INCREASES IN MACROALGAE AND WATER QUALITY TRENDS ASSOCIATED WITH SEAGRASS LOSS IN NORTH BISCAYNE BAY

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Overview

- DERM has conducted Submerged Aquatic Vegetation (SAV) annual surveys on fixed transects (4 stations) in North Biscayne Bay since 1986.

- Period of record indicates a seagrass community dominated by *Syringodium filiforme* in the area.

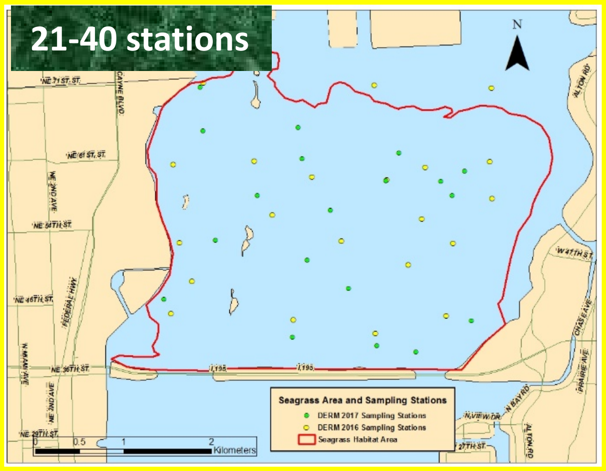
- While seagrass loss was noted in the northern areas of North Biscayne Bay at 2 of 4 stations in the late 90’s, stations farther south between Rickenbacker Causeway and Julia Tuttle Causeway maintained seagrass coverage through 2013.

- Additional sampling in the Julia Tuttle Basin was initiated by DERM in 2016 and the program was further expanded in 2018 to augment sampling of North Biscayne Bay. A shift from a seagrass-dominated to an algae-dominated community was evident in 2017. This algae community is now primarily represented by the genera *Halimeda*.

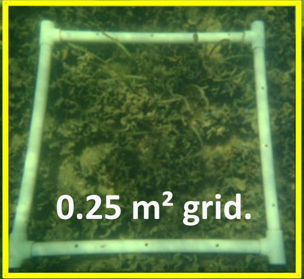
DERM Monitoring Program

DERM Monitoring program in North Biscayne Bay (1986-2018)

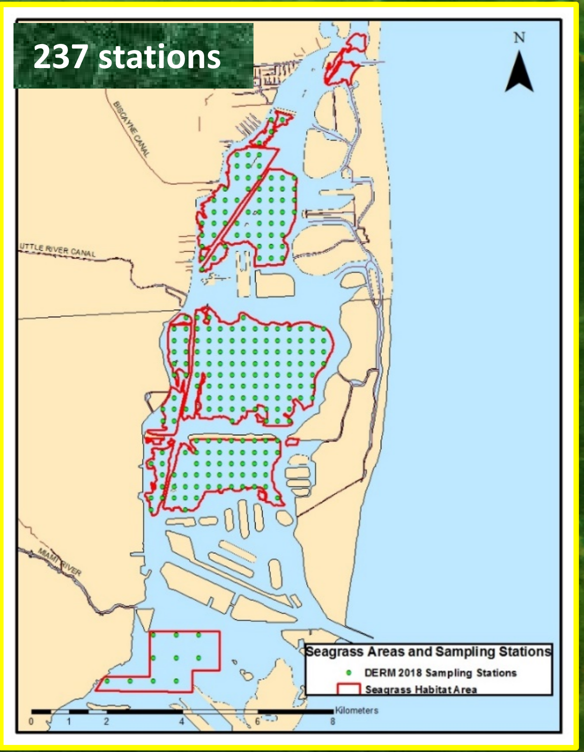
Julia Tuttle Basin Sampling (2016-2017)



Seagrass Habitat area 10.1 km^2



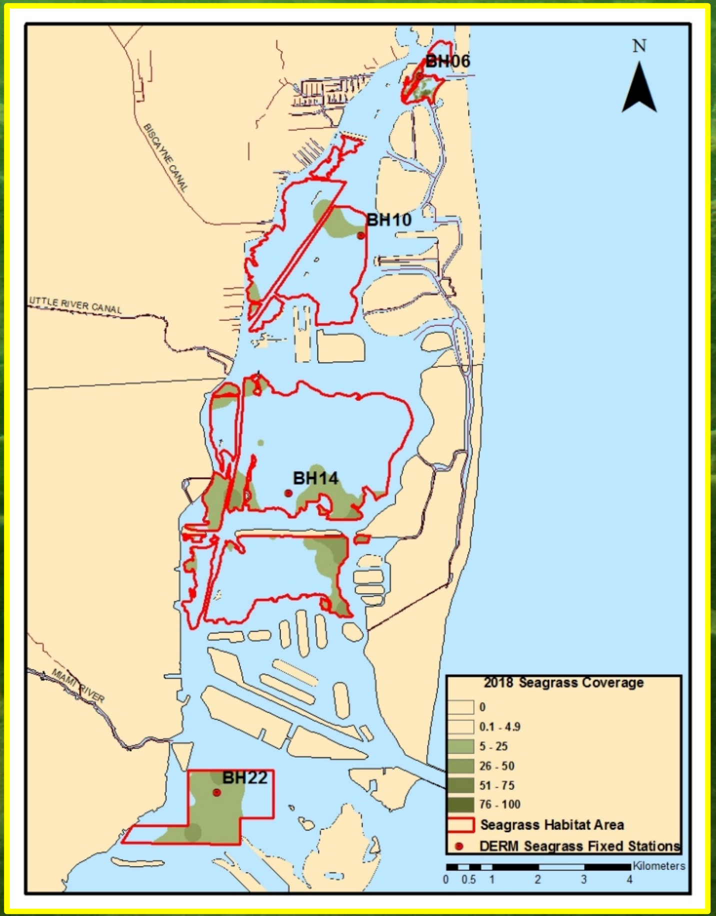
North Biscayne Bay Sampling (2018)



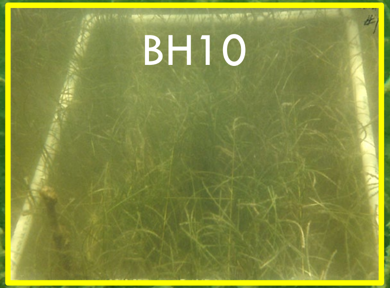
Seagrass Habitat Area 19.5 km^2

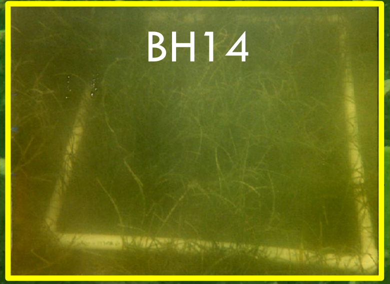
- Visual percent cover estimated using the Braun-Blanquet Coverage Abundance scale (BBCA) for both seagrass and macro algae within a grid.
- Seagrass shoot/m^2 abundance estimated in the 4 fixed stations.

Seagrass to Algae Transition

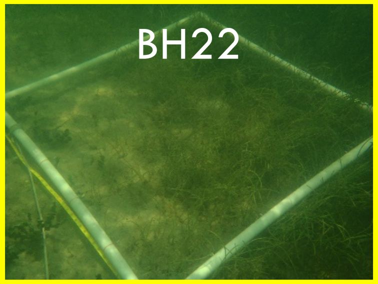


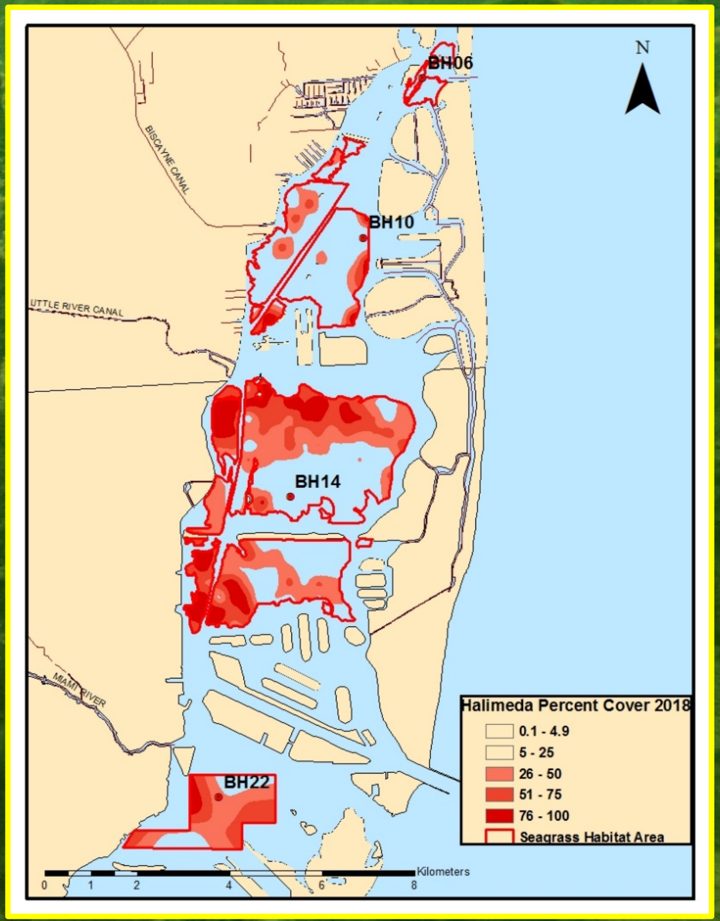
1986





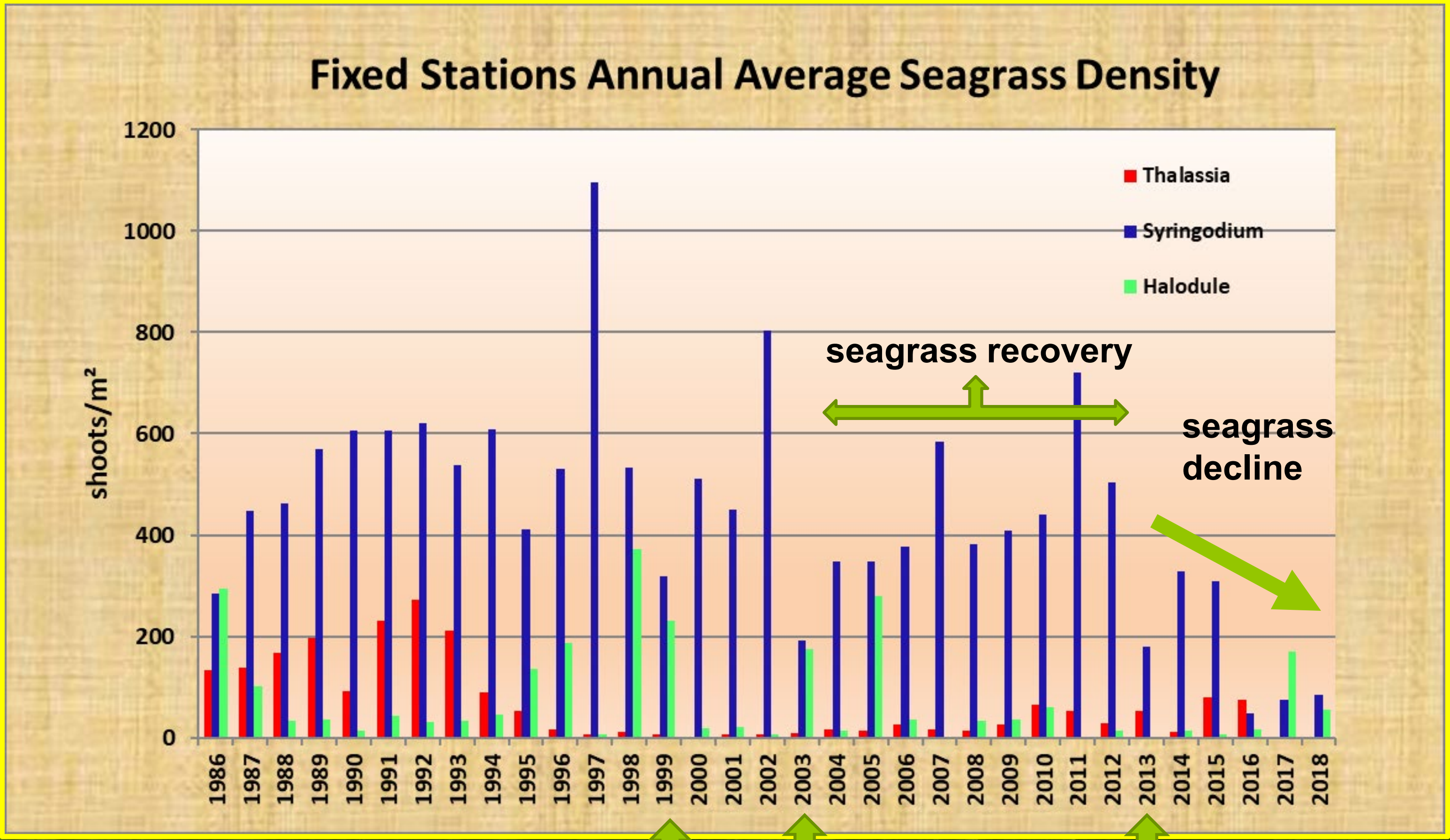
2018





The North Biscayne Bay area was predominantly characterized by very high *Syringodium* biomass (3 of 4 fixed stations depicted)

Seagrass to Algae Transition



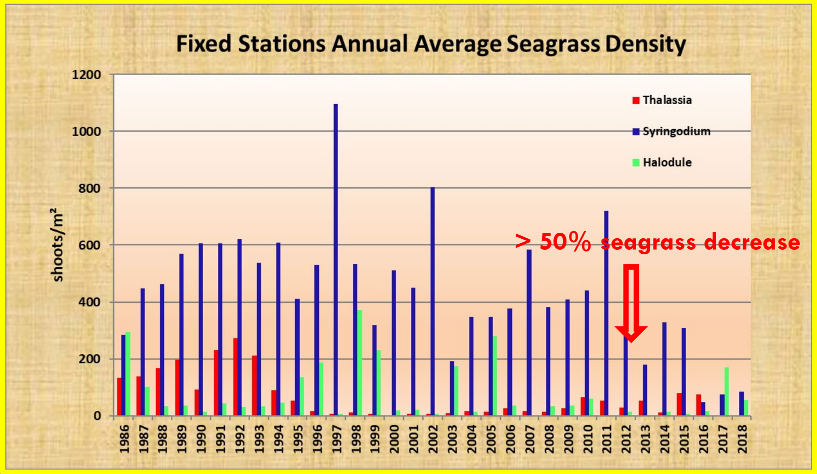
BH06 and BH10 seagrass reduction

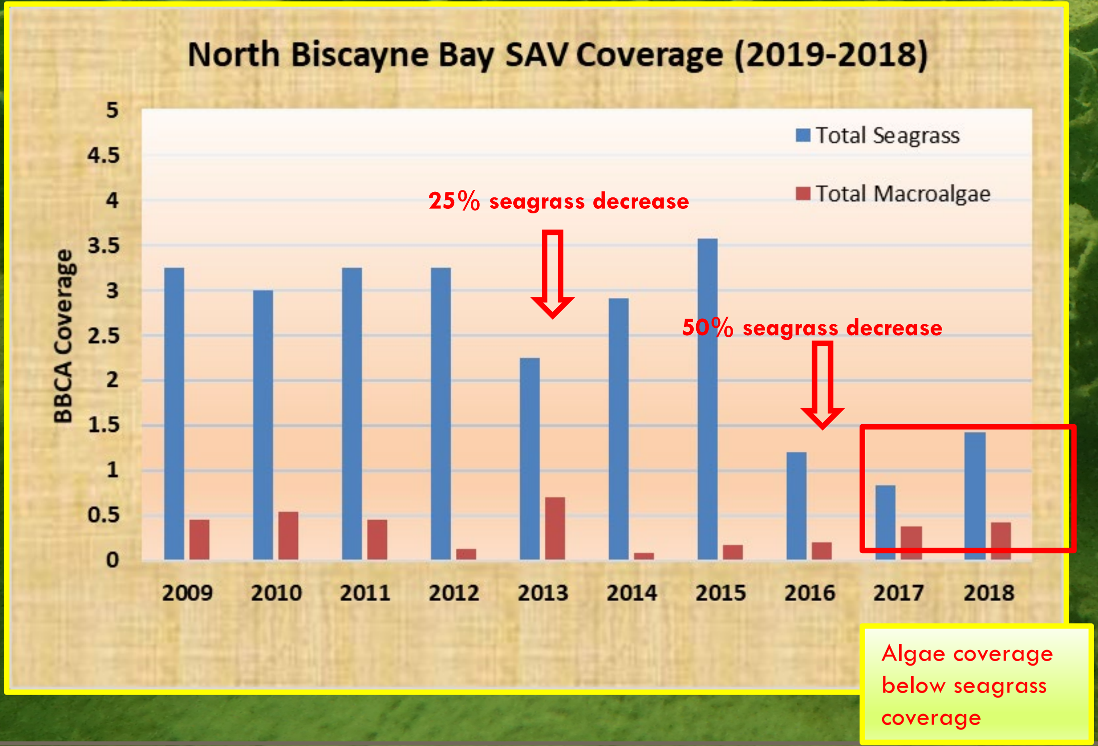
BH14 and BH22 seagrass reduction

> 50% seagrass decrease

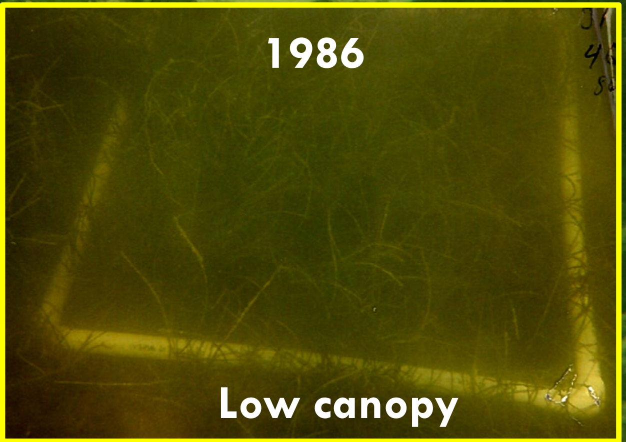
- Seagrass density data collected at the 4 Fixed Stations in North Biscayne Bay show a seagrass community dominated by *Syringodium* (1987-2015).
- Two previous seagrass decline events were observed in North Biscayne Bay in the late 90's and around 2003, followed by some seagrass recovery.
- An abrupt decrease in shoot/m^2 can be observed around 2013, followed by seagrass decline and instability.

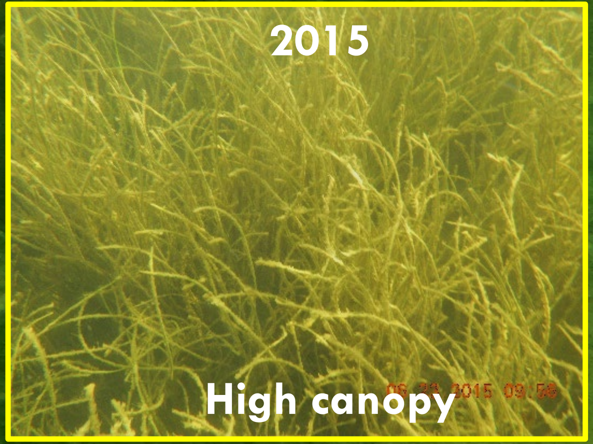
Seagrass to Algae Transition





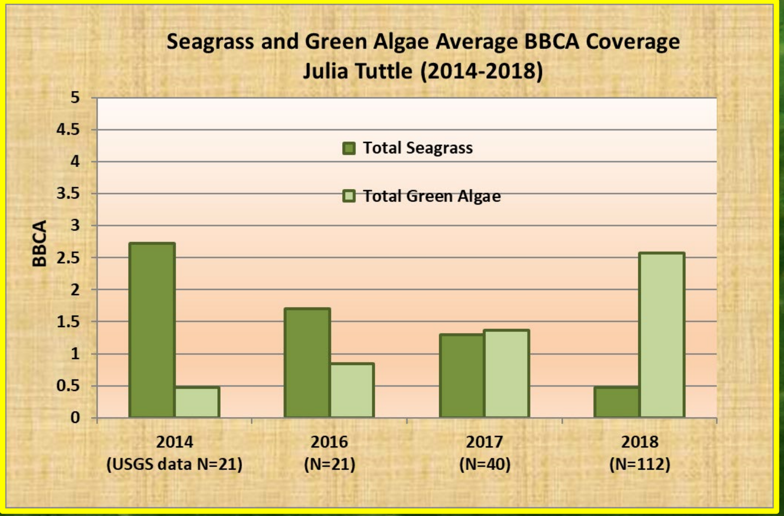
- Decrease in density better represented using shoot count.
- Shift in seagrass/macroalgae coverage was not evident at the 4 fixed stations using BBCA coverage (small *n*), evidencing the limited spatial representation of large basins in the historical monitoring.
- *Syringodium* canopy height increases previous to die-off could be a factor influencing BBCA metrics.





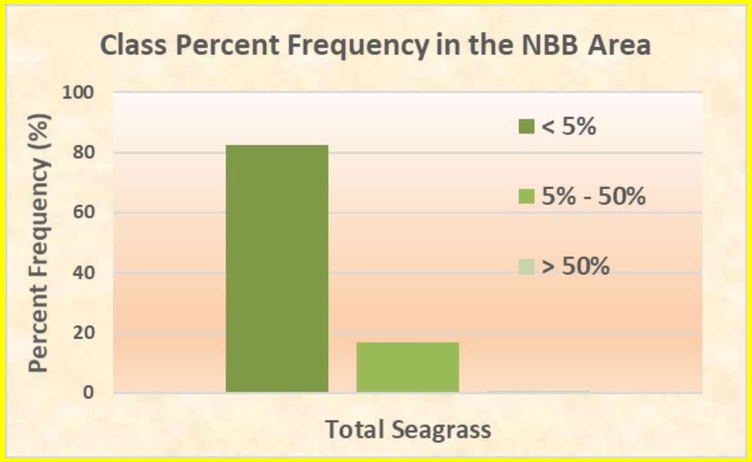
Seagrass-Algae Transition

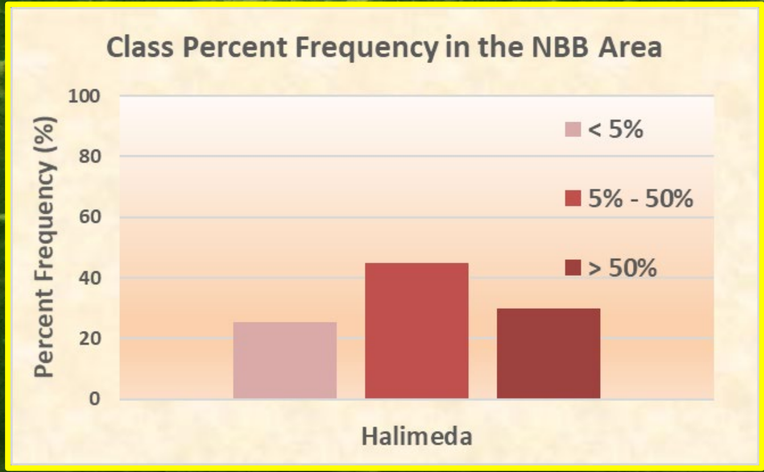
2014-2018 Julia Tuttle Basin



- Between 2016-2017, a transition between a Seagrass-dominated to an Algae-dominated community was apparent in North Biscayne Bay.

2018 North Biscayne Bay Sampling

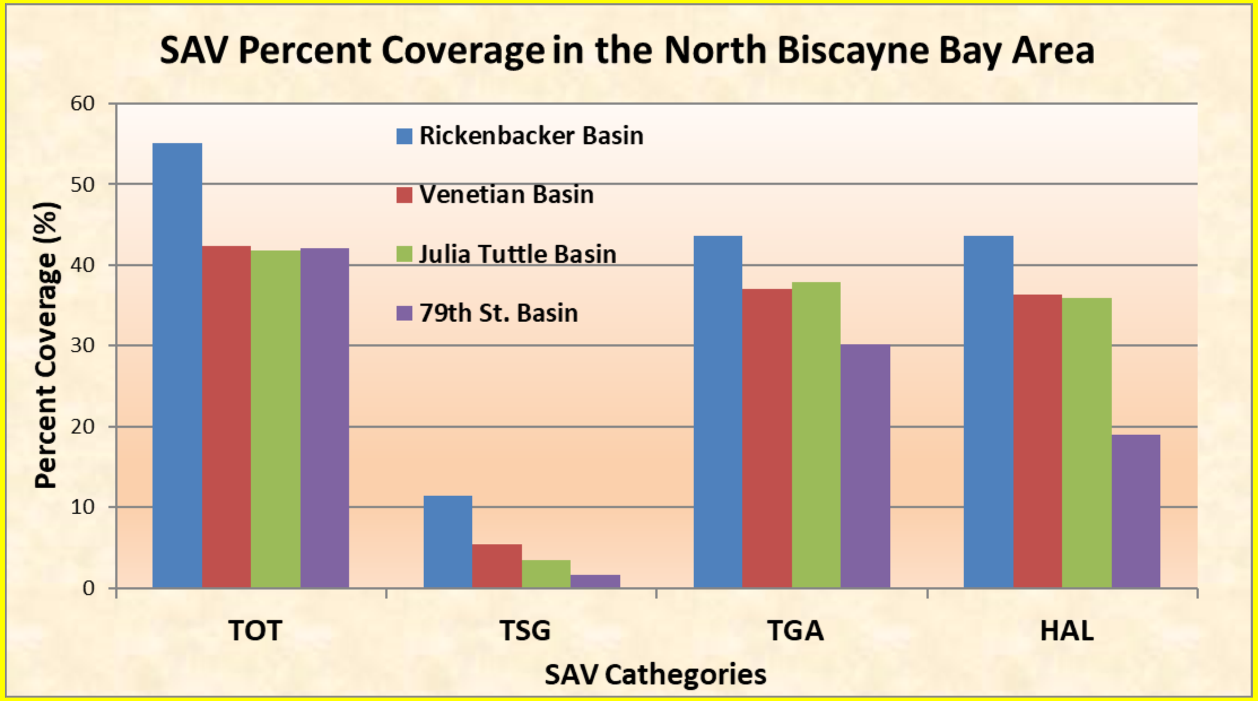


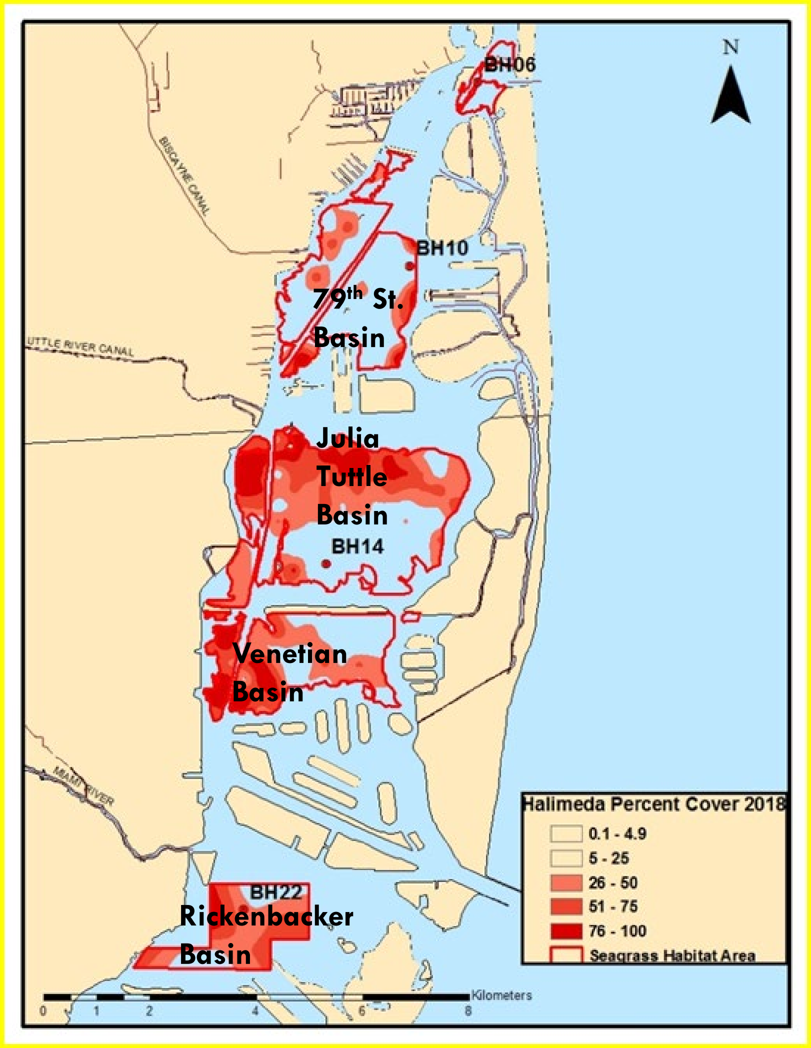


- In 2018, near 80% of the area previously dominated by seagrass was covered by 5% or more *Halimeda*.
- *Halimeda* was found in high coverage (above 50 %) in approximately 30% of the area previously dominated by seagrass.

Seagrass-Algae Transition

2018 North Biscayne Bay Sampling

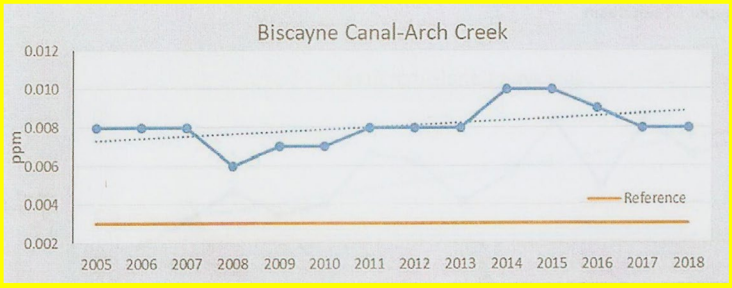




- SAV community now primarily represented by green algae, with *Halimeda* the most abundant genera.
- Total seagrass coverage (TSG) below 15% in all basins, with a decreasing North-South trend.

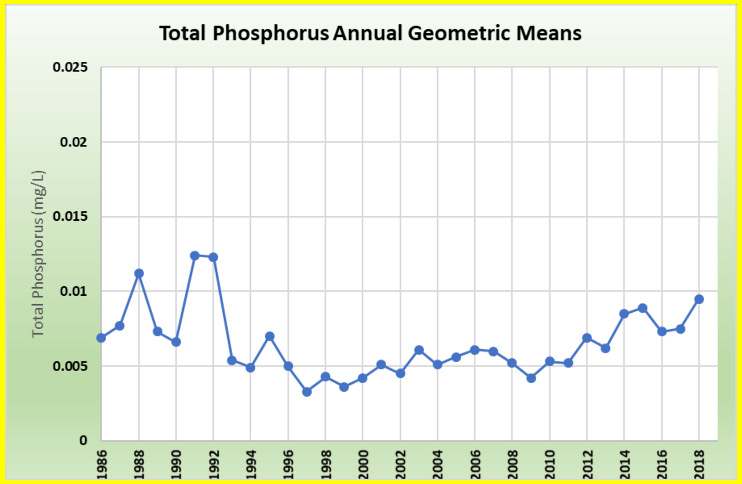
North Biscayne Bay Water Quality

- Chronic, low level nutrient loading and/or acute, pulsed nutrient loading (Total Phosphorus, Nitrate/Nitrites) is linked to seagrass loss in Biscayne Bay.



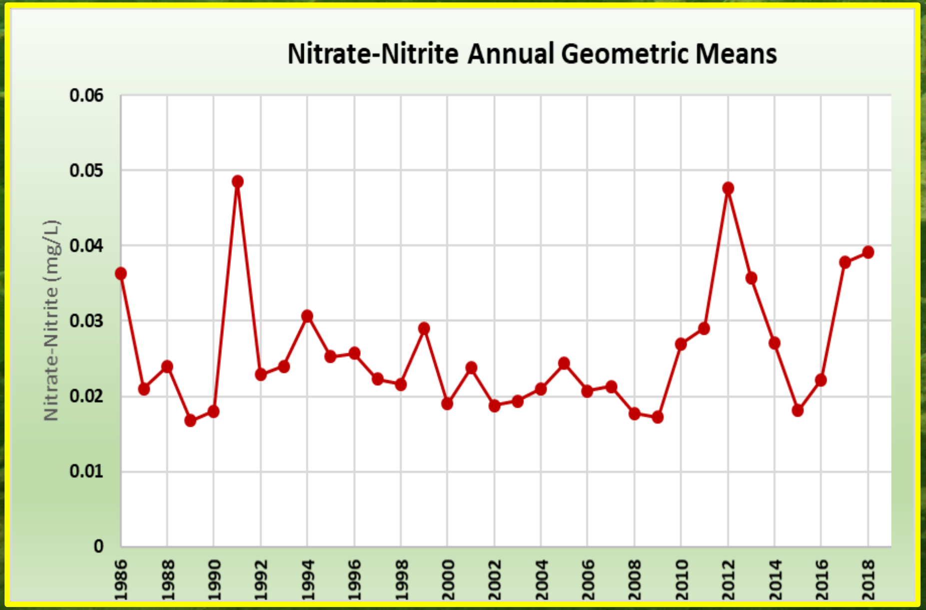
Total phosphorus annual mean.

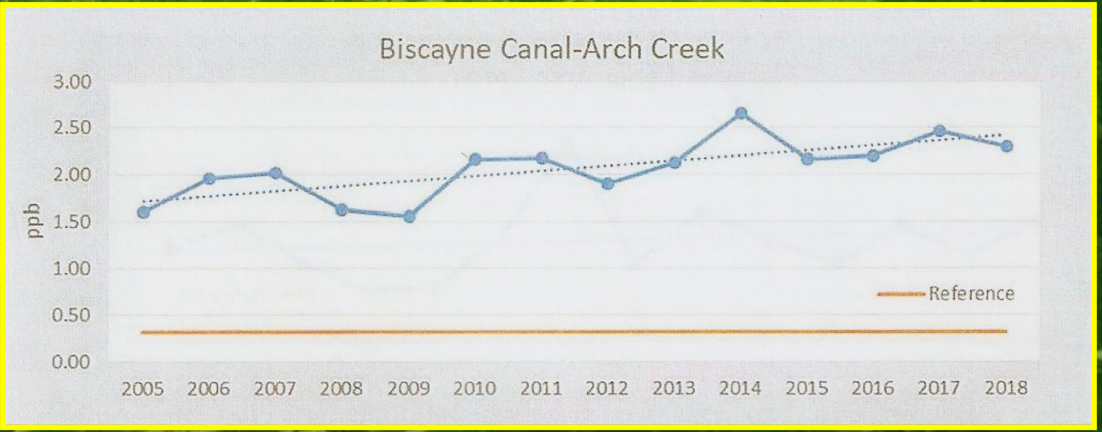
- Upward trend in Total Phosphorus.



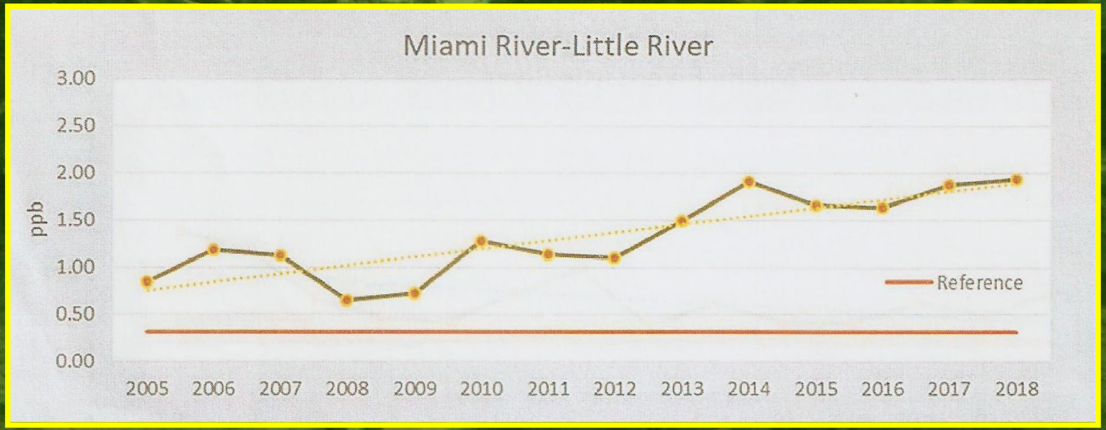
North Biscayne Bay Water Quality

- **Nitrate/Nitrite variable but seemingly trending upward.**



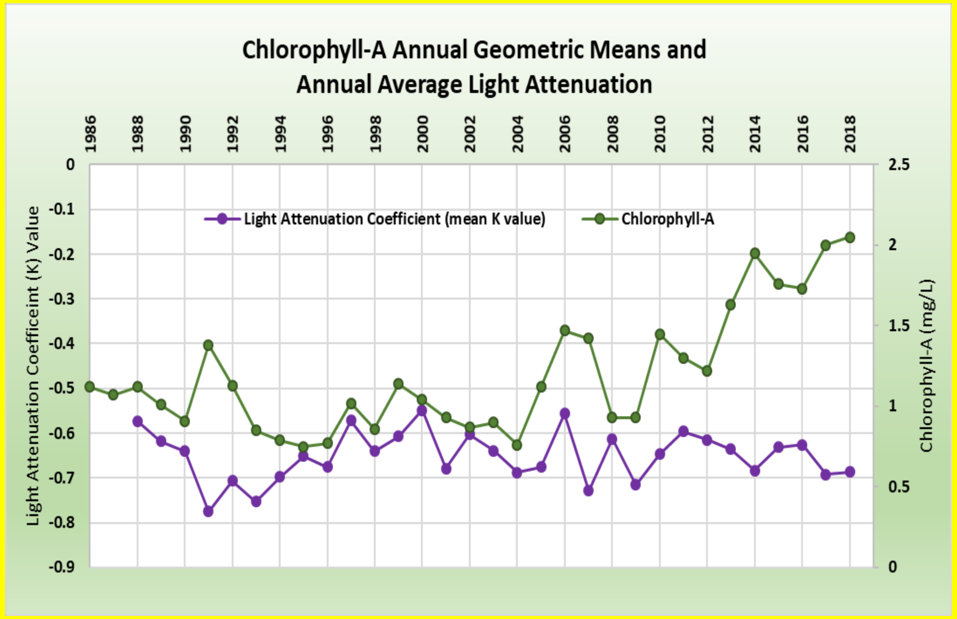


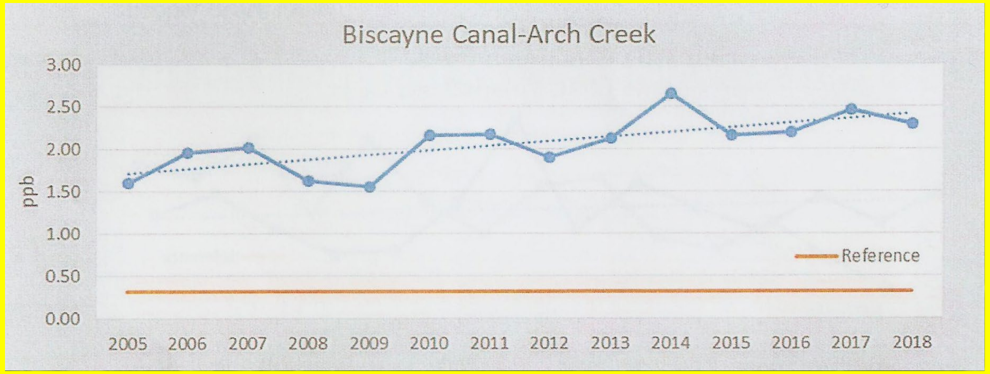
Nitrate annual mean.



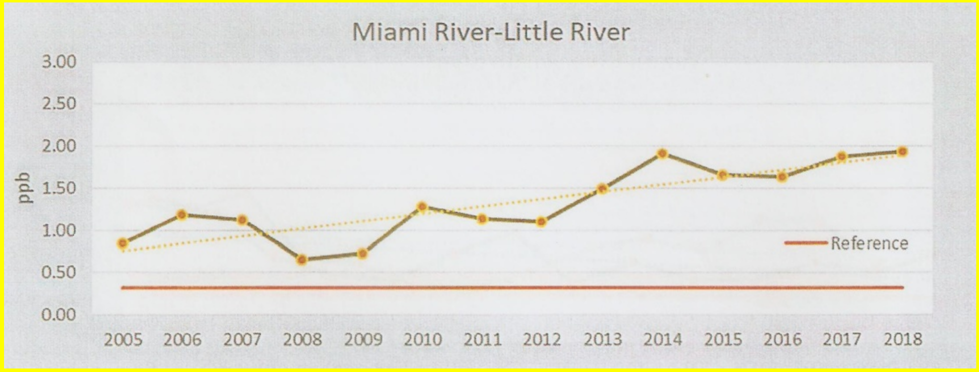
North Biscayne Bay Water Quality

- Upward trend in Chlorophyll A. Recent decreases in light penetration seems associated with Chlorophyll increases.



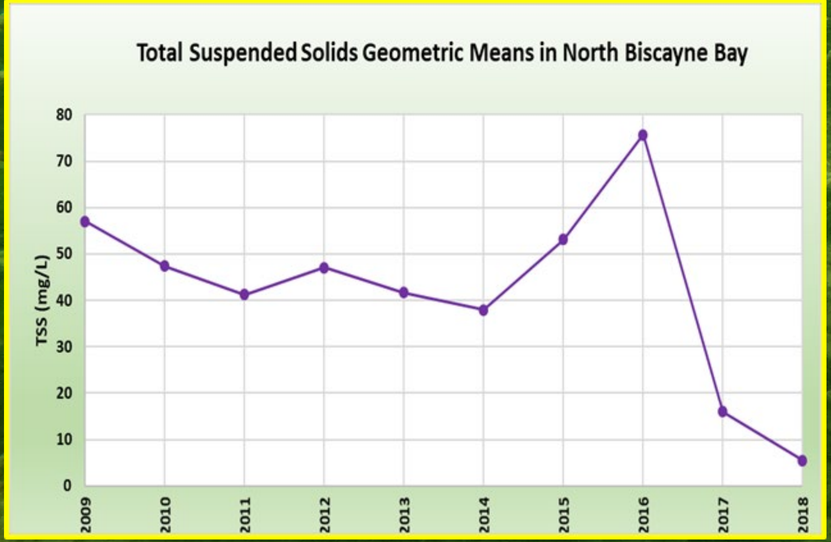


Chlorophyll A annual mean.



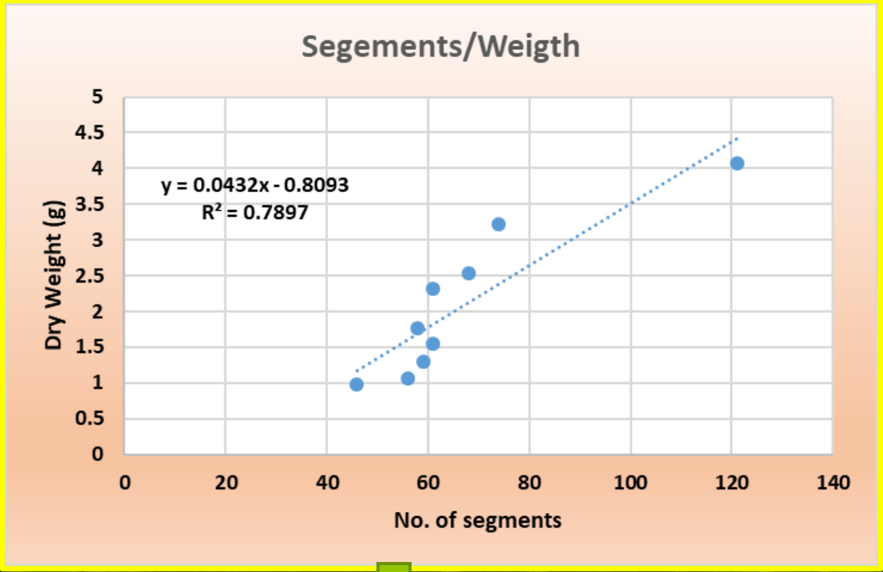
North Biscayne Bay Water Quality

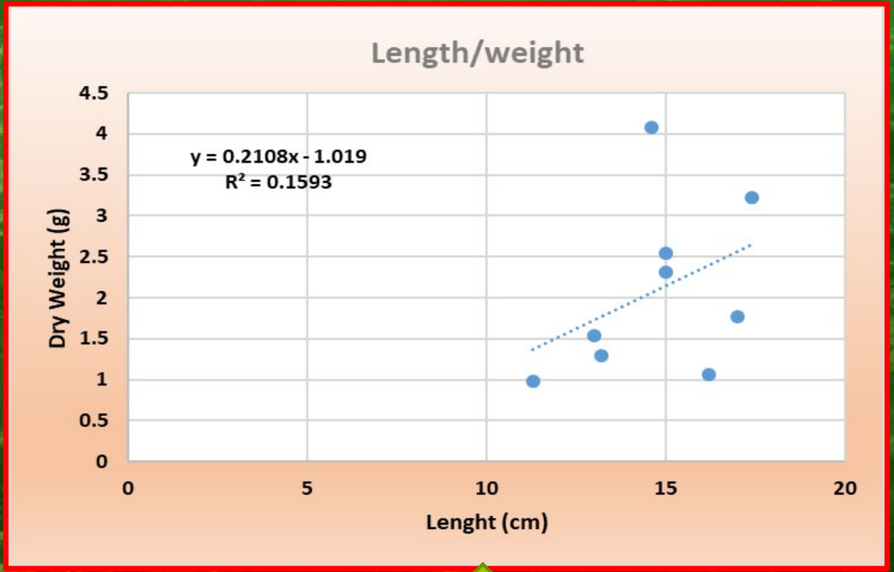
- Highest historical Total Suspended Solids (TSS) mean observed in 2016, at the peak of the seagrass die-off.
- TSS values declined dramatically during 2017-2018, with the increase of *Halimeda* coverage and the sediment stabilization.



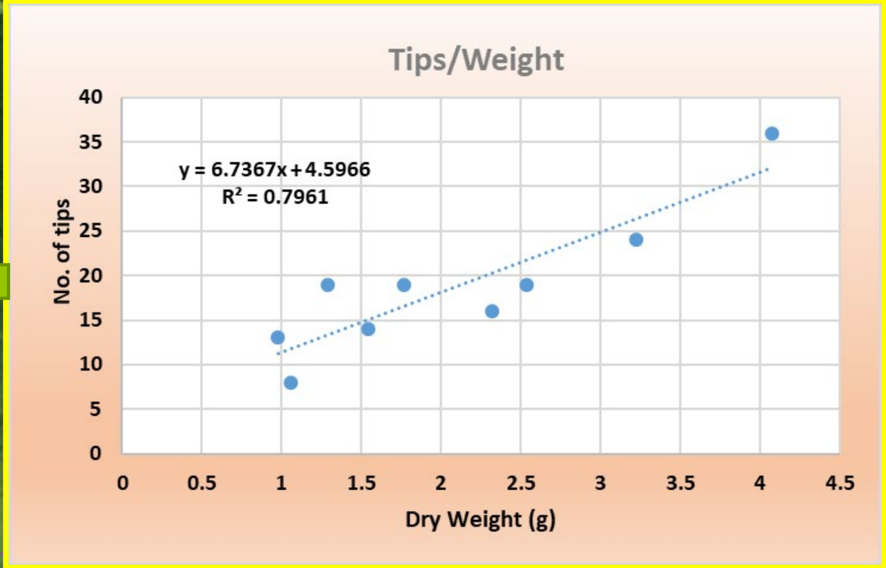
- Julia Tuttle basin Aerial pictures illustrate seagrass decline and subsequent increases macroalgae coverage.

Halimeda f. discoidea: Morphometry analysis





- Strong linear relationship (R^2 =0.79) between number of segments and nnumber of tips with biomass.



- Length is not a good allometric measure for biomass .

Halimeda f. discoidea: Preliminary Laboratory Experiments

LABORATORY CONDITIONS

- Average Salinity: 33 ppt
- Temperature: 20°C - 22°C
- Fotoperiod: 12:12

Low light (7-12 PAR)	Growth
Plant length	negative
No. of segments	positive
Width of segment	negative
Length of segment	positive

Mid light (50-80 PAR)	Growth
Plant length	positive
No. of segments	negative
Width of segment	positive
Length of segment	negative

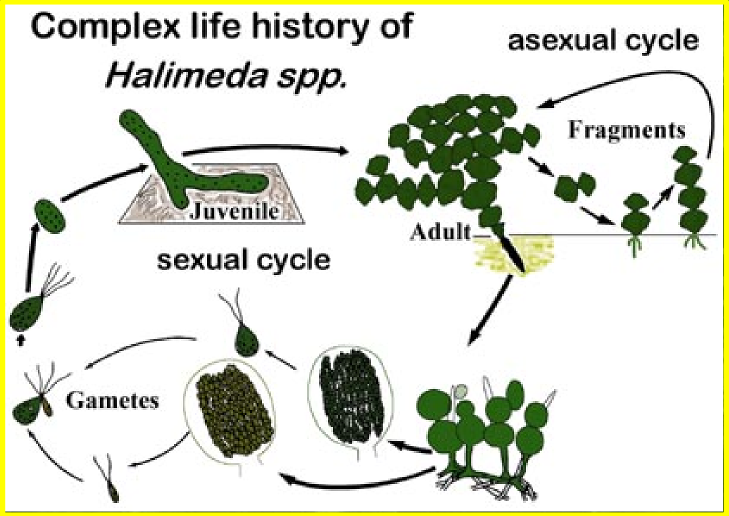
High Light (130-150 PAR)	Growth
Plant length	positive
No. of segments	negative
Width of segment	positive
Length of segment	positive

1- *Halimeda f. discoidea* is able to grow under very low light availability.
2- Even under extreme low light some growth was detected.
3- Temperature was also limiting growth .
4- Long survival in plants kept in laboratory.

Halimeda f. discoidea: Ecology and Reproduction

- *Halimeda f. discoidea* has the ability to reproduce by fragmentation. Sexual reproduction was also observed for this species under laboratory conditions.
- Both reproductive strategies contribute to the ability to increase coverage locally through asexual reproduction and spatially to greater distances through propagules of sexual structures.

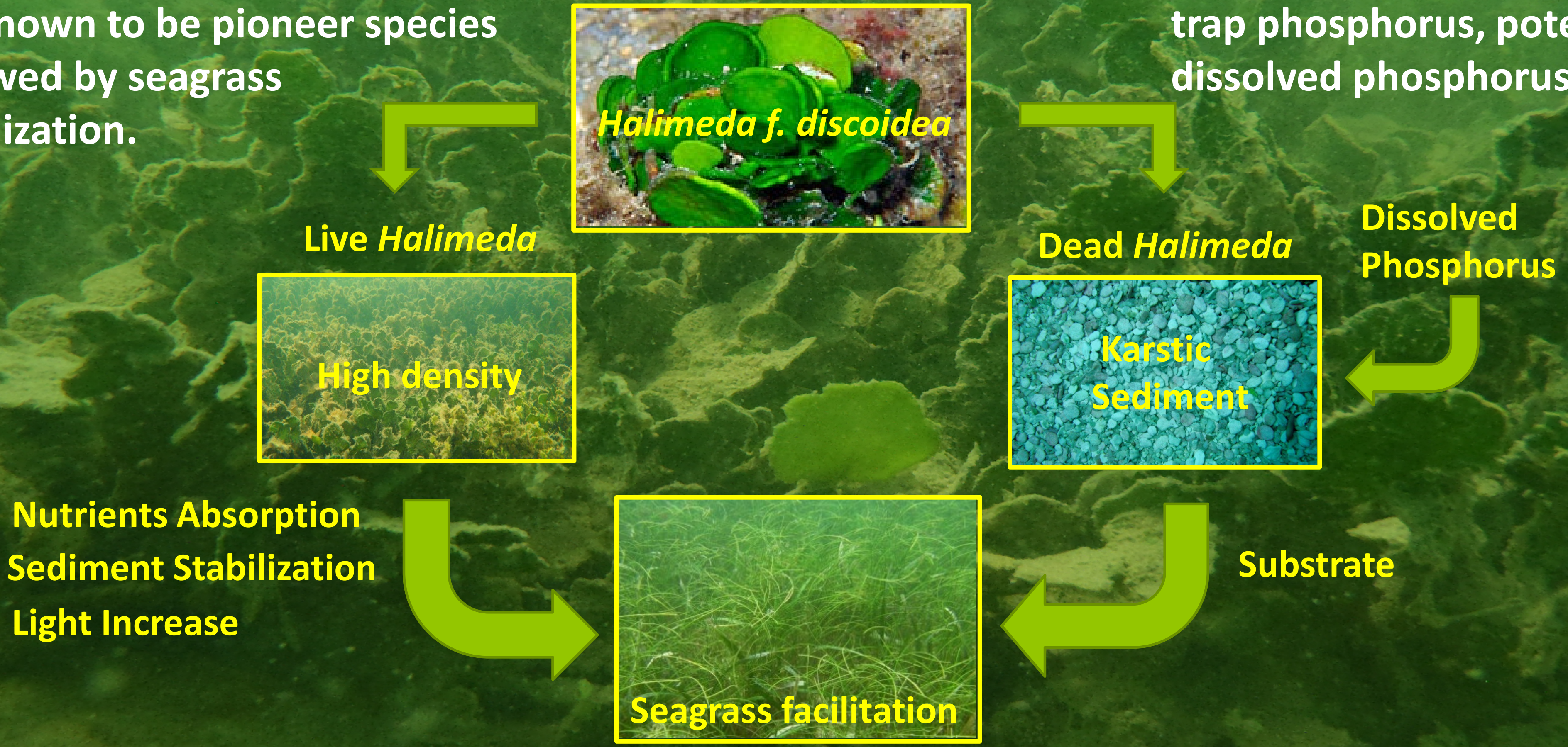
Sexual Propagation (gametes) under laboratory conditions



Asexual Propagation (fragments) observed in the field.

Halimeda f. discoidea: Restoration role

- Calcareous Green Algae (CGA) are known to be pioneer species followed by seagrass colonization.
- CGA produce karstic sediments that trap phosphorus, potentially reducing dissolved phosphorus availability.



- *Halimeda f. discoidea* in Northern Biscayne Bay standing stock is 214 g/m² dry weight.
- Average of 214 g/m² DW, producing 72% of calcareous sediment (214g DW, LOI 72% Organic Carbon 28%).
- *Halimeda f. discoidea* coverage of 20 km² contributes 2,996,000 Kg of calcareous sediment to the area.

SAV Summary

- Previous to the recent seagrass die-off, historical data collected in the North Biscayne Bay area shown a stable and diverse seagrass community dominated by *Syringodium filiforme*.

- Seagrass decline became evident around 2013 and declined rapidly during 2014-2018. By 2018, near 80% of the area previously dominated by seagrass was covered by 5% or more *Halimeda*.

- Between 2016 and 2017, Green Macroalgae, as a morphofunctional group, became dominant in the area. Sampling conducted by DERM in 2018 showed an average green algae coverage over 35% in the area. This macroalgae coverage is dominated by the genera *Halimeda*, with *Halimeda f. discoidea* as main component.

- Preliminary Laboratory experiments showed growth under all light conditions and a strong linear relationship between number of segments and number of tips with biomass.

- Sexual and asexual reproduction was observed for *Halimeda f. discoidea*, contributing to patch expansion and long distance propagation.

- *Halimeda f. dicoidea*, as pioneer specie, can play an important roll in sediment stabilization and nutrients intake, increasing light penetration and creating conditions for seagrass re-colonization.

Water Quality Summary

- **Chronic, low level nutrient loading and/or acute, pulsed nutrient loading (Total Phosphorus, Nitrate/Nitrites) is linked to seagrass loss in Biscayne Bay.**

- **Through the period 2012-2018, increases in Turbidity, Chlorophyll-A levels and Total Suspended Solids were measured in the area, along with low PAR values (decrease in light penetration). Such changes in water quality parameters has been associated to biomass (seagrass) mortality, subsequent sediment instability and phytoplankton increases in the water column. Recent increases in green rhizophytic algae coverage could have contributed to sediment stability observed during 2017-2018.**

Acknowledgements

To Kathryne Wilson, Damaso Rosales, Marques Lopez, James Brown, Mike Greenemeier, Maurice Pierre, Jonathan Sidner, Mary Zingler and all the great team of scientist that has contributed to the collection and analysis of the information presented.

To our colleagues from the USGS for the data provided to support this presentation.