Research into Engineered Destratification and Aeration in Rock Creek

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Tackling Hypoxia in the Baltic Sea: Is Engineering a Solution?

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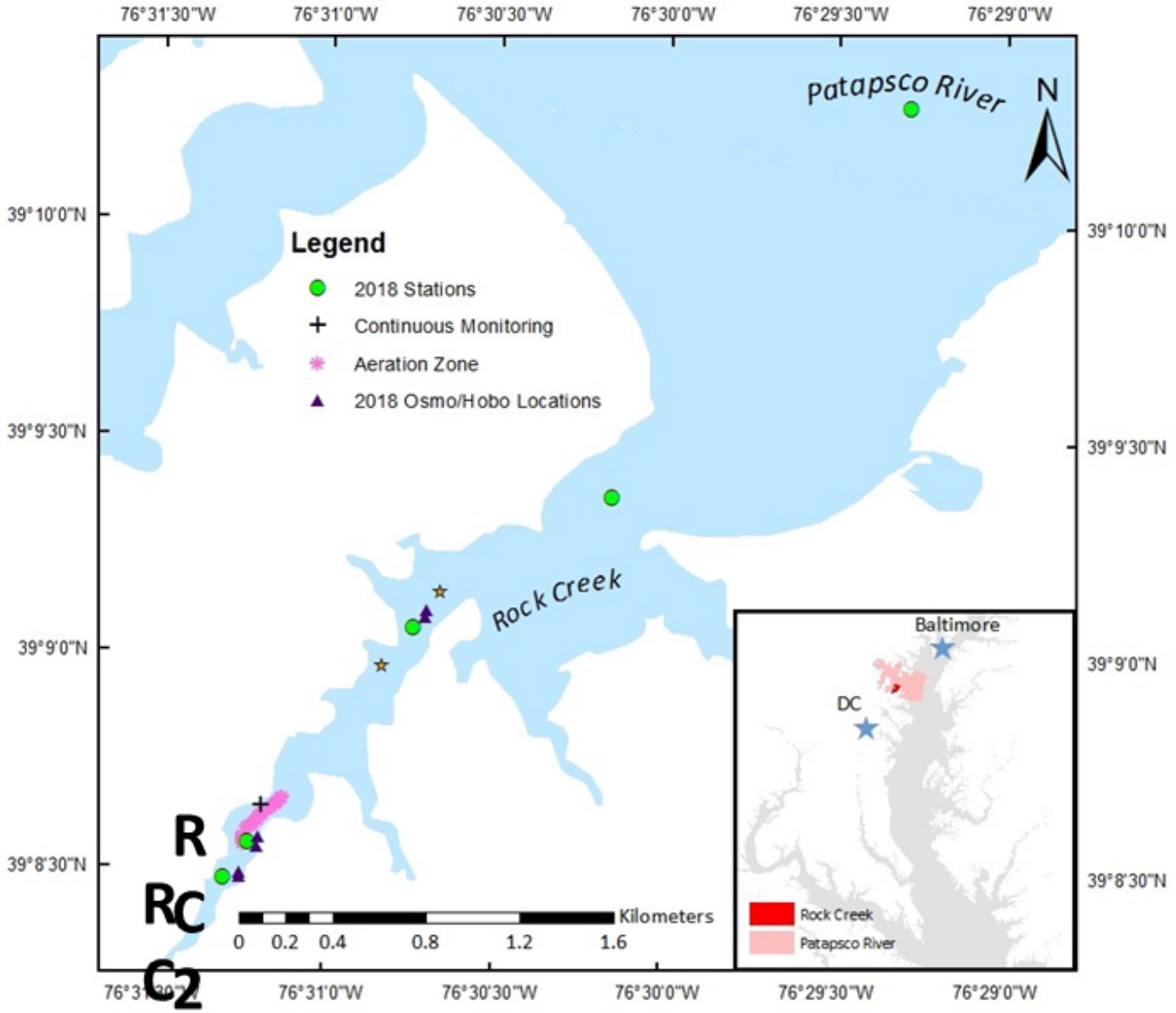
Save the Baltic Sea

Geoengineering efforts to bring oxygen into the deep Baltic should be abandoned, says **Daniel J. Conley**.

464 | NATURE | VOL 486 | 28 JUNE 2012


76°31'30"W
76°31'0"W
76°30'30"W
76°30'0"W
76°29'30"W
76°29'0"W
39°10'0"N
39°9'30"N
39°9'0"N
39°8'30"N
Patapsco River
N
Legend
2018 Stations
Continuous Monitoring
Aeration Zone
2018 Osmo/Hobo Locations
Rock Creek
R
RC
C2
1
Kilometers
0 0.2 0.4 0.8 1.2 1.6
Baltimore
DC
Rock Creek
Patapsco River

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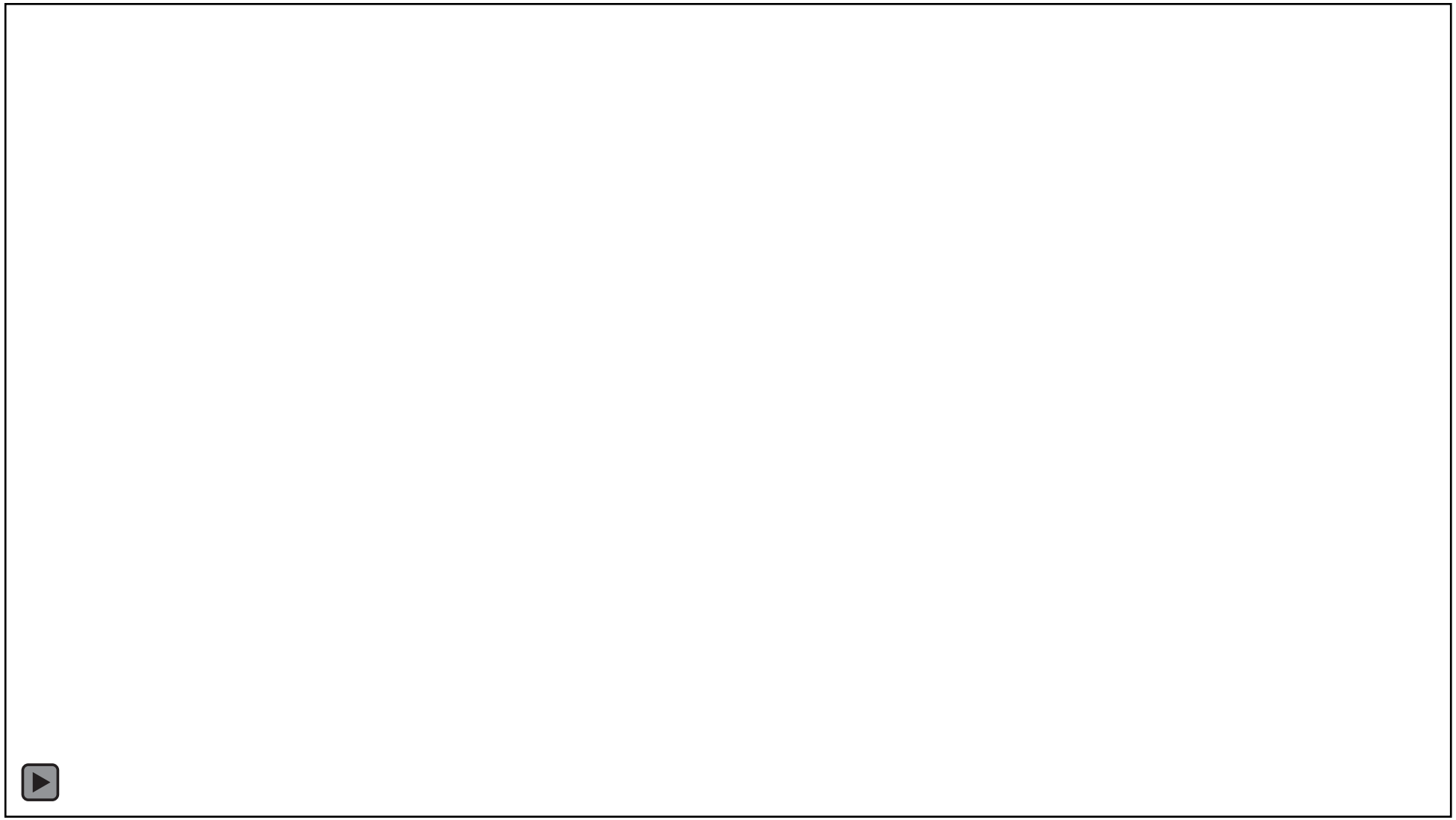
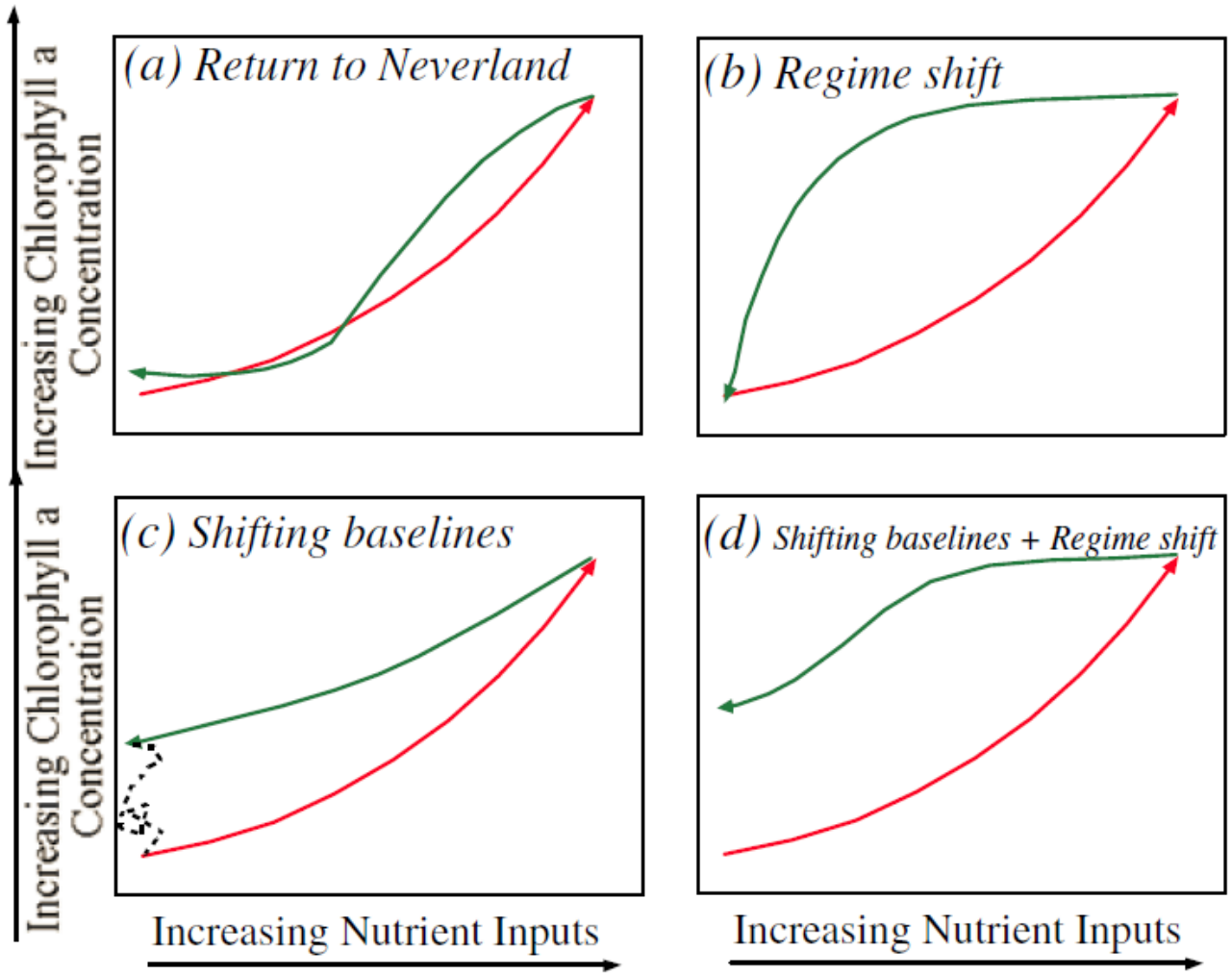
Optimizing recovery of eutrophic estuaries: Impact of destratification and re-aeration on nutrient and dissolved oxygen dynamics

L.A. Harris [a,*], C.L.S. Hodgkins [a], M.C. Day [a], D. Austin [b], J.M. Testa [a], W. Boynton [a], L. Van Der Tak [b], N.W. Chen [c]



Return to *Neverland*: Shifting Baselines Affect Eutrophication Restoration Targets

Carlos M. Duarte · Daniel J. Conley · Jacob Carstensen · María Sánchez-Camacho



Limnol. Oceanogr., 57(3), 2012, 835–850

doi:10.4319/lo.2012.57.3.0835

Hypoxia-induced shifts in nitrogen and phosphorus cycling in Chesapeake Bay

Jeremy Mark Testa,* and W. Michael Kemp

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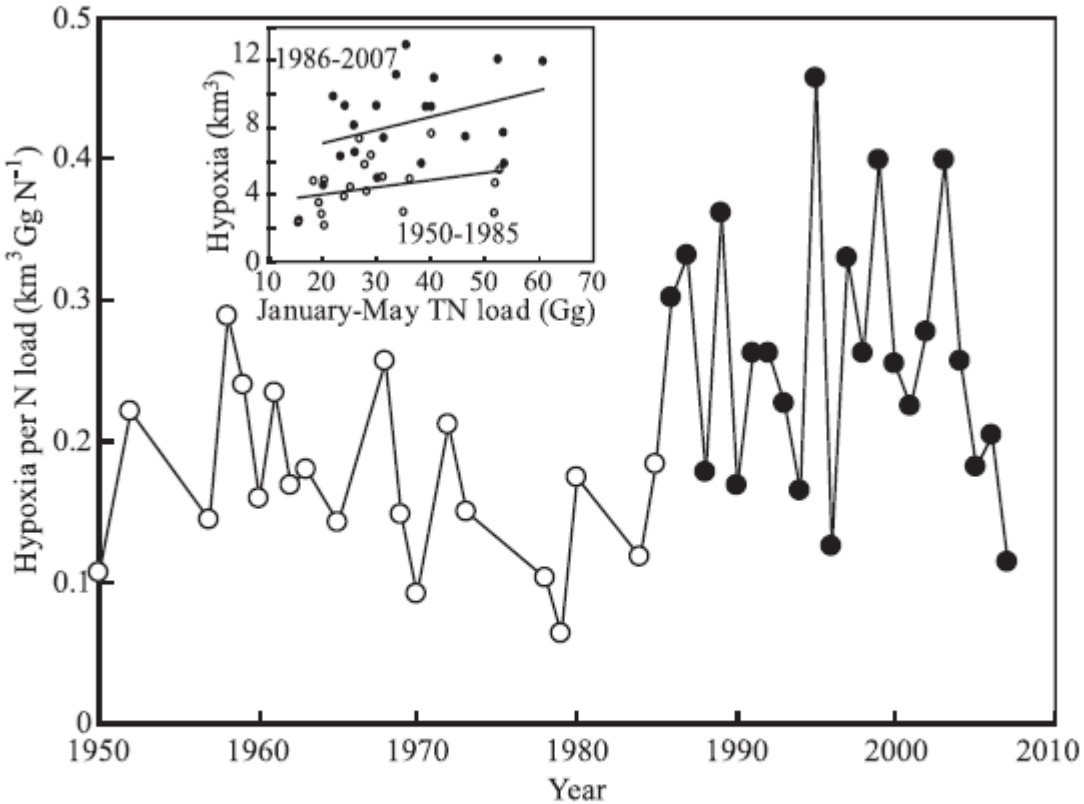


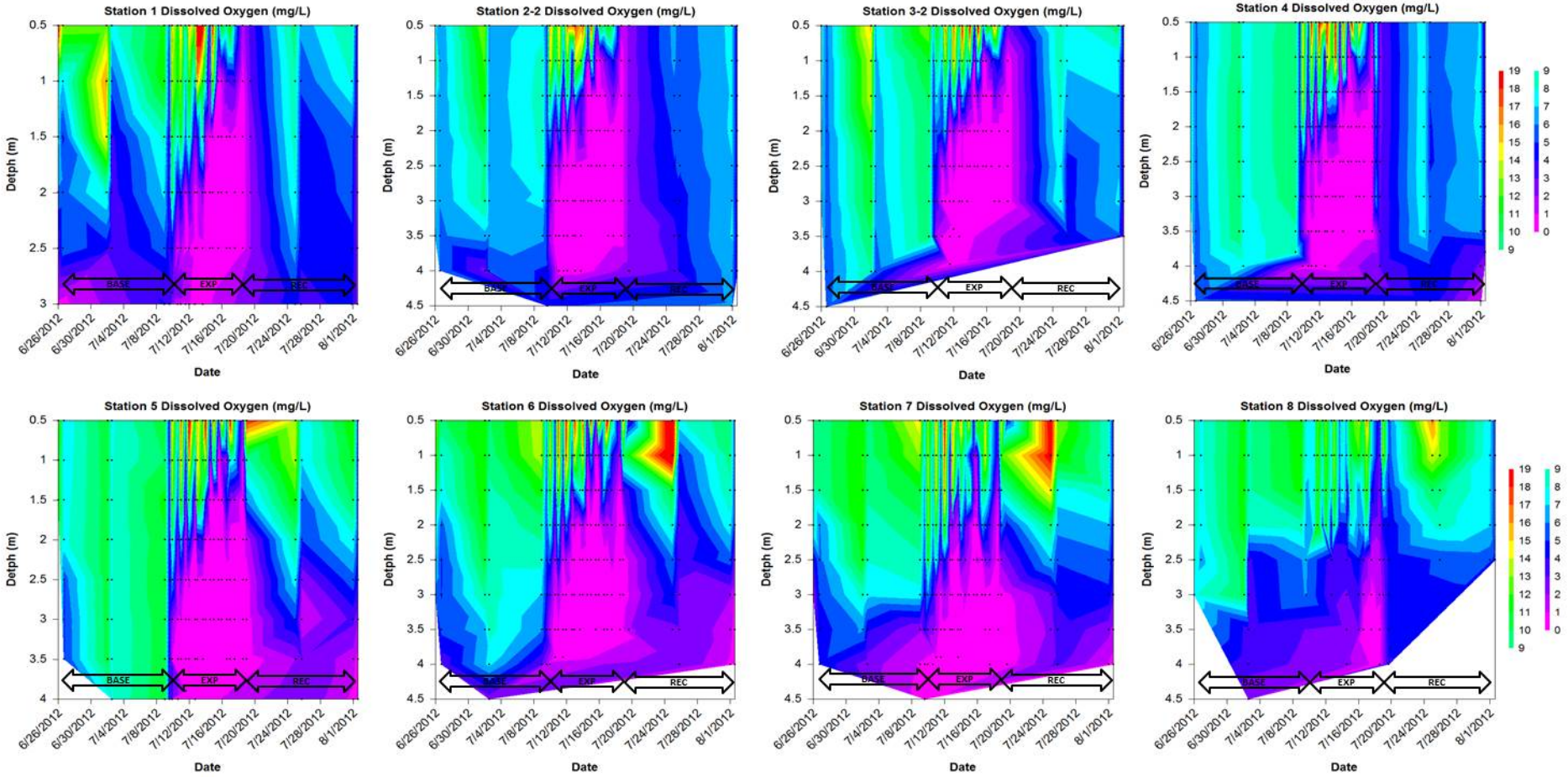
Fig. 2. Time series of July hypoxic ($O_2 < 62.5$ μmol L^{-1}) water volume per unit winter–spring Susquehanna River TN load (January to April) from 1950 to 2007 and (inset) correlations between TN load and hypoxic water volume in two periods (1950–1985, open circles; 1986–2007, closed circles). Hypoxic volume and TN loads were calculated as described in Methods.

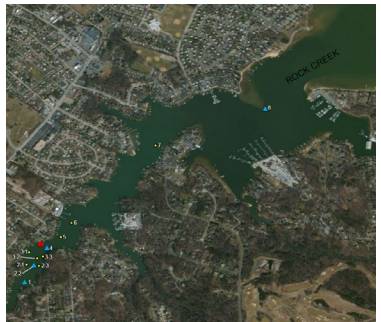
Effects of Reduced O_2 Levels

• NITROGEN	• PHOSPHORUS
• Inhibit coupled nitrification-denitrification • Shift system towards dissimilatory nitrate reduction to ammonium (DNRA) • Reduced N_2 output and increased NH_4^+ accumulation	• Reduction of Fe(III) and Mn(IV) to soluble states • Release of sorbed inorganic phosphate from metal oxide-hydroxide complexes • Increased efflux of PO_4^{3-} to overlying water column
Nutrients > Phytoplankton > POM > Hypoxia > Recycling > Nutrients	

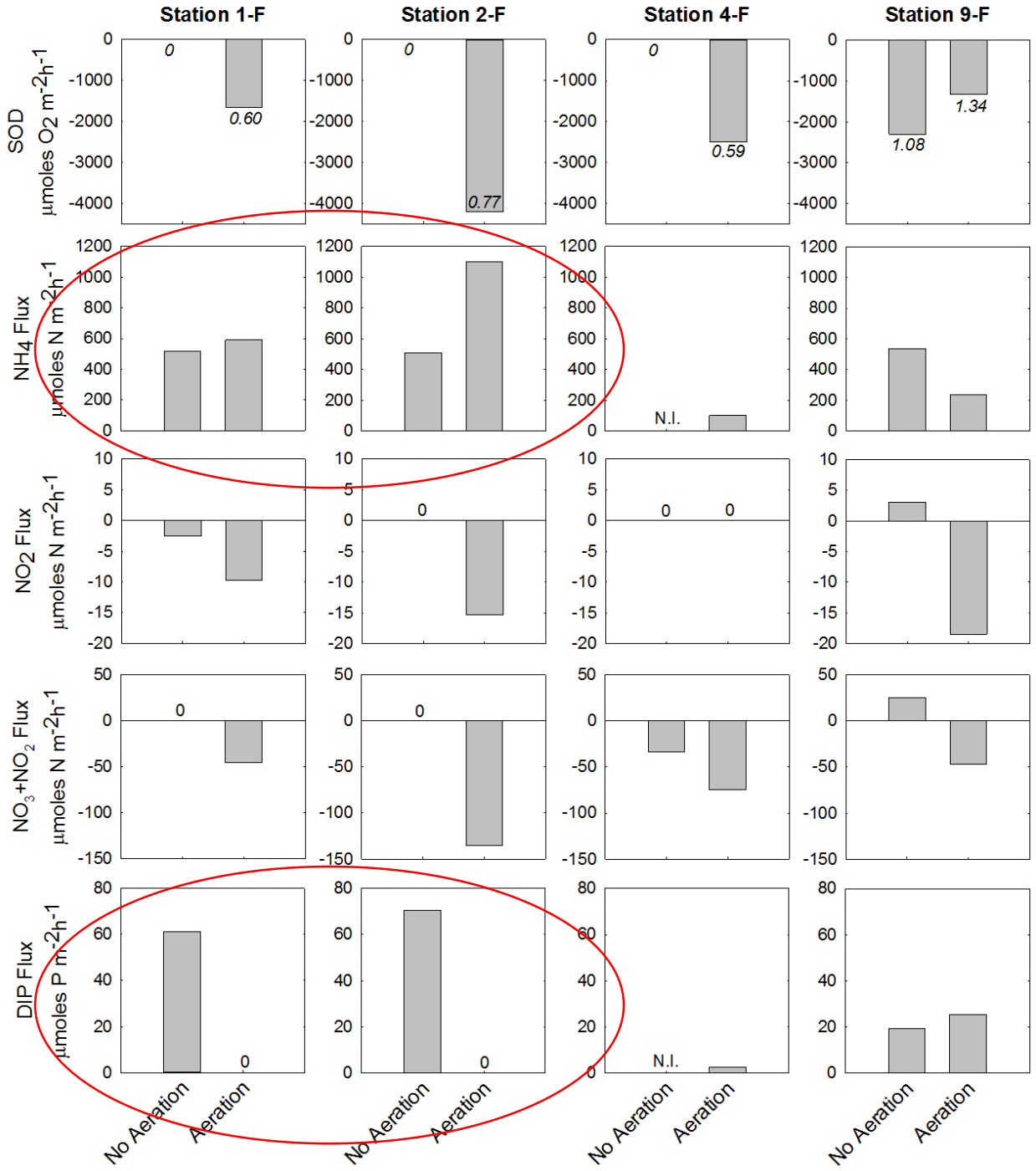
How long does hypoxia need to persist for these processes to occur?

Isopleths of water column DO (uM)





Sediment Flux Measuerements

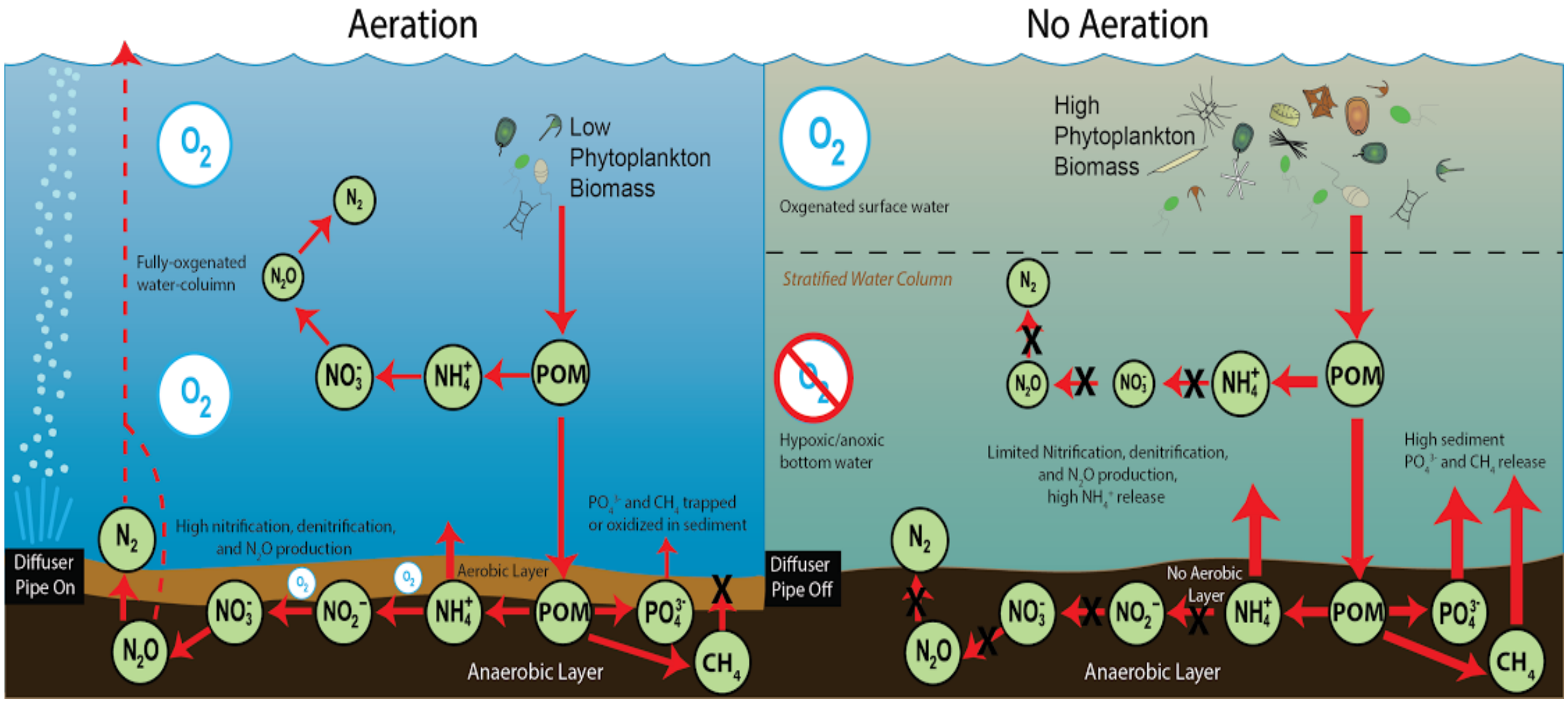


Effects of Reduced O_2 Levels

• GREENHOUSE GASES	• MERCURY
• Limits aerobic oxidation of methane • Enhances methane release to water column • Reduces N2O production by limiting nitrification/denitrification	• Enhanced methylation • Increased Me-Hg flux to water column
Reduced GHG but Increased Me-Hg under hypoxic conditions….	

How long does hypoxia need to persist for these processes to occur?

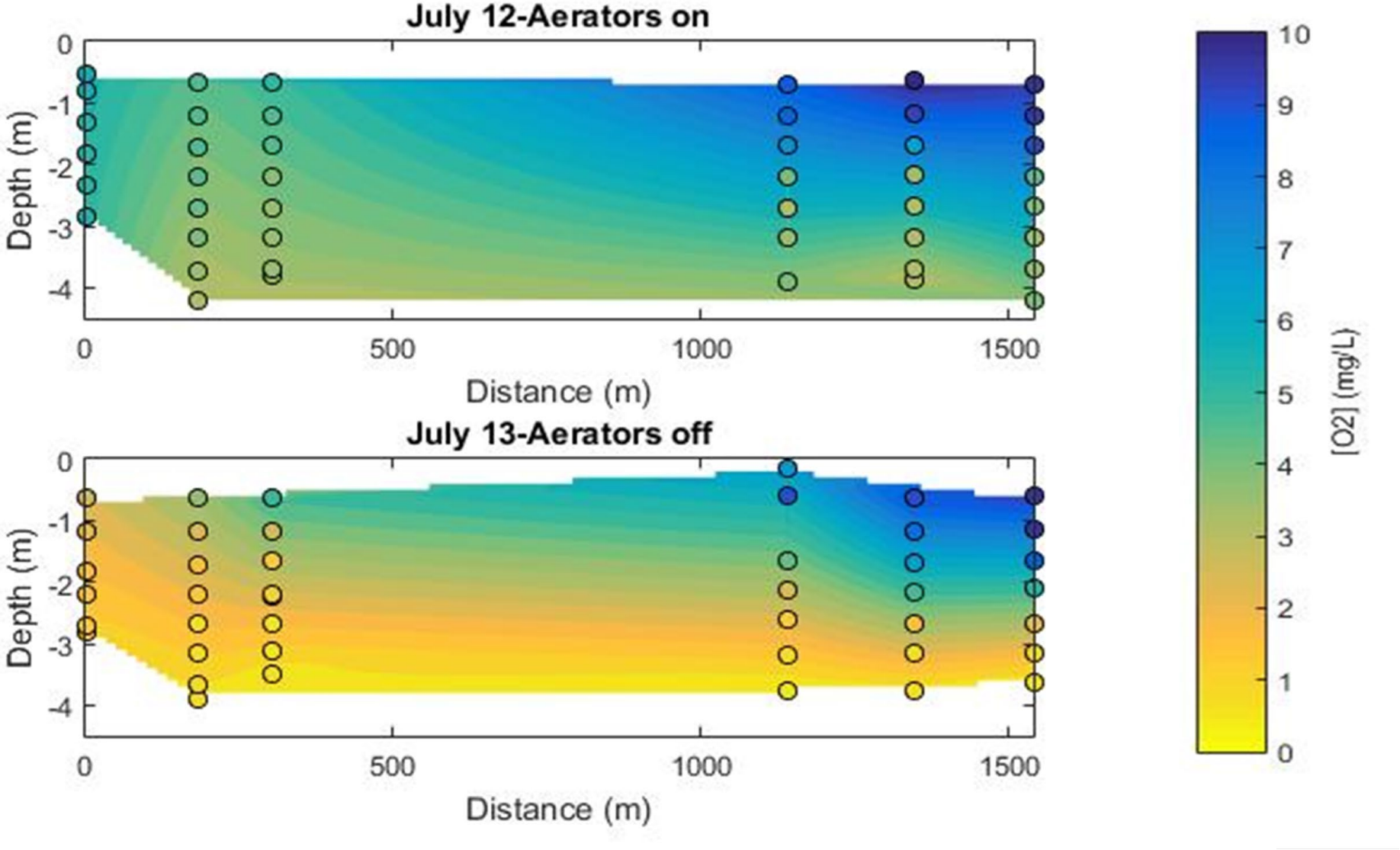
Refining our Conceptual Models of Engineered Aeration



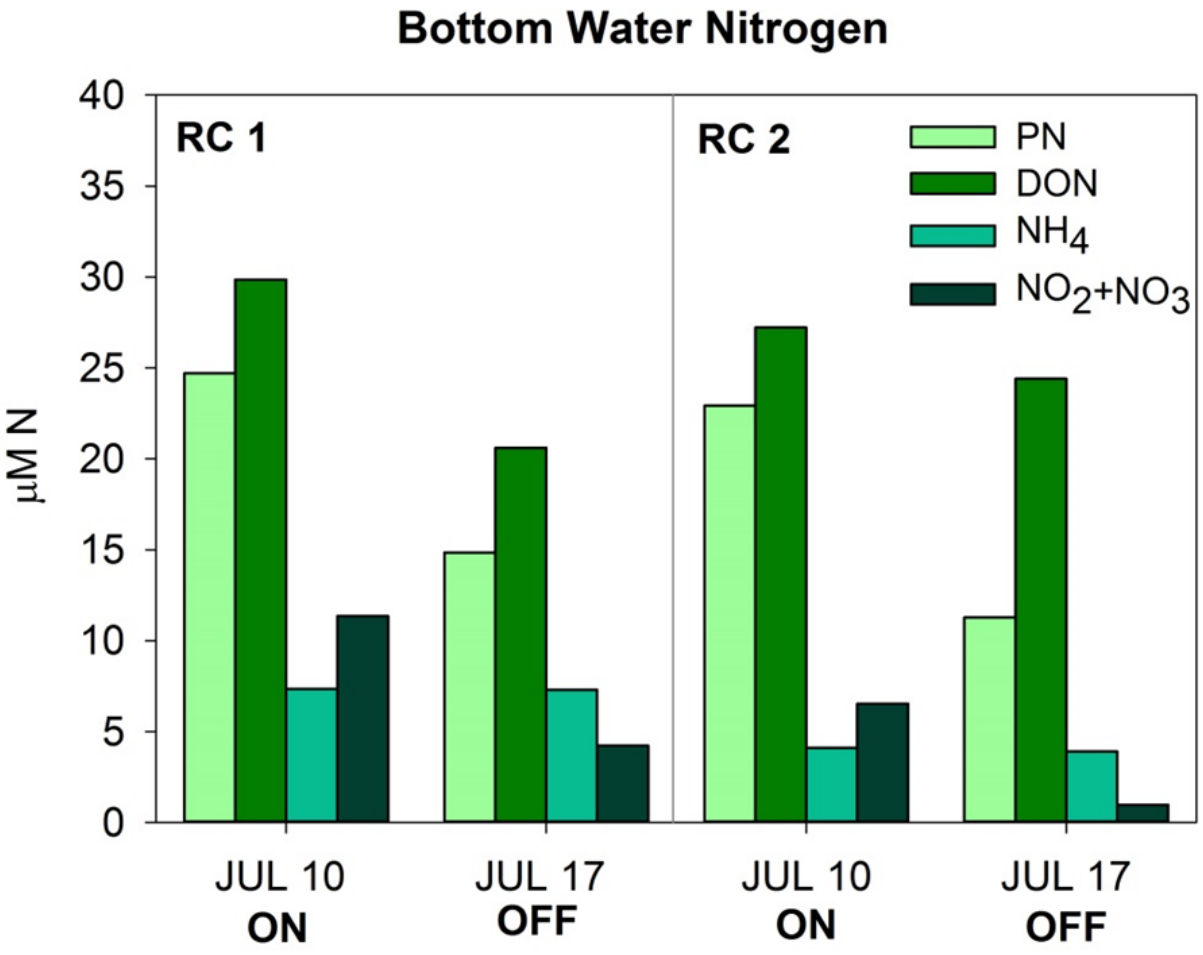
New NSF Research Goals and Hypotheses

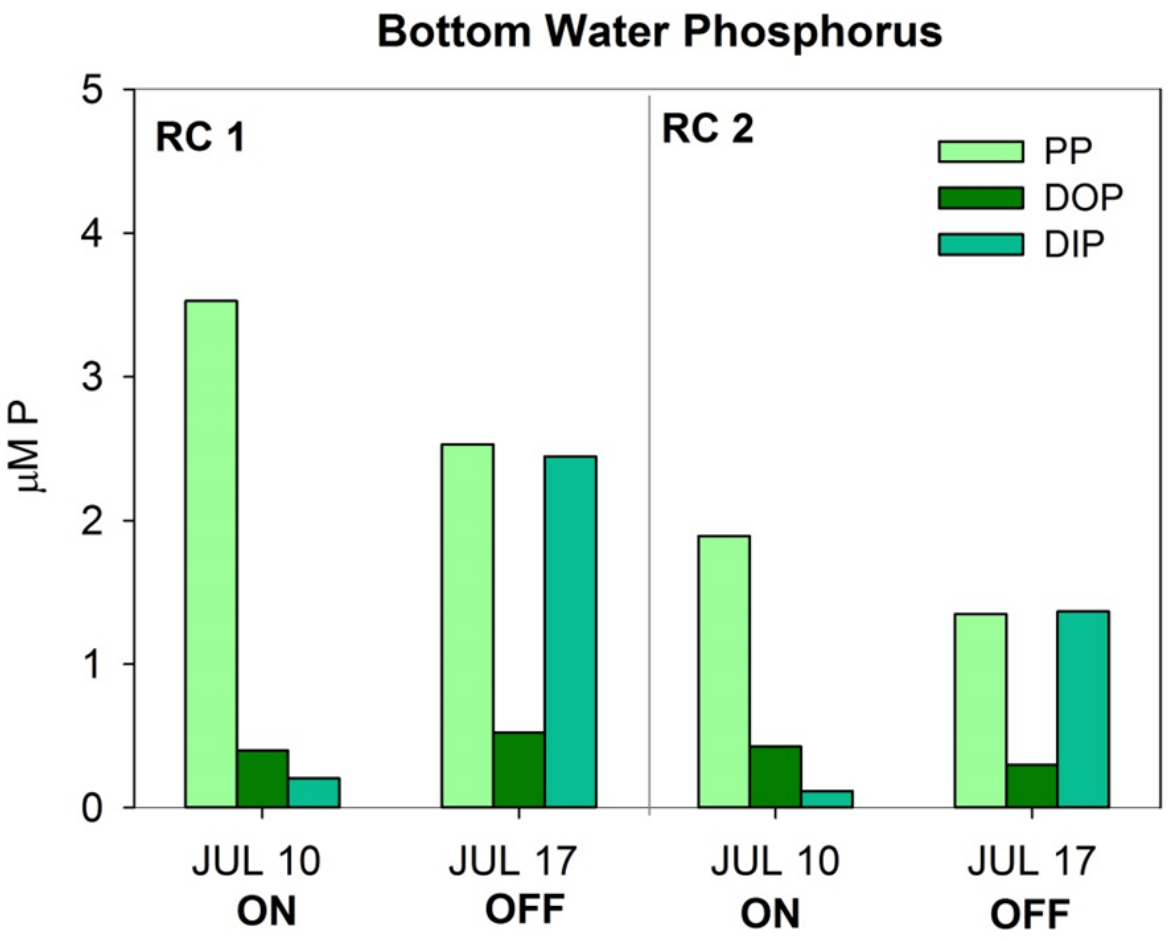
- Compare sediment-water column fluxes for analytes of N, P, N2O, and methane to determine the impact of destratification in a eutrophic setting on denitrification, N remineralization, P release from sediments, and methane release to the water column.
- Quantify rates of greenhouse gas emissions (methane and nitrous oxide) from the bottom waters to the surface waters and atmosphere.
- Evaluate concentrations of total mercury (T-Hg) and Me-Hg to assess the impact of destratification on conditions conducive to mercury methylation.

2018

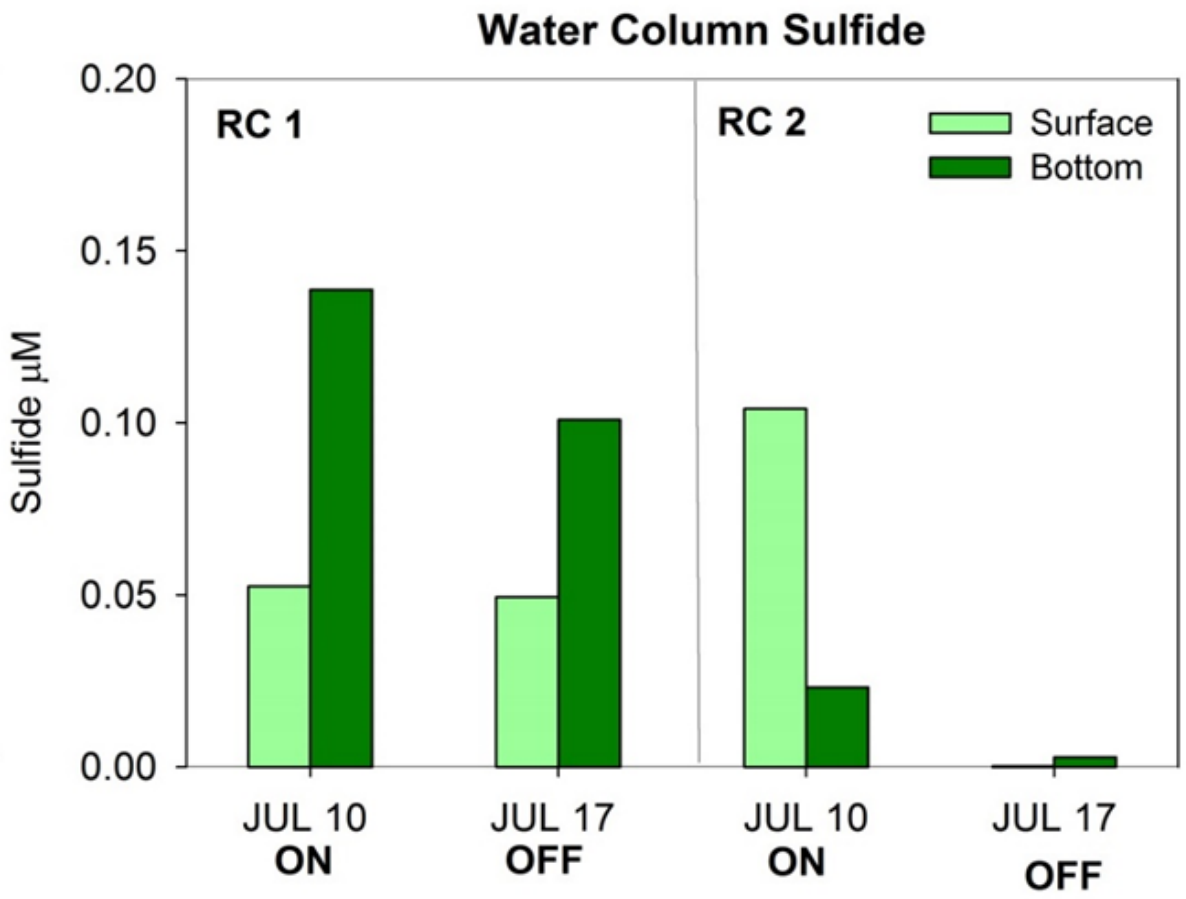

July 12-Aerators on
Depth (m)
0
-1
-2
-3
-4
0
500
1000
1500
Distance (m)
July 13-Aerators off
Depth (m)
0
-1
-2
-3
-4
0
500
1000
1500
Distance (m)
10
9
8
7
6
5
4
3
2
1
0
[O2] (mg/L)

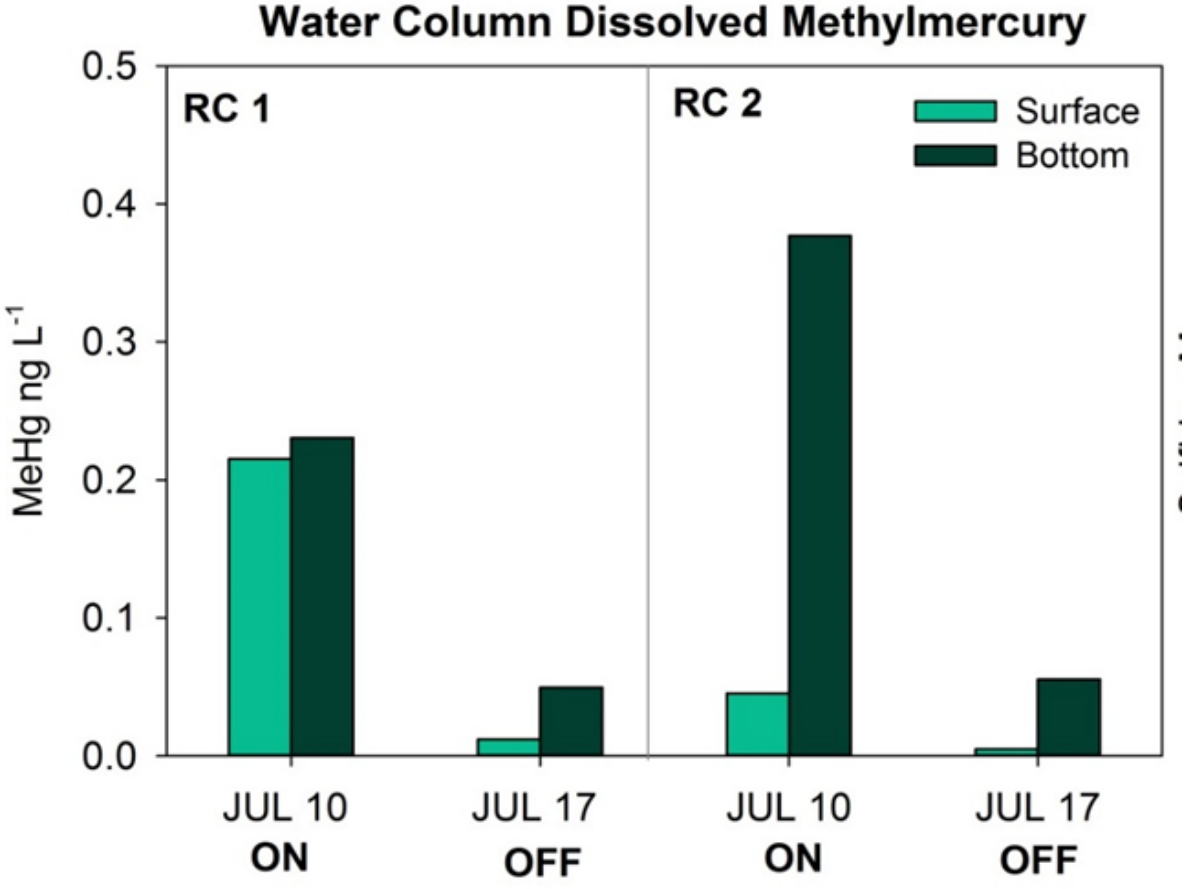
Water Column



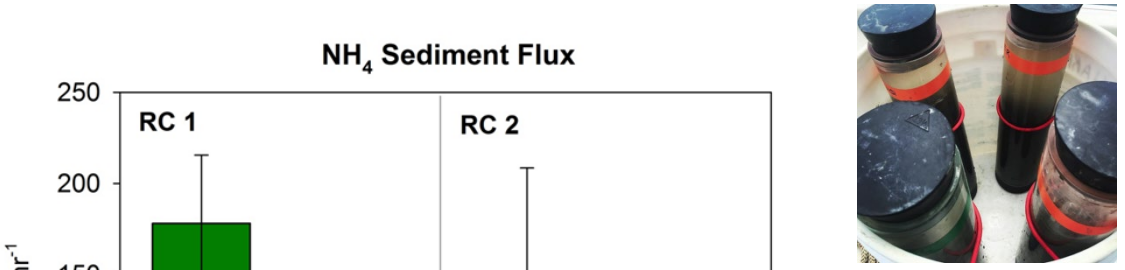


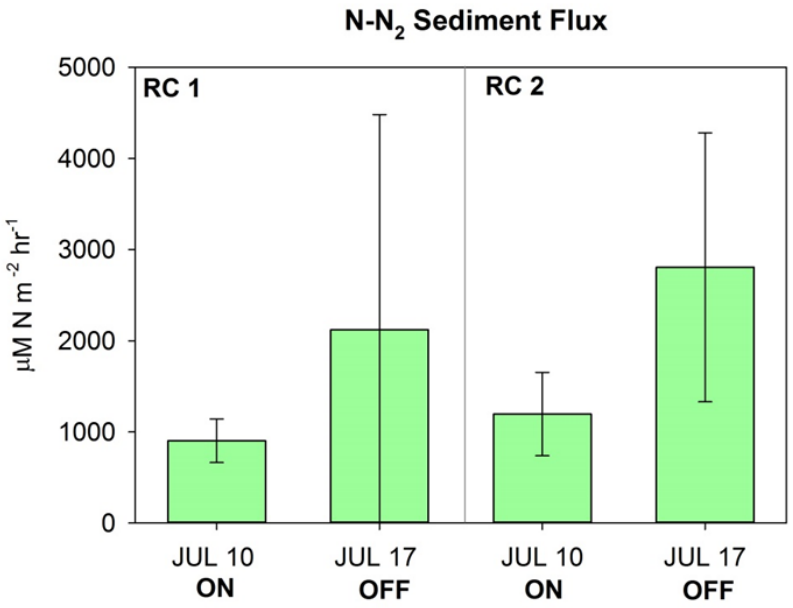
Water Column

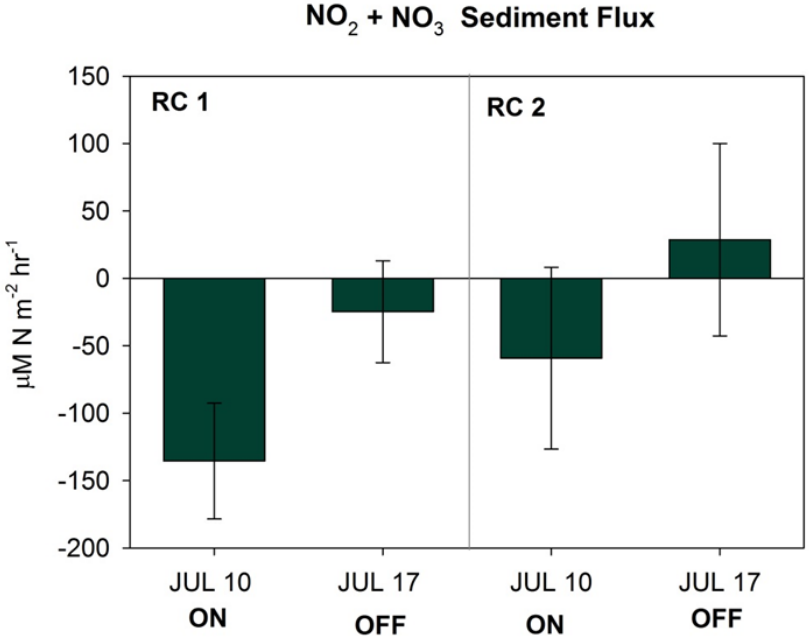


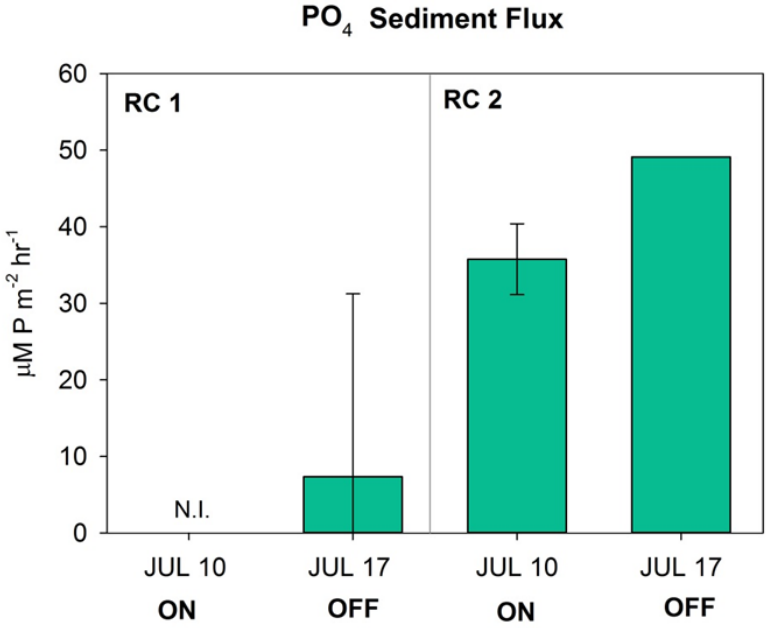


Sediment Fluxes





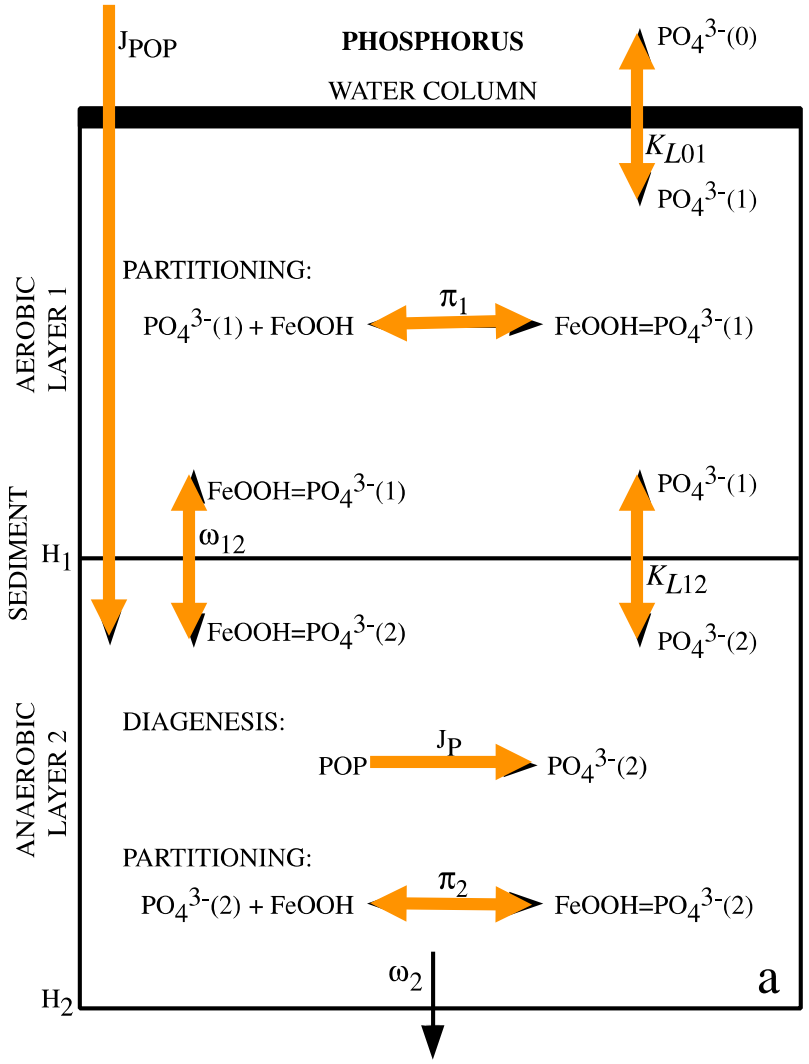




Sediment Biogeochemical Model Predictions

- Shifted simulation runs for varying hypoxic durations and severity

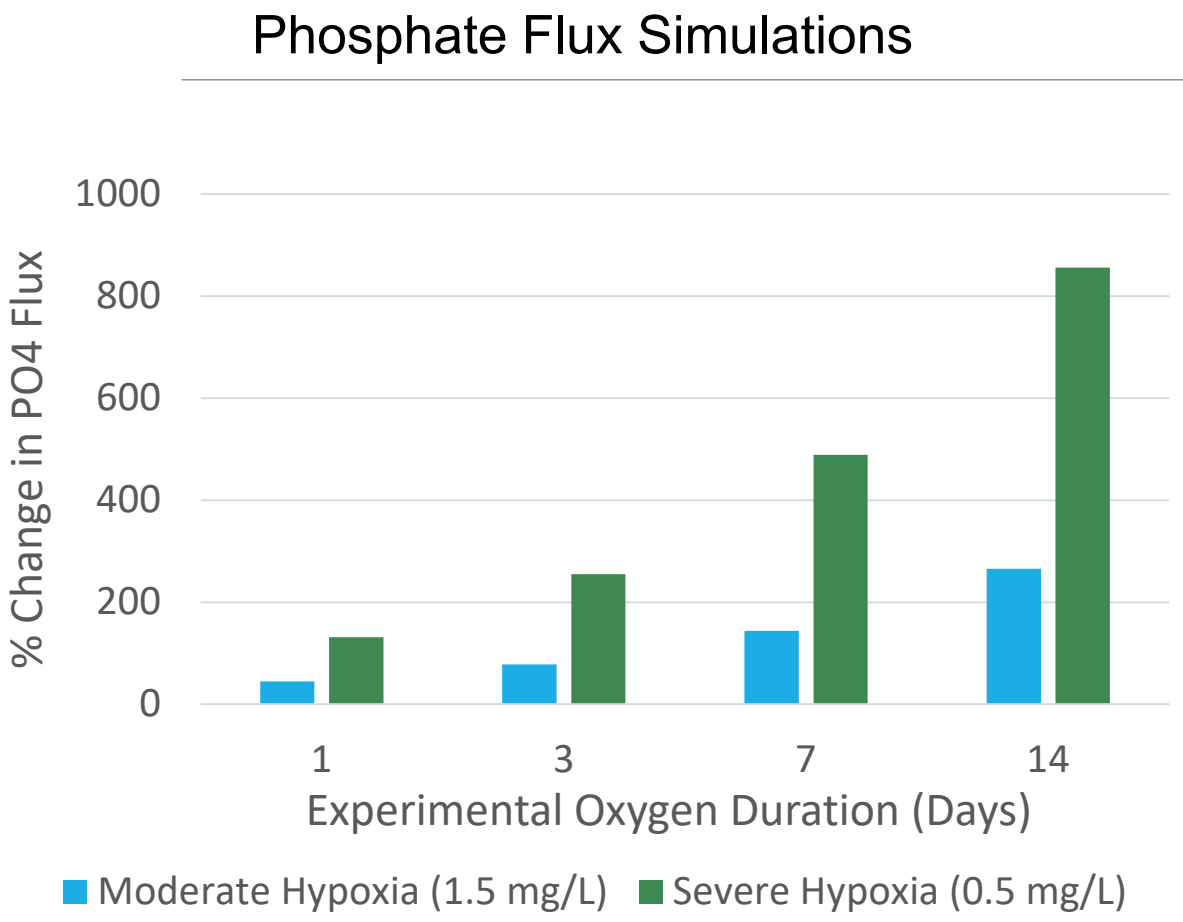
Simulation Trials				
Moderate Hypoxia (1.5 mg/L)	1-Day	3-Days	7-Days	14-Days
Severe Hypoxia (0.5 mg/L)	1-Day	3-Days	7-Days	14-Days

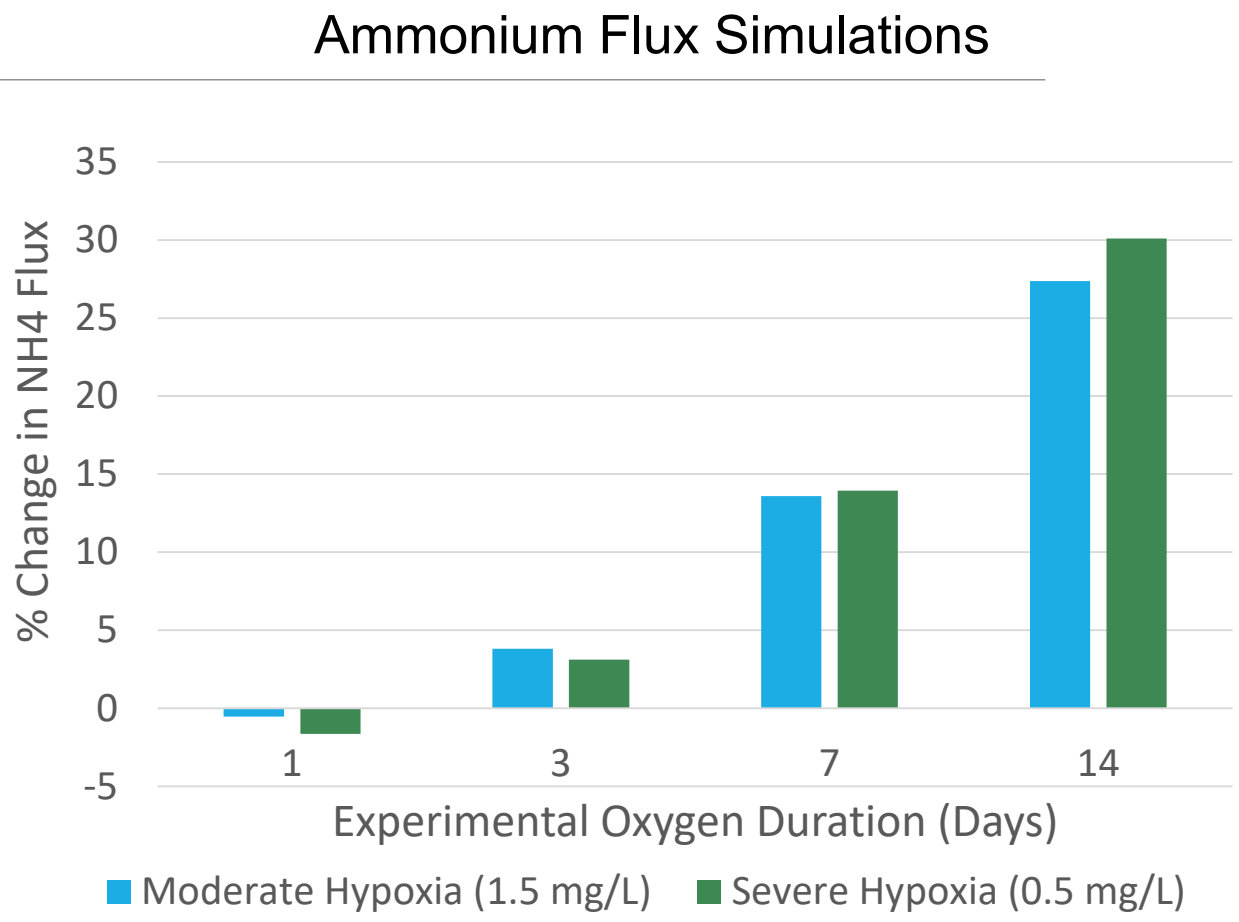


Applied and Validated for Rock Creek: (Harris et al. 2015)

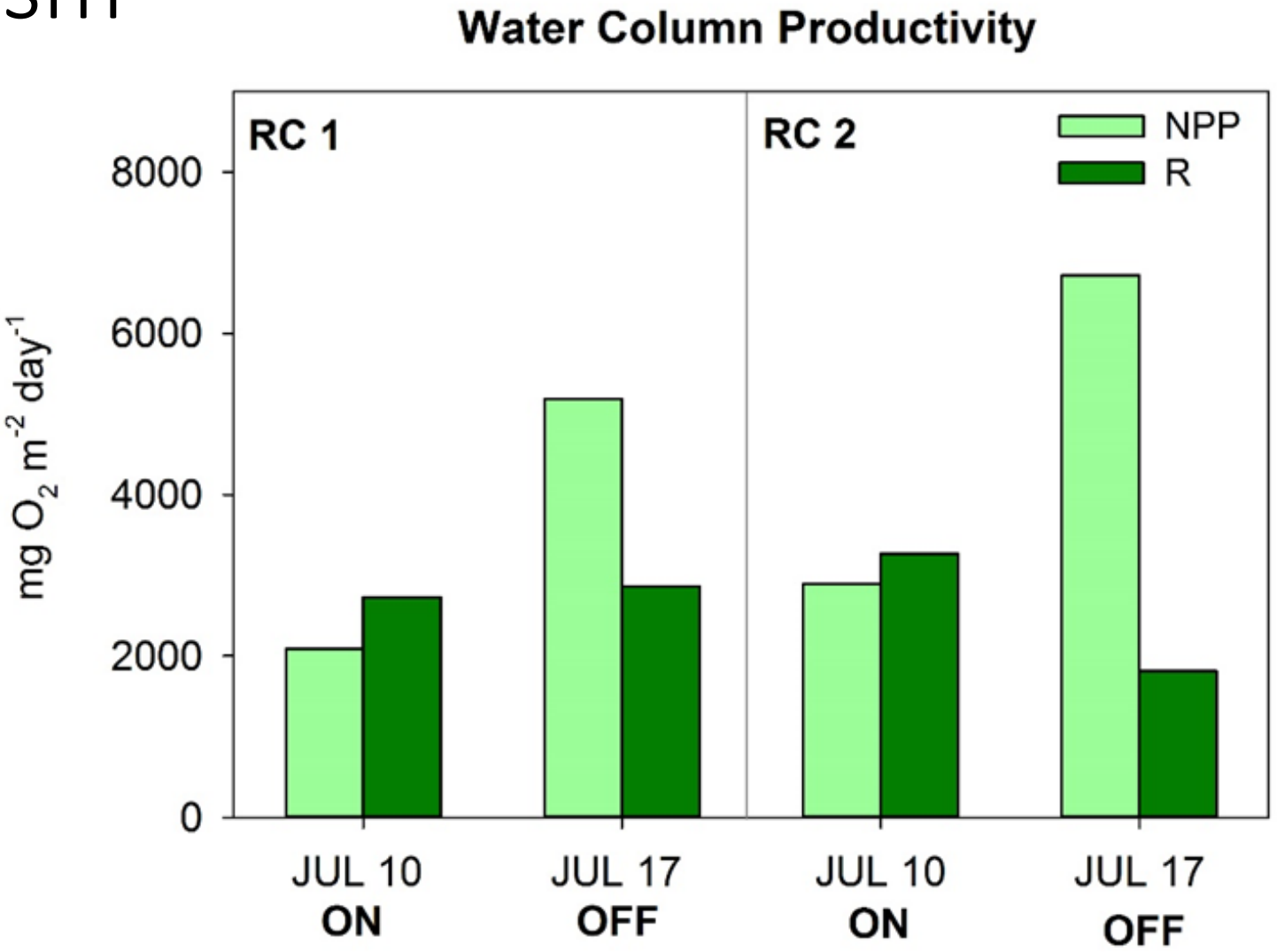
Originally Published: (Testa et al. 2013)

SFM Predictions

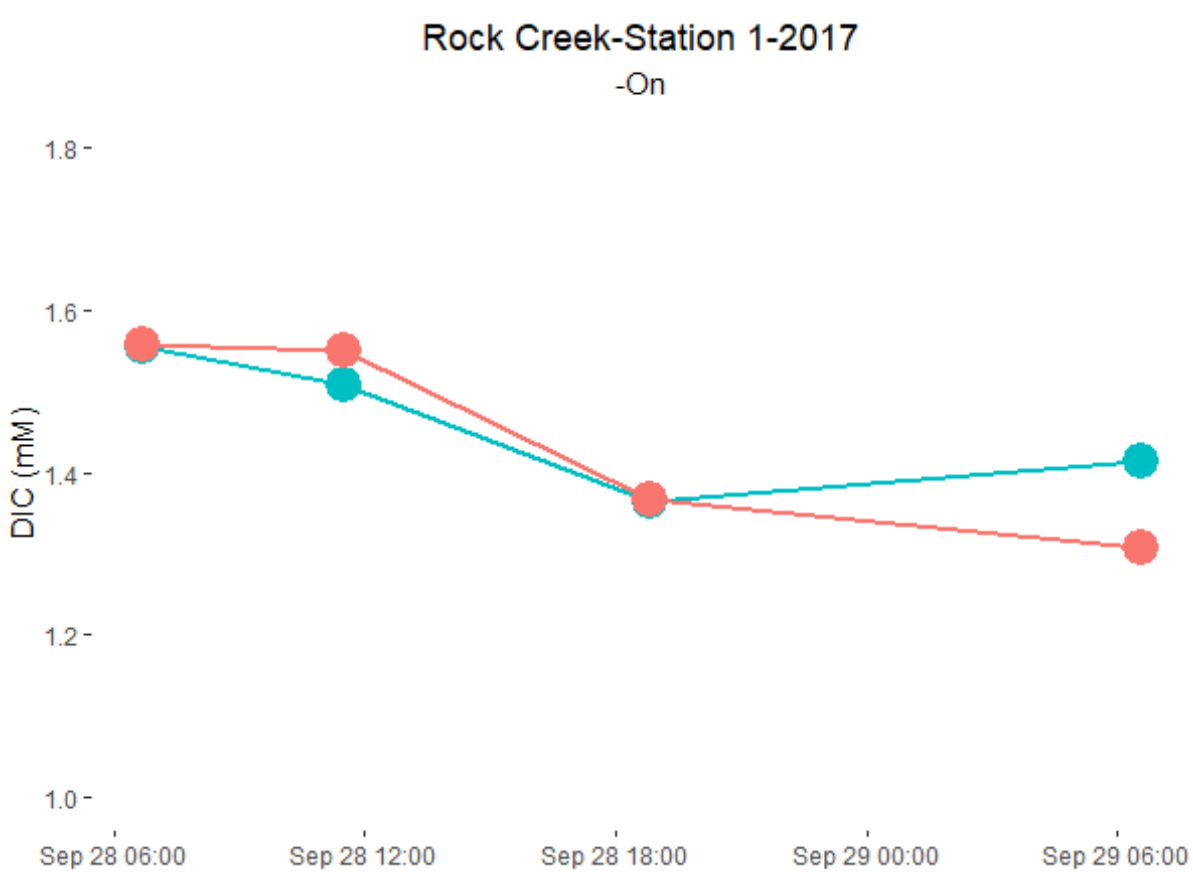


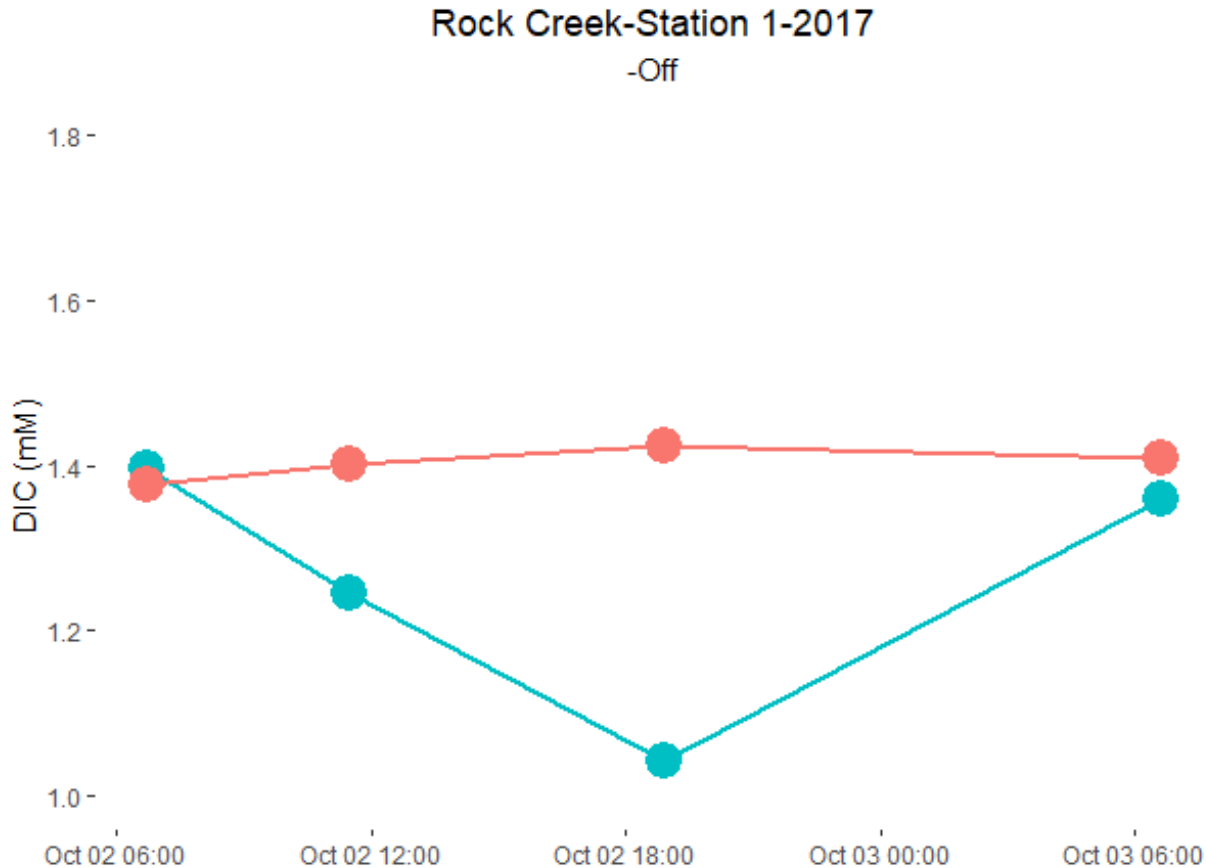


Metabolism

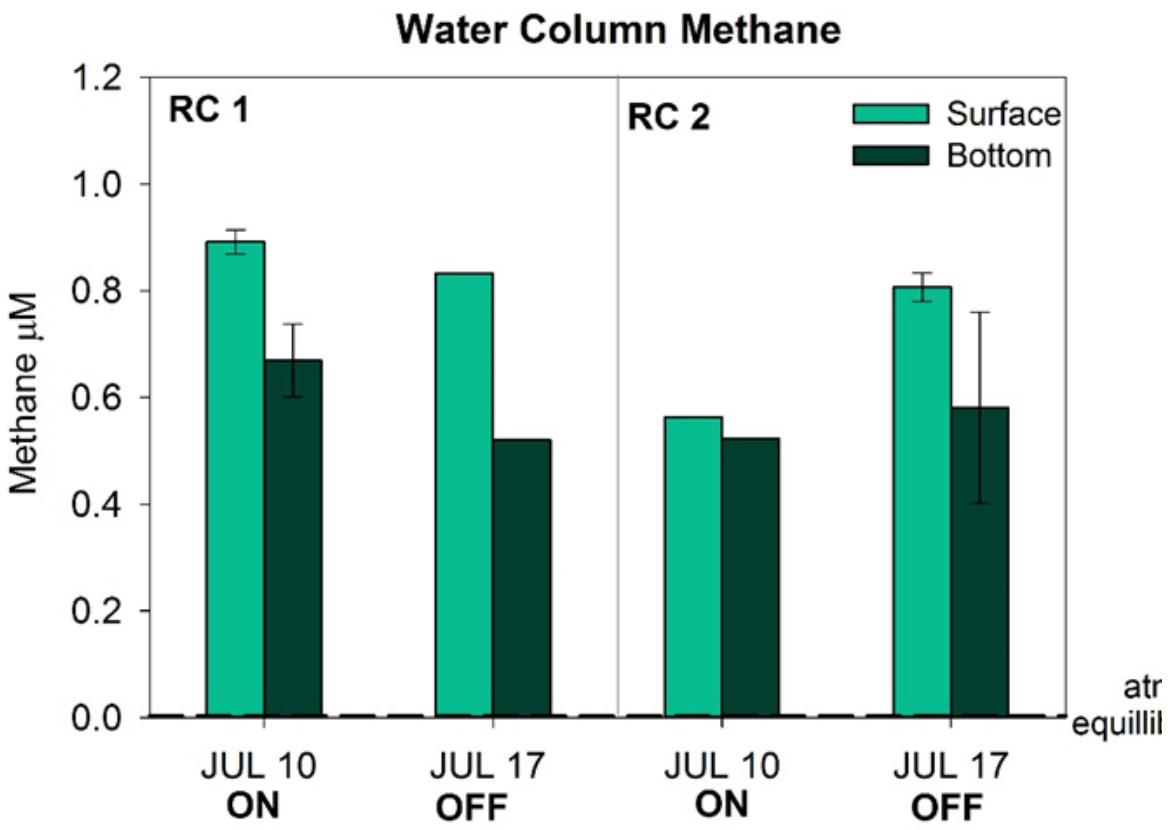

Water Column Productivity
RC 1
RC 2
NPP
R
8000
6000
4000
2000
0
mg O_2 m^{-2} day^{-1}
JUL 10
ON
JUL 17
OFF
JUL 10
ON
JUL 17
OFF

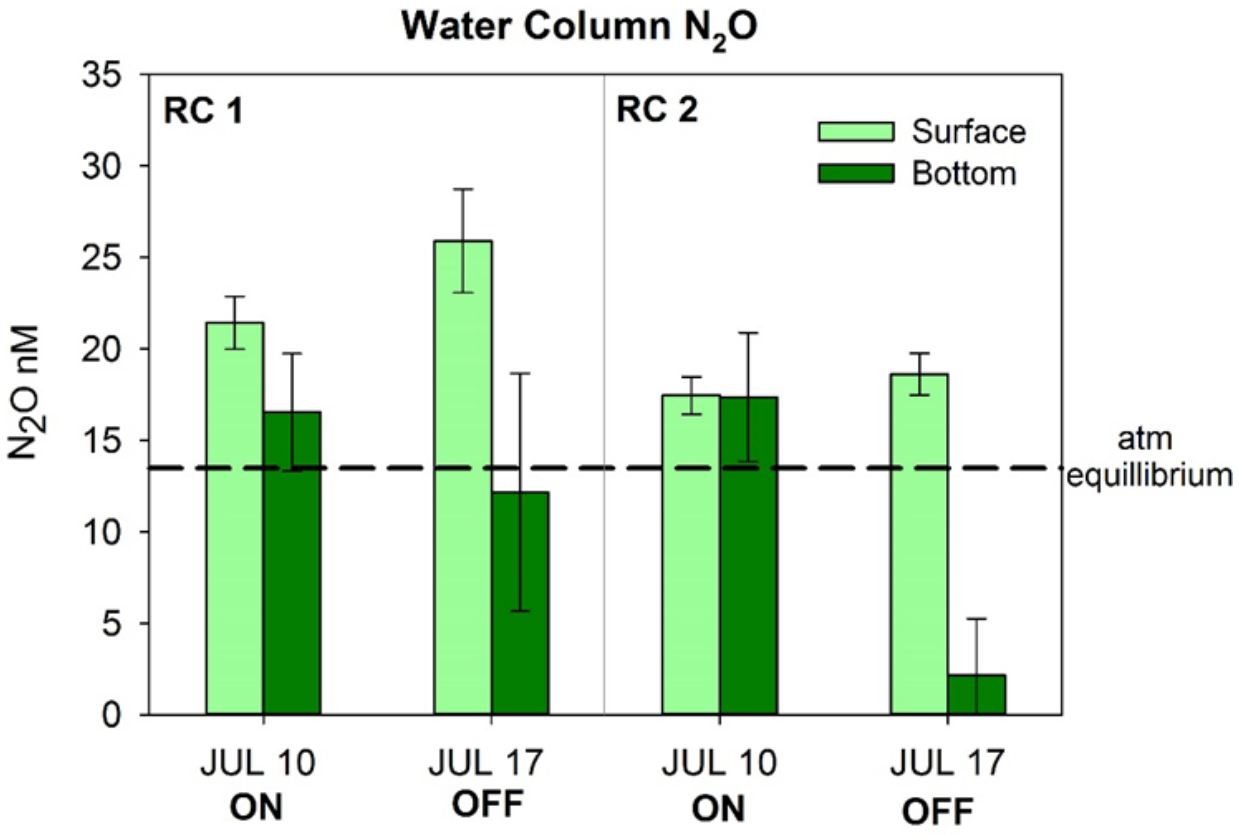
Open Water Metabolism



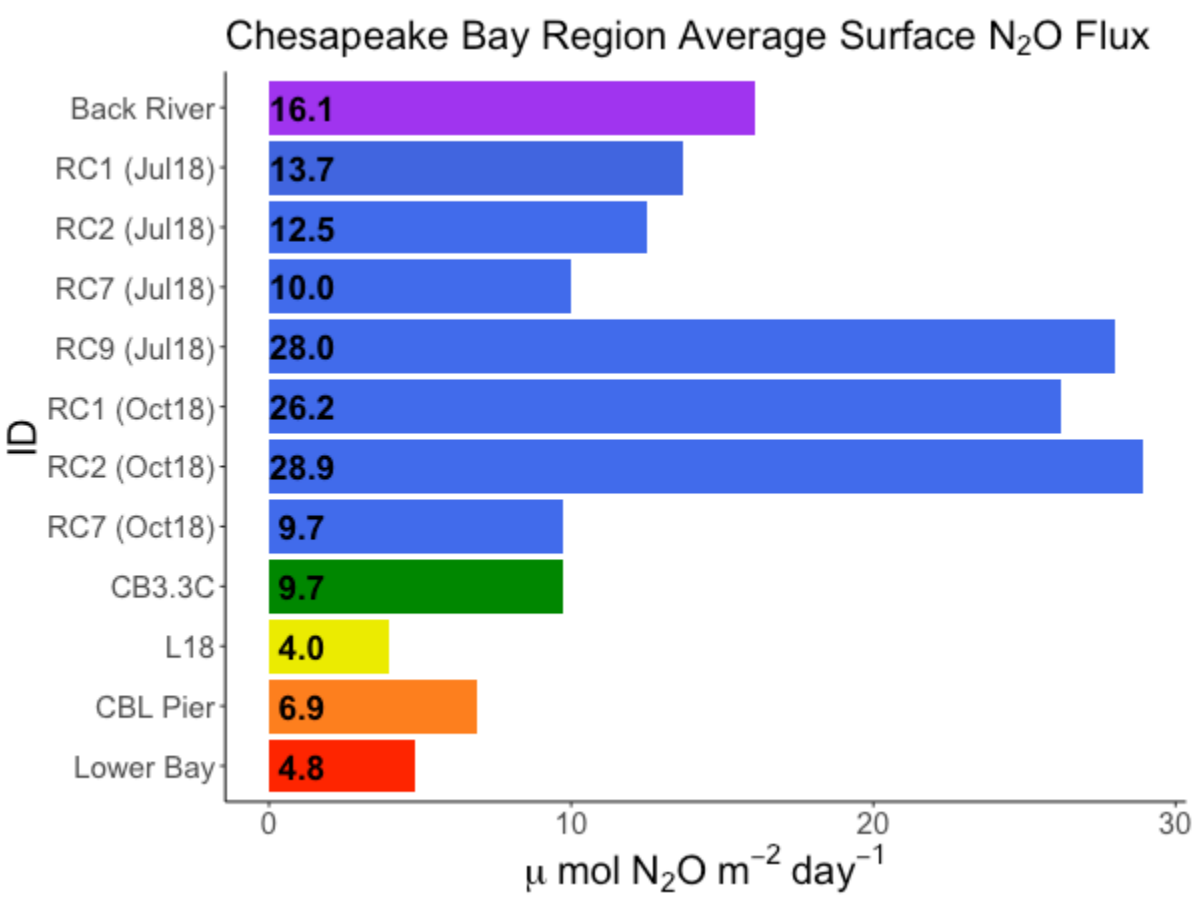


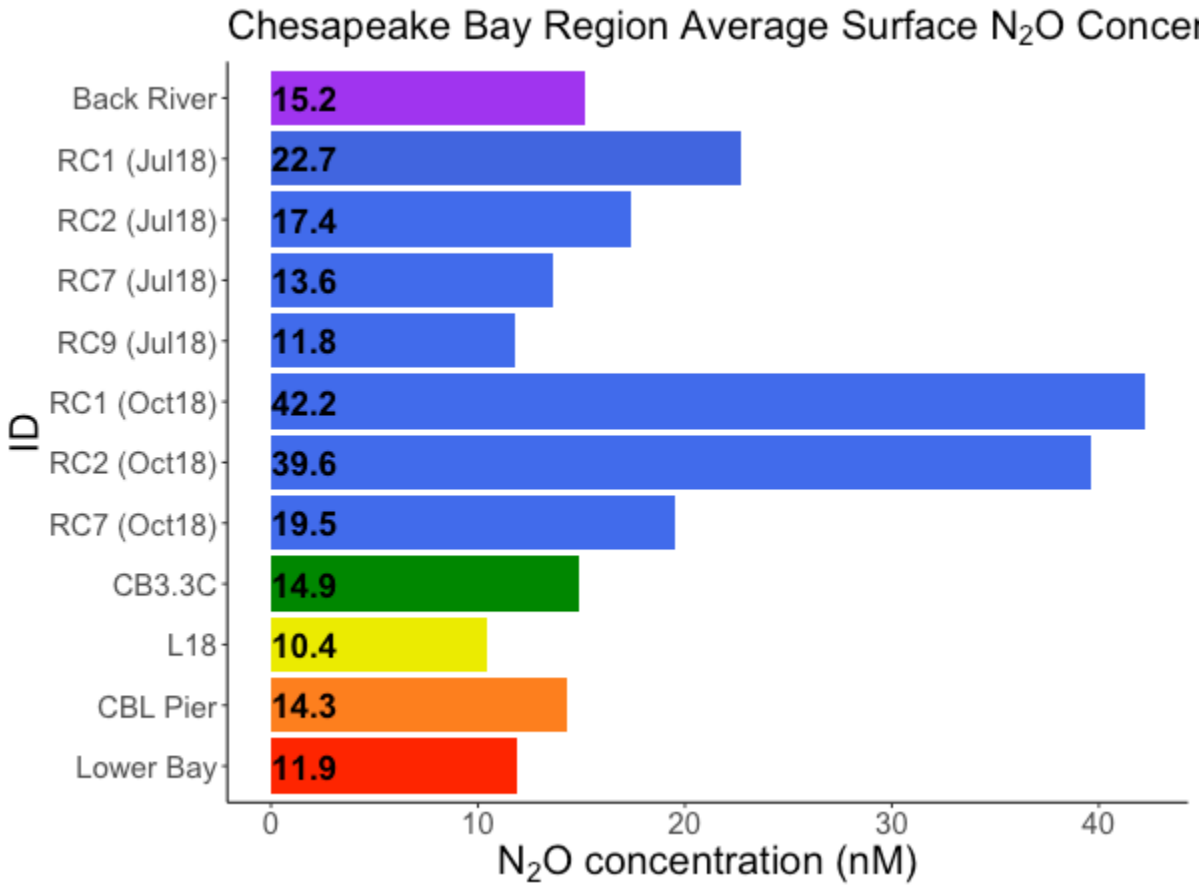
Greenhouse Gases



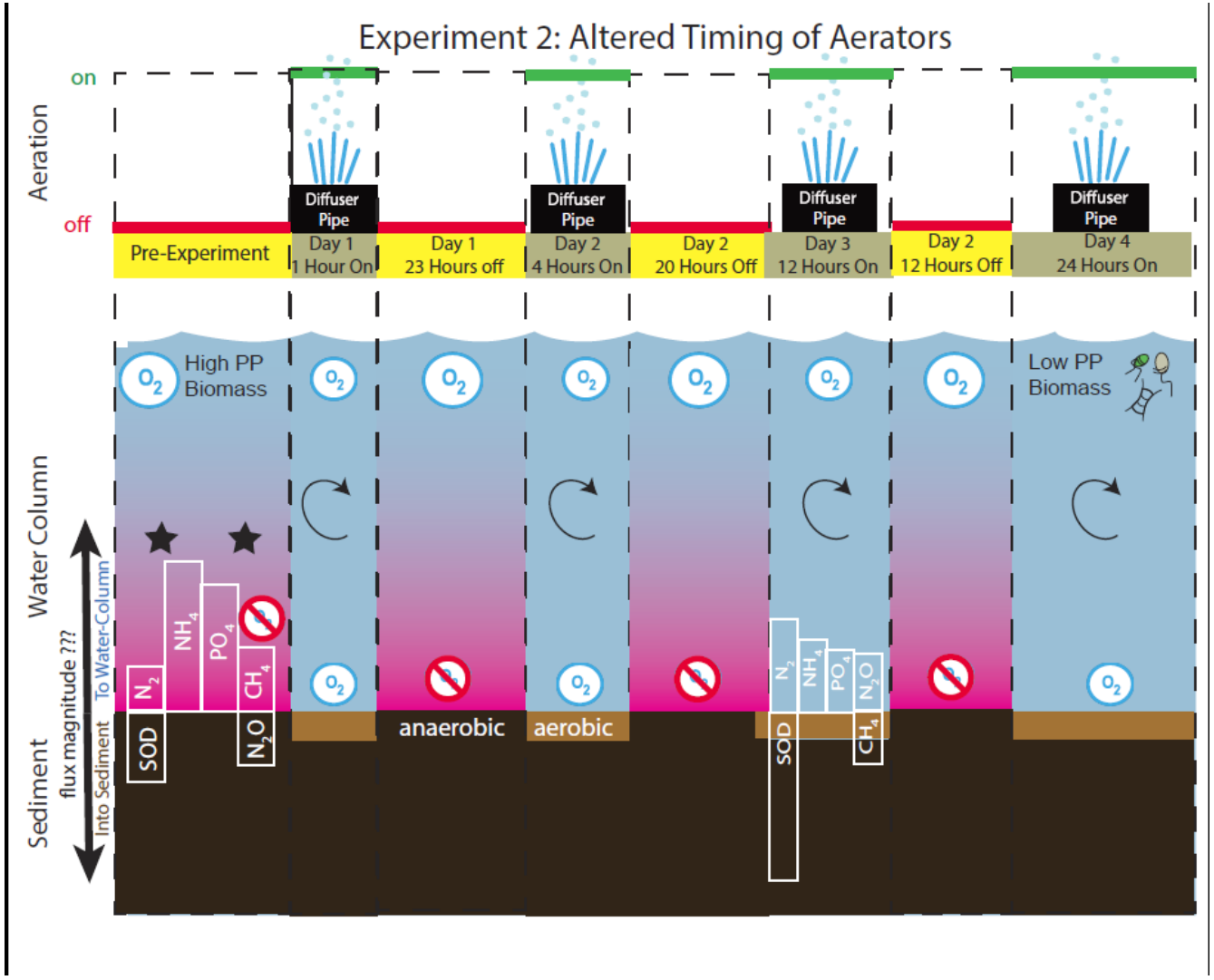


Greenhouse Gases





Summer 2019


Experiment 2: Altered Timing of Aerators
Aeration
on
off
Diffuser Pipe
Pre-Experiment
Day 1
1 Hour On
Day 1
23 Hours off
Day 2
4 Hours On
Day 2
20 Hours Off
Day 3
12 Hours On
Day 2
12 Hours Off
Day 4
24 Hours On
Water Column
High PP Biomass
Low PP Biomass
Sediment
flux magnitude ???
To Water-Column
Into Sediment
anaerobic
aerobic

Questions?


Sea Grant
Maryland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