

Have We Reached a New Normal?: Nutrient Cycling and Bloom Dynamics in the Northern Indian River Lagoon

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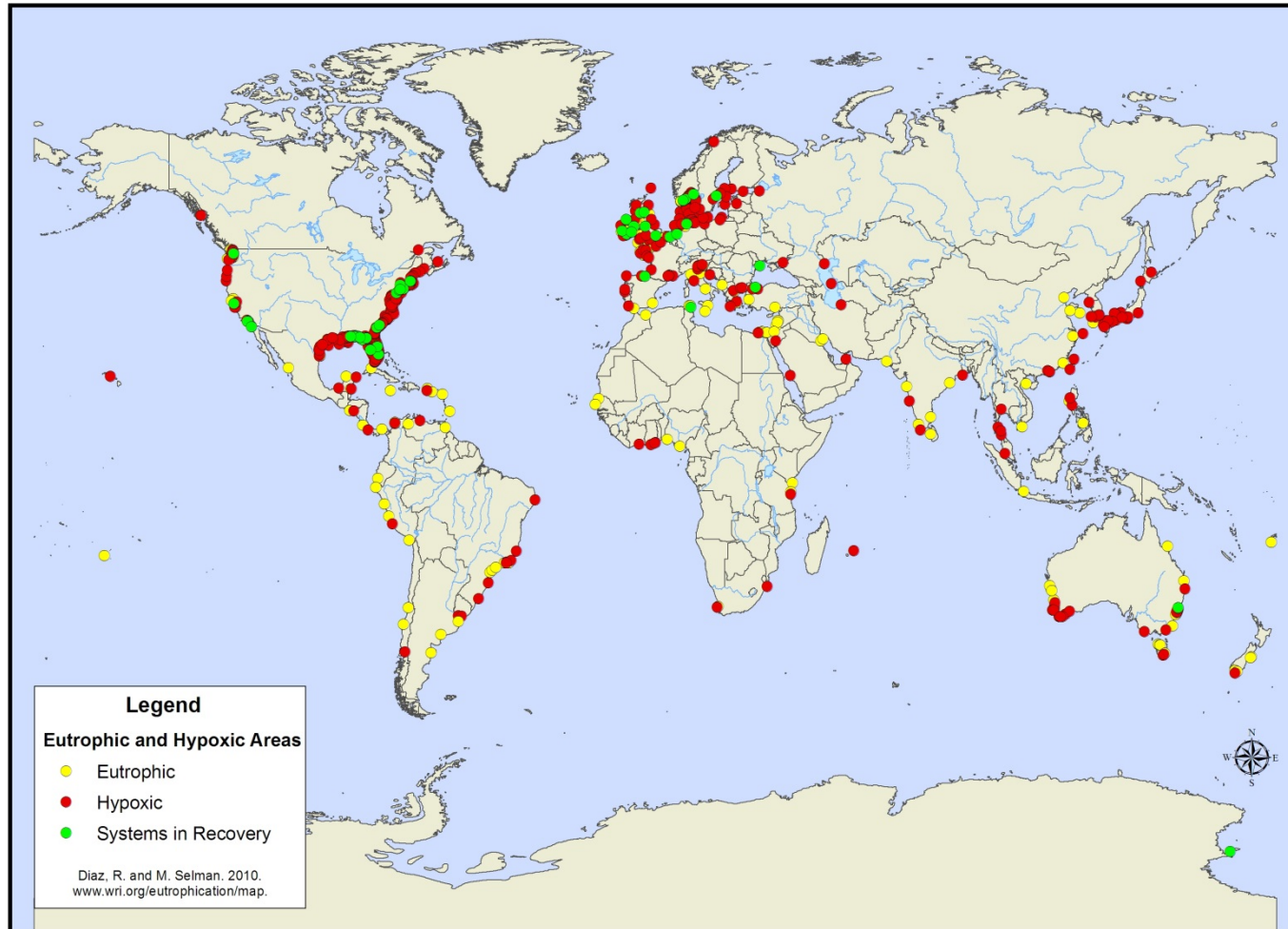
³St. Johns River Water Management District

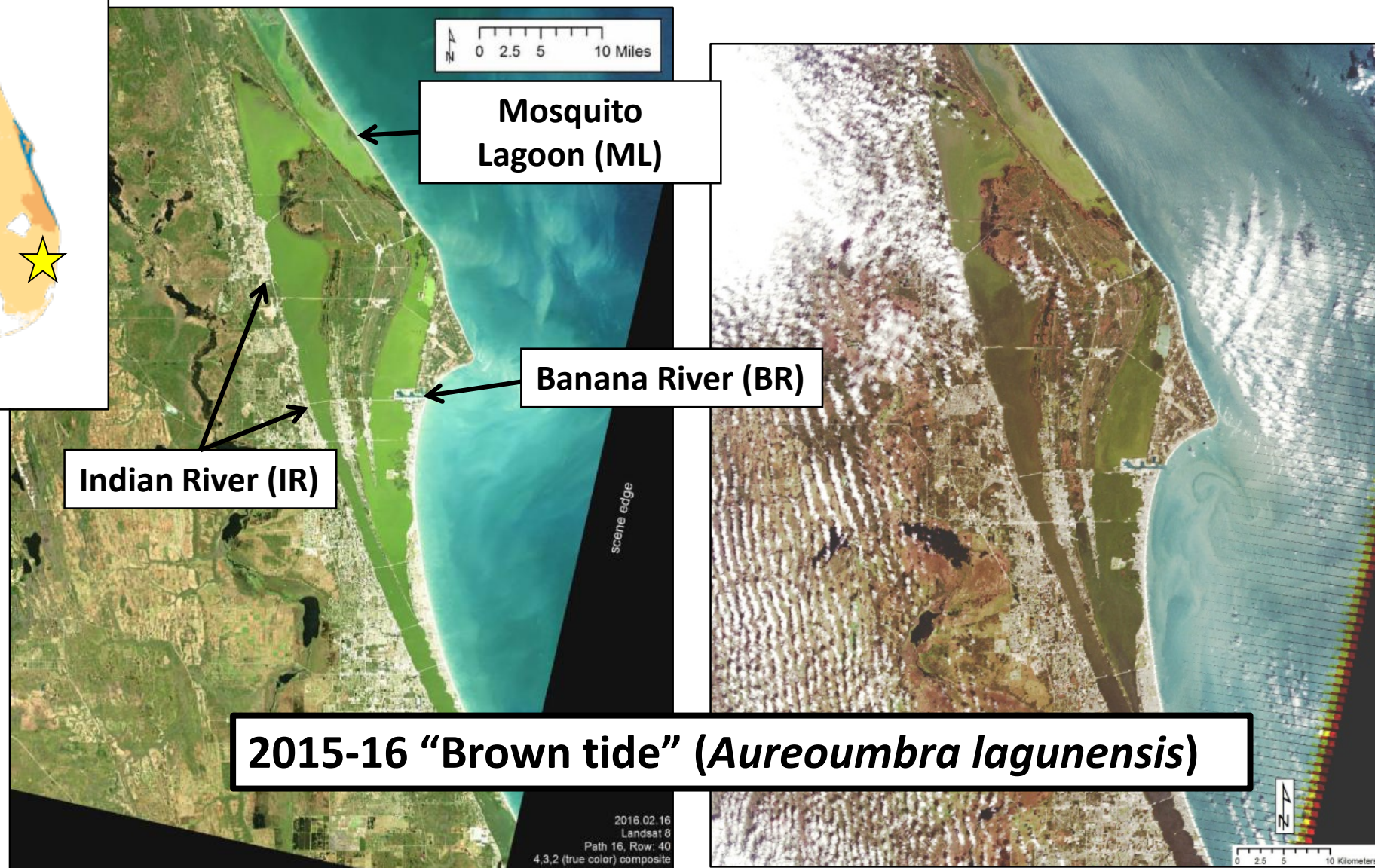
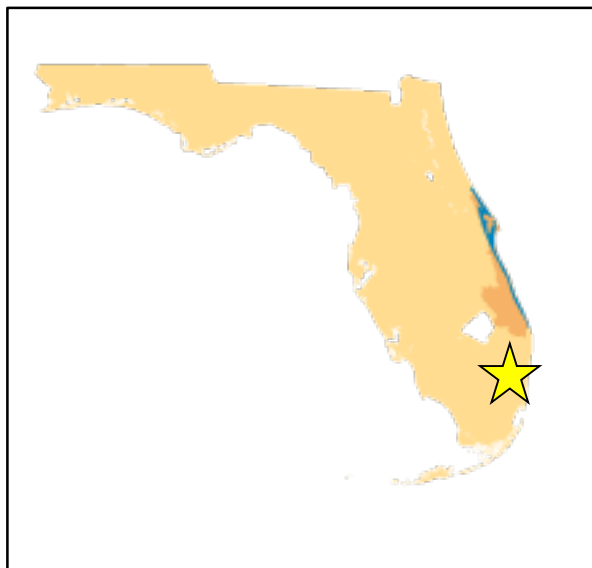


✉ *jrpapacek@ufl.edu  @josh_papacek

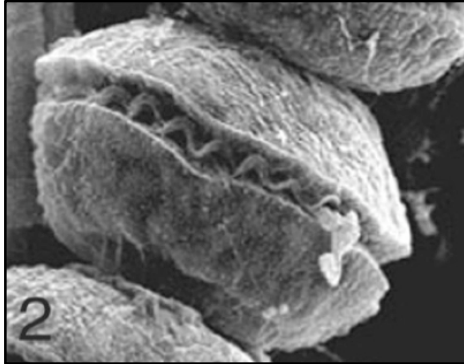
HARMFUL ALGAL BLOOMS (HABs)

World Hypoxic and Eutrophic Coastal Areas

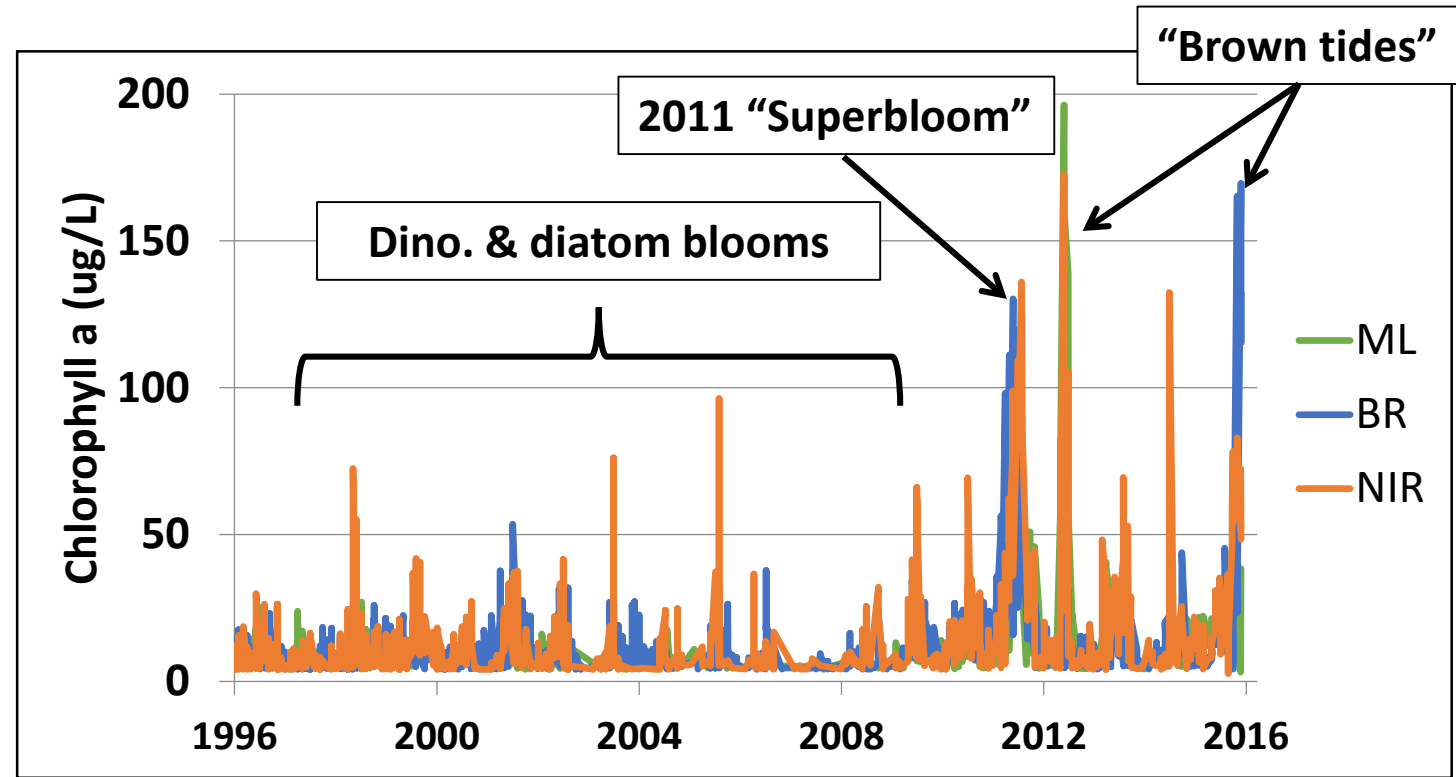




LANDSAT images from Ali Simpson (SJRWMD)



SEM image of
A. monalium
(www.sms.si.edu)



1950

1970

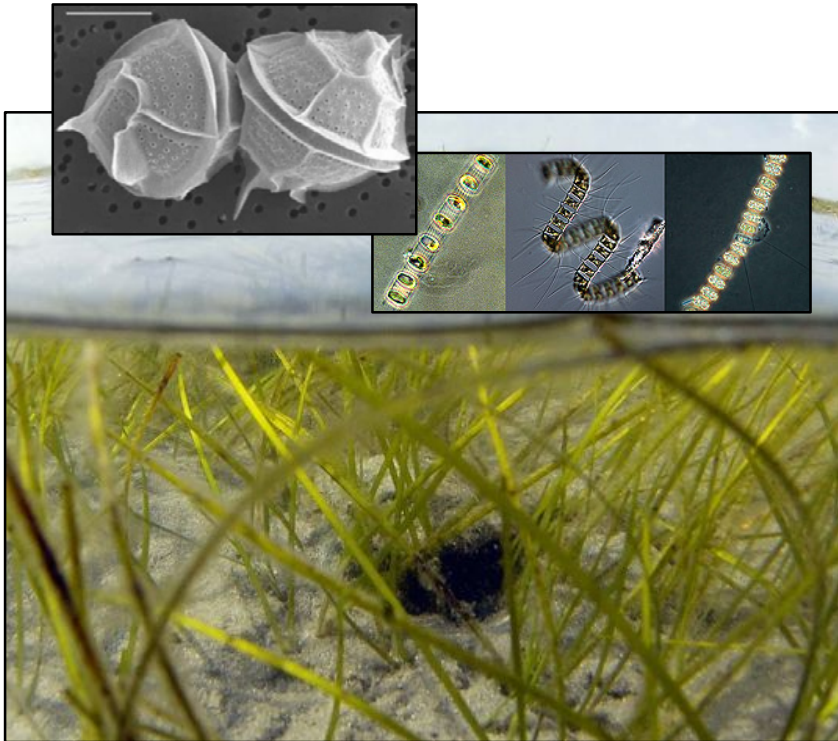
1990

2010

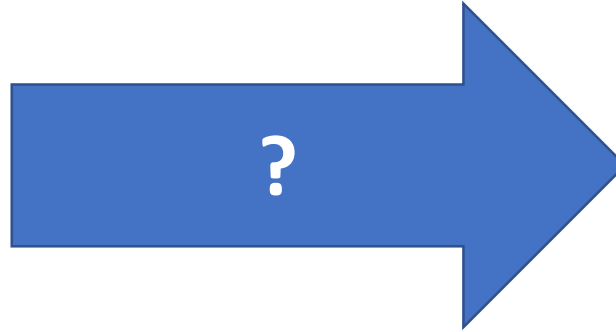
Severity & composition of blooms is changing

RESEARCH QUESTIONS

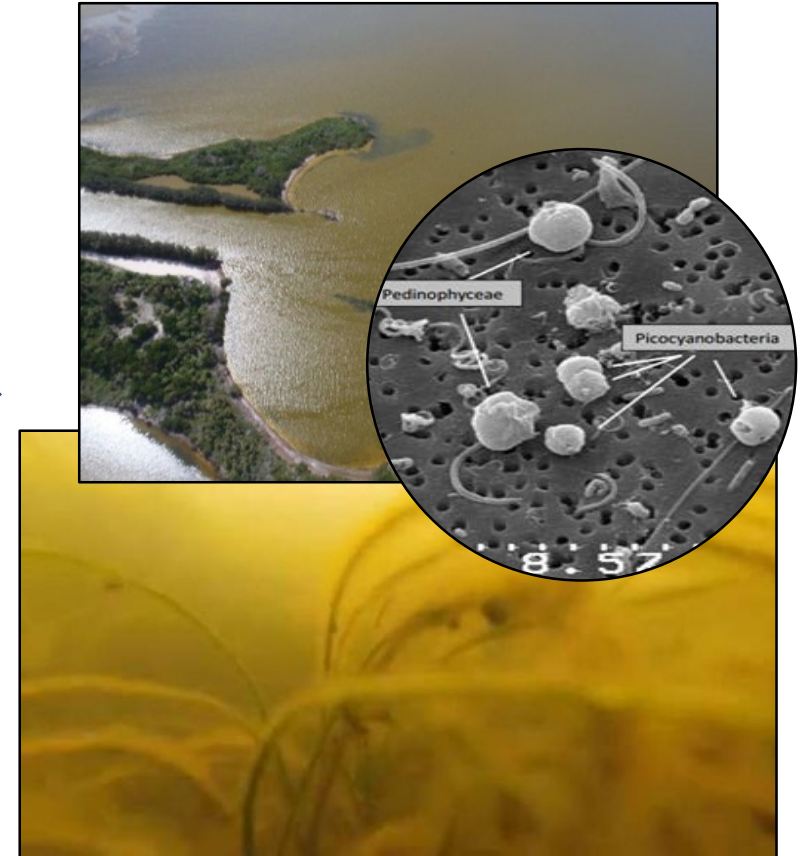
Pre-2011



Nutrients

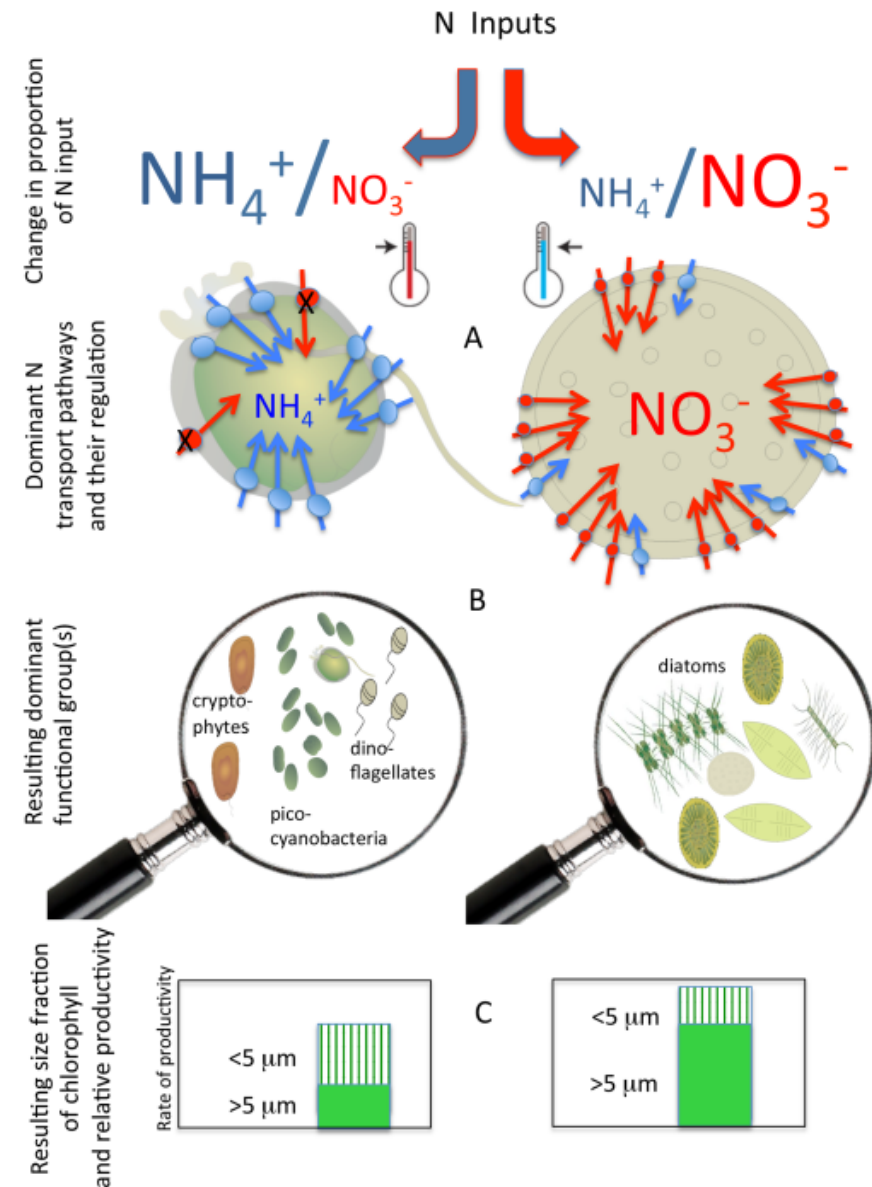


Post-2011



RESEARCH QUESTIONS

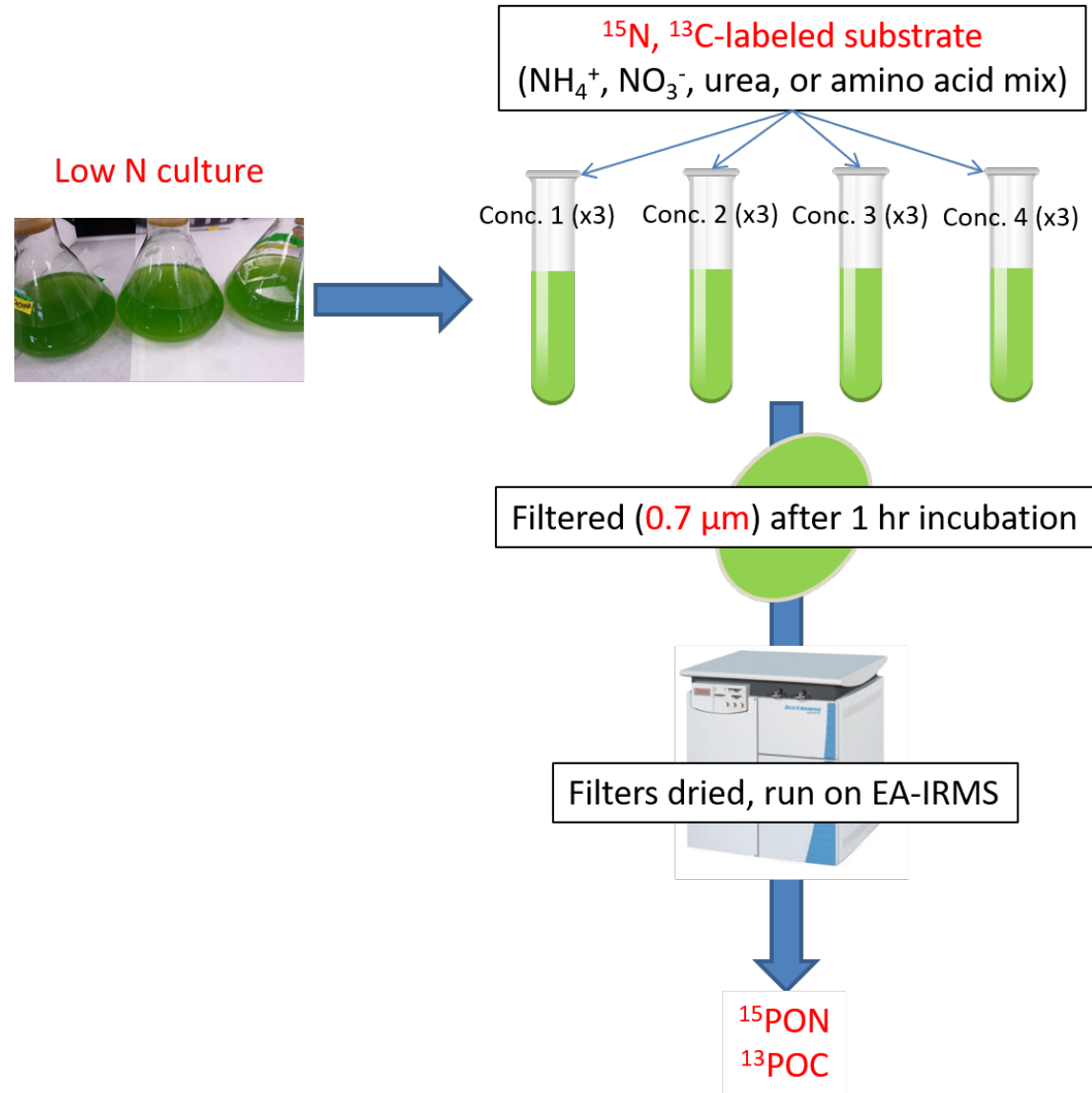
- Are shifts in nutrients linked to HABs in the IRL?
- Are there specific nutrients which HABs in the IRL prefer?



Glibert et al., 2016

CULTURE 15-N UPTAKE

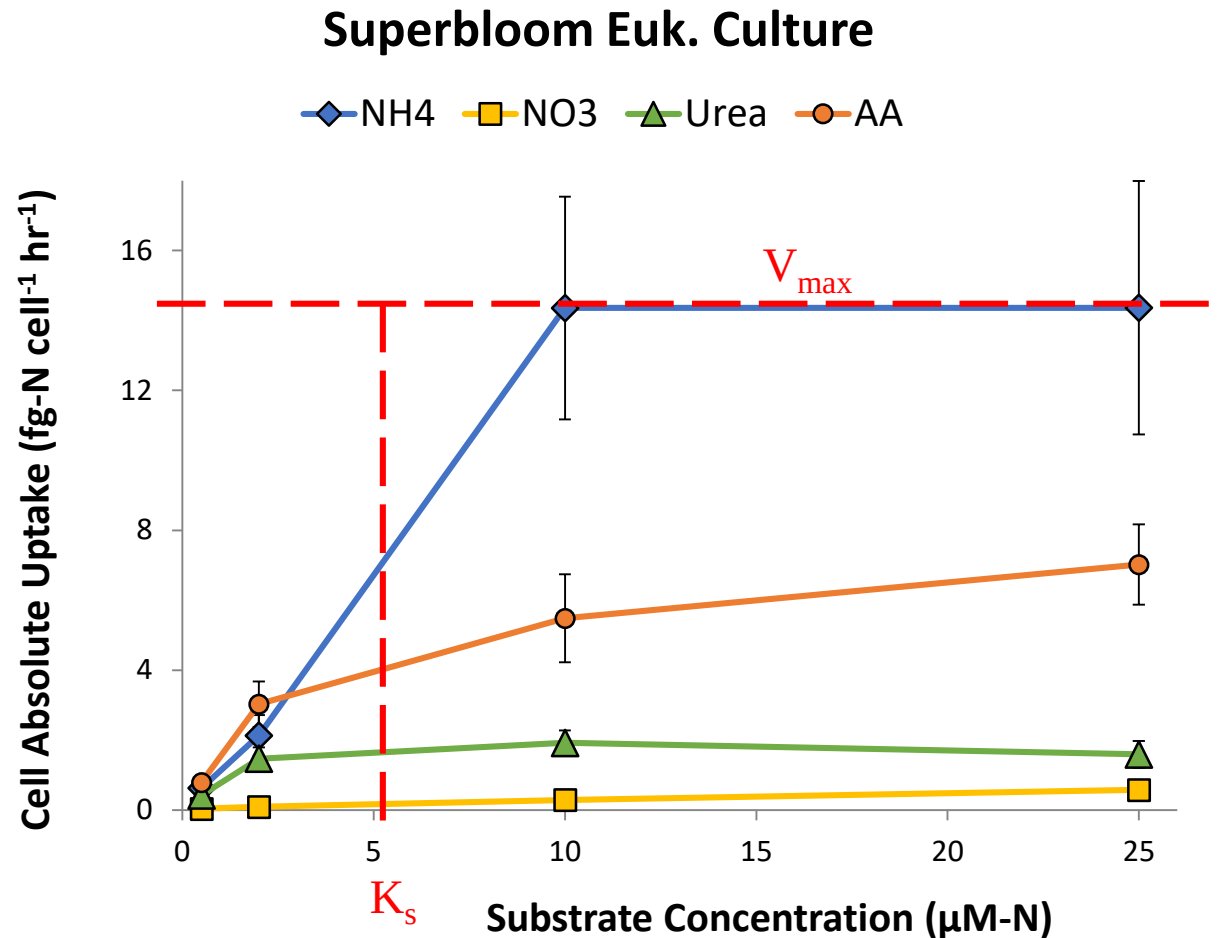
- Cultures spiked with ^{15}N substrates



CULTURE 15-N UPTAKE

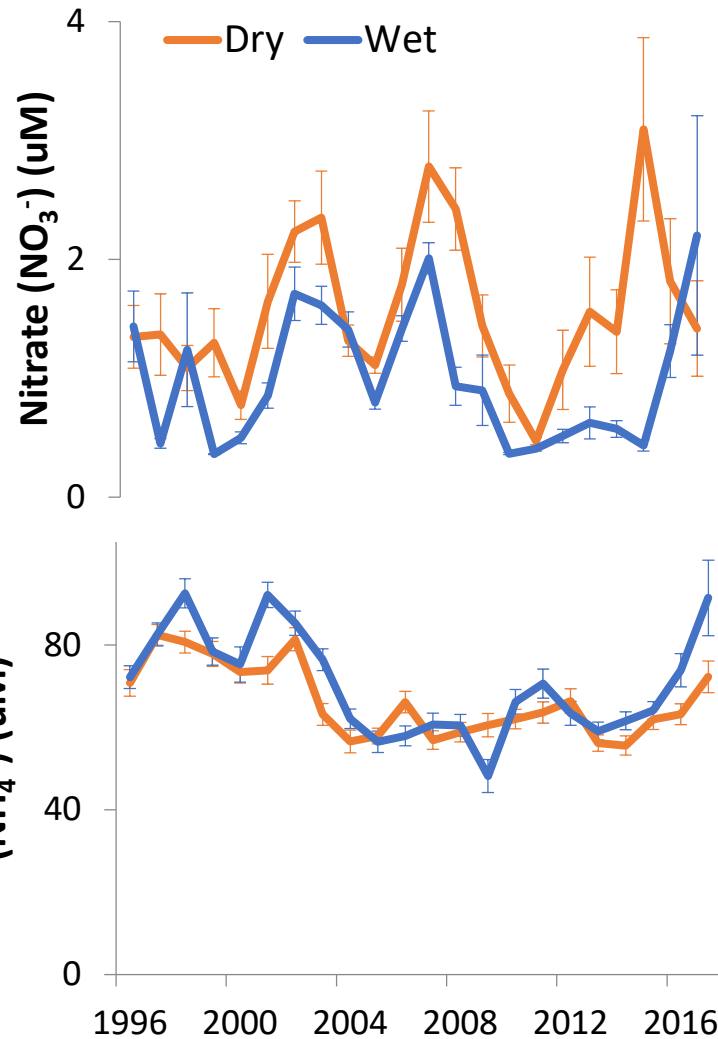
- Cultures spiked with ^{15}N substrates
- Superbloom taxa prefer reduced N
- Able to use organic N

M-M Model:
$$V = \frac{V_{\max} \times S}{K_s + S}$$
$$\alpha = V_{\max} : K_s$$

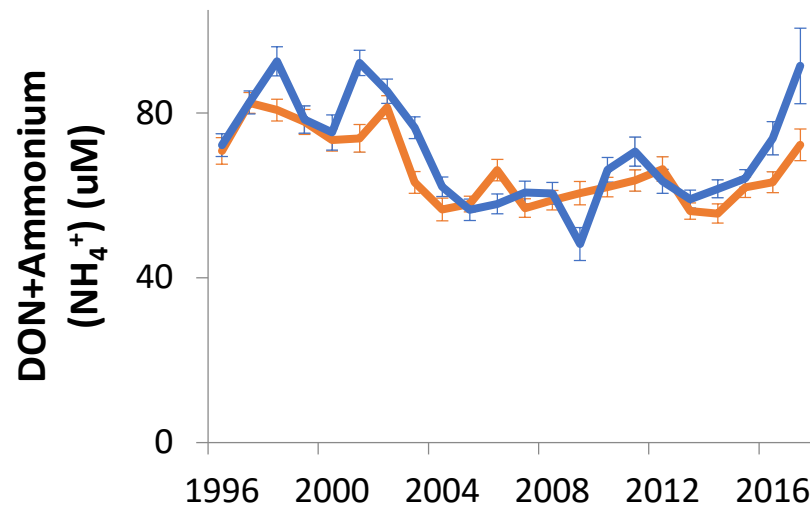


NUTRIENT TRENDS IN THE IRL

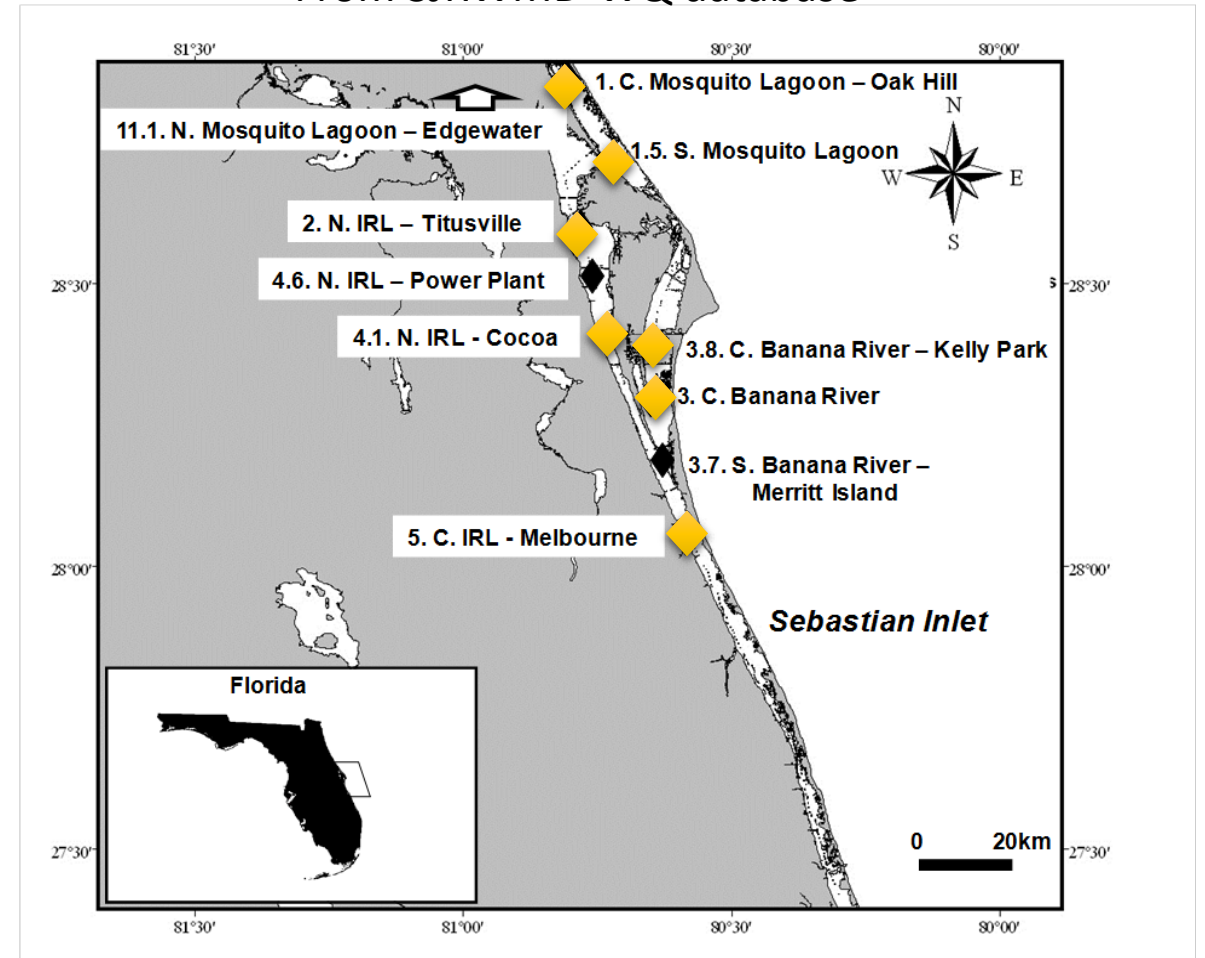
Oxidized N



Reduced N

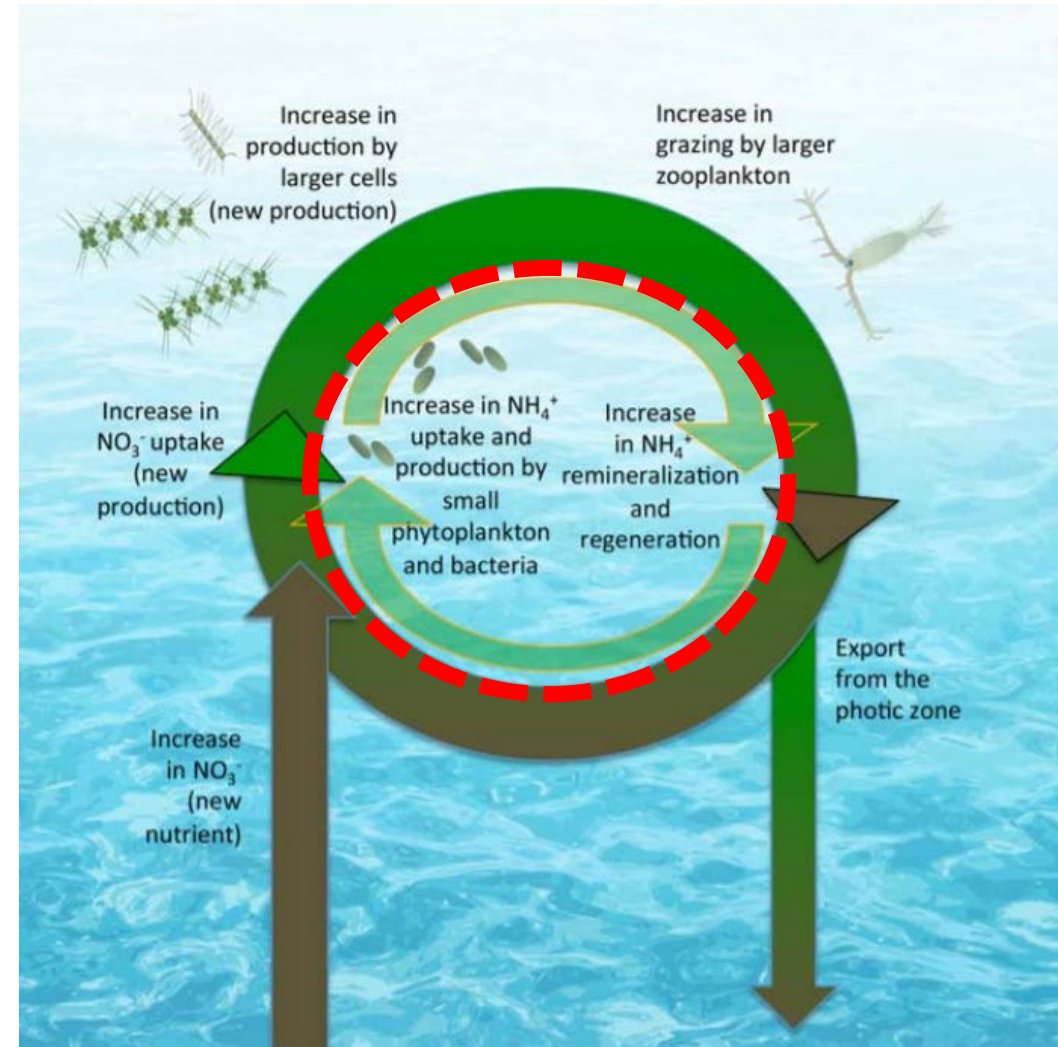


From SJRWMD-WQ database



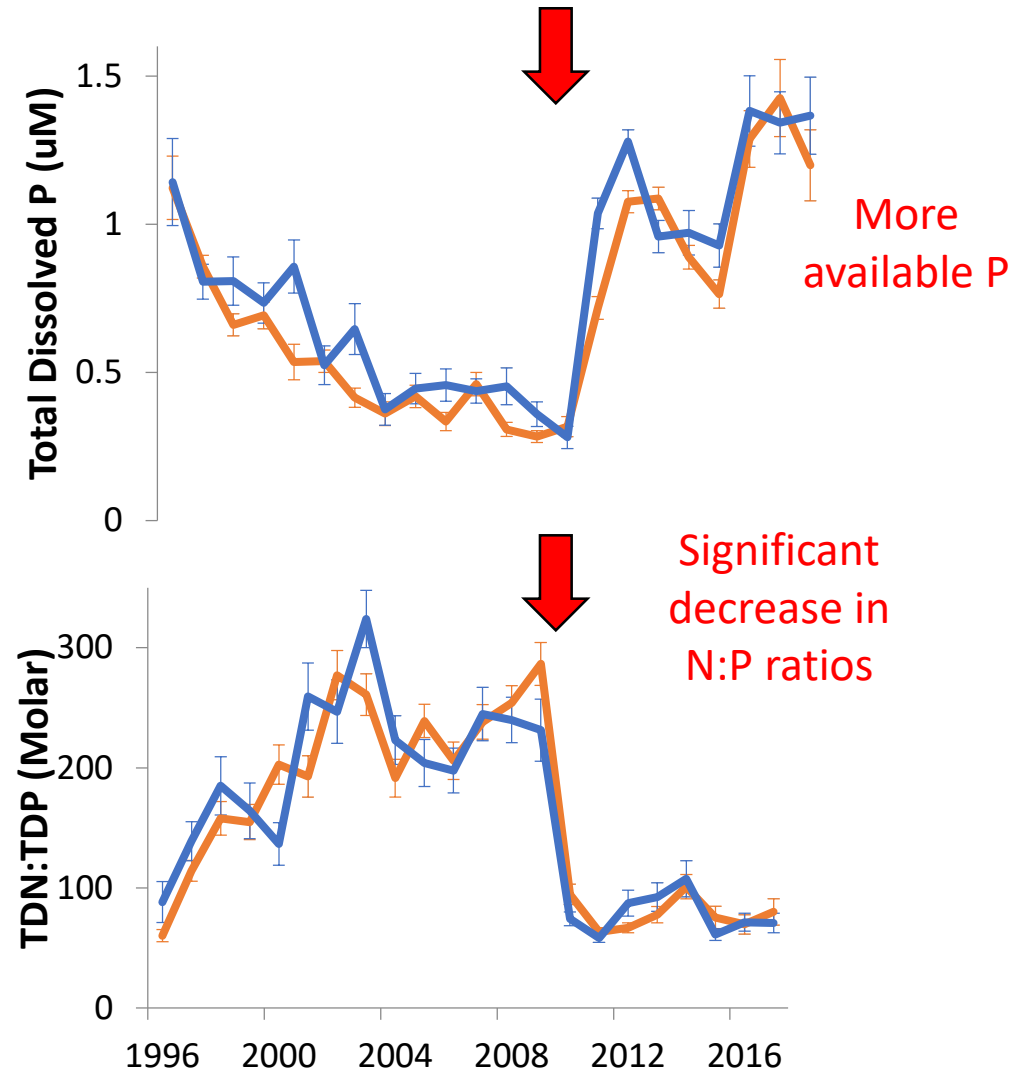
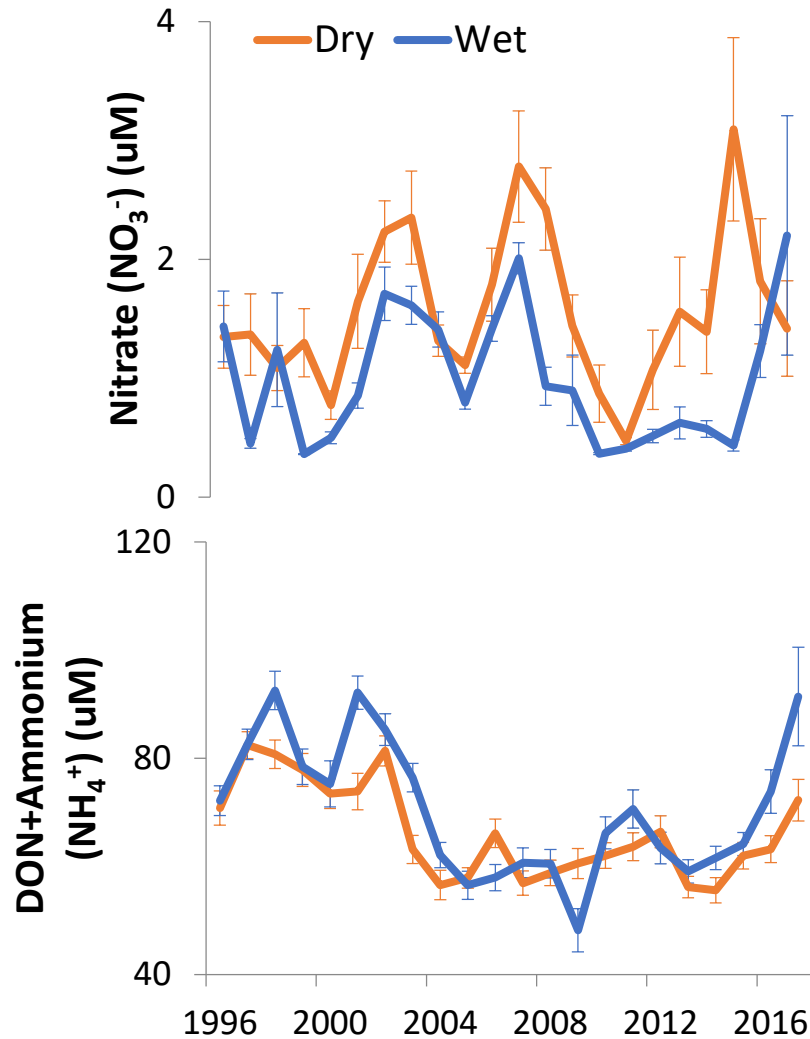
“MICROBIAL LOOP”

- Internal regeneration of reduced inorg. & org. N
- Favors small celled-phytoplankton

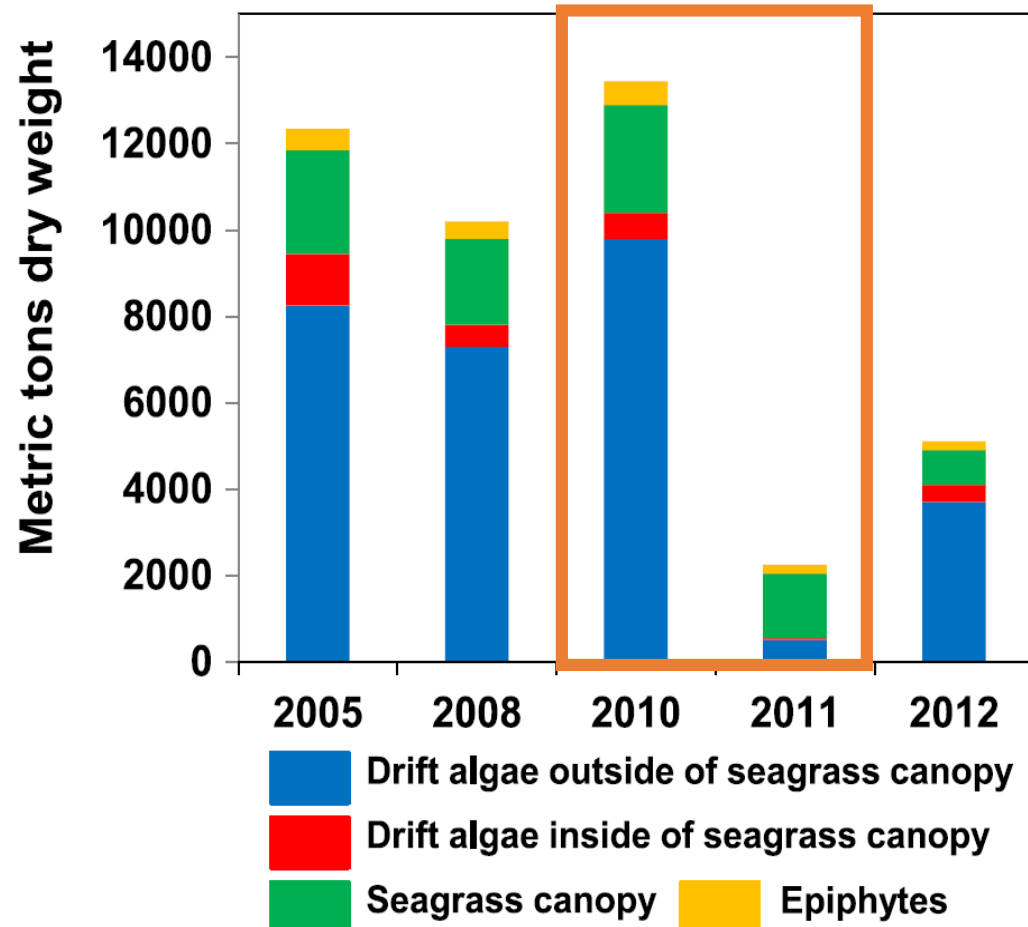


Glibert et al. 2016 (adapted from Dugdale & Goering 1967)

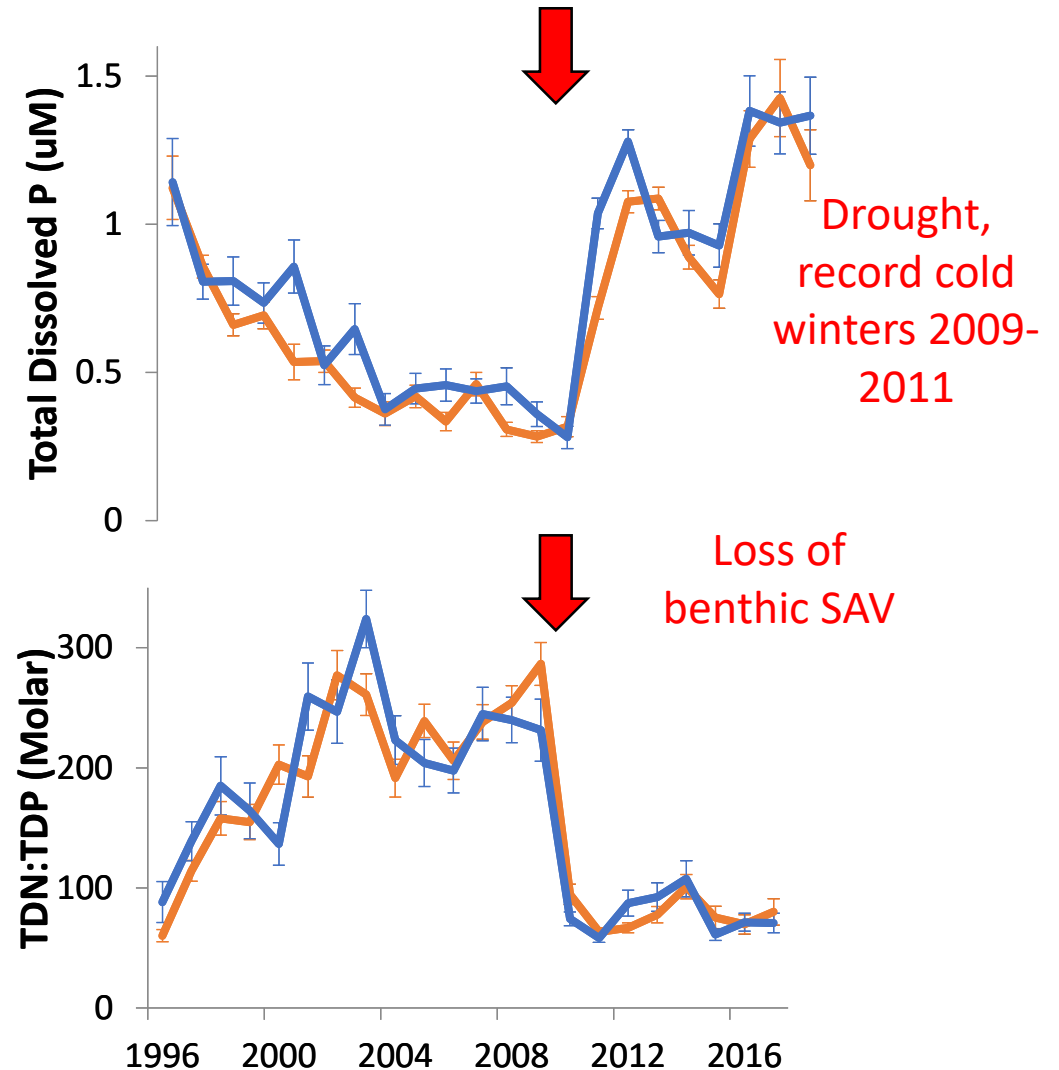
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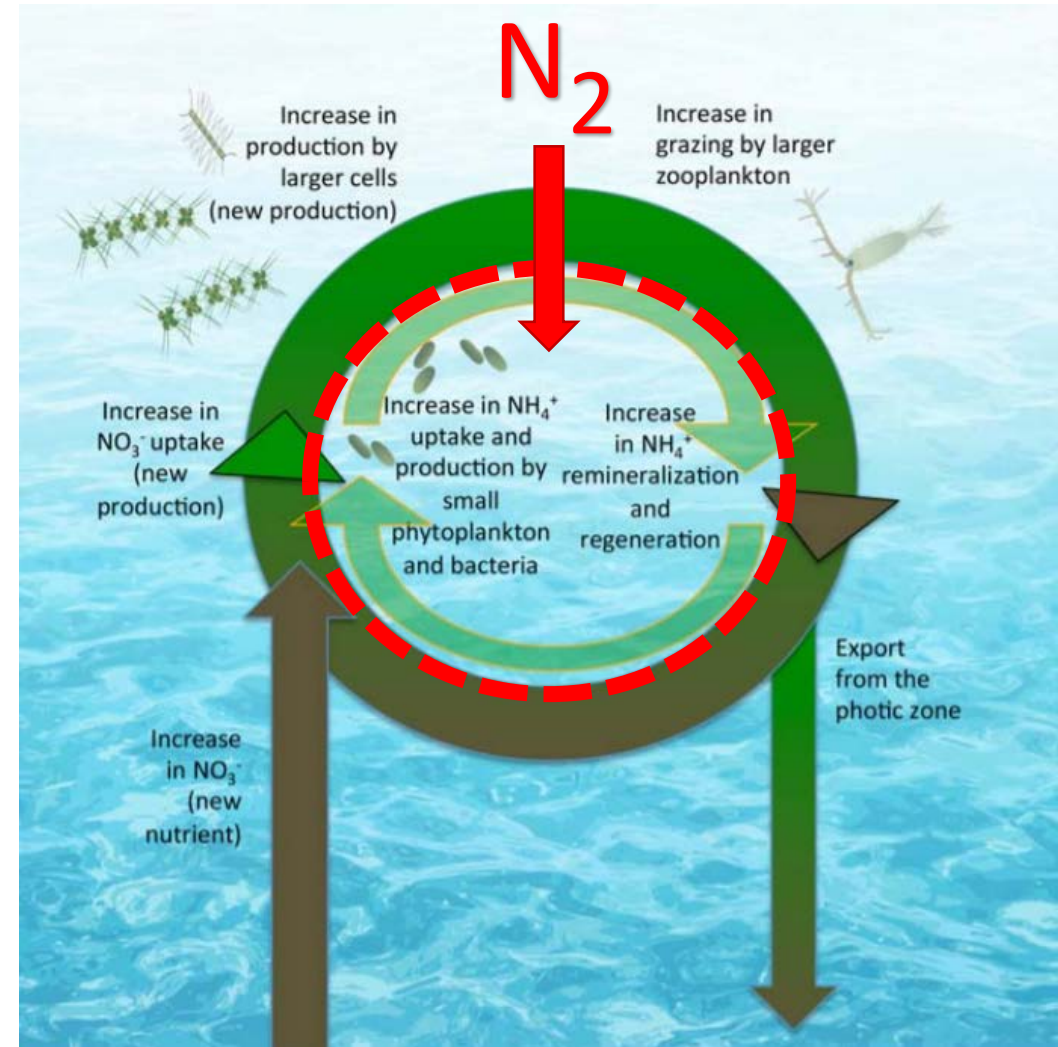


Phlips et al. 2015



“MICROBIAL LOOP”

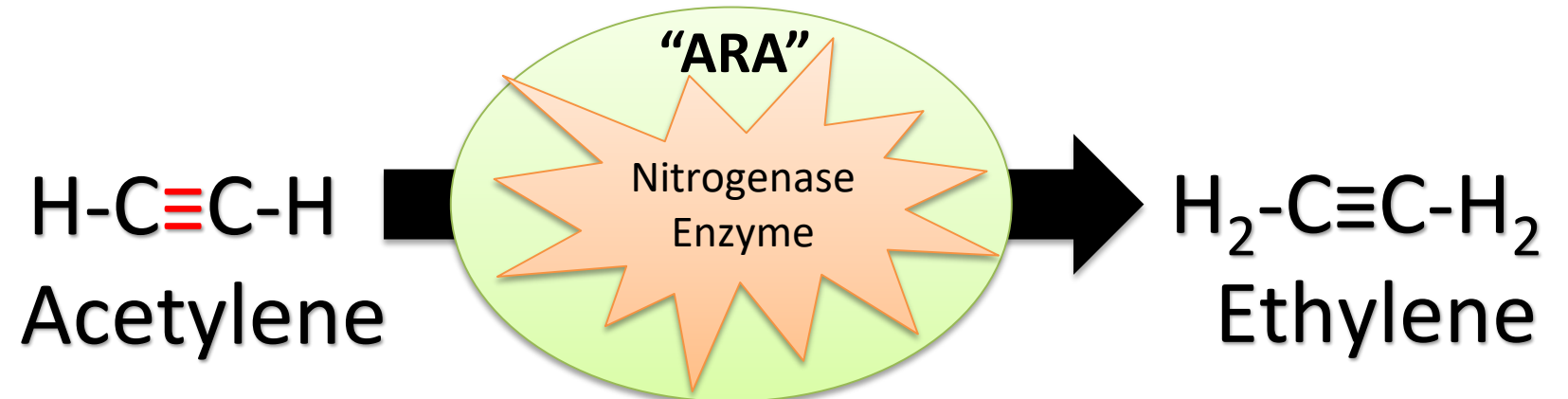
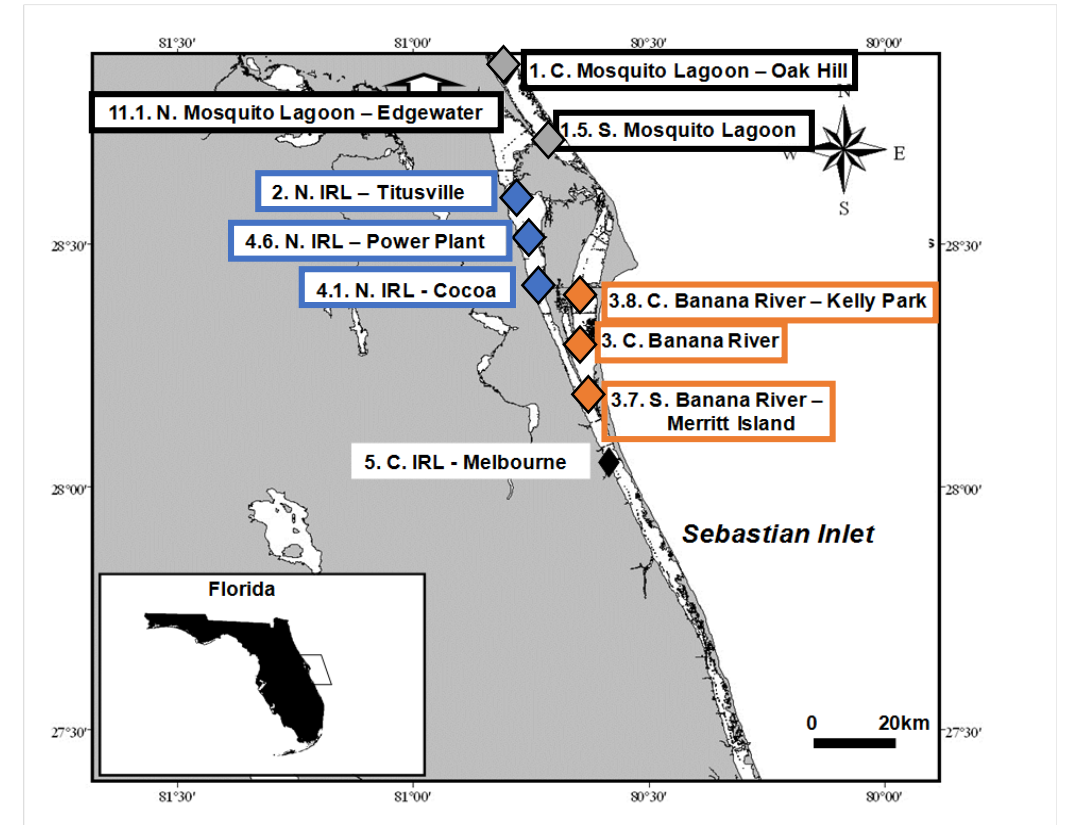
- Internal regeneration of reduced inorg. & org. N
- Favors small celled-phytoplankton
- $\uparrow P = N_2$ fixation?



Glibert et al. 2016 (adapted from Dugdale & Goering 1967)

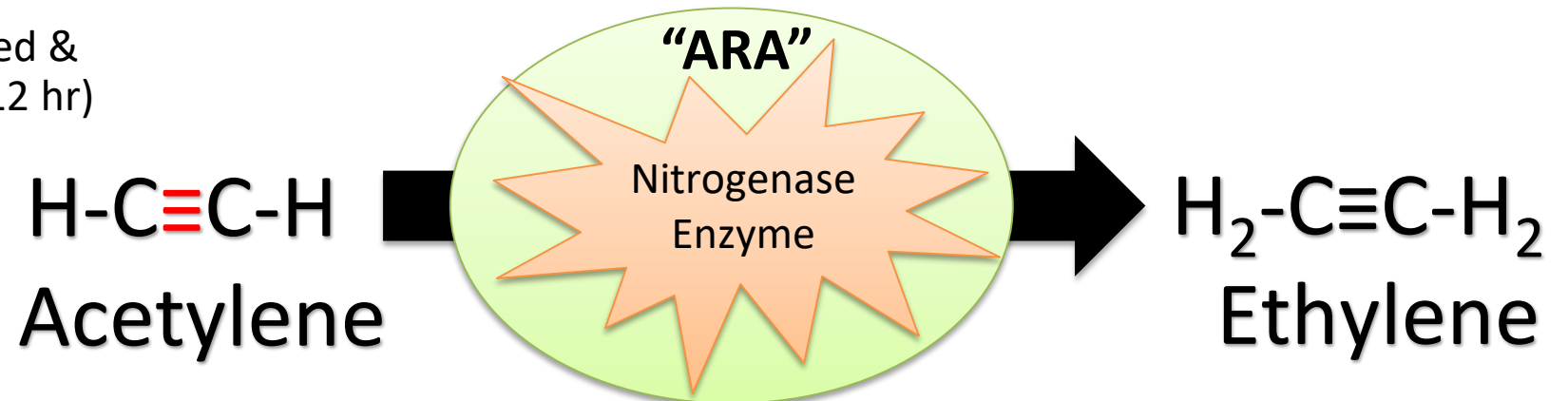
Water Column ARA

- Samples from 9 sites in IRL (ML, NIR, BR)
- Approximately bi-monthly Sep. 2014-June 2016



Water Column ARA

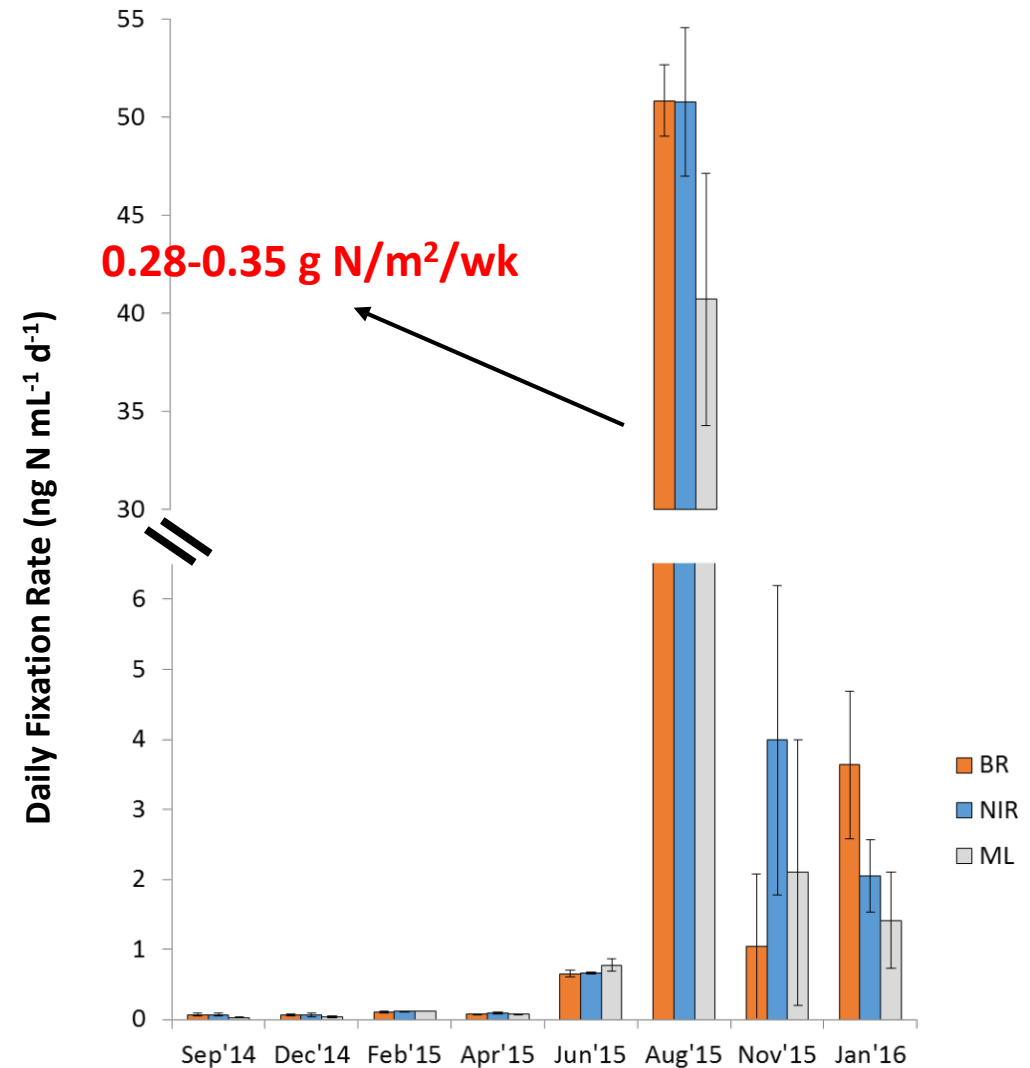
- Samples from 9 sites in IRL (ML, NIR, BR)
- Approximately bi-monthly Sep. 2014-June 2016
- Filtered & placed in flasks with site water filtrate
- Injected with C_2H_2 gas & incubated under light (100-200 μE) and dark
- Production of C_2H_4 measured & scaled up to daily rate (12:12 hr)



ARA Results

- Significant seasonal effect; rates highest in August
- Largely consistent across basins
- No light vs. dark effect

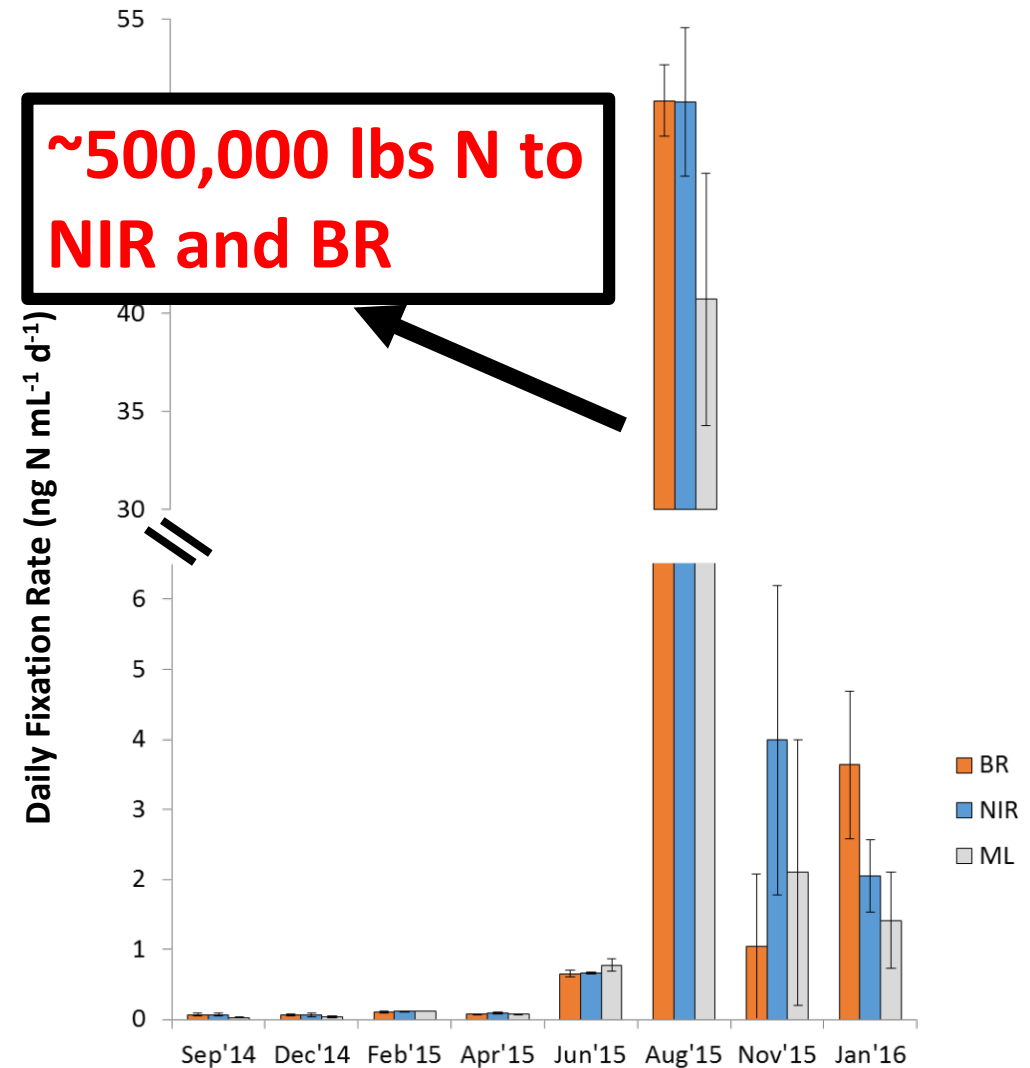
Effect	D.f.	F Ratio	p<
Month	7	333.98	0.0001
Basin	2	2.55	n.s.
Treatment	1	3.13	n.s.



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Potential Controls

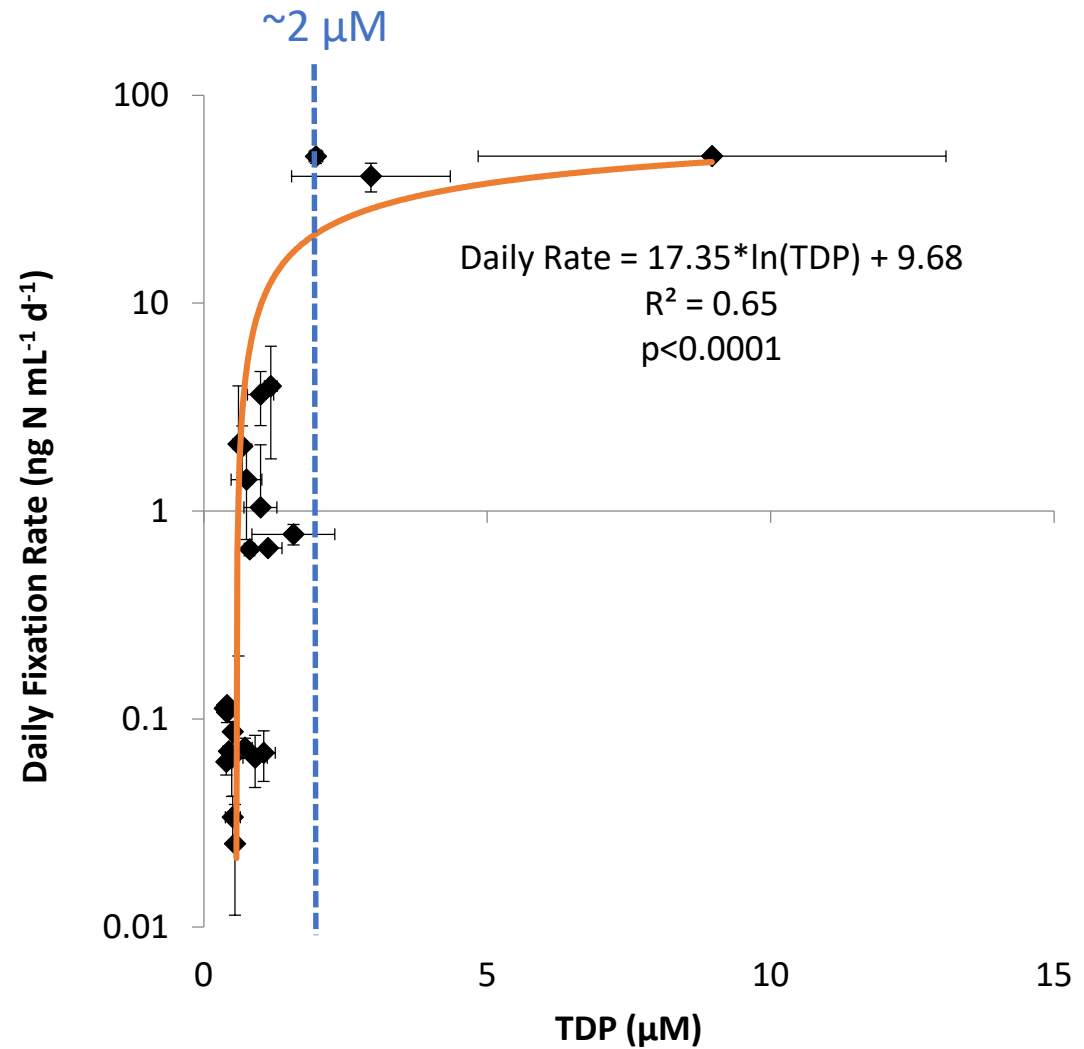
- + correlation to temp & picocyano counts
- - correlation to available N, N:P ratios

Calculated daily rates vs. select variables

Variable	Spearman ρ	$p <$
TN:TP	-0.46	0.001
NH_4^+ (μM)	-0.32	0.05
NO_3^- (μM)	0.09	n.s.
DIN:TDP	-0.50	0.0001
TDN:TDP	-0.48	0.0001
Chl α ($\mu\text{g L}^{-1}$)	0.23	n.s.
Salinity (psu)	-0.11	n.s.
DO (mg/L)	-0.12	n.s.
Temp ($^{\circ}\text{C}$)	0.41	0.005
Pico cell count (cells mL^{-1})	0.46	0.005

Potential Controls

- + correlation to temp & picocyno counts
- - correlation to available N, N:P ratios
- Highly related to TDP conc.



CONCLUSIONS & LINGERING QUESTIONS

- Recent HABs in the IRL prefer NH_4^+ & DON
- Reduced N > oxidized N in IRL
- $\uparrow$ P ($\downarrow$ N:P) since 2010
- BNF contributes to available N pool for HABs
- “Internal” N accounting undervalued in budgets
- **Have we reached a “new normal”?**



ACKNOWLEDGEMENTS

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- Lab and field assistance from:
 - Xiaolin Liao, Katelyn Foster, Sophia Carmen (WBL)
 - Kathryn Curtis (SWSD)
 - Leslie Landauer, Jean Lockwood, Susan Badylak & others (Phlips Lab)



Wetland Biogeochemistry
Laboratory

