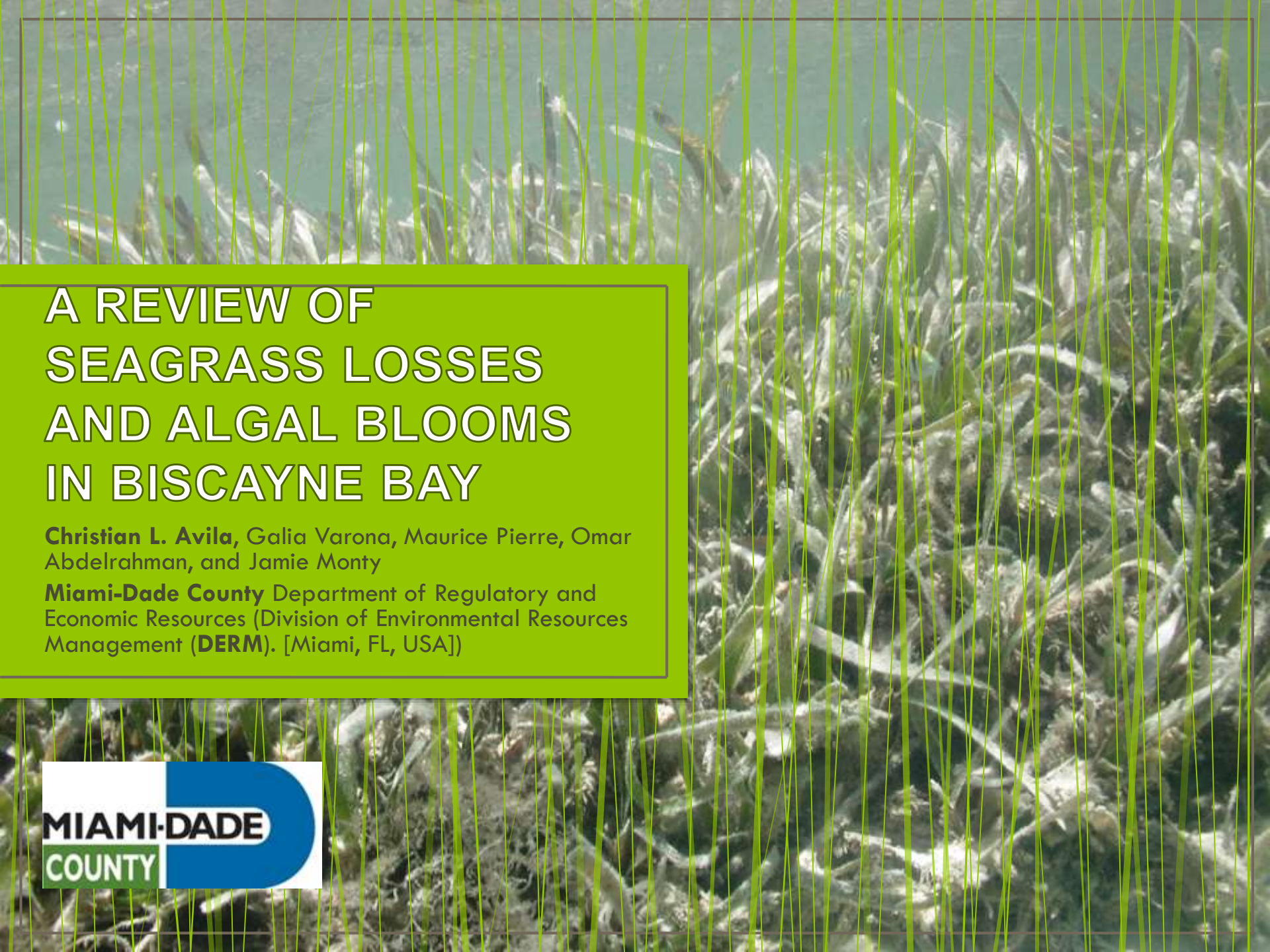

A REVIEW OF SEAGRASS LOSSES AND ALGAL BLOOMS IN BISCAYNE BAY

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MIAMI-DADE COUNTY

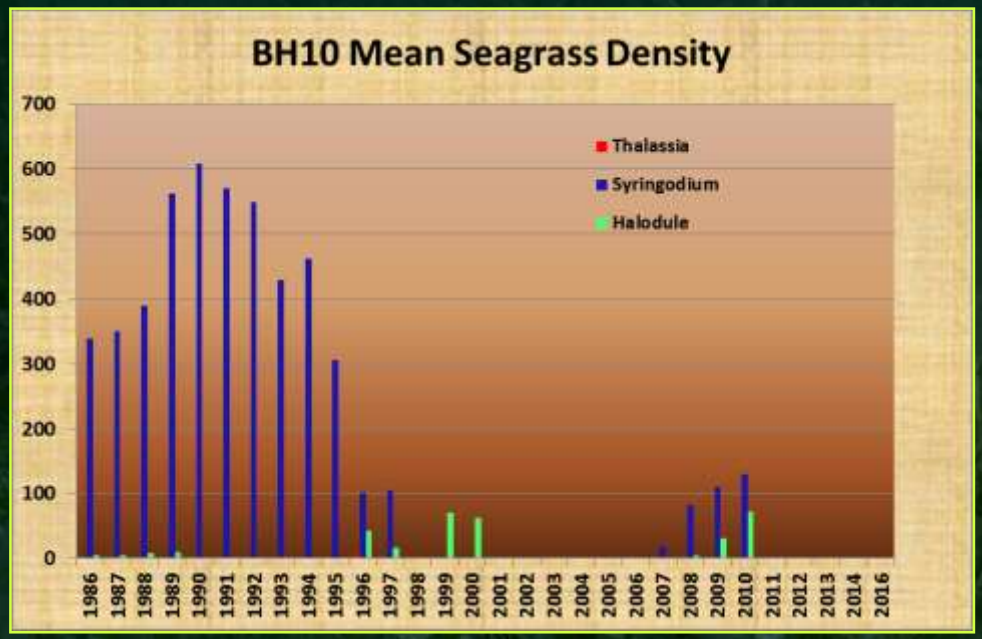
Biscayne Bay Seagrass and Algal Bloom Monitoring Timeline

- About 40 year time span
- One seagrass die off event documented prior to 2005 and no algal blooms
- Since 2005 - Four major events
  - One phytoplankton bloom coinciding with a seagrass die off event
  - One macroalgal bloom causing a seagrass die off
  - One diatom bloom
  - One seagrass die off currently advancing

North Bay Seagrass loss event in late 1990's

- Monitoring consists of one 30m transect (BH10) with three fixed quadrats

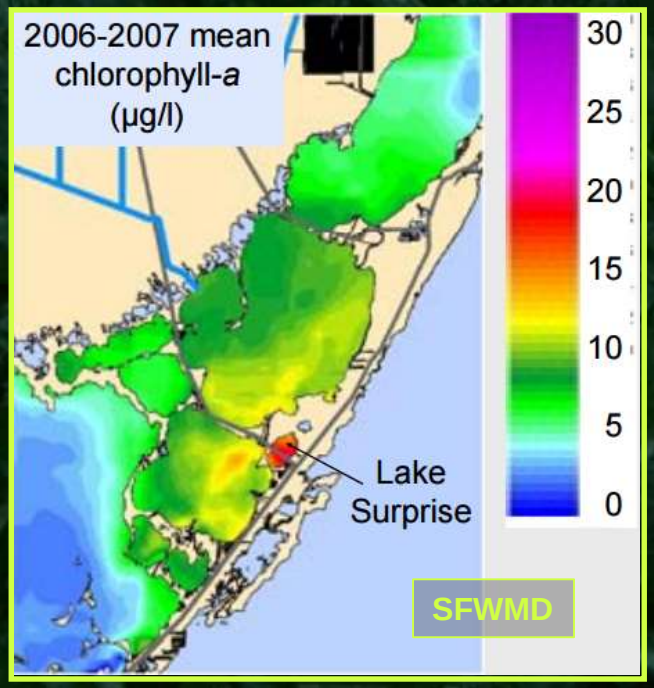
North Bay Seagrass loss event in late 1990's



- Density increased steadily 1986 – 1990
- Declined rapidly 1995-1997
- No causal event identified
- Seagrass monitioring in the basin has been limited – therefore the extent of the area lost is unknown
- Sustained recovery has not occurred in the transect area through 2016

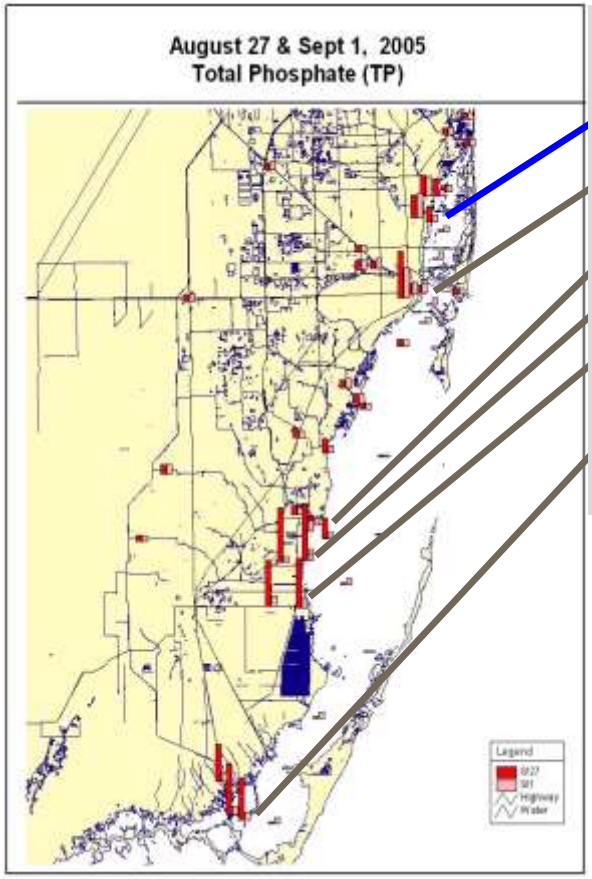
2005- 2007 Phytoplankton Bloom in the Southern Biscayne Bay Basins

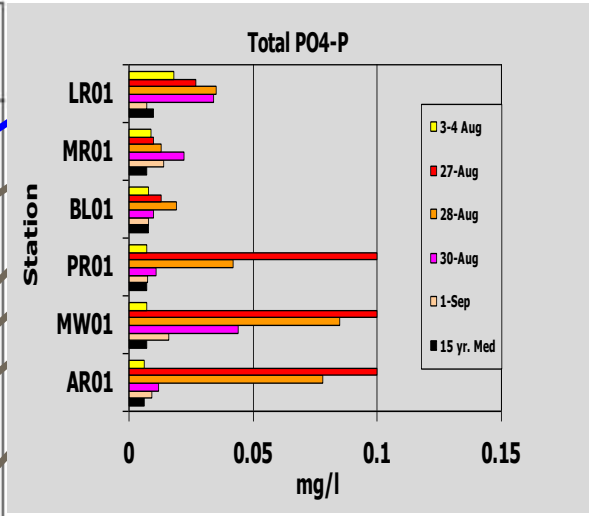
- Series of events contributed to the phytoplankton bloom that lasted 2.5 years
  - Preceded by a two year drought and hypersalinity event with database Period of Record highs in 2004 and 2005
  - Aug 2005 Hurricane Katrina rainfall resulted in a large Total Phosphorus discharge & rapid salinity decreases
  - Oct 2005 Additional disturbances to the region with Hurricane Rita
  - US1 road construction practices likely contributed (Rudnick et al. 2007)



2005-2007 Phytoplankton Bloom in the Southern Biscayne Bay Basins

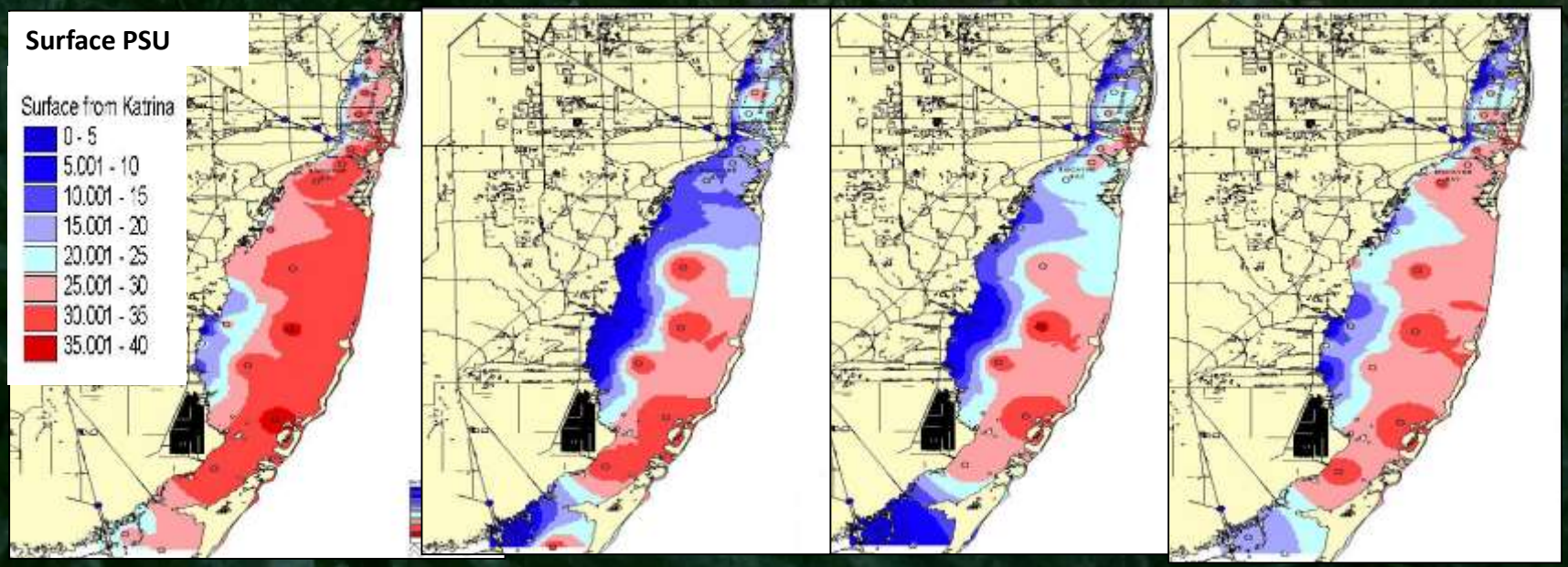
- Median concentrations of Total Phosphate (TP) in in the central, southern Bay, as well as Card and Barnes Sounds is 0.005 mg/l (5 ppb)
- August 2005, Post Hurricane Katrina concentrations increased to as high as 0.1 mg/l (100 ppb)





2005-2007 Phytoplankton Bloom in the Southern Biscayne Bay Basins

- Effect of freshwater discharge on salinities of the Biscayne Bay system following passage of Hurricane Katrina.
- Note the extent and duration of the salinity change in the southernmost basins Manatee Bay & Barnes Sound
    - Salinity in Manatee Bay and Barnes Sound was decreased from ~25 psu to 5 psu in less than 2 days

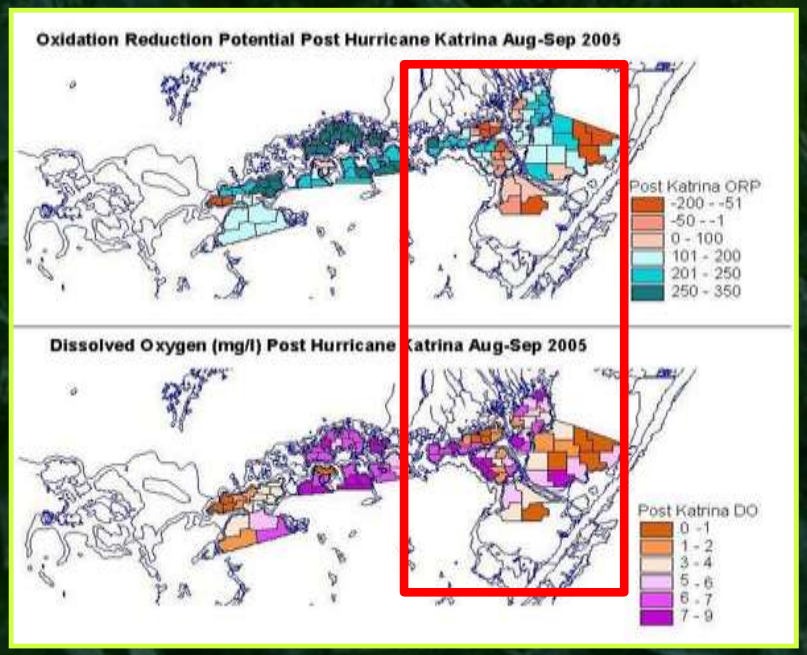


15-Year Median | 8/ 27/ 2005 | 9/1/2005 | 9/12/2005

2005-2007 Phytoplankton Bloom in the Southern Biscayne Bay Basins

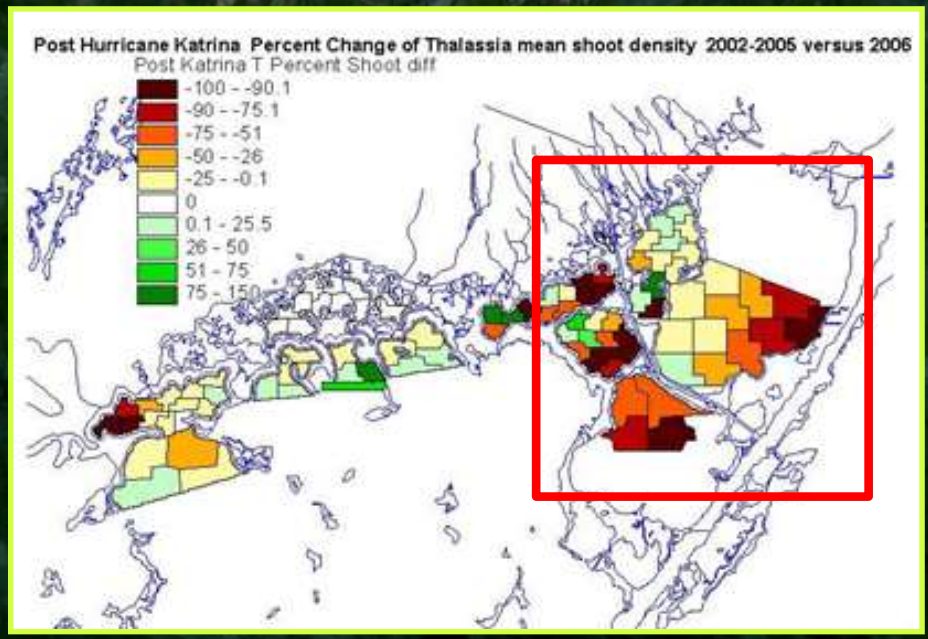
Low Dissolved Oxygen

In addition to the significant and sudden changes in salinity, Dissolved Oxygen (DO), and possibly sulfide mobilization (as indicated by historically low Oxidation Reduction Potentials [ORP]) were documented during post-storm sampling conducted by DERM.



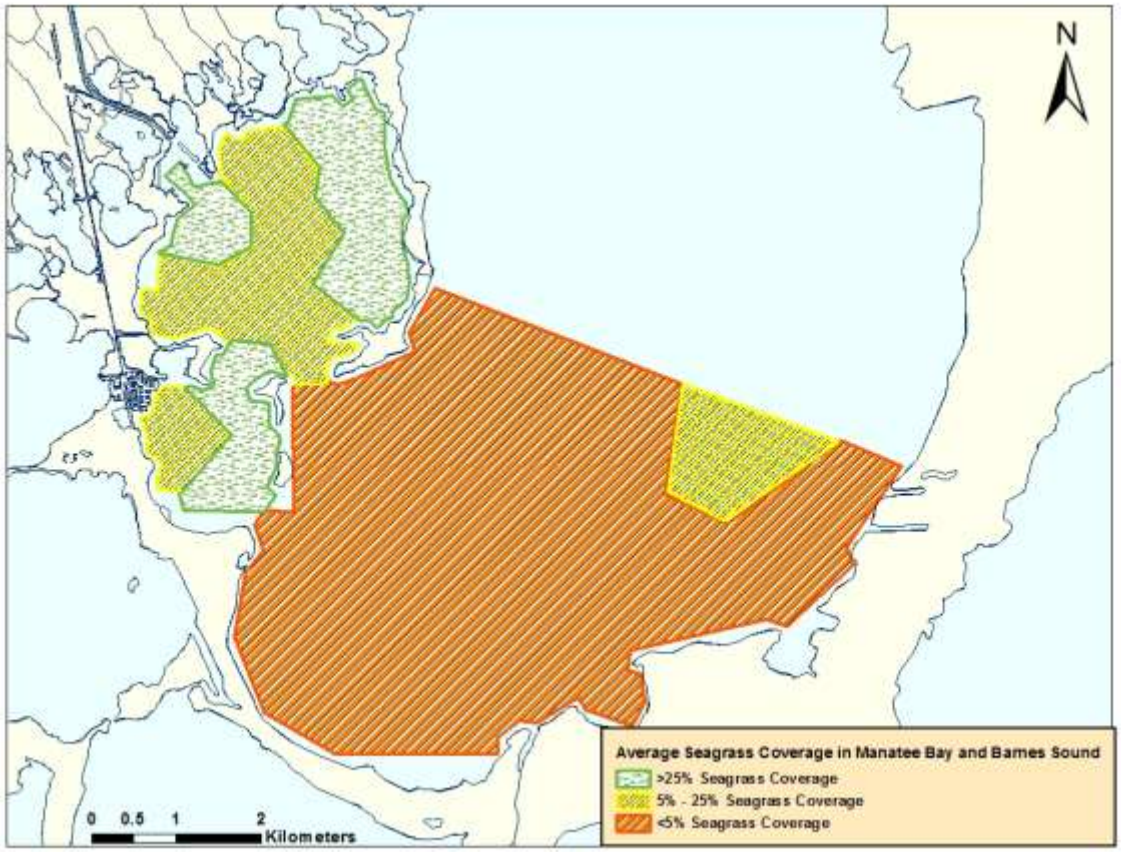
Seagrass losses

A general pattern was noted – the areas with moderate to highest density seagrass, measured the lowest DO & ORP and subsequently lost the most seagrasses.



2005-2007 Phytoplankton Bloom in the Southern Biscayne Bay Basins

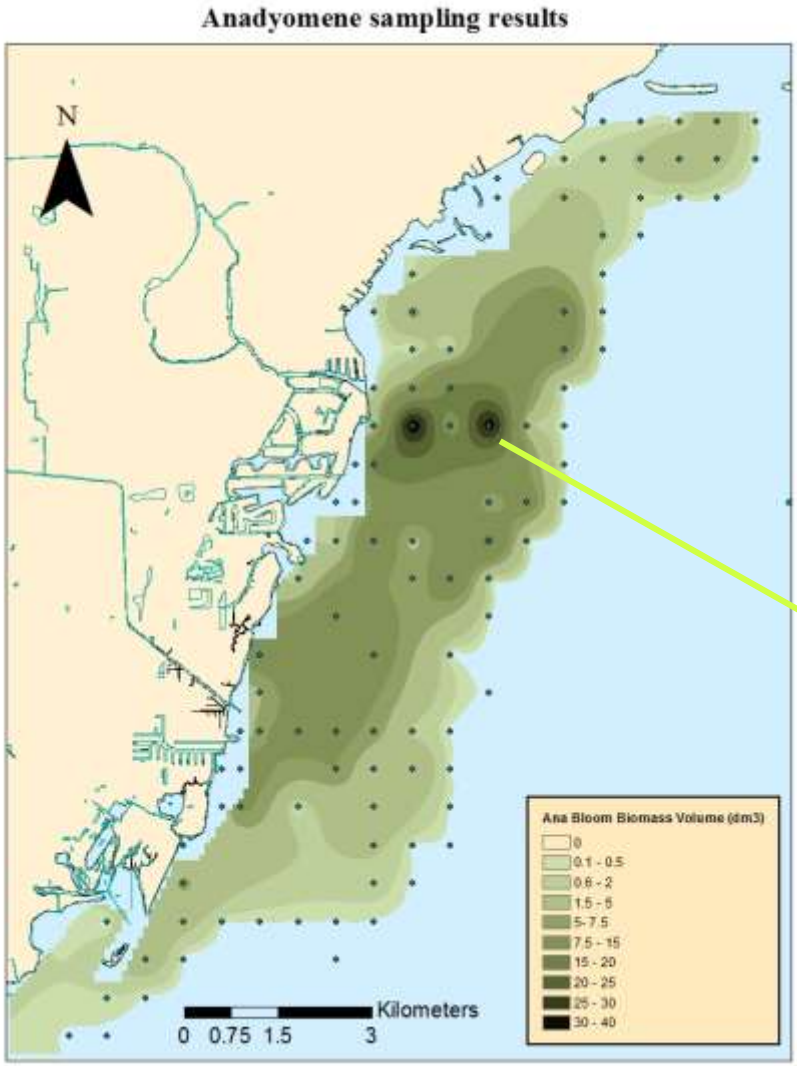
- **Current status of seagrass losses**



Before event	Present	Lost Area	Percent Decrease
24.5 Km² (2005)	12.6 Km² (2014-2016)	11.9 Km²	48.60%

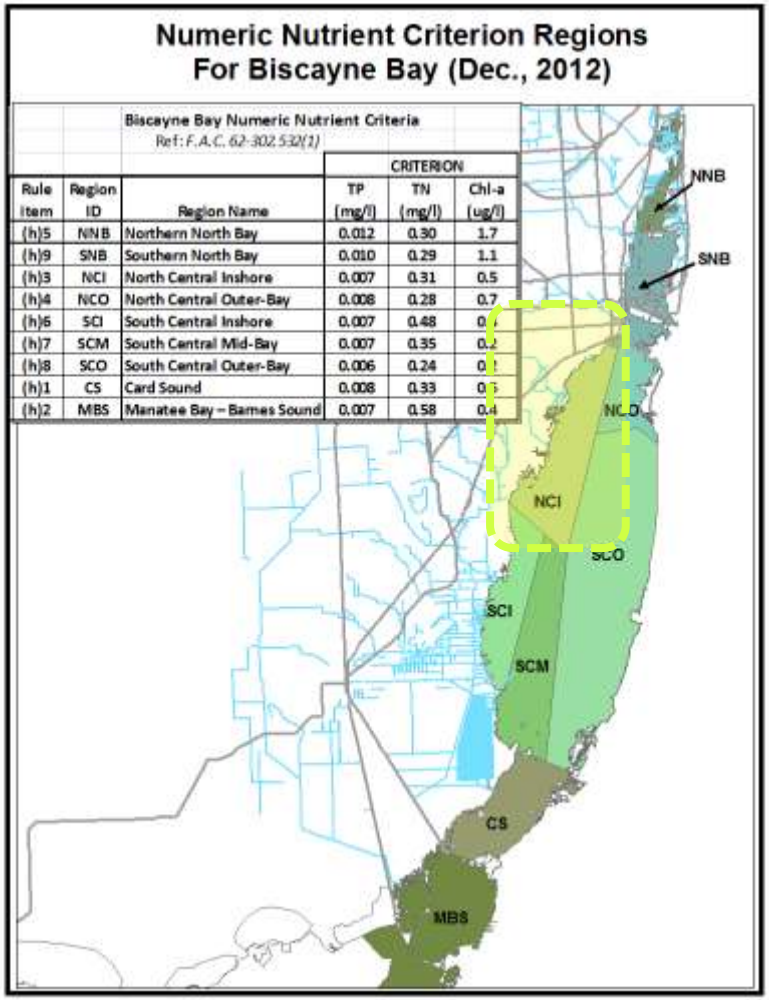
- Seagrass community appeared to stabilize following the cessation of the bloom
- *Halodule* increased and in some areas was replaced by *Thalassia*
- Seagrass succession did not continue throughout and coverage has not returned to pre-bloom levels
- Currently both basins have 49% less seagrass than pre-bloom

2005-Present macroalgal Bloom in the North Central Inshore Region



- Two species in the genus *Anodyomene*
- Majority of station had >75% cover – however, biomass was noted as variable
- Pattern of greatest biomass just offshore of the two main canals in the region: Snapper Creek and Coral Gables

2005-Present macroalgal Bloom in the North Central Inshore Region

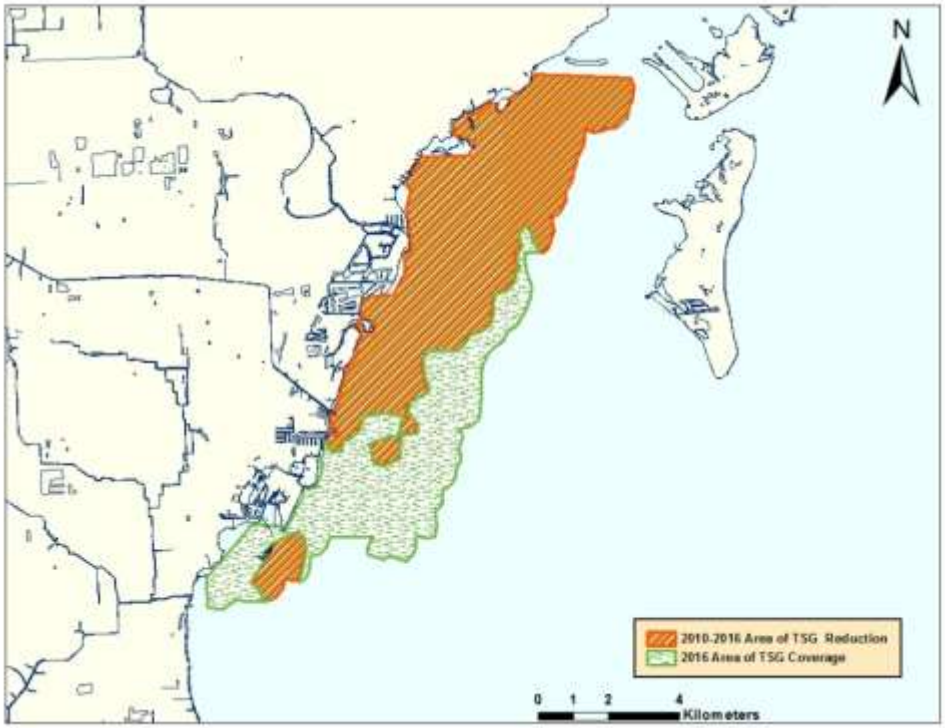


Bloom has remained confined to the North Central Inshore Region.

Anadyomene tissue analysis showed:

- Based on %N, %P, and N:P ratios the blooming macro algae have no limitation of N above 1.8 %N (Duarte 1990)
- High values of δN_{15} (> 5%) suggests anthropogenic sources of nitrogen supporting the bloom
- In 2016 20% of the samples from Coral Gables Waterway exceeded the standards for Fecal Coliform

2005-Present macroalgal Bloom in the North Central Inshore Region



- Presently 39.1 km² have <5% seagrass cover as a result of this macroalgal bloom
- With the bloom also receding much of the area is left bare

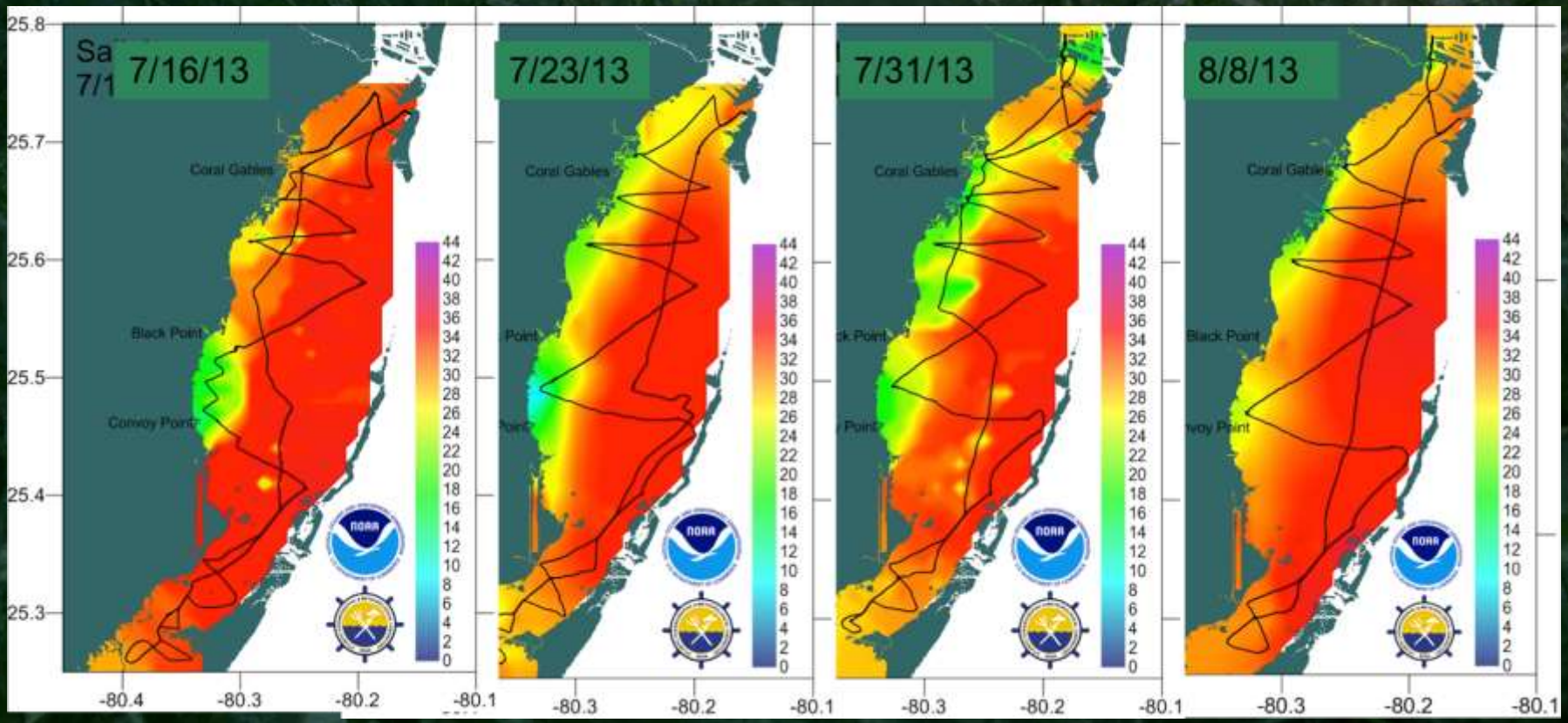
Before event	Present	Lost Area	Percent Decrease
51.2 Km² (2000-2003)	12.1 Km² (2014-2016)	39.1 Km²	76.40%

2013 Phytoplankton/Diatom Bloom

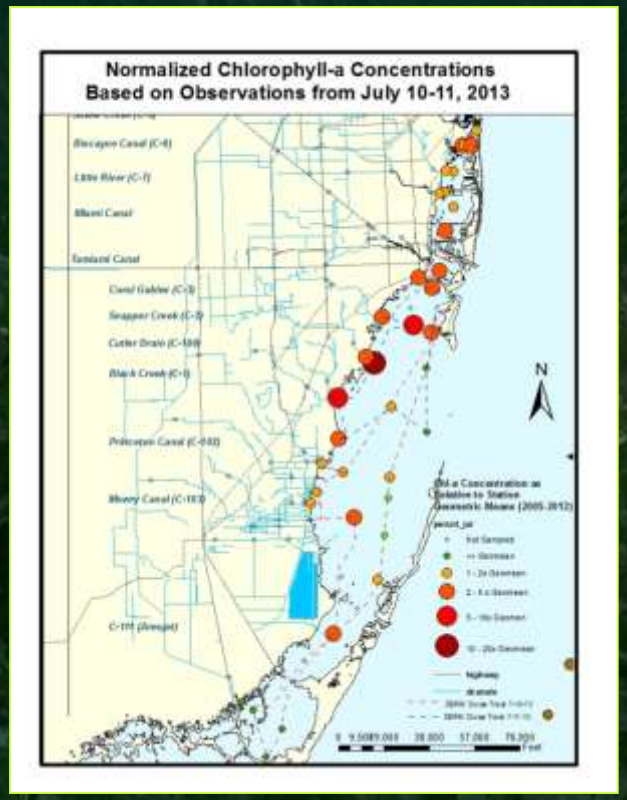
- In 2013 Diatom Bloom along inshore and the Southern Bay - Card Sound regions
- SFWMD analysis shows early onset of rainy season, and periods of heavy rains have resulted in high flow from coastal control structures
- Causes of this bloom are uncertain, however, higher flows from coastal structures would have increased nutrient loads

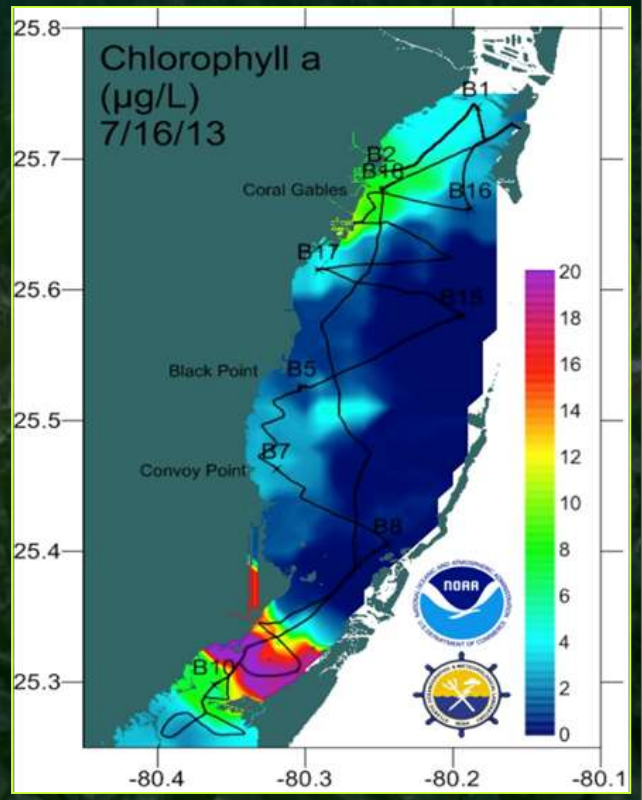
2013 Phytoplankton/Diatom Bloom

- Salinity (PSU) NOAA-AOML Cruise Sampling
- Discharges and salinity patterns relate to the bloom locations



2013 Phytoplankton/Diatom Bloom

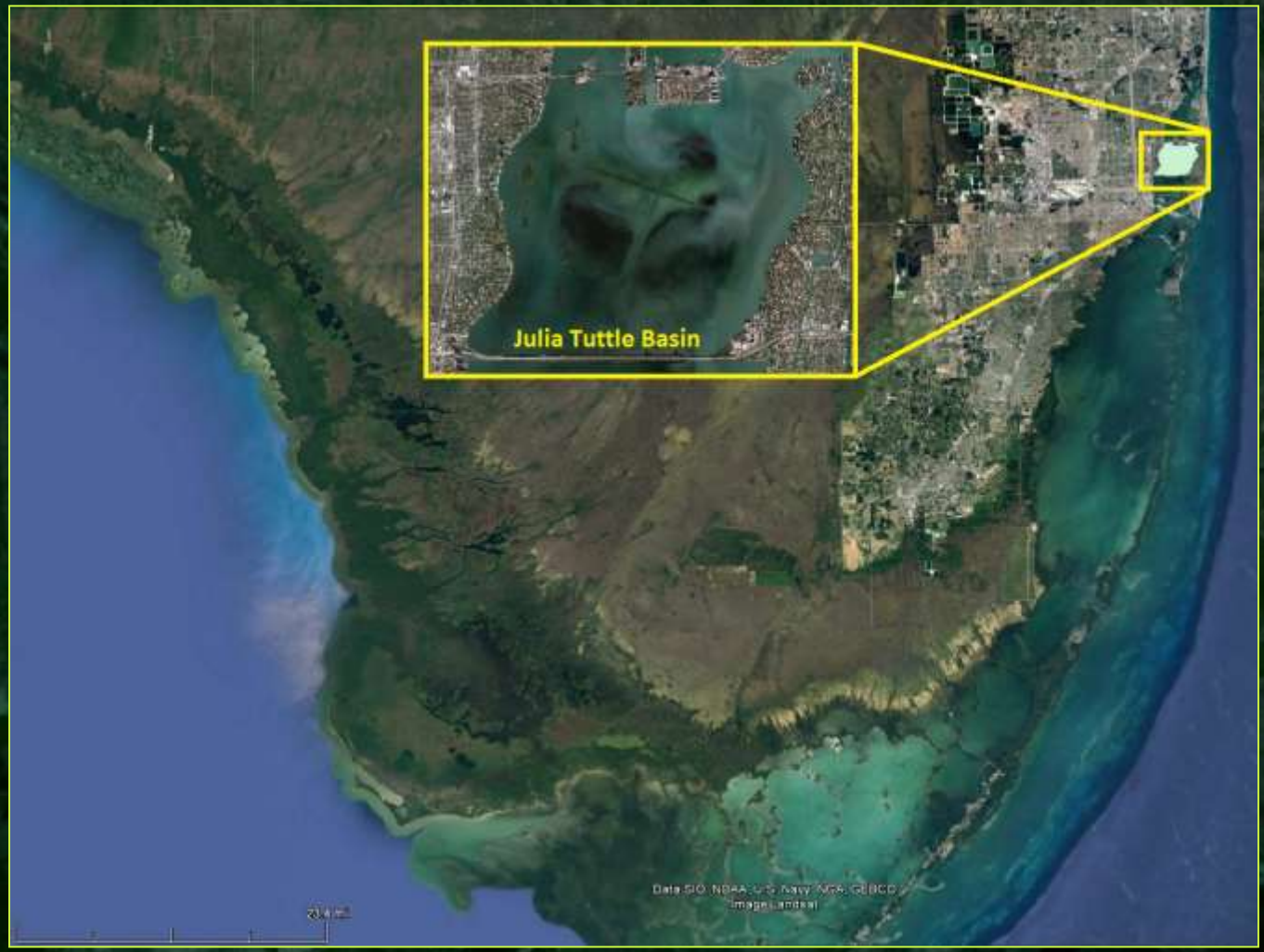




- Sampling showed Chlorophyll concentrations up to 20x normal values
- Again - Causes of bloom are uncertain, however, higher flows from coastal structures would increase nutrient loads

2013-Present Developing Seagrass loss event in North Biscayne Bay

Julia Tuttle Basin



2013-Present Developing Seagrass loss event in North Biscayne Bay

Julia Tuttle Basin

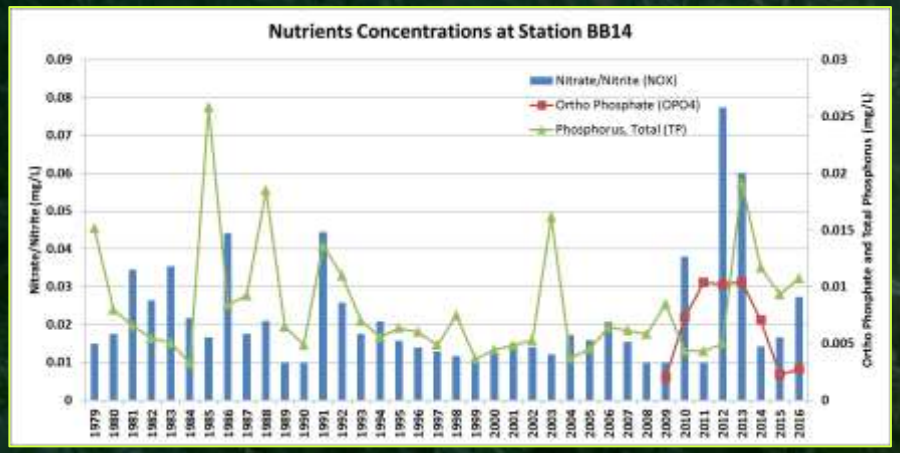

2016

2013-Present Developing Seagrass loss event in North Biscayne Bay

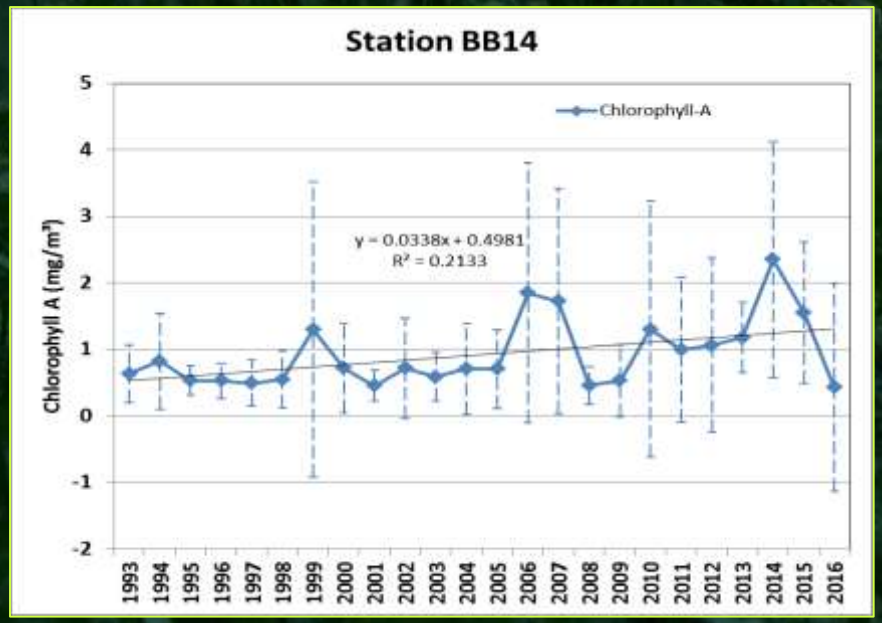
- The basin is (was) predominantly characterized by very high biomass *Syringodium*

2013-Present Developing Seagrass loss event in North Biscayne Bay

Julia Tuttle Basin Water Quality



Annual Average Nutrients Concentration (Nitrate/Nitrite, Ortho Phosphate and Total Phosphorus) at Station BB14 and Station LR01(exit of C7 canal)

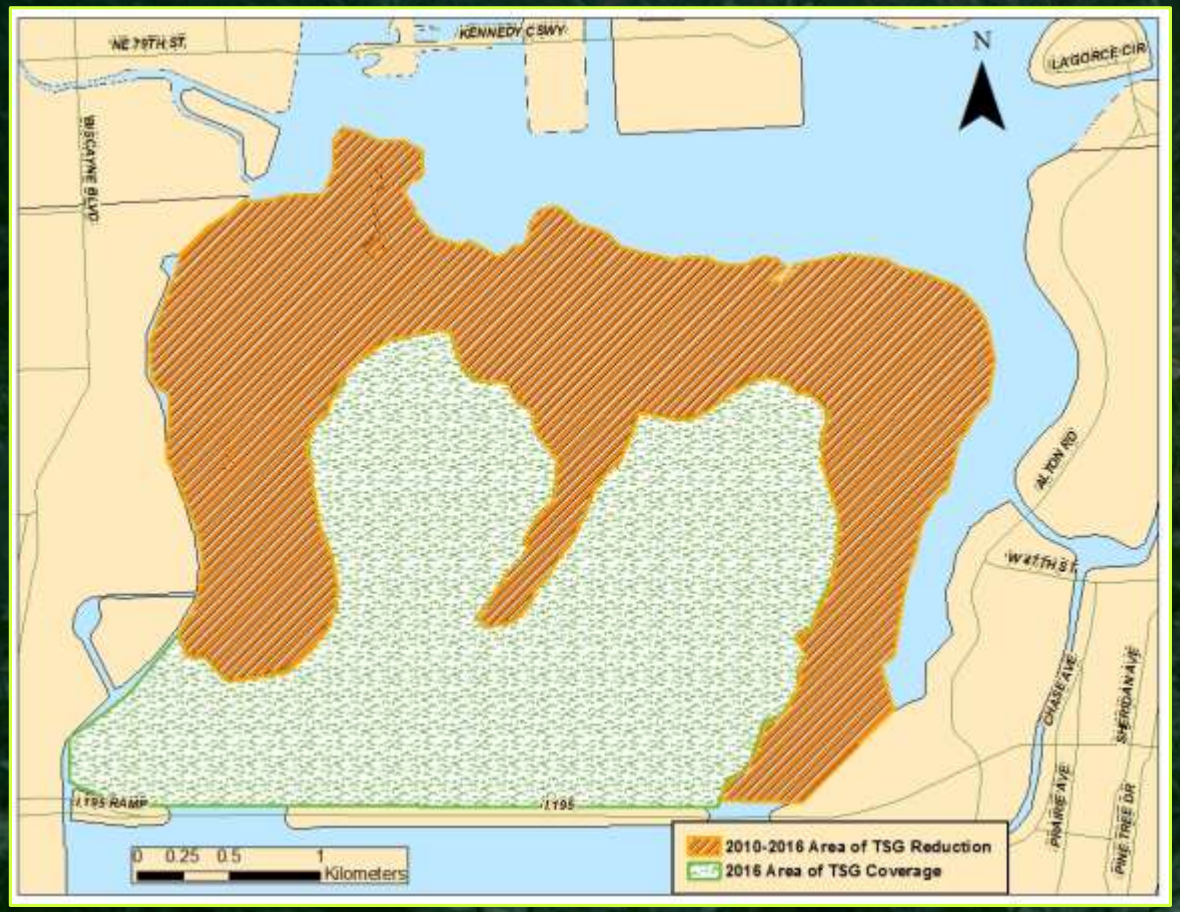


Annual Average Chlorophyll-A Concentration at Station BB14

Error bars indicates Standard Deviation

2013-Present Developing Seagrass loss event in North Biscayne Bay

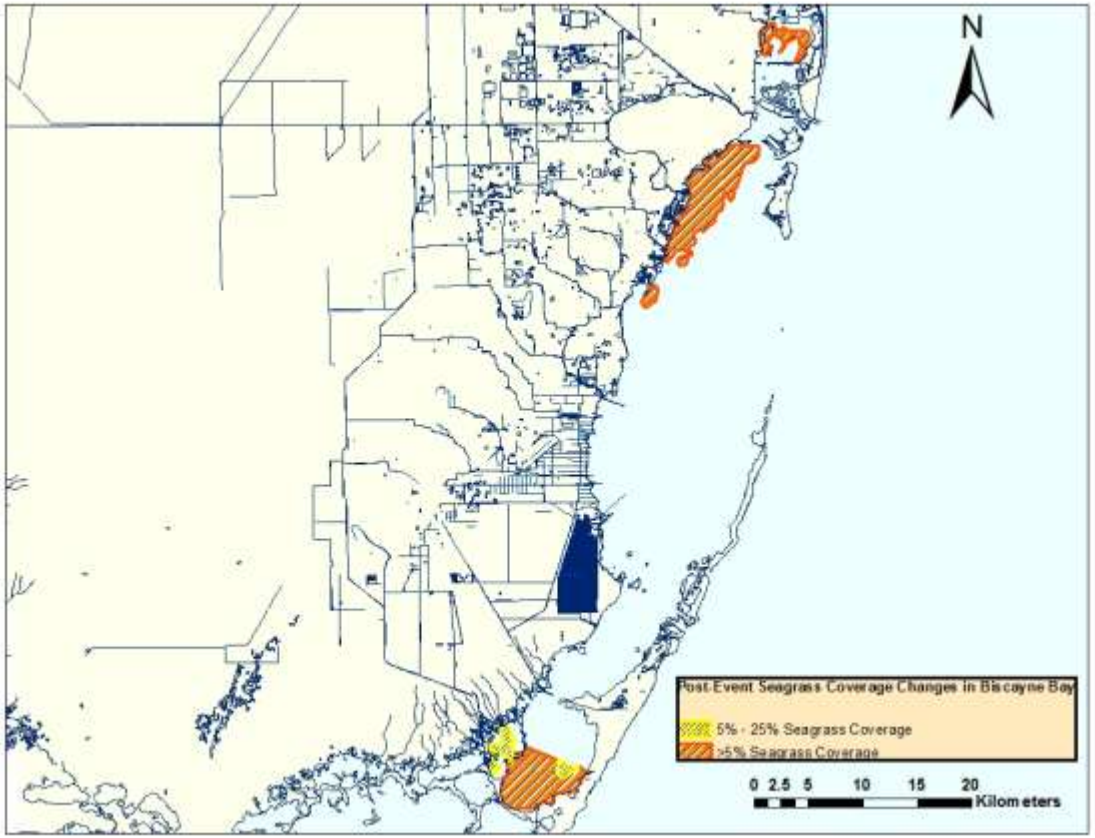
Julia Tuttle Basin



- **Estimated 45% loss of seagrass area**

Before event	Present	Lost Area	Percent Decrease
12.0 Km² (2002-2008)	6.6 Km² (2016)	5.4 Km²	45.00%

2005 - Present Summary of seagrass loss events



- An estimated total of 56km² of seagrass has been lost
- An 88km² area that has been effected and lost 64% of the seagrass.

Event	Before event	Present	Lost Area	Percent Decrease
Anadyomene Bloom Area	51.2 Km² (2000-2003)	12.1 Km² (2014-2016)	39.1 Km²	76.40%
Julia Tuttle Area	12.0 Km² (2002-2008)	6.6 Km² (2016)	5.4 Km²	45.00%
Barnes Sound/Manatee Bay	24.5 Km² (2005)	12.6 Km² (2014-2016)	11.9 Km²	48.60%
Total	87.7 Km²	31.3 Km²	56.4 Km²	64.31%

Take home points

- **In a monitoring program that dates back thirty years – there has been overall stability in the Bay, however the last ten have seen algal blooms and significant seagrass losses that were unprecedented in the prior twenty years.**

- **The two phytoplankton blooms were associated with storm/rain events with large discharges and associated nutrients which were preceded by periods of drought and elevated salinity.**

    - Further work is needed to better understand this dynamic.

- **Areas of high density/high biomass seagrass are can be repositories of nutrients and are at risk of loss events.**

    - Identifying areas of high seagrass biomass in conjunction with C:N:P ratios and isotopic N may help guide protective measures.

Acknowledgments

Present and past DERM staff, especially Susan Markley and Stephen Blair.

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