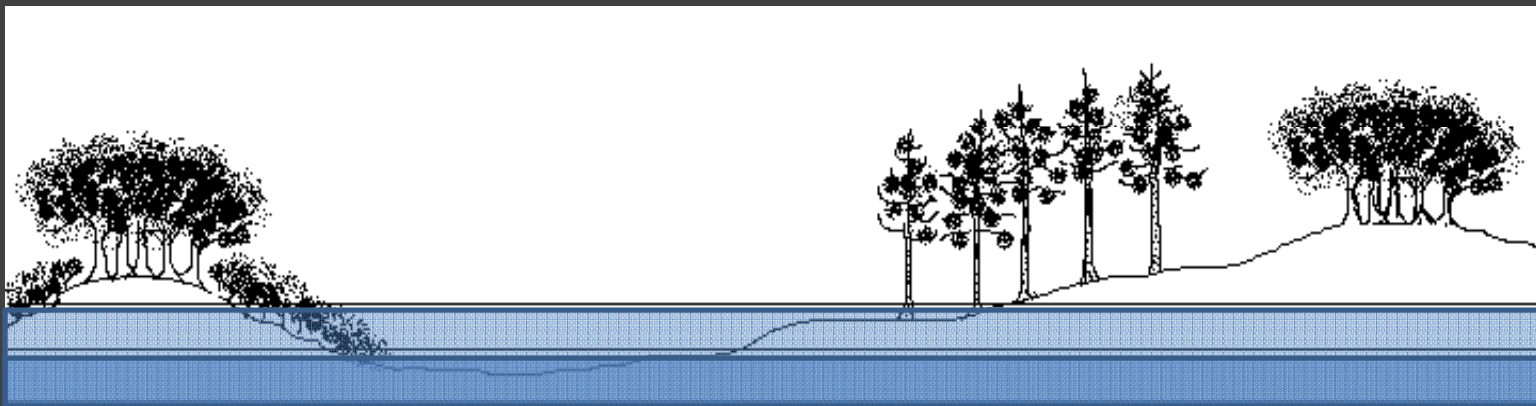


Droughts:  
while tree islands can expand,  
can tropical hardwood hammocks **VANISH ?**  
Tropical Hardwood Hammocks along a  
water availability gradient



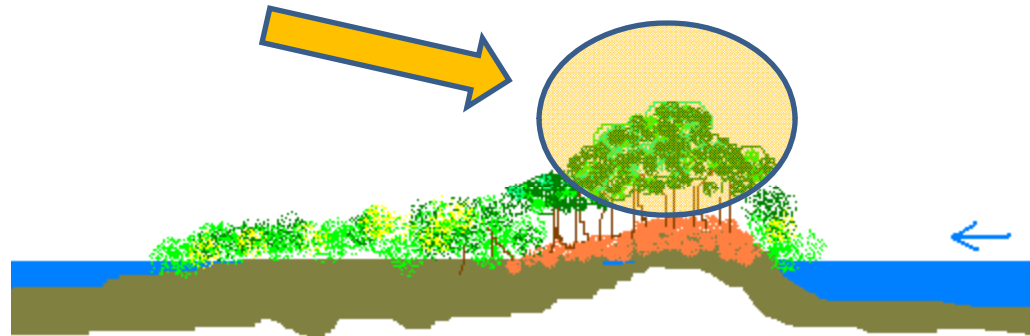
Amartya Saha<sup>1</sup>, Leonel Sternberg<sup>2</sup>, Michael Ross<sup>3</sup>, Fernando Miralles-Wilhelm<sup>3</sup>

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





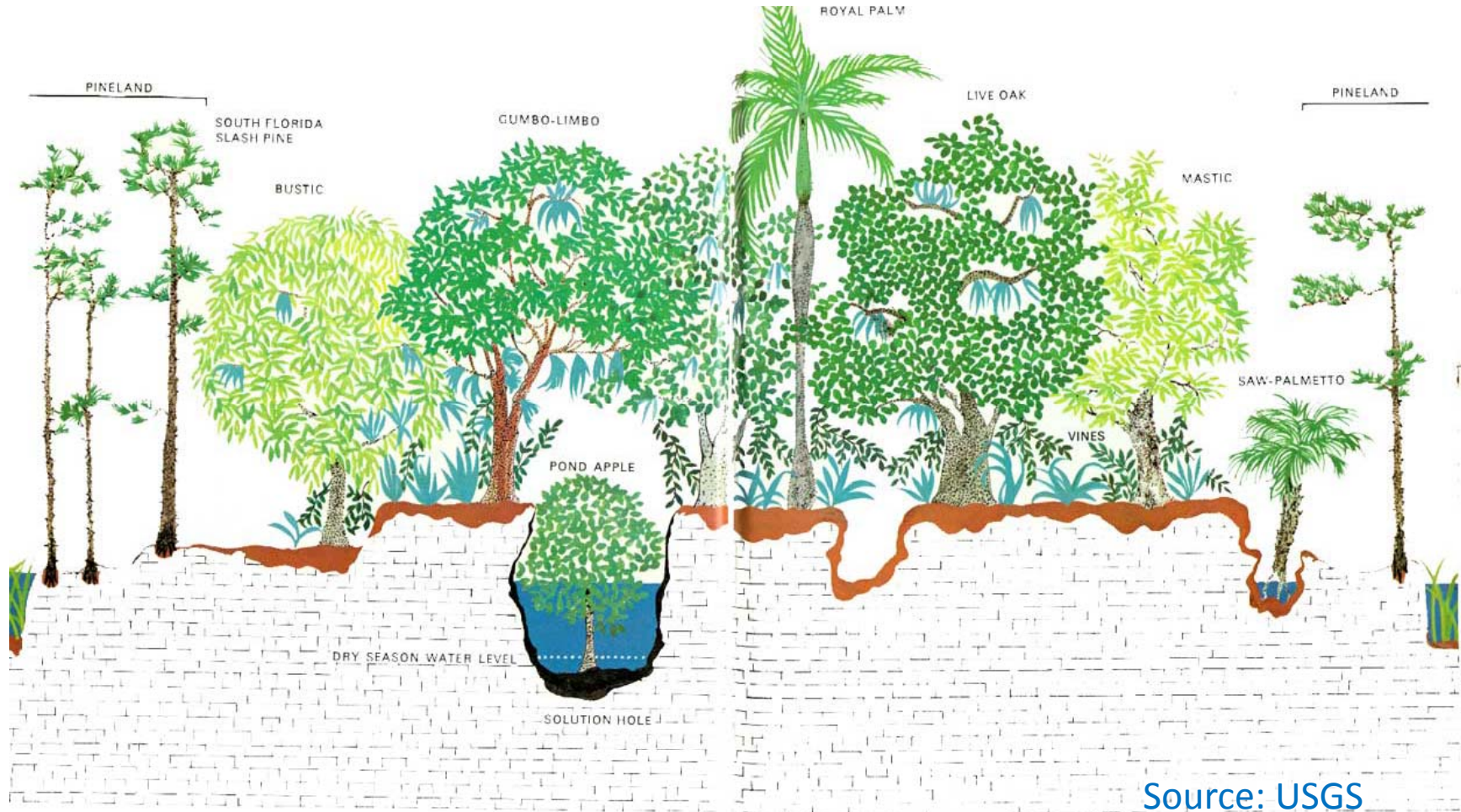
Tropical hardwood hammocks – HEAD of tree islands in Shark River Slough, ENP



# 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:

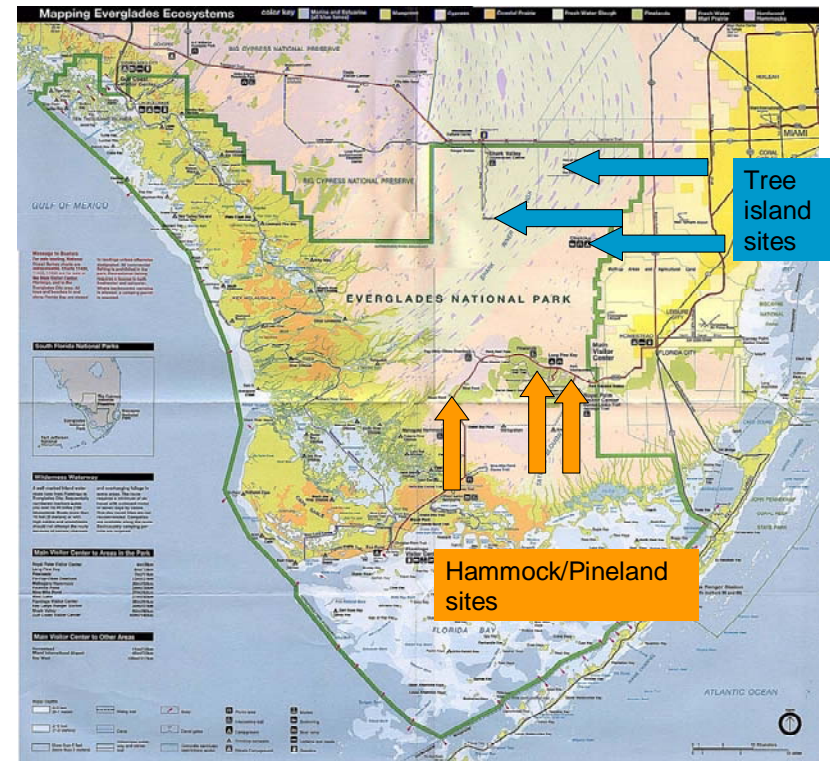
1. Miami Rock Ridge
2. Tree islands in Shark River Slough
3. Coastal ridges
4. Shell mounds

Flood intolerant.

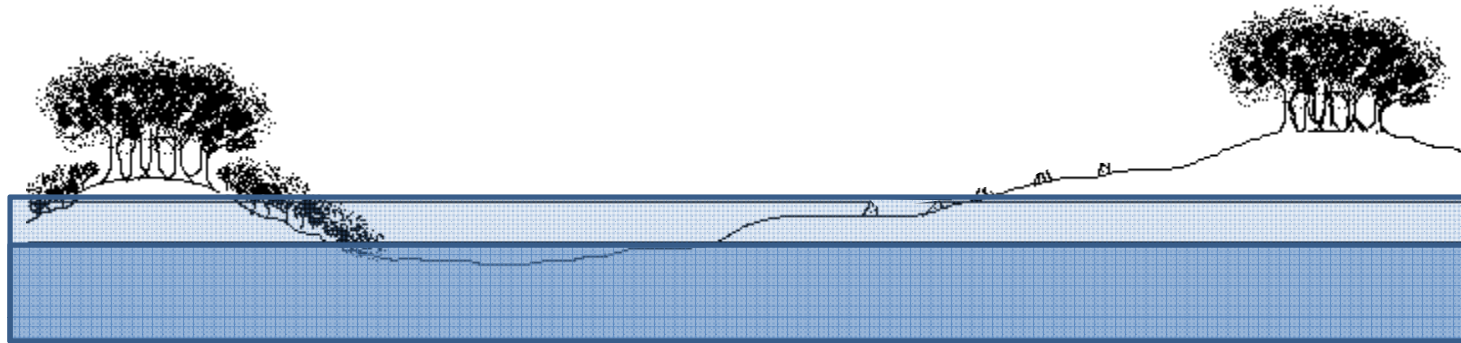
Susceptible to DROUGHT ?

Lowered water tables due to

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

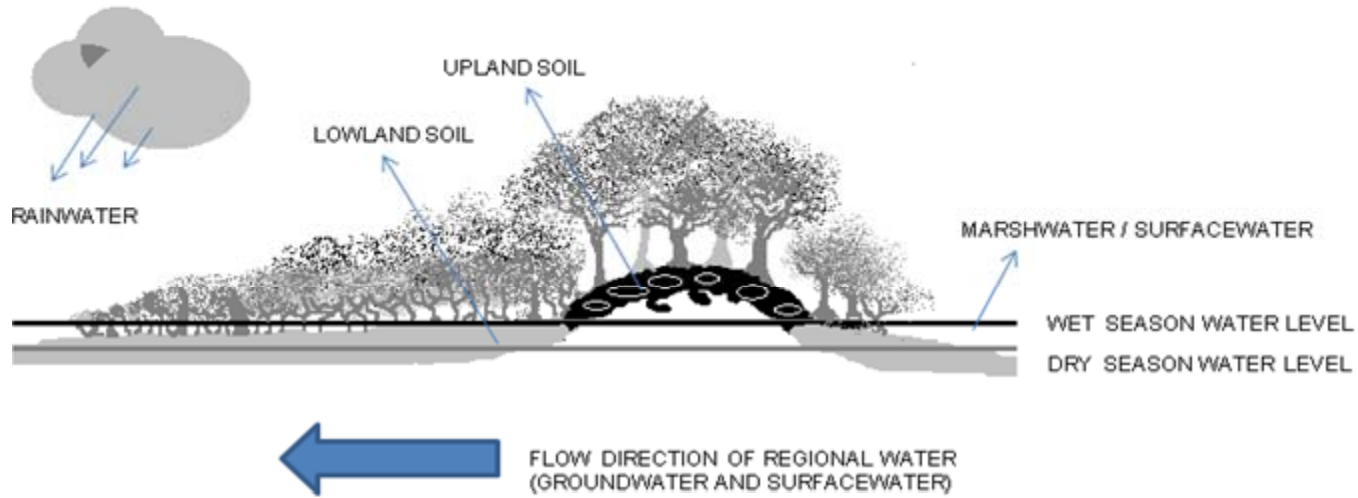


# Tropical Hardwood Hammocks along a water availability gradient

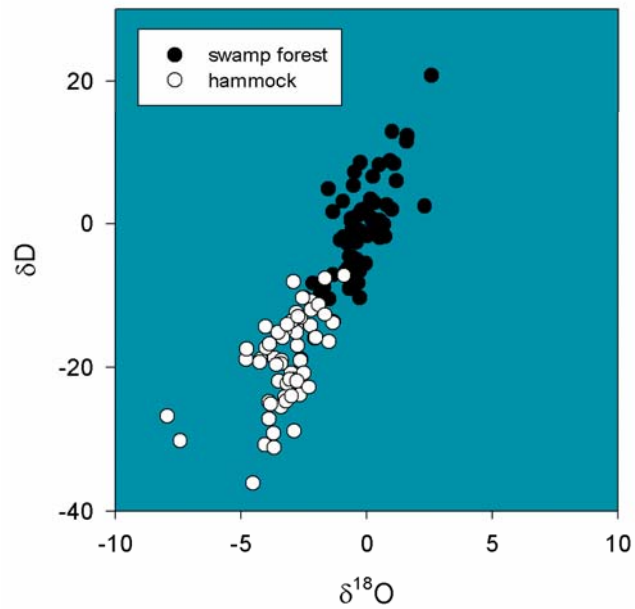


Tree island hammock	Miami Ridge Hammock
Year-round water availability	Seasonal water availability
Evergreen trees	Greater deciduousness
Lower water stress ?	Higher water stress ?

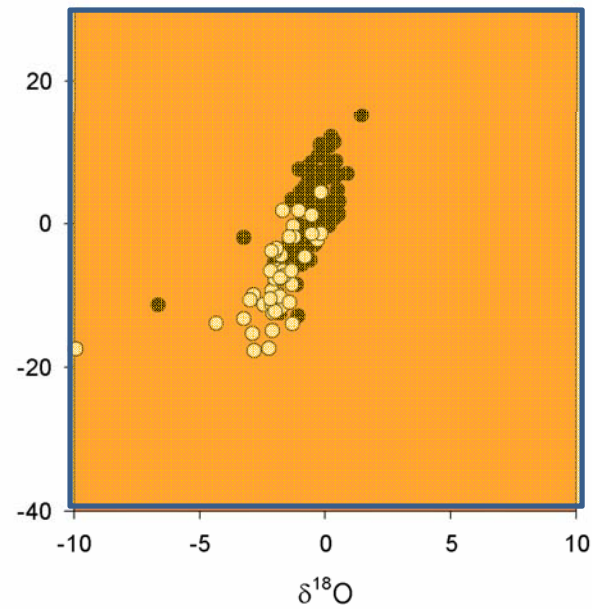
## Tree islands: hammocks use groundwater in dry season



November 2006

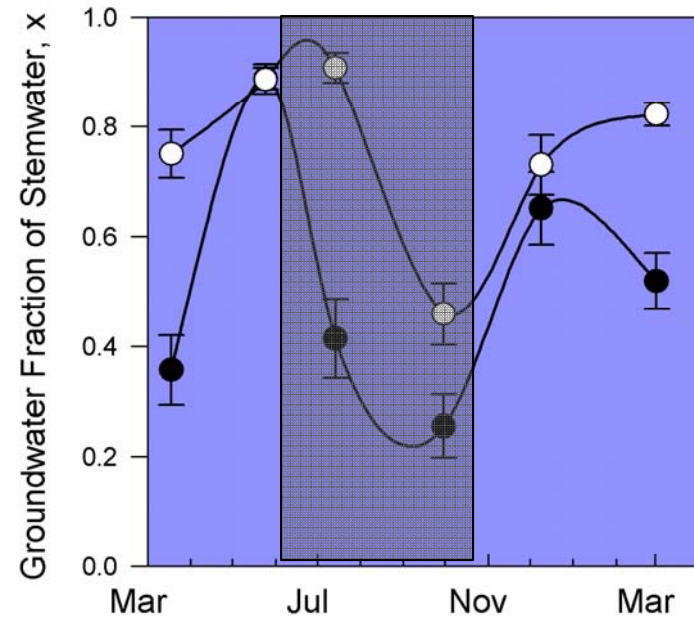
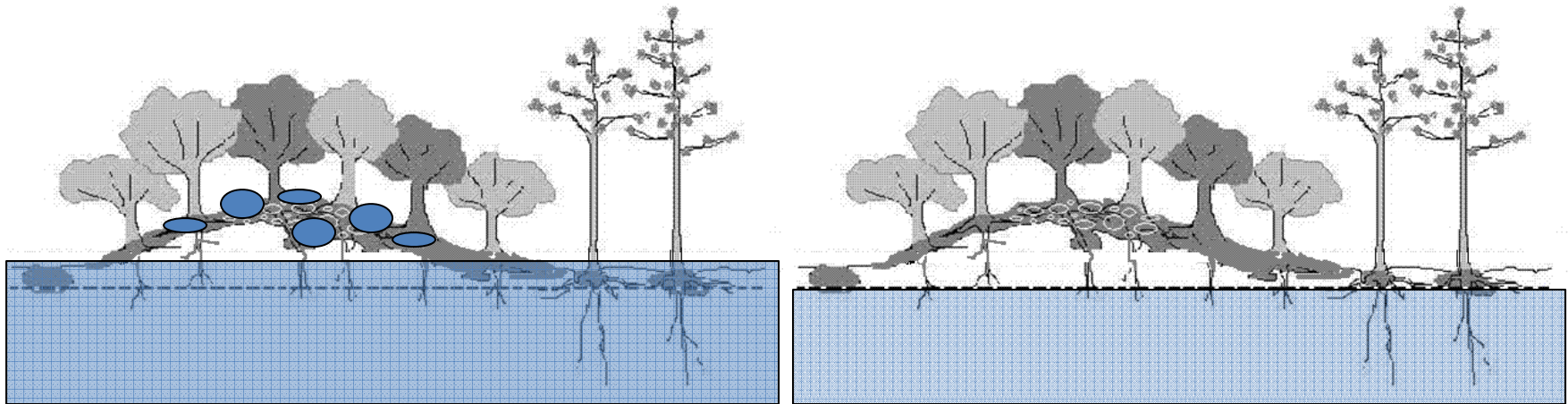


May 2007



Saha et al. 2010. Wetlands Ecol & Mgmt

# Miami Rock Ridge Hammocks: groundwater use in dry season



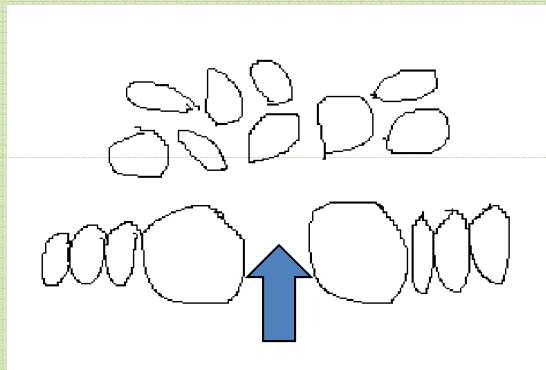
Saha et al 2009. Ecohydrology



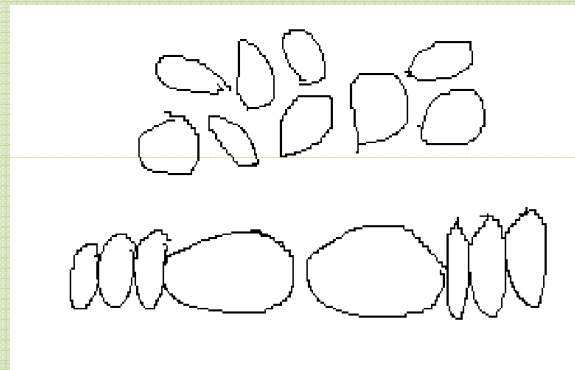
# Tropical Hardwood Hammocks: Is DRY SEASON water uptake ADEQUATE ?

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

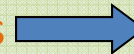
Plants discriminate against  $^{13}\text{C}$  during photosynthesis



$\text{CO}_2$  enters leaf

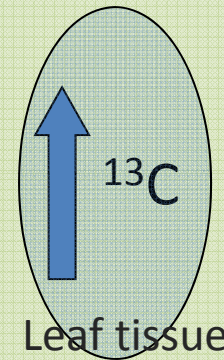


Water stress



Stomatal closure

Reduced discrimination

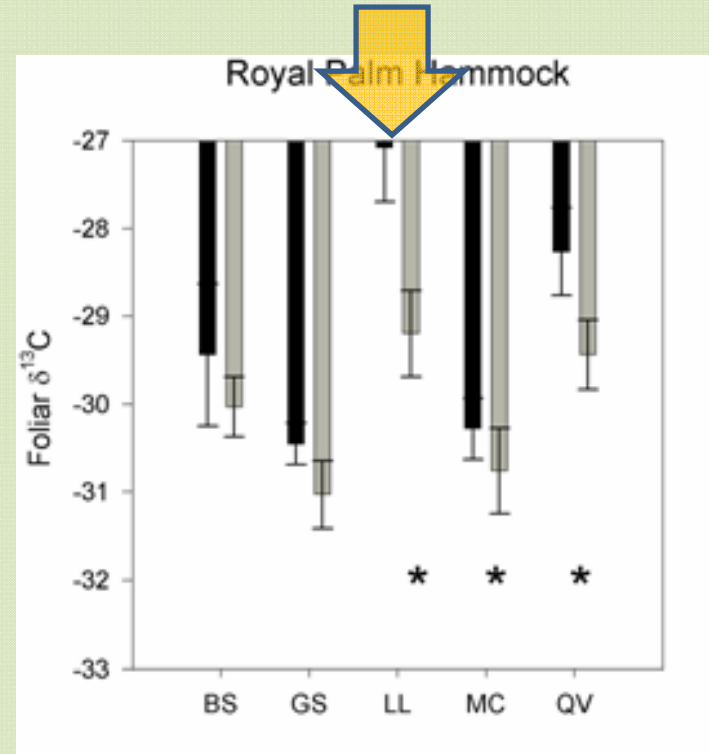
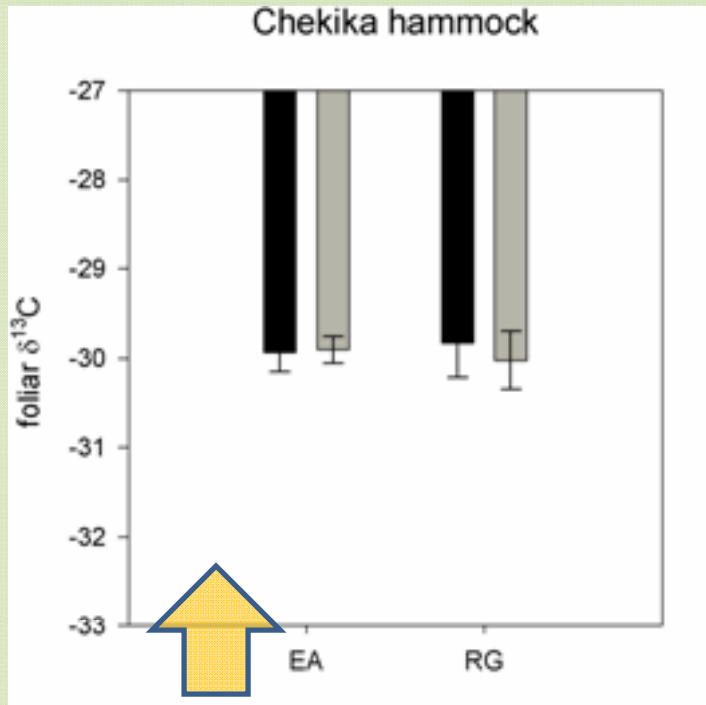


Leaf tissue

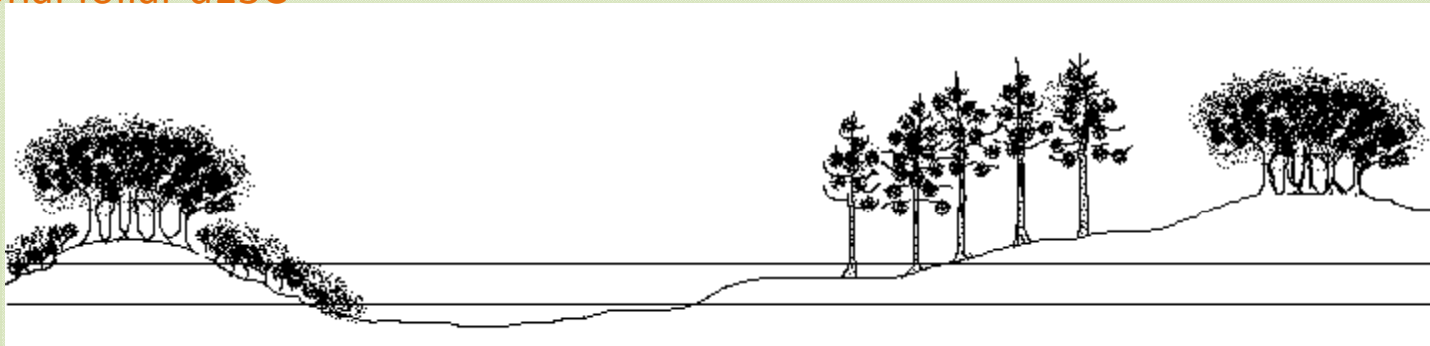
High  $\delta^{13}\text{C}$  indicates photosynthesis is being limited



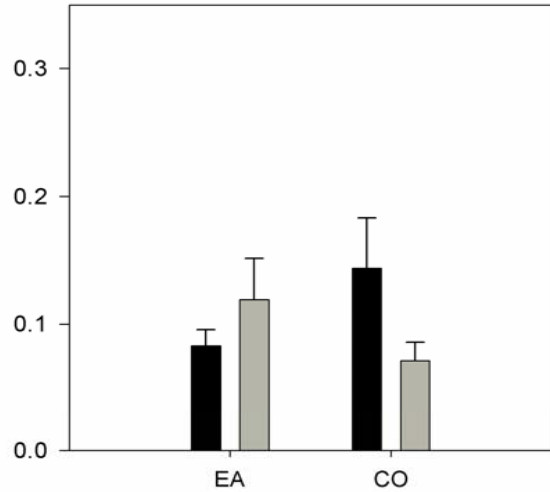
# Ridge Hammocks: Significantly water stressed in DRY SEASON



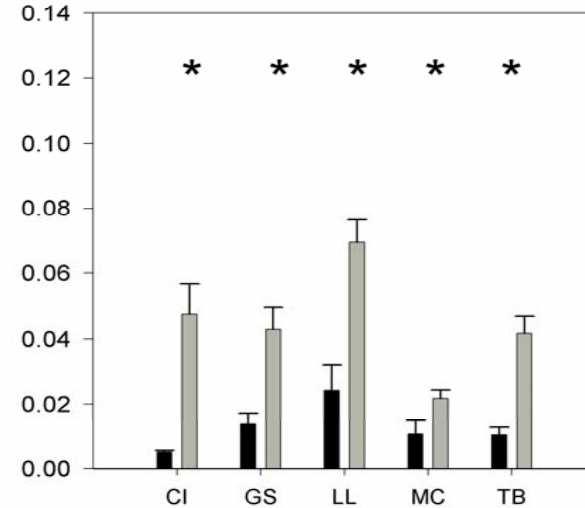
Tree Island Hammocks: no significant difference  
In seasonal foliar  $\delta^{13}\text{C}$



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

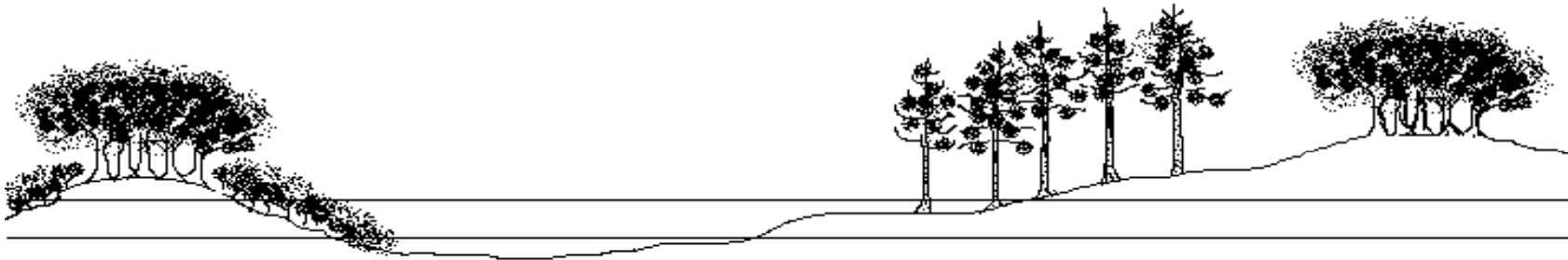


Tree islands:  
no significant seasonal difference

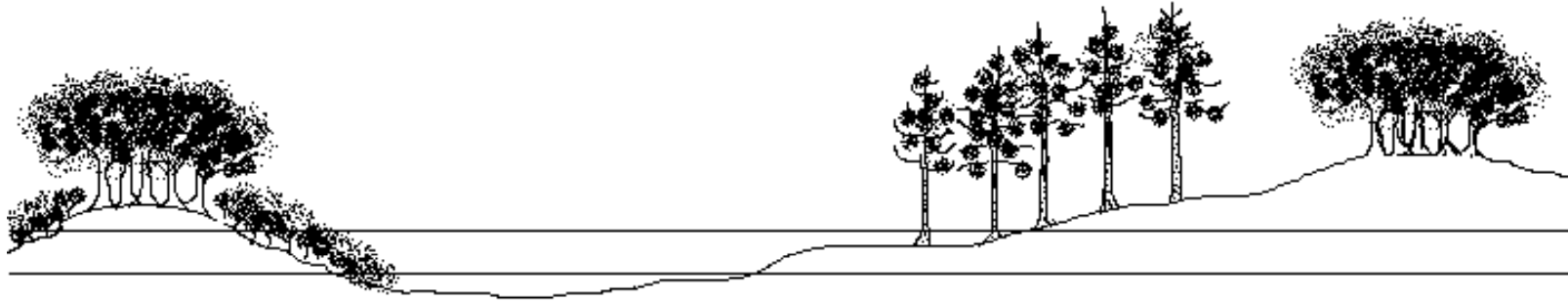


Ridge Hammocks:  
Significant seasonal difference

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



## RESULTS



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

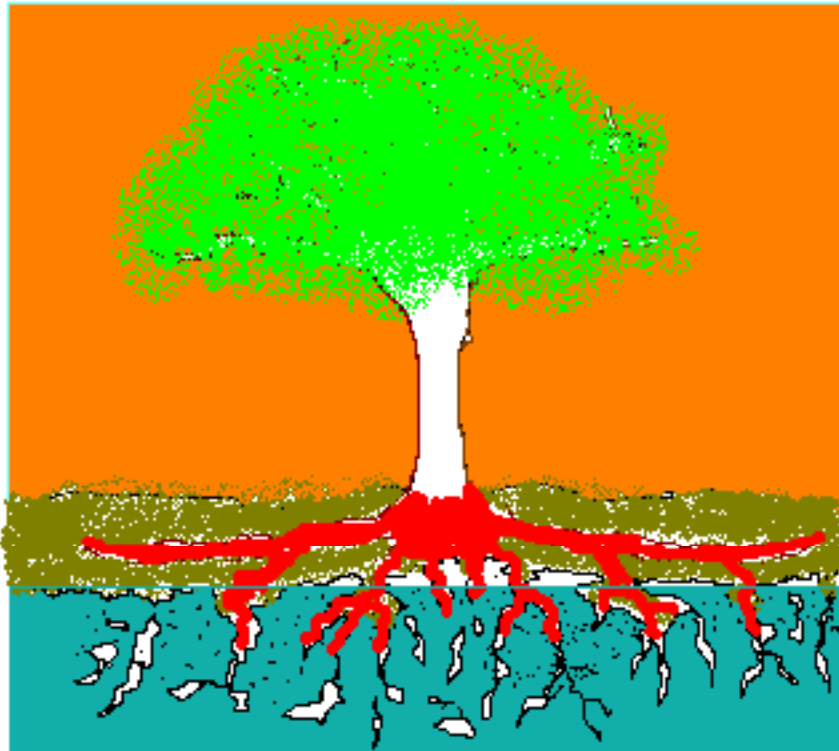
Ridge Hammocks

- 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* )

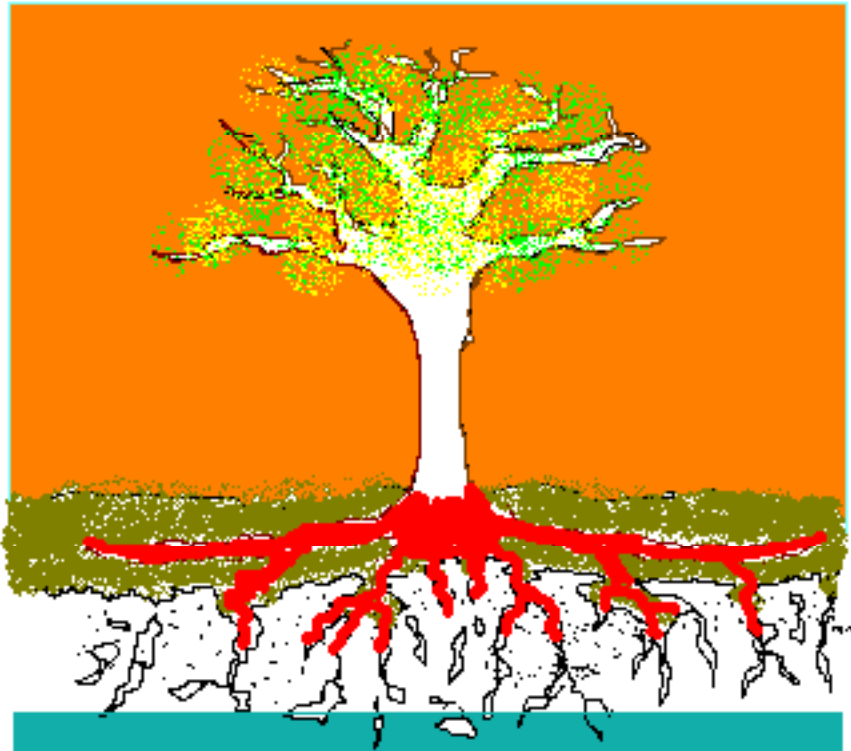
Why is water availability less in Ridge Hammocks ?



Limestone bedrock restricts DRY SEASON water access to existing cracks

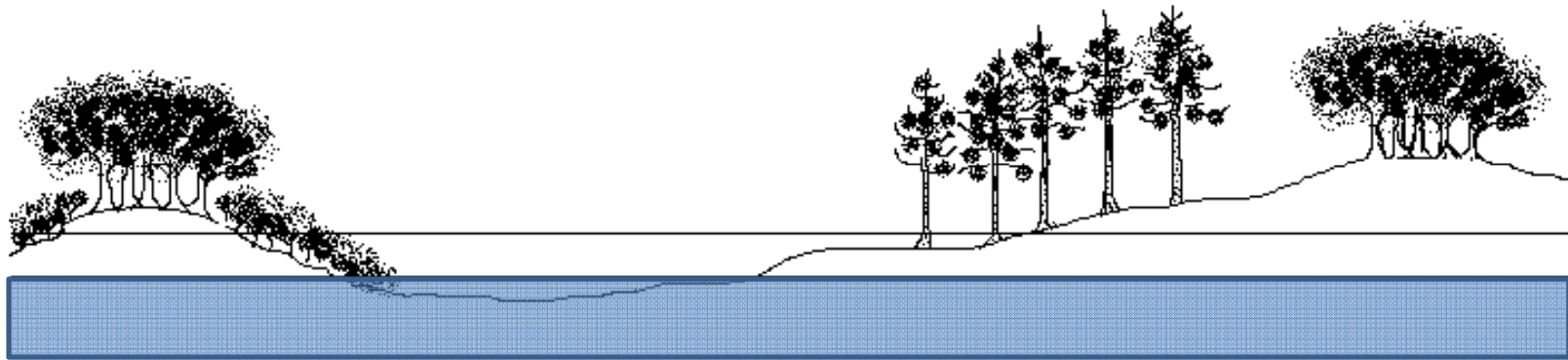


Wet season



Dry season

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



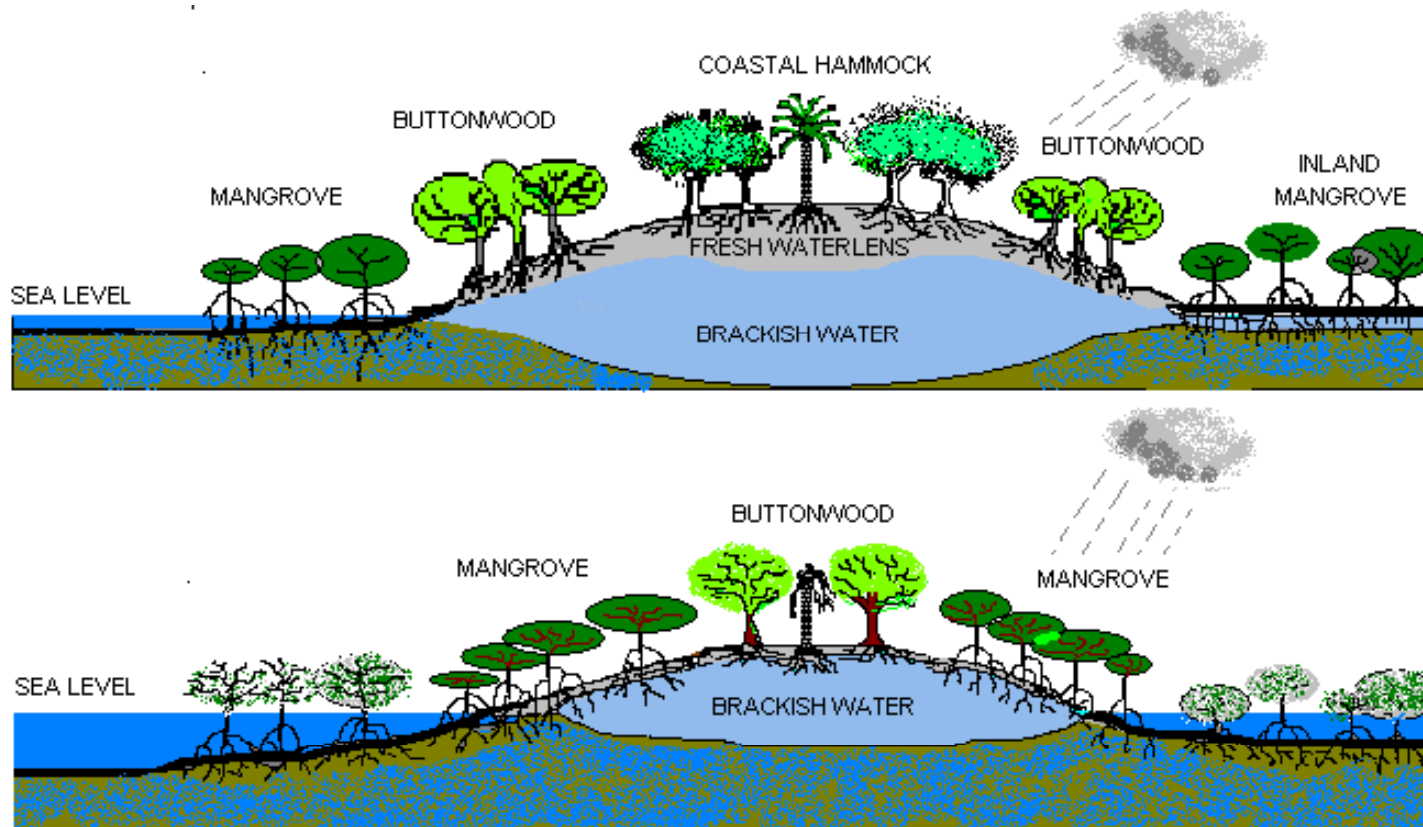
Additional Fire danger from dried Peat in slough.

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

