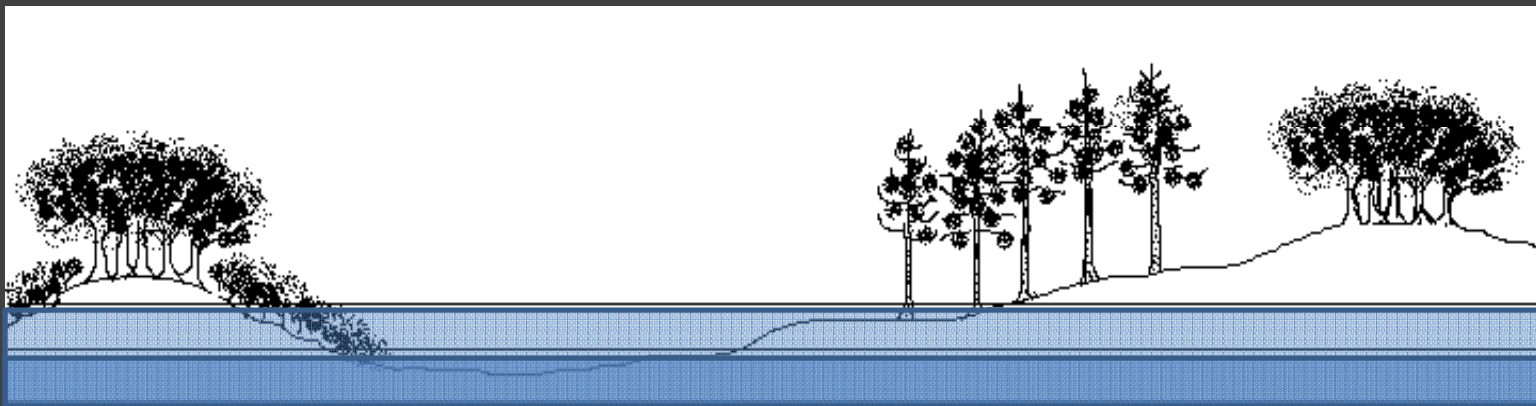


Droughts:
while tree islands can expand,
can tropical hardwood hammocks **VANISH** ?
Tropical Hardwood Hammocks along a
water availability gradient



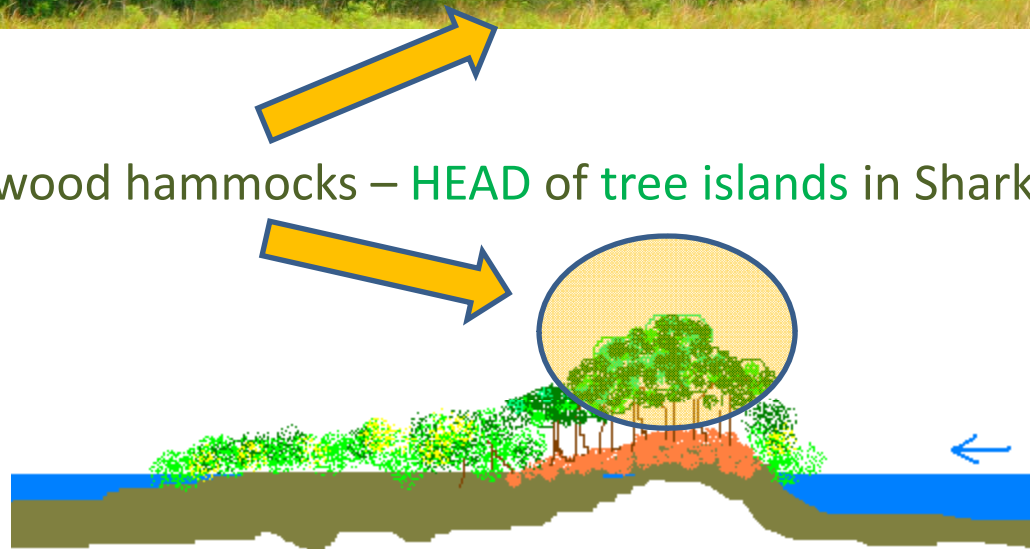
Amartya Saha¹, Leonel Sternberg², Michael Ross³, Fernando Miralles-Wilhelm³

1 SERC, FIU 2 Biology, University of Miami 3 Biological Sciences, FIU 4. Civil and Environmental Engg, FIU





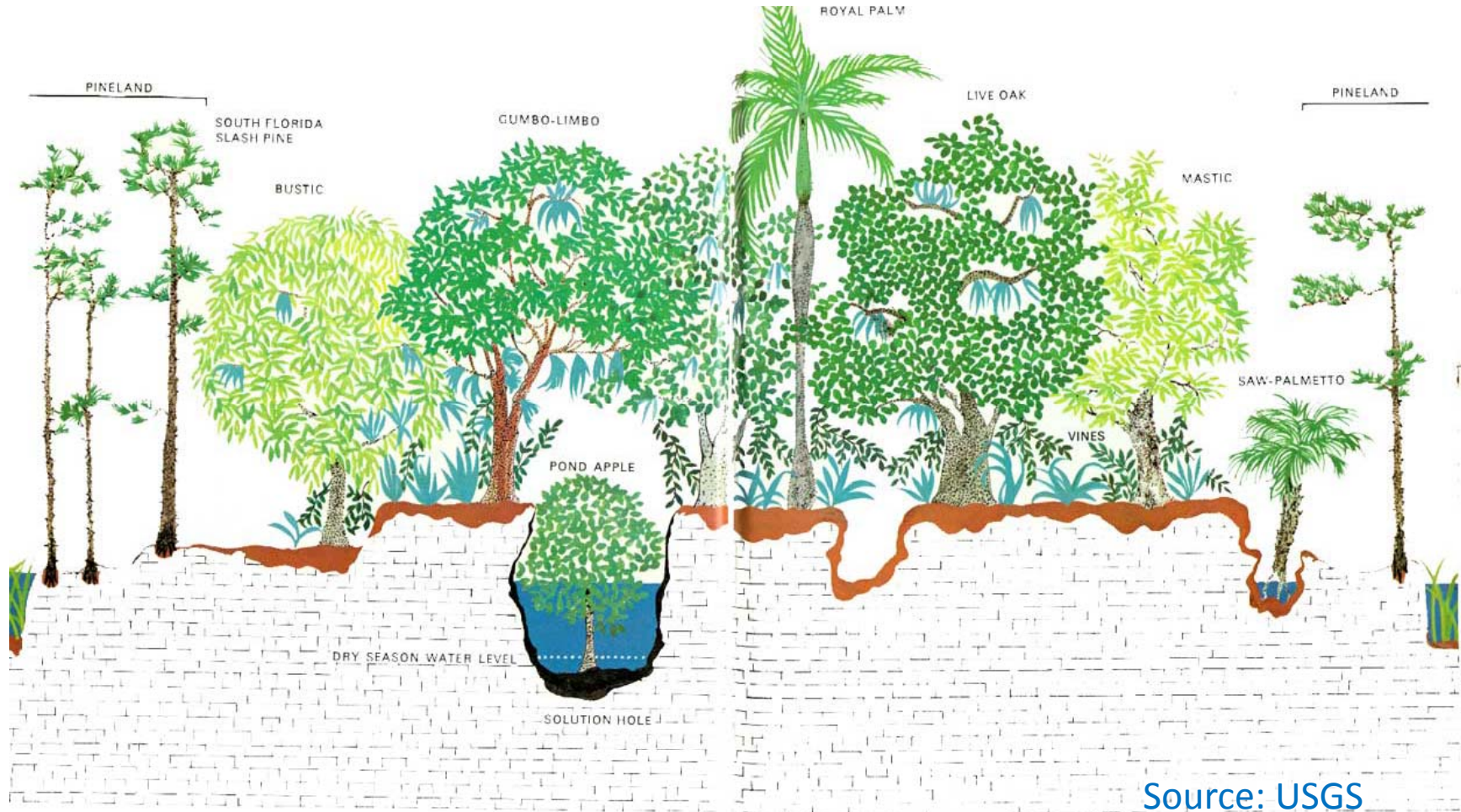
Tropical hardwood hammocks – HEAD of tree islands in Shark River Slough, ENP



Tropical Hardwood Hammock:

Plants of Caribbean/Neotropical origin, high diversity, habitat for terrestrial fauna in a wetland

Cannot tolerate frost, floods.



Tropical Hardwood Hammock - Occurrence

Areas of highest elevation in South Florida:

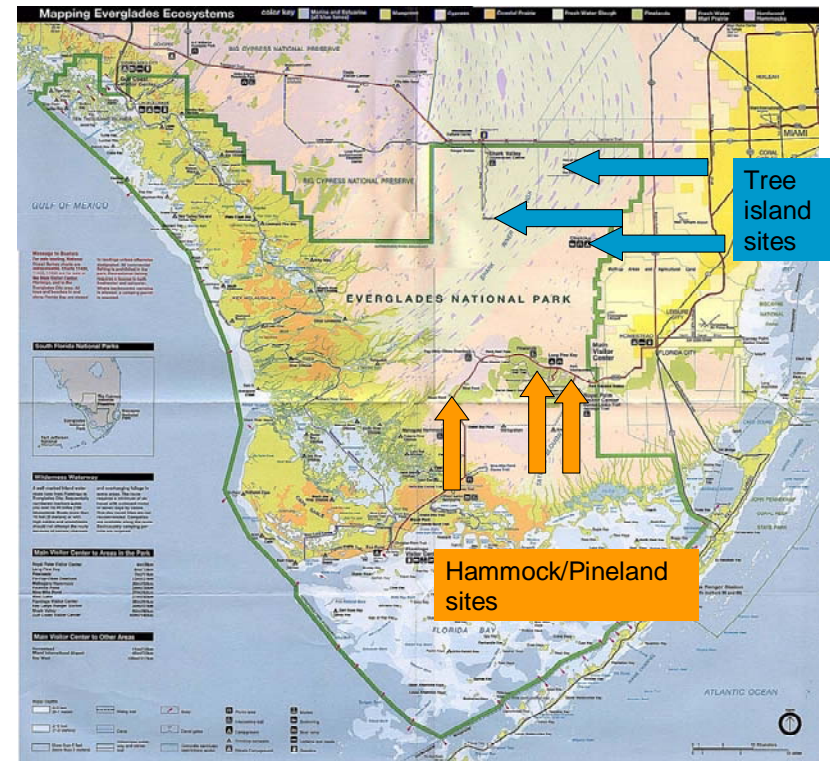
1. Miami Rock Ridge
2. Tree islands in Shark River Slough
3. Coastal ridges
4. Shell mounds

Flood intolerant.

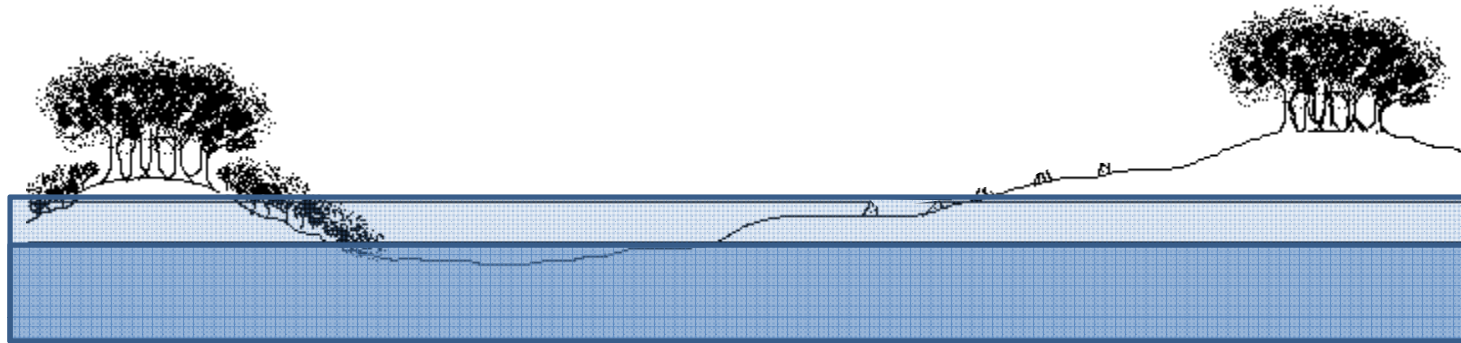
Susceptible to DROUGHT ?

Lowered water tables due to

1. Dry season water withholdings (mgmt)
2. Drought years

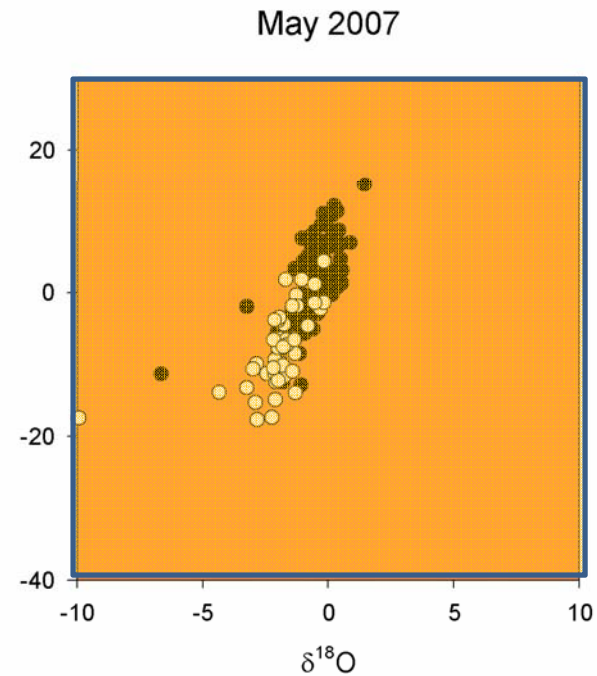
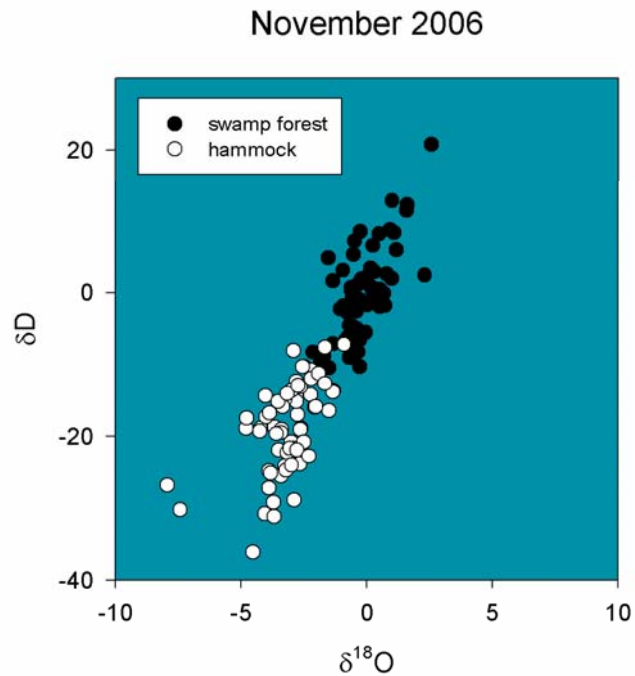
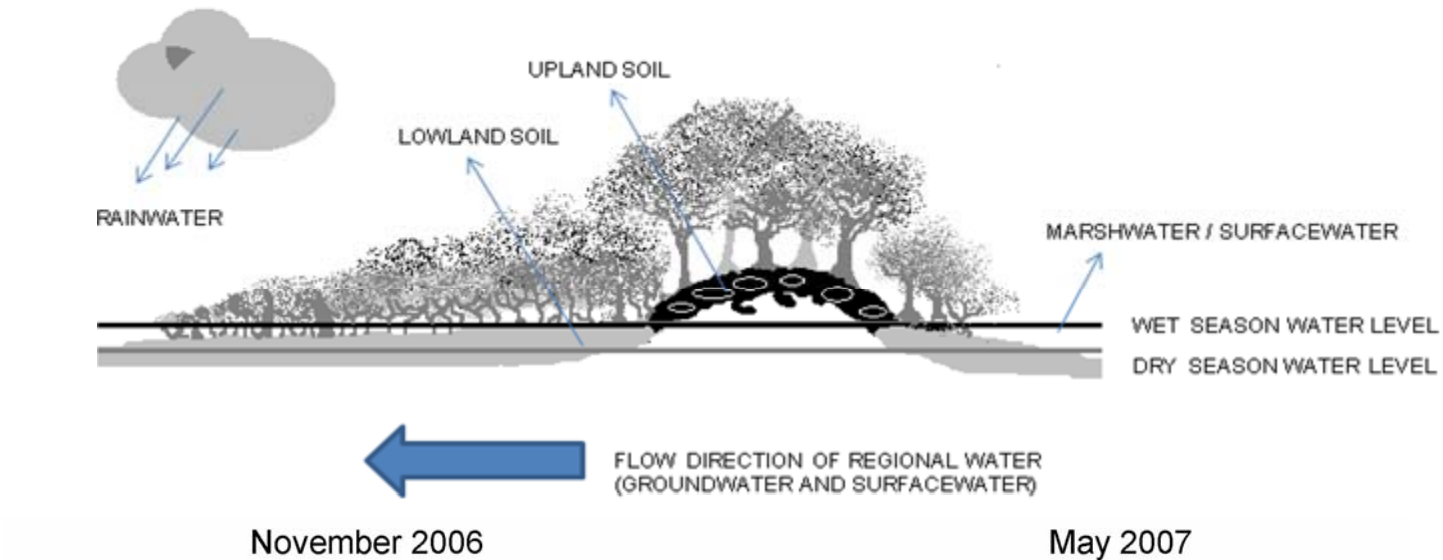


Tropical Hardwood Hammocks along a water availability gradient



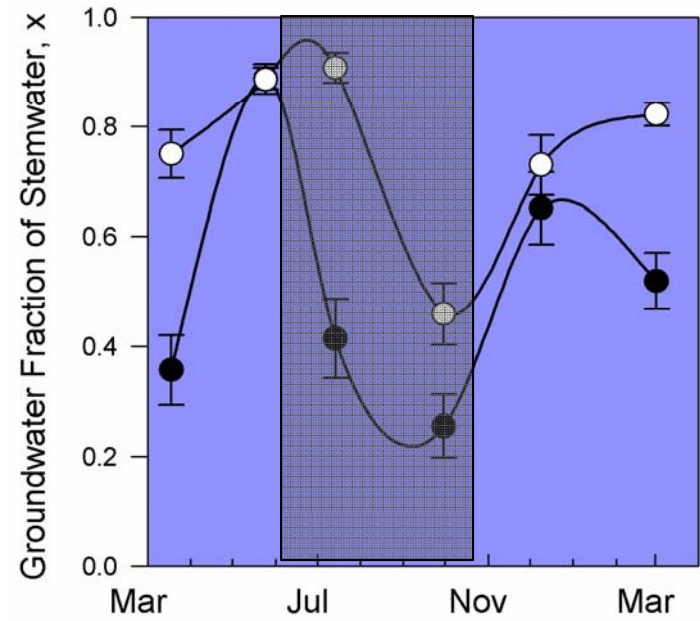
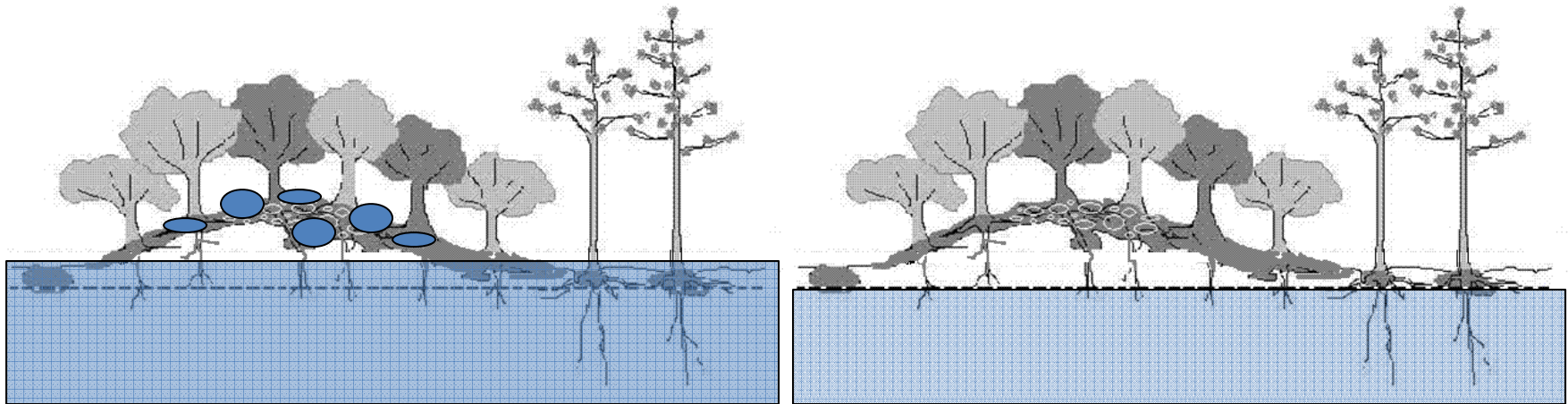
Tree island hammock	Miami Ridge Hammock
Year-round water availability	Seasonal water availability
Evergreen trees	Greater deciduousness
Lower water stress ?	Higher water stress ?

Tree islands: hammocks use groundwater in dry season



Saha et al. 2010. Wetlands Ecol & Mgmt

Miami Rock Ridge Hammocks: groundwater use in dry season

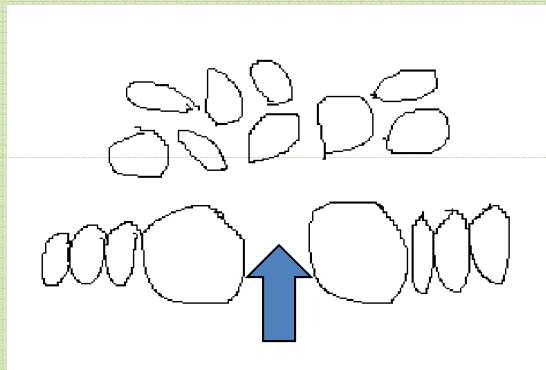


Saha et al 2009. Ecohydrology

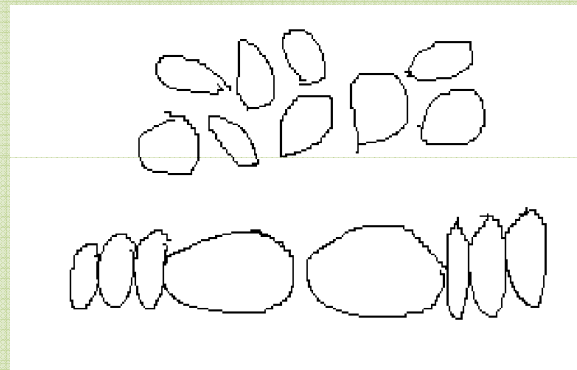
Tropical Hardwood Hammocks: Is DRY SEASON water uptake ADEQUATE ?

Plant water stress --- Stable Isotope of Carbon ($\delta^{13}\text{C}$)

Plants discriminate against ^{13}C during photosynthesis



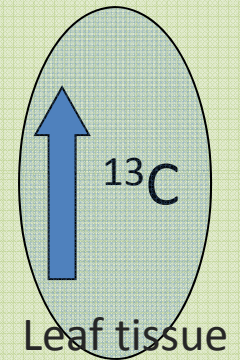
CO_2 enters leaf



Water stress

Stomatal closure

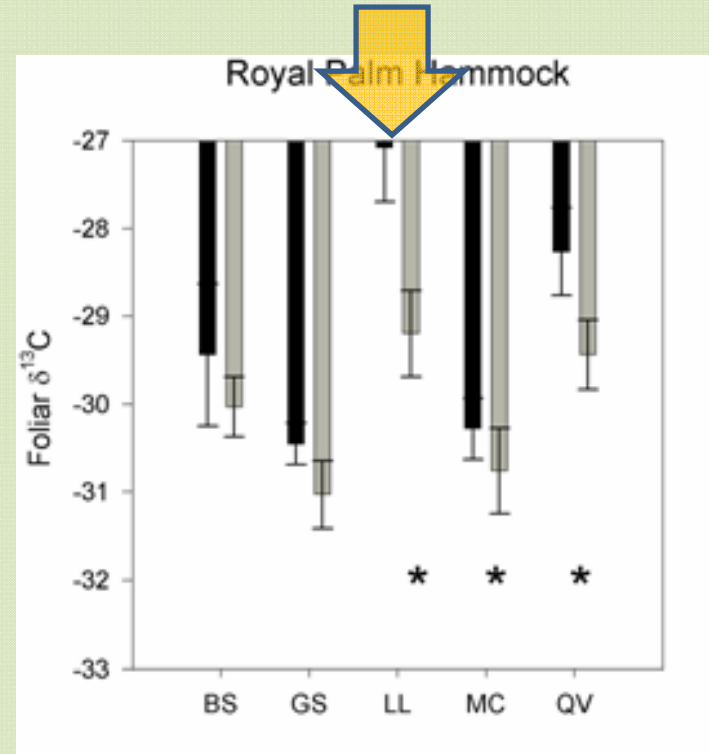
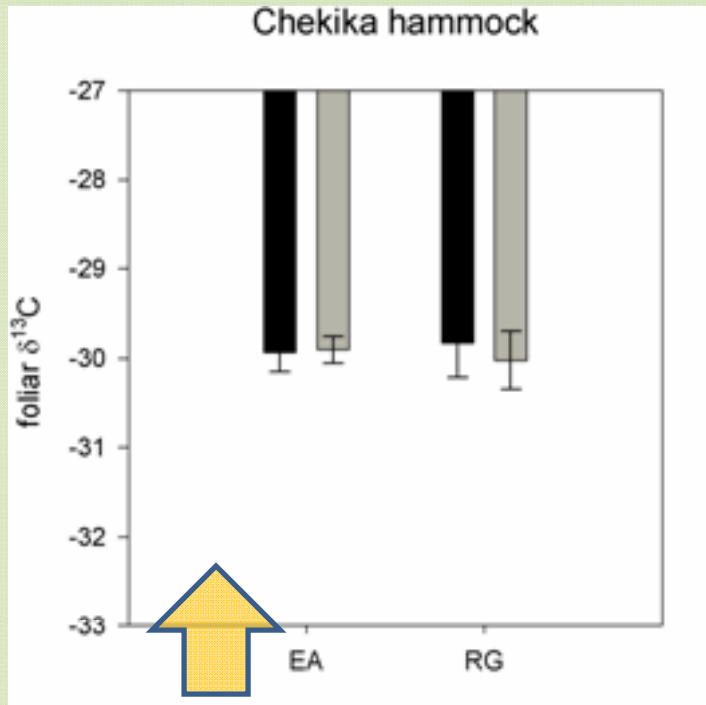
Reduced discrimination



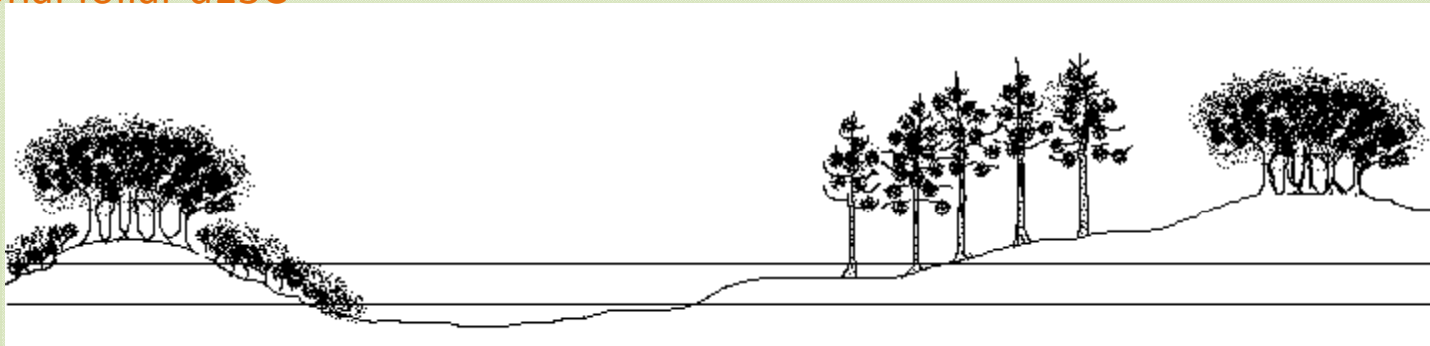
Leaf tissue

High $\delta^{13}\text{C}$ indicates photosynthesis is being limited

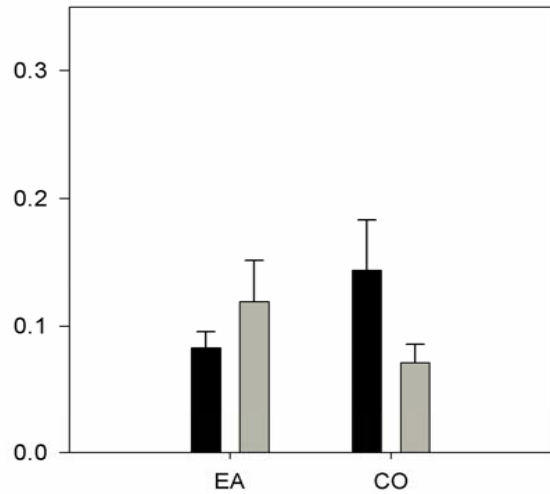
Ridge Hammocks: Significantly water stressed in DRY SEASON



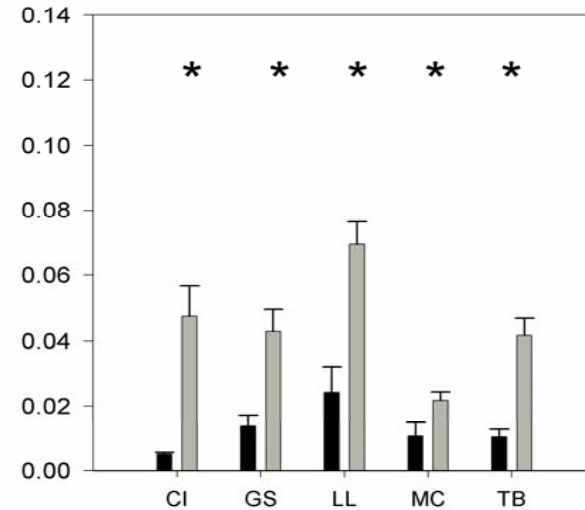
Tree Island Hammocks: no significant difference
In seasonal foliar $\delta^{13}\text{C}$



Leaf Phosphorus (mg/ml): period of water and nutrient uptake

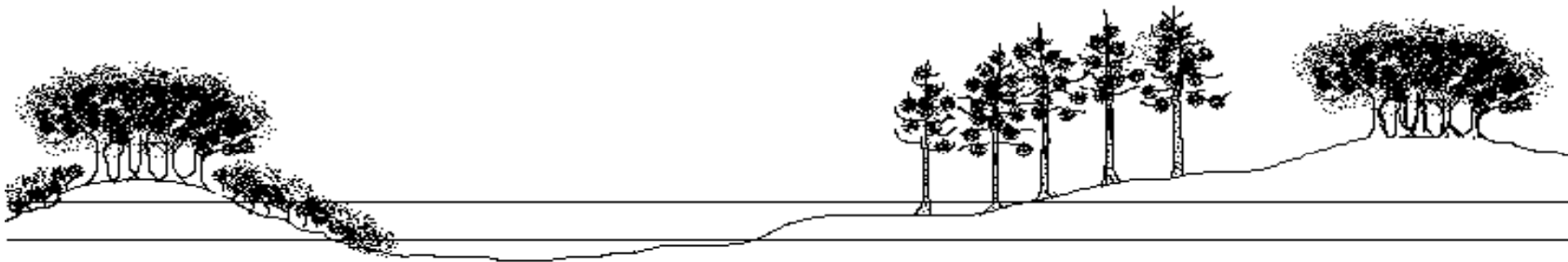


Tree islands:
no significant seasonal difference

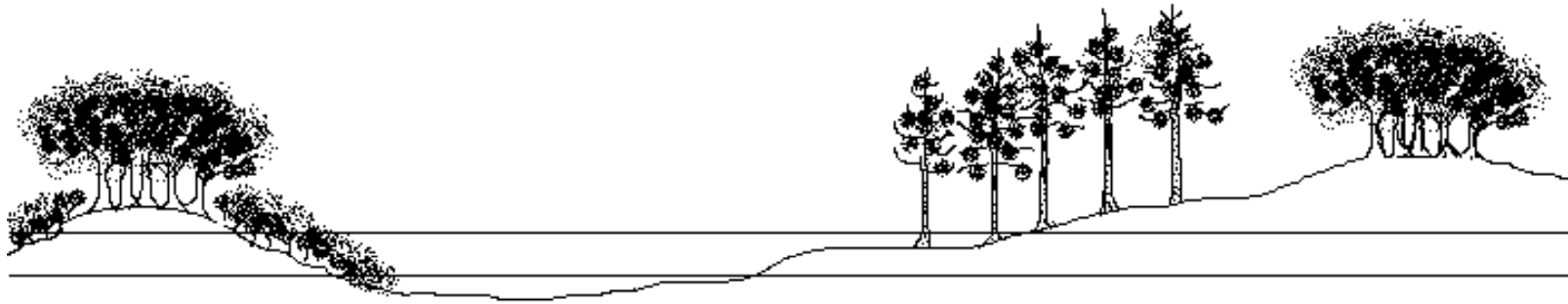


Ridge Hammocks:
Significant seasonal difference

Leaf P higher in wet season
-> season of water (and nutrient) uptake



RESULTS



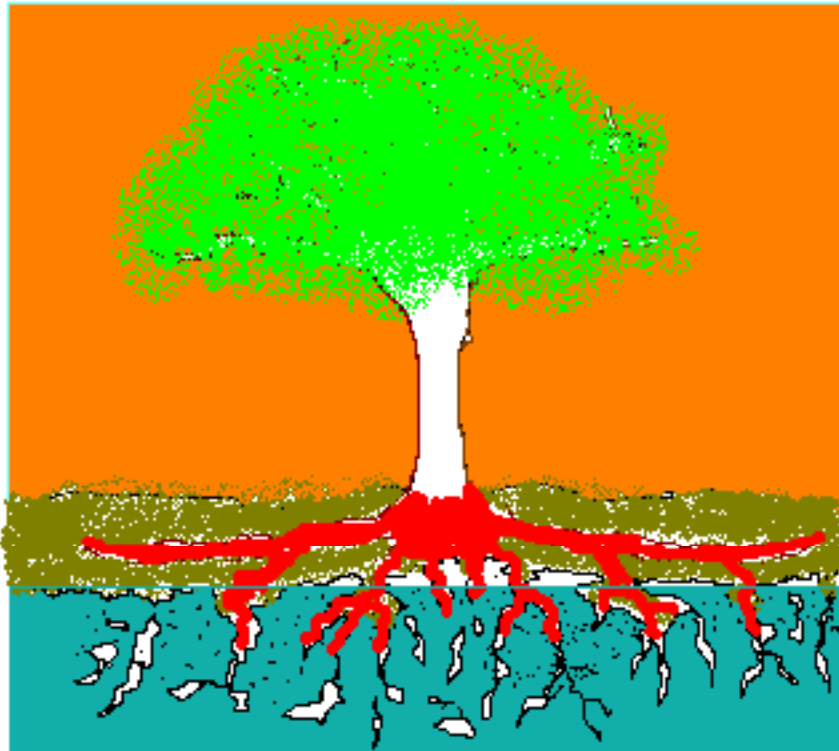
Ridge Hammocks are drier (lesser water availability) than tree island hammocks

Ridge Hammocks

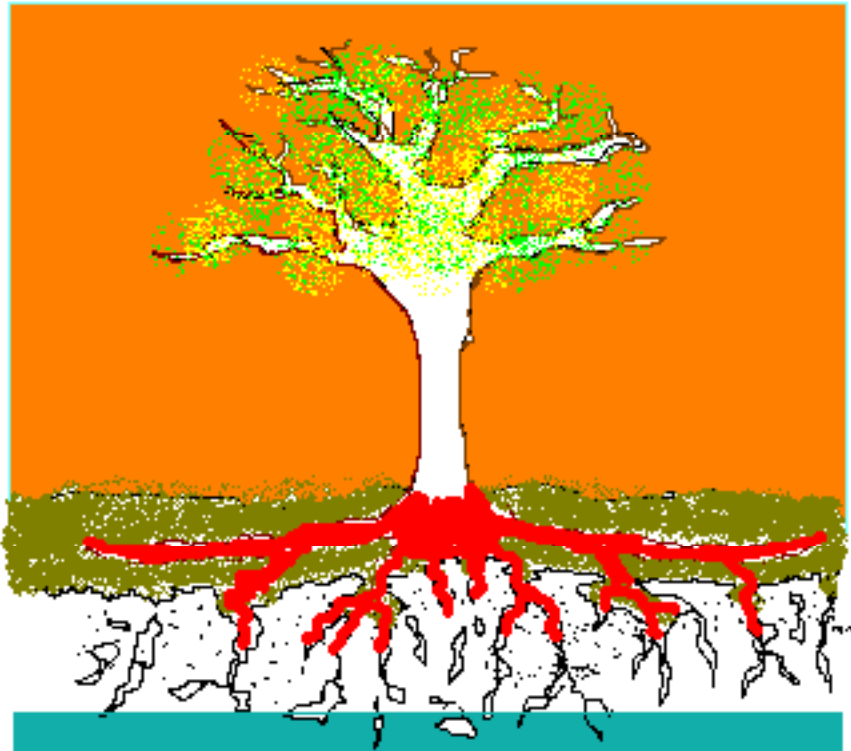
- Suffer greater water stress in dry season
- Take up most of their water (and nutrients) in the wet season
- A greater degree of deciduousness (eg *Lysiloma latisiliquum*)

Why is water availability less in Ridge Hammocks ?

Limestone bedrock restricts DRY SEASON water access to existing cracks

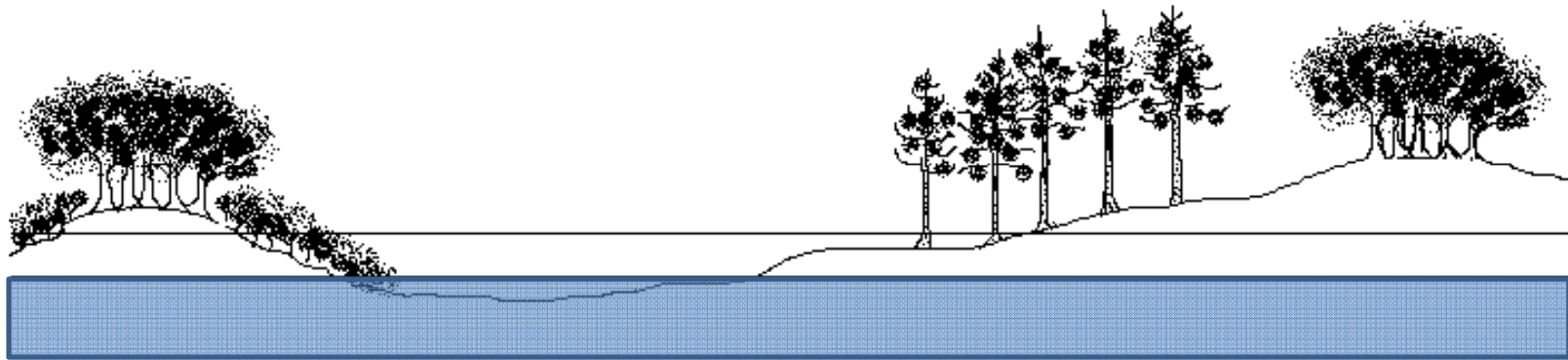


Wet season



Dry season

Lowered water table – tree island hammocks may face similar conditions as Ridge Hammocks



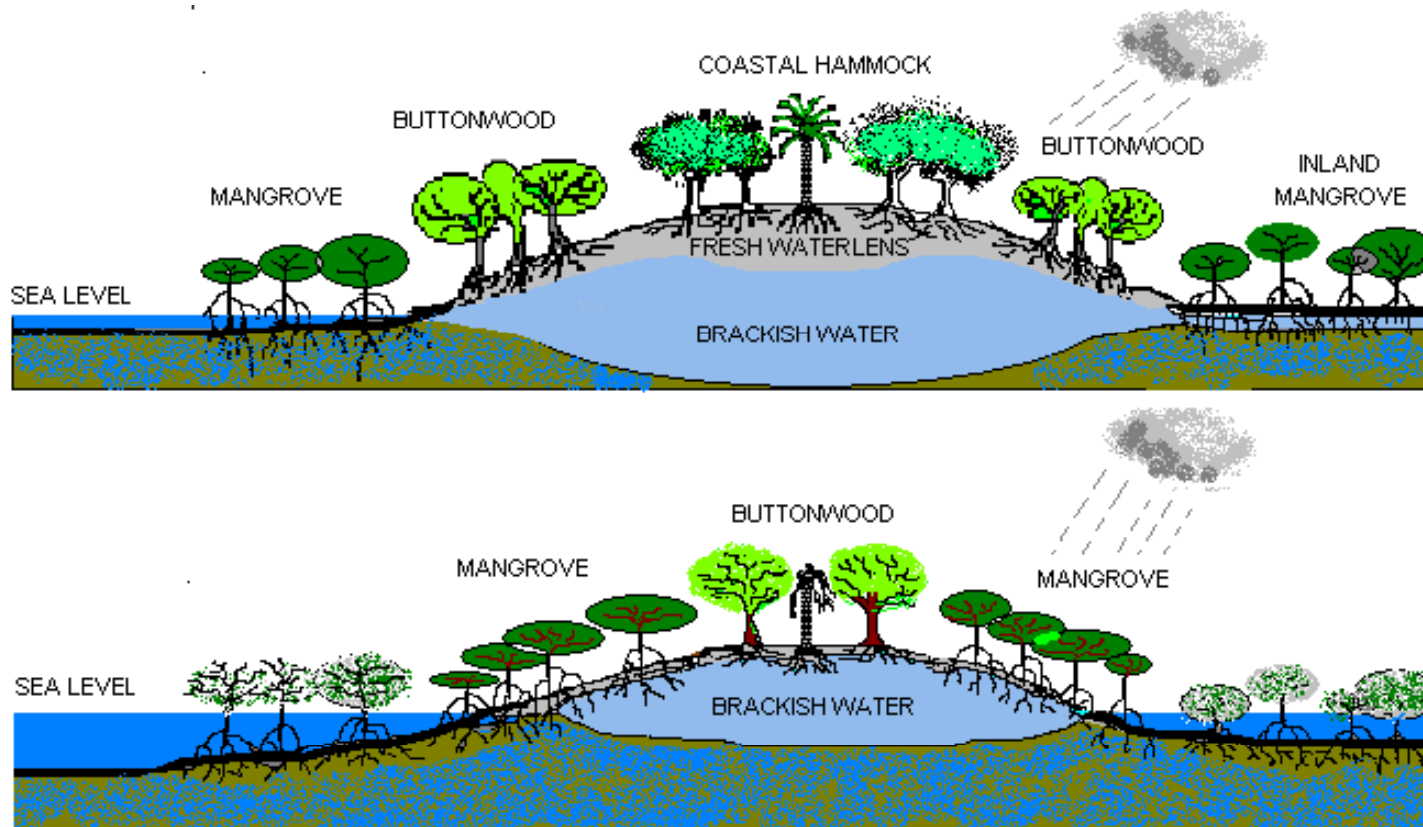
Additional Fire danger from dried Peat in slough.

Dry conditions will allow hammocks to expand ONLY IF successive wet season flooding does not kill saplings.

Multidecadal droughts can lead to hardwood hammock expansion.

But the Everglades also faces Sea Level Rise, with attendant salinization of The groundwater.

Vanishing Coastal hammocks: Sea Level Rise and Decreased Freshwater Inflows



Considerations for ENP tree islands management

Water management – increase period of inflows through S12s.

1. **Flood intolerance** – monitor daily stage on tree islands so as not to inundate hardwood hammocks (the head). Especially in years of HIGH precipitation, and sudden releases of water into Everglades NP.
2. **Drought susceptibility** – monitor daily stage so as to not drop below low levels (swamp forest) in dry season thereby increase drought and fire susceptibility. Especially for years with below normal precipitation.

Fire management



Acknowledgements

Dr Rene Price, Hydrologist, Department of Earth and Environment, FIU

Dr Sonali Saha, Ecologist, Institute for Regional Conservation, Miami

Dr Christopher Moses, FCE-LTER, FIU

Patrick Ellsworth, Xin Wang and other graduate students from University of Miami

Funding:

NSF - stable isotope and nutrient studies in the Everglades

FCE-LTER – logistical access to tree islands and support for this presentation

