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



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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"

Earth system trends Socio-economic trends 390 1600 25 i da Carbon 321 Nitrous Methane 숺 8 1600 Real GDP Population Foreign direct 60 dioxide oxide 360 1400 50 investment 300 \$ 15 40 2 130 1250 Articles of ŝ ŝ 30 1000 200 300 30 800 65 10 170 268 600 1850 1900 1950 2000 2010 . 'n 1850 1900 1958 2000 1750 1800 1850 1900 1950 2000 1750 1800 1750 1800 1800 1850 1900 1950 2000 1850 1900 1950 2000 1800 1850 1900 1950 2000 2010 1750 1750 1800 1750 2010 2010 Year Vear Vear 2010 3018 Veine Venie Vear -64 600 200 μ Surface Stratospheric Ocean 64 2 6.0 Urban Primary Fertilizer 80 500 ŝ temperature acidification 140 ozone population energy use consumption 6.2 5 400 16 (5 73 120 \$ 100 80 -0.2 \$ 7.0 200 20 -64 40 100 4.5 -0.5 0 11 8 1250 1800 1850 1900 1950 2000 1750 1800 1850 1900 1950 2000 1750 1800 1850 1900 1950 2000 1758 1800 1850 1900 1950 2000 1750 1600 1850 1900 1950 2000 1750 1800 1850 1900 1950 2000 2010 2010 2010 Year Year Veal 2010 2010 2010 Year Year Year -Shrimp Marine fish 70 Nitrogen to Large dams Water use 800 Paper 30 60 aquaculture coastal zone capture production 25 50 μų 100 100 20 40 Million to 3 15 2 200 30 -80 Ž 20 10 30 100 10 0 1750 1500 1850 1900 1950 2000 1750. 1800 1850 1900 1950 2000 1750 1600 1850 1900 1950 2000 1800 1850 1900 1950 2000 1800 1850 1900 1950 2000 1750 1750 1800 1850 1900 1950 2000 1750 2010 2010 2010 5010 2010 5010 Year Year Year Vale Vent Vest 1410 Tropical Domesticated Terrestrial Telecommunications \$ 1300 Transportation International 25 800 forest loss land biosphere 1000 tourism T 20 1 otal land degradation \$00 800 Witess (an 15 25 800 400 10 400 200 \$ 300 'n . n. . Teop 1650 1900 1950 2000 1900 1950 2000 1750 1800 1850 1900 1950 2000 1750 1800 1850 1750 1750 1800 1850 1900 1950 2000 1750 1800 1850 1900 1950 2000 1750 1800 1850 1900 1950 2000 2010 2090 2010 2010 Year 2010 2010 Year Year Year Year Year.

Source: Steffen et al. 2011

Florida Population Growth



Changes in Land Use



1900

Source: https://sofia.usgs.gov

2000







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

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

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

- Identify the existence of ecological thresholds and longterm 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





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



Wachnicka and Wingard, 2017

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



CBA

30.0

20.0



Shifts in the variance for % Similarity, 2002-1852.24 Target p = 0.05, cutoff length = 10, tuning constant = 2





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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

Impacts

Drivers of Change



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





Major Restructuring of Diatom Assemblages Florida Bay & Biscayne Bay





Wachnicka & Wingard, 2017 Wingard et al. 2017

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







Wachnicka & Wingard, 2017 Wingard et al. 2017

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













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Technical Assistance

