

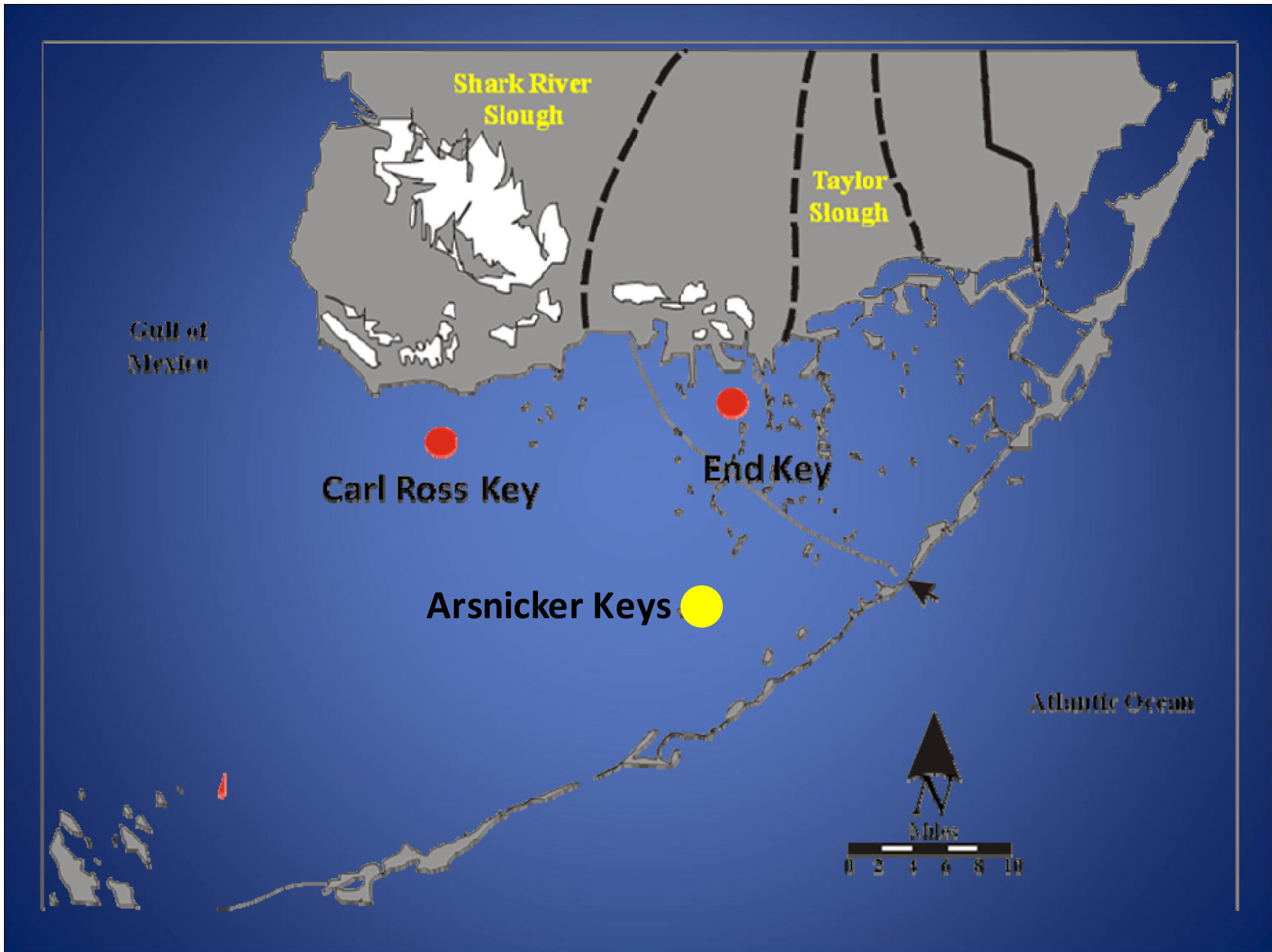
# Benthic Microalgal Nutrient Limitation Using Bioassays

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# Objectives

- Use mesocosms to evaluate if nutrients are limiting for benthic microalgae across Florida Bay in two ways: dissolved water column nutrient availability and benthic microalgal bioassays.
  - Tomas et al, 1999 using bioassays of natural pelagic phytoplankton: P in the East; N or P in the Central; N, sometimes P or Si in the West
- Synthesis of: benthic microalgal chlorophyll *a* standing stock and benthic nutrient flux across Florida Bay.



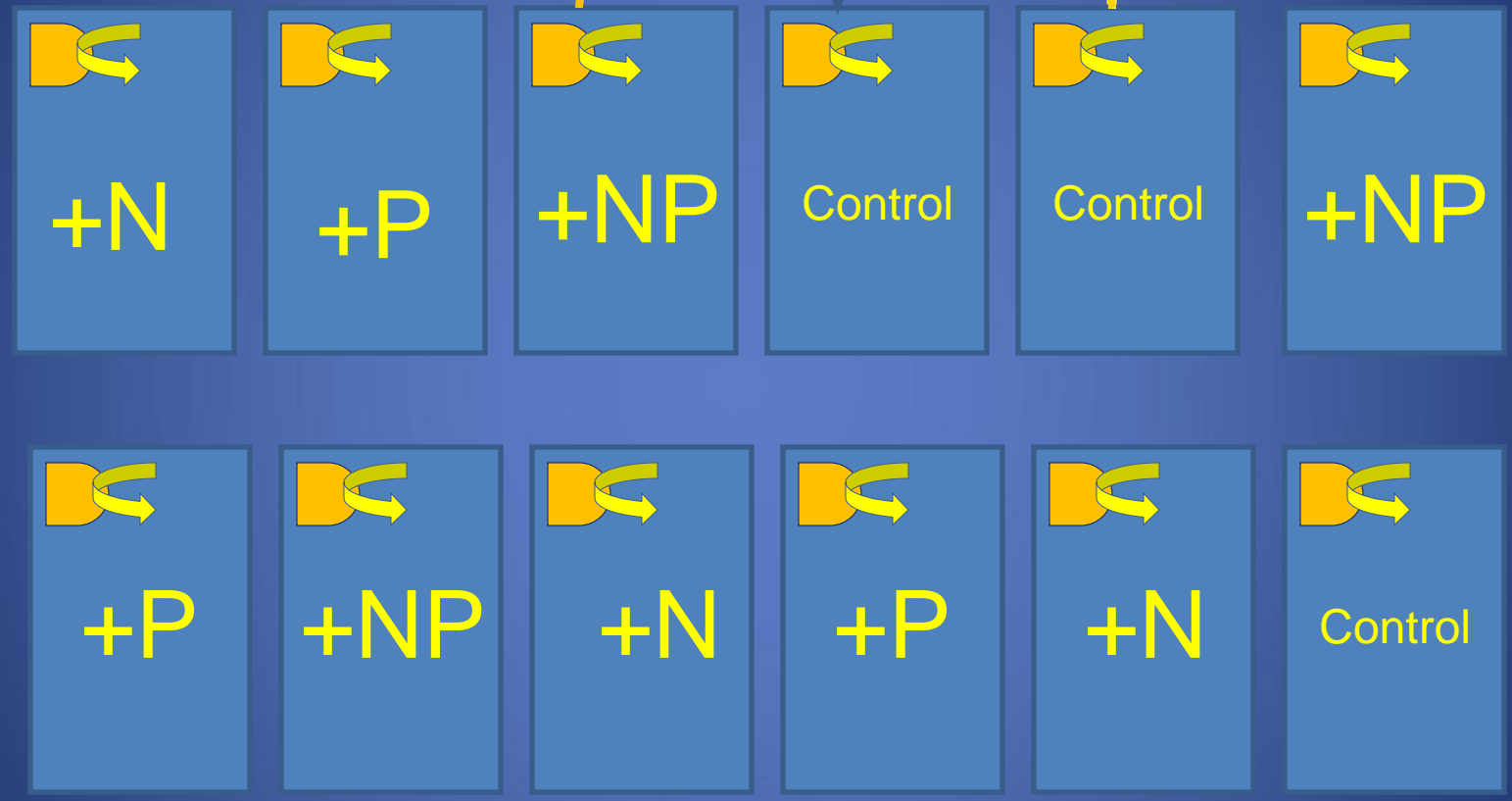
# BMA Nutrient Limitation Mesocosm Expt's

- Nutrients were added to the sediment via coiled tubing system in bottom.
  - Randomized block design: N, P, N+P, Controls
  - Water column replaced with 0.7 $\mu$  filtered site water
- Measured water column dissolved nutrient availability (TDP, SRP, TDN, NO<sub>3</sub>, NO<sub>2</sub>, SiO<sub>4</sub>, NH<sub>4</sub>) was used to predict nutrient limitation.
- Nutrient limitation was evaluated based upon changes in sediment and water column Chl *a*.

 = Recirculating pump



Seawater In 



 Seawater Out

Continuous Flow Ambient Seawater Bath

# Initial Dissolved Inorganic Nutrient Conditions

	Summer	Winter	Winter
	Central	Central	Western
TDP( $\mu\text{M}$ )	0.8	0.47	0.76
TDN( $\mu\text{M}$ )	69.77	58.29	22.87
SRP( $\mu\text{M}$ )	0.12	0.009	0.027
NH <sub>4</sub> ( $\mu\text{M}$ )	5.51	6.82	2.22
<b>PREDICTED LIMITING NUTRIENT</b>			
NO <sub>3</sub> +NO <sub>2</sub> ( $\mu\text{M}$ )	0.03	0.10	0

**TDN:TDP**

P limited

P limited

P limited

**NH<sub>4</sub>:SRP**

P limited

P limited

P limited

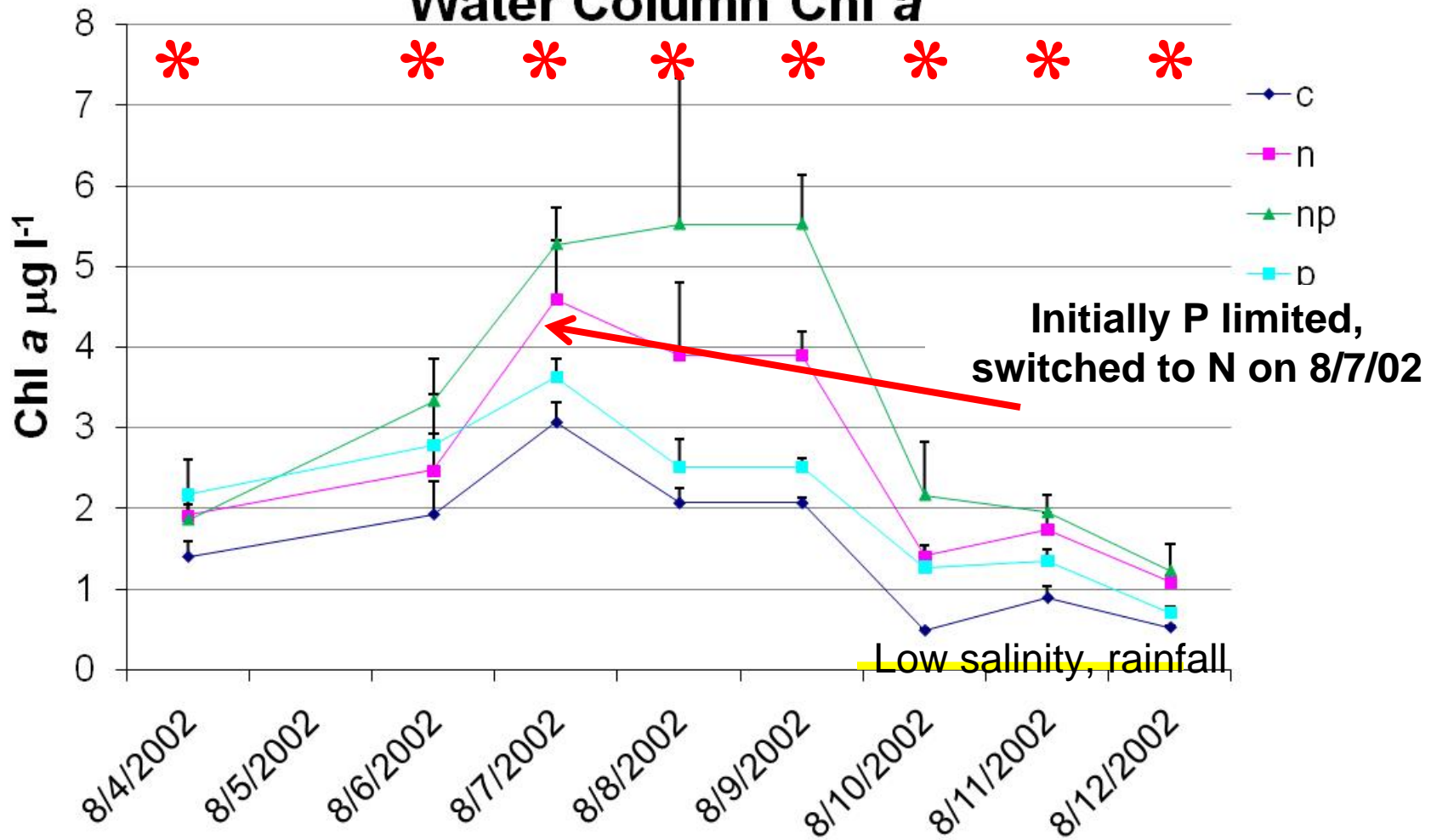
**NO<sub>3</sub>+NO<sub>2</sub>:SRP**

N limited

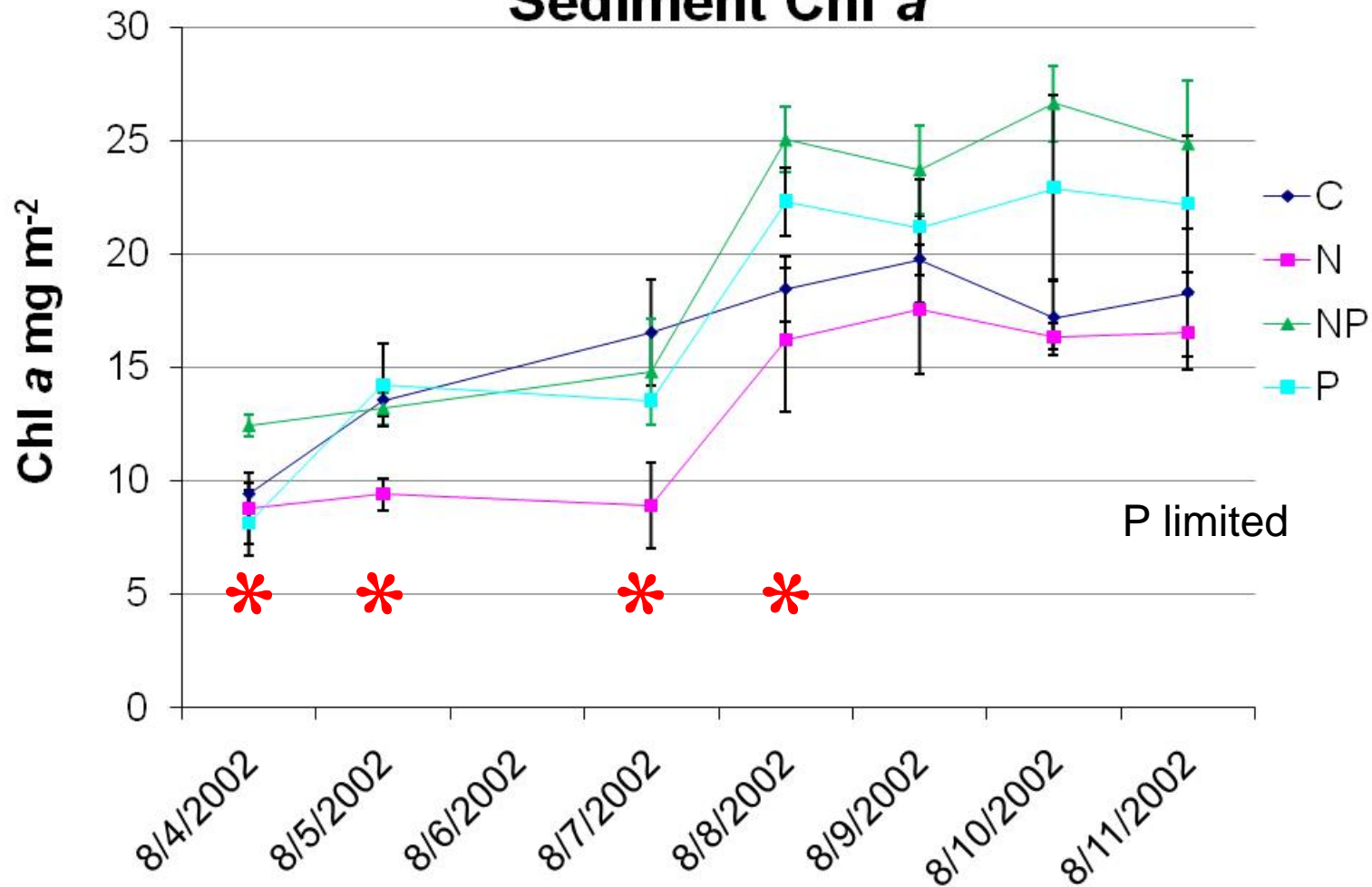
P limited

N limited

# August 2002 Central Bay Mesocosm Water Column Chl a

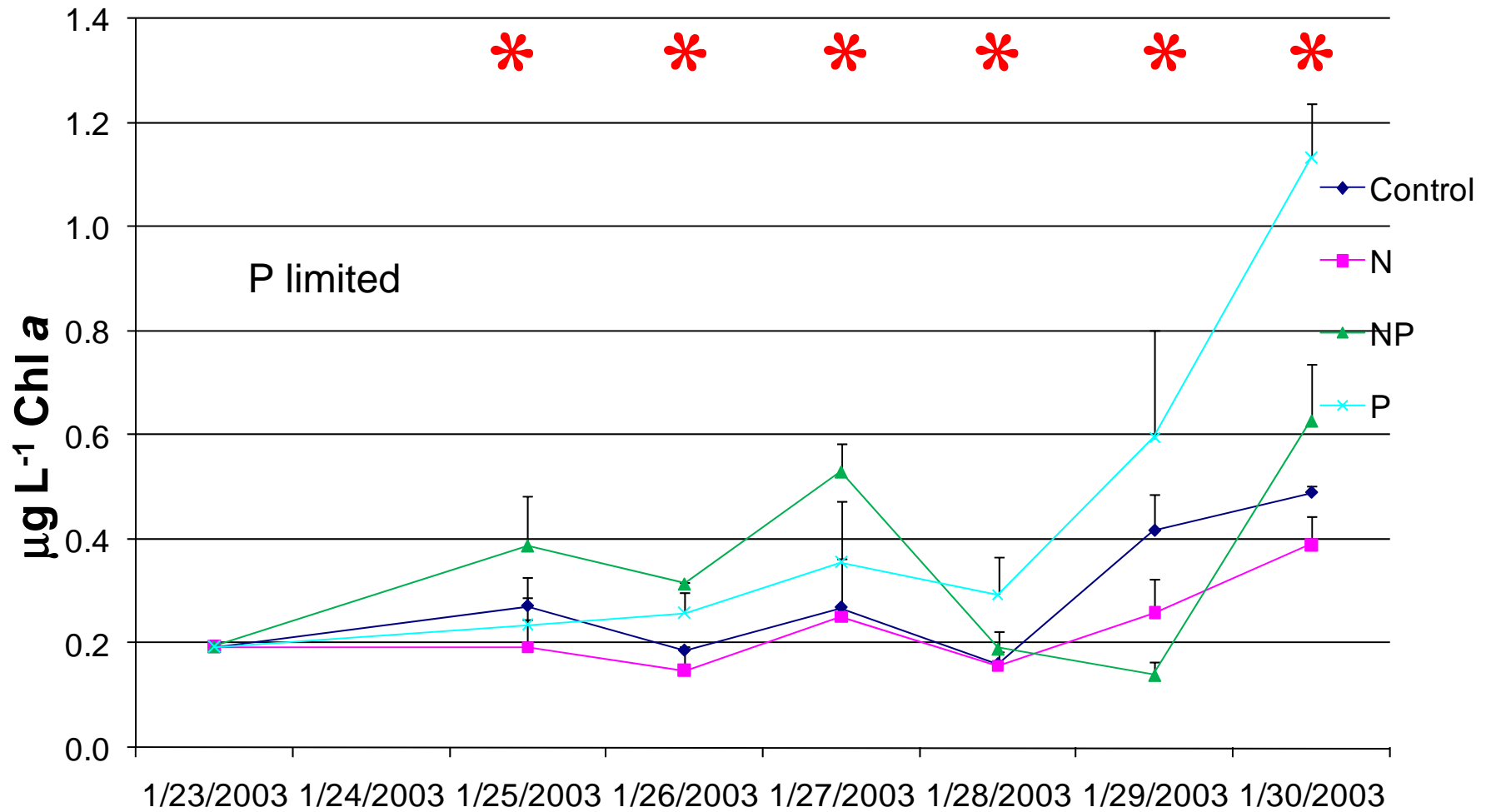


# August 2002 Central Florida Bay Mesocosm Sediment Chl a

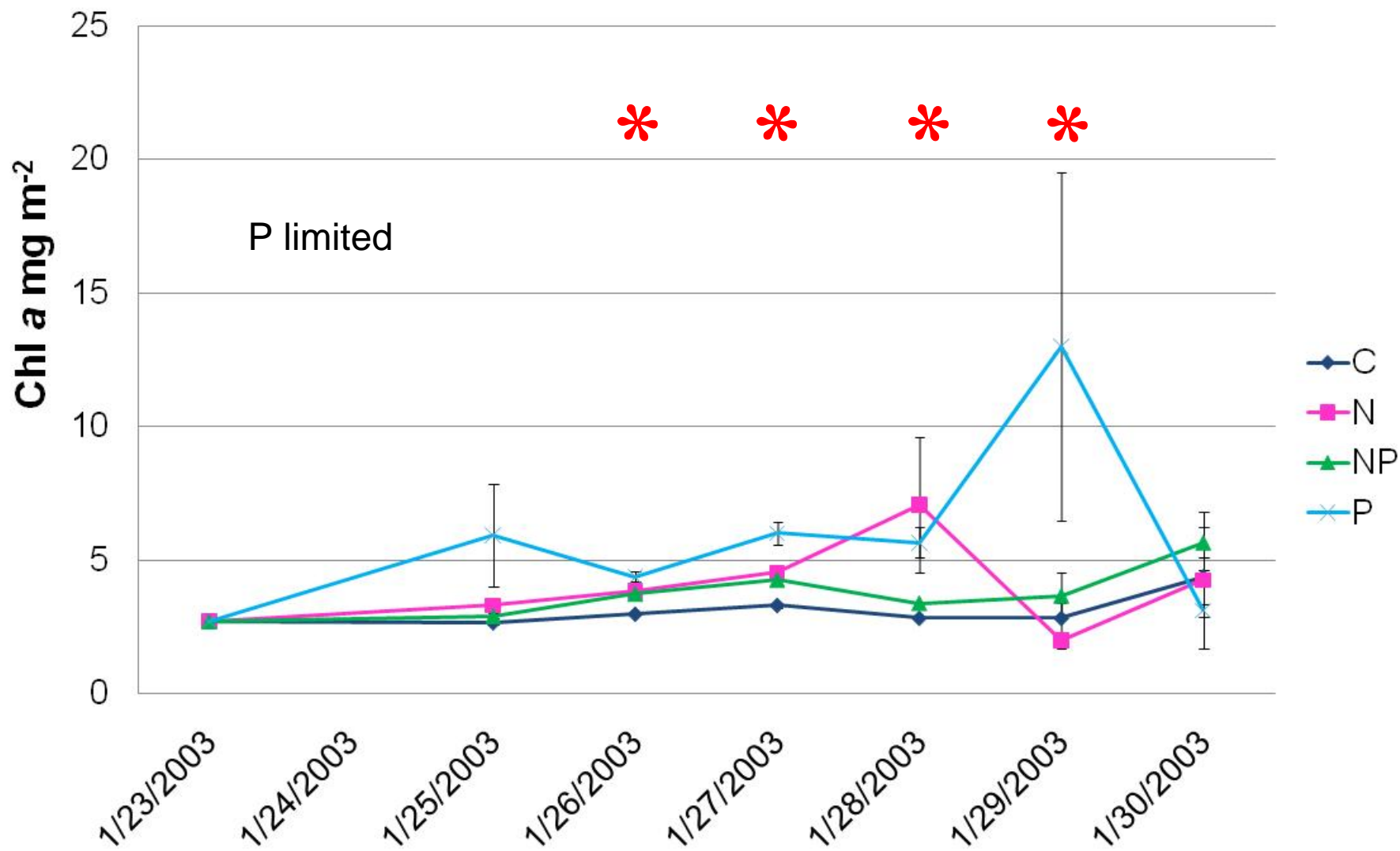




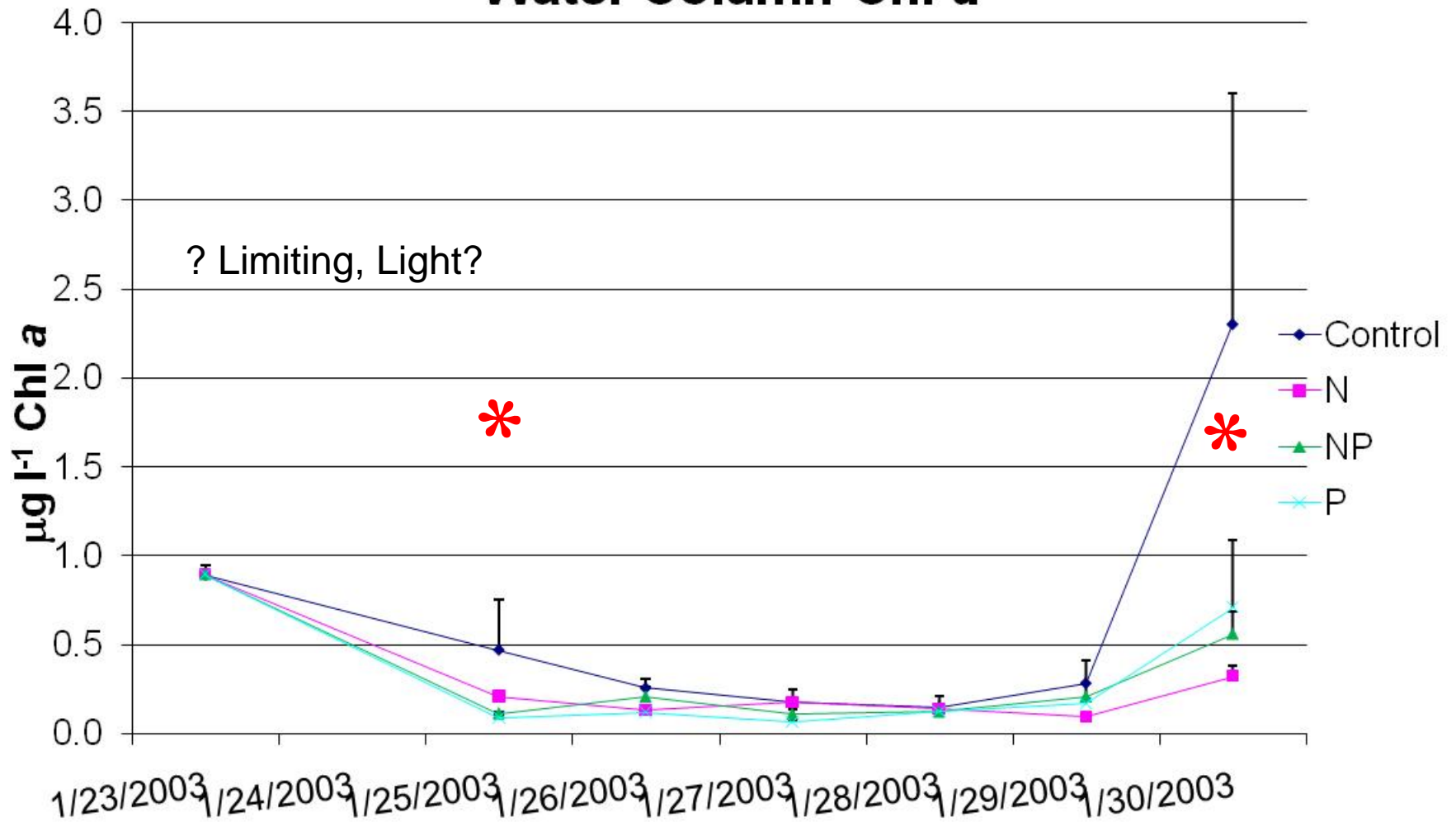
# January 2003 Central Florida Bay Mesocosms Water Column Chl *a*



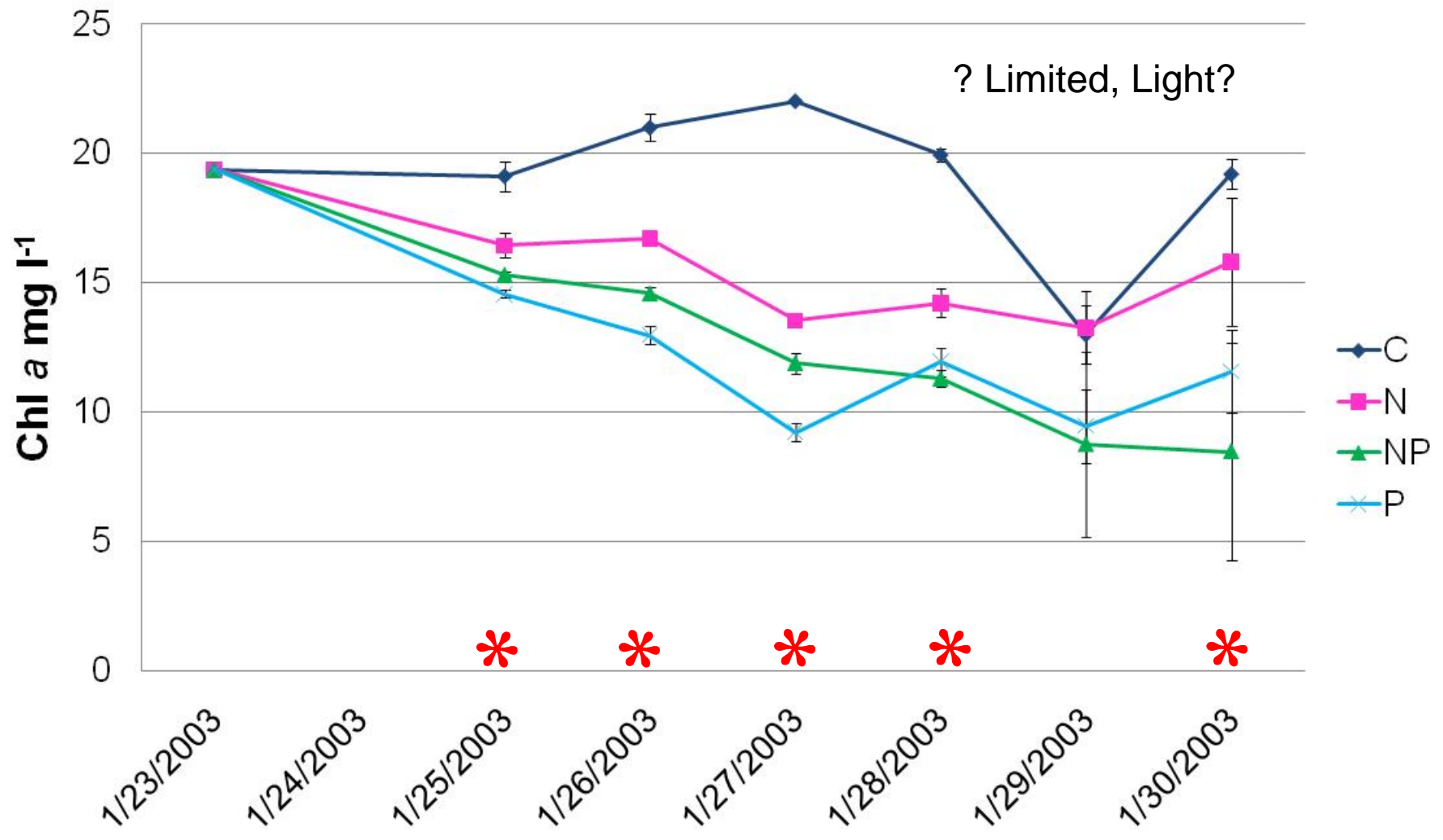
# January 2003 Central Florida Bay Mesocosms Sediment Chl *a*



# January 2003 Western Florida Bay Mesocosms Water Column Chl a



# January 2003 Western Florida Bay Mesocosms Sediment Chl a



# Initial Dissolved Inorganic Nutrient Conditions

## PREDICTED LIMITING NUTRIENT

	Summer	Winter	Winter
	Central	Central	Western
<b>TDN:TDP</b>	P limited	P limited	P limited
<b>NH<sub>4</sub>:SRP</b>	P limited	P limited	P limited
<b>NO<sub>3</sub>+NO<sub>2</sub>:SRP</b>	N limited	P limited	N limited

## ACTUAL LIMITING NUTRIENT

<b>Water Column Bioassays</b>	P then N	P limited	?
<b>Benthic Bioassays</b>	P limited	P limited	?

# BMA Nutrient Limitation Summary

- Bioassays were the best predictor of nutrient limitation in Central Florida Bay.
- In general, water column dissolved nutrient availability is not a good predictor of nutrient limited growth in Florida Bay.
- This finding supports field studies of nutrient bioassays using pelagic phytoplankton, but BMA bioassays should be investigated further.

# Range of Nutrient Flux and Benthic Microalgal Standing Stock in Florida Bay

Constituent	Location		
	Western	Central	Southeastern
SRP (mMm <sup>-2</sup> h <sup>-1</sup> )	-6.6 to +1.8	-0.22 to +1.76	-1.47 to +1.13
TDP (mMm <sup>-2</sup> h <sup>-1</sup> )	-8.1 to +3.3 (15)	-2.87 to +2.75	-5.17 to +3.16
TDN (mMm <sup>-2</sup> h <sup>-1</sup> )	-208.08 to +153.99	-408.64 to +393.59	14.32 to 47.51
Chlorophyll <i>a</i> (mg m <sup>-2</sup> )	0.56 to 111.77	2.26 to 42.9	3.39 to ~35
Phaeopigment (mg m <sup>-2</sup> )	7.07 to ~350	10.2 to 77.71	27.12 to ~153

Negative values are flux into the sediment  
 Positive values are flux out of the sediment

# Synthesis Conclusions

- Benthic microalgal standing stock exceeds that of the water column by an order of magnitude during non-bloom conditions.
  - Using hexane fractionation method minimizes overestimation of chlorophyll *a* while balancing practicality for large numbers of samples.
  - Seasonality and potential shading by the water column blooms.
- Dissolved nutrient flux to and from the sediment is variable temporally and spatially within the bay, but would be an important source for the benthic microalgae, macrophytes and phytoplankton in the overlying water column.
  - Primarily organic forms of N and P, except in SE Bay
  - Based upon our measurements and pelagic growth rates of organic nutrient flux accounts for 6-40% of P need and 100% of N need during nonbloom conditions.



# Synthesis Conclusions

- Based upon PAM fluorometry measurements benthic microalgal production varies across the bay with lower production in the central region.  $P_{max}$  was achieved at 200-500  $\mu\text{E m}^{-2} \text{ s}^{-1}$ , lower values in central bay.
- But chamber DO measurements did not reveal this trend. Both methods indicated net autotrophy at our sites, but heterotrophy was found at some sites at some times.
- In general, water column dissolved nutrient availability is not a good predictor of nutrient limited growth in Florida Bay because the microbial loop is ignored and presumes Redfield ratio. Bioassays are better and should include both benthic and pelagic trials.

# Implications for Everglades Restoration

- Benthic microalgae will still be there – monitor it to see if it changes
- Influx of more surface water will deliver more nutrients to the system
  - Will BMA take up the nutrients as a sink or will they be shaded by pelagic blooms?
  - Net autotrophy vs net heterotrophy?
    - Benthic-pelagic decoupling
  - More export of production?

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