The Everglades: At the Forefront of Transition

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Greater Everglades Ecosystem Restoration Conference, Coral Springs, April 22 - 25, 2019

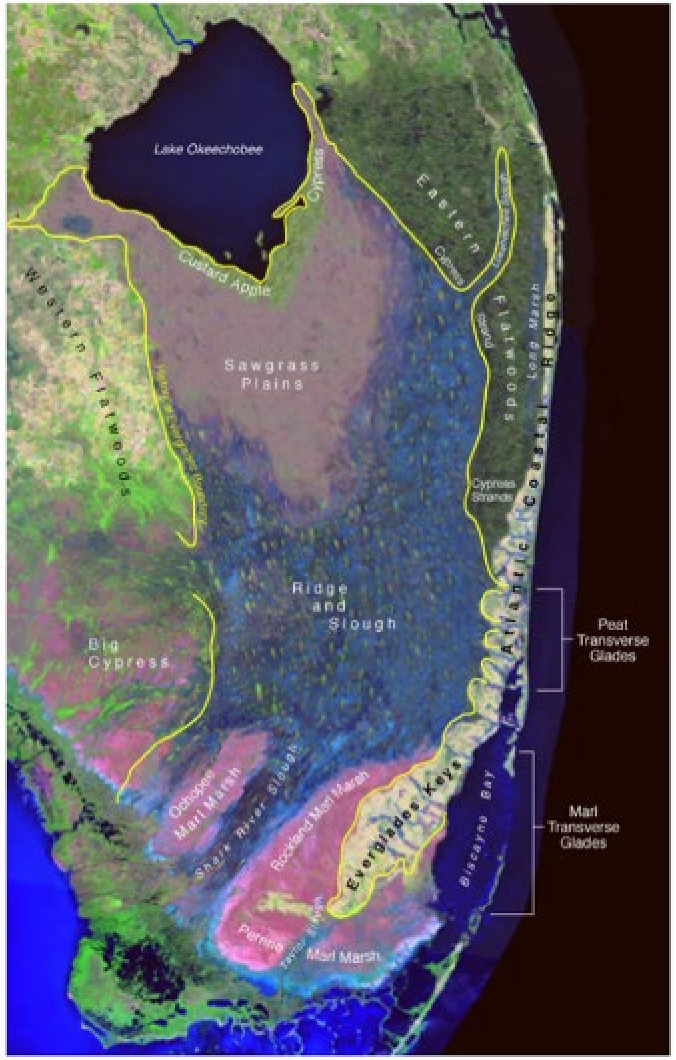
Acknowledgements:

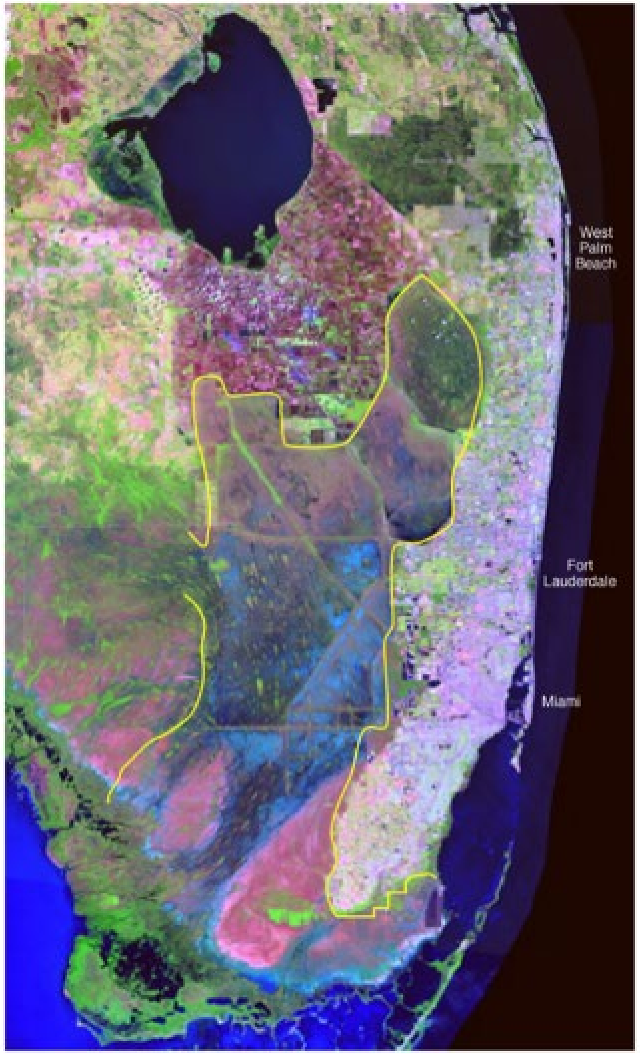
Benjamin Wilson, Jack Meeder, Steve Davis, Pablo Ruiz, Tom Dreschel, Theresa Strazisar, Carlos Coronado-Molina, Stephen Kelly, Christopher Madden, Tiffany Troxler, John Kominoski, Evelyn Gaiser, Viviana Mazzei, Shelby Servais, Laura Bauman, Fabiola Santamaria, and Michelle Blaha

HYPOTHESIS

The interaction of biology and ecology with water management and sea level rise in the coastal peatlands of the Everglades will determine its capacity for carbon sequestration, storm surge attenuation and habitat restoration.

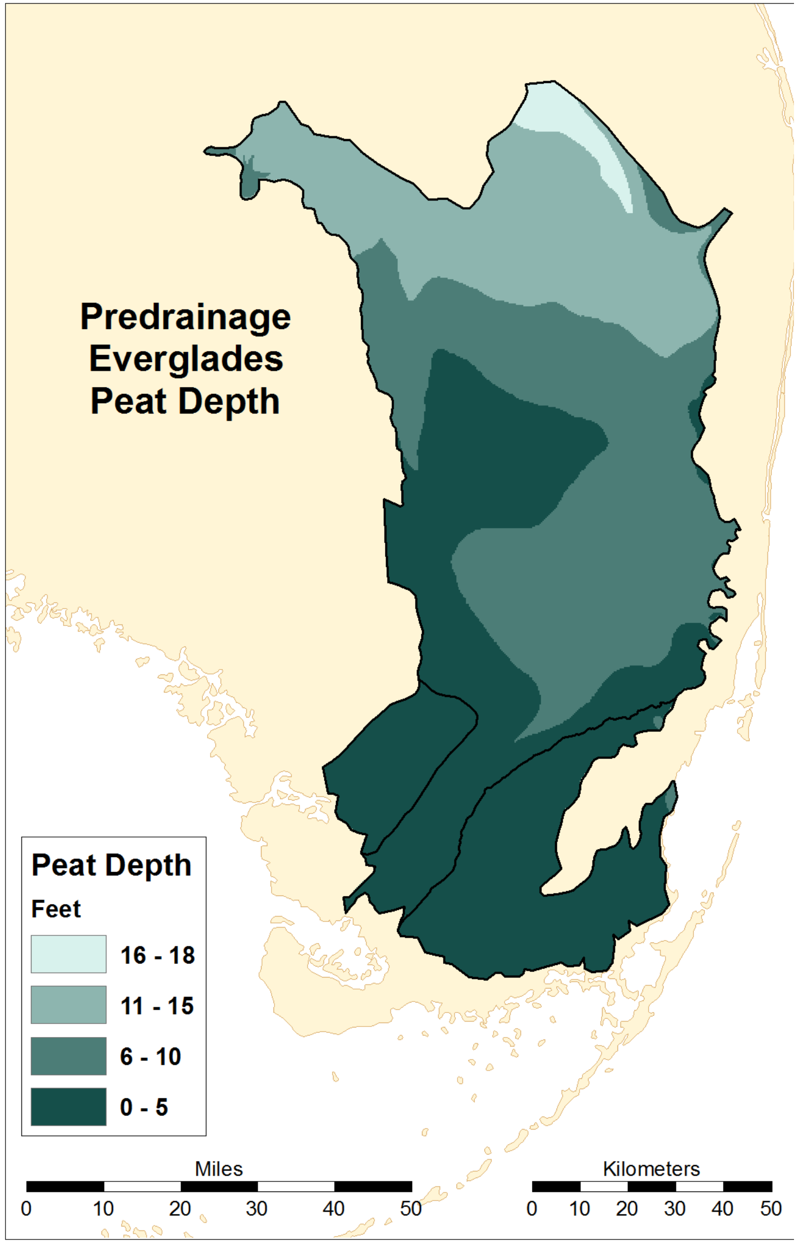
Water Management System Components

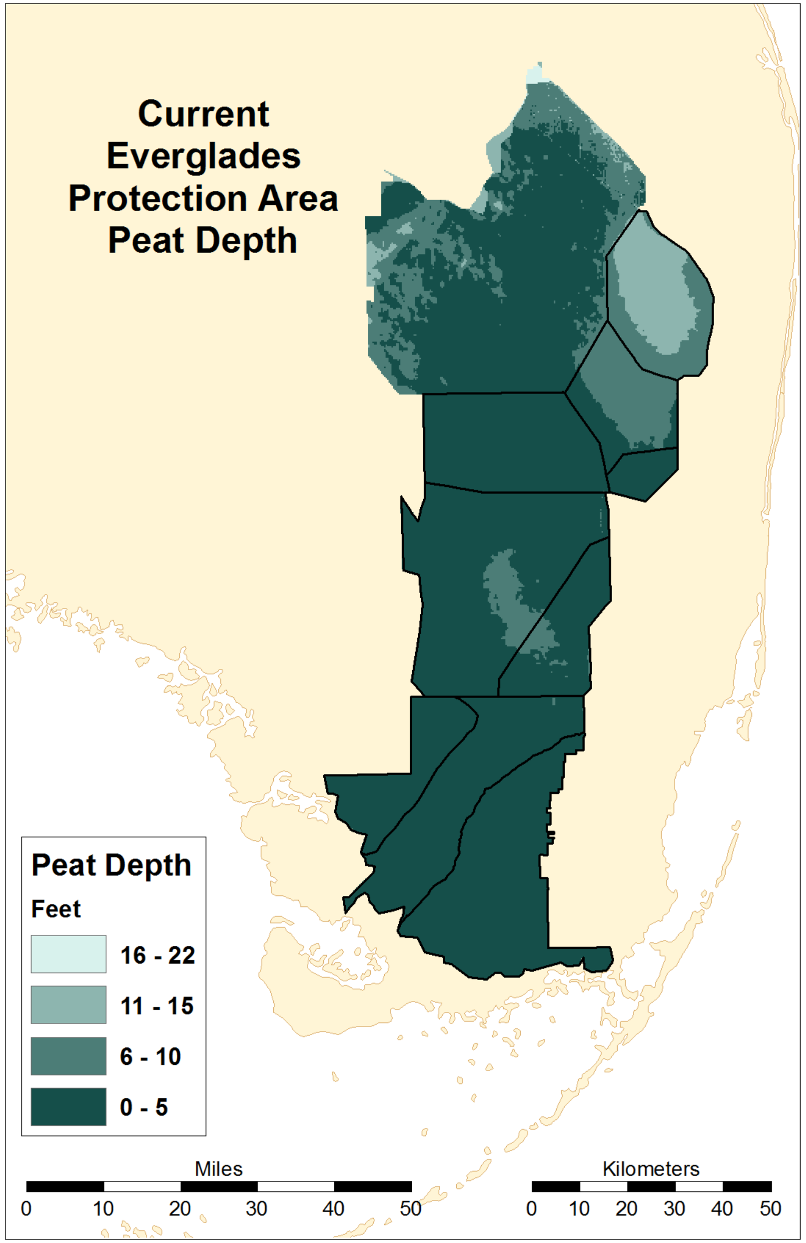




- ~3400 km of canals
- ~3200 km of levees/berms
- > 600 water control structures
- 71 pump stations

Pre-drainage Everglades (150 ybp) had a peat depth of 2 m, a peat volume of 20 billion m^3, and a carbon content of about 900 million metric tons





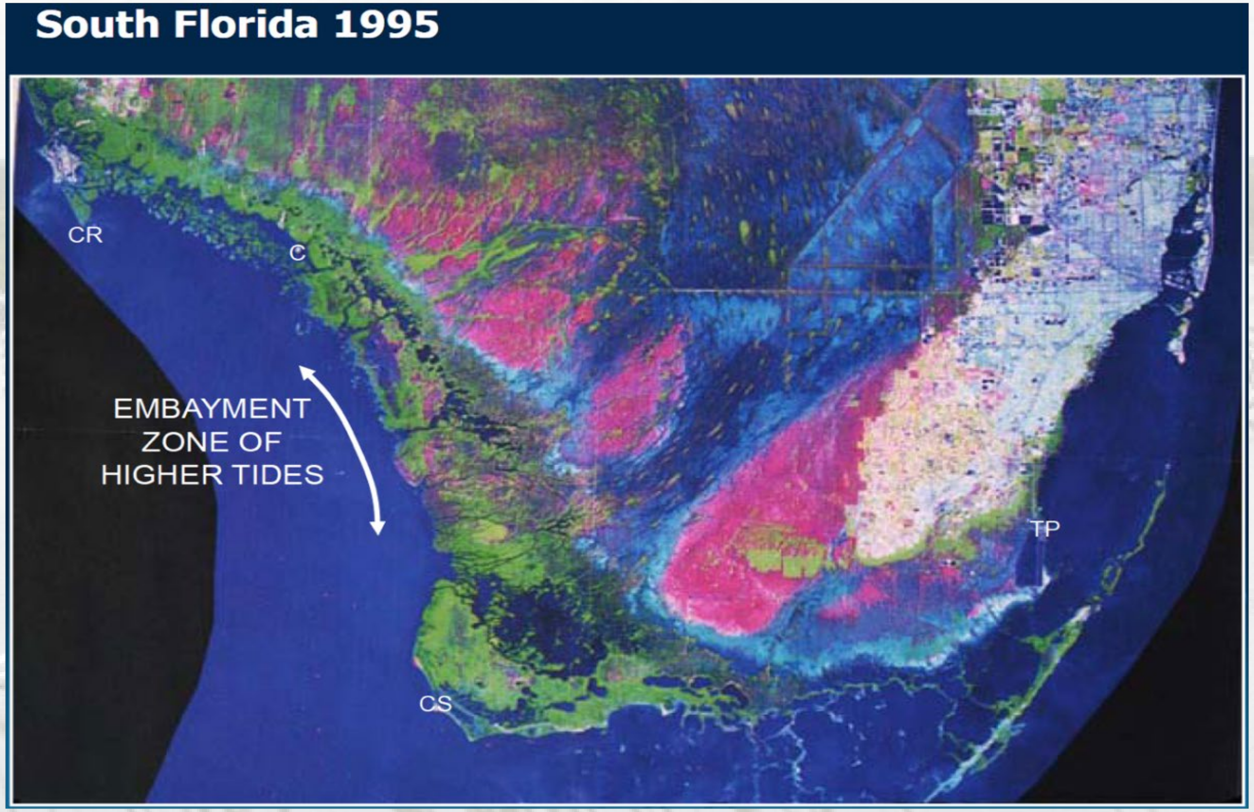
Current Everglades has a peat depth of 0.75 m, a peat volume of 5 billion m^3, and a carbon content of about 200 million metric tons.

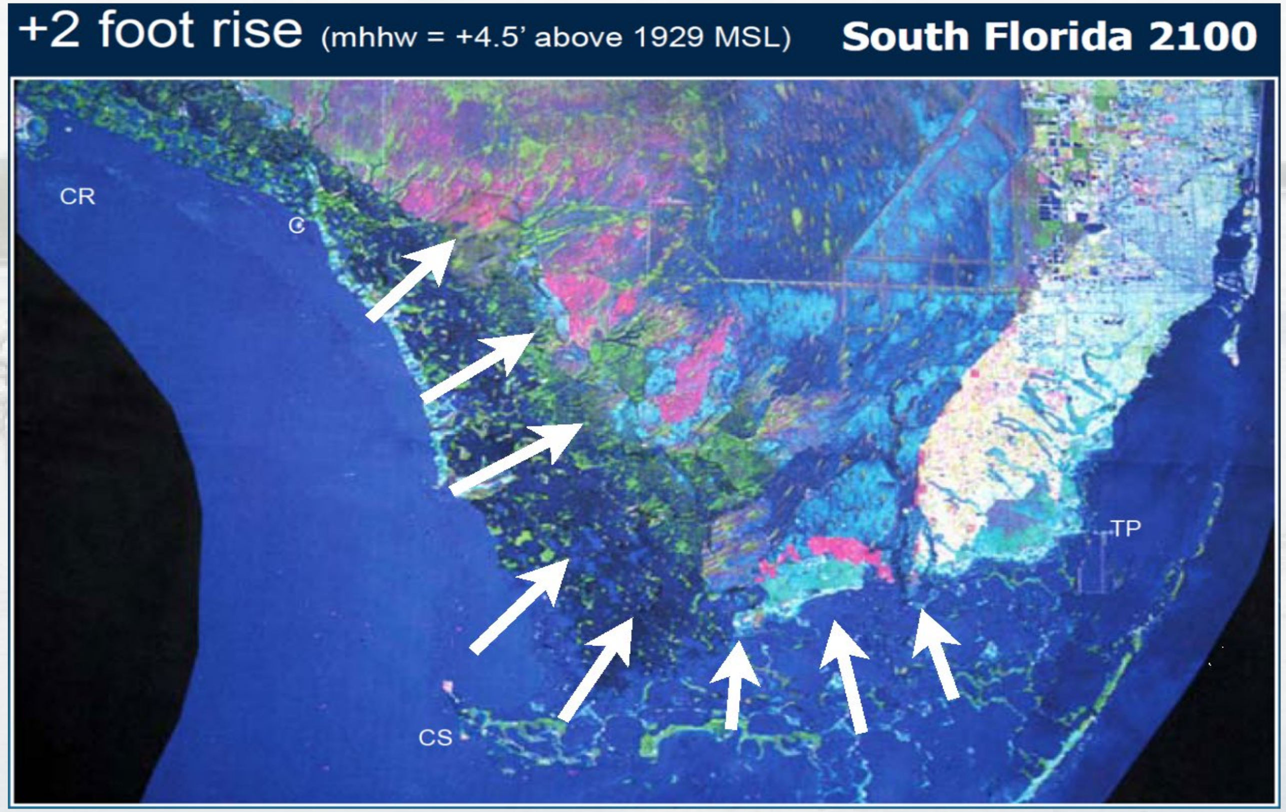
65% Peat Loss

77% Carbon Loss

Hohner and Dreschel, 2015. Everglades Peats. Mires and Peat. 16:1-15.

Sea level rise threatens coastal marshes

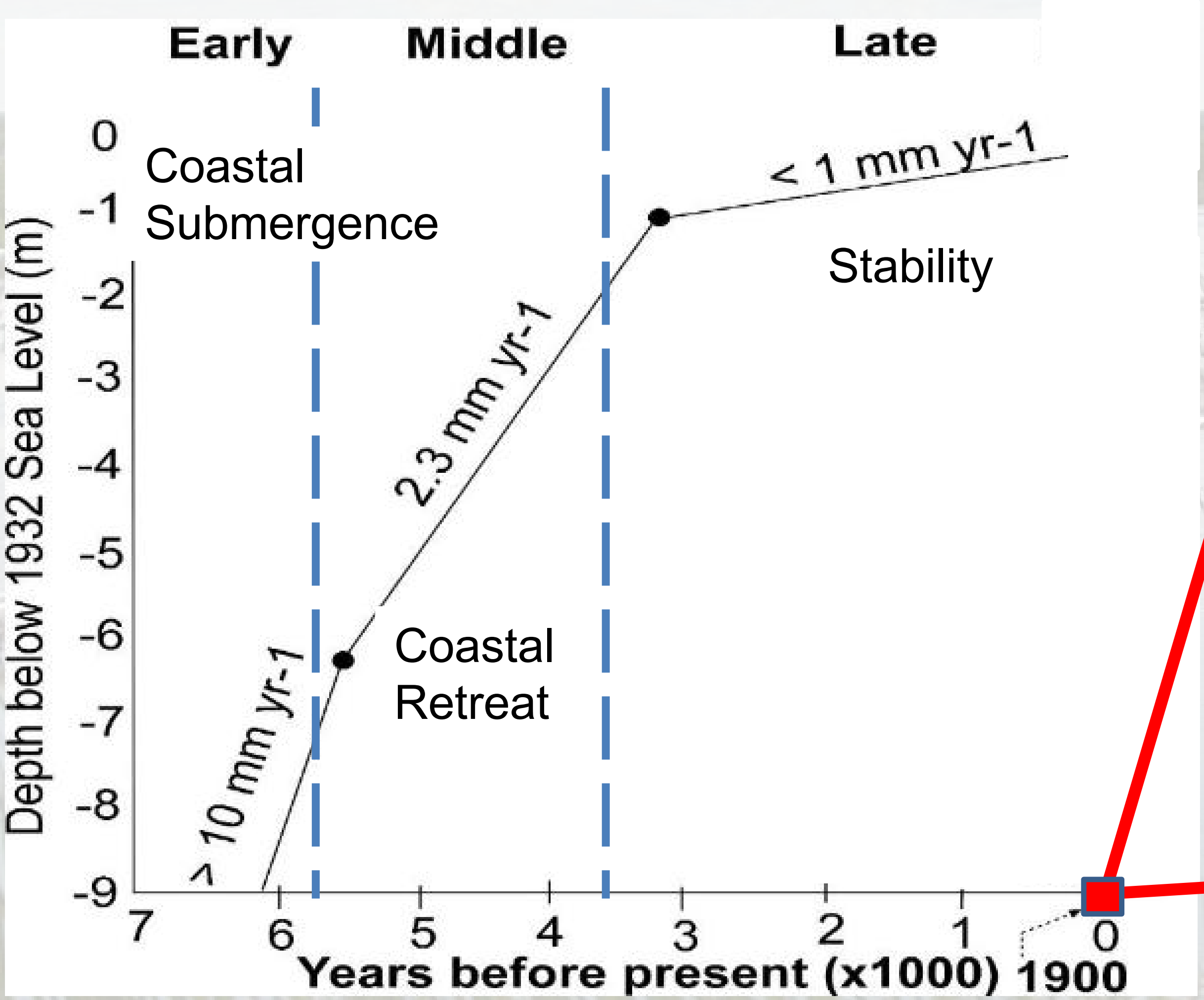




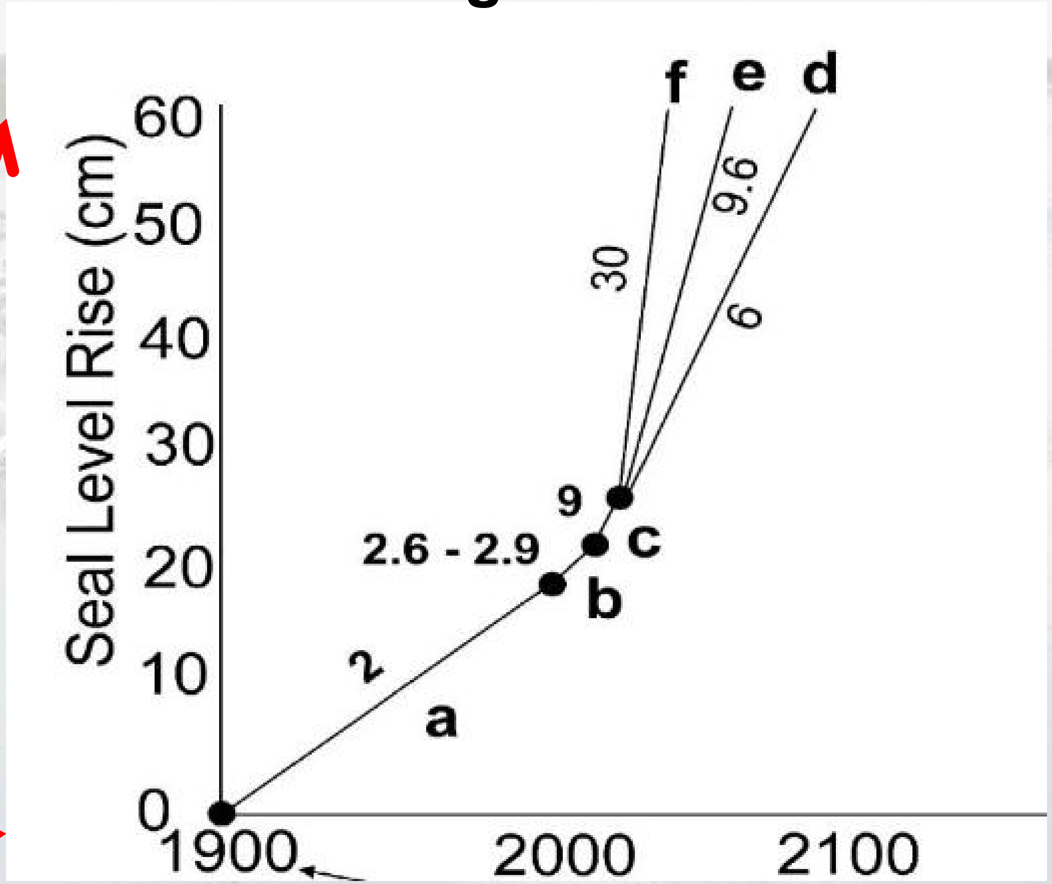
Maps showing current (left) and projected (right) coastline change, peat collapse and habitat movement resulting from a 2ft rise in sea level, projected by Dr. Hal Wanless, University of Miami in 1998

Increasing pressures from sea level rise combined with the geological history of Florida puts the Everglades at the “forefront of transition”

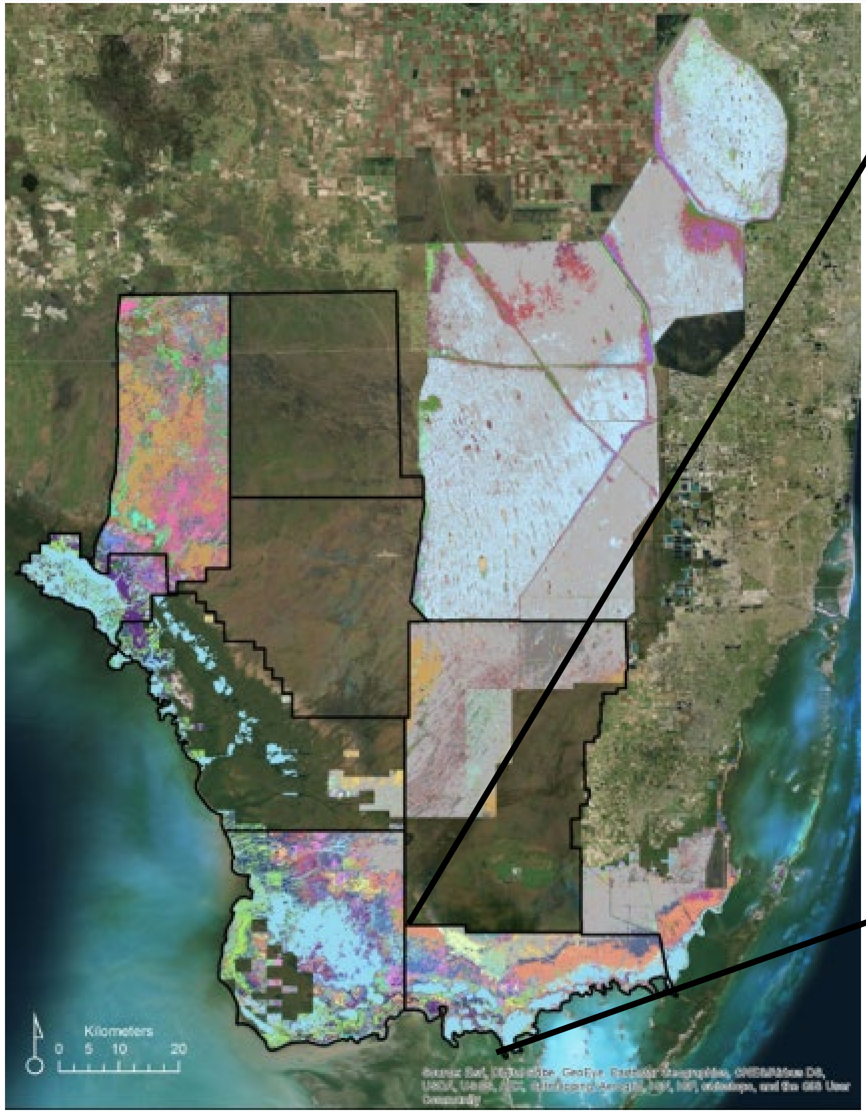
Holocene

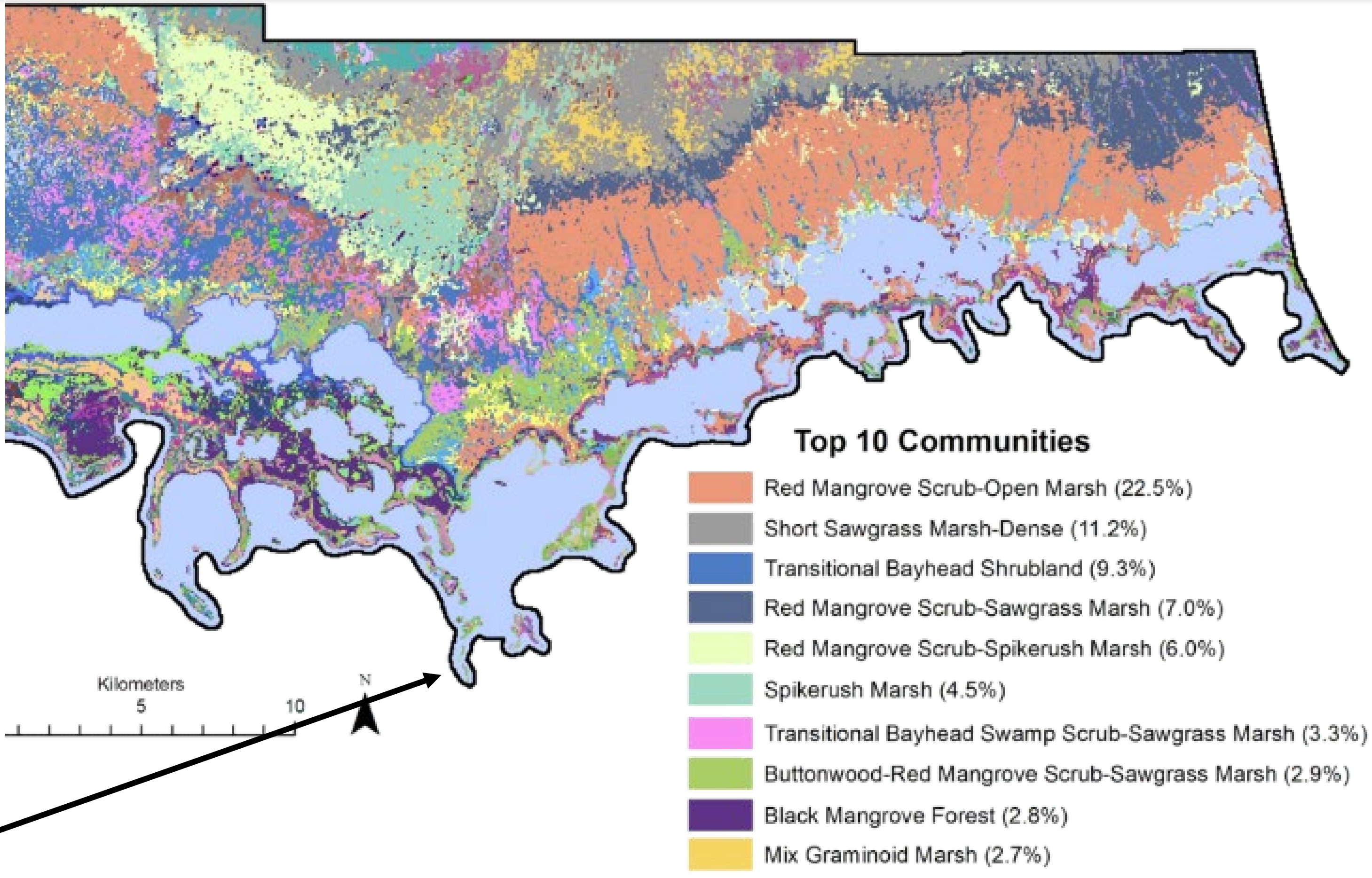


Anthropocene Marine Transgression



Southeast Saline Everglades





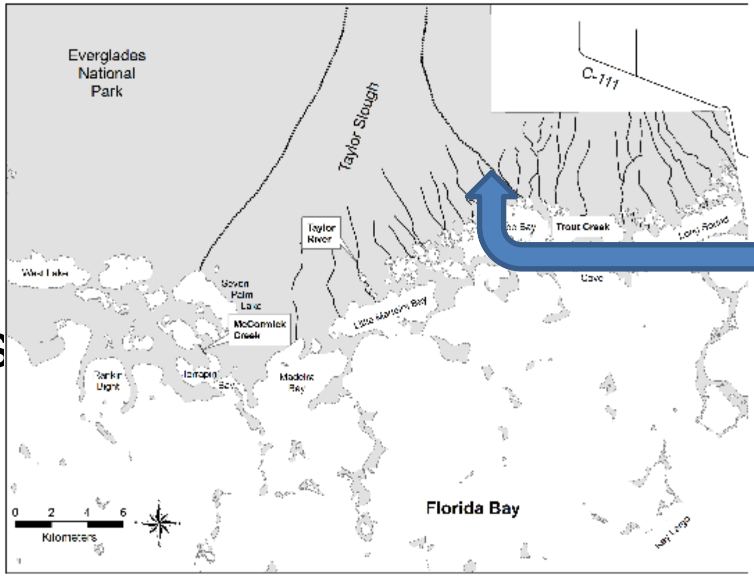
Why are we focused upon the southeast saline Everglades?

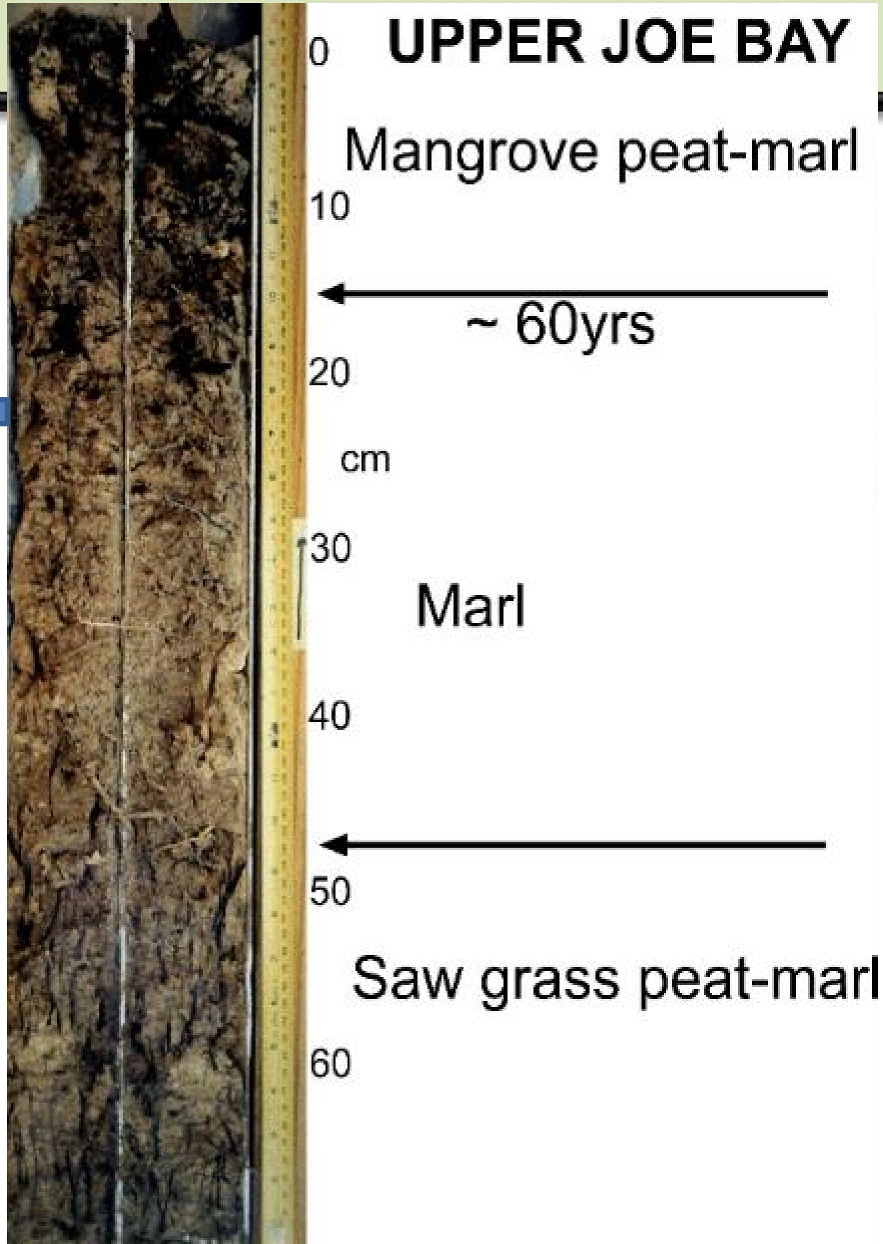
1. As a flat, low-lying landscape, the conventional thinking is that Everglades coastal habitats will gradually migrate upslope with increases in sea level as a transgressive process and as freshwater sawgrass marshes transition into brackish water marshes.

Mangroves “migrating” past a freshwater tree island in the southeast saline Everglades in response to the Anthropocene Marine Transgression. North is to the top, mangrove clumps range between 1 and 3 m in diameter. (Photo by Mike Ross).

Why are we focused upon the southeast saline Everglades?

2. Inland transgression of mangroves has been suggested as a means by which sub-tropical and tropical coastal landscapes will “adapt” to increasing SLR.





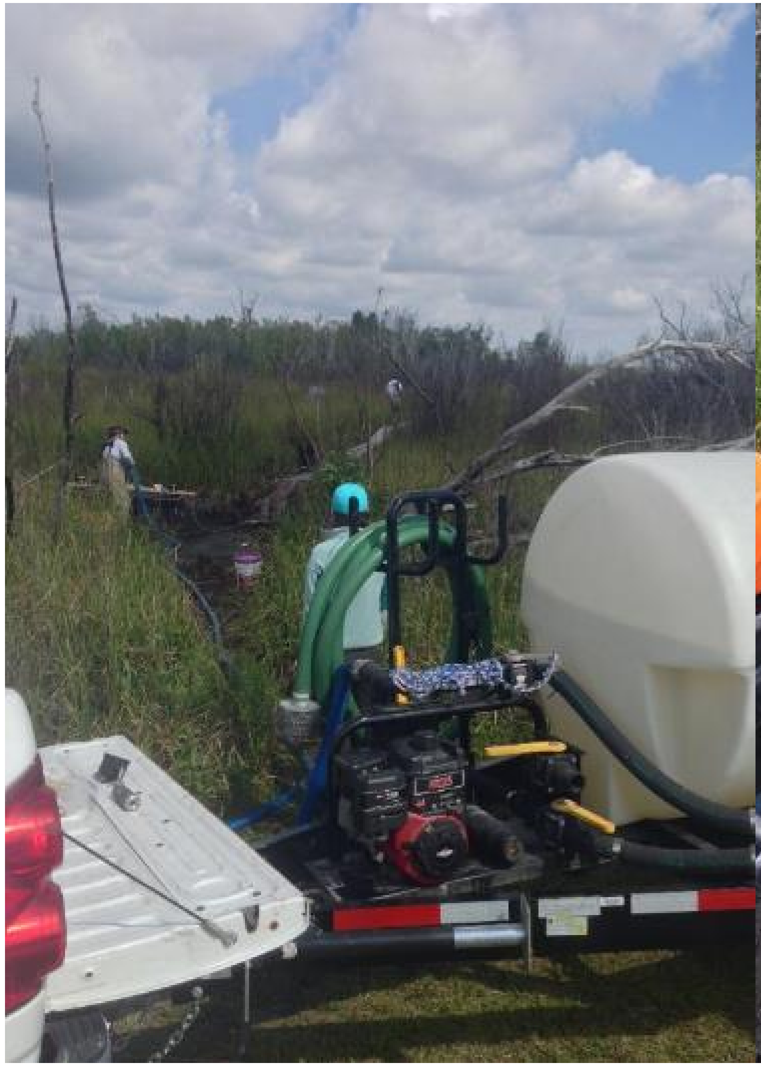
A core 5 km north of Joe Bay displays a transgressive stratigraphic sequence and documents saltwater encroachment. The date, based upon ^{210}Pb dating of mangrove peat-marl soils indicates an accretion rate of 3.2 mm yr^{-1} (Meeder et al. 2017).

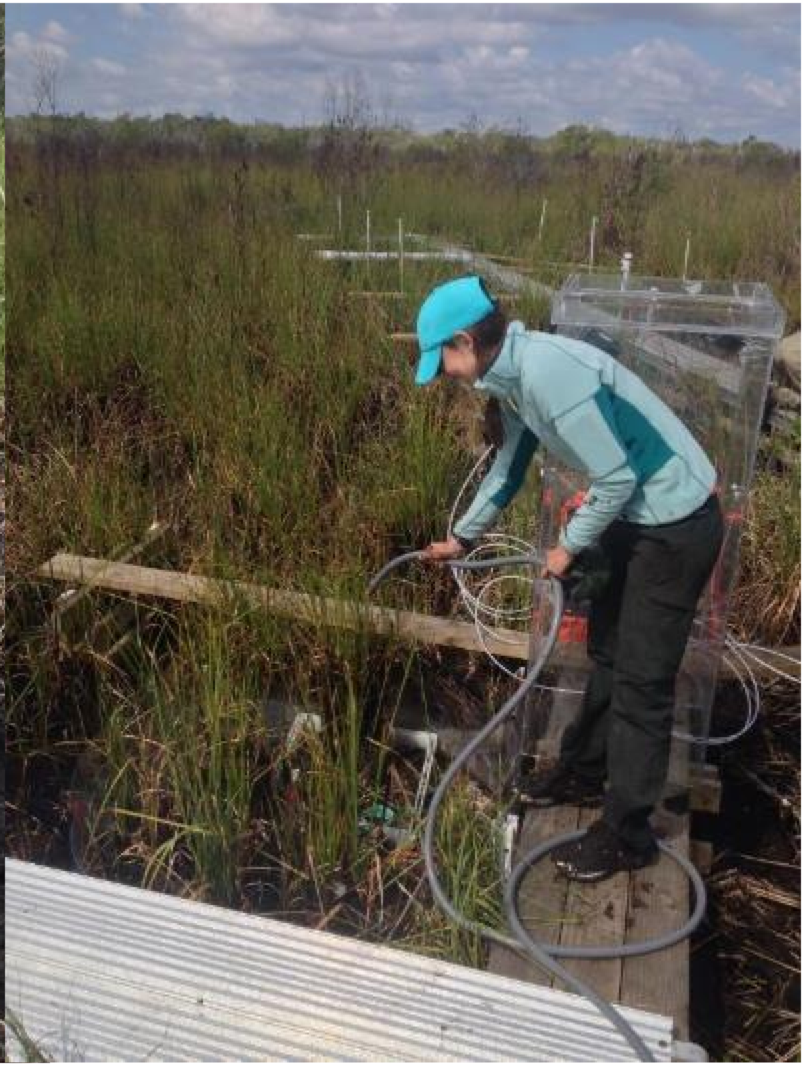
Why are we focused upon the southeast saline Everglades?

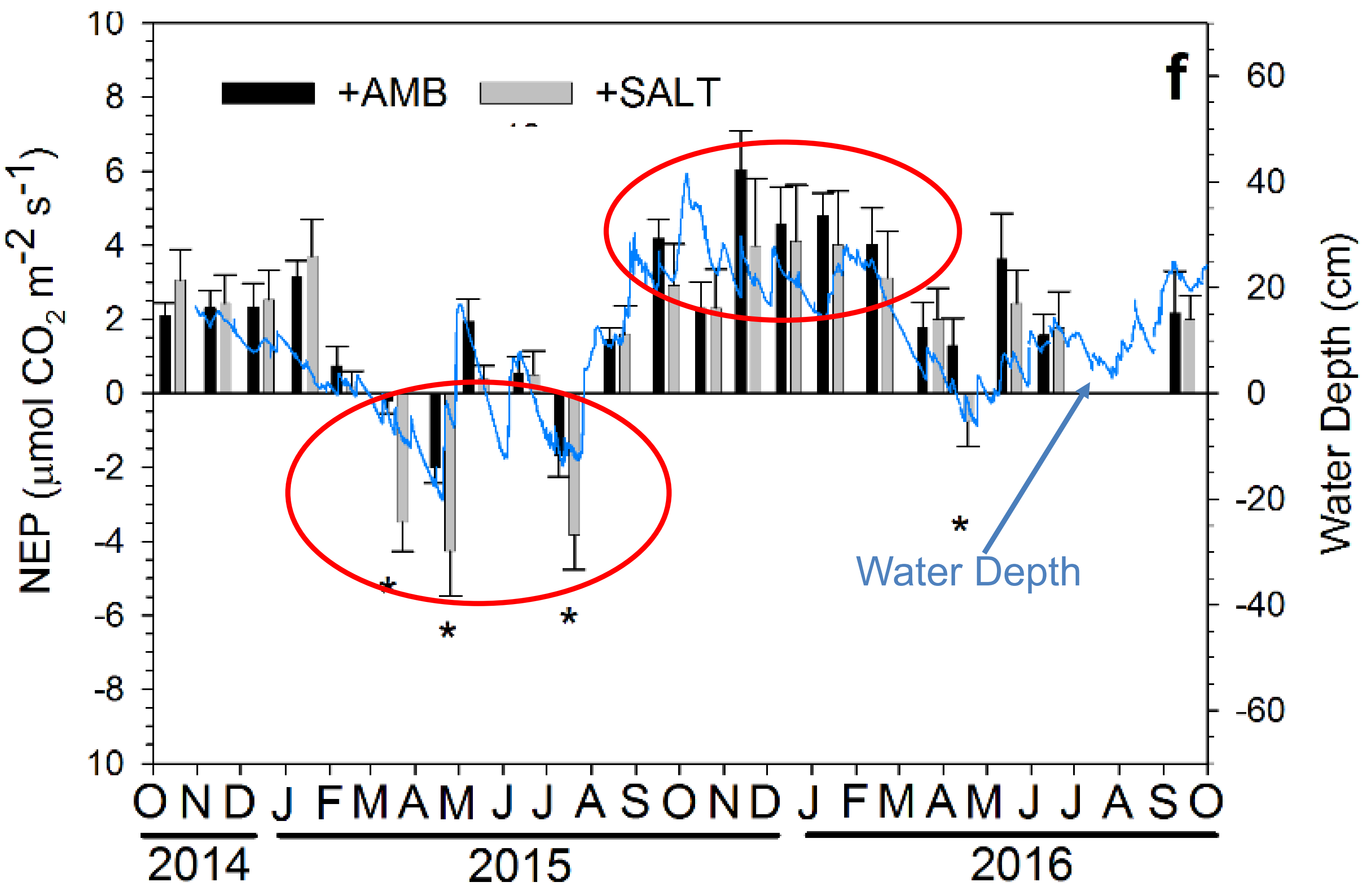
3. Erosion of coastal peats, inundation, ponding and overstep (i.e., salt water encroachment too fast for all communities to retreat) has already been observed in the southeast saline Everglades.

Peat collapse dosing experiments are in Shark River Slough in a brackish marsh area showing signs of peat collapse.

Saltwater Dosing Experiments





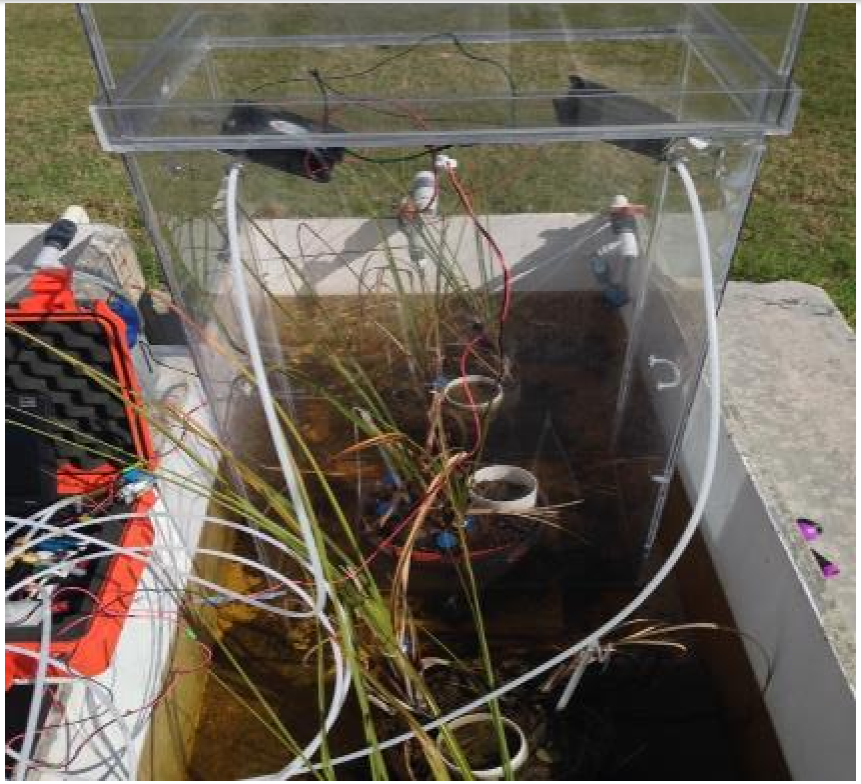


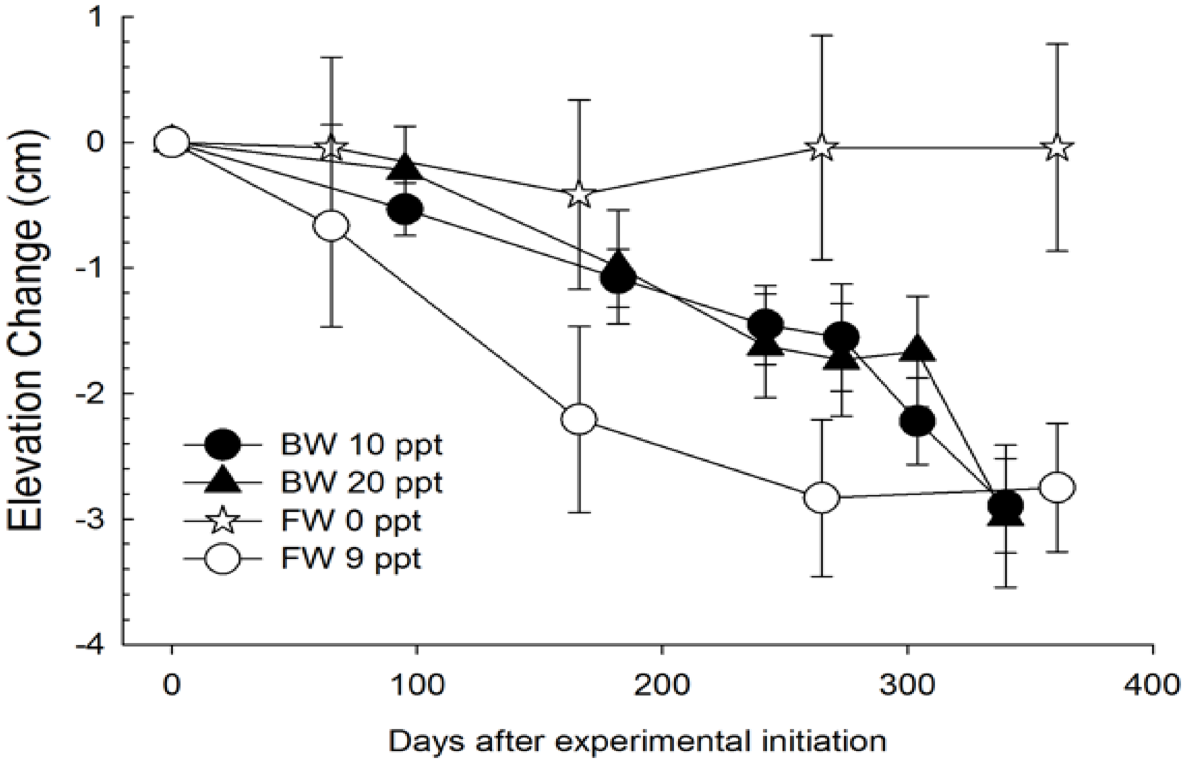
Brackish peat marsh field experiment with water level relative to soil surface plotted against net ecosystem exchange (NEE) for ambient (AMB) and 2X porewater salinity exposed (SALT) plots.

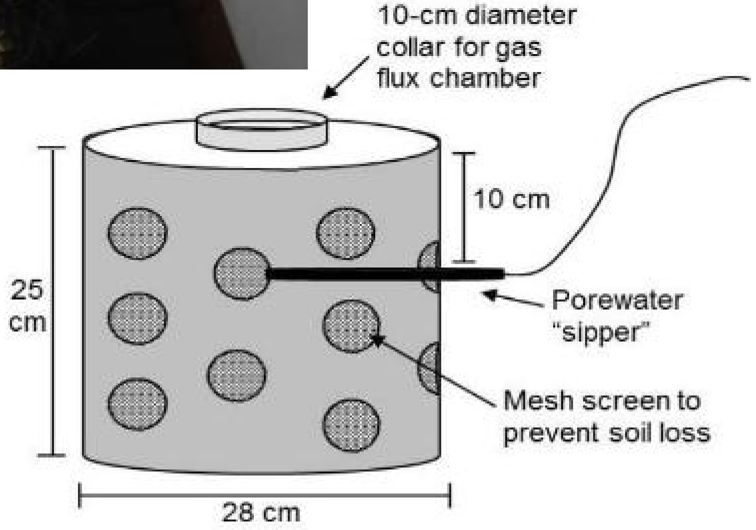
Results

- An extended "dry-down" pattern can led to increased porewater salinity.
- Elevated salinity reduced gross ecosystem productivity and belowground root growth.
- Drought stimulated organic matter mineralization and carbon dioxide loss from the marsh.

Ben Wilson et al. 2018. Salinity pulses in marshes interact with seasonal dry-down to increase ecosystem carbon loss in the Florida Everglades. Eco Apps. In press.

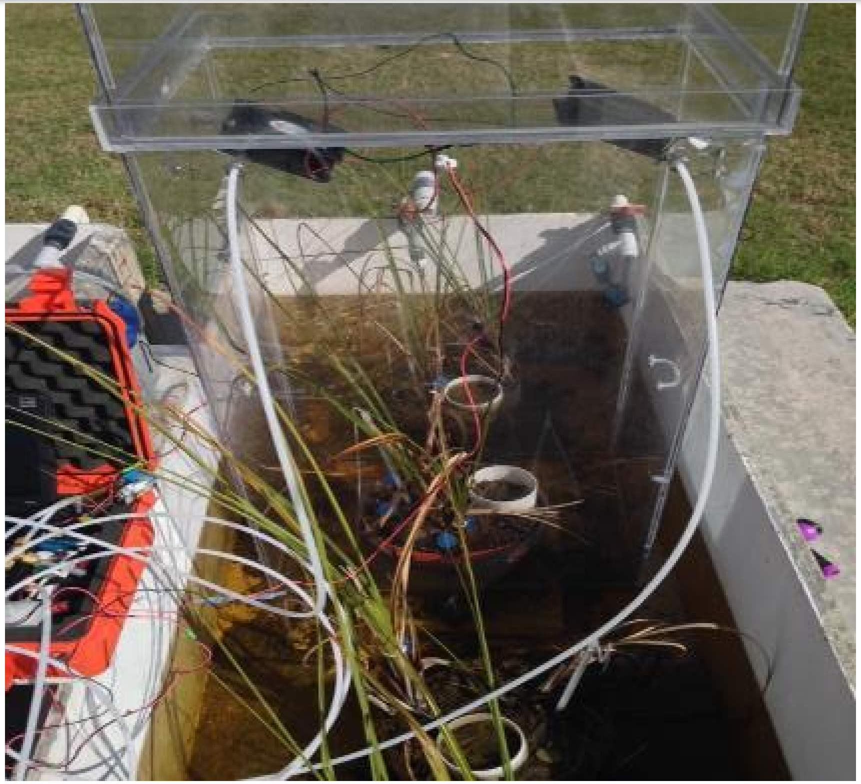


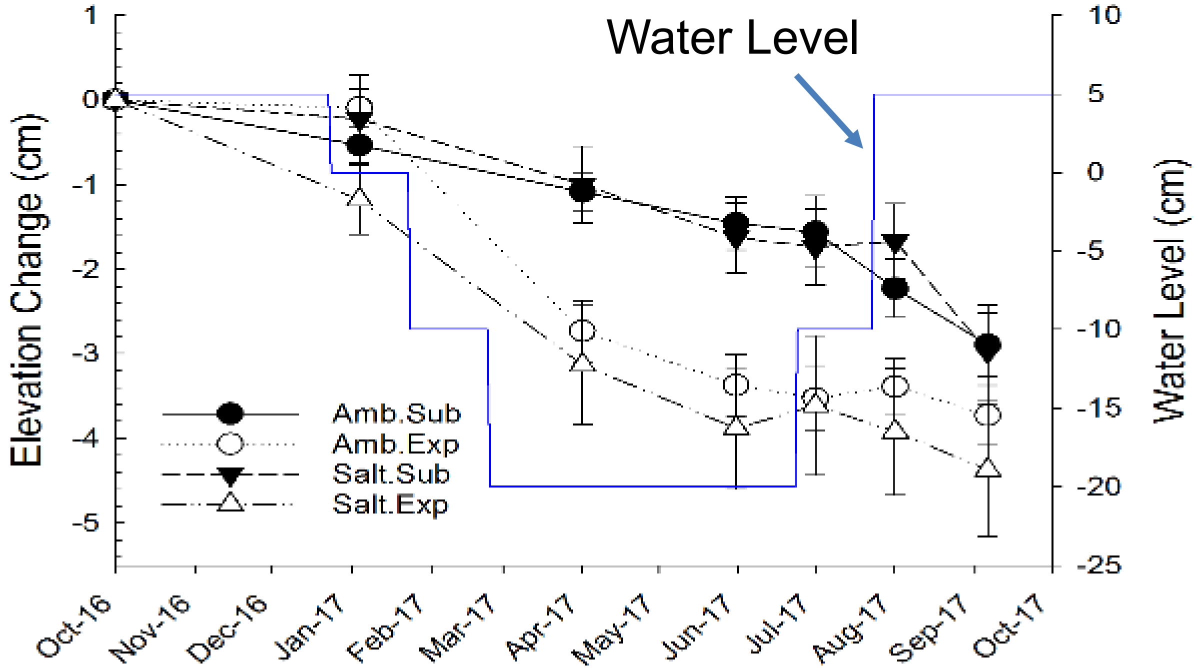




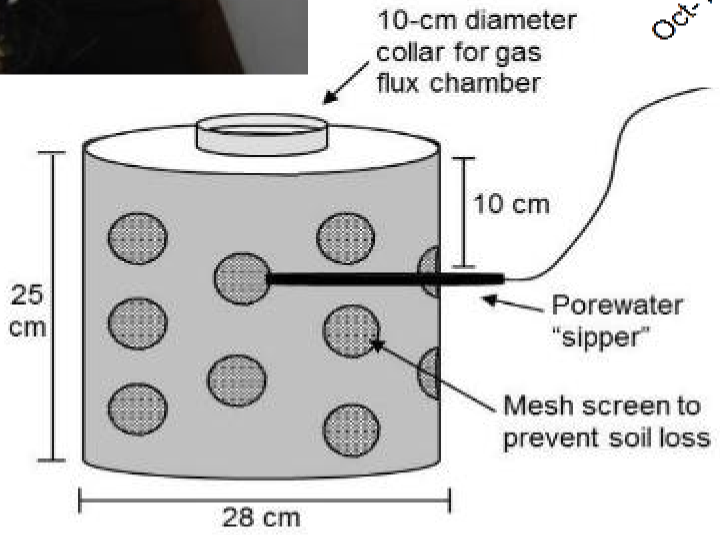
Schematic illustrating the mesocosm core design for the measurement of instantaneous NEE (right) and photo of the mesocosms (above) used to evaluate drought and salinity effects.

Ben Wilson et al. 2018. Saltwater intrusion and drought drive peat collapse in a brackish coastal peatland. Nature. In review.





Schematic illustrating the mesocosm core design for the measurement of instantaneous NEE (right) and photo of the mesocosms (above) used to evaluate drought and salinity effects.

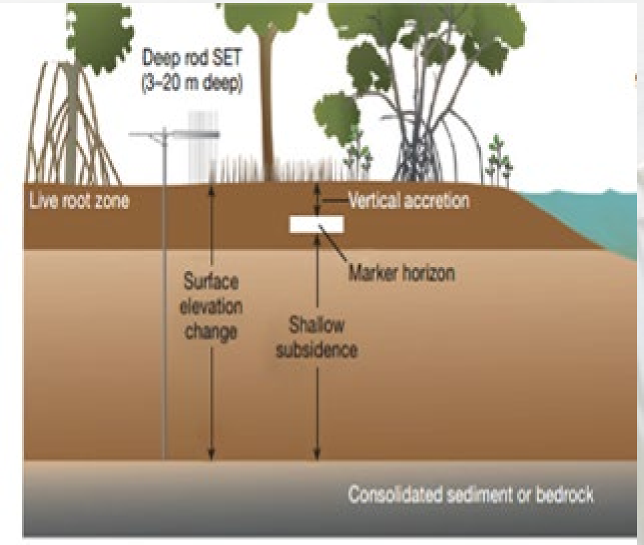


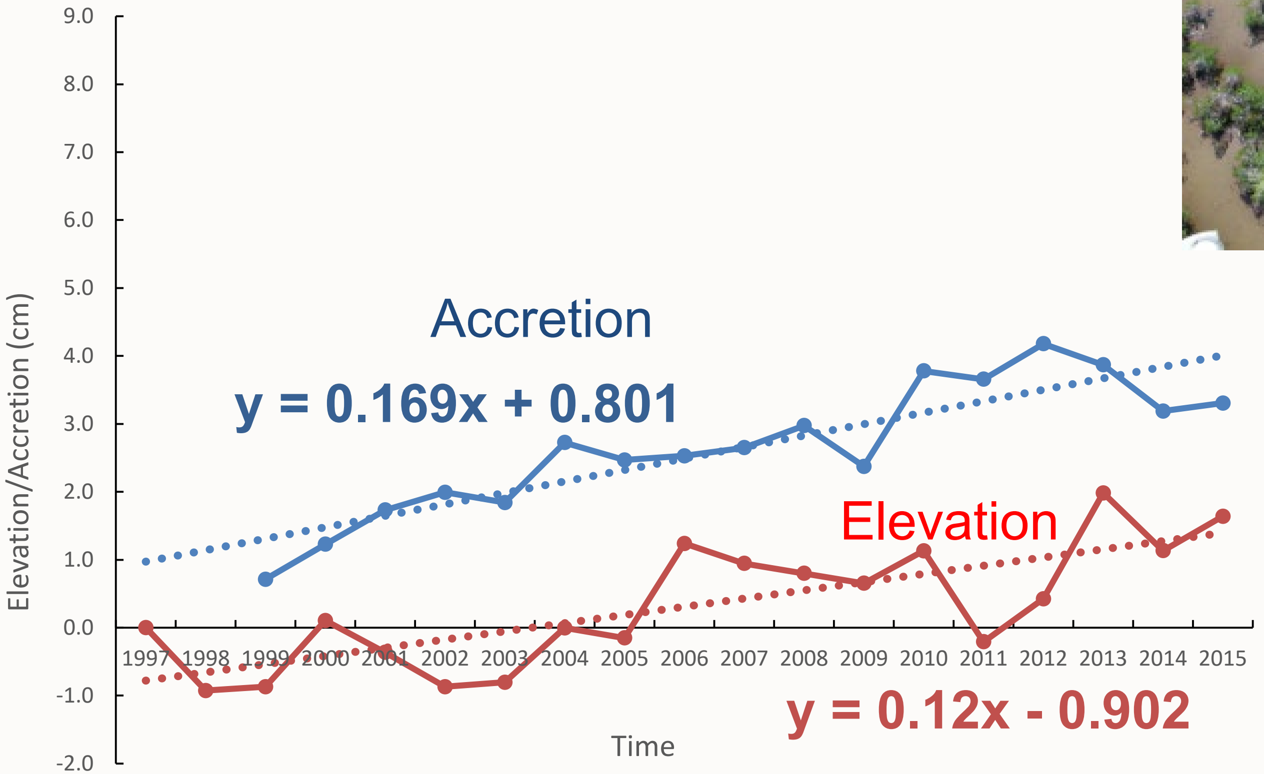
Results: Soil elevation declined ~2.9 cm in one year under brackish water conditions and by ~4.4 cm when elevated salinity was coupled with drought (exposed).

Ben Wilson et al. 2018. Saltwater intrusion and drought drive peat collapse in a brackish coastal peatland. Nature. In review.

Highway Creek: (Elevation Change = 1.2 mm/yr)
Low flow -- Always inundated

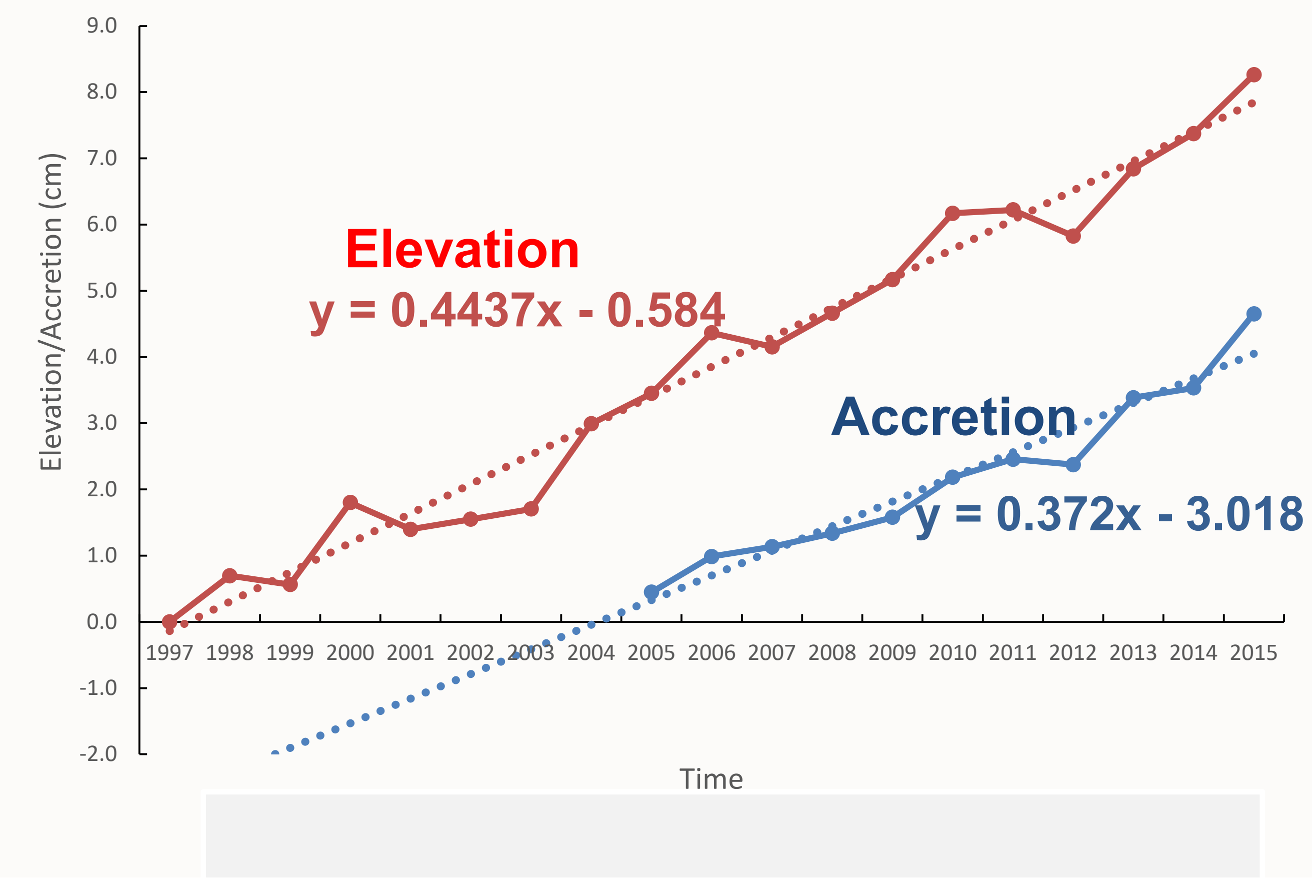
The SET-MH installation monitors changes in soil-surface elevation, soil accretion and shallow subsidence. Figure modified from Lovelock et al (2015).





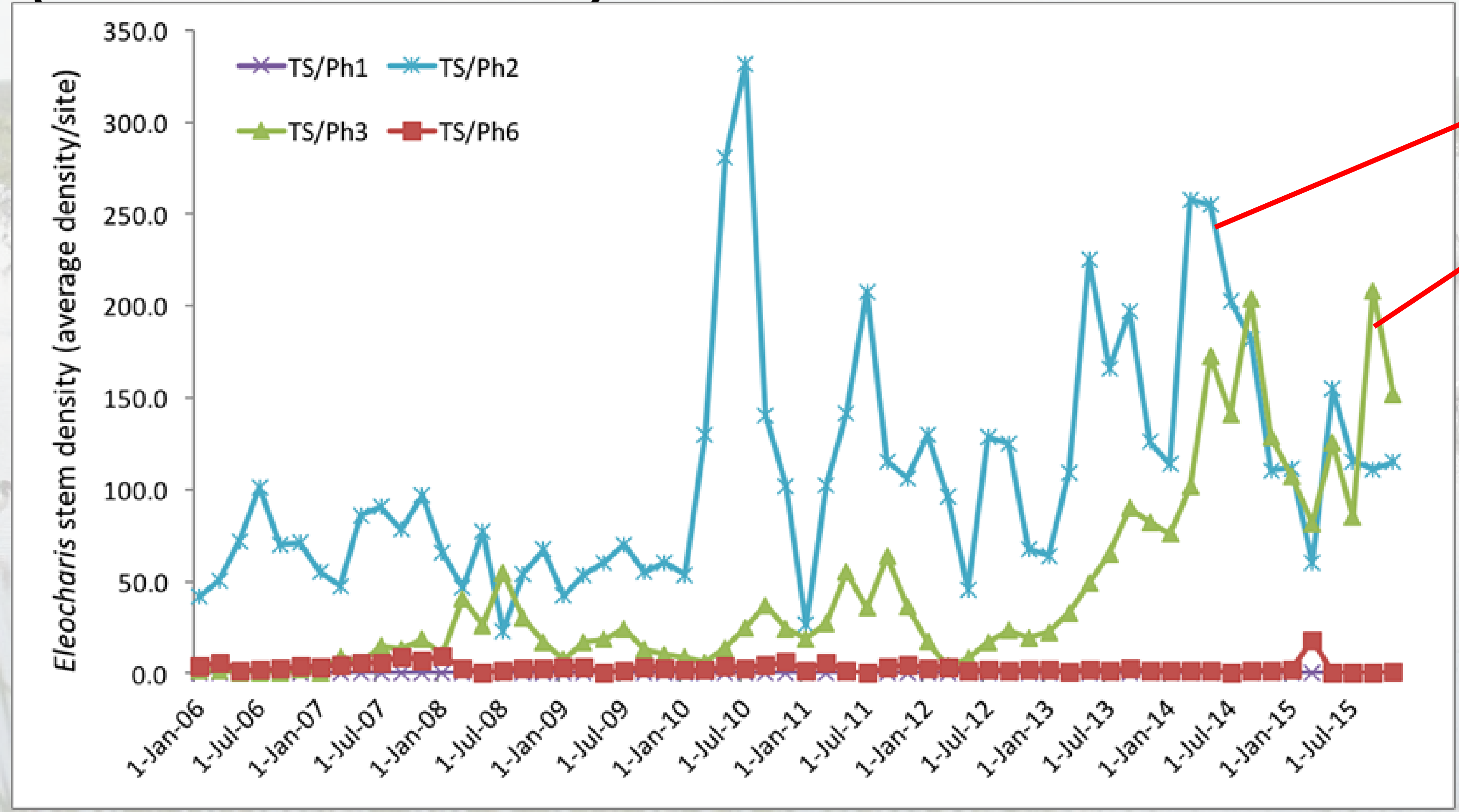
Carlos Coronado et al. 2019. Mangrove stability. In: Chapter 6 South Florida Environmental Report, SFWMD.

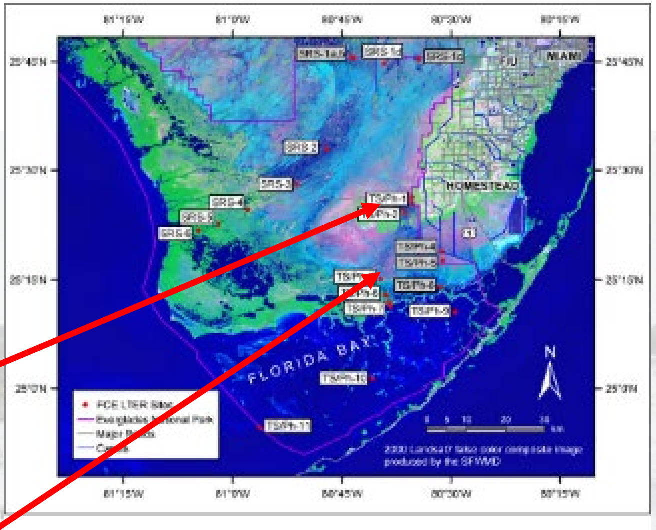
Taylor Slough (Argyle Henry): (Elevation Change = 4.4 mm/yr) High flow -- Seasonal inundation with freshwater



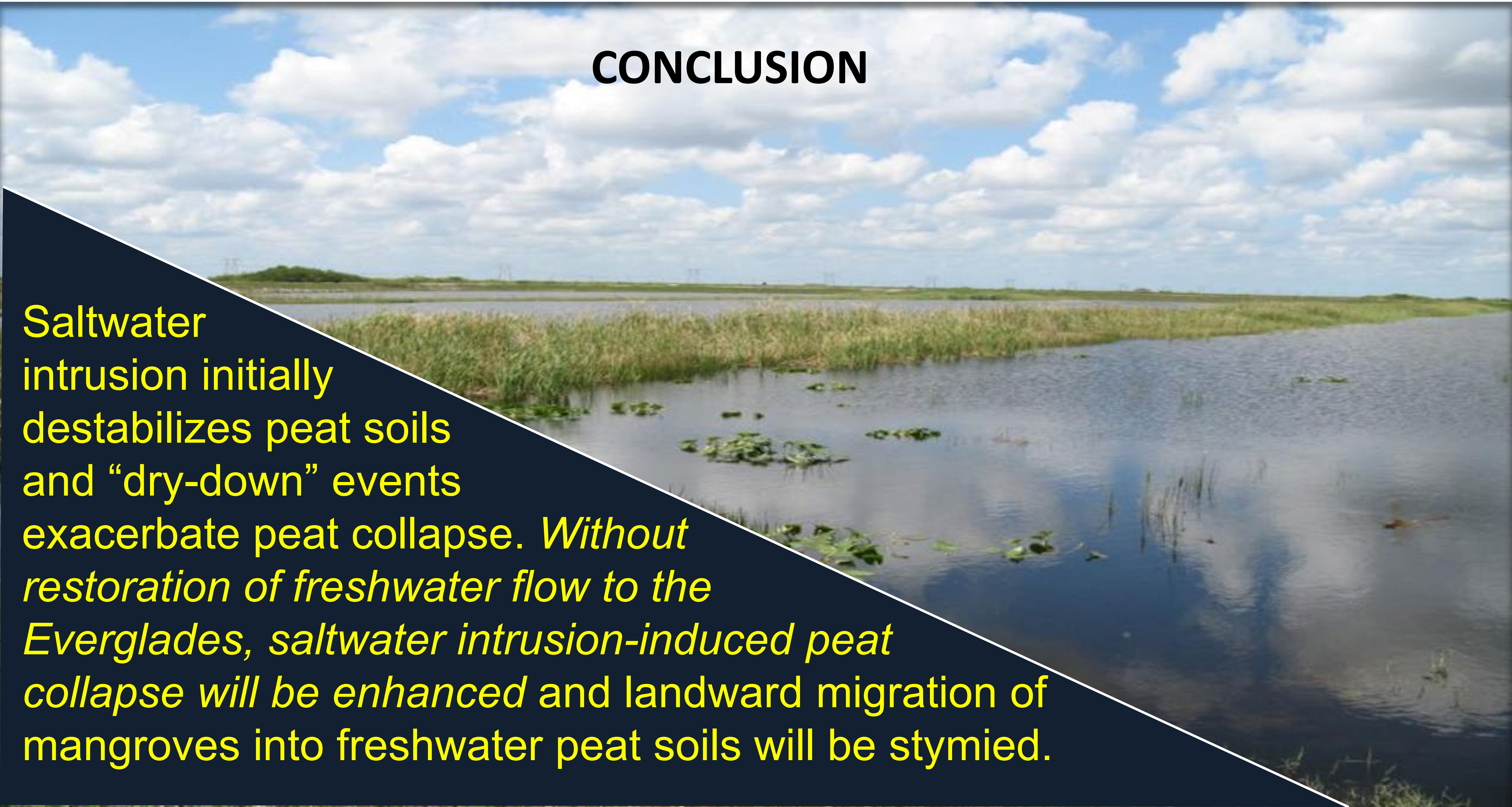
Carlos Coronado et al. 2019. Mangrove stability. In: Chapter 6 South Florida Environmental Report. SFWMD.

Hydrological restoration of Taylor Slough improves the distribution, community structure and viability of the southeast saline Everglades (Troxler et al. 2014)





High quality marsh habitat macrophyte species *Eleocharis* expanding at 2 sites downstream of C111 operations since 2012.



CONCLUSION

Saltwater intrusion initially destabilizes peat soils and “dry-down” events exacerbate peat collapse. *Without restoration of freshwater flow to the Everglades, saltwater intrusion-induced peat collapse will be enhanced* and landward migration of mangroves into freshwater peat soils will be stymied.

Thank You – Questions?

Everglades National Park

Sklar, F., J.F. Meeder, T.G. Troxler, T. Dreschel, S.E. Davis and P.L. Ruiz. In Press. The Everglades: At the Forefront of Transition (Chapter 13). In: E. Wolanski, J. Day, M. Elliott and R. Ramachandran. Coasts and Estuaries – The Future. Elsevier.