

Sustainability of coastal resources: sea level rise and coastal forests

René Price

Florida Coastal Everglades-LTER

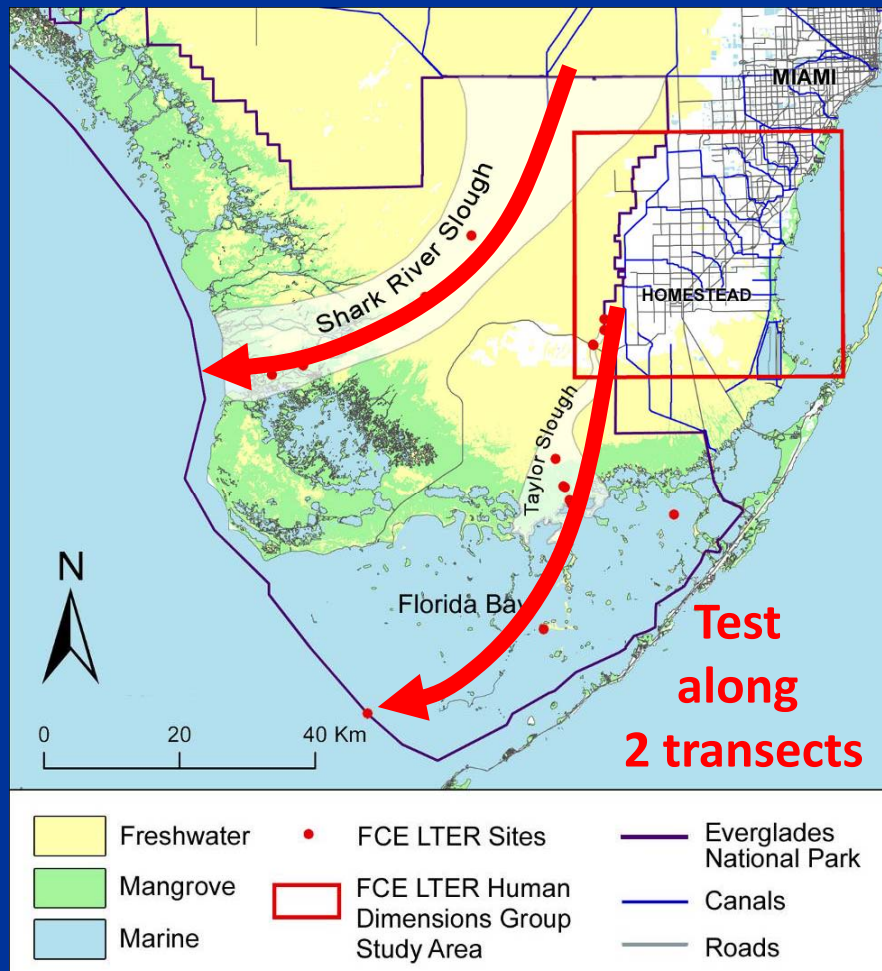
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Florida Coastal Everglades
Long Term Ecological Research



The FCE LTER follows water as it flows toward the Gulf of Mexico through 2 different Everglades wetland basins

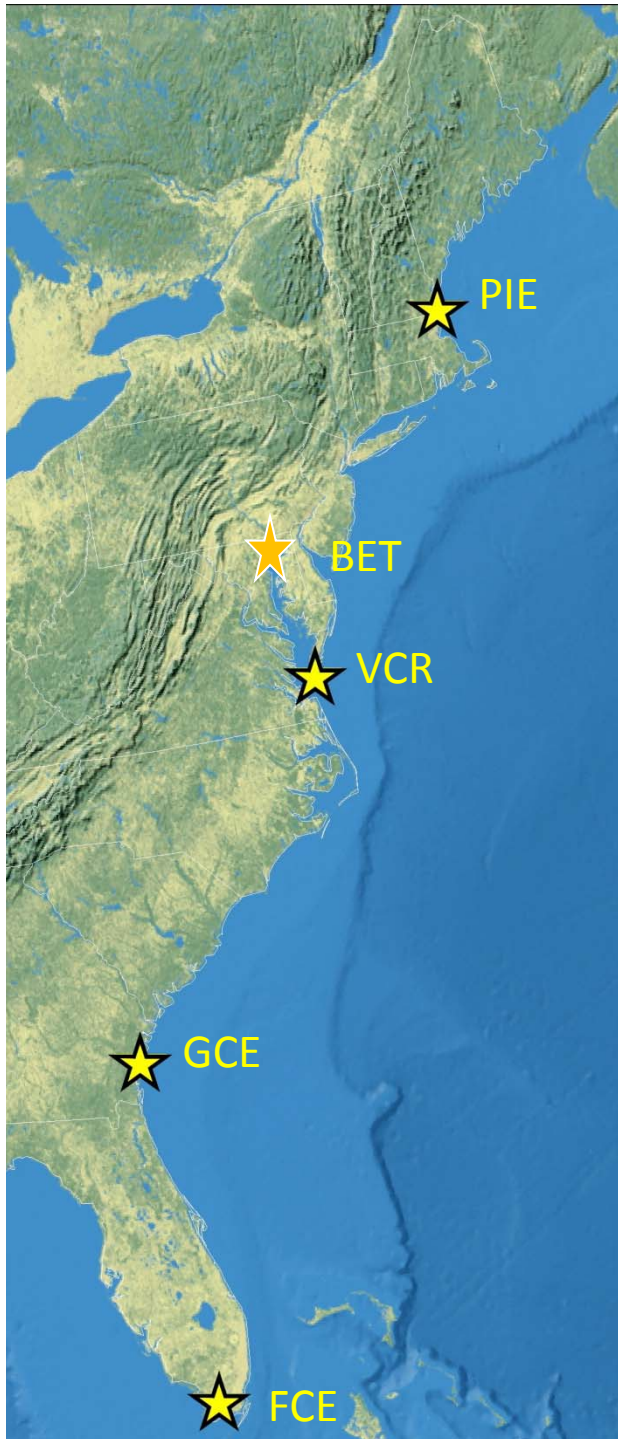


- Water source, residence time and local biotic processes influence the structure and function of populations and communities

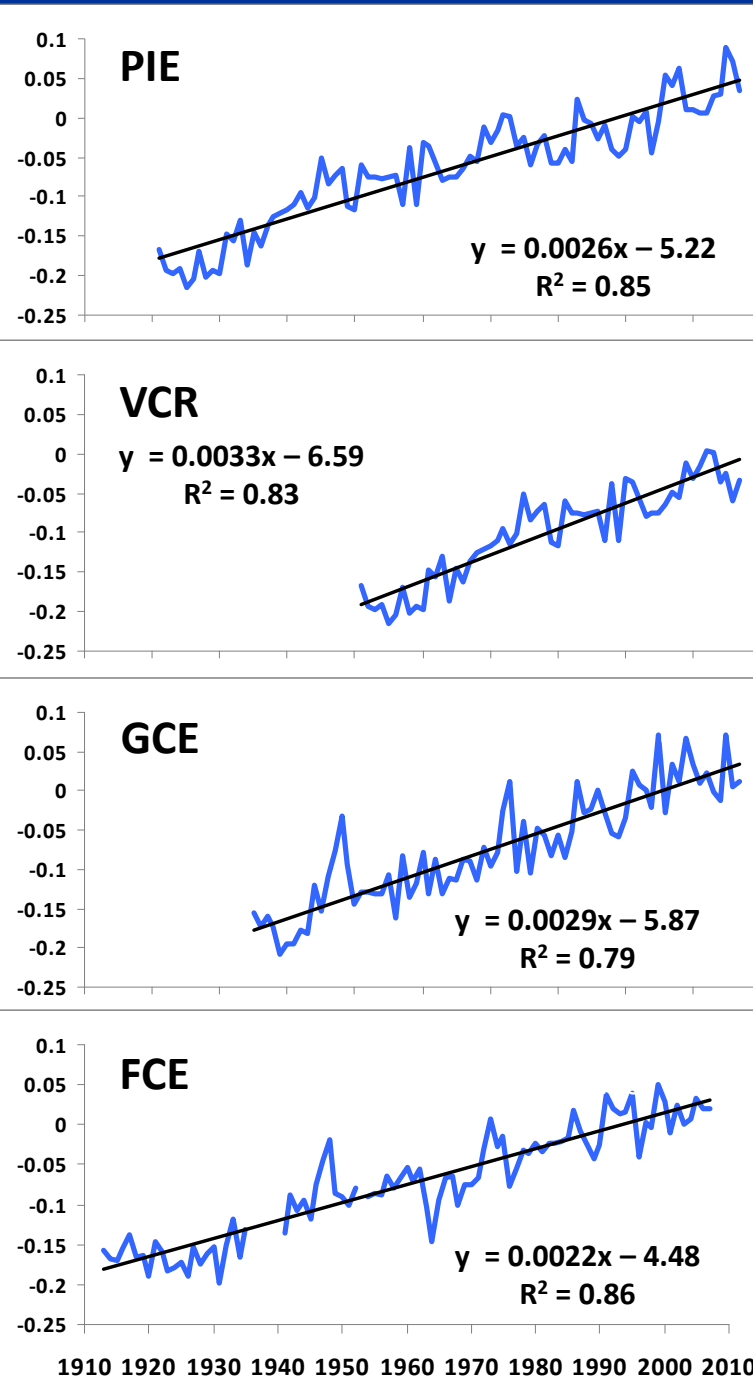
- Fresh and marine water supply is regulated by geomorphology, climate and built infrastructure and policies

- Response most dynamic in oligohaline ecotone





Relative Annual Mean Sea Level (meters)



Mean
Global SLR of
 $1.7 \pm$
0.5mm/yr
for the 20th
Century
from tide
gauges

[Bindoff et
al., 2007]

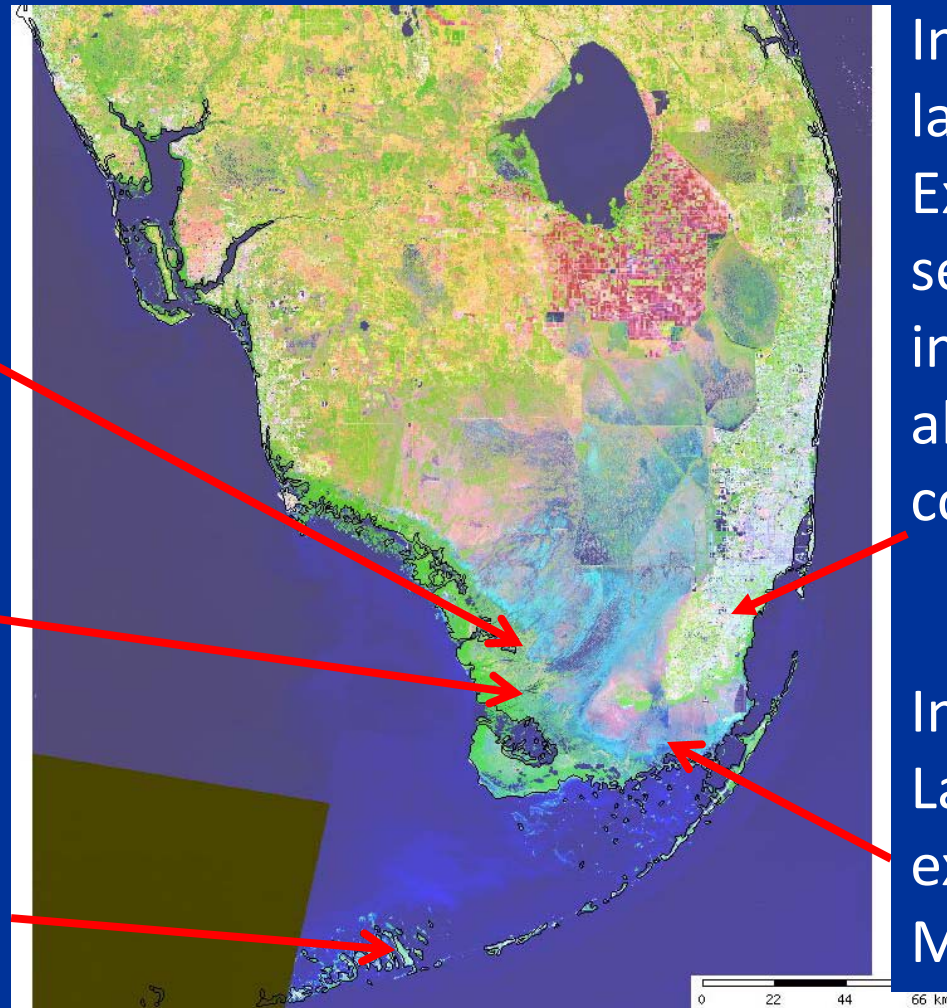
LTER Ecotrends

Observed Changes in South Florida's Coastal Resources in response to SLR

Surface water levels increase with SLR along coastline

Decrease in Coastal Hammock Species

>70% decrease in Pine Tree cover in some Florida Keys



Increase in the landward Extent of seawater intrusion along all coastlines

Increase in the Landward extent of Mangroves

Human Impacts

Perigean Spring Tide Oct 7 2010



Miami-Dade County
Credit: Miami-Dade DERM

Human Impacts Cont.



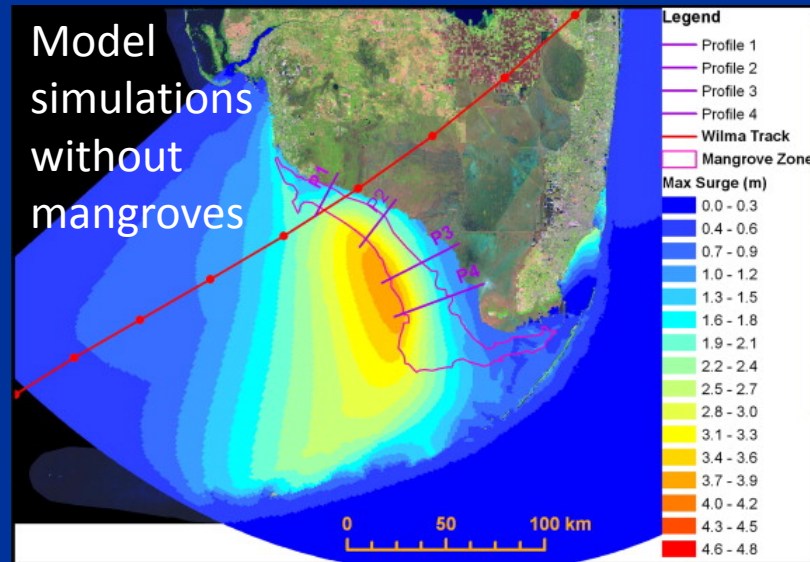
- Seawater intrusion effects fresh groundwater availability

- Flooding Prevention (saltwater and freshwater)

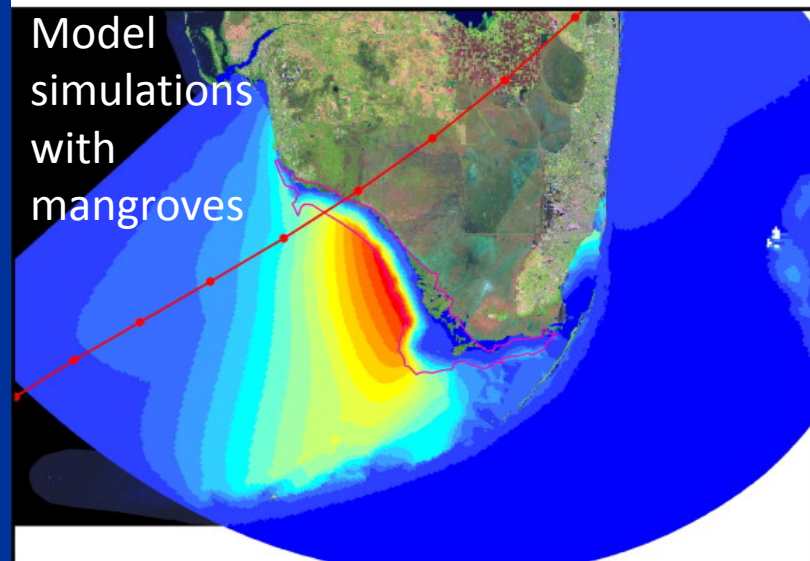
- Additional freshwater runoff

- Additional costs of treatment and flood prevention

Human Impacts Cont.



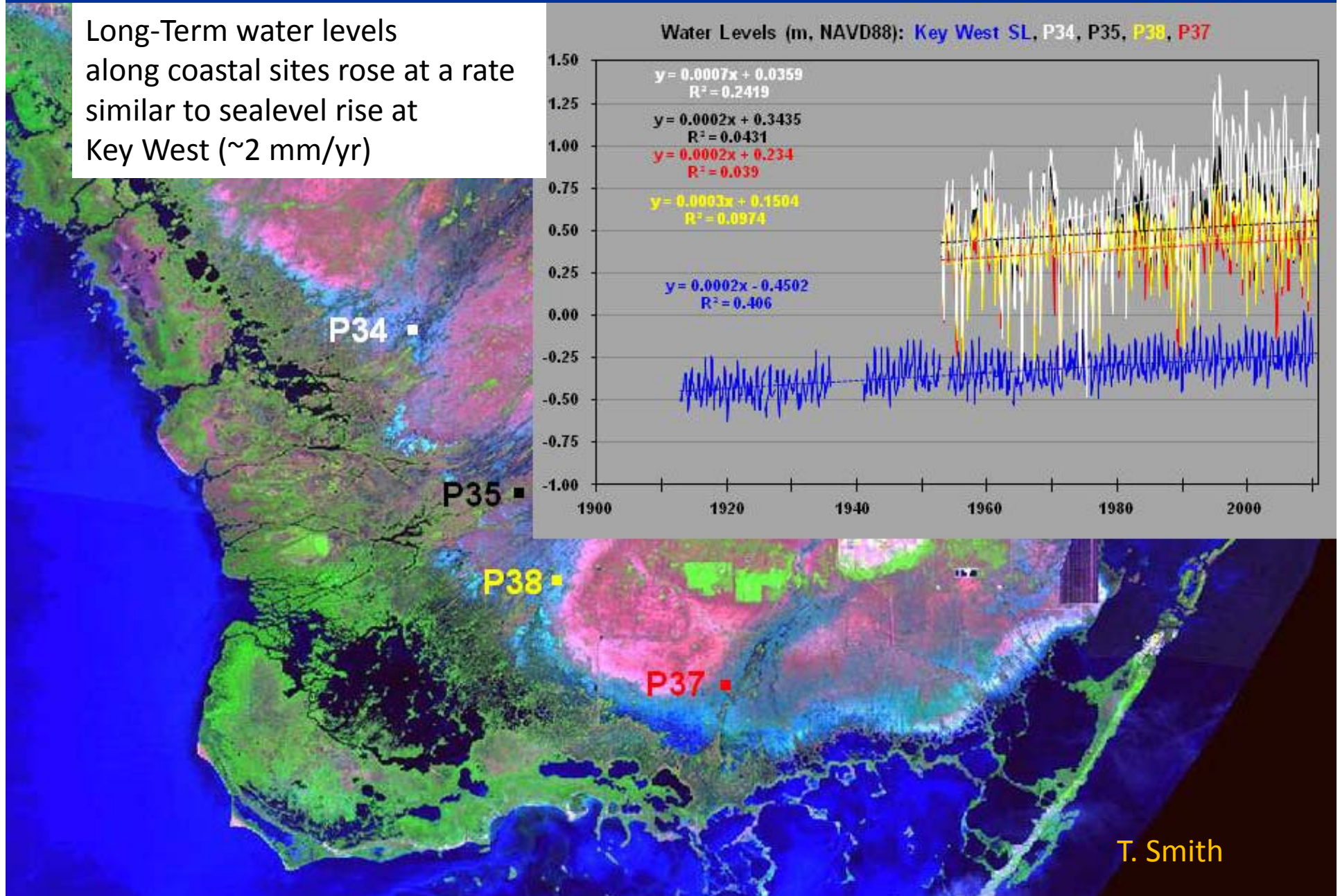
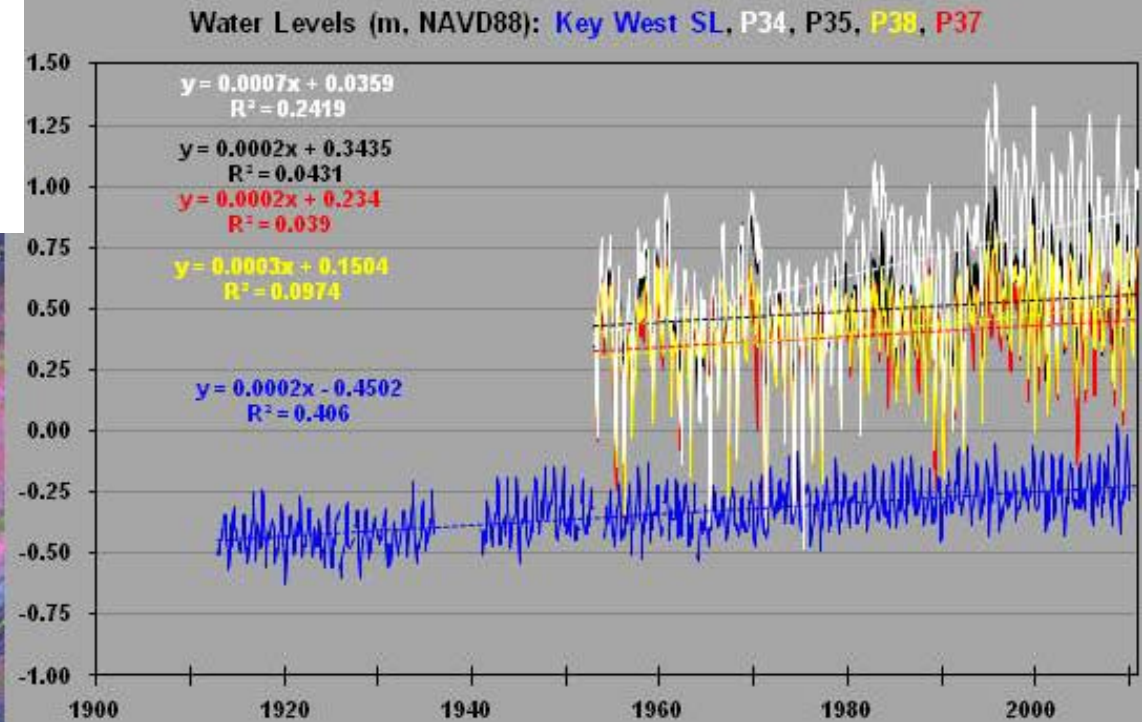
Loss of ecosystem services provided by the Everglades including aquifer rehydration, and storm surge protection



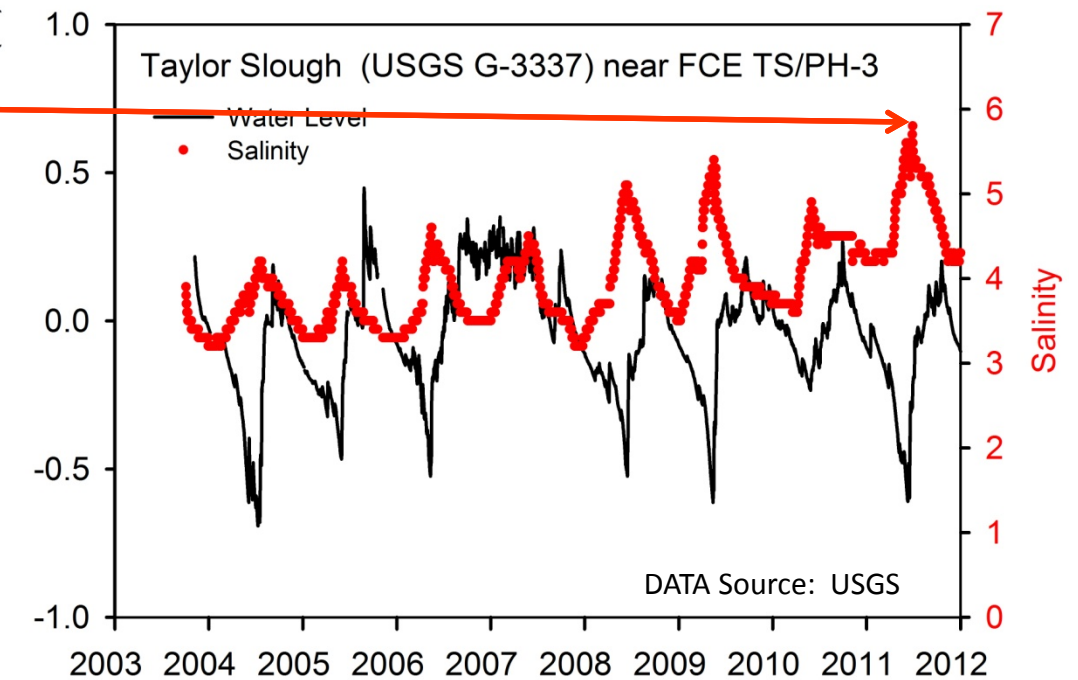
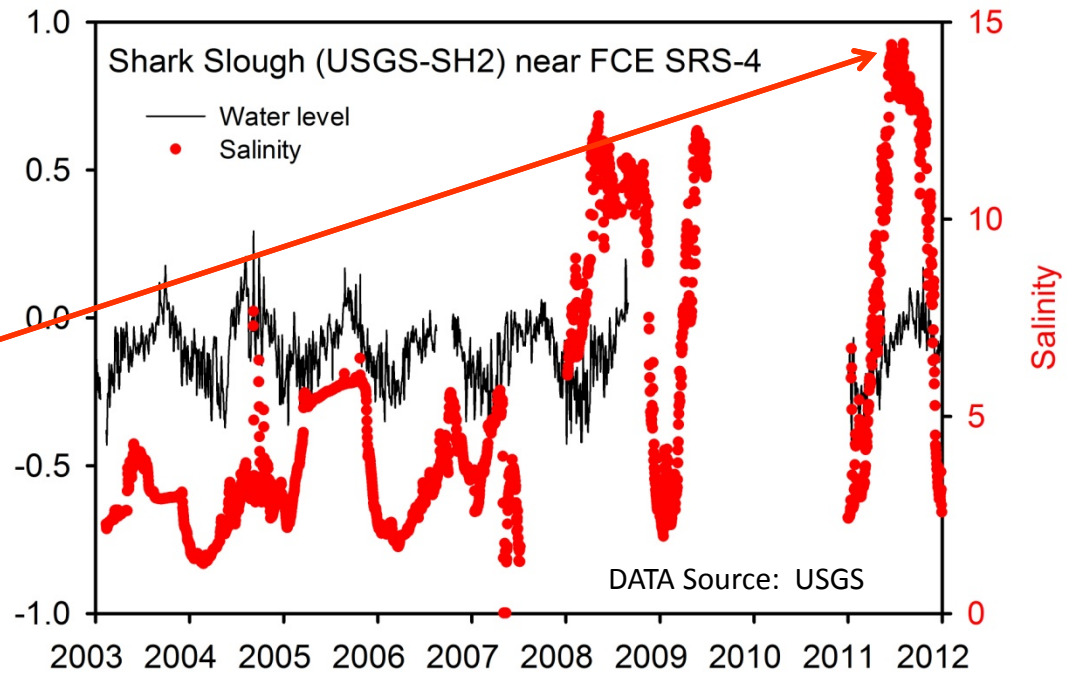
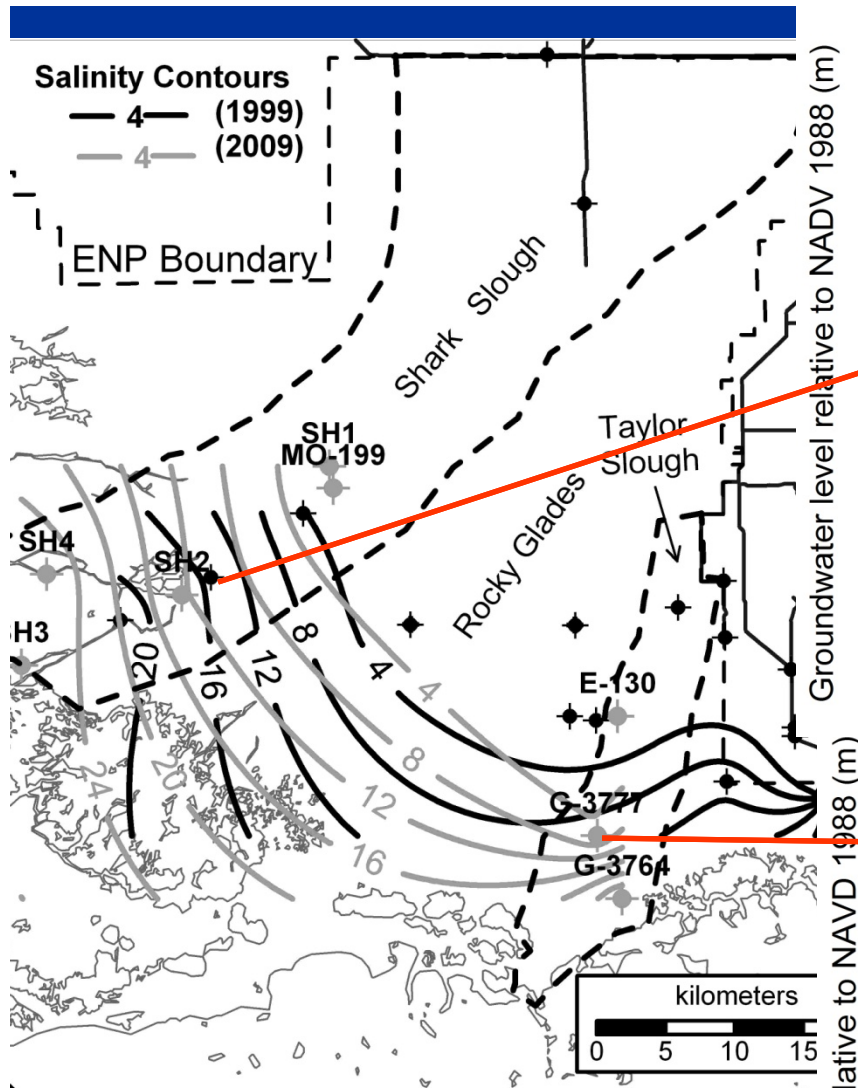
Extent of storm surge from Hurricane (Wilma 2005) was dampened inland of the coastline due to the presence of mangroves (Zhang et al. 2012)

Surface Water Levels

Long-Term water levels along coastal sites rose at a rate similar to sealevel rise at Key West (~2 mm/yr)



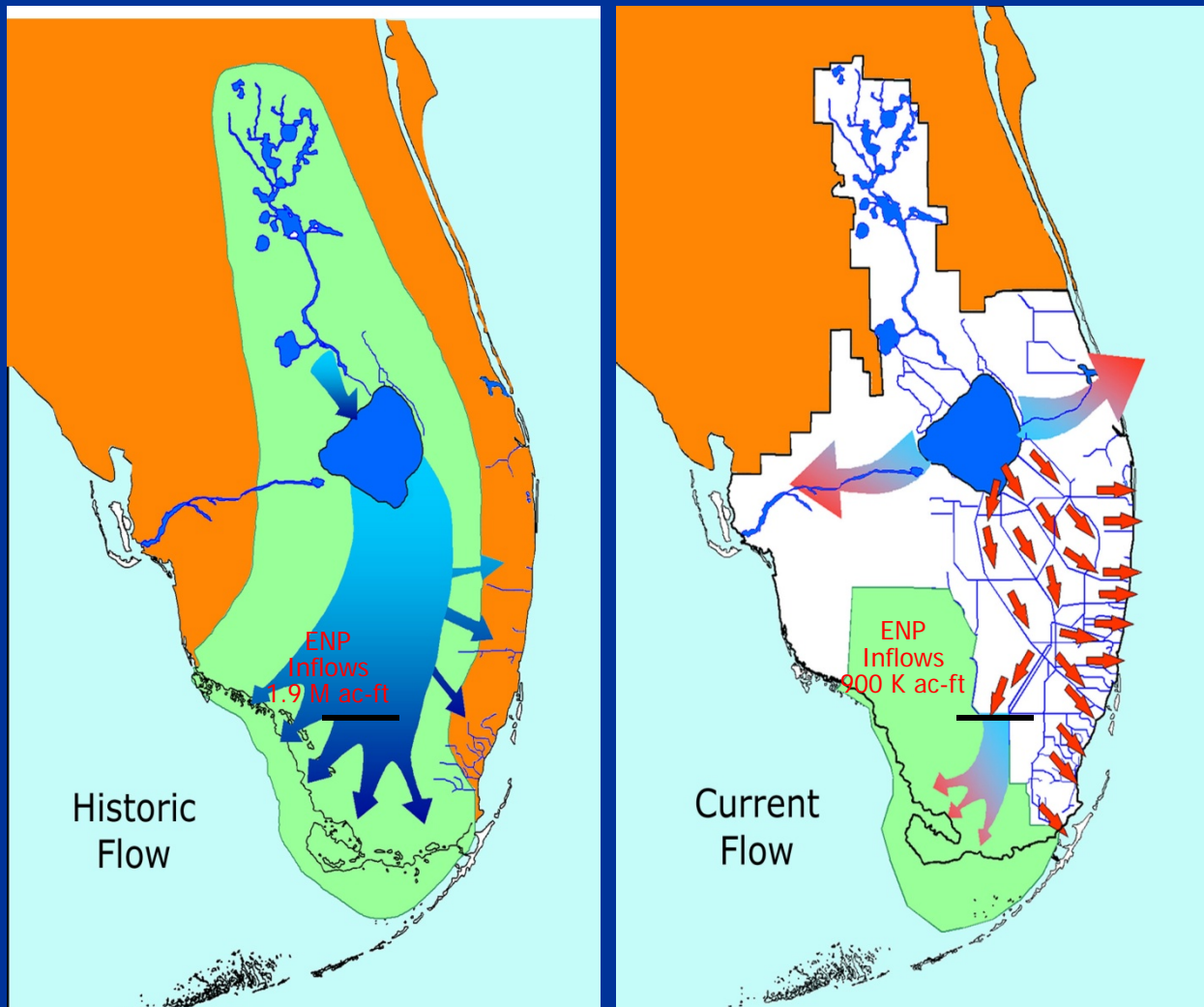
T. Smith



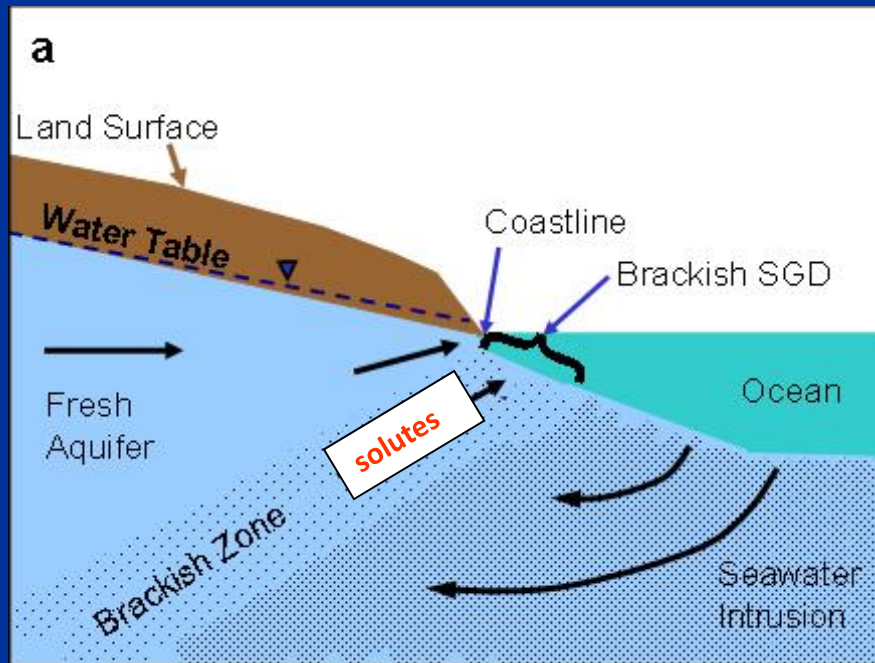
Groundwater salinity
 keeps rising

Saha, et al (2011)

Water Management Practices in last 100 years have exacerbated the effects of sea level rise along the coastlines, particularly in the Everglades

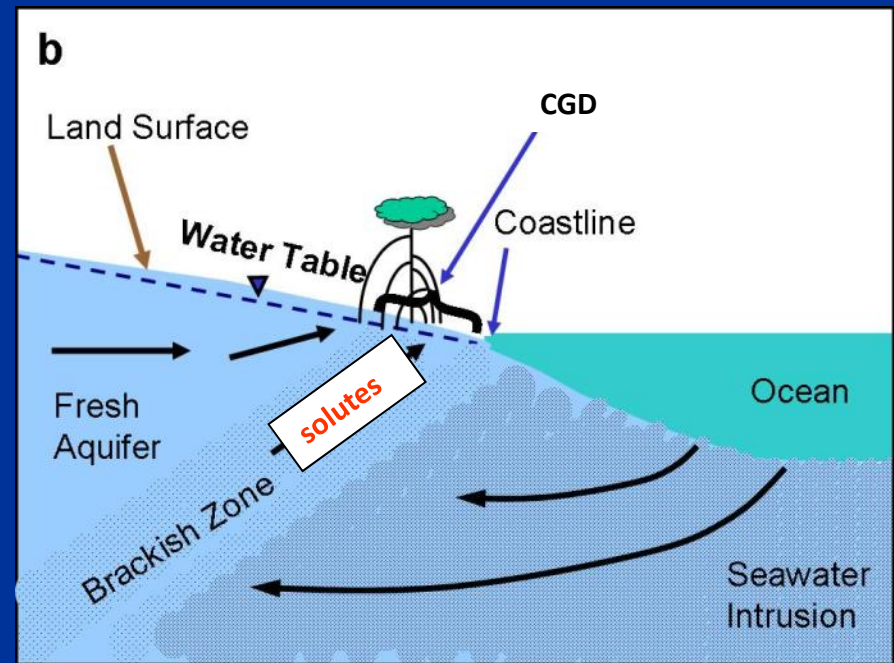


Submarine Groundwater Discharge (SGD)

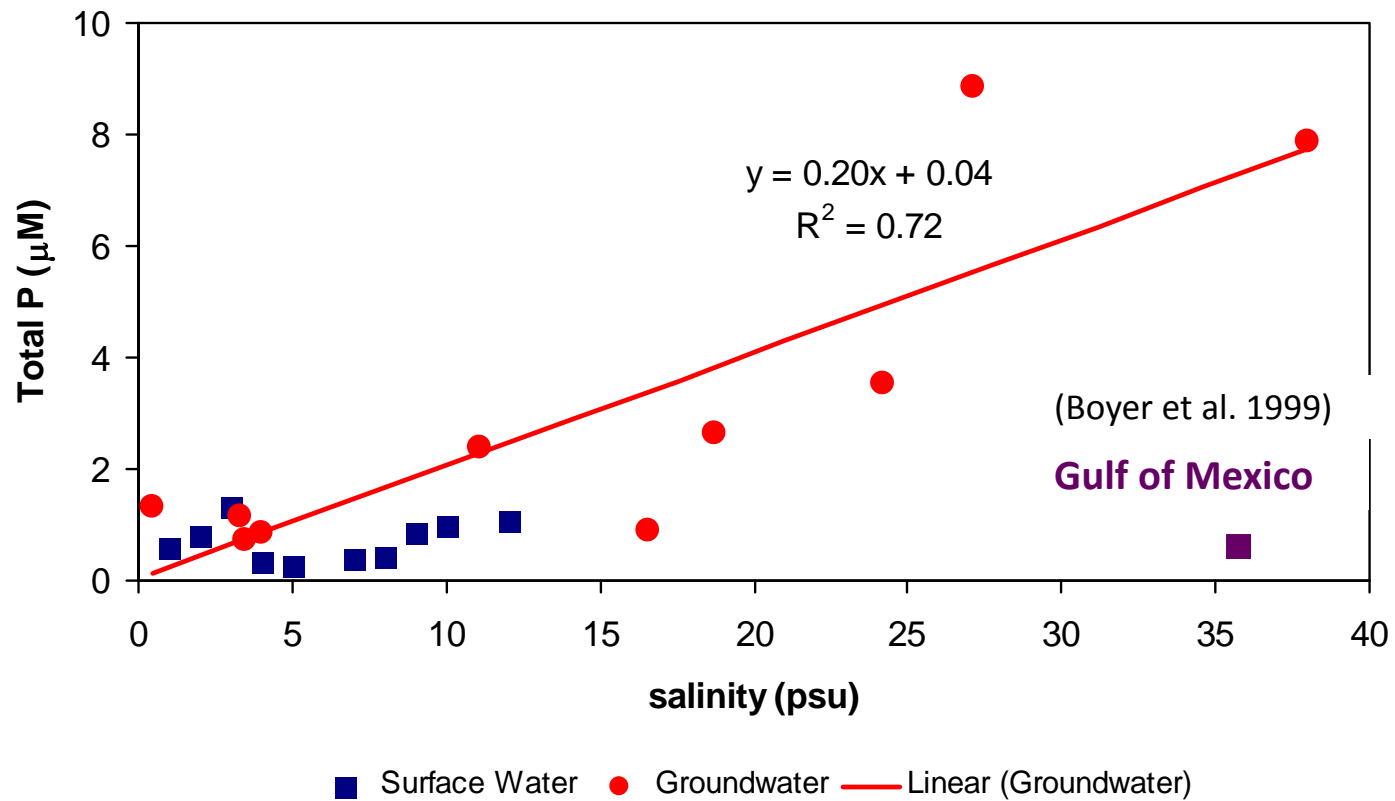


Fresh water head levels
Rainfall, climate
Seawater levels , tides, waves
Management

Coastal Groundwater Discharge (CGD)



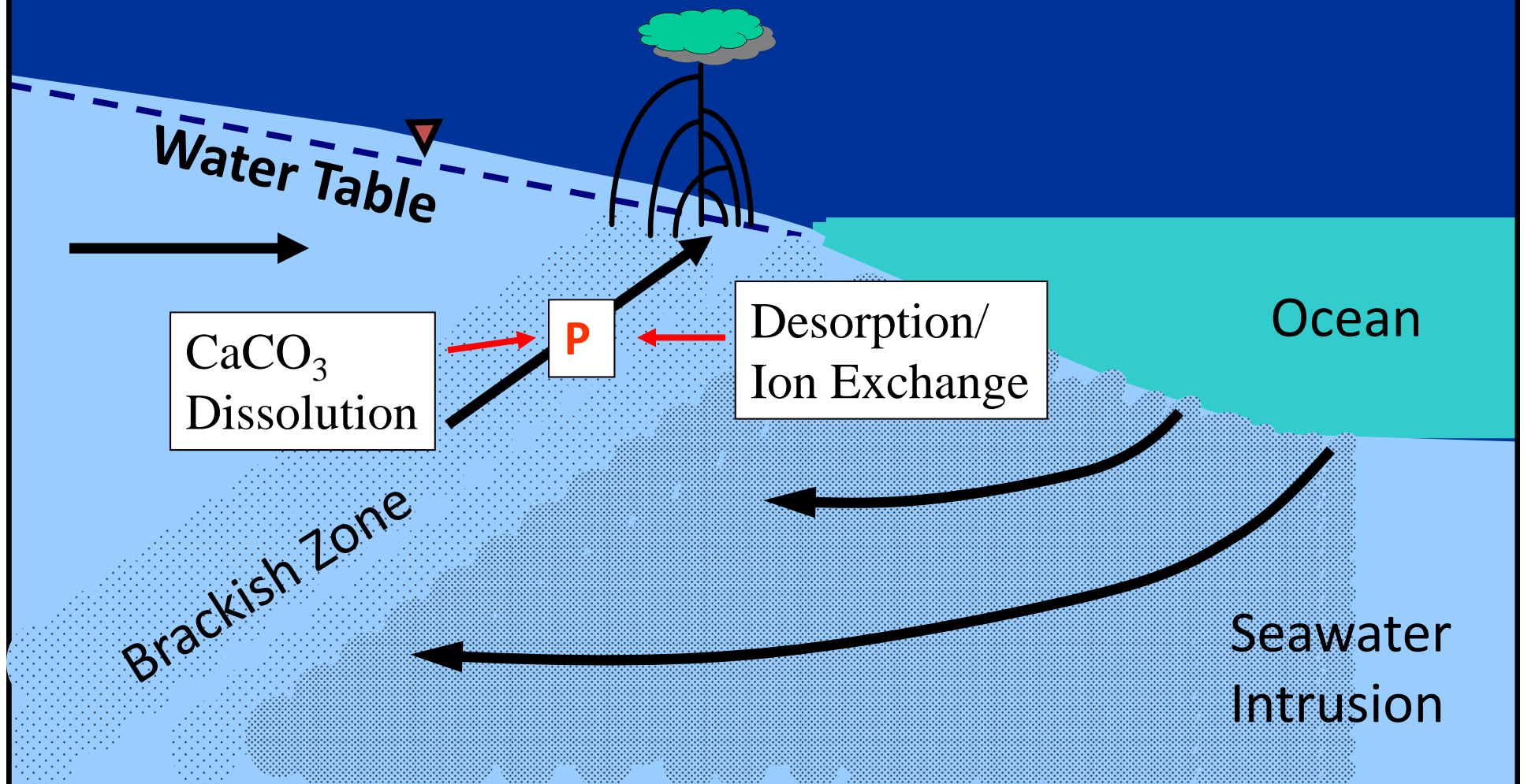
Southern Everglades

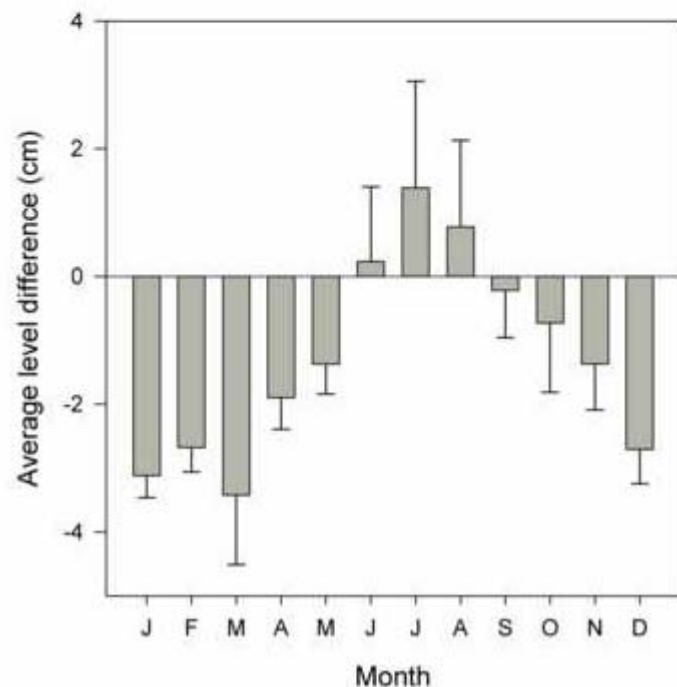
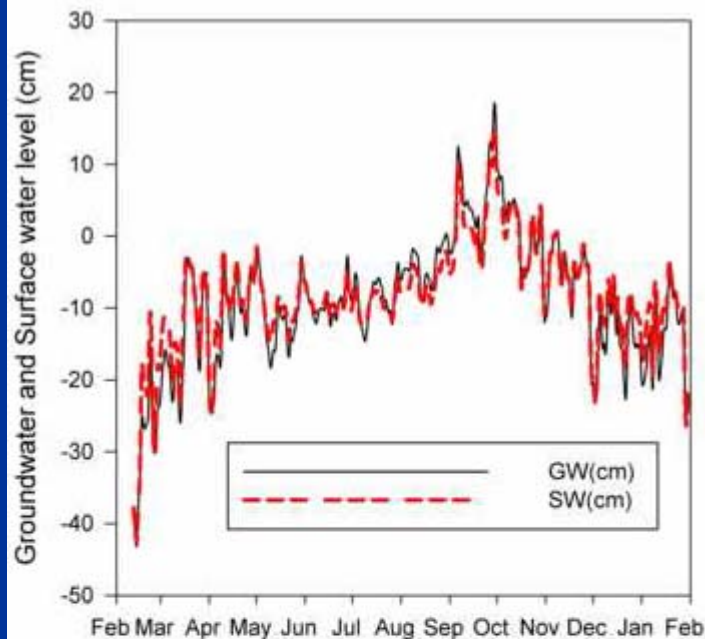


Price, RM, PK Swart, and JW Fourqurean, 2006. *Coastal groundwater discharge-an additional source of phosphorus for the oligotrophic wetlands of the Everglades*, *Hydrobiologia*, 569:23-36.



Price, RM, MR Savabi, JL Jolicoeur, S Roy. 2010 *Adsorption and desorption of phosphate on limestone in experiments simulating seawater intrusion, Applied Geochemistry*, 25:1085–1091.





Through detailed hydrological studies in the area using water budgets, water levels, geochemical and temperature measurements,

we concluded that groundwater discharge was seasonal, tending to occur in summer season (May- Aug);

with higher rates of groundwater discharge closer to the coastline.

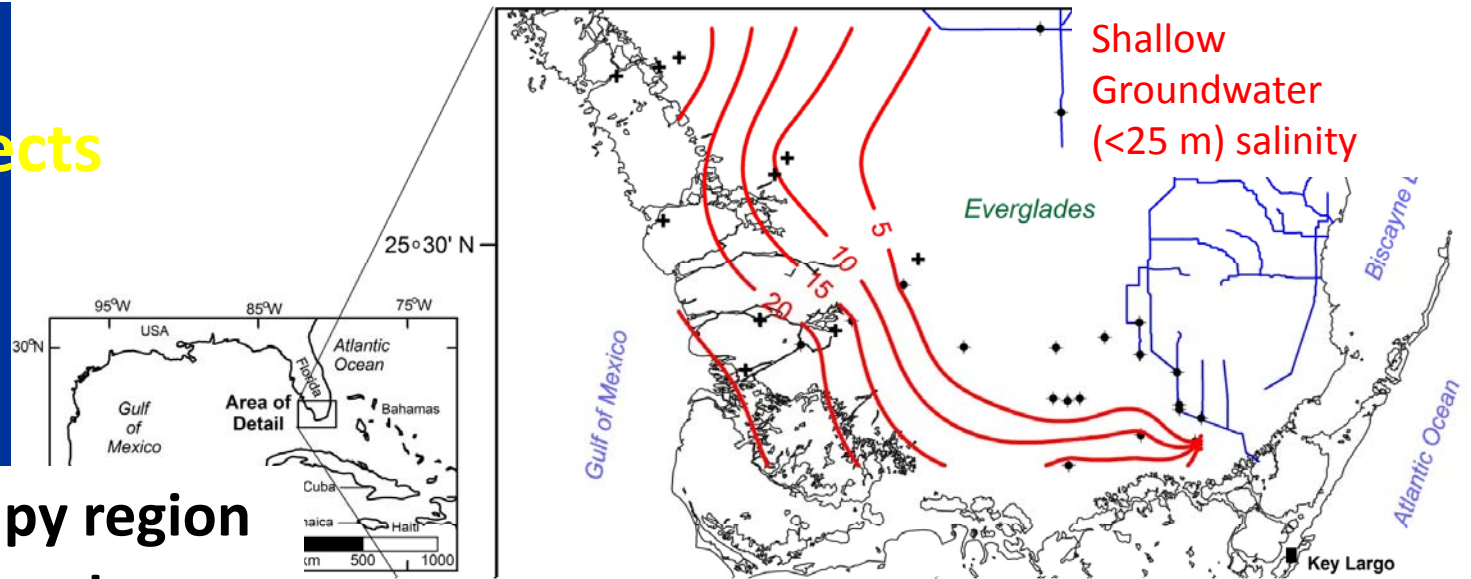
Saha et al., 2012. & Zapata-Rios and Price (in review)

Observed ecological effects of brackish groundwater discharge

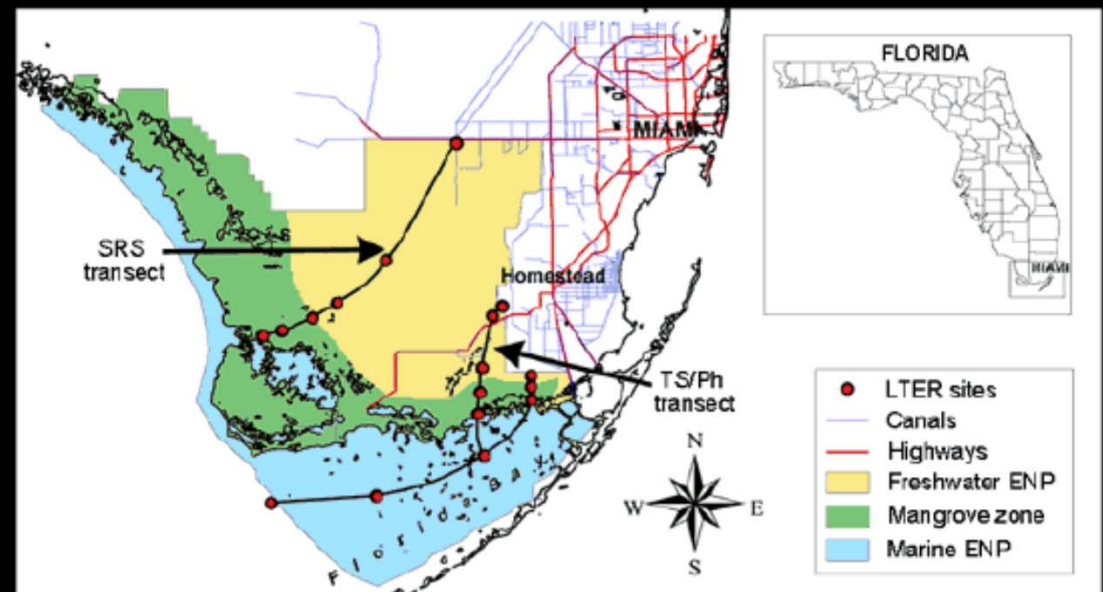
Mangroves occupy region underlain by seawater intrusion

Highest Mangrove biomass at the coastline (Simard et al. 2006)

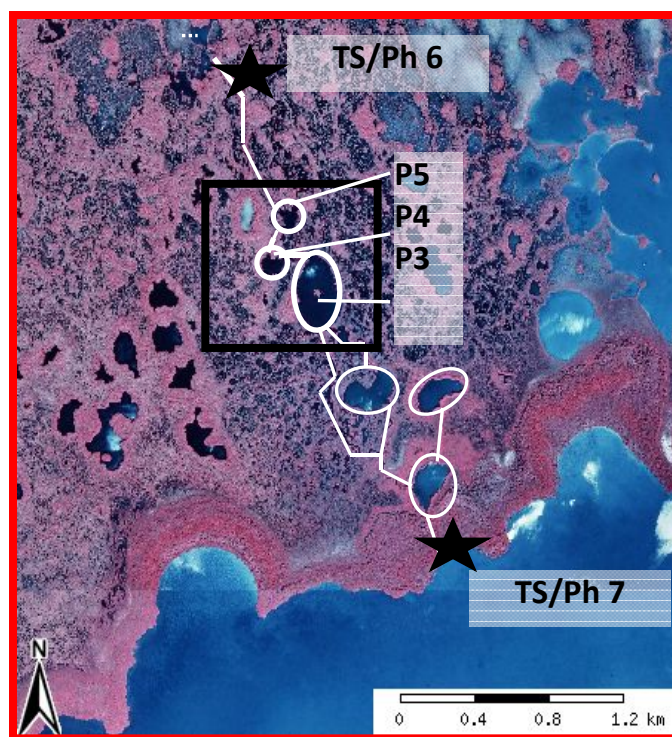
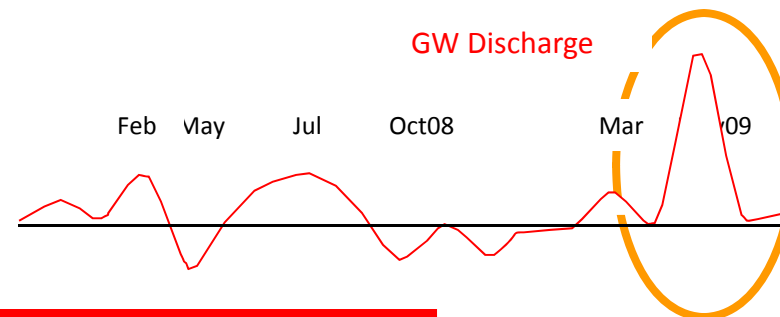
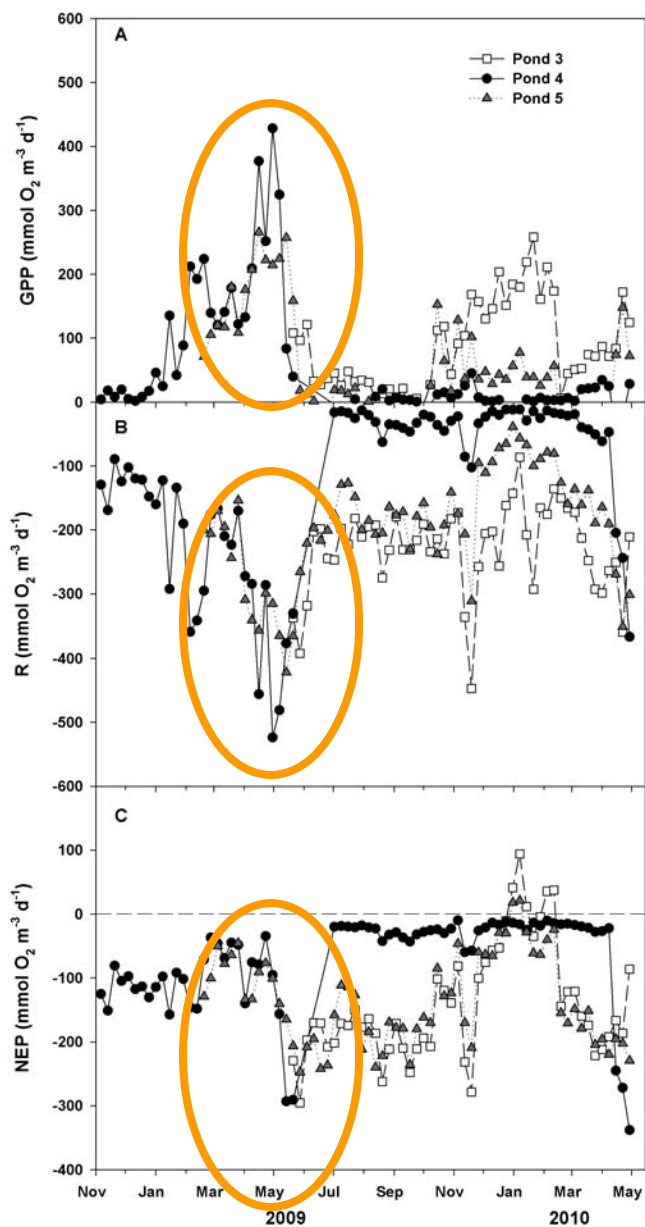
Highest P availability in sediments and seagrasses along the coastline (Herbert et al. 2009)



Florida Coastal Everglades LTER Sites



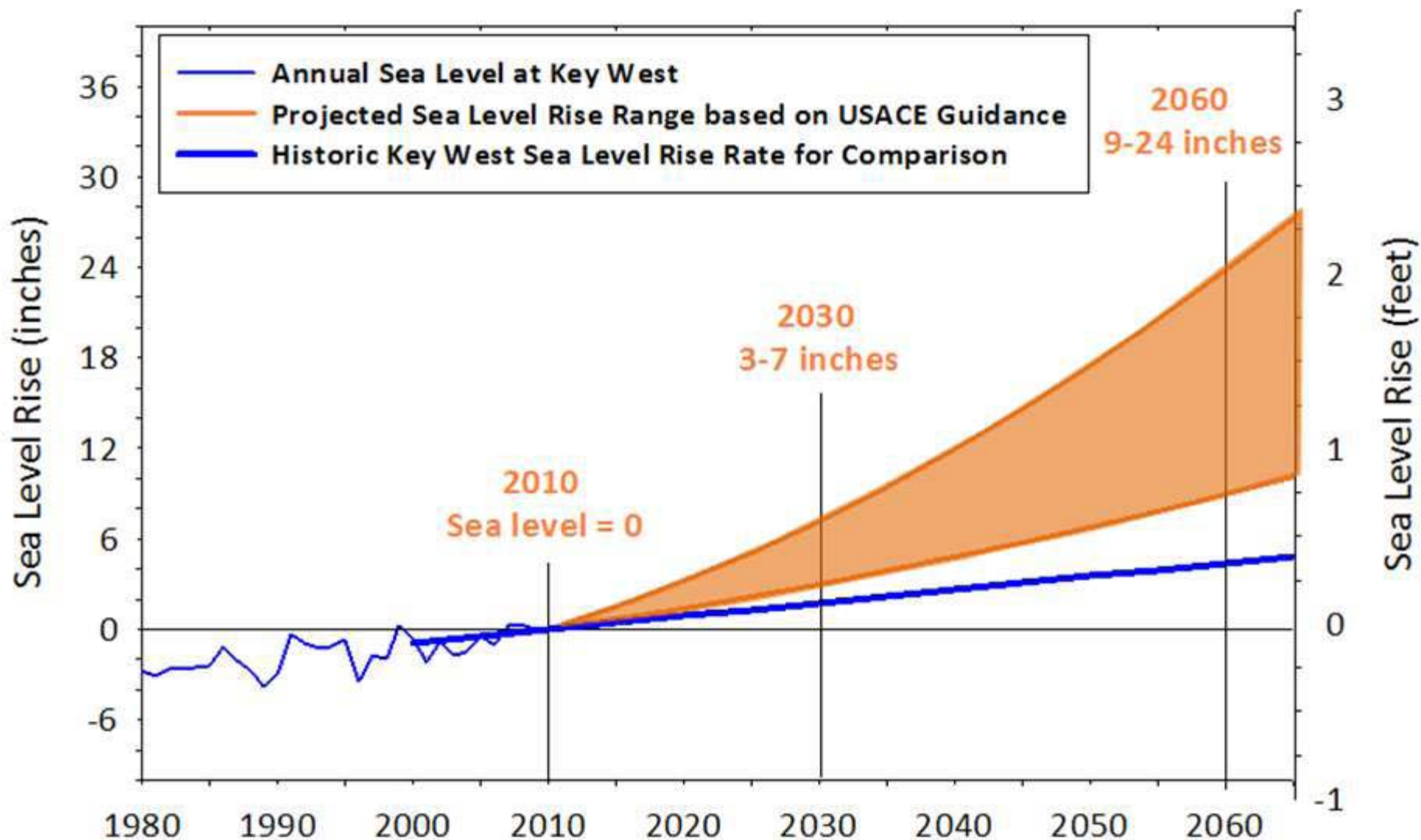
Water Balance Results



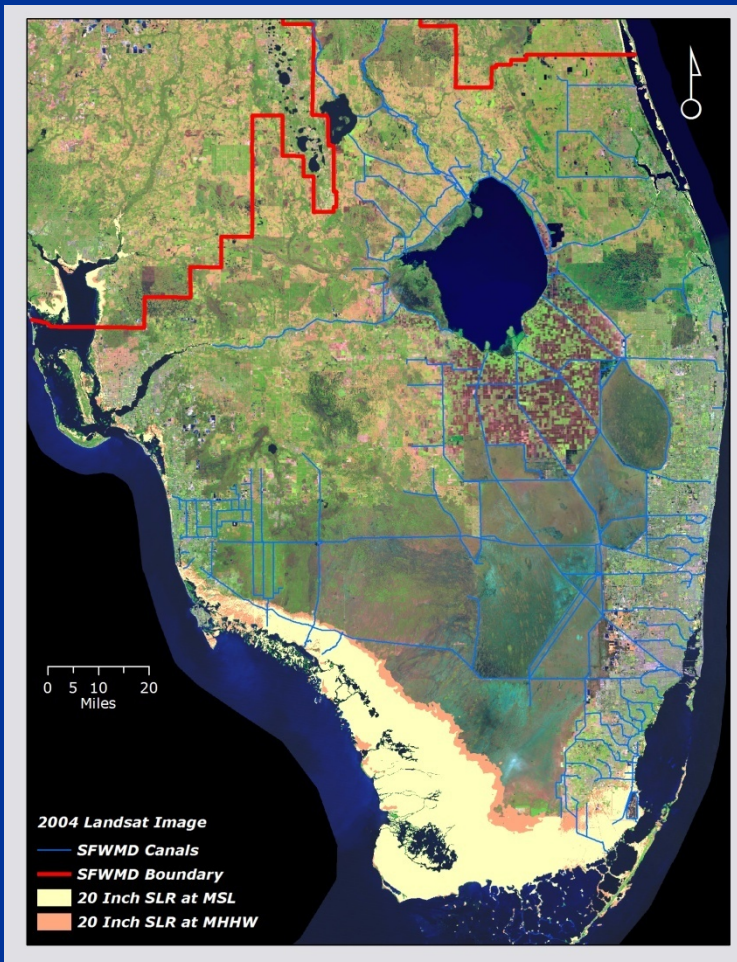
A Unified Sea Level Rise Projection for Southeast Florida

Southeast Florida Regional Climate Change Compact Counties

April 2011

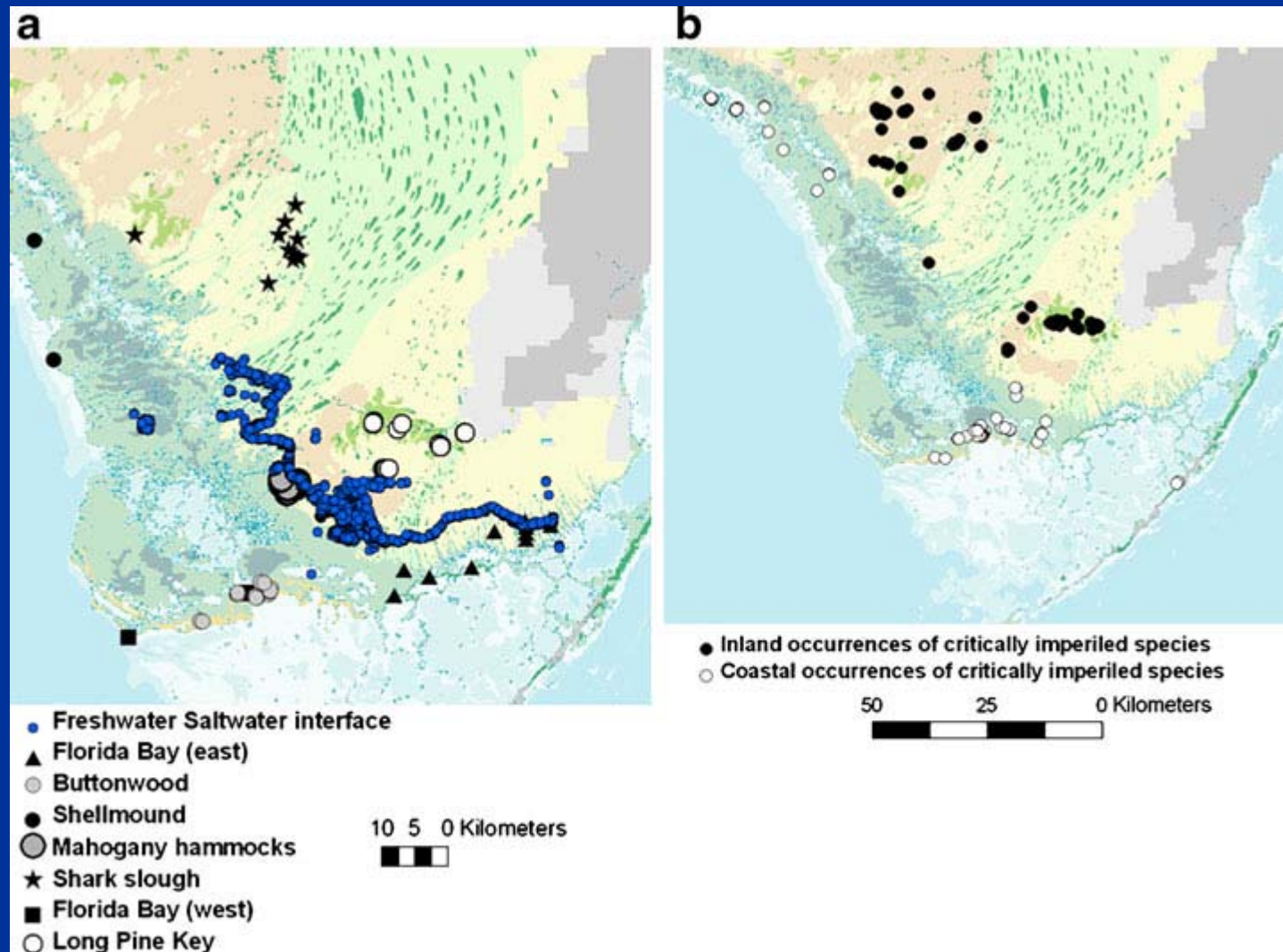


With a rapid increase in Sea Level: Southern Everglades Impacts



- Relocation and possible reduction of mangrove forests
- Loss of coastal Hardwood Hammocks (considered most vulnerable)
- Forced migration of wading birds north
- Potential peat collapse, coastal erosion, and redistribution of sediments
- Salinity intrusion into freshwater marshes can: discharge toxic hydrogen sulfide, cause coastal fish kills, and increase habitat loss

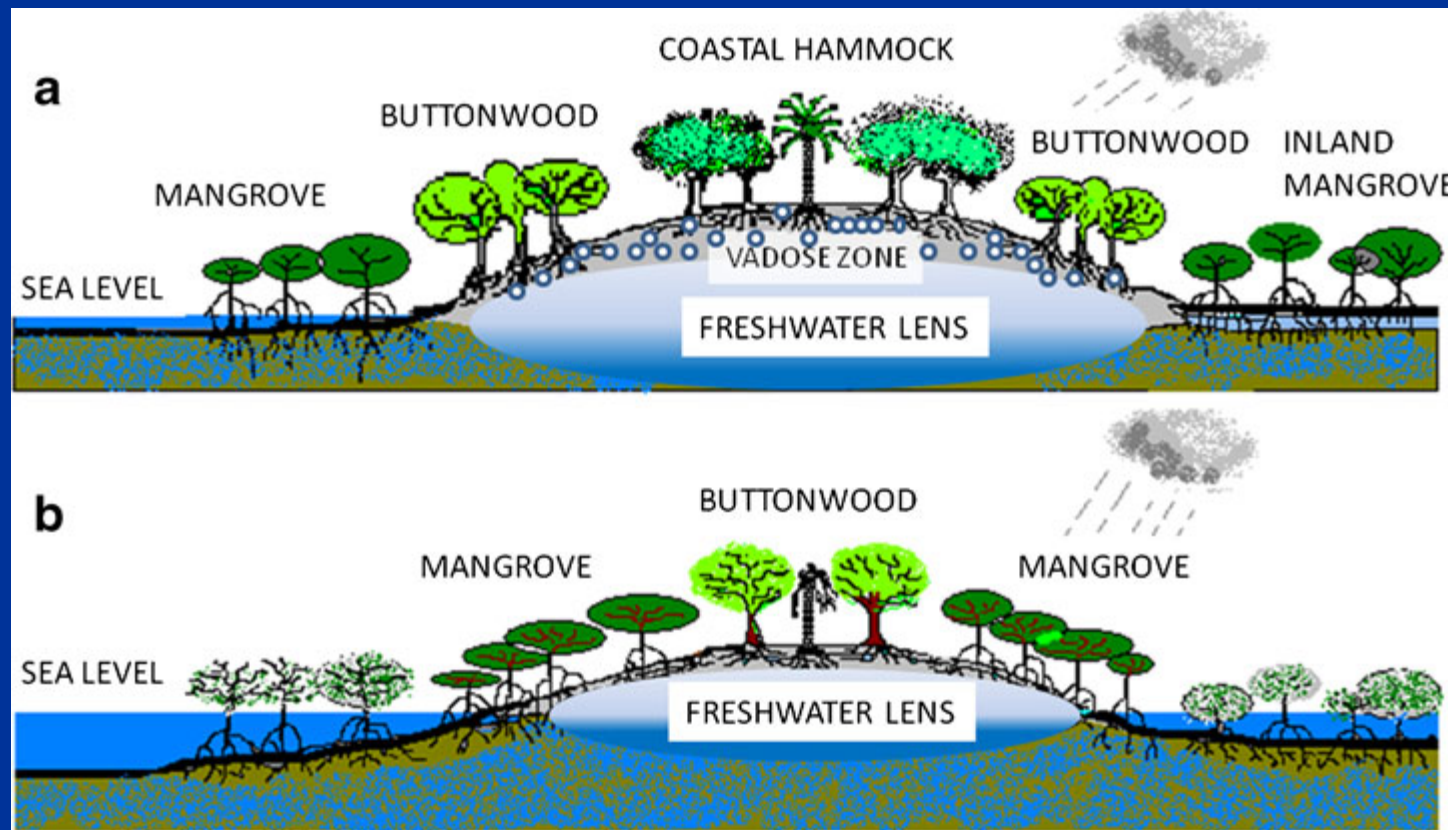
Current locations of coastal Hardwood Hammocks



Coastal Hardwood Hammocks occupy slightly elevated lands along the coastline

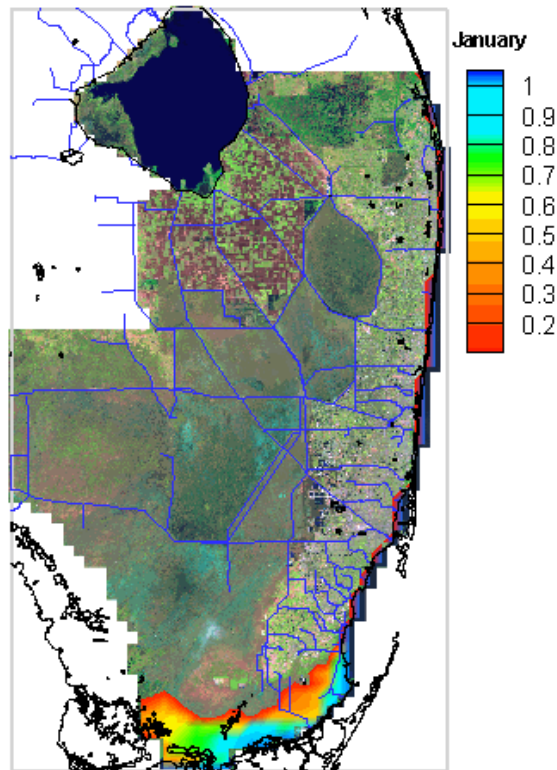


Increase in Sea level rise raises the freshwater table closer to the ground surface, reducing the extent of the vadose zone threatening Hardwood Hammock species that are dependent upon fresh soil water.

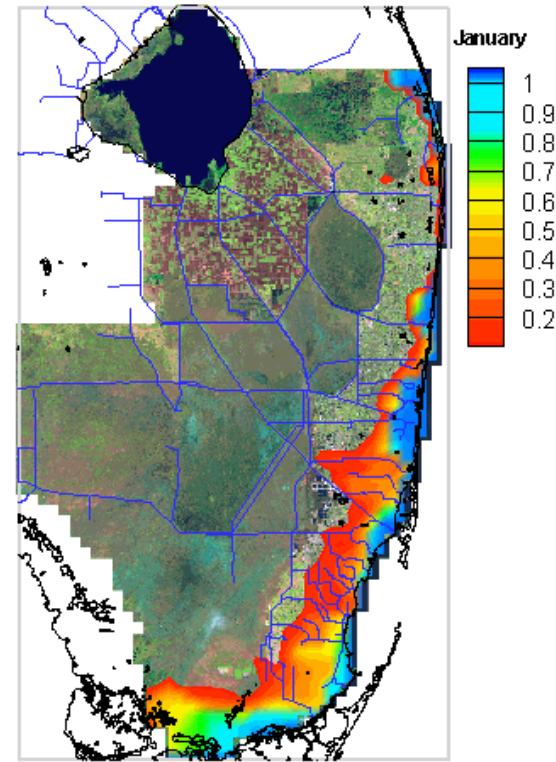


Monthly Increase in Ponding & Water Surface due to Sea Level Rise*

Surface Water Level Increase

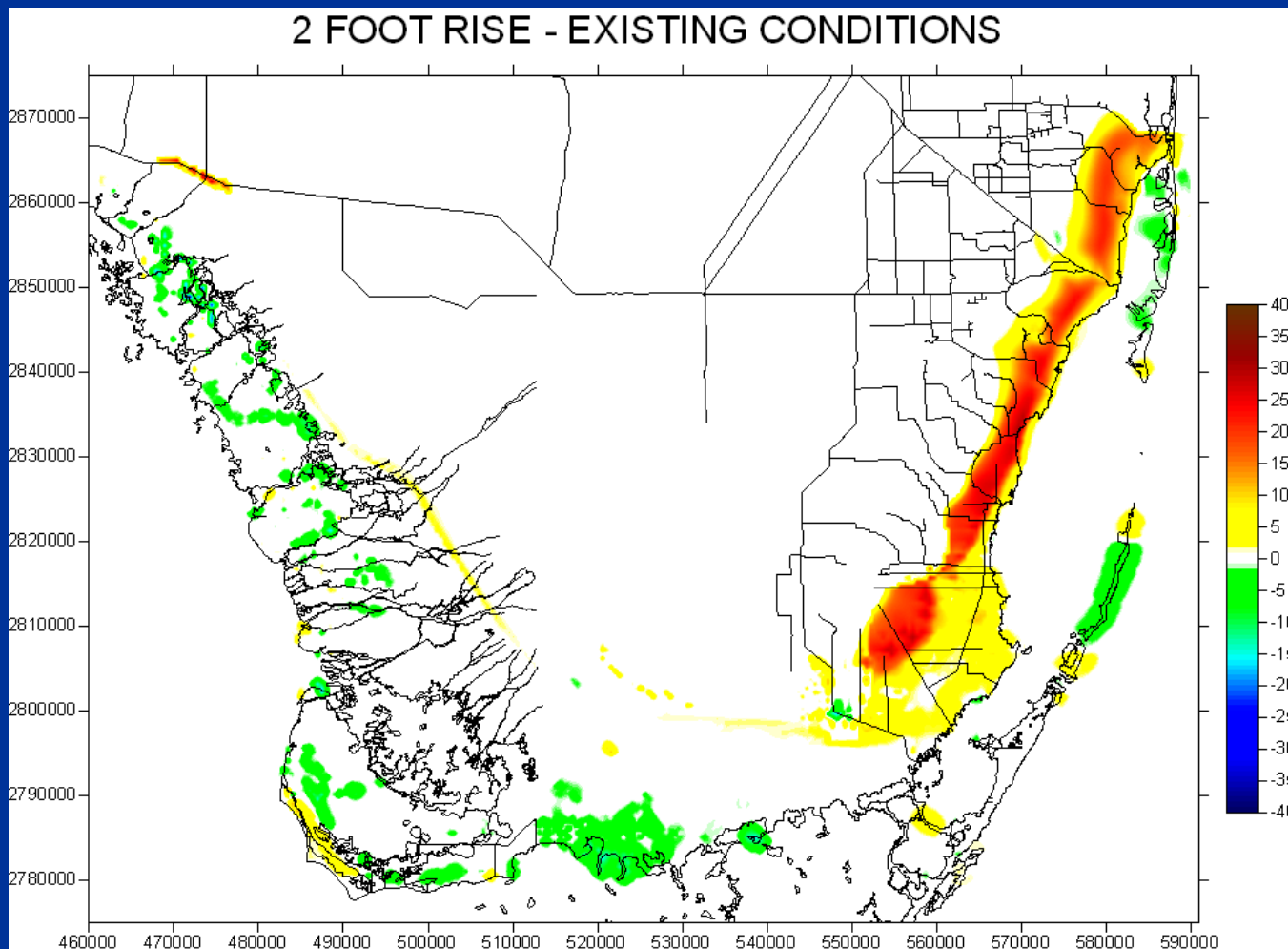


Groundwater Level Increase



*1.5 feet of SLR. Coastal canal maintenance levels increased to counter sea level rise. However, in some cases full increase was not possible due to flood protection concerns.

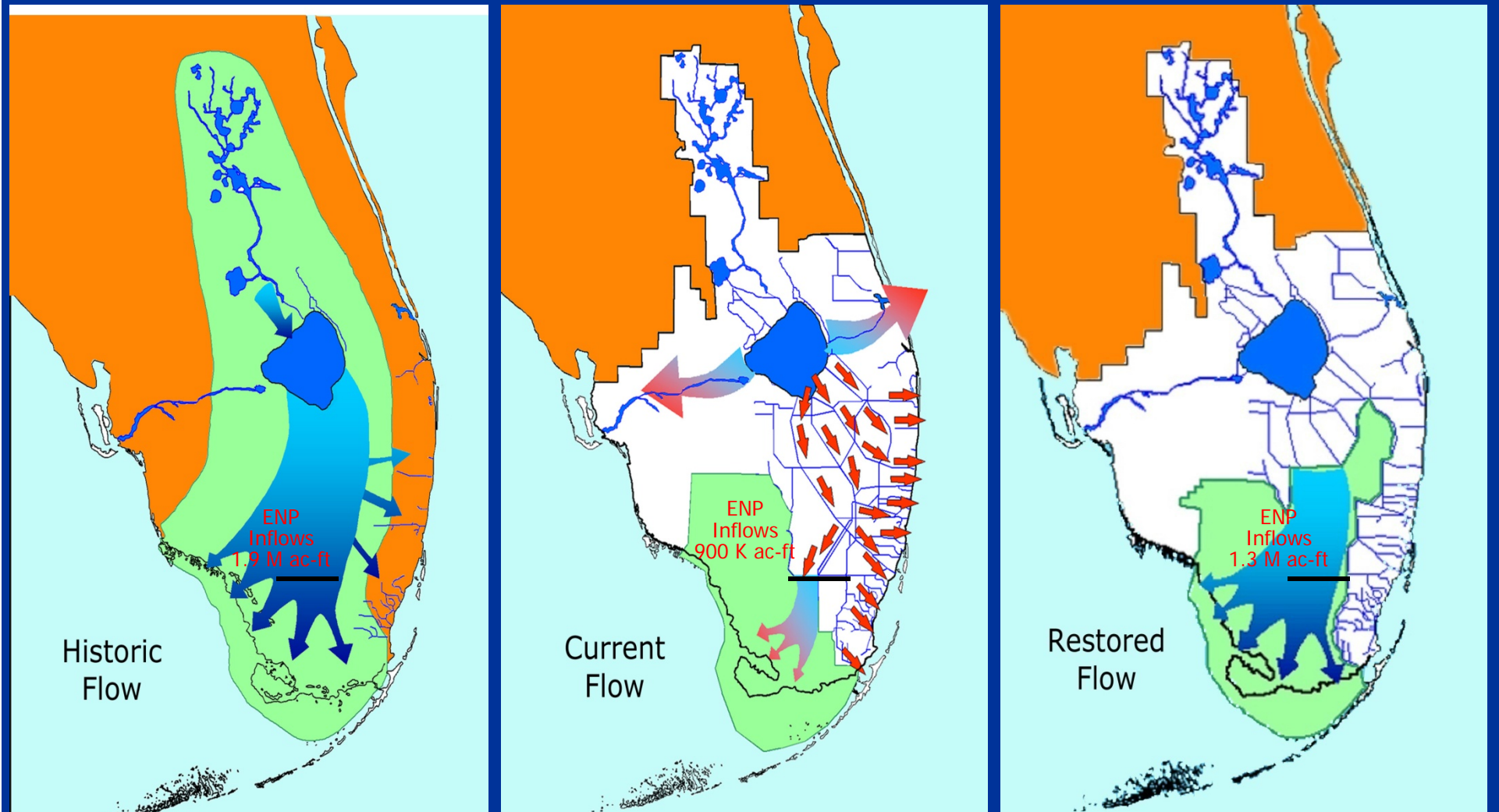
Groundwater salinity difference with two-foot sea-level rise



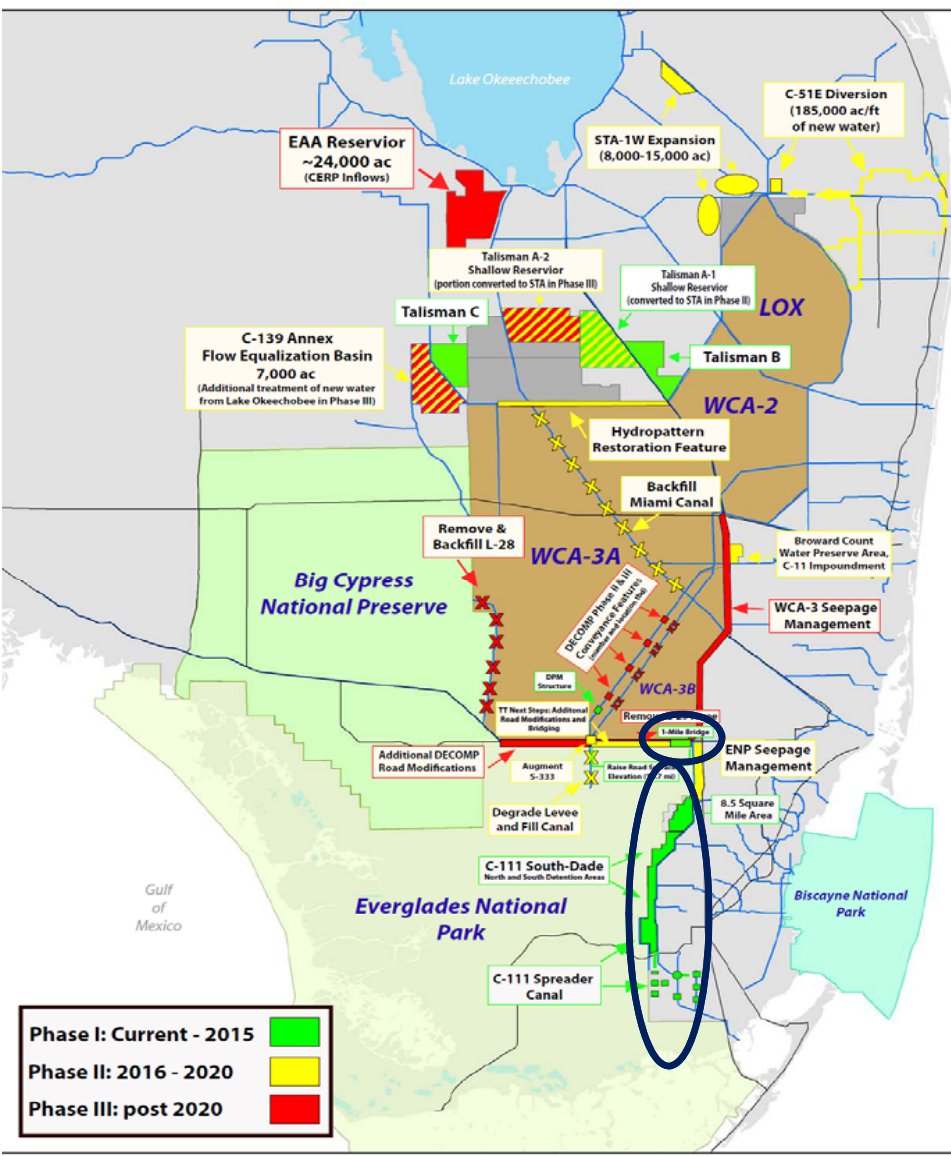
Courtesy: Eric Swain, USGS

Sustainability?

Comprehensive Everglades Restoration Plan (CERP) goal is to increase freshwater flows to coastal Everglades



CERP Projects During FCE III



Tamiami Trail Bridge Construction

March 13, 2012



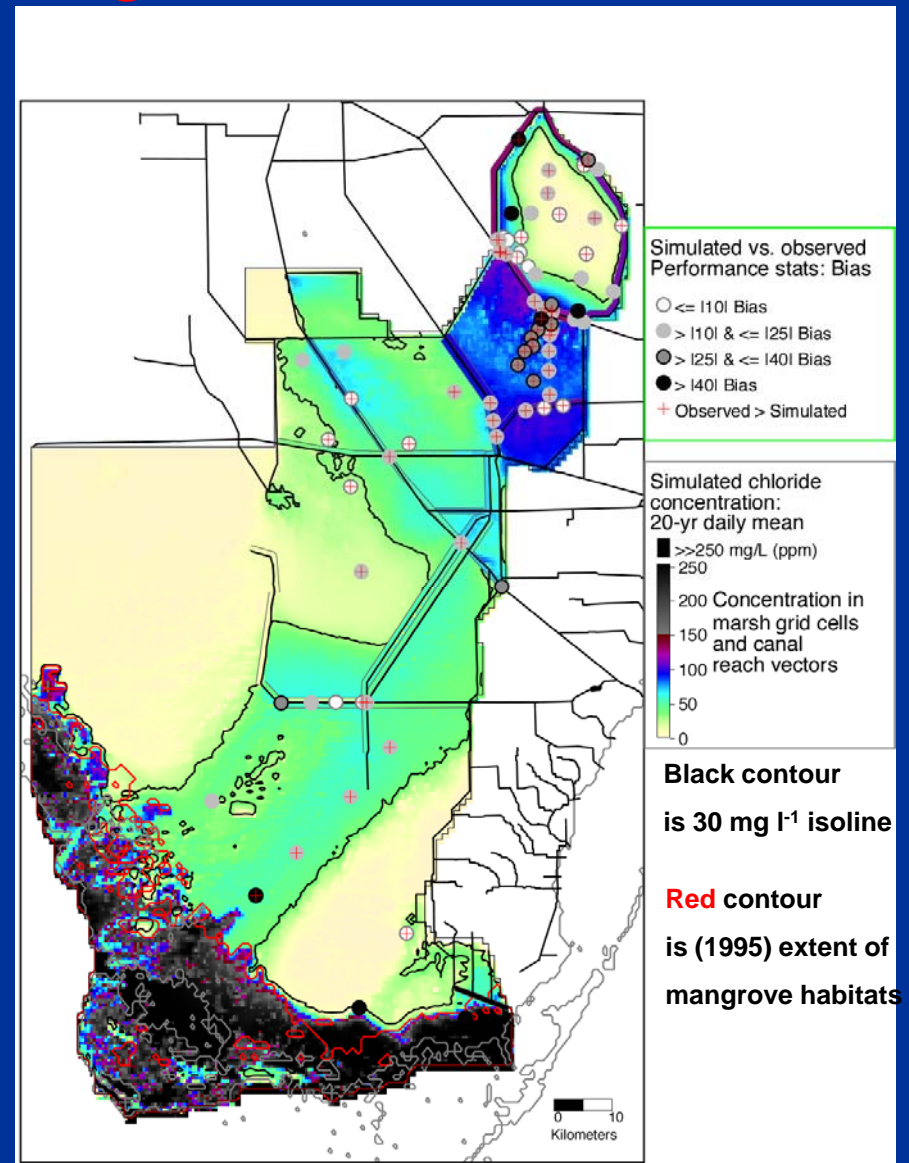
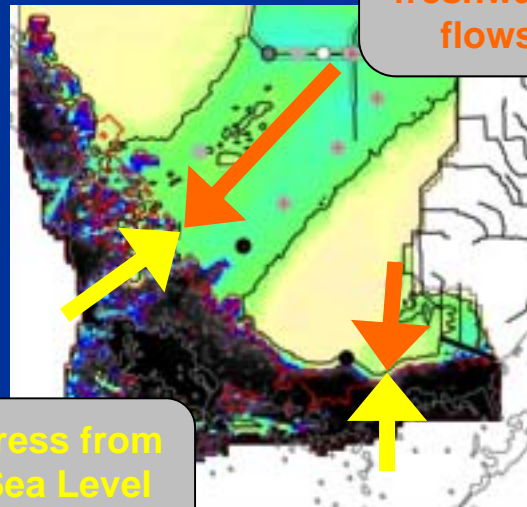
Ecological Landscape Modeling

Model experiments:

Ecological responses to

-- increased freshwater flows

-- & sea level rise



Simulated historical Cl concentrations

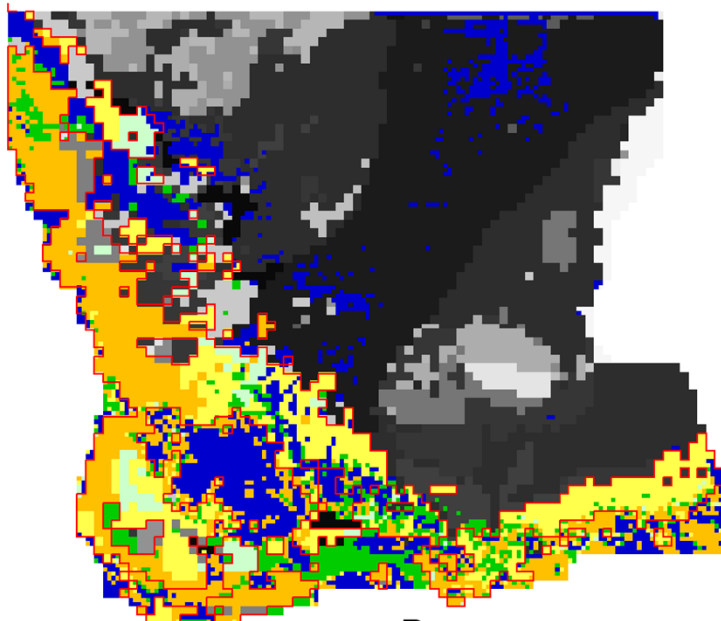
ELMreg500m v2.8.3

Fitz, C. and others: <http://ecolandmod.ifas.ufl.edu>

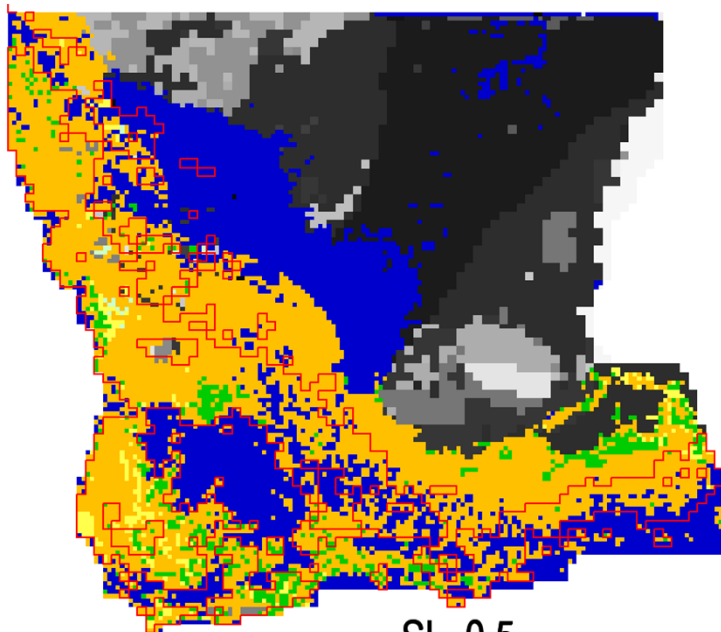
Habitat Classes, at Simulation-End

- Open Water/Slough
- Mangrove Forest
- Buttonwood Forest
- Mangrove Scrub
- Buttonwood Scrub

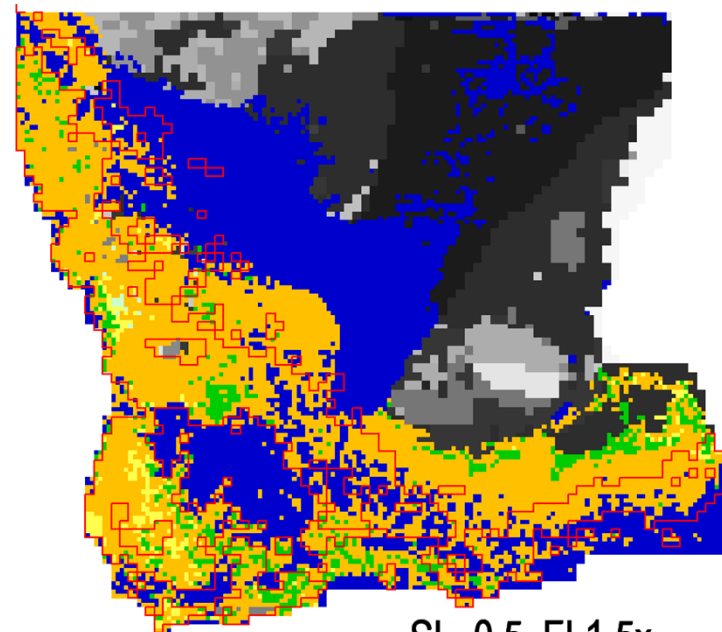
Red polygons are 1995 mangrove habitats



Base



SL_0.5



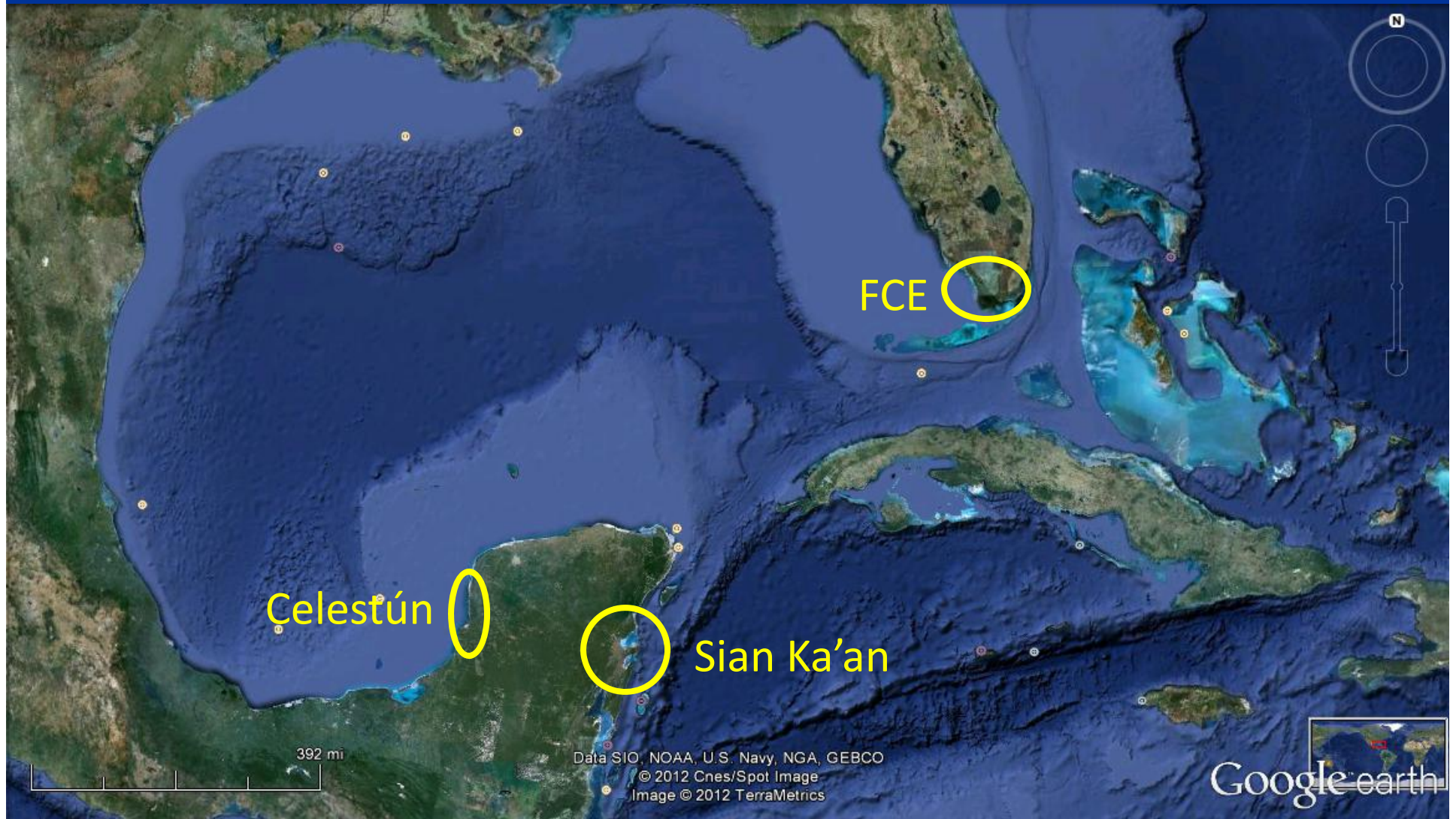
SL_0.5_FL1.5x

Needs for continued ecological and hydrological studies to determine the effects of sea level rise on coastal resources

Opportunity for cross-site comparisons
carbon accretion/transport/loss



Cross-site comparisons with Mexican LTER's in the Yucatan



Acknowledgements

Contributors:

Evelyn Gaiser – FIU

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Carl Fitz - UF

