Role of groundwater depth and salinity in distribution of coastal forest communities in Everglades National Park

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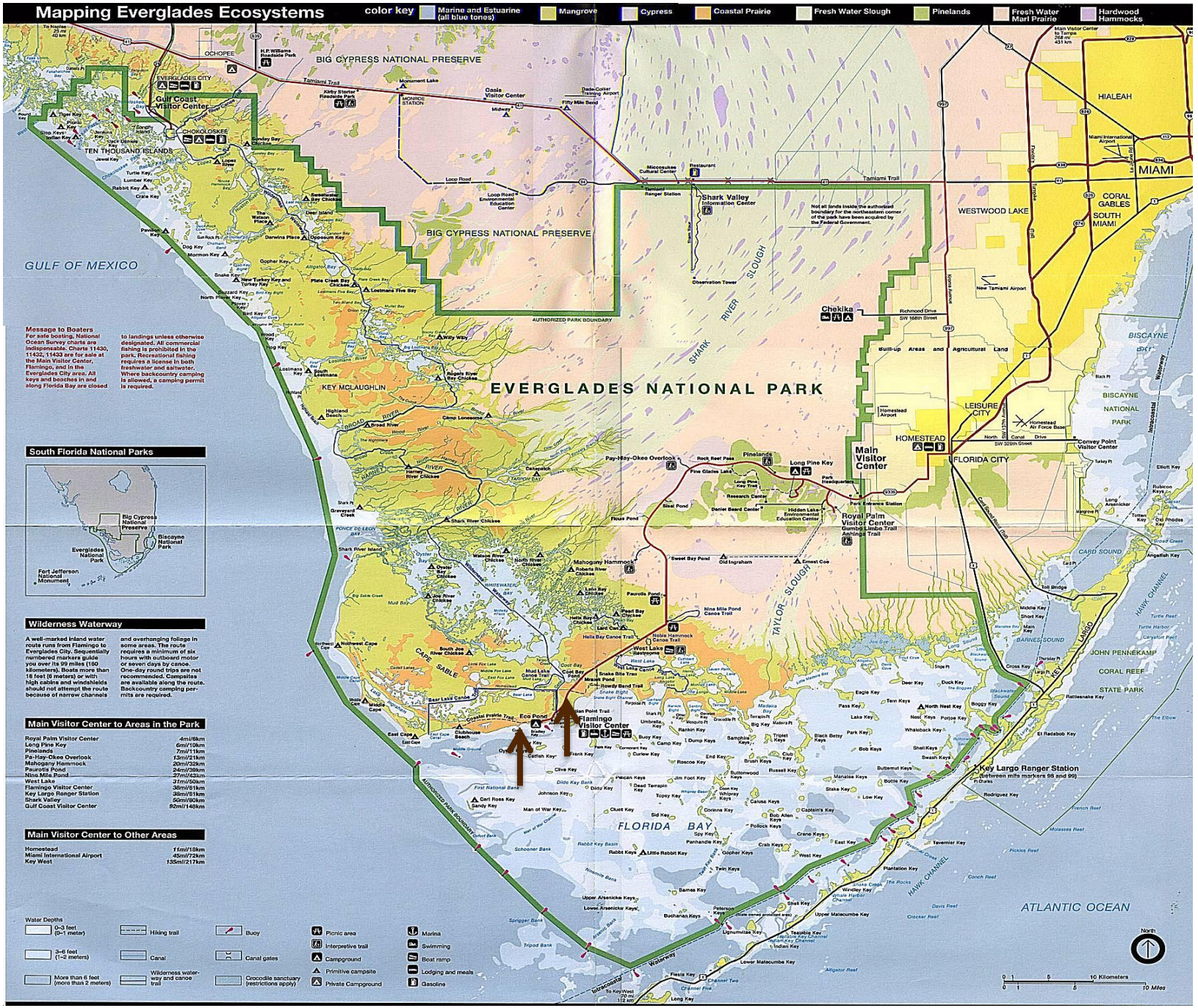
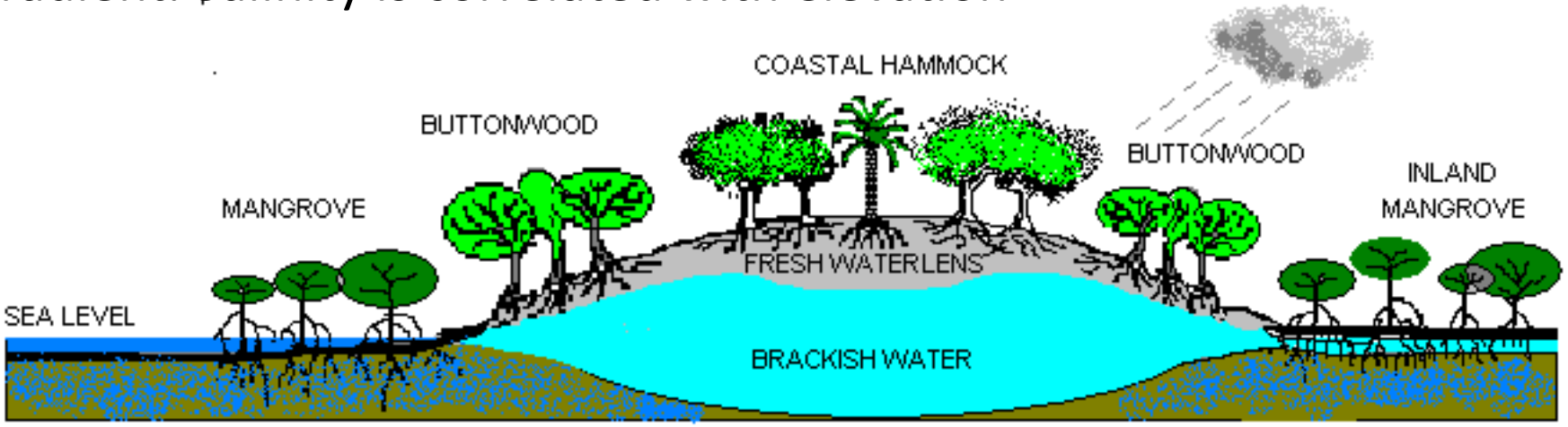
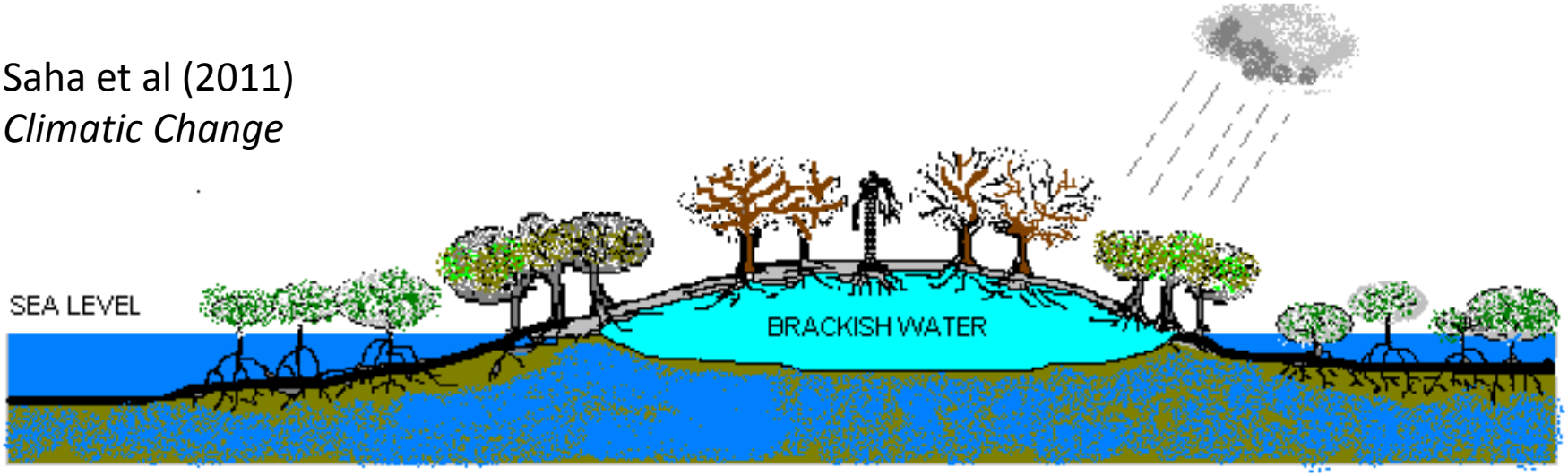

Mapping Everglades Ecosystems
color key
Marine and Estuarine (all blue tones)
Mangrove
Cypress
Coastal Prairie
Fresh Water Slough
Pinelands
Fresh Water Marl Prairie
Hardwood Hammocks
BIG CYPRESS NATIONAL PRESERVE
EVERGLADES NATIONAL PARK
GULF OF MEXICO
ATLANTIC OCEAN
FLORIDA BAY
OCHOPEE
EVERGLADES CITY
Gulf Coast Visitor Center
CHOKOLOSKEE
TEN THOUSAND ISLANDS
KEY MCLAUGHLIN
Shark Valley Information Center
Chekika
Main Visitor Center
Flamingo Visitor Center
Eco Pond
Royal Palm Visitor Center
Gumbo Limbo Trail
Ashinga Trail
Long Pine Key
Pa-Hay-Okee Overlook
Mahogany Hammock
Paurotis Pond
Nine Mile Pond
West Lake
Key Largo Ranger Station
(between mile markers 98 and 99)
HIALEAH
MIAMI
CORAL GABLES
SOUTH MIAMI
WESTWOOD LAKE
HOMESTEAD
FLORIDA CITY
LEISURE CITY
BISCAYNE NATIONAL PARK
JOHN PENNEKAMP CORAL REEF STATE PARK
Message to Boaters
For safe boating, National Ocean Survey charts are indispensable. Charts 11430, 11432, 11433 are for sale at the Main Visitor Center, Flamingo, and in the Everglades City area. All keys and beaches in and along Florida Bay are closed to landings unless otherwise designated. All commercial fishing is prohibited in the park. Recreational fishing requires a license in both freshwater and saltwater. Where backcountry camping is allowed, a camping permit is required.
South Florida National Parks
Big Cypress National Preserve
Biscayne National Park
Everglades National Park
Fort Jefferson National Monument
Wilderness Waterway
A well-marked inland water route runs from Flamingo to Everglades City. Sequentially numbered markers guide you over its 99 miles (160 kilometers). Boats more than 18 feet (6 meters) or with high cabins and windshields should not attempt the route because of narrow channels and overhanging foliage in some areas. The route requires a minimum of six hours with outboard motor or seven days by canoe. One-day round trips are not recommended. Campsites are available along the route. Backcountry camping permits are required.
Main Visitor Center to Areas in the Park
Royal Palm Visitor Center 4mi/6km
Long Pine Key 6mi/10km
Pinelands 7mi/11km
Pa-Hay-Okee Overlook 13mi/21km
Mahogany Hammock 20mi/32km
Paurotis Pond 24mi/38km
Nine Mile Pond 27mi/43km
West Lake 31mi/50km
Flamingo Visitor Center 38mi/61km
Key Largo Ranger Station 38mi/61km
Shark Valley 56mi/90km
Gulf Coast Visitor Center 92mi/148km
Main Visitor Center to Other Areas
Homestead 11mi/18km
Miami International Airport 45mi/72km
Key West 135mi/217km
Water Depths
0–3 feet (0–1 meter)
3–6 feet (1–2 meters)
More than 6 feet (more than 2 meters)
Hiking trail
Canal
Wilderness waterway and canoe trail
Buoy
Canal gates
Crocodile sanctuary (restrictions apply)
Picnic area
Interpretive trail
Campground
Primitive campsite
Private Campground
Marina
Swimming
Boat ramp
Lodging and meals
Gasoline
Waterway
Intracoastal
AUTHORIZED PARK BOUNDARY
North
0 1 5 10 Kilometers
0 1 5 10 Miles

Hypothesis 1: Plant communities aligned along well defined elevation gradient. Salinity is correlated with elevation



Saha et al (2011)
Climatic Change



Hypothesis 2: Hardwood species are most susceptible to SLR followed by buttonwood and associated rare taxa

Eugenia foetida

Piscidia piscipula

Capparis flexuosa

Chromolaena frustrata

Conocarpus erectus

Field studies to test hypothesis 1

- Measure depth and salinity regime of groundwater in buttonwood-hardwood hammock complex
- Get precise elevation

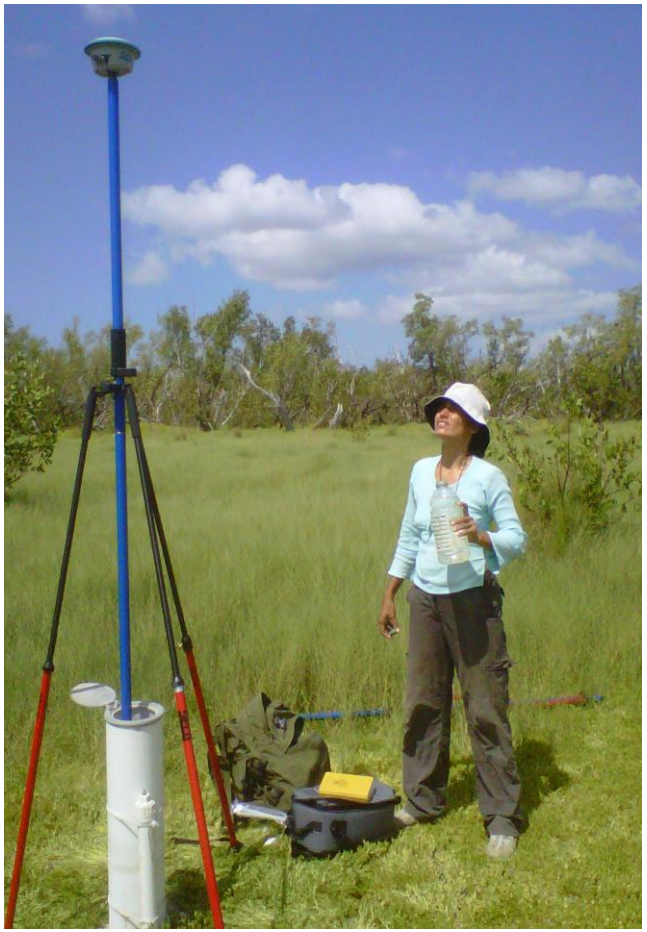
Installed 1 m deep wells in marl soil

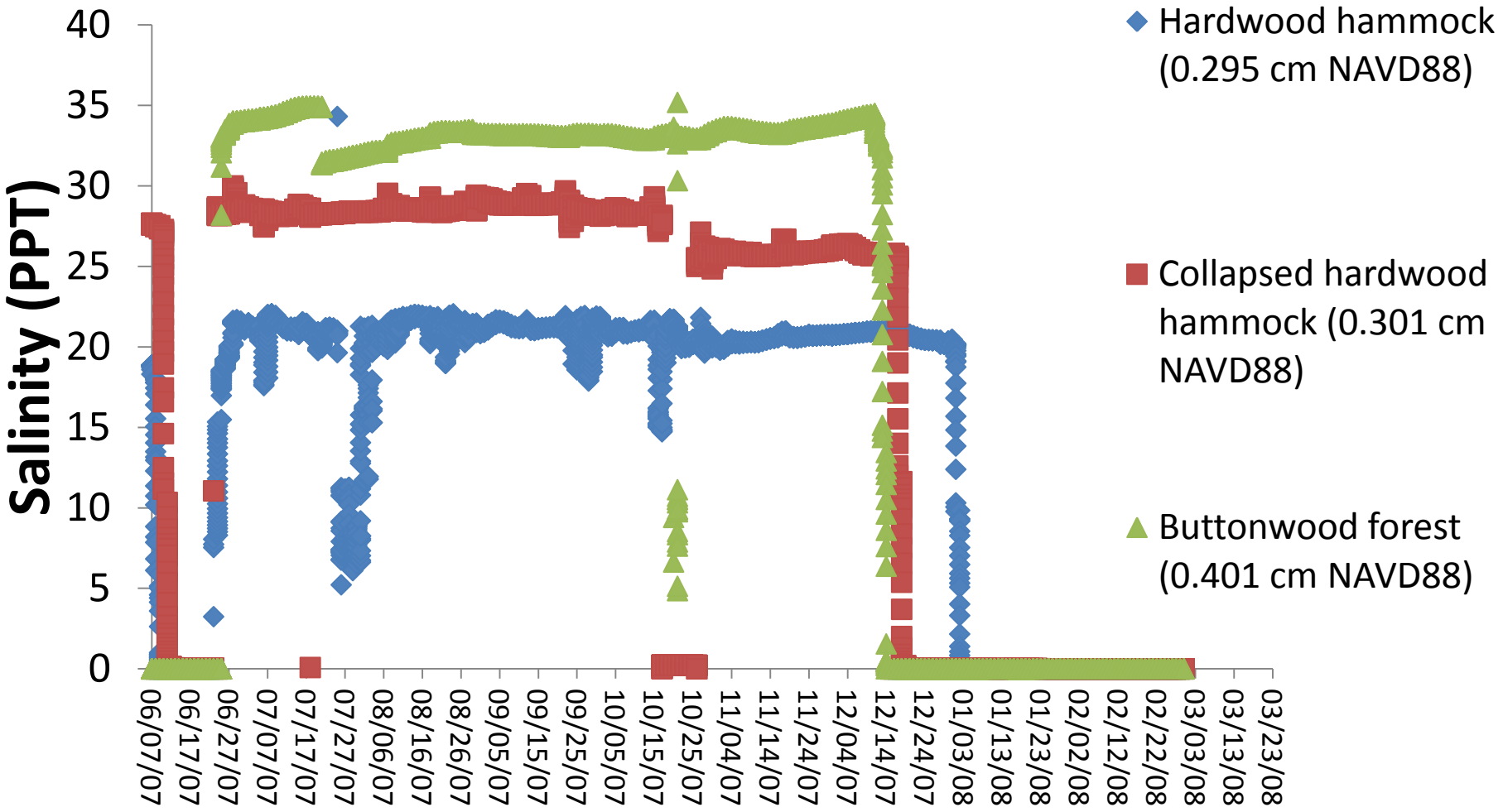
2-Hardwood hammocks

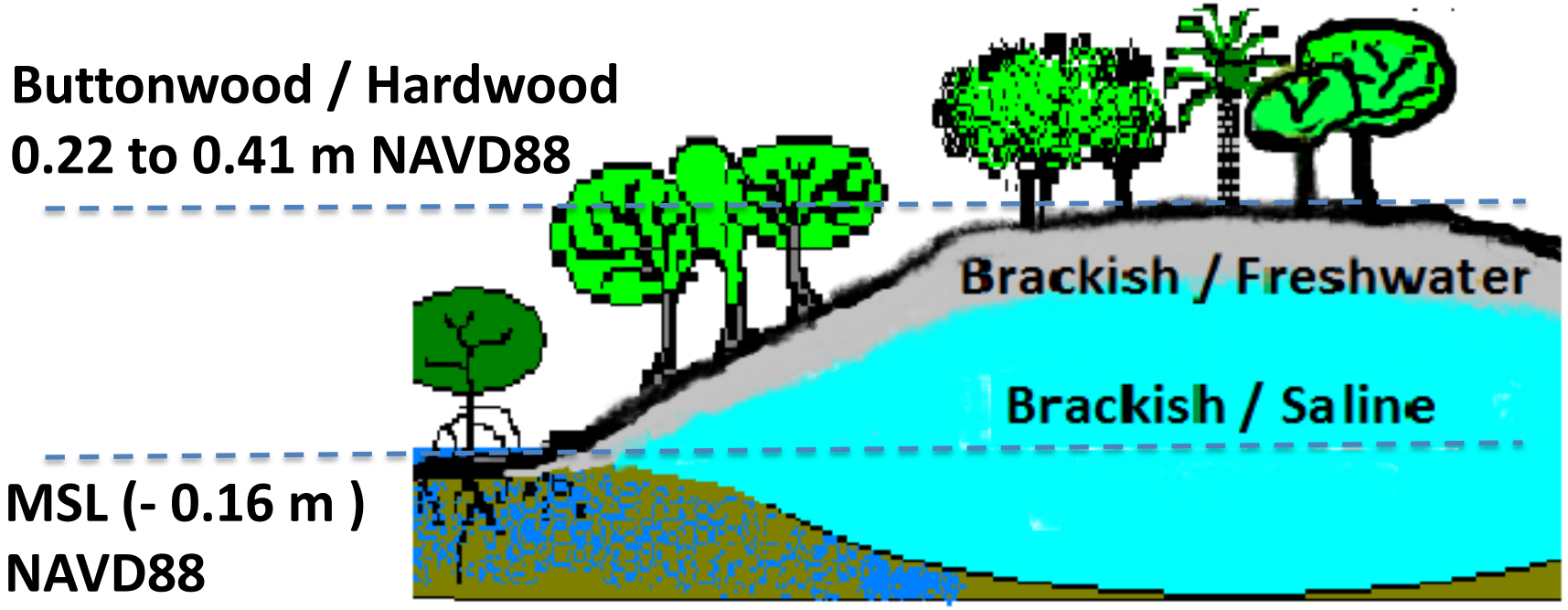
12-Buttonwood hammocks

5-Buttonwood prairies

Elevation at each well location obtained using Sokkia GPS




Salinity (PPT)
40
35
30
25
20
15
10
5
0
06/07/07
06/17/07
06/27/07
07/07/07
07/17/07
07/27/07
08/06/07
08/16/07
08/26/07
09/05/07
09/15/07
09/25/07
10/05/07
10/15/07
10/25/07
11/04/07
11/14/07
11/24/07
12/04/07
12/14/07
12/24/07
01/03/08
01/13/08
01/23/08
02/02/08
02/12/08
02/22/08
03/03/08
03/13/08
03/23/08
Hardwood hammock (0.295 cm NAVD88)
Collapsed hardwood hammock (0.301 cm NAVD88)
Buttonwood forest (0.401 cm NAVD88)


Buttonwood / Hardwood
0.22 to 0.41 m NAVD88
Brackish / Freshwater
Brackish / Saline
MSL (- 0.16 m)
NAVD88

Stable isotopes analyses- bridge between mechanisms and empirical data

- The knowledge of where plants are getting water from- shallow or deep soils and or groundwater along with data on salinity will help us understand-

a) the distribution of native plant communities

b) the results from experimental studies in the context of sea level rise

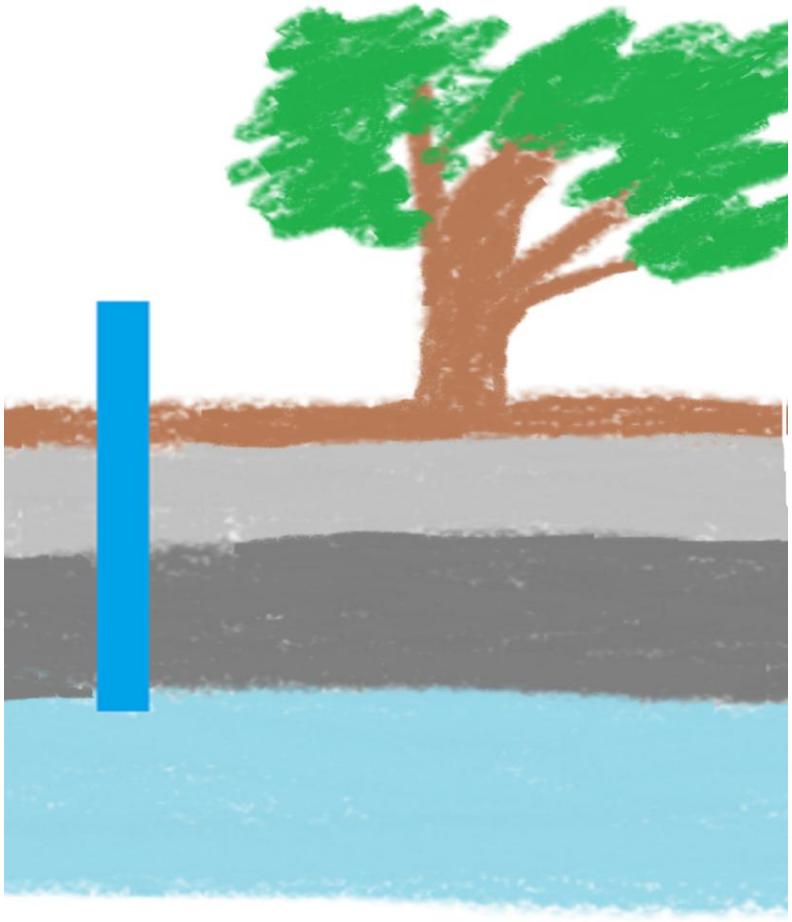
1. We collected groundwater and soil from

- 0-5 cm
- 5-15 cm
- 15-30 cm

2. Plant stems from target species from individuals near the wells

3. Analyzed the samples at Stable Isotopes Laboratory at University of Miami to obtain values of $\delta^{18}O$, $\delta^{2}H$

Stable isotopic signatures ($\delta^{18}O$ in parts per mil- ‰) of plant stems in buttonwood hammock suggest that Buttonwood and Capparis- common species of buttonwood forests, take water from shallow pools of water



0.14 ‰

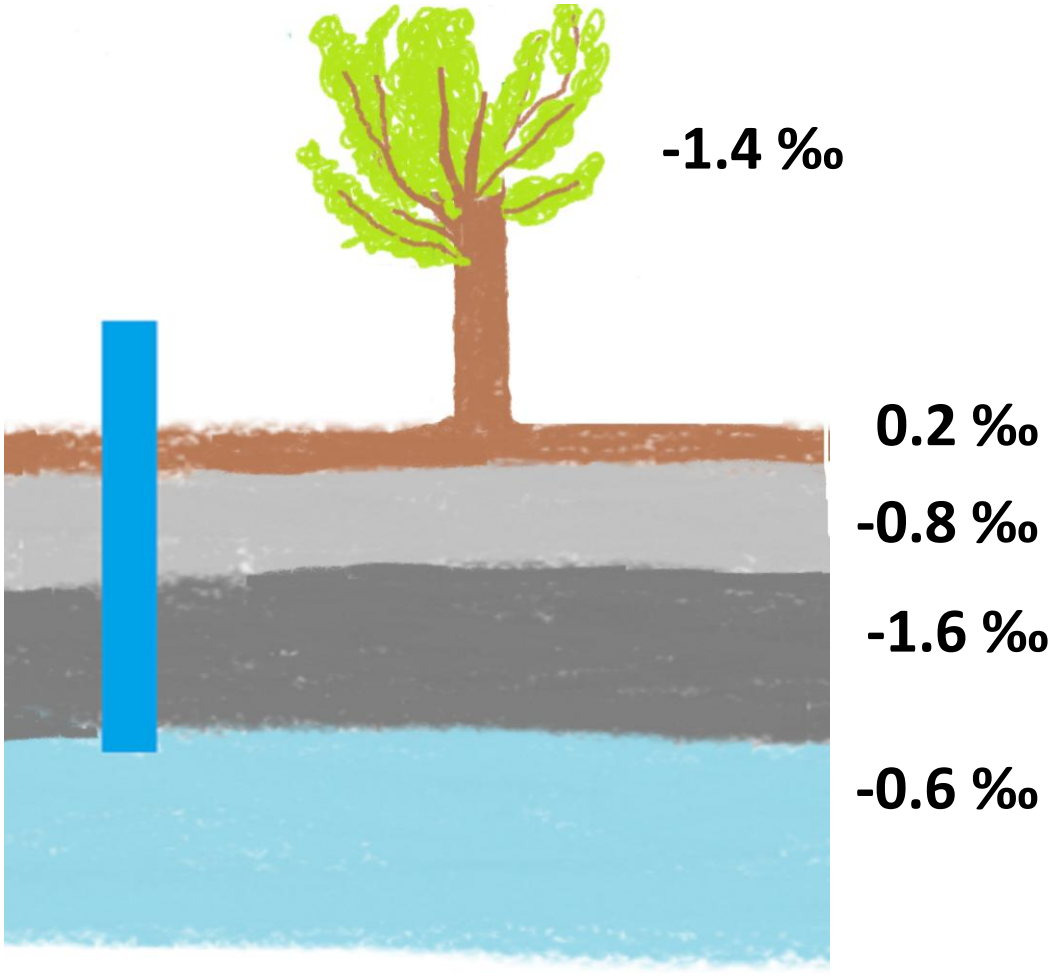
0- 5 cm (3.1‰)

5-15 cm (-0.05‰)

15- 30 cm (-0.25‰)

Groundwater (-0.9 ‰)

Stable isotopic signatures ($\delta^{18}O$ in parts per mil- ‰) of Jamaican dogwood (*Piscidia piscipula*), a hardwood hammock species indicate that they access deeper water pools



Experimental study to test hypothesis 2

(conducted at University of Florida's TREC campus)

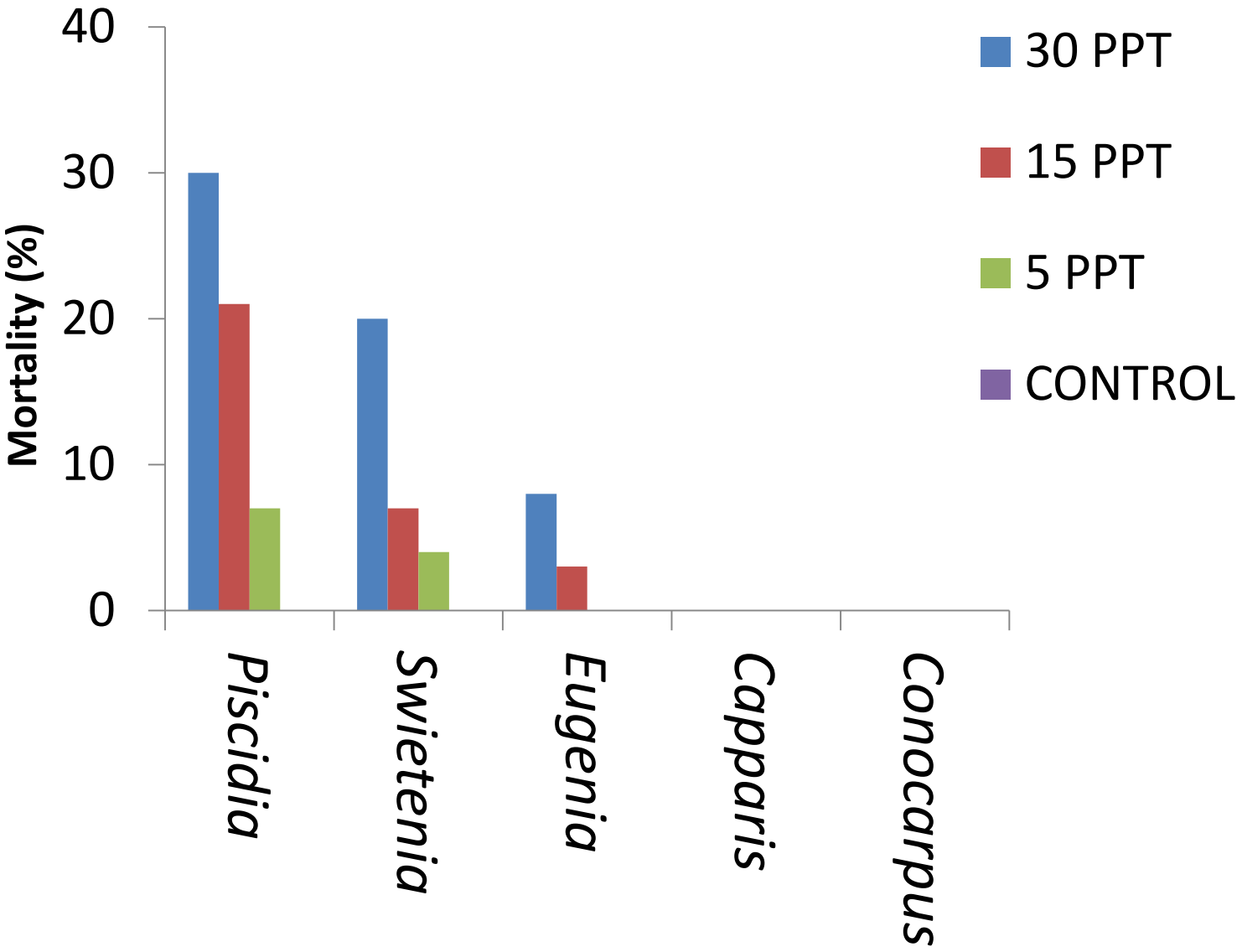
- How do saplings of focal species respond to different levels of salinity? We measured- transpiration rates, growth rates, final biomass and survival over a 10 month period. Plants were irrigated by –

- Tap water

Salt solutions of following concentration

- 5 PPT
- 15 PPT
- 30 PPT

Sapling mortality in the shadehouse



What we have learned so far…

- Buttonwood hammocks occur in areas with strongly brackish to saline groundwater.
- Buttonwoods show decline in transpiration and biomass but acclimatize to strongly brackish water
- Hardwood hammock species occur sporadically in areas with saline groundwater, show significant mortality when exposed to strongly brackish water
- Hardwood hammocks are not shielded from exposure to saline water in terms of elevation and are highly susceptible to increases in salinity

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