Potential Impacts of Climate Change and Sea Level Rise on South Florida’s Coastal Wetlands

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Mangroves form the defining ecological structure of South Florida’s Coastal Wetlands.

Importance of the mangrove ecotone

- 148,263 acres of mangroves
- Largest continuous mangrove coast in US

Mangroves form the defining ecological structure of South Florida’s Coastal Wetlands.
Importance of the mangrove ecotone: Ecosystem Services

- Habitat, nursery and food source for many marine species, commercially valuable fisheries, and protected species
- Stabilize coastline – provide protection from storms and coastal flooding
- Improve water quality – filter nutrients
- Carbon sequestration
- Aesthetic, recreational, and tourism value
Critical Management and Research Question:

What will the impacts to the mangrove ecosystem and ecological services be over the next century as climate changes and sea level rises?

From Wanless – U. Miami: Simulated 2 ft SLR
MARine and ESTuarine Goal Setting for South Florida

- A consortium of Federal, State, University, and NGO collaborators
- Three year project – began in September 2009 – final report due September 2012
- Developing Conceptual Ecological Models for each coastal region – picks up where CERP CEMs left off
MARES Goal:

“To reach a science-based consensus about the defining characteristics and fundamental regulating processes of a South Florida coastal marine ecosystem that is both sustainable and capable of providing the diverse ecological services upon which our society depends.”
MARES Framework – DPSER Model

Ecosystem Services

- What is measured condition?
- Attributes people care about?
- What is current condition?
- What is desired condition?

State

Pressures

- Internal
- External

Drivers

- Internal
- External

Responses

Managers

Users
Balance between salt water influx from the marine systems and freshwater flow from the terrestrial systems is what defines the transitions within any coastal wetland environment.

- Climate Change
  - Sea level rise
  - Precipitation patterns
- Anthropogenic alteration
  - Land use
  - Altered freshwater flow
MARES SW Coastal Wetlands CEM

Attributes Measured
- Spatial extent of mangrove forests & wetlands
- Primary & secondary productivity
- Species composition
- Habitat diversity and connectivity

Ecological Processes
- Fire Regime
- Coastal salinity gradients
- Coastal Transgression
- Sediment Supply
- Mangrove production & peat accretion
- Coastal nutrient dynamics
- Tidal channel dynamics

Pressures
- Frequency and intensity of storms
- Altered freshwater flow / water management
- Sea Level Rise
- Derelict Canals - Cape Sable
If rates of sea level rise surpass ability of mangroves to keep pace, Wanless et al. (2000) predicts “catastrophic loss of the coastal mangrove fringe” and inundation and/or erosion of the low-lying coastal wetlands.

Diverting or limiting freshwater flow affects supply of sediment to build up the coast and nutrients to promote plant growth.

If SLR > rate of accretion:

**ECOLOGICAL RESPONSE**
- Mangrove Peat Accretion
- Mangrove peat loss

**PRESSURES**
- Sea Level Rise
- Altered freshwater flow

**ATTRIBUTE MEASURED**
- Spatial extent of mangroves
- Primary productivity

**If SLR > rate of accretion:**
What are potential rates of Sea Level Rise?

Figure 2. Unified Southeast Florida Sea Level Rise Projection for Regional Planning Purposes. This projection uses historic tidal information from Key West and was calculated by Kristopher Esterson from the United States Army Corps of Engineers using USACE Guidance (USACE 2009) intermediate and high curves to represent the lower and upper bound for projected sea level rise in Southeast Florida. Sea level measured in Key West over the past several decades is shown. The rate of sea level rise from Key West over the period of 1913 to 1999 is extrapolated to show how the historic rate compares to projected rates.
Project: Sea Level Rise and Climate Impacts on Greater Everglades Ecosystem

Goals:

• Determine salinity history of the region using indicators of freshwater flow & marine influence
• Determine rates of sea level rise in South Florida for the last 500 to 3000 years and compare to rates projected for 21st century by IPCC
• Examine impacts of changing sea level and freshwater availability on biota
• Examine record of climate effects on ecosystem
• Use results of core analyses to provide Southern Estuaries Recover Team with estimates of pre-1900 AD flow
## What is the history of Sea Level Rise for South Florida?

<table>
<thead>
<tr>
<th>Years BP</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>6-7000</td>
<td>Freshwater peats began forming on FL platform underlying FL Bay – Sea Level was ~6.2 m below present.</td>
</tr>
<tr>
<td>5000</td>
<td>Sawgrass and water lily peats forming in area of present Everglades wetlands.</td>
</tr>
<tr>
<td>~3000</td>
<td>Rates of SLR slowed and stabilized FL coastline – began transition to mangrove peats.</td>
</tr>
<tr>
<td>Last 2000</td>
<td>Hydraulic fluctuations and global changes in climate and SLR have affected entire system.</td>
</tr>
<tr>
<td>~1000</td>
<td>Temporary slowing or still-stand in SLR.</td>
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</tbody>
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Cores form 3 transects up Shark River, Harney River and Lostmans River and one parallelling the coast.
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Tarpon Bay Core

Mangrove swamp – ~1 ka to present

Transition from fresh to mangrove - ~2.2 to 1.2 ka

Freshwater marsh – Prior to ~2.2 ka

Cores form 3 transects up Shark River, Harney River and Lostmans River and one paralleling the coast.
Shark River Slough Core 2A

Lowest portion of core – mostly benthic freshwater species – corresponds to TBA pollen.
Shark River Slough Core 2A

Middle portion of core – freshwater species carried in water column dominant

~1900 AD

~1000 BP

~3000-4000 BP
Shark River Slough Core 2A

Middle portion of core – beginning to see estuarine influence – corresponds to TBA transition to mangroves

~1000 BP

~3000- 4000 BP
Top of core – Freshwater species carried in the water column decline
Benthic freshwater species absent

~1900 AD

~1000 BP

Top of core – Outer estuarine to marine species become dominant – corresponds to TBA mangrove pollen increase
Cores form 3 transects up Shark River, Harney River and Lostmans River and one parallelling the coast.
Shark River Slough Core 1A

~ 1900 AD
What we know . . .

- Development of South Florida’s coastal wetlands has formed due to a balance of processes – rates of sea level rise, climate, and freshwater supply.
- Changes in these variables in the past have produced shifts in species composition.
- Migration of vegetation zones has tracked sea level changes throughout the last 6-7000 years.
- Past shifts seemed to be marked by transition periods, followed by periods of relative stability in species composition.

Results will provide the context to predict future changes associated with accelerated SLR.
What next . . .

• Complete our age models and analyses of existing cores
• Identify areas where additional coring is needed – new cores will be collected with accurate elevation data
• Improve our modern analog dataset for the SW coast (see Stackhouse & Colley poster tonight)
• Develop Linear Regression Models for the SW coast to derive salinity and flow targets for the SW estuaries (Frank Marshall’s talk Friday 9:20am Waterside A)
For more information on research visit:
http://sofia.usgs.gov/

Thank you!

For more information on MARES visit:
http://sofla-mares.org/