

# USGS Long-Term Monitoring of Hydrology, Sediment and Vegetation in the Coastal Mangrove Everglades: Collaborating with FCE-LTER to Understand the Oligohaline Ecotone Dynamics in the Southwest Coastal Everglades.

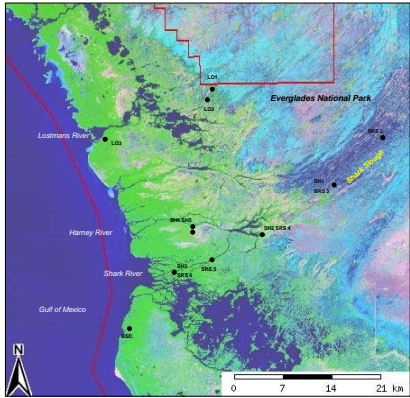
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## Abstract

The USGS Land-Margin Ecosystem Project was developed to examine effects of sea-level rise, increased freshwater inflows and disturbance on the coastal wetlands of the southwest Everglades. Our study has sampled coastal hydrology and mangrove vegetation across the oligohaline ecotone in the Shark River slough and estuary for more than a decade and wetland sediment elevation change since 1998. In phase two of the FCE LTER (2006-2012), our study can provide data and analyses to assist with several FCE II research questions, for example:

- (1) Specific Research Question 1-1. Evaluating salinity mixing across the oligohaline zone altered freshwater inflows before and throughout the Everglades restoration plan i.e. "Grand Experiment".
- (2) Specific Research Question 5-3. Understanding the impact that water source and hydrologic residence time has on soil elevation change and soil responses to long-term interaction of nutrients, below ground production, storm deposition and sea-level rise. We have a network of Sediment Elevation Tables (SET) along two transects, including SRS, with Deep and Shallow-Red SETs at all sites. Sampling is ongoing with seven years of sediment change data collected.
- (3) General Question 6. How is the ecotone controlled by changes in climate, freshwater inflow and disturbance. Our data from co-located hydrology sampling stations, SETs and permanent vegetation plots can all be used in addressing this question.

Here we illustrate our work for FCE scientists to further develop collaborative efforts as FCE II proceeds.



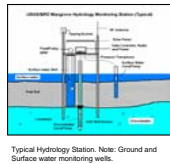
Map of USGS Land-Margin Ecosystem sites and corresponding FCE-LTER sites.

## Introduction

- Our project was developed to examine impacts of freshwater discharge, sea level change and disturbance on the mangrove-marsh ecotone (oligohaline zone) of the southwest coastal Everglades.
- Stations are located from upstream to downstream along the two major drainages of the southwest Everglades: the Shark and Lostmans Rivers (see map).
- Vegetation sampling began following Hurricane Andrew in 1992. Surface and groundwater sampling started in 1994 and sediment elevation sampling was begun in 1998.

## Acknowledgements

Thanks to the following for their support with our project: William Nuttle (hydrological design), Theo Vliar (Correlagrams), Jeff Kline (statistics), Kevin Whelan, Greg Ward and Ginger Tiling (sediment and vegetation), Rene Price (hydrological analysis) and auxiliary hydrology data from Kevin Kottman and Everglades NP. Our USGS study is supported by funding from the U.S. Army Corps of Engineers, Jacksonville District through the Greater Everglades restoration program. Salary support is provided by the Ecosystems Program of the USGS Biological Resources Discipline. Disclaimer: No Polar Bears or melting ice caps were discussed during this presentation.



Typical Hydrology Station. Note: Ground and Surface water monitoring wells.



Gordon Anderson and Fara Benish visit hydrology monitoring station Shark 1 (SH1) in Shark Slough near FCE-LTER site SRS-3.



Shark 2 (SH2) near Taupon Bay (SRS-4). Oligohaline or ecotone site.



Shark 3 (SH3) south bank of the Shark River (SRS-6). Mangrove Estuary Marine site near (SRS-6).

## FCE II Questions

**Specific Research Question 1-1.** Evaluating salinity mixing across the oligohaline zone altered freshwater inflows before and throughout the Everglades restoration plan i.e. "Grand Experiment".

- **Hydrology:** Over ten years of surface and shallow ground water salinity and water levels from USGS Land-Margin hydrologic stations, SH1, SH2, SH3 located adjacent to FCE-LTER sites SRS-3 (SH1), SRS-4 (SH2) and SRS-6 (SH3).

**Specific Research Question 5-3.** Understanding the impact that water source and hydrologic residence time has on soil elevation change and soil responses to long-term interaction of nutrients, below ground production, storm deposition and sea-level rise.

- **Sediment:** We have seven years of sediment change data collected from Sediment Elevation Table (SET) sites SH1, SH2 and SH3.

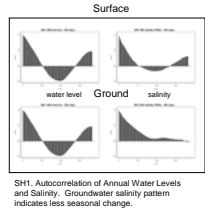
**General Question 6:** How is the ecotone controlled by changes in climate, freshwater inflow and disturbance.

- Our data from co-located hydrology sampling stations, Sediment Elevation Tables (SET) and permanent vegetation plots can all be used in addressing this question.



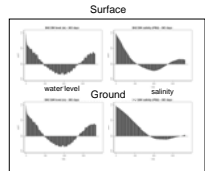
Measuring accretion, note the peat layer.

## Hydrology



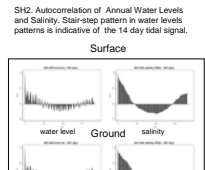
### SH1 (SRS-3)

**Hydrology:** Non-tidal, Low Salinity (Avg. Salinity <0.5 PSU). Oligohaline. Water level correlates to upstream freshwater (site P32, Kendall Tau 0.81,  $p < 0.01$ ). High residence time with surface water levels above average ground elevation all most times.  
**Sediment:** Black-colored, organic sawgrass muck peat, <2 m depth.  
**Vegetation:** predominantly sawgrass/rush located in lower Shark Slough (near SRS-3).



### SH2 (SRS-4)

**Hydrology:** tidal, flooding on spring tides. Oligohaline (Avg. Salinity ~4 PSU, high seasonal variability). Water level correlates to downstream Shark Estuary (site SR, Kendall Tau 0.66,  $p < 0.01$ ). Surface water levels exceed average ground elevation ~75% (2004 data).  
**Sediment:** Brown-colored, organic mangrove peat, 2-3 m depth.  
**Vegetation:** sawgrass/rush marsh adjacent to mangrove fringe located on east edge of Taupon Bay (near SRS-4).

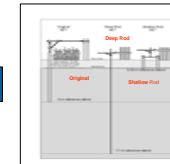


### SH3 (SRS-6)

**Hydrology:** Strong tidal energy, floods twice daily. Haline (Avg. Salinity 21 PSU, high seasonal variability). Water levels correlate to downstream Shark River Estuary (site SR, Kendall Tau 0.55,  $p < 0.01$ ). Short residence time, surface water levels exceed ground surface ~50% (2004 data).  
**Sediment:** Brown-colored, organic mangrove peat 5-6 m depth. Numerous Crab burrows  
**Vegetation:** Tall Mature Mangrove Forest (primarily Red and Black), sparse understory, located on south bank of Shark River (near SRS-6). Observed ~4 cm of marine deposition from Hurricane Wilma.

SH3. Autocorrelation of Annual Water Levels and Salinity. Pronounced jagged pattern of both surface and ground water levels shows in the correlogram is indicative of strong diurnal tidal signal.

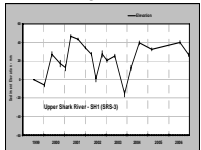
## Sediment



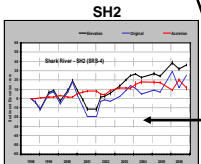
The three different Sediment Elevation Tables (SET) designs.



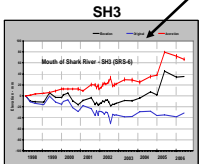
Karen Balentine measures accretion with a Shallow SET at mangrove site SH4. Ginger Tiling records notes.



SH1 Surface elevation change



SH 2 Surface elevation change



SH3 Surface elevation change

SET data for SH1, SH2 and SH3 for over eight years; **BLACK** line represents ground surface ELEVATION, **RED** line represents the surface ACCRETION and the **BLUE** line represents SHALLOW SUBSIDENCE. SH3 shows a spike in accretion due to Hurricane Wilma (Oct 2005).



Deep-root SET with anemometer measurement arm and pins at a coastal marsh site.



Tom Smith measured original SET at SH4, note the ramp per plate

## Vegetation

Permanent tree plots have been established at all mangrove sites. All stems are mapped, tagged and measured at Diameter at Breast Height (DBH) at regular intervals. Allometric equations have been developed that relate individual tree biomass to DBH (see chart). By measuring changes in DBH over time, and summing across all individuals in a plot, we can track changes in above ground biomass. We are currently developing allometric equations for marsh grasses at our sites where they are present (SH1, SH2, LO1, LO2)



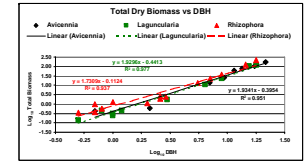
Field crew measures mangrove DBH, and species at a permanent mangrove forest plot near LO3



Jaclyn Kellner collects sawgrass samples near site LO1



Mangrove Forest Site SH3 near the Shark River and SRS 6



Allometric relationship for total dry aboveground biomass as a function of DBH.

## Working Together

1. Numerous questions remain that can be addressed collaboratively with FCE scientists, for example:
  - How does the affect marsh sediment surface elevation and surface water hydrology?
  - Are the interiors of the large islands in the coastal Everglades disconnected from upstream hydrology, particularly surface water?
  - How does burrowing by crabs influence sediment surface elevation, nutrient availability and hydrology in mangroves?
2. The USGS hosting student internships and independent studies.
  - What role do vines play in the ecology of the ecotone?
3. Summer employment and/or assist with specific student studies.
4. Data sharing and in-kind support for FCE-LTER researchers

## Recent Publications

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Ward, G.A., T.J. Smith, K.H.R. Whelan, and T.W. Doyle. 2006. Regional processes in mangrove ecosystems: spatial scaling relationships, above and below water flowing, accretion, disturbance. Hydrobiologia 2006:157-162.

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Whelan, K.H. R., T. J. Smith III, D.R. Cahoon, J.C. Lynch, and H. Anderson. 2005. Groundwater control of mangrove surface elevation: above and below water level with soil depth. Estuaries 28(2):303-310.