MONITORING SEA LEVEL RISE IMPACTS IN MANGROVES AND LAGOONAL ECOSYSTEMS OF THE LOWER FLORIDA KEYS

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www.ImpactsofSeaLevelRise.com
How long ago was it when?

- Tide gauges were still being used to measure sea level rise
- You had to drive down every road to see what was down there (there is no Landsat yet)
- Water levels were 4" (10 cm) lower than today, there were more hypersaline ponds and fewer key deer
- There was a road all the way to the southwest tip of Boca Chica

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MONITORING USING HISTORICAL DATA

Baseline data on beaches, mangroves, plants, animals, and water quality from:

- Graduate research at RSMAS (1973-1978)
- A set of long-term monitoring protocols that I co-authored and which received state and federal approval in 2010 during the Deepwater Horizon oil spill.
Photos & maps: Including a set of 1959 aerial photographs and LIDAR maps and SLR projections from the Nature Conservancy.

For example: here is the former Boca Chica Road with two channels (arrows) breaching a formerly hypersaline mangrove pond following a hurricane.
2 transects already selected (arrows below right) on Big Pine and Upper Sugarloaf Keys that focus on a set of 4 dynamic ecotones where changes are anticipated with the next 0.5 meters of sea level rise, including:

- 1B: Seagrass beds to fringing red mangroves
- 2B: Fringing red mangroves to black mangroves
- 3B: Black mangroves to supralittoral shrubs
- 4B: Supralittoral shrubs to seaward pines

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MONITORING – PLANTS

- Plants: Seasonal monitoring of structure & productivity: Mangroves, marsh plants, seagrass & algae (veg plots- summer-vs.-winter) using Caricomp forestry & seagrass methods
  - 10x10 meter vegetative plots with all trees >2.5cm DBH measured (below left and center)
  - Installing 5 one meter squared permanent veg plot for (below right) investigating marsh plants, mangrove seedlings and saplings
  - Monitoring herbivory by the key deer (fixed points & controlled experiments)
MONITORING – FISHES

- Fishes: Annual community structure, reproductive & population dynamics of seagrass, mangrove, saltmarsh & pond fishes:
  - Focus on the imperiled key silverside (below) (*Menidia conchorum*) and the Goliath grouper (lower right) (*Epinephalus itajara*)
  - Using seines & 1 meter squared throw traps

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DYNAMIC ECOTONES – TWO TRANSECTS
ONE DONE, ONE UNDERWAY

Big Pine Key - Watson Blvd

Upper Sugarloaf Key
ERODING MANGROVES/SEAGRASS BEDS
DEEPENING LAGOONS

Shallow lagoons surrounded by fringing red mangroves. Lagoons deepen until red mangroves do not colonize.

Site of future deepening lagoon formation on Big Pine Key (base map courtesy of Chris Bergh of Nature Conservancy)
LANDWARD EXPANDING MANGROVES

In 1959                      Today >44% increase

Shifting, large deposits of marine mud are expanding landward and being colonized by red mangroves on many of our sites.

Fringing red mangroves showing recent sedimentation in background.

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DYNAMIC ECOTONE BETWEEN RED AND BLACK MANGROVES (2B)

Landward expanding red mangroves. Spreading onto dwarf black mangrove flats.

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INDICATOR SPECIES-FISHES & WILDLIFE ADAPTATION

The (state) imperiled key silverside undergoing behavioral and population changes in deepening lagoons

Key deer foraging in landward-expanding mangroves

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DYNAMIC ECOTONE BETWEEN BLACK MANGROVE AND SUPRALITTORAL SHRUB (3B)

Black mangroves and saltmarshes are expanding landward

Supralittoral shrubs such as Joewood and buttonwood mangroves are dying back
PLOT 3B RESULTS - BIG PINE KEY WATSON BLVD

Dead buttonwood mangroves with successional black mangroves and salt marsh plants

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Red Mangrove</th>
<th>Black Mangrove</th>
<th>Joeewood</th>
<th>Buttonwood Mangrove</th>
<th>Pine Forest</th>
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</tbody>
</table>

Relative dominance = total basal area of a species / basal area of all species x 100
DYNAMIC ECOTONE BETWEEN SUPRALITTORAL SHRUB AND PINE FORESTS

Dying pine invaded by supralittoral shrub

Chlorotic (yellowing) and dying seaward pines.

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MANGROVE MONITORING PROJECT
OBJECTIVES

WHAT NEXT?

High resolution topographic profiling of these dynamic ecotones throughout the keys

• Initiating RTK transects
• Numerous habitat profiles
• Specific findings to a greater “keys-wide” study area
SUMMARY OF GAINS AND LOSSES BEING MONITORED

**Gains:**

- Rapid expansion of monotypic stands of low biomass, 1-3 meter tall stands of red mangroves, landward and seaward displacing black mangroves and rock/mud flats.
- Increased salt marshes and buttonwood mangroves in former pine forests and hammock.
- Increased seagrass and algae beds in interior deepening ponds.

**Losses:**

- Deepening lagoons and eroding shorelines prevent red mangrove colonization and forests are receding.
- Freshwater resources for wildlife including key deer and fishes
- Dwarf black mangroves on rock/salt flats and possibly loss of marsh rabbit habitat
- Loss of key silverside ponds grading into lagoons then bays

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Ongoing, transition underway from turtle grass, red mangroves, black mangroves to buttonwoods to pine forest.