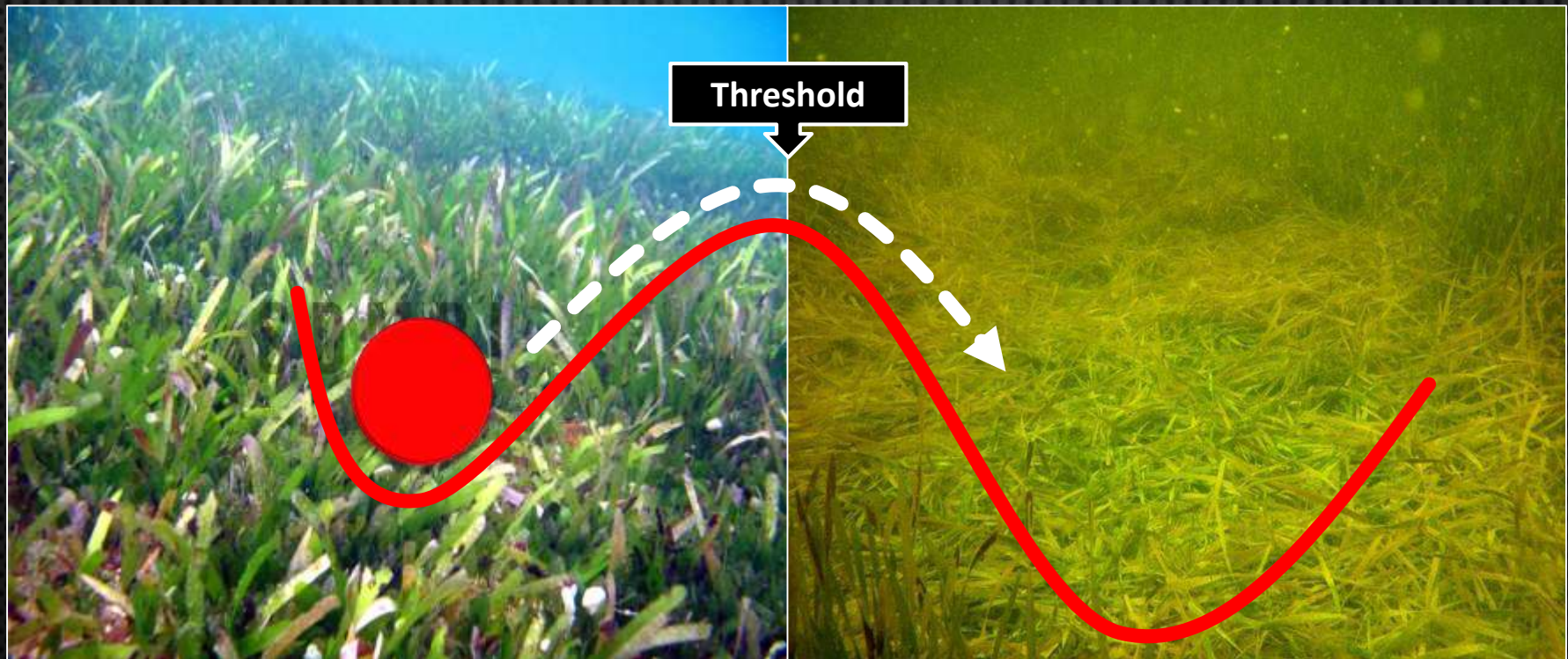


# Ecological Resilience and Regime Shifts: Evidence for Human and Climate Impacts on Coastal Ecosystems



Session Organizers: Anna Wachnicka<sup>1</sup> & Lynn Wingard<sup>2</sup>



<sup>1</sup>Florida International University, Miami, FL, USA

<sup>2</sup>U.S. Geological Survey, Reston, VA, USA

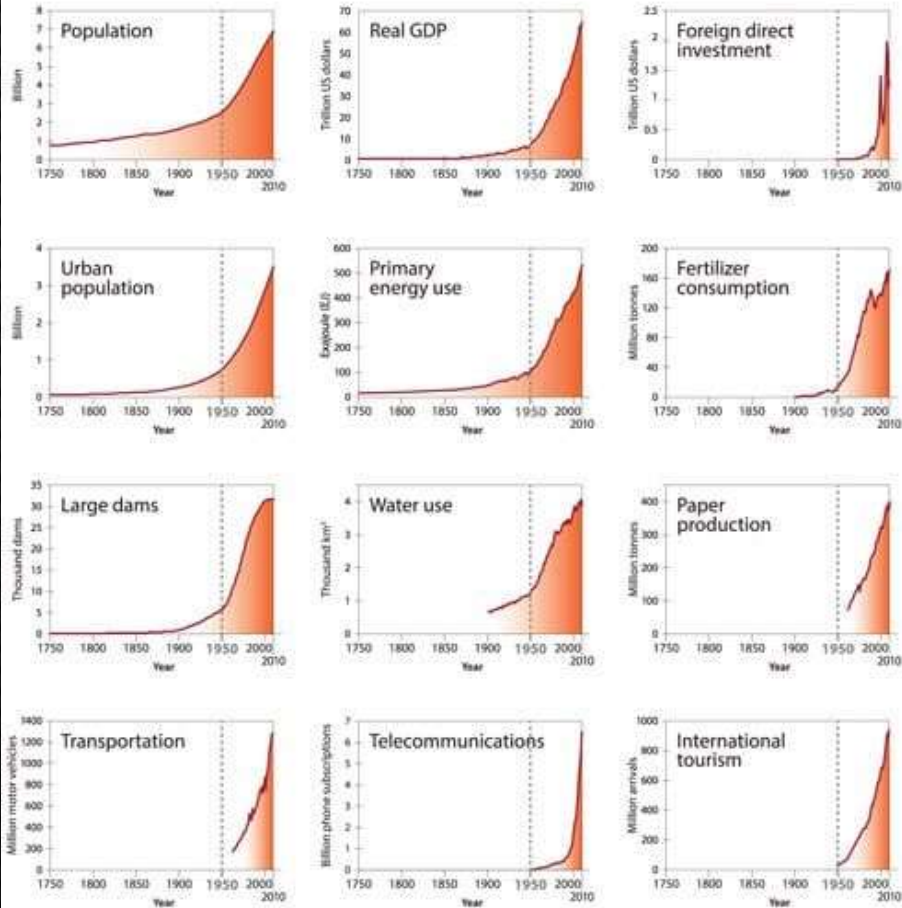


# Session Goals

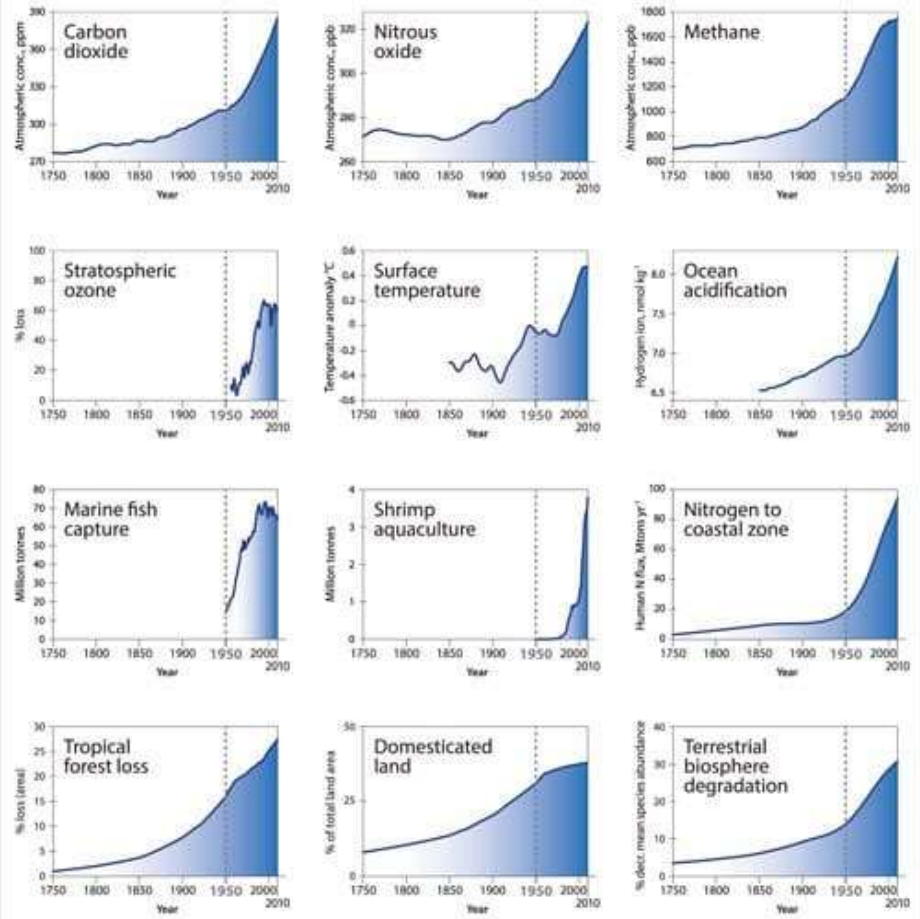
- *Explore advances in our understanding of ecological resilience and the history of regime shifts in coastal and marine ecosystems in South Florida*

# "The Great Acceleration"

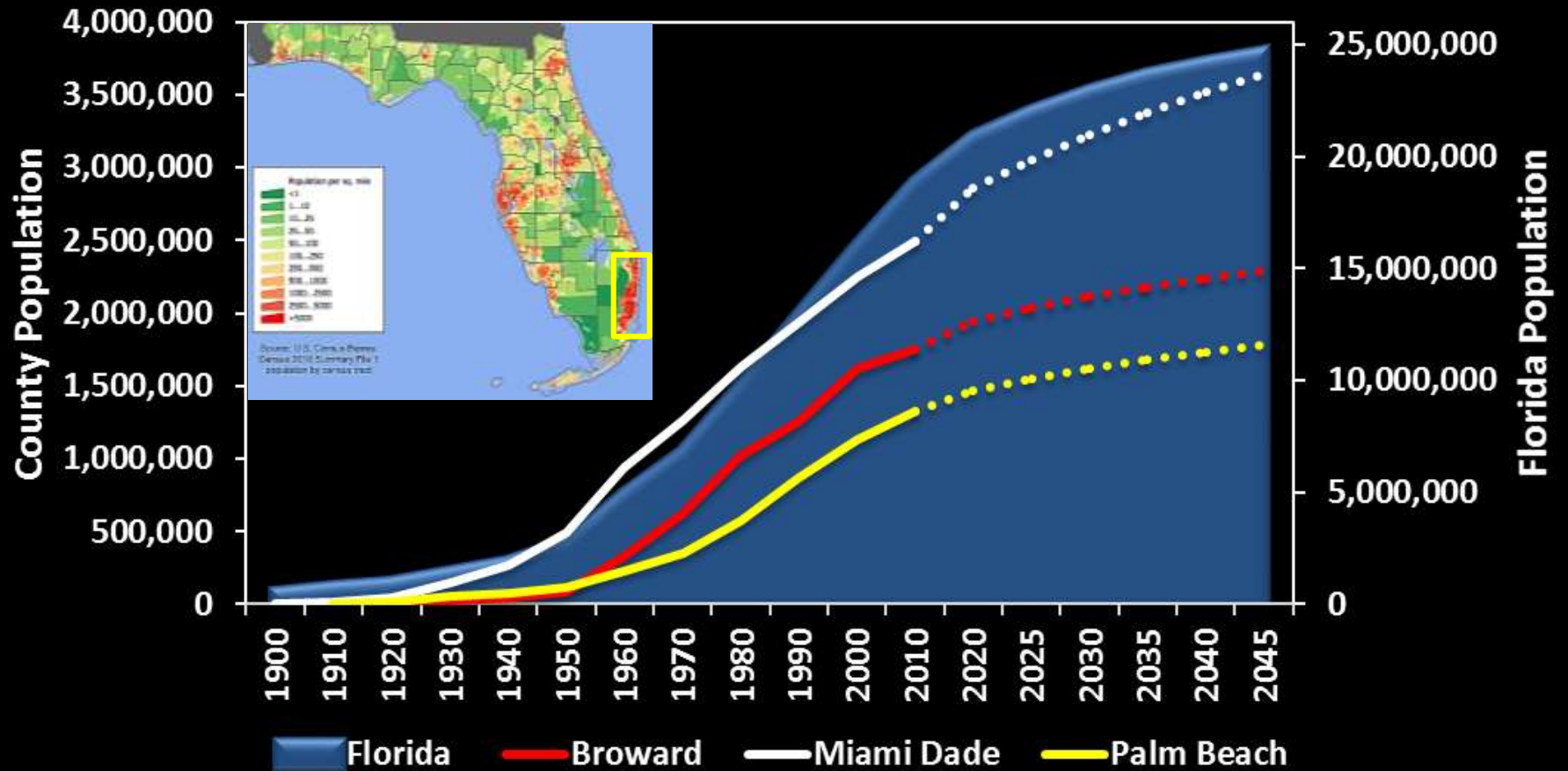
## Socio-economic trends



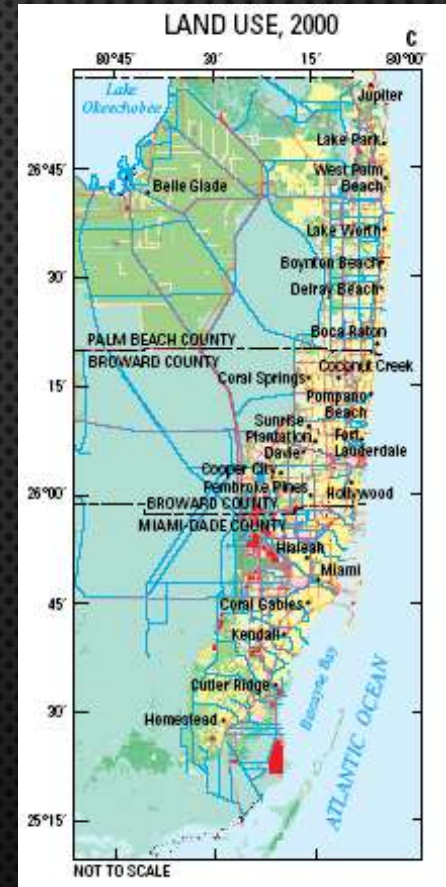
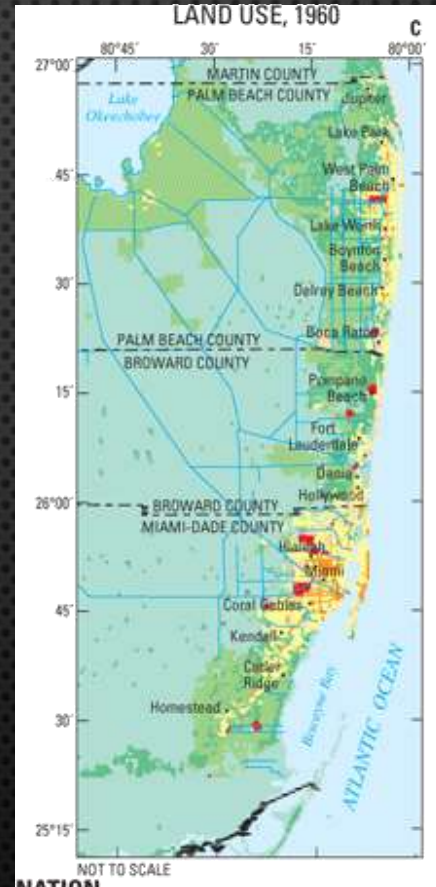
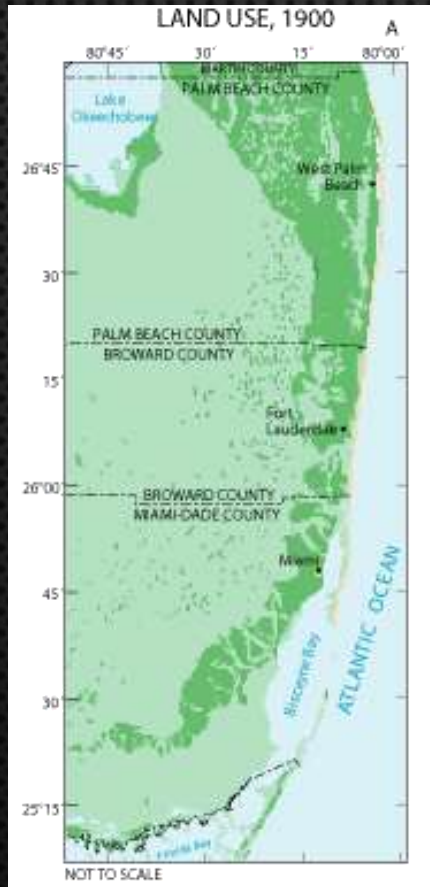
## Earth system trends



# Florida Population Growth



# Changes in Land Use

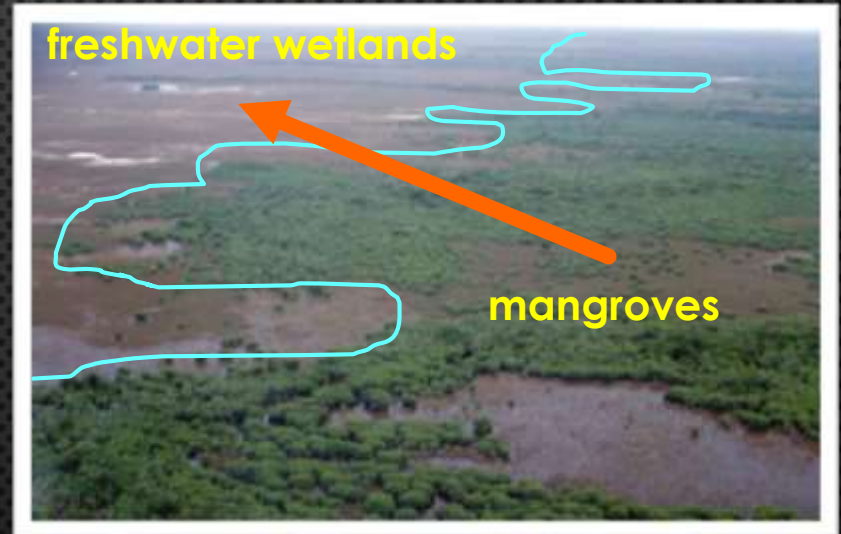
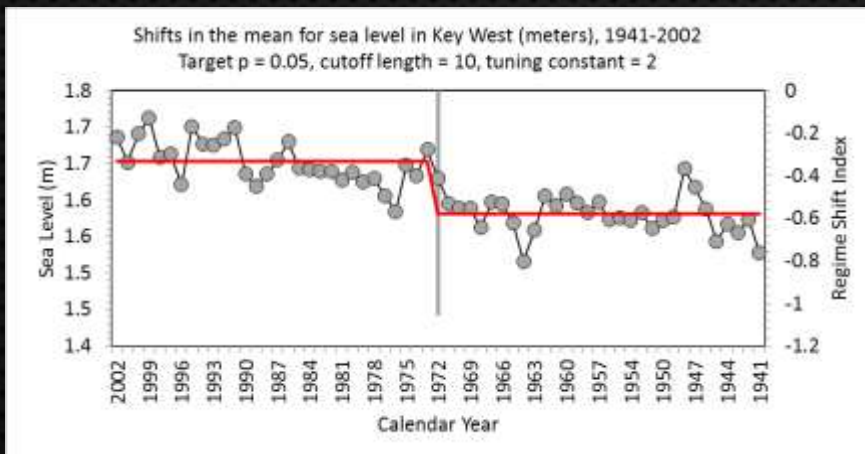
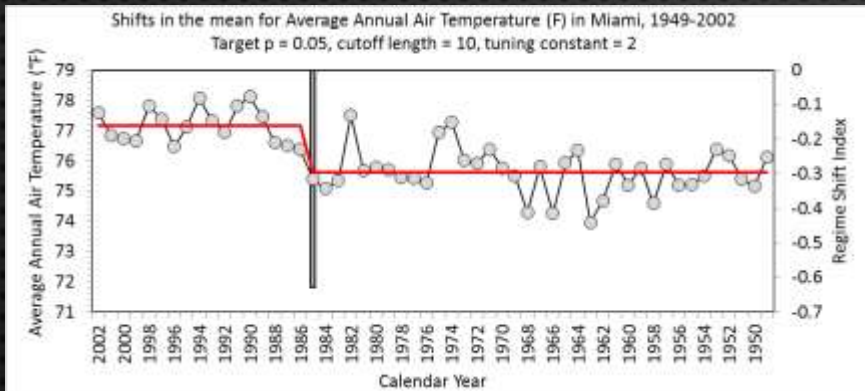
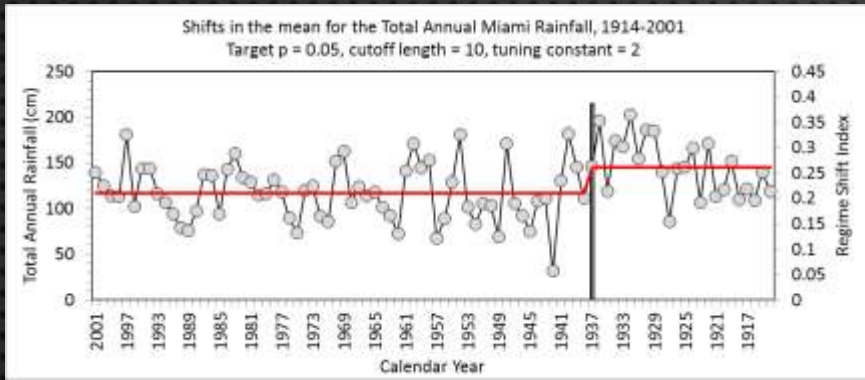


1900

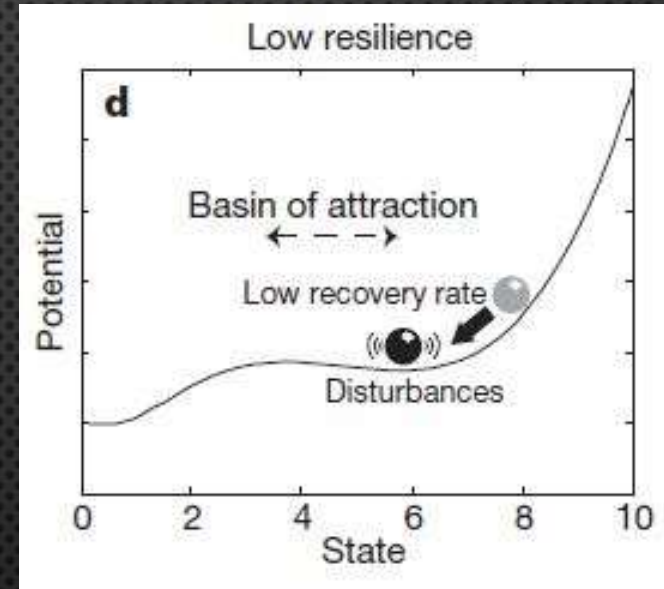
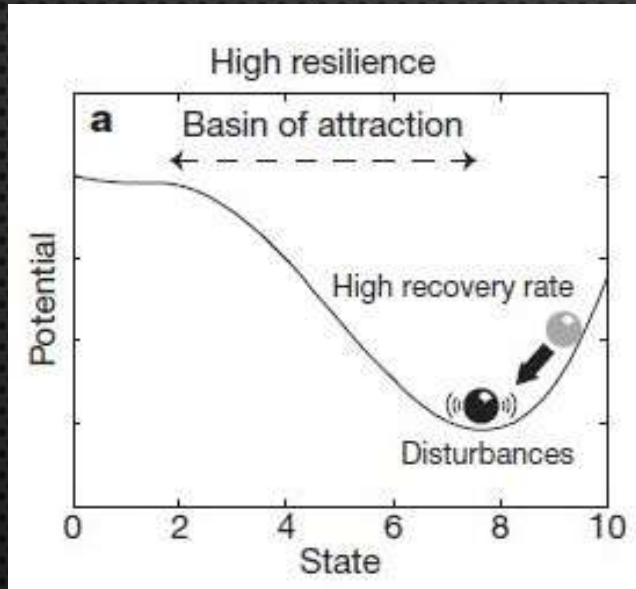


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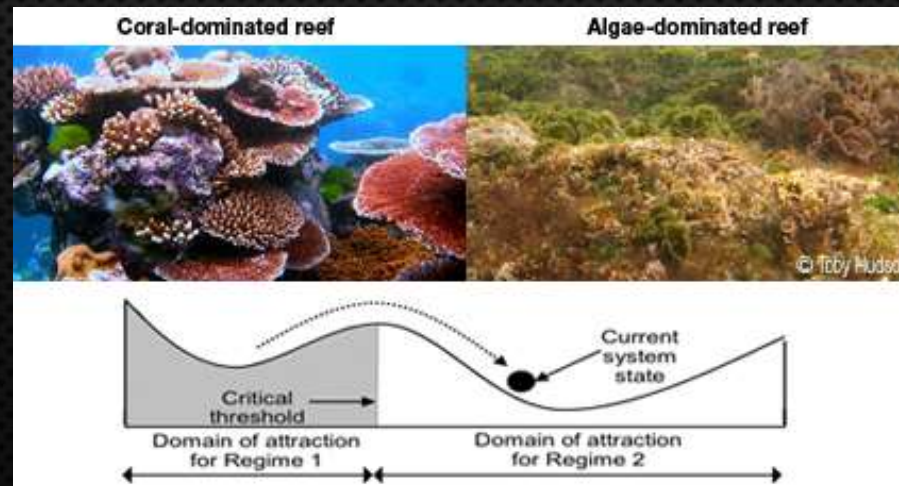
# Climate Change Impacts on Coastal and Estuarine Ecosystems



# Natural & Anthropogenic Changes Make Ecosystems More Vulnerable To Abrupt Ecological Regime Shifts



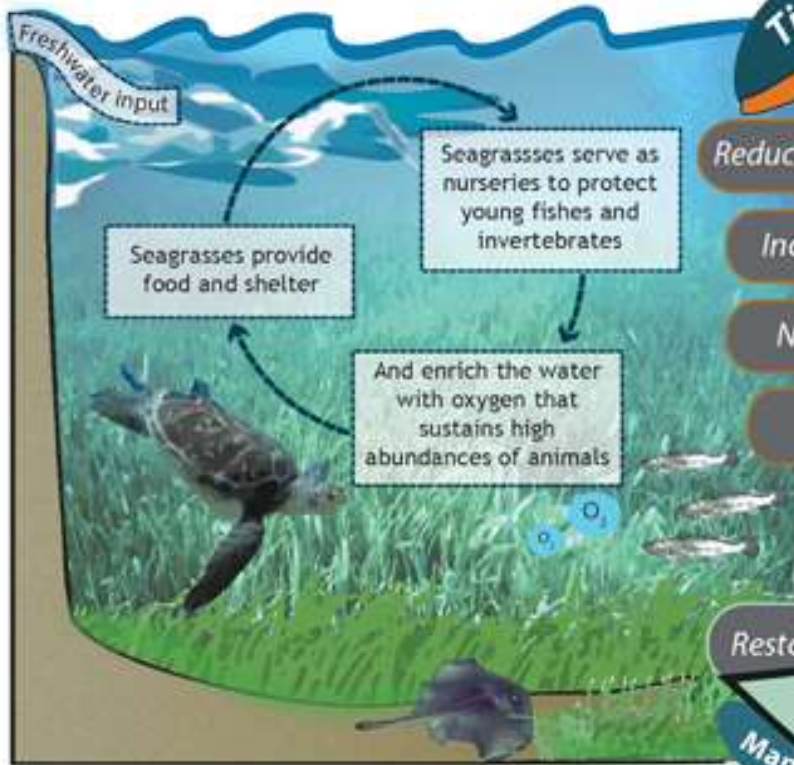
Source: Scheffer et al. 2009



Source: Foley et al. 2015

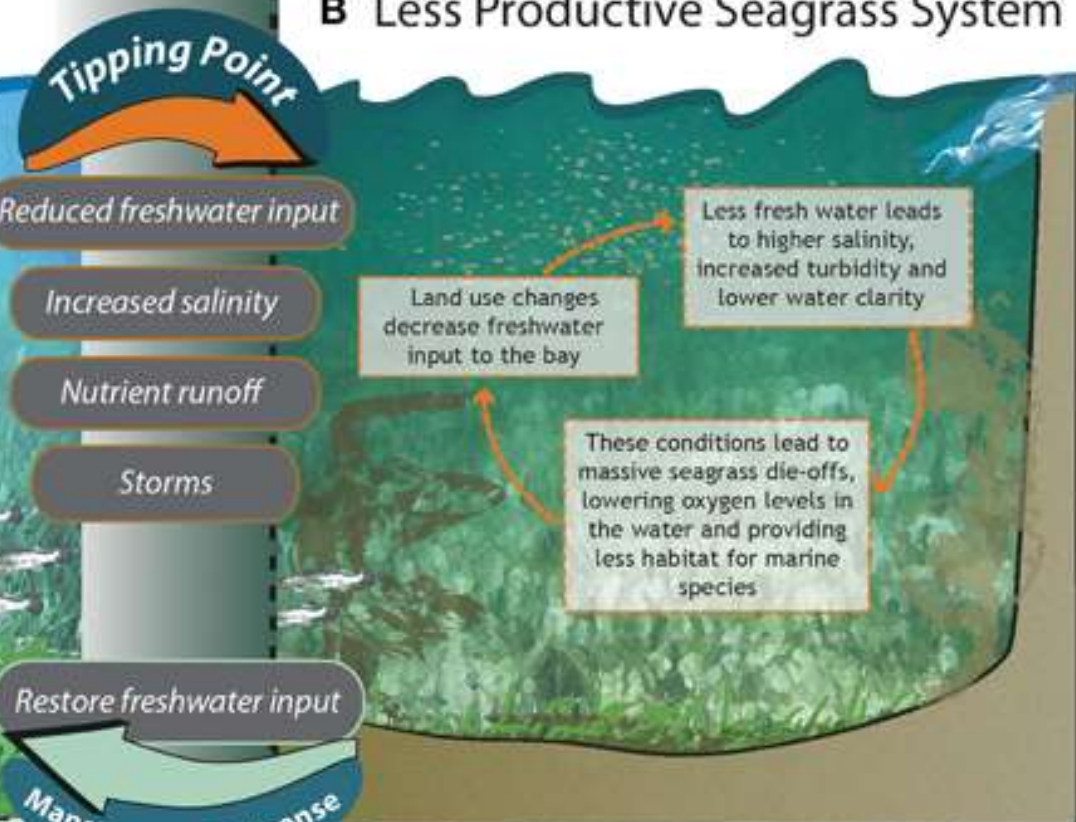
# FLORIDA BAY SEAGRASSES

## A Seagrass-dominated System



Productive seagrass ecosystems rely on specific water qualities in salinity, water clarity and the presence of important grazers to maintain high abundance of species

## B Less Productive Seagrass System



The reduction in freshwater input led to unfavorable water quality conditions for seagrasses and resulted in a less productive and less diverse ecosystem



# Detecting Signs Of Impending Large-Scale Ecological Regime Shifts In South Florida Estuaries Through The Lens Of Paleoecology

Anna Wachnicka<sup>1</sup> & Lynn Wingard<sup>2</sup>



<sup>1</sup>SERC Florida International University, Miami, FL, USA

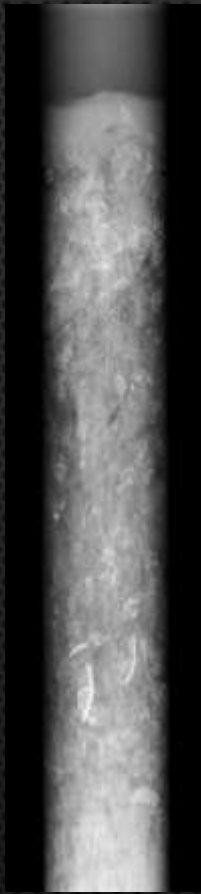
<sup>2</sup>U.S. Geological Survey, Reston, VA, USA



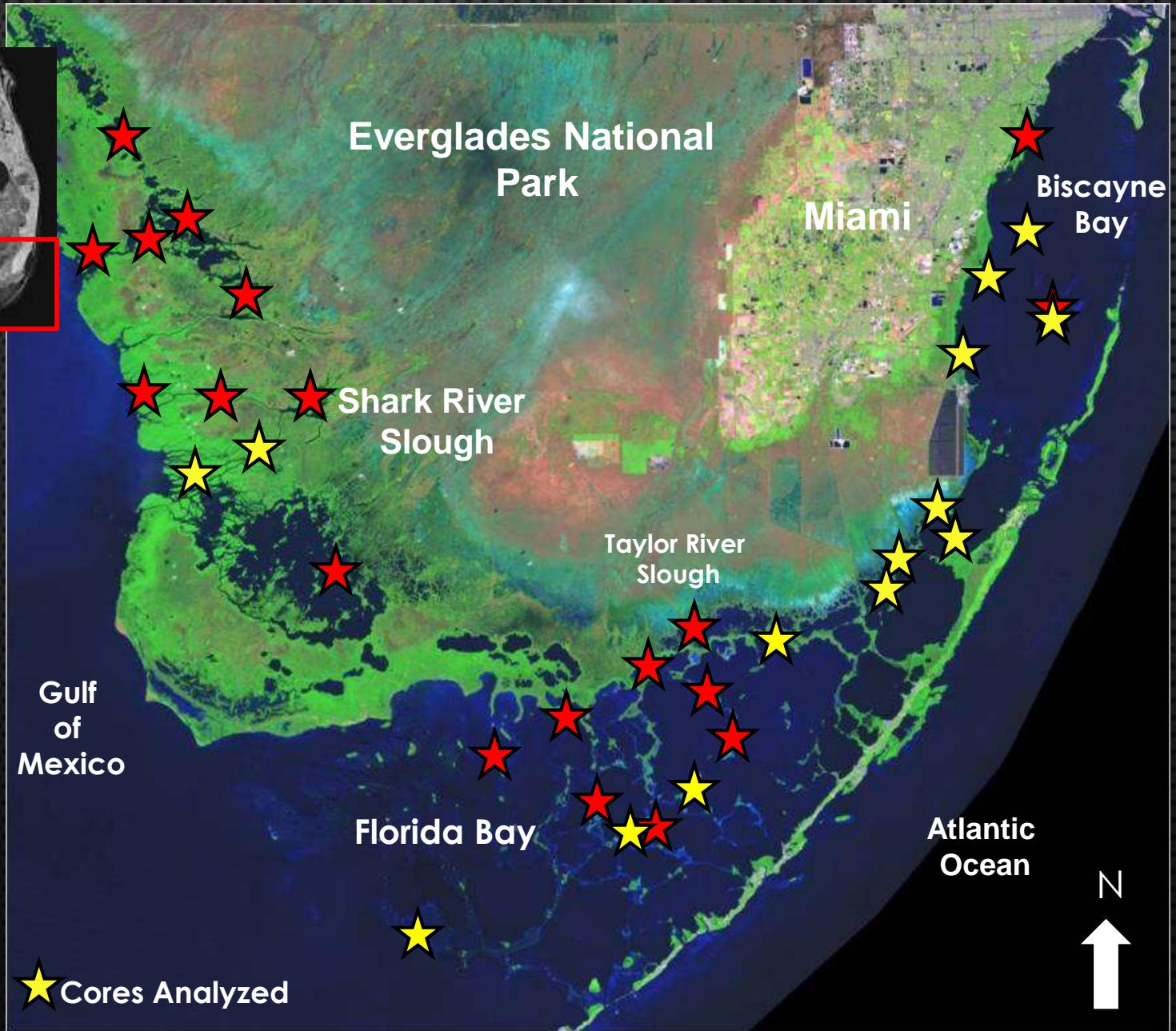
# How Can Paleoecology Help Us Understand The Dynamics Of Regime Shifts In South Florida Estuaries ?

- Identify the existence of ecological thresholds and long-term environmental processes leading to resilience loss & regime shifts
- Detecting frequency & duration of regime shifts between alternative states at timescales not accessible in the observed record
- Detecting changes in magnitude of variability of ecosystems
- Understand the contemporary and predict future biotic responses to climate change & anthropogenic stressors

# Coring Locations

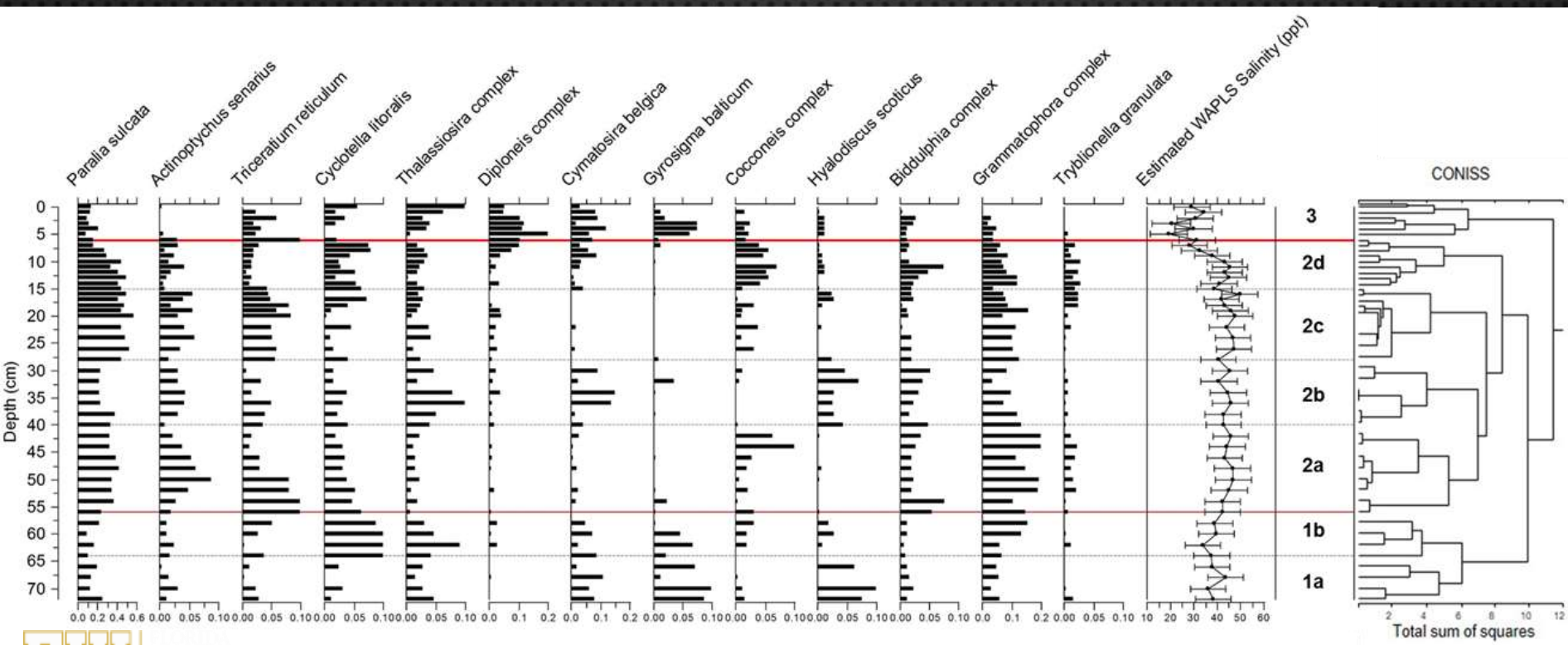
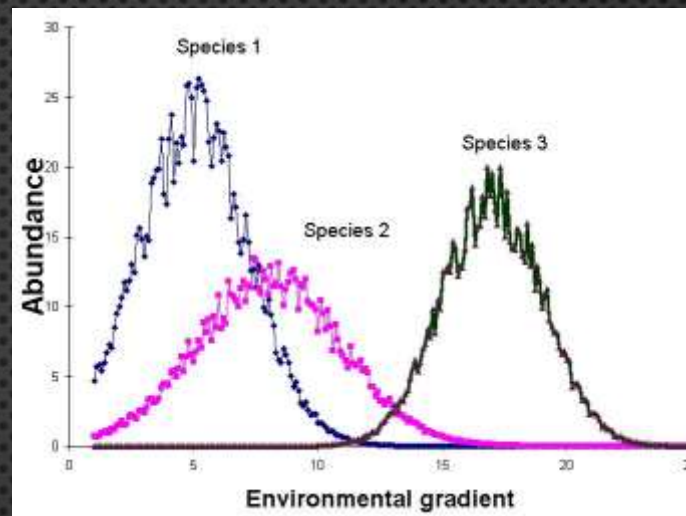
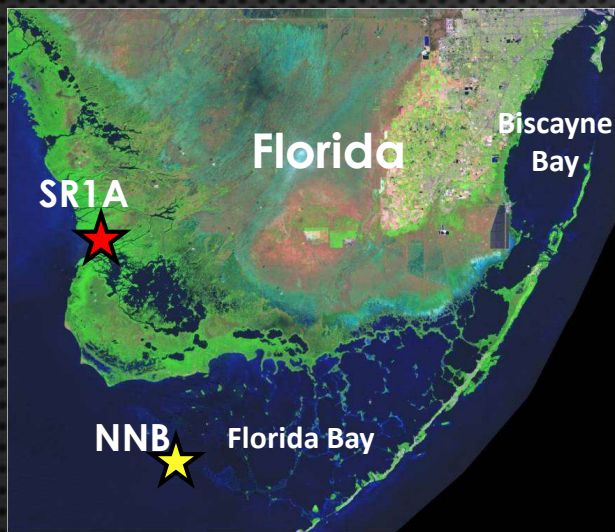


Core  
CAT-scan



★ Cores Analyzed

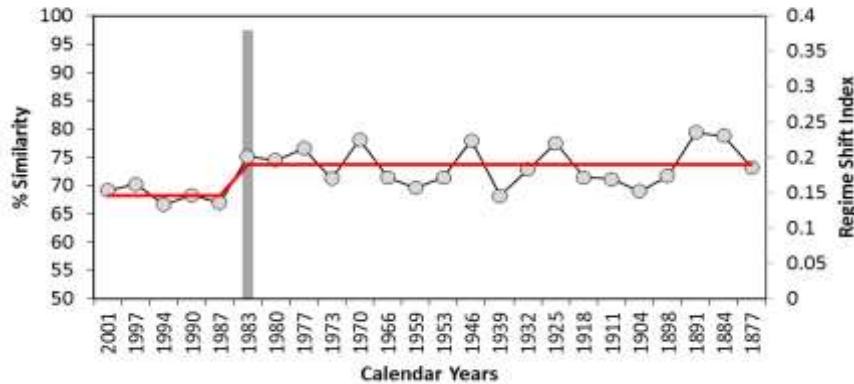




# Regime Shifts in Mean of % Assemblage Similarity in No Name Bank (NNA), Card Sound Bank (CBA) & Trout Cove (TC) Cores

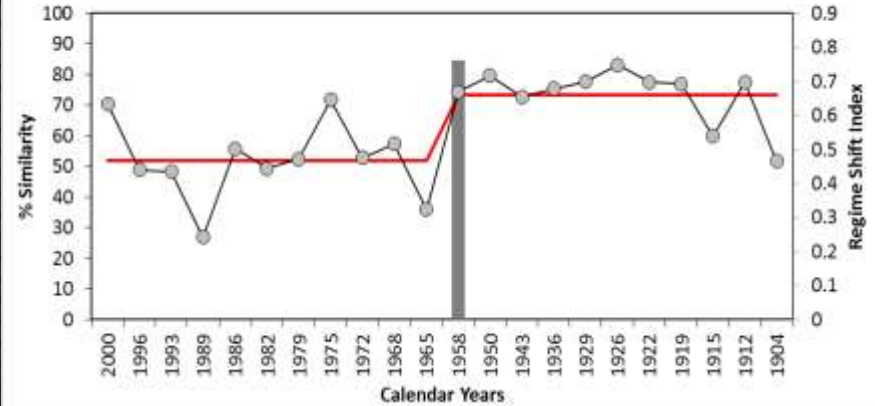
**NNA**

Shifts in the mean similarity (%), 1877-2001  
Target  $p = 0.05$ , cutoff length = 5, tuning constant = 2



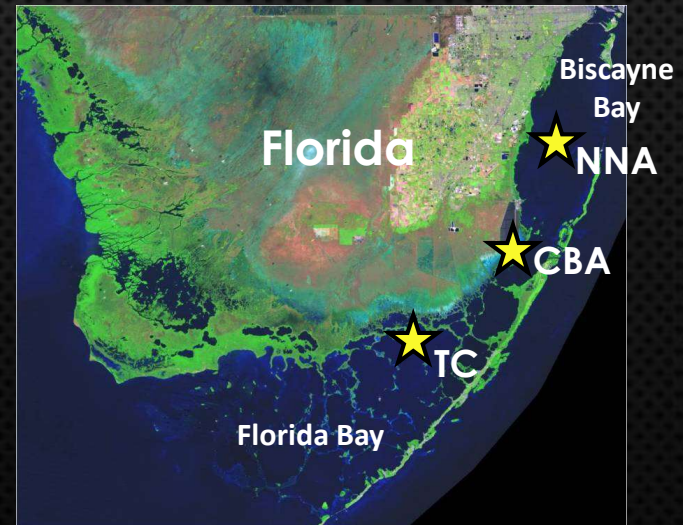
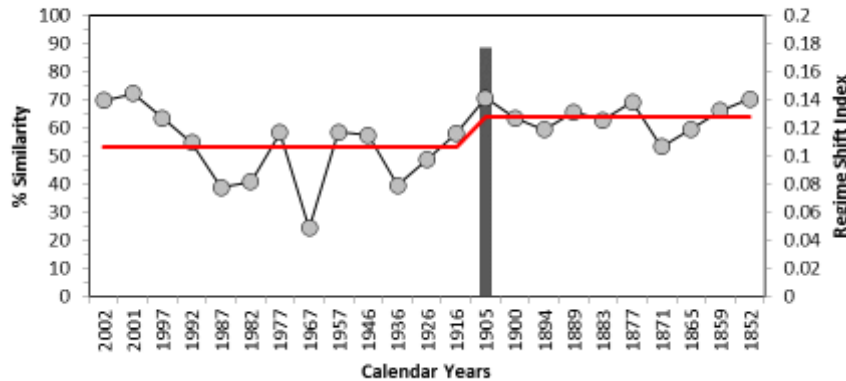
**TC**

Shifts in the mean similarity (%), 1903-1999  
Target  $p = 0.05$ , cutoff length = 10, tuning constant = 2

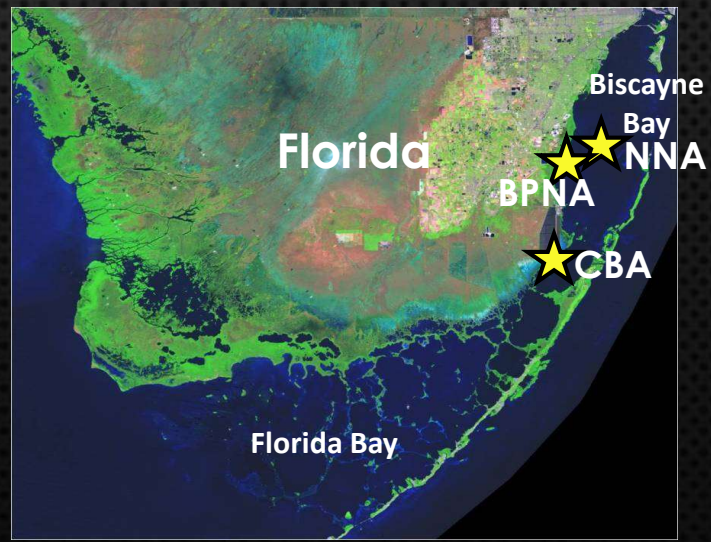
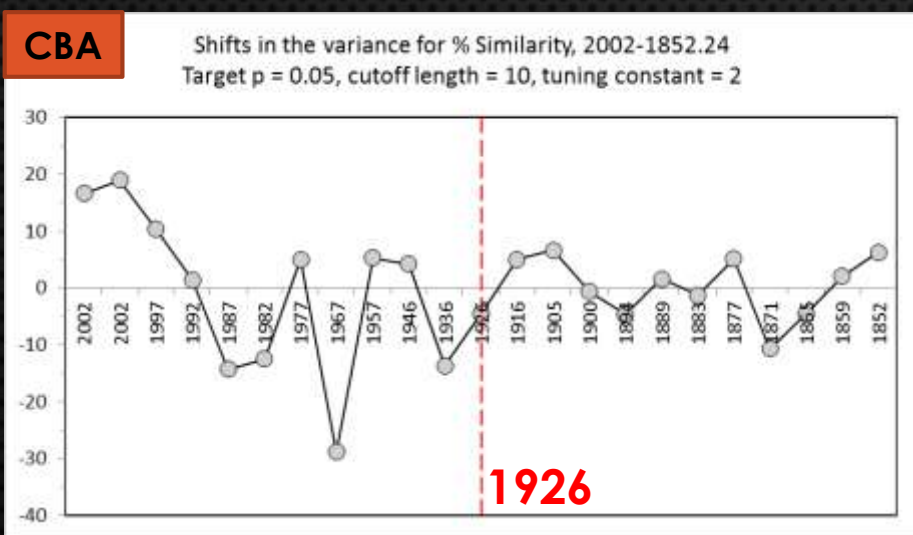
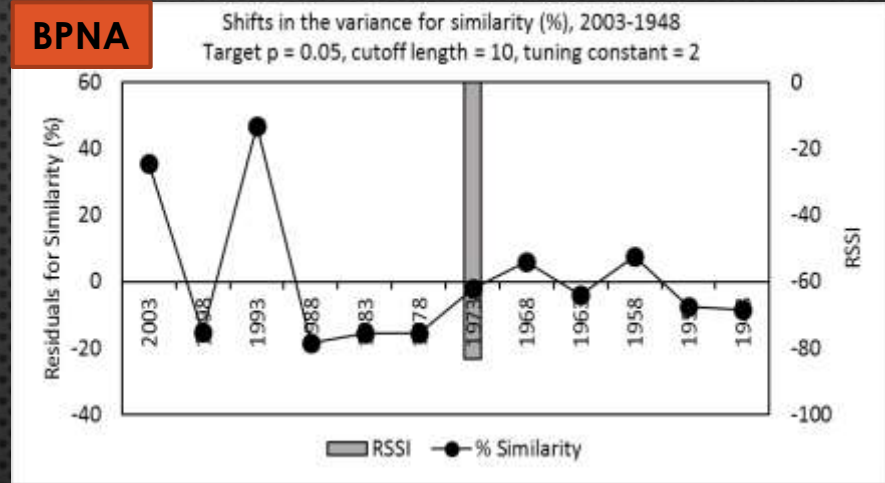
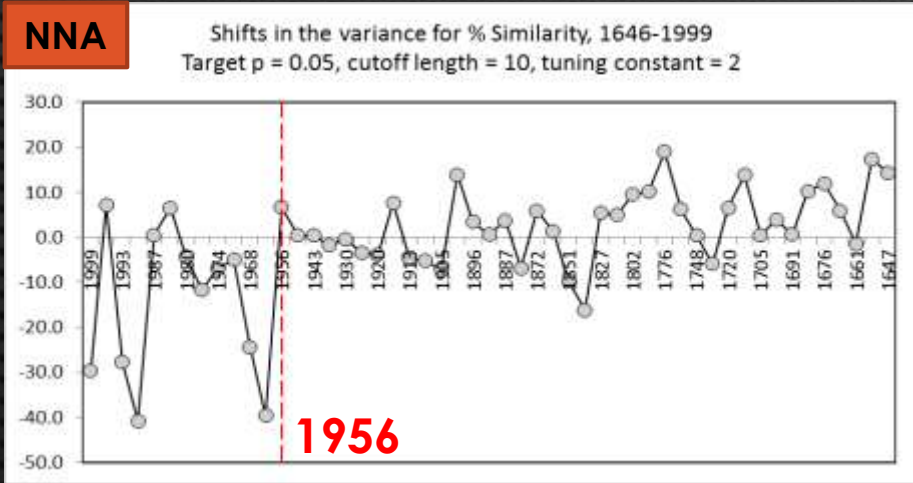


**CBA**

Shifts in the mean for % Similarity, 1852-2002  
Target  $p = 0.05$ , cutoff length = 10



# Regime Shift in Variance of % Similarity in No Name Bank, Black Point & Card Sound Bank Cores



# Factors Affecting Biscayne Bay Ecosystem

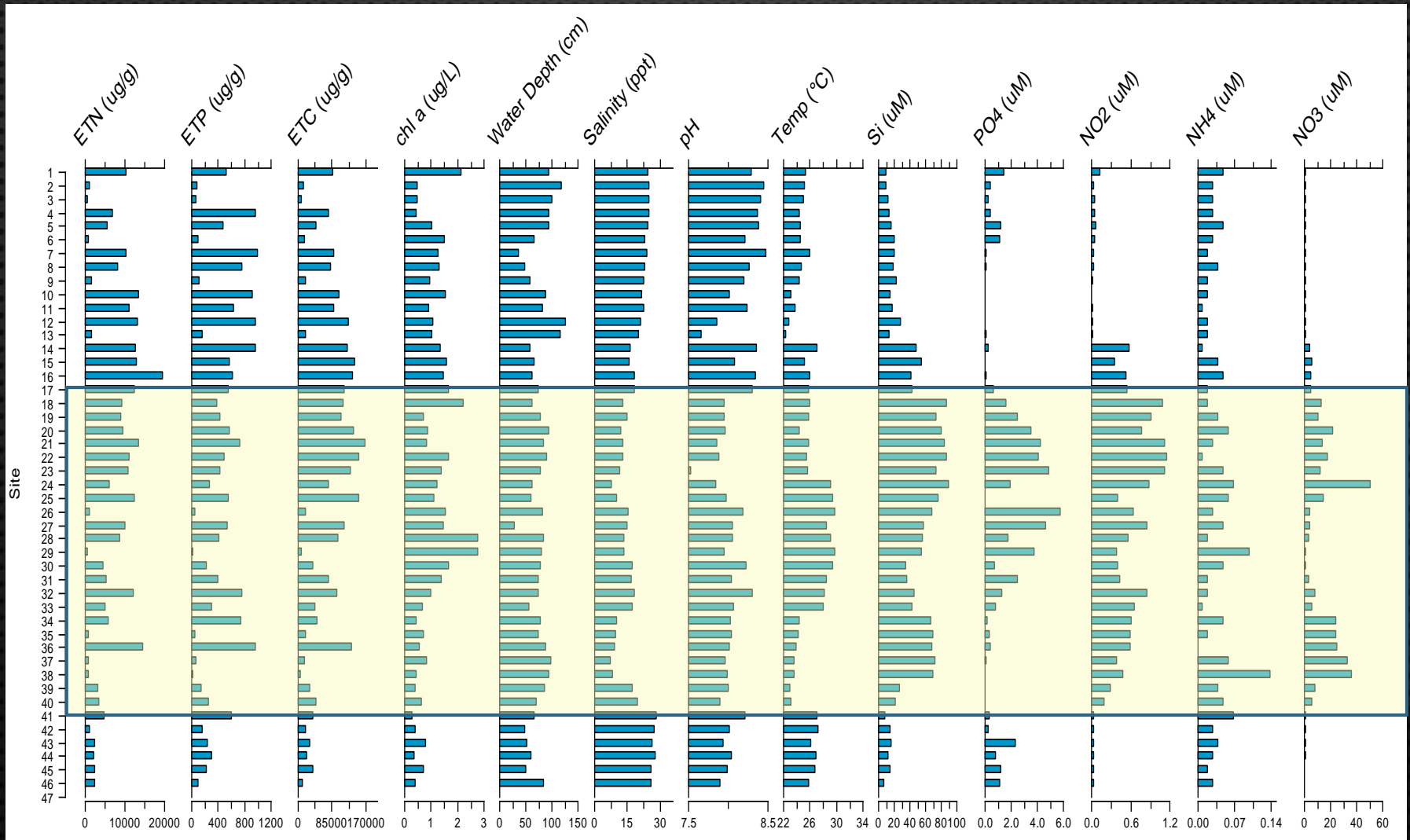


- Habitat loss (e.g., SAV)
- Shift in community composition
- Micro- & Macroalgal blooms (nearshore areas)
- Deteriorated water quality
- Saltwater encroachment
- Altered water circulation & residence time

**Drivers of Change**

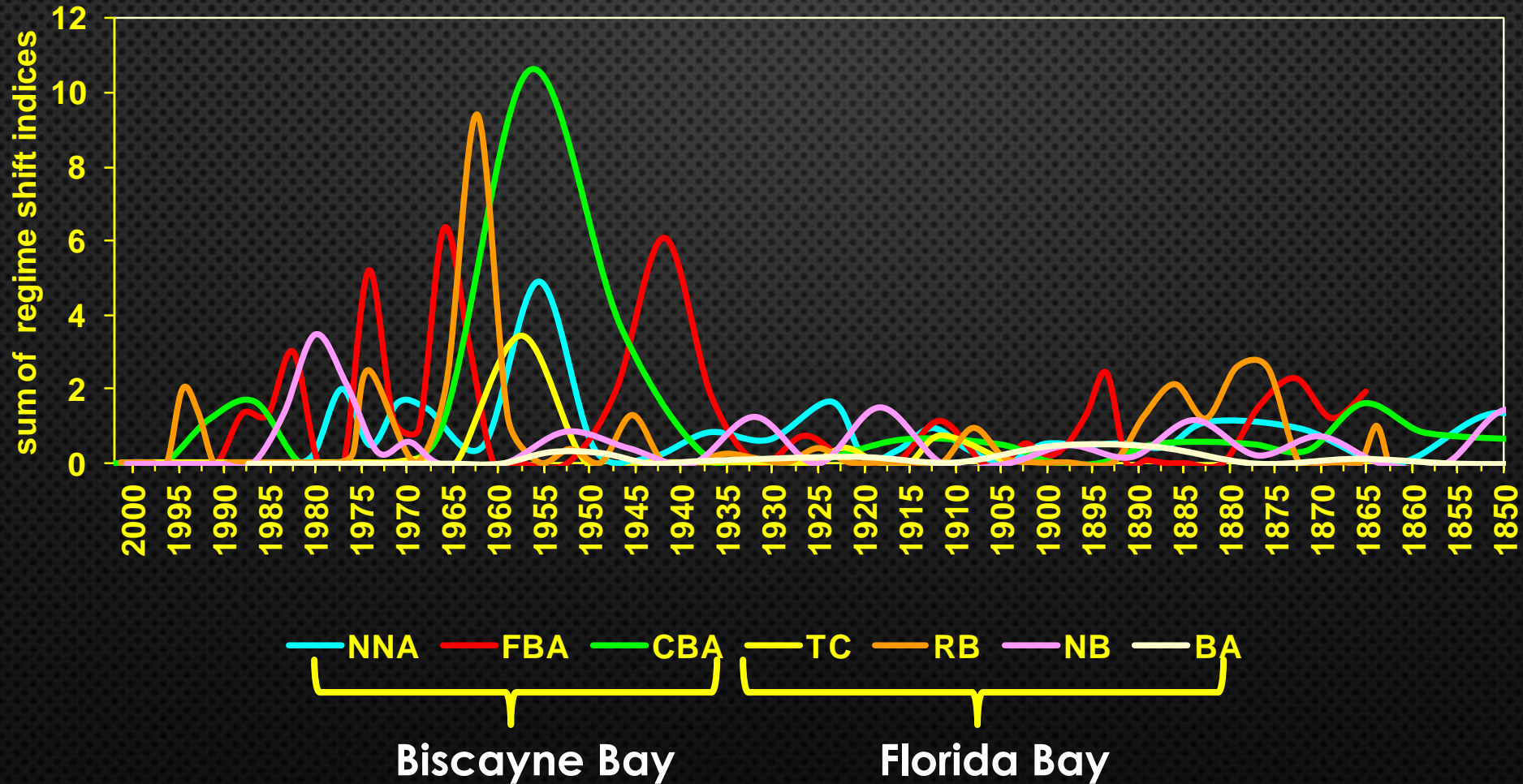
**Impacts**

# Cumulative Sums Of Standardize Anomalies Of Epiphytic Diatom Compositional Similarities In Biscayne Bay

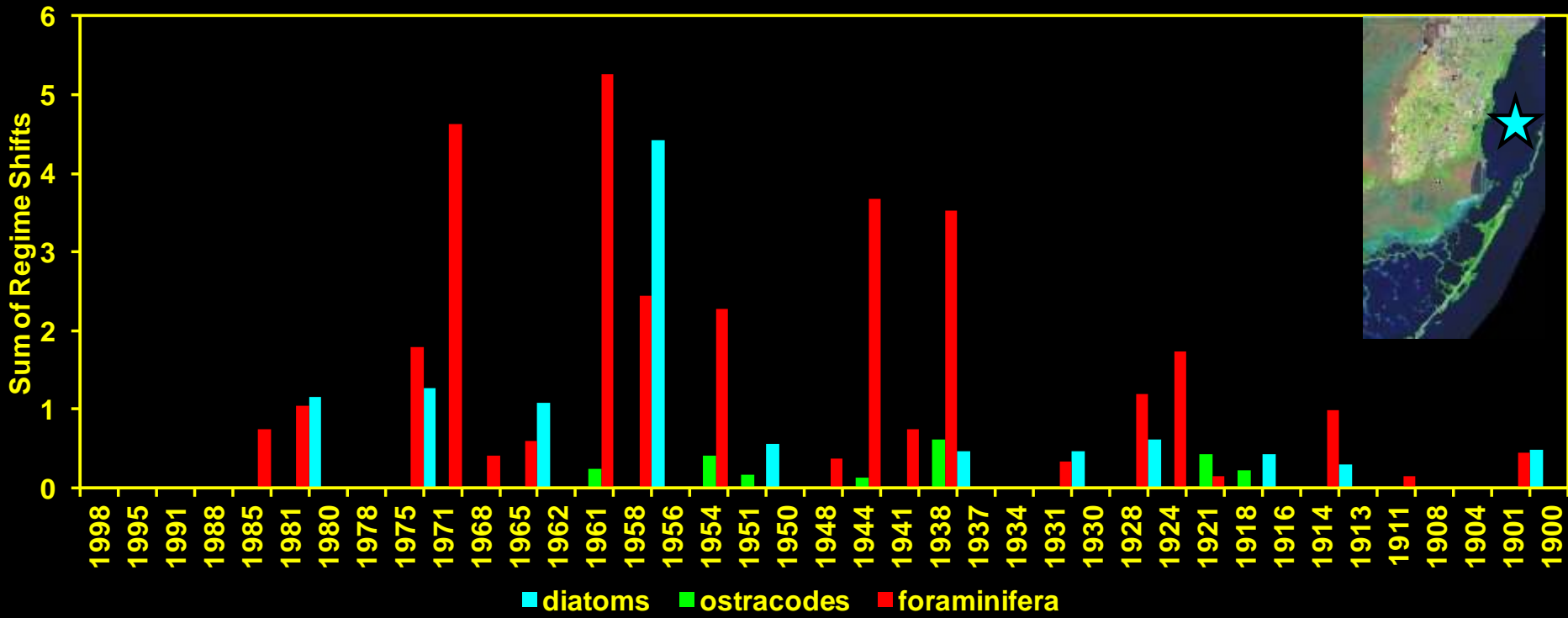




# Major Restructuring of Diatom Assemblages Florida Bay & Biscayne Bay



# Microbenthic Community Responses to Environmental Change, Featherbed Bank (Biscayne Bay)



# Major Shifts In Microbenthic Assemblages In South Florida Cores

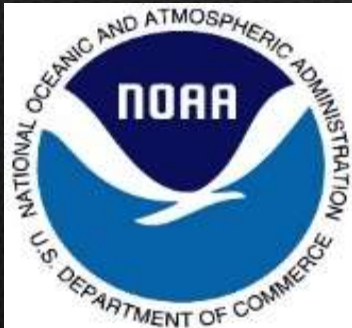


# Conclusions

- 1. Nearshore areas of Biscayne Bay and NE Florida Bay, which are directly exposed to perturbations, showed larger and more frequent changes in the structure of diatom assemblages compared to distant bay locations**
- 2. Significant increase in variance in % assemblage similarity was recorded at sites in Central Biscayne Bay, which may signal impending ecological regime shift in nearshore ecosystems in this region**
- 3. The timing and magnitude of the changes varied among the coring locations, because the timing of occurrence of disturbances in different regions of the bays also varied**

# ACKNOWLEDGMENTS

## Project Sponsors & Collaborators



## Technical Assistance

