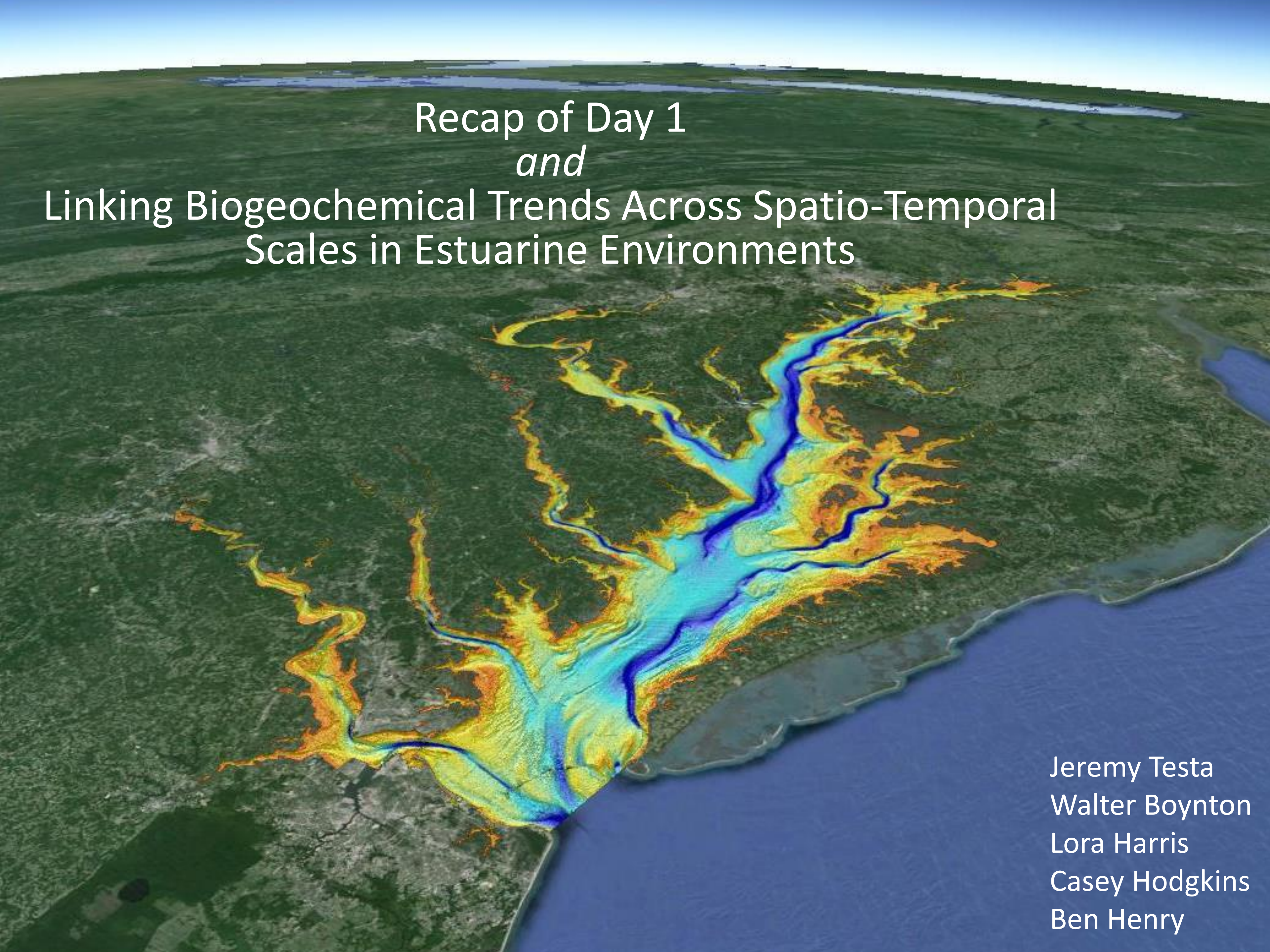
Recap of Day 1
and
Linking Biogeochemical Trends Across Spatio-Temporal Scales in Estuarine Environments



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Casey Hodgkins
Ben Henry

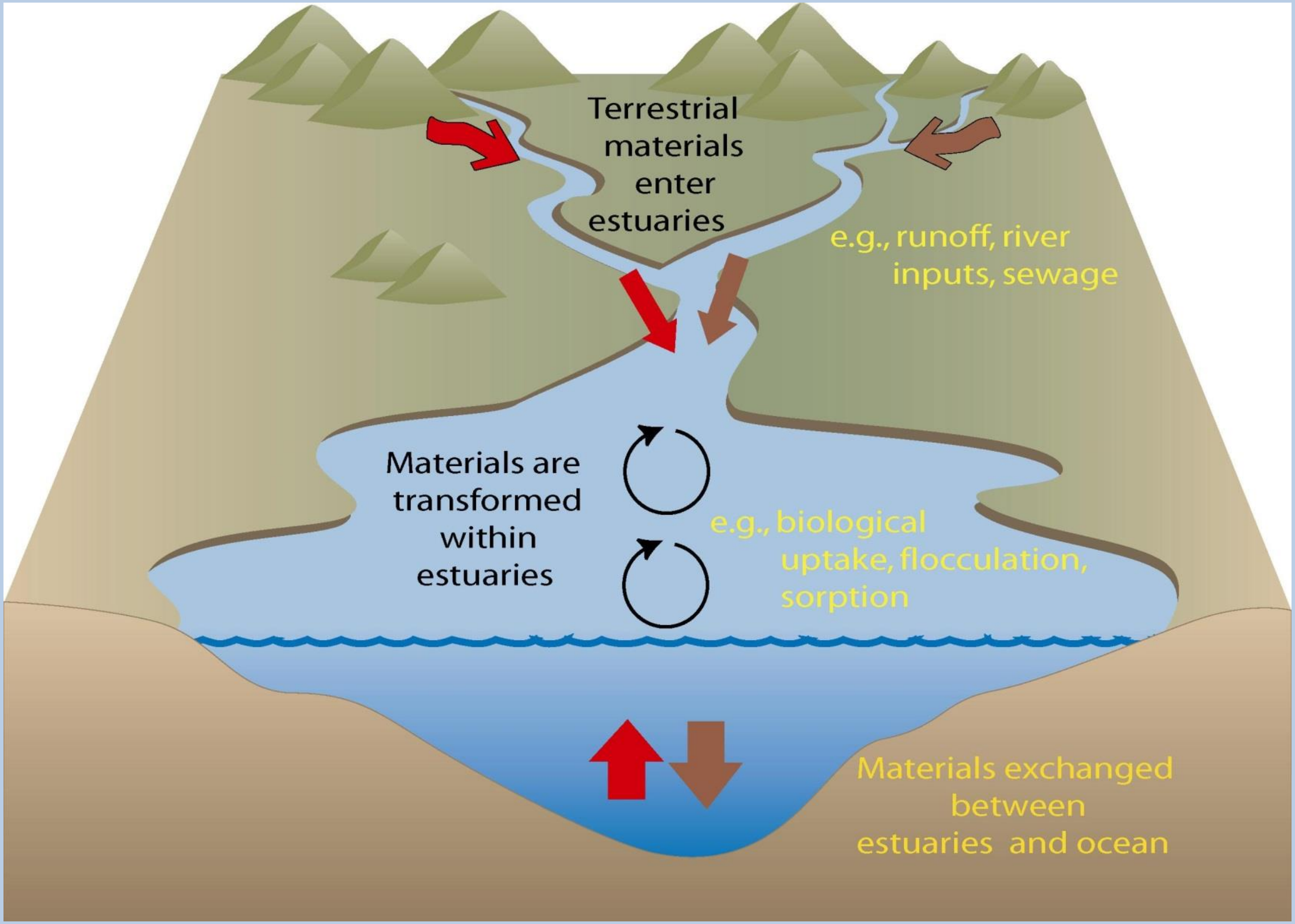
Key Questions/Objectives

- Does management focused on triblets provide new opportunities to meet CBP goals?
- Do Triblets have an outsized influence on CB?
- Do triblets behave like larger regions of CB and do they have unique problems?

Why We Emphasize Triblets?
(from yesterday)

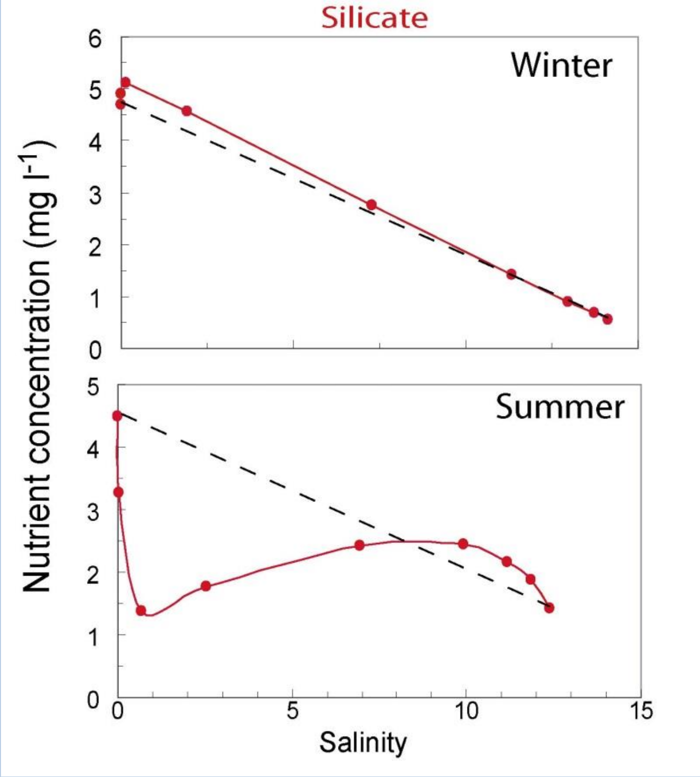
- This is the scale at which BMPs implemented, i.e., triblet knowledge will guide BMP planning
- Assess water quality where people live (and in the waters they adore)
- Understand reactor function of triblets – are they *Reactors* or *Pipes*?

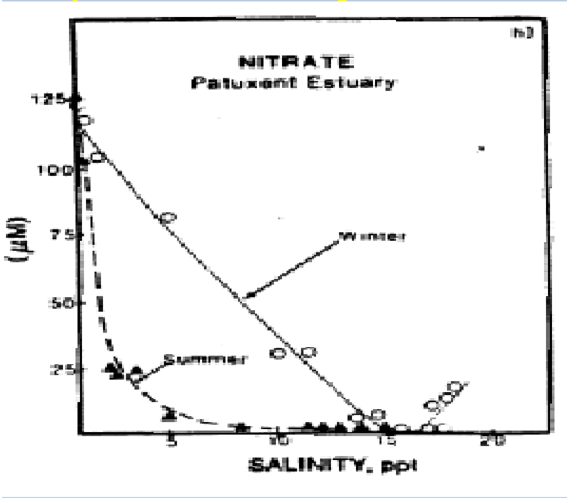
We are Here (*I think*) Because *We* Think They are Reactors



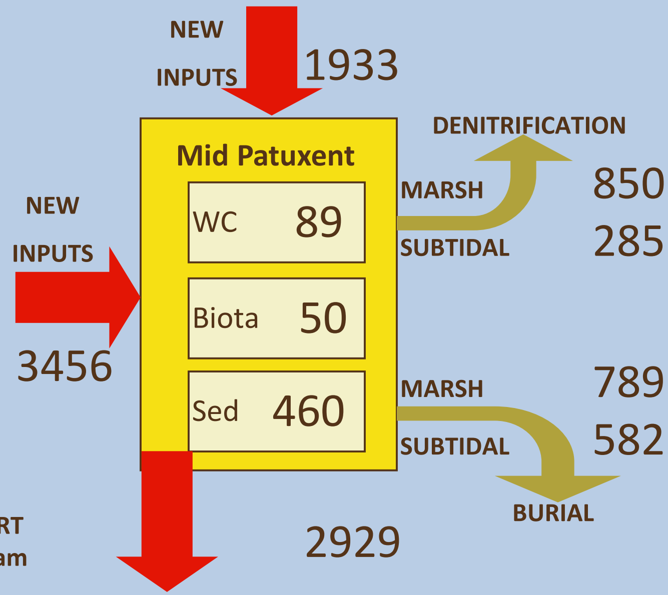
Reactors

Pipe
Net consumption
(reactor)
Net production
(reactor)
Non-conservative material
Salinity


Silicate
Winter
Summer
Nutrient concentration (mg l-1)
Salinity
0
5
10
15


NITRATE
Patuxent Estuary
Winter
Summer
(µM)
SALINITY, ppt

Total nitrogen inputs, transport, stocks and losses in the Patuxent estuary



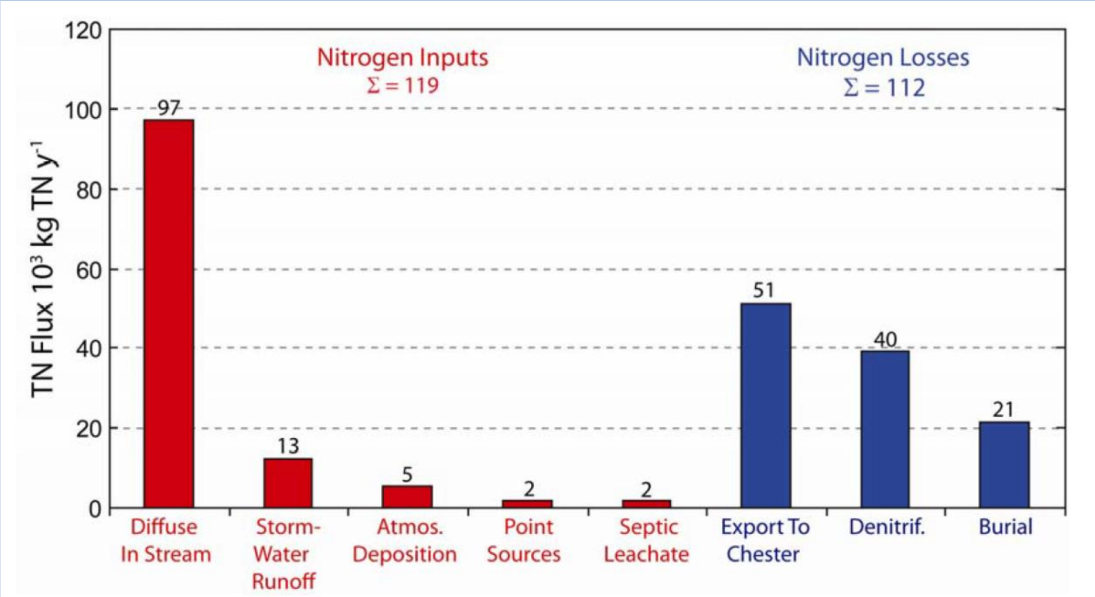
Mid Patuxent

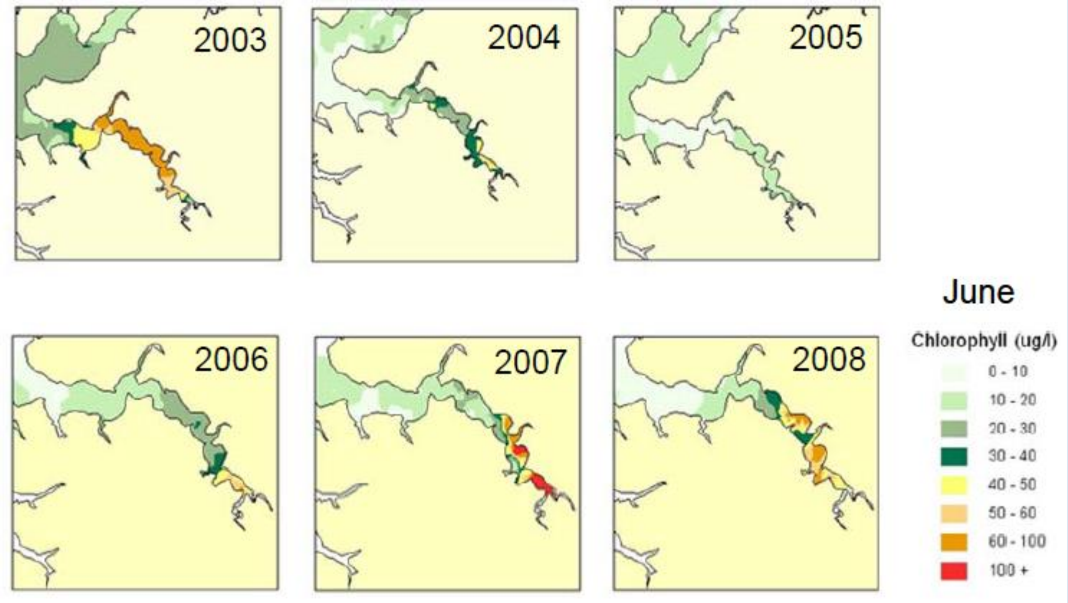
Inputs	+5389
Denitrification	-1135
Burial	-1371
Export	-2929
Net	46

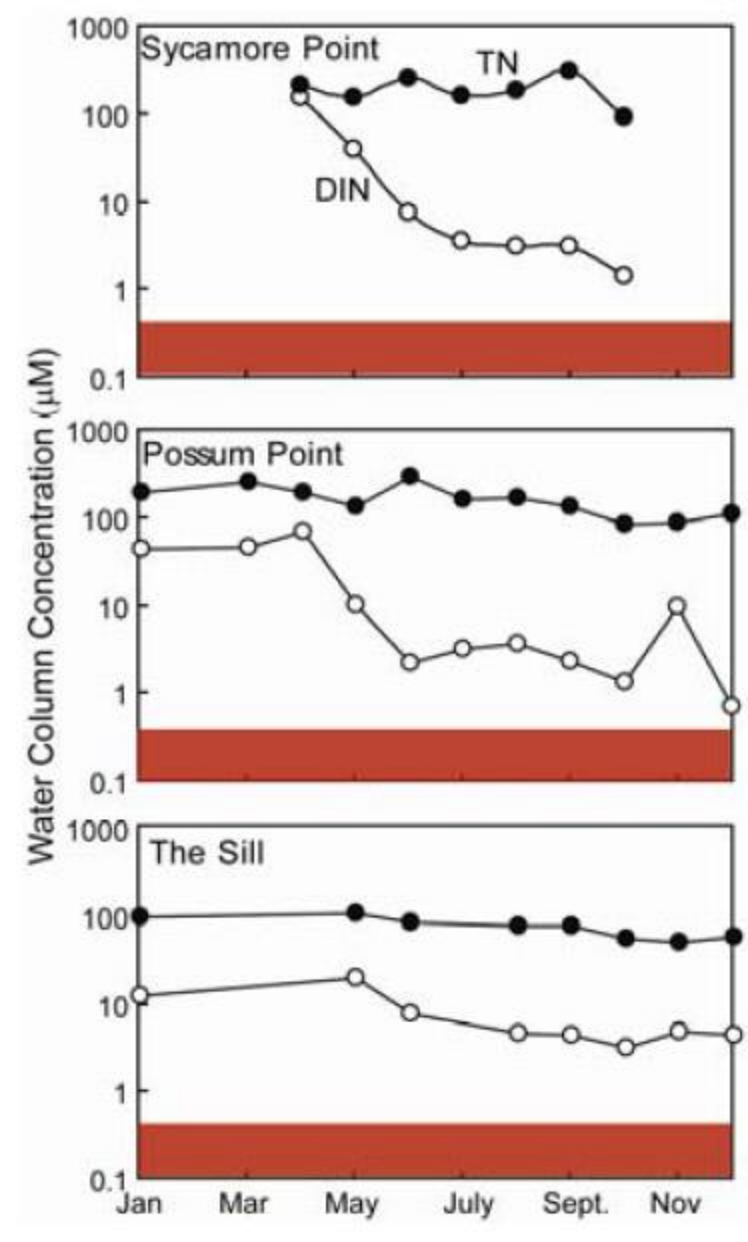
Flows kg N day^{-1}
Stocks kg x10^{3} N

Boynton et al. 2008

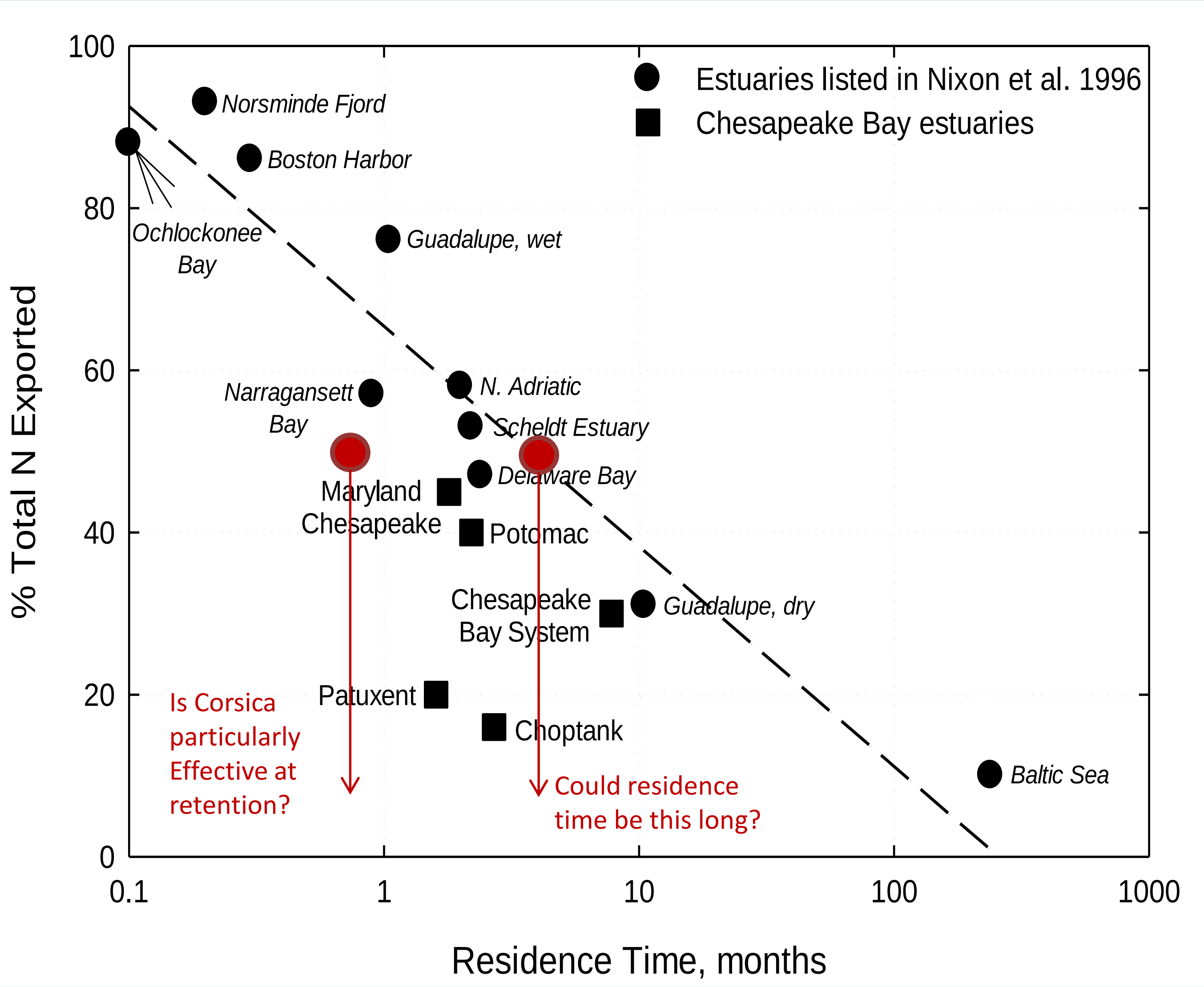
Corsica River: an example reactor







Residence Time is a Key Determinant of “Reactor” Role



Nixon et al., 1996

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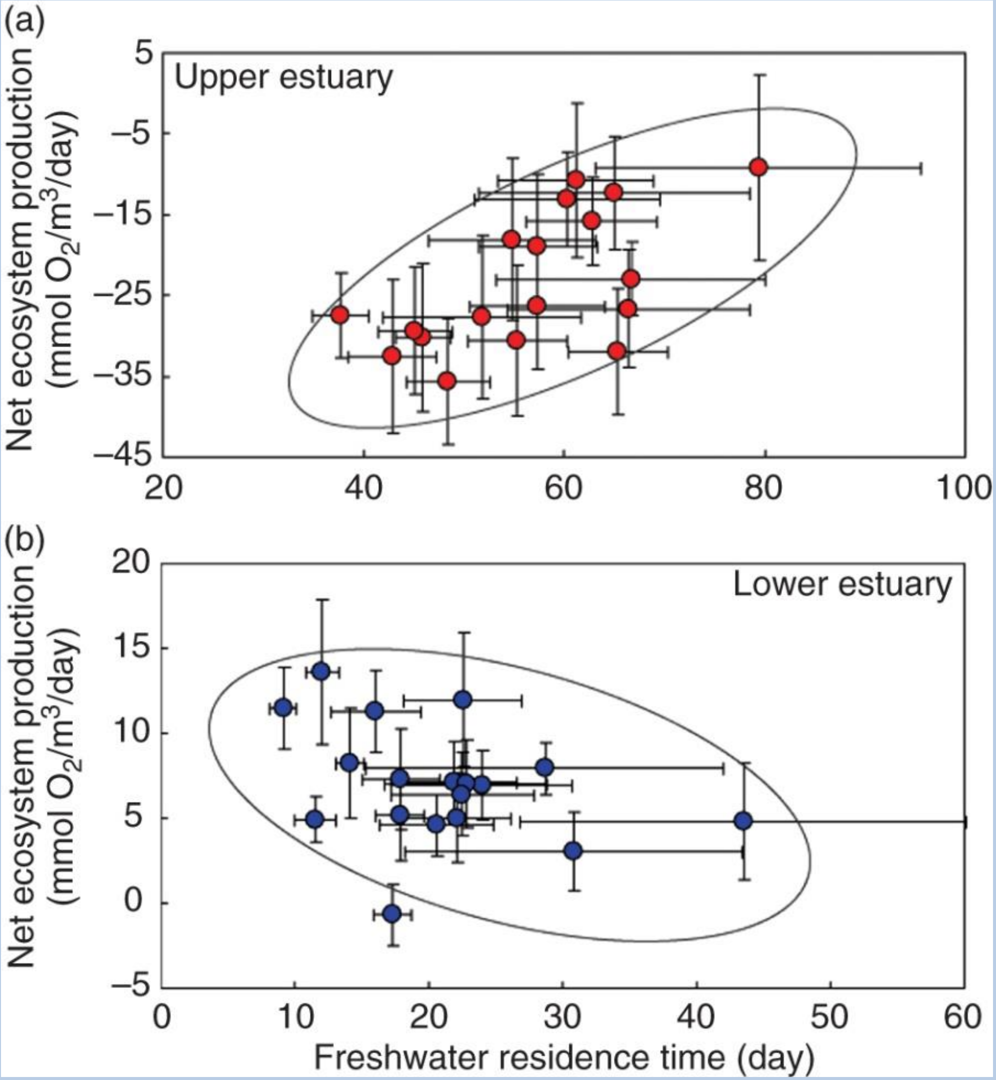


Testa et al. 2012

BUT

If these ecosystems are very retentive,
they are ALSO: ……….probably

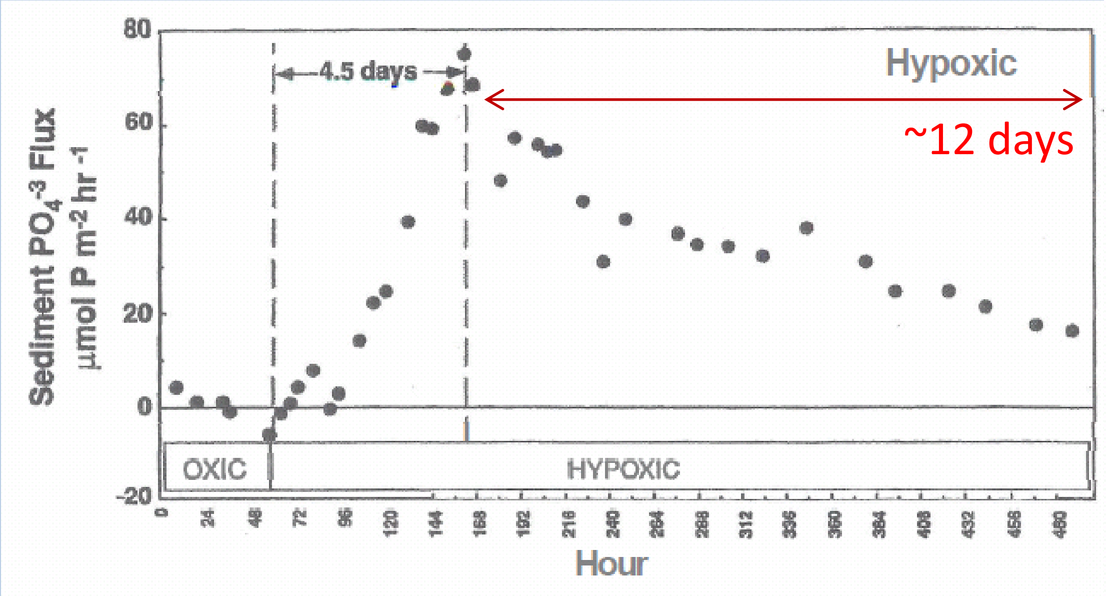
(1) Highly sensitive to eutrophication/degradation

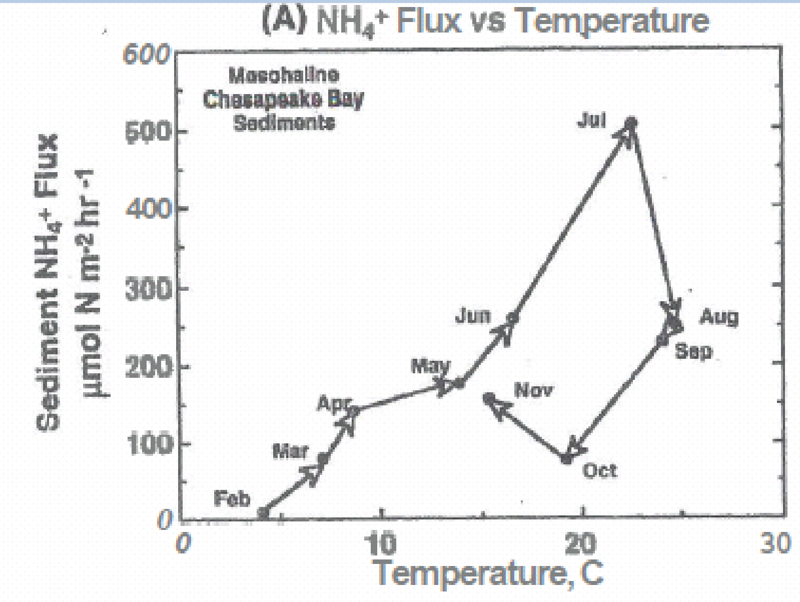
Recall from yesterday:

- hypoxia in Severn, Church creek, Corsica, Rock Creek………
- bacterial pollution
- degradation with land-use change

(2) Likely to store nutrients in sediments = legacy?

Limited Sediment Legacy in Mesohaline Sediments



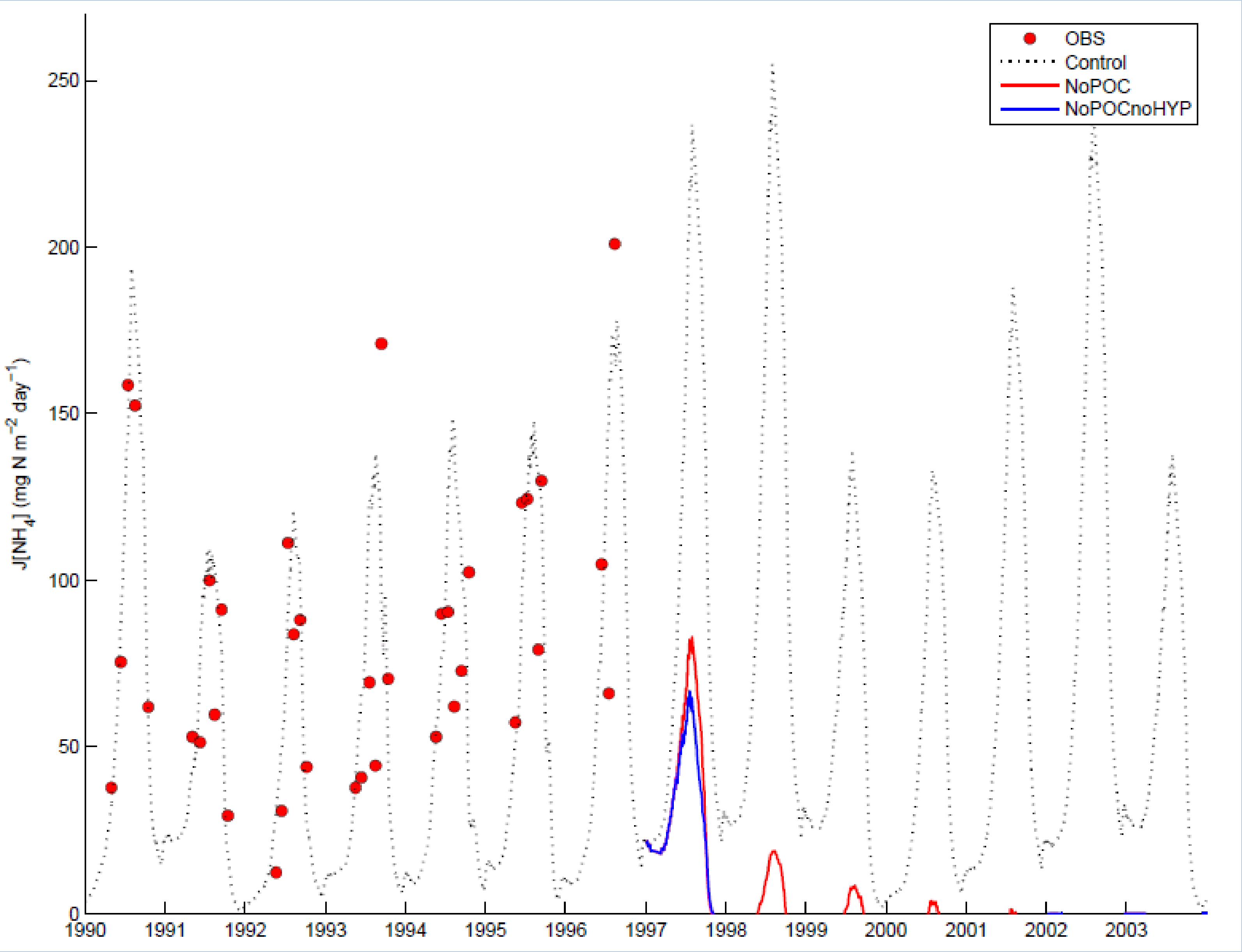


Despite hypoxia, PO4 fluxes decline after 5 days

By late summer, NH4 flux declines

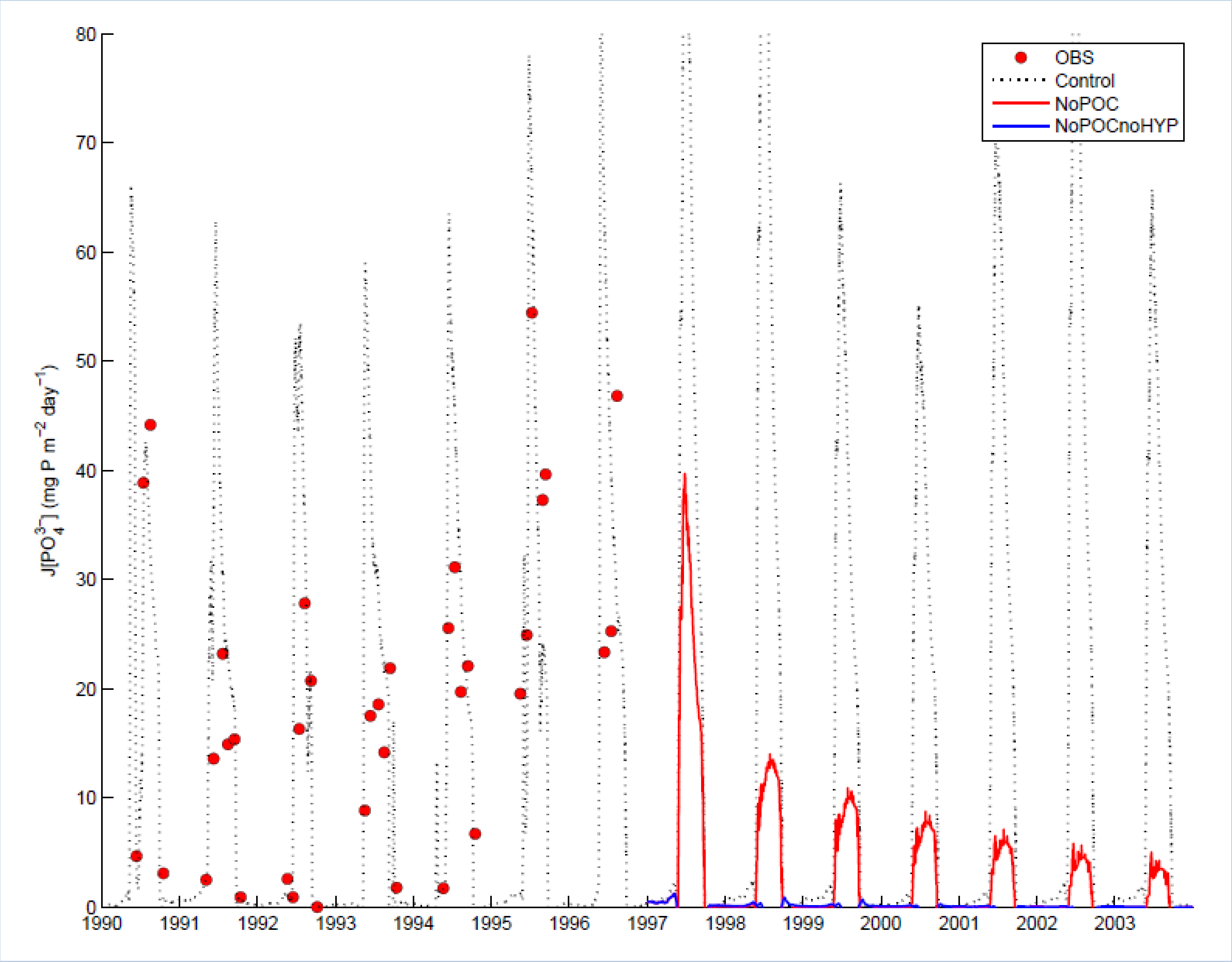
Boynton 2000

Modeling Sediment Legacy



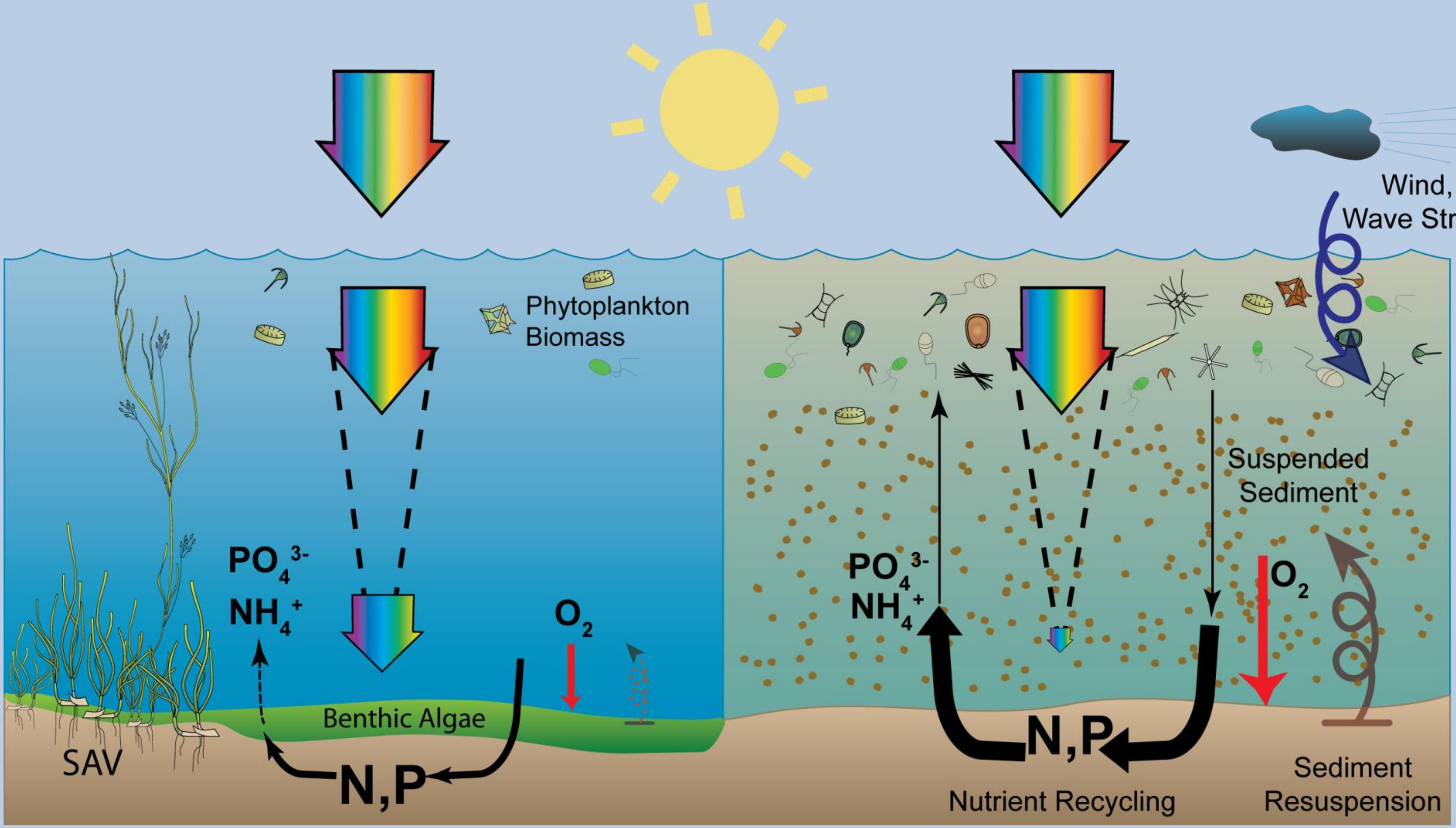
Testa, unpublished

Modeling Sediment Legacy

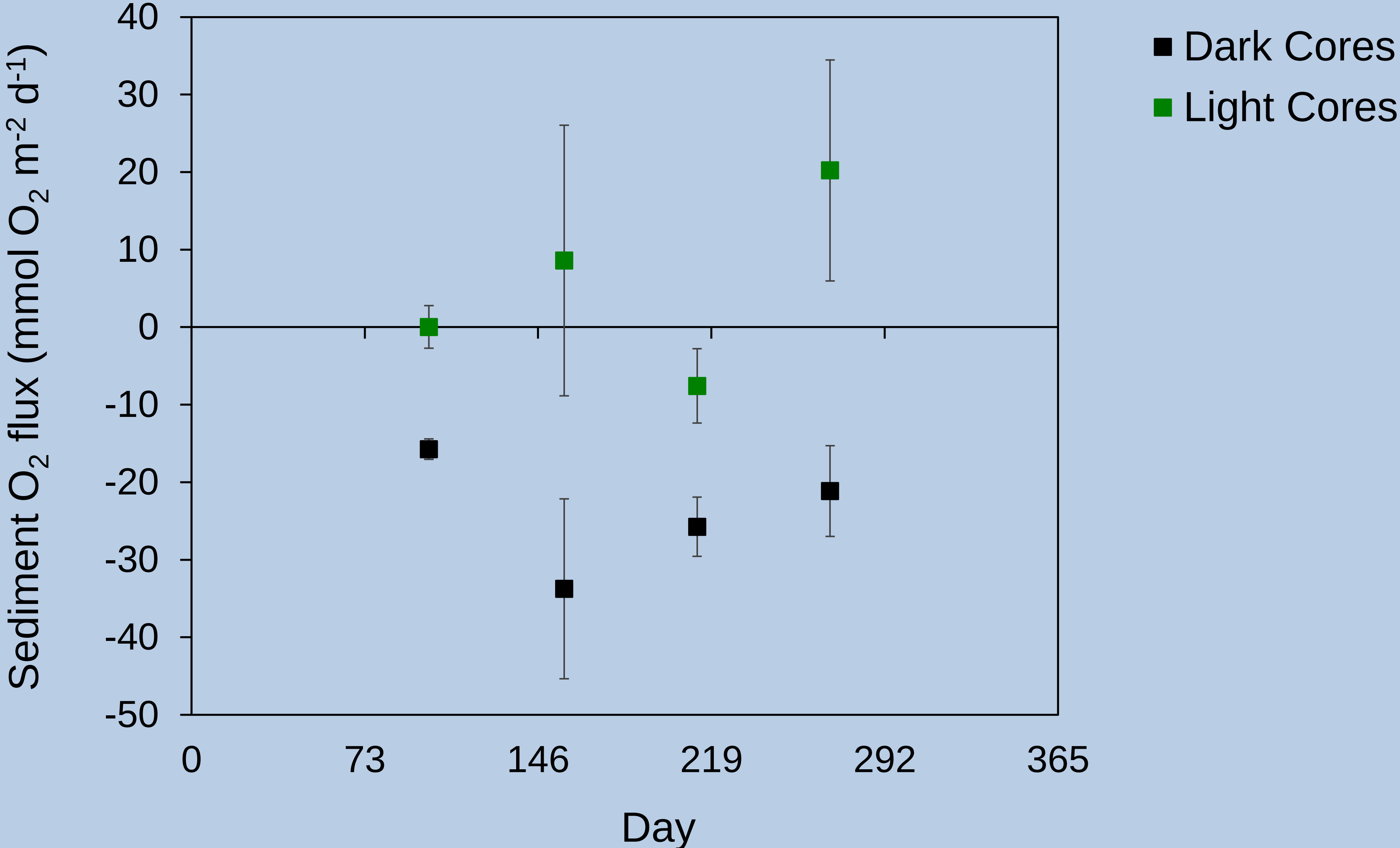


Testa, unpublished

In Shallow Water Systems (triblets), Light is Key Mediator of Nutrient Transformation

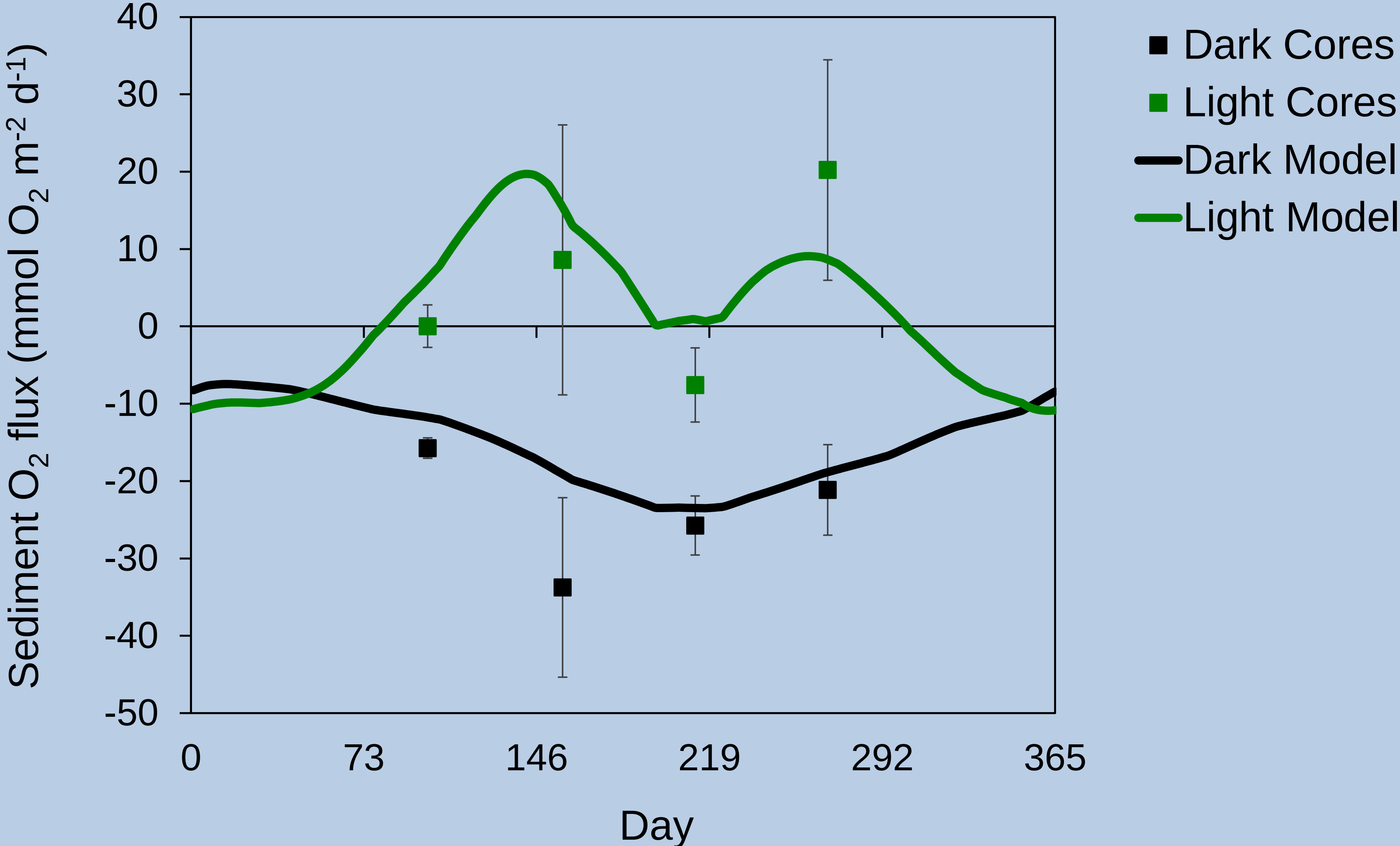


Microphytobenthos produce O_2 and counteract hypoxia



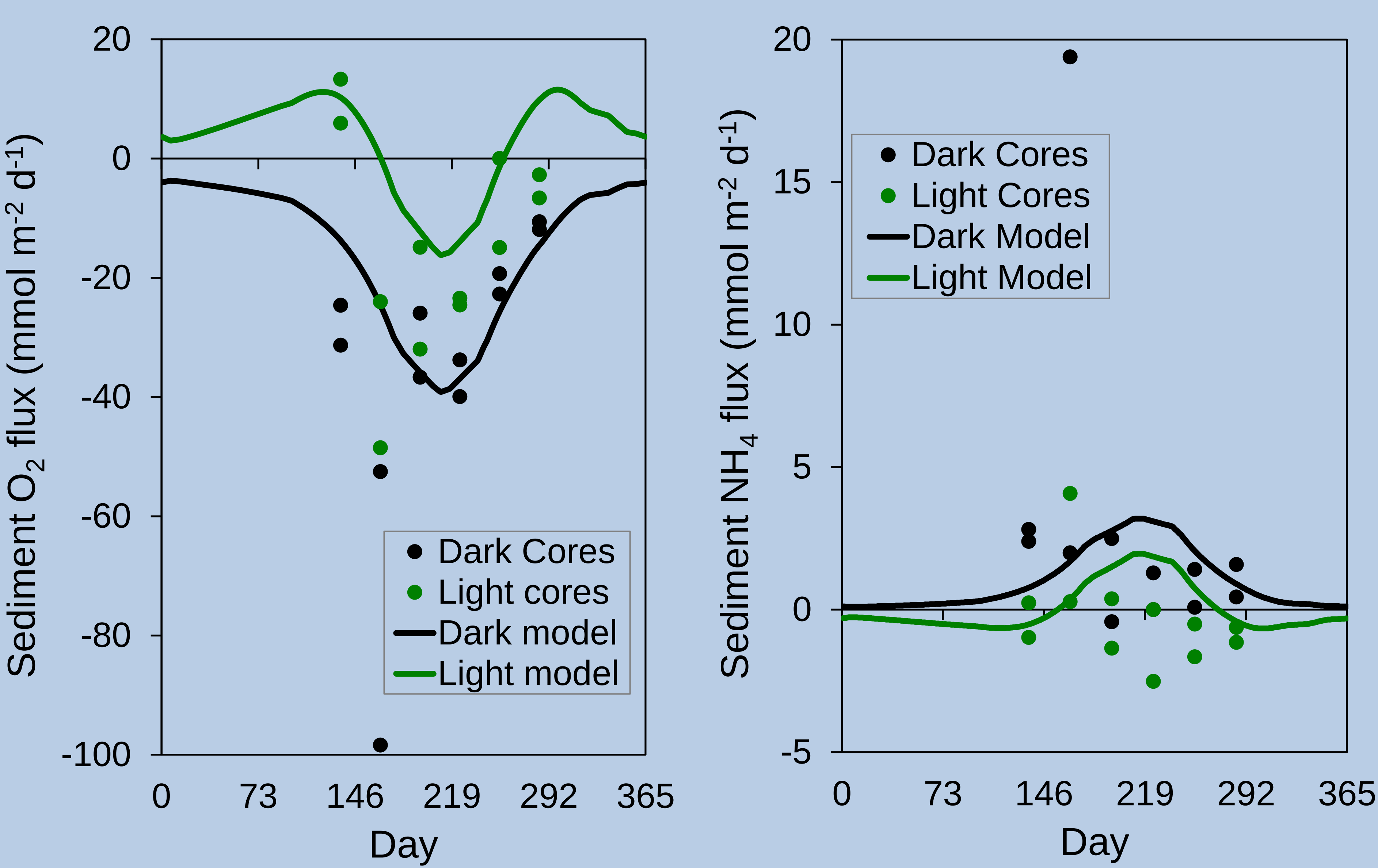
Field data from Choptank River,
courtesy of Cornwell and Owens

Microphytobenthos produce O_2 and counteract hypoxia

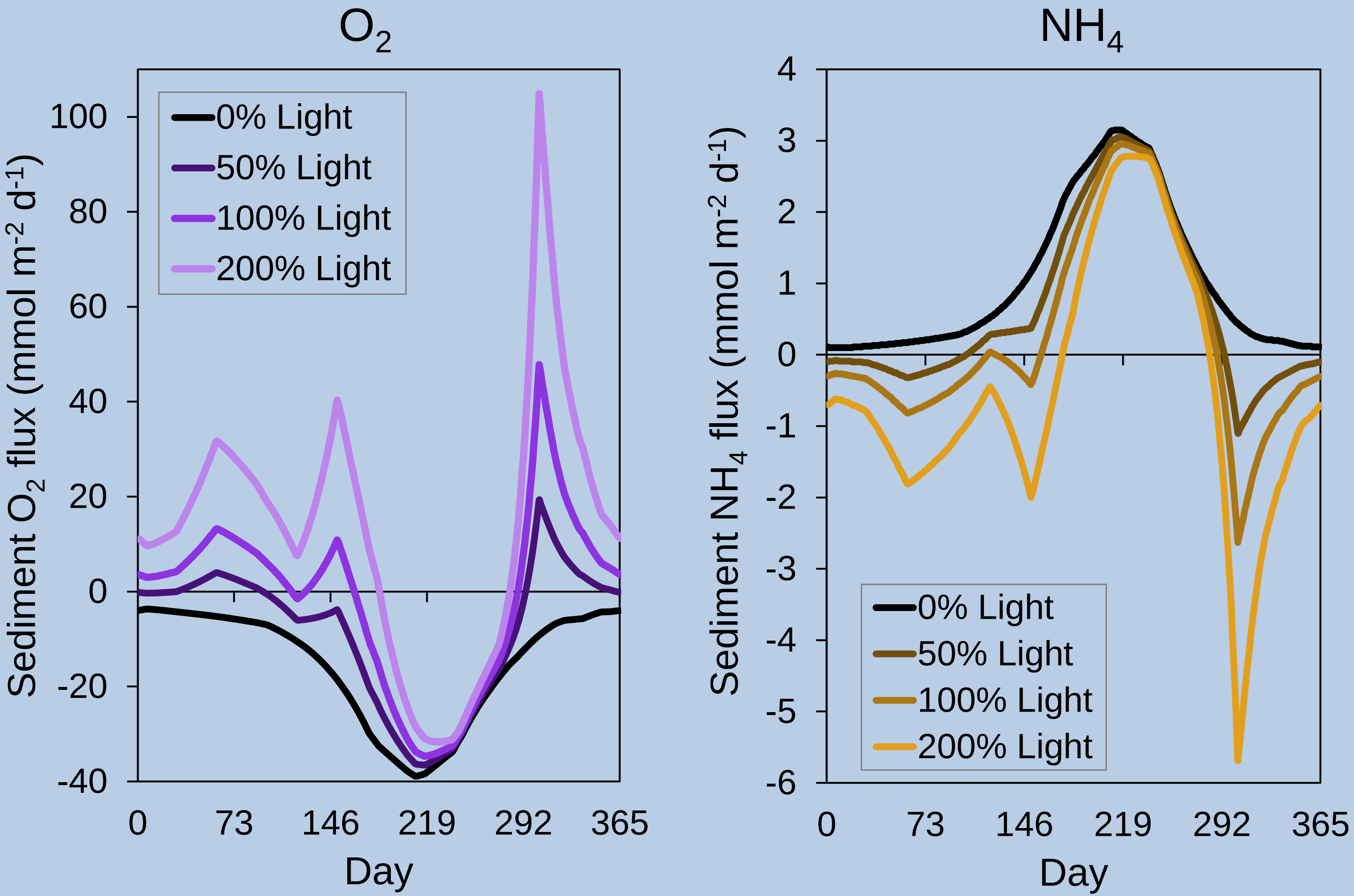


Field data from Choptank River, courtesy of Cornwell and Owens

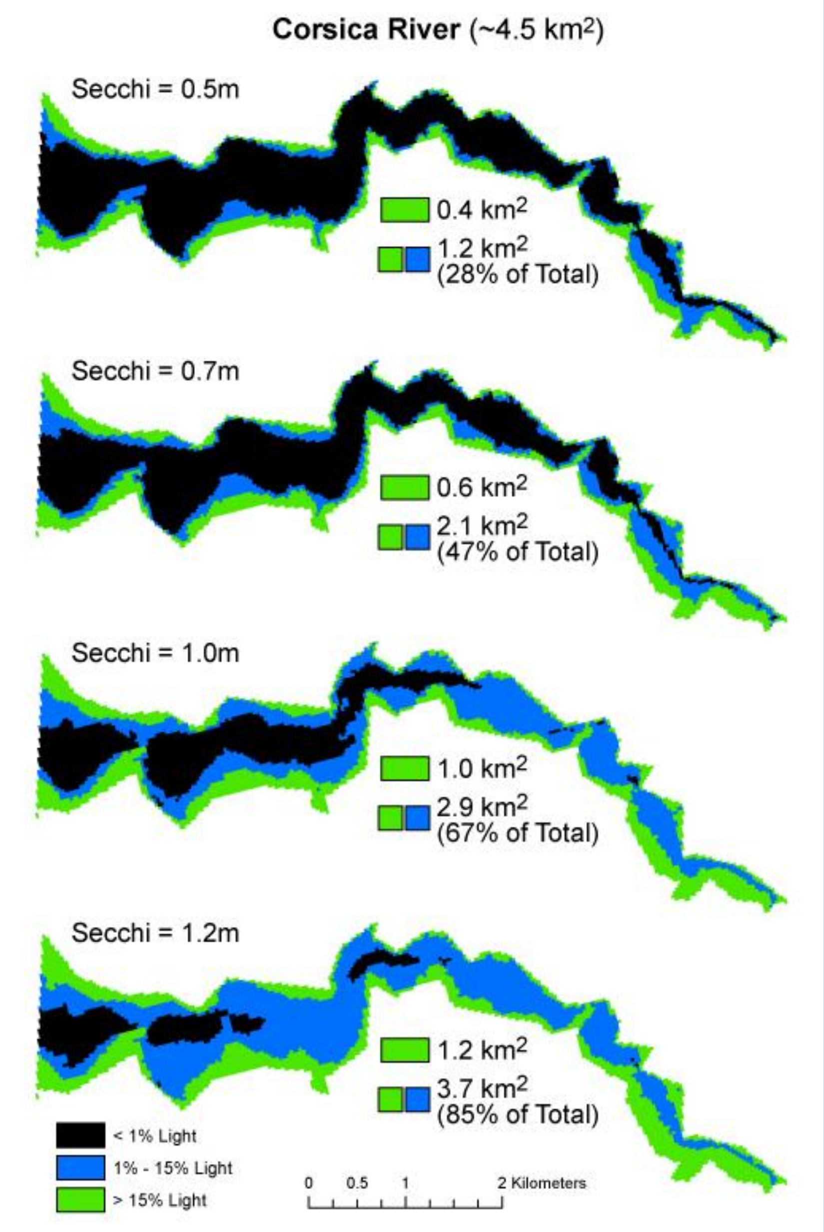
Sediment O_2 and NH_4 Flux in Corsica River

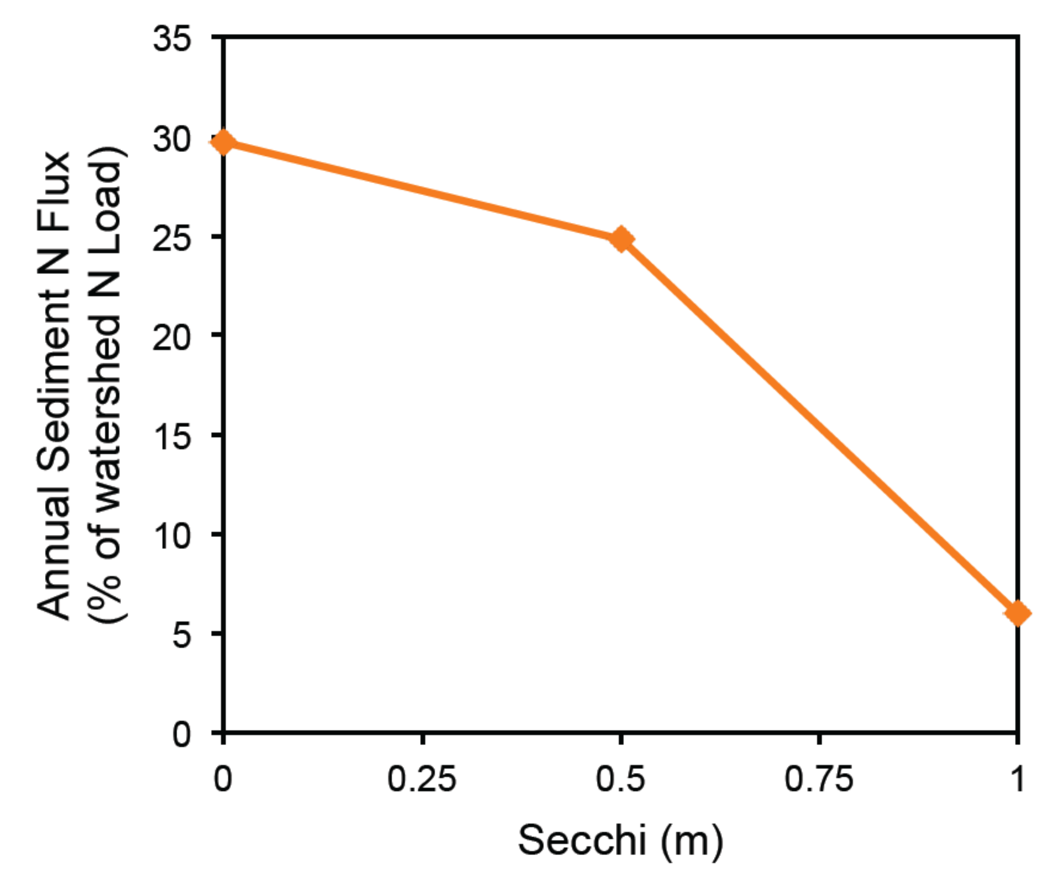


Illumination Alters O_2 and NH_4 Flux in Spring/Fall

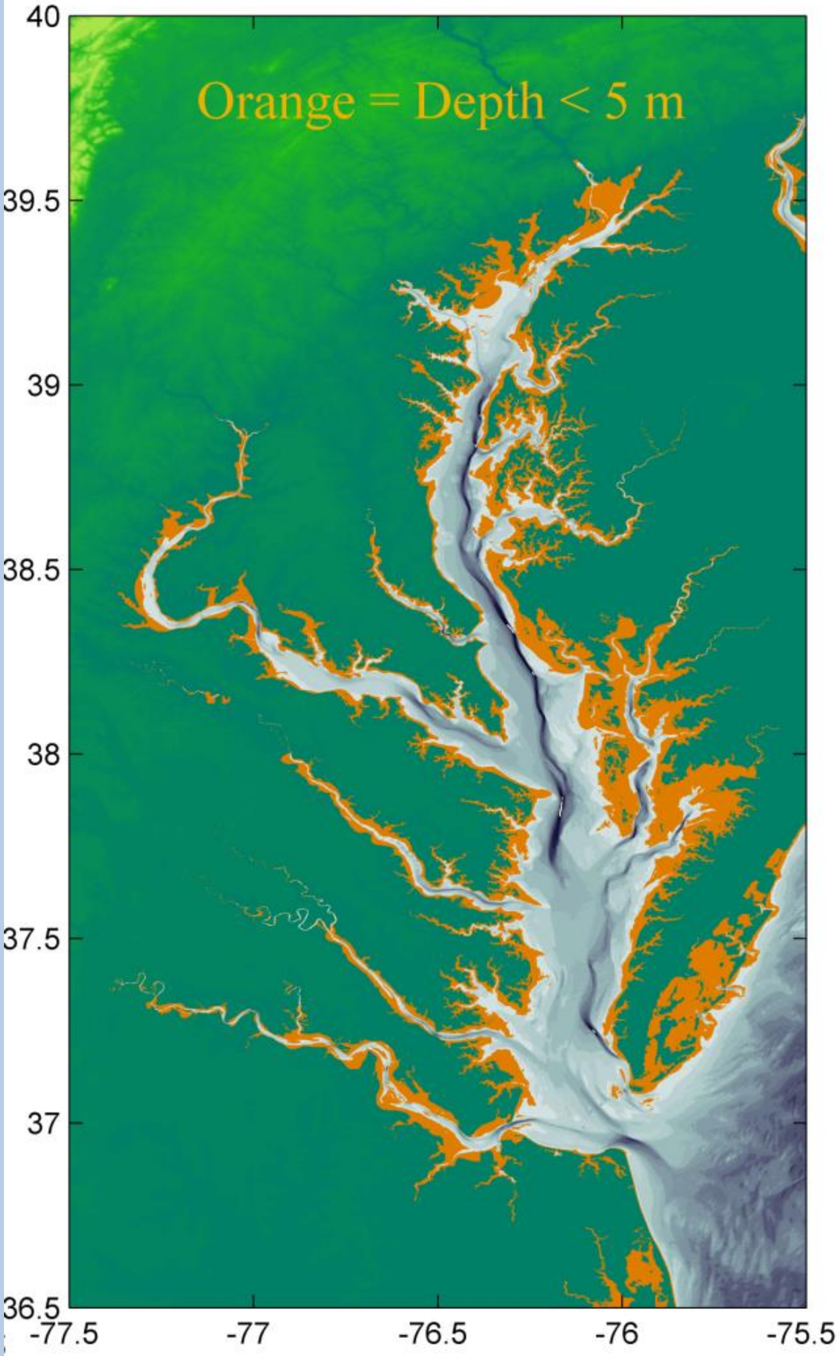


Potential Light Effects on System Scale N Budget

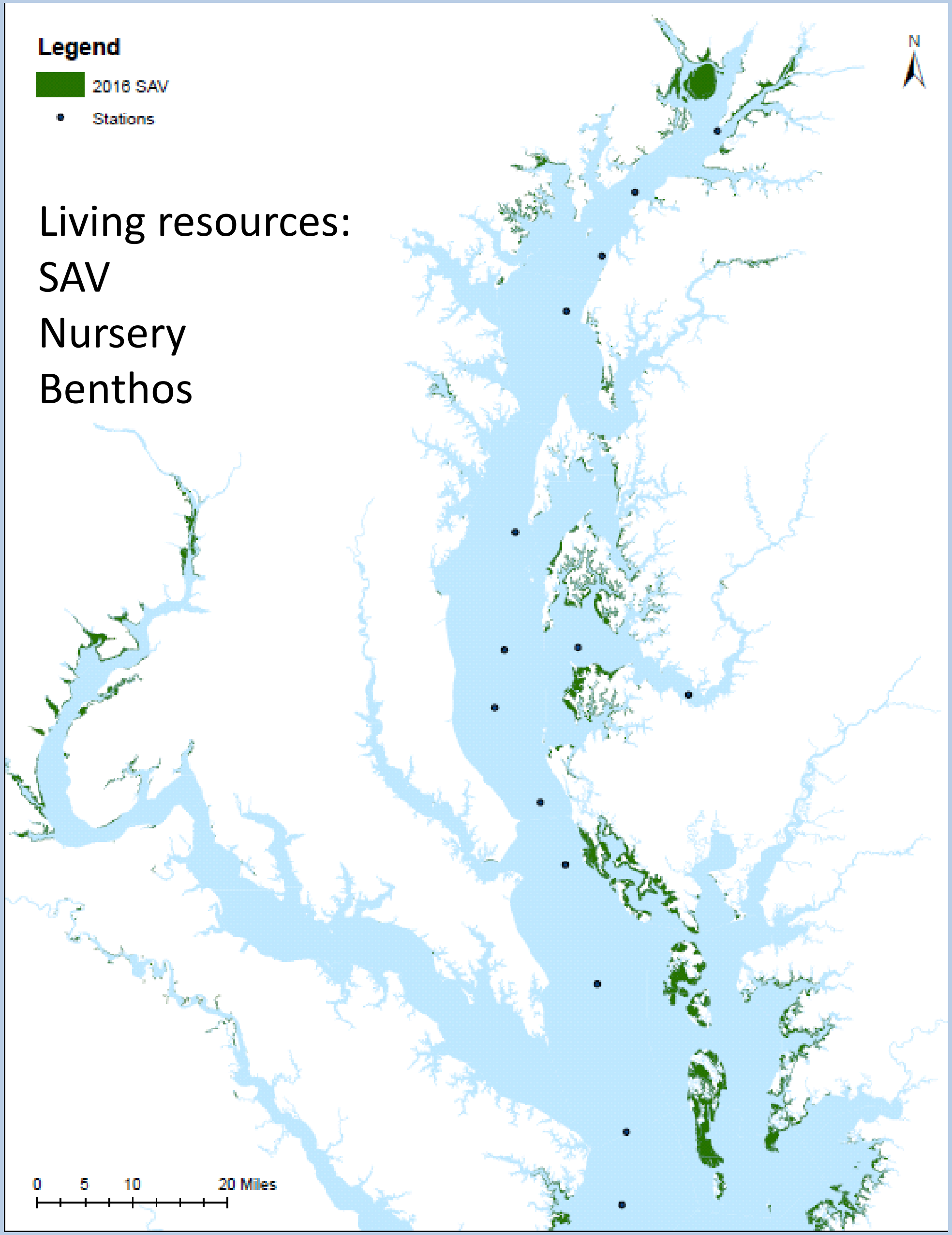




- **Small increase in Secchi (0.5 m → 1.0 m) yields large increase in photic bottom (1% surface light) from 28 → 85%**
- **Need to better understand these non-linear dynamics**



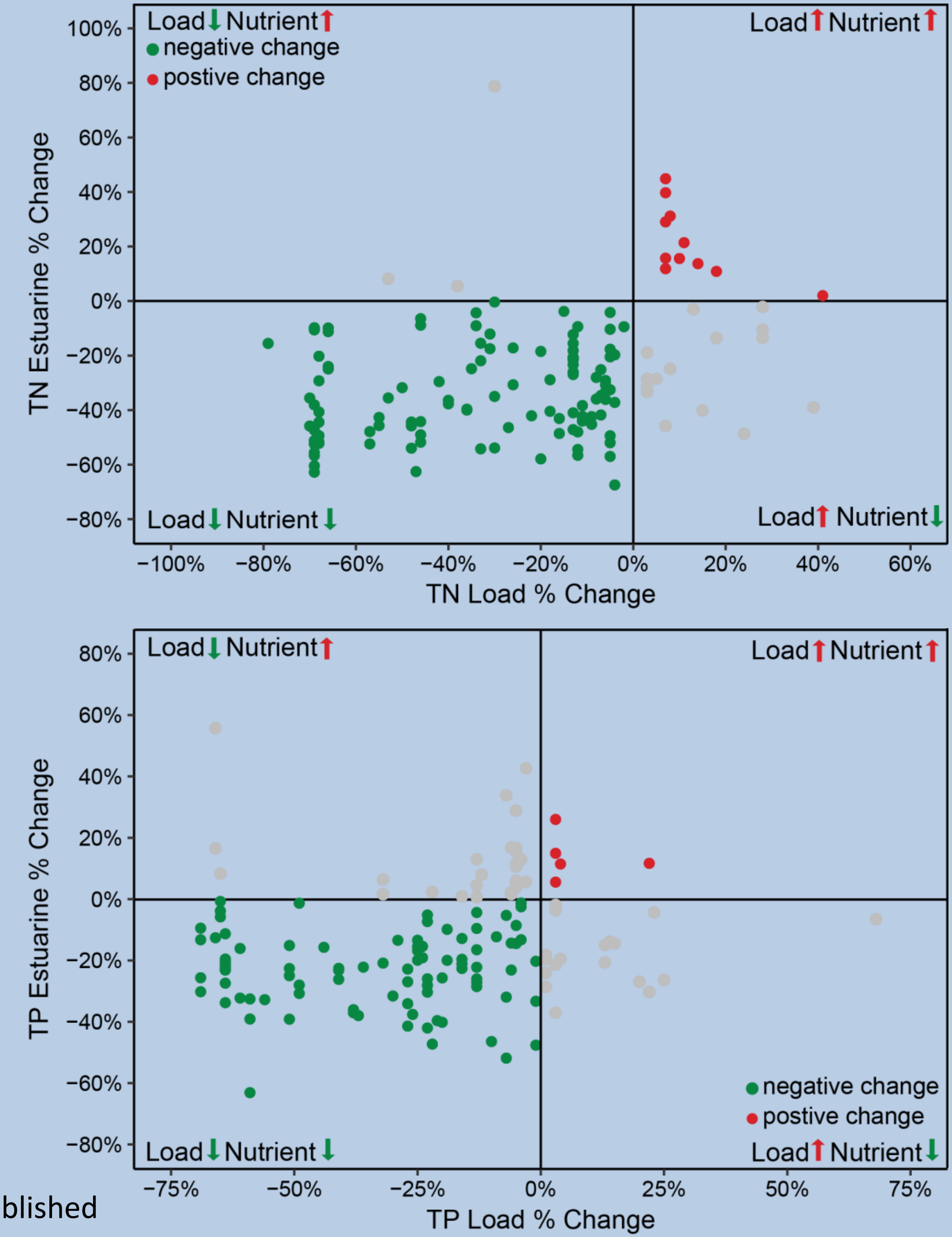
Shallow Triblets Abound



Living resources:
SAV
Nursery
Benthos

Load Declines Generally Correspond to Concentration Declines Across all Bay Segments

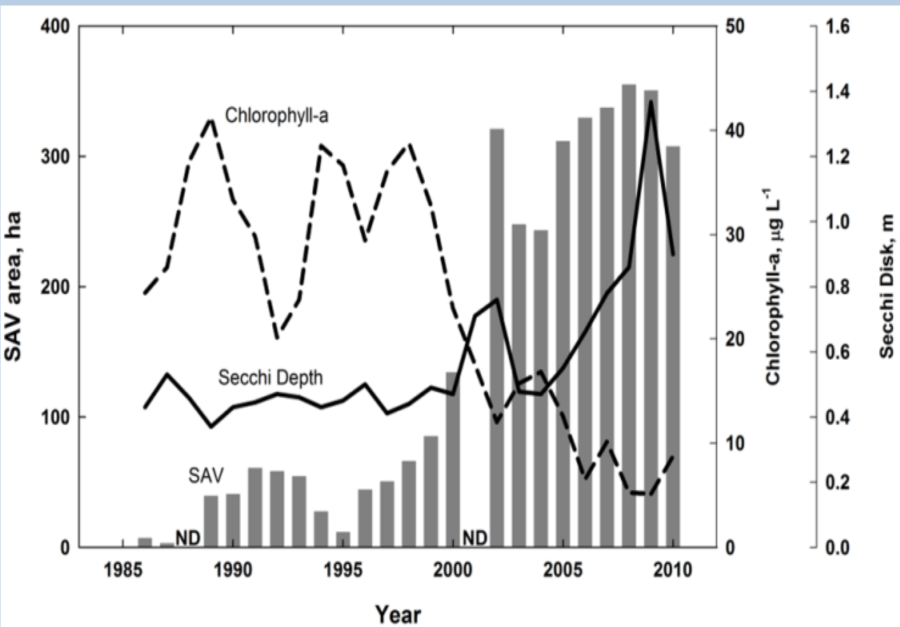
- Predominance of load and concentration declines for TN and TP (79% and 62% of all sites for TN and TP, respectively)
- Not all improvements significant
- Some sites exhibited load and concentration increases (8% and 4% for TN and TP)
- 13% (TN) and 34% (TP) of sites showed unexpected patterns



Testa et al., unpublished

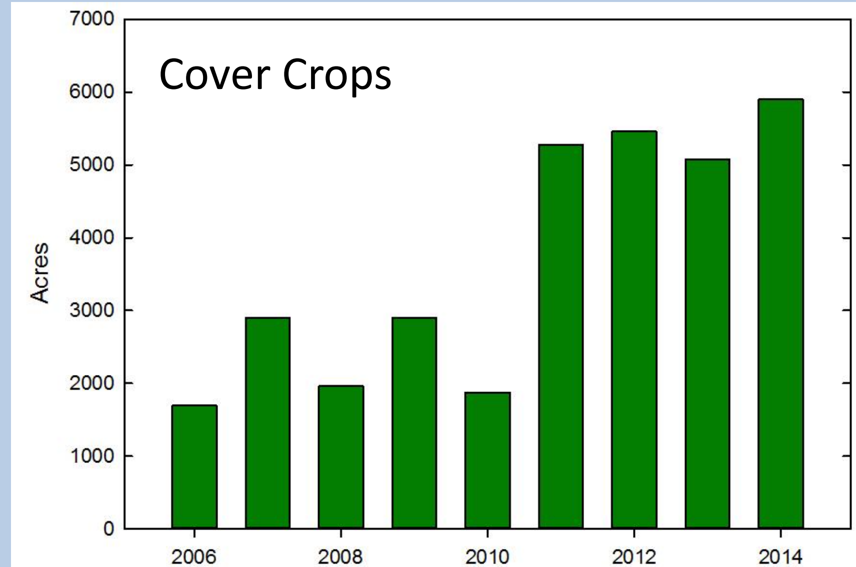
Triblets Respond To Load Reductions, Some more than others

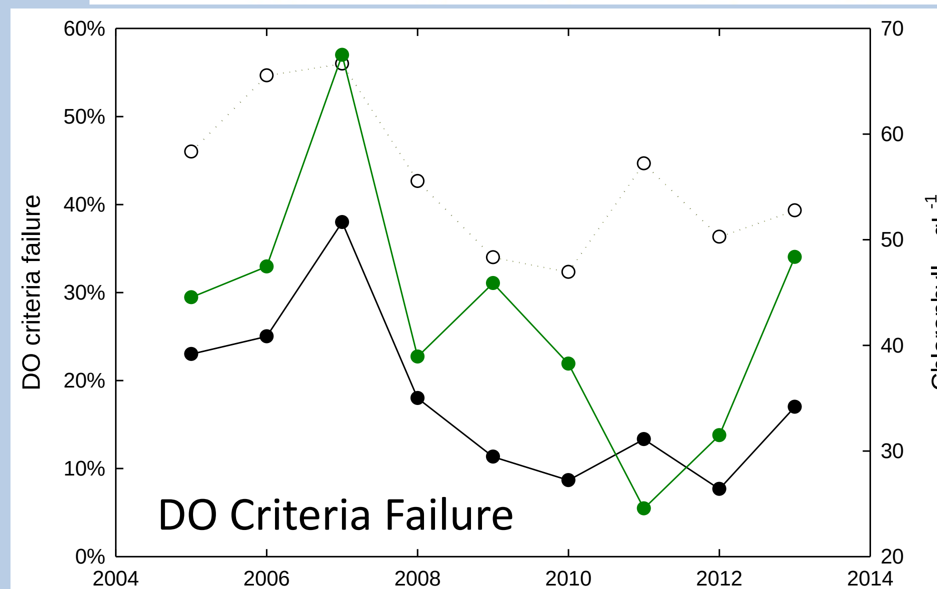
Mattawoman Creek
Large Load Reduction



Boynton et al. 2014

Corsica River, Limited Change





Testa et al. 2016

Some Useful Activities?

(1) Quantitative Framework to Analyze Triblets/subestuaries
(2) Identify potential new research avenues
(3) Identify what we do and don't know about triblets

-What characteristics of subestuaries are most important?
-We need data to assess biophysical setting
-New tools are available (e.g., models), plenty of data to synthesize

Table 4-2. Summary of physical characteristics of the Chesapeake Bay tributaries included in the modeling analysis.

Estuary	Basin Area $m^2 x10^6$	Estuary Volume $m^3 x10^6$	Estuary Surface Area $m^2 x10^6$	Basin Area: Estuary Area	Basin Area: Estuary Volume	Estuary Average Depth m	Estuary Maximum Depth m	max depth: avg depth	Estuary Mouth Length m	Smooth Shoreline Length m	Smooth Shoreline: Mouth	Shoreline Length m	Shoreline: Mouth
Middle	33	33	9	4	1	2	3	2	1315	37601	29	69108	53
WestRhode	66	29	15	5	2	2	4	2	4243	34110	8	77063	18
Magothy	94	64	19	5	1	3	10	3	851	30651	36	83684	98
Corsica	97	10	4	22	10	2	5	3	1501	22458	15	37532	25
Bohemia	131	15	10	13	9	2	7	5	1783	35793	20	56087	31
Back	144	25	16	9	6	2	8	5	1443	32878	23	45988	32
South	148	57	19	8	3	3	9	3	2936	48513	17	102875	35
Piscataway	176	3	3	53	67	1	2	3	1199	10963	9	10826	9
Severn	177	109	25	7	2	4	17	4	3319	49876	15	124283	37
Northeast	184	24	15	13	8	2	7	4	2294	20503	9	24316	11
Sassafras	217	82	30	7	3	3	17	6	5541	51045	9	127704	23
Mattawoman	245	9	6	39	27	1	8	6	1607	29572	18	34014	21
Bush	336	48	28	12	7	2	11	6	2513	46909	19	66885	27
Wicomico	561	52	29	19	11	2	12	7	2757	51021	19	148550	54
Gunpowder	1181	63	38	31	19	2	6	4	3392	50842	15	85809	25
Patapsco	1518	451	92	17	3	5	20	4	8026	97541	12	257208	32
Choptank	1951	1027	272	7	2	4	26	7	6246	176557	28	860716	138
Patuxent	2343	404	93	25	6	4	40	9	1094	140940	129	342262	313
Rappahannock	6918	1560	367	19	4	4	24	6	5899	275006	47	1038361	176