

Spatial and Temporal Trends of a Multi-year Macroalgal Bloom

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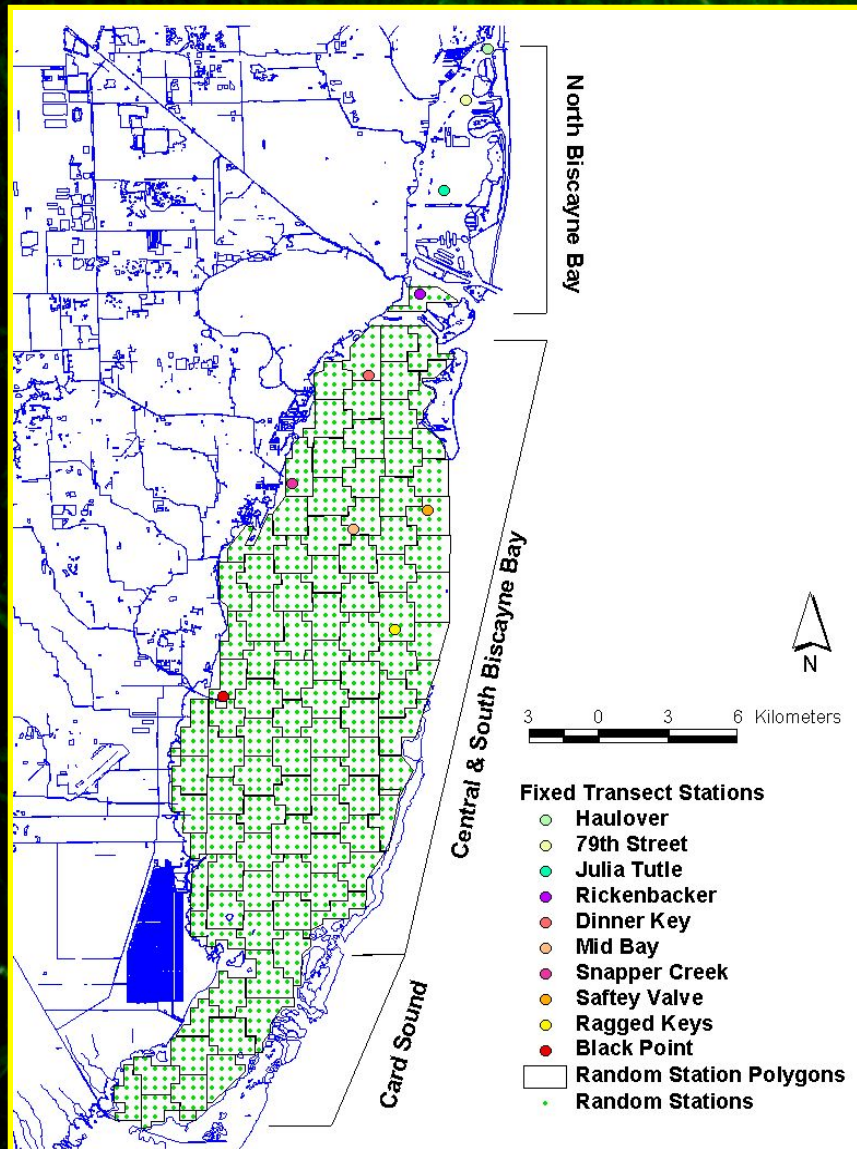
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Overview

- DERM had been conducting annual surveys of stratified random stations since 1999 and fixed transects since 1985.
- Period of Record showed stable seagrass community throughout Biscayne Bay through 2007.
- Bloom became apparent in 2010 and reviews of the data indicate development in 2004-2005.
- Bloom is composed of two species in the genus *Anodyomene*.
- Bloom has remained confined to the North Central Inshore (NCI) region of the bay.

Monitoring Program



- SAV surveys are conducted annually by at 11 fixed stations and 101 sampling sites within Biscayne Bay using a stratified random design.
- Additional sampling has been conducted since 2010 in the NCI region with a total of 165 stations surveyed between 2010-2014
- SAV Metrics
 - SAV is sampled with a 0.25m^2 grid.
 - 4 grids per station
 - Visual percent cover is estimated using the Braun-Blanquet scale (BBCA) for both seagrass and macro algae.

Braun-Blanquette Cover-Abundance scale.

0.1 = < 5% cover with a solitary

0.5 = <5% cover with few individuals/shoots

1 = <5% numerous individuals/shoots

2 = $\geq 5\%$ to $\leq 25\%$ cover

3 = $> 25\%$ to $\leq 50\%$ cover

4 = $> 50\%$ to $\leq 75\%$ cover

5 = $> 75\%$ cover

Biscayne Bay – North Central Inshore Region

Numeric Nutrient Criterion Regions For Biscayne Bay (Dec., 2012)

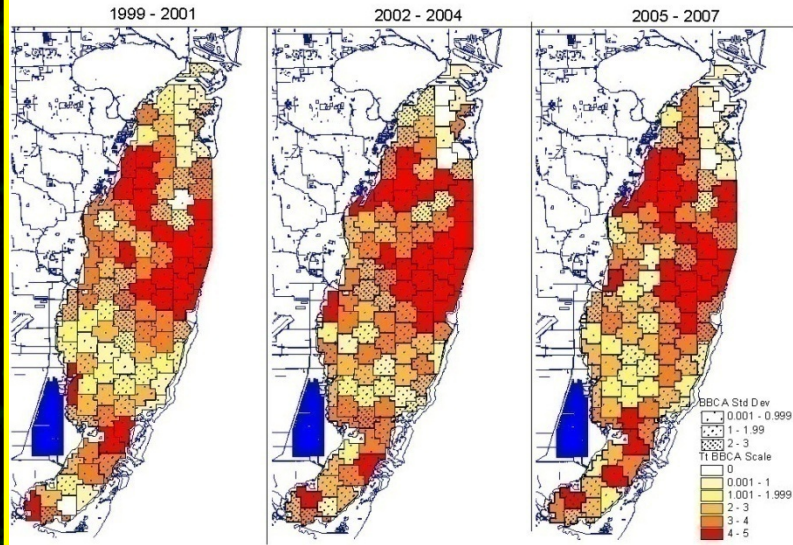
Biscayne Bay Numeric Nutrient Criteria Ref: F.A.C. 62-302.532(1)					
Rule Item	Region ID	Region Name	CRITERION		
			TP (mg/l)	TN (mg/l)	Chl-a (ug/l)
(h)5	NNB	Northern North Bay	0.012	0.30	1.7
(h)9	SNB	Southern North Bay	0.010	0.29	1.1
(h)3	NCI	North Central Inshore	0.007	0.31	0.5
(h)4	NCO	North Central Outer-Bay	0.008	0.28	0.7
(h)6	SCI	South Central Inshore	0.007	0.48	0.6
(h)7	SCM	South Central Mid-Bay	0.007	0.35	0.2
(h)8	SCO	South Central Outer-Bay	0.006	0.24	0.2
(h)1	CS	Card Sound	0.008	0.33	0.5
(h)2	MBS	Manatee Bay – Barnes Sound	0.007	0.58	0.1

- Identified as a distinct region in a number of multi-dimensional water quality analyses.
 - Combination of physical and nutrient data.
- Receives freshwater input from Coral Gables Waterway / C-2 and Snapper Creek / C-3
 - Relatively low flow but high N.
- The region had historically received significant groundwater contribution.

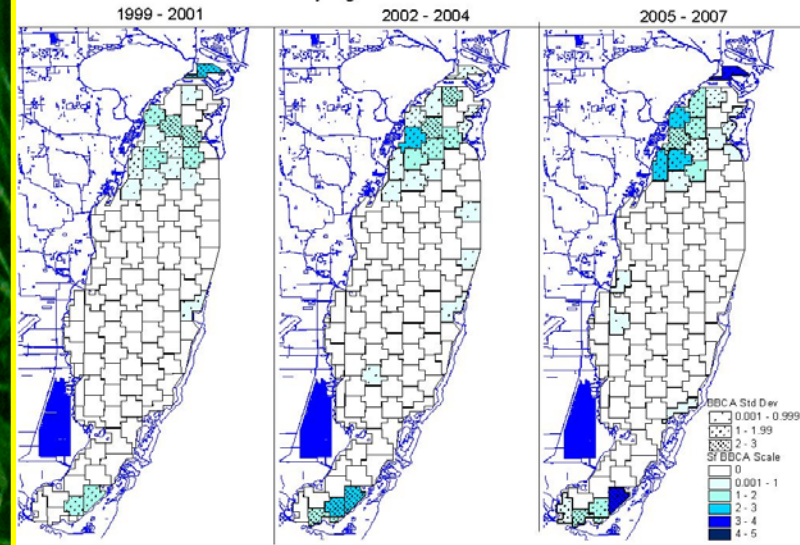


NCI Seagrasses 1999- 2007

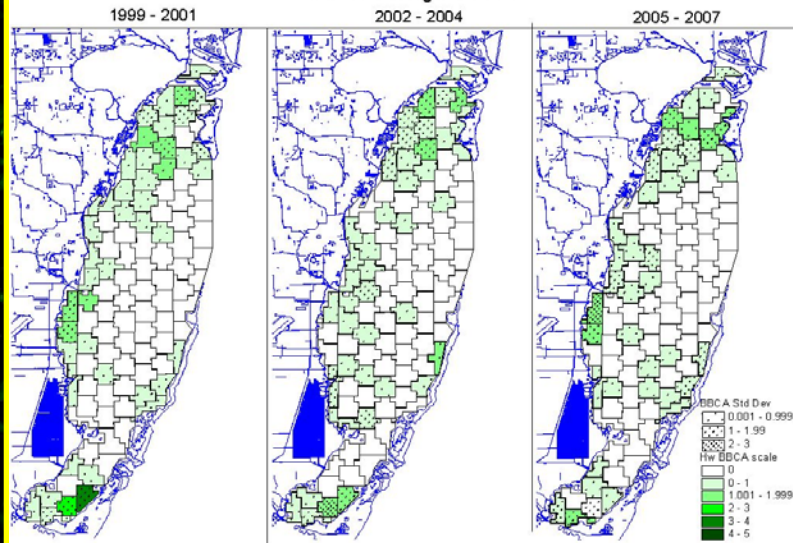
Three Year Evaluation Periods
Mean and Standard Deviation for
Thalassia testudinum BBCA



Three Year Evaluation Periods
Mean and Standard Deviation for
Syringodium filiforme BBCA

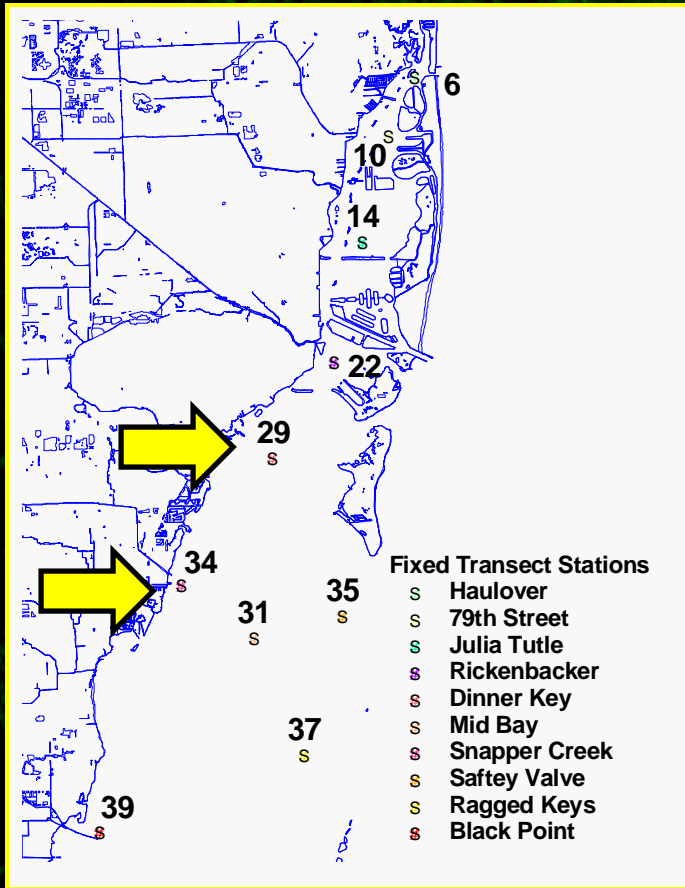


Three Year Evaluation Periods
Mean and Standard Deviation for
Halodule wrightii BBCA

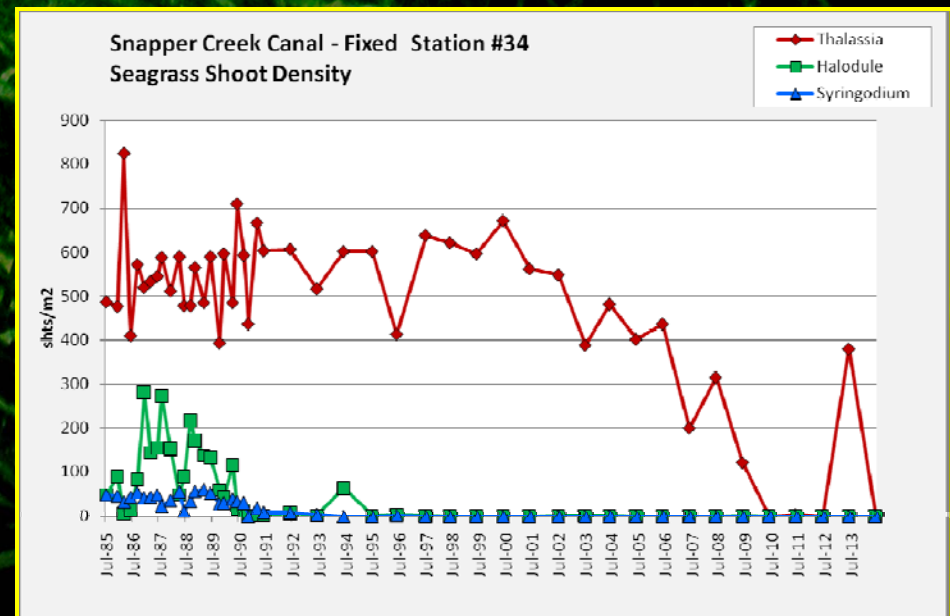
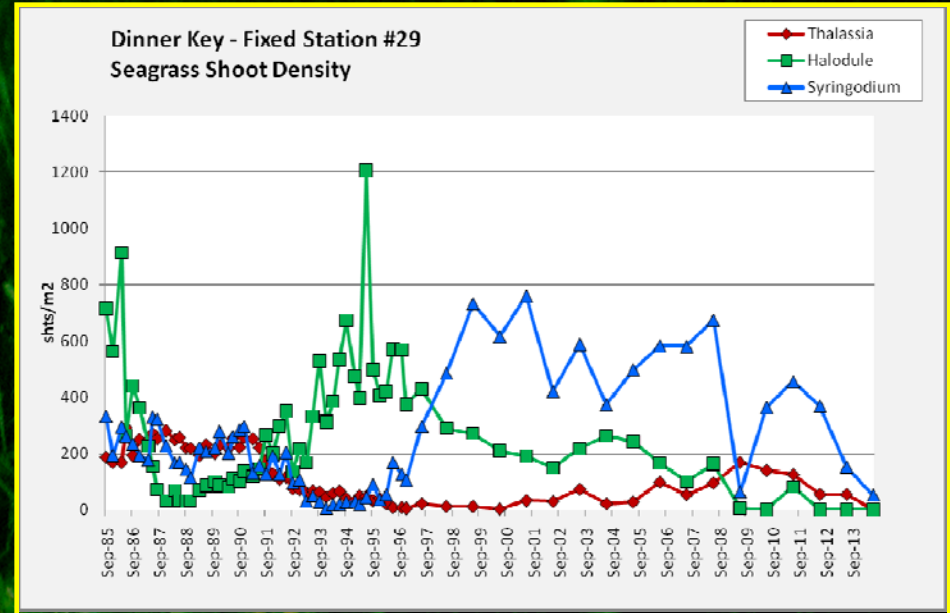


- NCI Region had a varied but stable mix of *Thalassia*, *Halodule*, and *Syringodium*.

NCI Seagrasses Fixed Stations



- Two fixed seagrass monitoring stations within in the bloom 29 & 34 .
- Period of Record dating to 1985, showing seagrass at high shoot densities through 2005

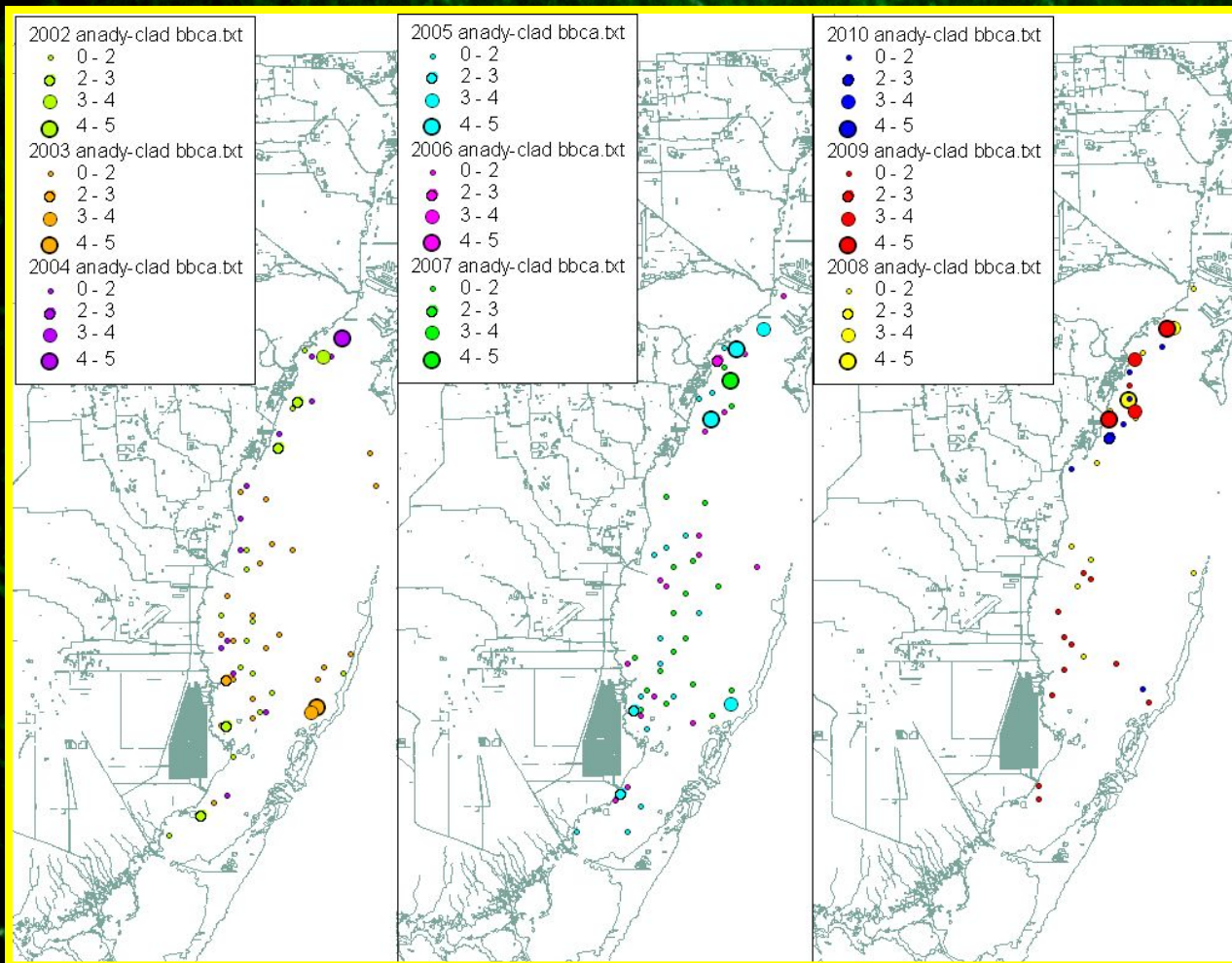


Bloom Composition



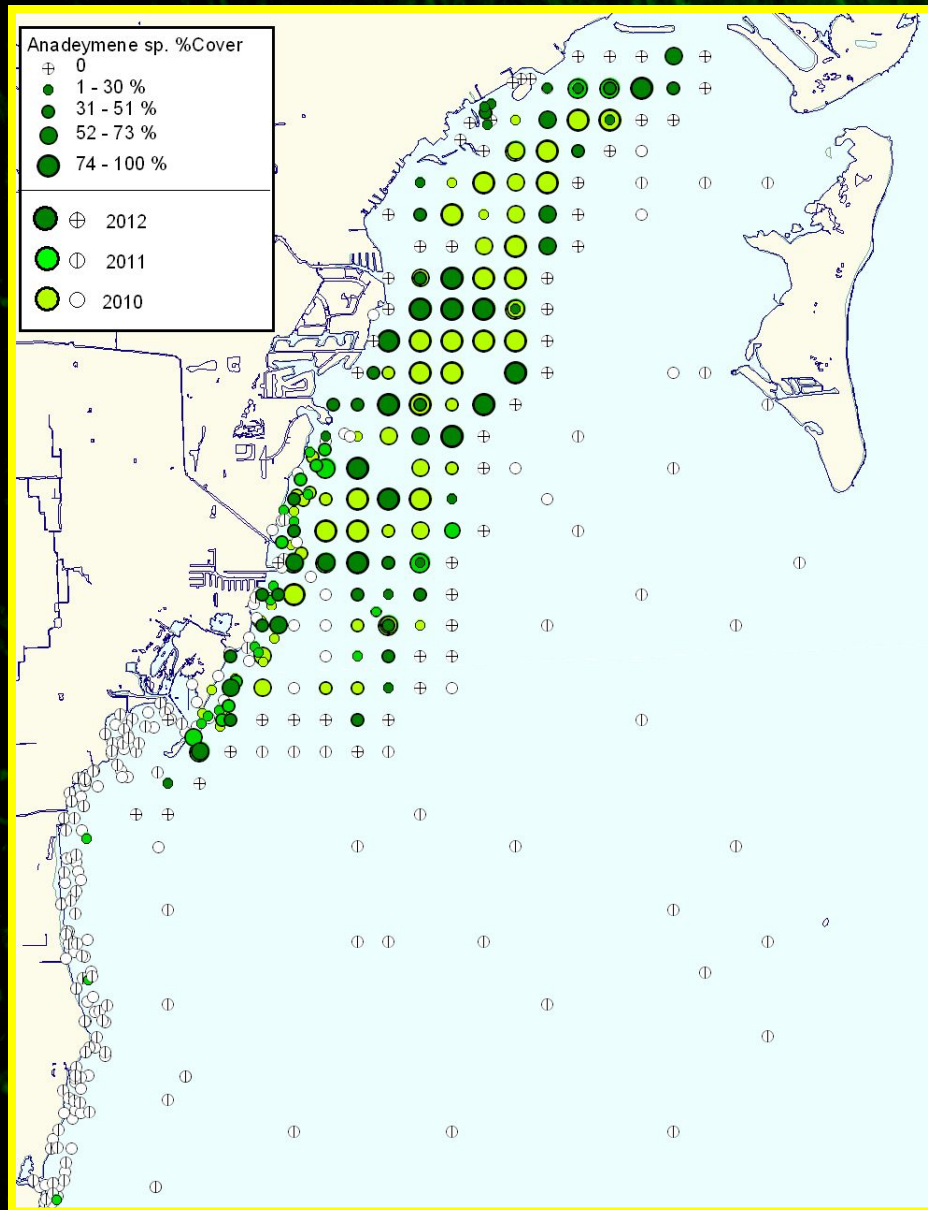
- Two species in the genus *Anadyomene*
- Image 1: *Anadyomene stellata*
 - Found throughout Central Southern Biscayne Bay <5% cover.
 - Present throughout the bloom area, with some areas of dominance in the north.
- Image 2: *Anadyomene sp*
 - DNA unable to confirm identification, appears morphologically closest to *Anadyomene linkiana* - previously described from single specimen collected from deep waters in the Bahamas.
 - Dominant throughout the bloom, regularly >75% cover and attaining high biomass.
 - Not previously recorded in Biscayne Bay or elsewhere in Florida.

Bloom Development



- **2002 – 2004:**
Present throughout the bay, mostly low percent cover.
 - First indications of bloom in the northern part of NCI.
- **2005 – 2007:**
Development becomes evident.
- **2008 – 2010:**
Bloom is established in the NCI region

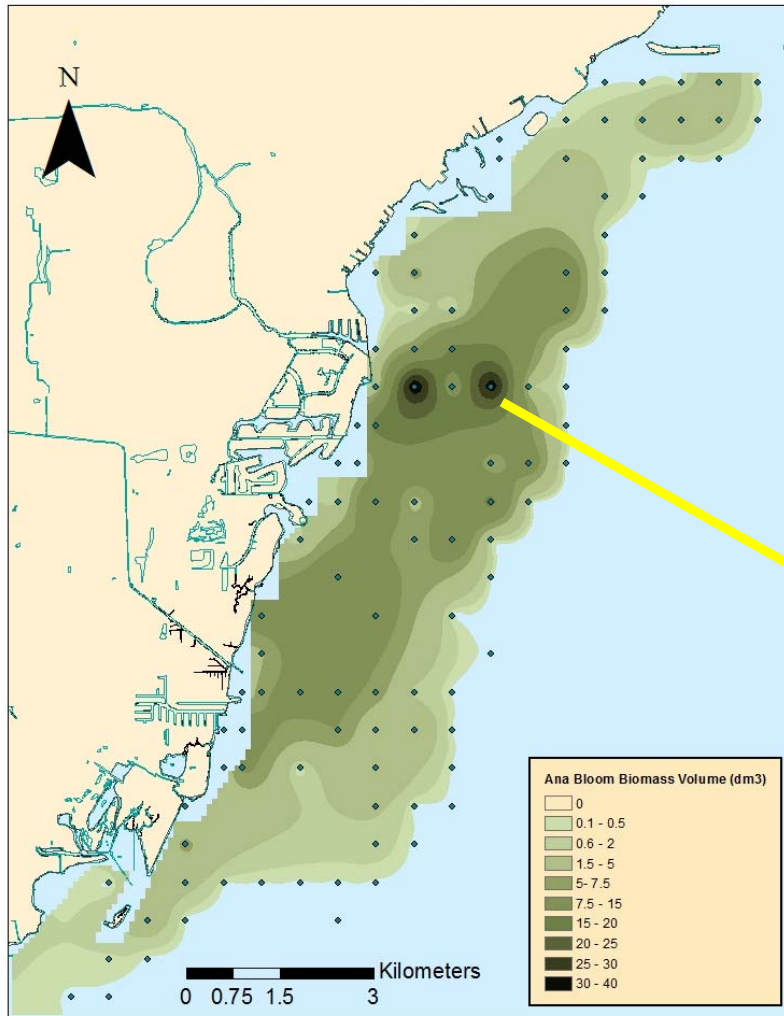
Bloom Peak 2010 - 2012



- Dedicated sampling beginning in 2010 using the full sampling grid in the NCI.
- Combined DERM & UM SWAPS data to produce a map the bloom .
- Large areas of *Anadyomene* with coverage 75-100%.
- Total approximate bloom area is approximately 60km².
- Distinct Eastern fringe from 75-100% cover to absent between station 2000ft apart.

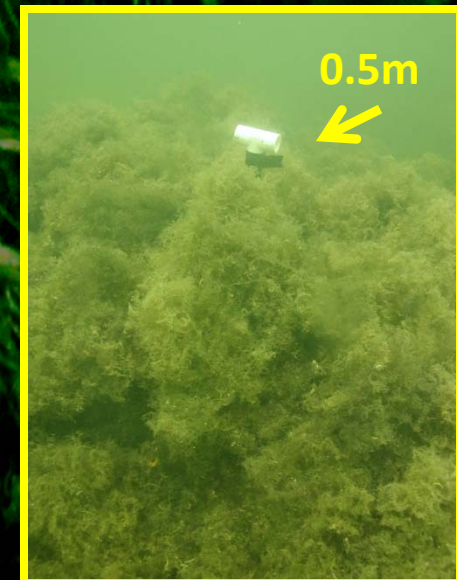
Bloom Peak 2010-2012

Anadyomene sampling results

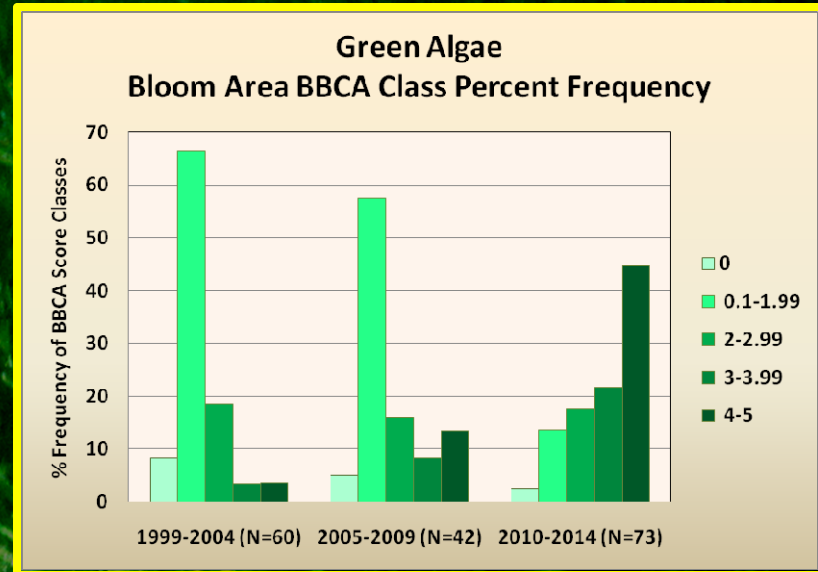
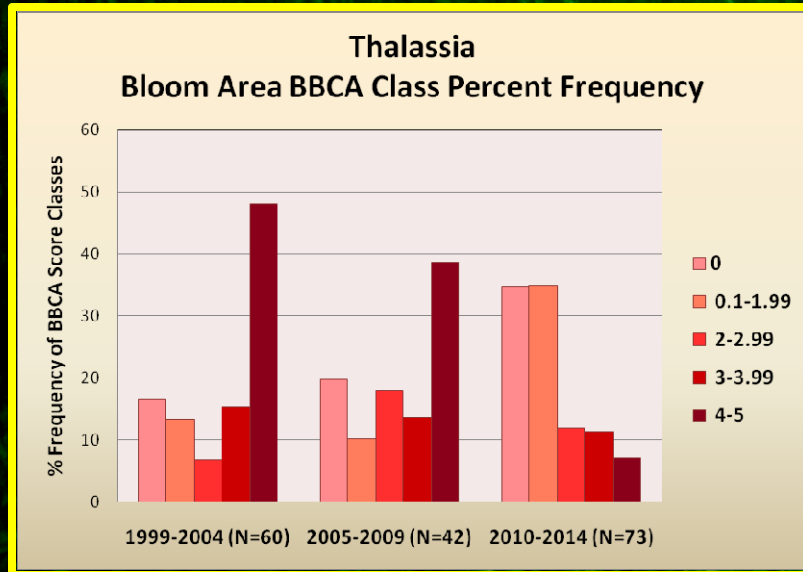


2012 Cubic volume evaluation:

- While the majority of station had >75% cover – biomass was noted as variable.
- Percent Cover x Area (0.25m²) x Height (cm).
- Pattern of greatest biomass just offshore of the two main canals in the region: Snapper Creek and Coral Gables.

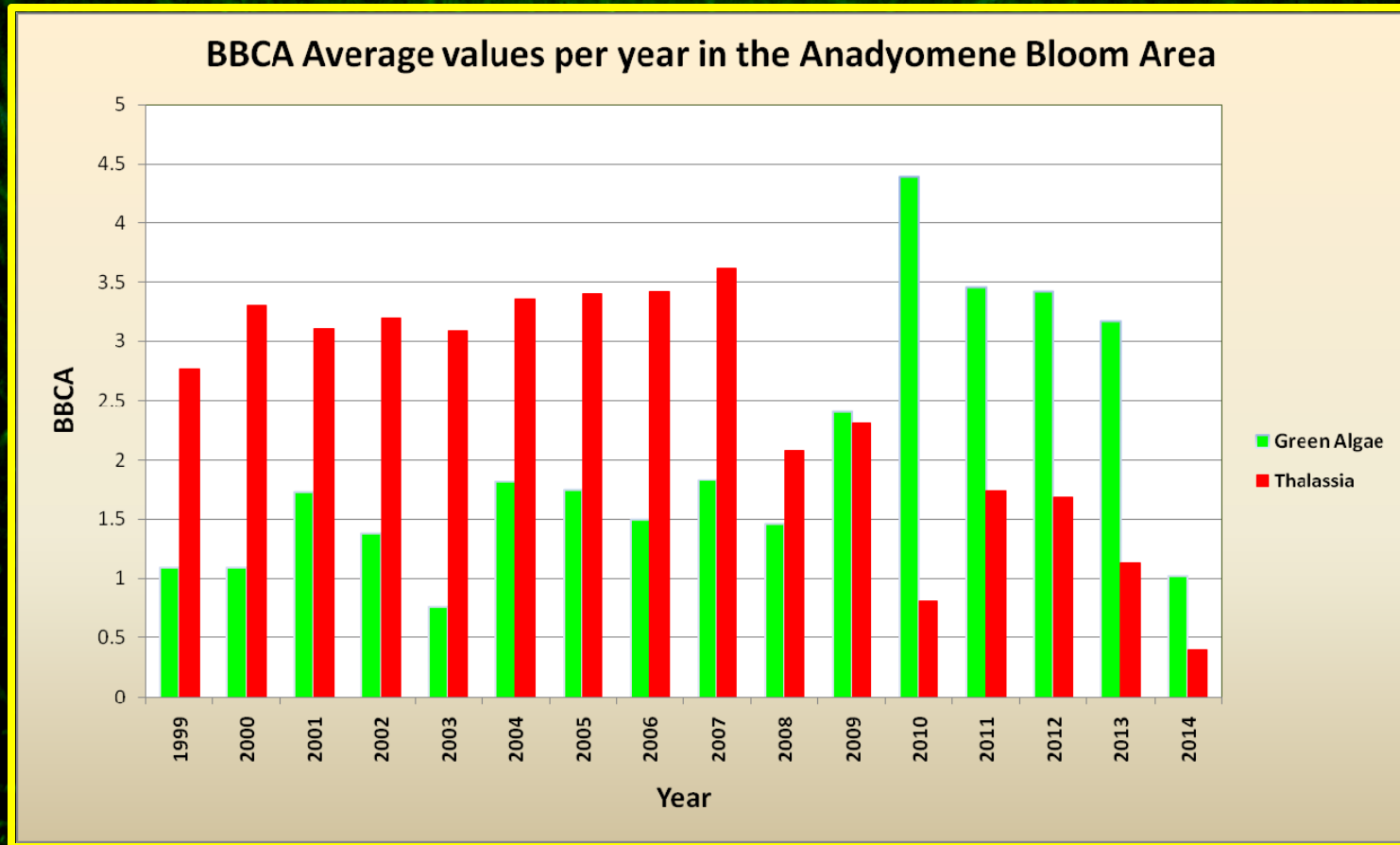


Seagrass Impacts



- **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)

Seagrass Impacts



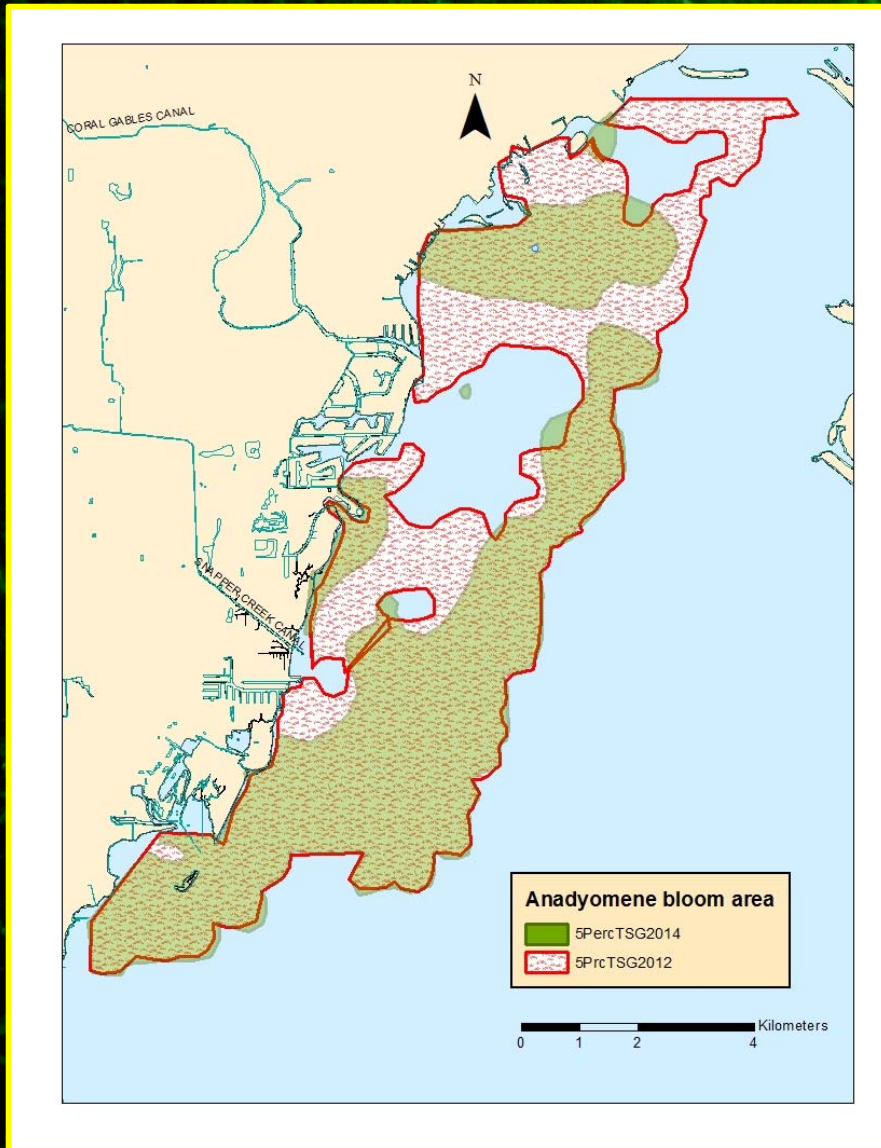
Shift in coverage from *Thalassia* dominant area to Green Algae dominance and subsequent decrease for both groups.

Seagrass Impacts

- During the pre-bloom (2000-2004) and bloom development (2005-2009) periods, the average Total Seagrass (TSG) coverage in the area was an estimated 51 km².
- Approximately 31 km² have been lost, a decline of 63% in TSG coverage.

NCI Bloom Total Area (60 Km ²)			
	Pre-Bloom	Bloom Development	Bloom
	2000-2004	2005-2009	2010-2014
Average Total Seagrass Coverage Area (Km ²)	50.6	51.1	18.7

Seagrass Impacts



- Detailed Map of Total Seagrass, at >5% cover, for 2012 and 2014 surveys.
- As of 2012 area off of Matheson Hammock absent of grass.
- Between 2012-2014, the reduction in the TSG coverage area was 10.71 km².

Bloom Time Series

Station 3G

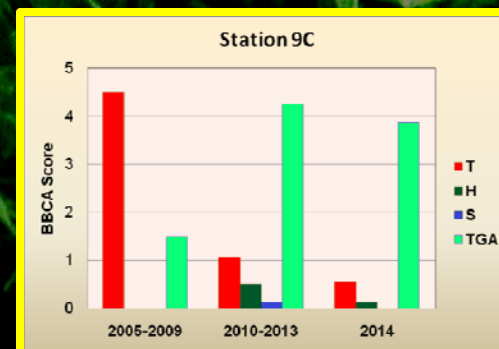
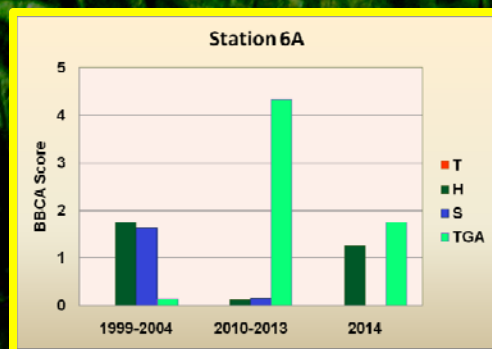
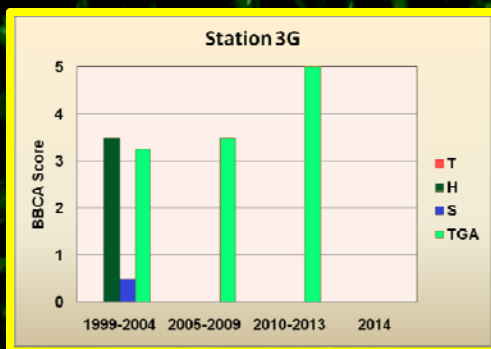
Station 6A

Station 9C

2010-2012

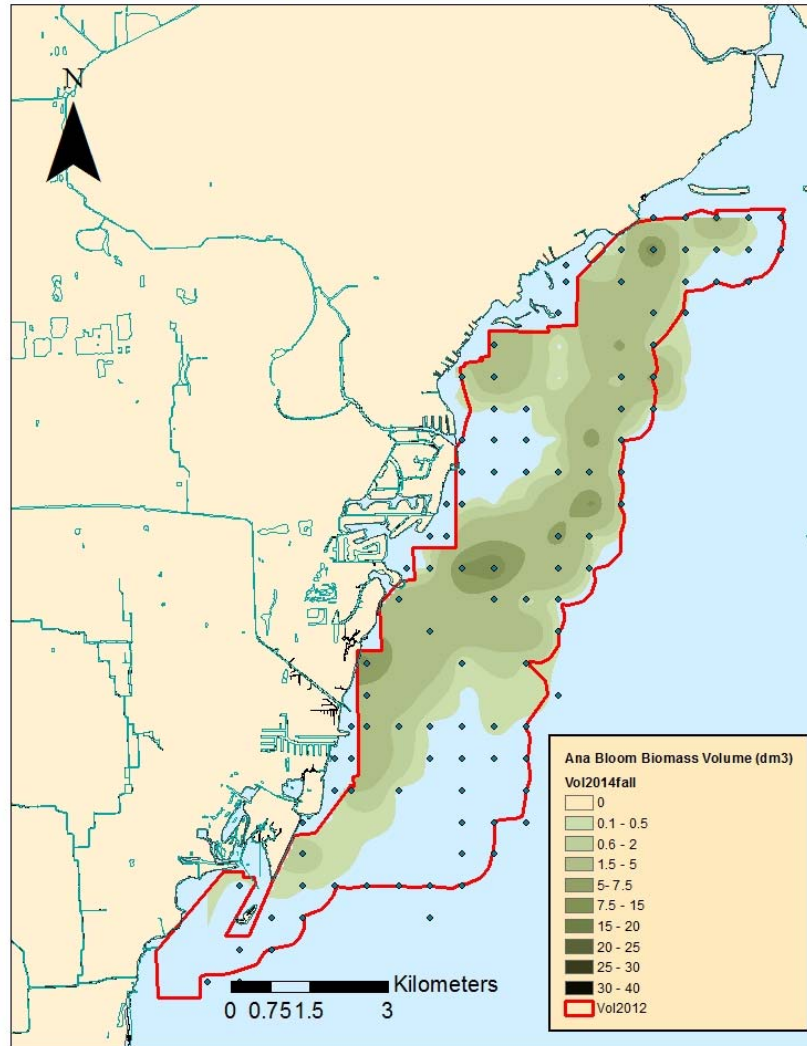


2014



Bloom Current Status

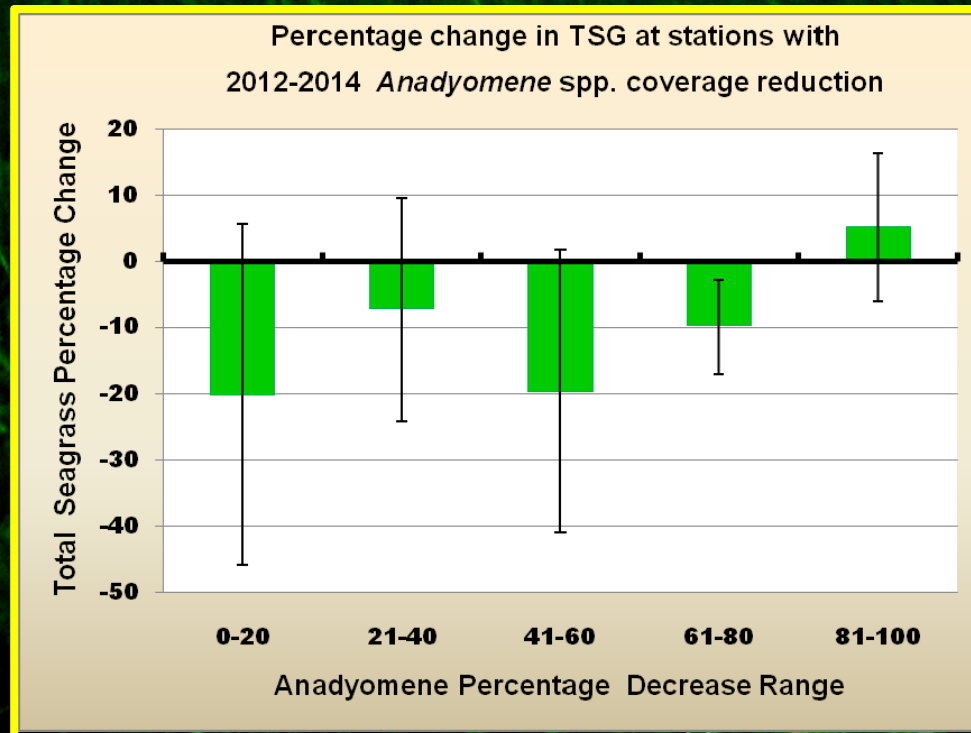
Anadyomene sampling results



2014 Cubic volume evaluation:

- Snapper Creek: Decrease in the *Anadyomene* spp. percent cover and height.
- Coral Gables Waterway: Barren bottom areas throughout area.
- Overall reduction in the total bloom area in the southern extent.

Seagrass Recovery



- Losses of seagrasses are ongoing where *Anadyomene* spp. persists.
- Only stations with a reduction in 80% or more in *Anadyomene* spp. coverage experienced some seagrass recovery.

Summary

- Prior to the *Anadyomene* spp. bloom NCI had a stable diverse seagrass community, dominated by *Thalassia*.
- The *Anadyomene* spp. bloom developed rapidly during the 2004 – 2009, and peaked 2010-2012.
- The bloom, which covers ~60km², has remained confined to the North Central Inshore region.
- *Anadyomene* spp. had become the dominant SAV in the region.
- Approximately 30 km² of seagrass coverage has been lost, which is decline of 63%.
- The bloom has dissipated from a peak in 2012, however seagrass recovery has been minimal to date.

Future Considerations

- *Anadyomene* sp., where else is it?
- What will the SAV community be like going forward?
 - Will seagrass recover?
 - Will the bloom persist?
- The DERM Biscayne Bay SAV monitoring program is presently without a funding partner and is unable to continue.