FLORIDA INTERNATIONAL UNIVERSITY

Southeast Environmental Research Center

SOIL BUILDING PROCESSES IN RE-CREATED EVERGLADES TREE ISLANDS

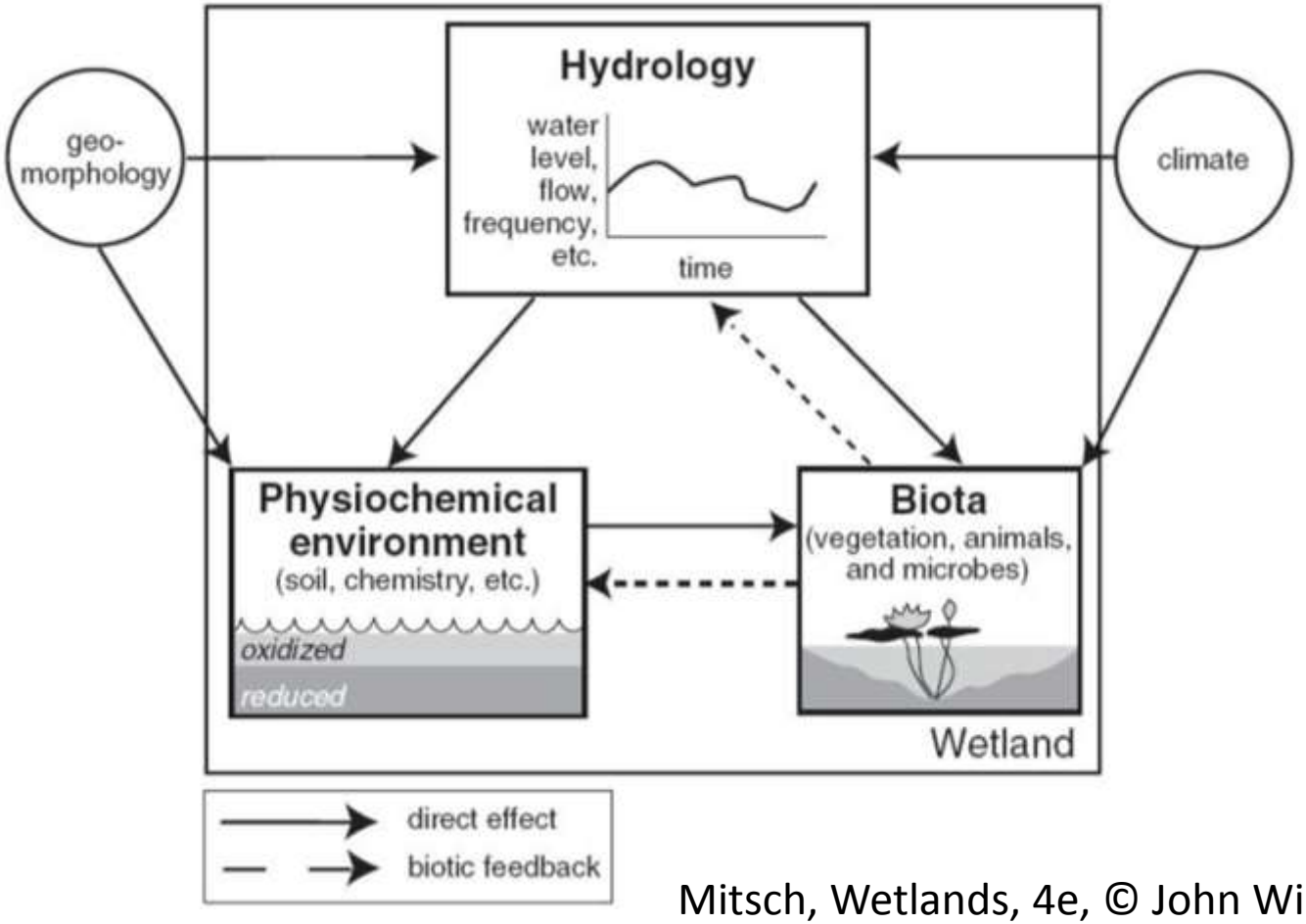
Leonard J. Scinto[1], **Alexandra Serna**[1],
Diana N. Johnson[1], Andres Rodriguez[1,2],
Eric Cline[3], Thomas Dreschel[3], Fred H. Sklar[3]

UF UNIVERSITY of FLORIDA

April 20, 2017 ● GEER 2017

[1] Southeast Environmental Research Center, Florida International University
[2] Soil and Water Science Department, University of Florida
[3] Everglades Systems Assessment Section, South Florida Water Management District

To define hydrologic conditions that allow the establishment of biota, and soil building is important to restore and conserve tree islands



Mitsch, Wetlands, 4e, © John Wiley & Sons

Tree Islands

- Tree islands are considered biogeochemical hotspots because of their high nutrient concentrations, high rates of nutrient cycling, but small areal extent (<5%) (Wetzel et al. 2005)
- A decline in the number of Everglades'tree island has been attributed to changes in the hydrology
- Elevation differences within tree islands lead to variation in periods of inundation
- Vegetation plays an important role in tree islands dynamics

Image from Wetzel et al. (2005)

General Objective

- To determine the influence of hydroperiod (the length of time a soil is flooded per year) on soil building processes of re-created tree islands

Specific Objectives

- To quantify changes in soil elevation in re-created tree islands at different hydroperiods

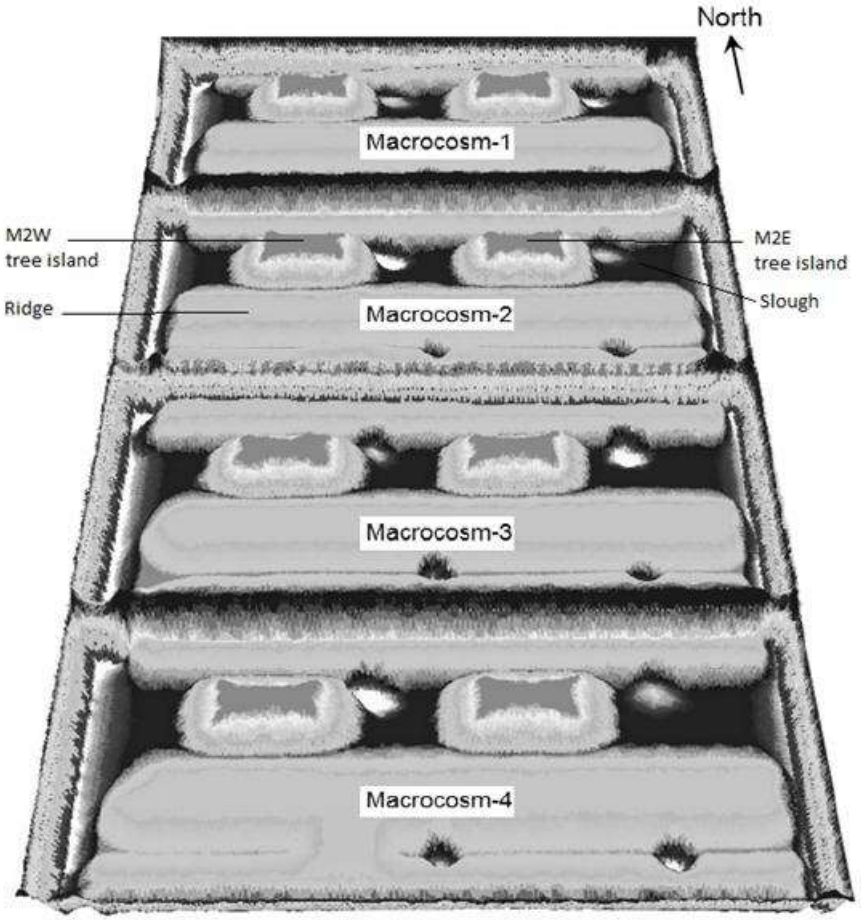
- To determine rates of soil accretion or loss through time at different hydroperiods

Hypothesis

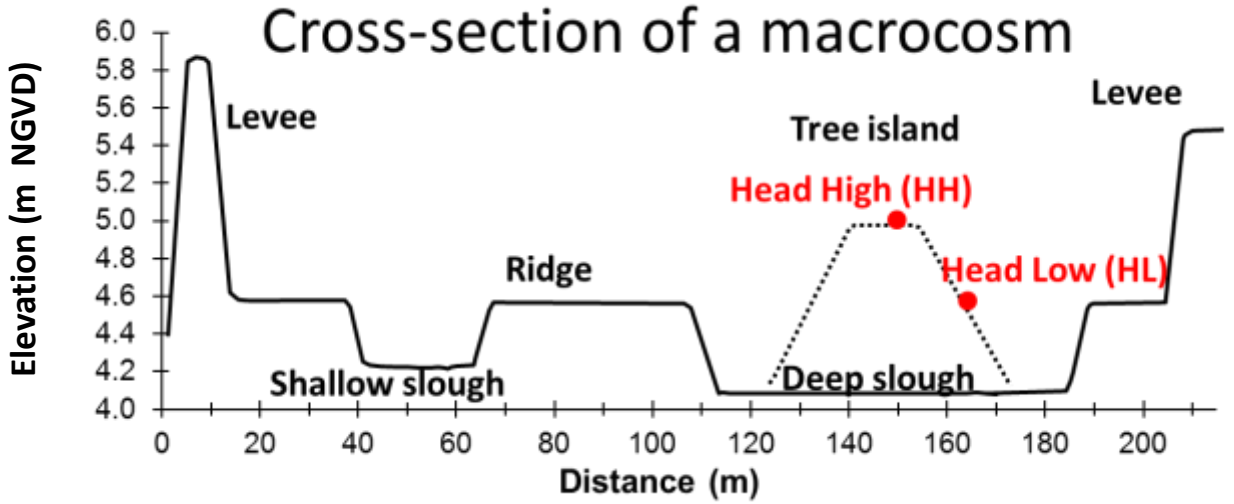
Soil building would have a positive change of tree islands soil elevation at shallower water depth and reduced inundation because it favors organic matter production

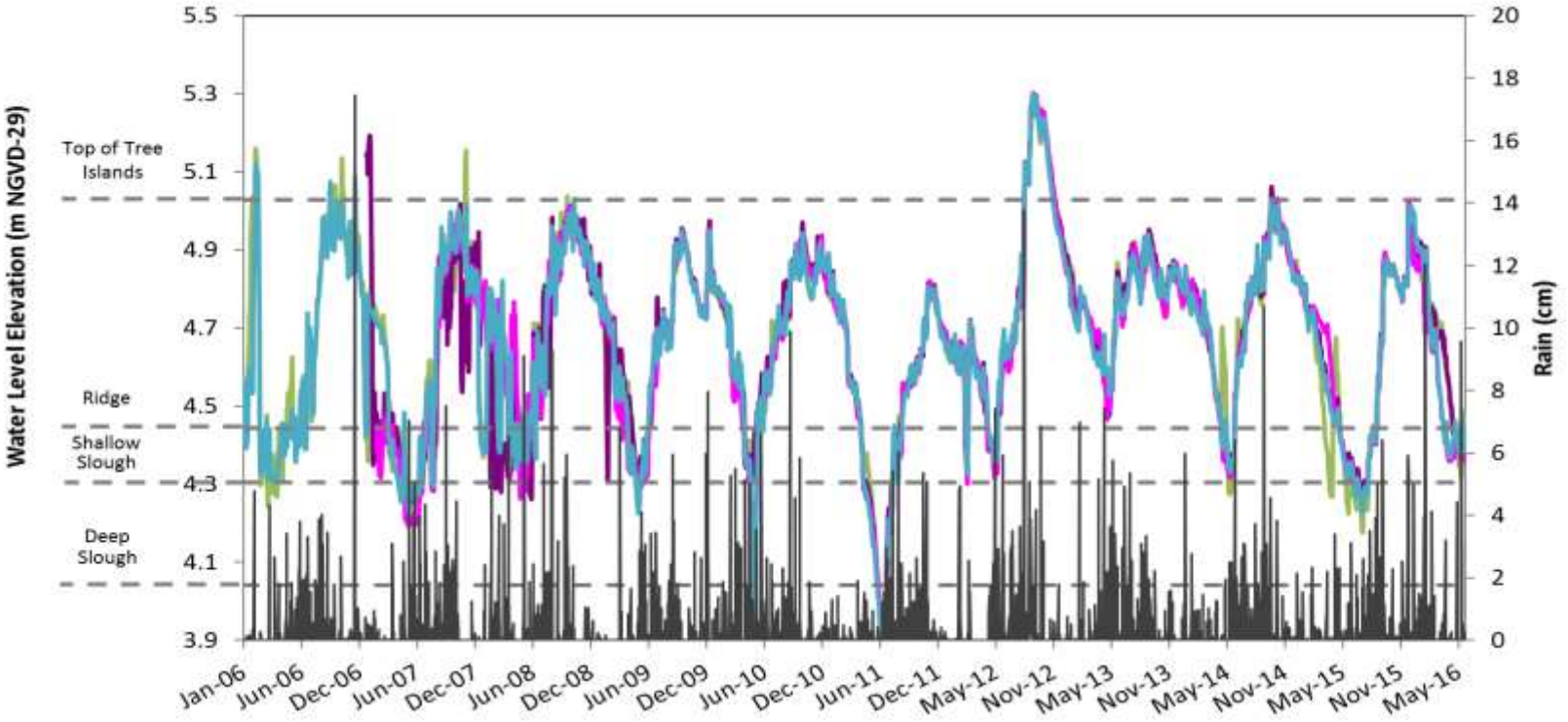
Loxahatchee Impoundment Landscape Assessment (LILA)

- Located in Boynton Beach, Florida
- Four 8-ha macrocosms
- Four tree islands were built using a Limestone core, and four were built using a Peat core
- M1 and M4 were planted in 2006. M2 and M3 were planted in 2007



Modified from Aich et al. (2011)


Cross-section of a macrocosm
Elevation (m NGVD)
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
Levee
Shallow slough
Ridge
Tree island
Head High (HH)
Head Low (HL)
Deep slough
Levee
0
20
40
60
80
100
120
140
160
180
200
Distance (m)


Water Level Elevation (m NGVD-29)
Rain (cm)
Top of Tree Islands
Ridge
Shallow Slough
Deep Slough
5.5
5.3
5.1
4.9
4.7
4.5
4.3
4.1
3.9
20
18
16
14
12
10
8
6
4
2
0
Jan-06
Jun-06
Dec-06
Jun-07
Dec-07
Jun-08
Dec-08
Jun-09
Dec-09
Jun-10
Dec-10
Jun-11
Dec-11
May-12
Nov-12
May-13
Nov-13
May-14
Nov-14
May-15
Nov-15
May-16

Soil elevation measured with Surface Elevation Tables (SETs)

- Developed by Cahoon et al. (2002)
- Confidence interval: ± 1.3 - 4.3mm
- Extensively used especially in coastal wetlands

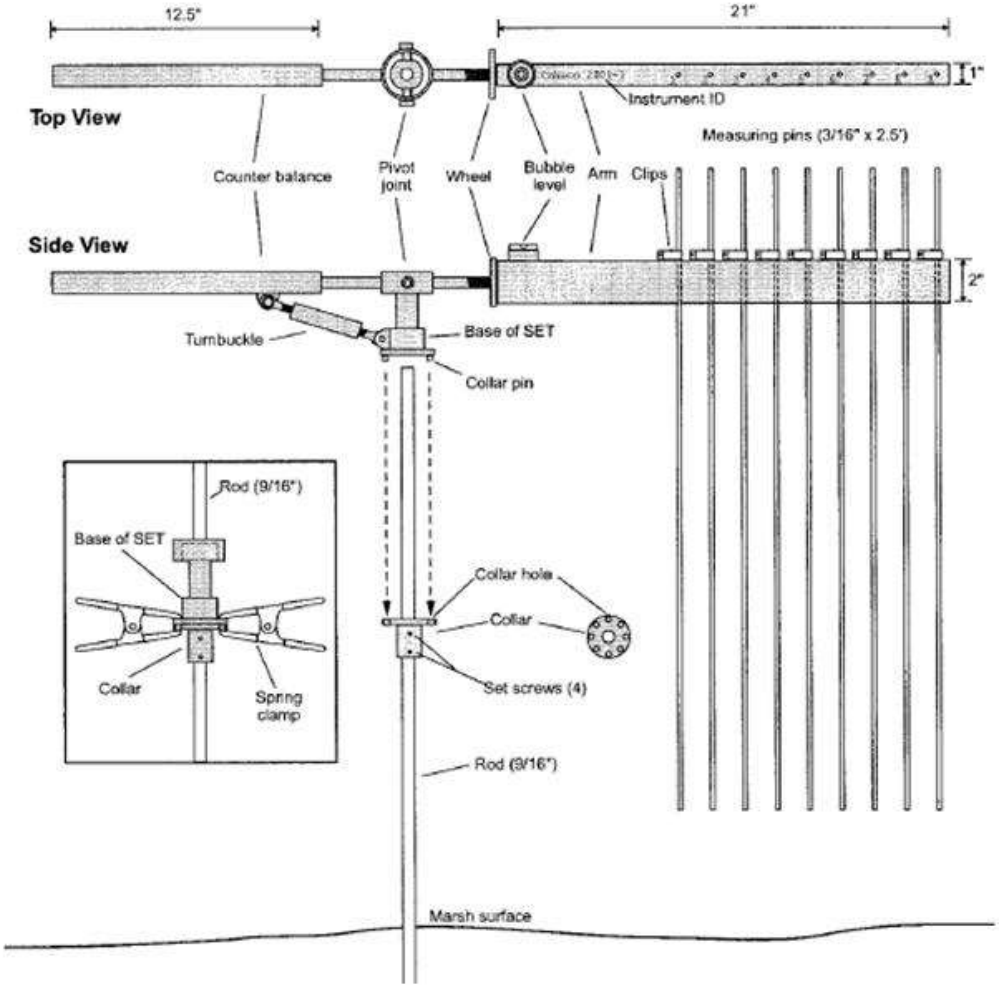
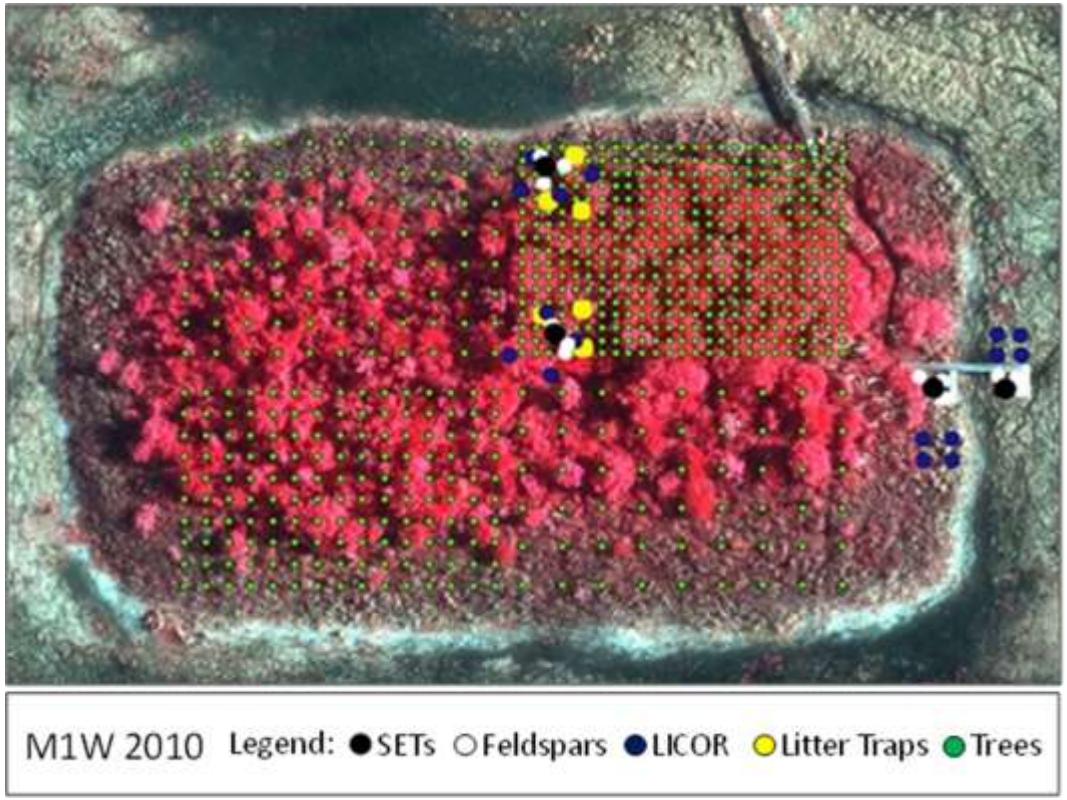


Image from Cahoon et al. (2002)

Soil elevation measured with Surface Elevation Tables (SETs)

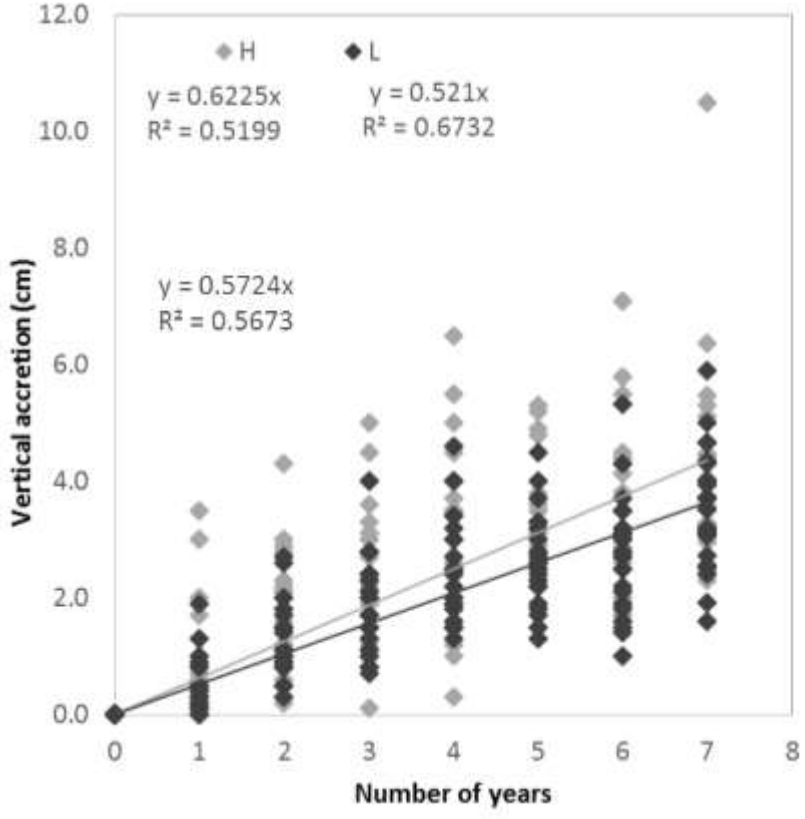
- SETs platforms were established on the eight tree islands
- Two SETs are located at the head of the tree islands
- Measurements were made annually from 2009 between April and June

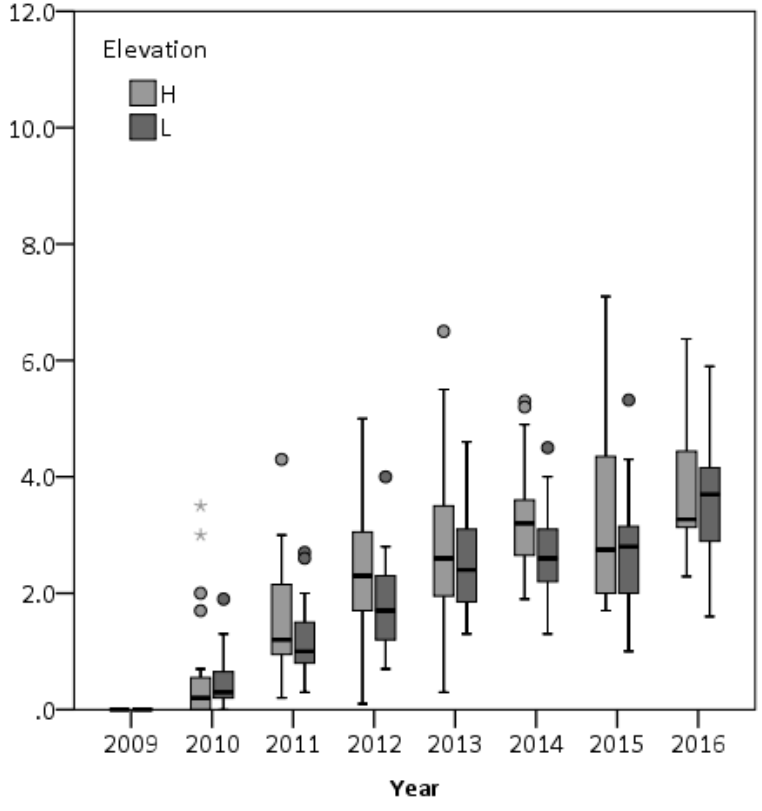


Soil accretion measured with feldspar marker horizons

- Visible clay layer
- Used to measure rates of accretion
- Feldspar marker horizons were established in 2009 in the proximity of the SETs
- Annual measurements from 2010 to 2016

Soil development at LILA (app. 0.6 cm yr^{-1}), more rapid at higher elevations where trees were maximally productive





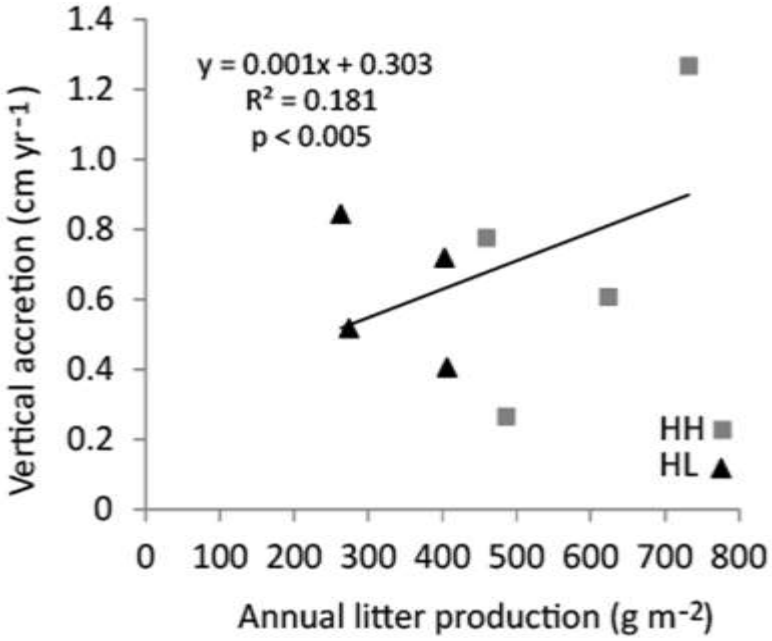
Soil Sci. Soc. Am. J. 78:2090-2099 2014

Soil Accretion Influenced by Elevation, Tree Density, and Substrate on Reconstructed Tree Islands

Wetland Soils

Andres F. Rodriguez
Alexandra Serna
Leonard J. Scinto*
Dep. of Earth and Environ. and Southeast Environ. Res. Center
Florida International Univ.
11200 SW 8th St.
Miami, FL 33199

Within a Tree Island the higher elevations generally had higher biomass, litter production, and soil accretion



Serna and Scinto (2017)

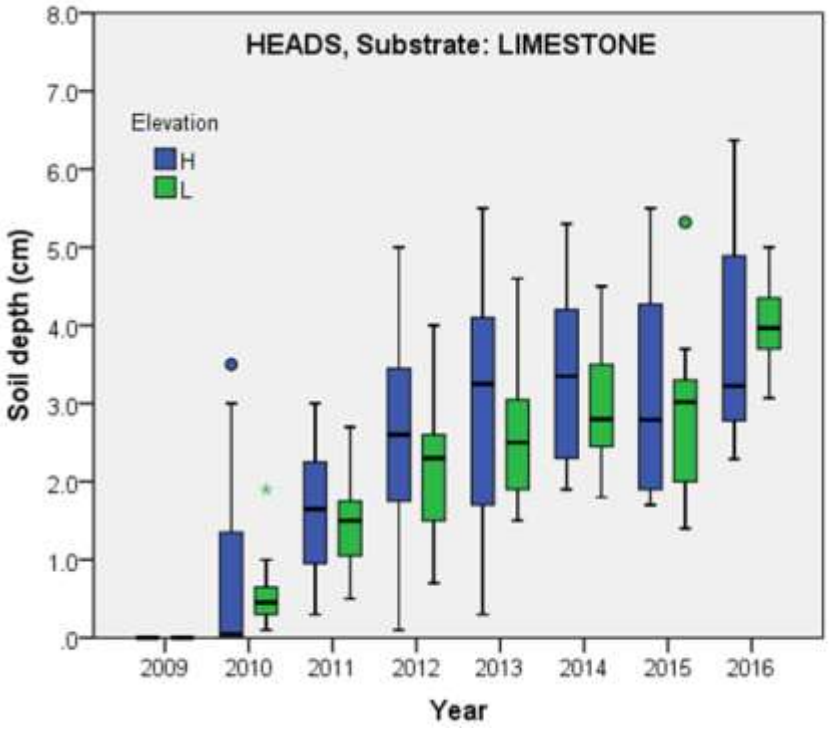
Soil accretion and formation of surface soils of LILA tree islands are determined by high rates of litter production and slow litter decomposition rates

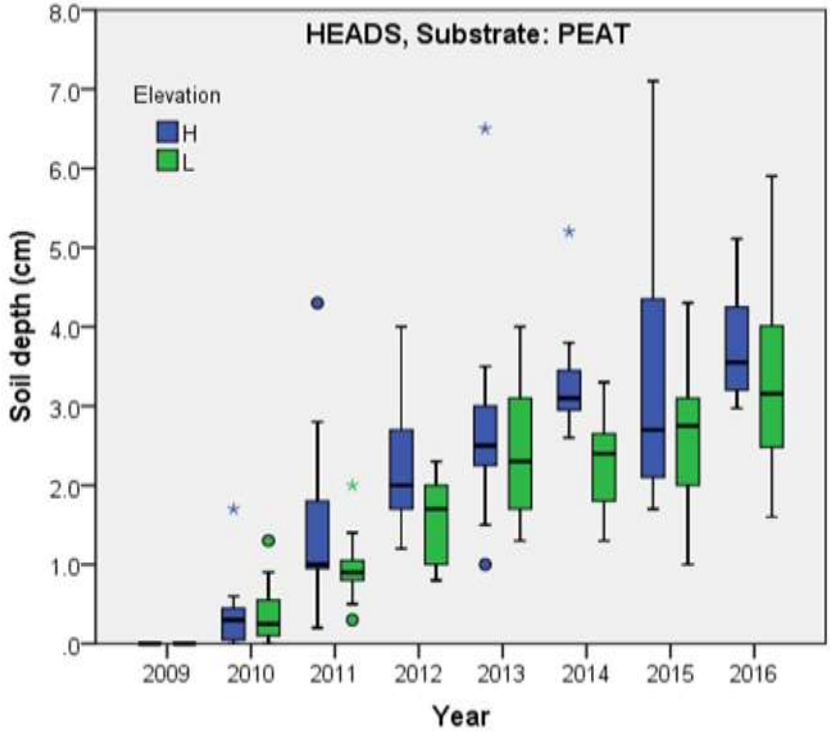
	Elevation			
Parameter (unit)	High	Low	p value	n
Litterfall production ($g\ m^{-2}\ y^{-1}$)	607 ± 158	344 ± 160	<0.001	72
Litter production rate k' (d^{-1})	0.4209 ± 0.0381	0.2421 ± 0.0687	<0.001	12
Decomposition rate k (d^{-1})	0.0022 ± 0.0003	0.0012 ± 0.0001	<0.001	12

Serna and Scinto (2017)

Annual litter production and decomposition were all greater at higher (drier) elevations. However, on balance accretion of surface soils was greater at the higher elevations (HH)

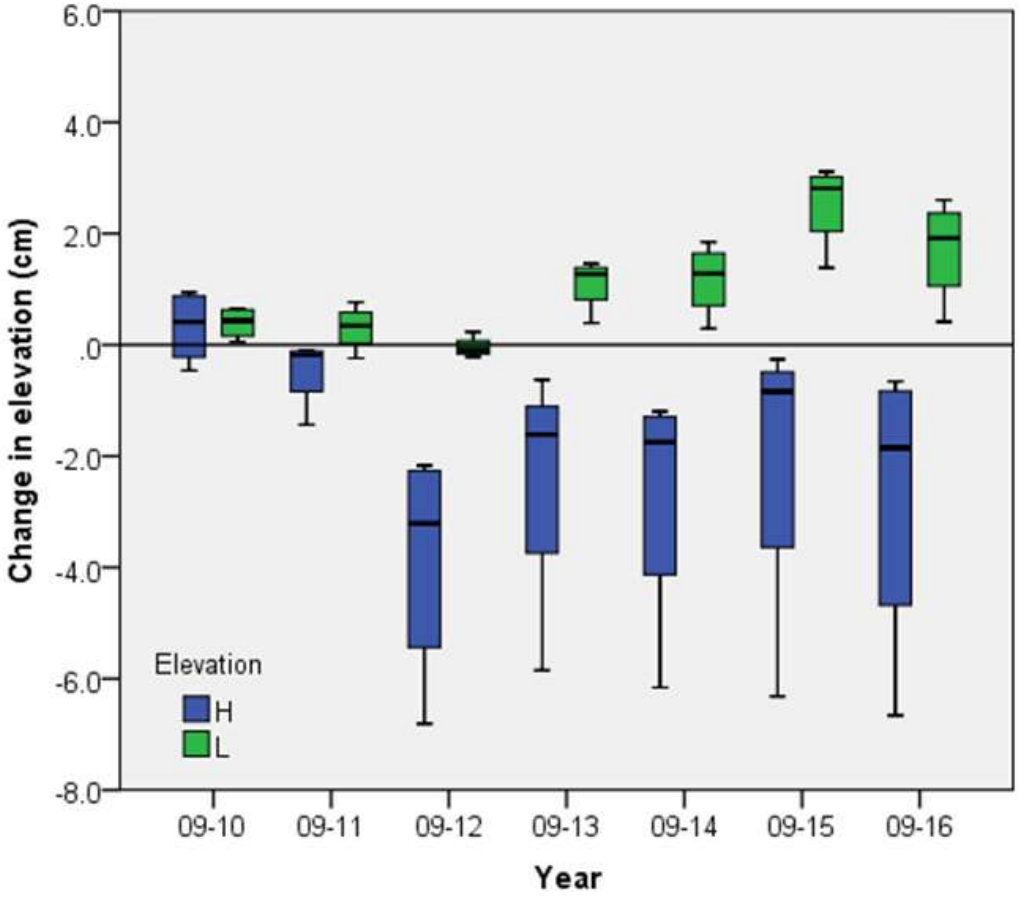
Soil accreting after 2009 initial measurements above feldspar markers





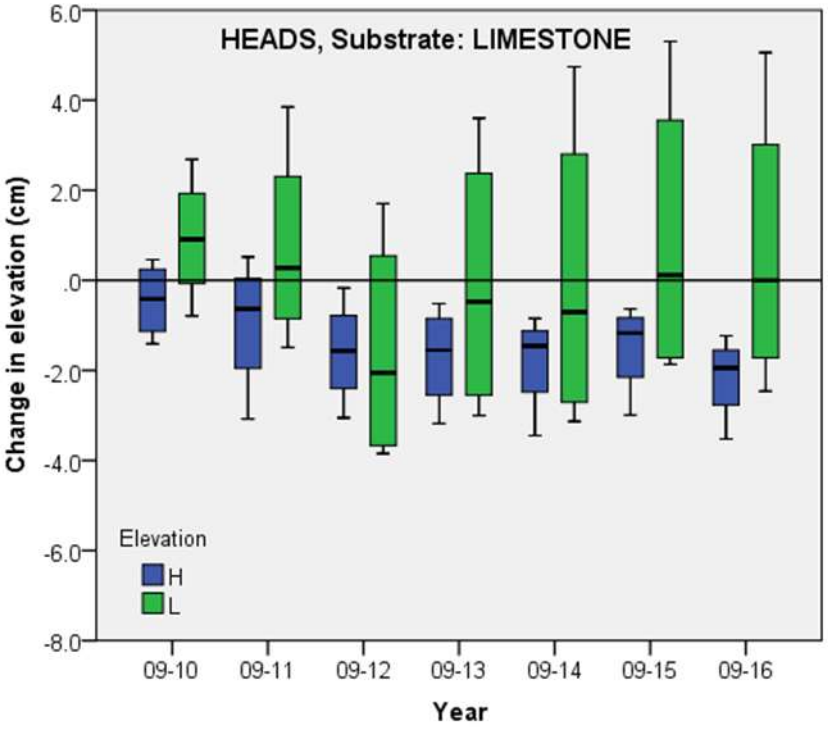
Peat islands at higher elevation had the highest total carbon (TC) content, the lowest bulk density, and the highest accumulation of organic matter

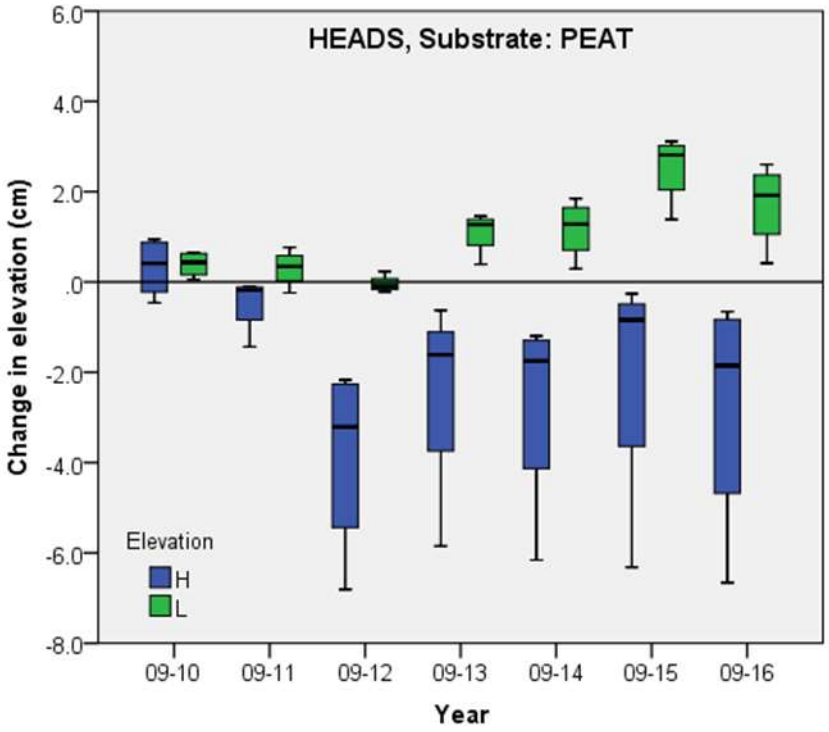
Surface elevation table (SET) elevation differences



A negative change on soil elevation was observed at higher tree island elevations

Surface elevation table (SET) elevation differences





Limestone tree islands exhibit less change in elevation, and similar accretion than peat tree islands

Conclusions

- Soil building at the center of the tree islands (higher elevation and therefore a shorter hydroperiod)

  ➡ Higher OM production

- A negative change on soil elevation was observed

  ➡ Groundwater withdrawal

  ➡ Sediment compaction

Conclusions

- Variations in water levels within a tree island produce different soil characteristics
- Loss of drained peat is a fast process but building is a slow one
- Water depth and type of island substrate influence the biogeochemistry of the Everglades systems, specifically, concerning soil building processes of tree islands

Future directions

- Continued annual soil elevation measurements with SETs
- Conceptual model

  Hydrodynamics of the tree islands is driven by vegetation biomass, which in turn regulates soil development processes

- Summary manuscript 10 yr data

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Questions?

scintol@fiu.edu