Sea level rise and pine forest loss in the Florida Keys

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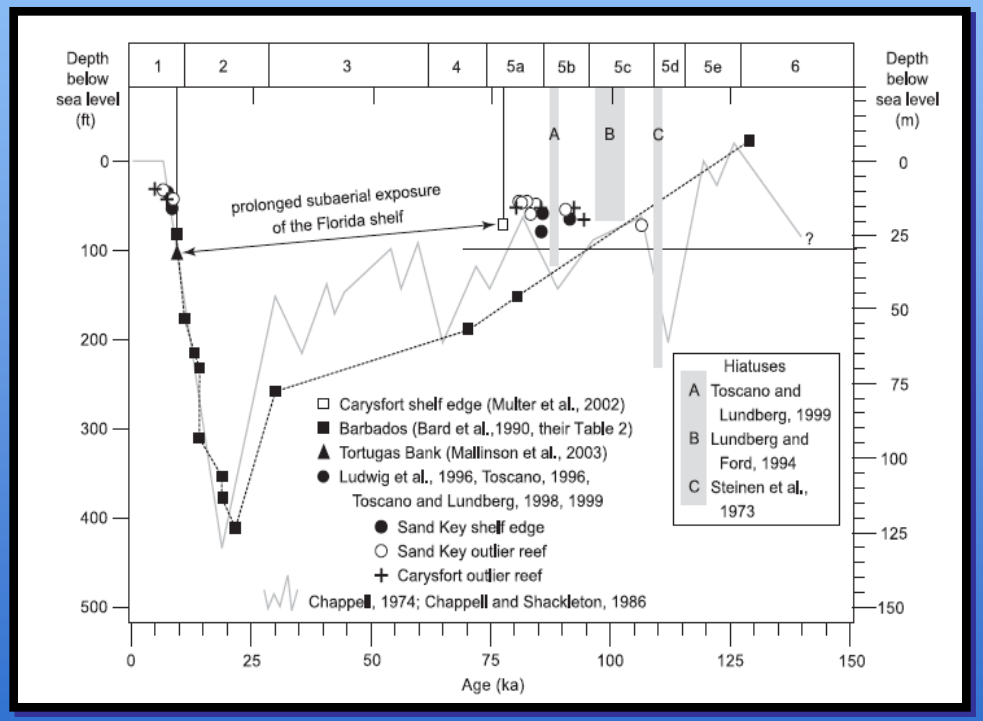
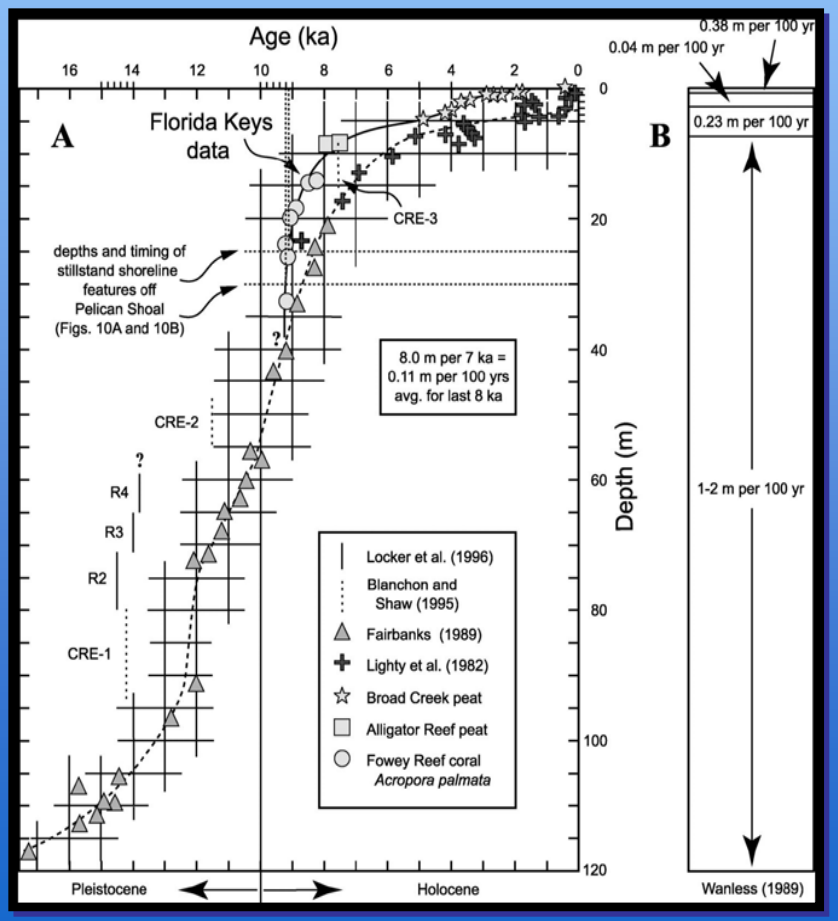
Sea level change over the long haul – the Late Quaternary period

135 K yrs ago to present



20 K yrs ago to present

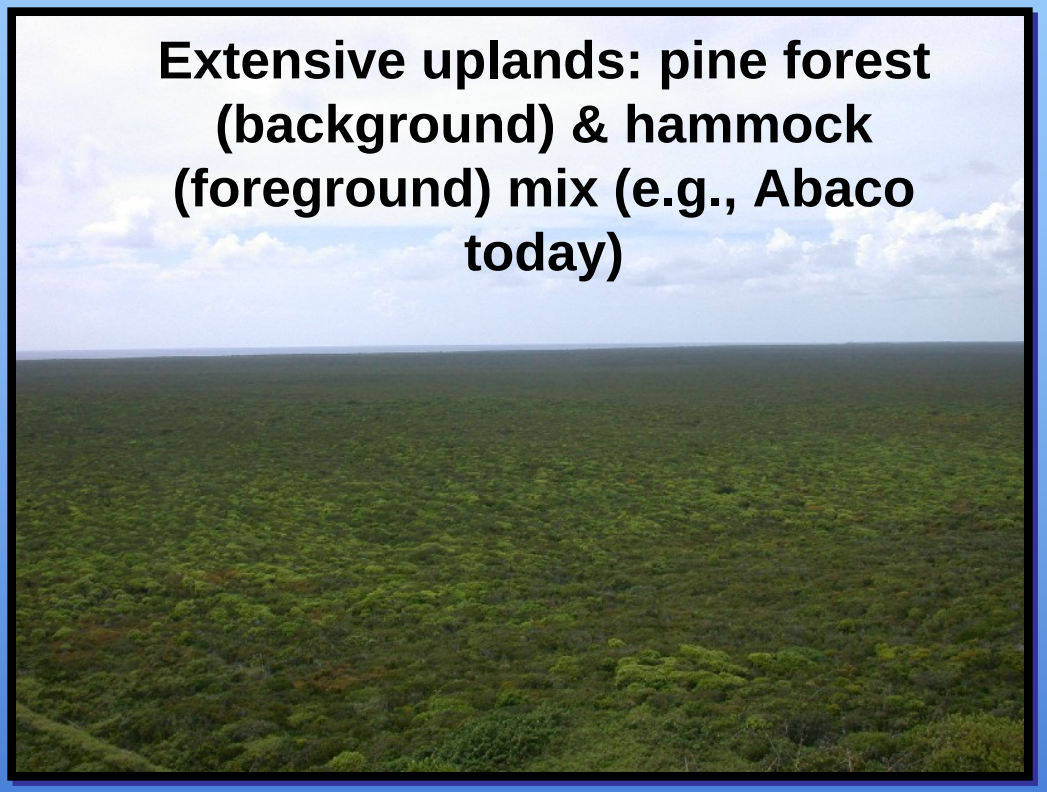


The lower Keys 8 - 9K years ago?

Evidence from the sea

Organic debris deposit, New Ground Reef, 35 miles w of Key West: ^{13}C ~8500 yrs BP

Extensive uplands: pine forest (background) & hammock (foreground) mix (e.g., Abaco today)

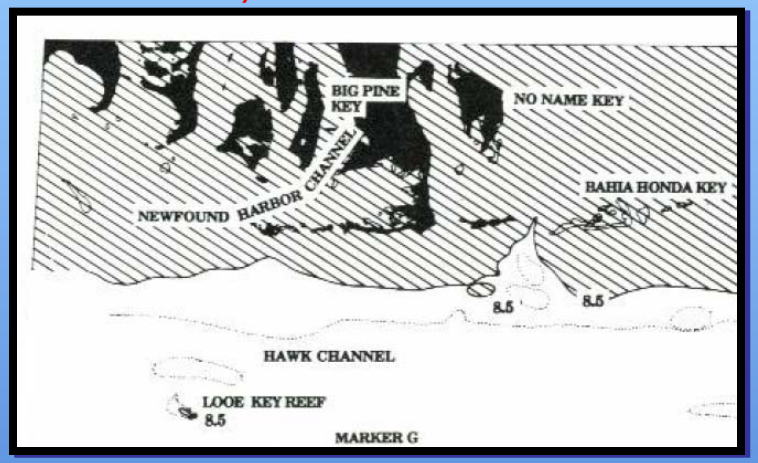


Debris components:
burned pine wood
pine cone

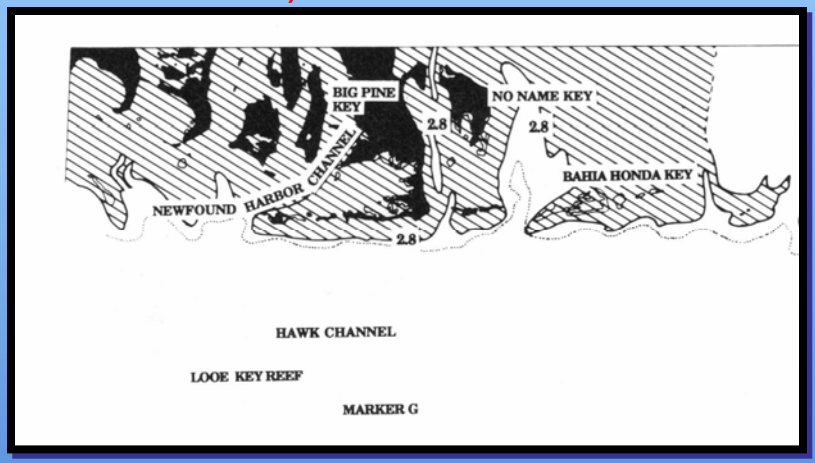
Debris photos courtesy Corey Malcom, Mel Fisher Maritime Heritage Exhibit

Lower Keys land surface, 8000 years BP to the present (**from Lidz & Shinn 1991**)

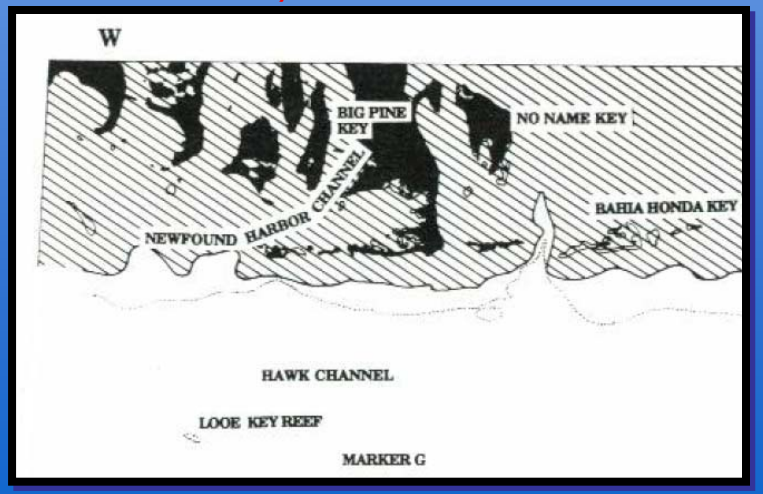
8,000 YRS BP



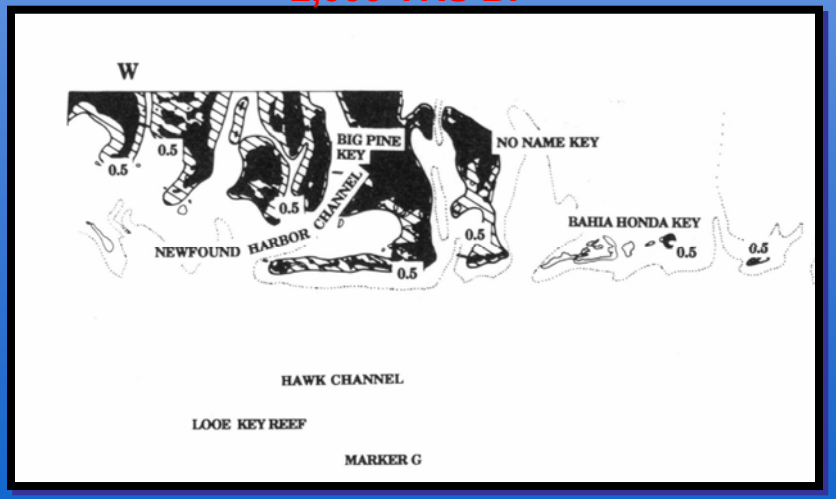
4,000 YRS BP



6,000 YRS BP



2,000 YRS BP

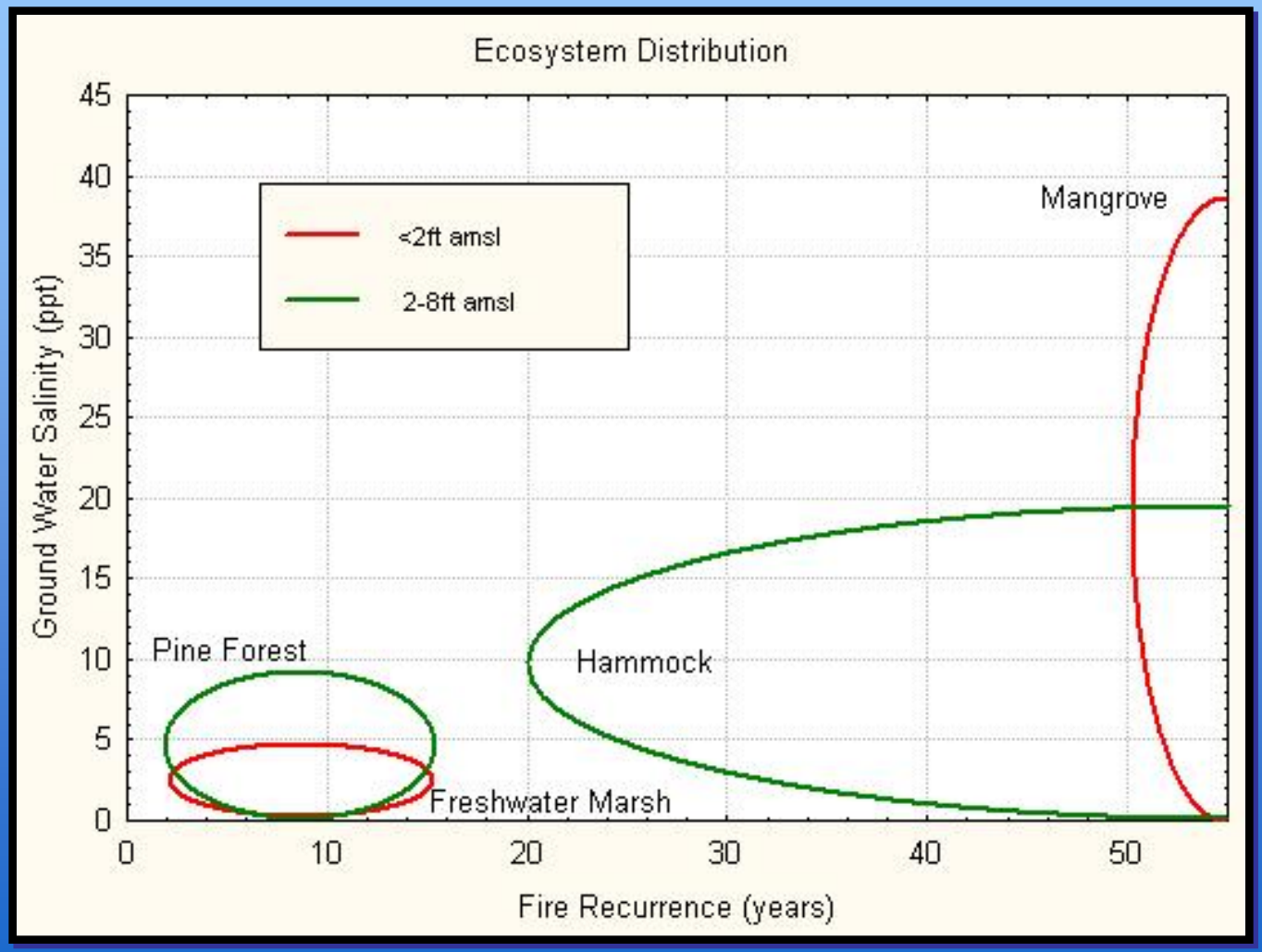


Evidence of environmental change on Sugarloaf Key– pine snags in buttonwood woodland

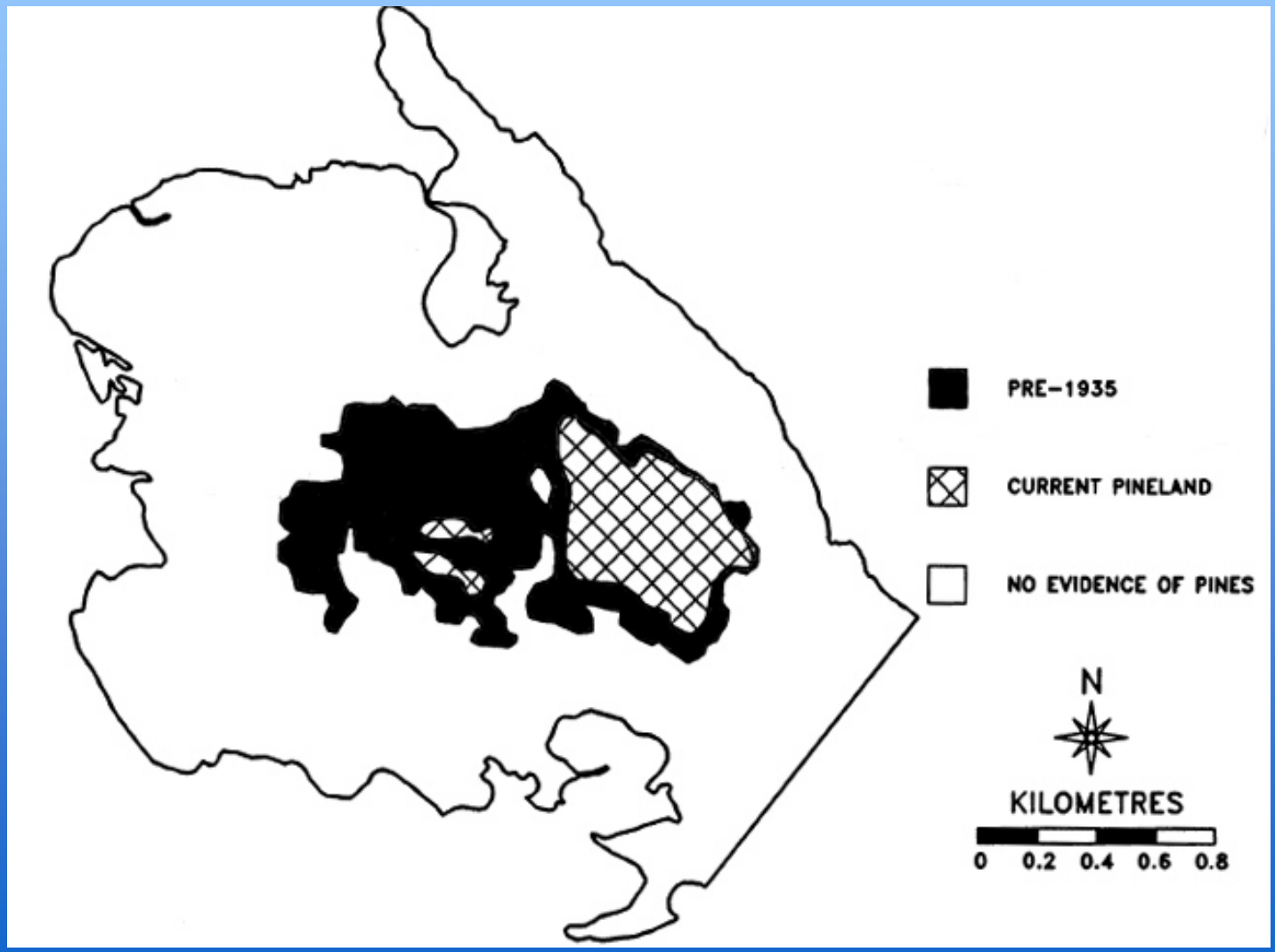
Sampling methods

1. Surveyed topography along woods road network
2. Developed current (1991) vegetation map
3. Interpreted vegetation from historical aerials (1935, 1959, 1971)
4. Searched for pine snags in each 50 x 50 m cell to edge of island

Approximate distribution of Keys terrestrial communities along three major ecological gradients



Recession of Sugarloaf pine forest (toward the interior of the island, toward higher elevations)



SeaChange: A sea-level driven model of vegetation change for the Florida Keys

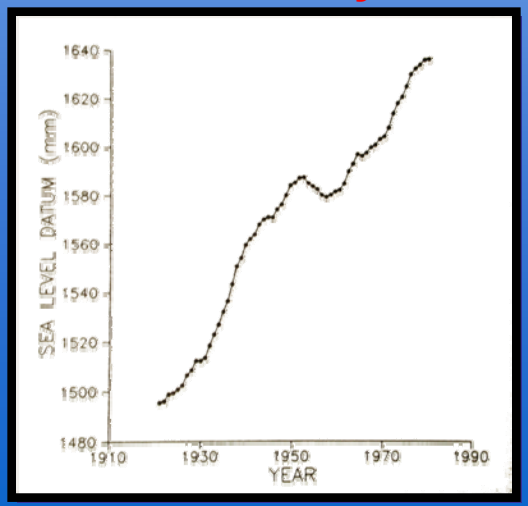
Model rules:

1. Start with 1991 vegetation pattern and elevation above sea level; raise sea level in 2 cm increments
2. Relative area of community types within 10 cm elevation bands remains constant
3. Proportional habitat "adjacency" remains constant
4. Fractal index of landscape remains constant
5. Except as above, community types expand by adding cells at their edges

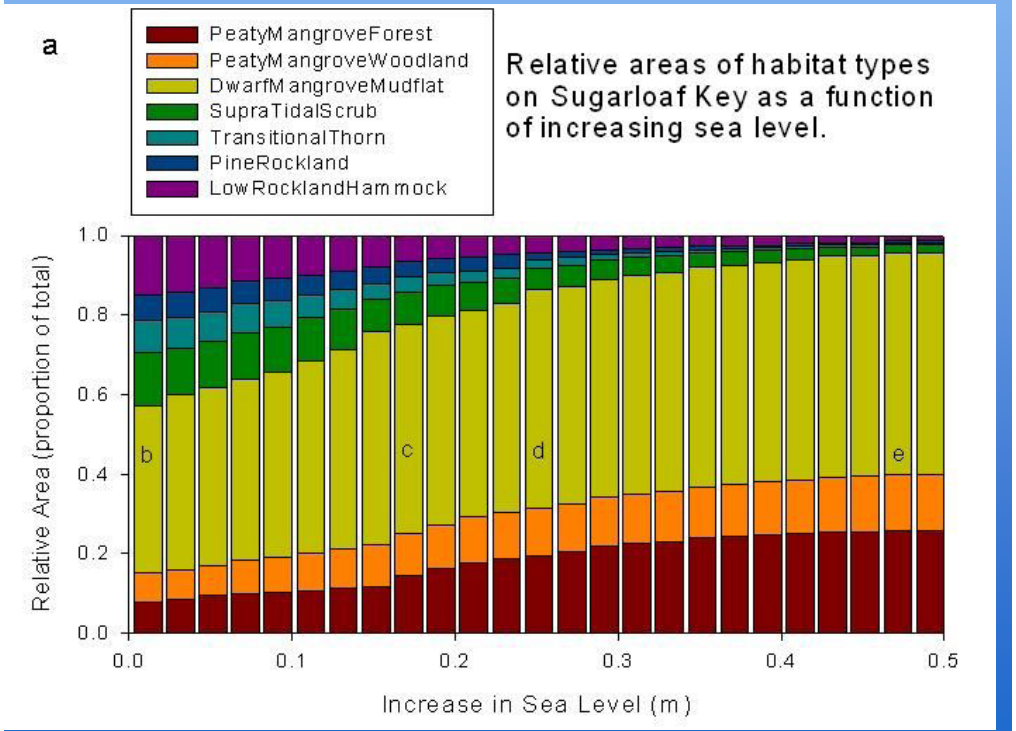
Verification:

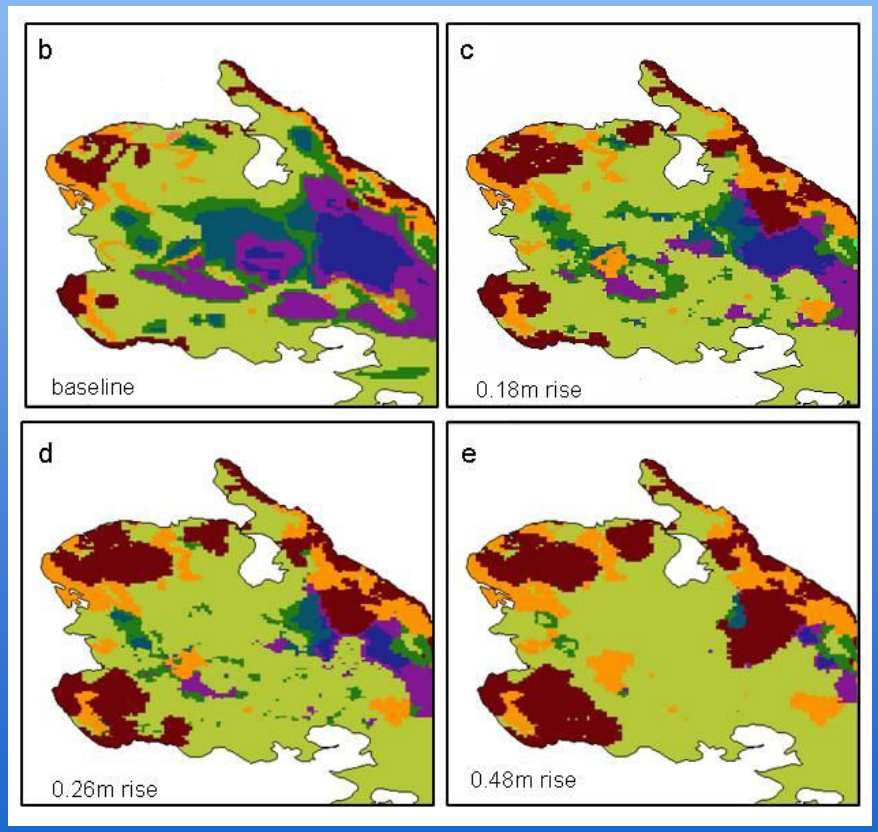
1. 1935 – 1991 model run, using sea level data from Key West, compared to vegetation change (3 broad types) from photo interpretation
2. Model predicted well for uplands & mangroves, not so well for transitional habitats

Sea level at Key West



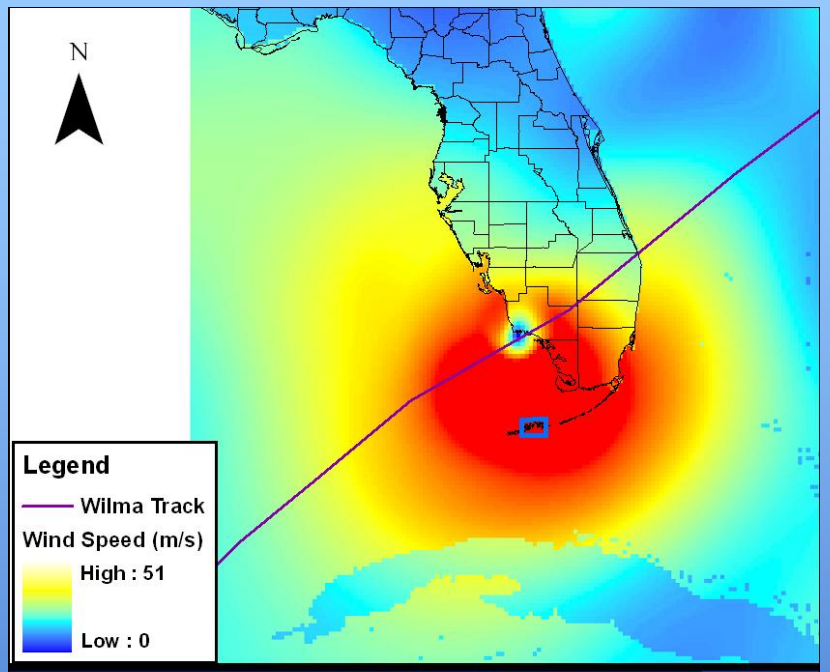
Projected habitat change with sea level rise on Sugarloaf Key



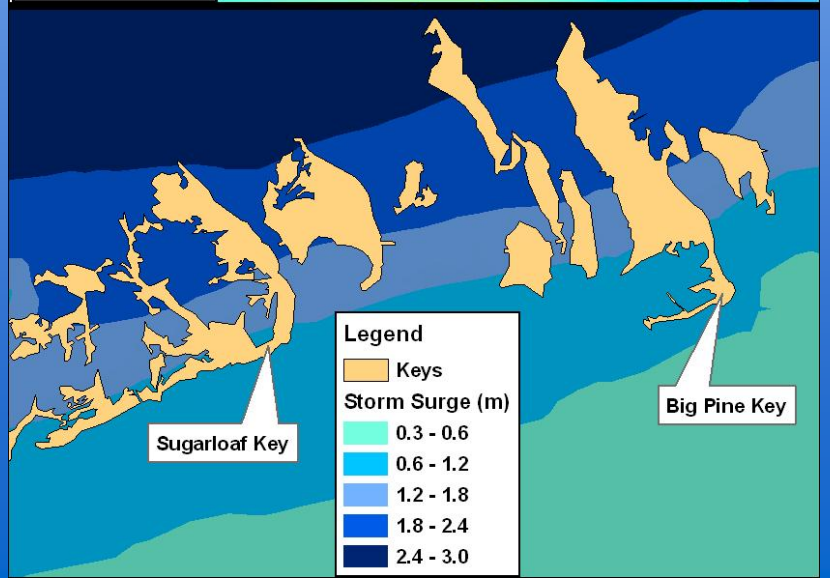


Hurricane Wilma, October 24th, 2005

Windfield at landfall on South Florida mainland

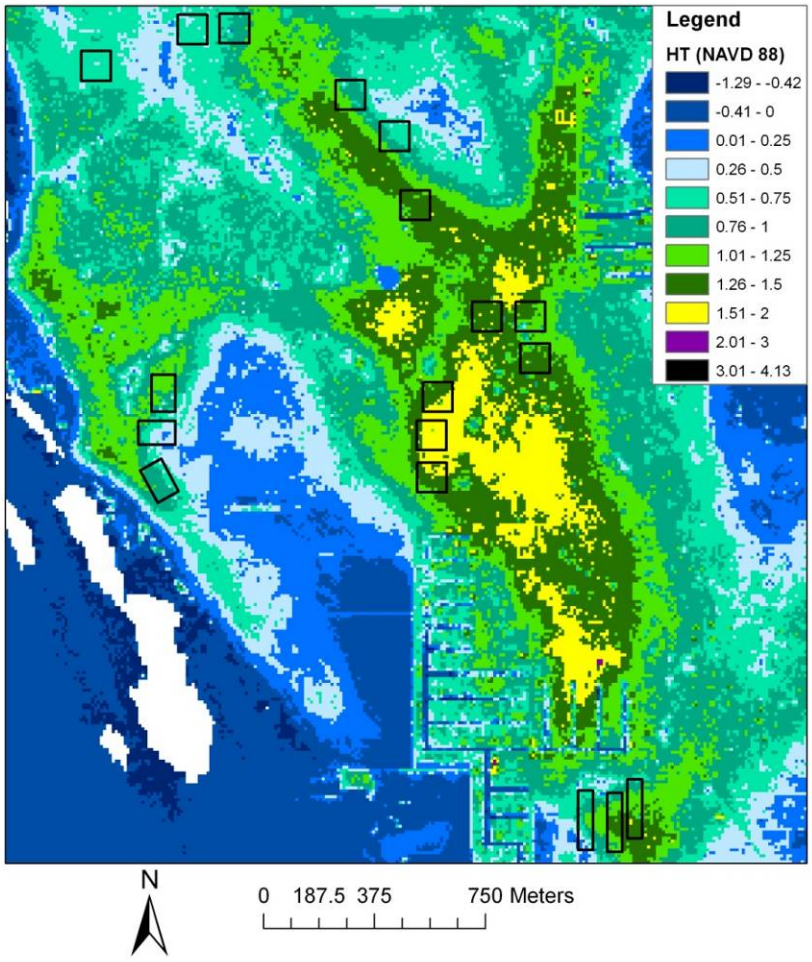


Storm Surge several hrs later in the lower Keys

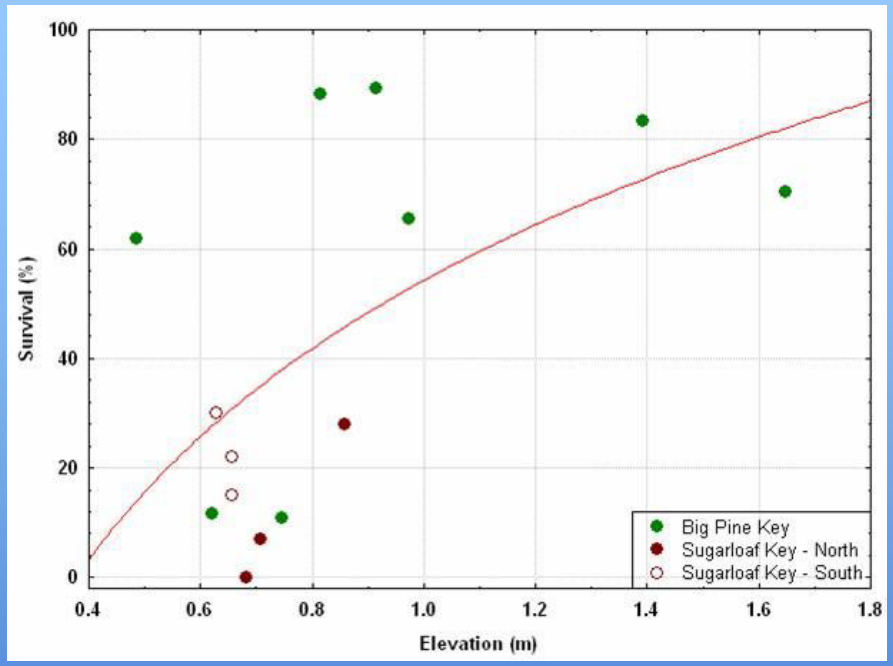


Wilma-related mortality: Sugarloaf Key, 70-100%; Big Pine Key, 10-90%

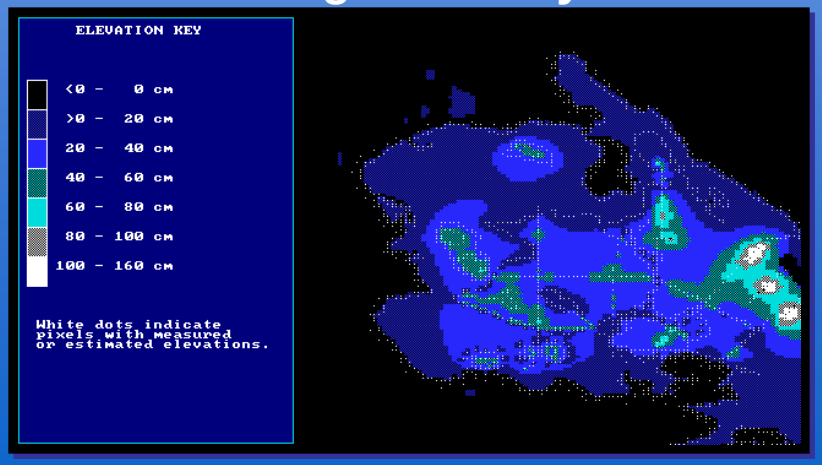
Big Pine Key



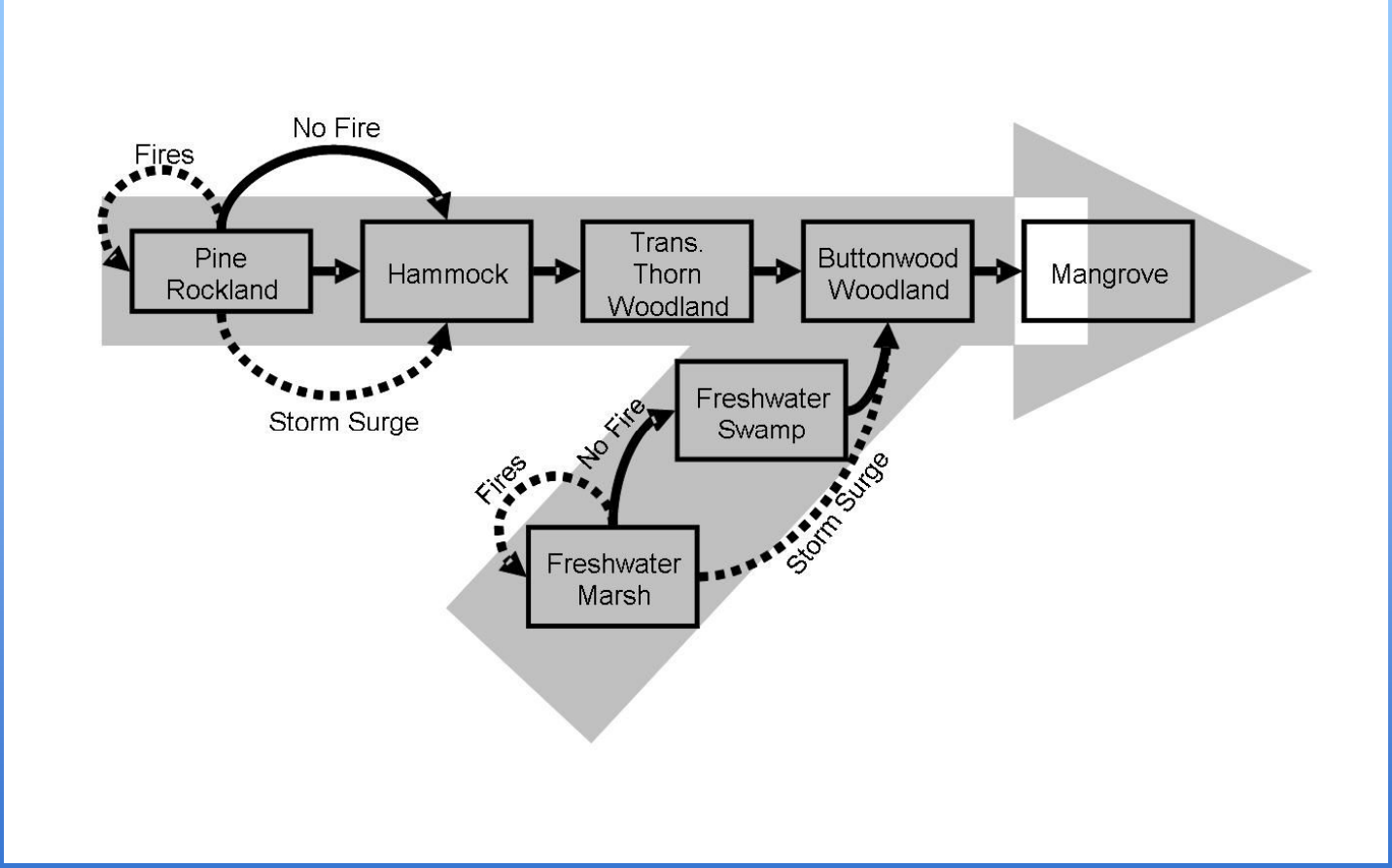
Survival v. elevation, both islands



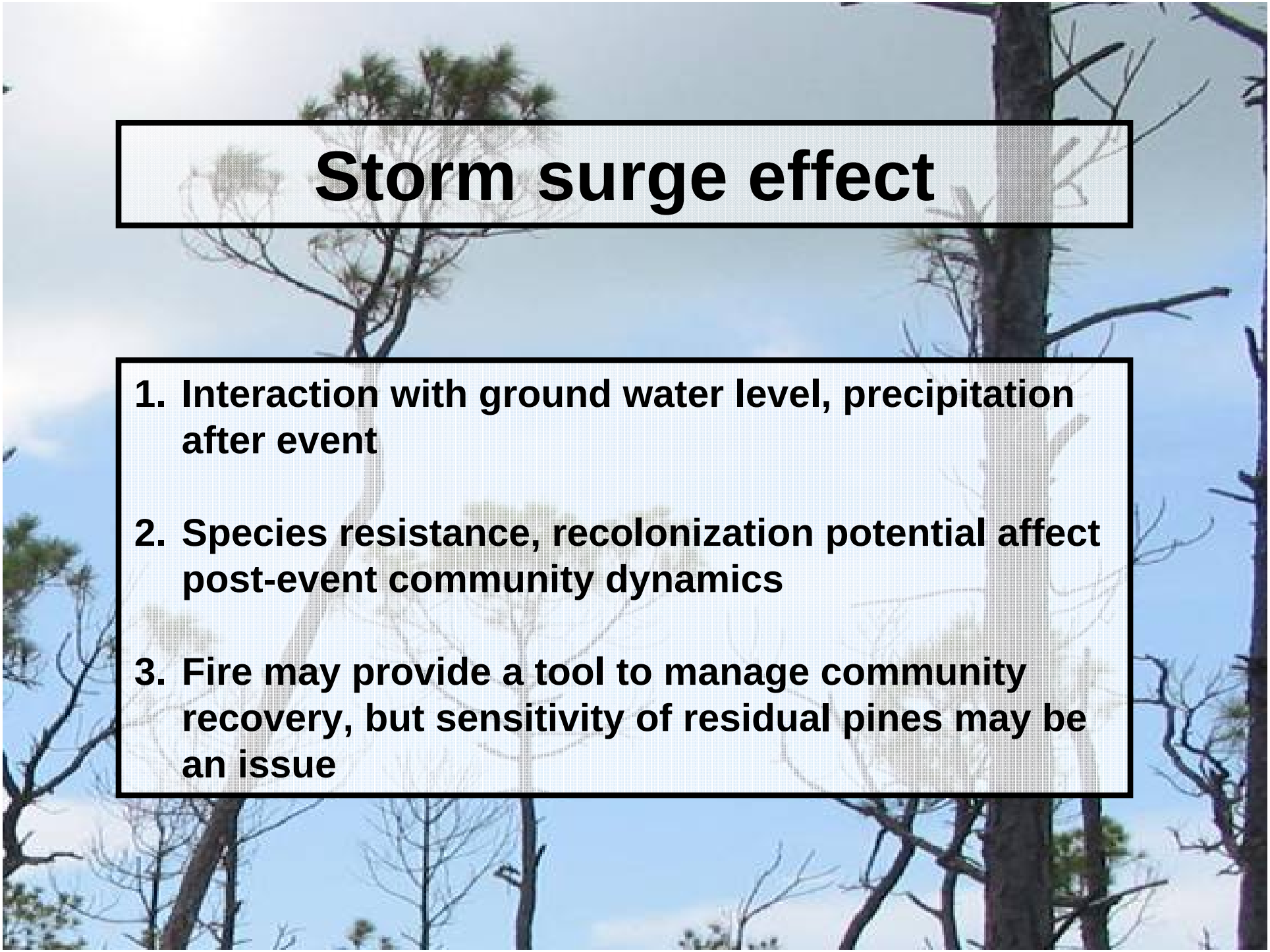
Sugarloaf Key



Global change, disturbance, and vegetation succession

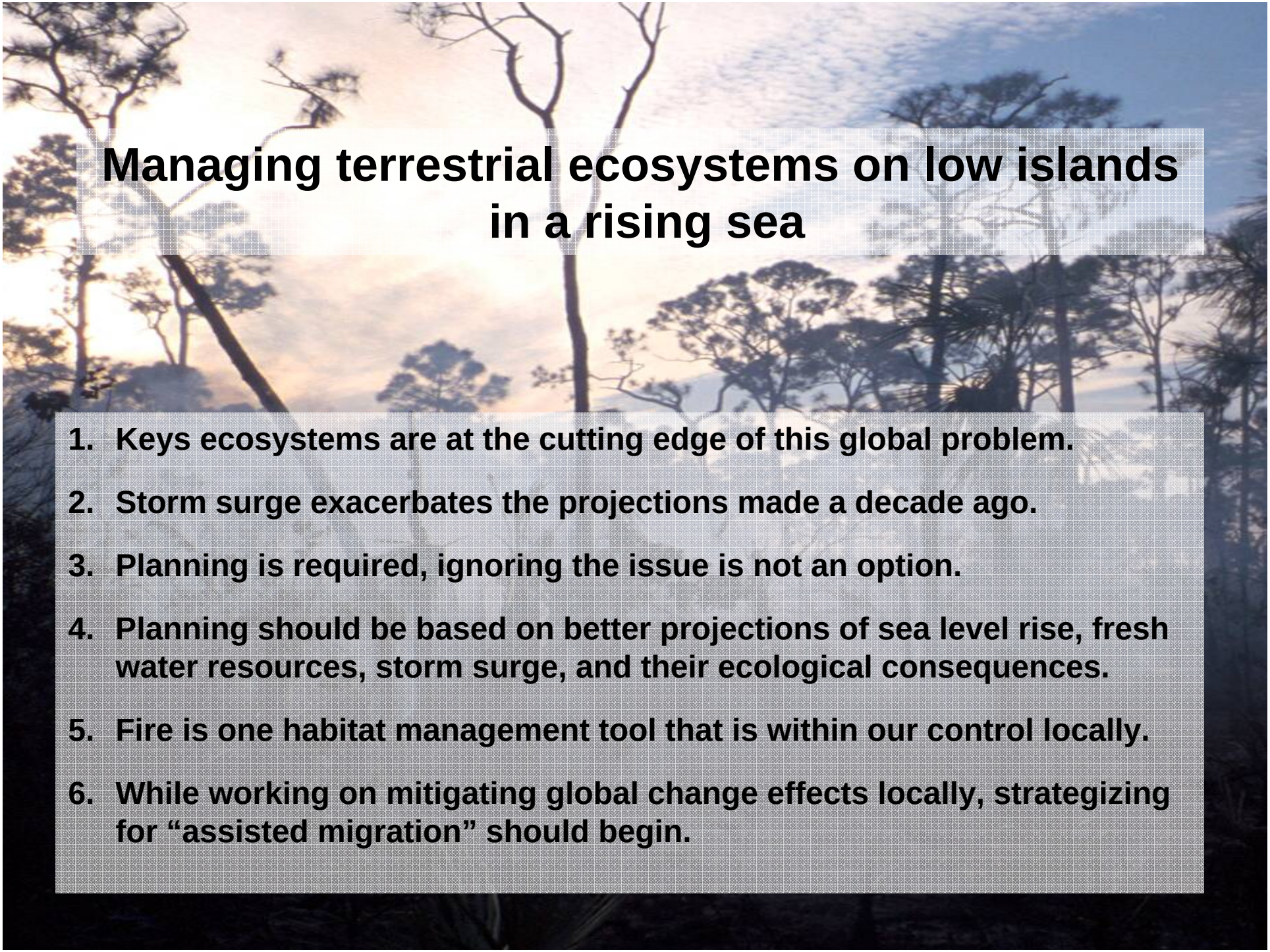


Sea level rise (a ramp disturbance) alters longstanding regimes of fire and storm surge (pulse disturbances), with consequences for landscape pattern



Storm surge effect

1. Interaction with ground water level, precipitation after event
2. Species resistance, recolonization potential affect post-event community dynamics
3. Fire may provide a tool to manage community recovery, but sensitivity of residual pines may be an issue



Managing terrestrial ecosystems on low islands in a rising sea

1. Keys ecosystems are at the cutting edge of this global problem.
2. Storm surge exacerbates the projections made a decade ago.
3. Planning is required, ignoring the issue is not an option.
4. Planning should be based on better projections of sea level rise, fresh water resources, storm surge, and their ecological consequences.
5. Fire is one habitat management tool that is within our control locally.
6. While working on mitigating global change effects locally, strategizing for “assisted migration” should begin.