Impacts and consequences of water flow from land on macroalgal community structure.

Ligia Collado-Vides

Florida International University

CESU- 2016
Biscayne National Park
Miami, FL

Collaborators and acknowledgments

- Diego Lirman UM
- Christian Avila and Galia Varona DERM
- Trey Melton University of Alabama
- Frederik Leliaert Ghant Belgium

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-
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MIAMI-DADE COUNTY

UNIVERSITY OF MIAMI

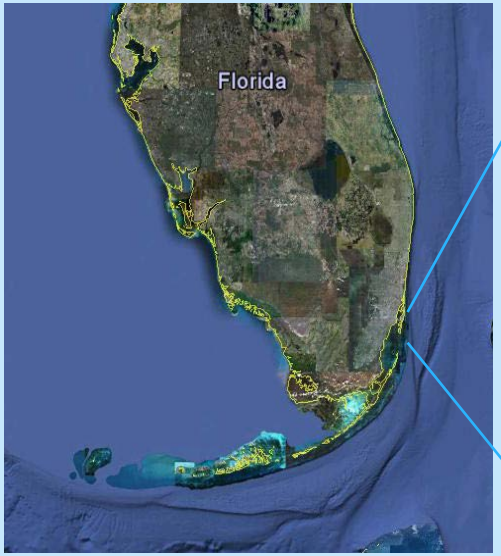
DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA
Biscayne Bay Aquatic Preserves

NATIONAL PARK SERVICE

Outline

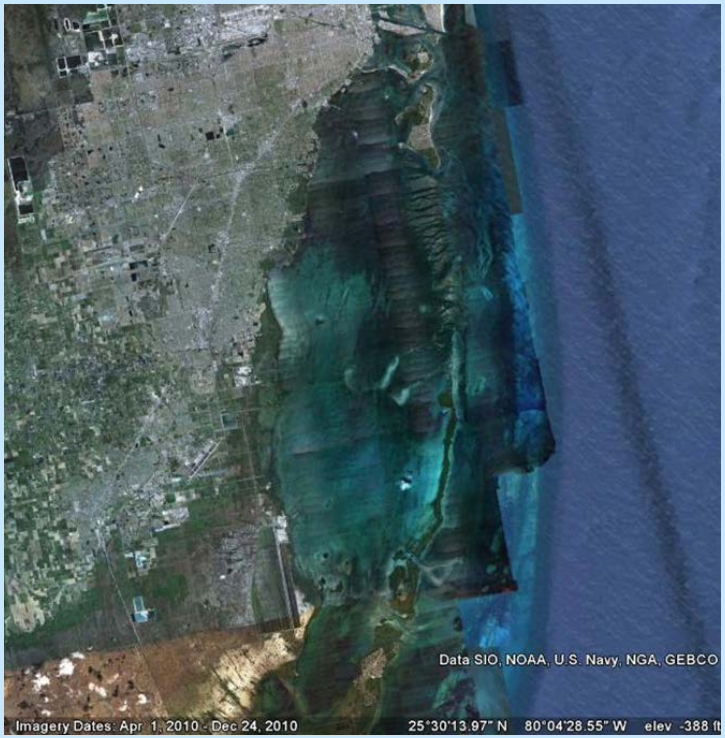
- Potential impact by modification in flow towards Biscayne Bay.
  - Salinity impacts
  - Nutrient impacts
  - Macroalgae responses
  - Macroalgae impacts on seagrass beds

- Are we crossing a tipping point towards chronic eutrophication levels?



Miami's metro area is the 7th most populous and 5th urban area in the United States, with a population of around 5.5 million.

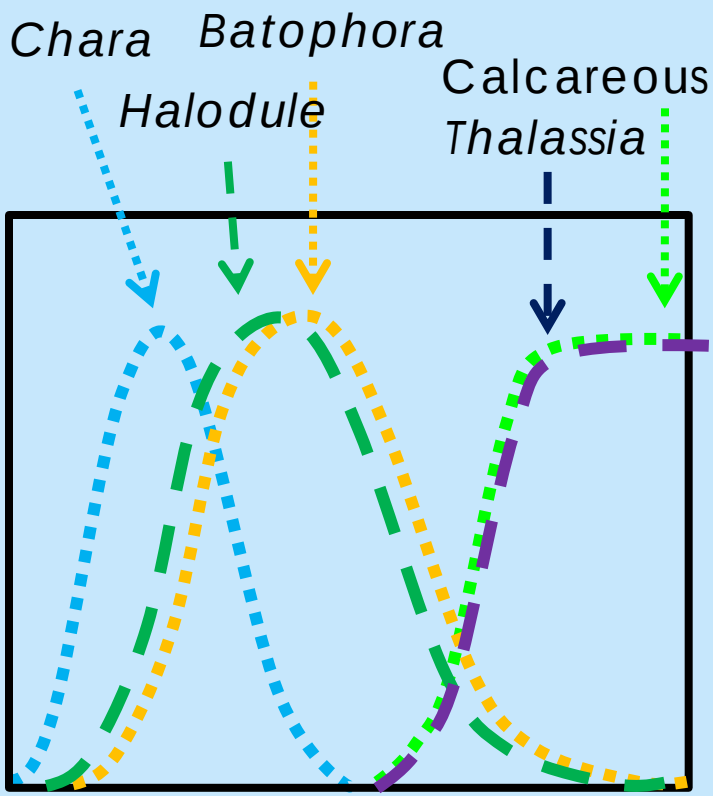
US Census Bureau

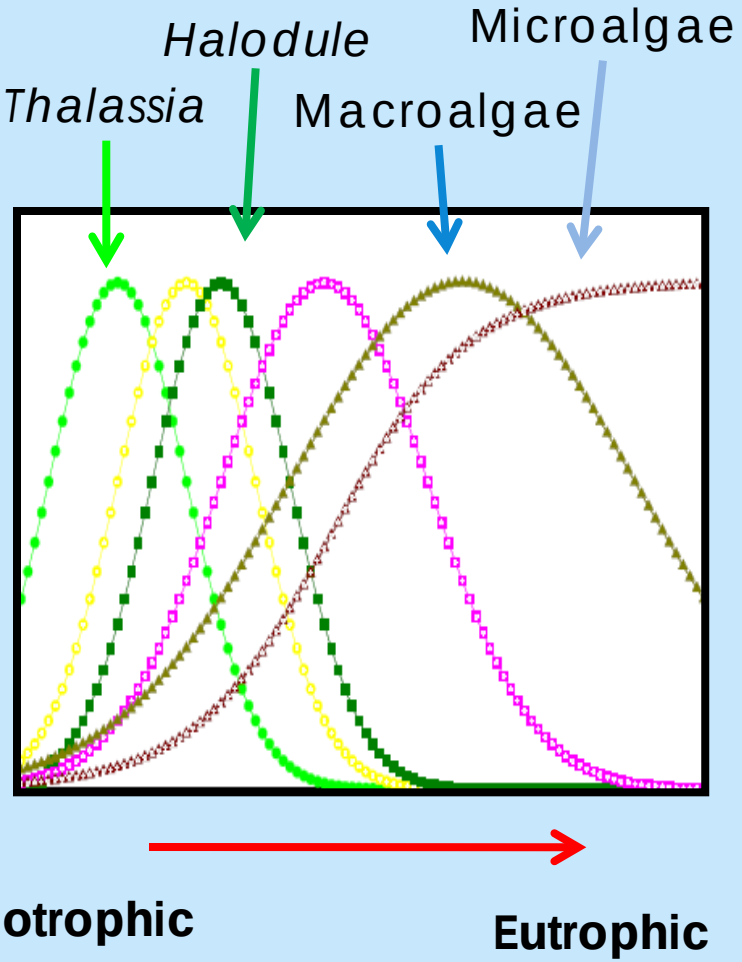


Biscayne Bay

Study Site

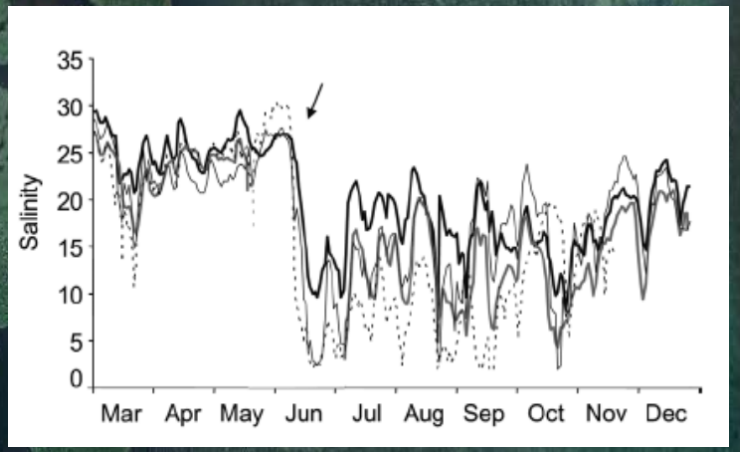
Salinity-Nutrient Gradients as drivers of SAV





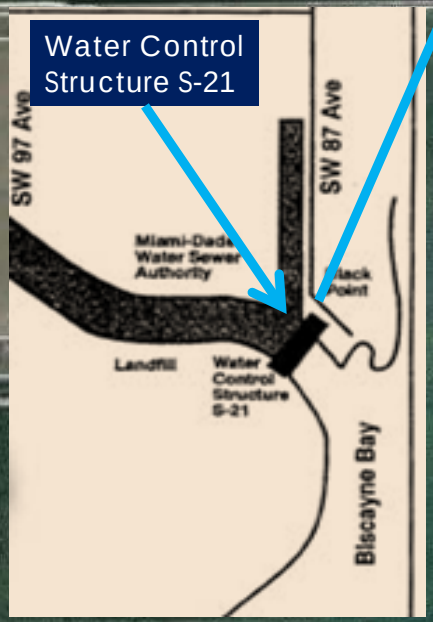
Modified from http://www.fiu.edu/~seagrass/

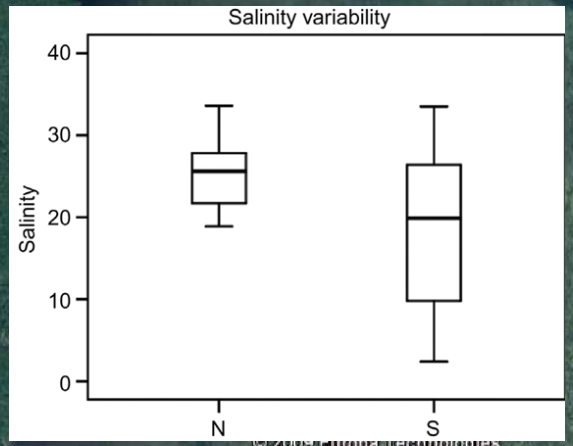
Freshwater input from Black Creek canal



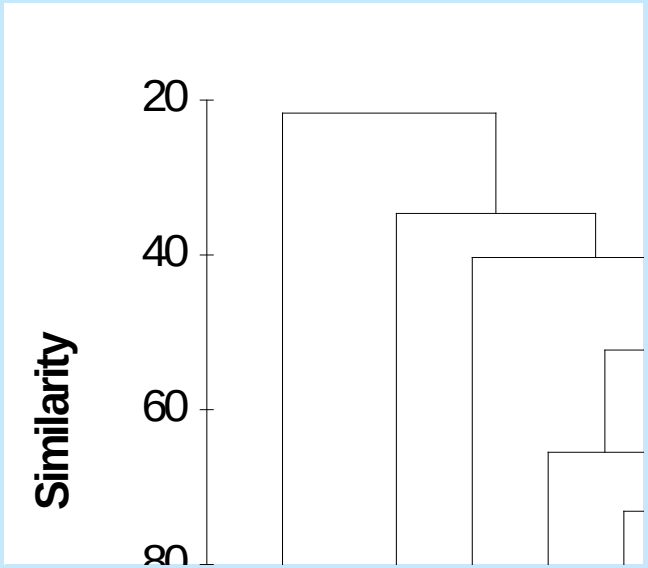
Black Point Marina

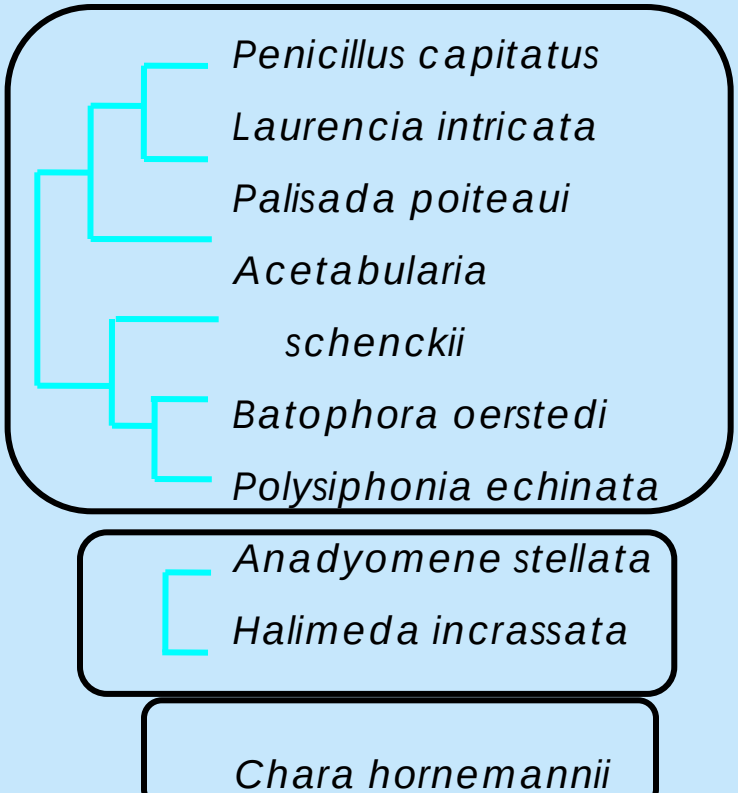
Water Control Structure S-21





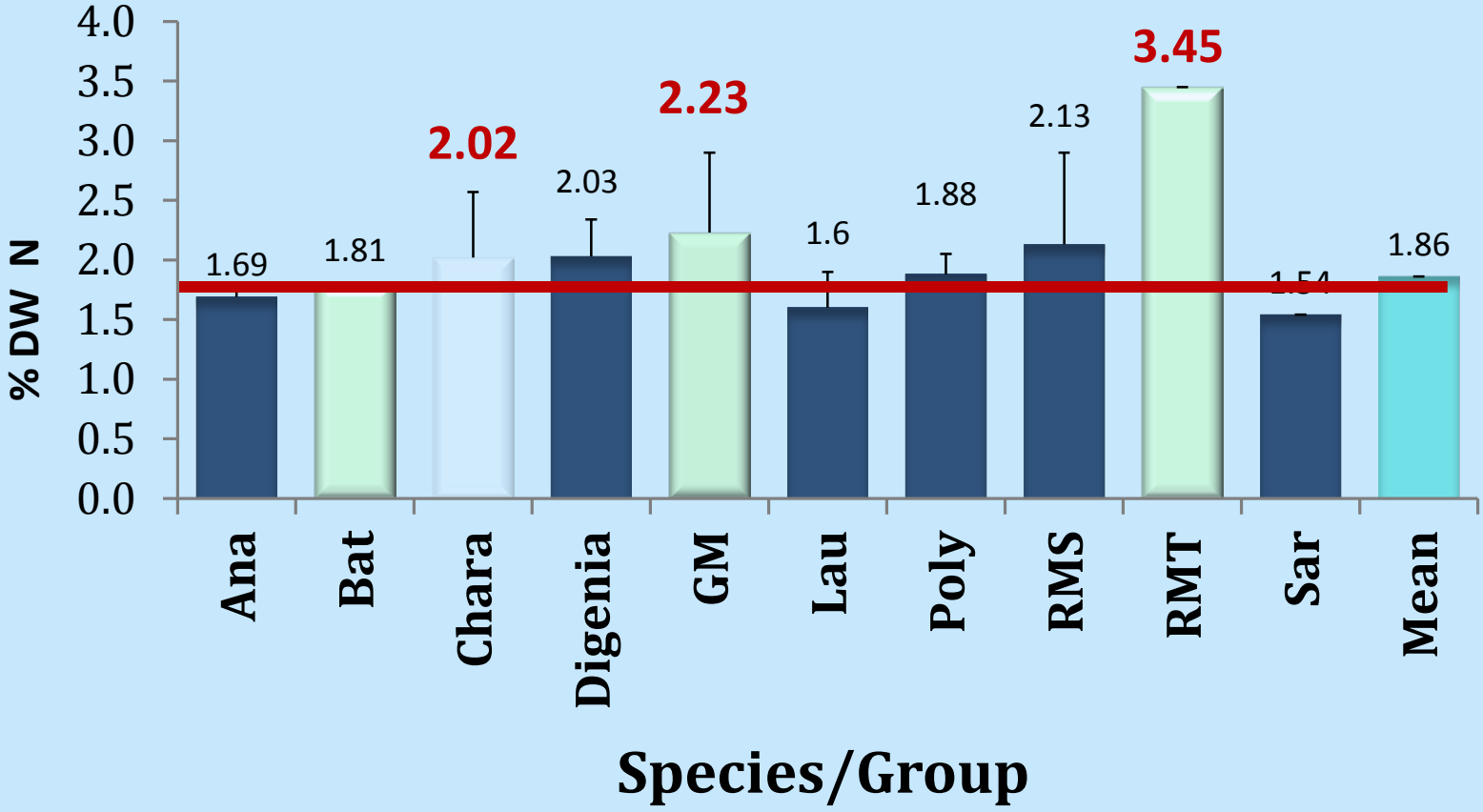
SAV spatial distribution





Drivers of SAV structure

Tissue nutrient Content
High Levels of Nitrogen

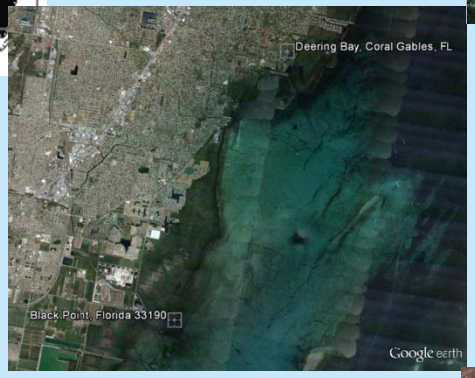


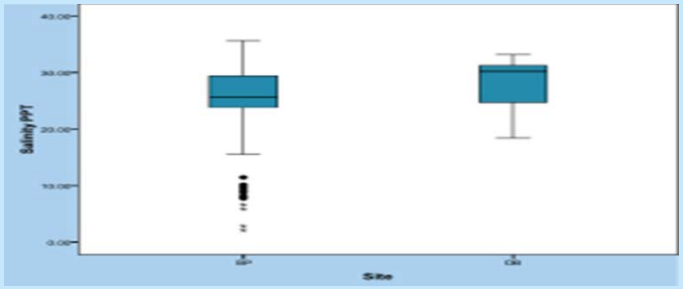
Lapointe 2005; *Anadyomene* (% N 2.38) *Codium* (% N 1.33) *Ulva* (% N 2.26)

Contrasting environments

Deering Bay

Richness= 49
H' = 3.892

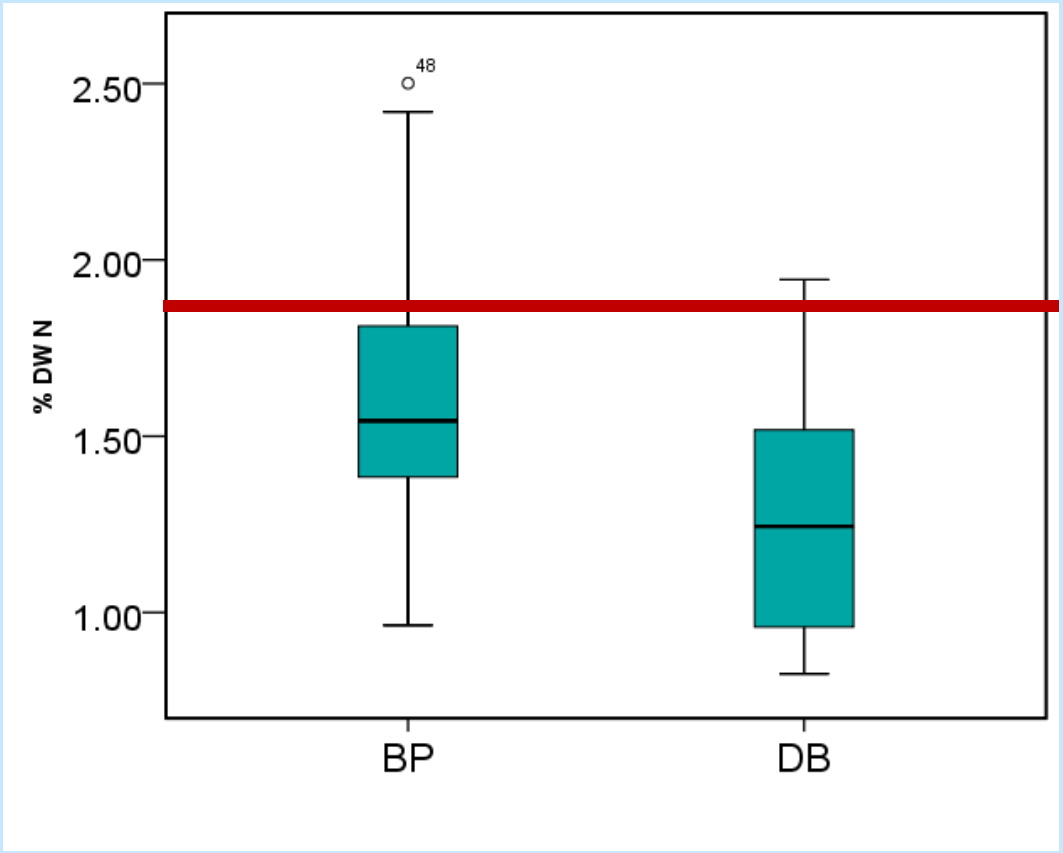




Black Point

Richness= 31
H' = 3.434

Laurencia tissue nutrient content show high N levels



Regional level
DB *vs* BP

T 43.76 df 94 *p* 0.0001

2016 Deering Bay after flooding experiment

Taxon	Mean %N	Mean ∂15N	Max ∂15N
Caulerpa	4.34	4.35	4.35
Digenia	**2.69**	4.85	4.85
Halodule	2.55	4.66	**8.79**
Thalassia	2.48	6.07	**10.57**
Ulva (Entero-form)	3.15	9.61	**11.92**
Ulva ohnoi	1.76	13.43	**14.8**

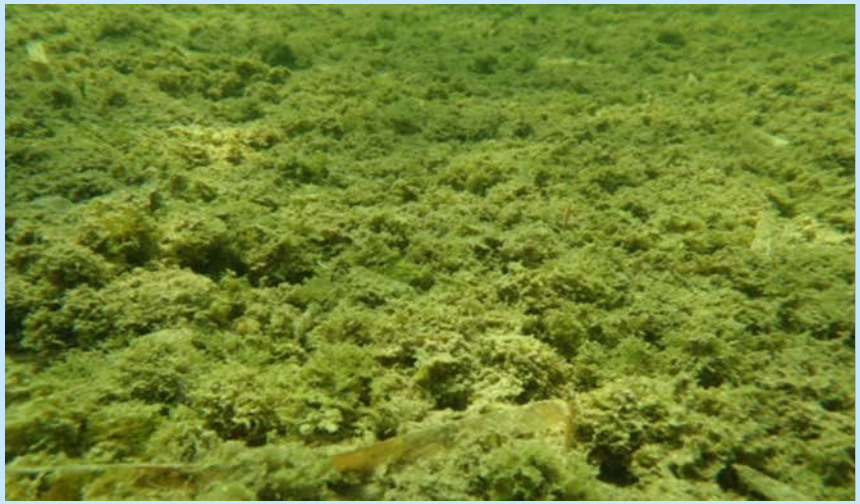
nutrient content of macroalgae

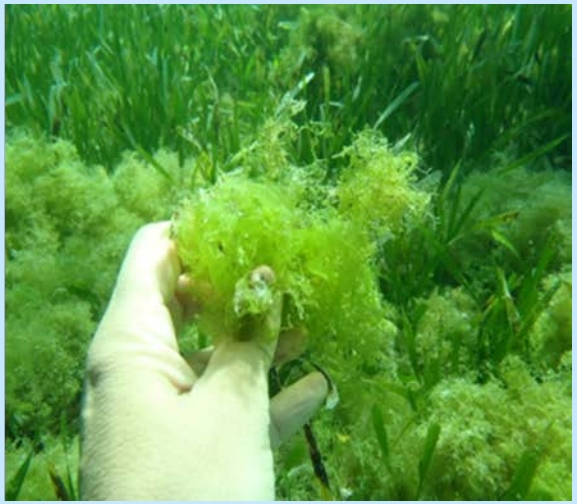
Salinity

- High variability and low values will reduce macroalgal diversity.
- Brackish water tolerant species will dominate.
- Close to shore sites are showing signs of increased nutrient availability.

Remarks

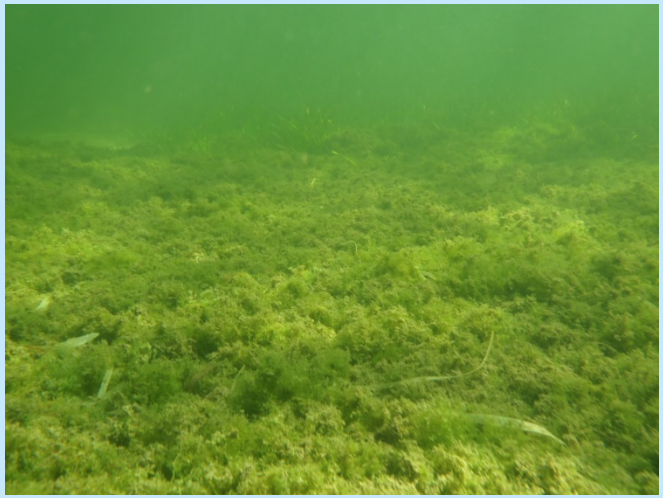
Macroalgal Blooms in a Heavily Urbanized Area of South Florida

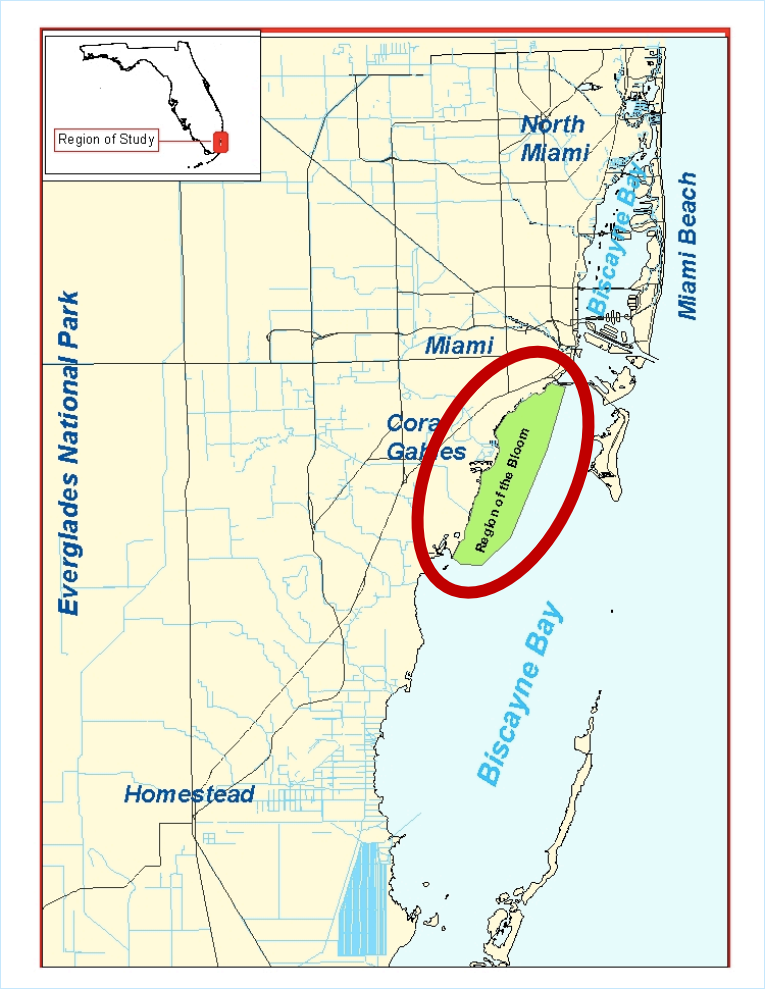




Macroalgae Bloom

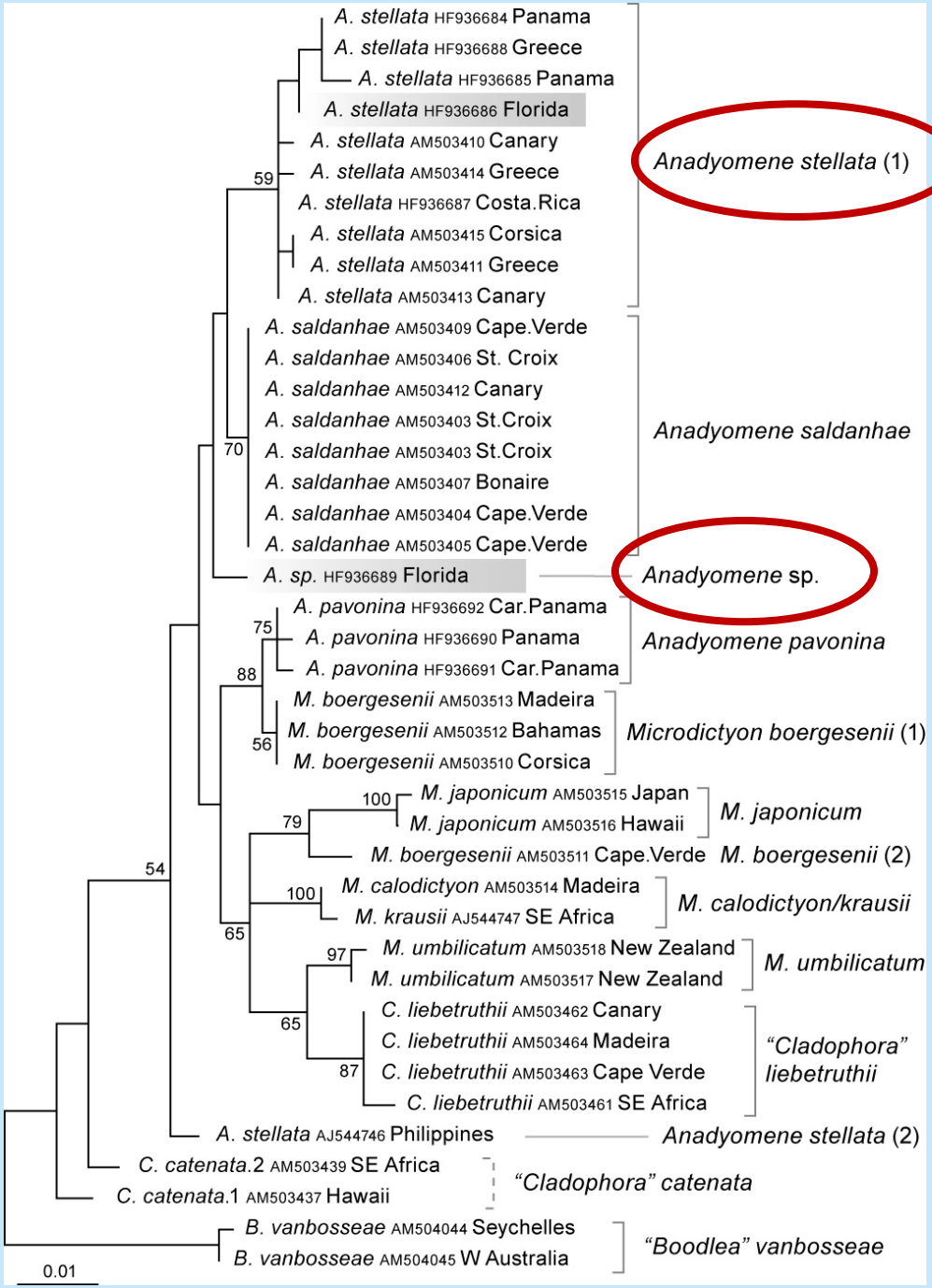
A green macroalgae bloom at Biscayne Bay FL





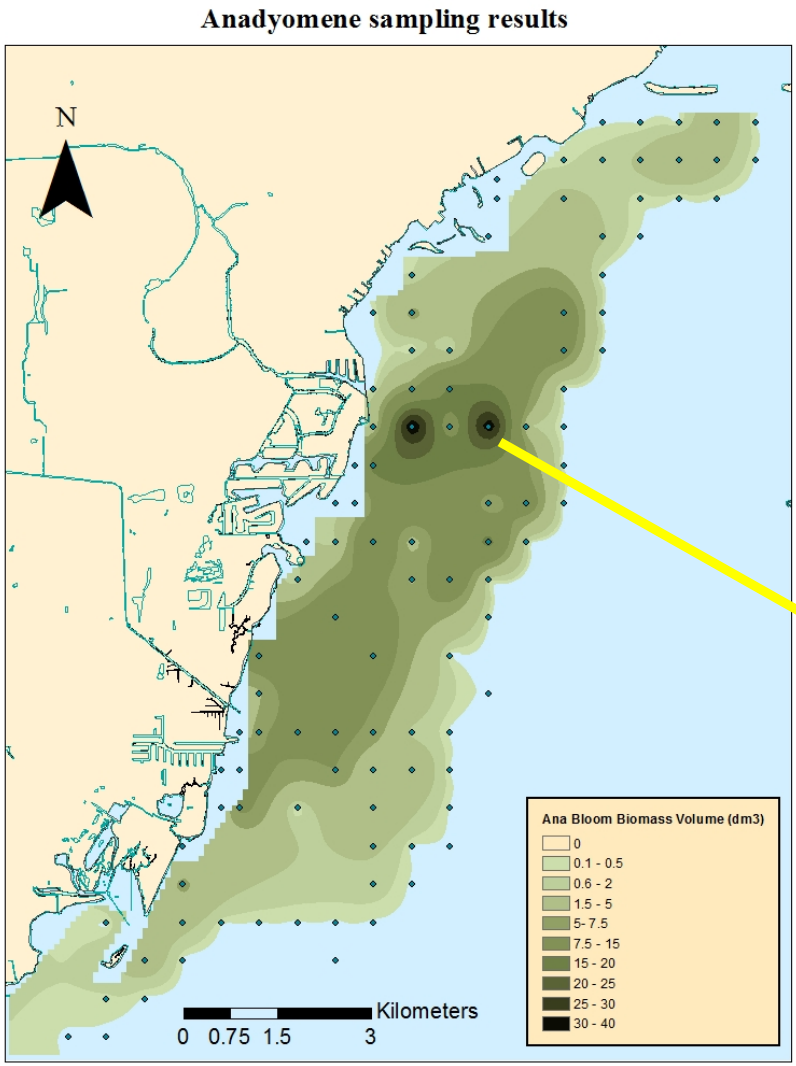
- A persistent harmful algal bloom of a green macroalgae species complex was detected in 2002.
- It is a massive growth of green macroalgae with blooming dimensions since 2008, and has persisted through 2013.

Macroalgae Bloom



C1D2 region of the large subunit (LSU)nrDNA

Bloom Peak 2010-2012: Avila/Varona

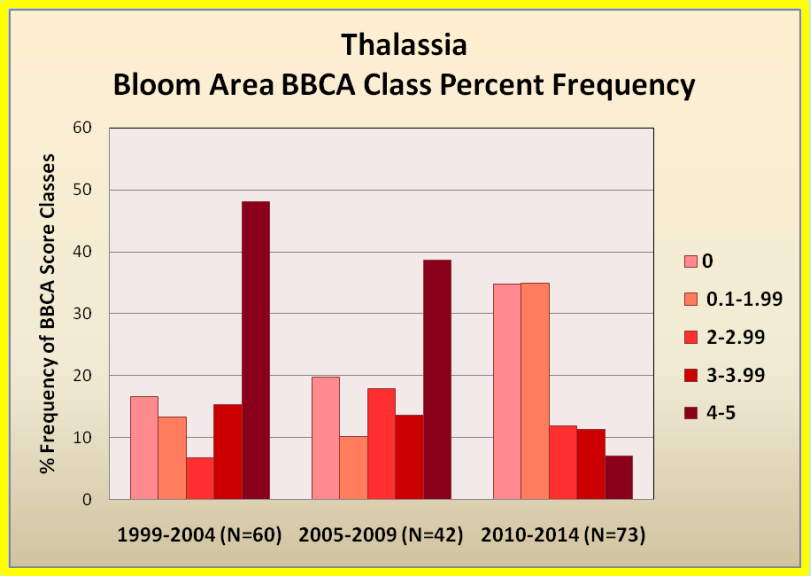


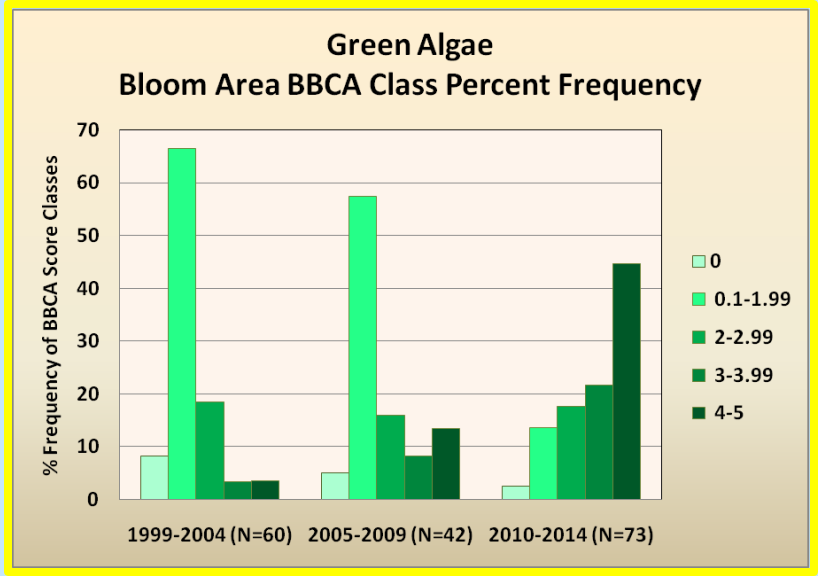
2012 Cubic volume evaluation:

- **While the majority of station had >75% cover – biomass was noted as variable.**
- **Percent Cover x Area (0.25m^2) x Height (cm).**
- **Pattern of greatest biomass just offshore of the two main canals in the region: Snapper Creek and Coral Gables.**

Macroalgae Bloom

Seagrass Impacts Avila/Varona





- **1999-2004 Pre-bloom: Seagrass high BBCA values (> 50% coverage), Green Algae low BBCA values (<5%)**
- **2005-2009 Bloom Development: Increase in Green Algae BBCA coverage in the 5% to 25% category and some increase in the highest categories (> 50% coverage).**
- **2010-2014 Bloom: Opposite abundance pattern than observed during pre-bloom (< 5% coverage for seagrasses, >50% coverage for Green Algae)**

Bloom Impact

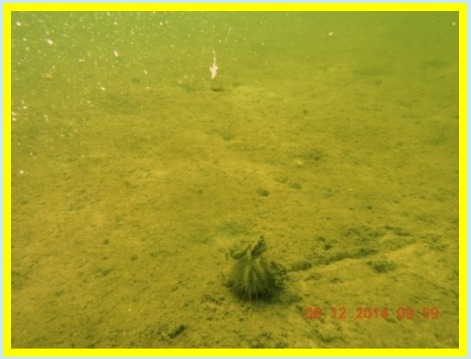
Bloom Time Series Avila/Varona

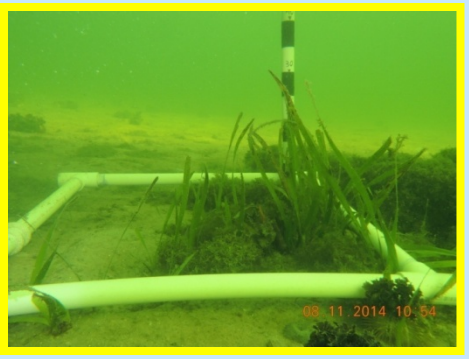
Station 3G | Station 6A | Station 9C

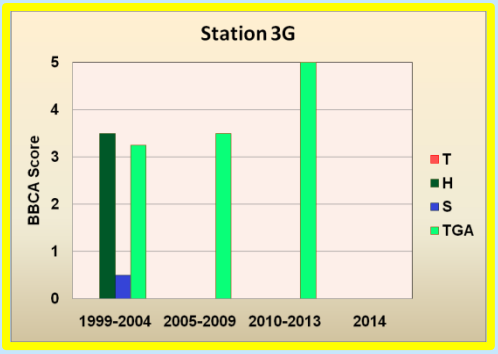
2010-2012

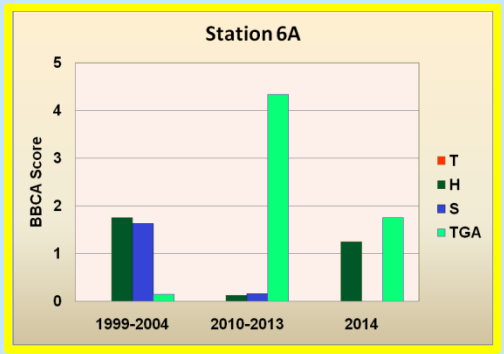


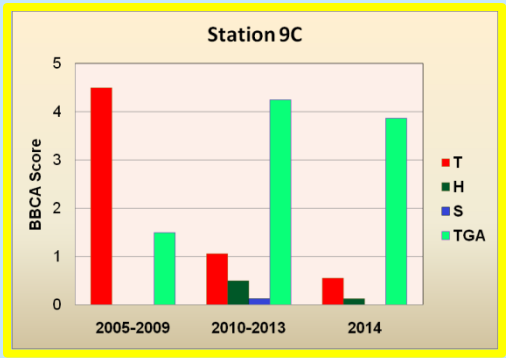
2014











Bloom Impact

Anadyomene stellata nutrient tissue content

	N	Min	Max	Mean
N	38	0.824	1.977	1.335
N15	38	0.780	**8.801**	5.992
P	38	0.009	0.036	0.016
N:P	38	103.433	369.867	193.571

Anadyomene sp. nutrient tissue content

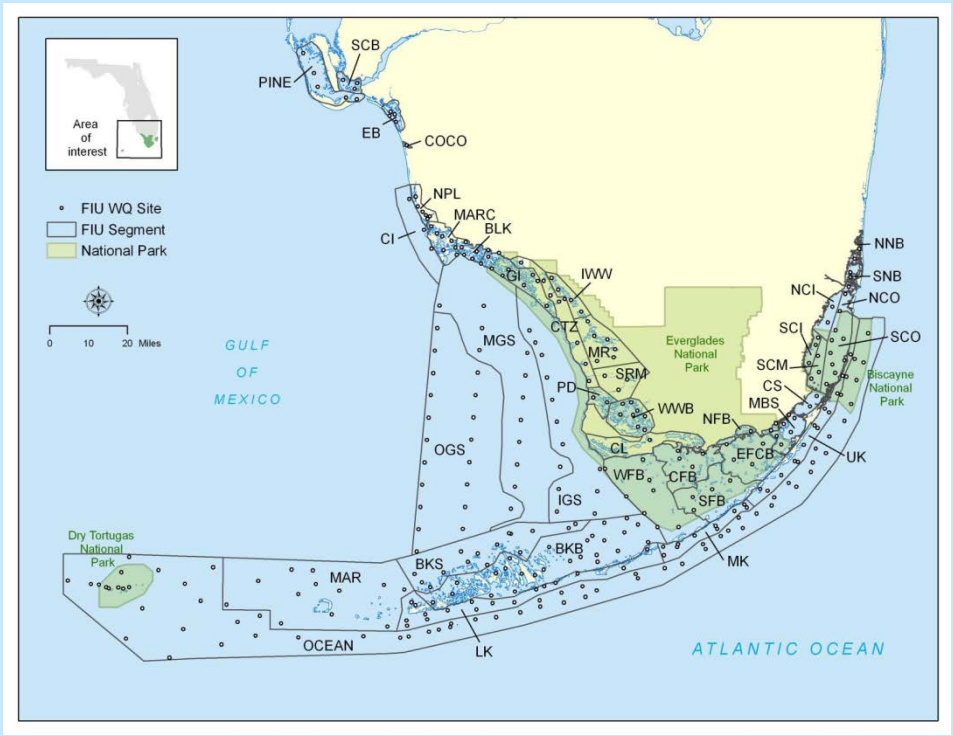
	N	Min	Max	Mean
N	65	0.893	**2.193**	1.487
N15	65	03.189	**11.000**	6.283
P	64	0.005	0.037	0.021
N:P	64	75.459	561.117	185.869

General average accepted as non-limited. Duarte 1991

%N = 1.82
%P = 0.02

***Anadyomene* (% N 2.38)**
***Codium* (% N 1.33)**
***Ulva* (% N 2.26)**

Lapointe, 1997, 2005



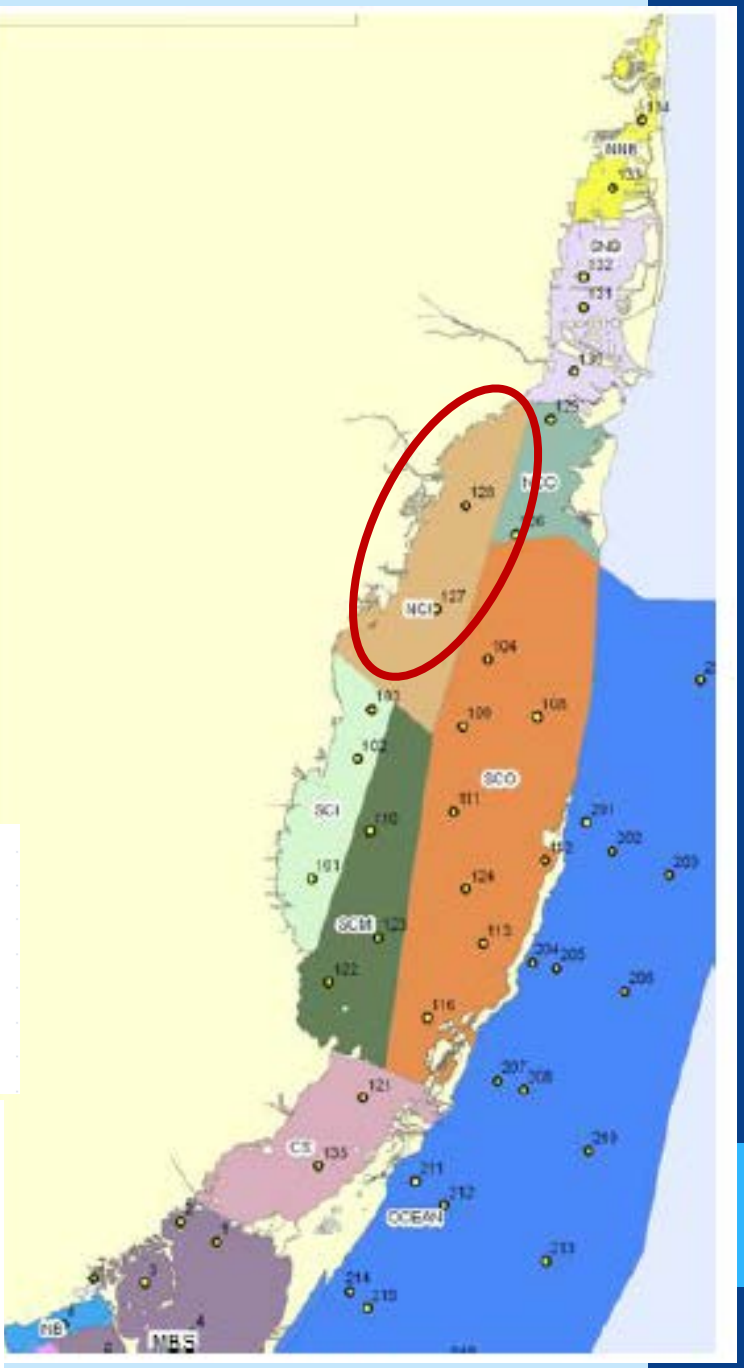
Water quality classification

Total Nitrogen

	CS	MBS	NCI	NCO	NNB	SCI	SCM	SCO	SNB
Mean	0.285	0.468	0.289	0.251	0.267	0.433	0.322	0.216	0.261
Median	0.273	0.447	0.267	0.227	0.237	0.405	0.288	0.199	0.242
Std. Dev.	0.121	0.164	0.184	0.122	0.132	0.204	0.155	0.106	0.121
Minimum	0.055	0.068	0.048	0.050	0.064	0.083	0.031	0.011	0.047
Maximum	0.760	1.085	2.185	1.129	0.869	1.560	1.066	1.313	1.011
Range	0.706	1.017	2.137	1.079	0.805	1.477	1.035	1.303	0.964

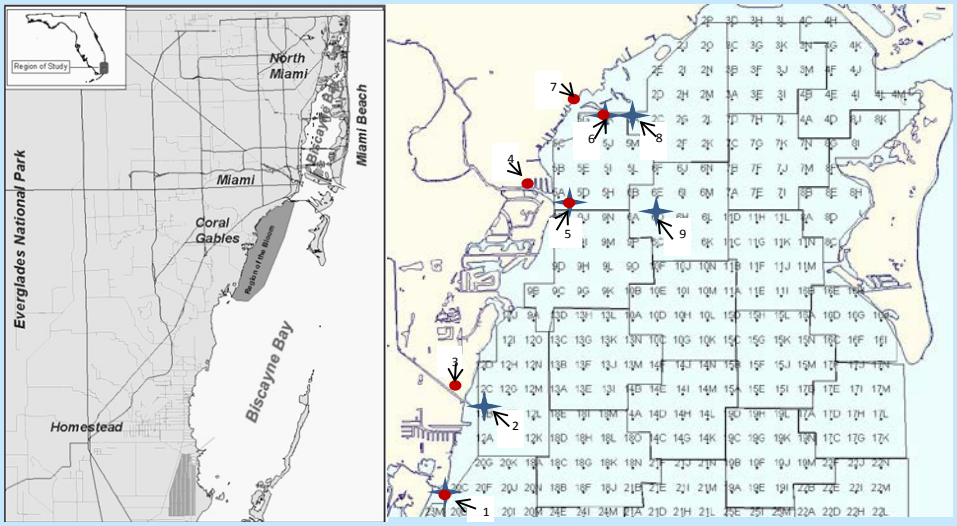
Total Phosphorous

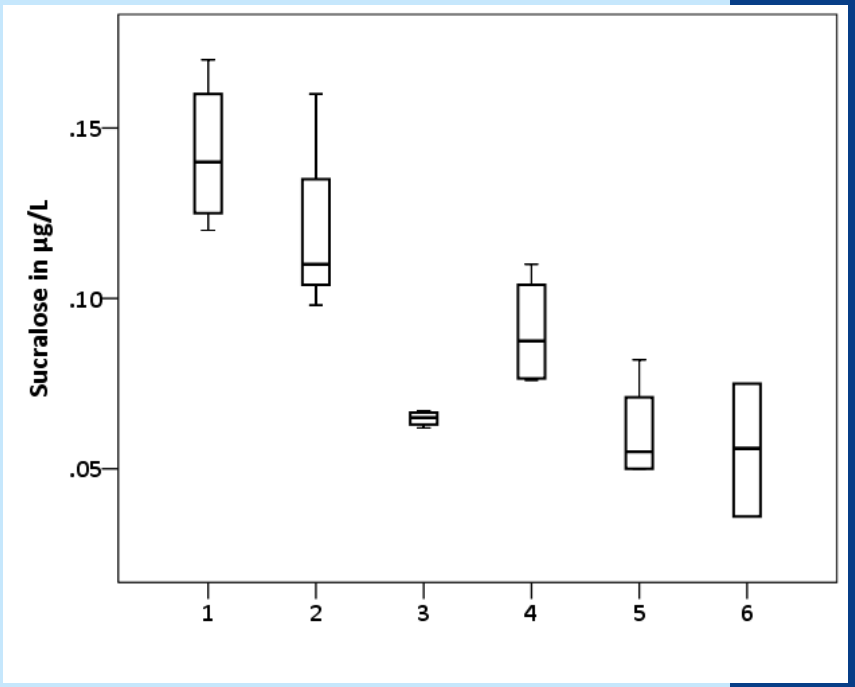
	CS	MBS	NCI	NCO	NNB	SCI	SCM	SCO	SNB
Mean	0.007	0.009	0.007	0.007	0.011	0.008	0.006	0.006	0.009
Median	0.006	0.006	0.005	0.006	0.010	0.006	0.005	0.005	0.008
Std. Dev.	0.005	0.008	0.005	0.005	0.006	0.007	0.005	0.005	0.005
Minimum	0.002	0.001	0.001	0.002	0.002	0.000	0.001	0.000	0.002
Maximum	0.030	0.097	0.037	0.045	0.053	0.052	0.059	0.049	0.058
Range	0.028	0.096	0.036	0.044	0.051	0.052	0.057	0.049	0.055



EPA-SERC 2011 Report

Sucralose as marker for anthropogenic sources





1= Deering Estate, Site 2= 12B, Site 3= Snapper Creek Inside Canal, Site 4= Coral Gables Inside Canal, Site 5= Coral Gables Canal Mouth, Site 6= Dinner Key Bay

Sucralose remarks

- The detected **values 0.04 to 0.17 µg/L** are in the range of those reported for Western Europe (Loos *et al*. 2009).

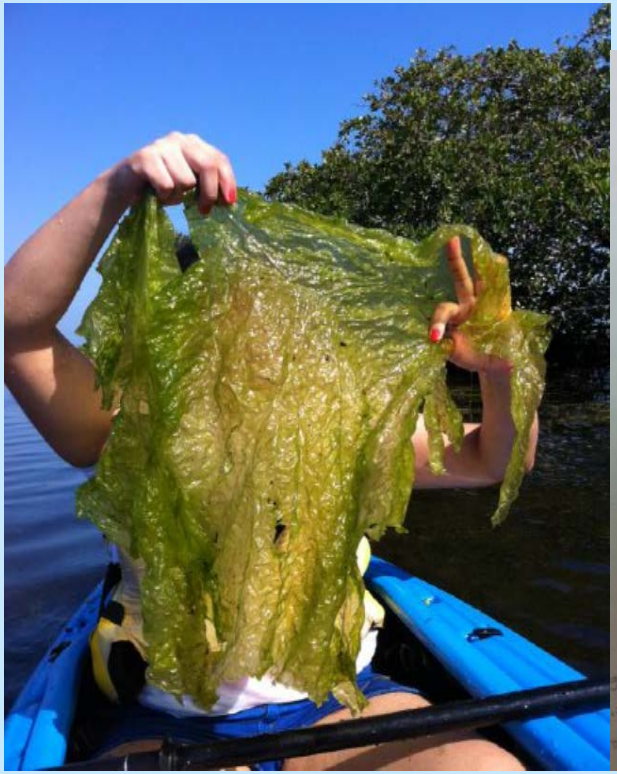
- Following Oppenheimer *et al.* (2011) classification Biscayne Bay falls in the category of **impacted by waste-waters (maximum values) to low impacted (minimum)**.

- Impacts are stronger at canals, with the highest values coming from Deering Estate, Snapper Creek and Coral Gables.

- These results are **consistent with the Swart *et al.* (2013)** research who suggest that the possible sources for N in Biscayne Bay could be local waste water treatment plant, and septic systems that are highly present in the area adjacent to the bloom

Other species

- Recently an incipient bloom was detected in the Deering Estate area

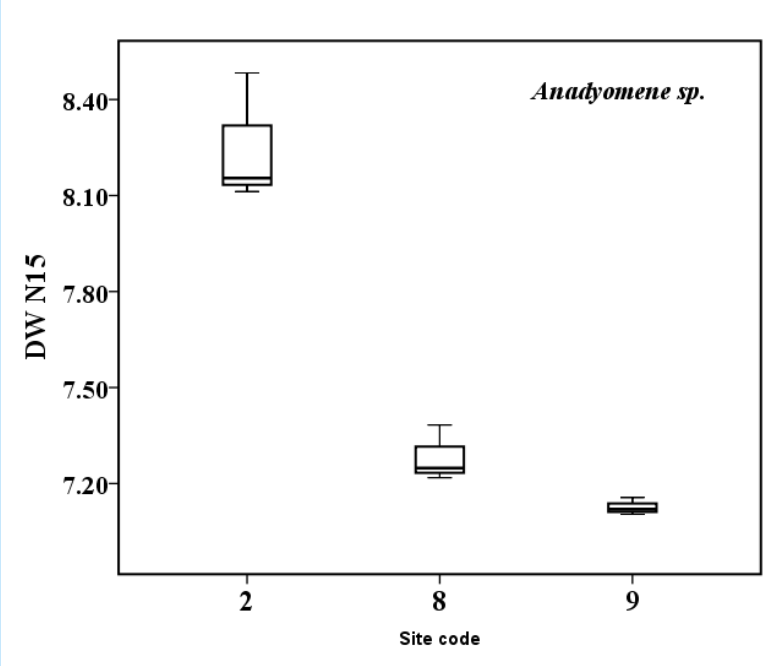


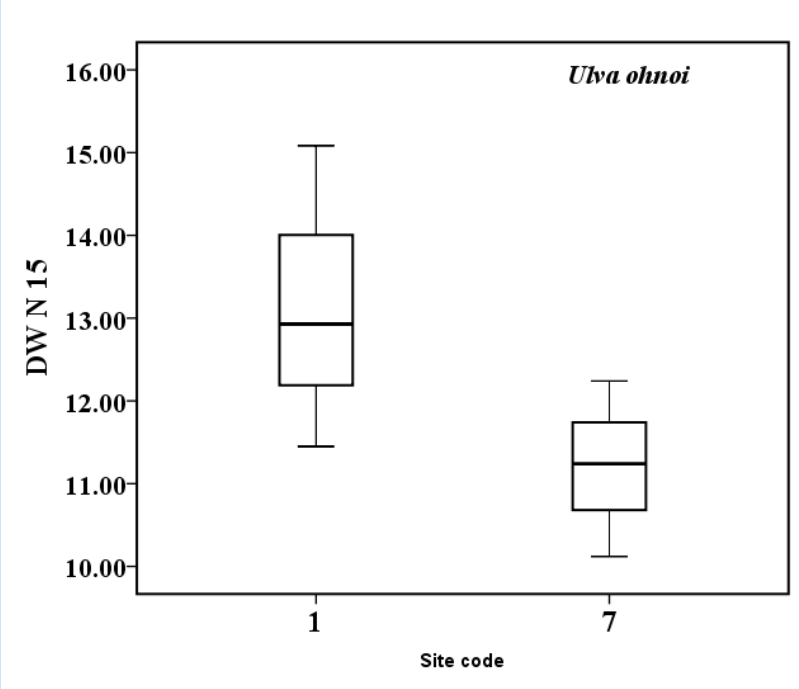
Ulva species are green macroalgae with many species responsible for the green tides around the world

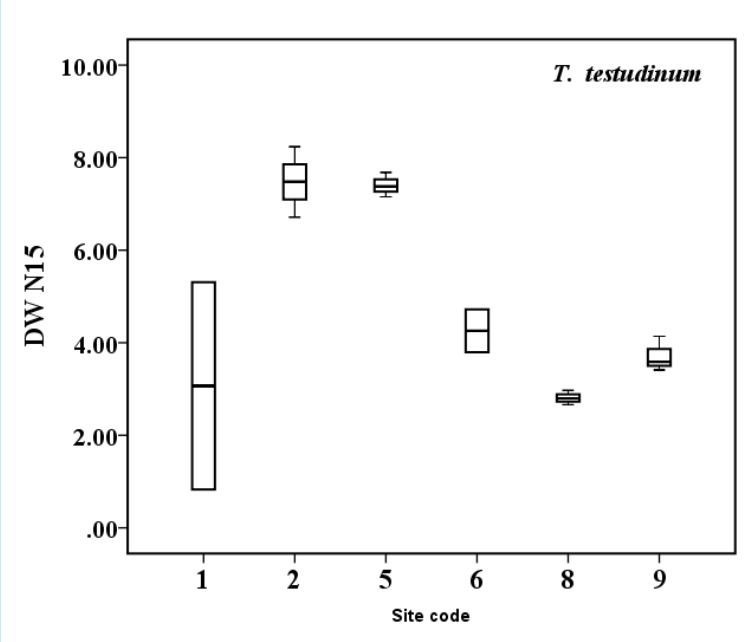
Ulva ohnoi

We recently demonstrate this is an introduced species, and is rapidly dispersing. Melton, Collado-Vides, Bautista 2016 Aquatic Invasions.

N15 values

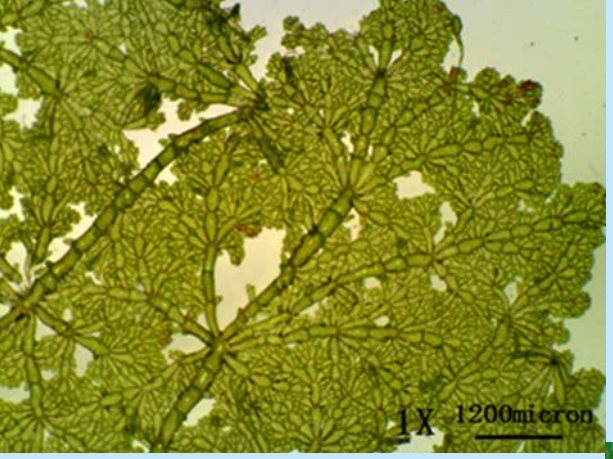


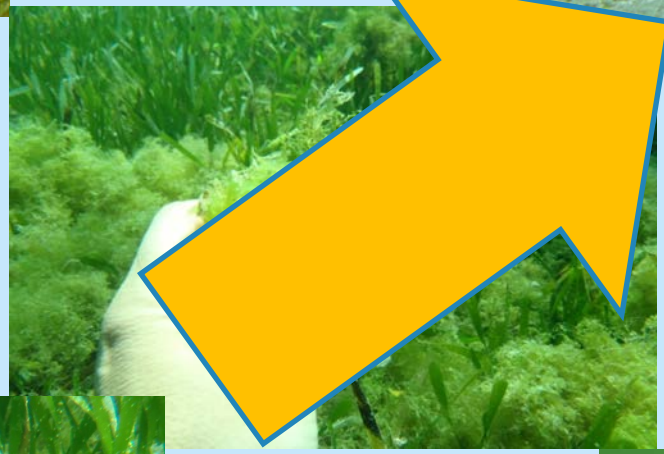


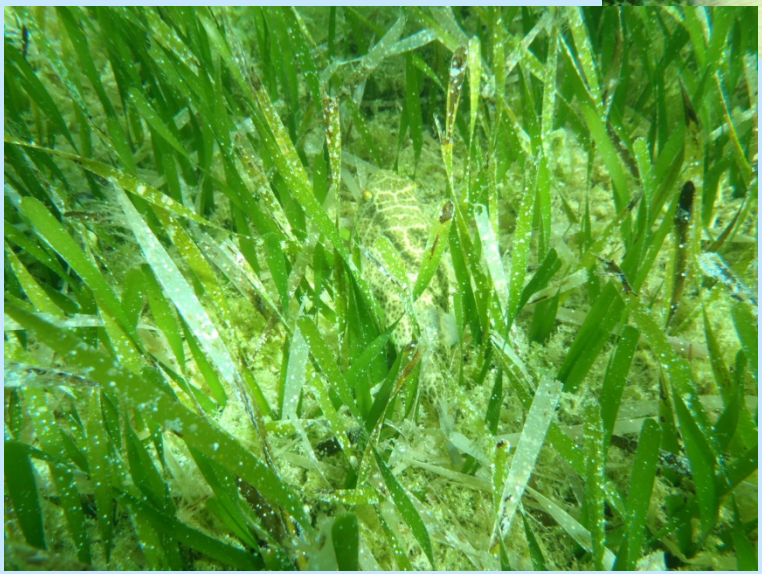


∂15N are extremely high in *U. ohnoi*

Ulva ohnoi: nutrient content


1X 1200micron





Possible effects to tourism

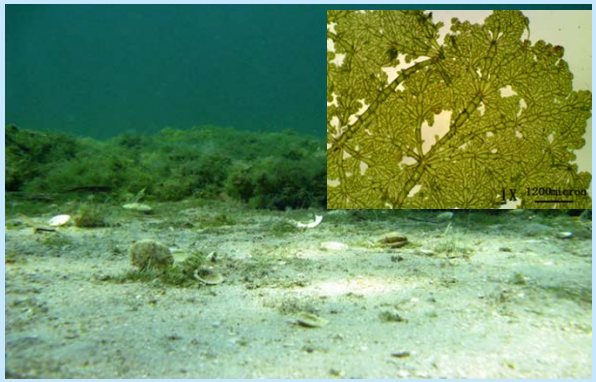
January 16-2016 at Biscayne Bay dog beach. Pictures L. Collado-Vides

Massive wash-out of *Anadyomene stellata* demosntrating large amounts of algal growth in 2015 winter season

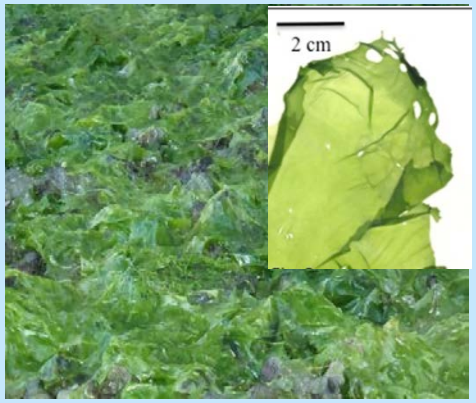
Closing remarks

- **We have a persistent green algal bloom**
- **1) Taxonomy requires revision, thin rapid growing green algae might be a new species. New arrivals such as Ulva ohnoi require a close monitoring**
- **2) Sucralose indicates waste water impact**
- 3) **This bloom is indicating high levels of N15 in close to shore habitats. A clear signature of anthropogenic sources.**
- **4) Other sites in the world are experiencing ephemeral green algal blooms. What green macroalgae are telling us?**

Phase-shift and its consequences



Anadyomene complex



Ulva ohnoi

Red algae complex:
Laurencia/Digenia/Acanthophora

Opportunistic macroalgae are increasing.

Which is the probability of the detected species to become a larger nuisance?

We need to understand their nutrient uptake capabilities in relation with nutrient availability in the bay.

Thank you for your attention. Questions?

Contact me at **colladol@fiu.edu**