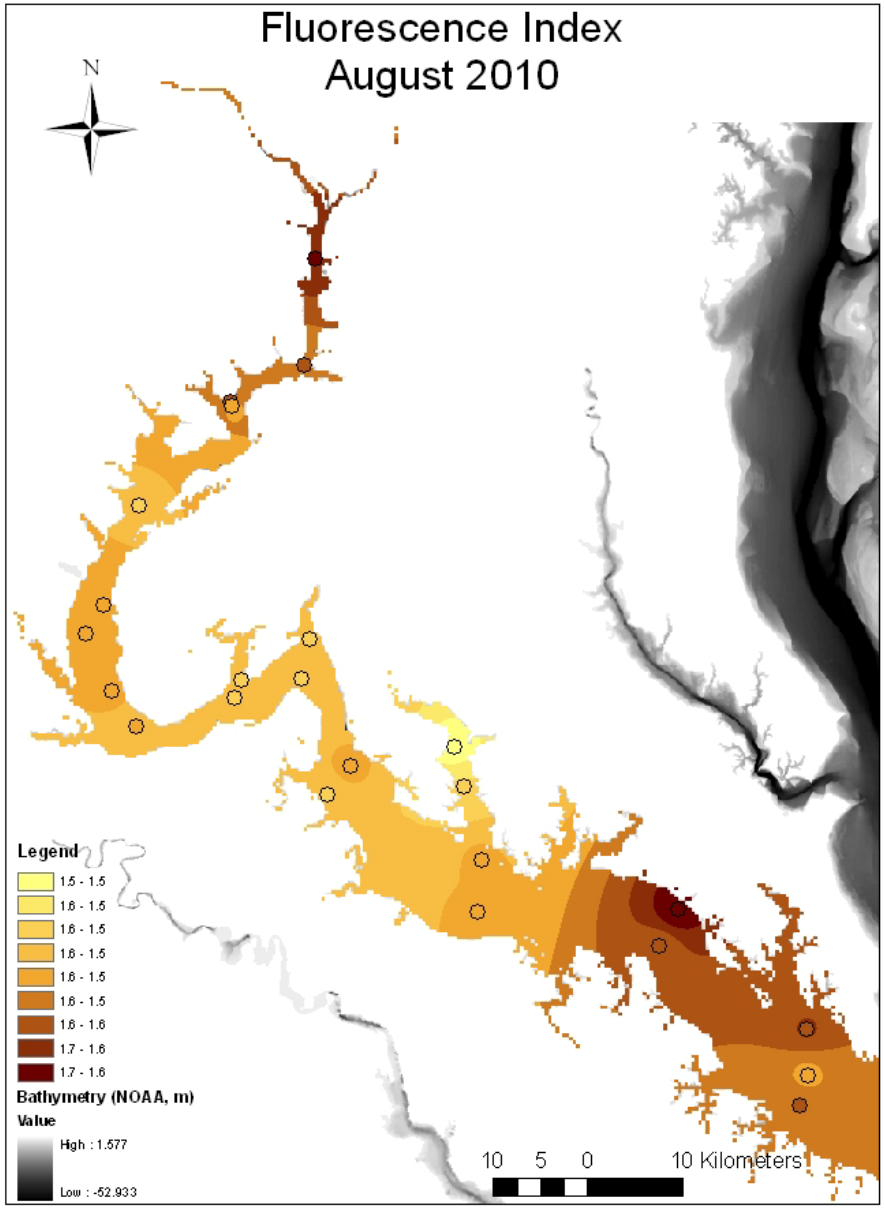

Interpolated Total Dissolved Nitrogen
August 2010
N
Legend
0.31 - 0.35
0.36 - 0.39
0.4 - 0.43
0.44 - 0.47
0.48 - 0.51
0.52 - 0.55
0.56 - 0.59
0.6 - 0.63
0.64 - 0.67
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers

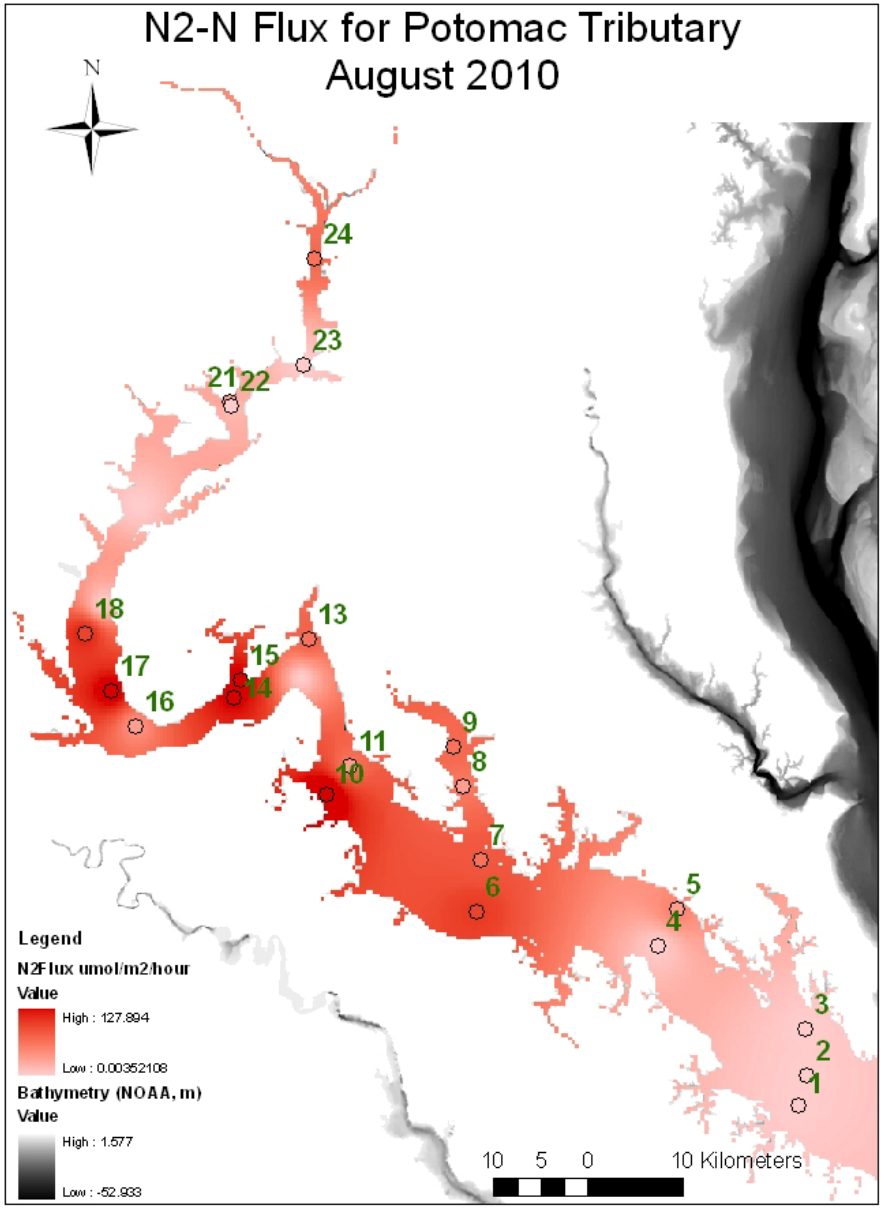

Interpolated Particulate Nitrogen
August 2010
N
Legend
0.12 - 0.14
0.15 - 0.15
0.16 - 0.17
0.18 - 0.19
0.2 - 0.2
0.21 - 0.22
0.23 - 0.24
0.25 - 0.25
0.26 - 0.27
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers


Interpolated Particulate Phosphate
August 2010
N
Legend
0.014 - 0.021
0.022 - 0.027
0.028 - 0.034
0.035 - 0.04
0.041 - 0.047
0.048 - 0.053
0.054 - 0.06
0.061 - 0.067
0.068 - 0.073
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers


Interpolated Surface Water Fluorescence
August 2010
N
Legend
0.62 - 6.2
6.3 - 12
13 - 17
18 - 23
24 - 28
29 - 34
35 - 39
40 - 45
46 - 51
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers


Interpolated Sediment Chlorophyll
August 2010
N
Legend
65 - 83
84 - 100
110 - 120
130 - 140
150 - 160
170 - 170
180 - 190
200 - 210
220 - 230
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers


Fluorescence Index
August 2010
N
Legend
1.5 - 1.5
1.6 - 1.5
1.6 - 1.5
1.6 - 1.5
1.6 - 1.5
1.6 - 1.5
1.6 - 1.6
1.7 - 1.6
1.7 - 1.6
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers


N2-N Flux for Potomac Tributary
August 2010
N
24
23
21
22
18
13
17
15
16
14
9
11
8
10
7
6
5
4
3
2
1
Legend
N2Flux umol/m2/hour
Value
High : 127.894
Low : 0.00352108
Bathymetry (NOAA, m)
Value
High : 1.577
Low : -52.933
10 5 0 10 Kilometers

Estimates of Denitrification

1. Rate measurements of N2-N fluxes interpolated across lower Potomac

2. Raster dataset exported fromArcGIS, predictions summed to estimate total denitrification rate for Potomac.

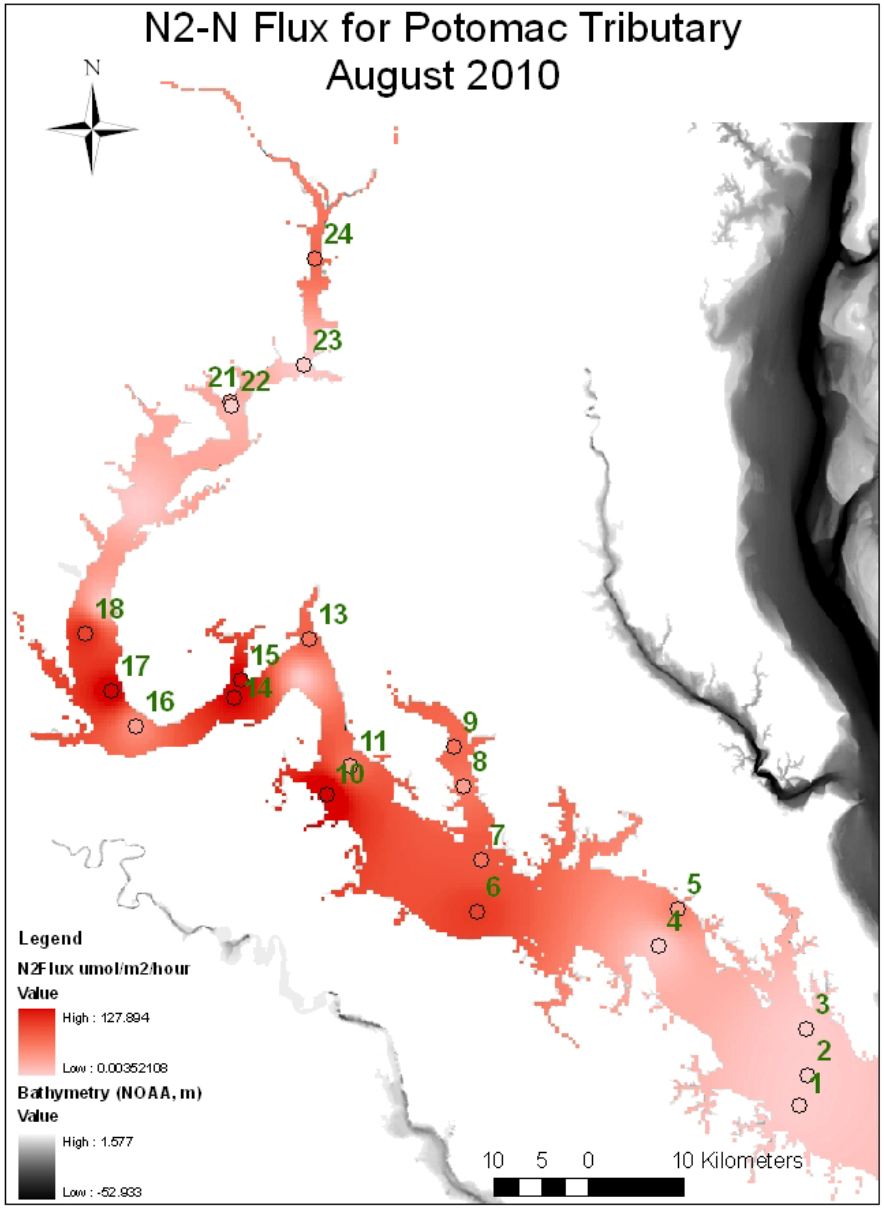
   ~15,900 kg N per day

3. Inputs of N from upper Potomac averaged for July and August, 2009

   8695 kg N per day

4. Inputs of N from Blue Plain averaged for July and August, 2007

   6976 kg N per day



Missing Pieces:

Seasonal Variability:

~~***Spring:*** High Nitrate, High Oxygen, Spring Bloom~~
Funded by DCWATER in May of 2011!

Fall: Low Nitrate, High Oxygen,

Winter: Low Temp, High Nitrate, High Oxygen

Measured Parameters:

Nutrient Burial

SAV Denitrification/Nitrification

DON Bioavailability

Modeling:

Ideally incorporate into Potomac version of Bay Model to improve formulation of rate processes.

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Acknowledgements

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M Niesen, M Forsyth, K Ziombra (UMCES-CBL)

A Bayard & L Wainger

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Sally Bowen & Mark Trice

S Murthy, W Bailey, M Siddique

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