

# FKNMS Benthic Habitat Monitoring Program



FKNMS Steering Committee Meeting, Feb 12, 2014, Marathon, FL

# Goals for the project

## *At the regional scale:*

- Define the present distribution of benthic communities within the FKNMS
- Provide high-quality, quantitative data on the status of the seagrasses within the FKNMS
- Quantify the importance of seagrass primary production in the FKNMS
- Define the baseline conditions for the seagrass communities of south Florida
- Determine relationships between water quality & benthic community status
- Detect trends in the distribution and status of the benthic communities

# Monitoring strategy

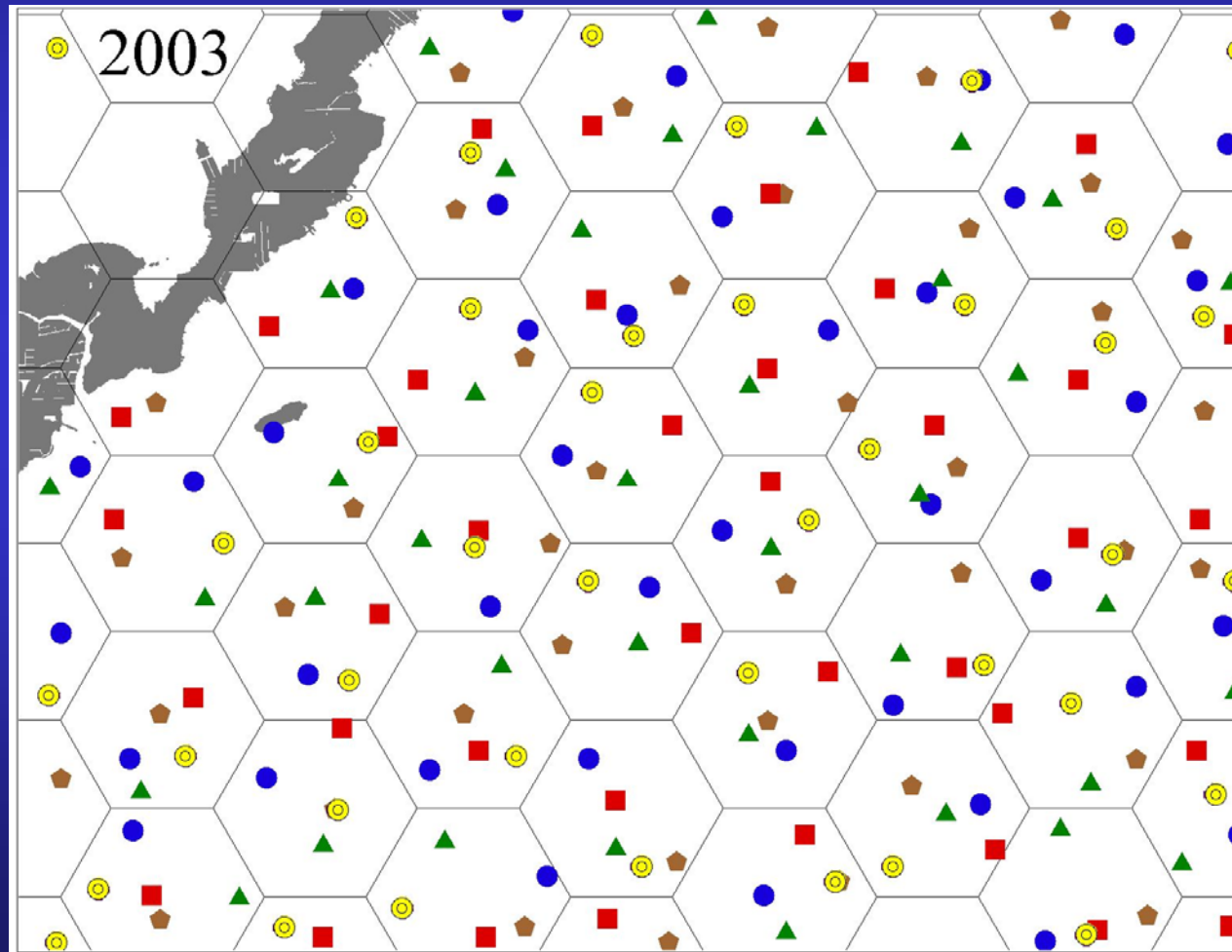
*Given that it is not possible to measure everything, everywhere, all the time:*

- Limited resources had to be allocated to addressing the competing goals of spatial comprehensiveness and temporal sensitivity.
- ~~Spatial comprehensiveness assured by adopting a distributed, stratified-random site selection procedure for “synoptic mapping” sites (REMAP).~~
- Temporal sensitivity assured by concentrating some of the sampling effort on randomly-selected, permanent sites

# Information being collected

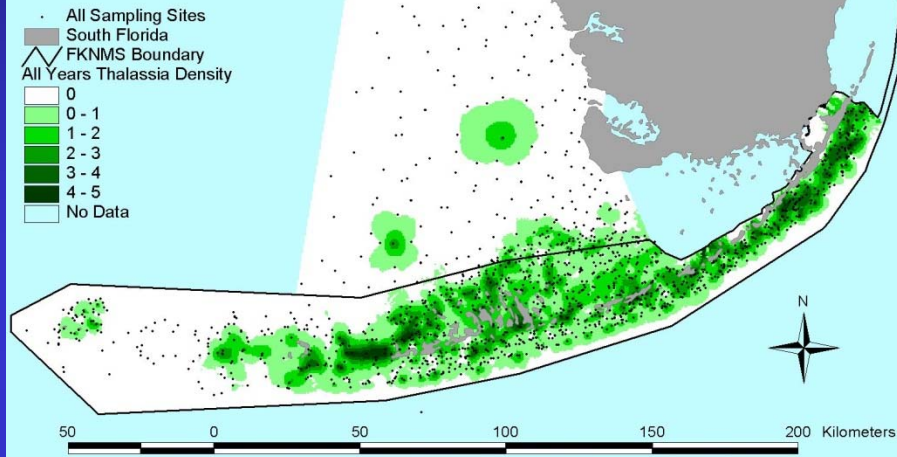
- Distribution & abundance of seagrasses and associated fauna and flora using rapid assessment Braun-Blanquet surveys
  - ~~30~~ 40 permanent sites 2 times a year
  - ~~Ca. 200 mapping sites/year~~
- Seagrass nutrient availability using tissue concentration assays and stable isotopic analyses
  - ~~30~~ 40 permanent sites 2 times a year
  - ~~Ca. 200 mapping sites/year~~
- Water column physicochemical data
  - ~~30~~ 40 permanent sites 2 times a year
  - ~~Ca. 200 mapping sites/year~~

# Describing spatial pattern in monitoring data – Stratified-random sampling

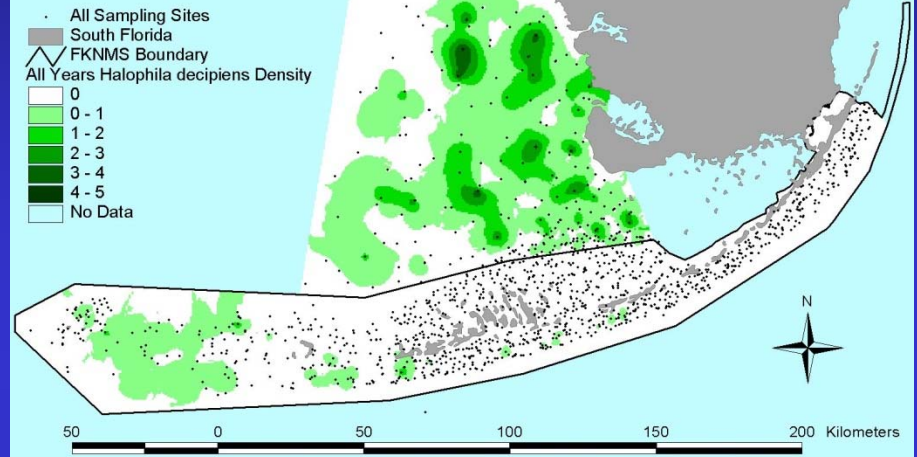


# Synoptic Surveys: Species distributions

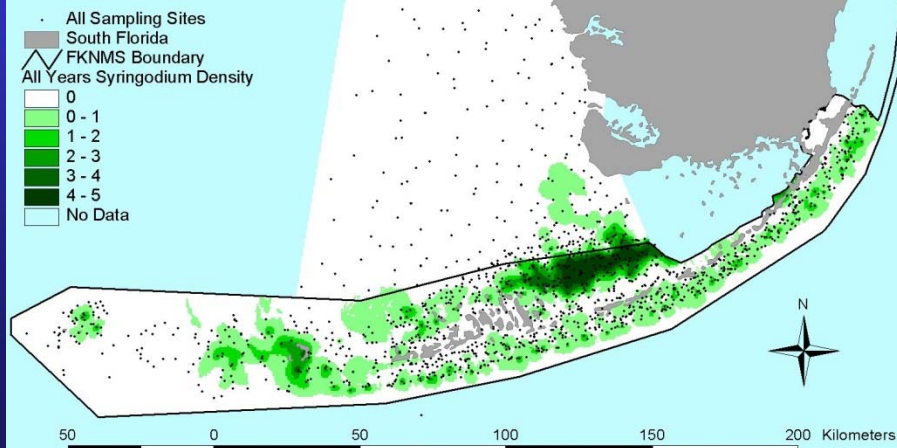
## *Thalassia testudinum*



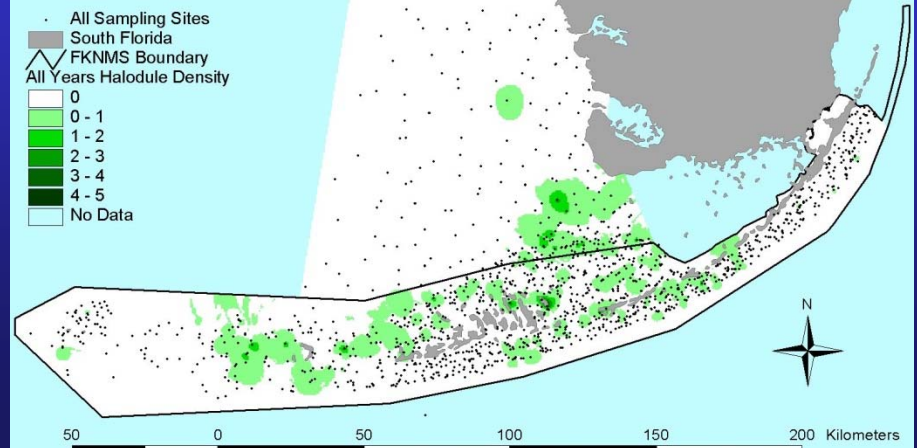
## *Halophila decipiens*



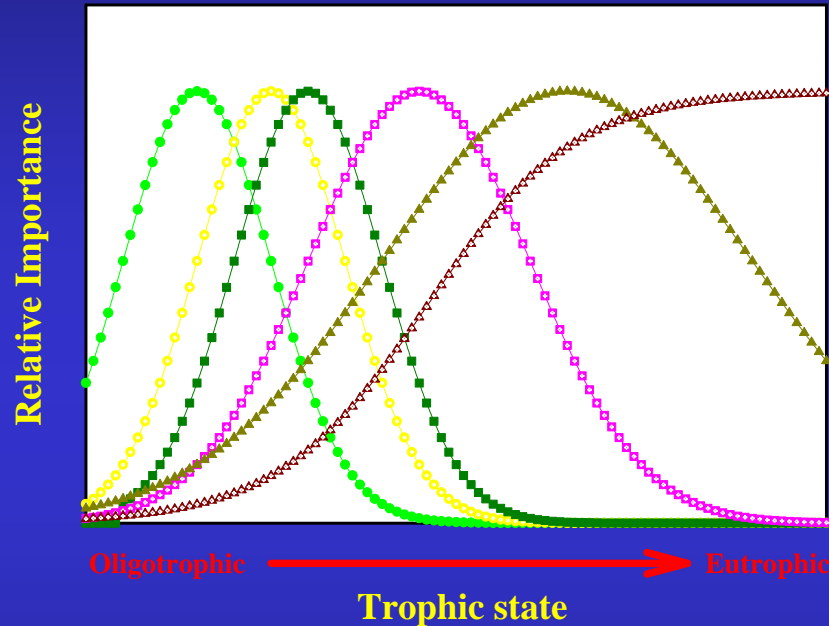
## *Syringodium filiforme*



## *Halodule wrightii*



## Eutrophication model

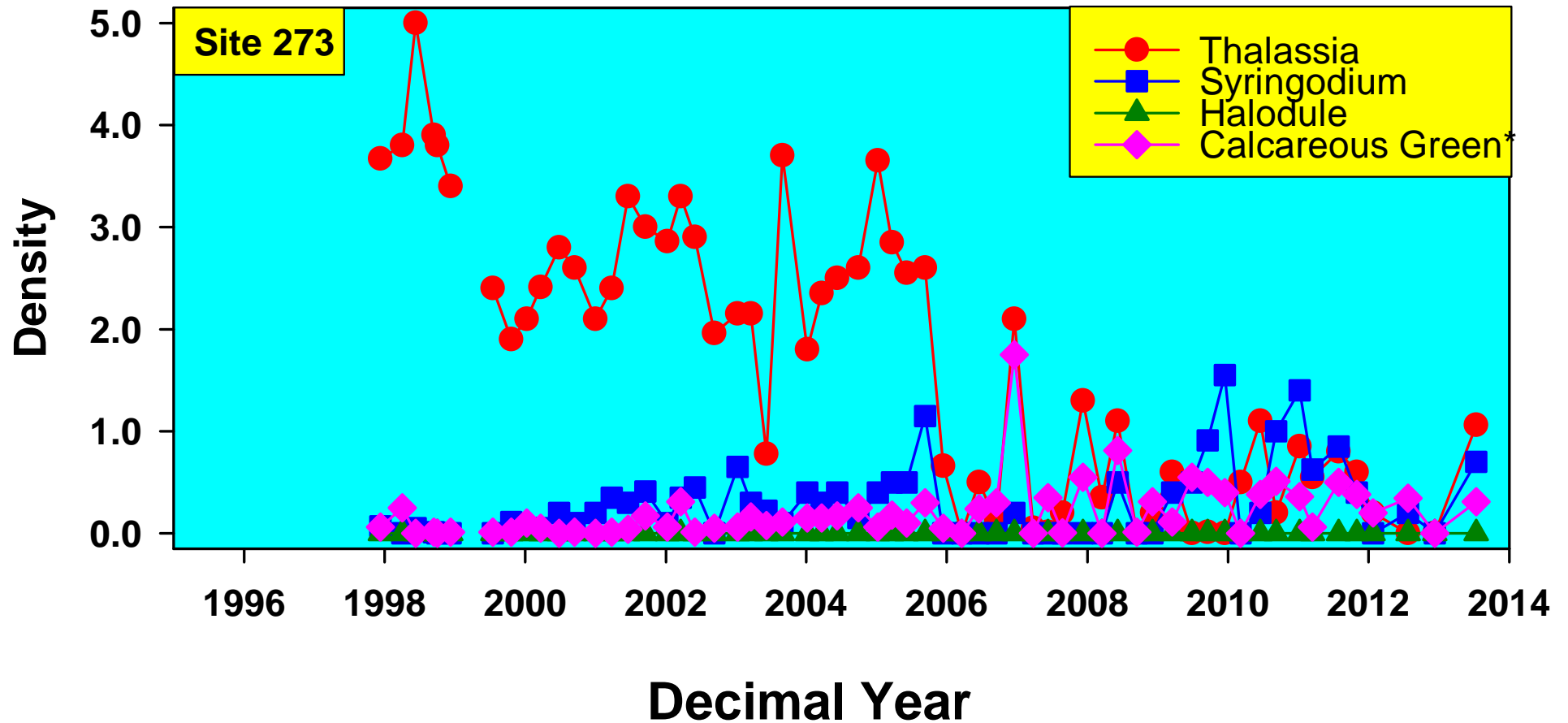


- *Thalassia testudinum*
- *Syringodium filiforme*
- *Halodule wrightii*
- *Ruppia maritima*
- ▲— Macroalgae
- △— Microalgae

Explicit model of ecosystem behavior #1

Nutrient pollution will lead to changes in relative abundances of primary producers in a predictable way.

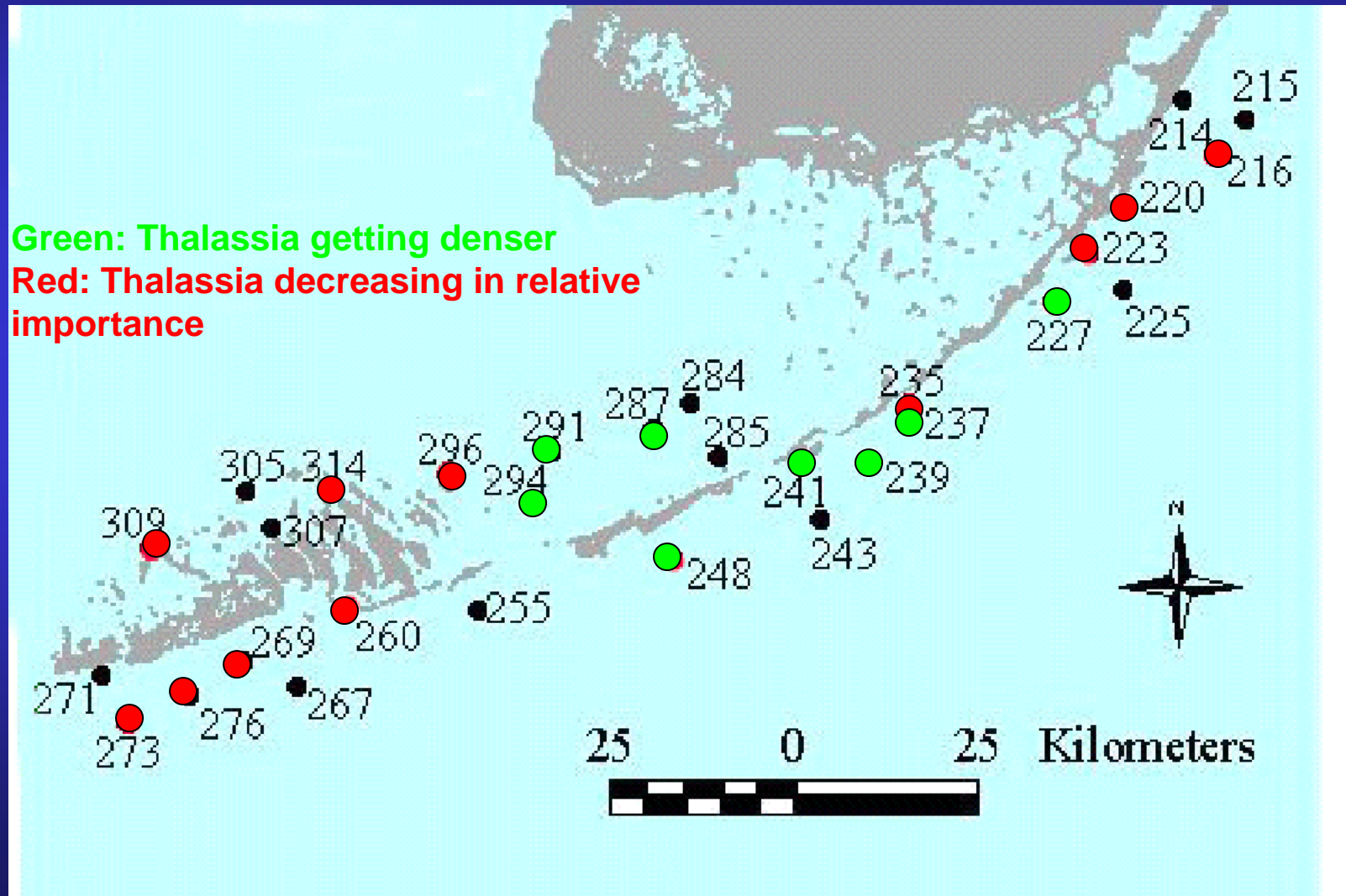
# Changes in relative abundance of primary producers





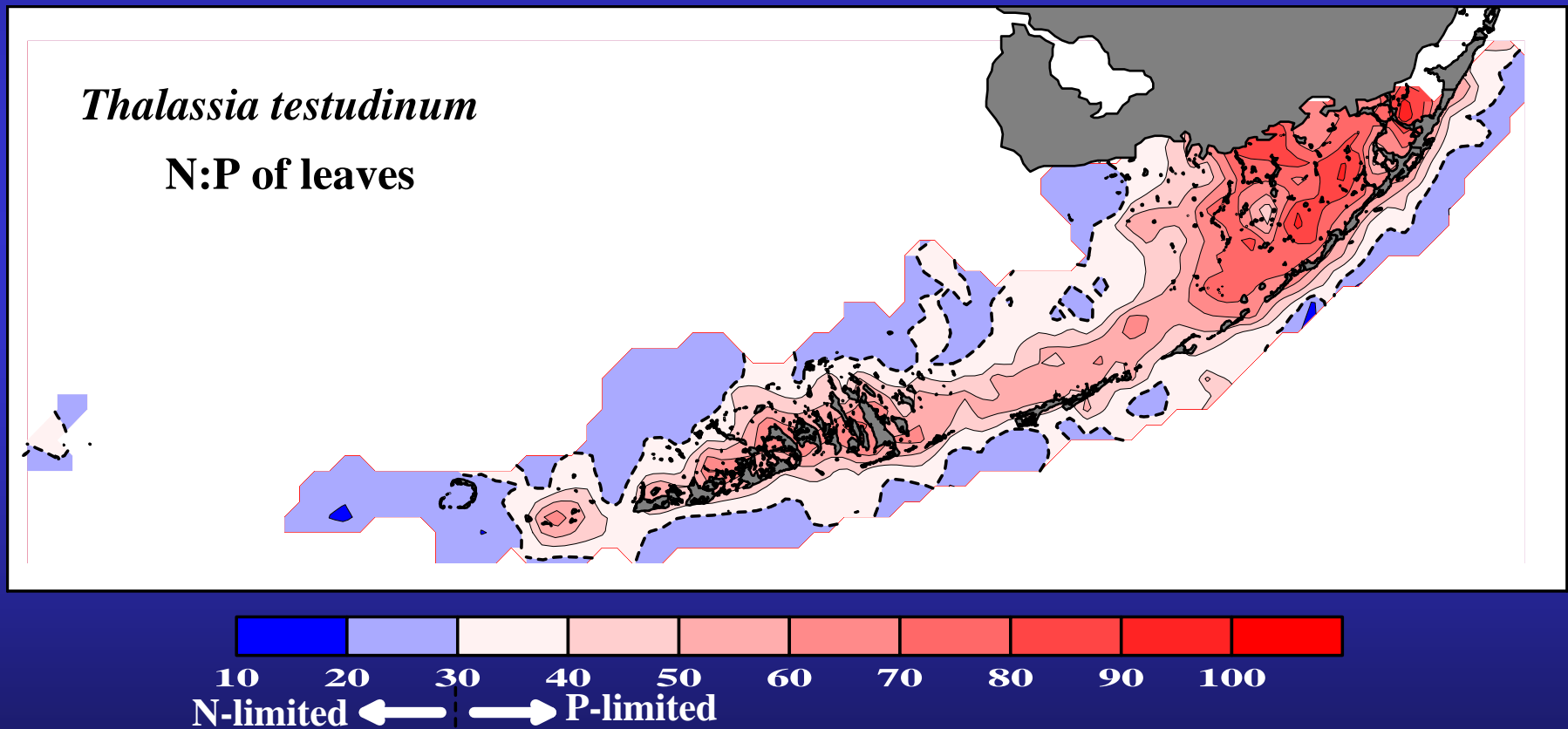
# Changes in relative abundance of primary producers

At 19 of 30 sites, species composition has shifted in a manner consistent with increased nutrient availability



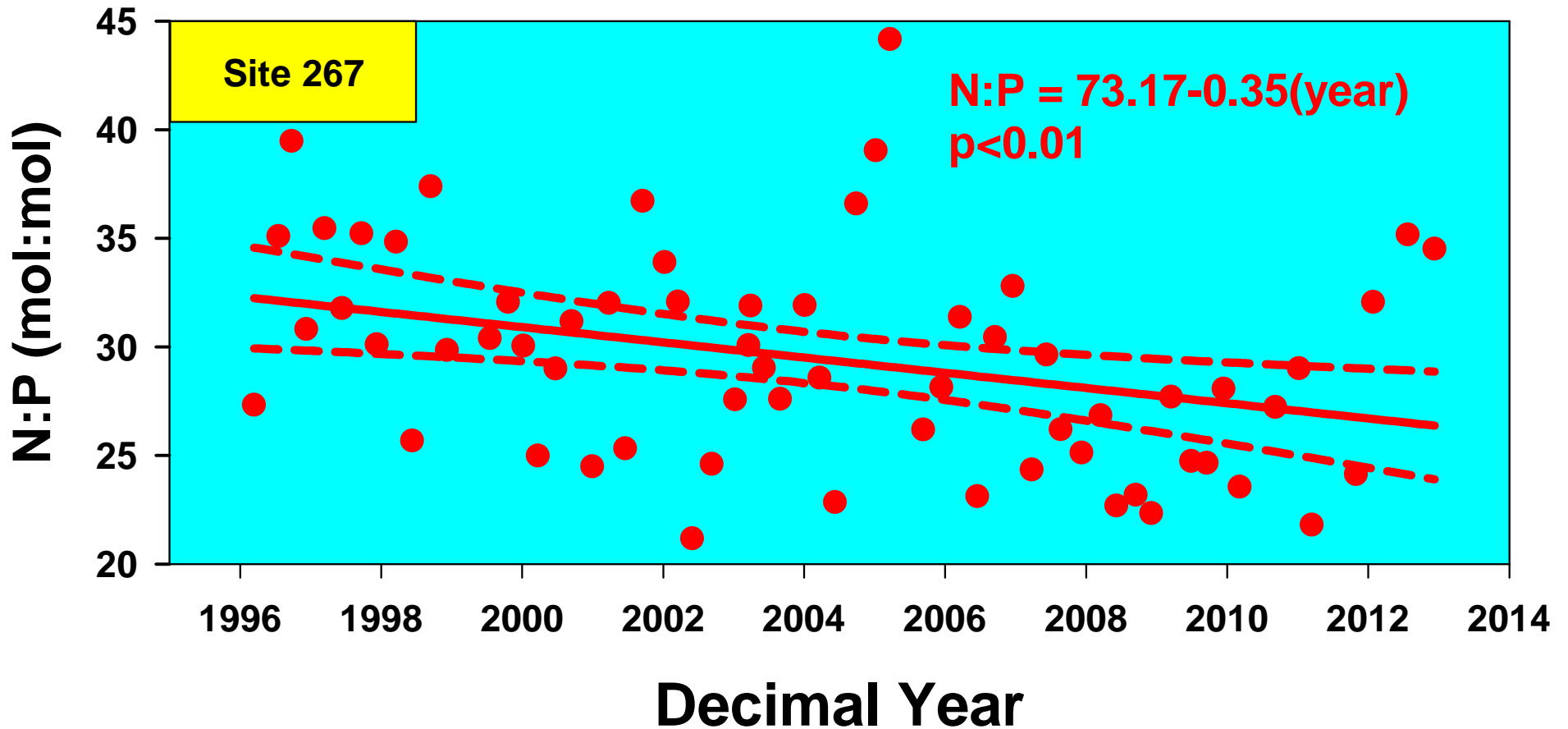
# Changes in N:P of primary producers #1:

There is a spatial pattern in the relative availability of N and P

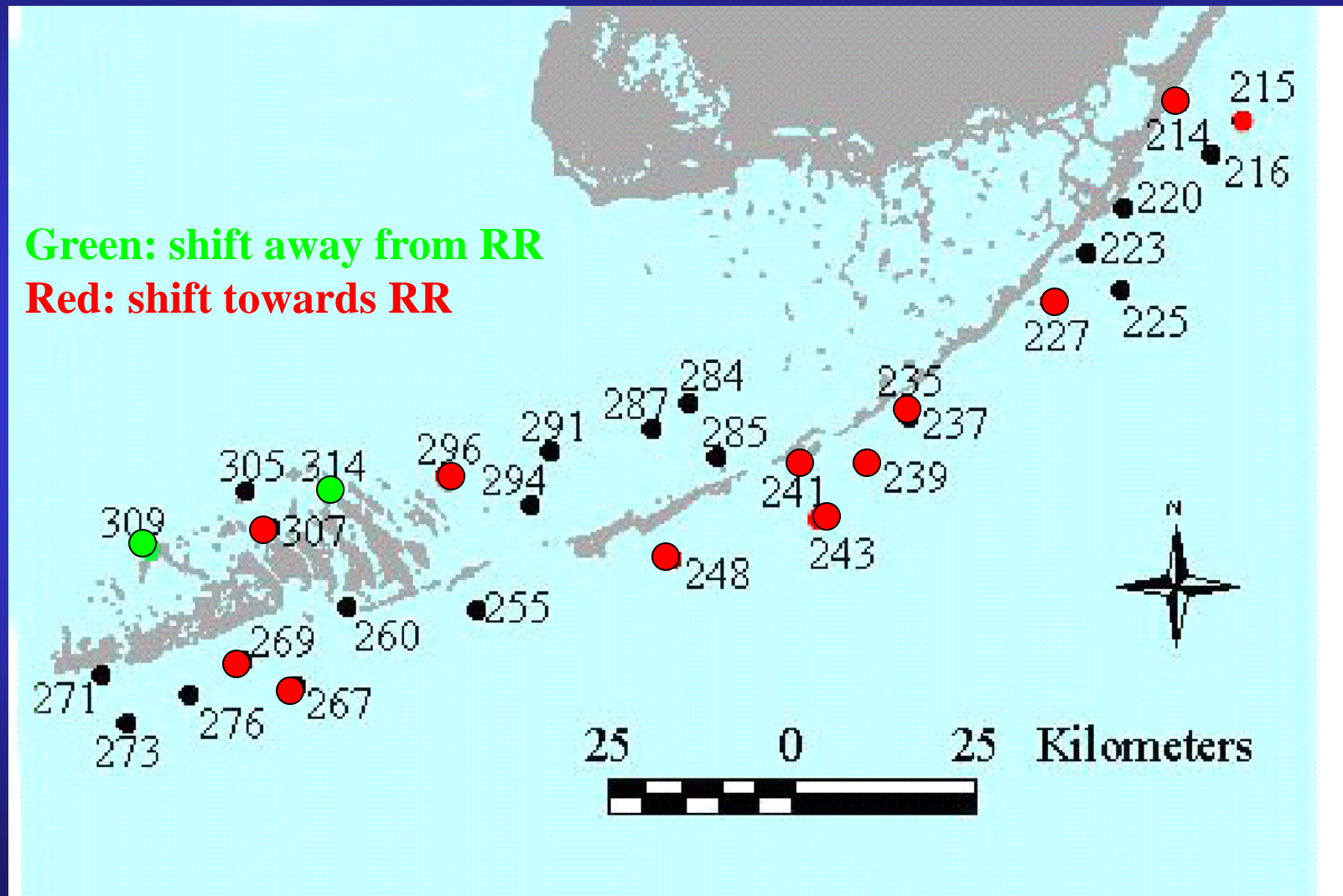


# Changes in N:P of primary producers

At 13 of 30 sites, N:P is trending towards “seagrass Redfield ratio”

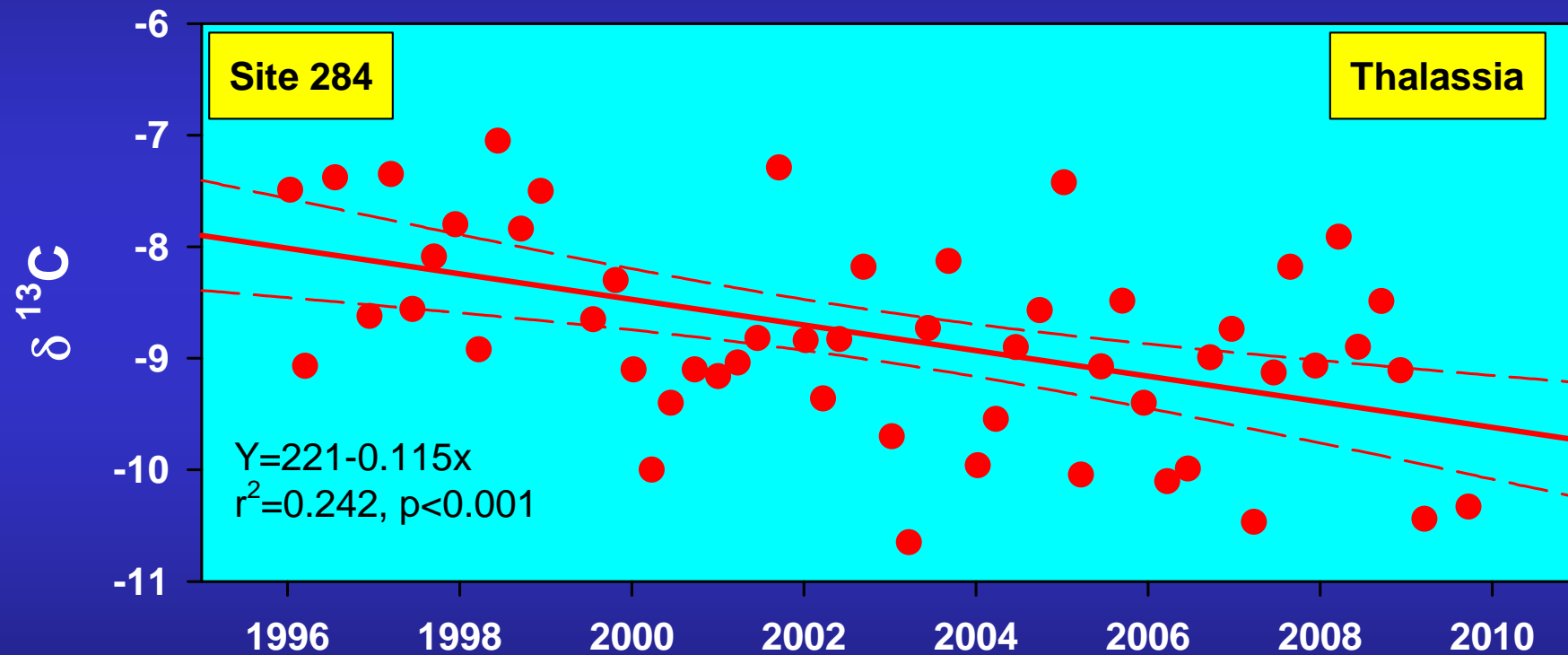


# Changes in N:P of primary producers

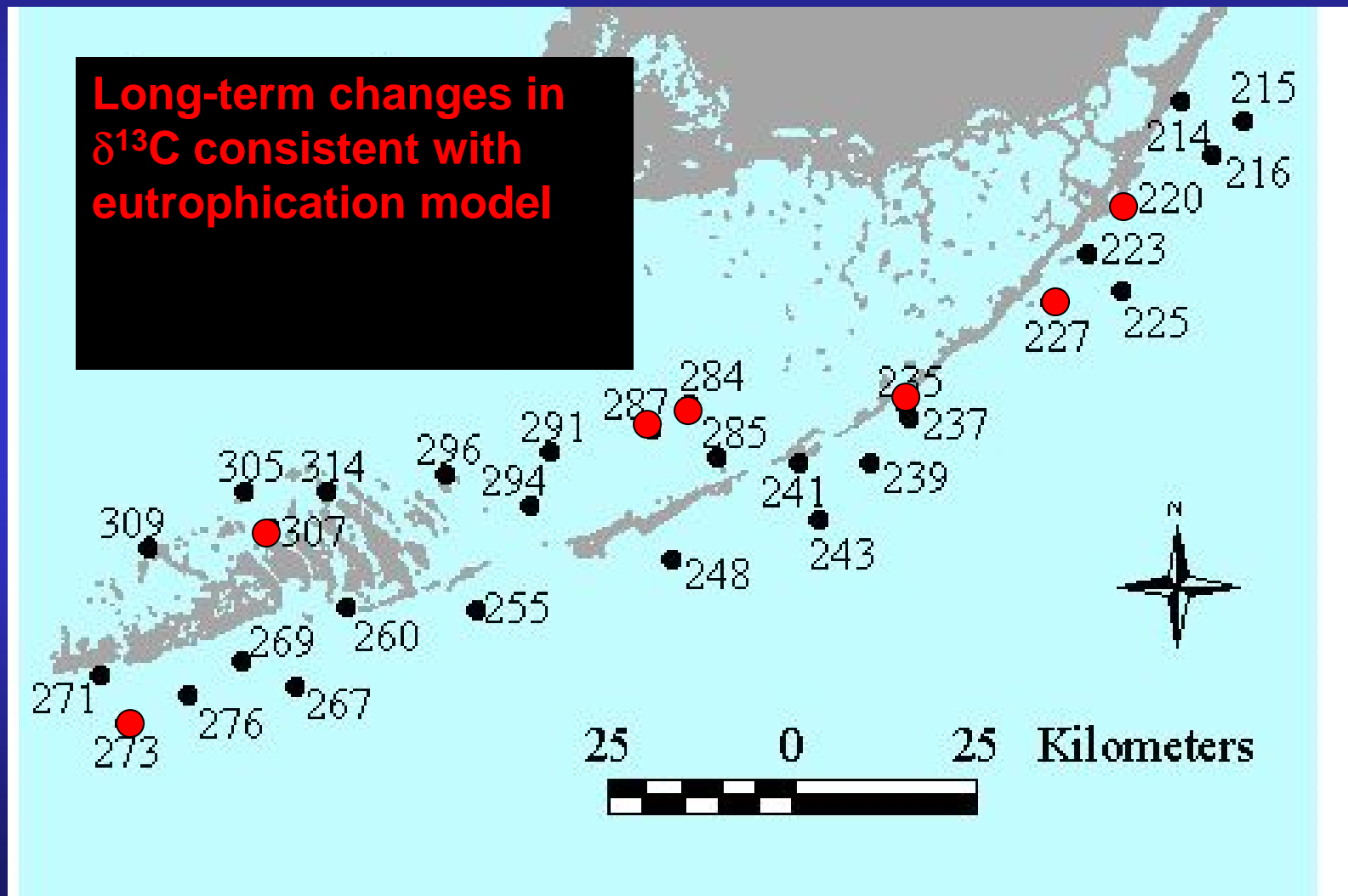


# Changes in $\delta^{13}\text{C}$ of primary producers

At 7 of 30 sites, significant  $\delta^{13}\text{C}$  trends consistent with eutrophication (7 of 30 last year)



## Changes in $\delta^{13}\text{C}$ of primary producers #2



# Site-specific indicator summary 1995-2009

Site	N:P	SCI	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$
214	Red	Green	Green	+
215	Green	Green	Green	+
216	Green	Green	Green	Green
220	Green	Yellow	-	+
223	Green	Red	Green	+
225	Green	Green	Green	Green
227	Red	Yellow	-	Green
235	Red	Red	-	Green
237	Green	Green	Green	Green
239	Red	Green	Green	Green
241	Red	Yellow	Green	Green
243	Red	Green	Red	Green
248	Red	Yellow	Green	+
255	Green	Green	Green	+
260	Green	Red	Green	Green

Site	N:P	SCI	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$
267	Red	Green	Green	Green
269	Red	Red	Green	+
271	Green	Green	Green	Green
273	Green	Red	Green	+
276	Green	Red	Green	Green
284	Green	Green	-	+
285	Green	Yellow	Green	+
287	Green	Yellow	-	Green
291	Green	Yellow	Green	Green
294	Green	Yellow	Green	+
296	Red	Red	Green	-
305	Green	Red	Green	Green
307	Red	Green	-	Green
309	Green	Red	Green	-
314	+	Red	Green	-

# FKNMS Seagrass Status Criteria

- We have defined 2 criteria to track the status of seagrasses Sanctuary-wide, based on our conceptual models

- The first is based on the relative dominance of slow-growing species:

$$SLOW = \frac{A_{Tt}}{A_{Tt} + A_{Sf} + A_{Hw} + A_{Macroalgae}} \quad SCI = \frac{\sum_{i=1}^{30} SLOW_i}{30}$$

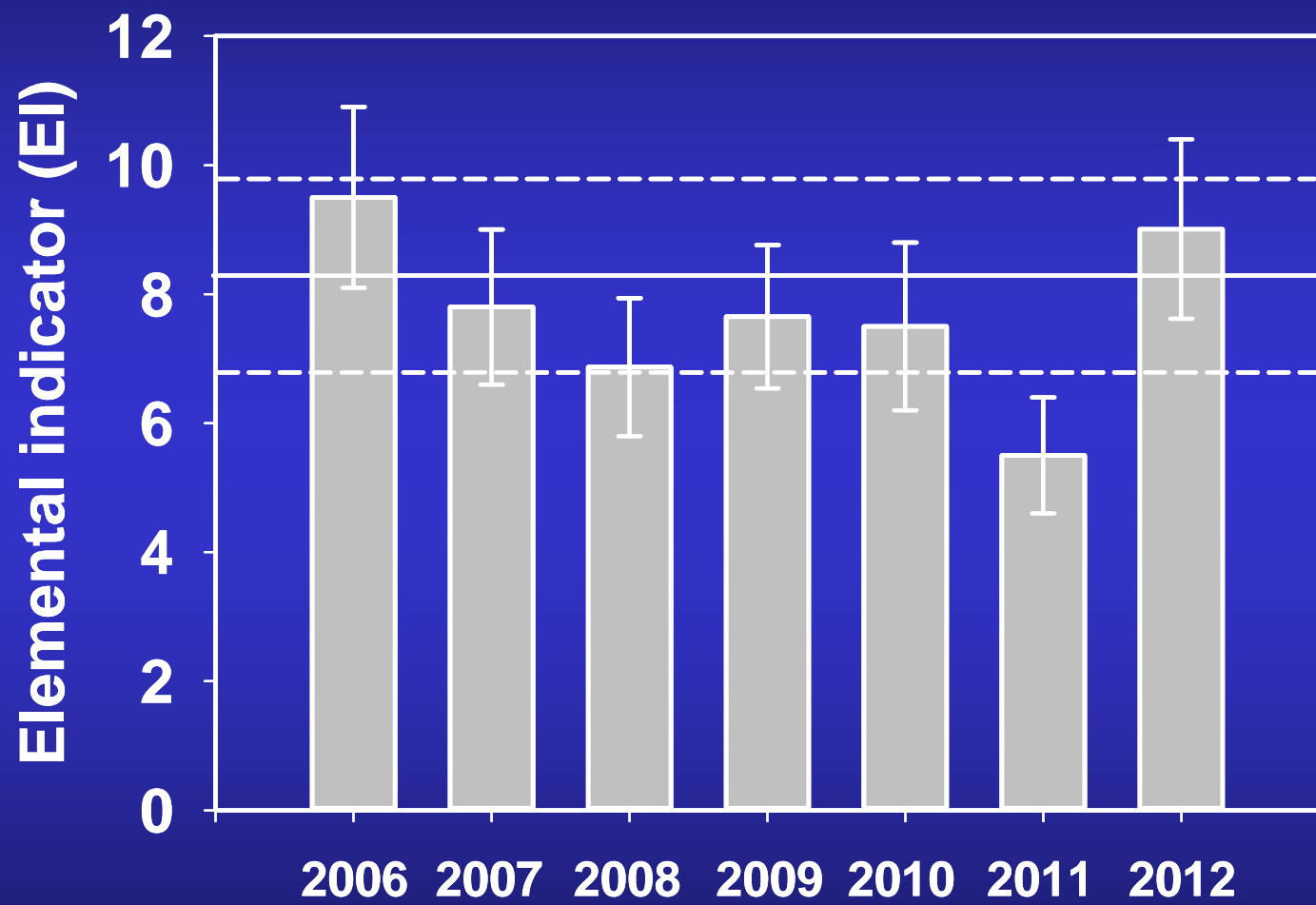
- The baseline SCI, calculated from data collected between 1995-2005, was  $0.48 \pm 0.04$ . Any decrease in SCI indicates declining water quality

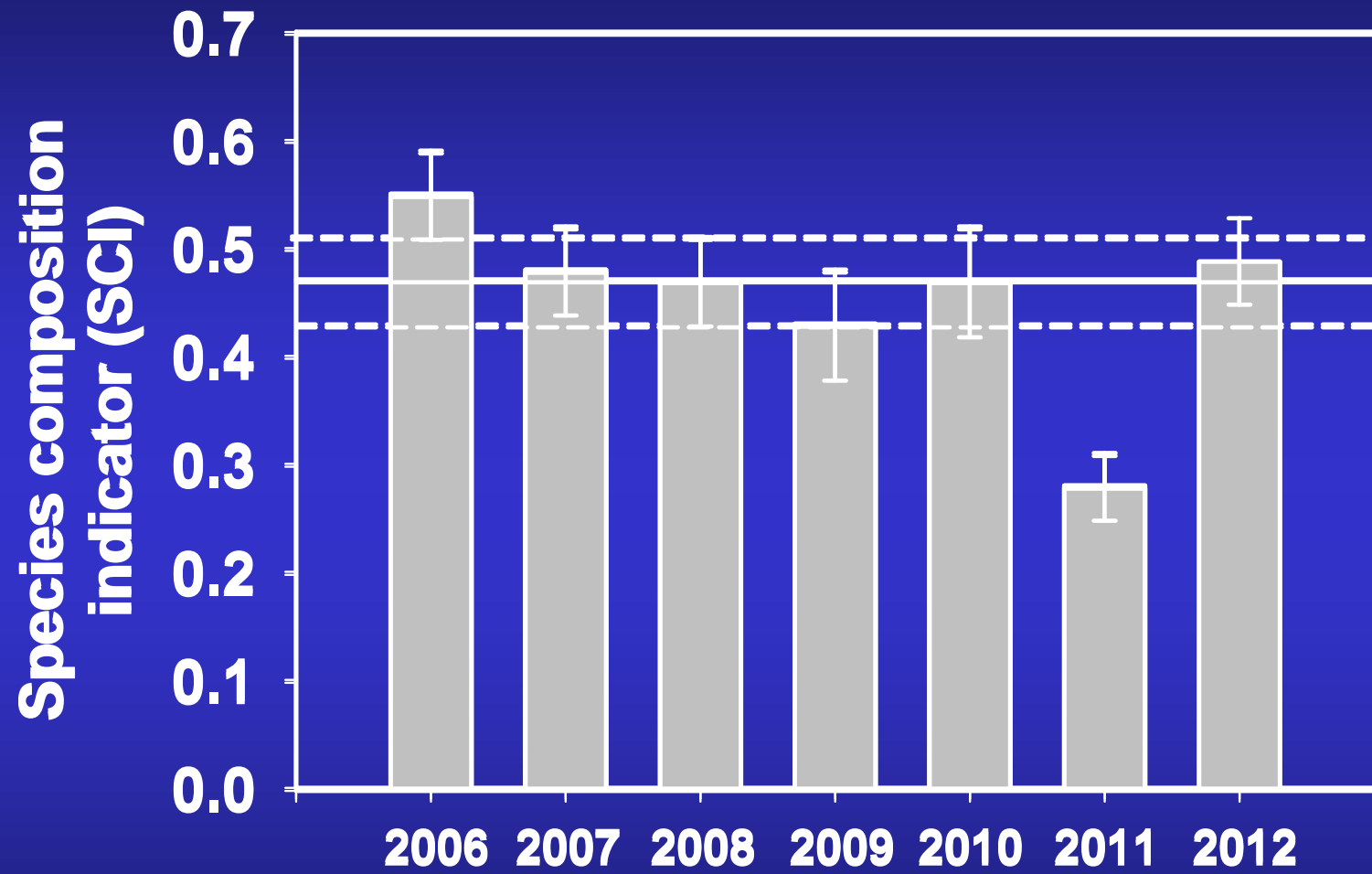
- The second is based on nutrient content of the slowest growing species:

$$EI = \frac{\sum_{i=1}^{30} |NP_i - 30|}{30}$$

- The long-term average EI of *Thalassia* leaves at the 30 sites is  $8.28 \pm 1.47$







## Summary points

- Rapid population increases adjacent to oligotrophic marine ecosystems in south Florida *may* have deleterious effects on those ecosystems
- Changes are occurring in south Florida seagrass beds that are consistent with increased nutrient availability in the system – *but few increases have been observed in the water column*
- These changes are relatively subtle, we have not witnessed loss of seagrass beds in this regional and decadal scale program. *There is time to act!*
- Many different factors can influence our indicators that are independent of the main management concern – anthropogenic nutrient enrichment
- Congruence of patterns among independent indicators increases confidence in the observations

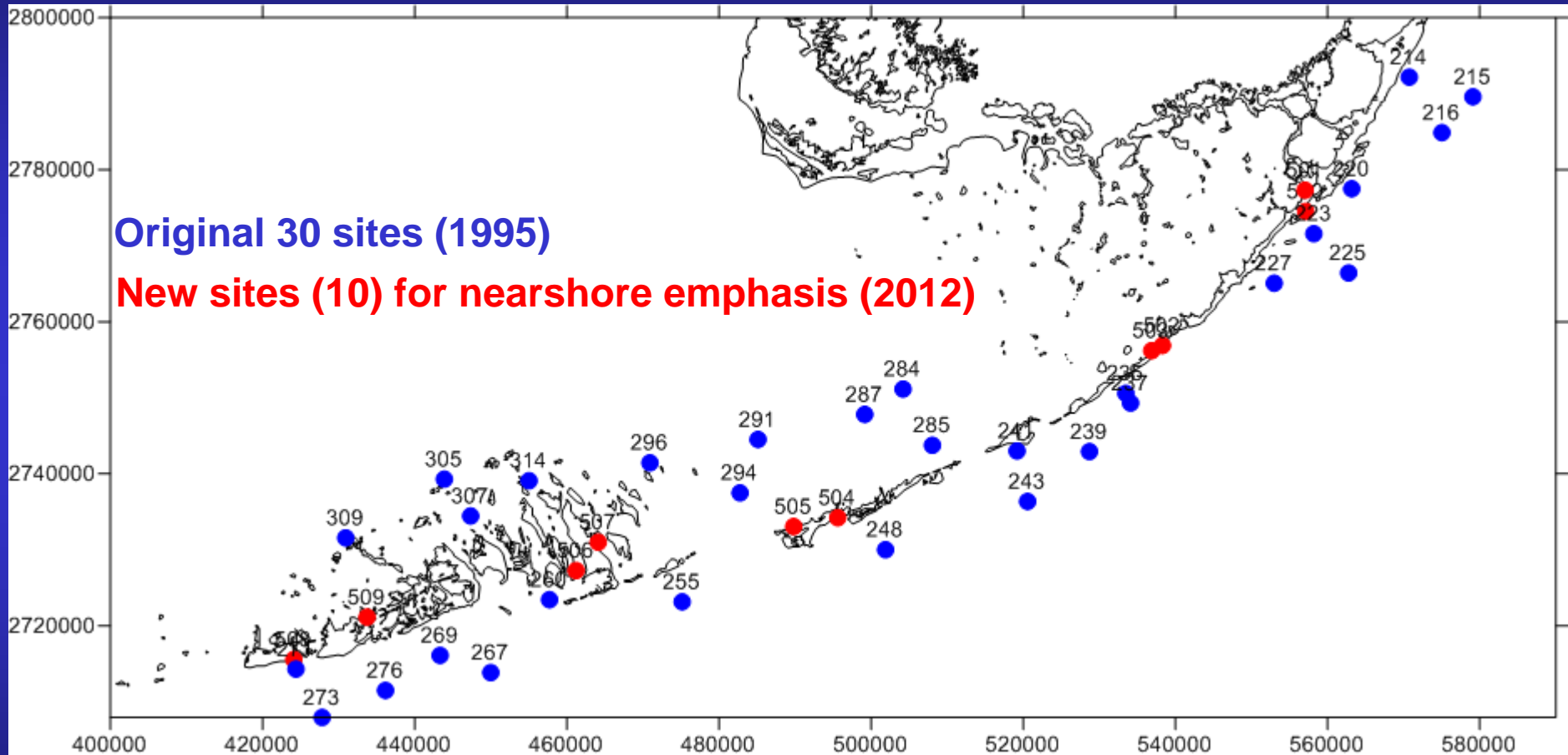
## **Major project accomplishments:**

- **We have defined the spatial extent and species composition of the largest documented seagrass bed on earth, and solidly defined a baseline to assess change.**
- **We have defined the spatial and temporal pattern of seagrass community dynamics in the FKNMS and made predictions about future trajectories.**
- **We have identified long-term trends at stations in the FKNMS that are consistent with increases in nutrient availability.**
- **We have defined the effects of changing water quality on seagrass communities in south Florida**
- **We have documented the effects of storms on seagrass communities.**
- **We have experimentally confirmed the role of nitrogen, and of phosphorus near shore and in Florida Bay, in controlling seagrass bed structure and productivity near the reef tract in the FKNMS.**
- **We have provided data for the analysis of potential human impacts on benthic communities to other groups and agencies.**
- **23 scientific publications have resulted from this monitoring project to date.**



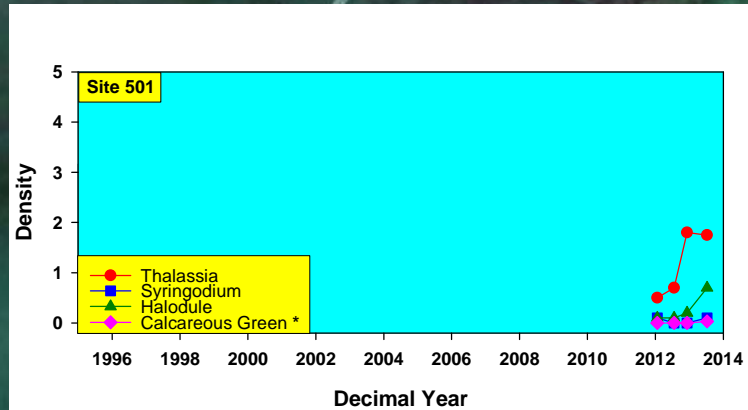
- **Not all environmental threats can be monitored in a given monitoring program**
- **The original monitoring program design was regional in scope**

# Benthic Habitat Permanent Monitoring Sites



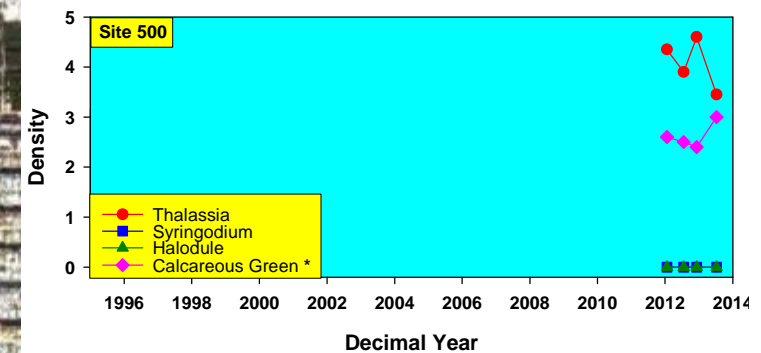
# New nearshore sites – Key Largo

Buttonwood Sound



501

Overseas Hwy



500

Pelican Key

Sunset Cove

Key Largo

© 2012 Google

© 2012 Europa Technologies

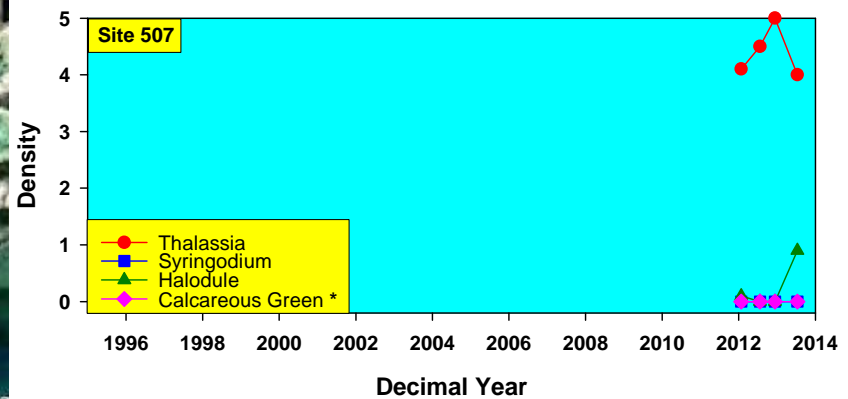
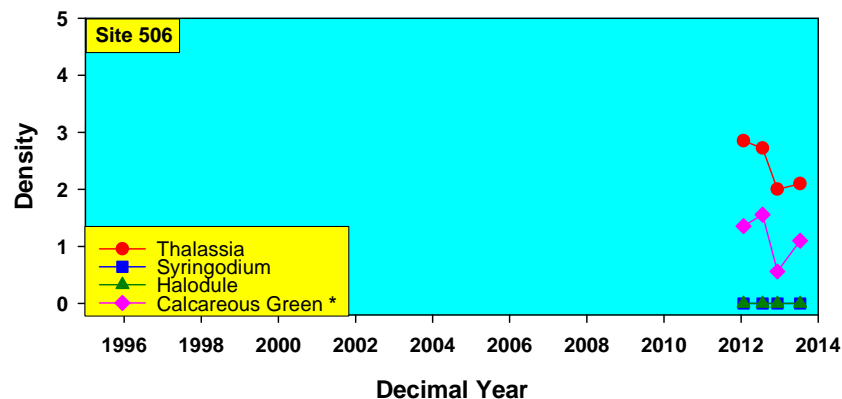
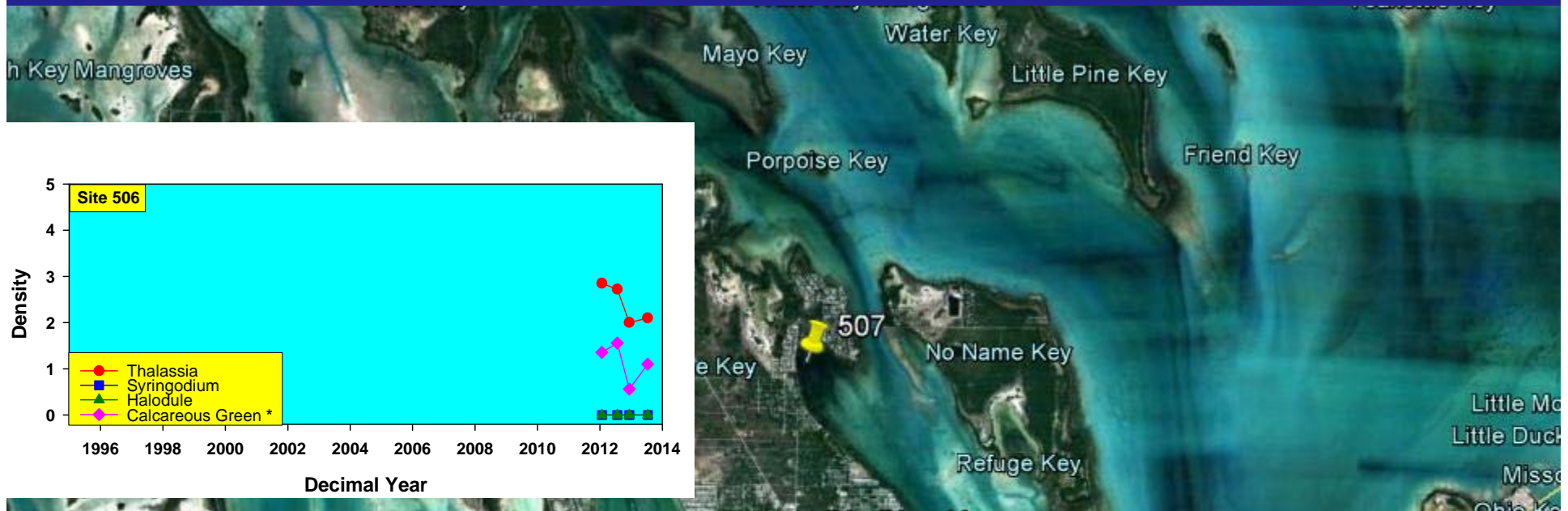
Google earth

Imagery Date: 12/23/2010

lat 25.097670° lon -80.439967° elev 6 ft

Eye alt 16945 ft

# New nearshore sites – Big Pine





Are we describing locally-induced changes, responses to larger-scale processes, or natural cycles?

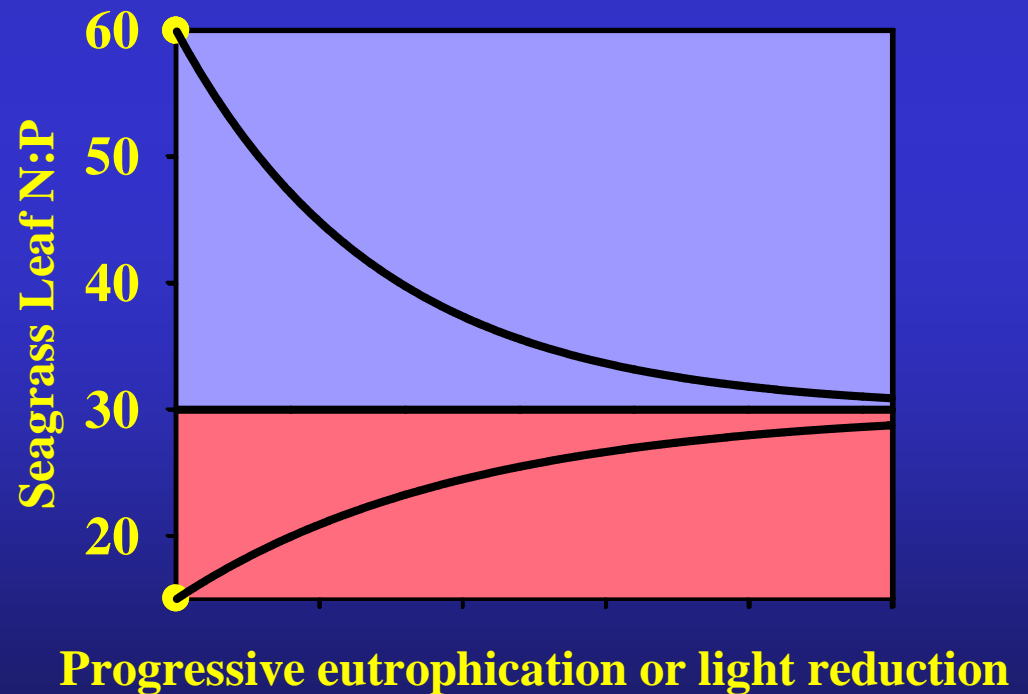
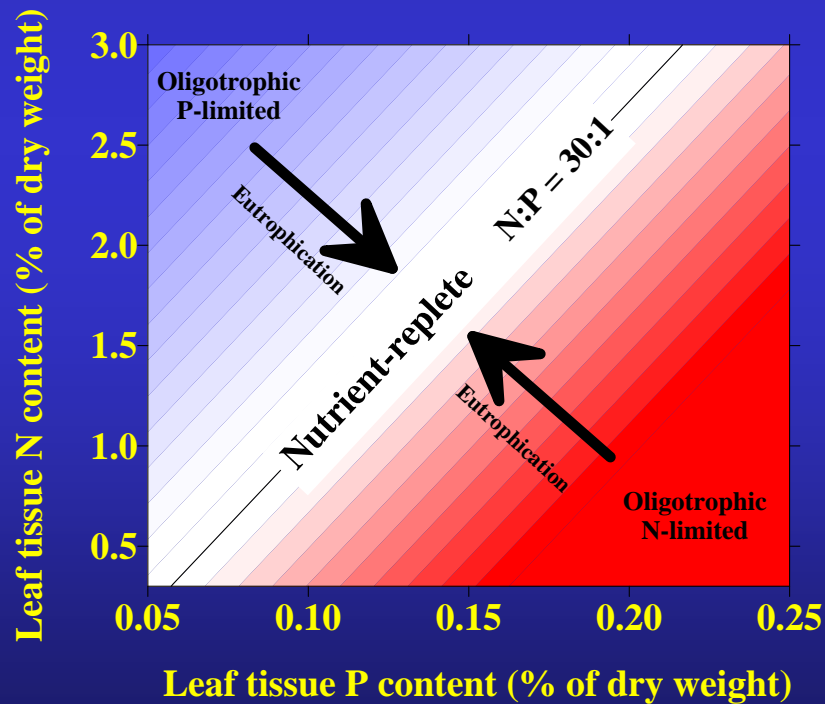
Our redesigned sampling program will contribute to answering this question





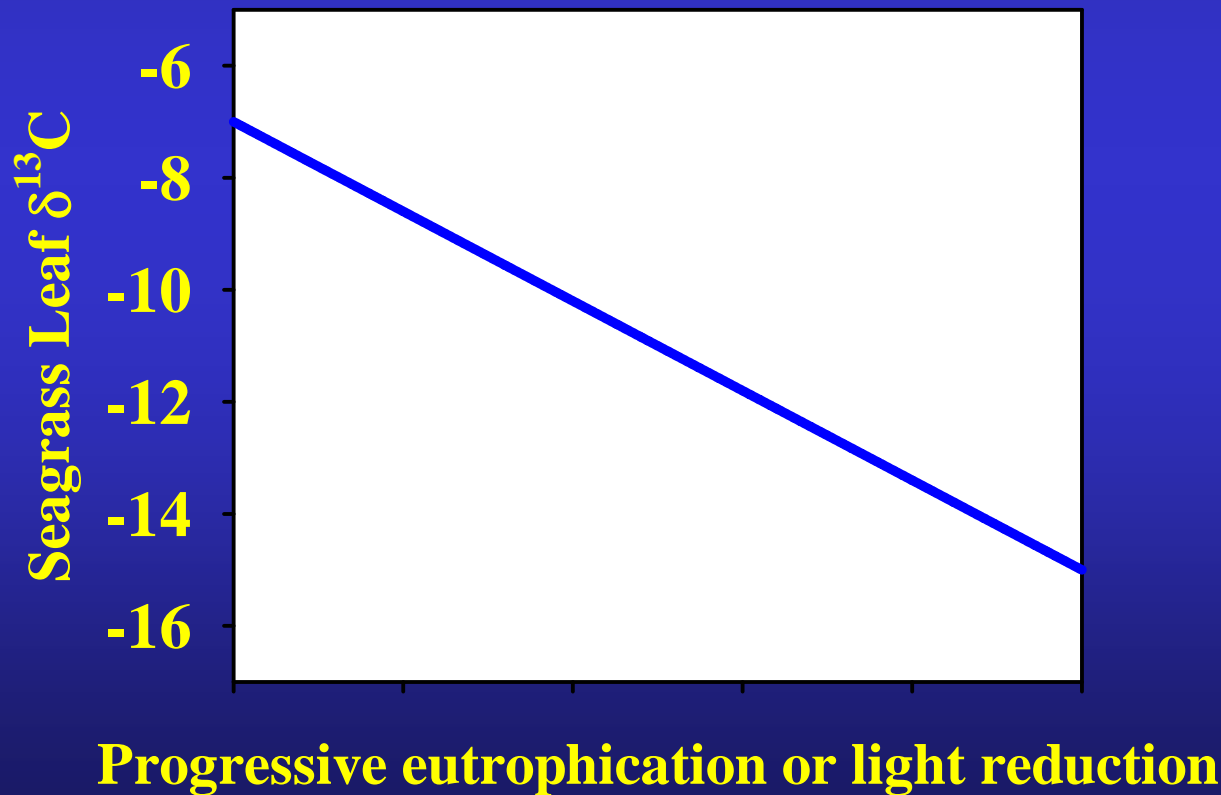
## Explicit model of ecosystem behavior #2

Nutrient pollution will shift N:P ratios of primary producers towards a taxon-specific “Redfield ratio”



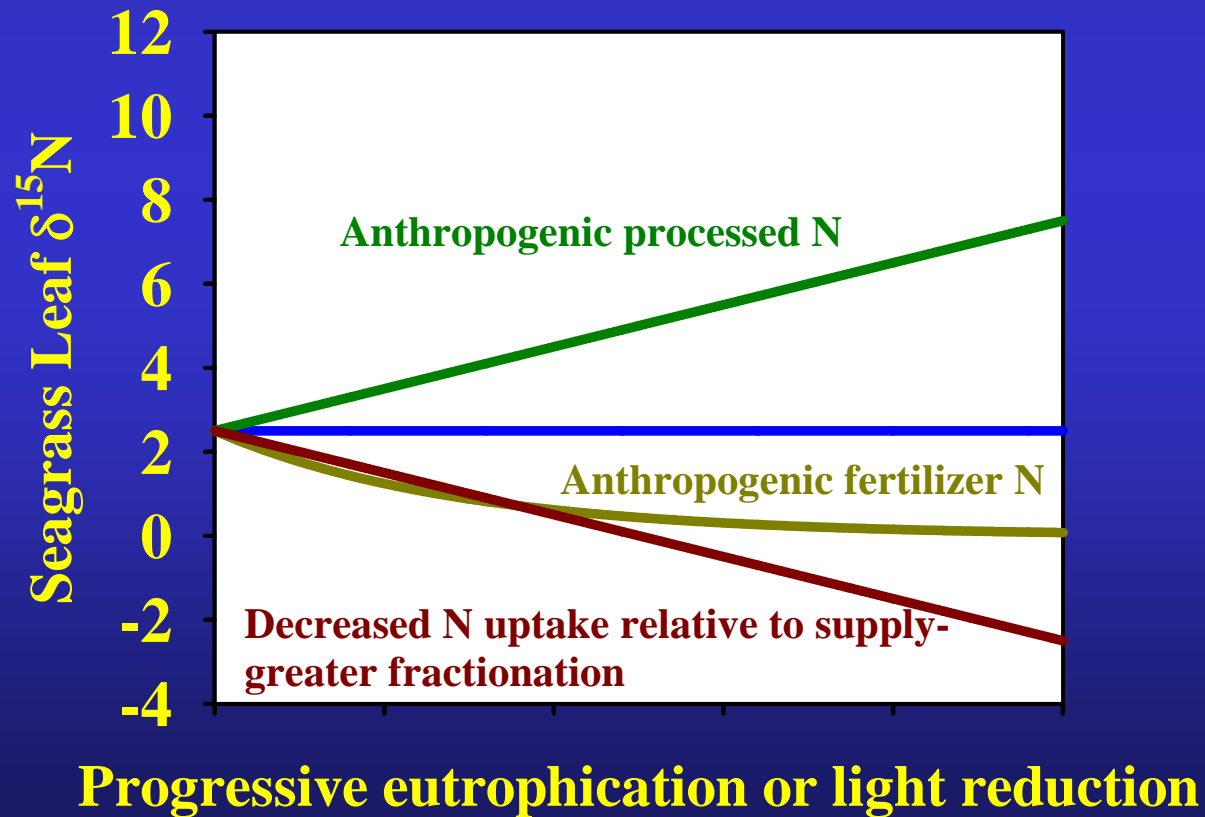
## Explicit model of ecosystem behavior #3

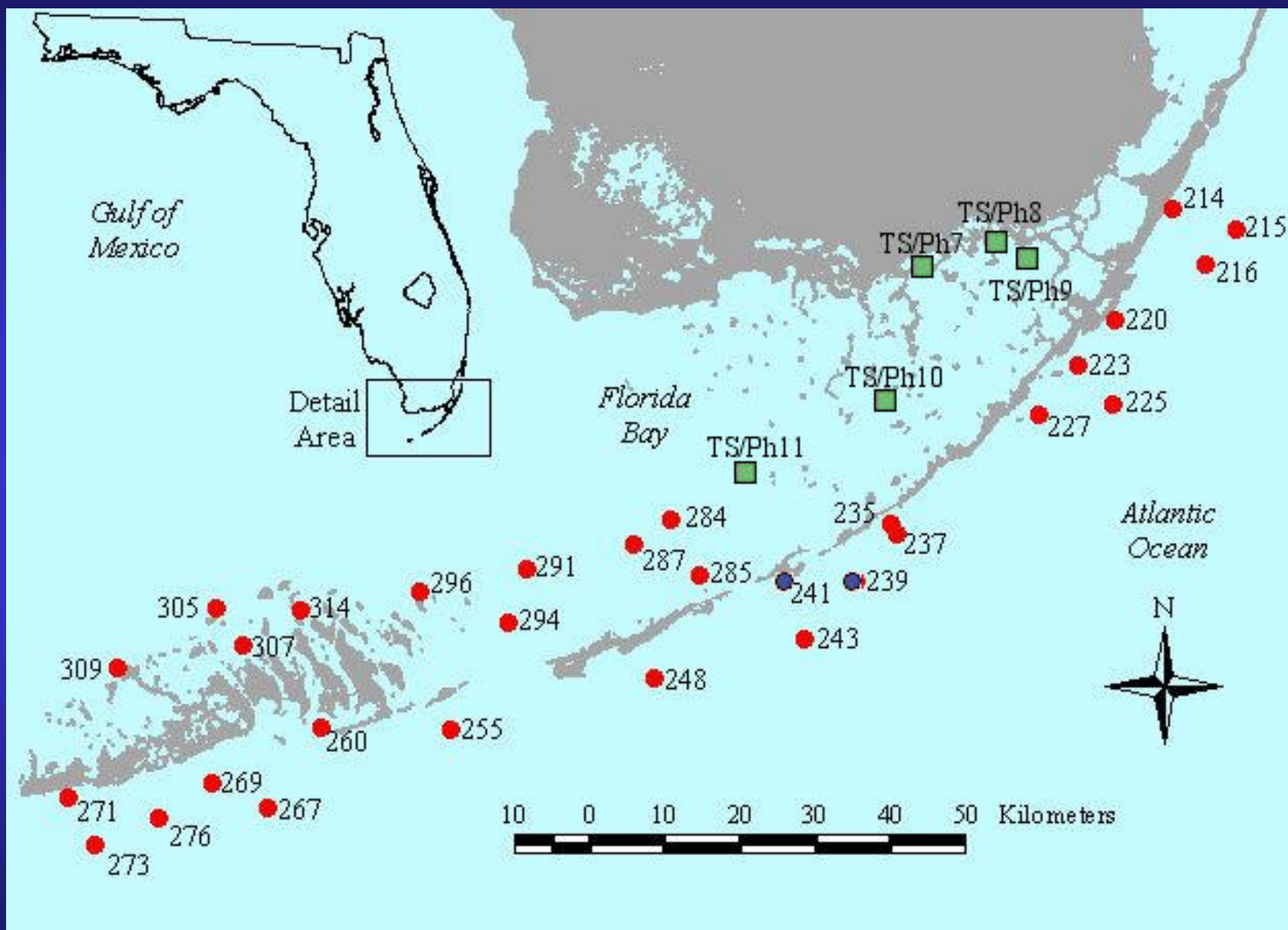
Nutrient pollution will shift seagrass  $\delta^{13}\text{C}$  towards more negative values because of increased discrimination against  $^{13}\text{C}$  in low light conditions



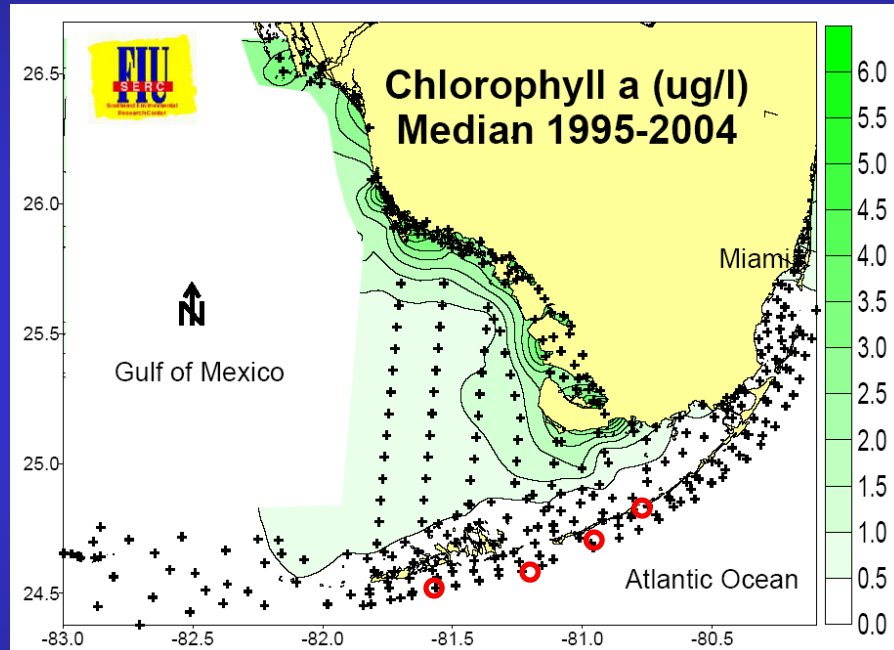
## Not-so-Explicit model of ecosystem behavior #4

Nutrient pollution will cause some kind of change in  $\delta^{15}\text{N}$  of primary producers





# Changes in relative abundance of primary producers #1



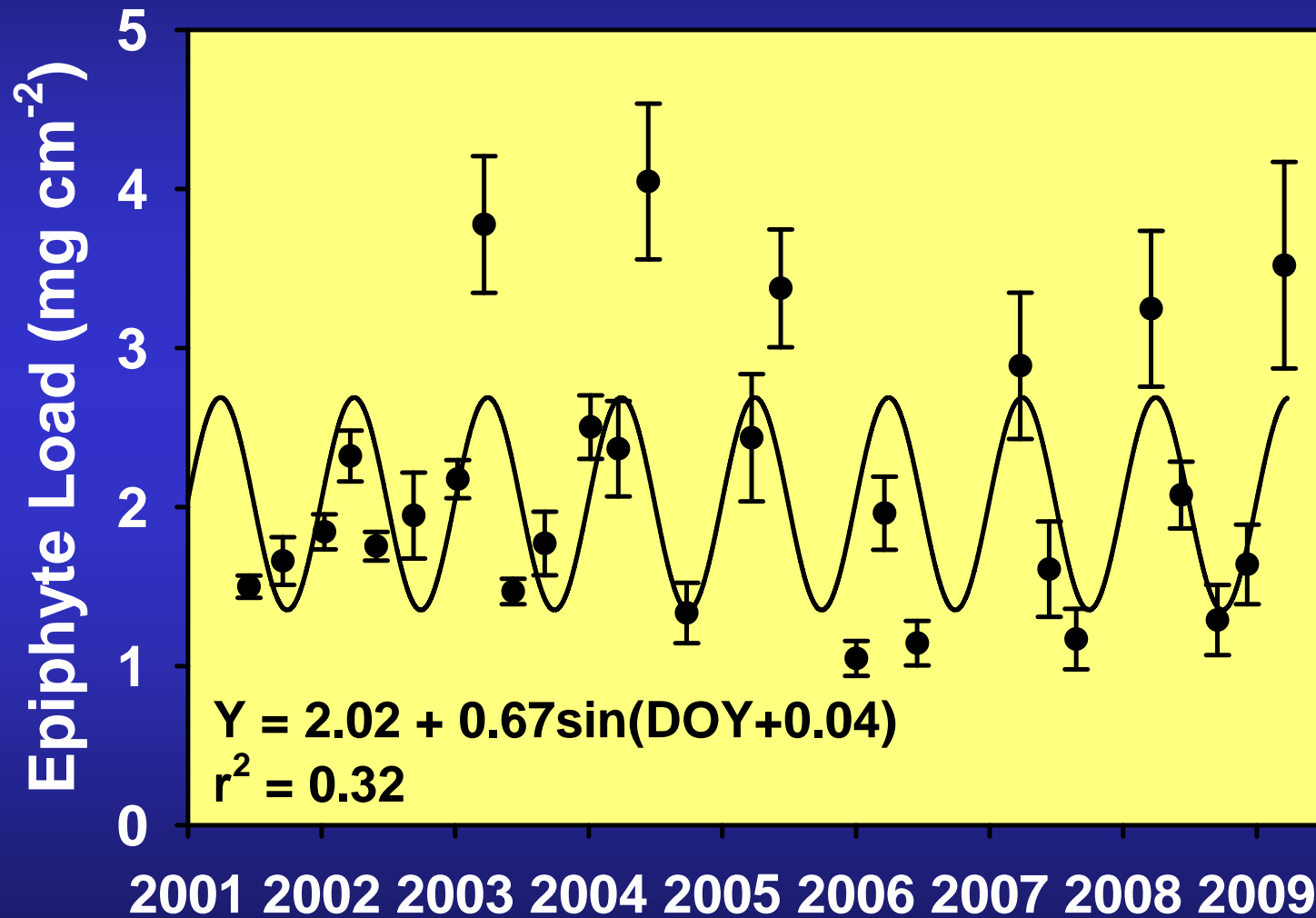
Phytoplankton concentrations are low across the system, and there are no sites with a significant increase in Chl-a over the time period.

In fact, at four of our monitoring sites, there has been a statistically significant decrease in Chl-a over the period (slopes of  $-0.03 \mu\text{g l}^{-1}\text{y}^{-1}$ )

Data from FKNMS water quality monitoring program

## Changes in relative abundance of primary producers #2

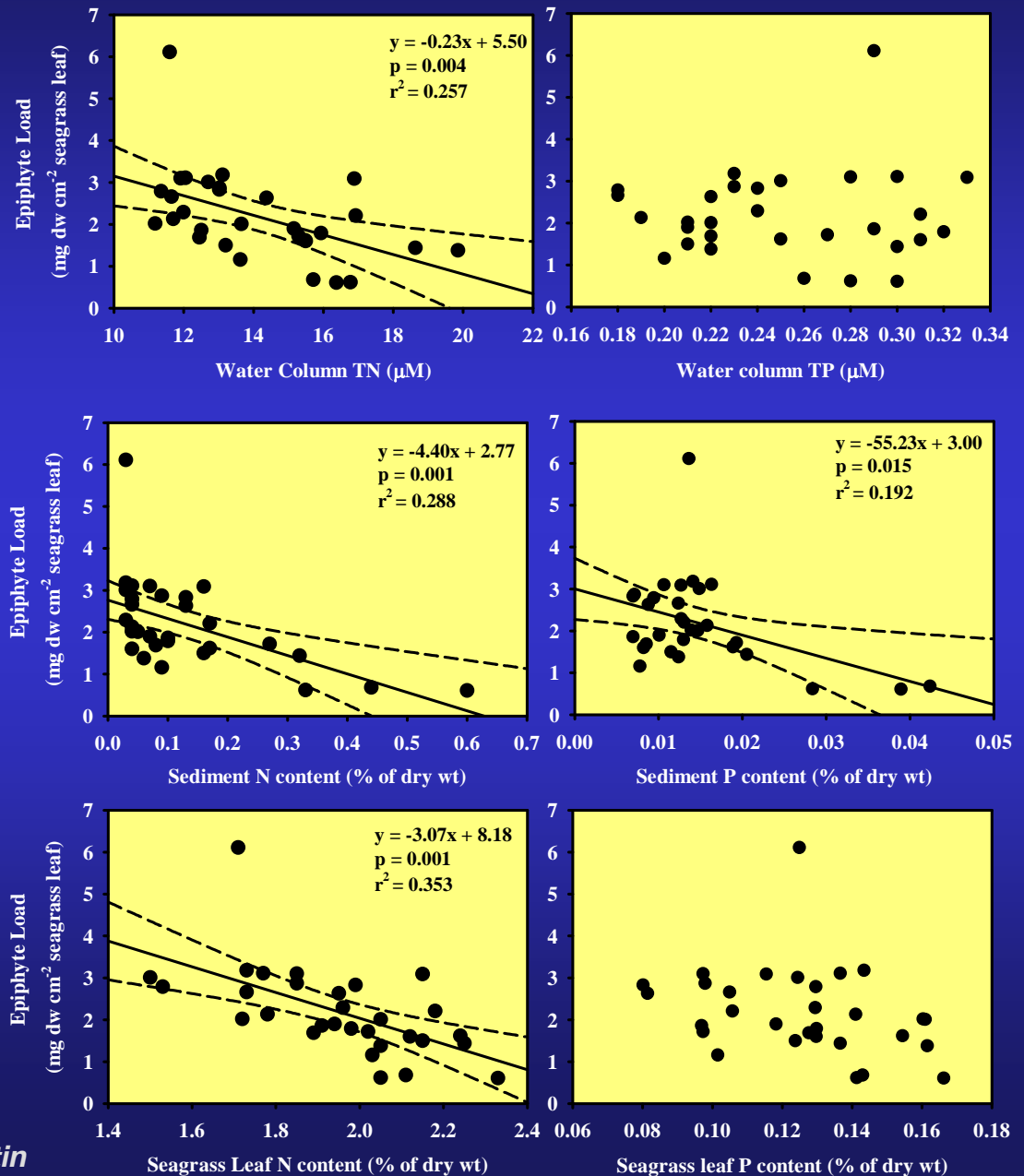
### Epiphyte loads are highly seasonal in the FKNMS



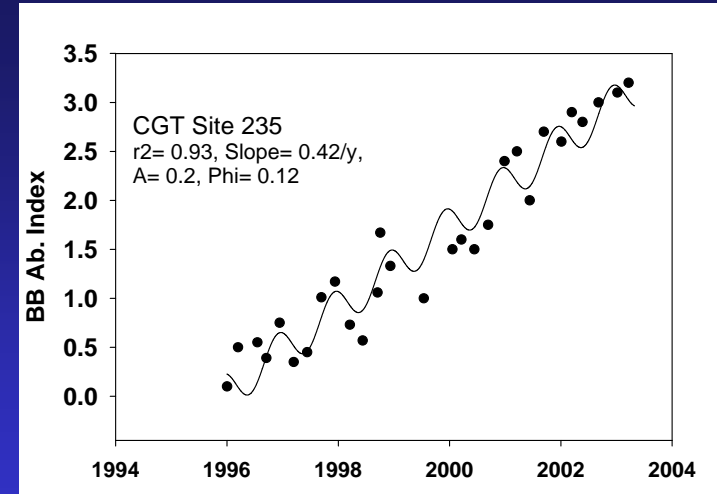


# Changes in relative abundance of primary producers #3

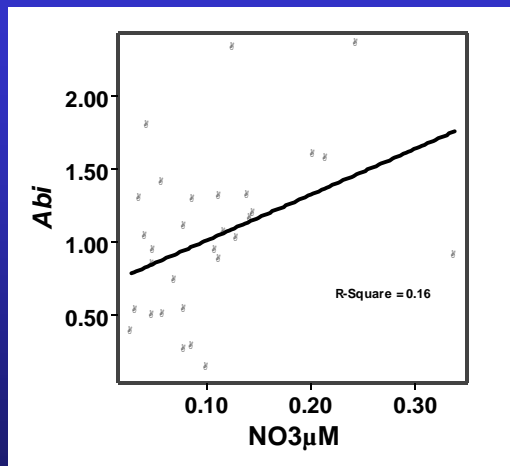
Unlike more eutrophic systems, epiphyte loads are not correlated with increased nutrient loads at the scale of our sampling in the FKNMS



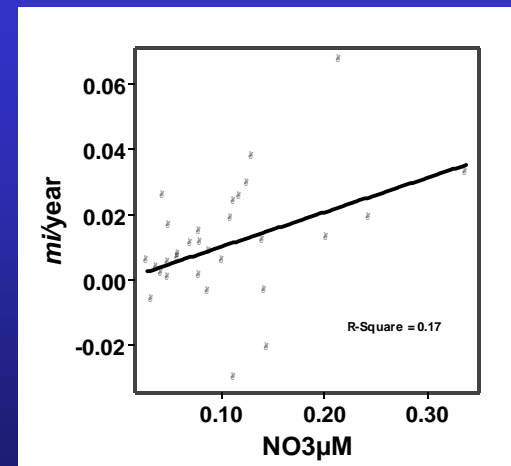
# What do the stations with increasing abundance of fast-growing algae have in common?



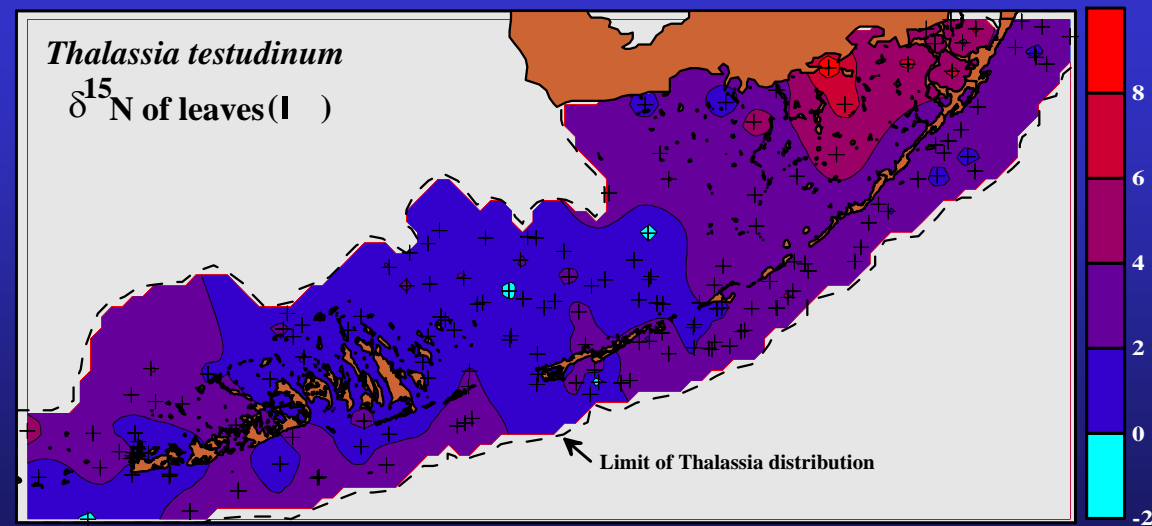
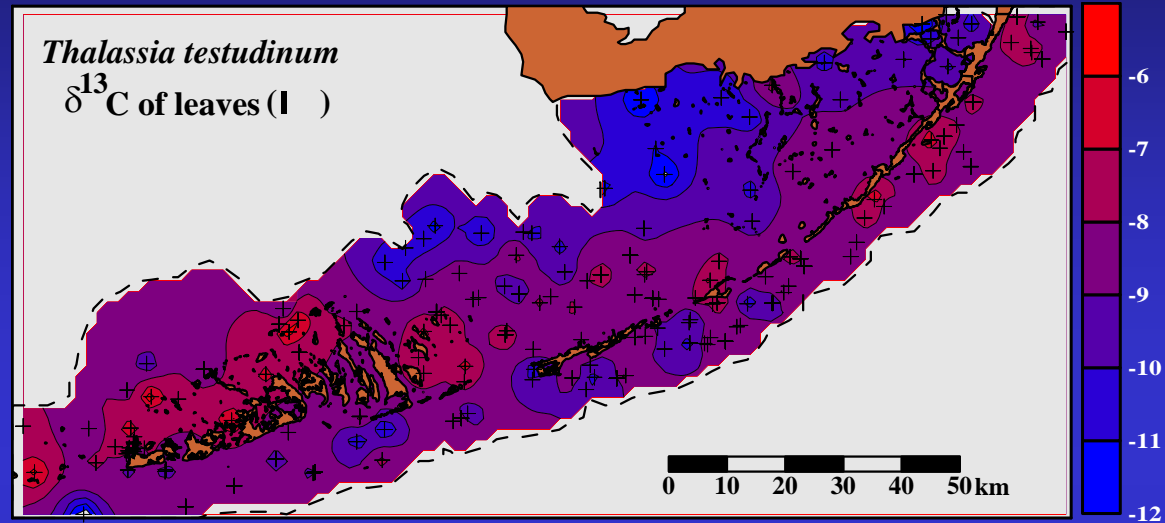
Algae are more abundant in high nitrogen areas



...and high-N stations have higher increases in algae

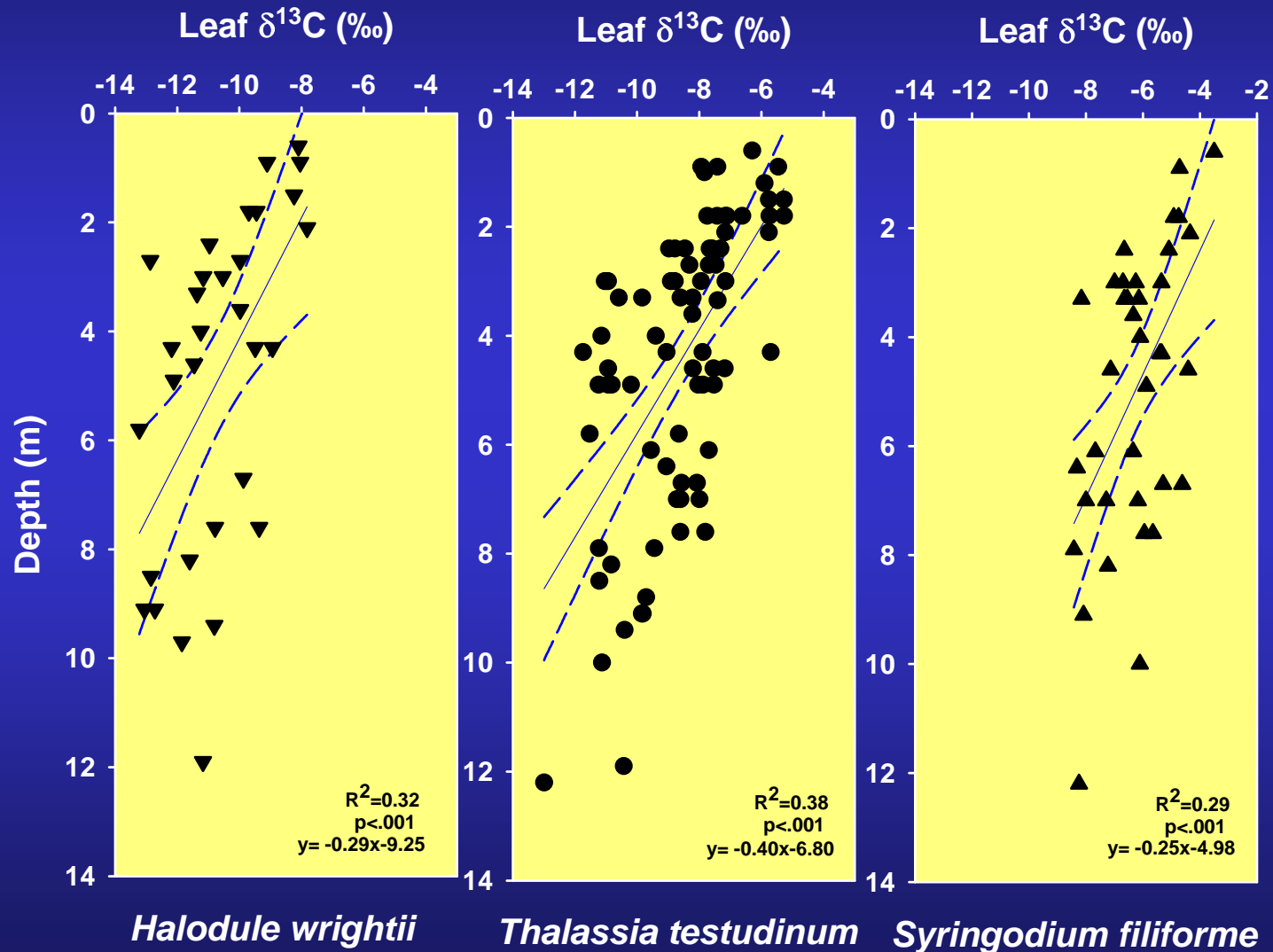


# Spatial patterns in stable isotope ratios in south Florida

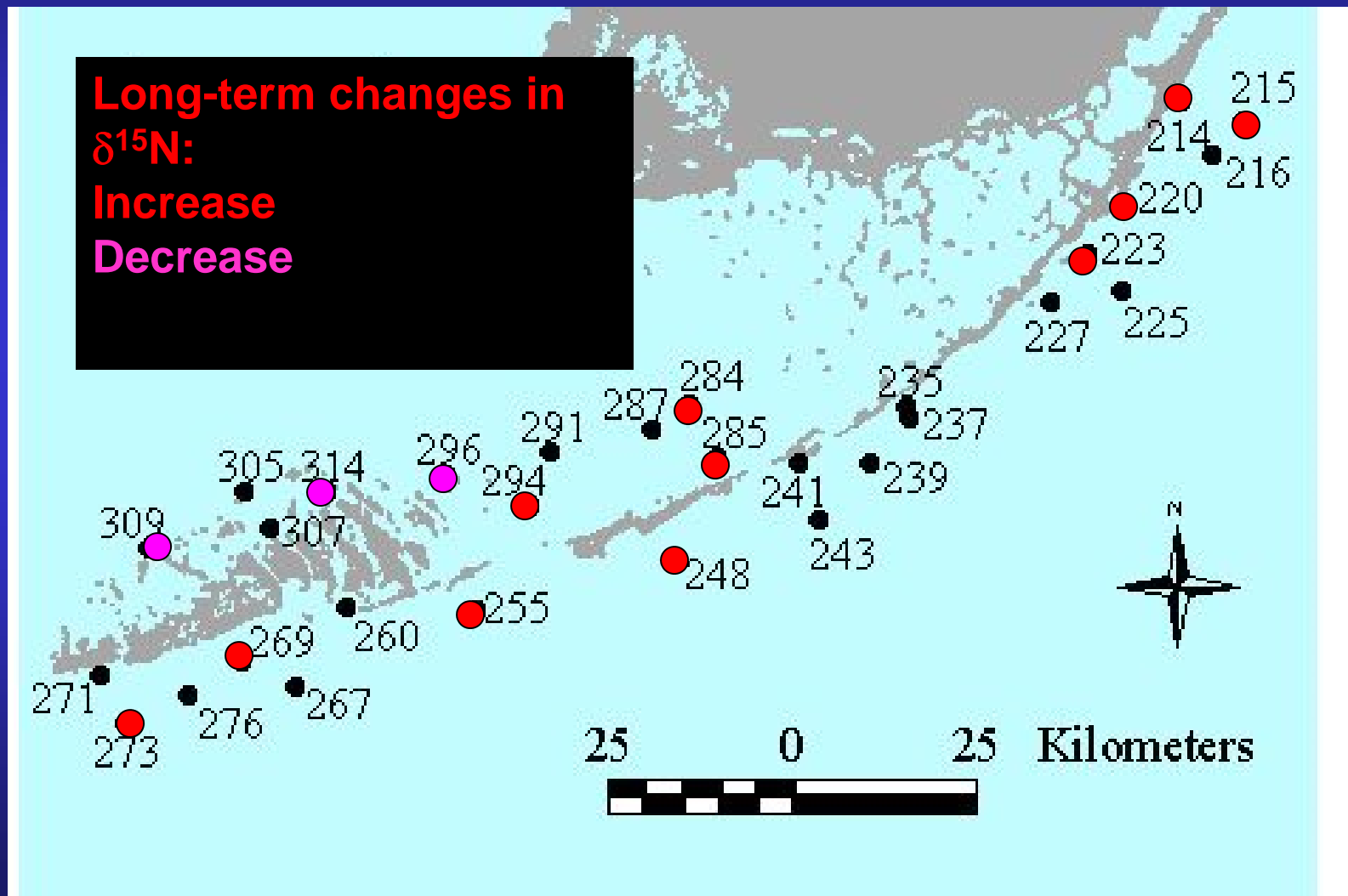


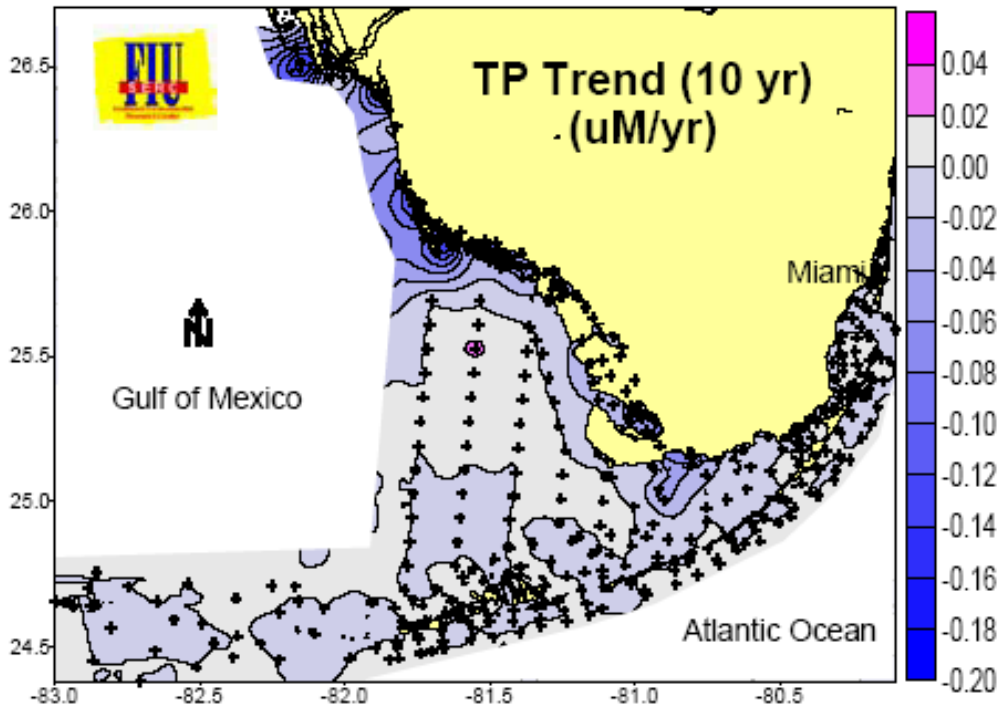
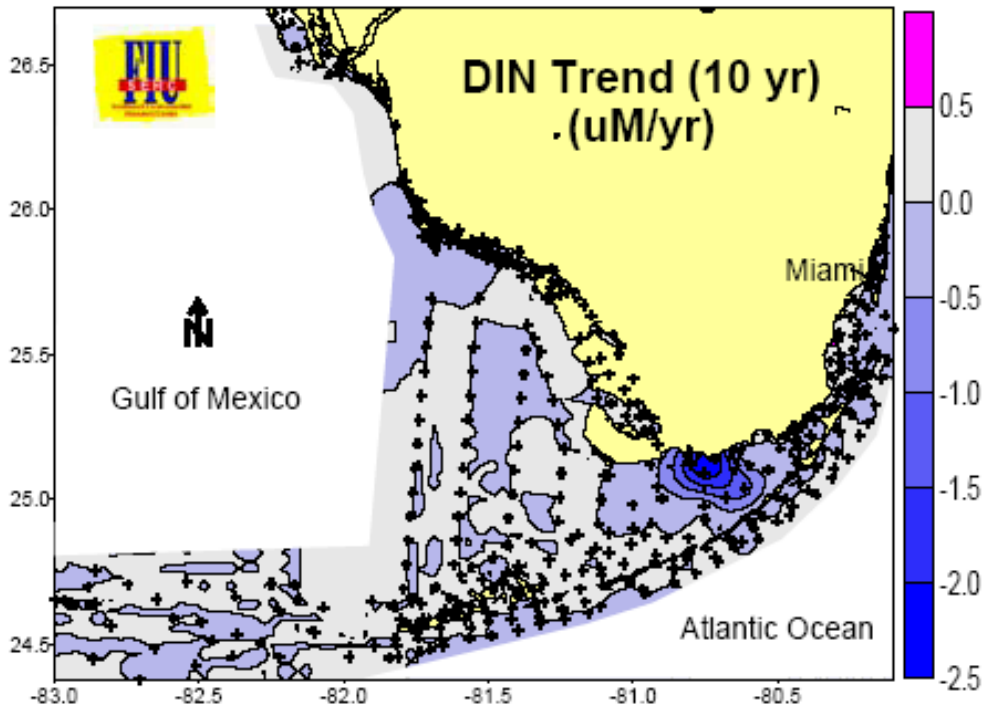
# Changes in $\delta^{13}\text{C}$ of primary producers #1:

As light decreases with depth,  $\delta^{13}\text{C}$  decreases



## Changes in $\delta^{15}\text{N}$ of primary producers #2





Our benthic indicators of eutrophication of the system are measuring troubling changes, even in the absence of trends in water quality

Is the benthos more sensitive to changes in nutrient loading than water column nutrient concentrations?

Are we perhaps merely measuring a long-term cyclicality of the seagrasses of south Florida?

# Oil Spills in Seagrass beds

- Seagrasses are the most extensive of the marine habitats of south Florida
- Seagrass beds have a high ecological and economic value
- WQPP monitoring sites are providing baseline data for assessing ecological effects of Deepwater Horizon oil spill



# Oil Spills in Seagrass beds

- **GOOD NEWS:** Seagrasses are relatively insensitive to oil and dispersants.
- **BAD NEWS:** The animals that live in seagrass beds are very sensitive to oil and dispersants.





# Web accessibility of data and reports: www.fiu.edu/~seagrass

