



# ***Controls and consequences of algal blooms in Jamaica Bay, NY, USA***

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Number of peer-reviewed publications on the subject of 'nitrogen' and 'phytoplankton' in the major US mid-Atlantic and northeast estuaries, Web of Science, 2010

<b>Estuary</b>	<b># of publications</b>
Chesapeake Bay	346
Delaware Bay	47
Narragansett Bay	41
Long Island Sound	28
Hudson River	23
Great South Bay	18
<i>Jamaica Bay</i>	<i>0</i>

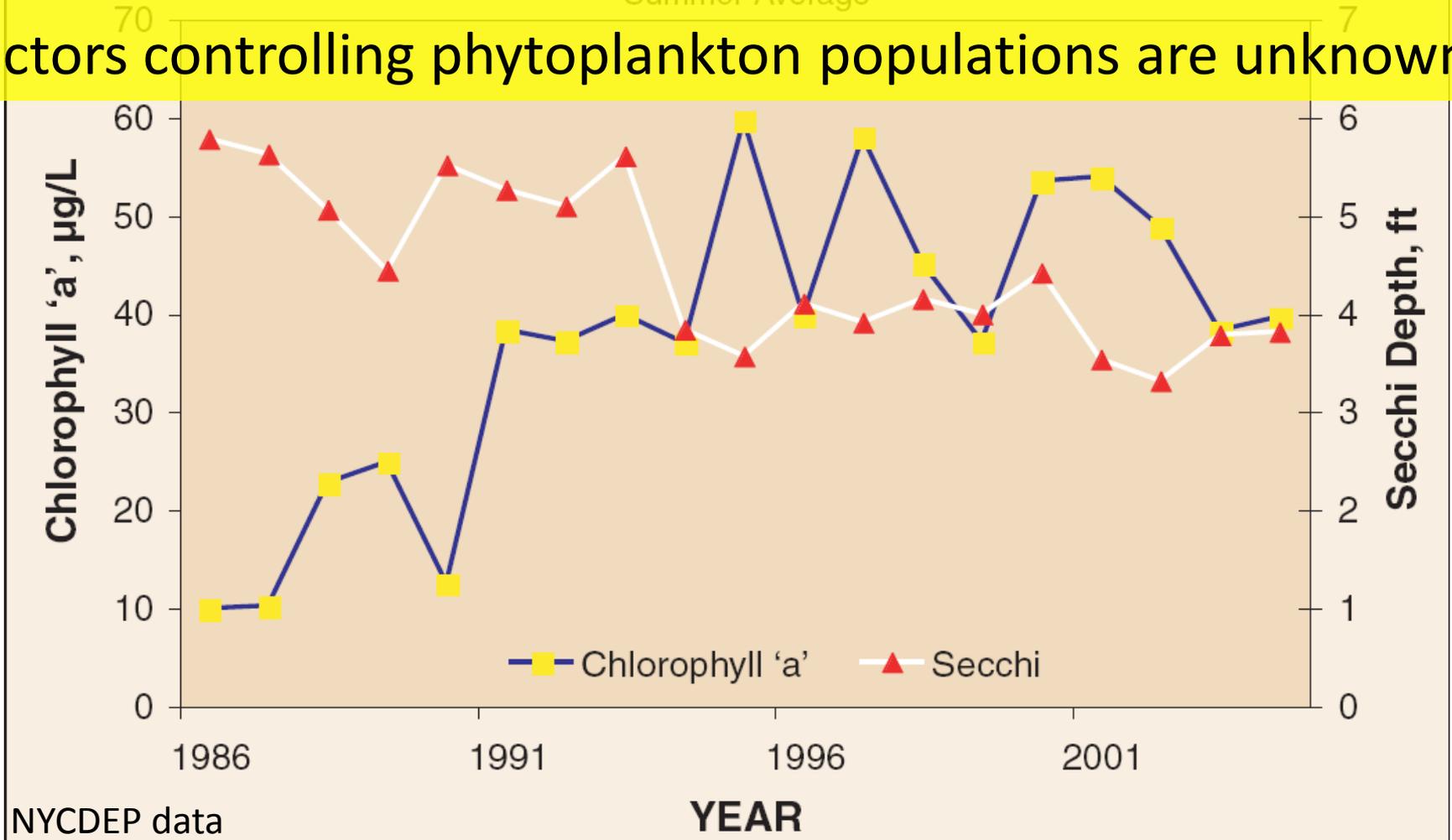
# Chlorophyll 'a' and Secchi Transparency

Phytoplankton comprising these blooms are unknown.

Jamaica Bay

Summer Average

Factors controlling phytoplankton populations are unknown.



NYCDEP data

# Macroalgal blooms in Jamaica Bay

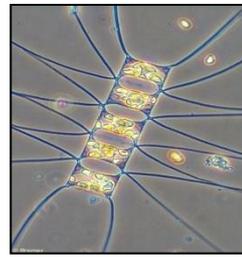
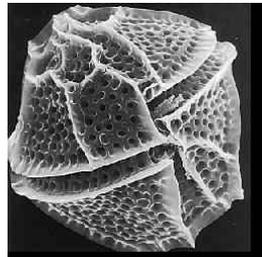
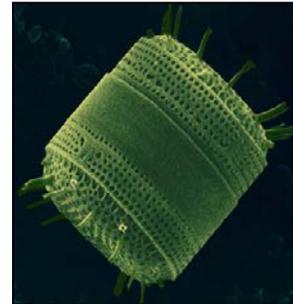
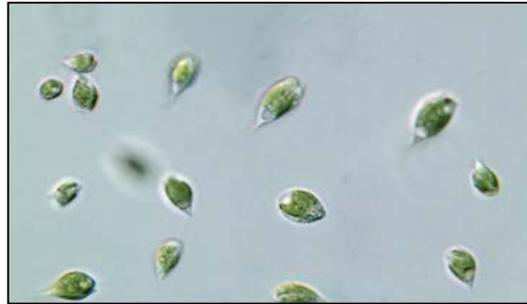
- Jamaica Bay is known to experience dense blooms of *Ulva* that contribute to ecosystem disruption.
- The species of *Ulva* blooming in Jamaica Bay is unknown.
- The temporal and spatial dynamics of these populations are unknown.
- The factors controlling these populations are unknown.



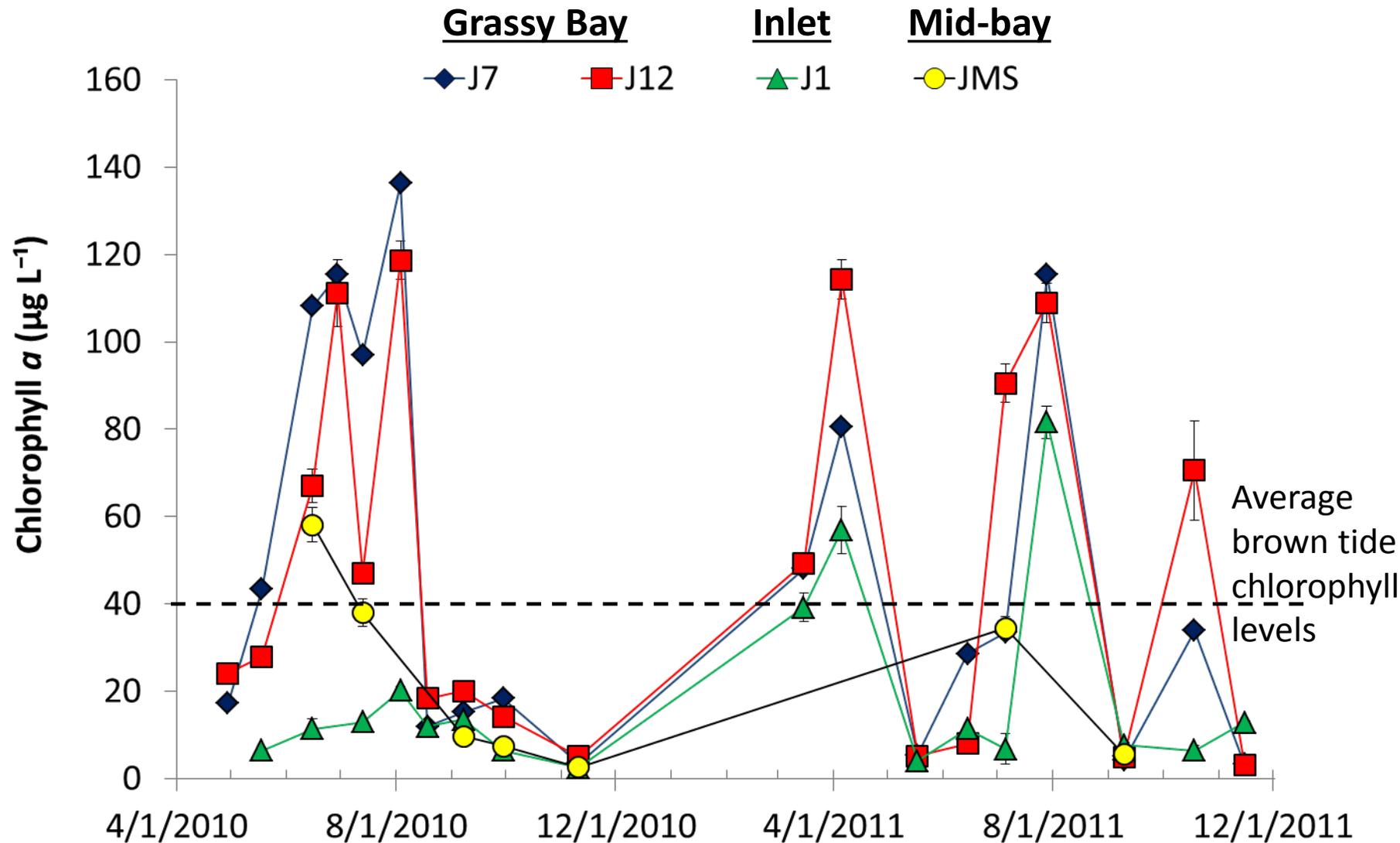
# **OBJECTIVES:**

1. Identify the species of phytoplankton and macroalgae forming blooms in Jamaica Bay.
2. Establish the spatial and temporal dynamics of nutrients, phytoplankton communities, and macroalgae in Jamaica Bay.
3. Assess the temporal and spatial dynamics of nutrient limitation of phytoplankton and macroalgal in Jamaica Bay.
4. Assess ability of physical factors including flushing and light levels to control populations of phytoplankton and macroalgae in Jamaica Bay.

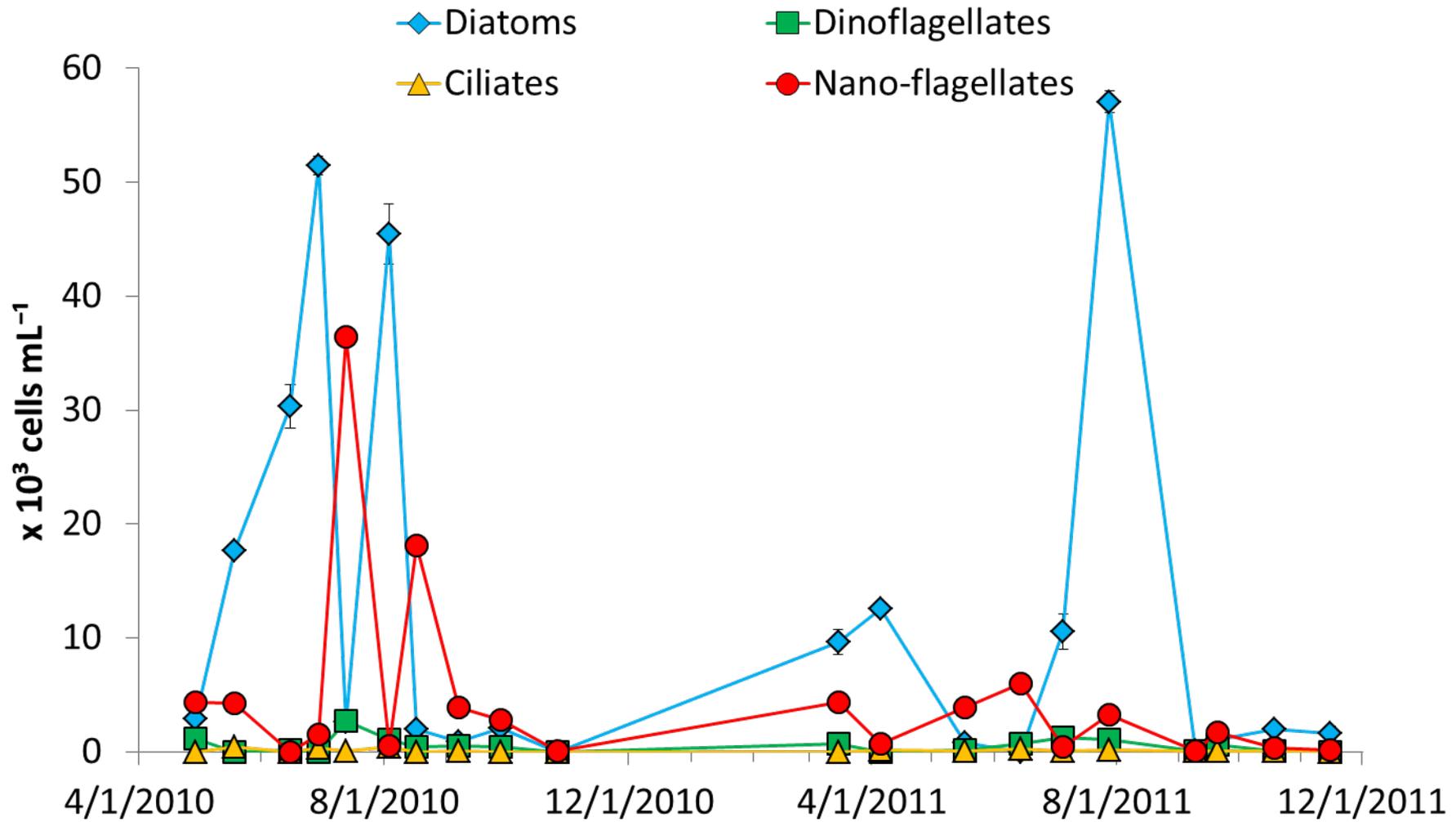
# Phytoplankton Dynamics



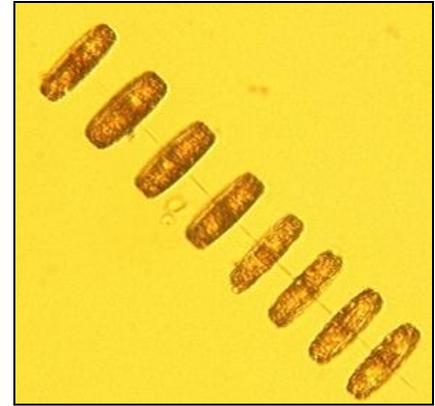
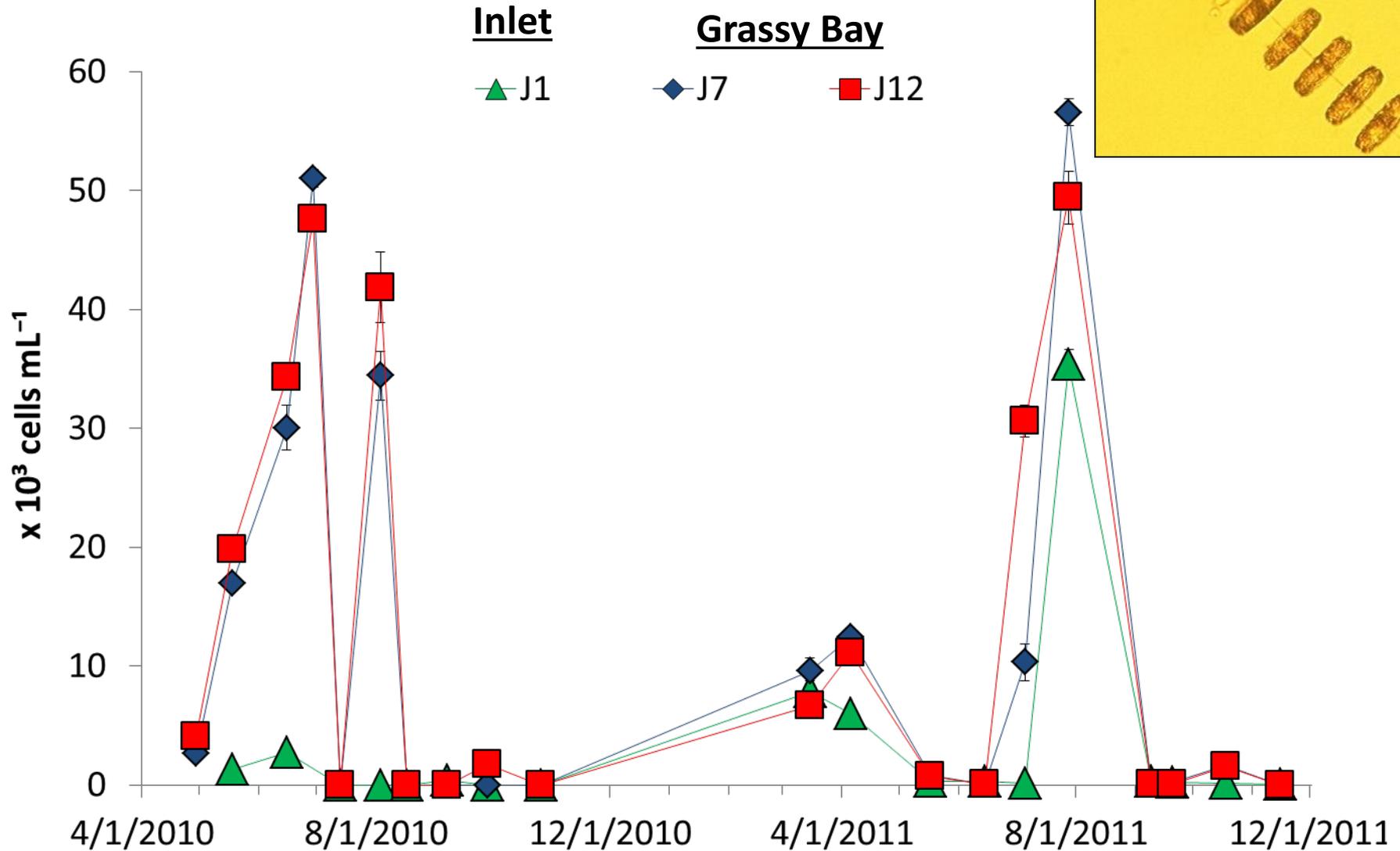
# Chlorophyll *a* time series



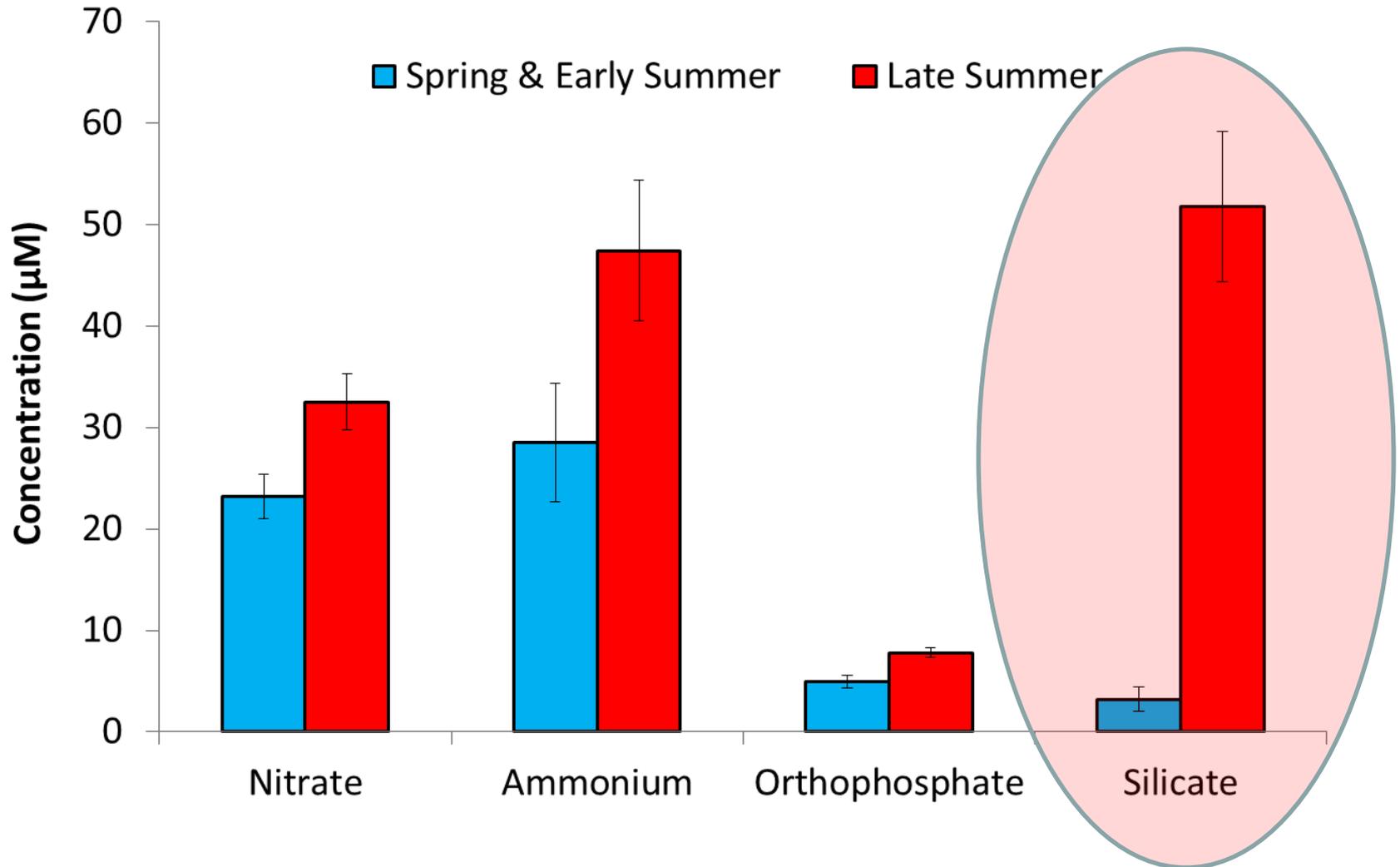
# Plankton community time series



# Dynamics of the diatom *Thalassiosira* spp.

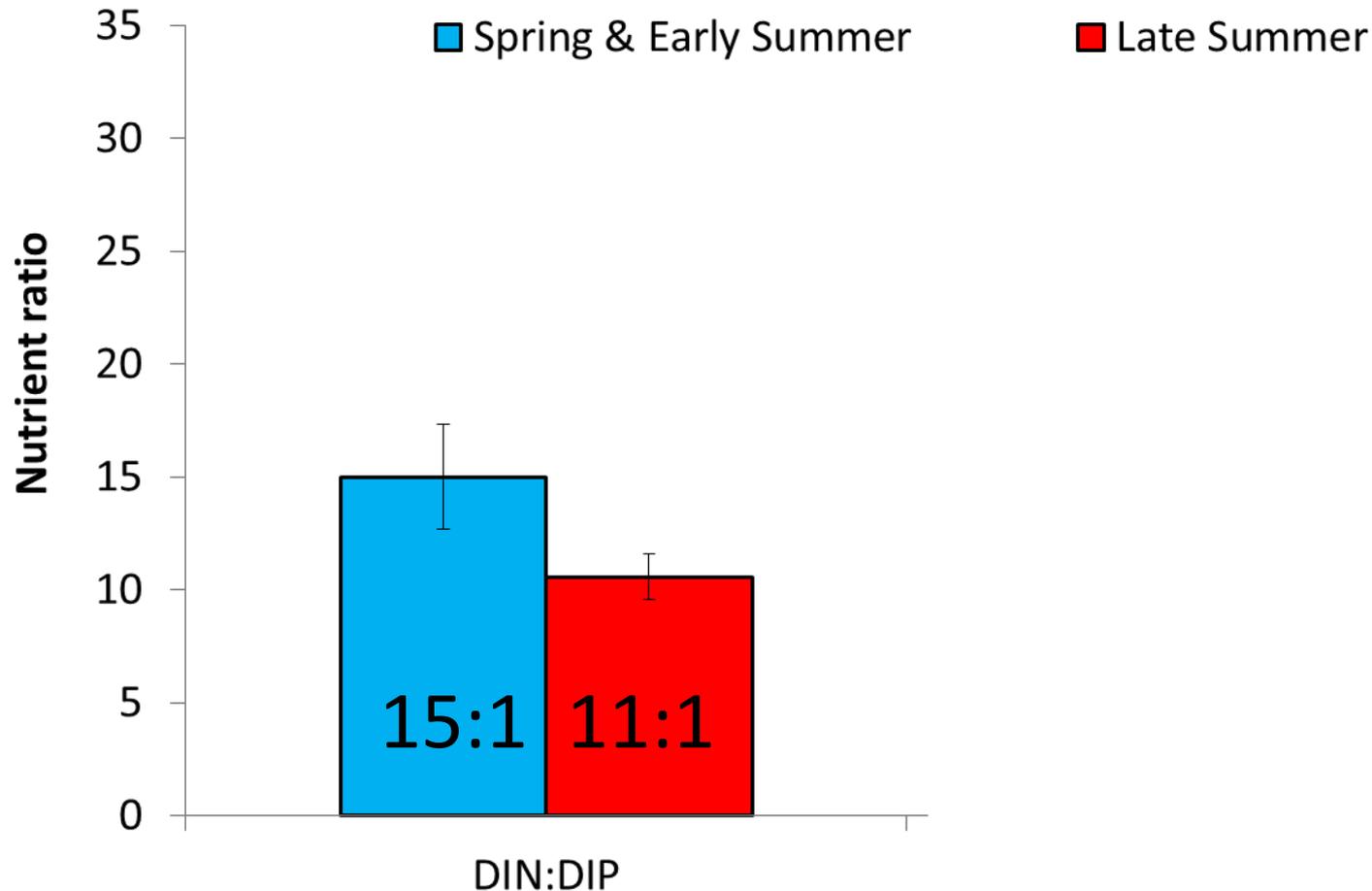


# Temporal trends in nutrients, Grassy Bay & North Channel



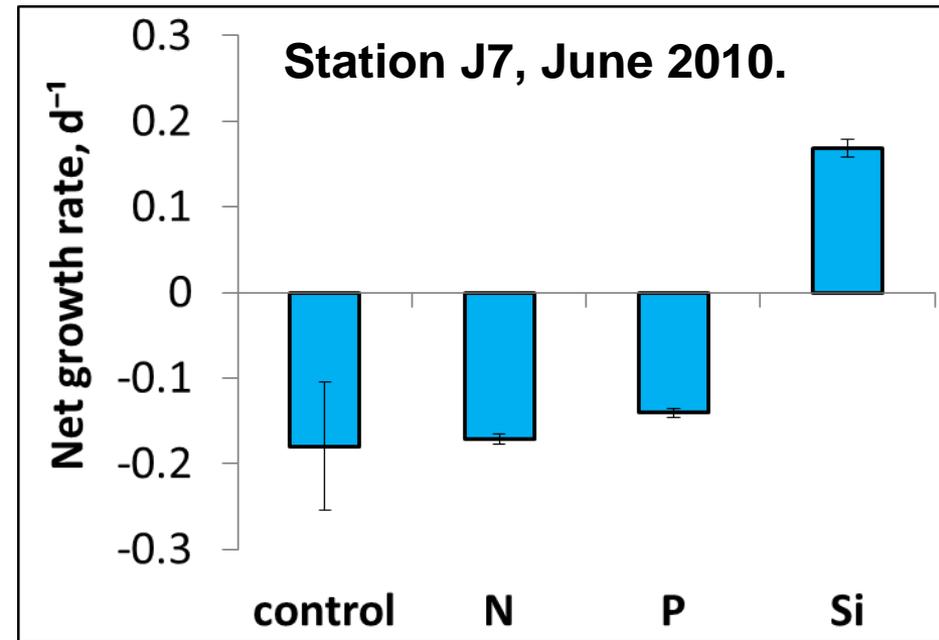
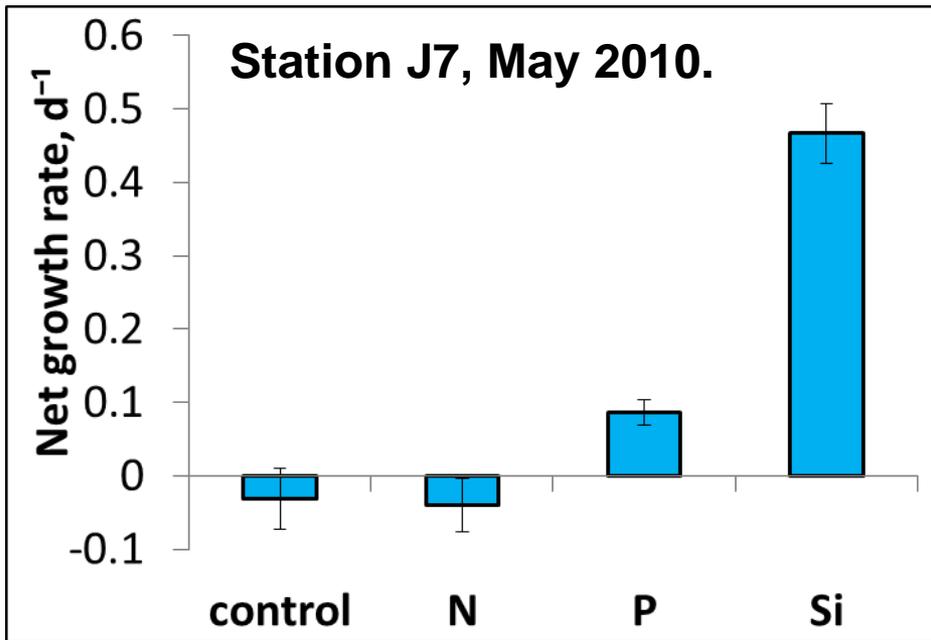
- 20-fold lower in silicate concentrations in spring / early summer
- Spring / early summer concentrations occasionally  $< 1 \mu\text{M}$

# Temporal trends in nutrients ratios



Redfield = 16:1

# Silicate limitation of phytoplankton during spring & early summer

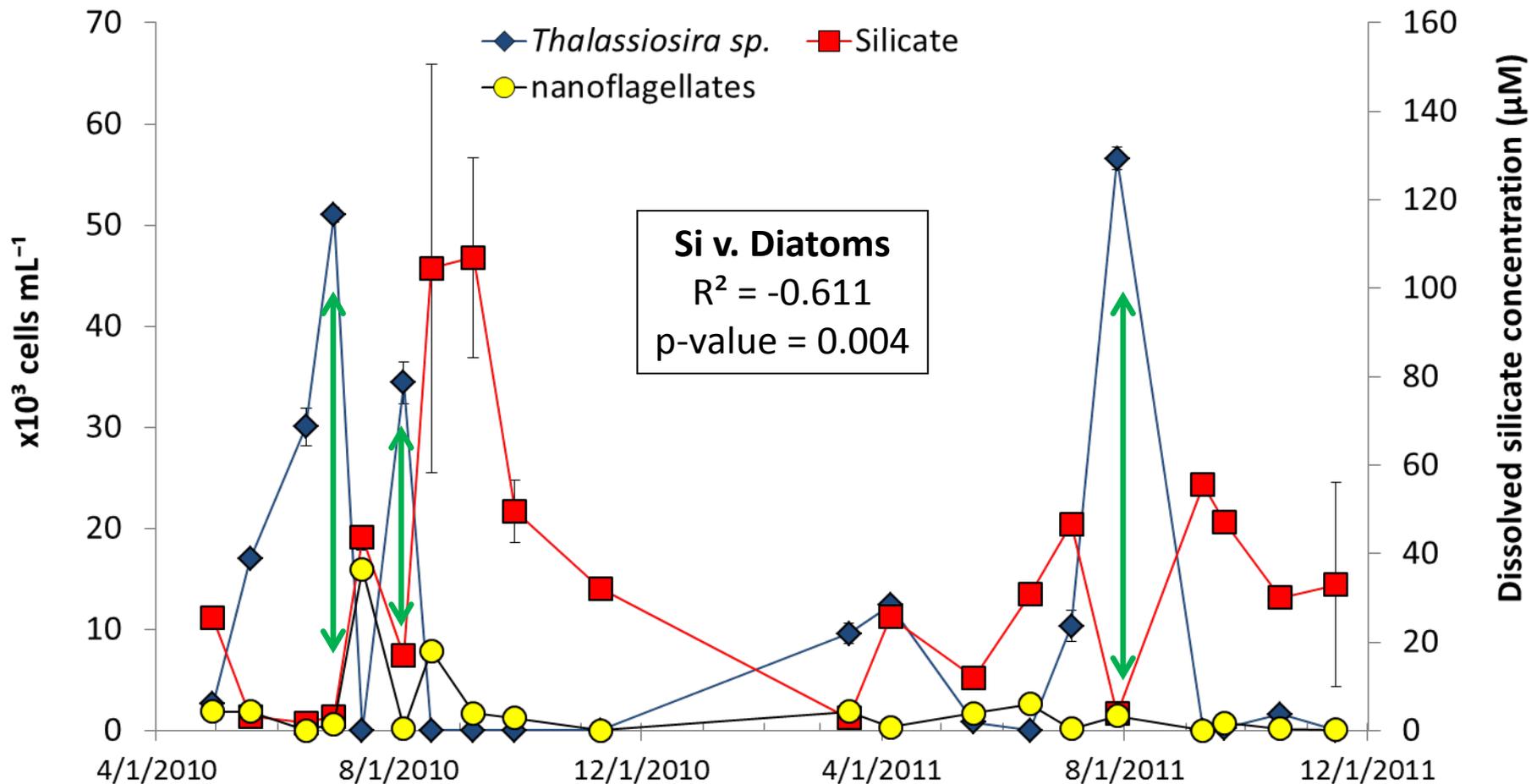


Limiting nutrient determined by significant increases in the net growth rate of phytoplankton compared to control treatments

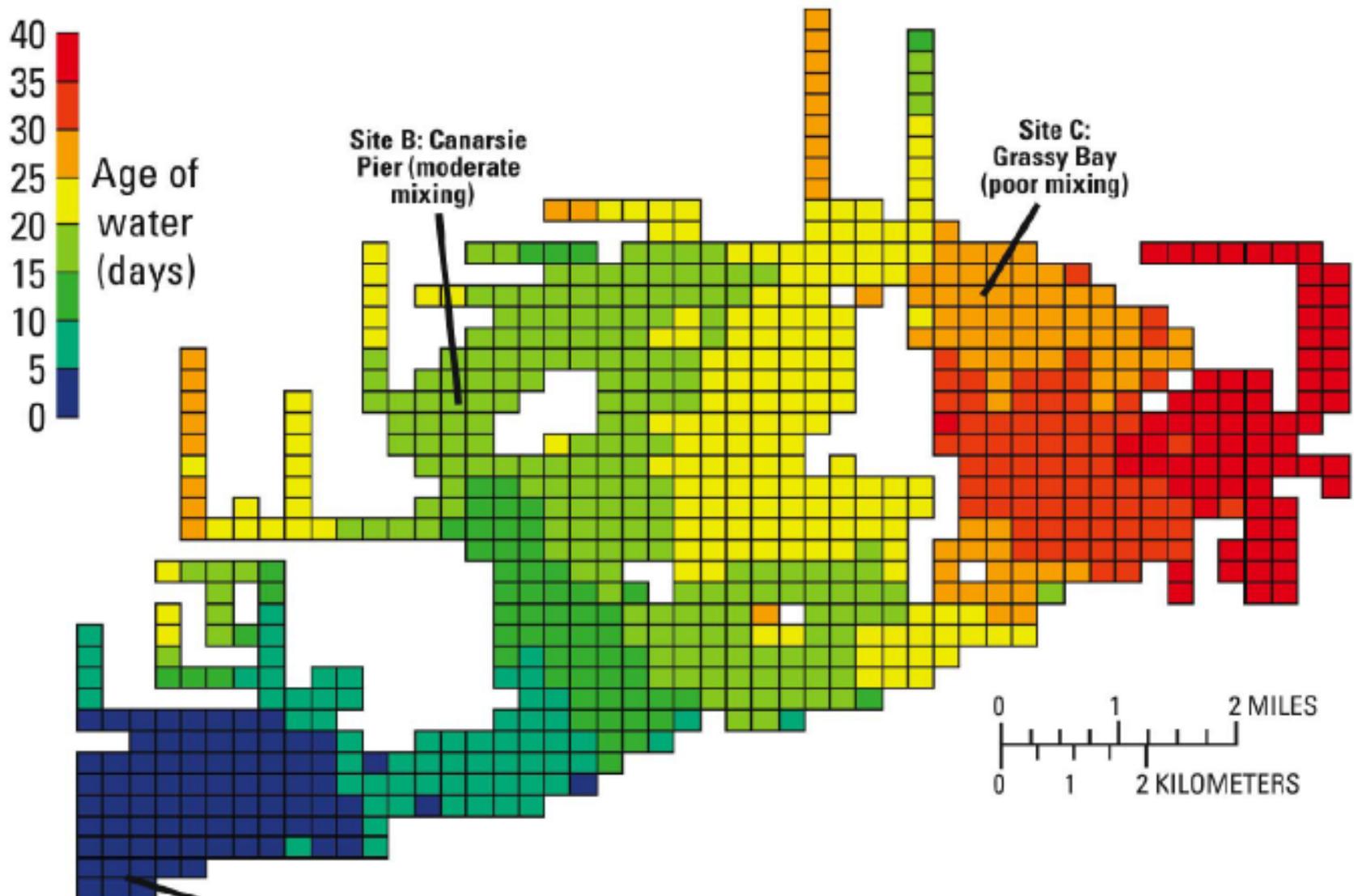
p < 0.05\* p < 0.01\*\* p < 0.001\*\*\*

date	Grassy Bay		North Channel	
	J7	J12	J8	J9A
4/29/2010	NL	n/a	n/a	n/a
5/18/2010	Si***	n/a	n/a	n/a
6/15/2010	Si***	n/a	n/a	n/a
6/29/2010	Si*	n/a	n/a	n/a
7/13/2010	NL	NL	NL	NL
8/3/2010	NL	N**	N***	N*
8/18/2010	NL	NL	NL	NL
9/7/2010	NL	Si**	NL	NL
9/29/2010	NL	NL	NL	NL
11/10/2010	NL	NL	NL	NL
3/15/2011	NL	Si***	Si**	Si**
4/5/2011	NL	NL	Si*	NL
5/17/2011	NL	NL	NL	NL
6/14/2011	NL	NL	NL	NL
7/5/2011	NL	n/a	n/a	n/a
7/28/2011	Si***	NL	n/a	n/a
9/9/2011	NL	NL	n/a	n/a
9/20/2011	NL	NL	n/a	n/a
10/18/2011	NL	NL	n/a	NL

# Drawdown in silicate during *Thalassiosira* sp. blooms

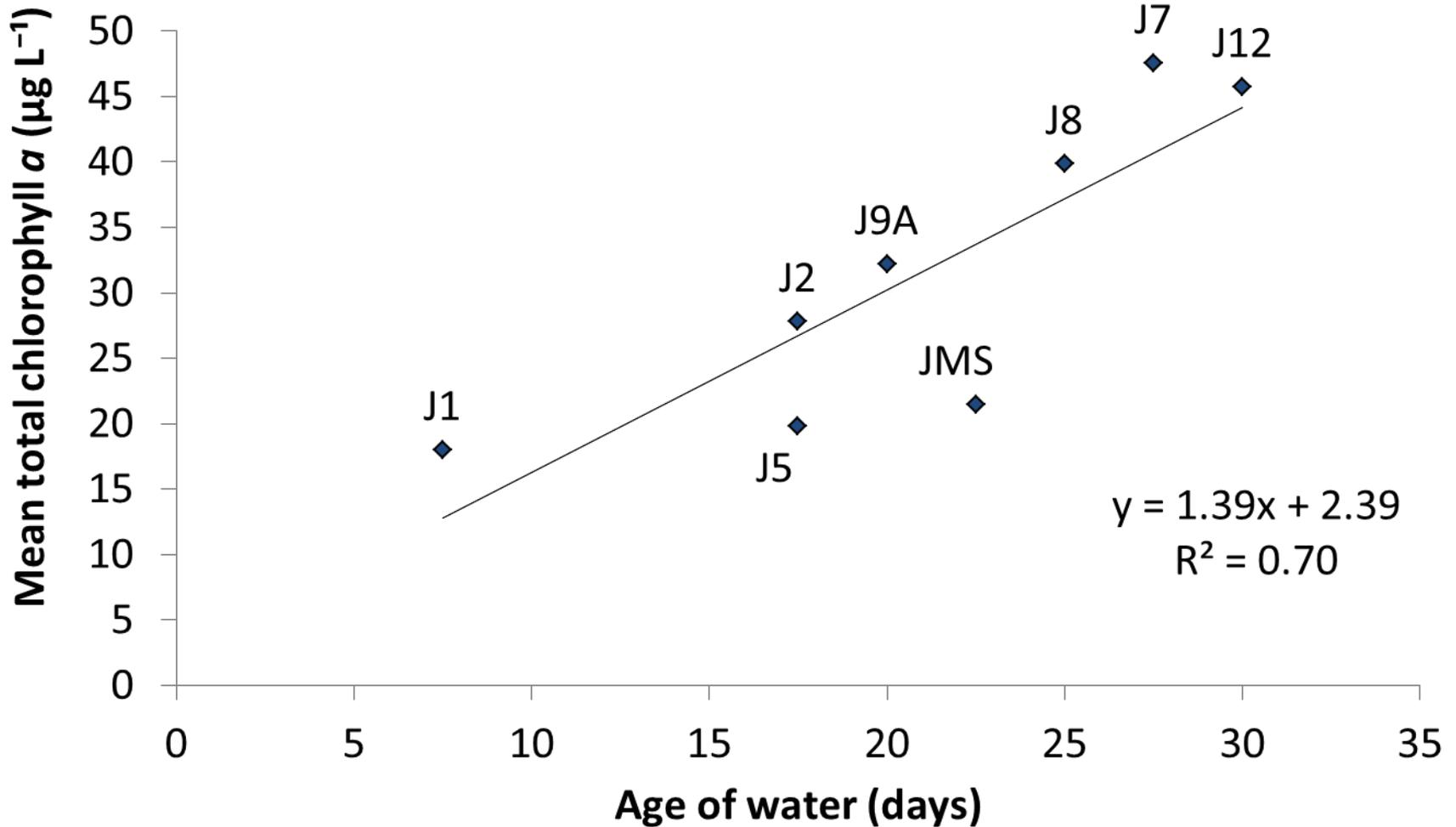


# Flushing rates of Jamaica Bay



Benotti et al. 2007

The accumulation of ***total phytoplankton biomass*** is largely controlled by physical flushing.



Intensity of phytoplankton blooms lessened from the northeast to the southwest (Stations J7 & J12 > J8 & J9A > J1), with Rockaway Inlet (station J1) consistently having the lowest algal biomass

# Macroalgae, *Ulva* spp.



# Which *Ulva* sp. is blooming in Jamaica Bay?

*Eur. J. Phycol.* (2010) 45(3): 230–239



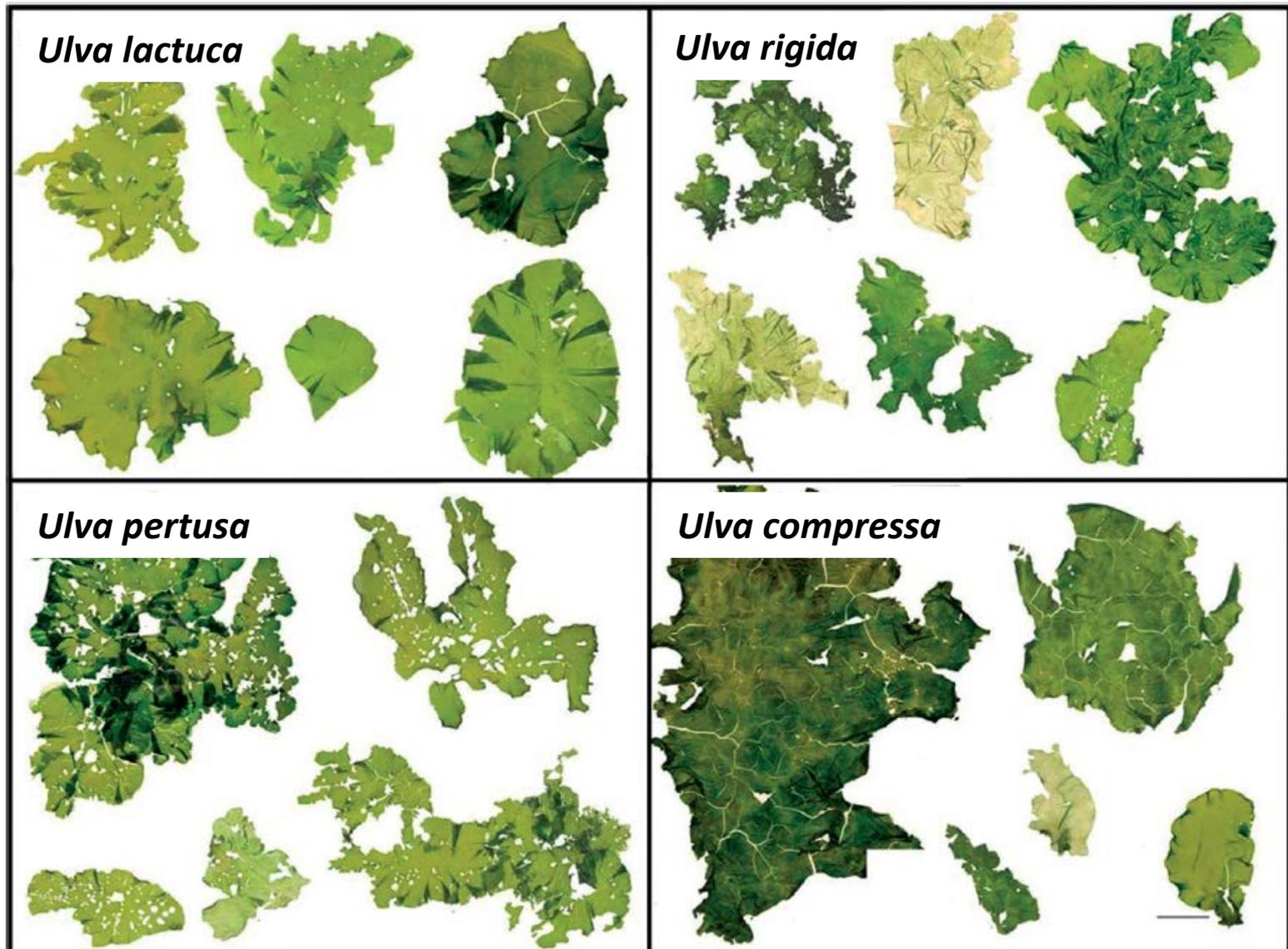
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## Cryptic diversity of *Ulva* (Ulvales, Chlorophyta) in the Great Bay Estuarine System (Atlantic USA): introduced and indigenous distromatic species

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LAURIE C. HOFMANN<sup>1,†</sup>, JEREMY C. NETTLETON<sup>1</sup>, CHRISTOPHER D. NEEFUS<sup>1</sup>  
AND ARTHUR C. MATHIESON<sup>1,2</sup>

# Which *Ulva* sp. is blooming in Jamaica Bay?

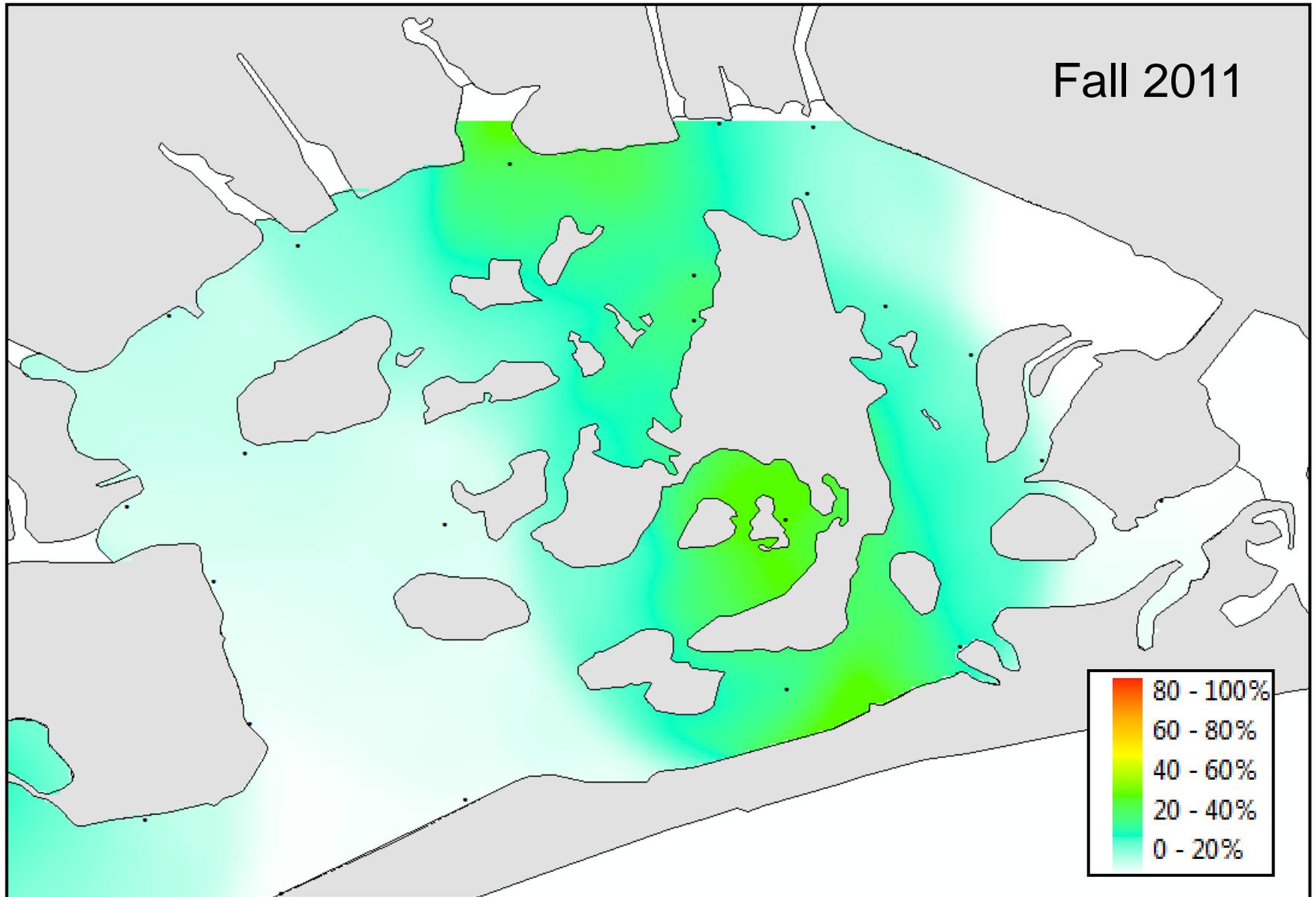


# Survey says... *Ulva rigida*

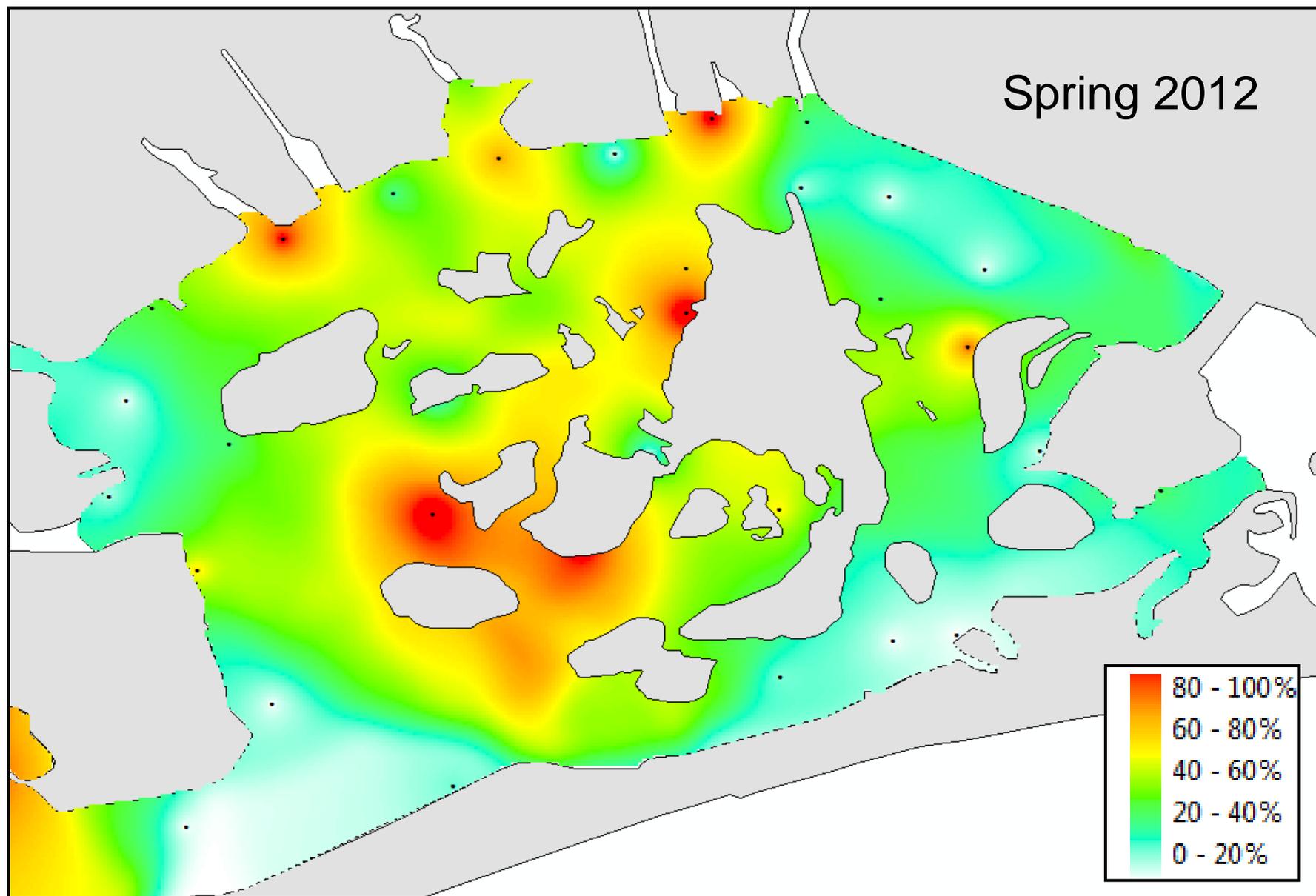
- Sequencing of ITS region I and II of the ribosome from samples collected from Jamaica Bay during spring, summer, and fall.

<input type="checkbox"/>	Name	Description	Sequence Length	# Sequences	% Pairwise Identity ▼
	AB097659	<i>Ulva rigida</i>	318	2	100.0%
	AB097660	<i>Ulva rigida</i>	318	2	100.0%
	AB097661	<i>Ulva rigida</i>	318	2	100.0%
	AB097662	<i>Ulva rigida</i>	318	2	100.0%
	EU933970	<i>Ulva laetevirens</i>	342	2	99.7%
	EU933989	<i>Ulva laetevirens</i>	342	2	99.7%
	AJ234316	<i>Ulva fenestrata</i>	341	2	99.7%
	AJ000208	<i>Ulva lactuca</i>	341	2	99.1%

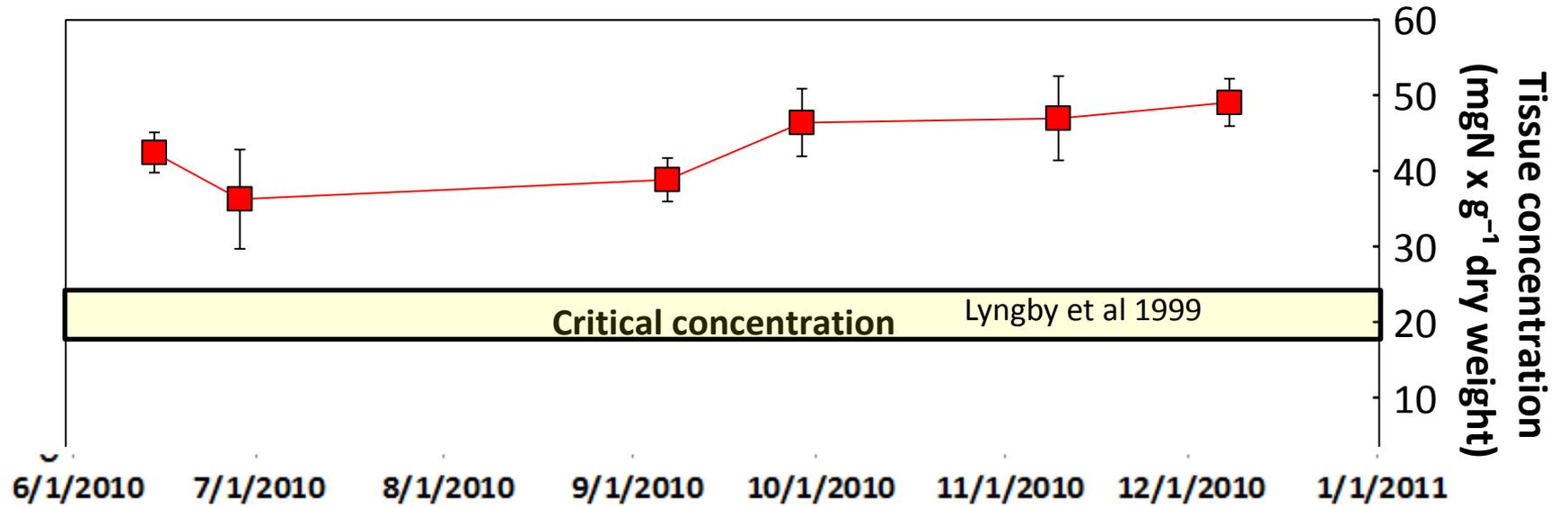
# Percent bottom coverage of *Ulva rigida* in Jamaica Bay



# Percent bottom coverage of *Ulva rigida* in Jamaica Bay



# Total nitrogen tissue concentration collected from central Jamaica Bay

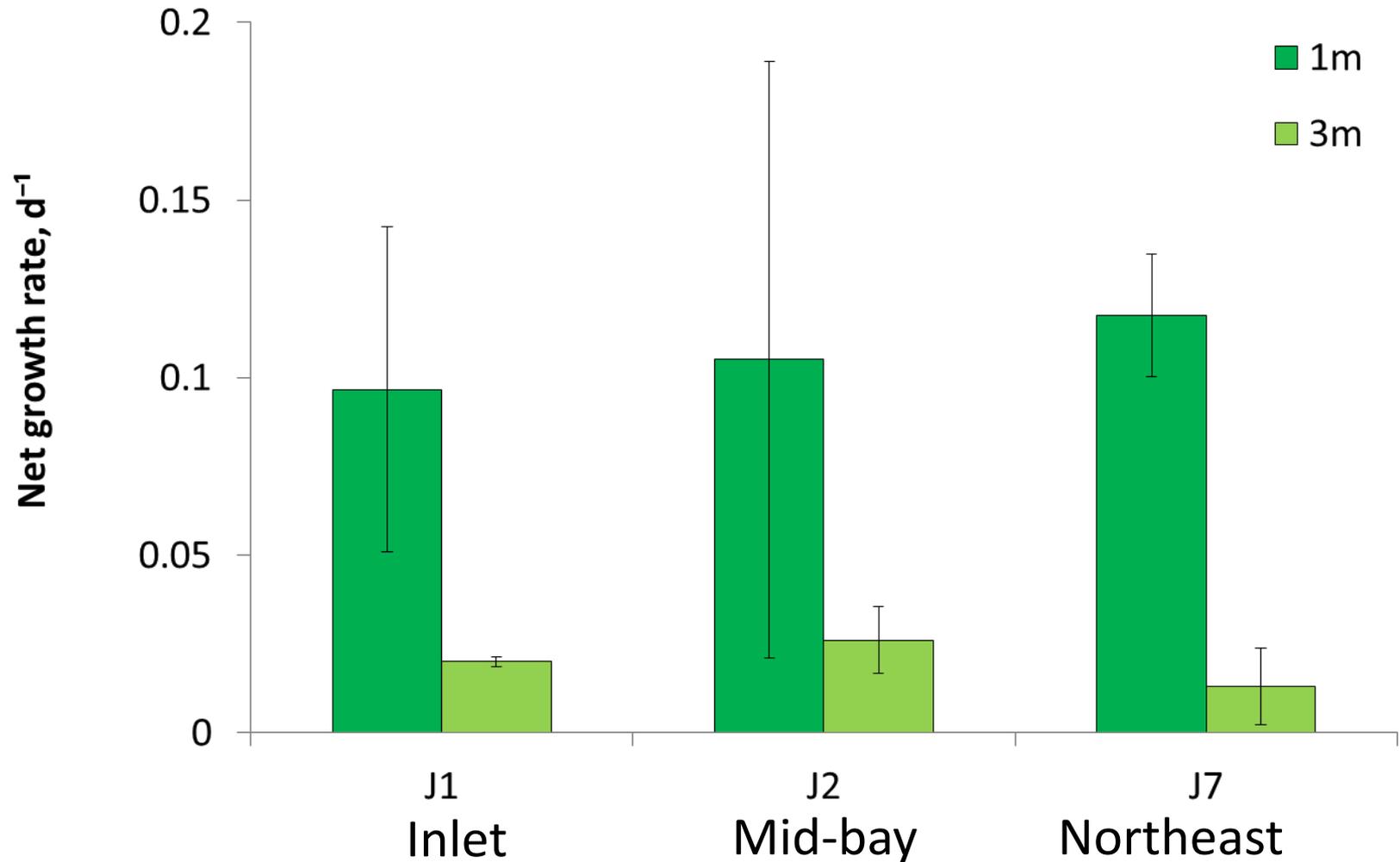


# Limiting nutrient determined by growth rate of *Ulva rigida* during nutrient enrichment experiments

Date	Limiting Nutrient
6/15/2010	NL
6/29/2010	NL
9/7/2010	NL
9/29/2010	NL
11/10/2010	Nitrogen*
12/8/2010	NL
7/5/2011	NL
9/9/2011	NL
9/20/2011	NL
10/18/2011	NL

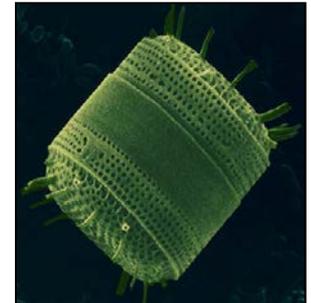
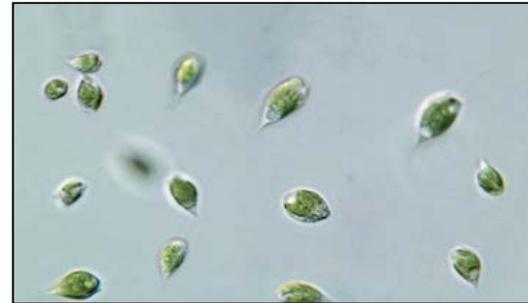
p < 0.05\*

# In situ growth rates of *Ulva rigida* in October 2011

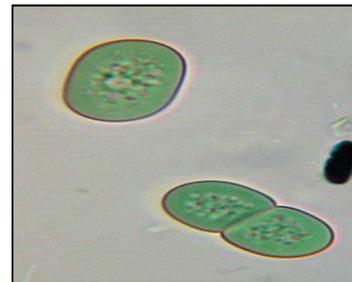
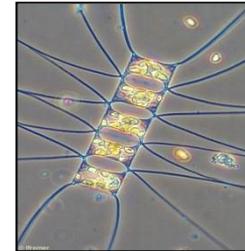
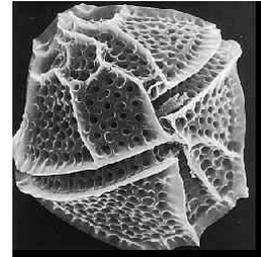


- *Ulva* growth rates at 1 meter depth were significantly higher than the *Ulva* incubated at 3 meters depth ( $p < 0.001$ ).

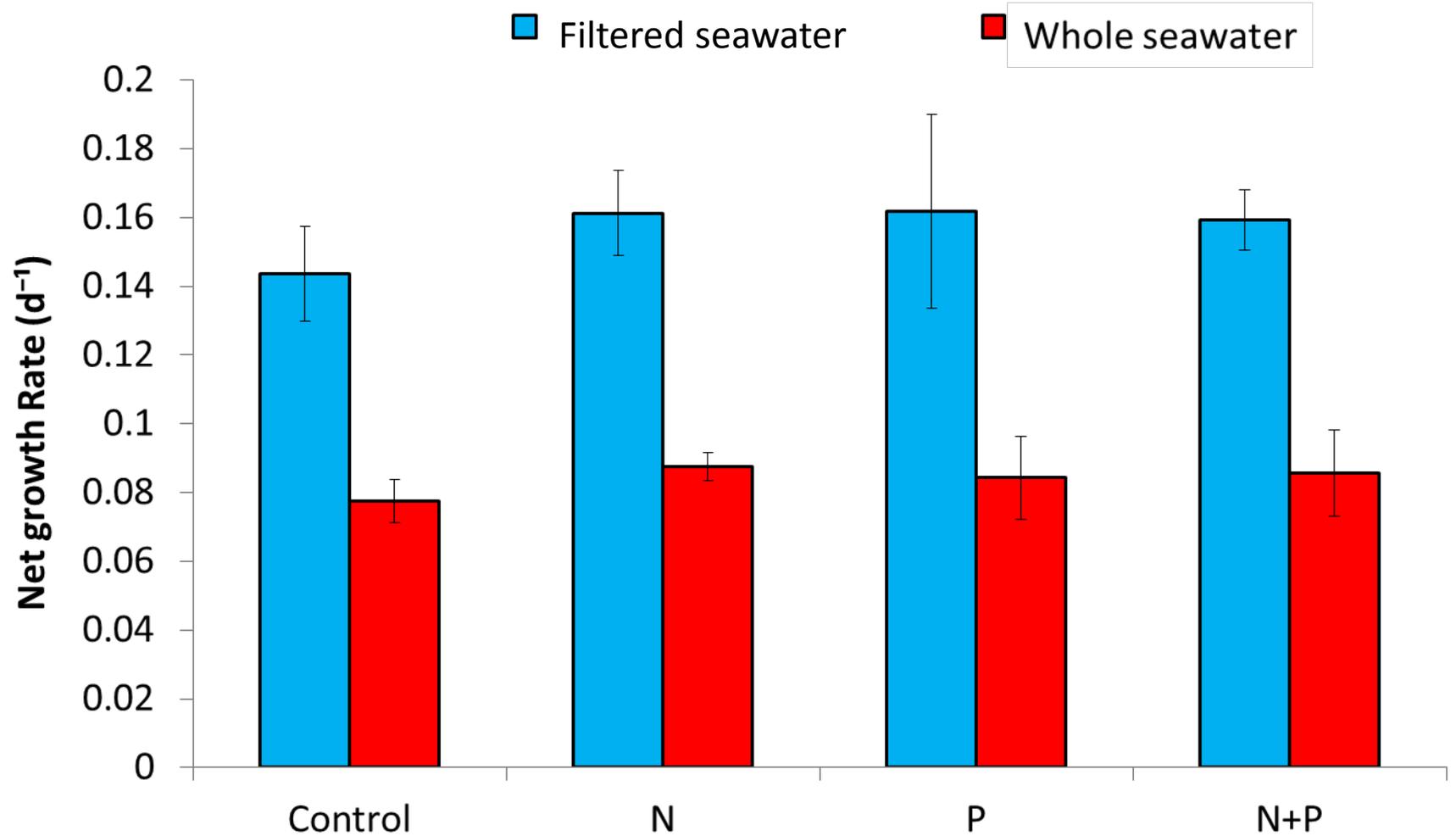
# Microalgal – macroalgal competition



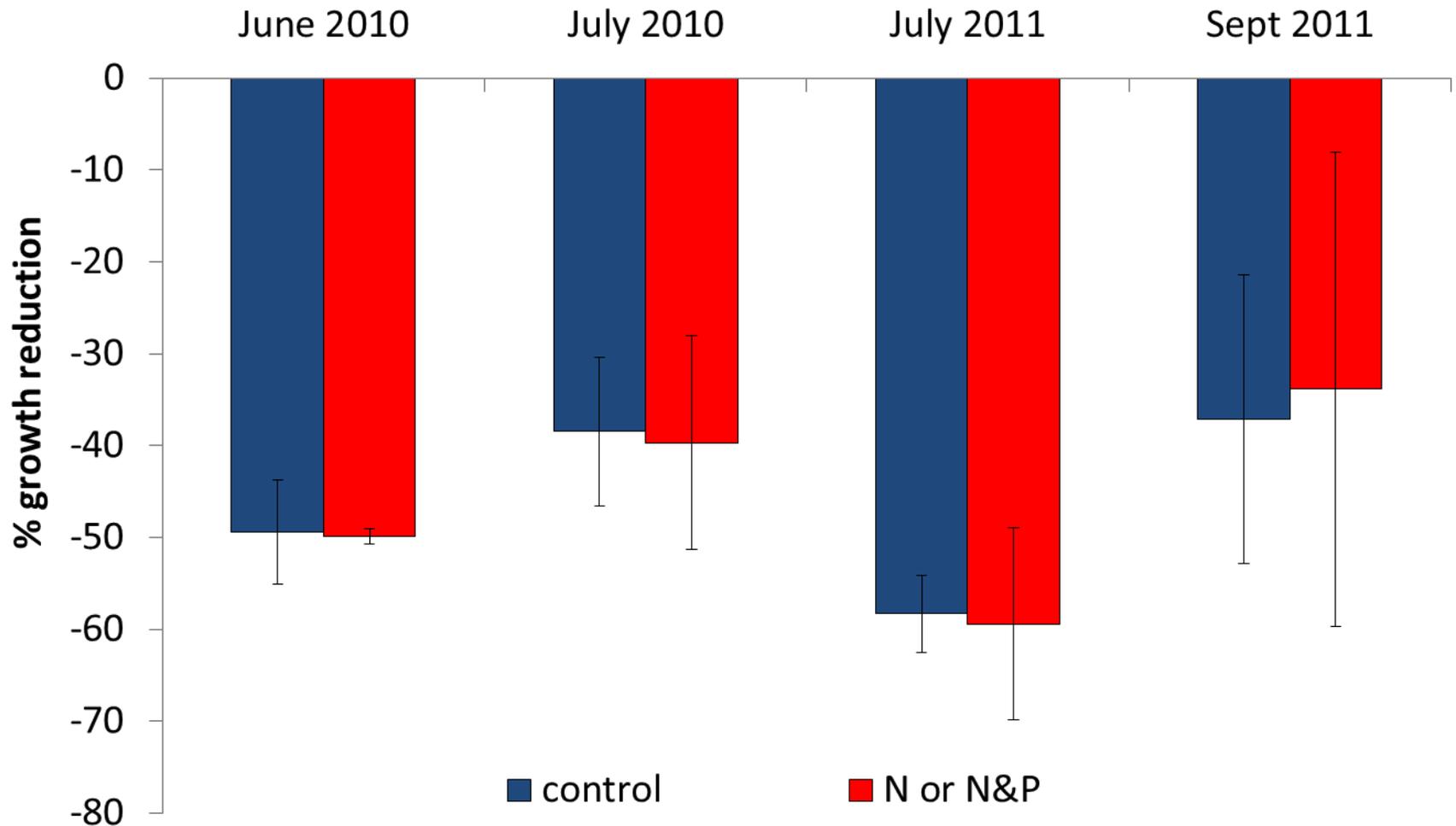
vs.



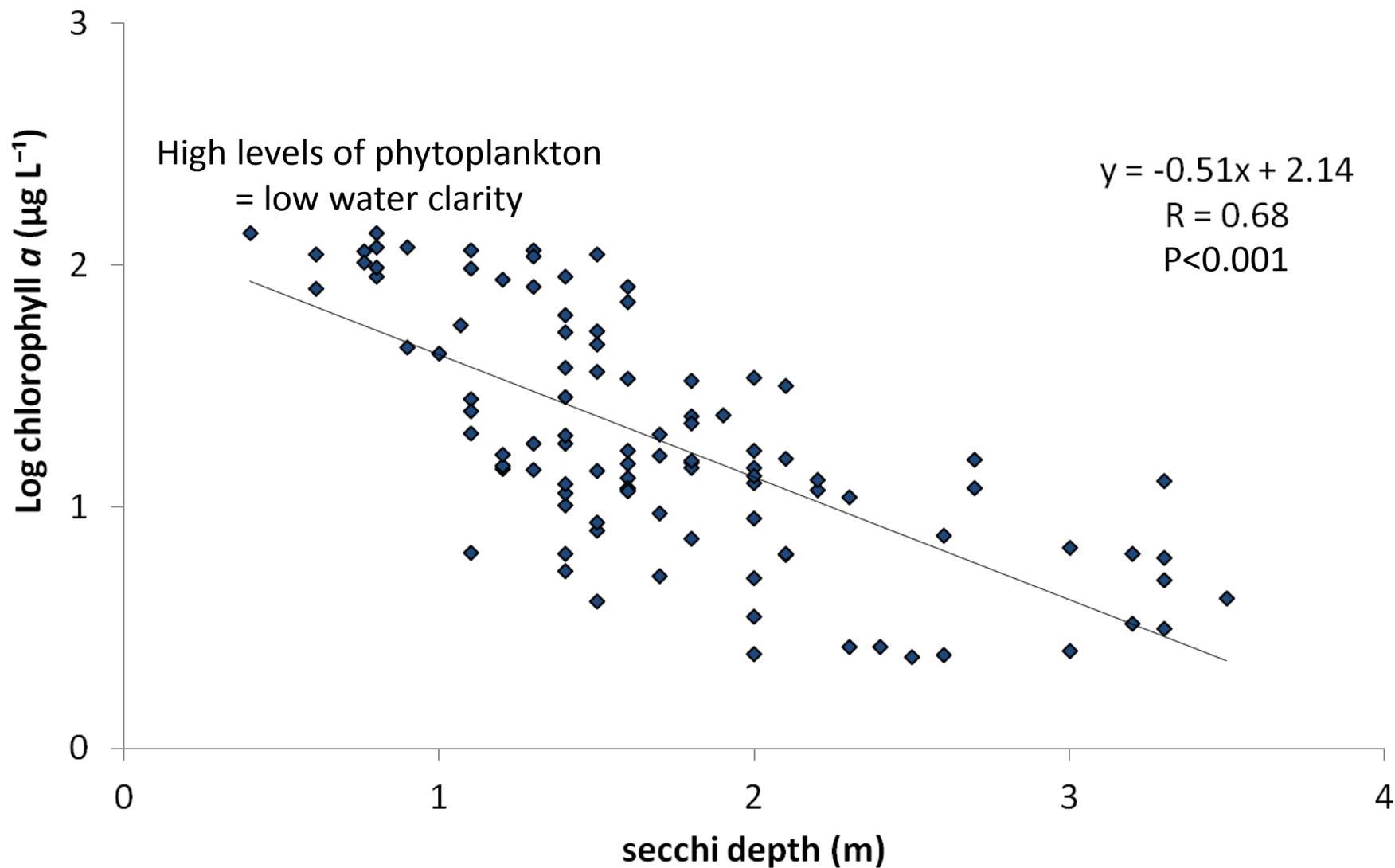
# Response of *Ulva rigida* to nitrogen & phosphorous with and without phytoplankton present



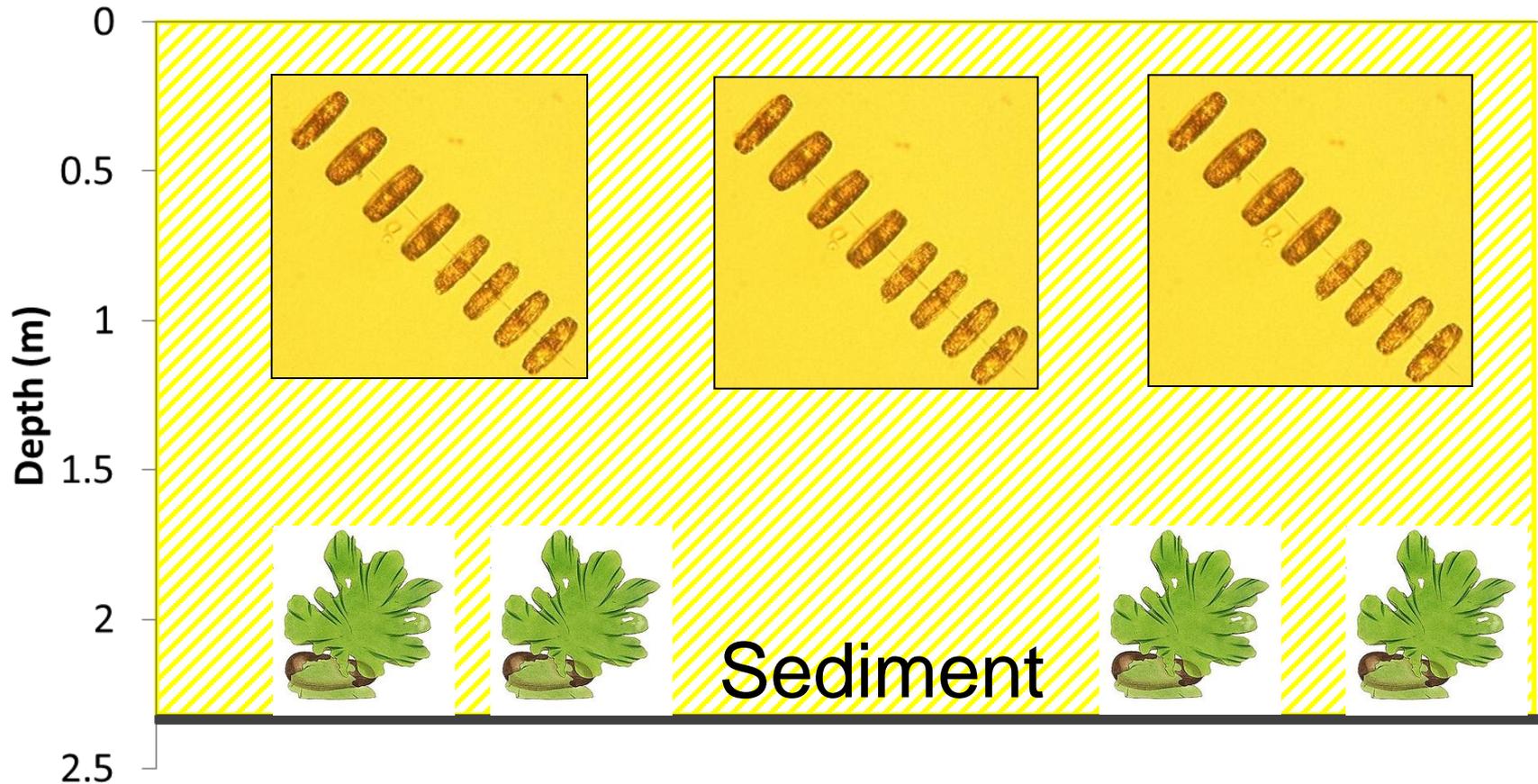
Percent reduction in growth of *Ulva rigida* when incubated with whole phytoplankton community compared to incubations in filtered seawater, with and without nutrient additions.



# Chlorophyll and water clarity in Jamaica Bay

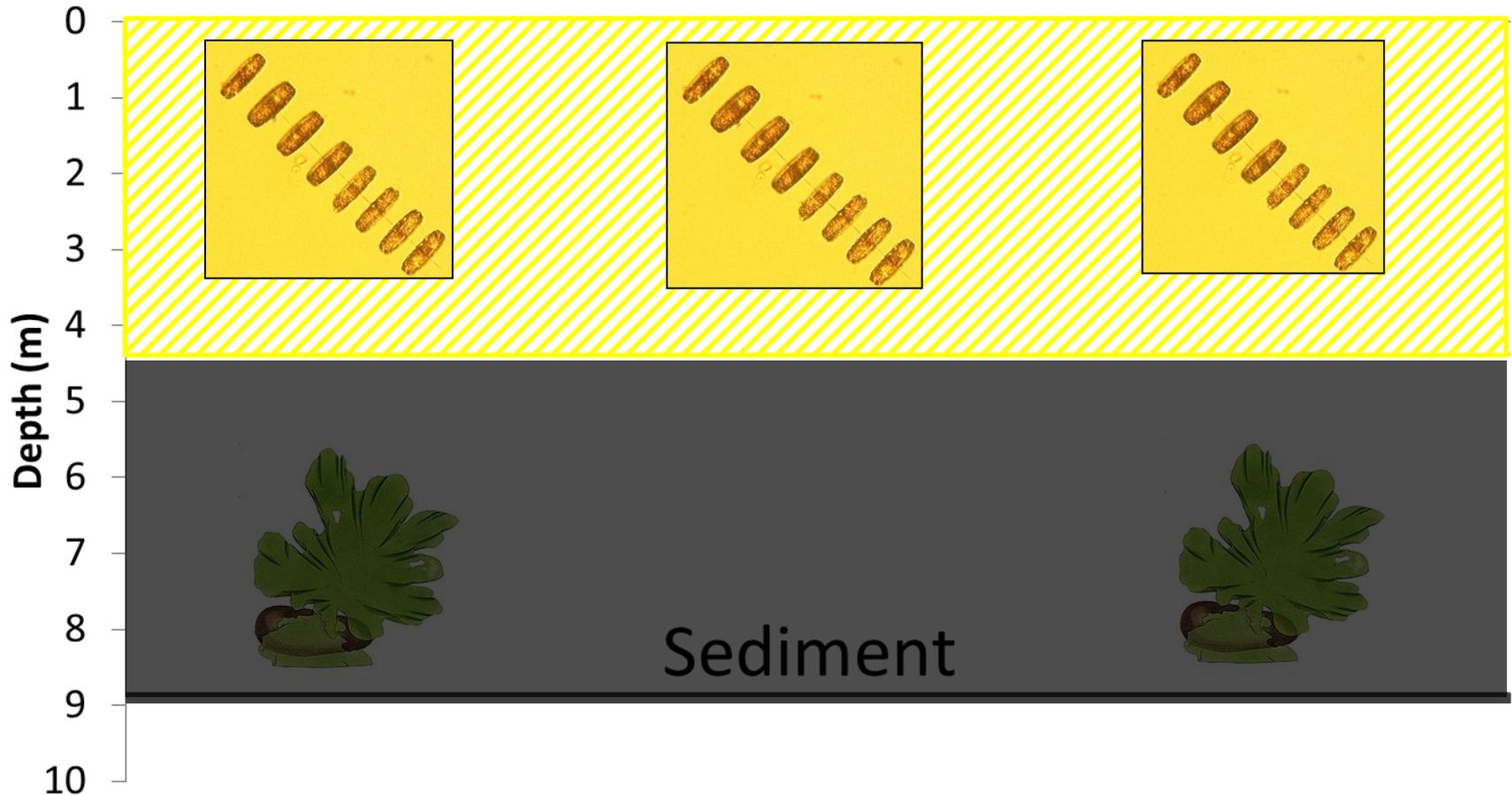


# Euphotic zone, central bay



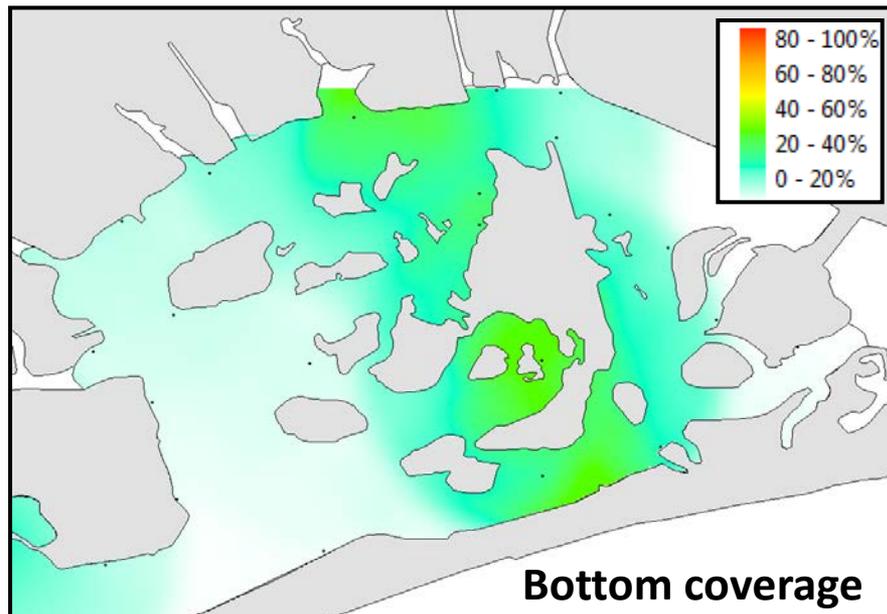
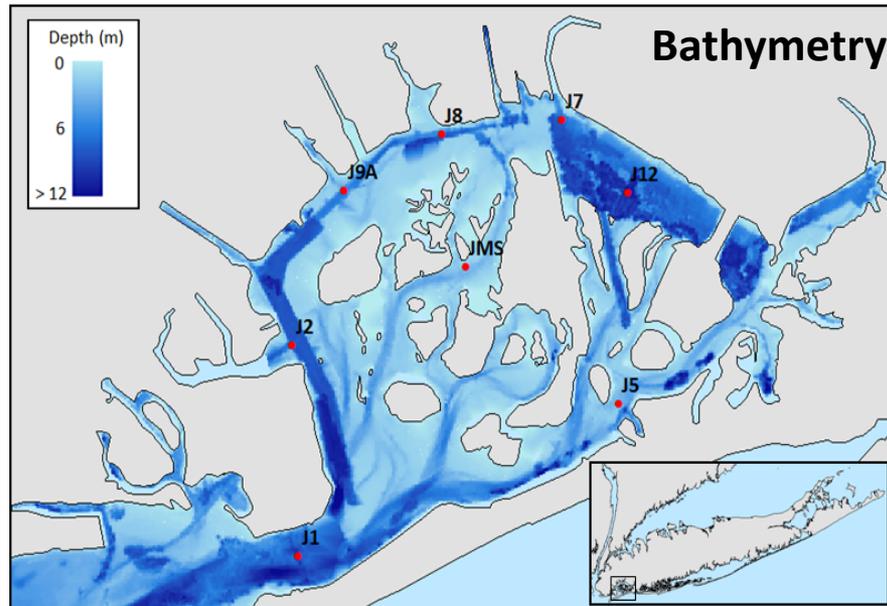
Sand-Jensen 1988: *Ulva* requires 1% of incident light to grow

# Euphotic zone, North Channel and Grassy Bay



Sand-Jensen 1988: *Ulva* requires 1% of incident light to grow

# Depth and coverage of *Ulva rigida* in Jamaica Bay



# Conclusions

- The discharge of two large wastewater treatment plant outfalls into the region with the longest residence times promotes the proliferation and persistence of high density phytoplankton blooms.
- Phytoplankton blooms were dominated by *Thalassiosira* spp. during the spring, summer, and fall.
- The enormous input of nutrients from these plants prevents N or P from limiting the growth of phytoplankton or macroalgae.
- Phytoplankton populations were controlled by silicate supply and residence times.
- *Ulva rigida* populations were rarely limited by nutrients but instead were strongly light limited by dense phytoplankton blooms.

# Acknowledgements

