

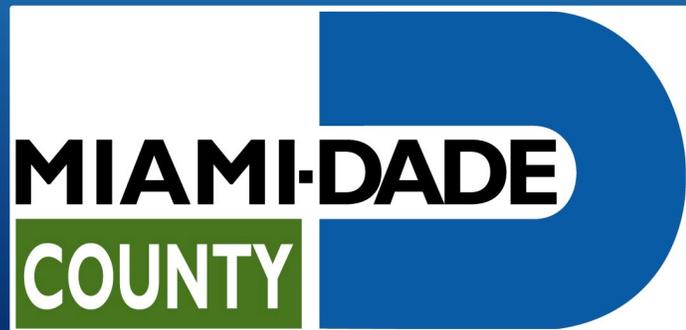
Seagrass Changes Associated with Long-Term Algae Blooms in Biscayne Bay

GEER Conference | April 2025

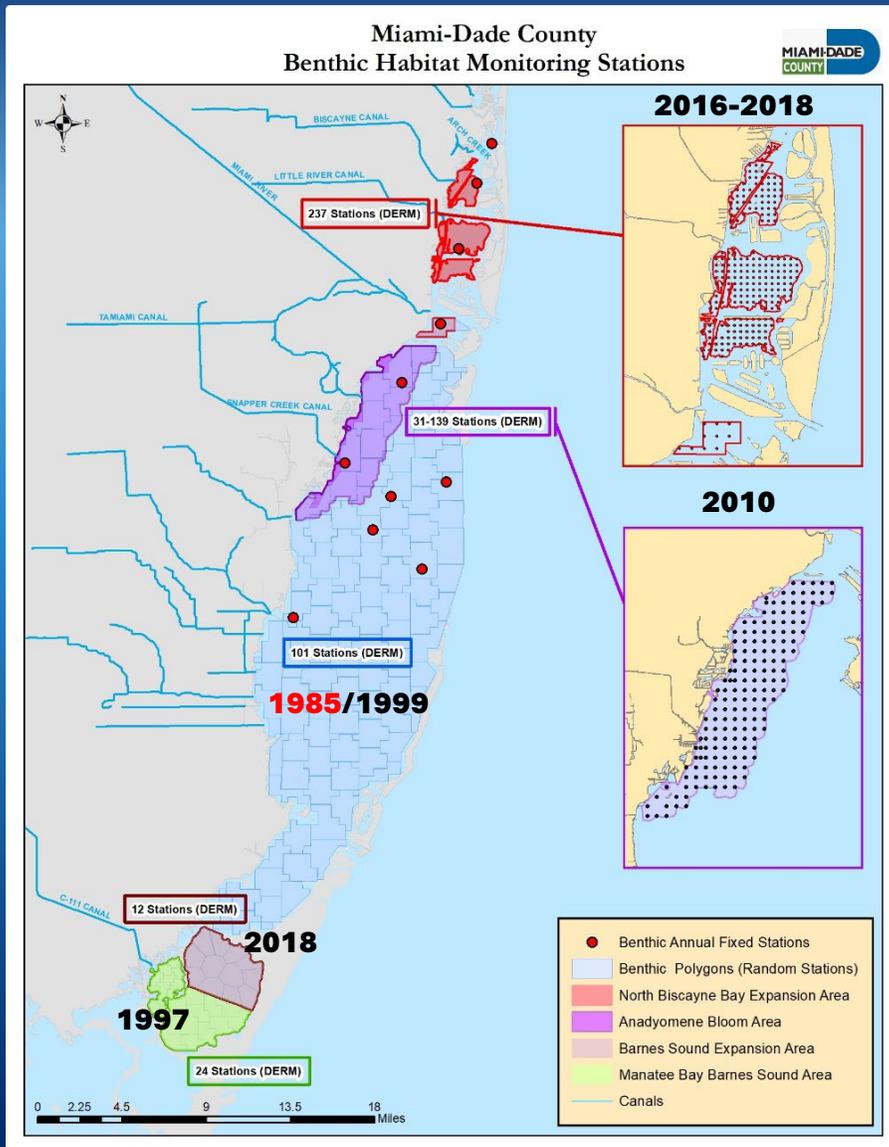
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DERM Biscayne Bay Benthic Habitat Monitoring Program (BBBHMP)



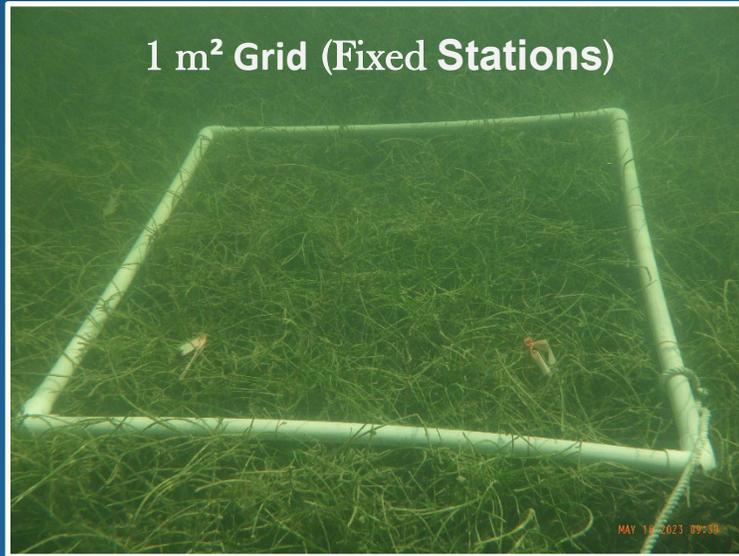
Historical Monitoring Program

- Initiated in 1985 with 10 fixed survey transects (Benthic Annual Fixed Stations).
- Expanded in 1999 with 101 stratified stations (blue polygons).
- Florida Bay Program (SFWMD) covered additional 24 random stations monitored by DERM since 1997 (green polygon).

Monitoring Program Expansions

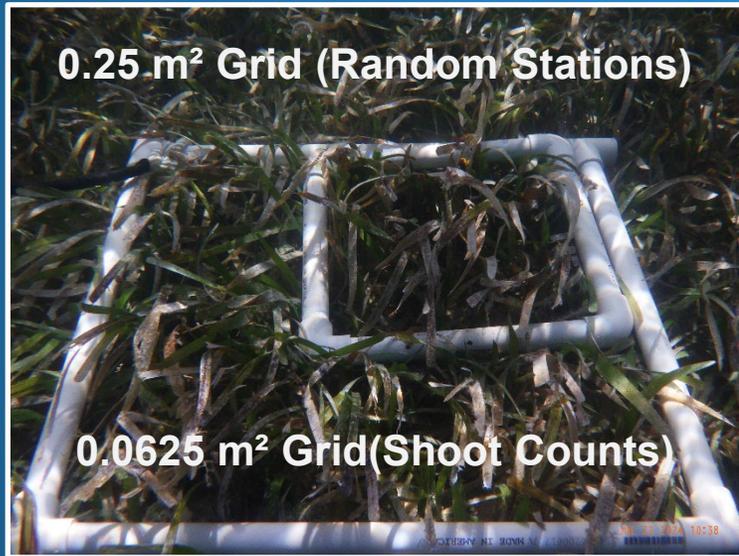
- 2010: *Anadyomene* spp. Bloom Sampling.
- 2016-2018: Julia Tuttle - North Biscayne Bay monitoring expansion.
- 2018: North Barnes Sound monitoring expansion.

DERM BBBHMP – Methods and Metrics



More than **400 stations** assessed by **Braun-Blanquet Cover Abundance (BBCA)** and **Percent Cover** methods through 3 monitoring levels.

Density (Shoot Counts)
Seagrass.



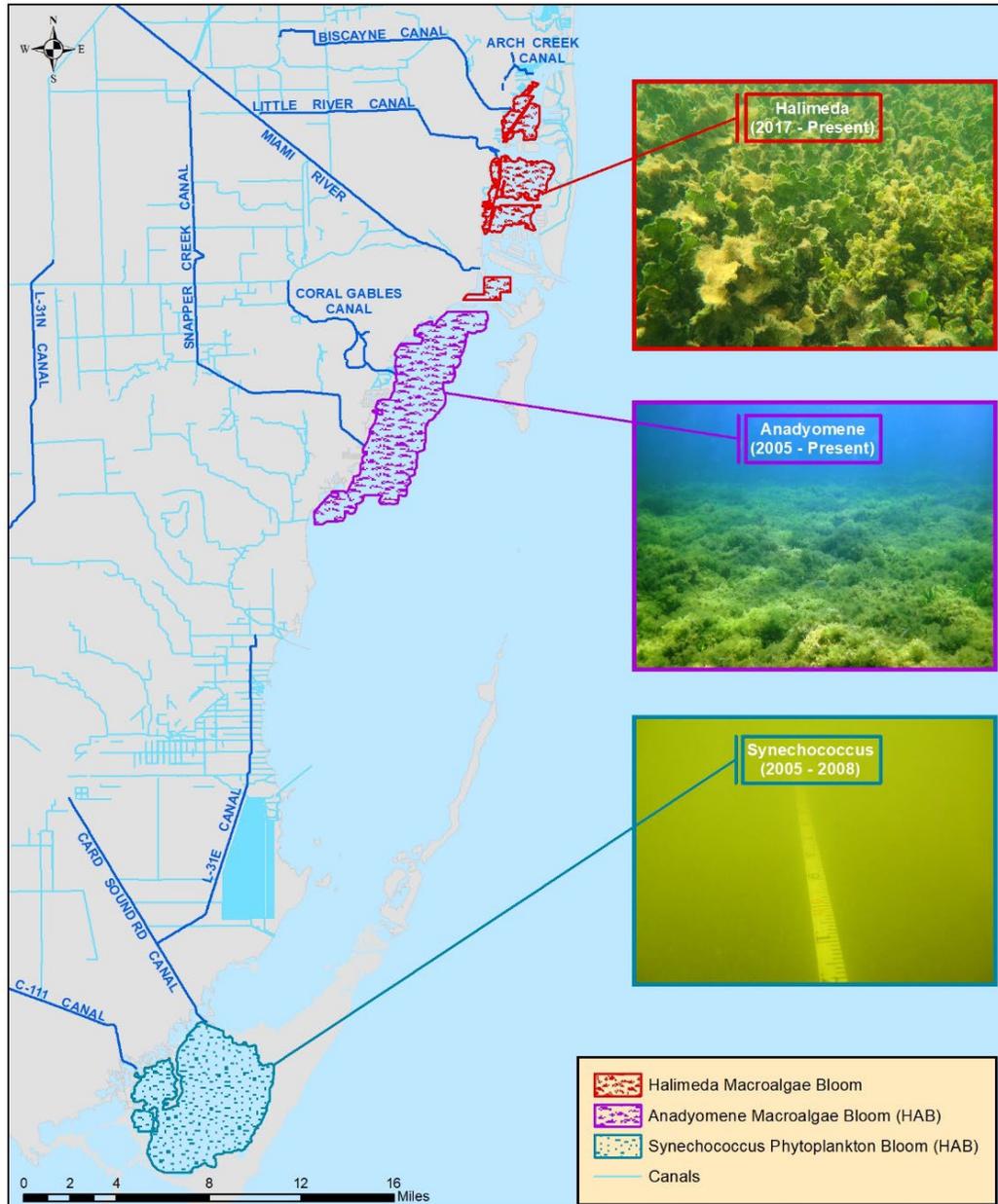
Coverage
(Percent / BBCA)

+75%-100% (5)

+50%-75% (4)

+25%-50% (3)

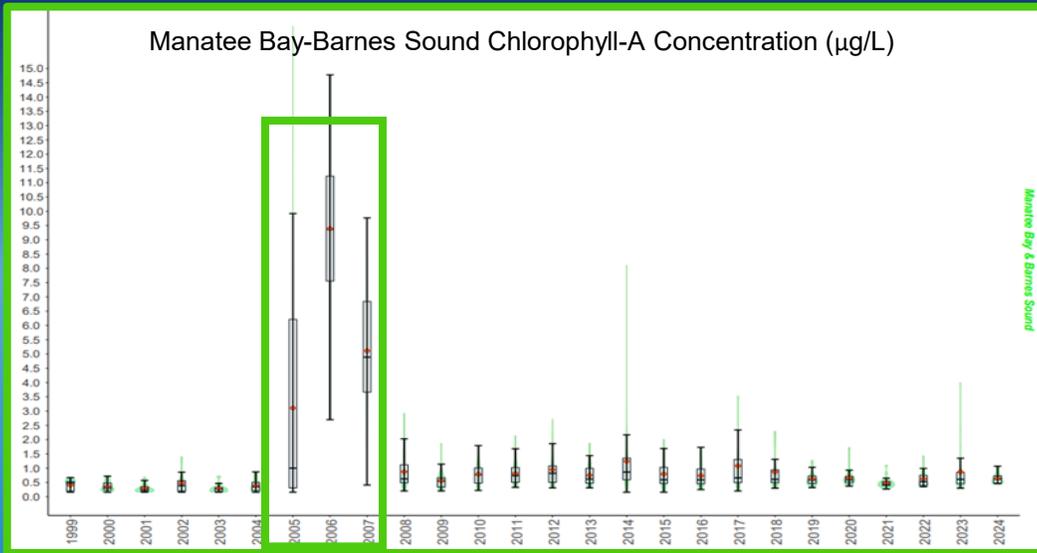
5%-25% (2)



Overview

- DERM annual surveys (1985 – Present) shows overall stable seagrass community throughout Biscayne Bay until 2004-2005.
- Since 2004, three long term (multiyear) algae blooms have been recorded in three areas of the Bay in association with seagrass die-off events:
 - *Synechococcus* Bloom (Pycophytoplankton): Caused seagrass die-off.
 - *Anadyomene* spp. Bloom (Drift Green Macroalgae): Caused seagrass die-off. Dominant species: *A. linkiana*.
 - *Halimeda* spp. Bloom (Rizophytic Green Macroalgae): Following seagrass die-off. Dominant species: *H. macroloba*.
- Seagrass recovery has been marked by species shifts and instability in these areas, still dominated by macroalgae and high chlorophyll levels.

Manatee Bay-Barnes Sound: *Synechococcus* Bloom Area



Mean Chlorophyll-A Annual Concentration

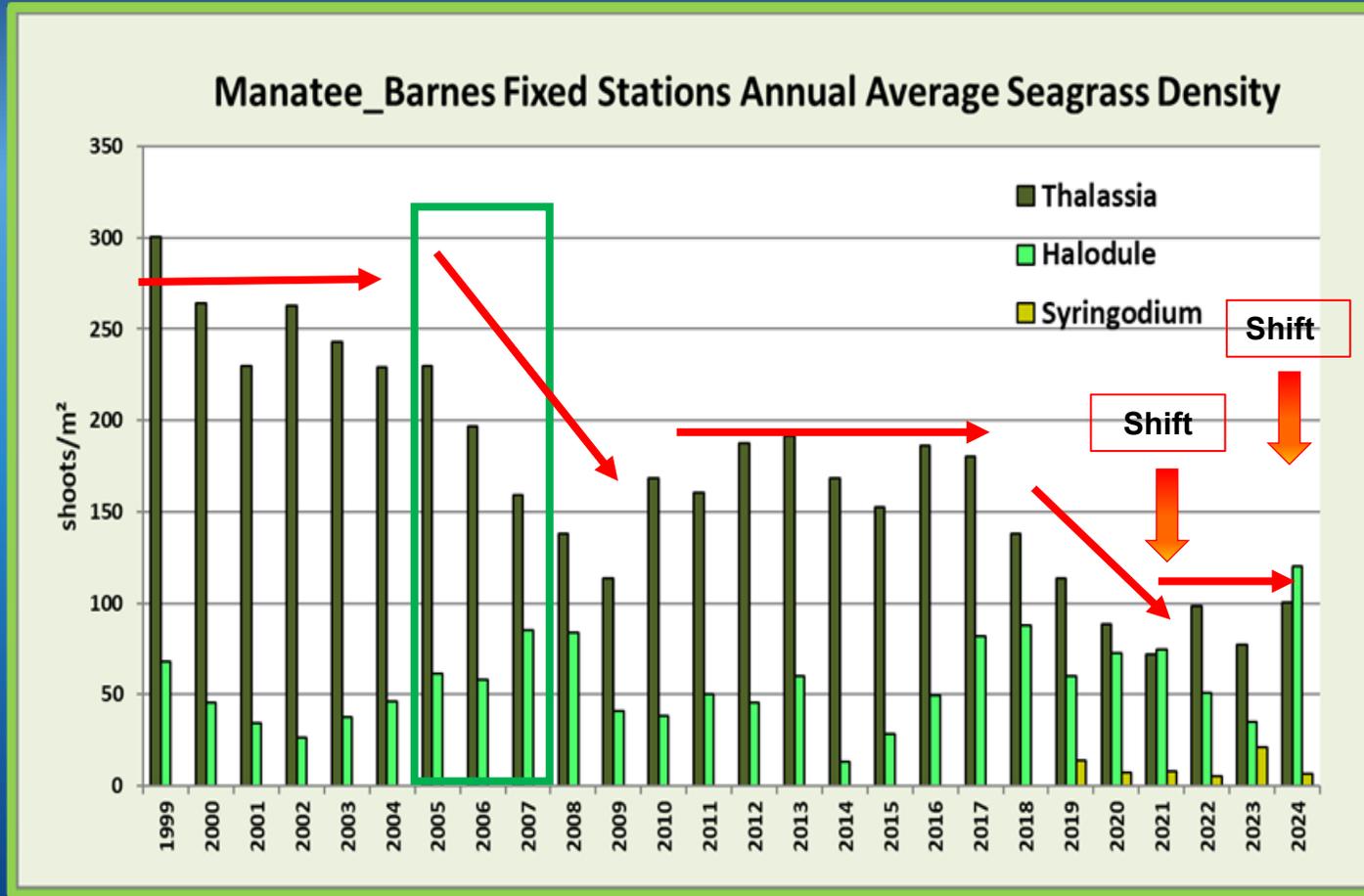
- 1999-2005: 0.5 $\mu\text{g/L}$ – low variability.
- 2005-2008: 0.5 $\mu\text{g/L}$ – 9 $\mu\text{g/L}$ (near 20 times higher)!
- 2009-2024: > 0.5 $\mu\text{g/L}$ - high variability. Shift in baseline Chlorophyll levels.

Seagrass Coverage

- 2005: Near 50% of the Manatee Bay area covered with dense seagrass (above 50% coverage). 50% of the Barnes Sound area covered with 25% or more seagrass.
- 2009: Low coverage (below 50%) across Manatee Bay. Low seagrass coverage (below 25%) in Barnes Sound.



Manatee Bay-Barnes Sound: *Synechococcus* Bloom Area



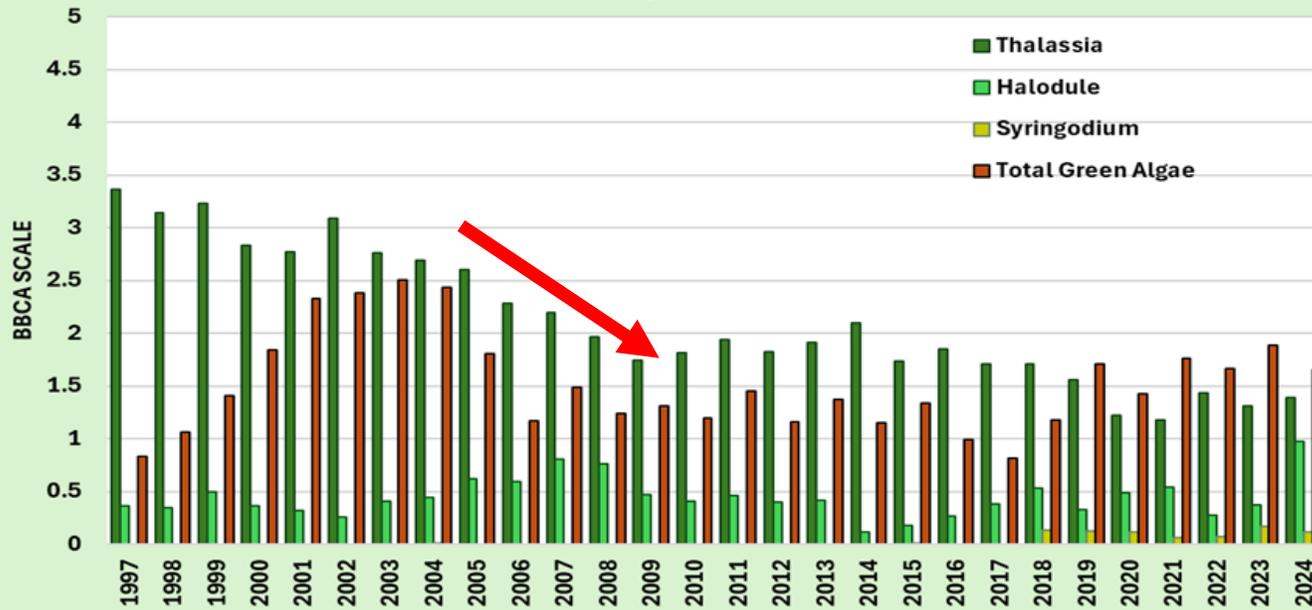
Seagrass density

- 1999-2005: Low *Halodule wrightii*, high stable *Thalassia testudinum*.
- 2005-2009: 50% decline in *Thalassia*, increases in *Halodule*.
- 2010-2017: *Thalassia* recovery (below 2005 levels).
- 2018-2024: Seagrass dominance shifts. *Thalassia* declines.

Manatee Bay-Barnes Sound: *Synechococcus* Bloom Area

Seagrass – Macroalgae Coverage changes

Seagrass and Green Algae abundance changes in the Manatee Bay - Barnes Sound Area



- 1999-2005: Low *Halodule*, high stable *Thalassia* (25-50 percent coverage). Increases in green Macroalgae preceded phytoplankton bloom.
- 2005-2009: General decline for all benthic vegetation.
- 2010-2018: Limited *Thalassia* recovery (below 1997-2005 period).
- 2019-2024: Green Macroalgae dominating over seagrass species since 2018. Record *Halodule* coverage in 2024.

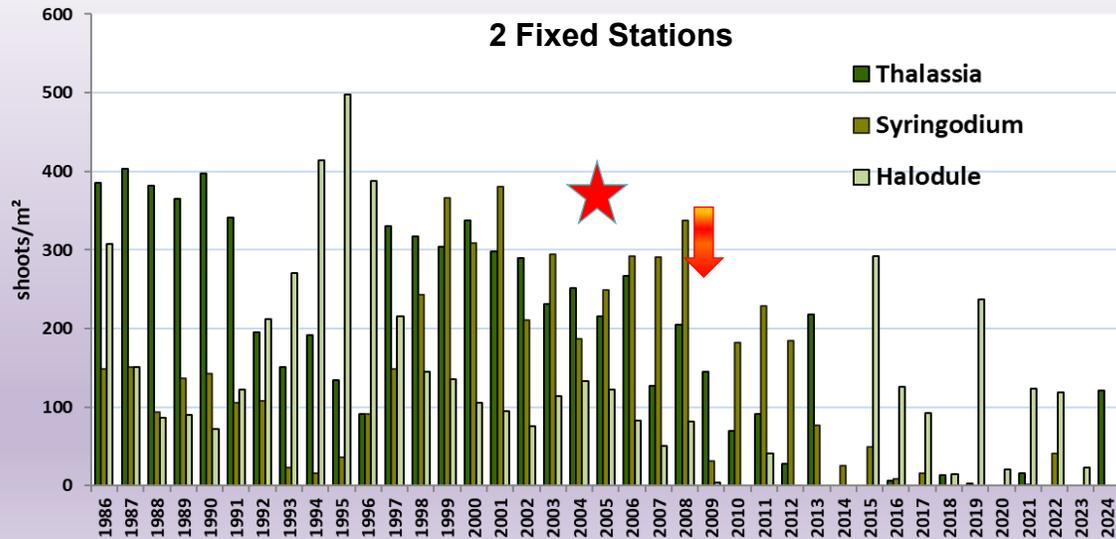
Higher seagrass coverage
(1997 – 2018)

Higher green algae
coverage
(2019 – 2024)

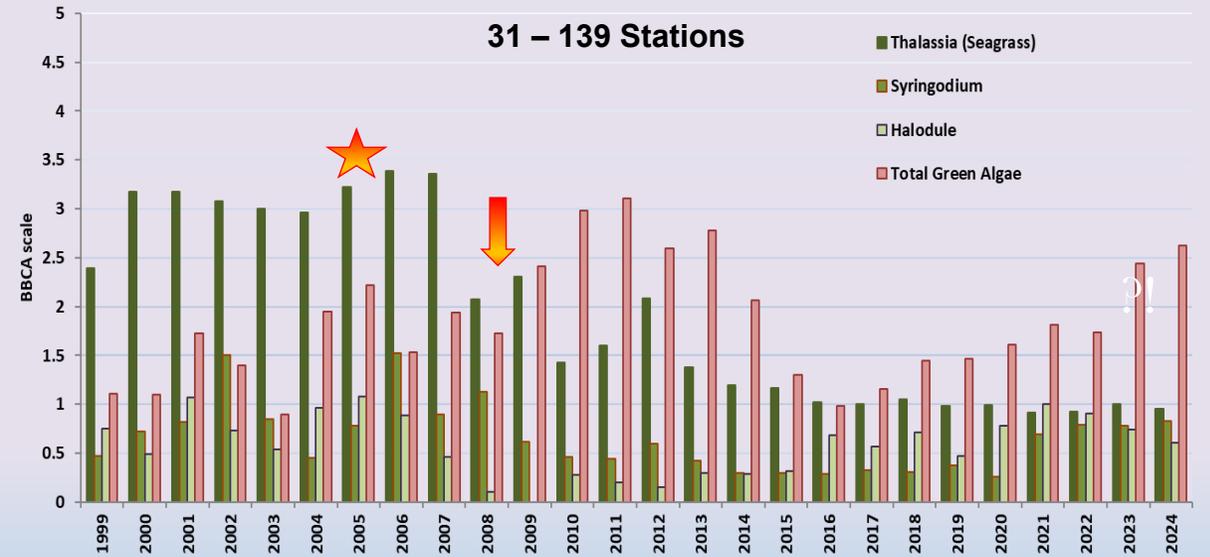
North Central Inshore: *Anadyomene* spp. Bloom Area

- 2004-2009: Initial Increase in common benthic macroalgae. High seagrass density.
- 2009-2014: Seagrass density declines. Shift from seagrass to macroalgae coverage dominance in 2009.
- 2015-2022: Higher *Halodule* density. Increases in SAV seems to be driven by benthic macroalgae.
- 2023-2024: Resurgence of *Anadyomene linkiana* diving algae density increases

NCI Fixed Stations Annual Average Seagrass Density



Seagrass and Green Algae abundance changes in the Anadyomene Bloom Area



Dense variable seagrass
(1986 – 2008)

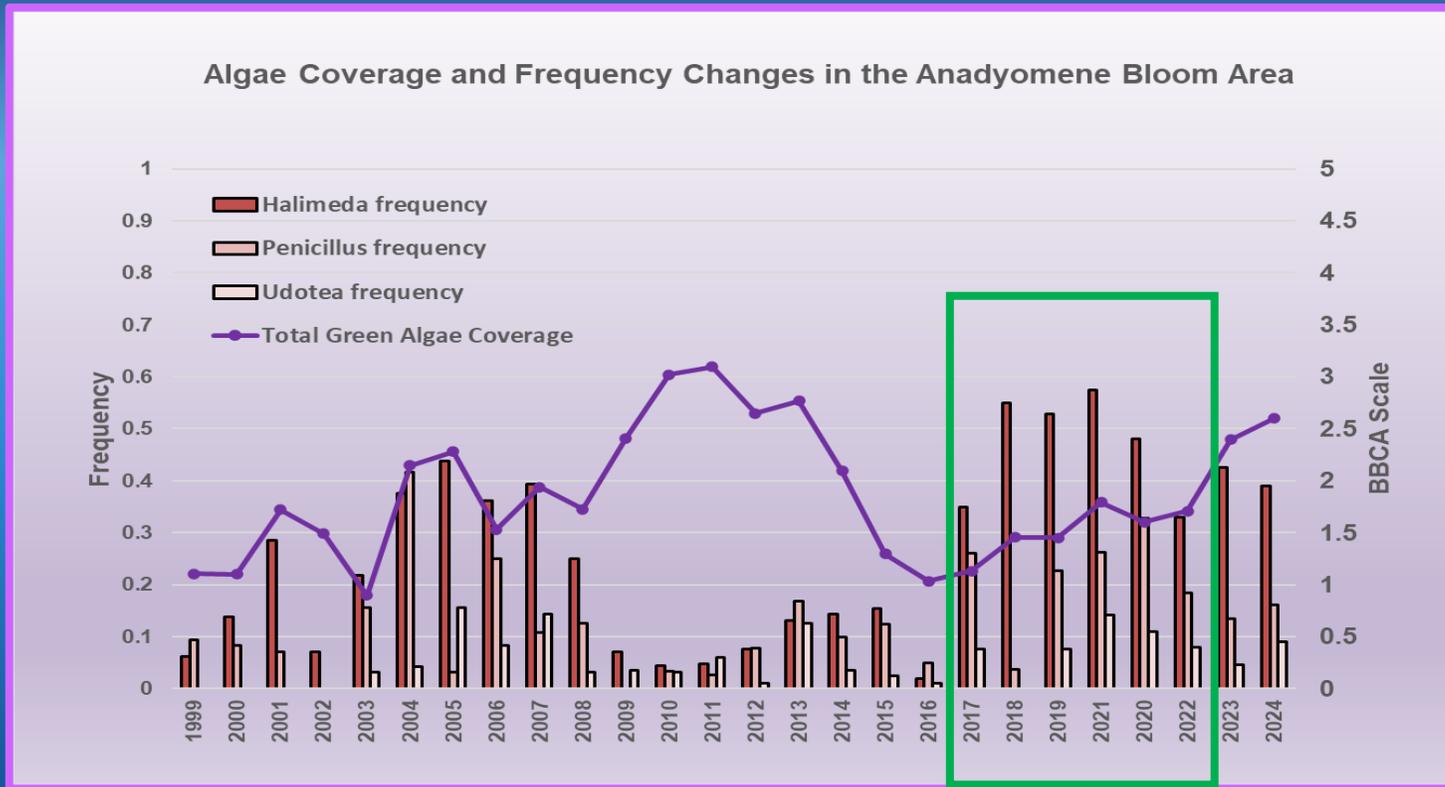
Higher *Halodule*
(2015 – 2022)

Higher seagrass coverage
(1986 – 2008)

Higher green algae coverage
(2009 – 2024)

North Central Inshore: *Anadyomene* spp. Bloom Area

Green Macroalgae Changes



Anadyomene stellata
Always present



Halimeda spp.
Frequency increases
after 2016



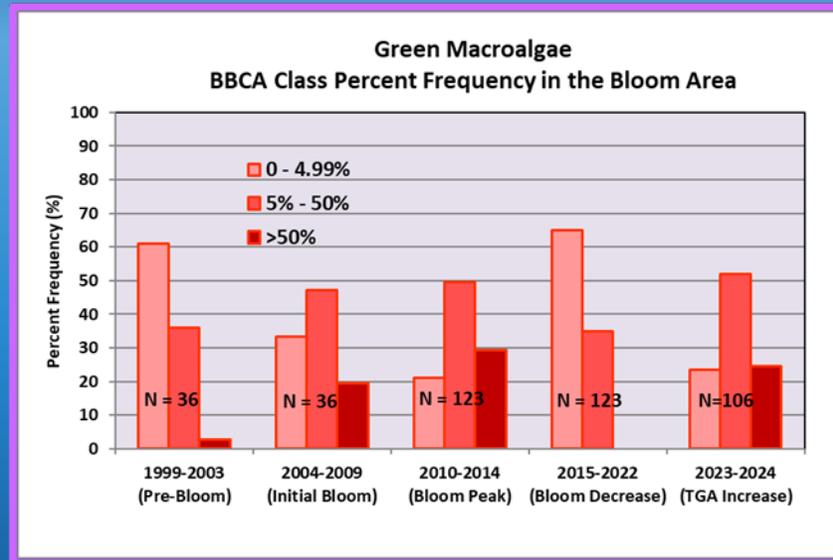
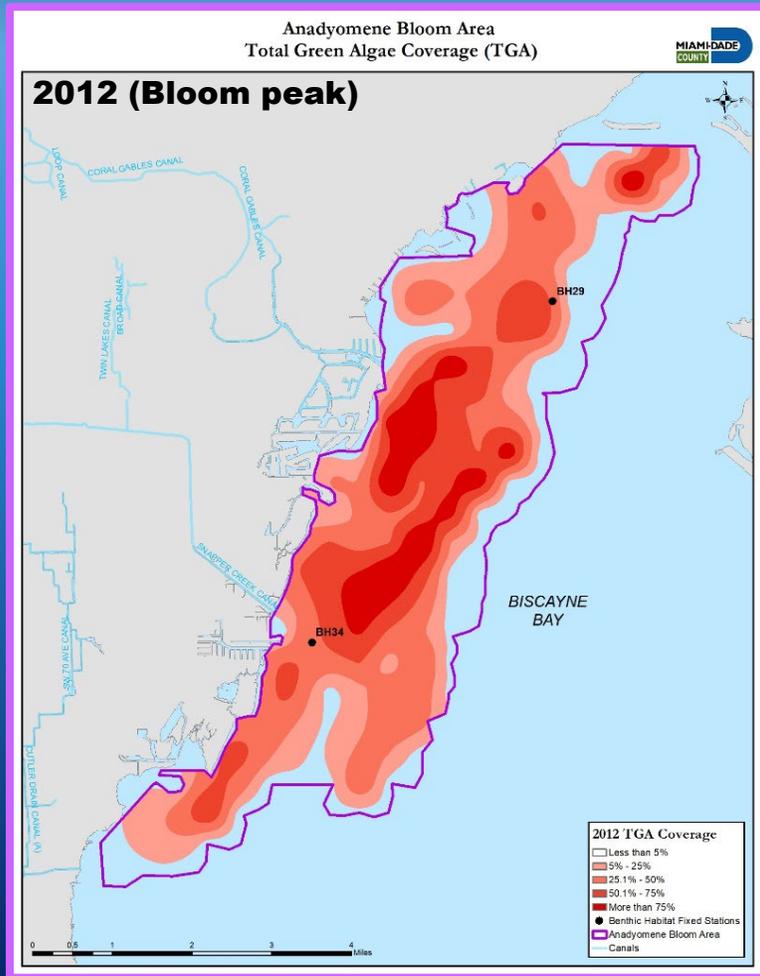
Anadyomene linkiana
Absent 2017-2022

- 2009-2015: *Anadyomene* spp. bloom peak with declining calcareous algae
- 2016-2022: *Anadyomene linkiana* absence with increasing calcareous algae, mainly *Halimeda* spp.

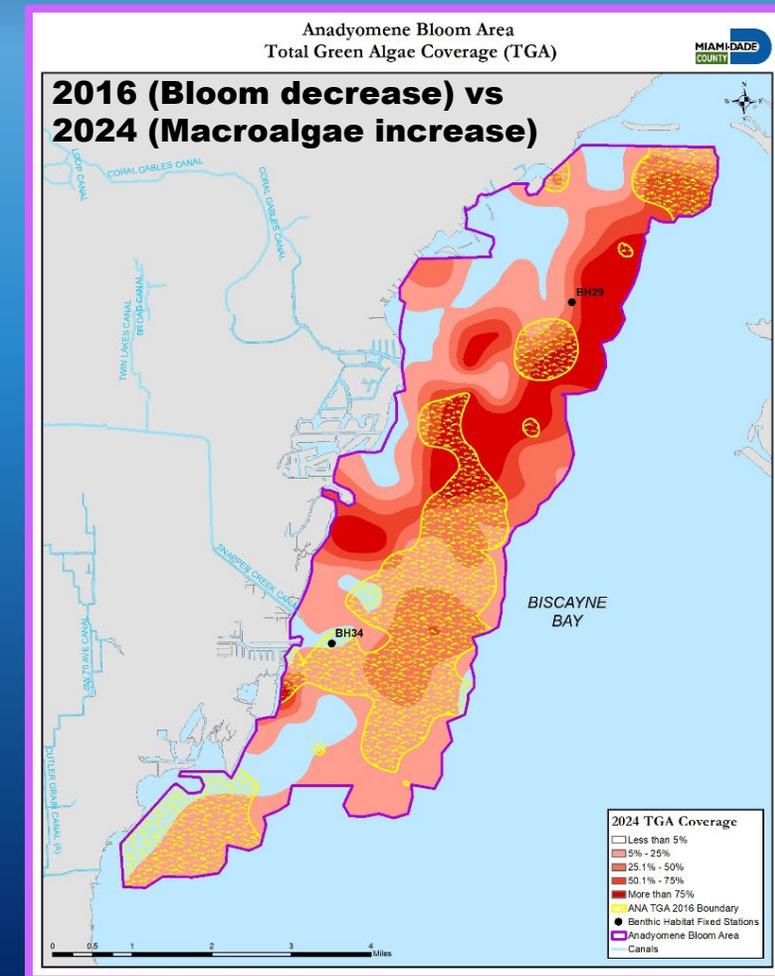
North Central Inshore: *Anadyomene* spp. Bloom Area

Green Macroalgae Changes

1999 - 2014: Increases in the highest coverage categories (>50%).
 2015 - 2022: Green Macroalgae below 50% coverage.



Coverage distribution 2023-2024 similar to Bloom Peak Period.

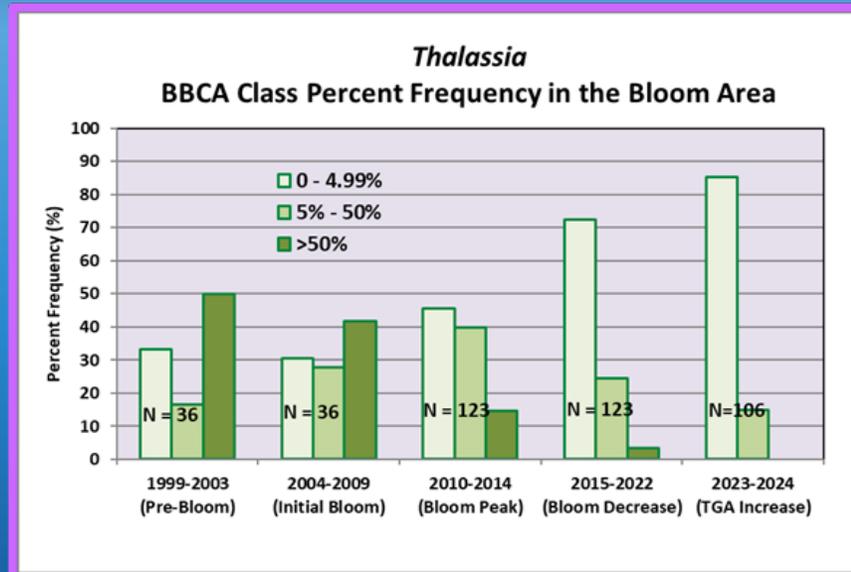
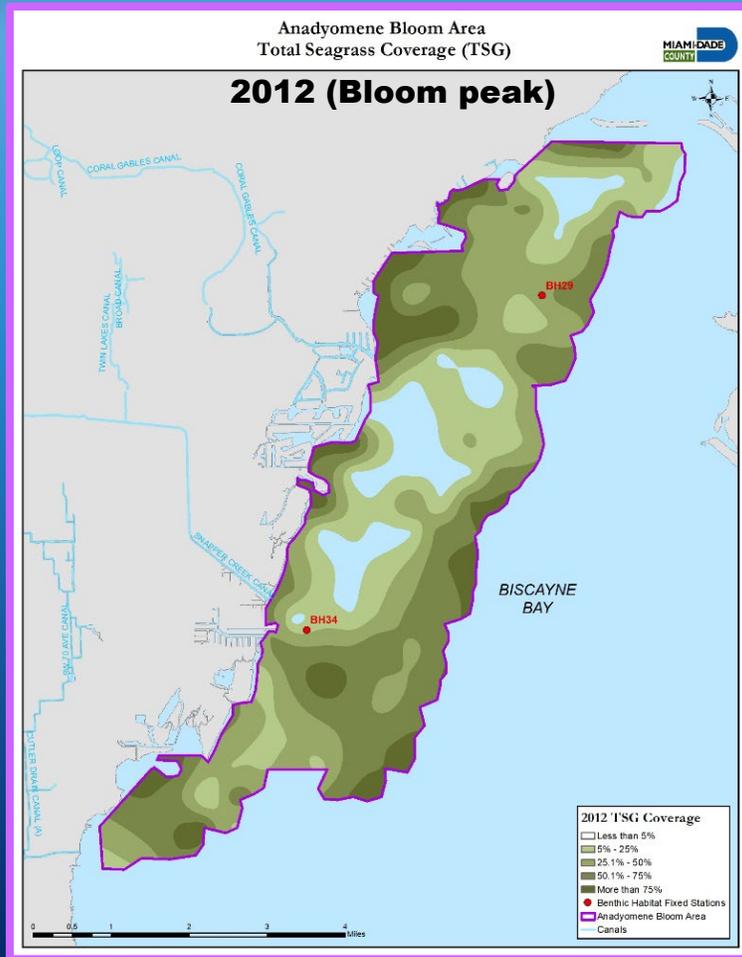


North Central Inshore: *Anadyomene* spp. Bloom Area

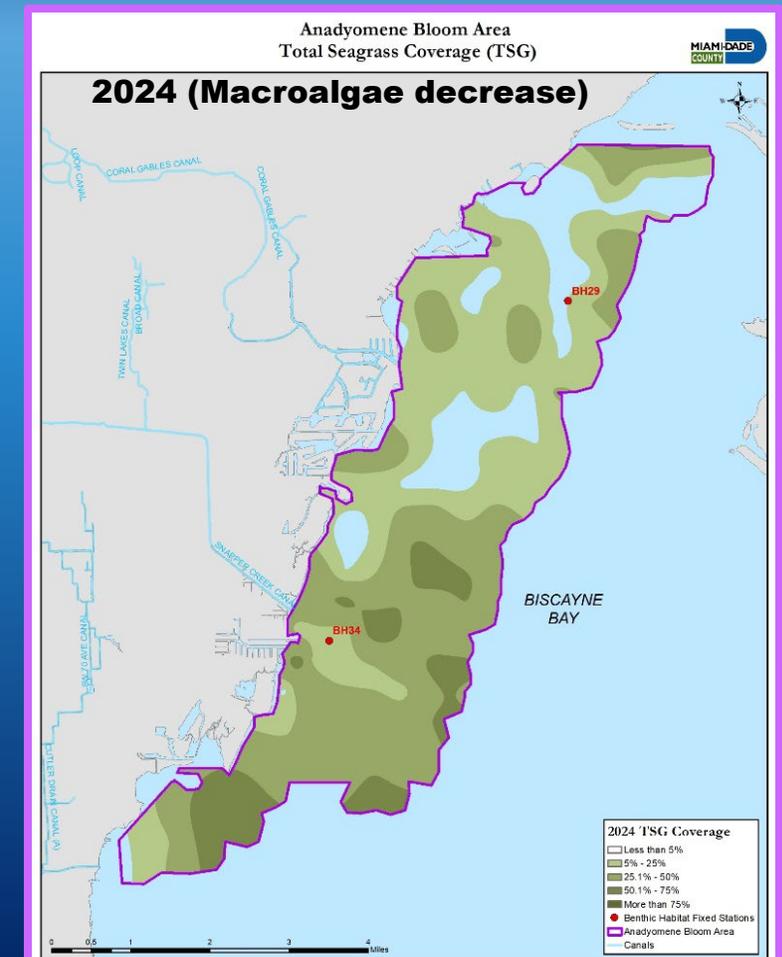
Seagrass Changes

1999 – 2022: Continuous decrease in the highest coverage categories (>50%).

2023 – 2024: *Thalassia* below 50% coverage in the area through the last period of algae increase.

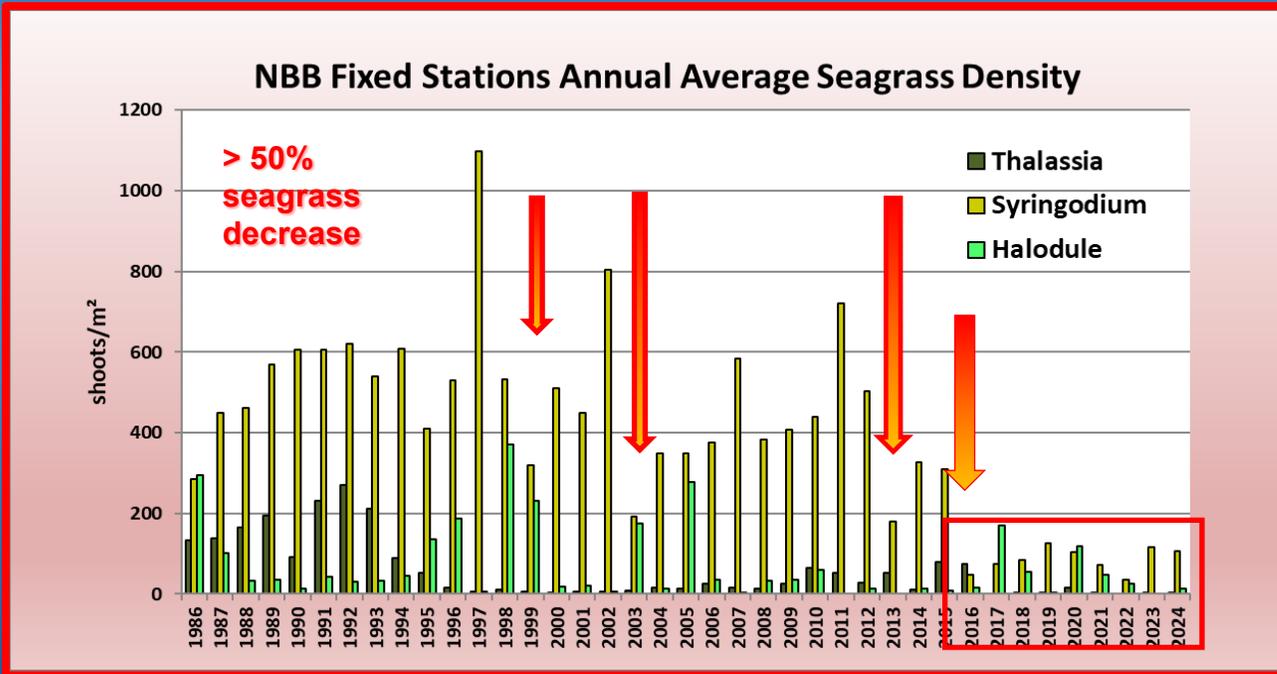


No seagrass recovery observed following “Bloom Peak”.



North Biscayne Bay: *Halimeda* spp. Bloom Area

4 Fixed Stations

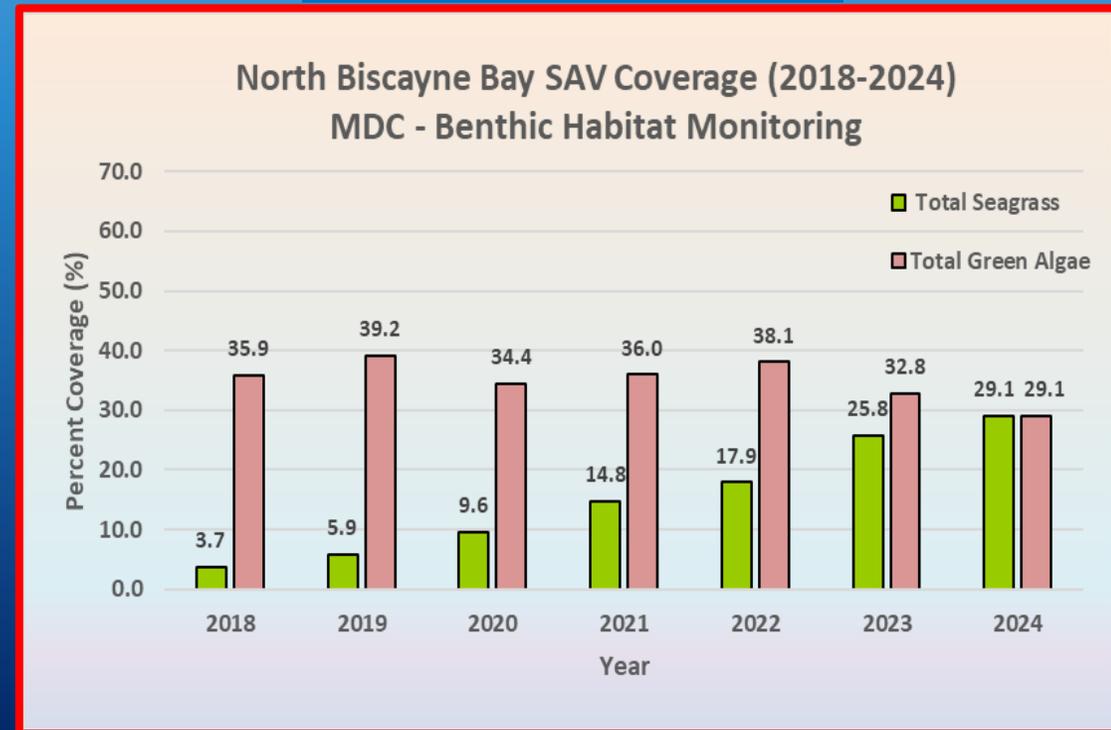


2016-2020: Shifts in seagrass species dominance following *Syringodium* die-off.

Syringodium steadily recovered and has maintained its dominance as main seagrass in the area since 2020 - 2021.

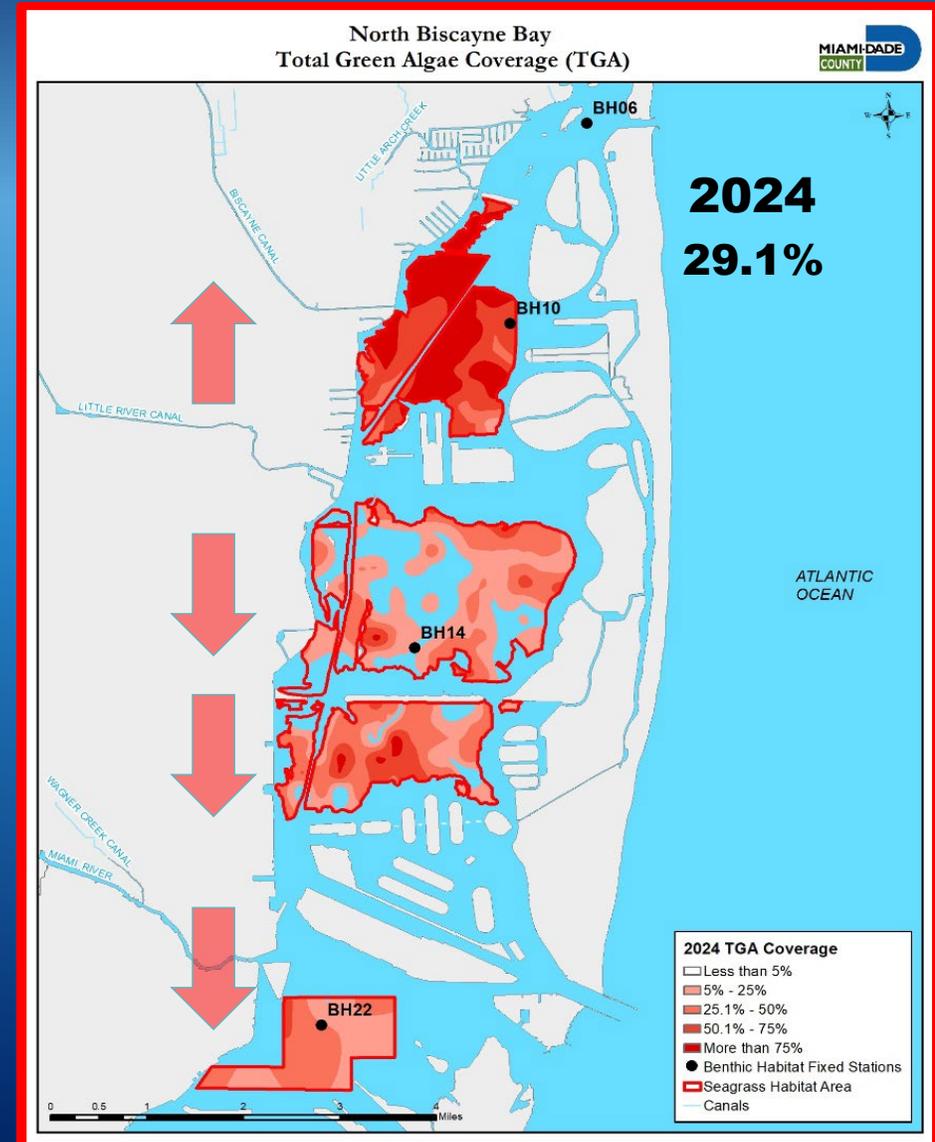
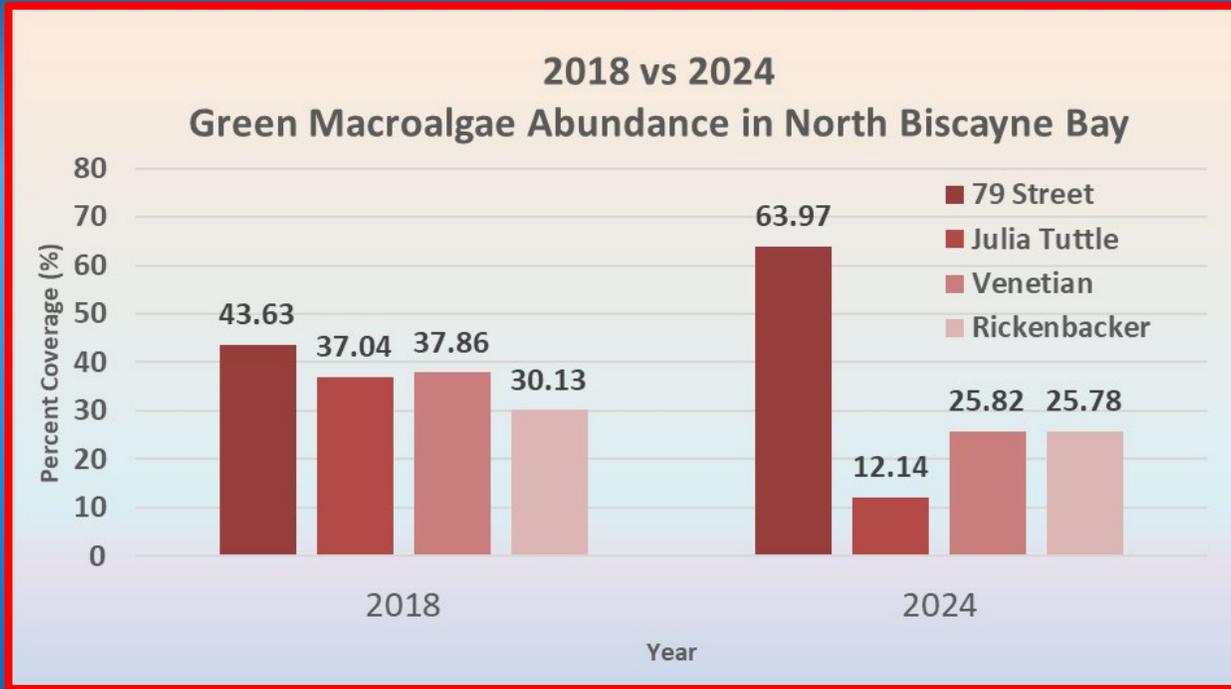
2018-2024: Continuous increases in seagrass and decrease in macroalgae across the area.

230+ Fixed Stations



North Biscayne Bay: *Halimeda* spp. Bloom Area

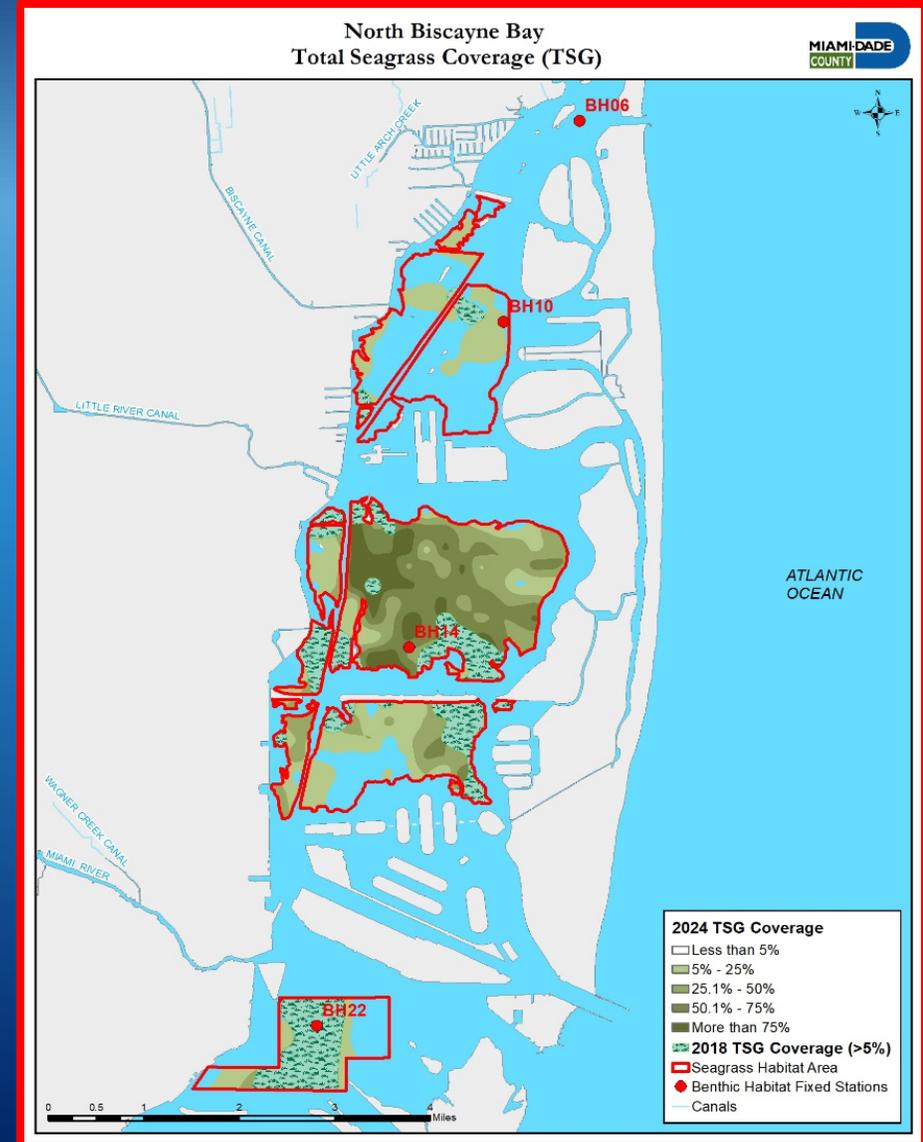
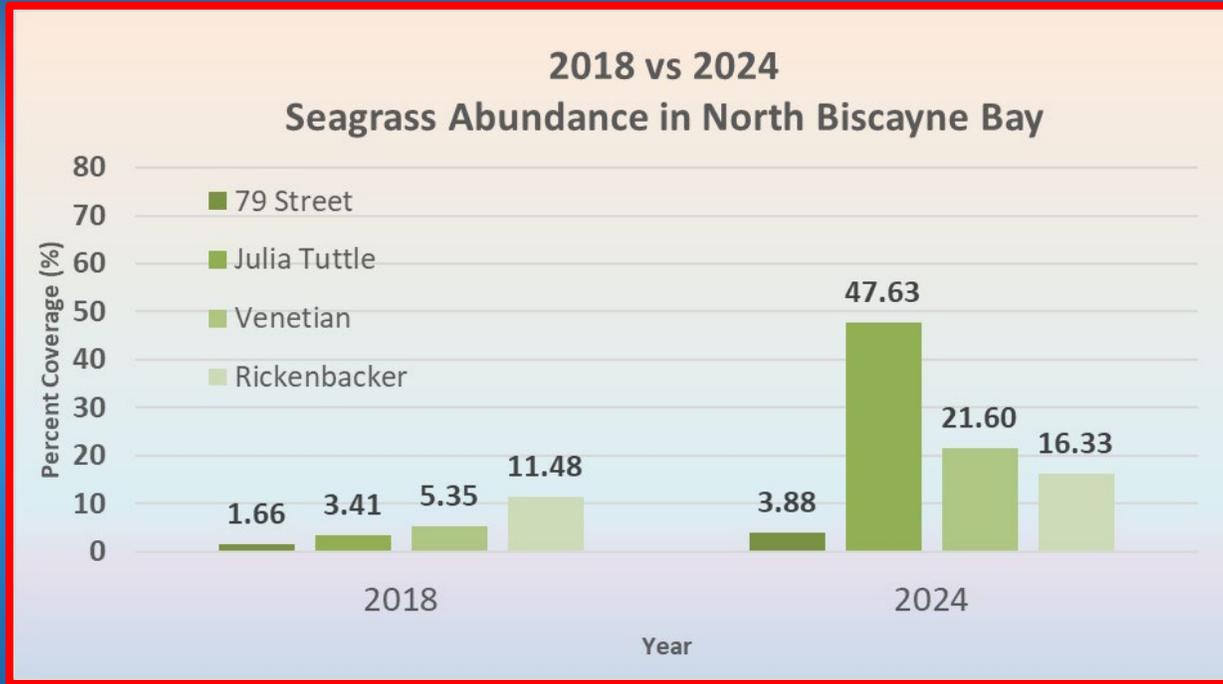
Seagrass – Green Macroalgae Abundance and Distribution (2018 vs 2024)



- Decrease on Total Green Macroalgae in North Bay, except in the 79 St Basin.
- TGO (*Caulerpa*) algae abundant in 79 St. Basin, although calcareous (*Halimeda*) remains the dominant TGA.

North Biscayne Bay: *Halimeda* Bloom Area.

Seagrass - Macroalgae Abundance and Distribution (2018 - 2024)



- 2018 vs 2024: Seagrass increase in all North Basins.
- Highest seagrass coverage in Julia Tuttle. **Shift from *Halimeda* to *Syringodium* as main SAV since 2023!**

Summary

- The southern area of Manatee Bay – Barnes Sound experienced moderate increases in *Thalassia testudinum* (2010 – 2017) following senescence of a *Synechococcus* phytoplankton bloom (2005-2008), although annual Chlorophyll-*a* concentrations remain higher than pre-event mean values. A second seagrass decline observed after 2017, following Hurricane Irma, led to green macroalgae increases and a shift to an algae dominated ecosystem by 2019. Record *Halodule* coverage and density levels were observed during 2024.
- In the *Anadyomene spp.* bloom area, dominance of algae over seagrasses has persisted since 2009. *Thalassia testudinum*, the main seagrass species in the area, remains low in coverage and hasn't recovered to pre-bloom values, while increases in coverage and density of *Halodule wrightii* has led to dominance shifts between these two seagrass species. Through the last two years, a resurgence of the *Anadyomene linkiana*, absent during the 2016-2022 period, combined with *Halimeda spp.* (primarily *H. macroloba*) expanded coverage, has fueled green algae increases back to blooming coverage values.
- North Biscayne Bay SAV coverage has been dominated by the genera *Halimeda* since 2018. Seagrass density (*Syringodium filiforme*) has steadily increased in the area signaling recovery from a die-off event, although density values at the area's fixed stations are still below pre-die-off levels. In the northern area (79 St. Basin), recent *Caulerpa* increases have contribute to the macroalgae coverage and may cause future seasonal blooms.

Acknowledgements

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