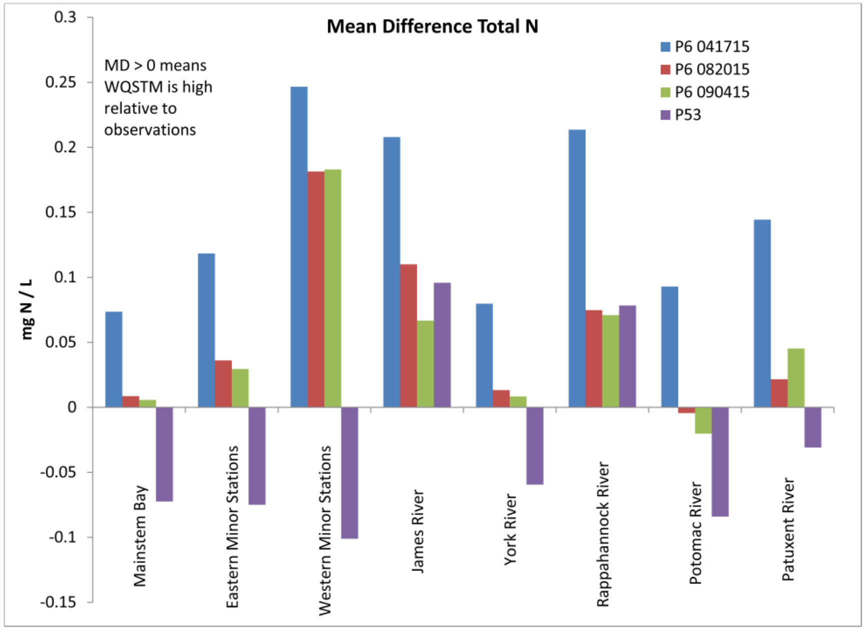
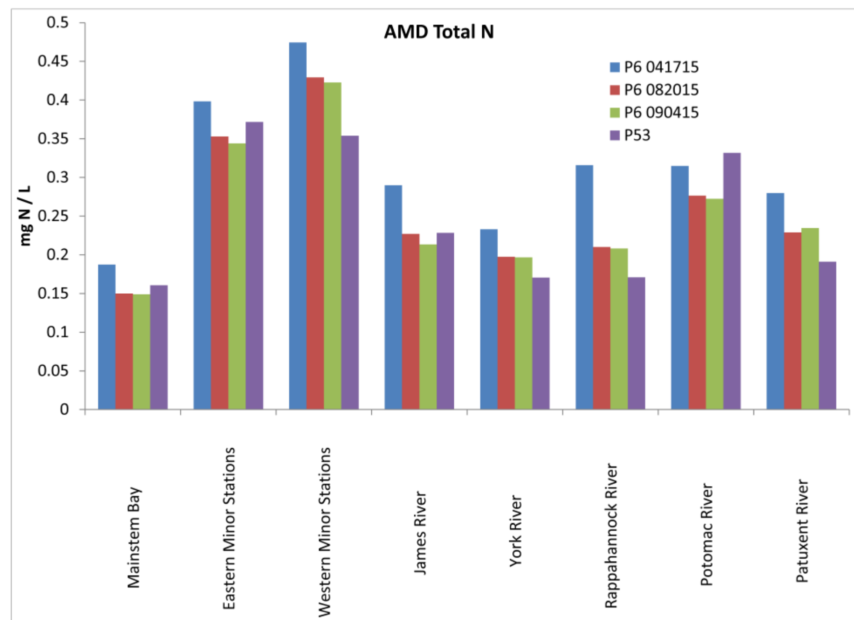
Goal and Timetable

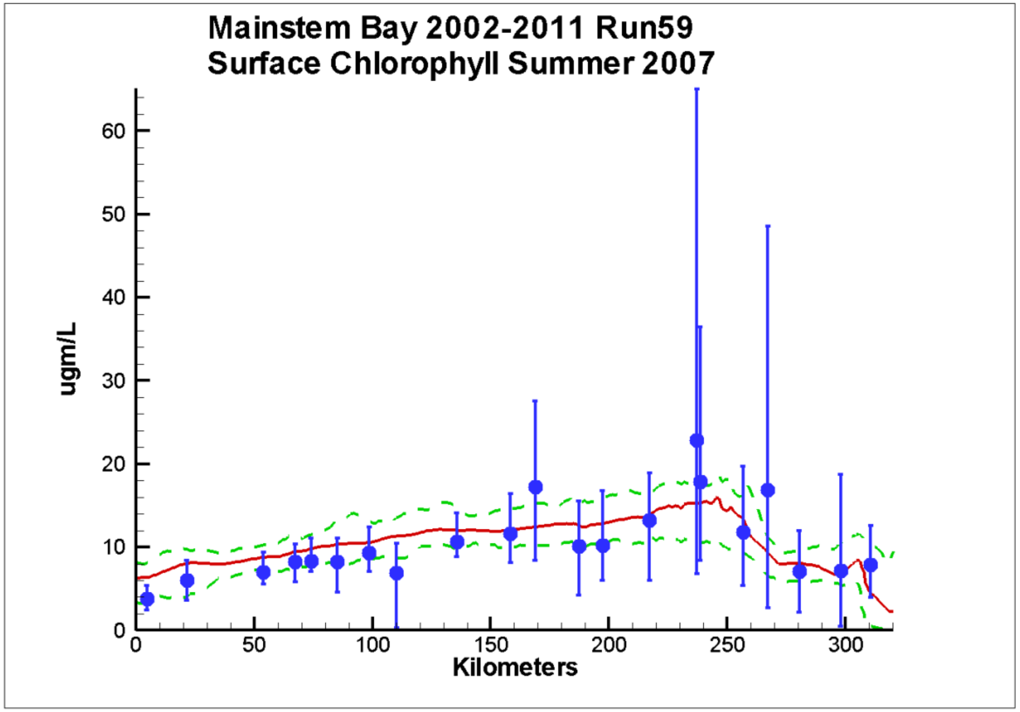
- Phase 6 WSM delivered first week in January 2016
- Fully-operational WQM by the end of January 2016
  - Results as good as or better than model version used in 2010 TMDL study
  - Incorporation of G1, G2, G3 organic matter
  - Wetland nutrient attenuation and wetland loss
  - Oyster sanctuaries and aquaculture
  - Representation of shallow-water data and processes

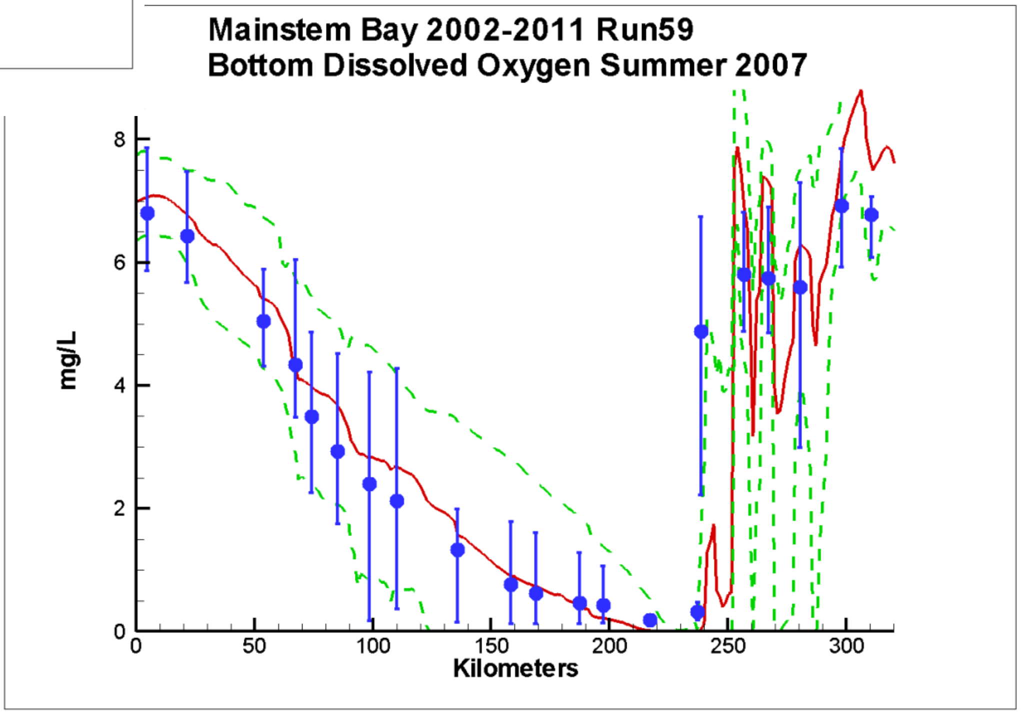
Results as Good as or Better than 2010 TMDL Study

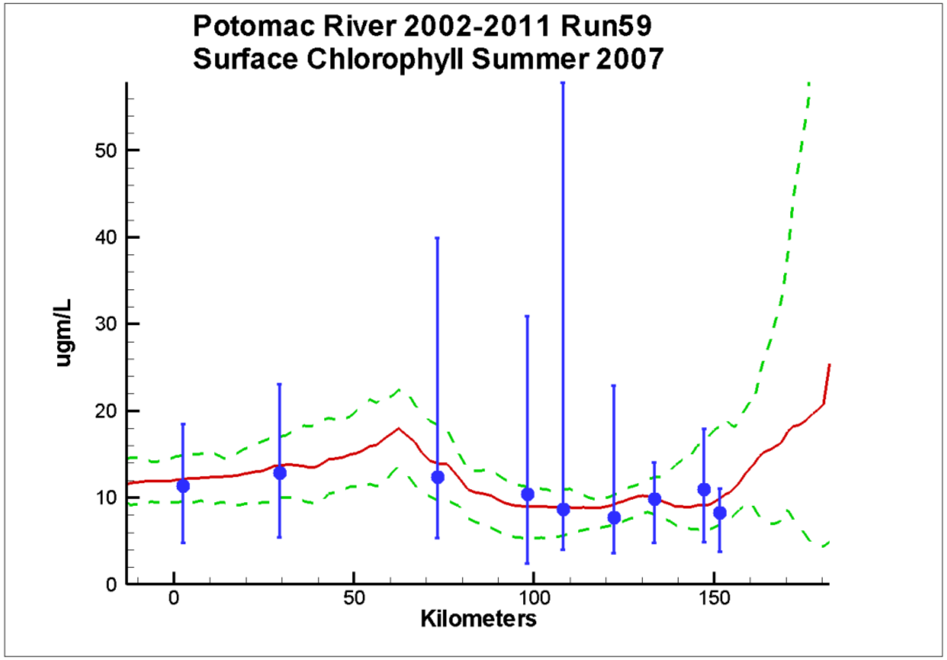
Statistical Comparisons

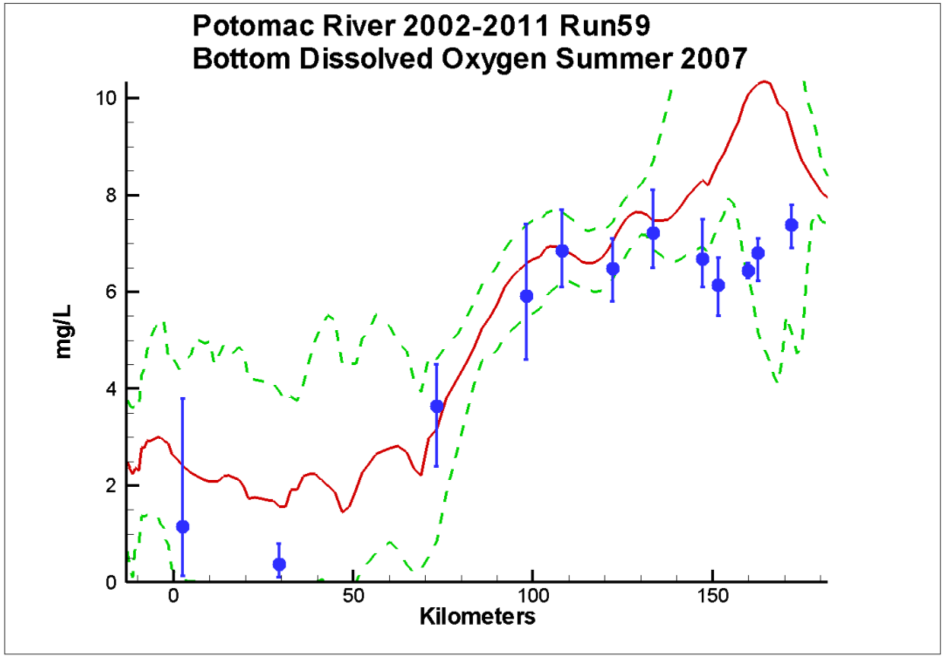


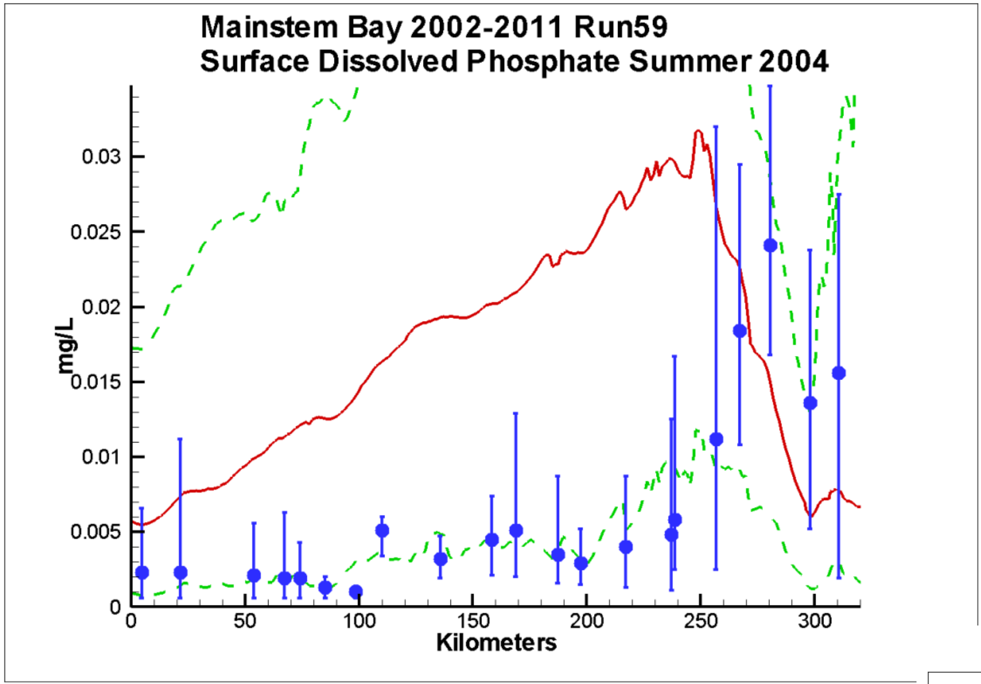


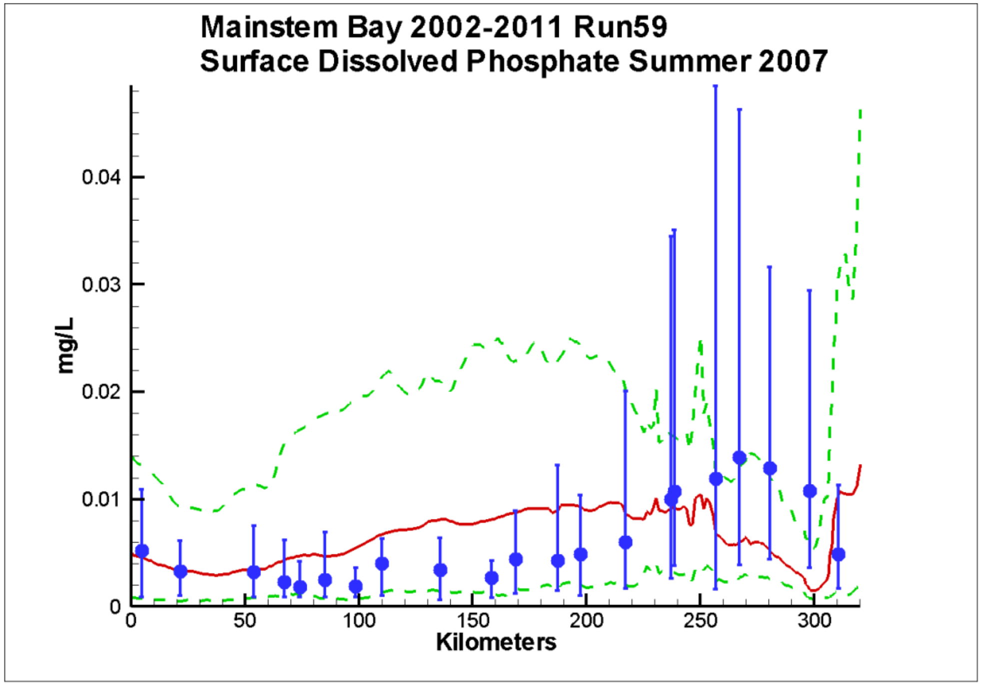

Mainstem Bay 2002-2011 Run59
Surface Chlorophyll Summer 2007
ugm/L
Kilometers
0
10
20
30
40
50
60
0
50
100
150
200
250
300


Mainstem Bay 2002-2011 Run59
Bottom Dissolved Oxygen Summer 2007
mg/L
Kilometers
0
2
4
6
8
0
50
100
150
200
250
300


Potomac River 2002-2011 Run59
Surface Chlorophyll Summer 2007
ugm/L
0
10
20
30
40
50
0
50
100
150
Kilometers


Potomac River 2002-2011 Run59
Bottom Dissolved Oxygen Summer 2007
mg/L
0
2
4
6
8
10
0
50
100
150
Kilometers


Mainstem Bay 2002-2011 Run59
Surface Dissolved Phosphate Summer 2004
mg/L
0
0.005
0.01
0.015
0.02
0.025
0.03
0
50
100
150
200
250
300
Kilometers

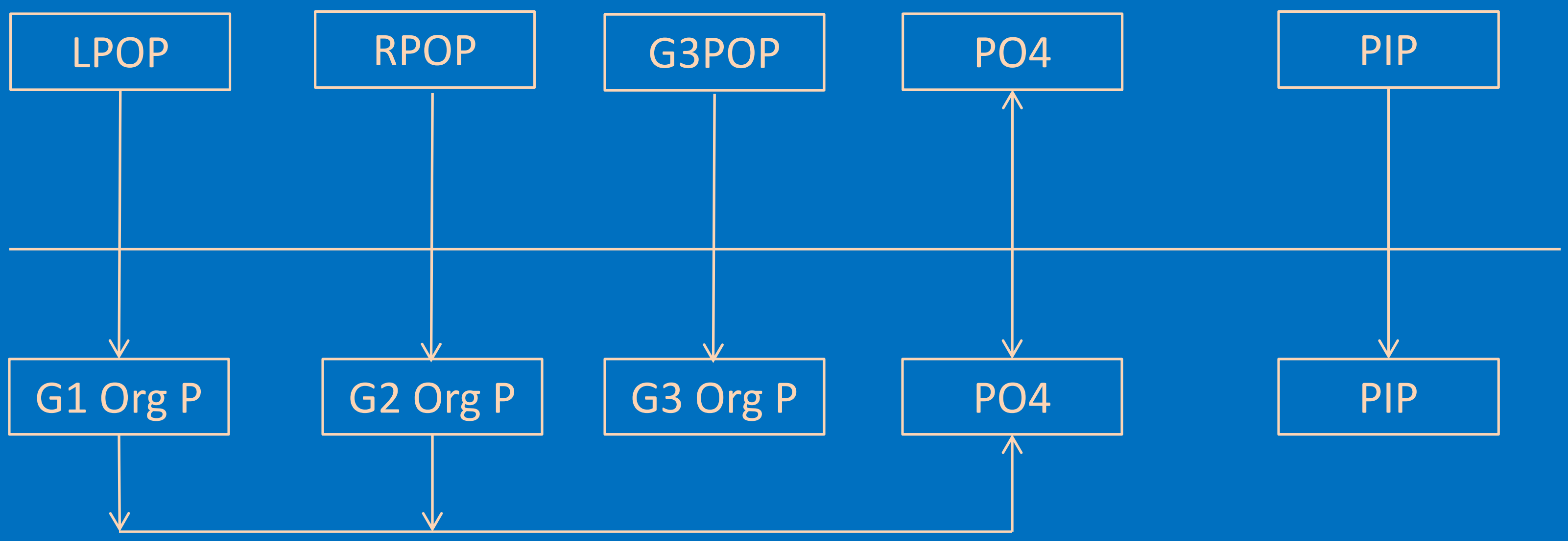

Mainstem Bay 2002-2011 Run59
Surface Dissolved Phosphate Summer 2007
mg/L
0
0.01
0.02
0.03
0.04
0
50
100
150
200
250
300
Kilometers

What's Missing?

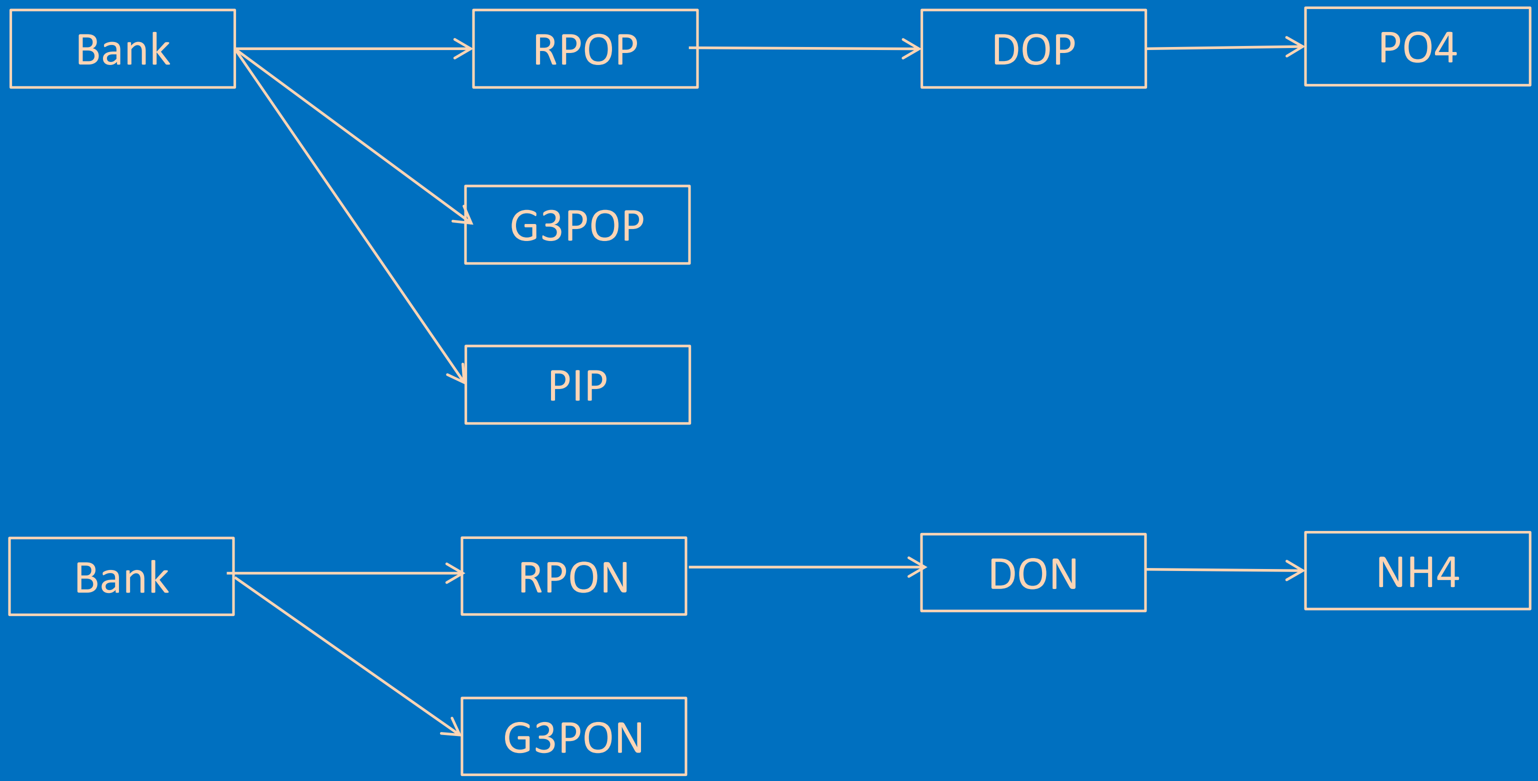
- Calibration to January 2016 Phase 6 WSM.
- Phosphorus can use some work. Likely, we will restore "Total Active Metal" or some other means of removing dissolved PO4. Maybe tune PIP a bit.
- Both tasks should be ready by the end of January 2016.

Incorporation of G1, G2, G3 Organic Matter

Revised Routing of Water Column P to Sediments



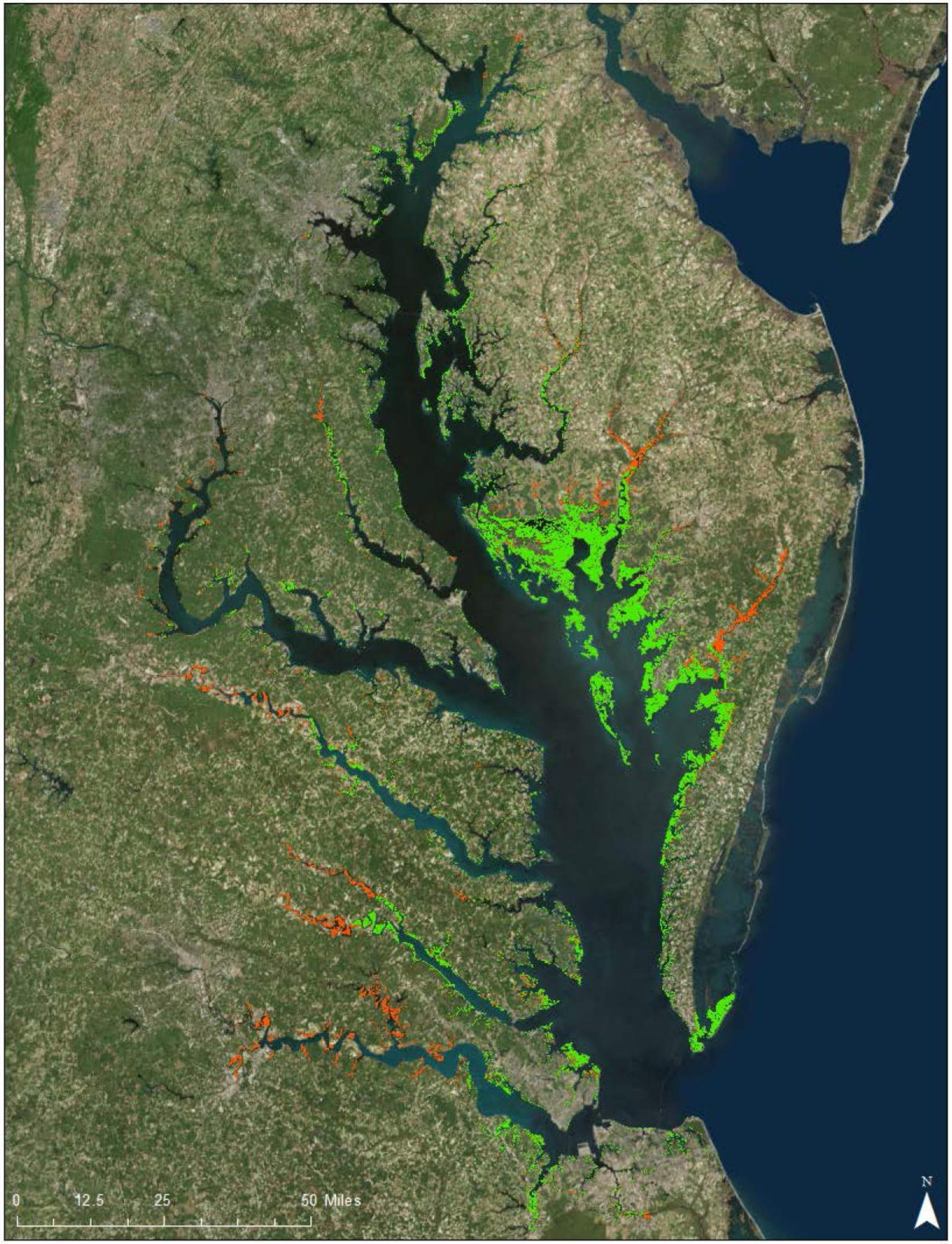
Revised Routing of Bank Nutrient Loads to Water Column



What's Missing?

- Data to assign G1, G2, G3 splits to loads.
- Right now, splits are assigned to keep the amounts of reactive material similar to previous (2010) calibration.
- Laboratory studies are underway to examine reactivity of material in Conowingo sediments. Available sometime in 2016.
- Model studies are proposed to improve predictions of reactivity of loads at Conowingo spillway. Available December 2016?
- Laboratory studies are proposed to examine reactivity of eroding wetlands material. Available December 2016?
- For January, we go with what we have now.

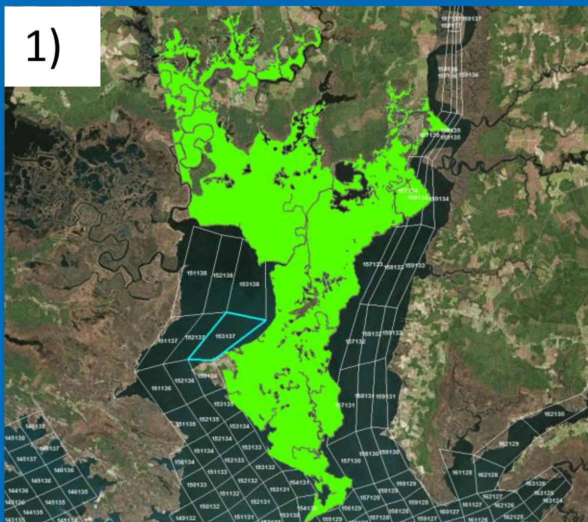
Wetland Nutrient Attenuation and Wetland Loss

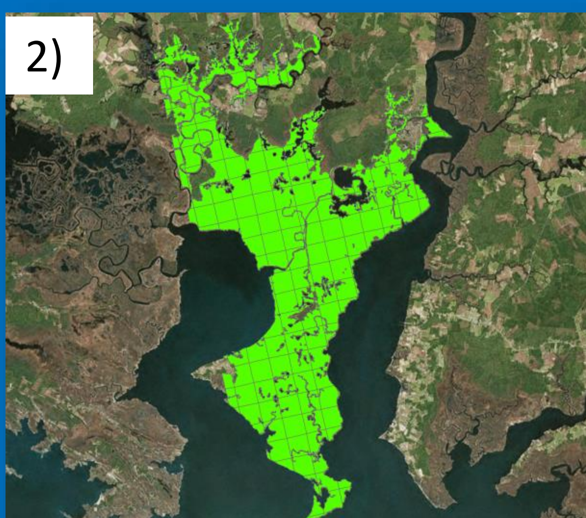


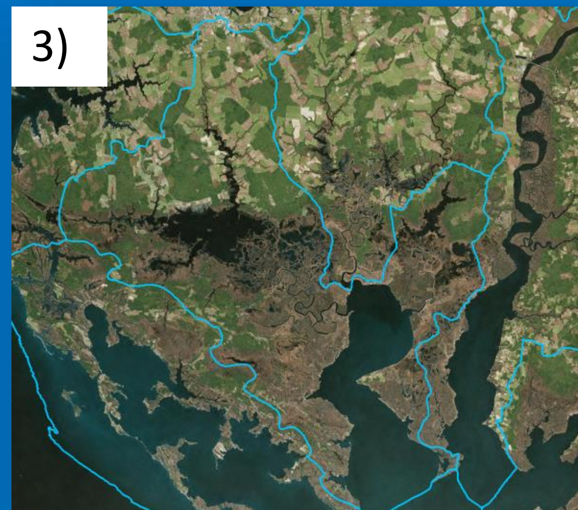
Chesapeake Bay Tidal Wetlands

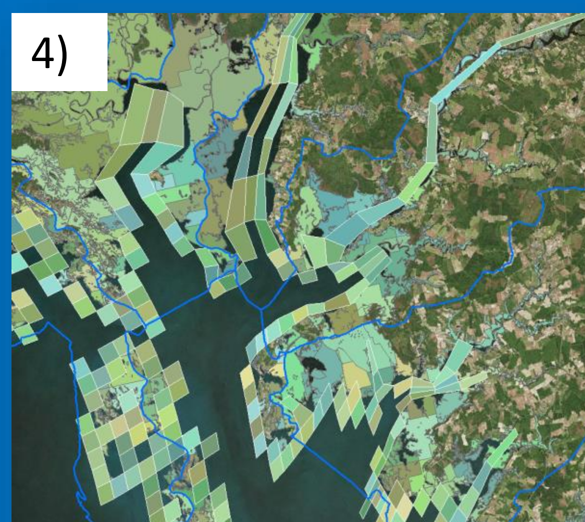
- Extent from National Wetlands Inventory.
- Determined largely from vegetation perceived via aerial photography.
- 190,000 hectares of estuarine (green) and tidal fresh (red) wetlands.
- Shape files provided by Quentin Stubbs and Peter Claggett, EPA Chesapeake Bay Program.

Assign Wetlands Areas to Model Cells









1. Wetlands polygon.
2. Divide polygon into "fishnet."
3. Overlay 10-digit HUC boundaries.
4. Assign wetlands areas to model cells based on proximity and local watershed boundaries.
5. Thank you, Scott Bourne, ERDC.

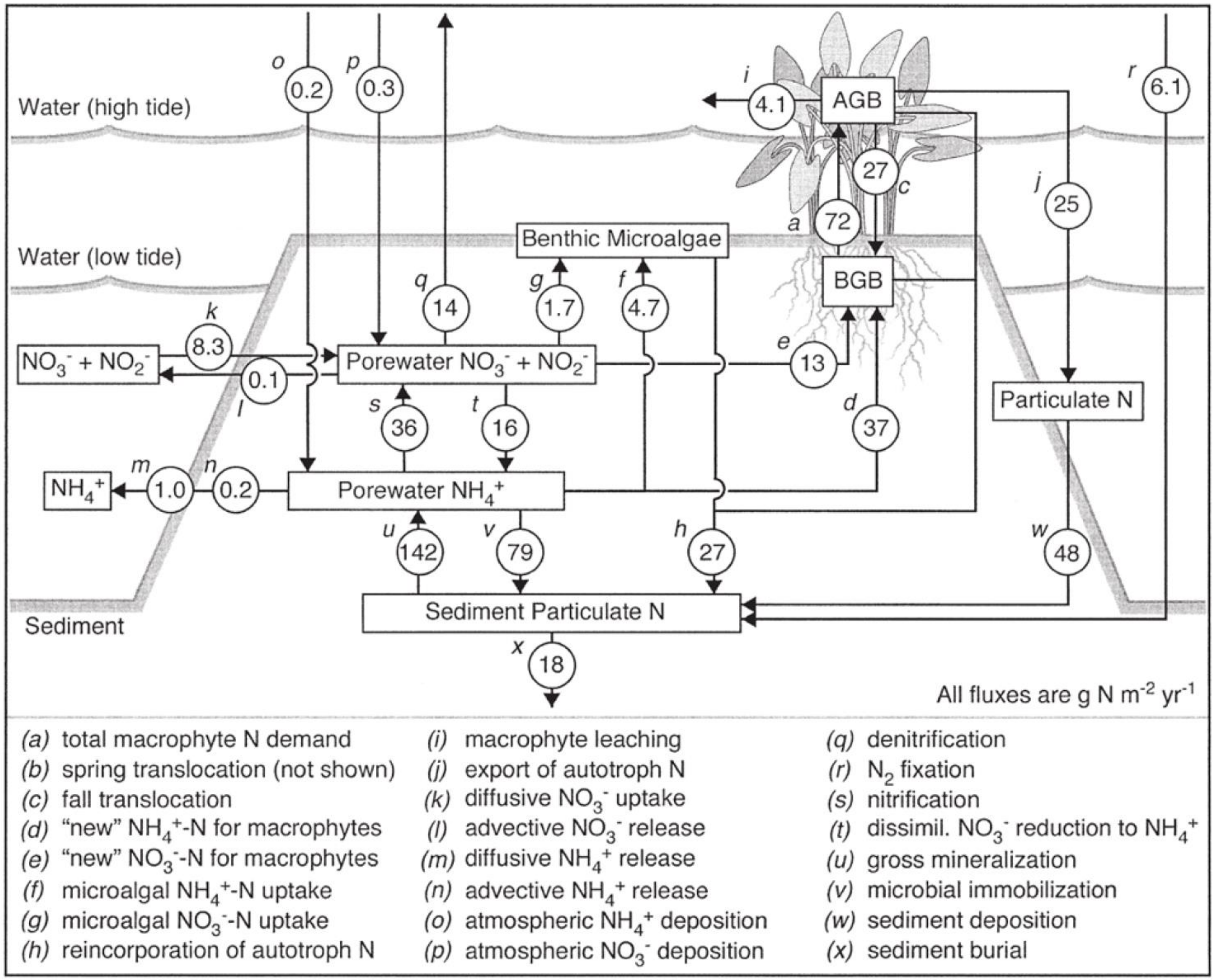


Fig. 3. Nitrogen mass balance for Sweet Hall marsh. All fluxes are in g N m^{-2} yr^{-1} and are based on measured rates, literature values, or calculated by difference (assuming steady state) as detailed in the text. Standard deviations for each flux are omitted for visual clarity but can be found in Table 1 and in the text. AGB = aboveground macrophyte biomass; BGB = belowground macrophyte biomass.

Estuaries Vol. 28, No. 6, p. 909–922 December 2005

Nitrogen Cycling and Ecosystem Exchanges in a Virginia Tidal Freshwater Marsh

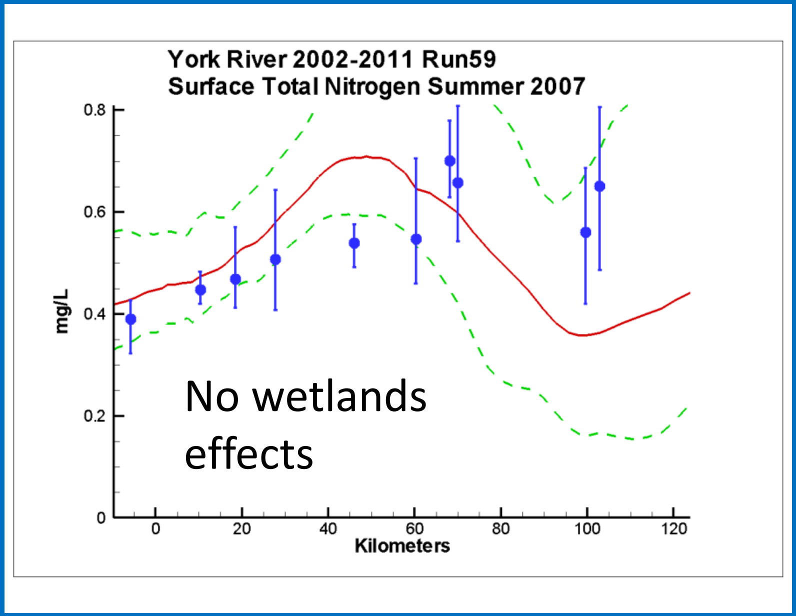
Scott C. Neubauer[1,2*], Iris C. Anderson[1], and Betty B. Neikirk[1]

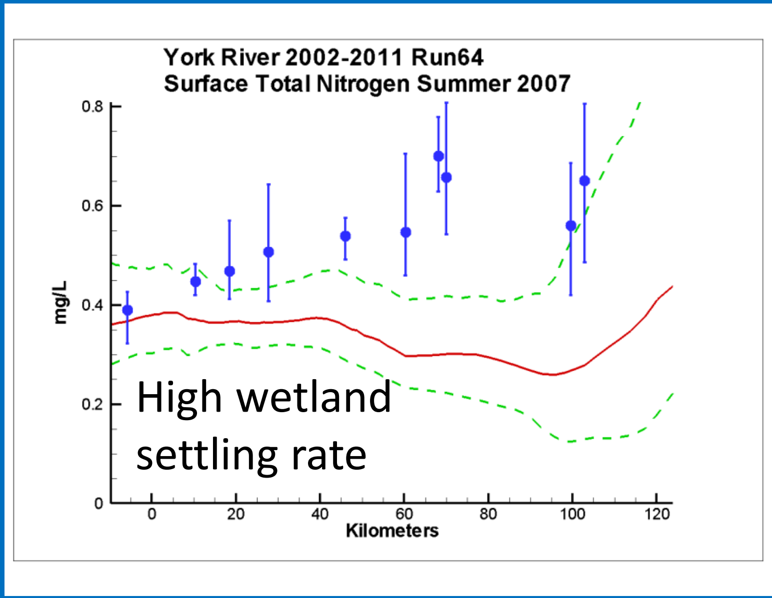
$$V \cdot \frac{dC}{dt} = Transport + Kinetics - WSw \cdot C \cdot Aw$$

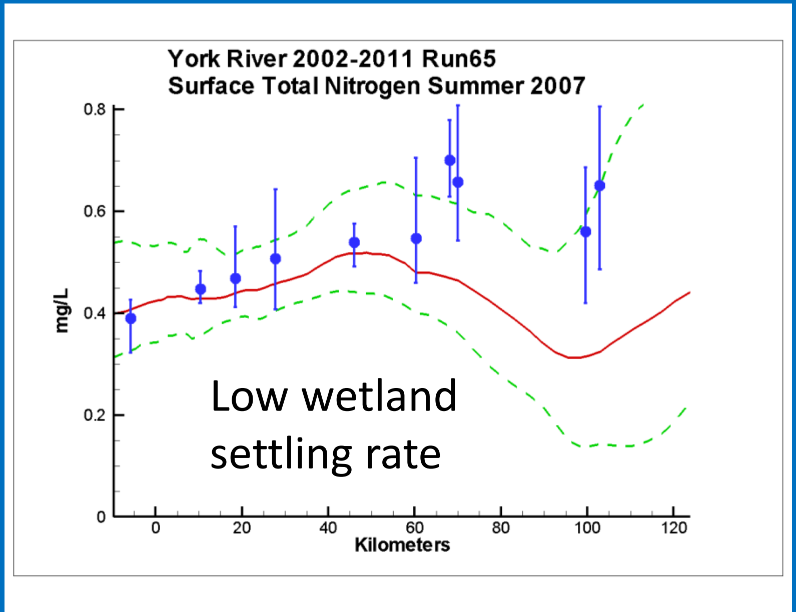
V = volume of WQM cell adjacent to wetlands
C = concentration
WSw = wetland settling velocity
Aw = area of wetland adjacent to WQM cell

This applies to all particles, organic and inorganic.

Proof of Concept





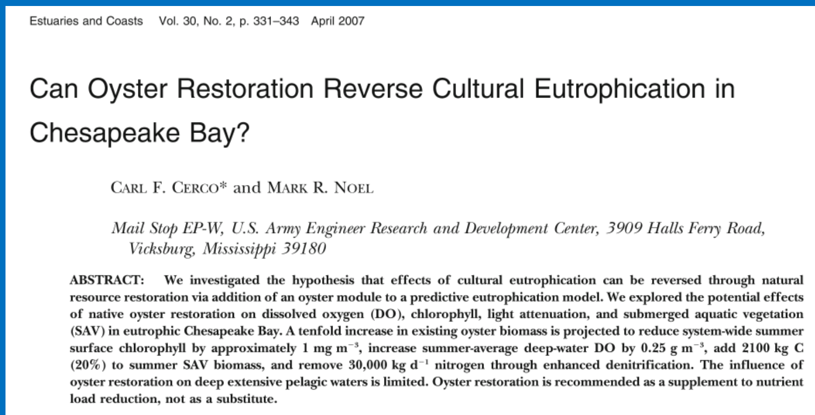


What’s Missing?

- Calibration of wetlands settling rate(s).
- Additional processes e.g. wetlands respiration.
- Projections of wetlands loss due to sea-level rise.
- We should have minimum wetlands module (nutrient removal, respiration) for existing conditions by end of January.
- Projections of wetlands loss later in year.

Oyster Sanctuaries and Aquaculture

What Do We Have?

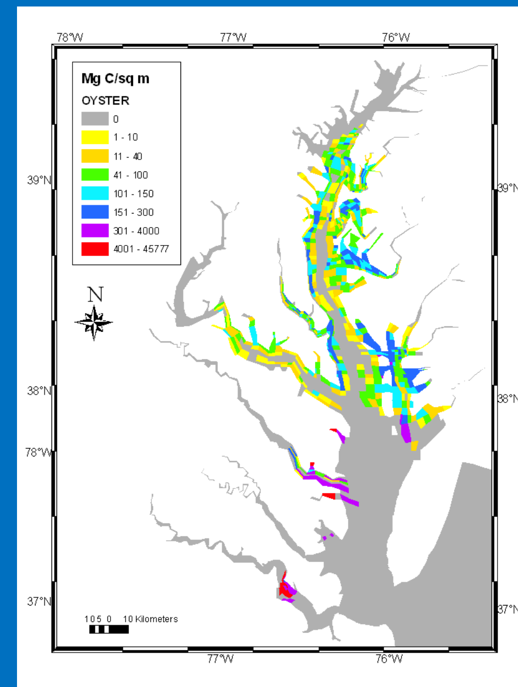

Estuaries and Coasts Vol. 30, No. 2, p. 331–343 April 2007

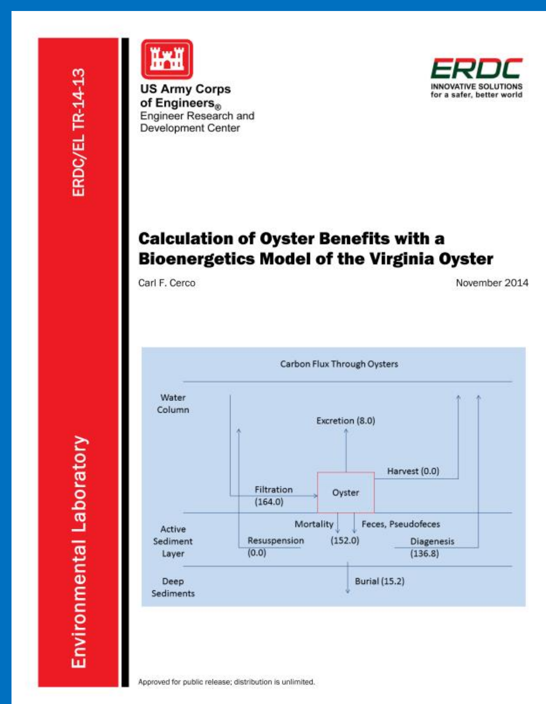
Can Oyster Restoration Reverse Cultural Eutrophication in Chesapeake Bay?

CARL F. CERCO* and MARK R. NOEL

Mail Stop EP-W, U.S. Army Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, Mississippi 39180

ABSTRACT: We investigated the hypothesis that effects of cultural eutrophication can be reversed through natural resource restoration via addition of an oyster module to a predictive eutrophication model. We explored the potential effects of native oyster restoration on dissolved oxygen (DO), chlorophyll, light attenuation, and submerged aquatic vegetation (SAV) in eutrophic Chesapeake Bay. A tenfold increase in existing oyster biomass is projected to reduce system-wide summer surface chlorophyll by approximately 1 mg m^{-3}, increase summer-average deep-water DO by 0.25 g m^{-3}, add 2100 kg C (20%) to summer SAV biomass, and remove 30,000 kg d^{-1} nitrogen through enhanced denitrification. The influence of oyster restoration on deep extensive pelagic waters is limited. Oyster restoration is recommended as a supplement to nutrient load reduction, not as a substitute.





What's Missing?

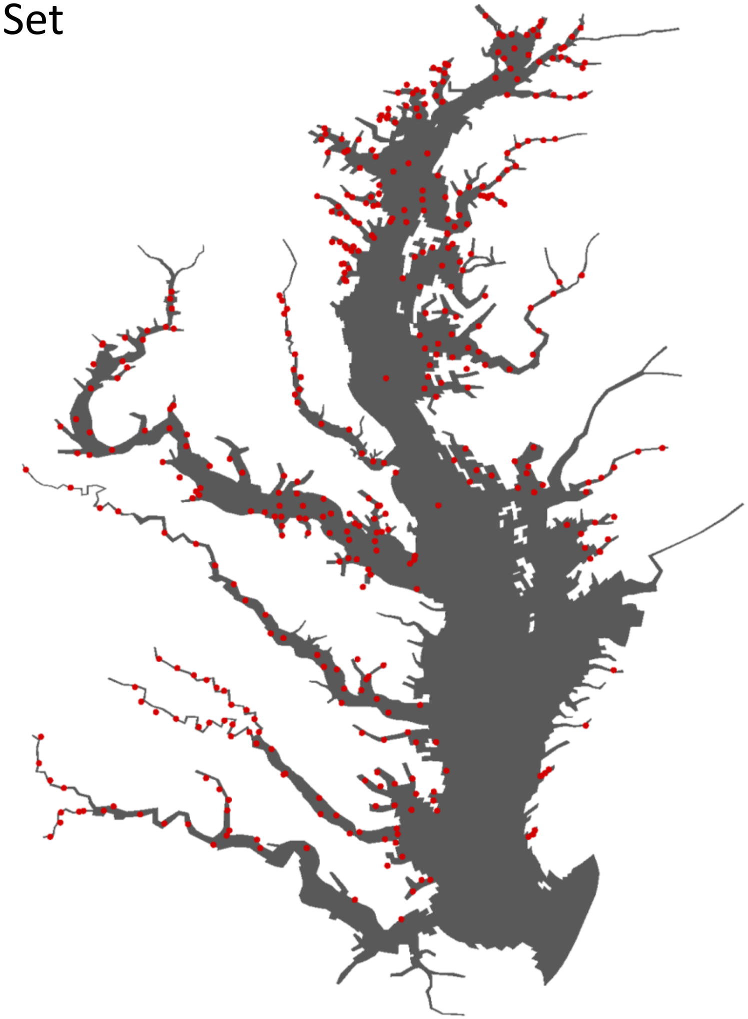
- Present oyster biomass and distribution.
- Information on aquaculture (location, methods, harvest).
- Incorporation into present model.
- The 2005 oyster model is operational in the present model.
- By January, we can make projections similar to the effects of a ten-fold biomass increase, using previous biomass estimates.
- Time to obtain more recent information is open-ended.

Representation of Shallow-Water Data and Processes

WQSTM Shallow-Water Simulation

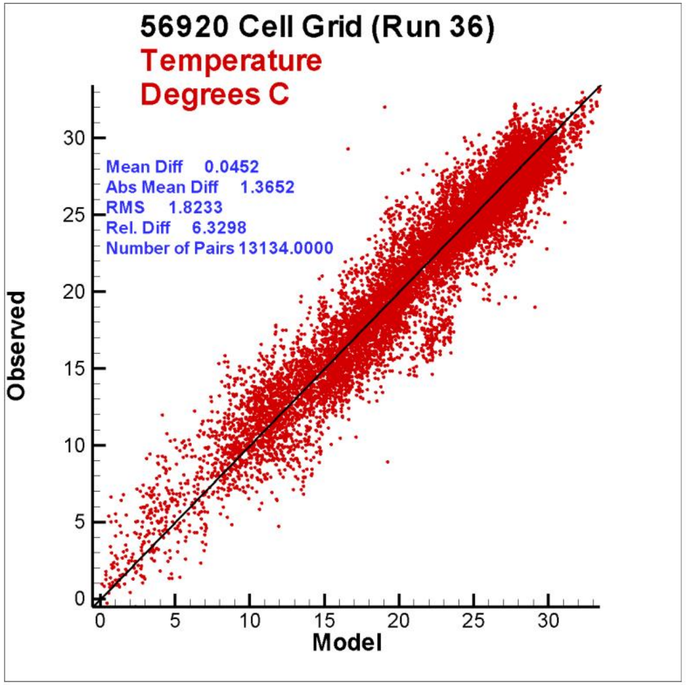
- We received the shallow-water database from CBP circa autumn 2012.
- These are grab samples and measures collected when continuous stations are serviced and coincident with Dataflow cruises.
- More than 750,000 records.
- Roughly 84,000 useful observations.

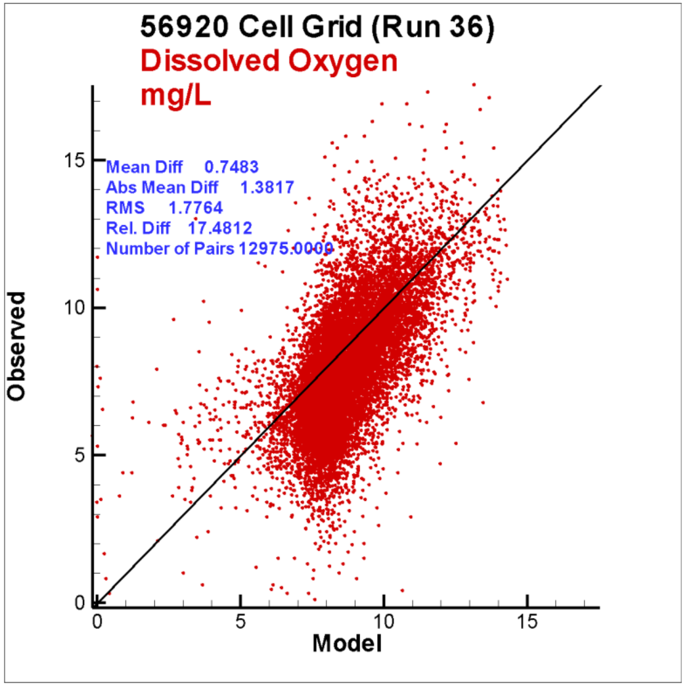
Complete
Data Set

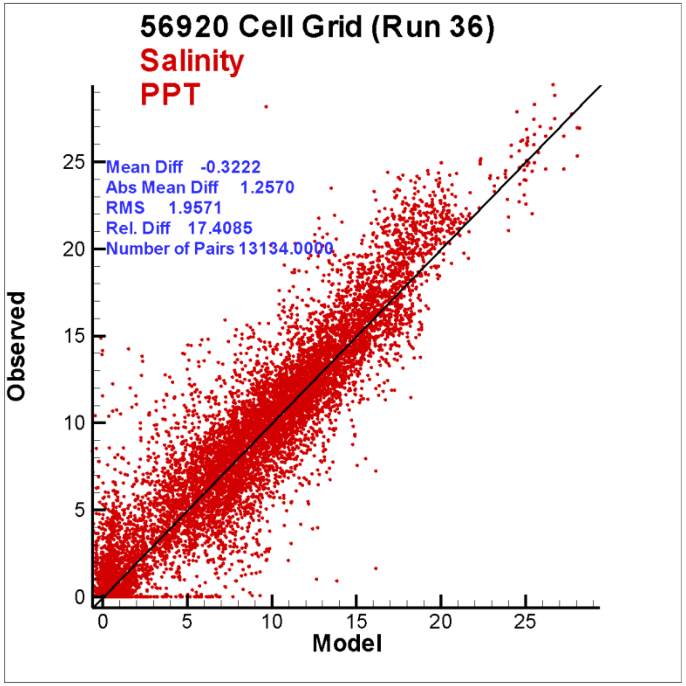


Revised,
< 4m deep

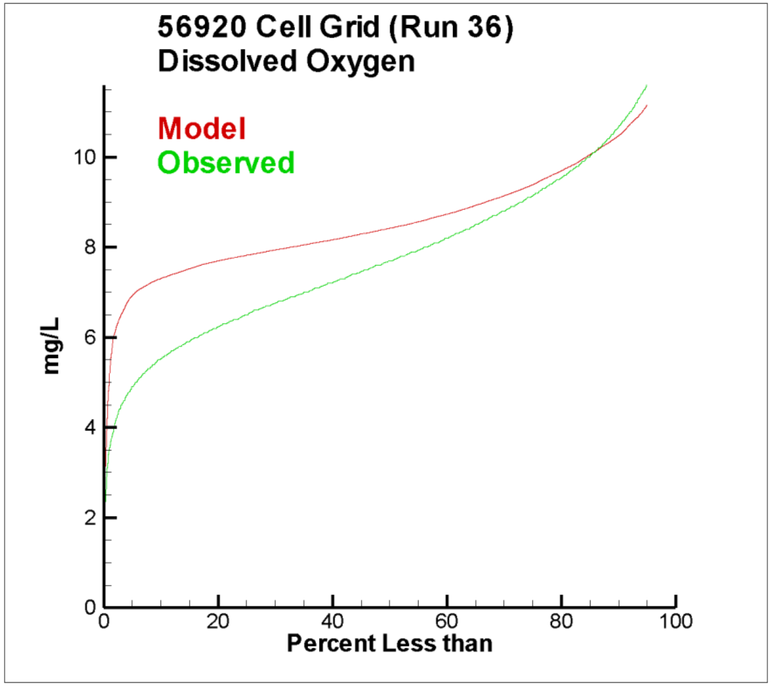
We're in reasonable agreement with physical quantities such as temperature, salinity, dissolved oxygen.

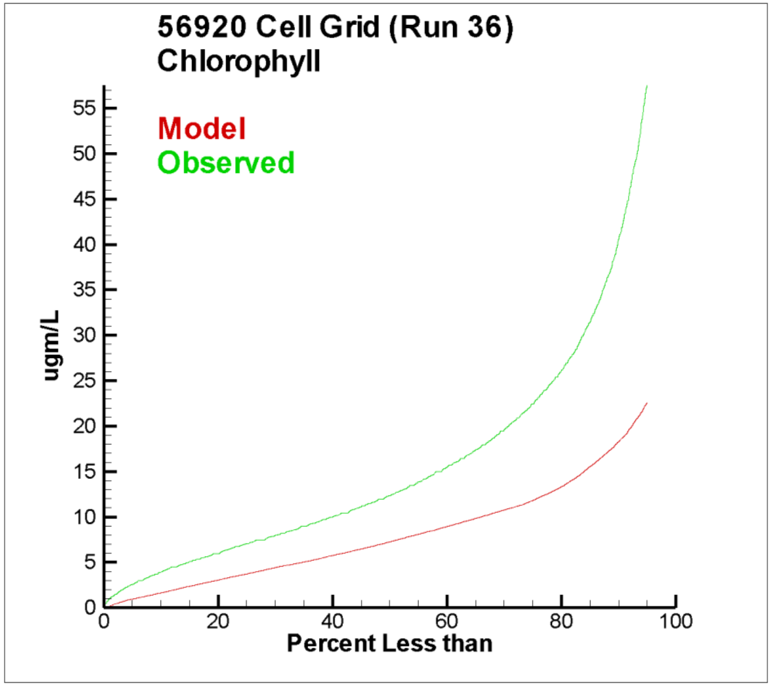


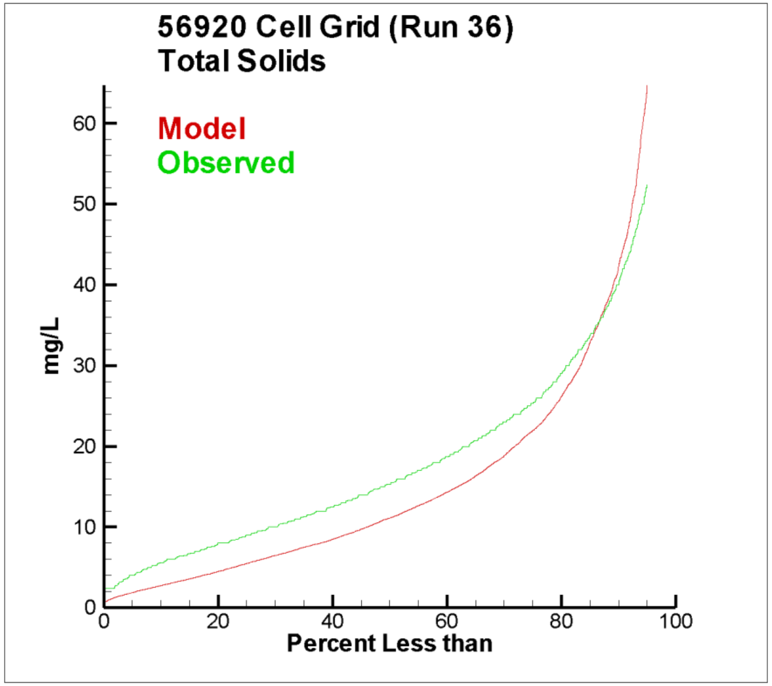


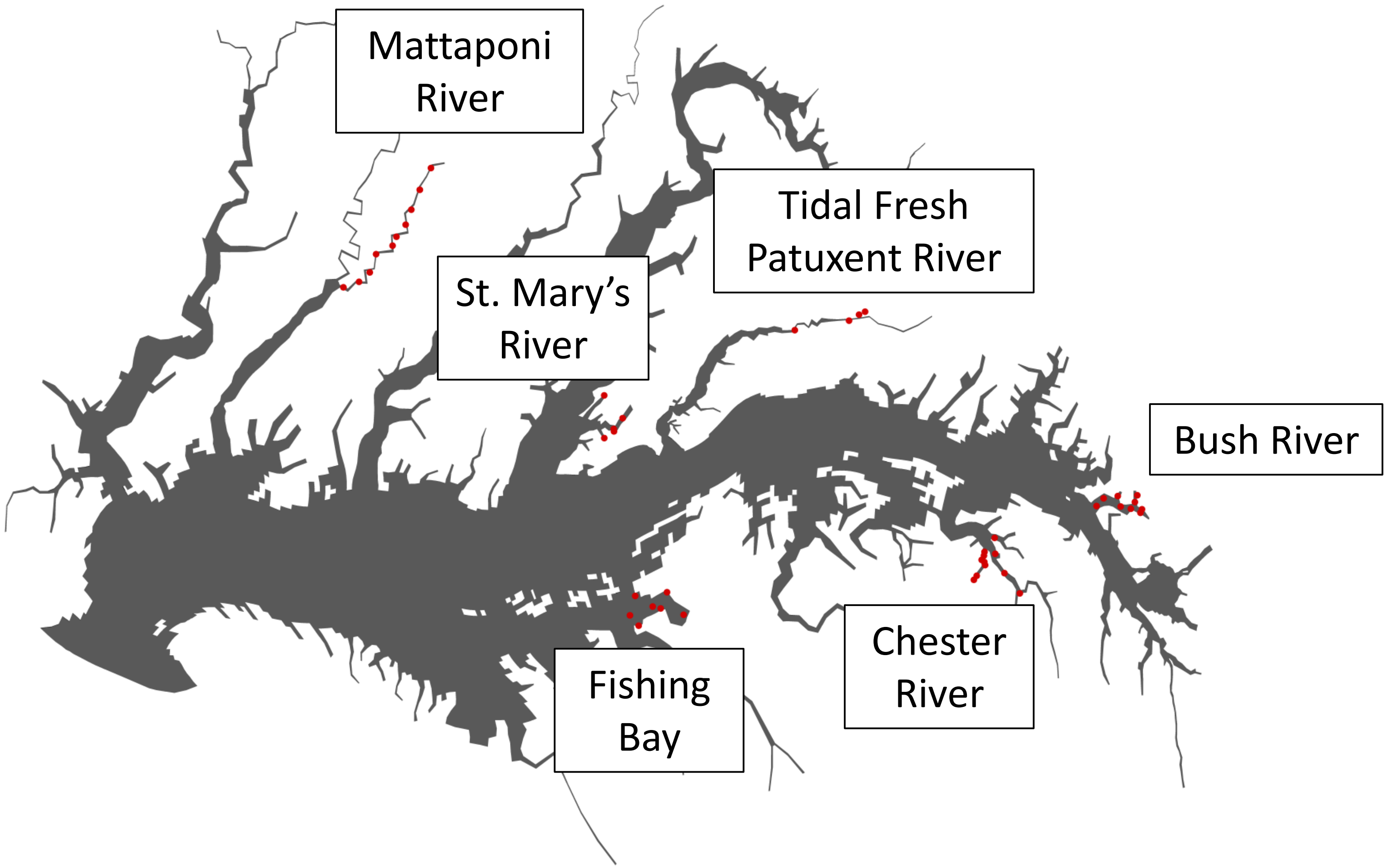


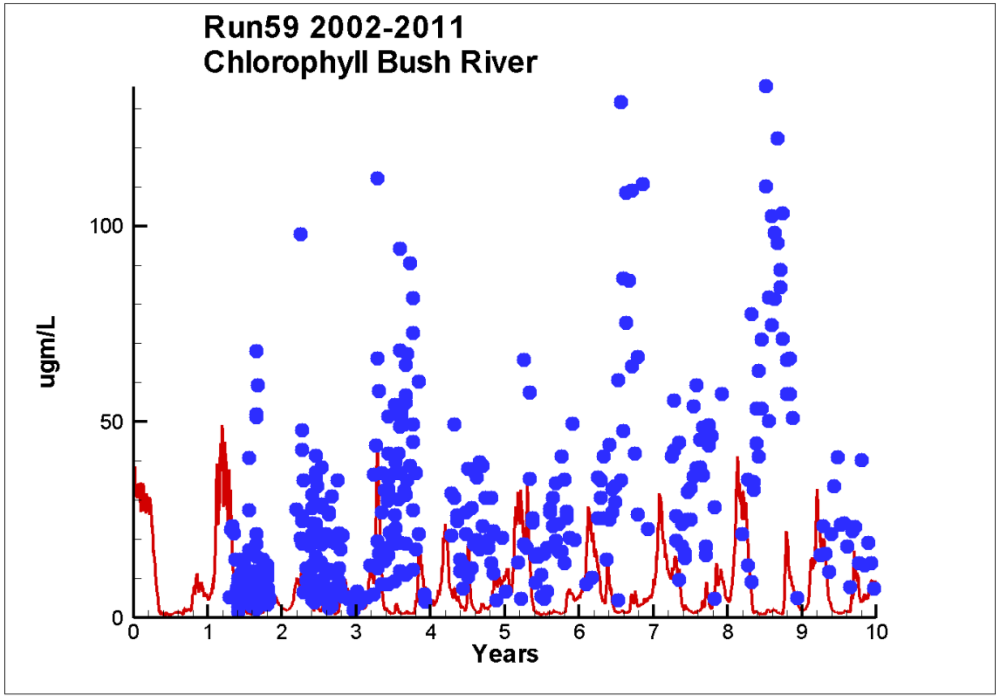
Overall, we tend to be low on chlorophyll, TSS, high on dissolved oxygen.



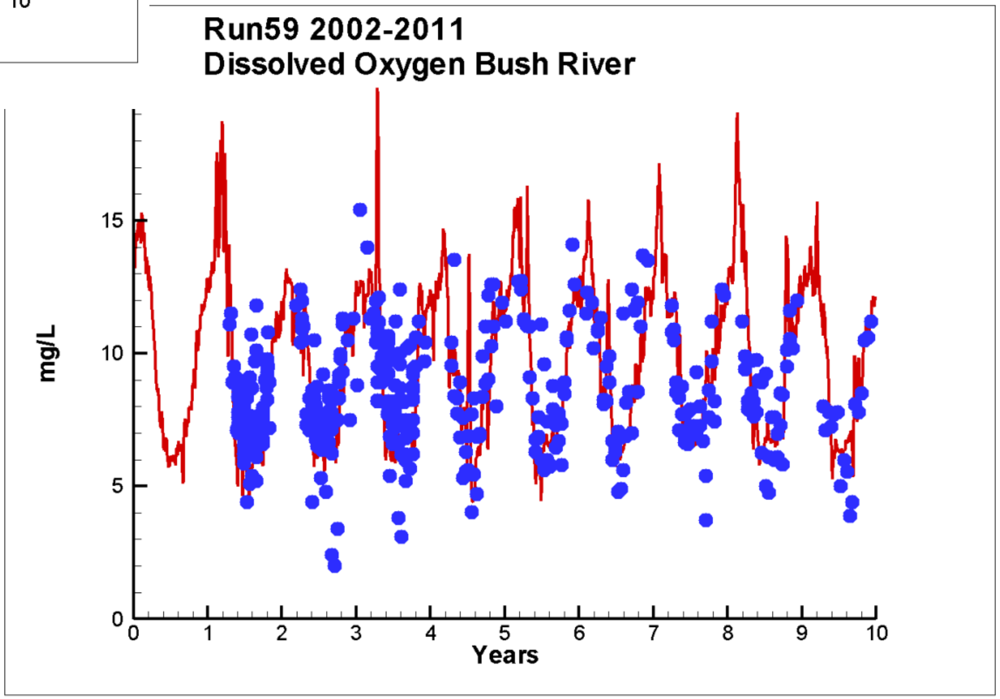




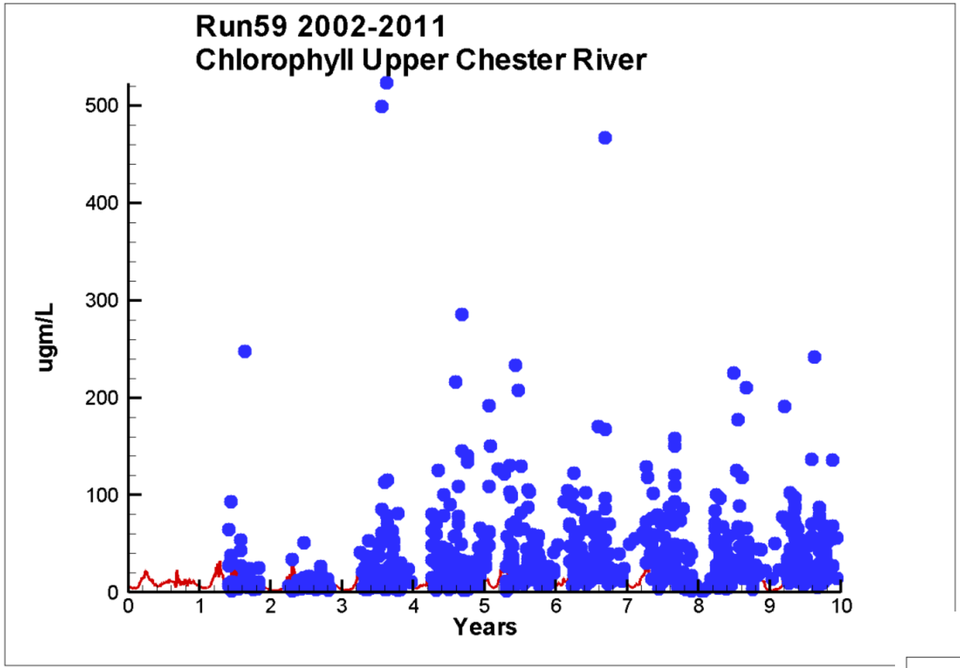

Mattaponi River
Tidal Fresh Patuxent River
St. Mary's River
Bush River
Chester River
Fishing Bay

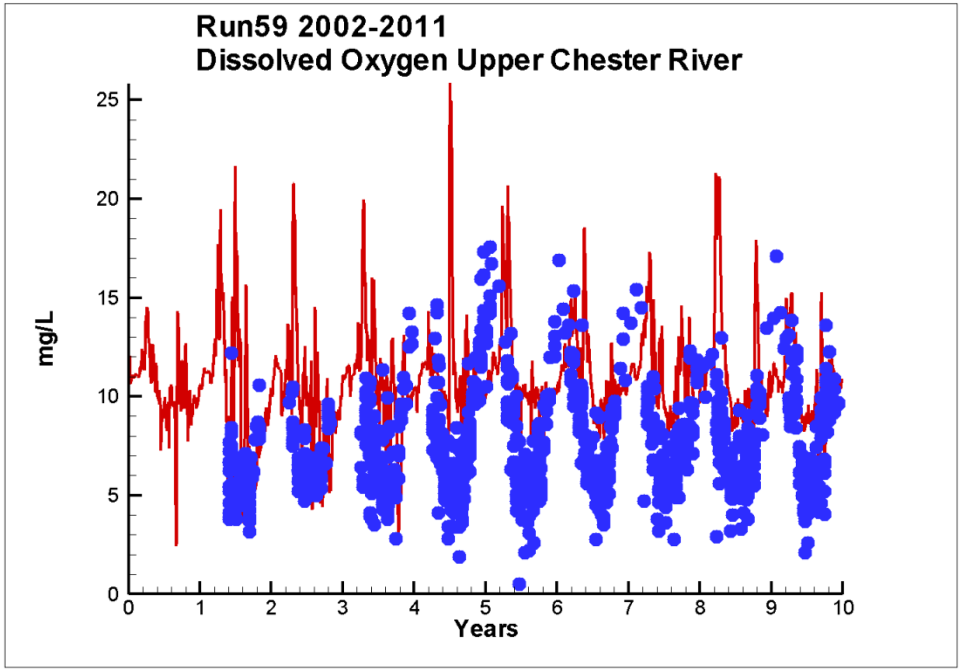


Run59 2002-2011
Chlorophyll Bush River
ugm/L
0
50
100
0
1
2
3
4
5
6
7
8
9
10
Years



Run59 2002-2011
Dissolved Oxygen Bush River
mg/L
0
5
10
15
0
1
2
3
4
5
6
7
8
9
10
Years


Run59 2002-2011
Chlorophyll Upper Chester River
ugm/L
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
Years


Run59 2002-2011
Dissolved Oxygen Upper Chester River
mg/L
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
Years

What's Missing?

- Specific shallow-water model parameterization.
- Shallow-water regions depend on other deliverables such as WSM, characterization of shoreline erosion loads and wetlands processes.
- We will have major processes in place by January 2016.
- Additional developments as time and information become available in 2016.