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

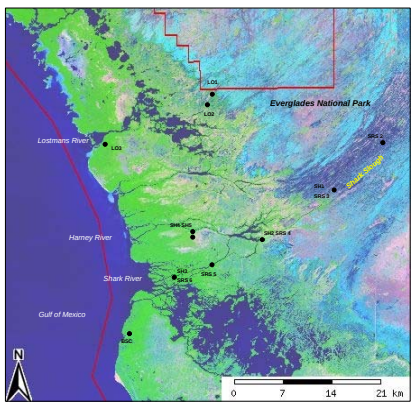
The USGS Land-Margin Ecosystem Project was developed to examine effects of sea-level rise, increased freshwater inflows and disturbance on the coastal wetlands of the southwest Everglades. Our study has sampled coastal hydrology and mangrove vegetation across the oligohaline ecotone in the Shark River 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. To evaluate the position of the salinity mixing zone during the "Grand Experiment" of altered freshwater inflows across the oligohaline zone. We maintain surface water and shallow groundwater wells adjacent to FCE sites SRS-3 (SH1), SRS-4 (SH2) and SRS-6 (SH3) and at many other sites in the coastal Everglades. These are currently collecting hourly data for stage, conductivity and temperature. We have a 10-year archive of hydrologic data for many sites.

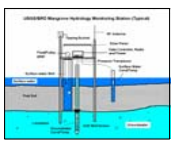
(2) Specific Research Question 5-3. Understanding the impact that water source and hydrologic residence time has on soil elevation change and soil responses to long-term interaction of nutrients, below ground production, storm deposition and sea-level rise. We have a network of Sediment Elevation Tables (SET) along two transects, including SRS, with Deep and Shallow-Rod 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.

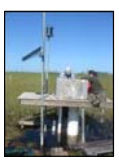
Here we illustrate our work for FCE scientists to further develop collaborative efforts as FCE II proceeds.



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



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



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

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

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

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

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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.*

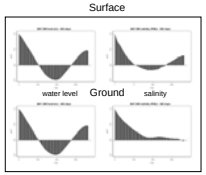
• Sediment: We have seven years of sediment change data collected from Sediment Elevation Table (SET) sites SH1, SH2 and SH3.

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

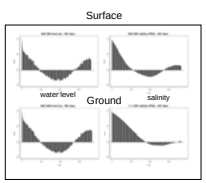
• Our data from co-located hydrology sampling stations, Sediment Elevation Tables (SET) and permanent vegetation plots can all be used in addressing this question.

Measuring accretion, note the feldspar layer.

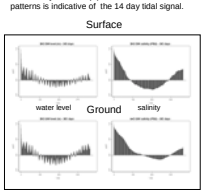
Hydrology



SH1. Autocorrelation of Annual Water Levels and Salinity. Groundwater salinity pattern indicates less seasonal change.



SH2. Autocorrelation of Annual Water Levels and Salinity. Stair-step pattern in water levels patterns is indicative of the 14 day tidal signal.



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

SH1 (SRS-3)

Hydrology: Non-tidal. Low Salinity (Avg. Salinity <0.5 PSU). Oligotrophic. Water level correlates to upstream freshwater (site **P33**, 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: predominately 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 Tarpon Bay (near SRS-4)

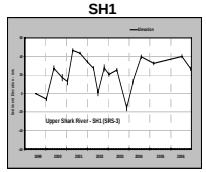
SH3(SRS-6)

Hydrology. Strong tidal energy, floods twice daily. Haline (Avg. Salinity 21 PSU, high seasonal variability). Water levels correlates 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).

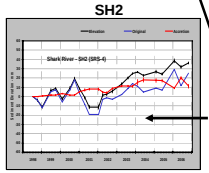
Sediment: Brown-colored, organic mangrove peat 5-6 m depth. Numerous Crab burrows

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.

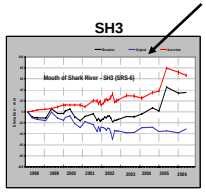
Sediment



SH1 Surface elevation change

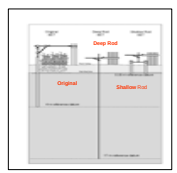


SH 2 Surface elevation change



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).



The three different Sediment Elevation Tables (SET) designs.

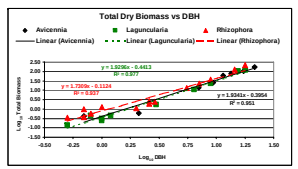
Karen Balentine measures sediment with a Shallow SET at mangrove site SH4. Ginger Tiling records value.

Deep-rod SET with removable measurement arm and pins at a coastal marsh site.

Tom Smith measures original SET at SH3, note the nine pin 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)



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

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

Working Together

1. Numerous questions remain that can be addressed collaboratively with FCE scientists, for example:

- How does fire 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

Links

Dynamics of Land Margin Ecosystems: Historical Change, Hydrology, Vegetation, Sediment and Climate

http://sofia.usgs.gov/projects/dyn_margin/

Everglades Depth Estimation Network (EDEN) for support of Biological and Ecological Assessments

http://sofia.usgs.gov/eden/

Recent Publications

Anderson, G. H., and T. J. Smith III. 2006. Hydrologic Data Report for Lower Shark River Monitoring Network, Everglades National Park, Florida; Water Years 1996-2002. U.S. Geological Survey Open-File Report 2006-1368.

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Rutchey, K. T. N. Schall, R.F. Doren, A. Atkinson, M.S. Ross, D.T. Jones, M. Madden, L. Vilchek, K.A. Bradley, J.R. Snyder, J.N. Burch, T. Pernas, B. Witcher, M. Pyne, R. White, T.J. Smith III, J. Sadle, C.S. Smith, M.E. Patterson and G.D. Gann. 2006. Vegetation Classification for South Florida Natural Areas U.S. Geological Survey Open-File Report 2006-1240.

Schaffranek, R. W. and T. J. Smith III. 2004. An Investigation of the Interrelation of Everglades Hydrology and Florida Bay Dynamics to Ecosystem Processes in South Florida U.S. Department of the Interior U.S. Geological Survey FS-49-03.

Smith, T.J., III, and Cahoon, D.R. 2003. Wetland sediment surface elevation in the Florida Everglades: response to surface water stage variation. Proceedings, 5th International Symposium on Coastal Engineering and Science of Coastal Sediment Processes. East Meets West Productions, Corpus Cristi, TX.

Smith, T. J. III. 2004. Development of a Long-term Sampling Network to Monitor Restoration Success in the Southwest Coastal Everglades: Vegetation, Hydrology, and Sediments. U.S. Geological Survey FS 2004-3015.

Smith, T. J. III, and K. R. T. Whelan. 2006. Development of allometric relations for three mangrove species in South Florida for use in the Greater Everglades Ecosystem restoration. Wetlands Ecology and Management (2006) 14:409-419

Ward, G.A., T.J. Smith, K.R.T. Whelan, and T.W. Doyle, 2006. Regional processes in mangrove ecosystems: spatial scaling relationships, biomass, and turnover rates following catastrophic disturbance. Hydrobiologia, 569(1): 517-527.

Whelan, K. R. T. and T. J. Smith III. 2004. Lightning Gaps in the Mangrove Forest of Everglades National Park, U.S. Geological Survey FS 2004-3016.

Whelan, K. R. T., T. J. Smith III, D. R. Cahoon, J. C. Lynch, and G. H. Anderson. 2005. Groundwater control of mangrove surface elevation: shrink and swell varies with soil depth. Estuaries. 28(6):833-843.