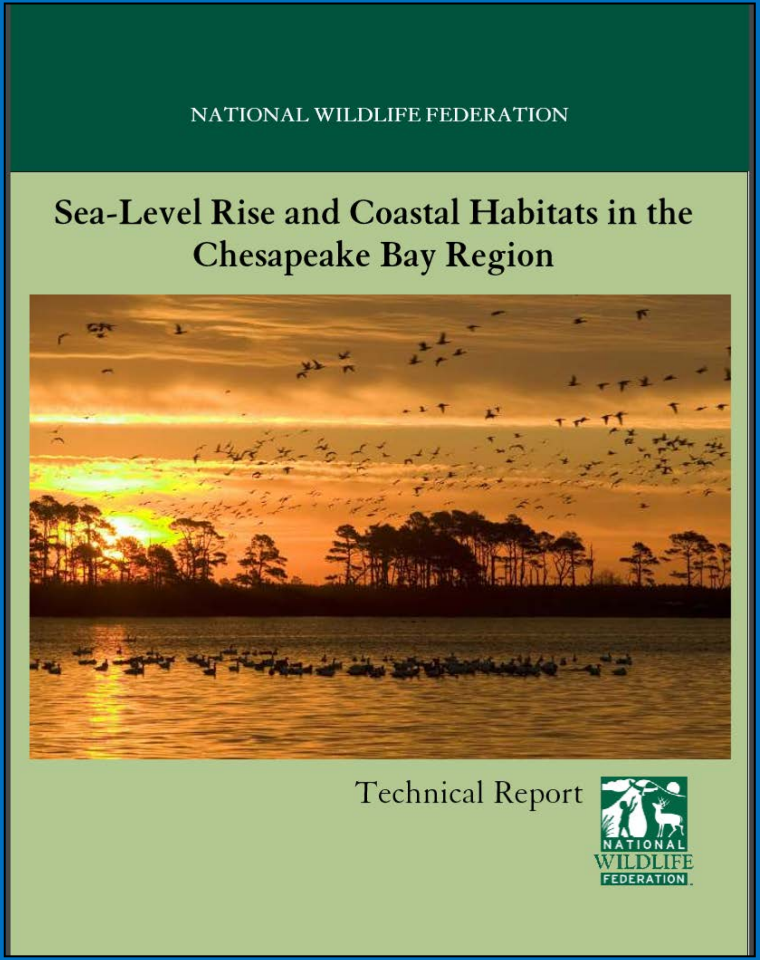
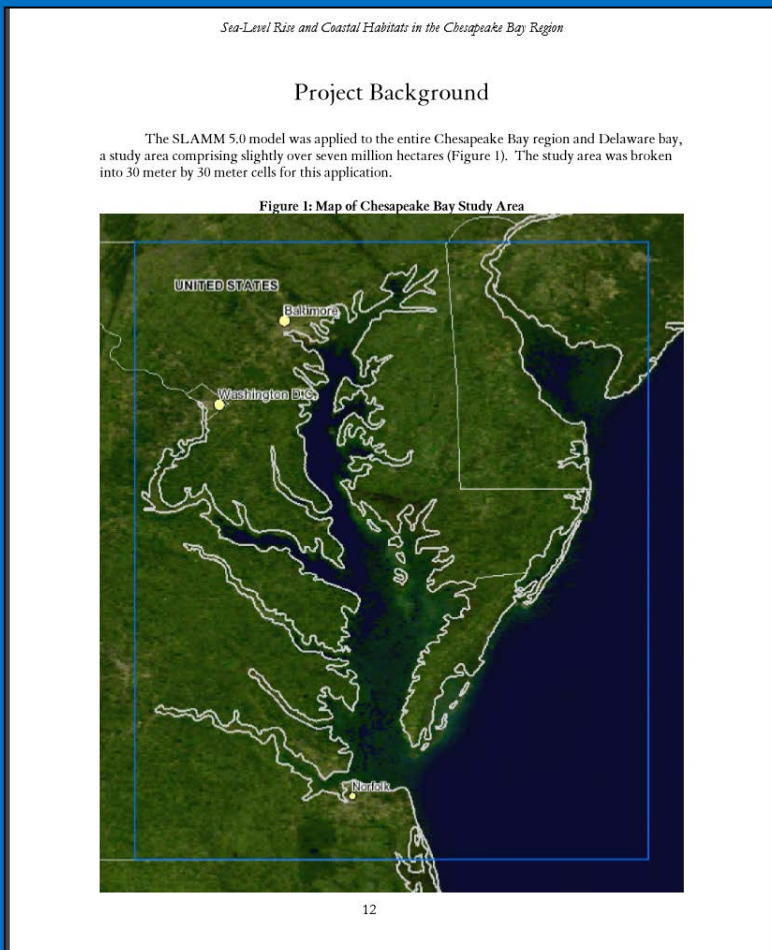
Sea-Level Rise and Tidal Wetlands



- Our estimates of effect of sea-level rise on tidal wetlands come from the Sea-Level Affecting Marshes Model (SLAMM).
- Study conducted for the national Wildlife Federation by Glick et al. (2008).
- SLAMM scenarios:
  - IPCC B1: 0.31 m sea-level rise, broken into four increments.
  - 1 Meter: 1 m sea-level rise, broken into four increments.

Sea-Level Rise and Tidal Wetlands


Sea-Level Rise and Coastal Habitats in the Chesapeake Bay Region

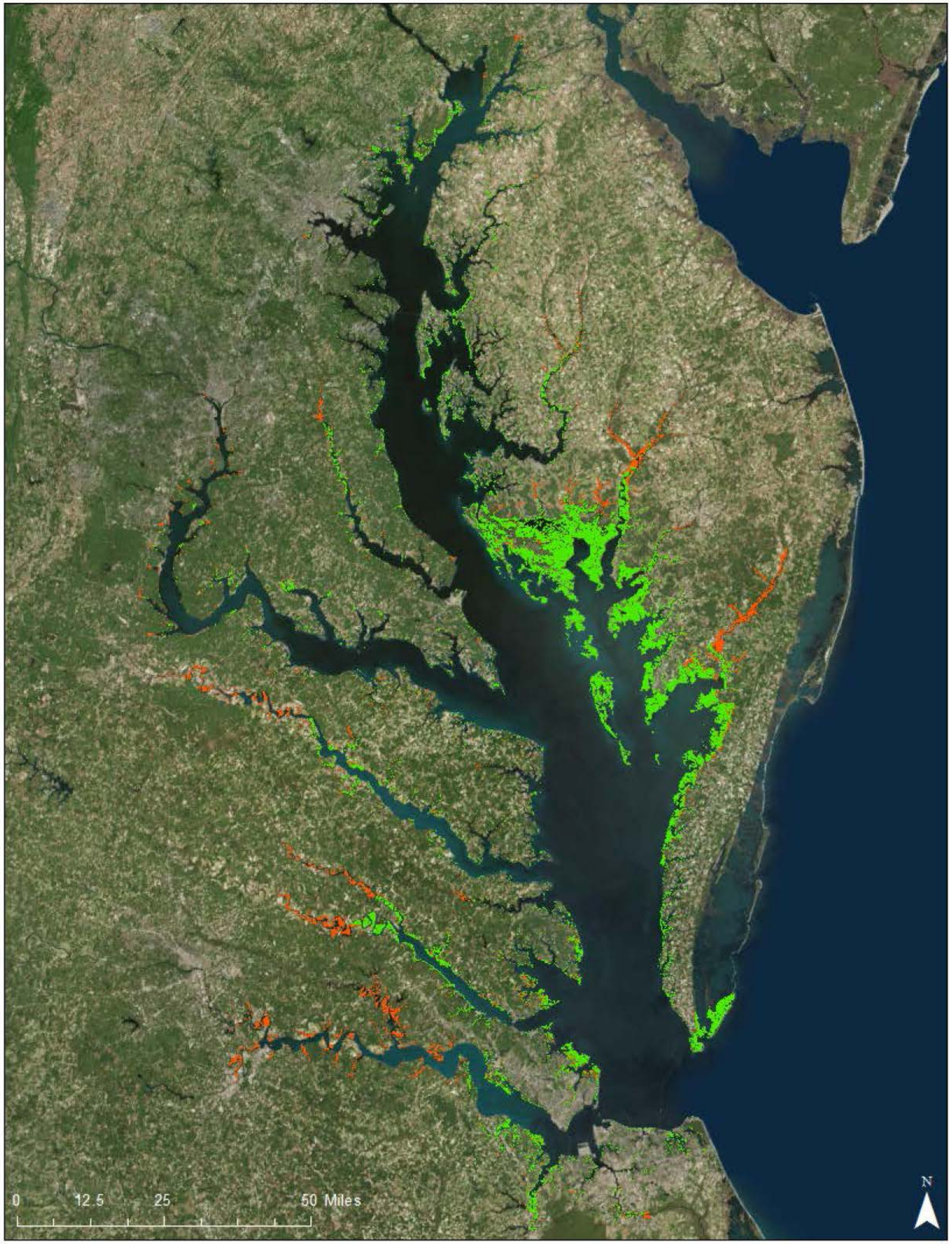
Project Background

The SLAMM 5.0 model was applied to the entire Chesapeake Bay region and Delaware bay, a study area comprising slightly over seven million hectares (Figure 1). The study area was broken into 30 meter by 30 meter cells for this application.

Figure 1: Map of Chesapeake Bay Study Area

12

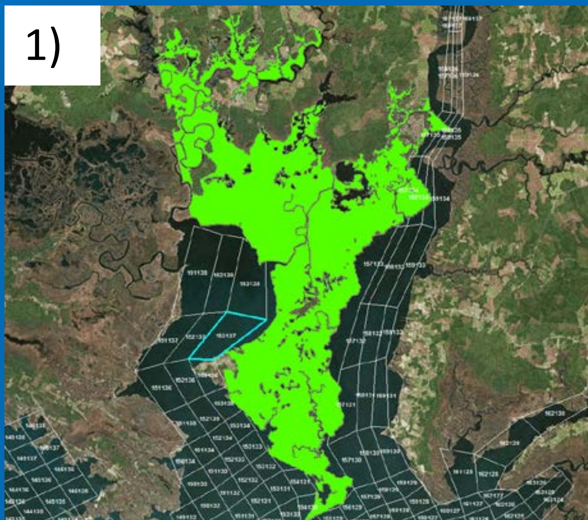
- The study included Delaware Bay and Atlantic coastal regions.
- The Chesapeake Bay portion was extracted from the complete model output and provided to us by Lora Harris of University of Maryland.
- Four Wetlands Categories:
  - Brackish Marsh
  - Salt Marsh
  - Transitional Marsh
  - Tidal Freshwater Marsh

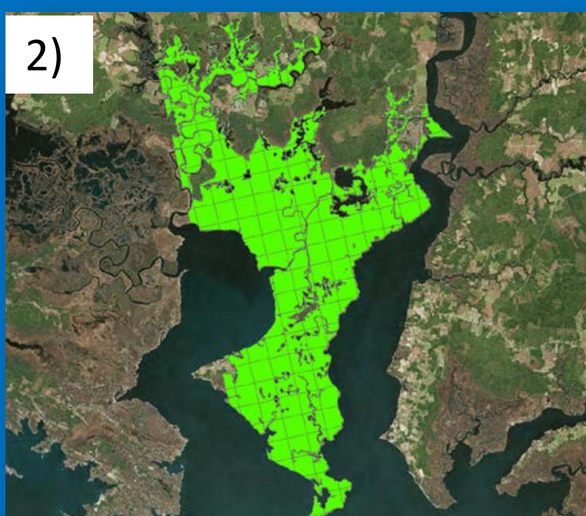


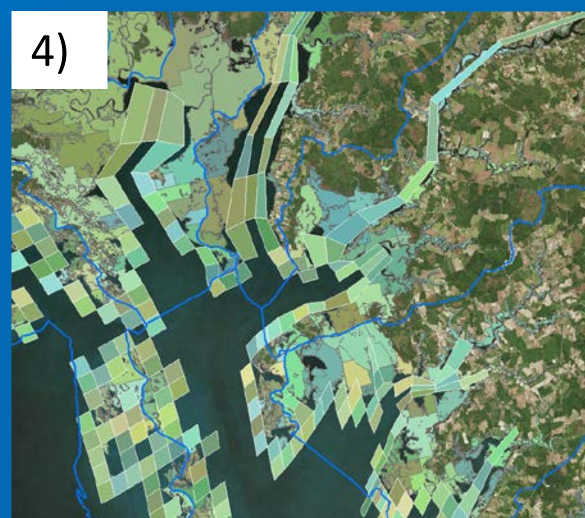
Chesapeake Bay Tidal Wetlands

- We compared the existing wetlands area extracted from SLAMM to an independent National Wetlands Inventory dataset provided by the Bay Program.
- We determined the areas were sufficient close:
  - 133,000 hectares SLAMM
  - 125,000 hectares NWI
- SLAMM provides our model with existing and projected wetlands areas.

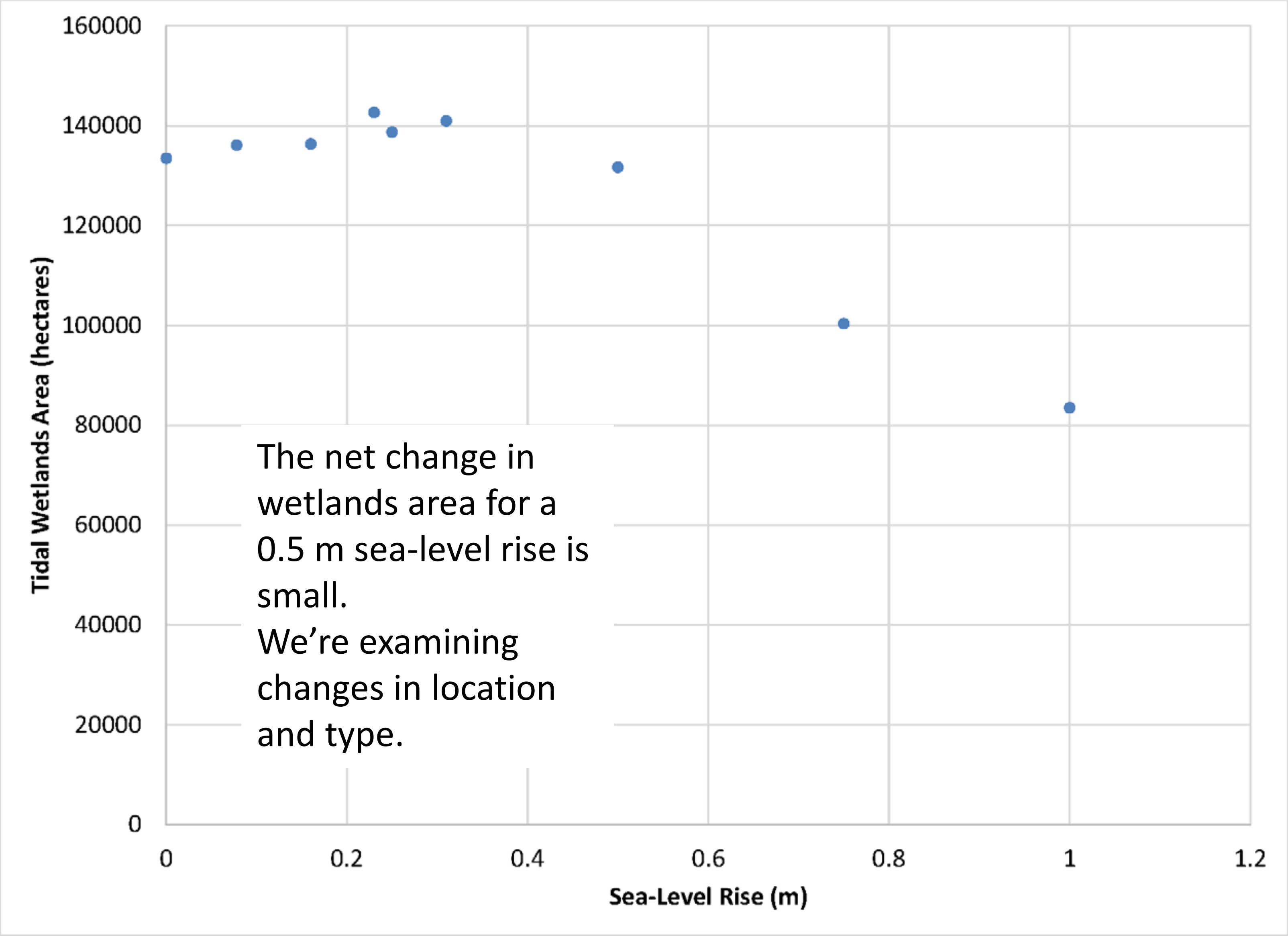
Assign Wetlands Areas to Model Cells



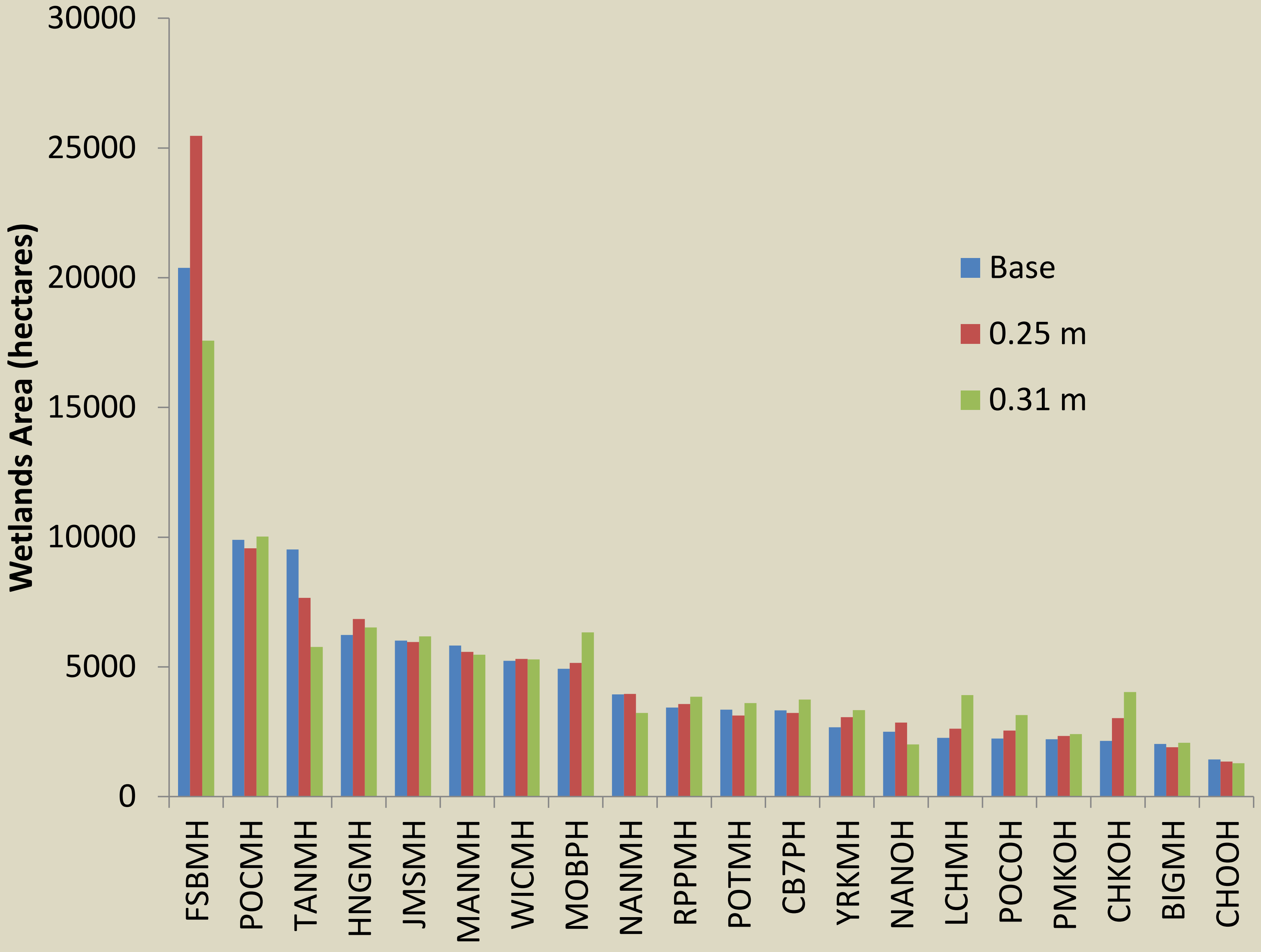




1. Wetlands polygon.
2. Divide polygon into “fishnet.”
3. Overlay 10-digit HUC boundaries.
4. Assign wetlands areas to model cells based on proximity and local watershed boundaries.
5. Thank you, Scott Bourne, ERDC.



The net change in wetlands area for a 0.5 m sea-level rise is small.
We're examining changes in location and type.



30000
25000
20000
15000
10000
5000
0
Wetlands Area (hectares)
Base
0.25 m
0.31 m
FSBMH
POCMH
TANMH
HNGMH
JMSMH
MANMH
WICMH
MOBPH
NANMH
RPPMH
POTMH
CB7PH
YRKMH
NANOH
LCHMH
POCOH
PMKOH
CHKOH
BIGMH
CHOOH

Wetlands Module

- We don’t want to develop a complete wetlands biogeochemical model.
- We do want to develop a simplified module that includes:
  - Particle burial (organic and inorganic)
  - Respiration
  - Denitrification
  - Primary production?
  - Others?

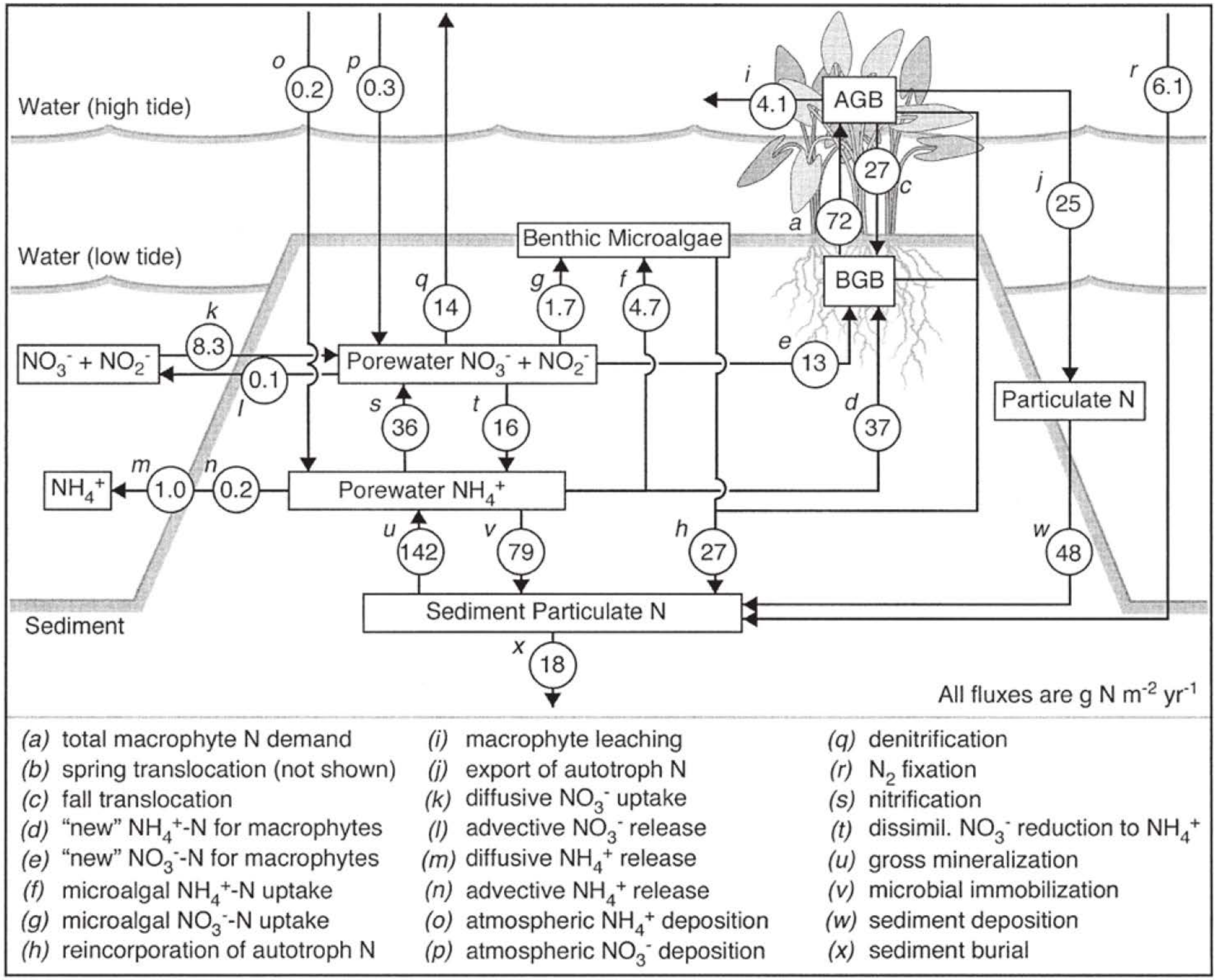


Fig. 3. Nitrogen mass balance for Sweet Hall marsh. All fluxes are in $g\ N\ m^{-2}\ yr^{-1}$ and are based on measured rates, literature values, or calculated by difference (assuming steady state) as detailed in the text. Standard deviations for each flux are omitted for visual clarity but can be found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

Particle Settling

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

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. Present settling rates 0.05 m/d for most particles, 0.005 m/d for phytoplankton.

Respiration

$$V \cdot \frac{dC}{dt} = Transport\ + Kinetics\ - f(DO) \cdot f(T) \cdot WOC \cdot Aw$$

V = volume of WQM cell adjacent to wetlands
C = concentration
f(DO) = limiting factor = DO/(Kh+DO)
f(T) = temperature effect
WOC = wetland oxygen consumption
Aw = area of wetland adjacent to WQM cell

At present, WOC = 0.5 g DO/sq m/d at 20C. WOC doubles for a 10C temperature increase. Kh = 1.0 g DO/m3.

Previous calibration had WOC = 1 g DO/sq m/d and no limiting factor. Wetland areas from TMDL model.

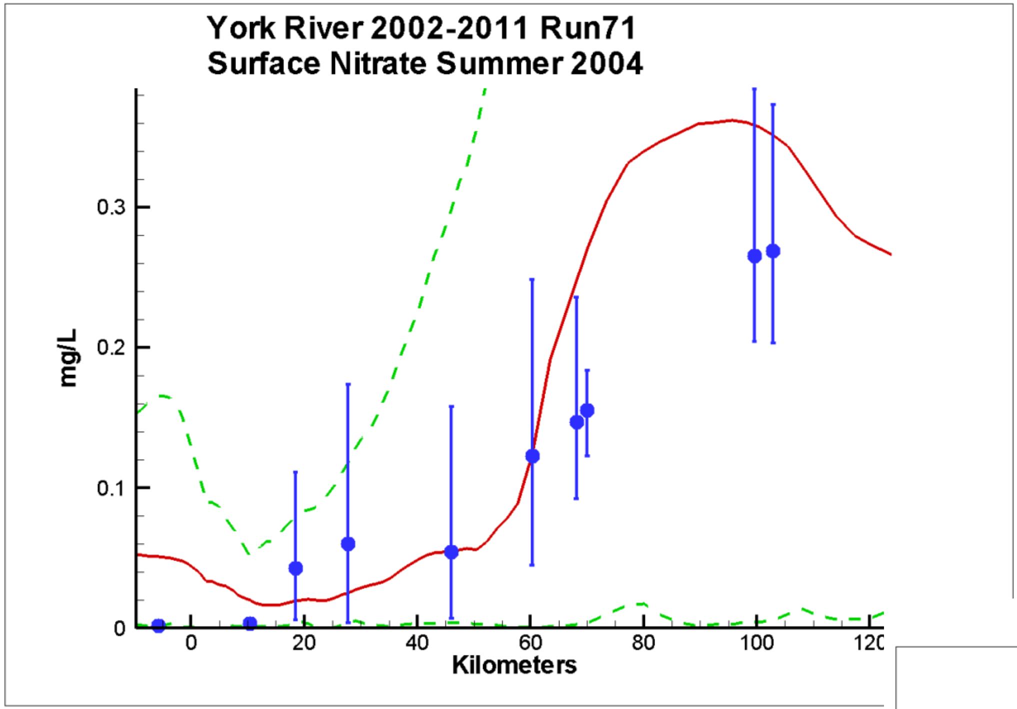
Denitrification

$$V \cdot \frac{dC}{dt} = Transport + Kinetics - MTC \cdot f(T) \cdot C \cdot Aw$$

V = volume of WQM cell adjacent to wetlands
C = nitrate concentration
MTC = mass-transfer coefficient
f(T) = temperature effect
Aw = area of wetland adjacent to WQM cell

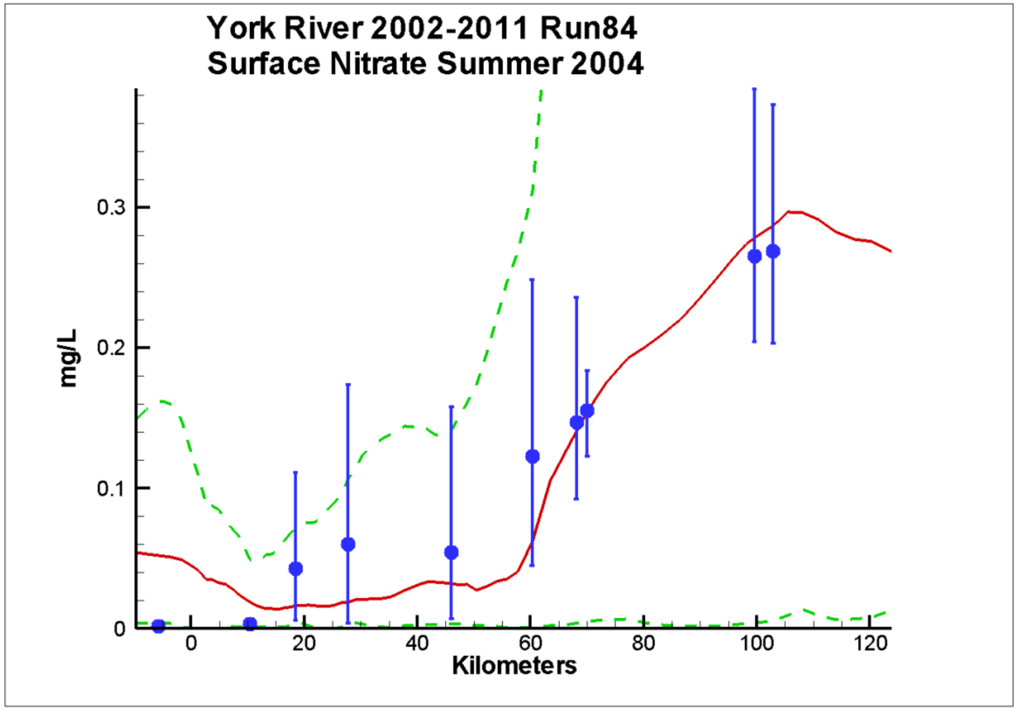
At present, the mass-transfer coefficient is 0.05 m/d.
Denitrification doubles for a 10C temperature increase.

Nitrate in York River

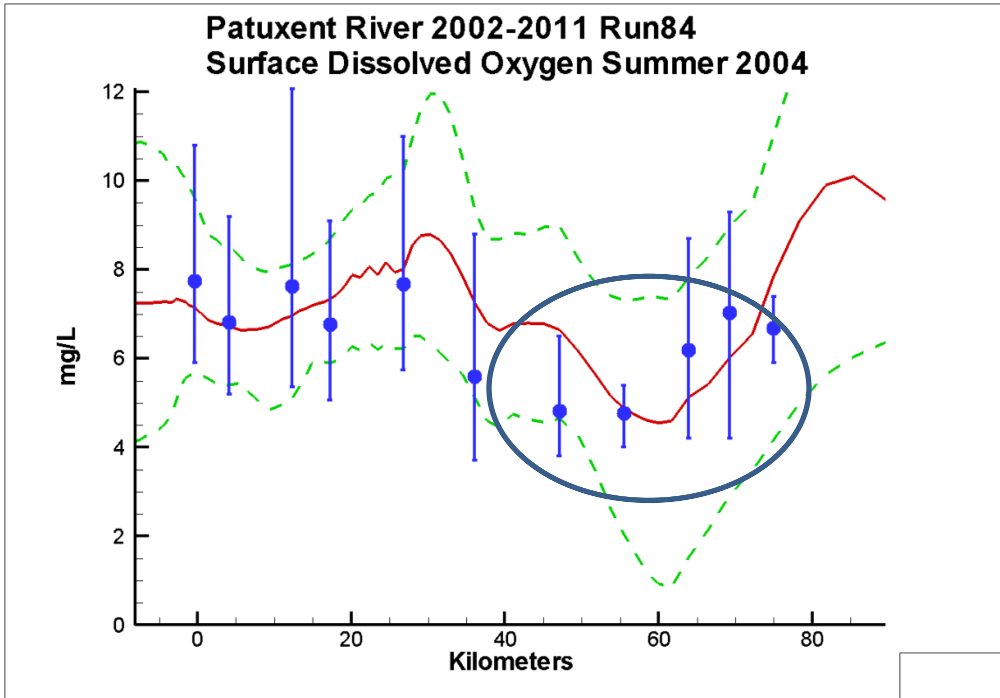


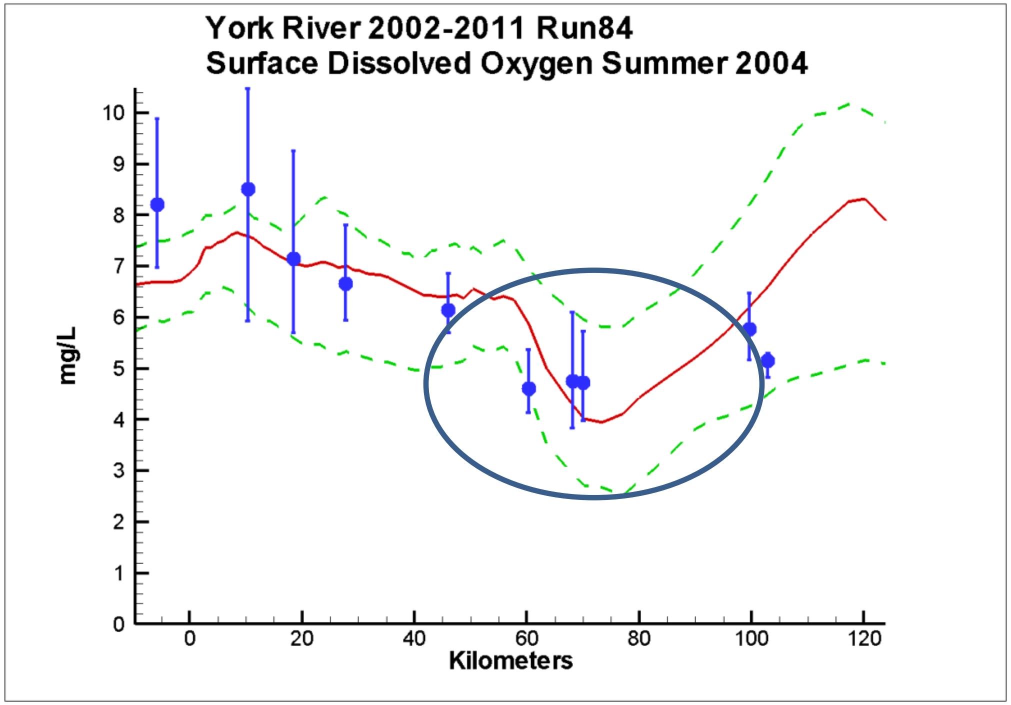
No Wetlands

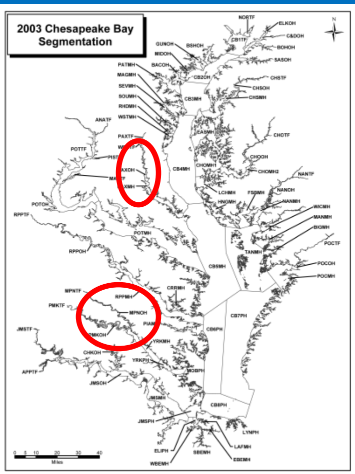
With Wetlands



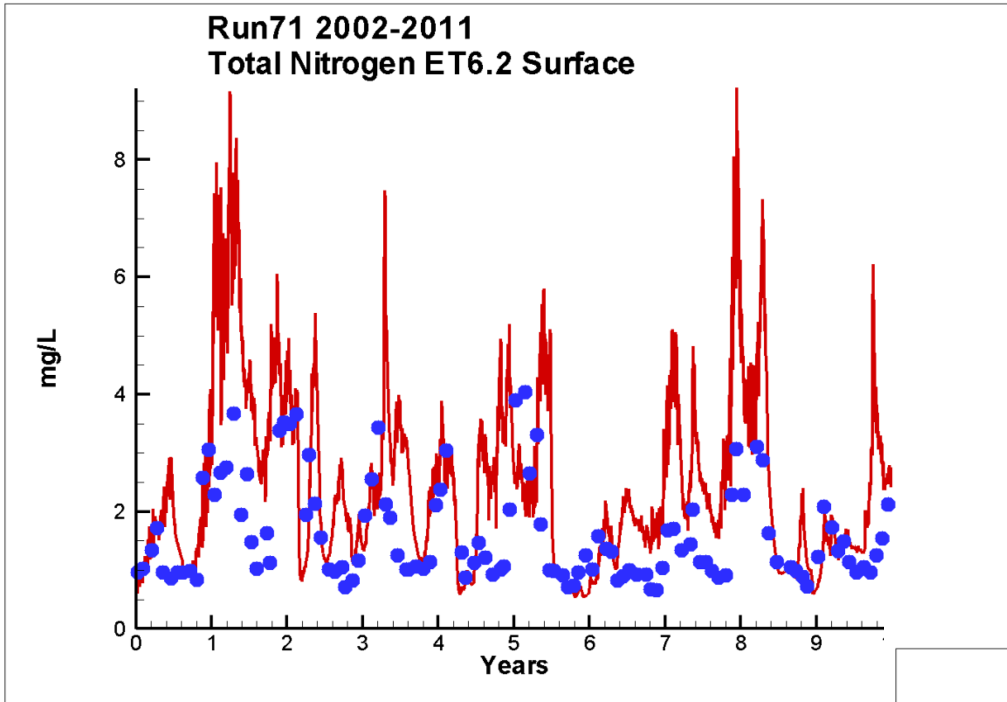
Wetlands DO Effects





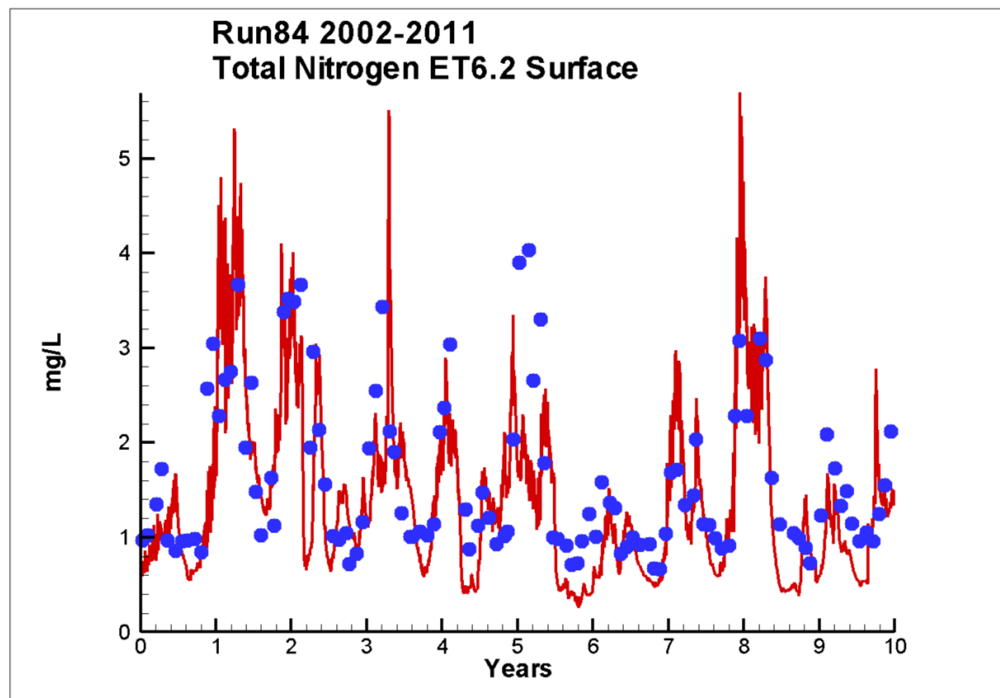


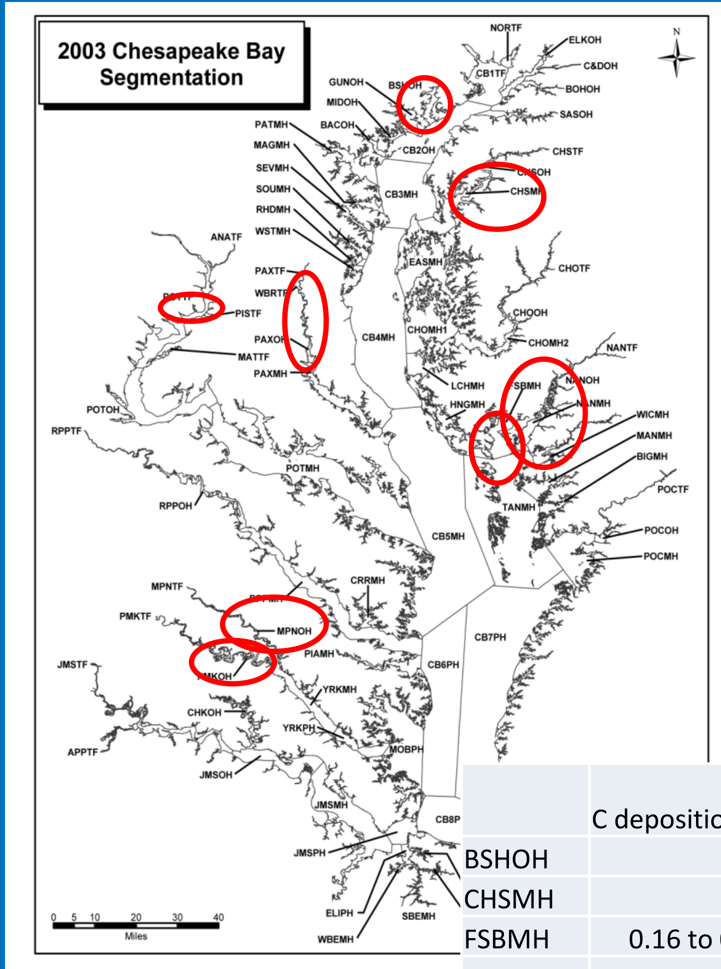
Total Nitrogen in Nanticoke River



No Wetlands

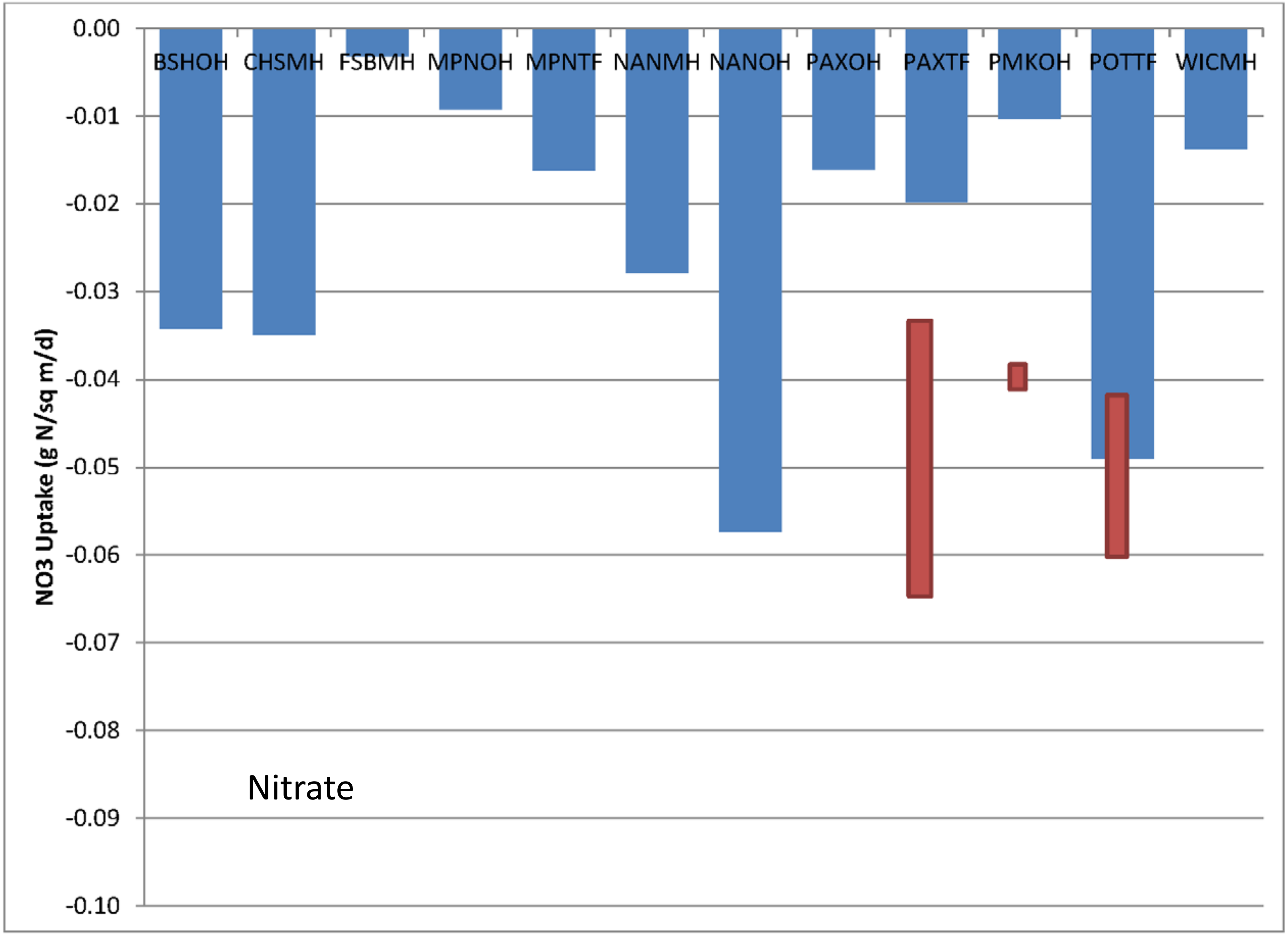
With Wetlands



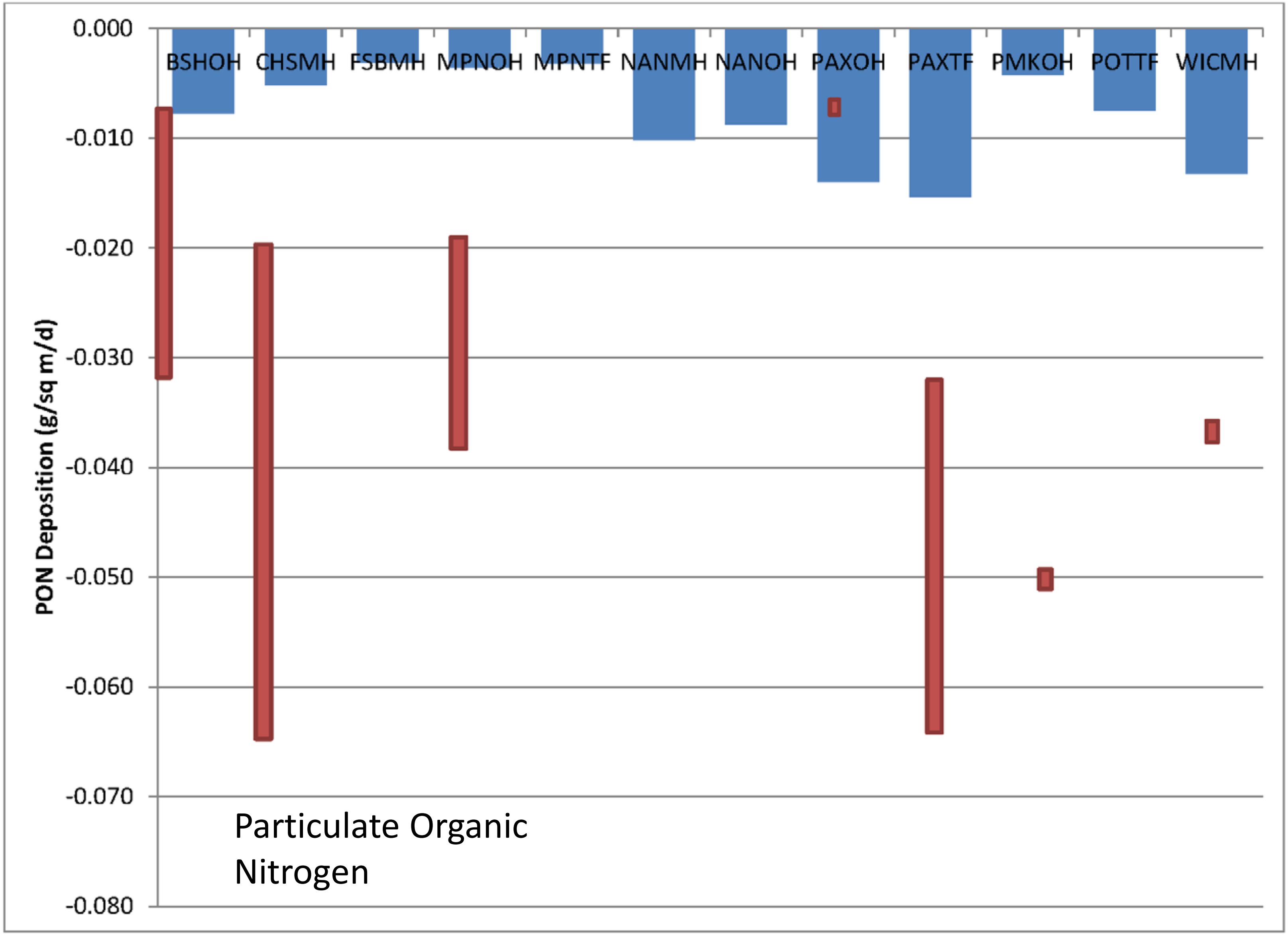


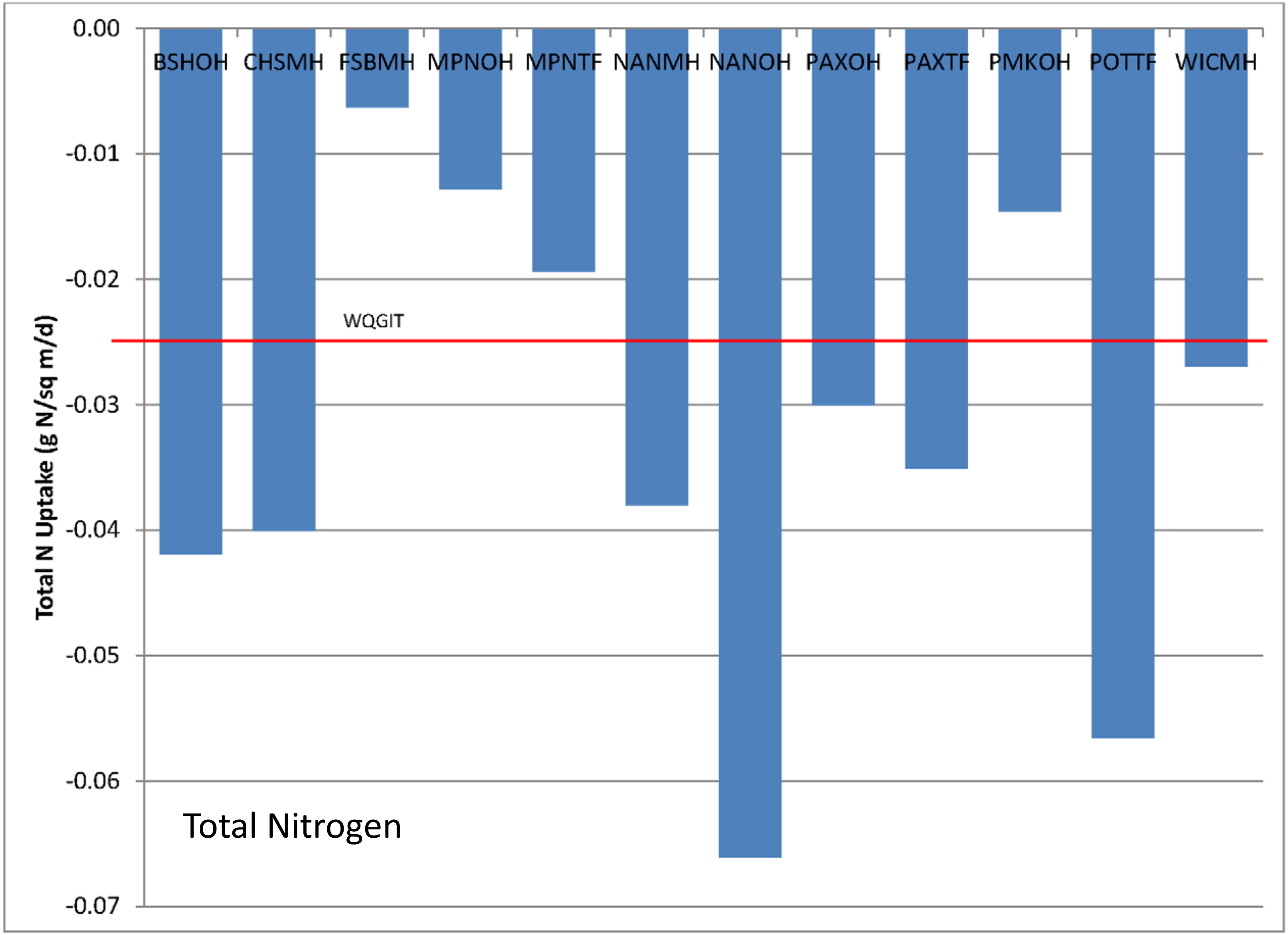
Hot Spots for Calibration

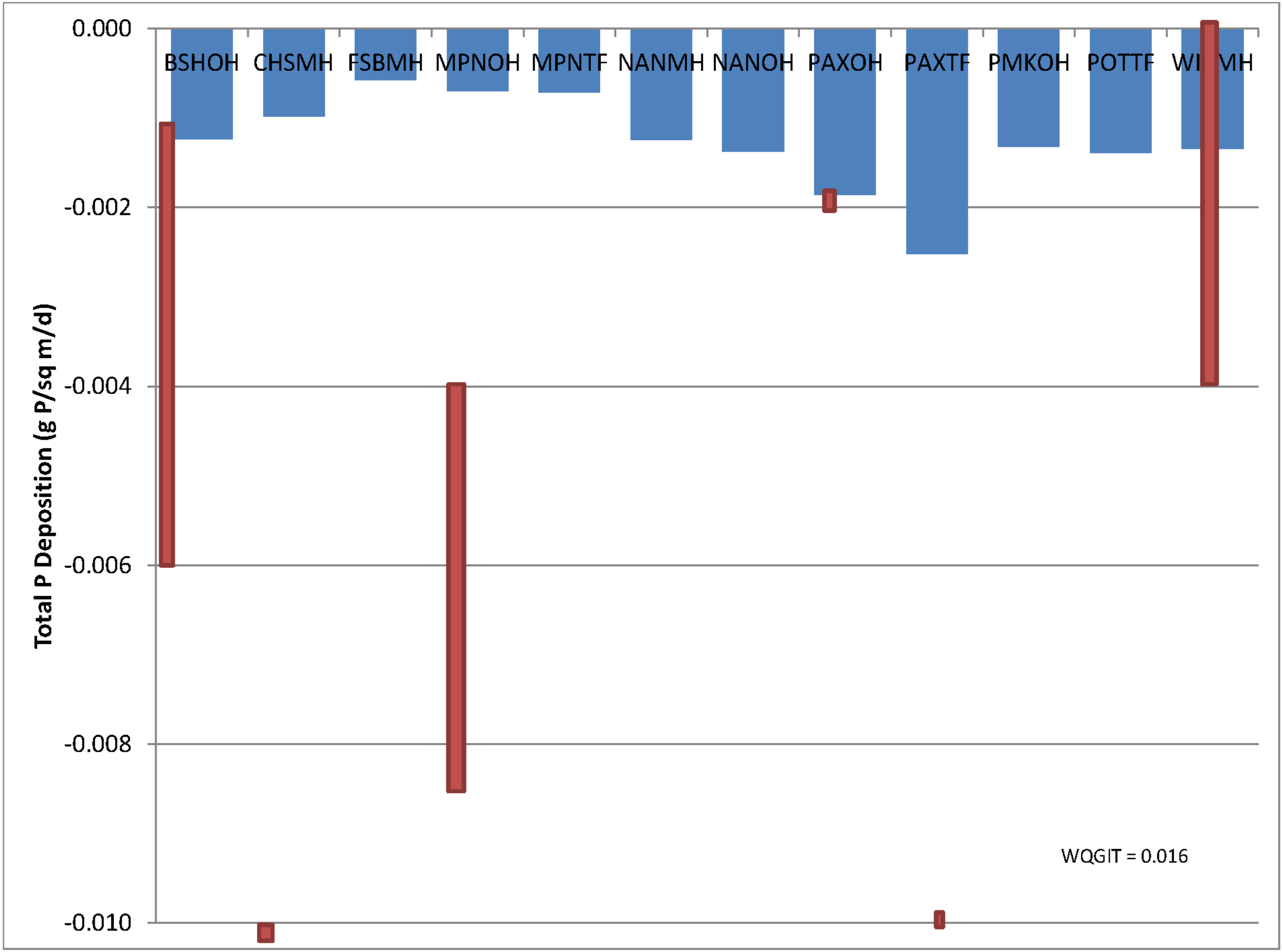
	C deposition	N deposition	P deposition	denitrification	solids deposition	respiration
BSHOH		0.008 to 0.032	0.001 to 0.006			
CHSMH		0.02 to 0.064	0.01 to 0.019		3.6	
FSBMH	0.16 to 0.33				0.3	
MPNOH	0.24 to 2.77	0.019 to 0.238	0.004 to 0.085		1.43 to 42.0	
MPNTF						
NANMH	0.033 to 0.126				1.61 to 8.12	
NANOH	0.033 to 0.126				1.61 to 8.12	
PAXOH		0.008	0.002		5.75	
PAXTF		0.033 to 0.064	0.01	0.108 to 0.197	5.75	
PMKOH	0.61	0.05		0.04		1.12 to 2.77
POTTF	1.44			0.043 to 0.06	5.88	
WICMH	0.033 to 0.126	0.037	2.74x10^-5 to 0.004		1.61 to 8.12	
CHOMH		0.053 to 0.074	4.9x10^-4 to 0.005			
WQGIT			0.0016	0.026		



0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
NO3 Uptake (g N/sq m/d)
BSHOH
CHSMH
FSBMH
MPNOH
MPNTF
NANMH
NANOH
PAXOH
PAXTF
PMKOH
POTTF
WICMH
Nitrate


0.000
-0.010
-0.020
-0.030
-0.040
-0.050
-0.060
-0.070
-0.080
BSHOH
CHSMH
FSBMH
MPNOH
MPNTF
NANMH
NANOH
PAXOH
PAXTF
PMKOH
POTTF
WICMH
PON Deposition (g/sq m/d)
Particulate Organic Nitrogen


0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
Total N Uptake (g N/sq m/d)
BSHOH
CHSMH
FSBMH
MPNOH
MPNTF
NANMH
NANOH
PAXOH
PAXTF
PMKOH
POTTF
WICMH
WQGIT
Total Nitrogen


0.000
-0.002
-0.004
-0.006
-0.008
-0.010
Total P Deposition (g P/sq m/d)
BSHOH
CHSMH
FSBMH
MPNOH
MPNTF
NANMH
NANOH
PAXOH
PAXTF
PMKOH
POTTF
WQGIT = 0.016

Wrap-Up

- We have obtained existing tidal wetlands areas and mapped them to our grid.
- We have projections of future wetlands areas as a function of sea-level rise.
- We have a set of basic algorithms to deal with wetland nutrient removal and respiration.
- We can use the algorithms to demonstrate impacts of wetlands on the adjacent water column.
- We are validating the algorithms with water column monitoring data and reported wetlands fluxes.
- Final parameterization and reporting await a final set of system-wide loads.