Soil Accretion on Constructed Everglades Tree Islands: Production and Decomposition Affected By Water Levels

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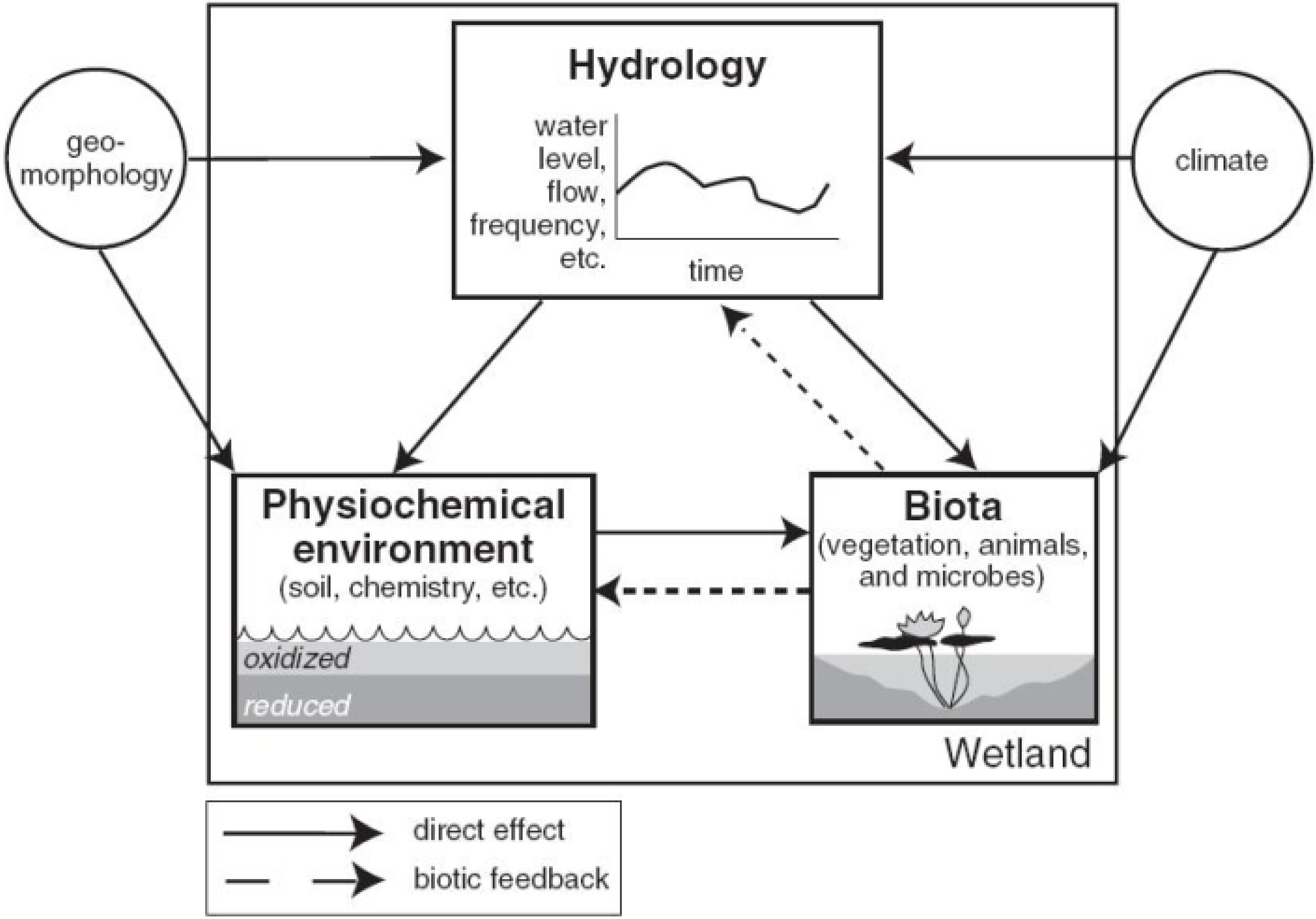
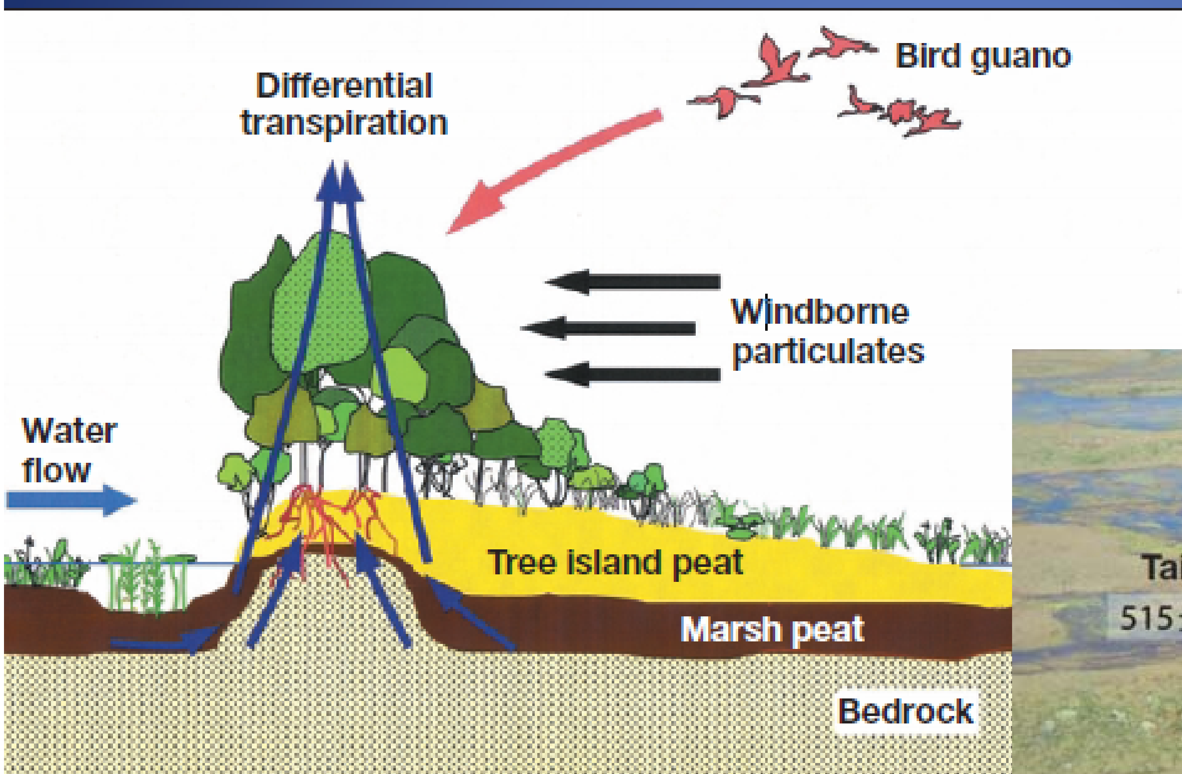
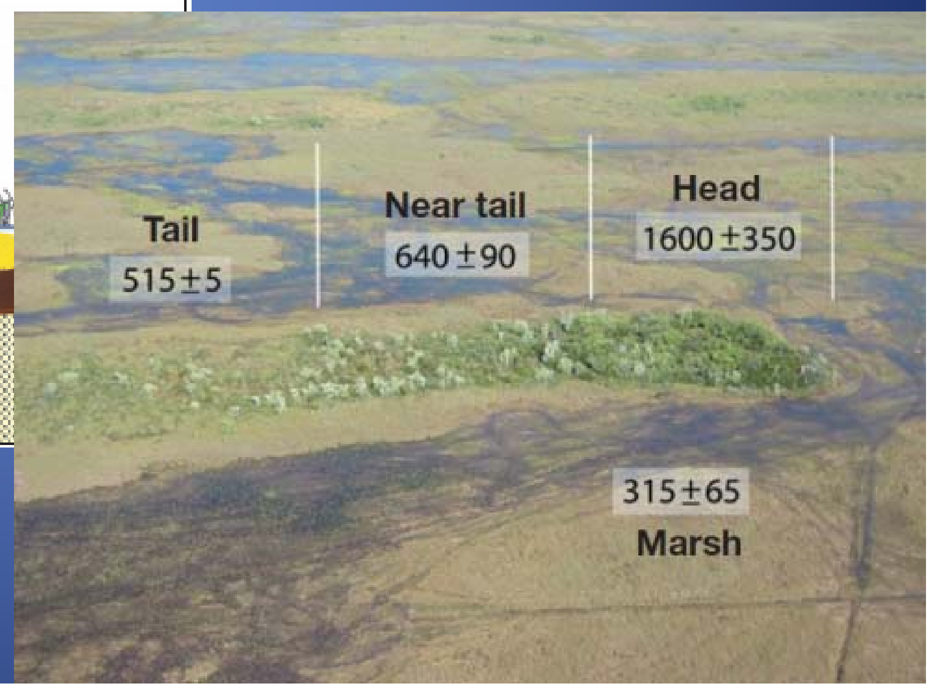
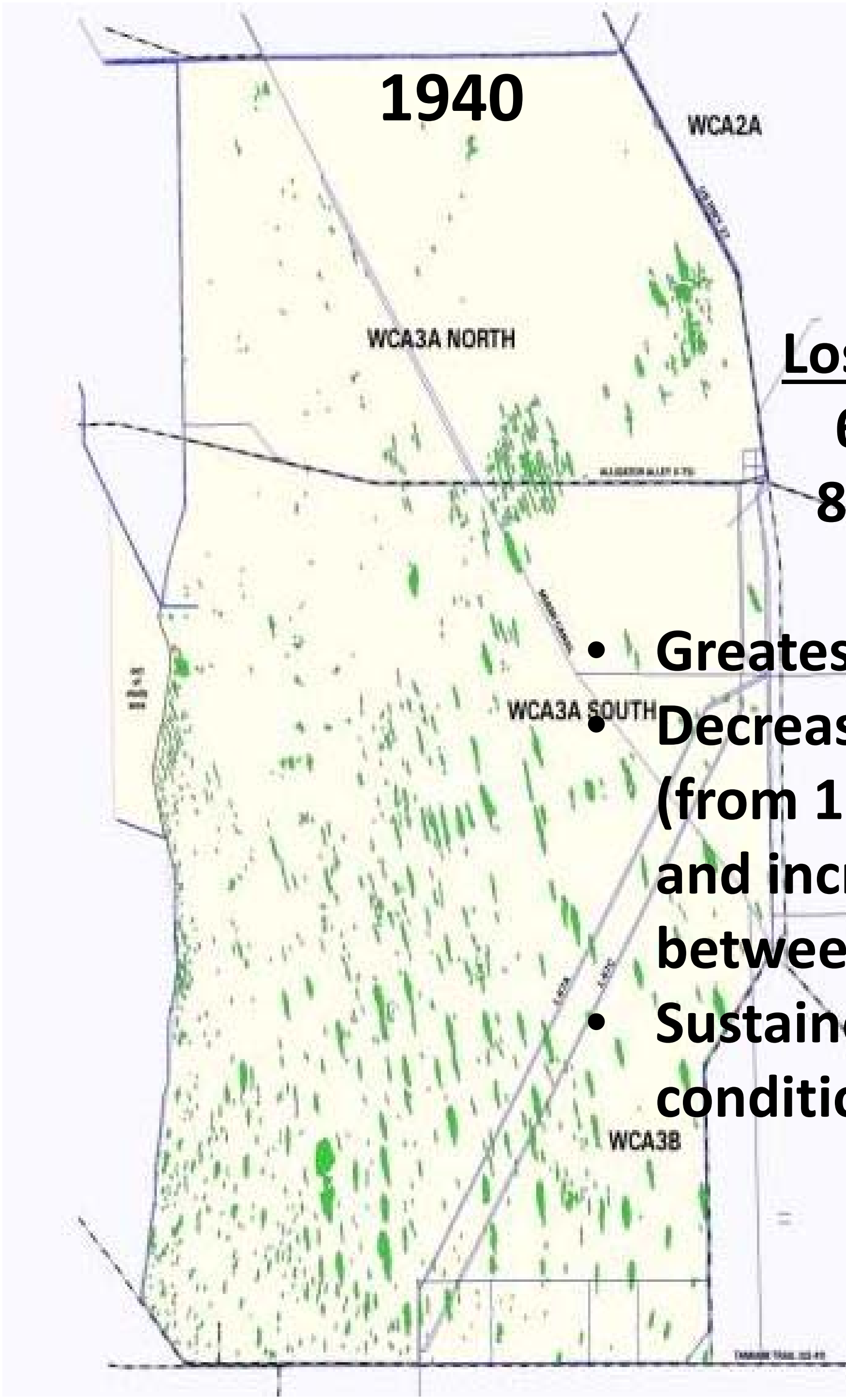


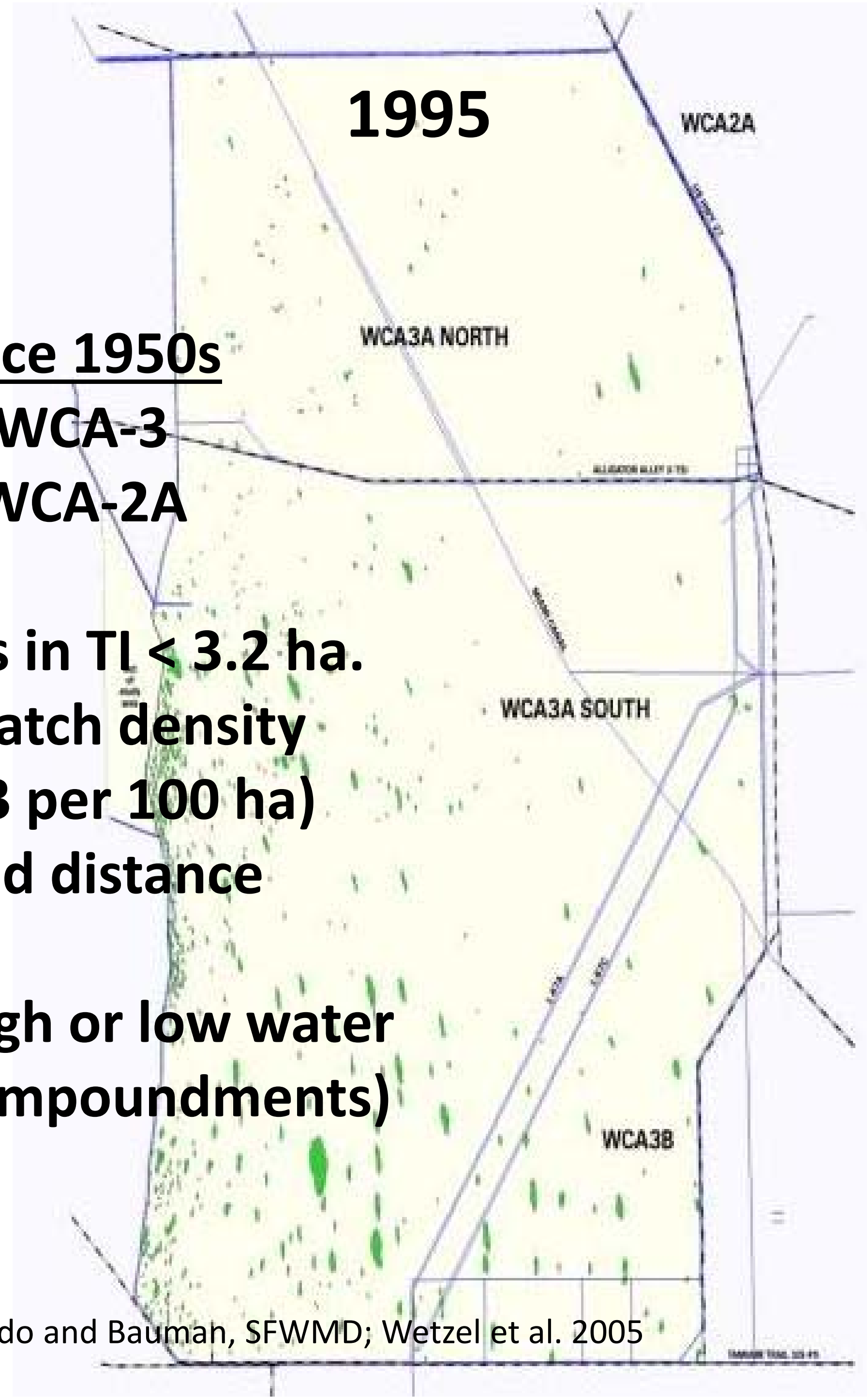
Hydrology
water level, flow, frequency, etc.
time
geo-morphology
climate
Physiochemical environment
(soil, chemistry, etc.)
oxidized
reduced
Biota
(vegetation, animals, and microbes)
Wetland
direct effect
biotic feedback

- Elevation differences within tree islands lead to variation in periods of inundation.
- 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).









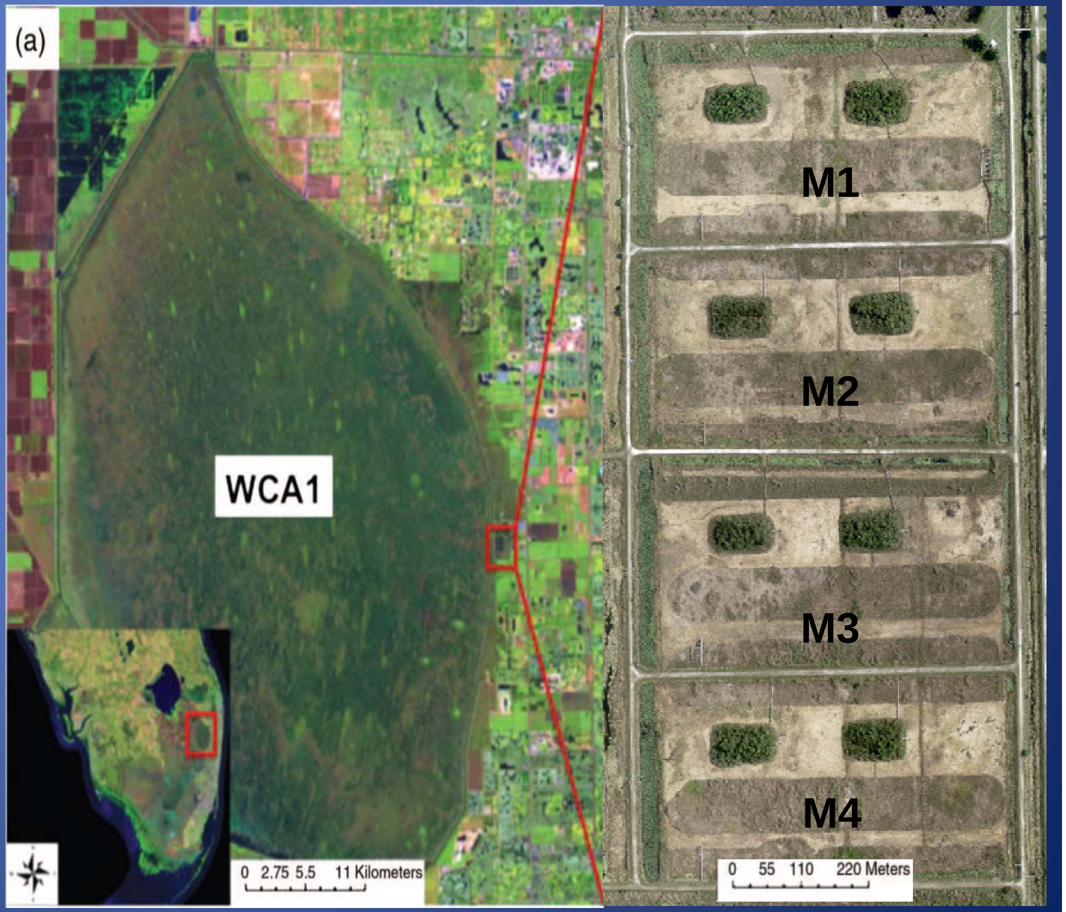
Loss since 1950s
61% WCA-3
87% WCA-2A

- **Greatest loss in TI < 3.2 ha.**
- **Decreased patch density (from 16 to 3 per 100 ha) and increased distance between TI**
- **Sustained high or low water conditions (impoundments)**

Coronado and Bauman, SFWMD; Wetzel et al. 2005

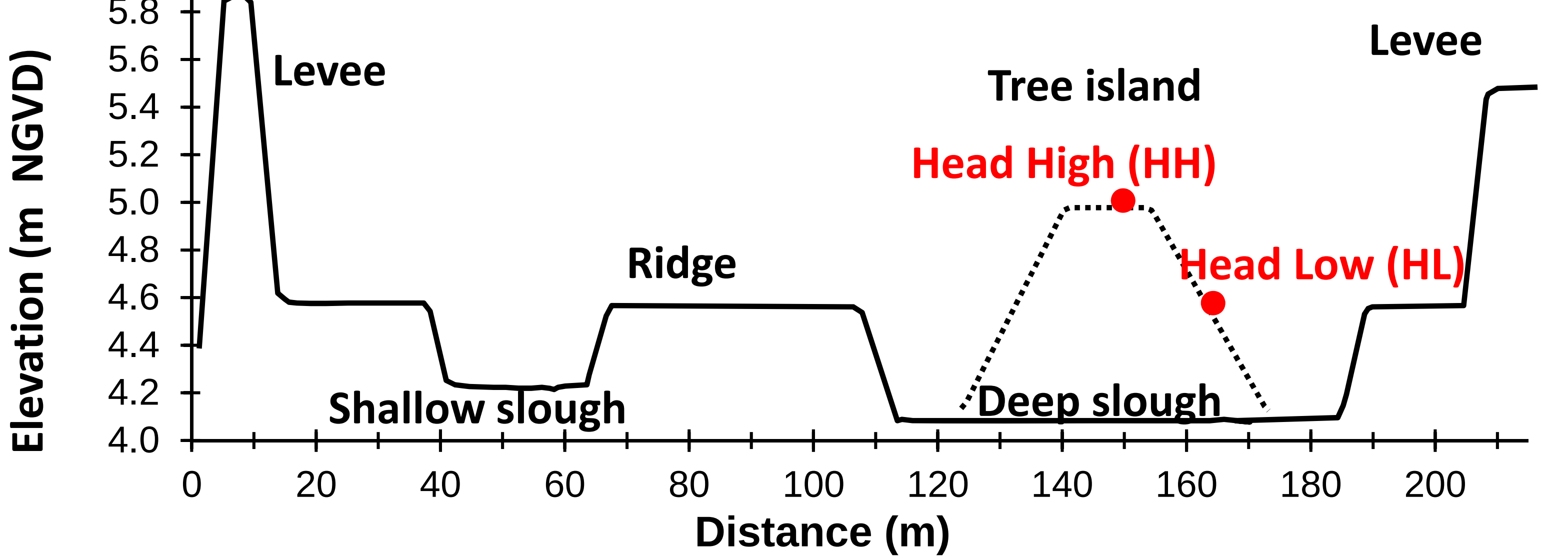
Loxahatchee Impoundment Landscape Assessment - LILA

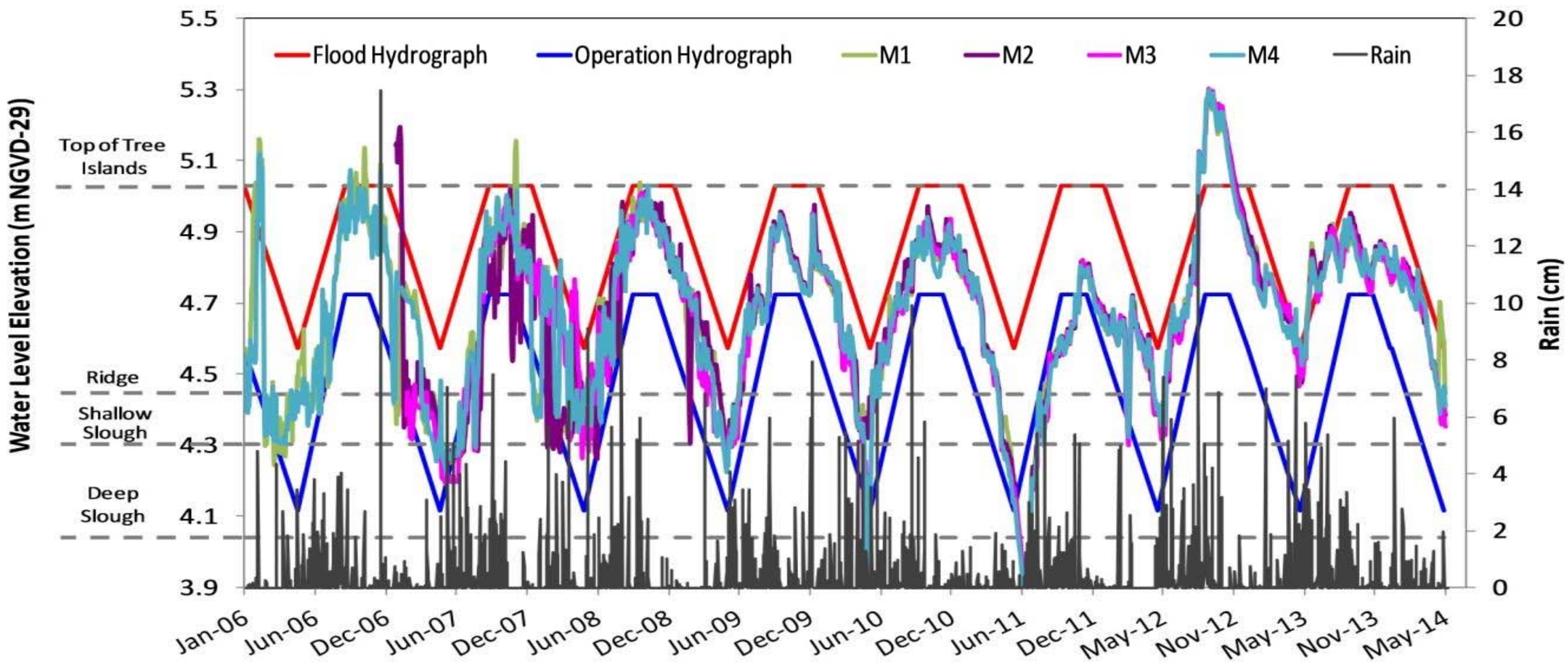
- Semi-controlled "living laboratory" to determine the effects of water regime to sustain healthy tree islands and ridge and slough ecosystems.
- Reduce the uncertainty of CERP water management on the response of TI and R&S, especially the plant community composition, and the maintenance of TI and ridges elevated above sloughs.
- Provide a publically-accessible, visual example of Everglades Restoration Programs in Action.



Three Major Topographical Features of a Marsh Habitat

Cross-section of a macrocosm



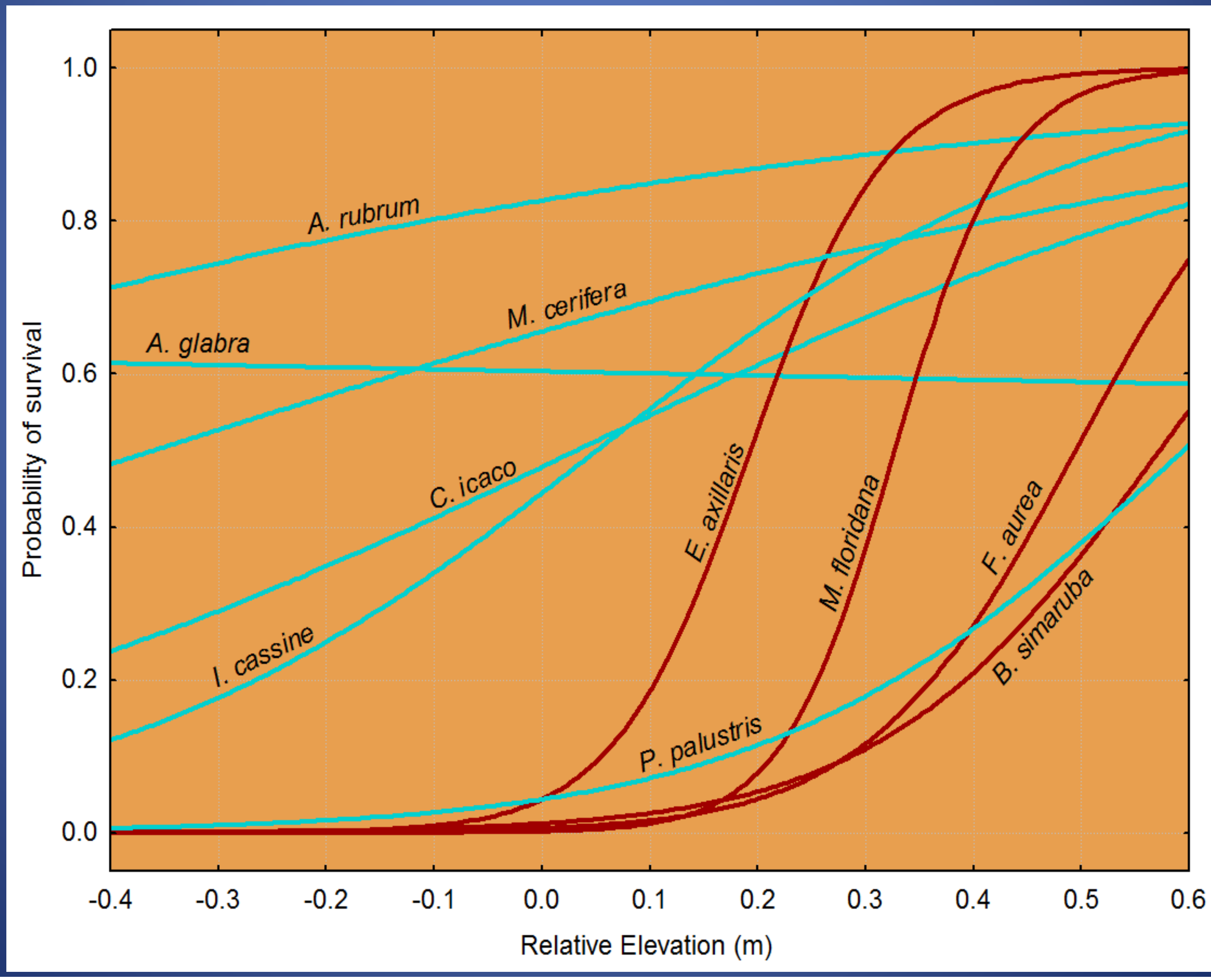



Tree island
planting 2006

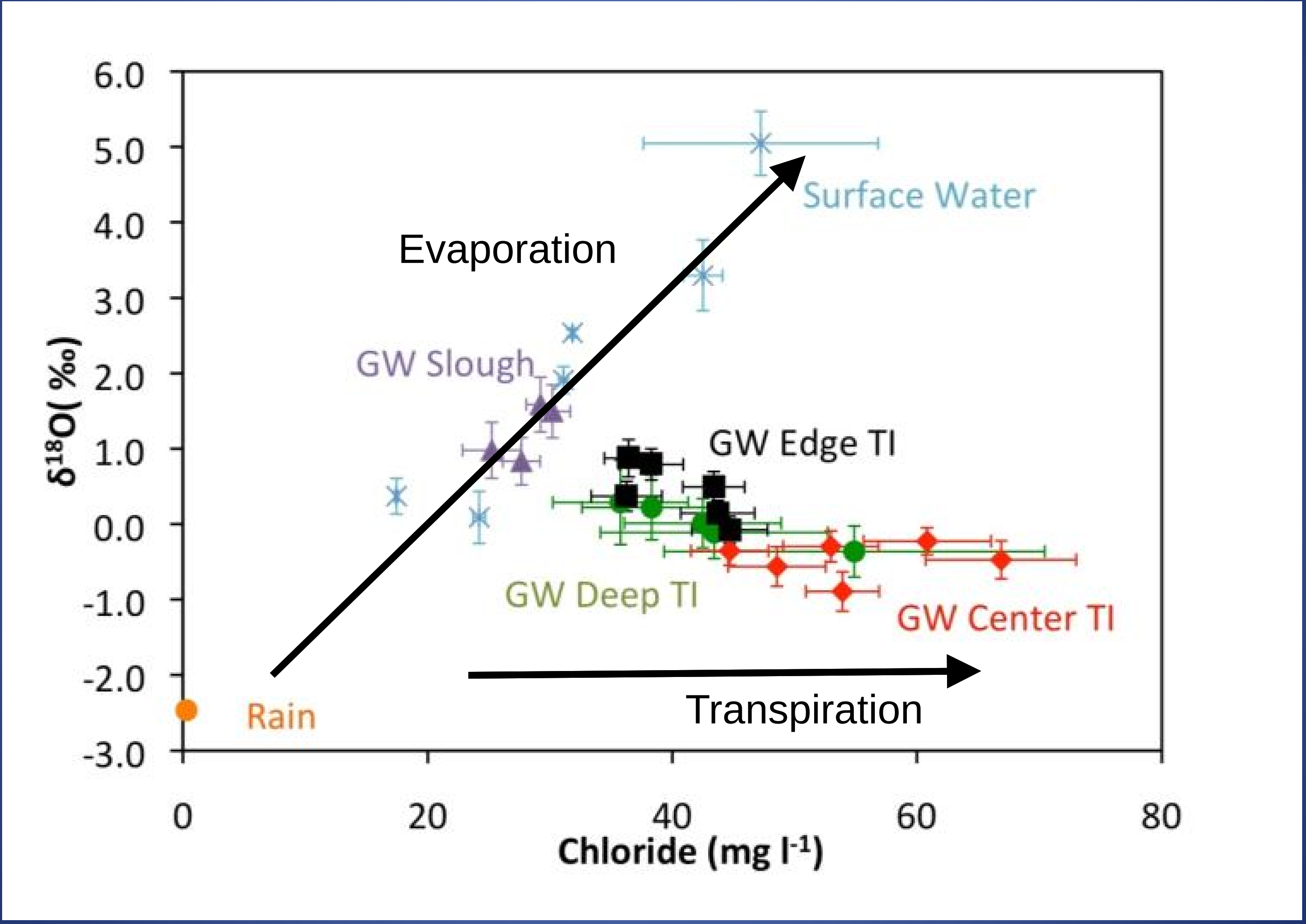

2010


2014
Photo – E. Cline

Survivability of upland species (red) were generally more sensitive to relative elevation than wetland species (blue). Similar performance in LILA experimental setting and in natural setting. (Ross et al.; Stoffella et al. 2010; Session 27).



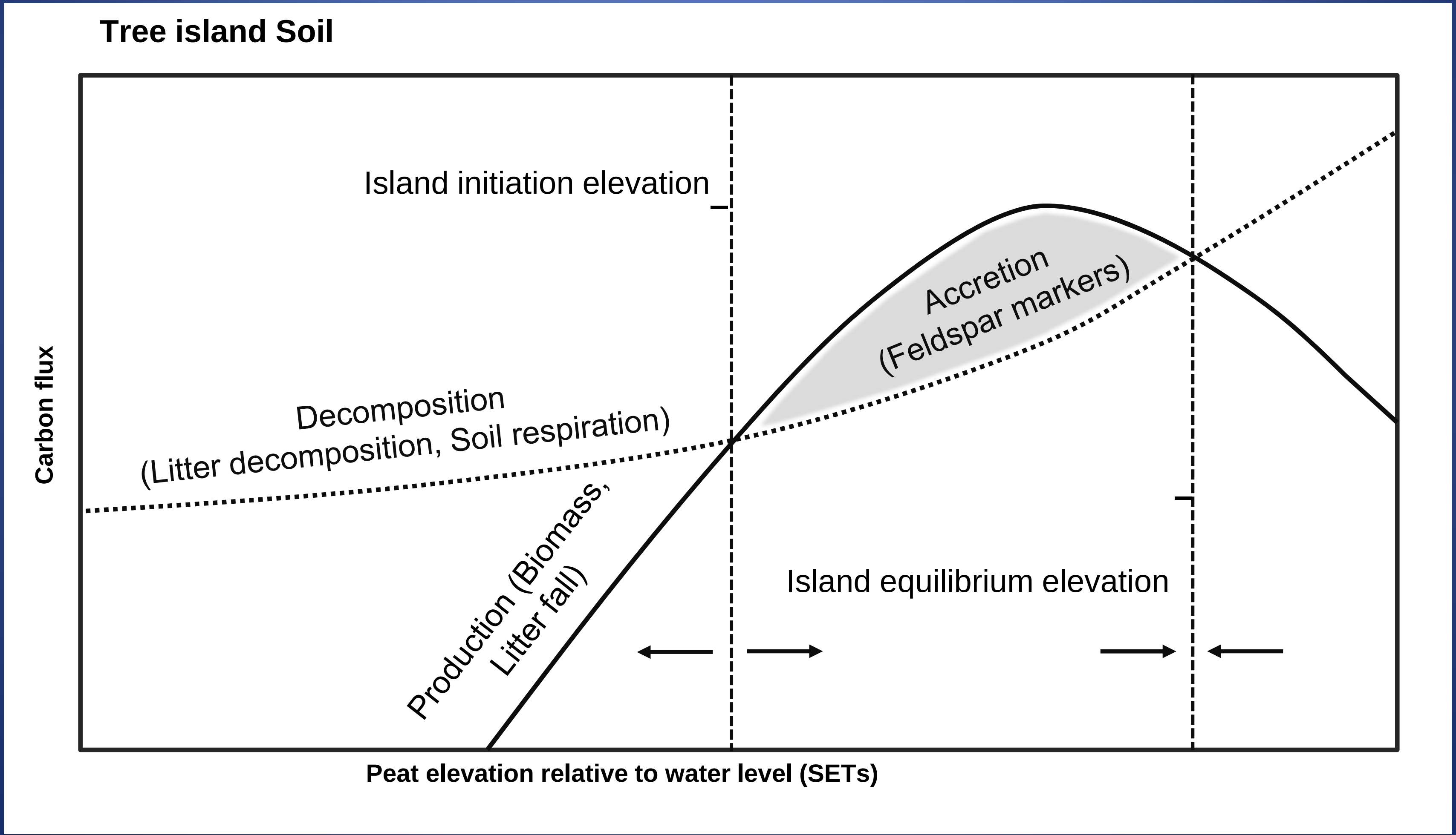
Typically, the GW in the center of the tree islands is significantly different from the SW and GW in the slough and edge of the islands



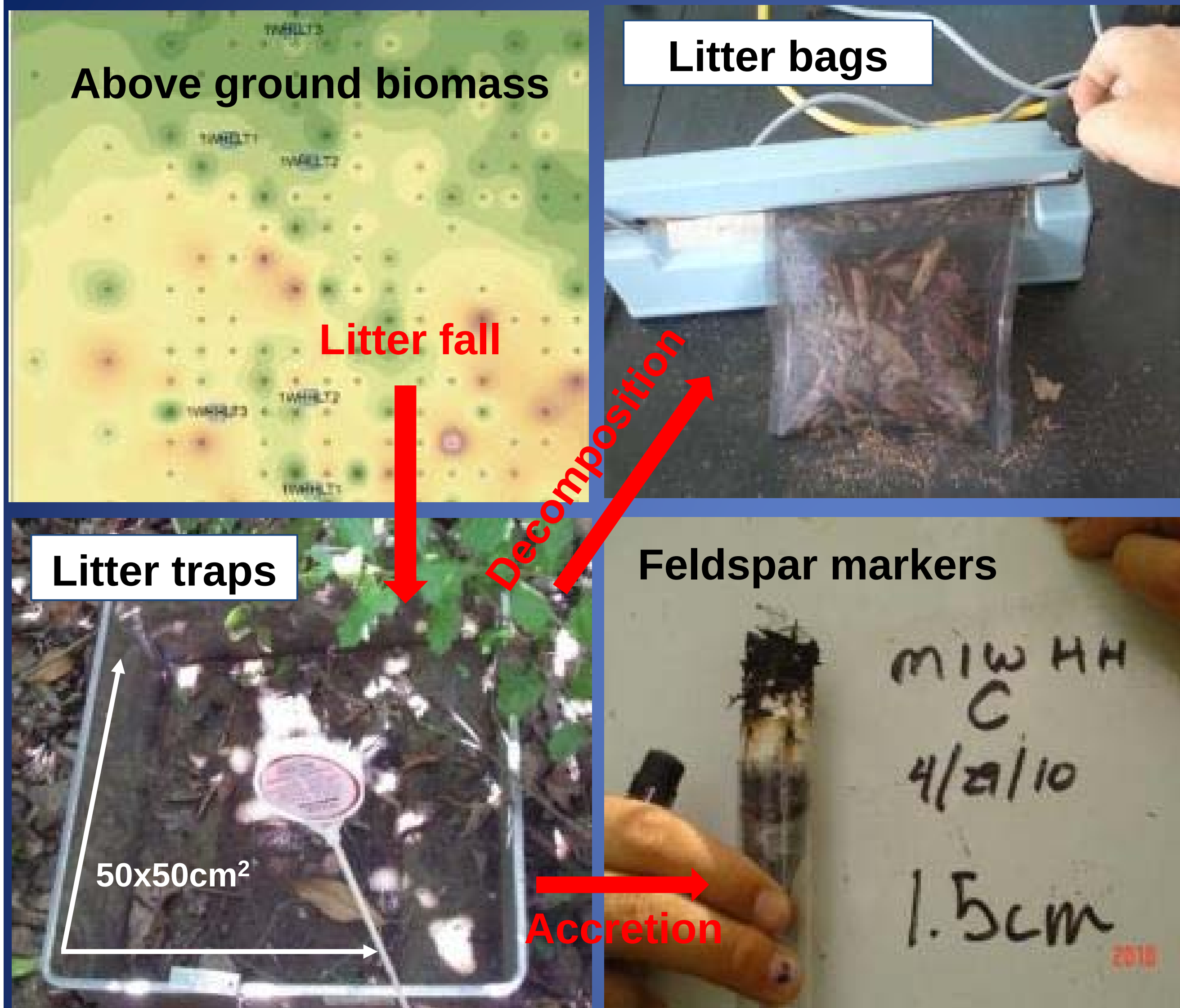
(Sullivan et al. 2011; 2014 – Session 27)

Hydrological Effects

Defining the equilibrium between **Decomposition** and **Production** in relation to **relative water depth (RWD)** for tree islands can aid in Everglades restoration.



Adapted from Fig. 4 Larsen et al., 2011 Crit Rev Environ Sci Technol. 41 (S1):344-381



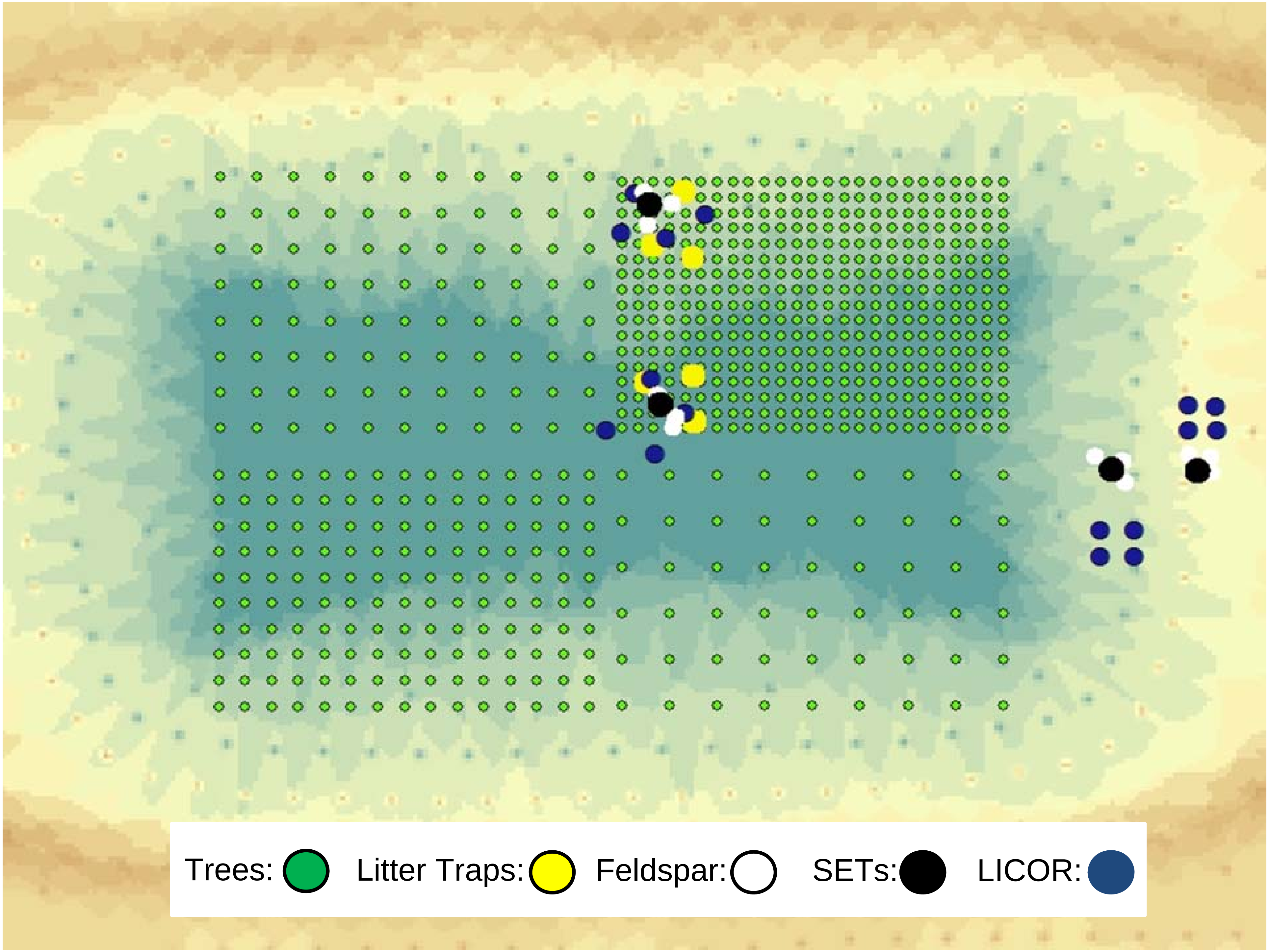
Soil accretion is a balance between production and decomposition.

Litter production and soil building will be higher at high elevations because of higher biomass growth.

Decomposition will be greatest at high elevations due to oxic conditions.

Tree islands will increase in elevation if soil building occurs at a rate greater than decomposition


Trees:
Litter Traps:
Feldspar:
SETs:
LICOR: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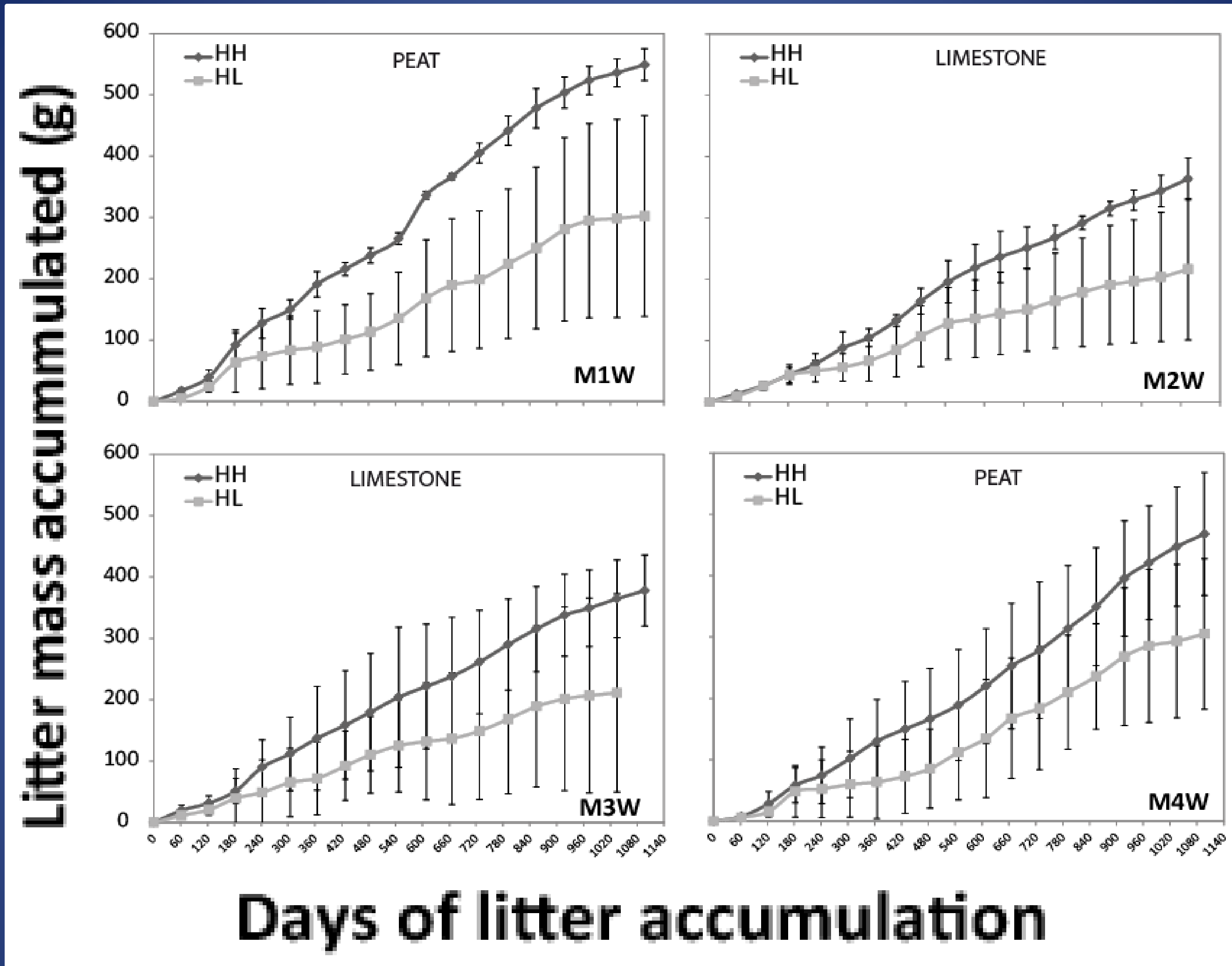
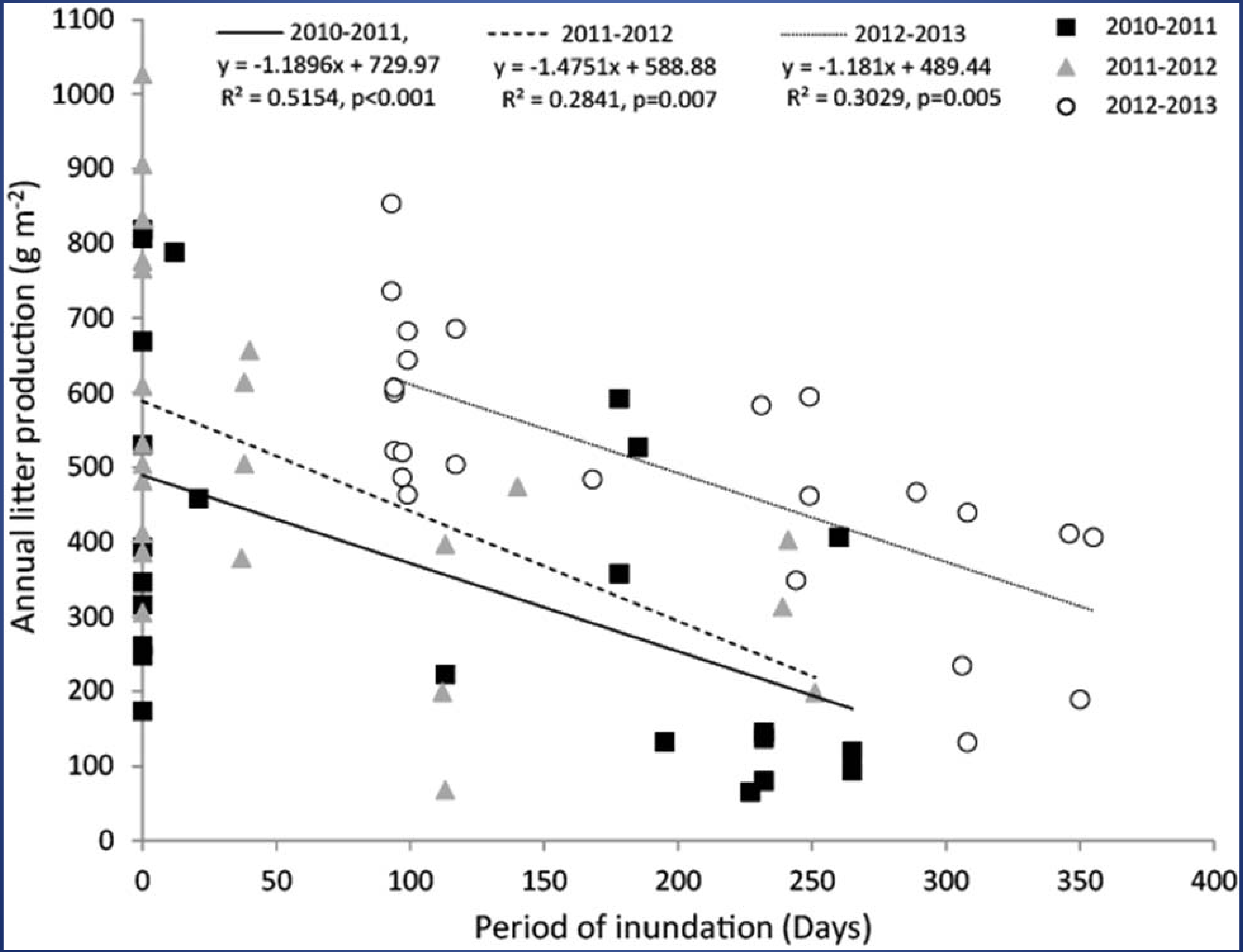
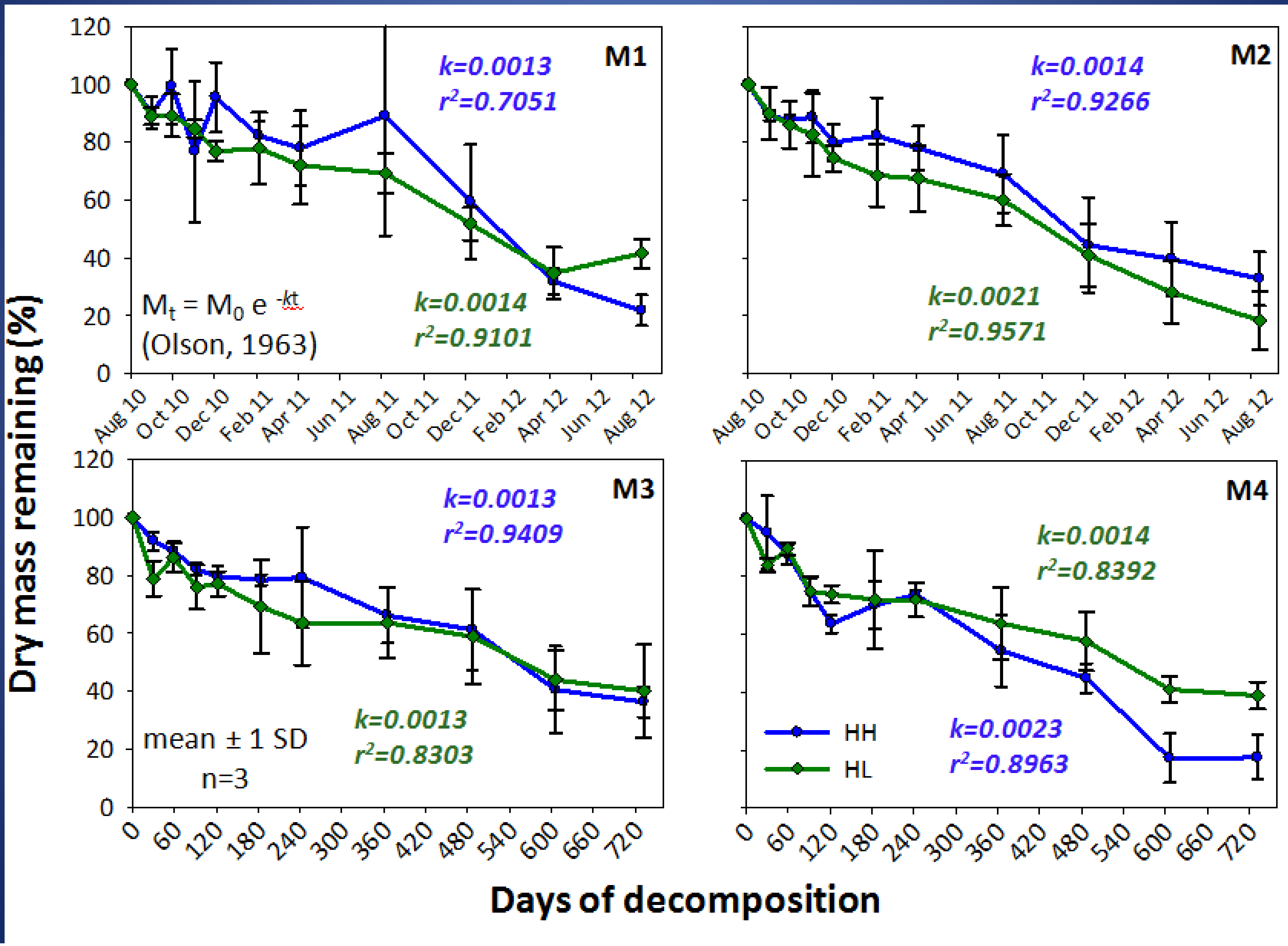


Litter fall added material to soil surface with greater additions at higher elevations (where trees were maximally productive).

Annual litter production decreased with increased inundation (lower elevations).



Litter decomposition was also slightly greater at higher elevations compared to lower elevations.



	Elevation			
Parameter (unit)	High	Low	p value	n
	Mean ± SD			
Litterfall production ($g\ m^{-2}\ y^{-1}$)	599 ± 302	353 ± 296	<0.001	108
Litterfall rate *k'* (d^{-1})	0.4678 ± 0.1033	0.2731 ± 0.1268	0.015	6
Decomposition rate *k* (d^{-1})	0.0022 ± 0.0003	0.0012 ± 0.0001	<0.001	6

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

Wetland Soils

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

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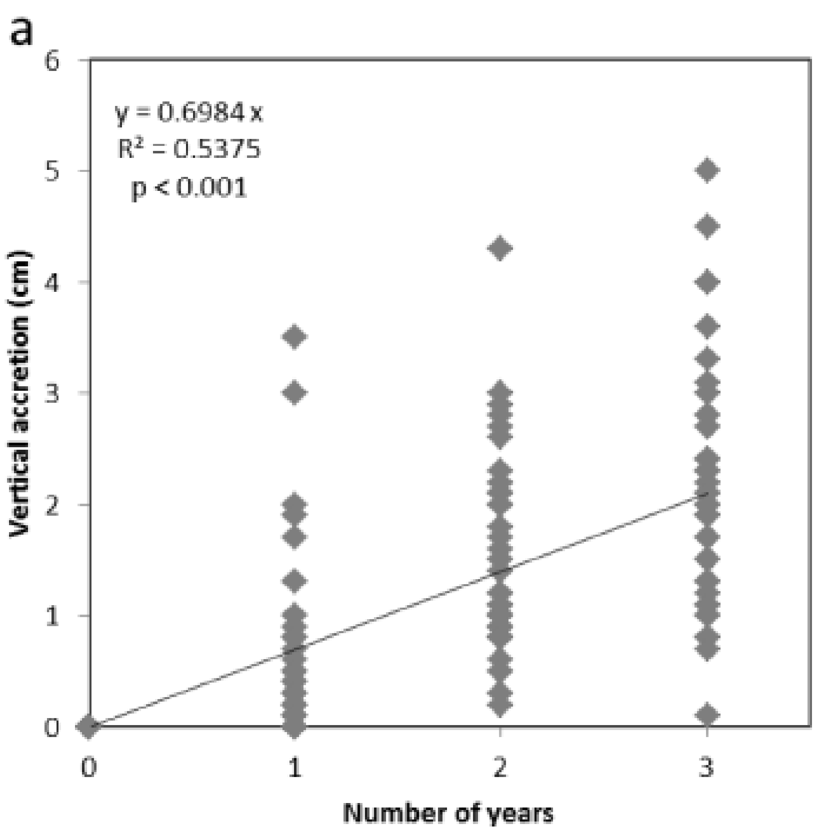

Soil development at LILA (app. 0.7 cm y-1), more rapid at higher elevations where trees were maximally productive.

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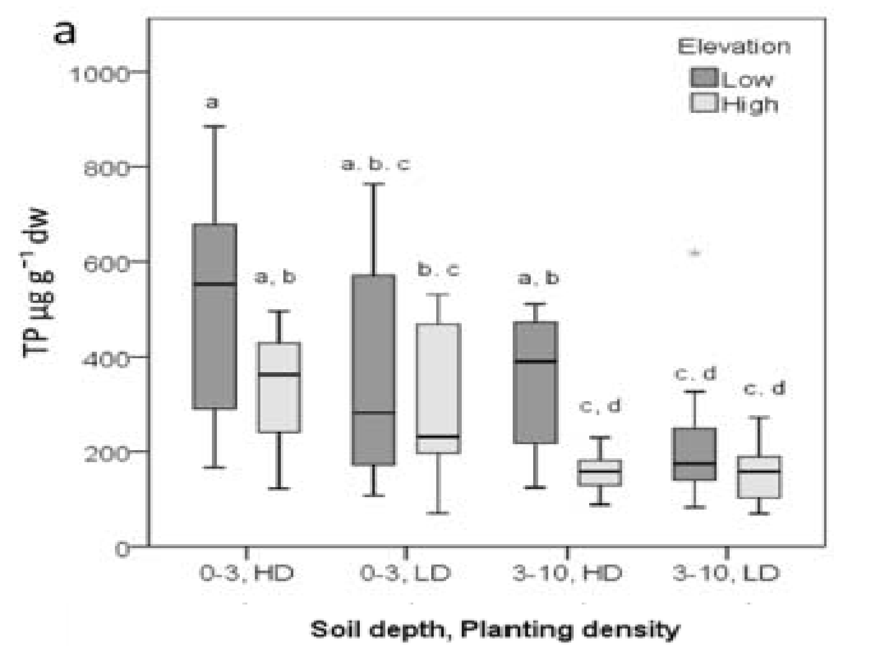
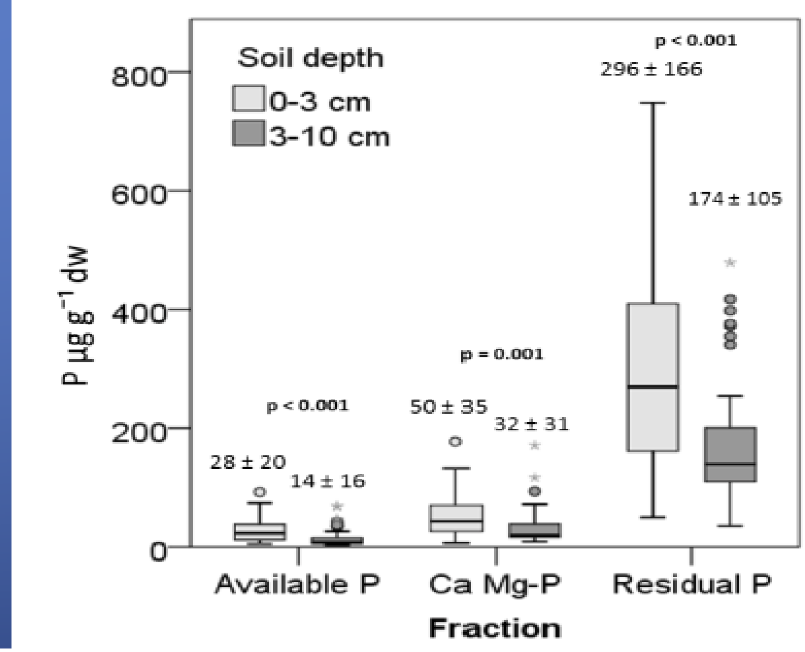
Physicochemical Parameters for “new” (0-3 cm) versus “older” (3-10 cm) soils on all islands all planting densities (Mean ± SD, n = 48).

Parameter	Unit	Soil Depth		p value
		0-3 cm	3-10 cm	
Field BD	g dw cm^{-3}	0.45 ± 0.22	0.73 ± 0.33	<0.001
$TP_{conc.}$	µg g^{-1} dw	374 ± 202	216 ± 134	<0.001
TP_{mass}	µg cm^{-3}	135 ± 56	122 ± 38	0.557
TN	mg g^{-1} dw	14.4 ± 6.8	10.2 ± 5.7	0.001
TC	mg g^{-1} dw	190 ± 90	132 ± 75	0.001
OM	g g^{-1} dw	0.36 ± 0.19	0.25 ± 0.18	0.001
OM significantly (p = 0.001) correlated to TC, TN, TP (Spearman)				





Conclusions

- Newly accreted soils had higher concentrations of TP and Available P then older soils.
- Areas with greater litterfall produced soils of higher P content.
- Soil accretion in newly created LILA tree islands add to increased elevation at rates ~0.7 cm y^{-1}.
- Differences in production rather than decomposition responsible for surface soil accretion.
- Within a Tree Island the higher elevations generally had higher biomass, litter production, and soil accretion.
- Processes and mechanisms (e.g. transpiration driven ion import) appear to follow expected trajectories.
- Tree growth and survivorship were quantified and there appears to be a good match between LILA setting and GEE.

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