Climate Change Projected Effects on Coastal Foundation Communities of the Greater Everglades Using a 2060 Scenario: Need for a New Management Paradigm

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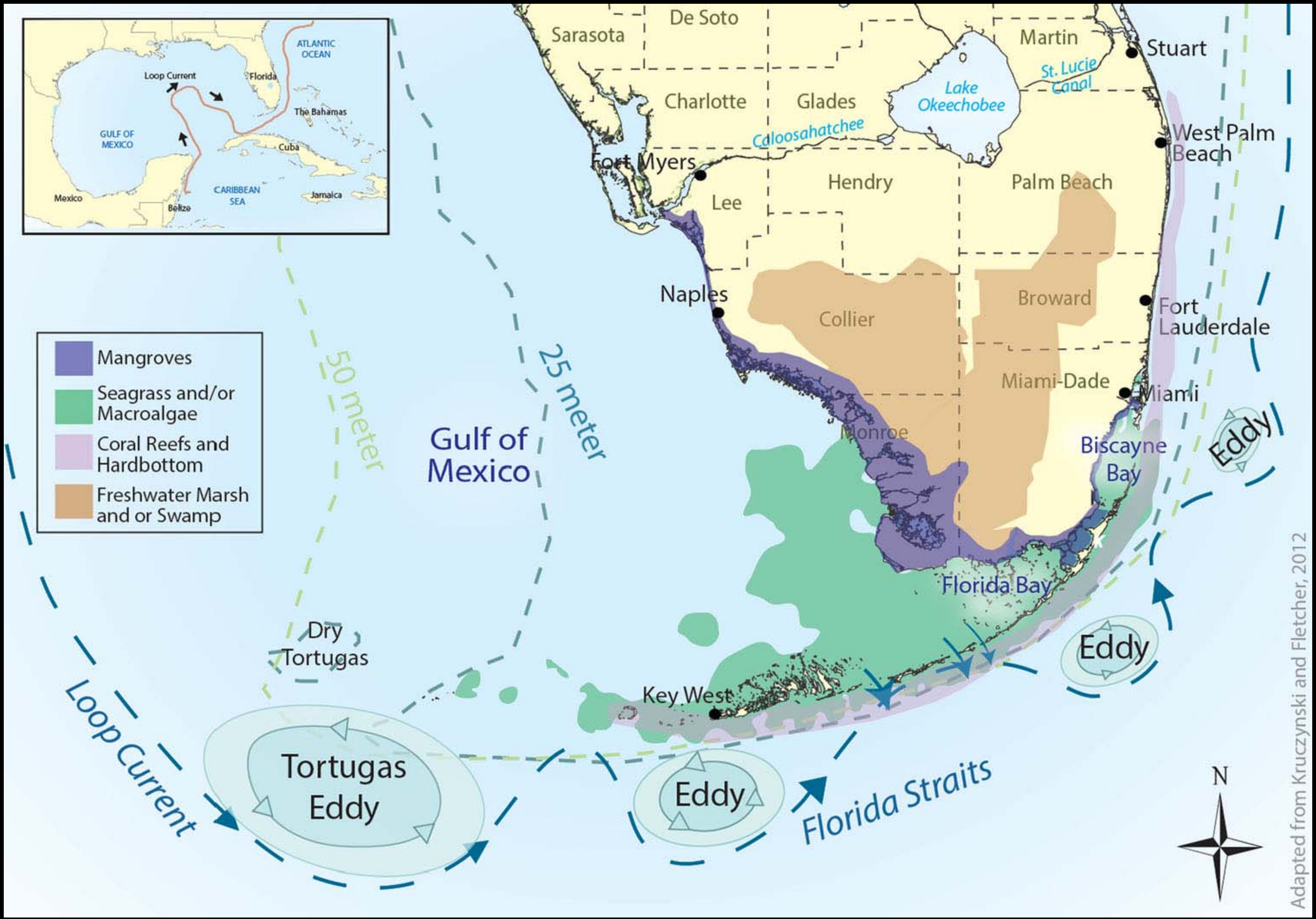
OUTLINE

I. Greater Everglades Coastal Foundation Communities
II. 2060 Climate Change Scenarios Examined
III. Synthesis of Community Response to Drivers
IV. Conclusion/Recommendations
    1. NEED FOR A NEW MANAGEMENT PARADIGM
    2. Cross-System Research, Monitoring, Management
    3. Active Management

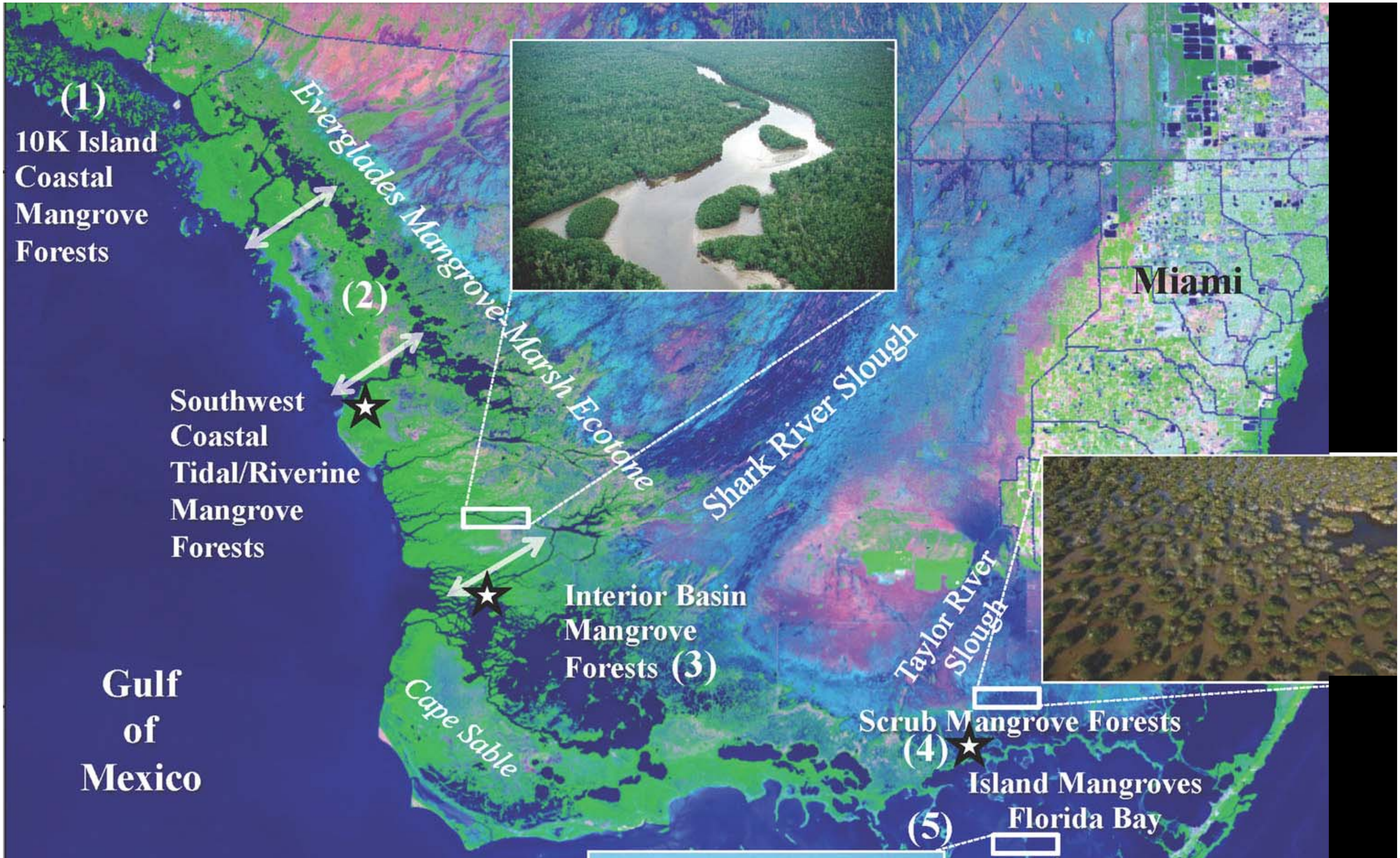
GREATER EVERGLADES' COASTAL MARINE FOUNDATION COMMUNITIES

THREATS TO TRANSGRESSIVE BOUNDARIES (CLIMATE AND SEA LEVEL RISE)



Specific Future Climate Scenarios (2060)

I. 1.5 Foot SLR Increase (9.5 mm y^{-1})
II. +1.5 ^{o}C Temperature Increase
III. 490 ppm CO_2
IV. +/- 10% Change in Precipitation



I. Greater Everglades' Mangrove Communities

II. Greater Everglades' Seagrass, Macroalgae (Mudbanks in FL Bay)
III. Reef Communities

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Foundation Community	Effect	Strength	Direct	Summary/Comments	Confidence (L,M,H)
Sea Level Rise (46 cm)					
Mangrove	(-)	3	D	• Everglades' forest elevation change < 3 mm y^{-1} • Storm surge, salt intrusion and loss of peat	• MH • LM
Seagrass/ Macroalgae	(-)	2-3	I	• Wetland and mudbank erosion/nutrient flux leads to low light • Shift seagrass to phytoplankton system under low light conditions	• L • L
Coral Reefs	(-)	2-3	I	• Water quality ↓ with wetland & mudbank erosion and Gulf/FL Bay/Reef connection	• L

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Foundation Community	Effect	Strength	Direct	Summary/Comments	Confidence (L,M,H)
Temperature Rise (+1.5°C)					
Mangrove	(-/0)	1-2	D-I	• Optimal temperatures ↓ (25-30 °C) • High thermal tolerance (~40°C) • High temperature can ↑ soil salinity • Thermal and salinity stress ↓ root production important counter ↑ sea levels	• M • M • H • LM
Seagrass/ Macroalgae	(-)	1-2	D-I	• Long water residence time FL Bay - ↑ temperatures (36-40°C) at thermal limits • Hypersalinity (60-70 psu) with ↑ temp • Greater exchange with sea level rise may ameliorate this temperature/salinity stress • Hypoxia & toxic sulfides sediments ↑ with ↑ temp	• H • H • L • H
Coral Reefs	(-)	3	D-I	• Currently at thermal limits - ↑ bleaching • Decadal decline in reef building corals in Florida and wider Caribbean region • Increased coral disease with ↑ temperature • Species-specific resilience	• H • H • MH • LM

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Foundation Community	Effect	Strength	Direct	Summary/Comments	Confidence (L,M,H)
Increase Atmospheric CO_2 (490 ppm)					
Mangrove	(+/0)	1	D	• Increased CO_2 ↑ photosynthesis if CO_2 limited • Increase above and below-ground production	• L • L
Seagrass/ Macroalgae	(+/-/0)	1-2	D/I	• Some seagrass/fleshy macroalgae ↑ growth & photosynthesis with ↑ CO_2 • Calcifiers & sediments ↑dissolution ↓calcification • Daily variance CO_2 ↑ (~325–725 ppm) in FL Bay • Short-term global ocean 2060 level irrelevant • Long-term ↑ dissolution ↓ calcification & release calcium-bound nutrients from sediment	• LM • L • MH • M • L
Coral Reefs	(-)	1-2	D/I	• Lower $CaCO_3$ saturation ↓ net calcification • Refugia patch reefs in seagrass ↓ CO_2 • Reef structure ↓ integrity ↑ bioerosion	• L • LM • L

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Foundation Community	Effect	Strength	Direct	Summary/Comments	Confidence (L,M,H)
Higher Precipitation (10%)					
Mangrove	(+)	2	D/I	• Lower salinity stress • Greater above- and below-ground production • Mitigate sea level rise influence at inland boundary • % increase in precipitation to ameliorate impacts	• H • LM • L • L
Seagrass/ Macroalgae	(+)	2	D	• Less hypersalinity in northern FL Bay • Modest effect on central bay /western areas • % increase in precipitation to ameliorate impacts	• MH • MH • L
Coral Reefs	(0/+)	1	I	• Not likely to affect reefs unless affect temperature	• MH

Foundation Community	Effect	Strength	Direct	Summary/Comments	Confidence (L,M,H)
Lower Precipitation (10%)					
Mangrove	(-/+)	2-3	I	• Increased salinity stress & > saltwater intrusion • > oxidation freshwater peats & fire probability • increase mangrove movement inland • Percent increase in precipitation cause impacts	• MH • MH • MH • L
Seagrass/ Macroalgae	(-)	2-3	D/I	• Increased hypersalinity events FL Bay • Increased hypoxia • Less seagrass biodiversity at ecotone • Percent increase in precipitation cause impacts	• MH • M • MH • L
Coral Reefs	(0/-)	1	I	• Not likely to affect reefs unless affect temperature	• MH

THE OLD PARADIGM

- Definitive “Stable” Boundaries
- Containment Management Approach

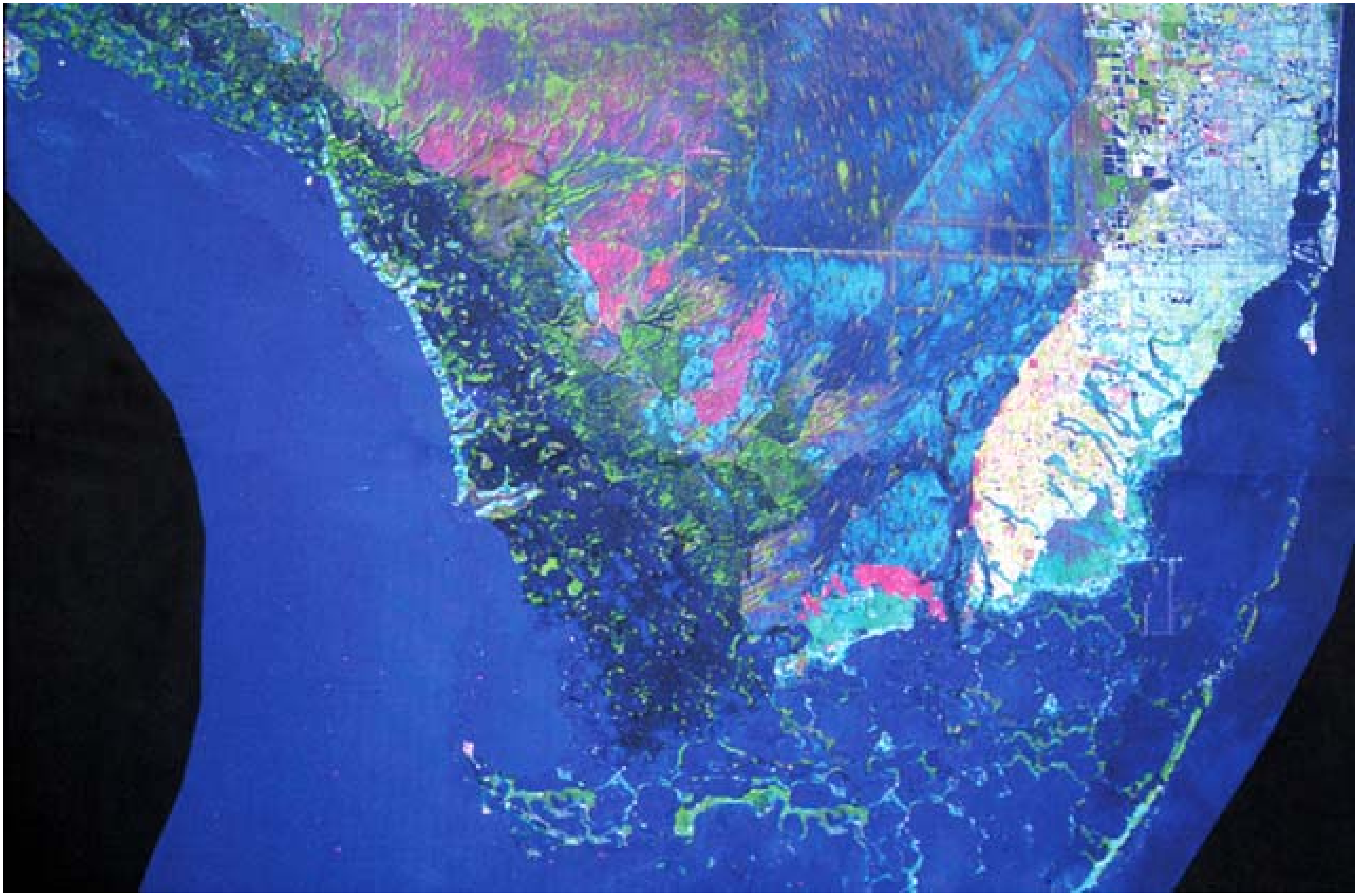
THE NEW PARADIGM

- Transgressive Boundaries - Moving
- Adaptive "Active" Management Approach

RECOMMENDATION #1

- An **integrative** and **resilience-focused** management strategy is needed as marine-terrestrial boundaries become dynamic with marine transgression, particularly in landscapes such as South Florida with micro-elevation gradients.

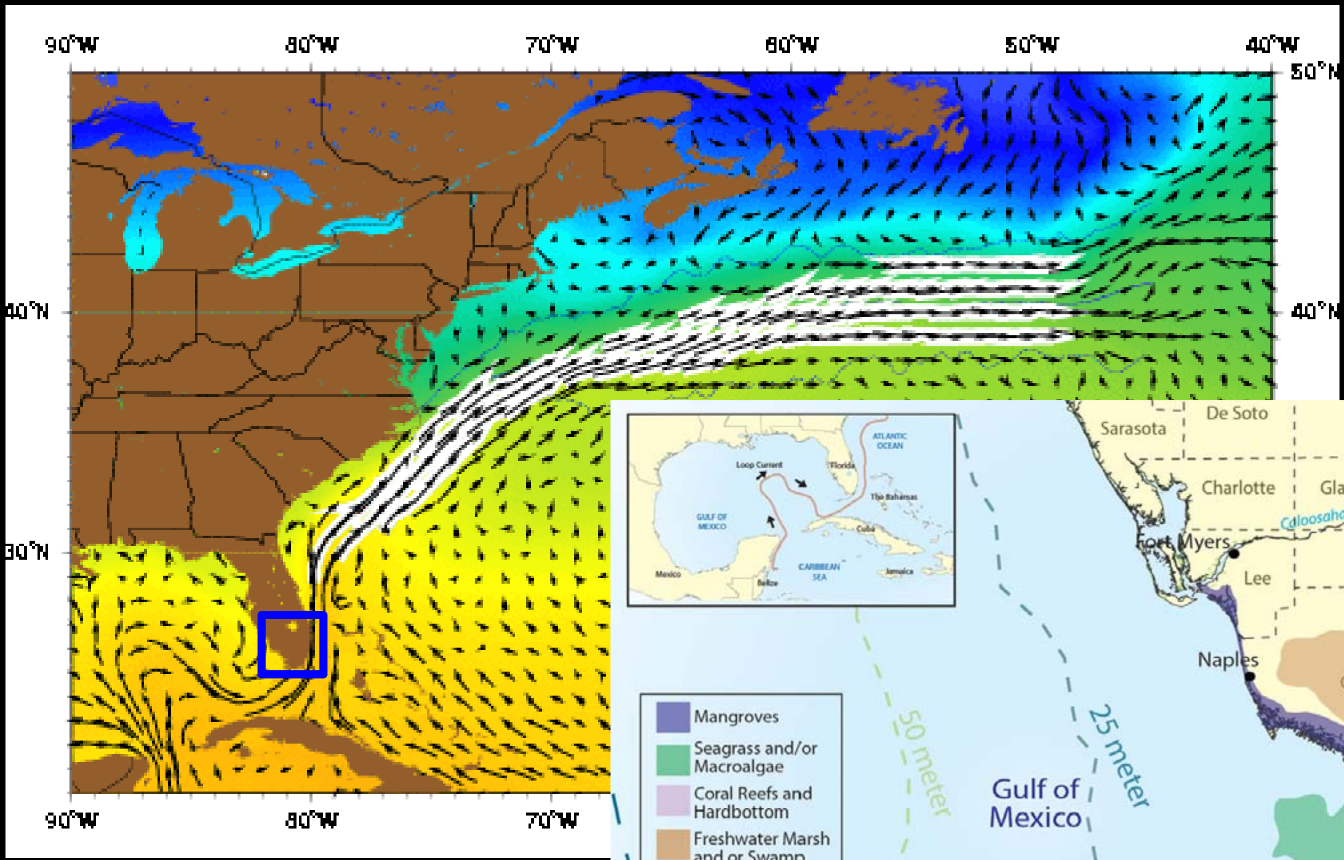
New management Approach on broad-scale coupling of structure and dynamics: Connected terrestrial, freshwater, and marine ecosystems under climate change.

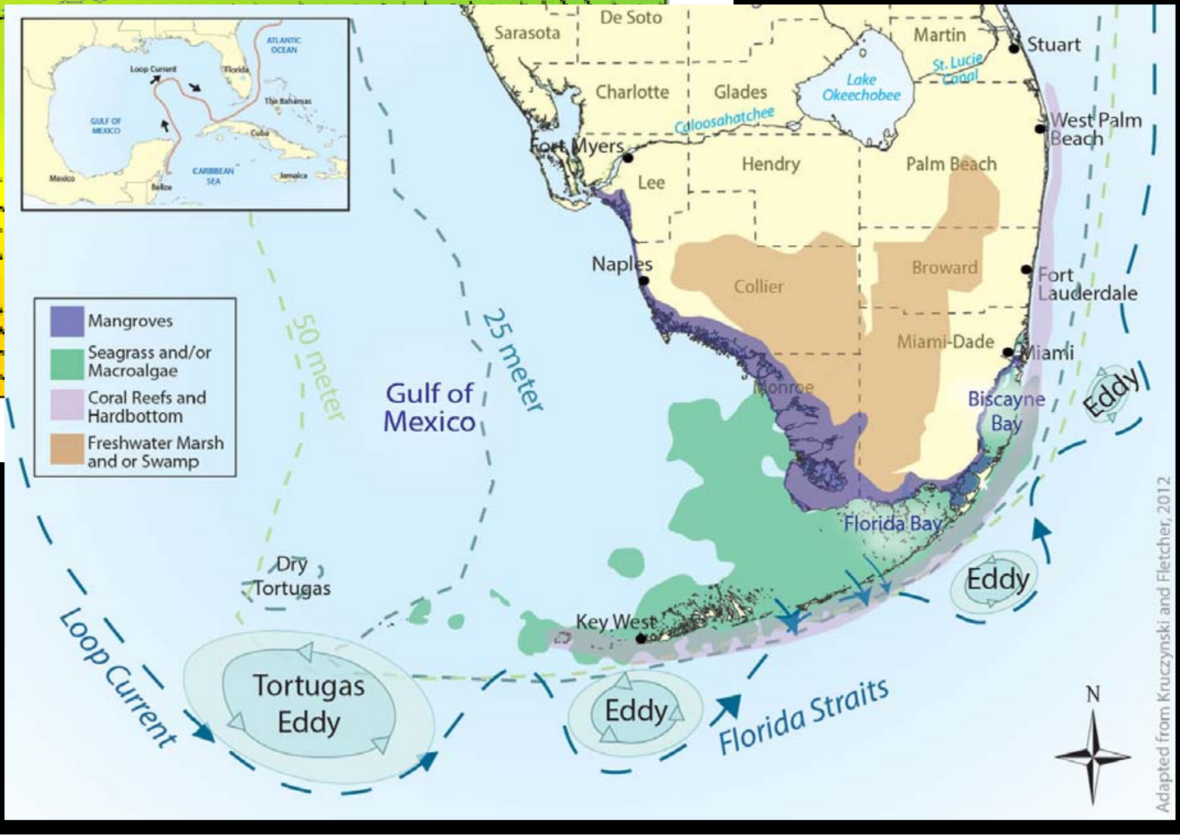


RECOMMENDATION #2

- Develop large-scale watershed-coastal models that integrate water, land, infrastructure and management to optimize natural and built system sustainability.
- Downscaled sea level rise models.
- Modeling climate impacts and upstream water management effects on critical coastal habitats.
- Model data requirements (water quality, hydrographic, geomorphological, and ecological)

Strong Regional Drivers
(Climate, Currents, Ocean Temperature)





RECOMMENDATION #3

Active approach to management to sustain marine ecosystems succumbing to climate impacts.

Coral Propagation and Resettlement

CORAL RESTORATION FOUNDATION

Recovery Plan

Elkhorn Coral *(Acropora palmata)* and Staghorn Coral *(A. cervicornis)*

United States Department of Commerce

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

March 2015

Southeast Regional Office
Protected Resources Division
263 13th Avenue South
Saint Petersburg, Florida 33701
Phone (727) 824-5312

Staghorn Coral *(Acropora cervicornis)*

Elkhorn coral *(A. palmata)*

RECOMMENDATION #4

Develop a comprehensive regional/local governance and planning framework to coordinate research and planning efforts to sustain South Florida under climate change.

Summary

Salient Responses Scenarios:

- Mangrove and Reef Communities threatened by sea level rise and climate change, respectively (high impact and certainty)
- Less Certainty Water Quality, Geomorphology and Regional Current Changes
- Higher Precipitation Positive and Lower Precipitation Negative Effect, but amounts that ameliorate sea level Rise Uncertain

Recommendations:

- An integrative and resilience-focused management strategy
- Larger-regional model integration and geographic linkages
- Active Management
- Comprehensive regional/local governance and planning

Questions?