Modeling Chester River Water Quality.....

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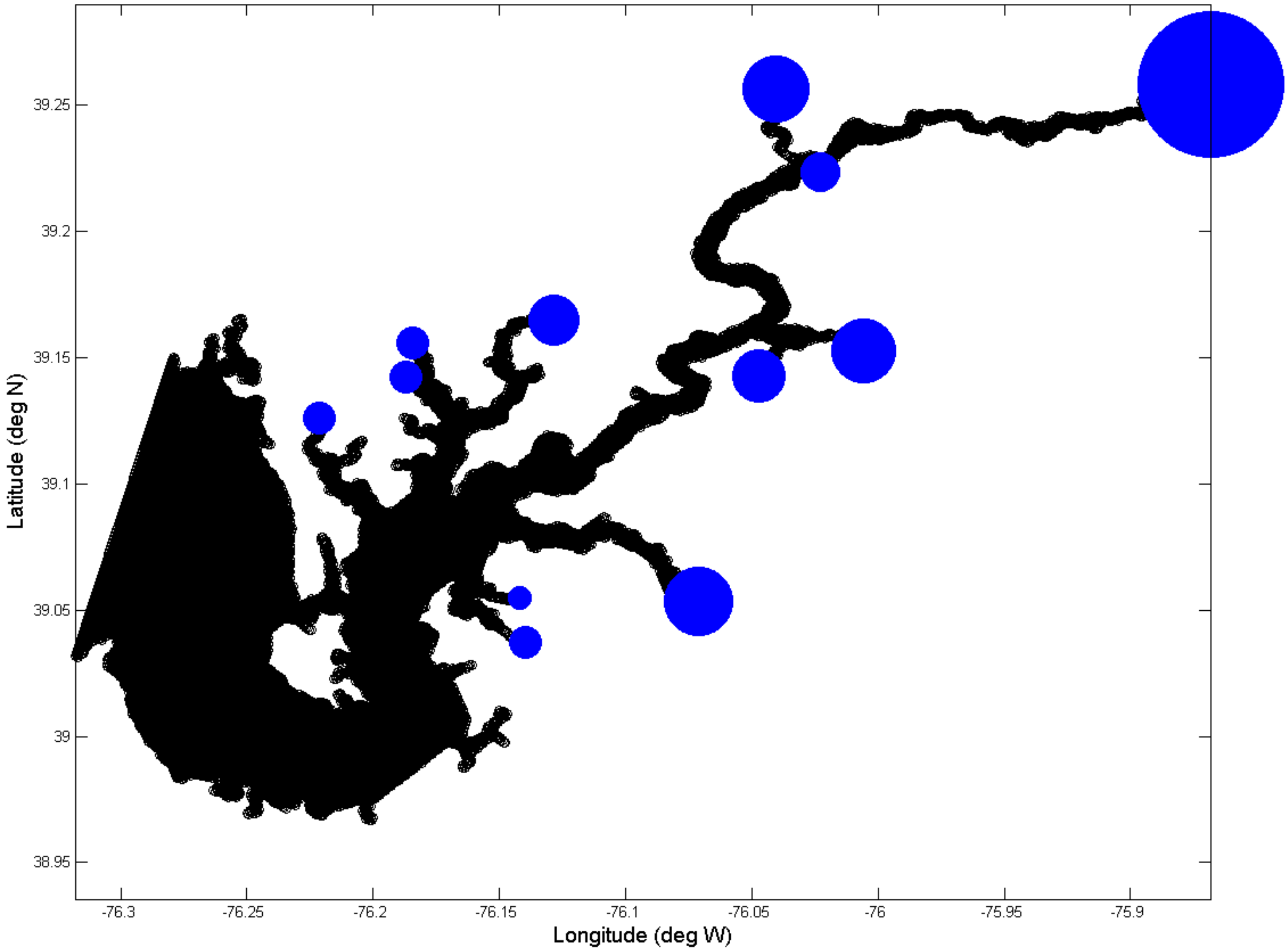
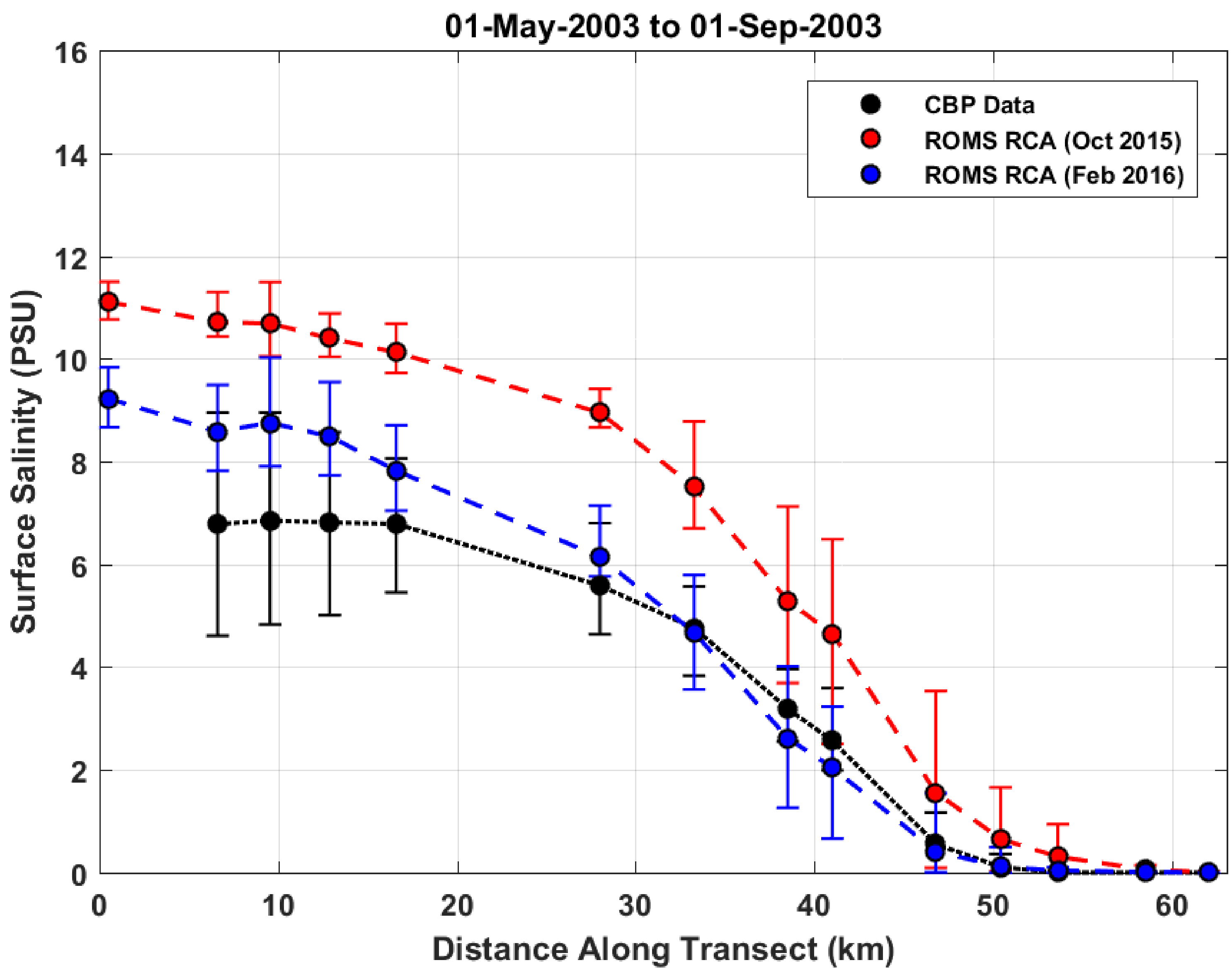
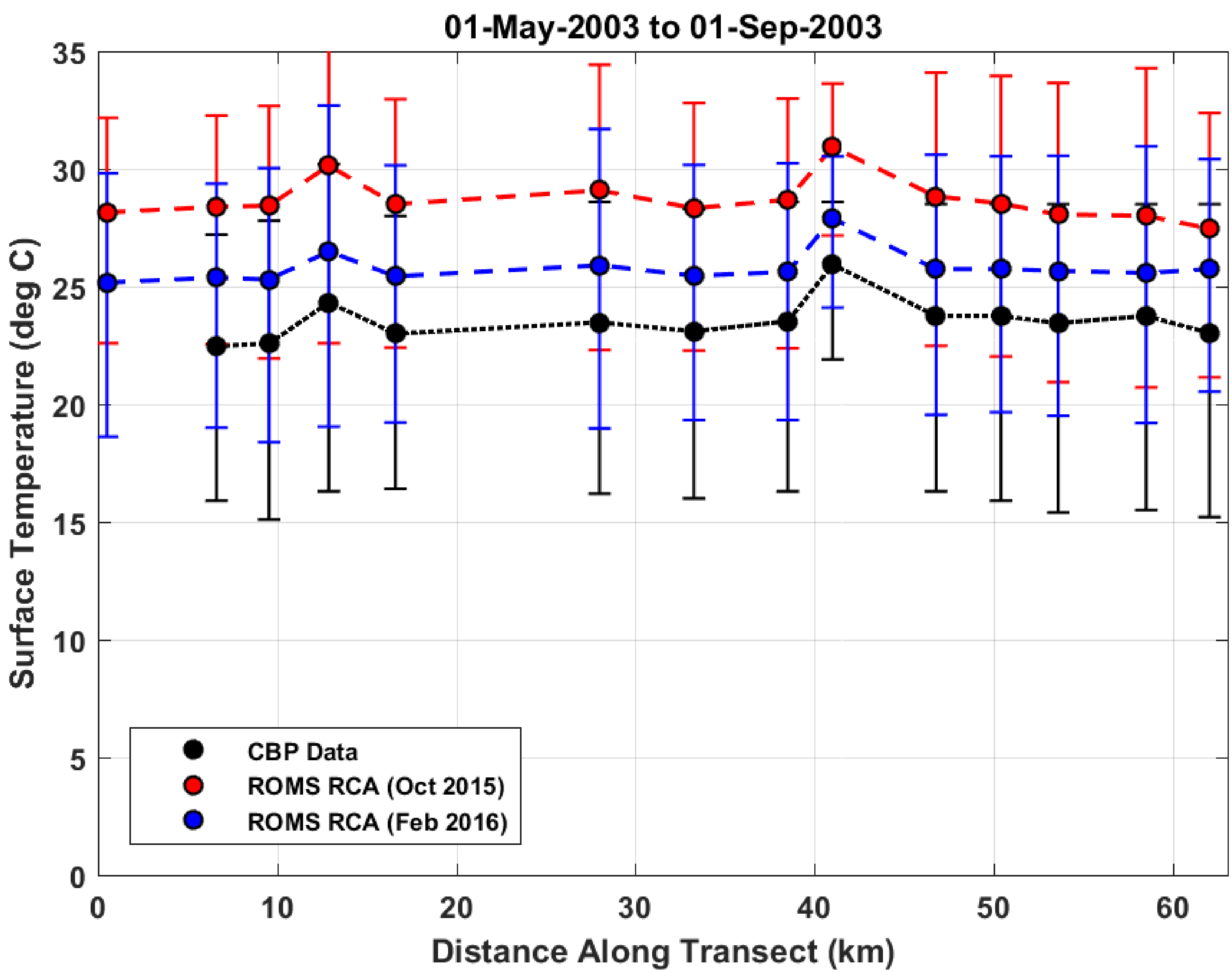
Outline

(1) Quick update on ROMS
(2) Comparison of RCA and ICM
(3) Some Chester water quality trends
(4) Modeling benthic algae/MPB
(5) Metabolism, pH, and sediment P Flux

(1)Forcing Effects on ROMS Salinity

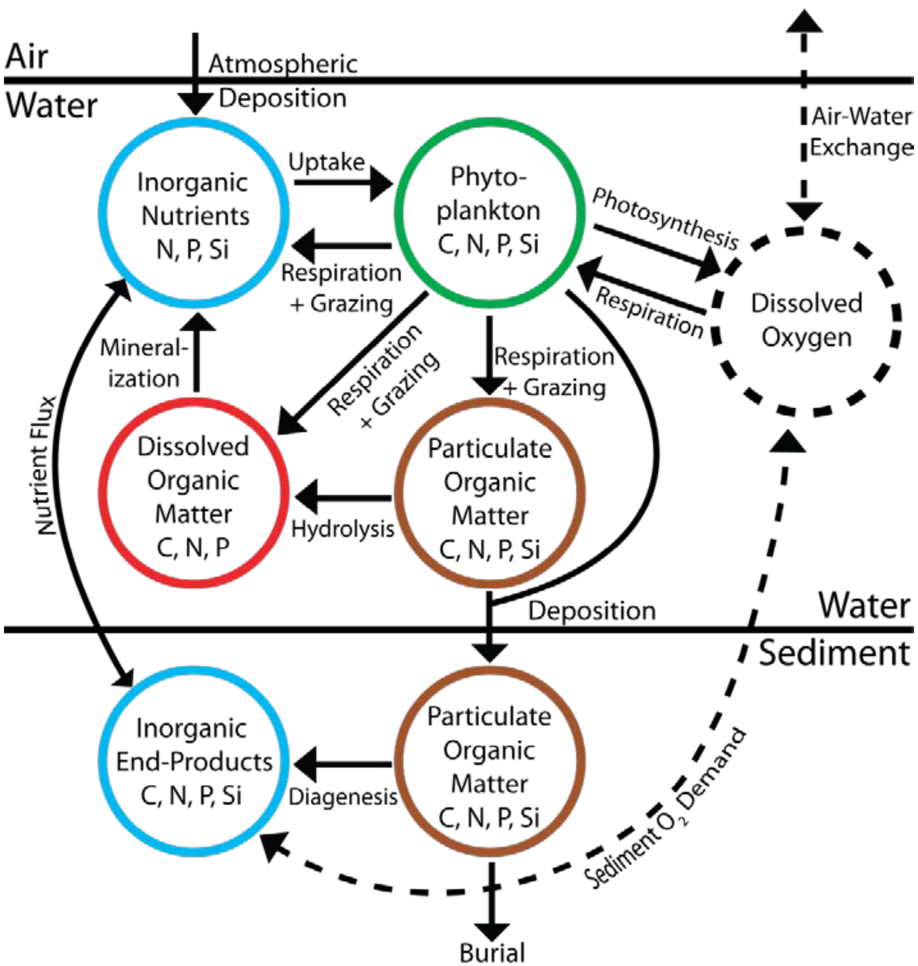



01-May-2003 to 01-Sep-2003
CBP Data
ROMS RCA (Oct 2015)
ROMS RCA (Feb 2016)
Surface Salinity (PSU)
Distance Along Transect (km)
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60

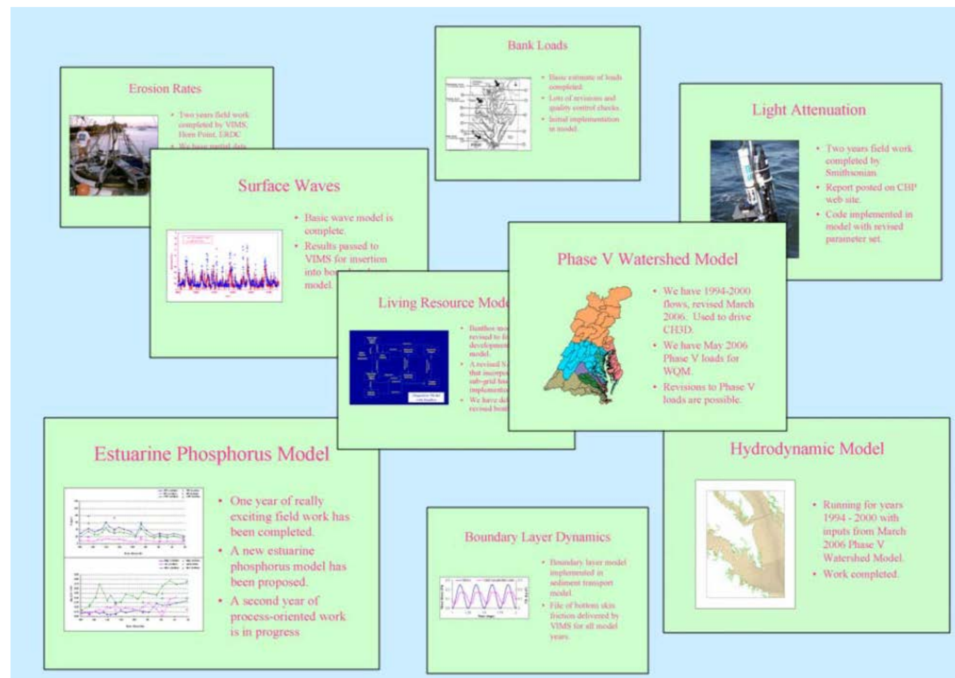

01-May-2003 to 01-Sep-2003
Surface Temperature (deg C)
Distance Along Transect (km)
CBP Data
ROMS RCA (Oct 2015)
ROMS RCA (Feb 2016)
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60

Animation of Chester Salt Fronts

(2) RCA versus ICM



RCA Schematic

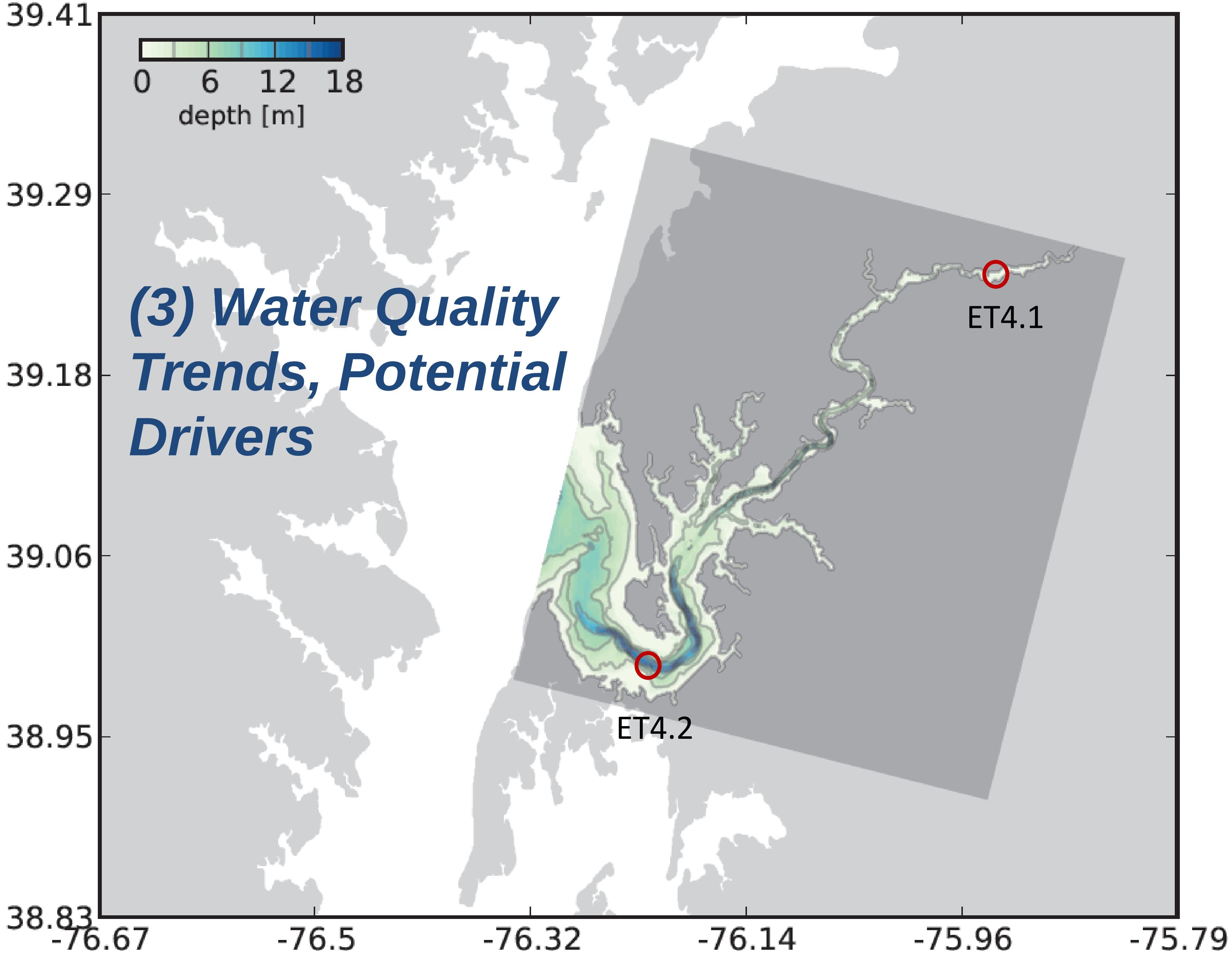


ICM Modules

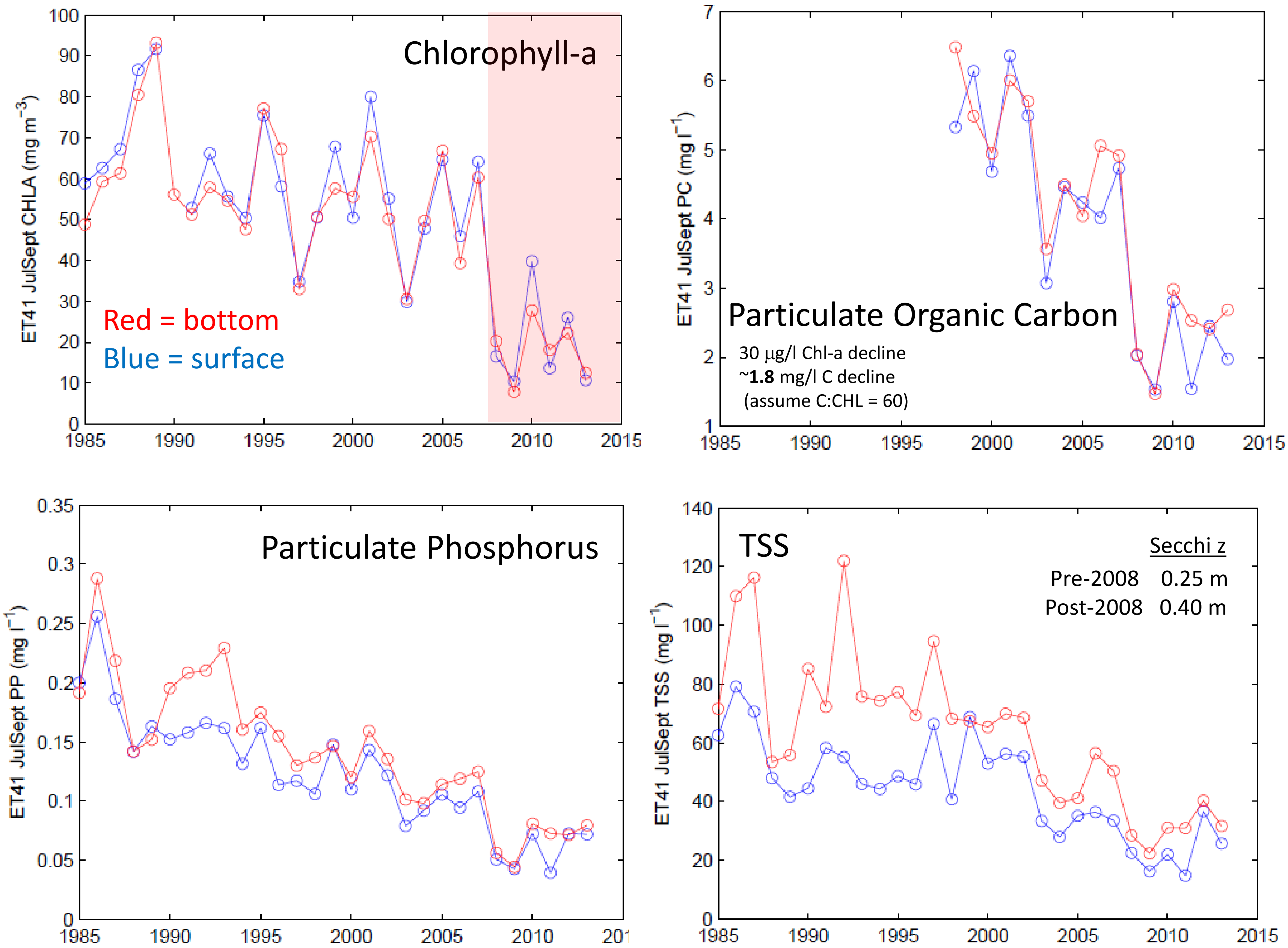
RCA	ICM
(1) Organic and inorganic N, P + Si, Org C, O_2	Same
(2) Di Toro Sediment Flux Model	Same
(3) Refractory and labile OM pools in WC, sed	Same
(4) No dynamic sediment transport	Sediment transport (bankloads, resuspension)
(5) Three phytoplankton groups	Same
(6) No explicit zooplankton	Two zooplankton groups
(7) No explicit benthos	Benthic invertebrate model
(8) Carbon:Chl-a Ratio Fixed or dynamic	Same
(9) Simple, empirical regression for kd	Optical model (scattering, absorption, etc)

- Light, temperature, and nutrient constraints on phytoplankton growth similar
- Some processes slightly different (P sorption to solids, nitrification)

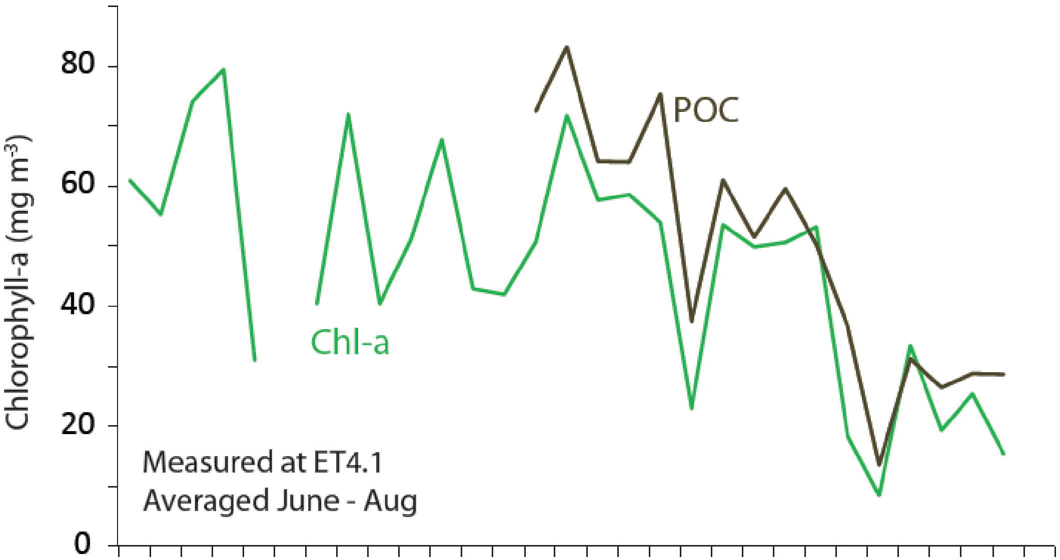
- These models share a lot of parameters, some of which the models are highly sensitive to (algal settling rate, phyto growth model, sediment model)

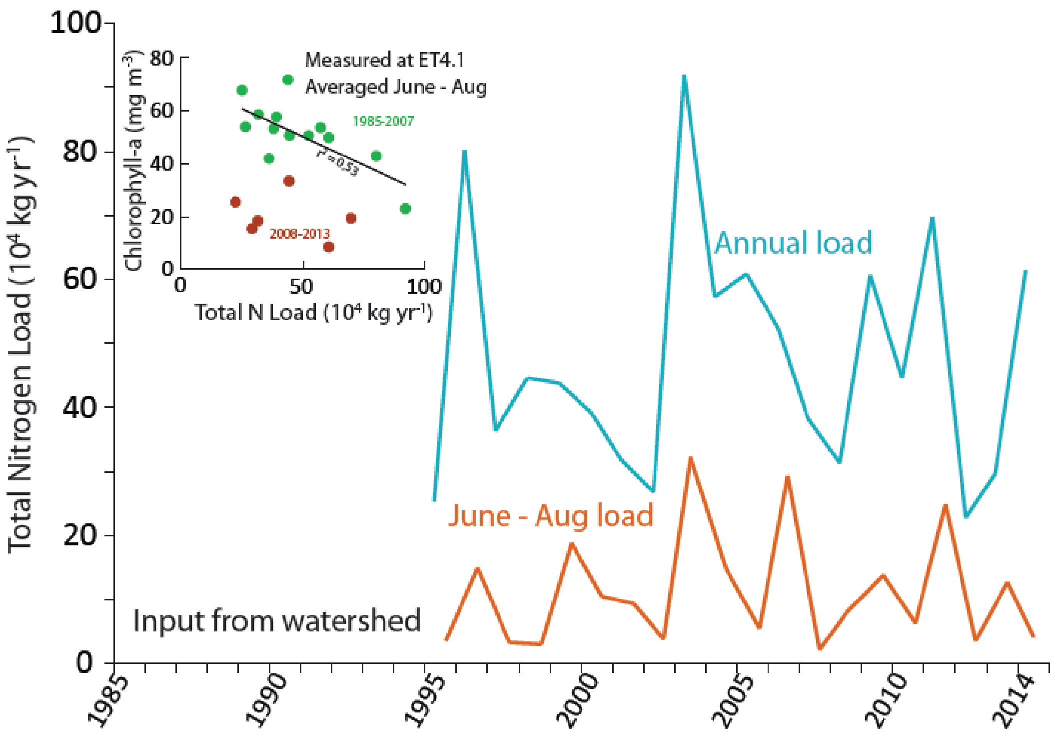


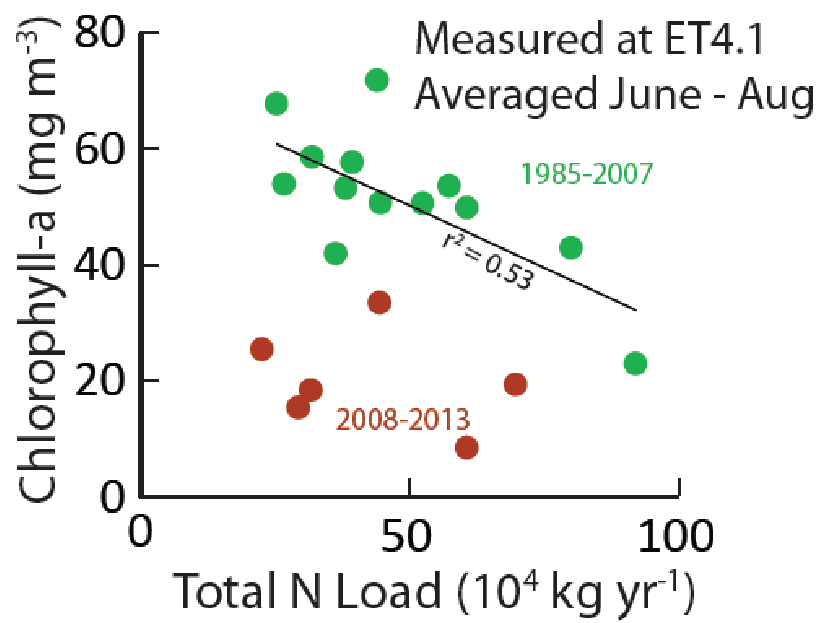
0
6
12
18
depth [m]
(3) Water Quality Trends, Potential Drivers
ET4.1
ET4.2
39.41
39.29
39.18
39.06
38.95
38.83
-76.67
-76.5
-76.32
-76.14
-75.96
-75.79


Chlorophyll-a
ET41 JulSept CHLA (mg m^{-3})
Red = bottom
Blue = surface
Particulate Organic Carbon
ET41 JulSept PC (mg l^{-1})
30 µg/l Chl-a decline
~**1.8** mg/l C decline
(assume C:CHL = 60)
Particulate Phosphorus
ET41 JulSept PP (mg l^{-1})
TSS
ET41 JulSept TSS (mg l^{-1})
Secchi z
Pre-2008 0.25 m
Post-2008 0.40 m

Chlorophyll-a, Nutrient Load, and Flushing







Estuaries Vol. 17, No. 3, p. 614–621 September 1994

The Asiatic Clam (*Corbicula fluminea*) Invasion and System-Level Ecological Change in the Potomac River Estuary Near Washington, D.C.

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University of the District of Columbia
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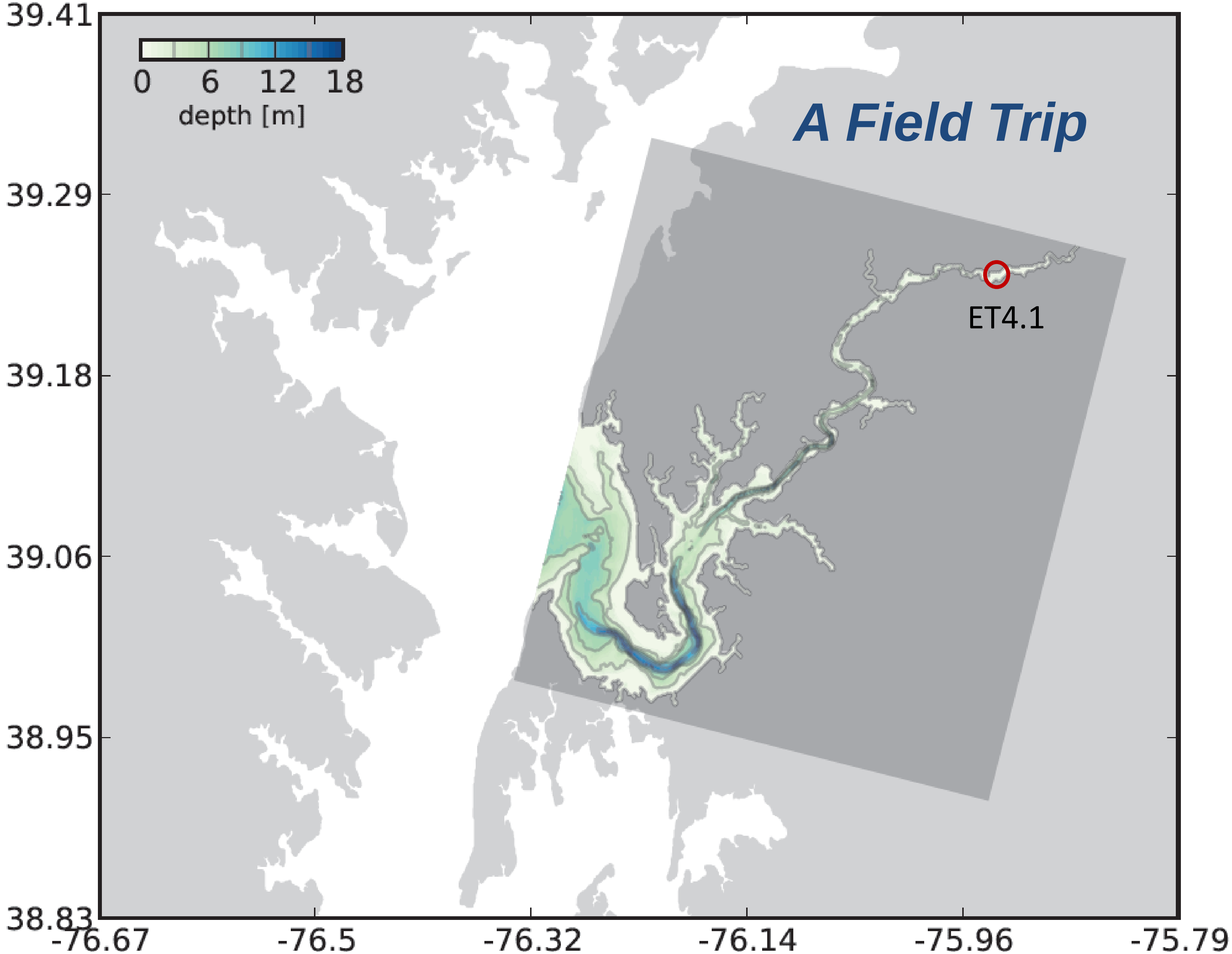
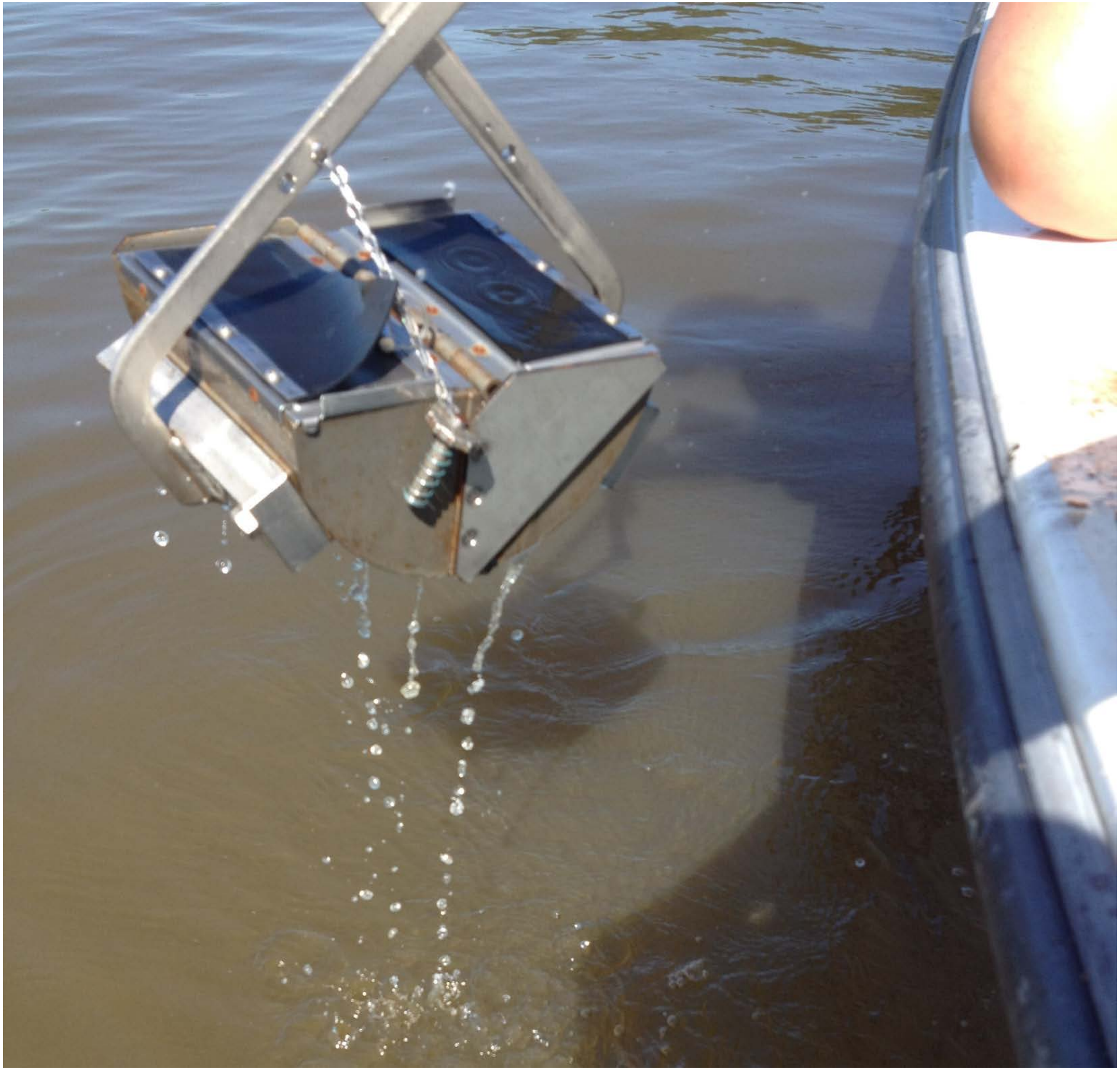
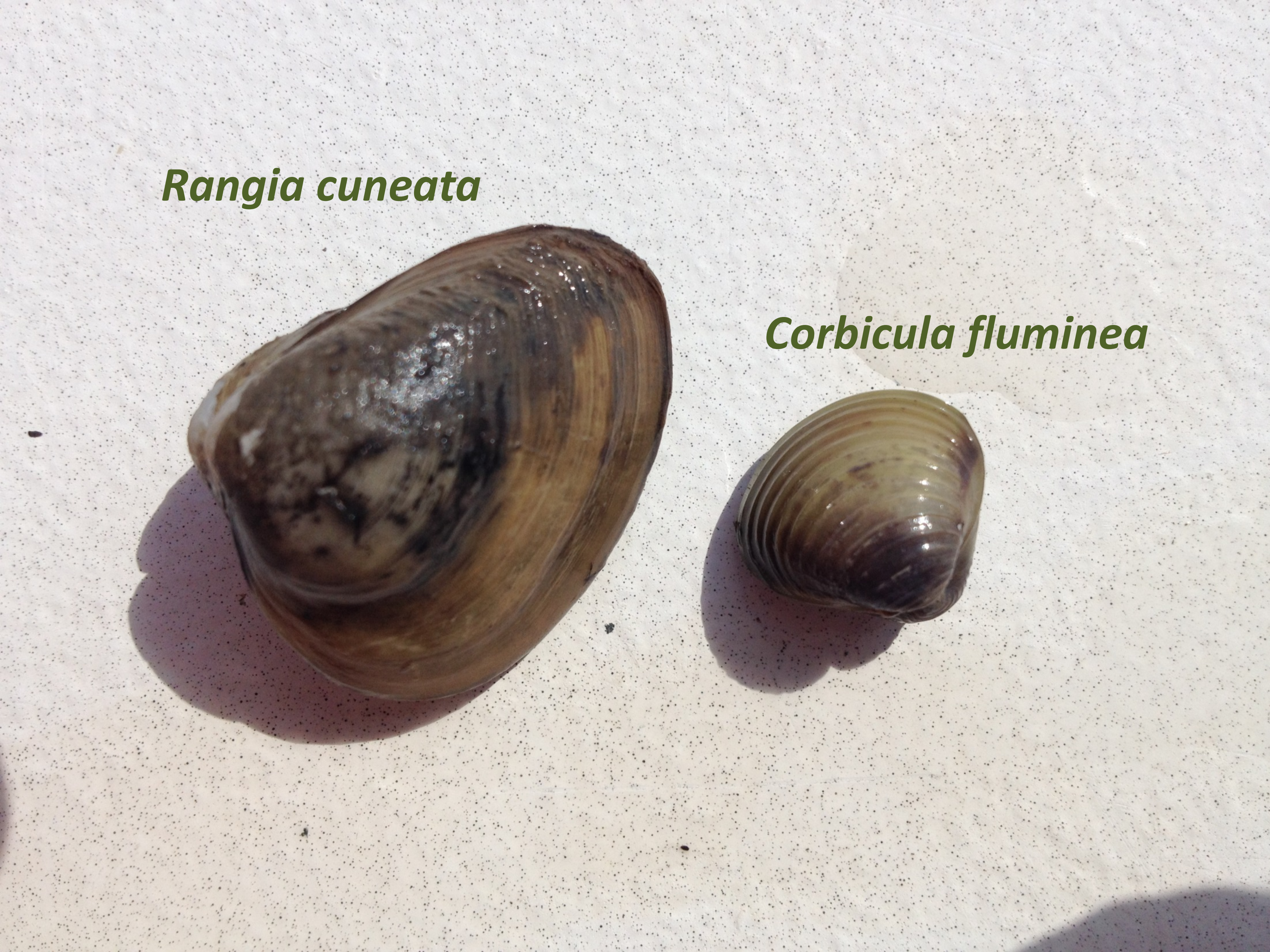
ABSTRACT: The exotic freshwater clam species *Corbicula fluminea* (Asiatic clam) was first reported in the tidal freshwater Potomac estuary near Washington, D.C., in 1977, and was found in benthic surveys conducted in 1978, 1982, 1984, 1986, and 1992. In 1981 a tripling of water clarity was reported in the region of the clam beds, followed in 1983 by reappearance of submerged aquatic vegetation (SAV) absent for 50 yr.



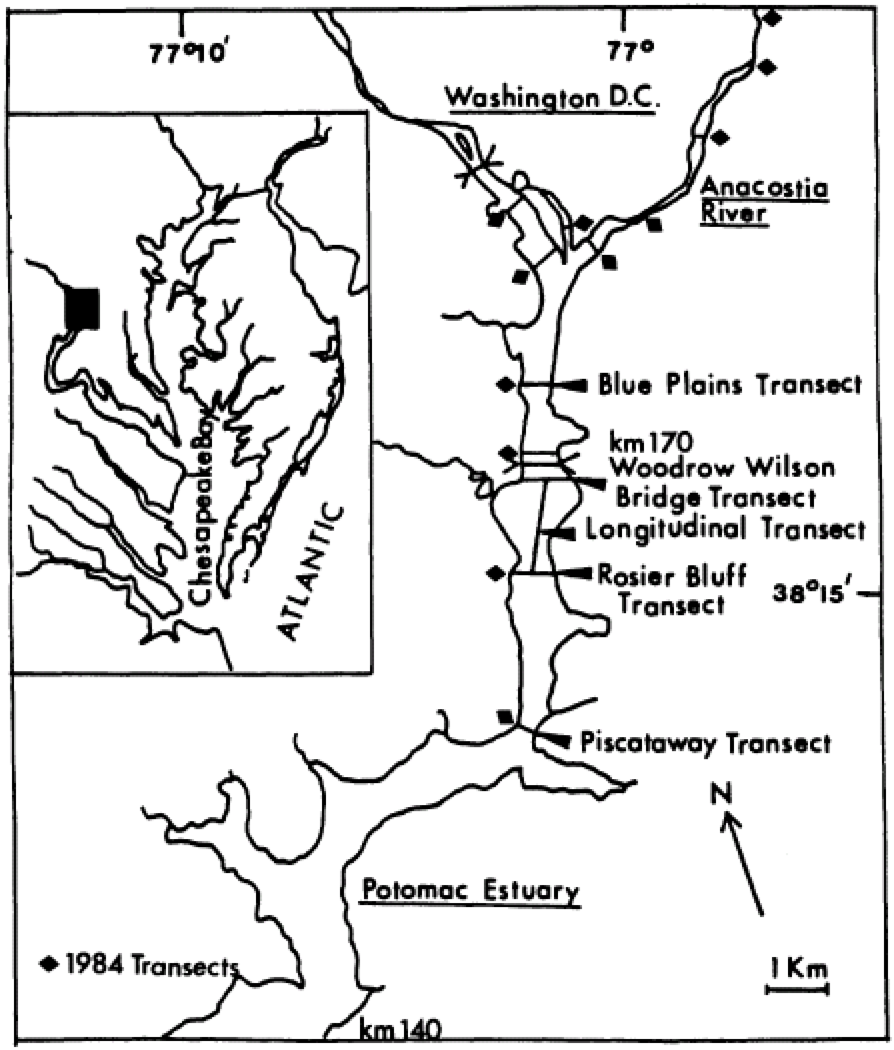
39.41
39.29
39.18
39.06
38.95
38.83
-76.67
-76.5
-76.32
-76.14
-75.96
-75.79
0
6
12
18
depth [m]
A Field Trip
ET4.1


Riverview
Farms Trucking
Clipper Ln
Birres Creek
290
Chester River
Dogwood Ct
Lodge Ct
Piver Ln
Custom Creations
Front St
2nd St
3rd St
4th St
Shoals Rd
Pine St
Chester River
Crumpton Landing
Crumpton
Sutton Point
Pearl Creek
Market St
Matthew Dr
Andrew Dr
Forth St
Blue Heron Ln
Phillips Ln
Jim Jungle Rd
Dixon's Furniture
Auction
544



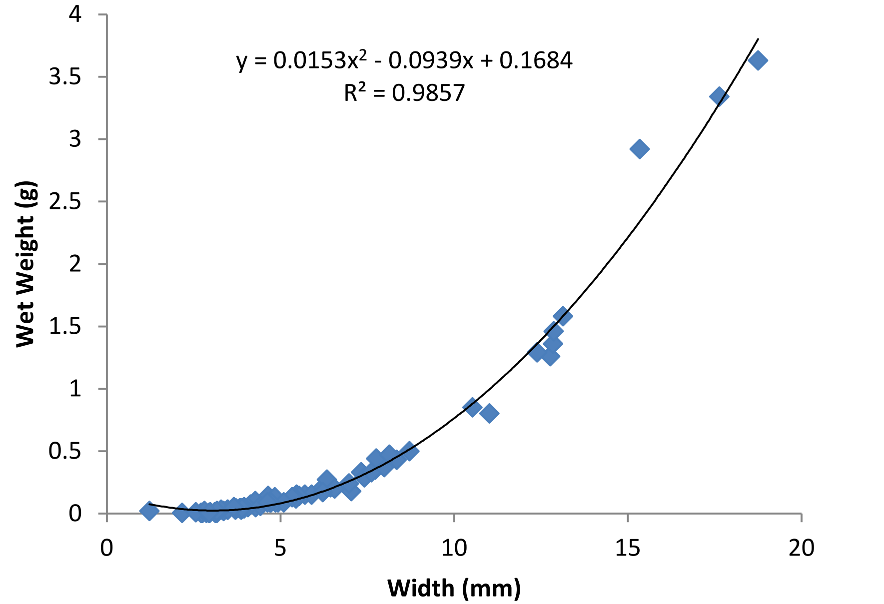

Rangia cuneata
Corbicula fluminea

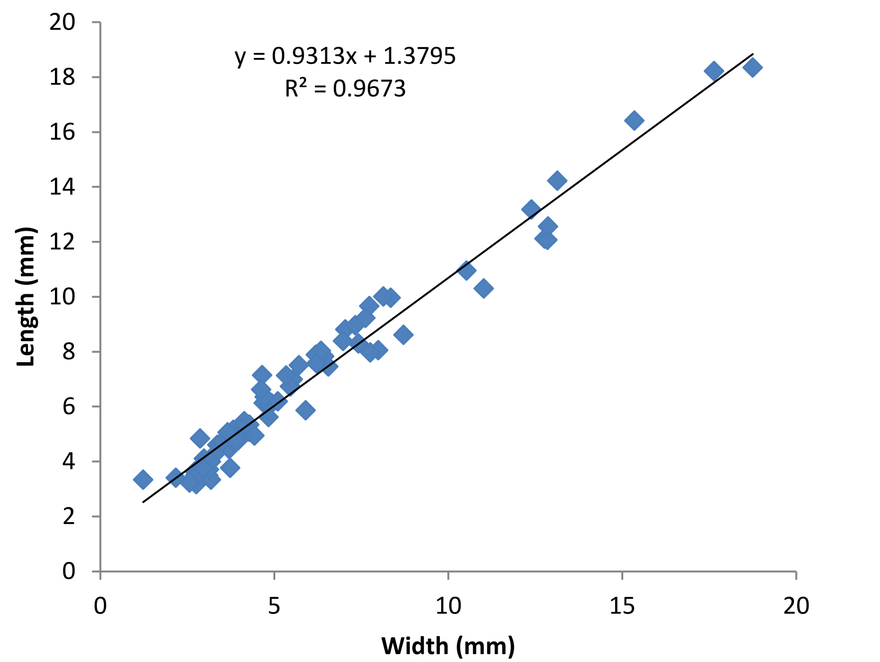
August 2015 Chester River Data



Cohen et al. 1984

Year class	Mean wet wt per clam (g)	±SD	*n*
1	0.48	0.23	36
2	1.47	0.50	50
3	4.30	0.98	50
4	10.37	2.76	41





August 2015 Chester River Data

# Samples	Location	# Corbicula	# Corbicula/m2	Days to Filter Water Column
2	South of ET4.1	13	1679.17	45 ± 16
5	ET4.1	41	2118.34	101 ± 68
3	North of Bridge	24	2066.67	8 ± 4

*Filtration Rates from (Cohen et al. 1984) in ml/h-g wet weight

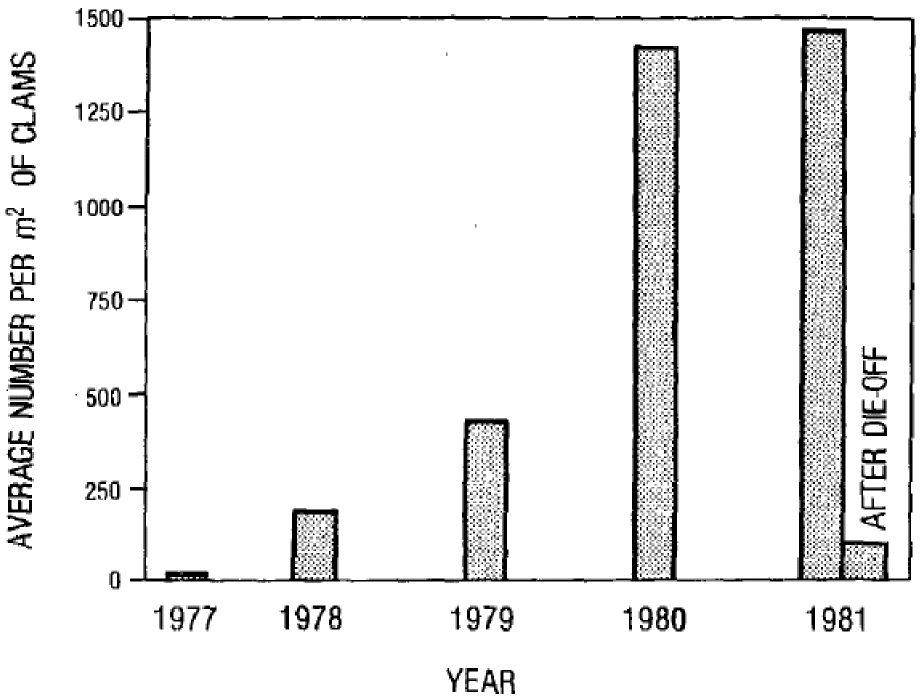
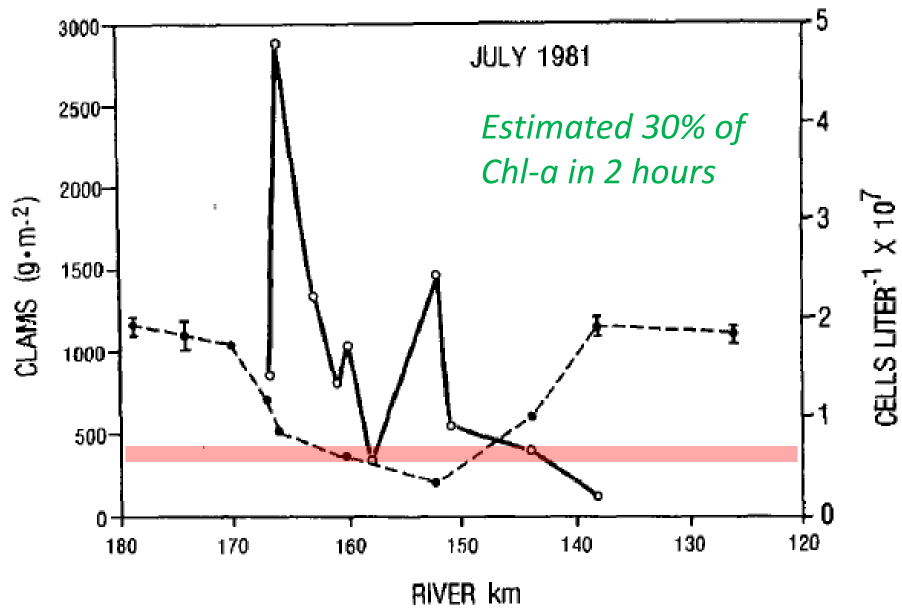
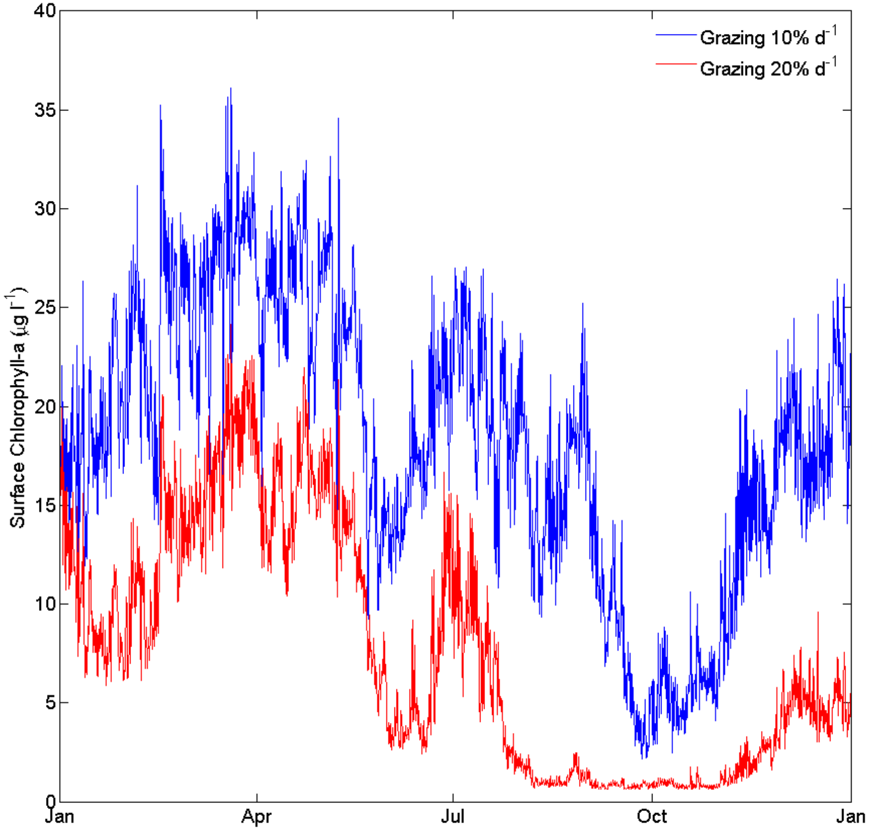


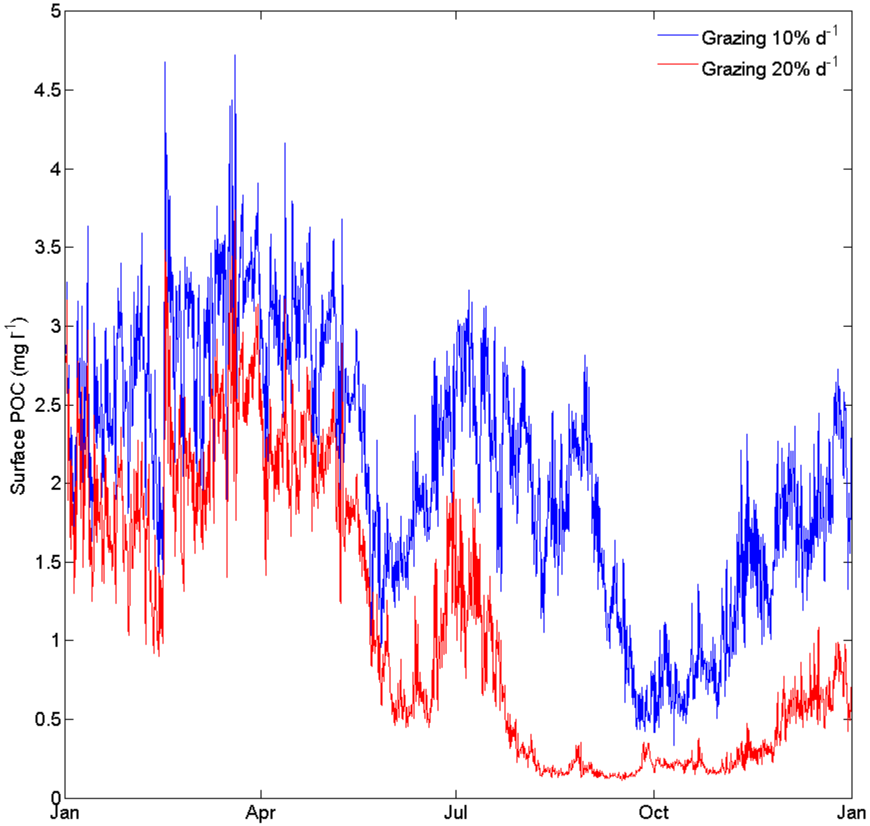
Fig. 5. Mean number of *Corbicula fluminea* at Rosier Bluff, 1977–1981. Units are clams·m⁻².



Cohen et al. 1984

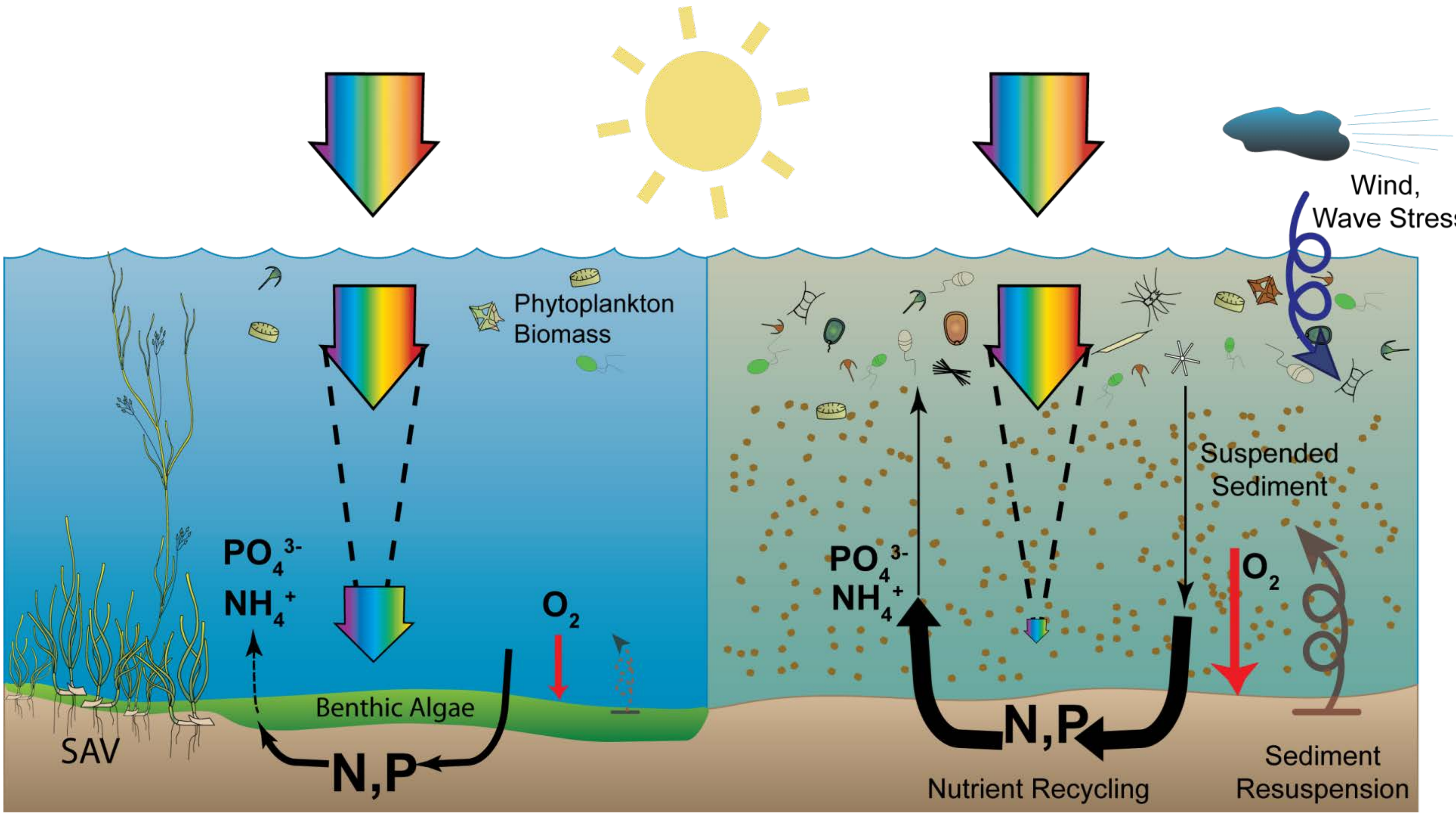
ROMS-RCA Simulated Chlorophyll-a is Sensitive to Grazing

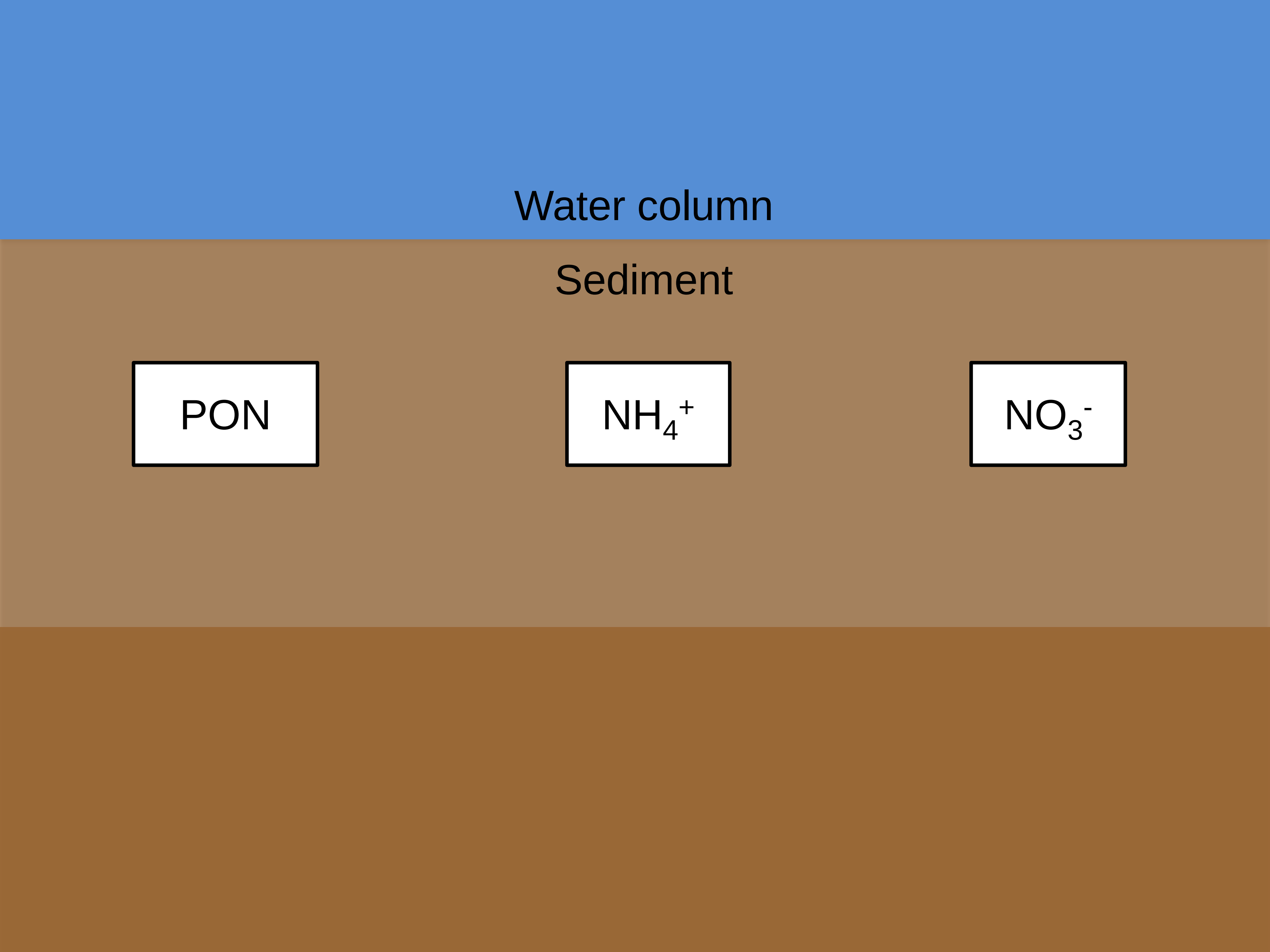


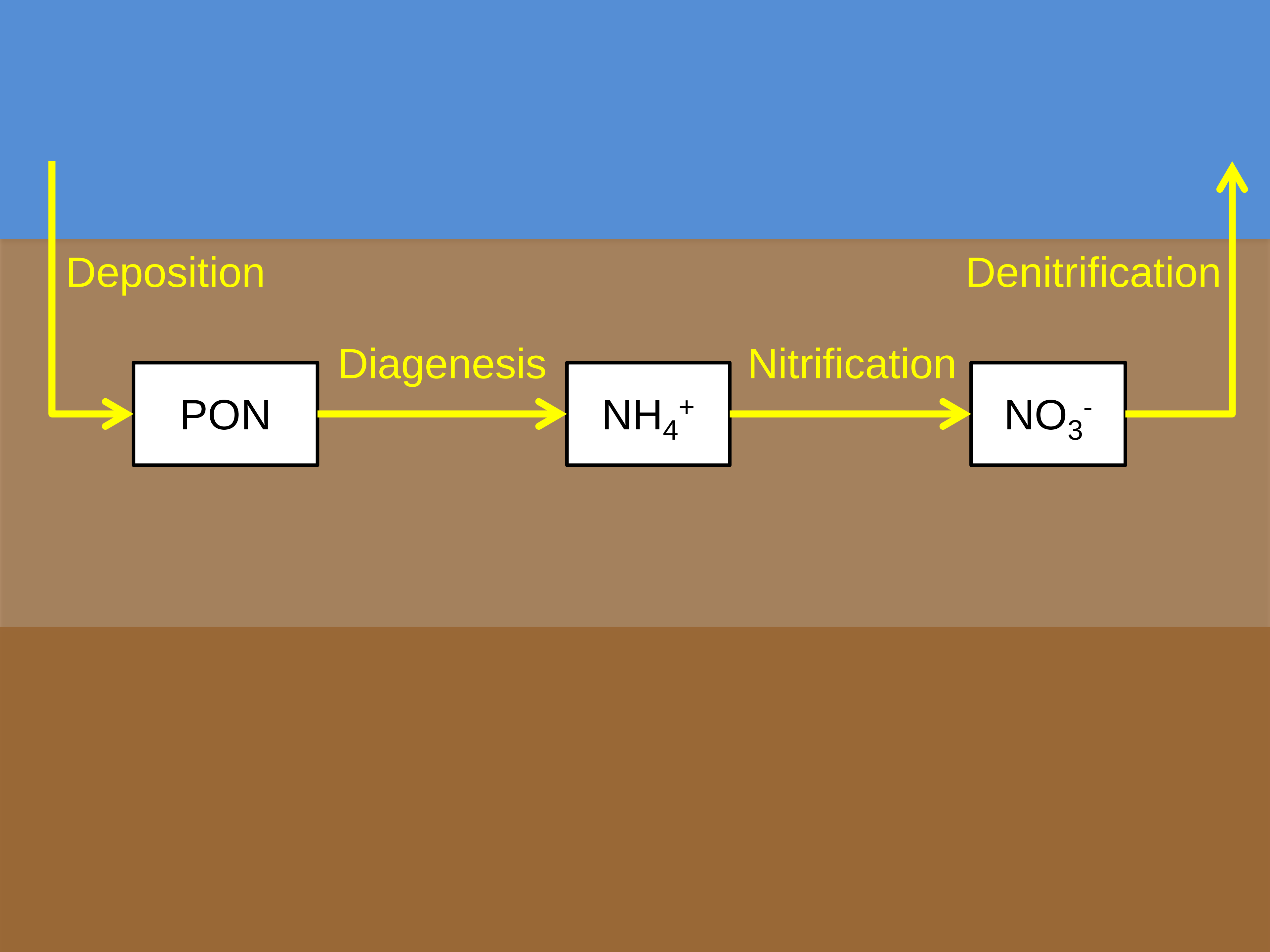


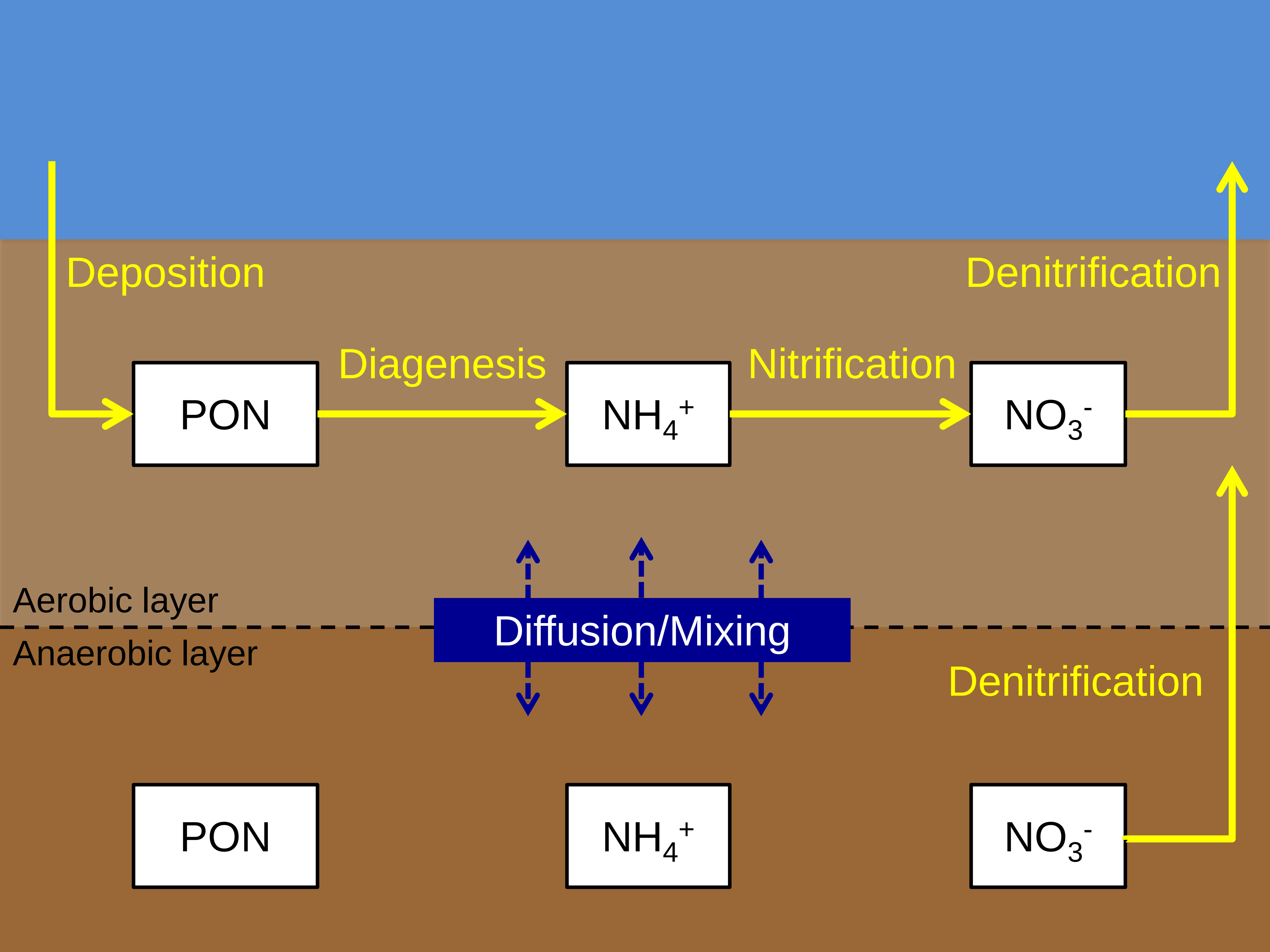
(4) Modeling Benthic Algae in ROMS-RCA

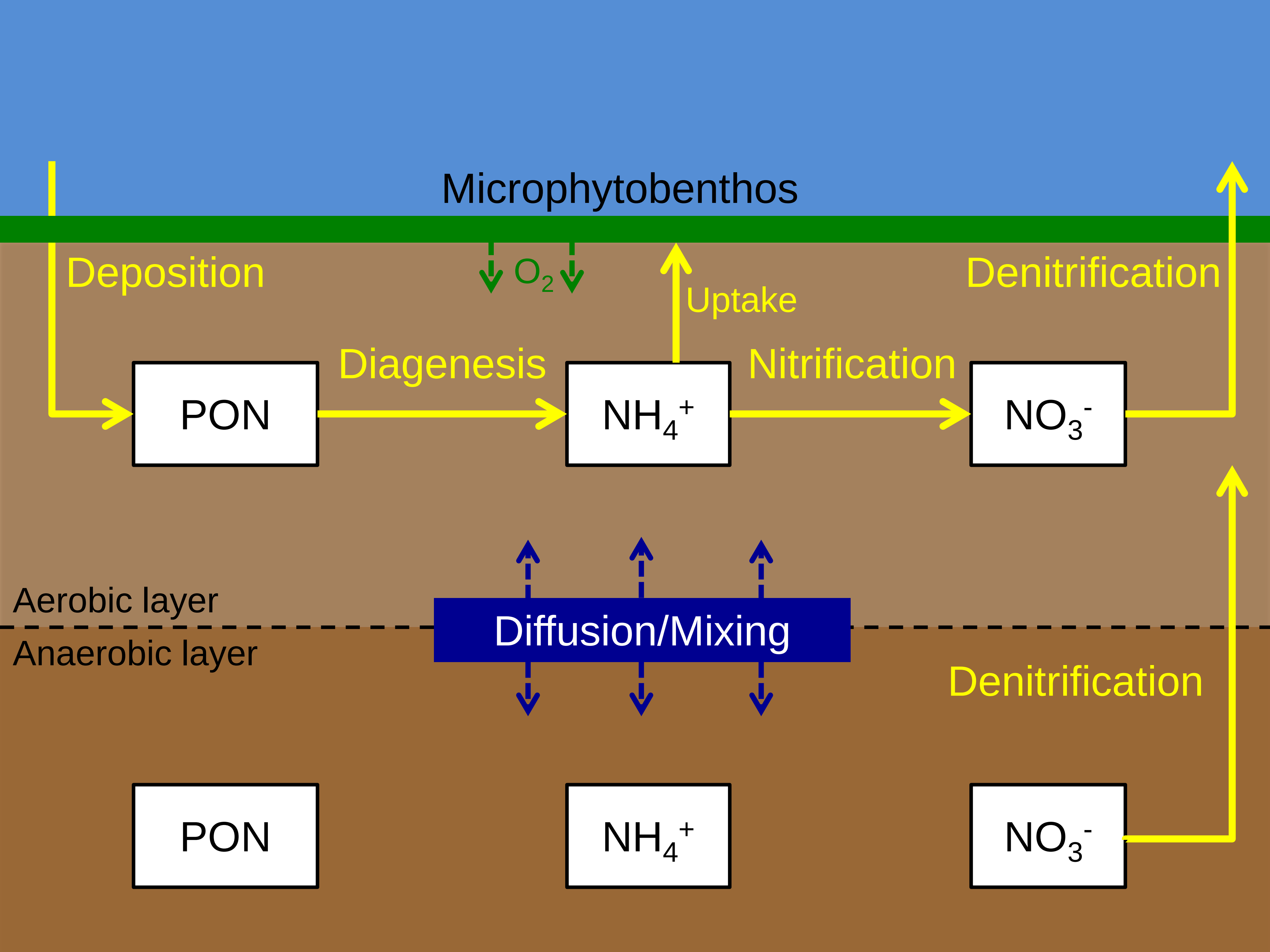
Benthic Algae and O_2/Nutrient Fluxes in Chester/Corsica Rivers



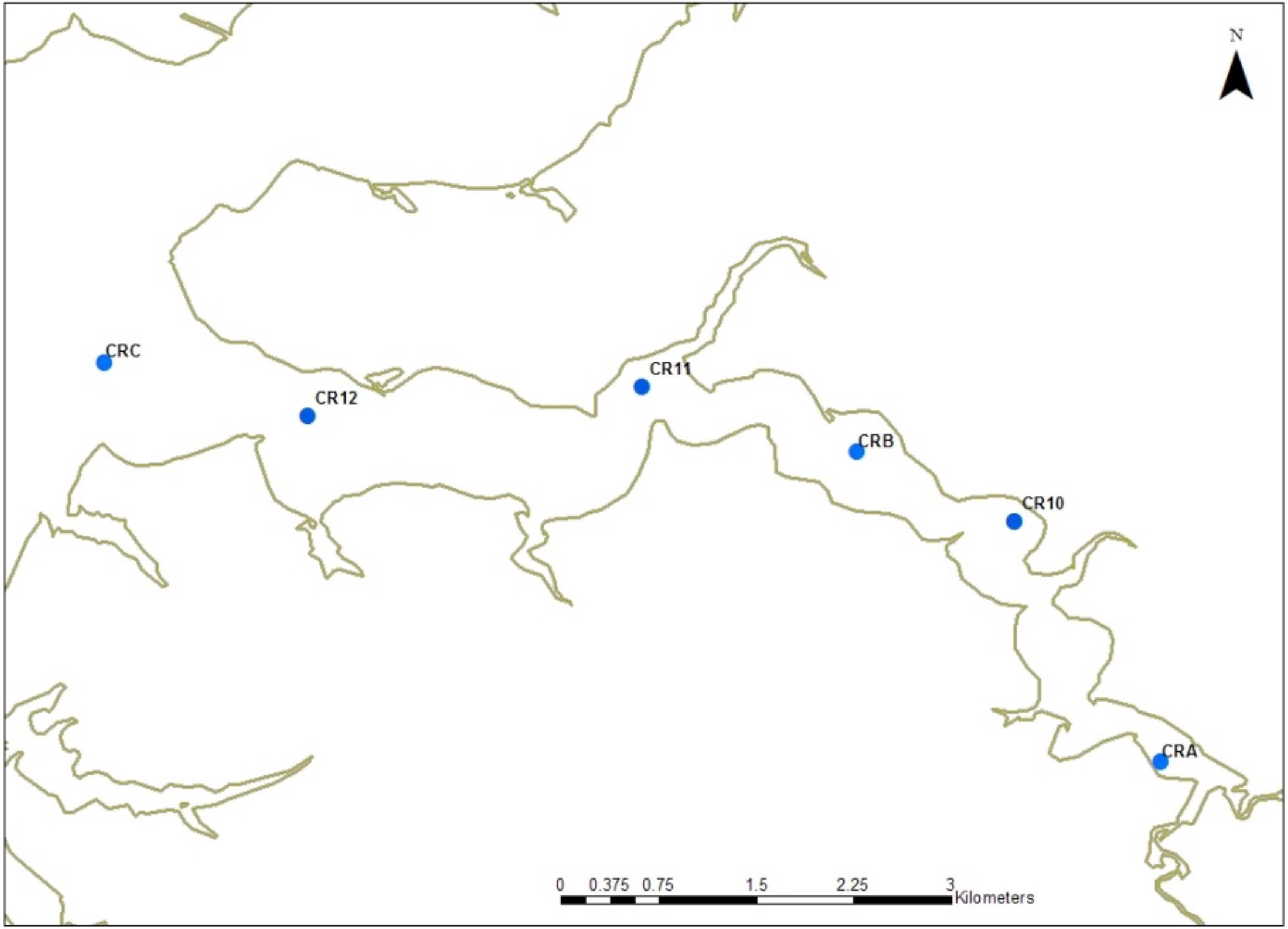

Water column
Sediment
PON
NH_4^+
NO_3^-


Deposition
Denitrification
Diagenesis
Nitrification
PON
NH_4^+
NO_3^-


Deposition
Denitrification
Diagenesis
Nitrification
PON
NH_4^+
NO_3^-
Aerobic layer
Diffusion/Mixing
Anaerobic layer
Denitrification
PON
NH_4^+
NO_3^-

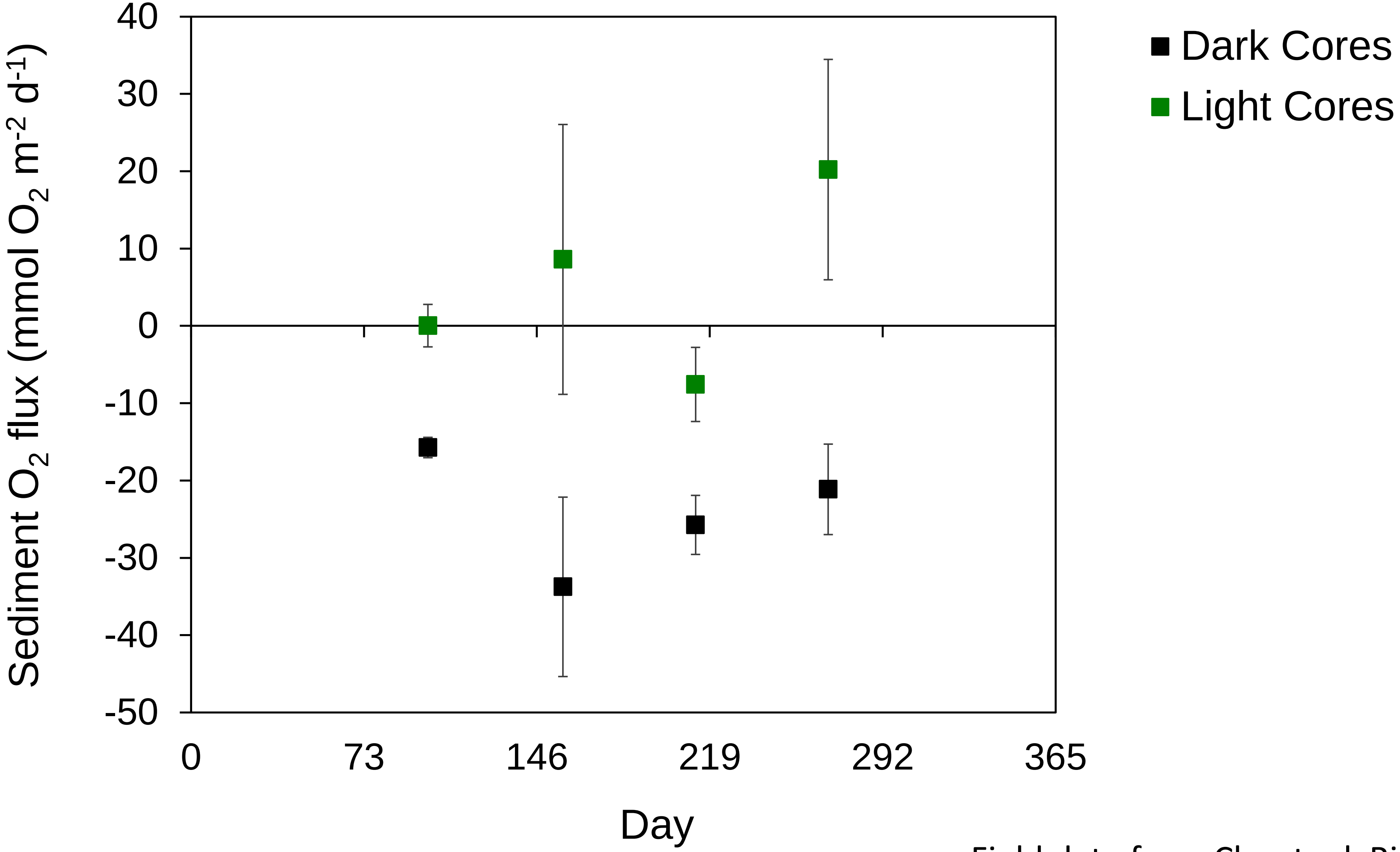


Microphytobenthos
Deposition
O2
Uptake
Denitrification
Diagenesis
Nitrification
PON
NH4+
NO3-
Aerobic layer
Diffusion/Mixing
Anaerobic layer
Denitrification
PON
NH4+
NO3-



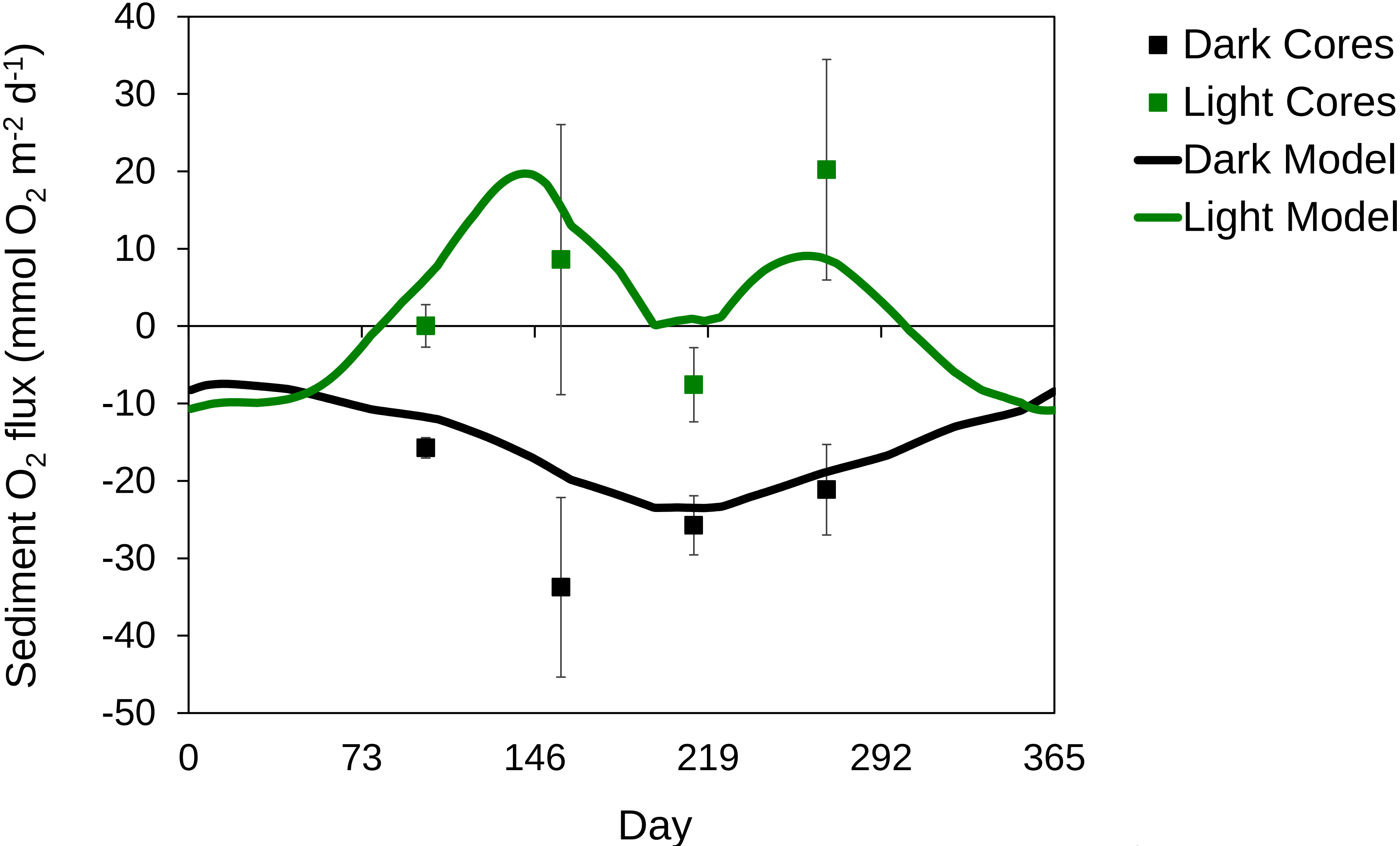
Corsica River Flux Stations

Microphytobenthos produce O_2 and counteract hypoxia



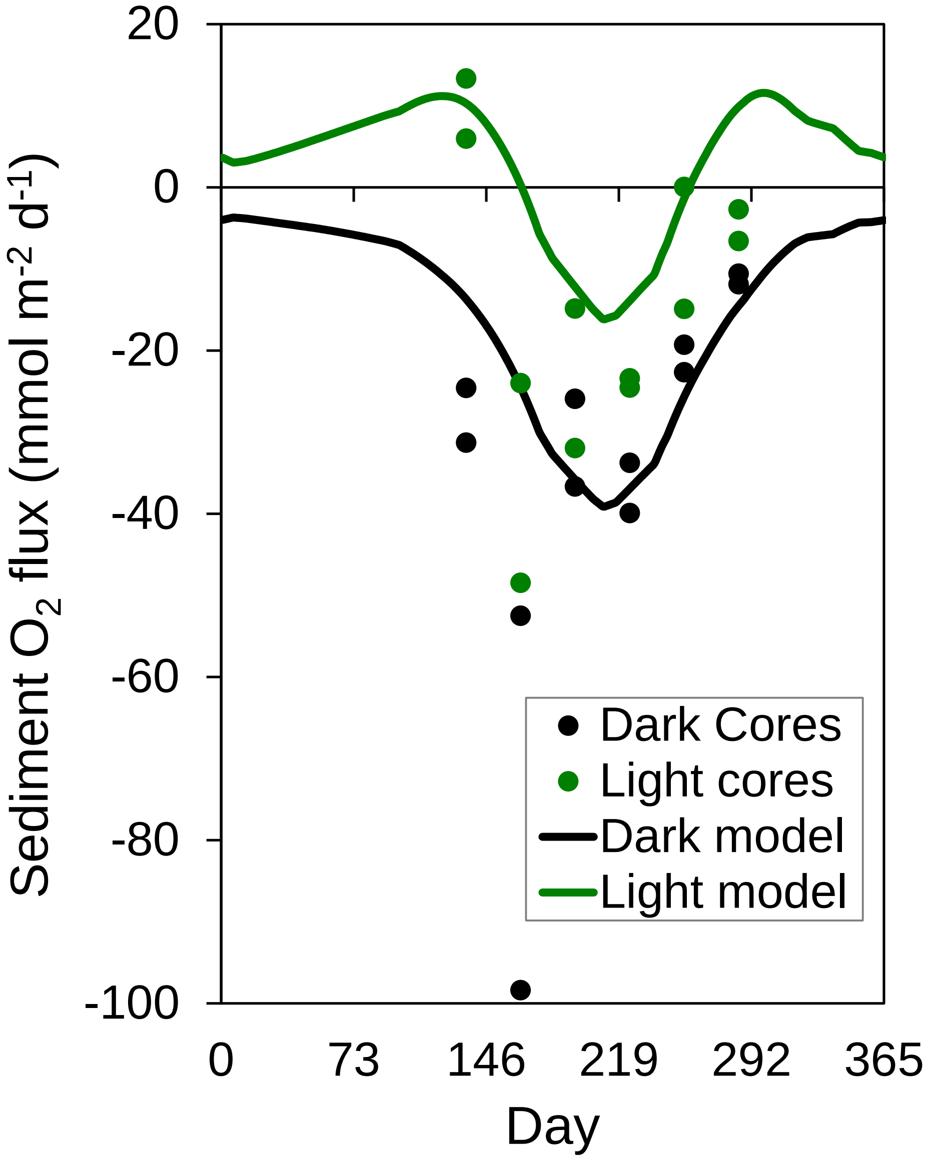
Field data from Choptank River, courtesy of Cornwell and Owens

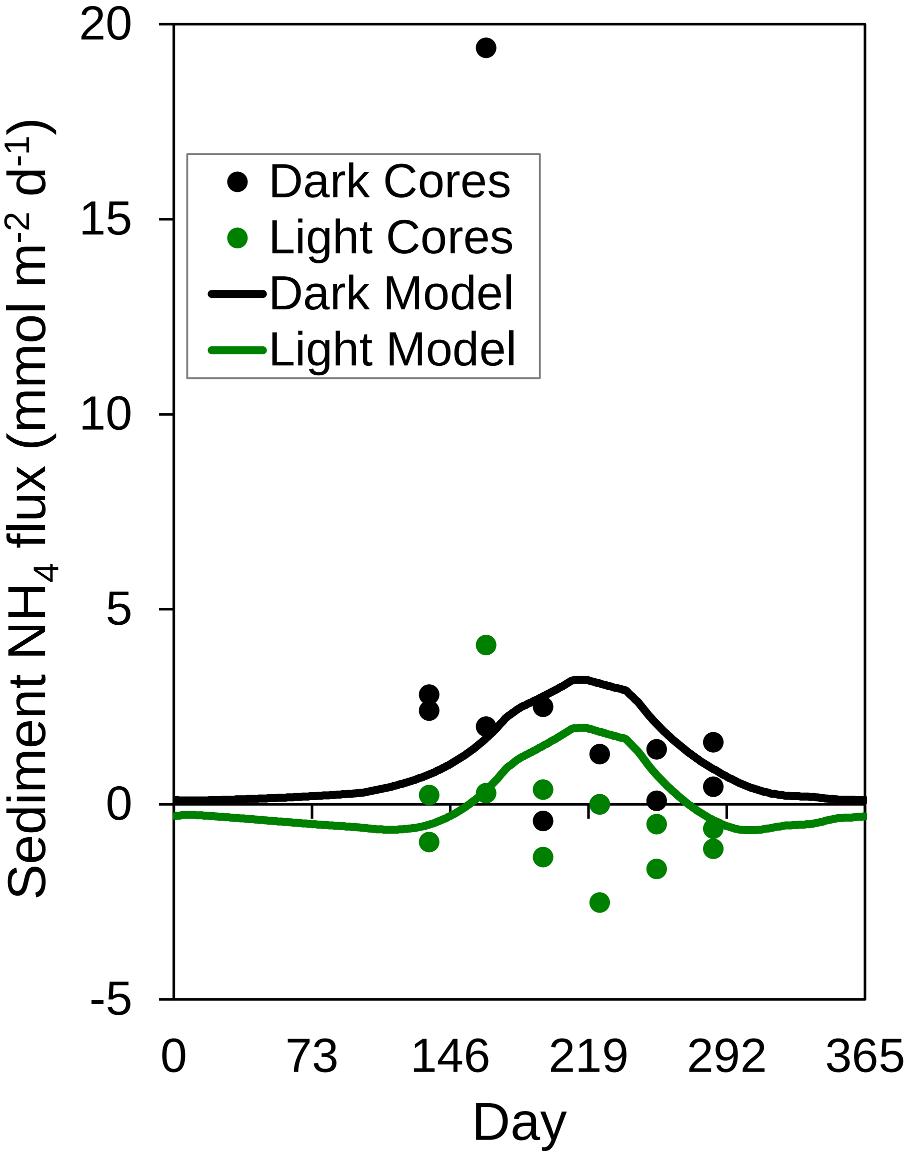
Microphytobenthos produce O_2 and counteract hypoxia



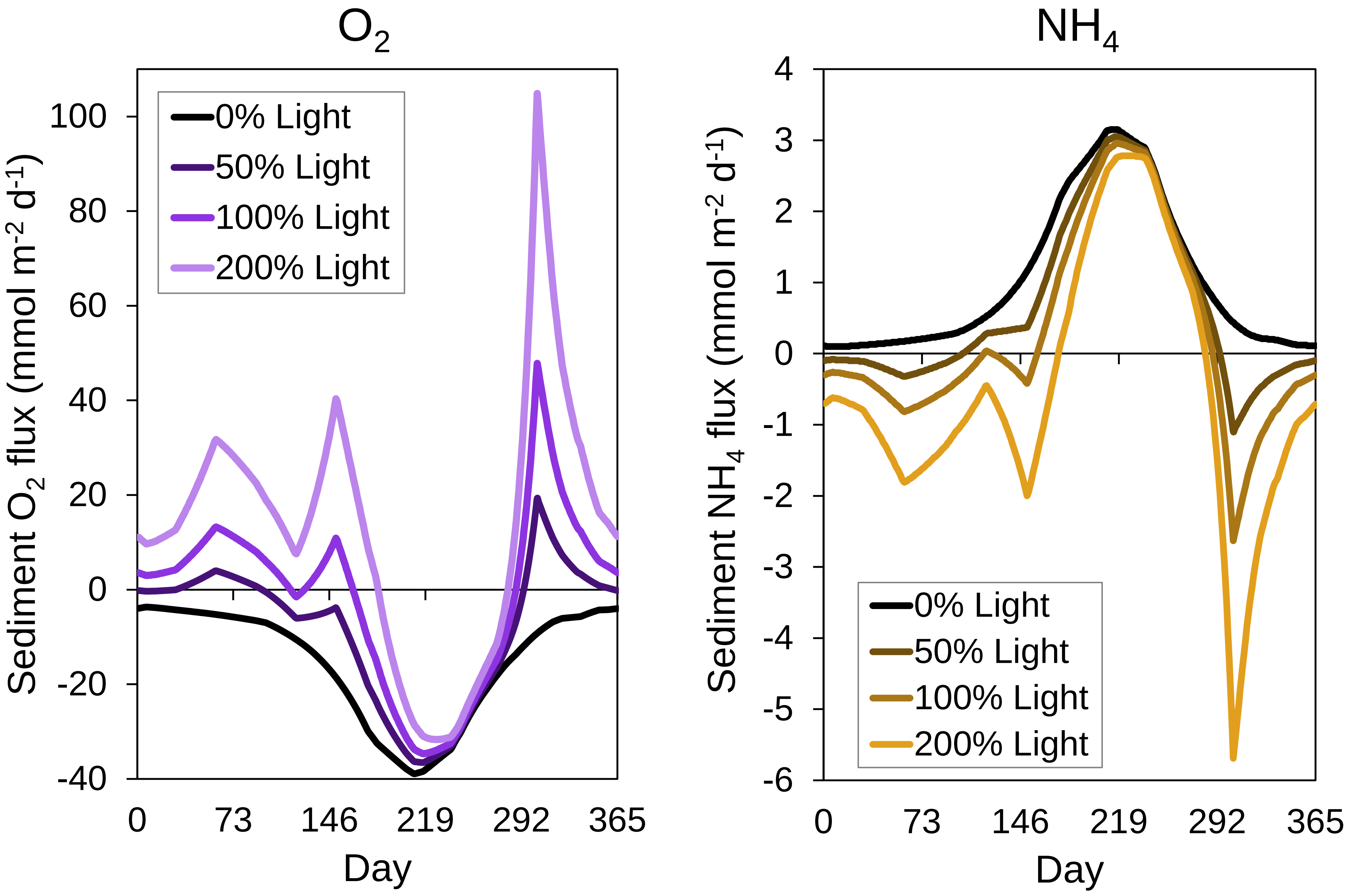
Field data from Choptank River, courtesy of Cornwell and Owens

Sediment O_2 and NH_4 Flux in Corsica River

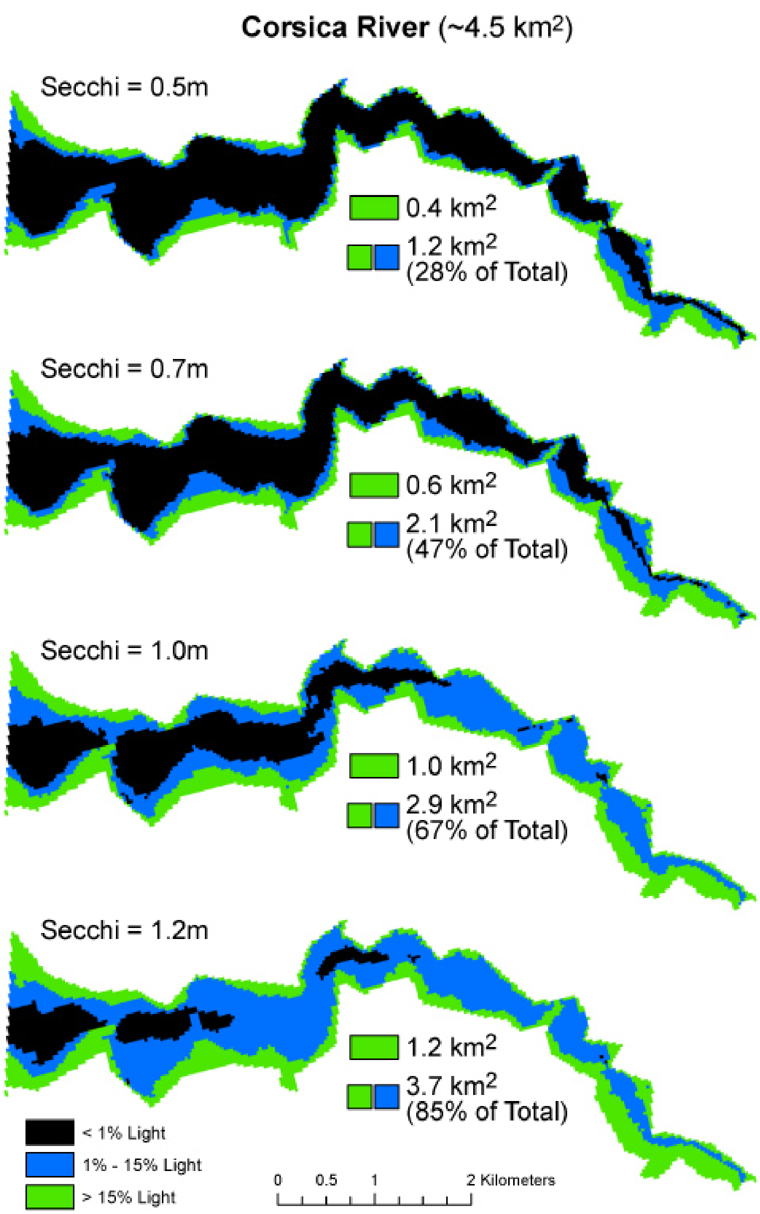


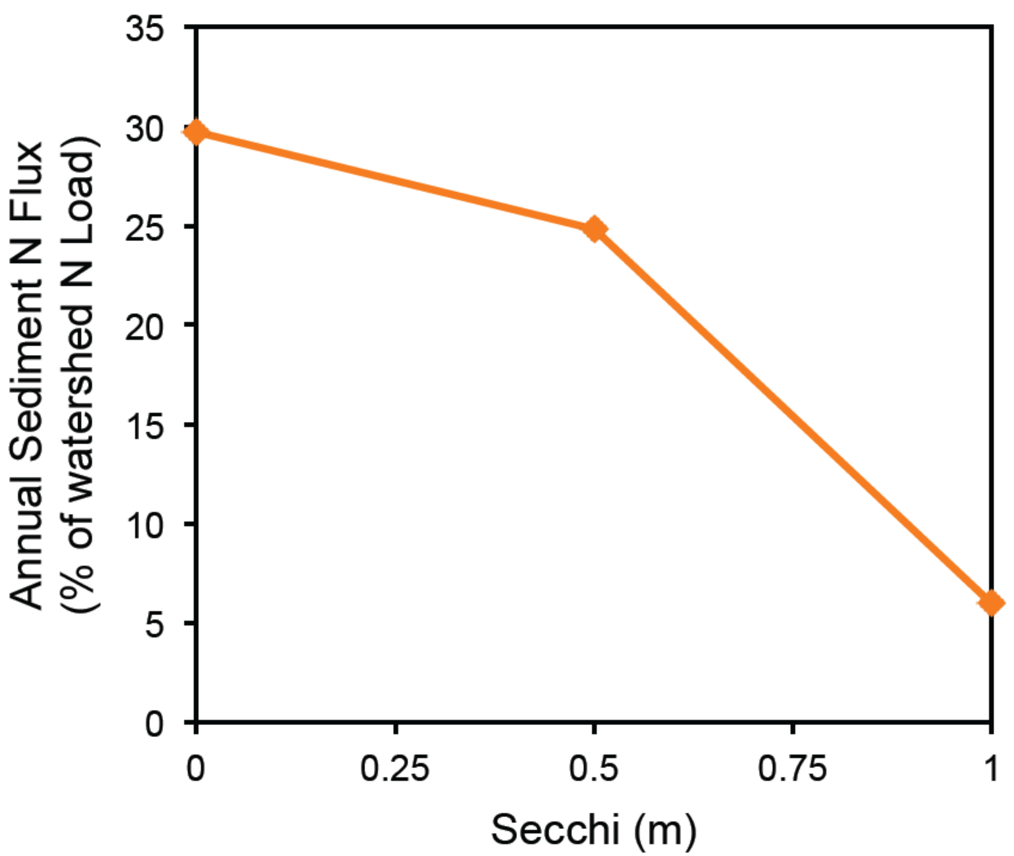


Illumination Alters O_2 and NH_4 Flux in Spring/Fall



Potential Light Effects on System Scale N Budget

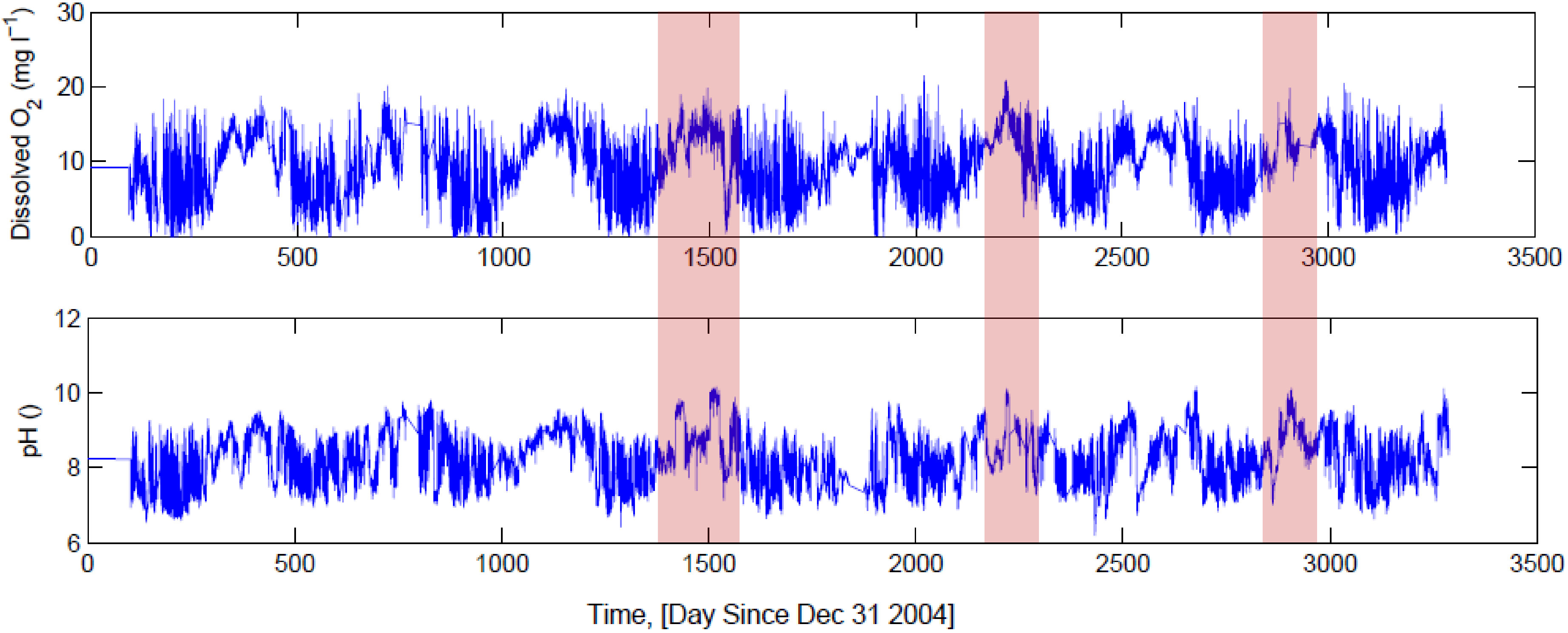




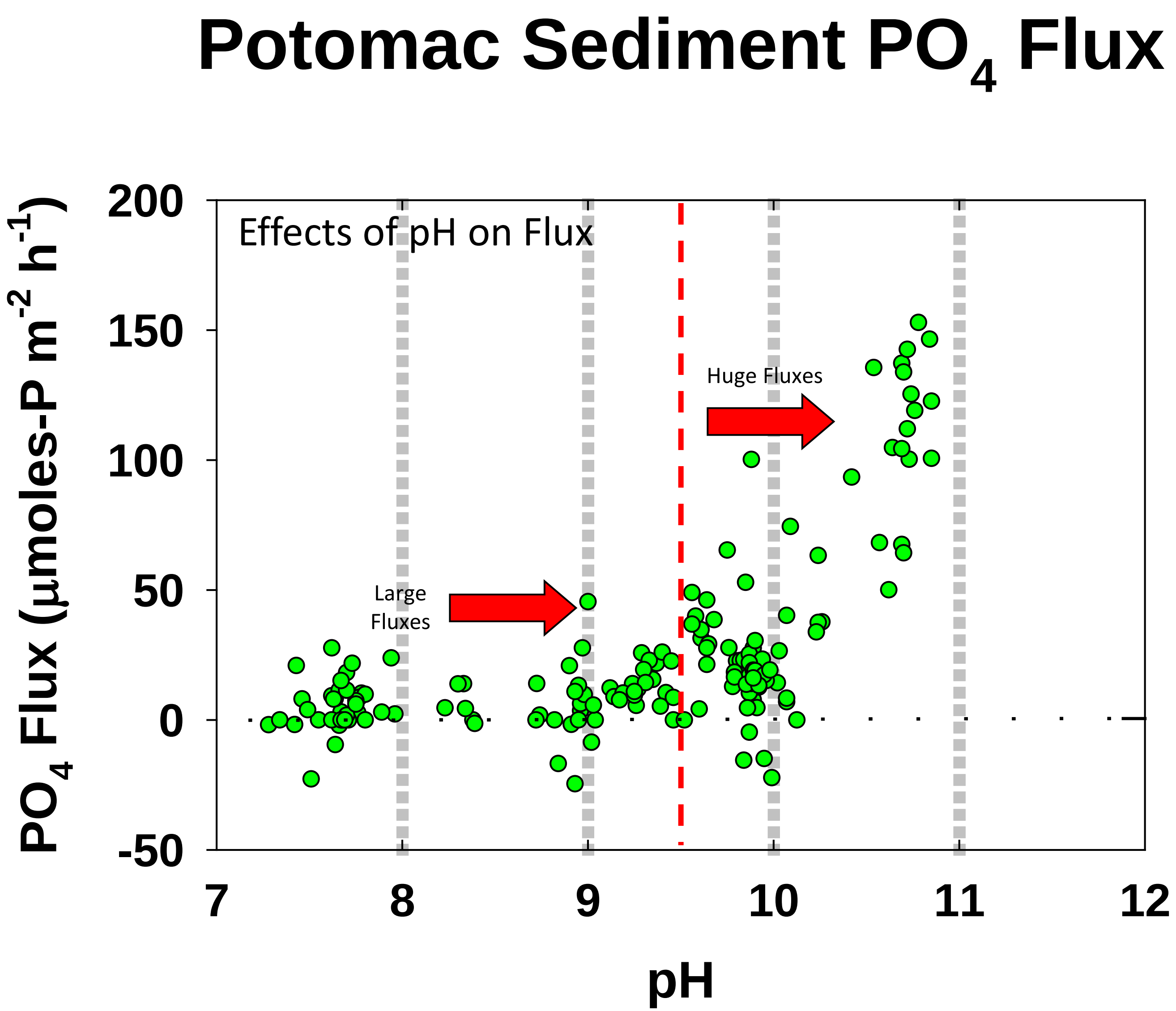
Small increase in Secchi (0.5 m → 1.0 m) yields large increase in photic bottom (1% surface light) from 28 → 85%

(5) Ecosystem Metabolism, pH, and Phosphorus Fluxes in the Chester River

Large DO and pH Swings at Some Stations



pH and DIP Fluxes in the Chester/Corsica



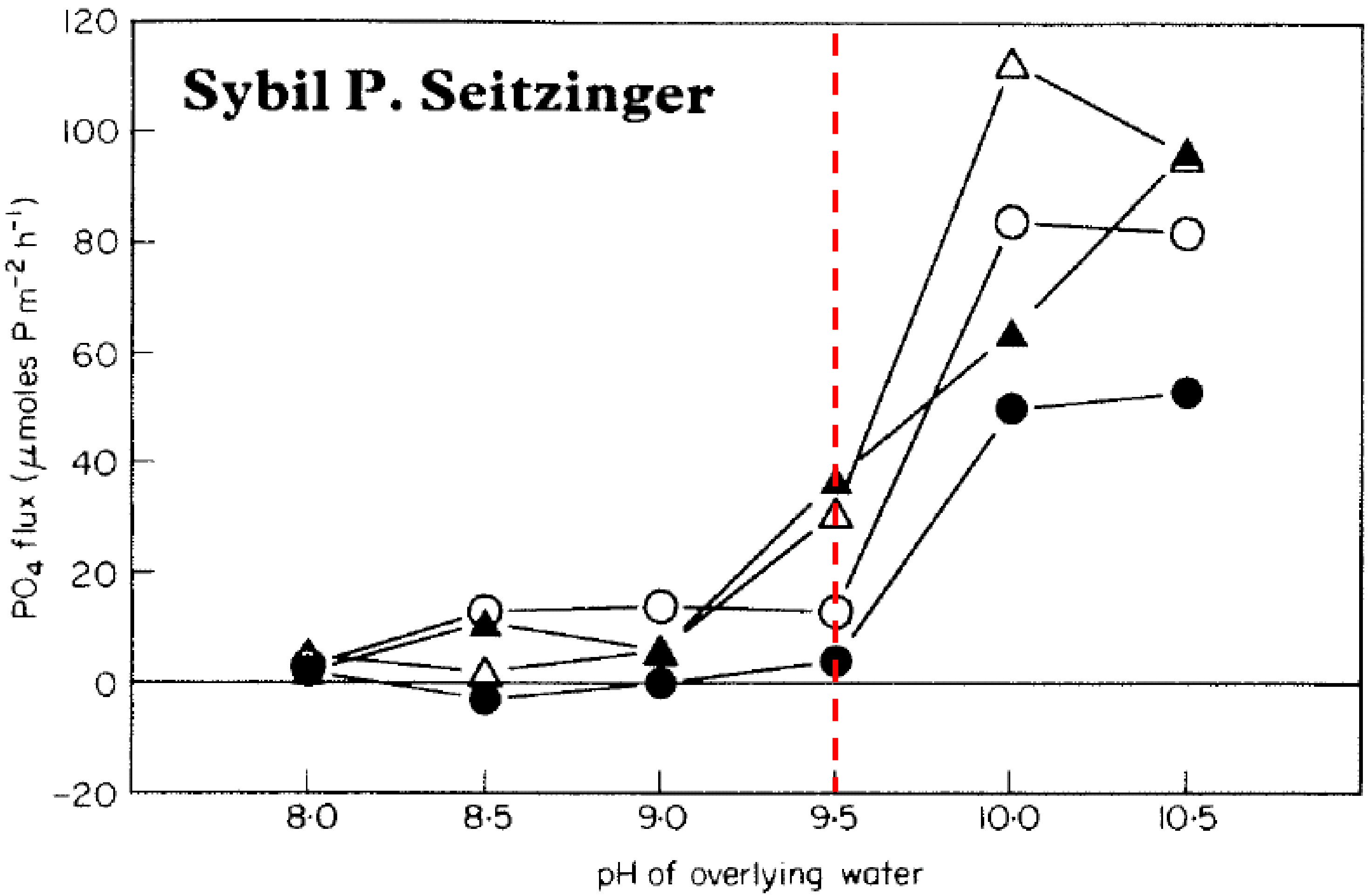
So, how much algal production could a P-flux of 50 umol/m2/hr support?

50 x 24 = 1200
C:N:P = 100:16:1
1200 x 100 x 12 =
1.4 g C/m2/day
A substantial rate and a simple "rule of thumb" conversion

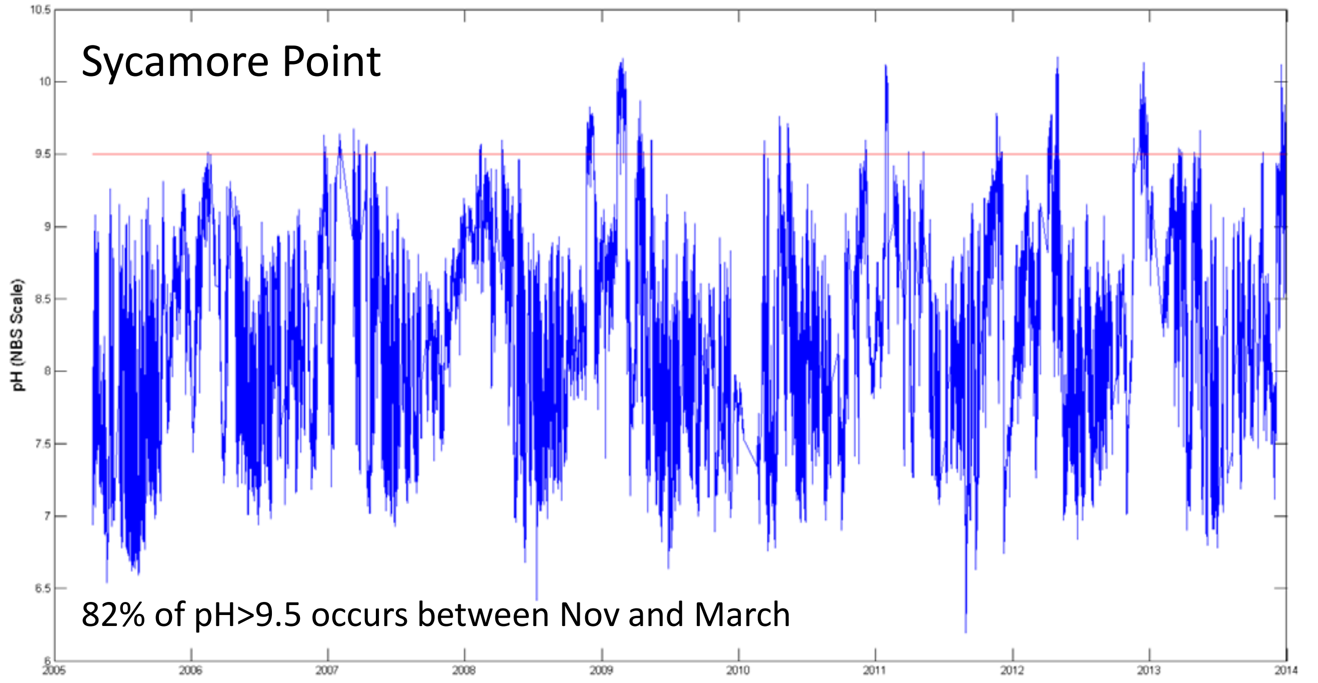
From Bailey et al. 2006

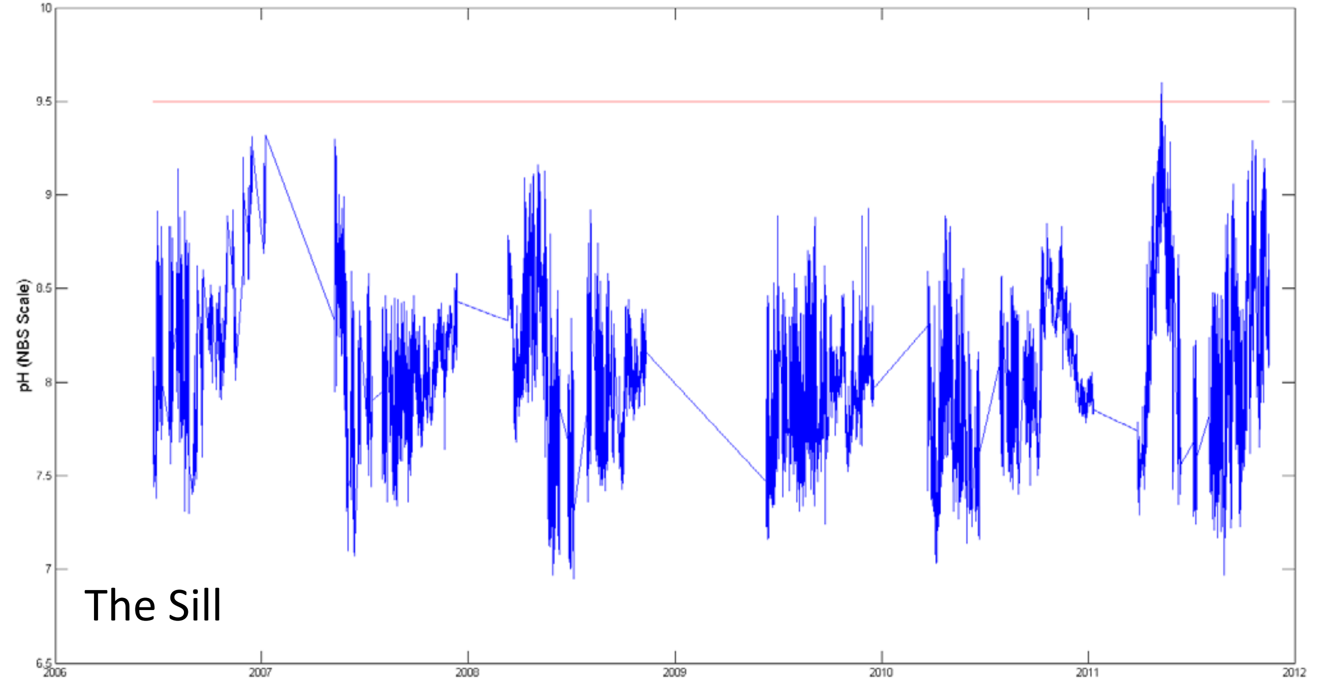
The Effect of pH on the Release of Phosphorus from Potomac Estuary Sediments: Implications for Blue-green Algal Blooms

Sybil P. Seitzinger

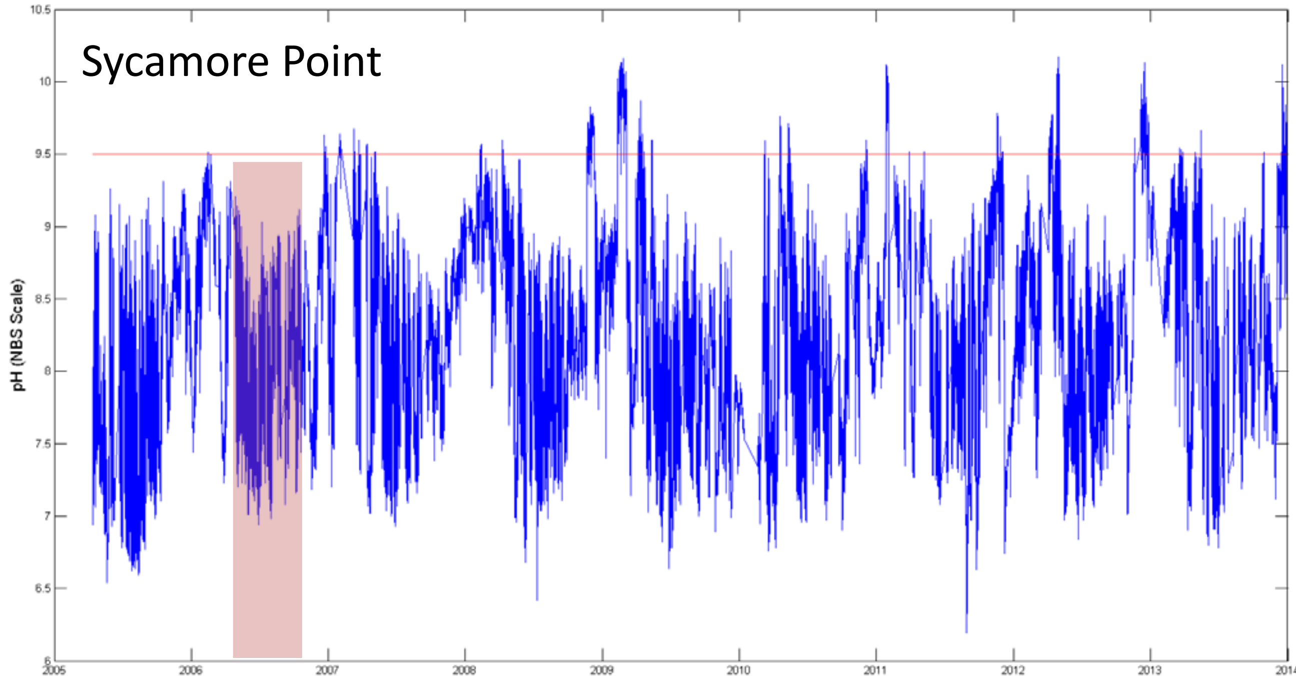


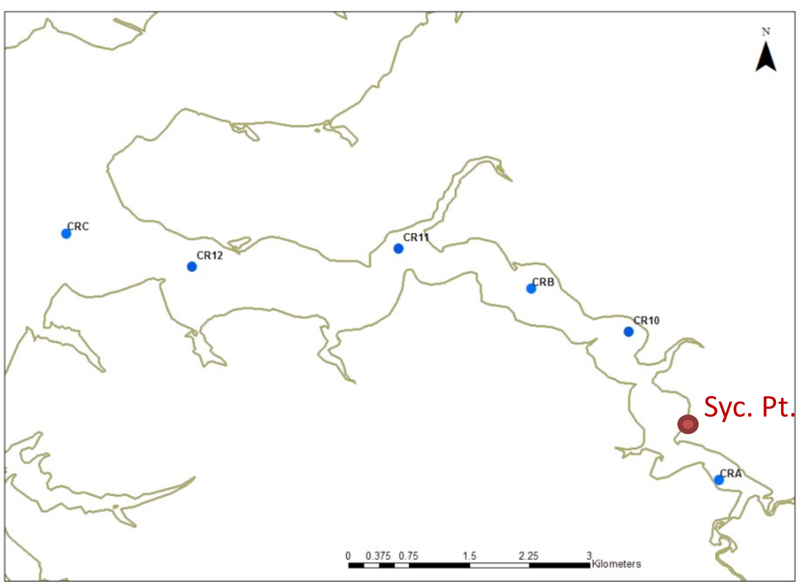
Corsica River pH 2006-2014



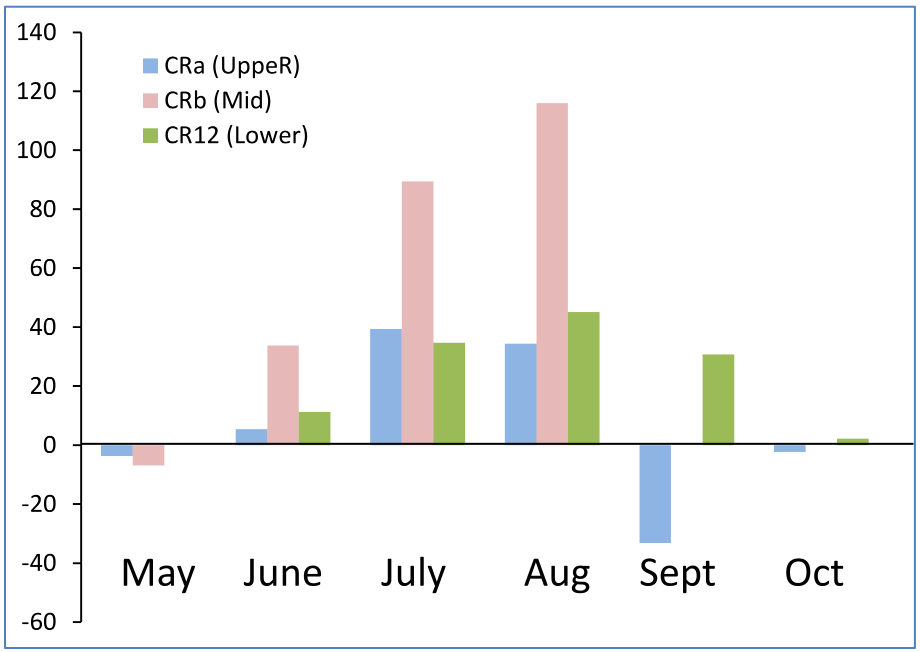


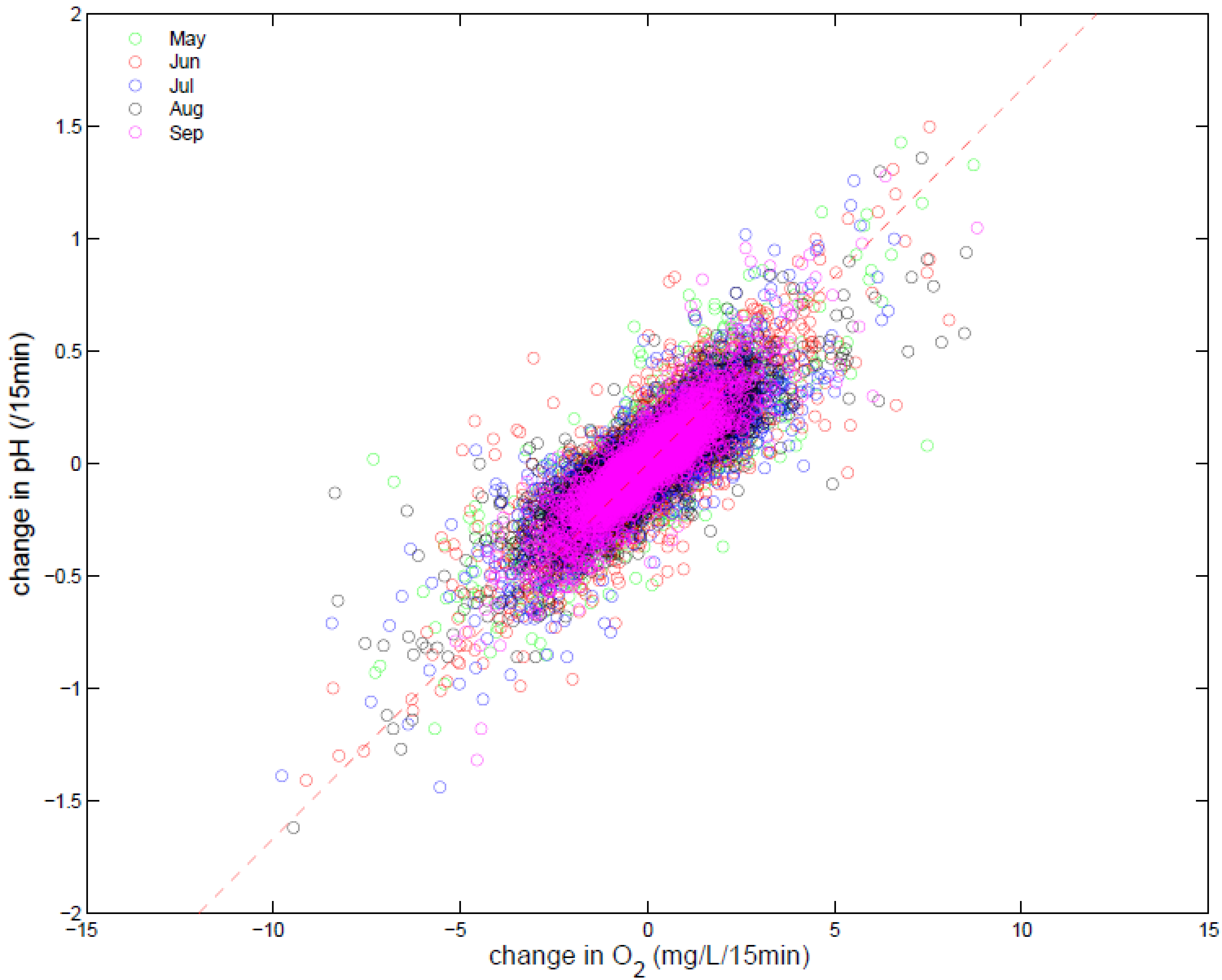
High DIP Fluxes Occur in Summer, High pH in Winter





Corsica River Flux Stations





May
Jun
Jul
Aug
Sep
change in pH (/15min)
change in O2 (mg/L/15min)
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
−15
−10
−5
0
5
10
15

In conclusion.

How does your WQ model differ from the other teams' models?

(1) *As Above*

What does your WQ model do well, and why?

(1) *We should have RCA simulations in the next month, where we will know this*
(2) *Past work has reproduced diel cycling hypoxia, captured spatial variations in sediment-water fluxes*

What needs more work, and why?

(1) *Benthic grazing may be important in some regions, but more work needed*
(2) *Understanding model sensitivity to freshwater inputs, key parameters*

What will be you be focusing on improving in the future?

(1) *Fully Implementing benthic algal model*
(2) *Improving the formulation for kd*
(3) *Potentially considering pH effects on P sorption*
(4) *Making sure we capture storm-induced P loads*

Thank You