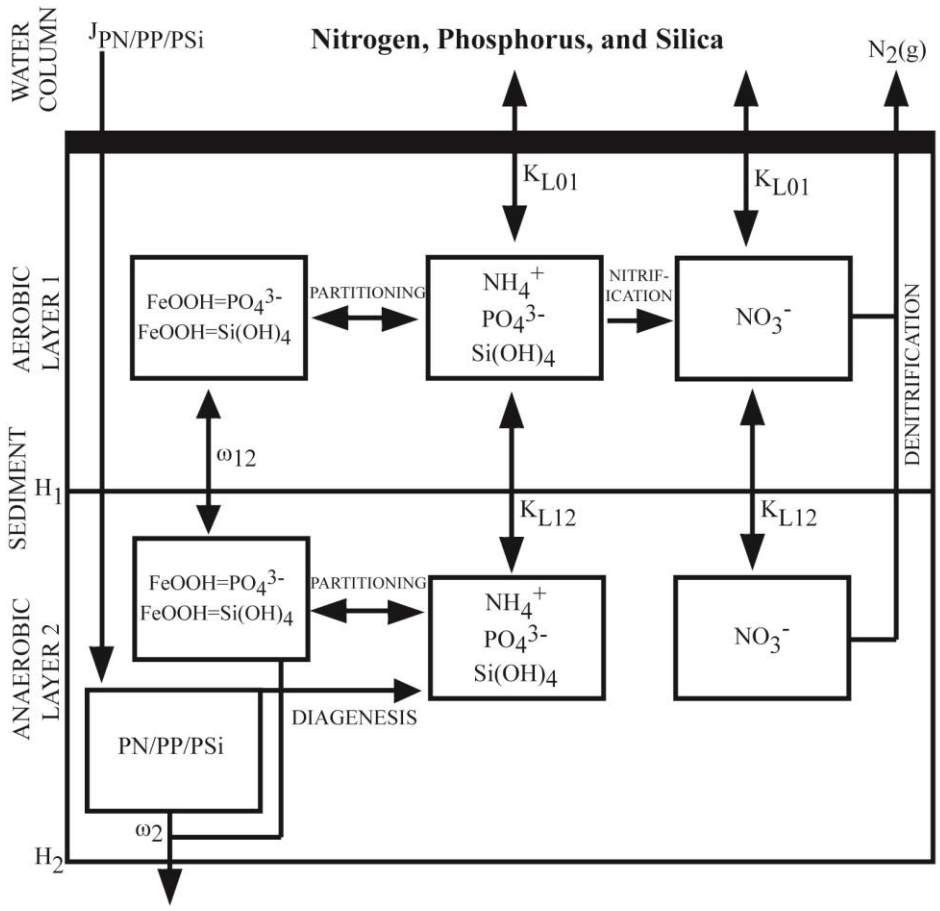
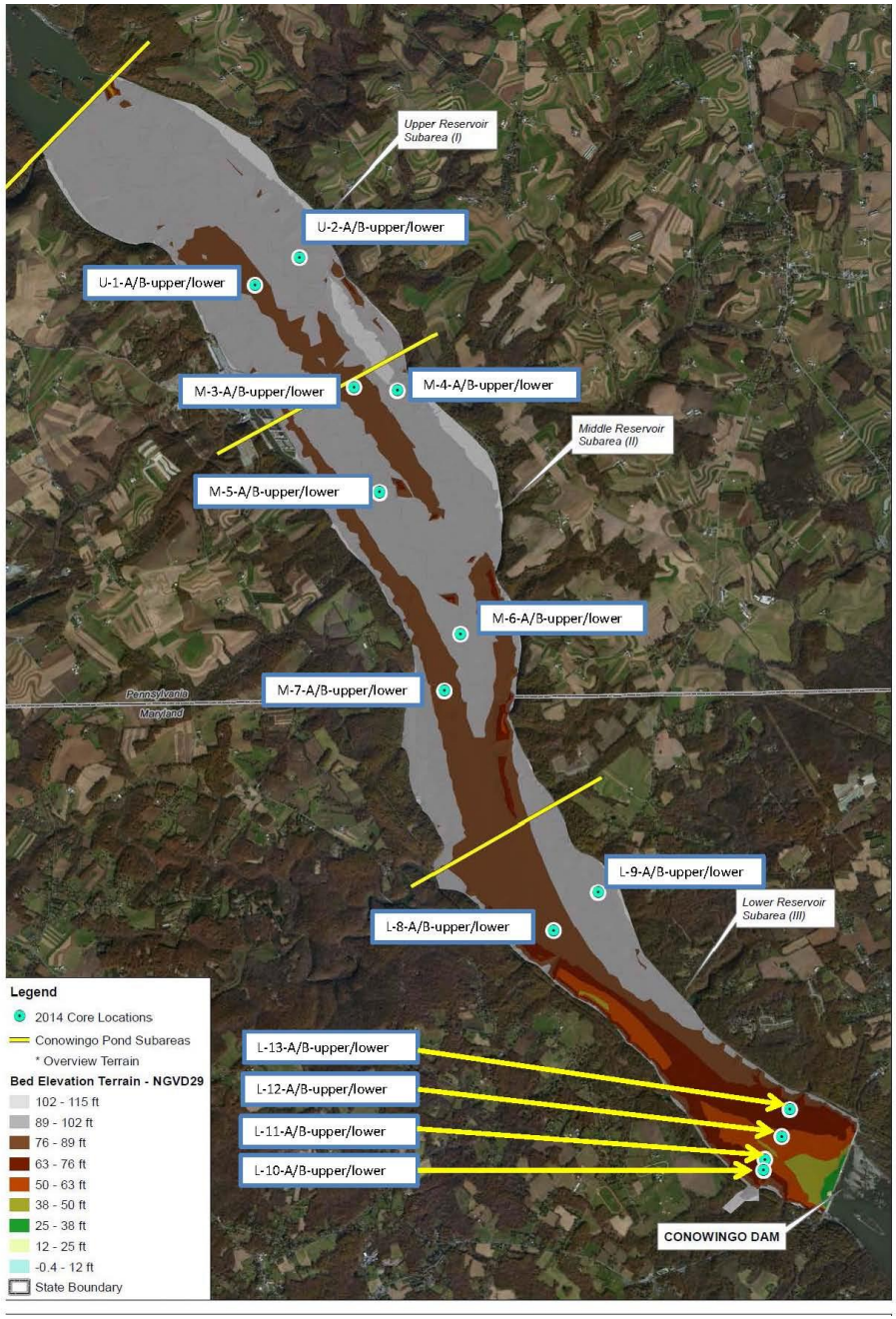
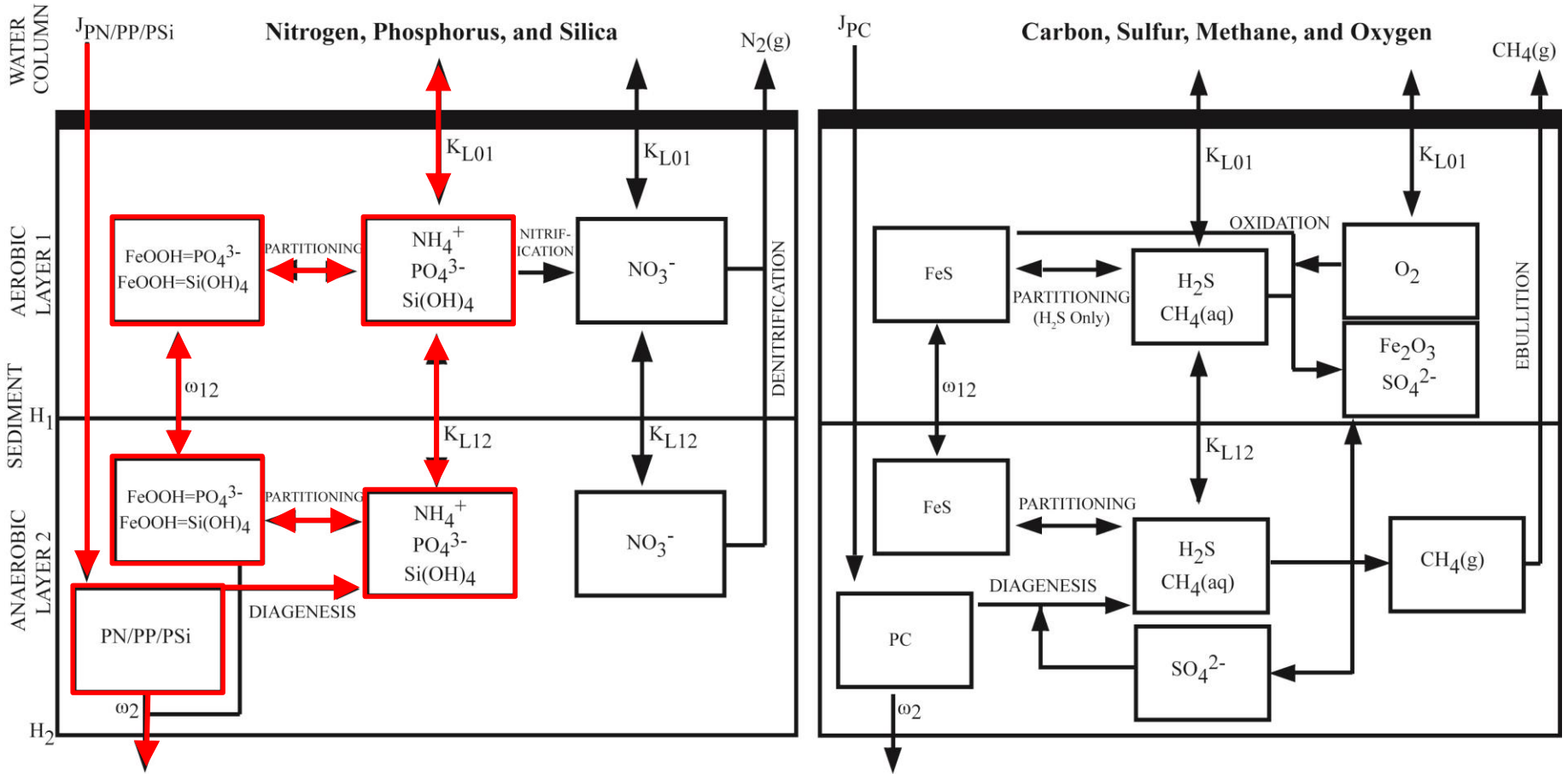
Sediment Flux Modeling of Conowingo Reservoir





Sediment Flux Model Schematic



*Deposited organic matter partitioned into 3 reactivity classes, representative of algal material or non-algal material

Sediment Flux Model Simulation Details

- Simulation period: 1980 to 2015
- Overlying water boundary is a climatology from CB1.0 (Susquehanna River below discharge)
- Temporal pattern of POM disposition is a sine wave with a May peak (as with reservoir Chl-a)
- Magnitude of POM deposition based on June sediment traps from Boynton et al. (1984)
- Simulations run for stations 1 to 13 in the reservoir, with the same deposition and OLW for all
- G1 = 0.13; G2 = 0.13; G3 = 0.74

Validation Data

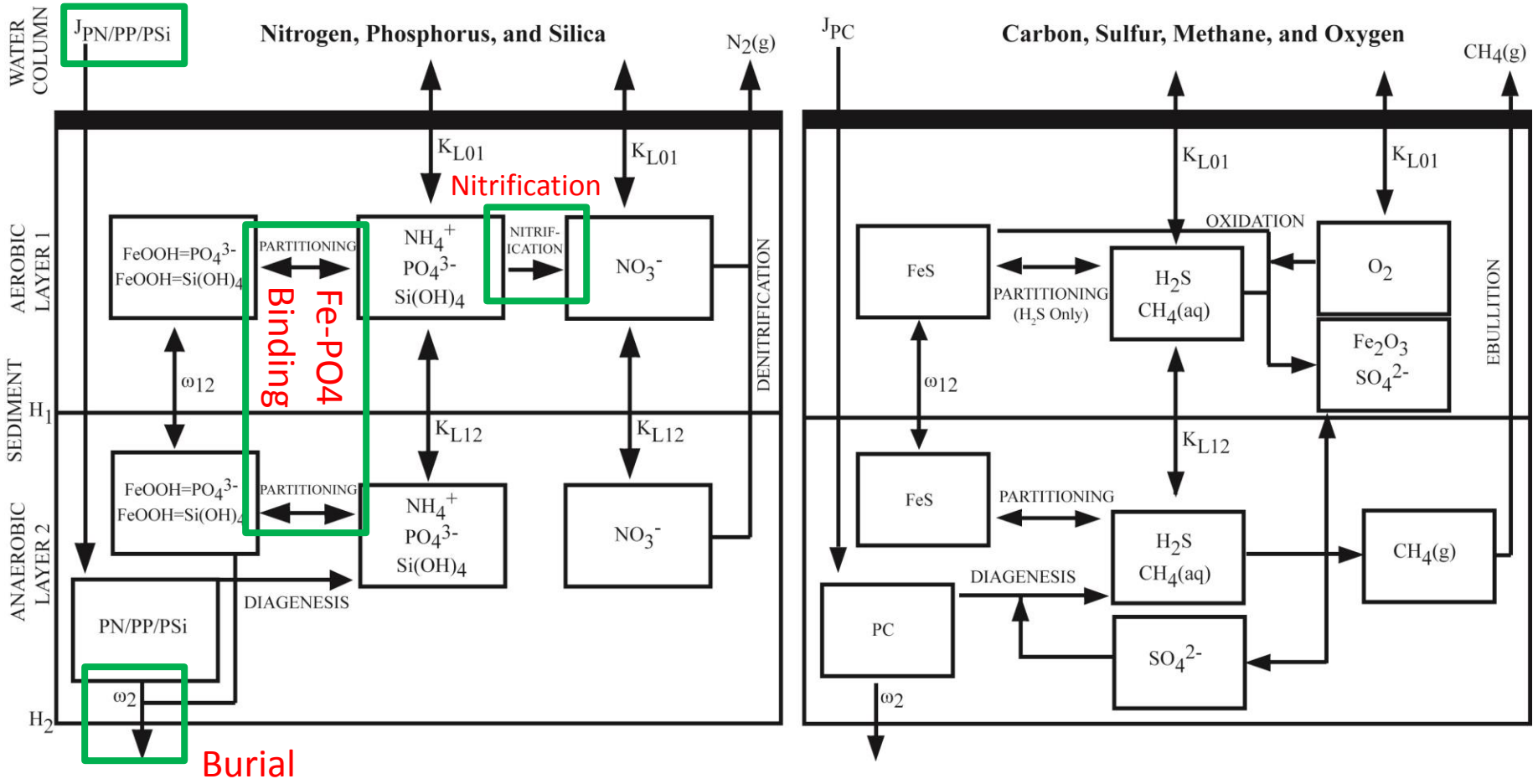
- Sediment C:N:P content from 2000
- Cornwell, Owens, Perez sediment-water fluxes of O_2, NH_4, NO_x, N_2, and SRP
- Boynton et al. (1984) SOD rates

Test Simulations

(1) “Algal POM & CB Params” = Traditional CB parameters and G-Model Splits
(2) “Algal+Terr C Low Burial” = G-Model splits as above and burial = 1.5 cm/yr
(3) “Algal+Terr C Low Burial High Fe” = #2 above, but dpiepo4 = 800 and pie2po4 = 600;
(4) “Algal+Terr C Low Burial High Fe Low Nit” = #3 above, but nitrification kappnh4f = 0.05

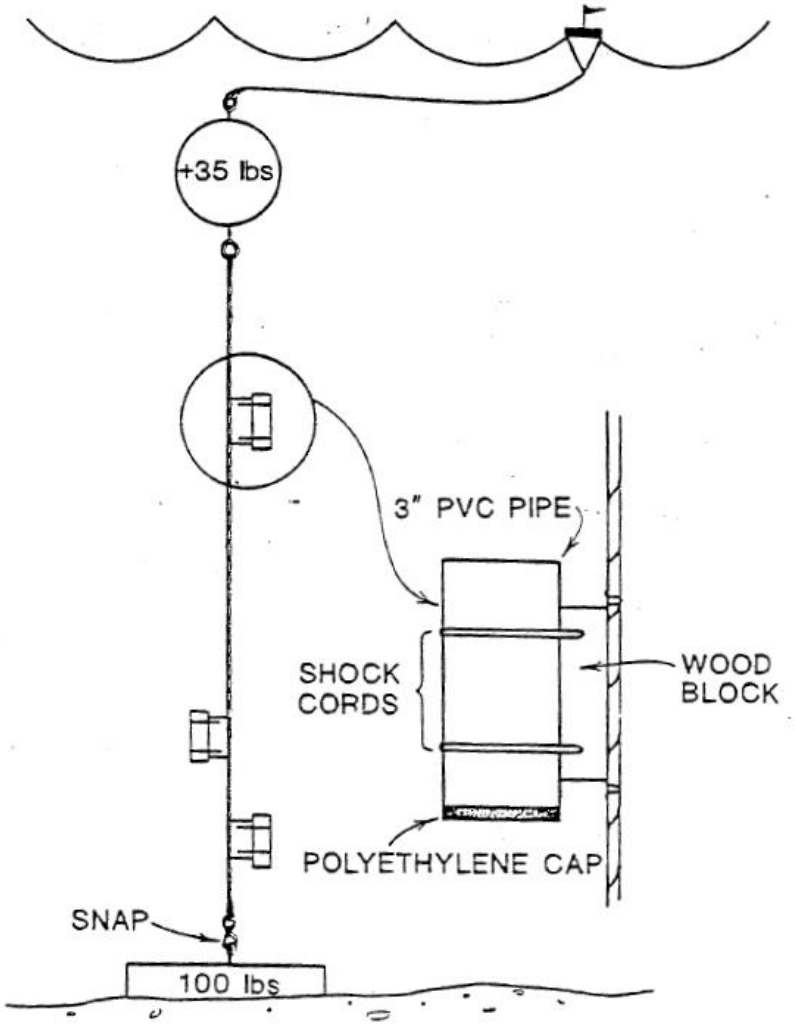
Sediment Flux Model Schematic

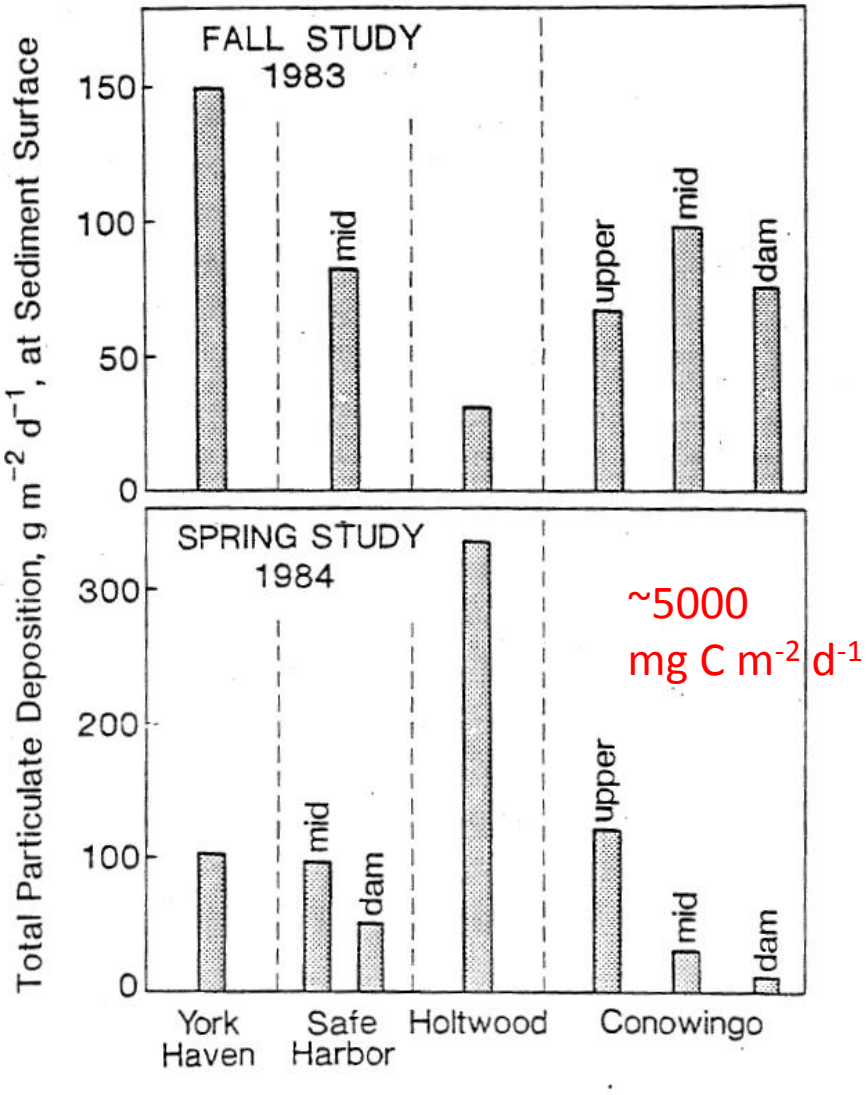
Organic Matter Deposition



*Deposited organic matter partitioned into 3 reactivity classes, representative of algal material or non-algal material

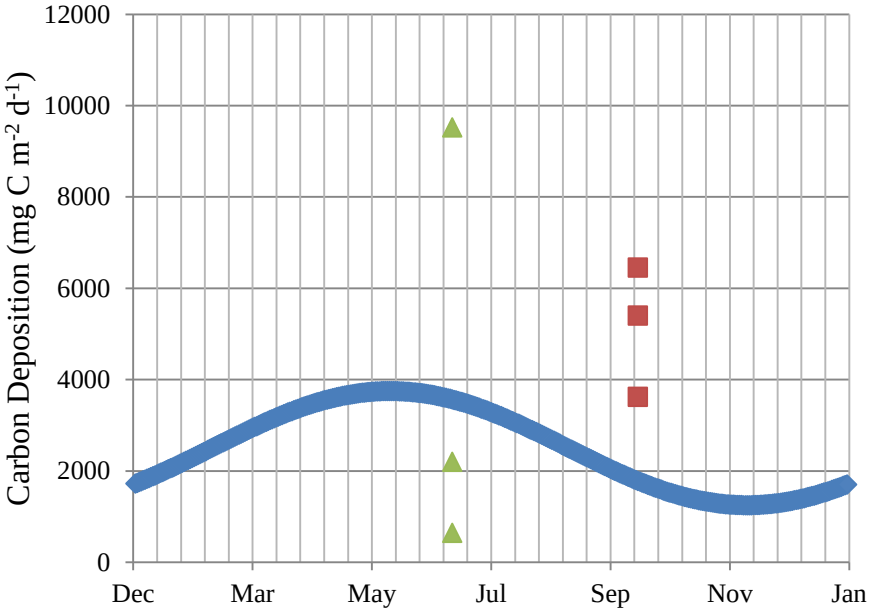
Past Sediment-Trap Observations in Reservoirs

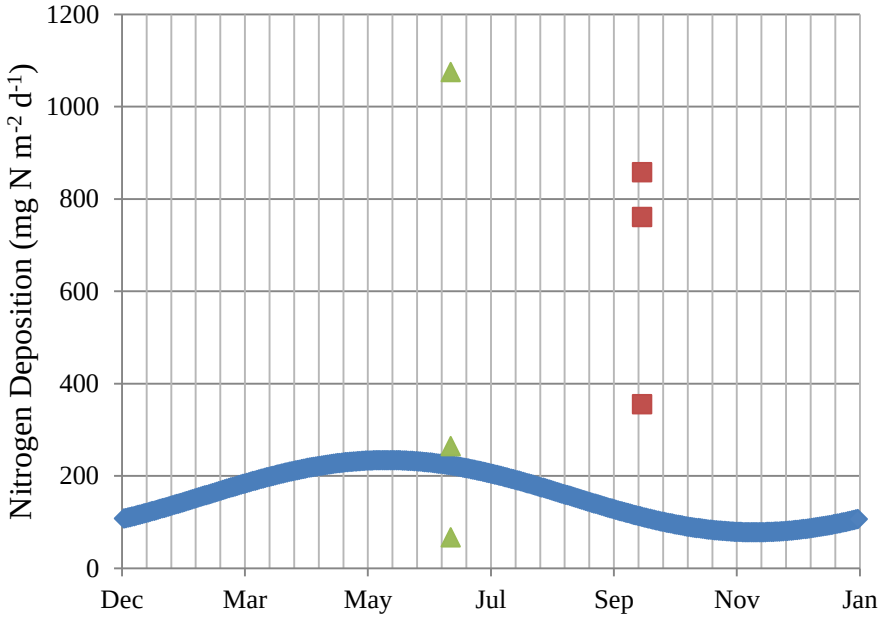




Boynton et al. (1984)

Results: Sediment Trap versus SFM Deposition





*Mean deposition based on average June values but the fall trap numbers are high

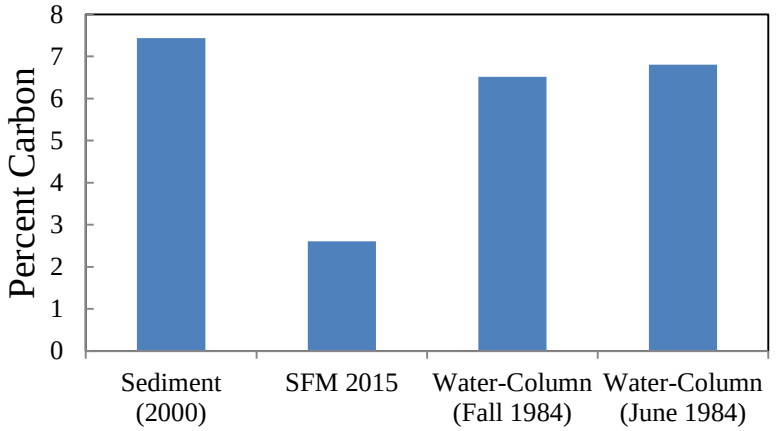
*Seasonality of deposition based on long-term flow and chl-a (this will change)

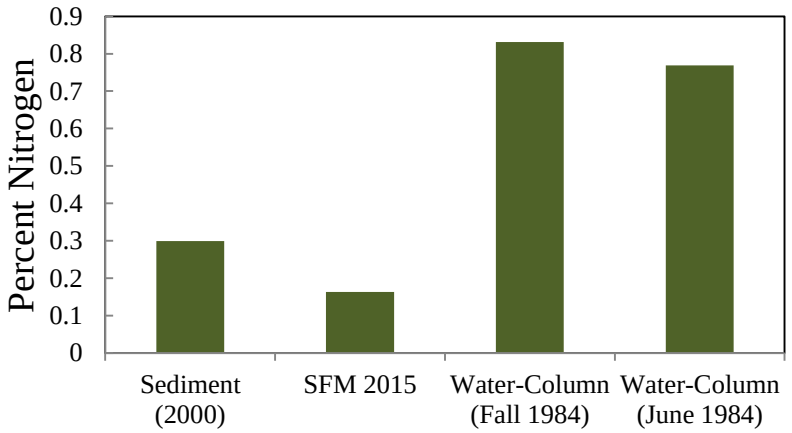
Results: Sediment C:N:P content

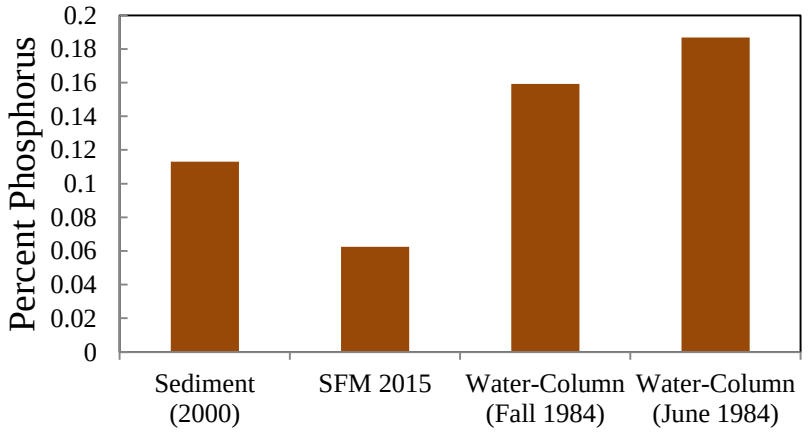
*SFM C:N:P content is lower than the observations we have, but it is reasonable

*This supports the idea that deposition is underestimated

* BUT, as you will see in the next slides, I am Generally over-estimating most of the NH_4 and O_2 fluxes







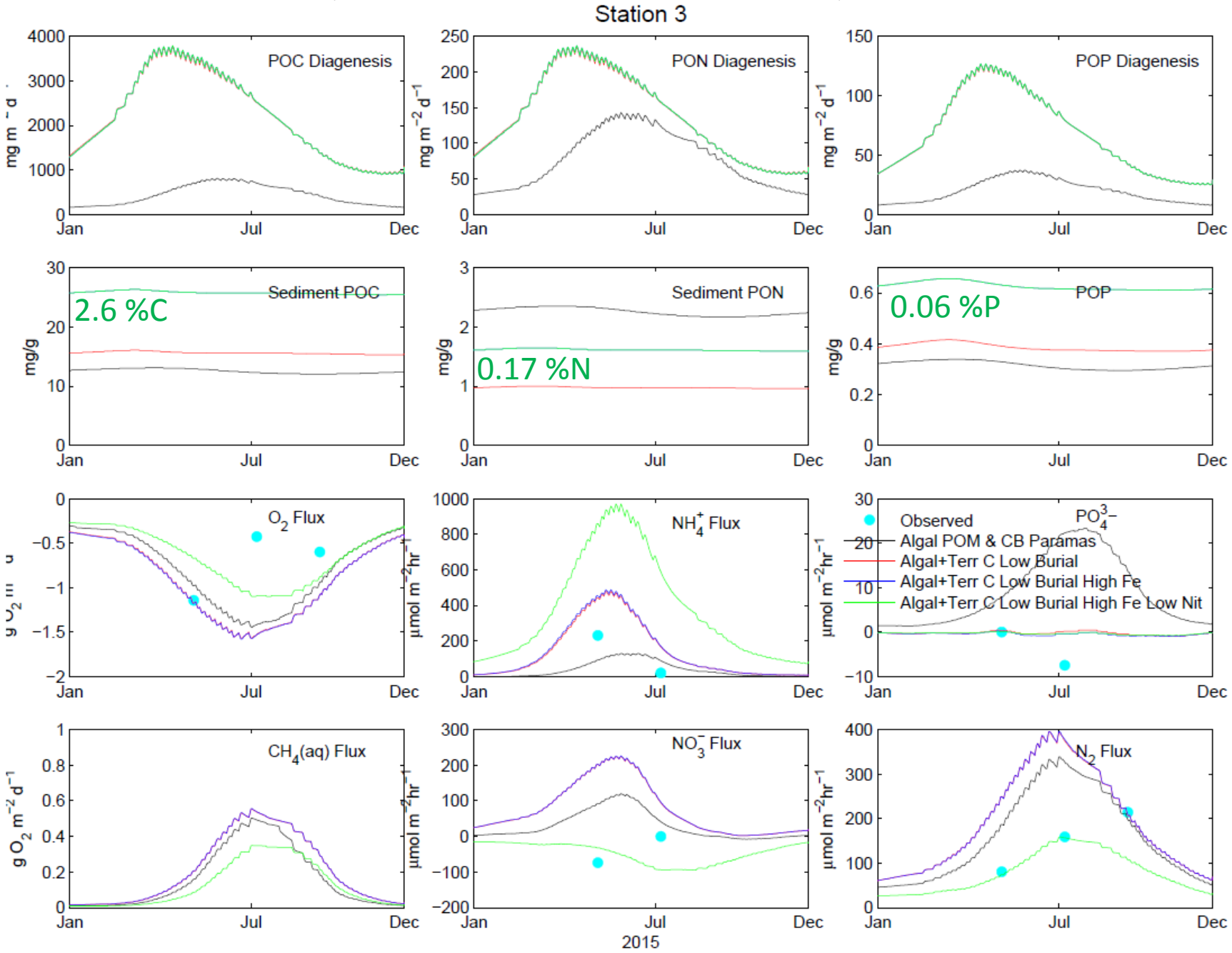
Results: SFM Rates and Fluxes

In the following slide, I compare the results from the below scenarios:

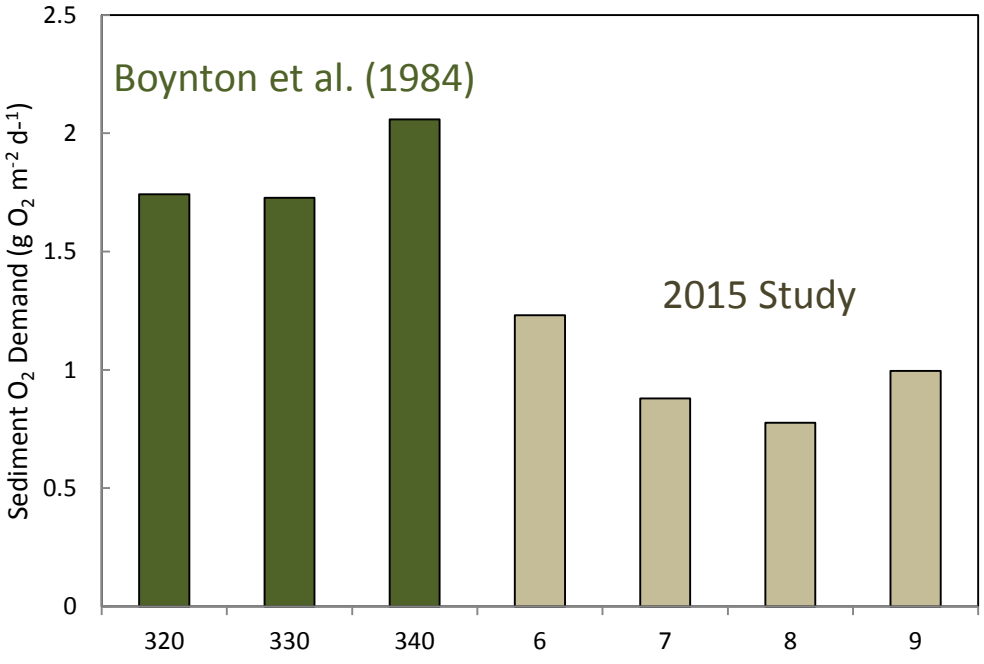
(1) "Algal POM & CB Params" = *Traditional CB parameters* and *G-Model Splits* (black line)
(2) "Algal+Terr C Low Burial" = G-Model splits as above and *burial = 1.5 cm/yr* (red)
(3) "Algal+Terr C Low Burial High Fe" = #2 above, but *$d\pi po4 = 800$ and $\pi_2 po4 = 600$* (blue)
(4) "Algal+Terr C Low Burial High Fe Low Nit" = #3 above, but *nitrification rate* LOW(green)

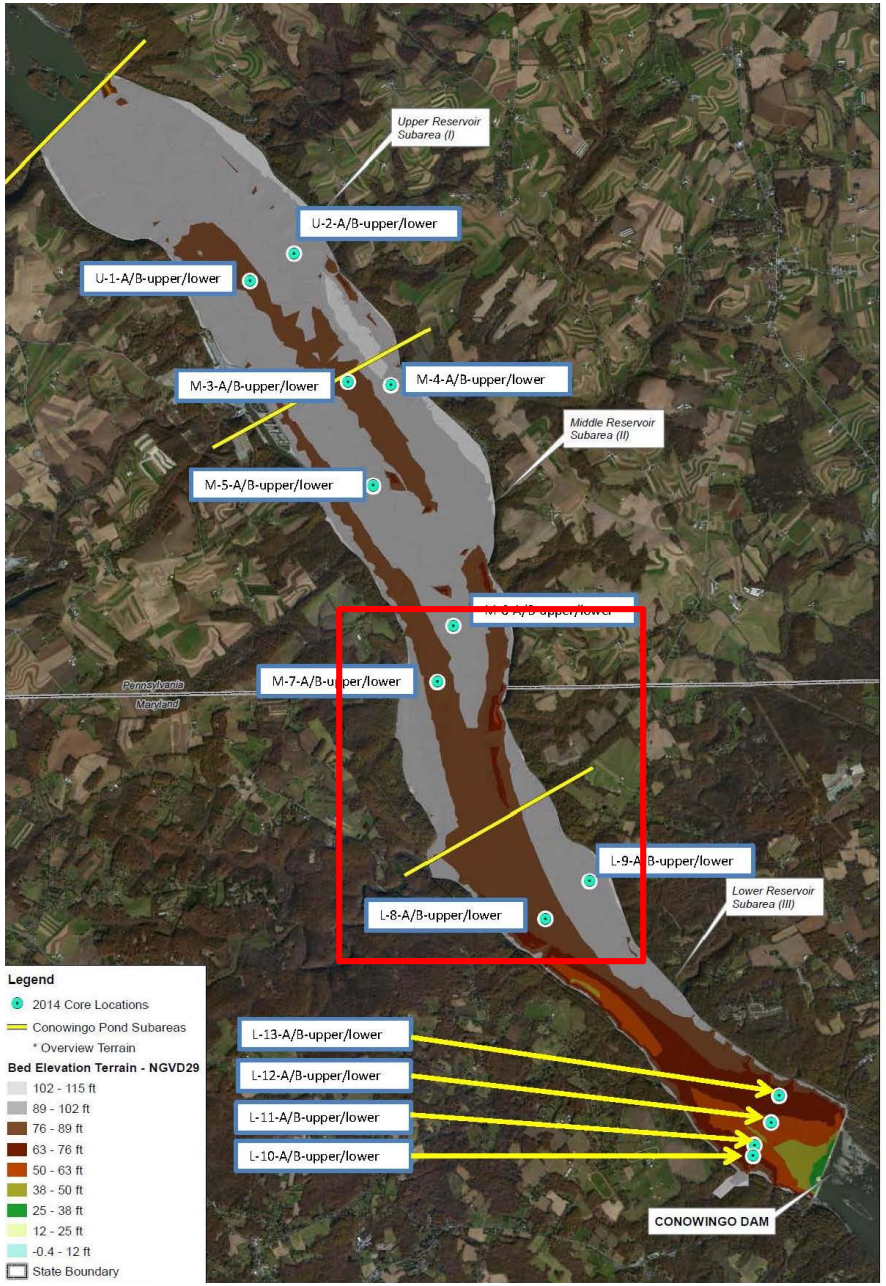
I consider the green line to be the best, but it'd clearly is missing something

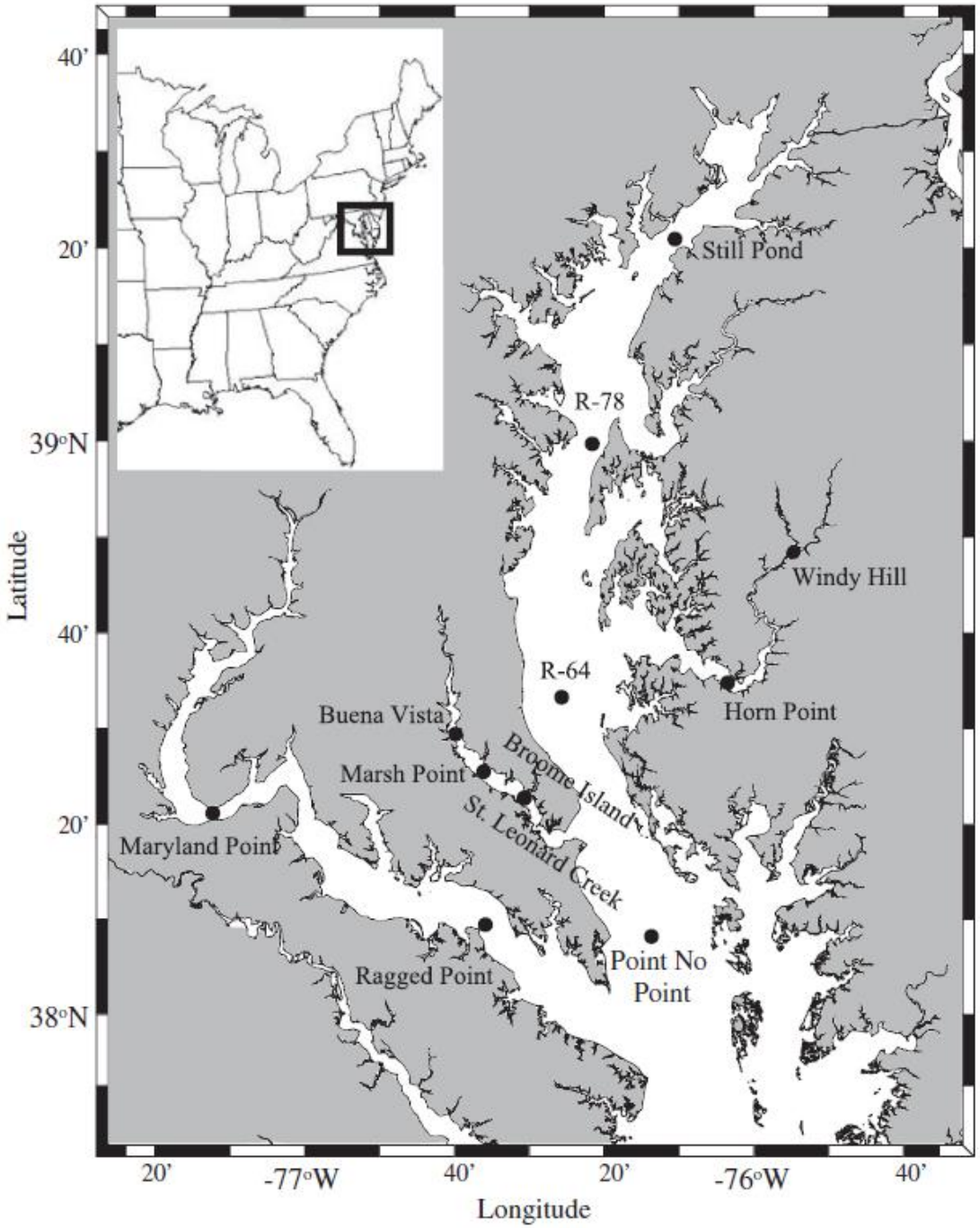
SFM Captures Magnitude, Except NH_4^+ Flux



New versus "Old" Sediment Oxygen Demand Rates



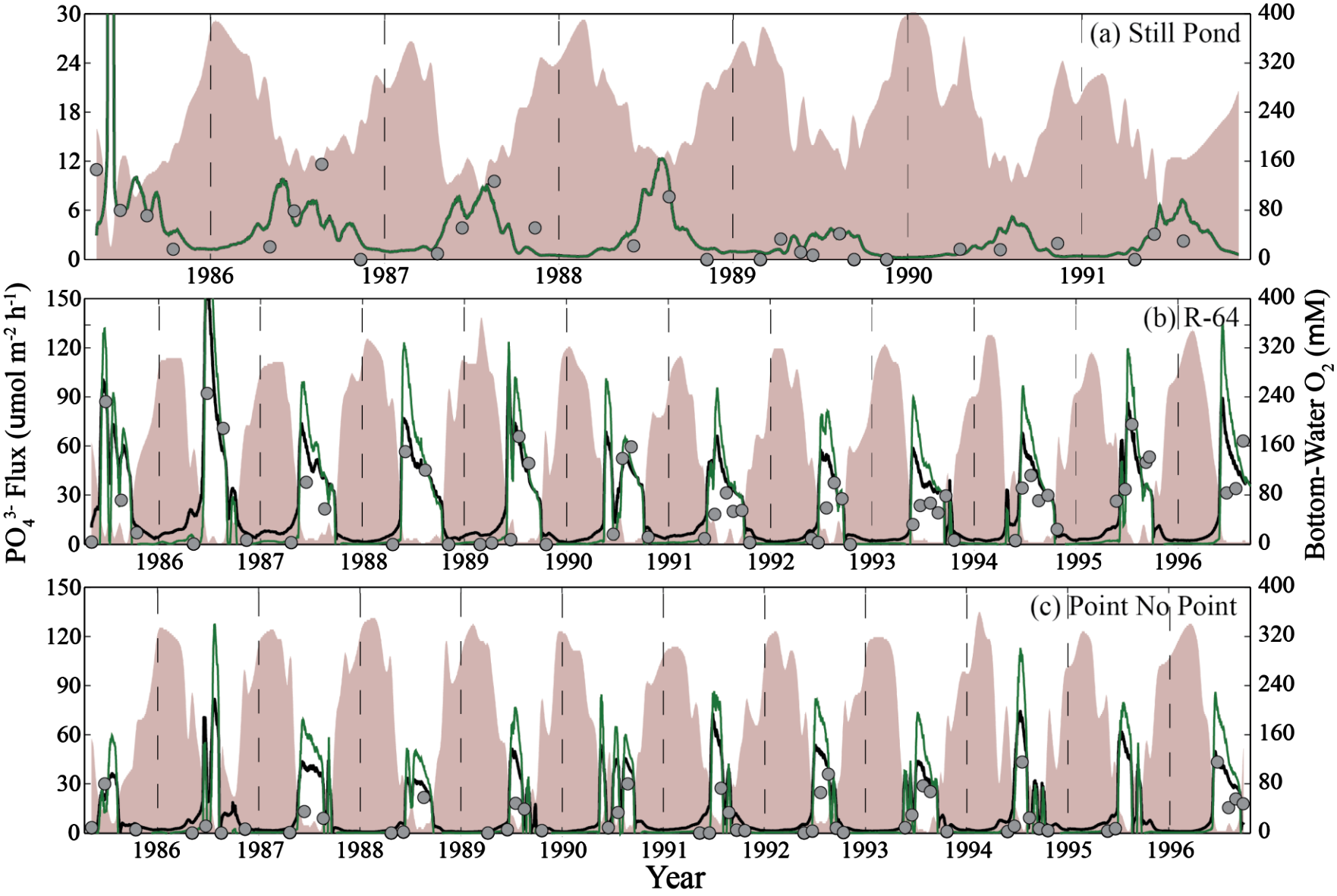




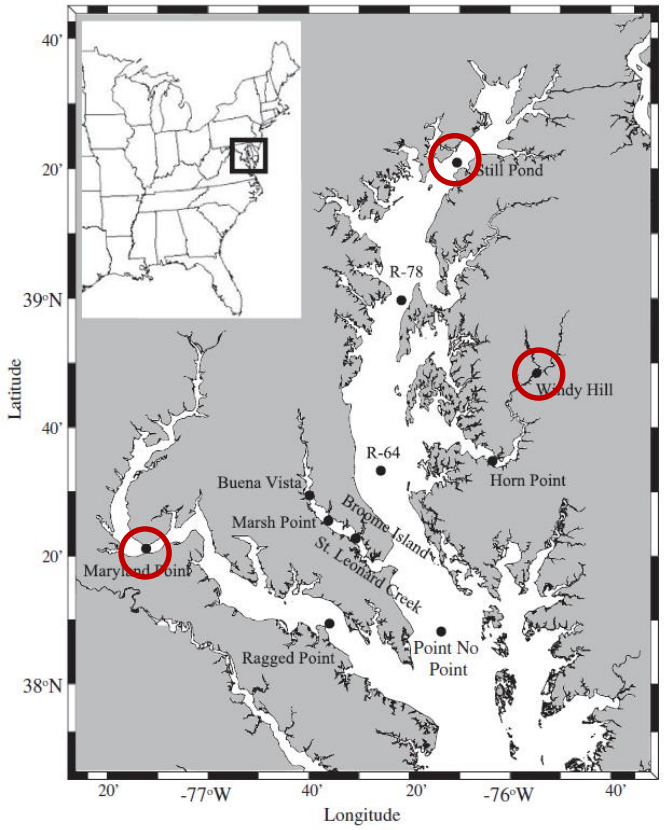
Sediment Flux Model Run in "Stand-Alone" For Chesapeake Bay

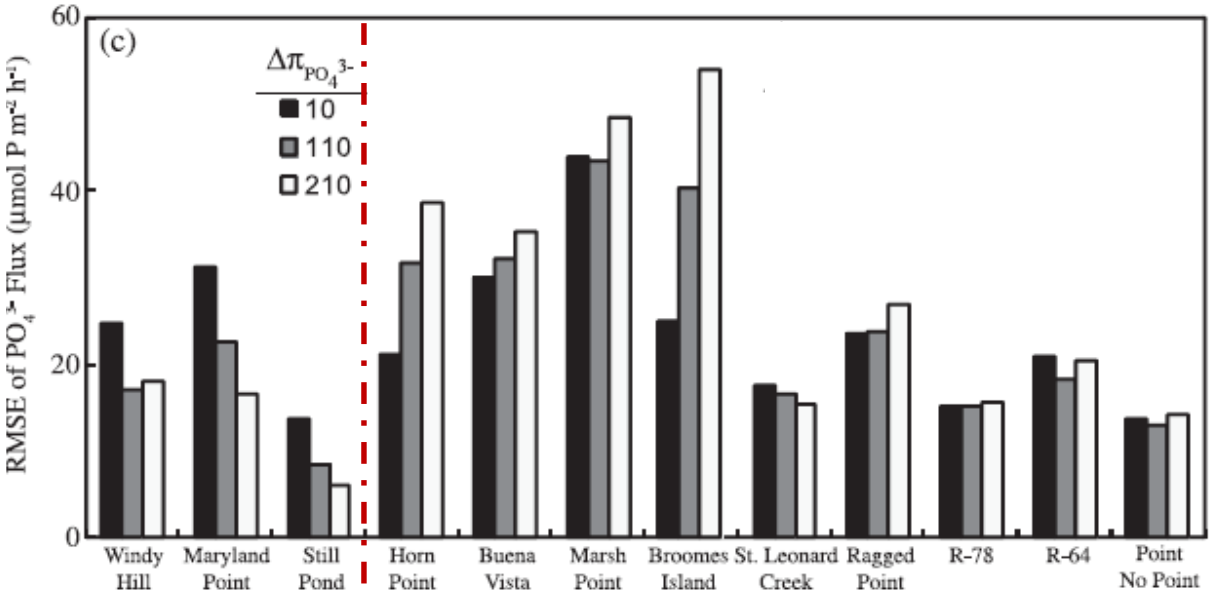
- Model forced by overlying-water nutrient and oxygen concentrations
- POM deposition estimated by fitting model NH_4^+ flux to observations
- Rapid runs allow for sensitivity runs, scenarios

Model Time-Series of PO_4^{3-} Flux and O_2

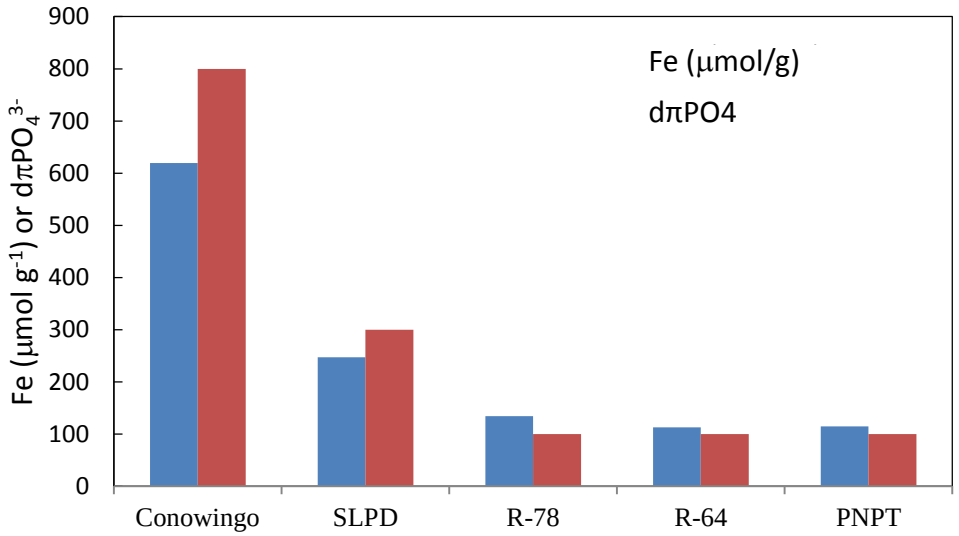


Spatially-Dependent Model Optimization



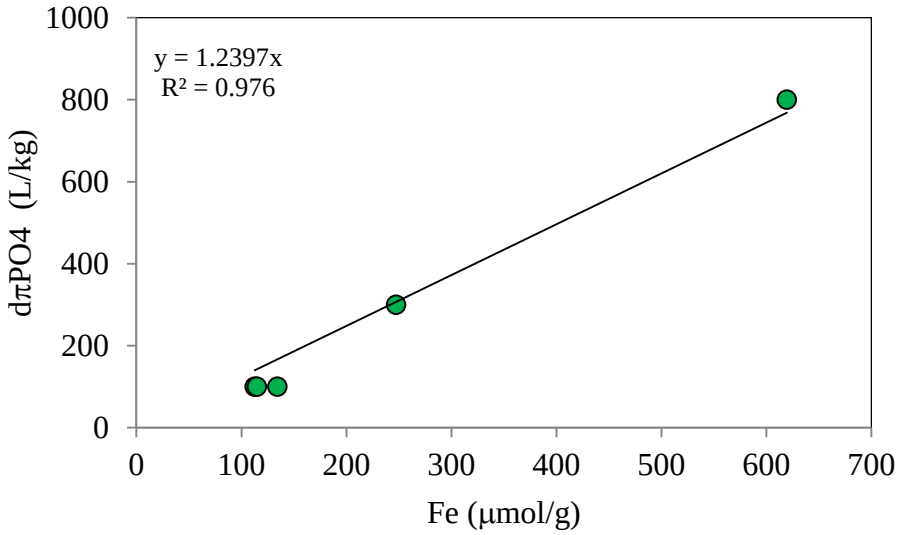


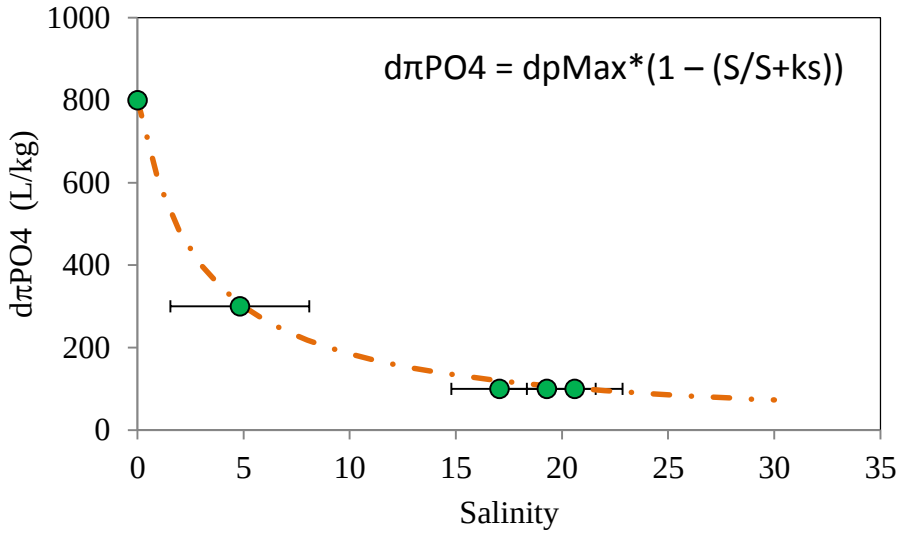
Results: P-Partitioning Parameterization



-Partitioning coefficients were increased substantially to avoid P fluxes out of sediments

-Related aerobic layer partitioning coefficient to Fe availability (Bay data are oxalate-extractable Fe from Cornwell and Sampou 1995 top 3 cm, while Conowingo are total Fe from 200 report).





Summary

- Initial SFM Simulations for the Reservoir show promise, but deposition rates are high
- Deposited organic material appears to be dominated by relatively refractory material
- Nitrification appears ton be low in reservoir sediments. Reason unclear at this time
- It appears that reservoir sediment have a high capacity to retain phosphorus

Moving Forward

- Test alternative timing and magnitude of deposition rates
- Test flux sensitivity to low oxygen. Oxygen was high during 2015 experiments, but prior work has showed low concentrations in certain times and places
- It appears that reservoir sediment have a high capacity to retain phosphorus