Ecological Patterns and Processes in Ghost Tree Islands of the Everglades

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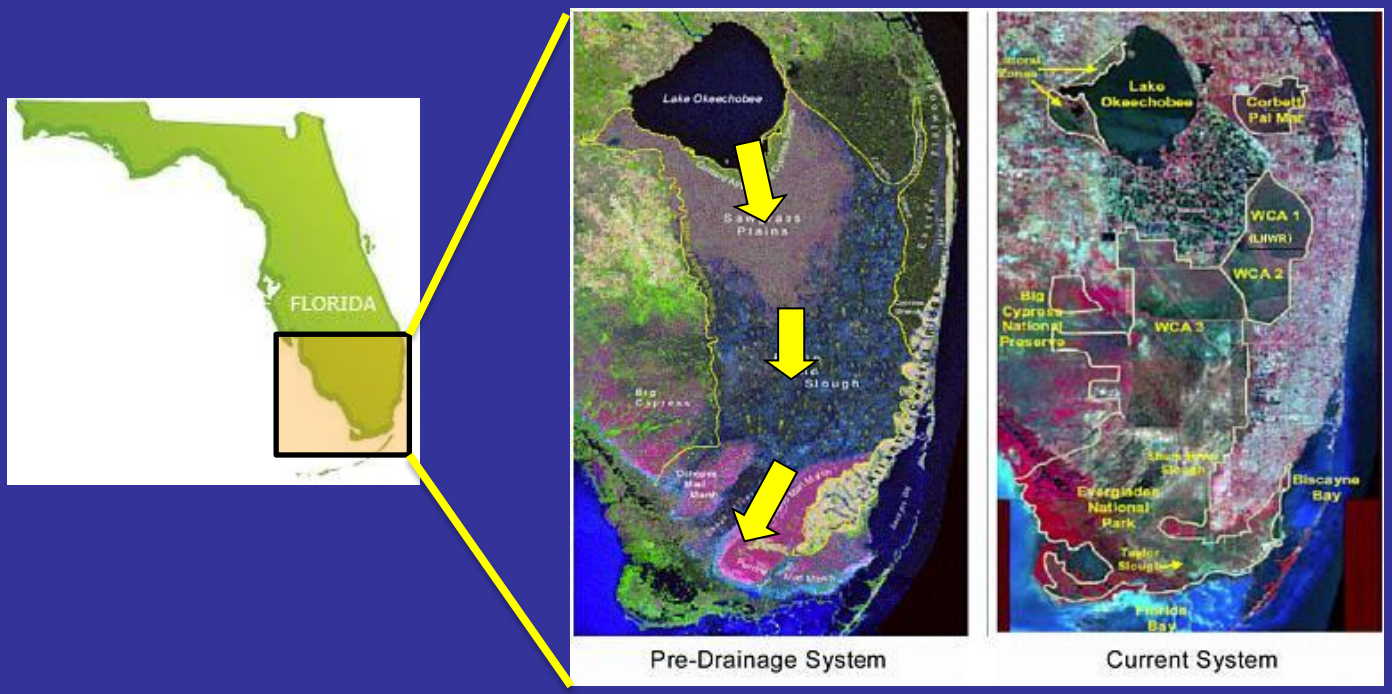
What are tree islands?

- Areas of woody vegetation within wetlands dominated by non-woody species.
- Key features in the Everglades wetlands complex.

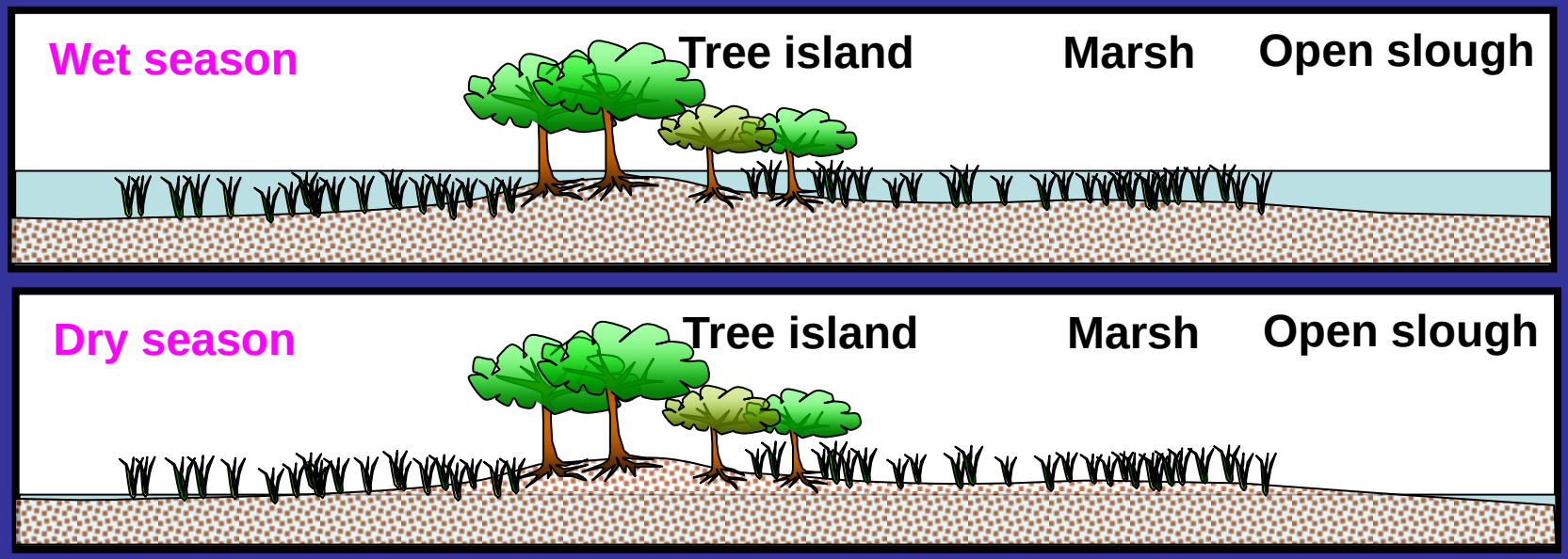
Everglades flow patterns

- Historically, the Everglades has been a “River of Grass”.
- In the wet season, water flow extended north of Lake Okeechobee into Florida Bay as sheetflow, ~50 cm deep and 60-100 km across.
- Today, it is a highly compartmentalized and regulated system.



Impacts on Tree Islands

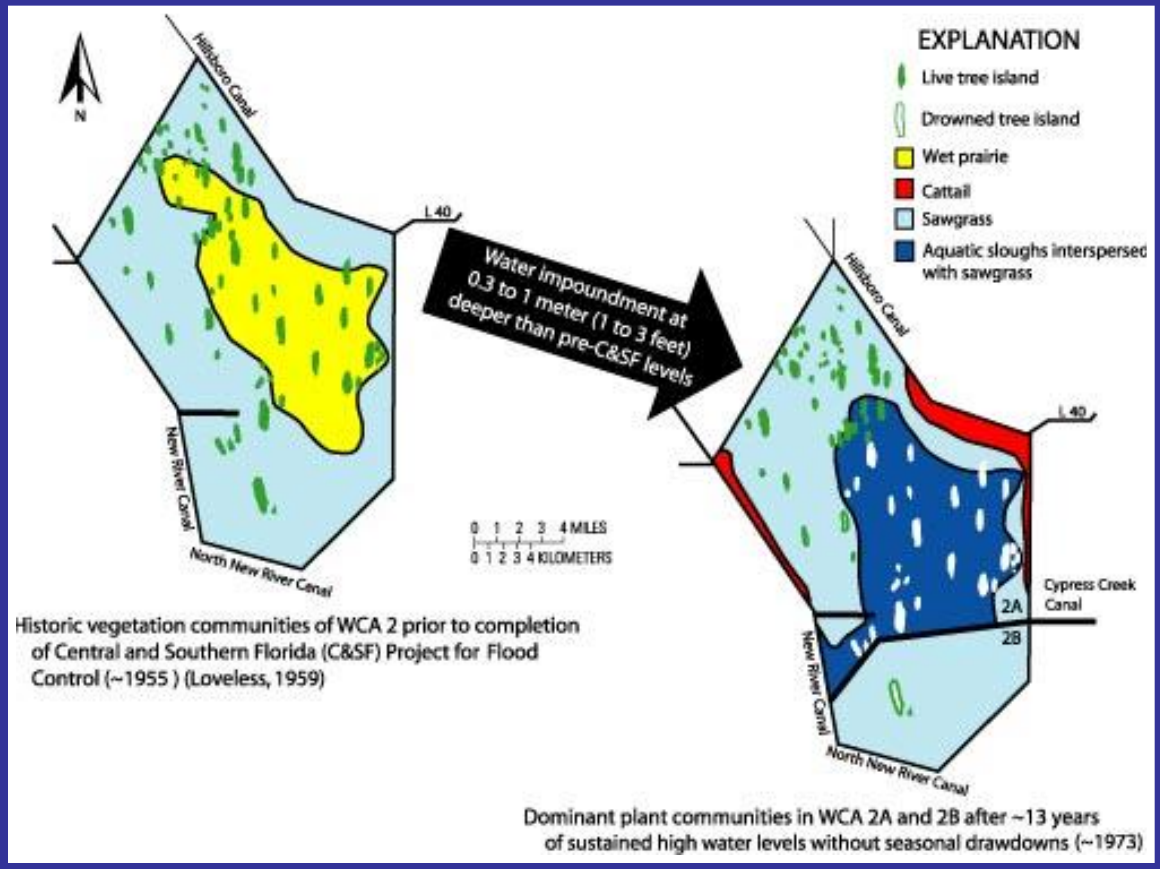
- Tree islands have been adversely impacted by compartmentalization of the Everglades ecosystem



- Tree islands are only 5% of total land mass but are a key habitat within the Everglades as they:
  a) support high biodiversity
  b) are a refugia for fauna in the wet season
  c) are nutrient sinks (soil phosphorus hotspots)

Status of tree islands in Everglades

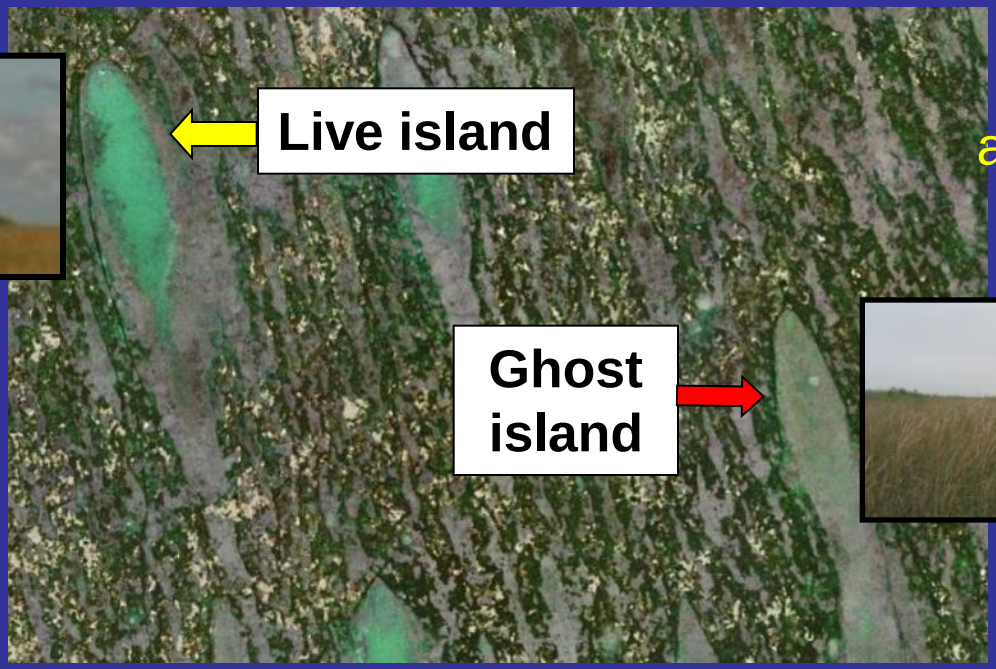
- For >50 years, the ecology and physiology of tree islands have been altered by water management.
- >60% of the tree islands have been lost.
- >90% of the tree islands in Water Conservation Area 2A have been lost.



What is a Ghost island?

- “Ghost island” is a tree island with significant loss in community structure i.e. degraded islands

Healthy vegetation.



“Ghost” island appears to be just a scar in the landscape.

- Area with the most number of ghost islands is WCA-2.
- Today there are only 3 living tree islands in WCA-2.

Issues/Concerns

- Can ghost tree islands be restored?

- Part of the CERP goal: halt tree islands loss by 2020 (1999 Baseline Report for CERP)
- Eventual goal: restore tree islands in the Everglades

Objectives

- Assess microtopography, soil structure and chemistry, and vegetation patterns of living and ghost tree islands in WCA-2A.
- Review aerial imagery to understand trajectory of island loss.
- Objective: increase understanding of the ecology and biogeochemistry of these islands and *how* to implement island restoration.

Live tree islands → **Loss of island structure and function** → **"Ghost" islands**

RESTORATION

Study location in WCA-2A

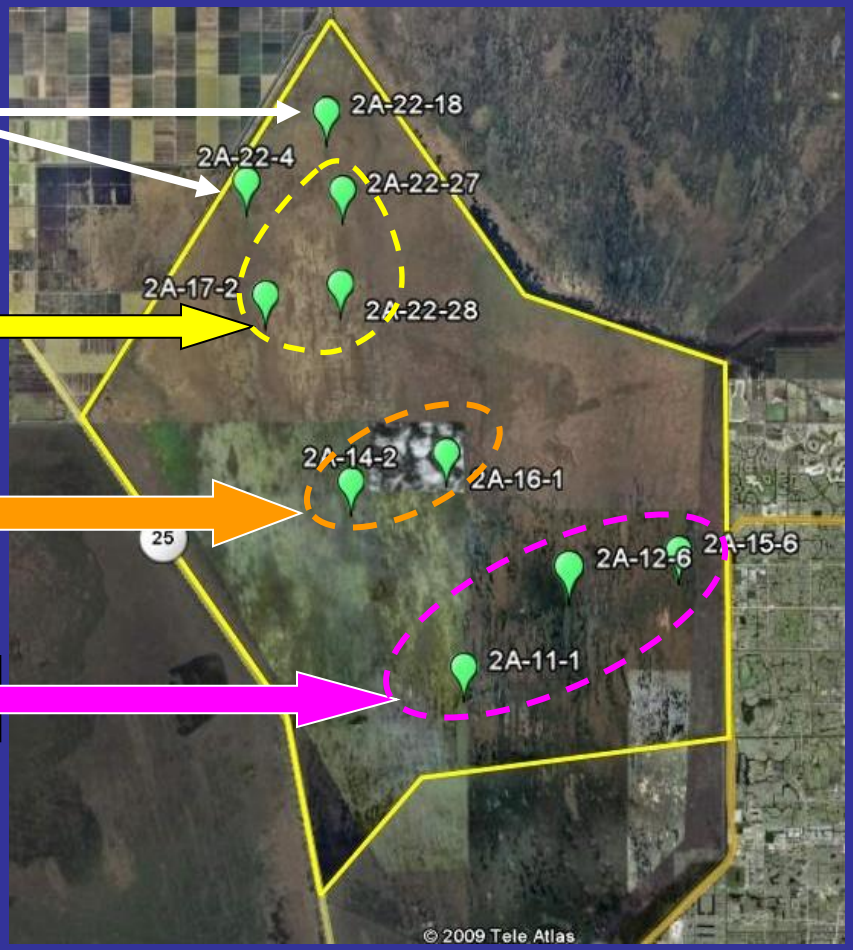
- Sampling in WCA 2A across a hydrologic range
- 10 islands surveyed: 8 “ghost” + 1 live island,1 additional “dying” island surveyed

Live: 2A-22-18
Dying: 2A-22-4

North: 2A-22-27, 2A-17-2, 2A-22-28

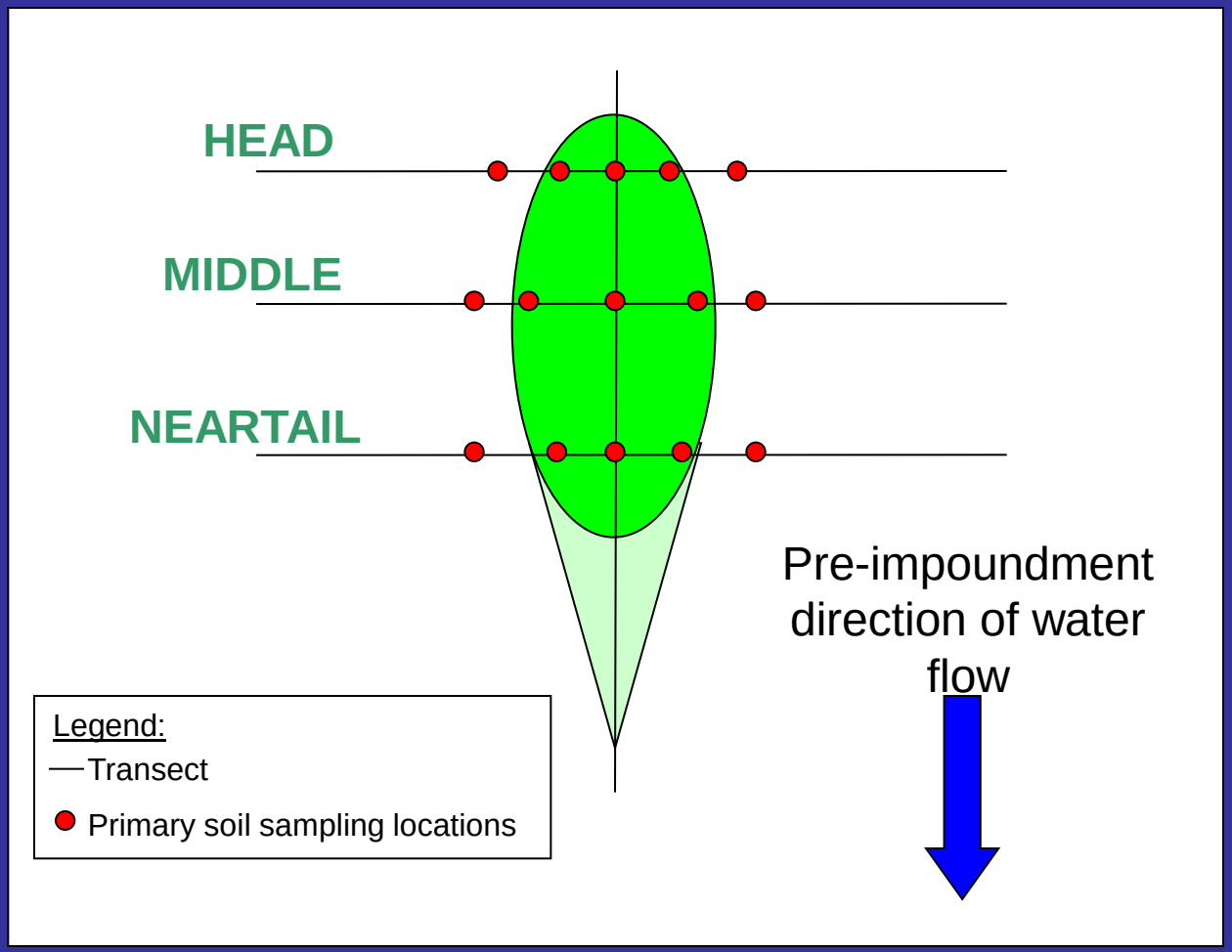
Central: 2A-14-2, 2A-16-1

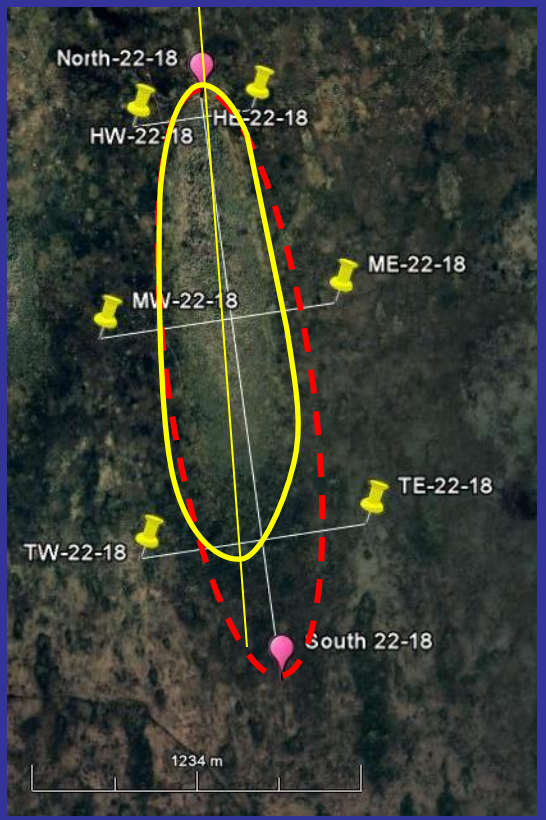
South: 2A-15-6, 2A-12-6,2A-11-1



Sampling Design

- Sampled in transects across the islands based on current discernible extent of island

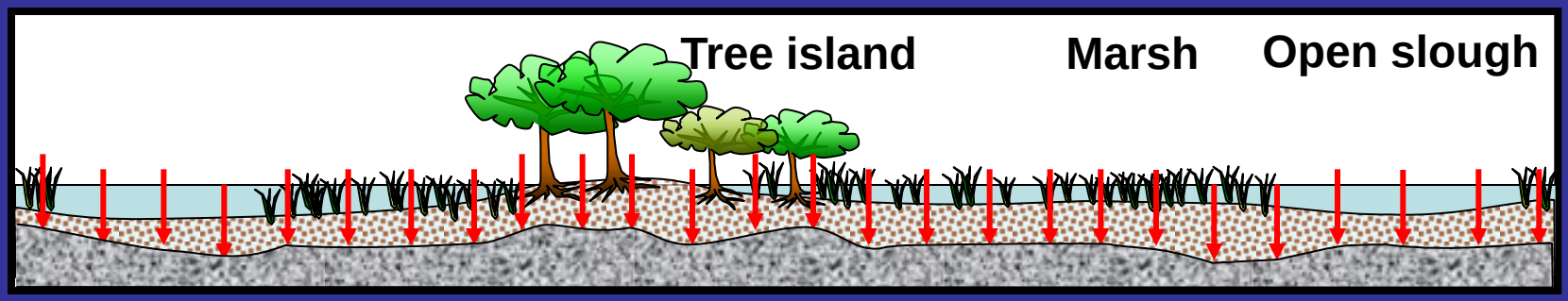




1a. Measuring soil topography

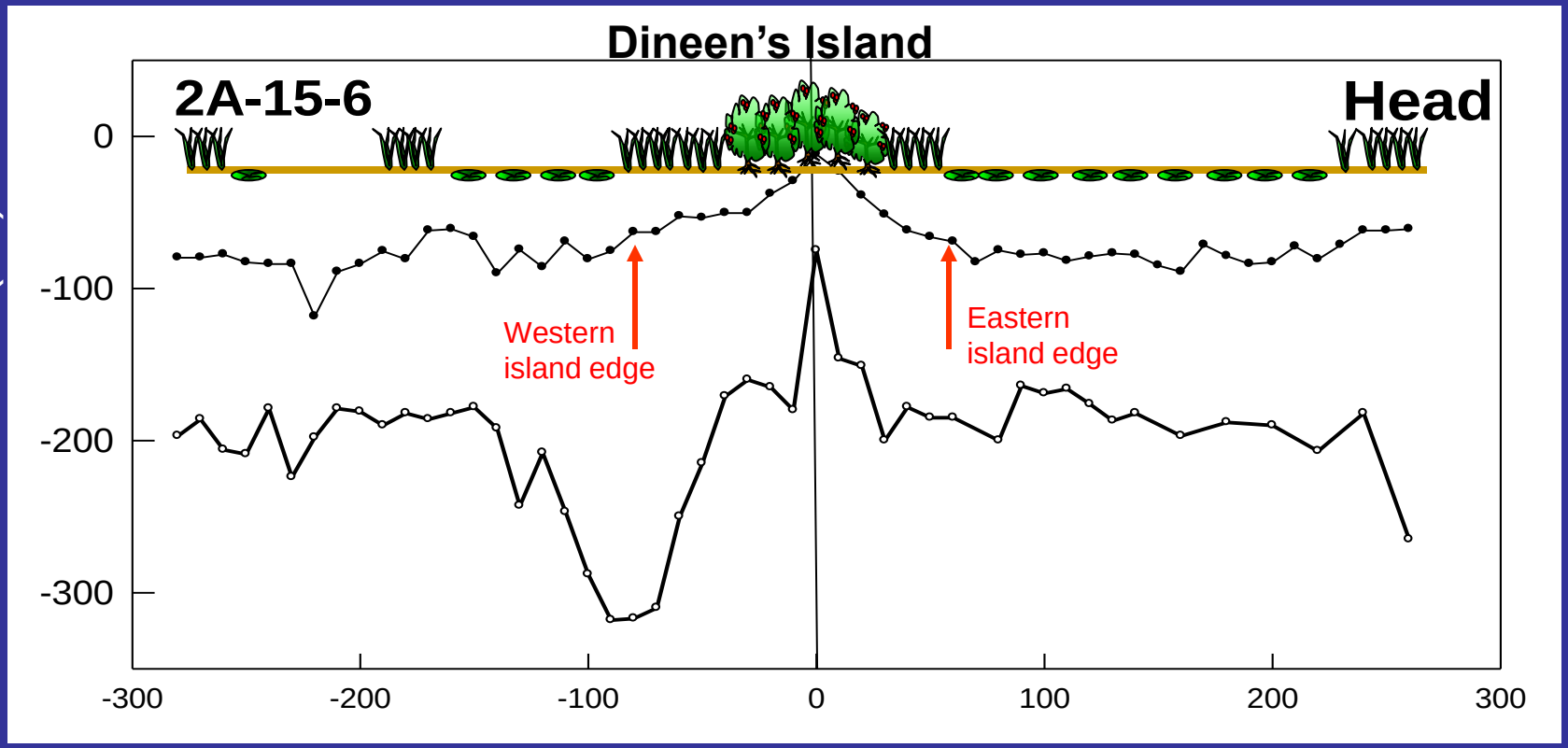
- PVC sounding rod used to assess elevation every 10 m.
- Measured from across island from nearest western ridge to eastern ridge.

1b. Bedrock topography



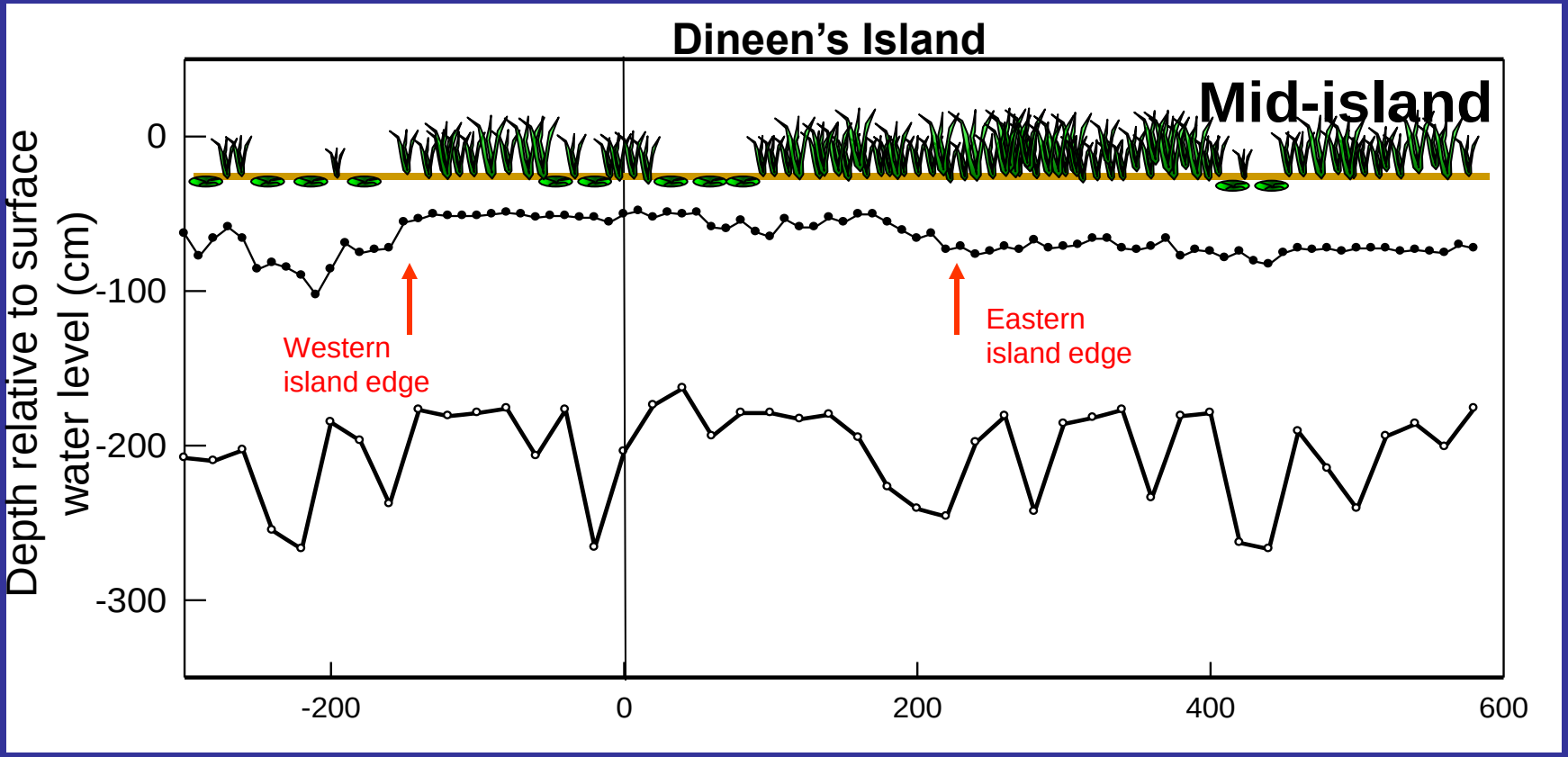
- Metal rod used to assess changes in bedrock every 20 m.
- 20+ km of transects across 10 islands measured (~2000 shallow and ~1000 deep points measured).

Results



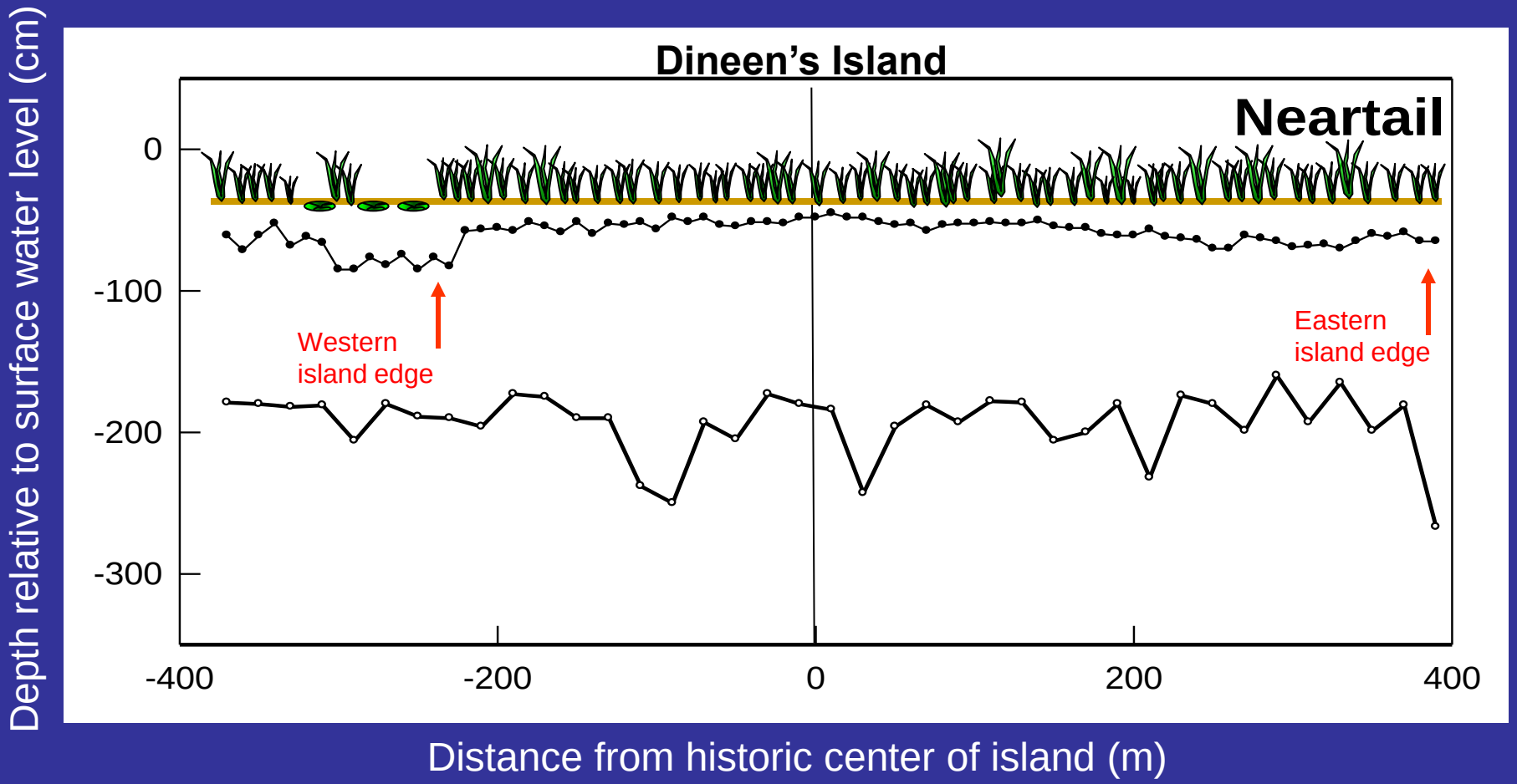
- Average depth to bedrock (all transects): 161 cm
- Pinnacle rock and elevated soil surfaces observed at the historic center of some island heads (example above).

Results



- Limited topographic highs mid-island.
- No large trees observed, only sawgrass *(Cladium jamaicense)* and some open water.

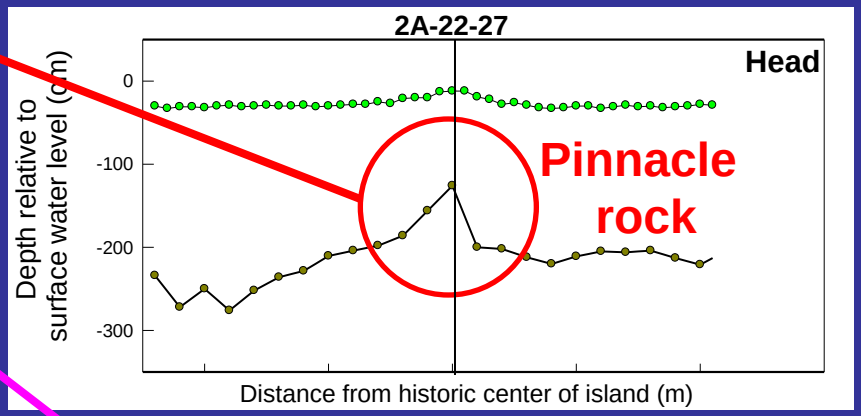
Results

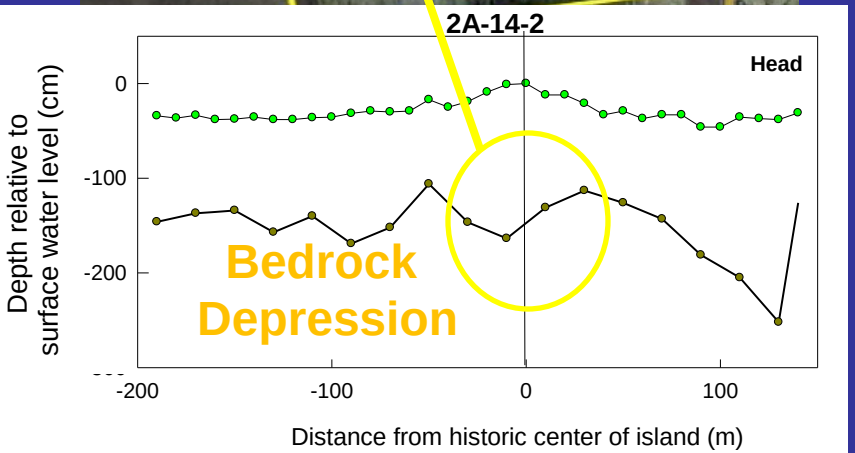


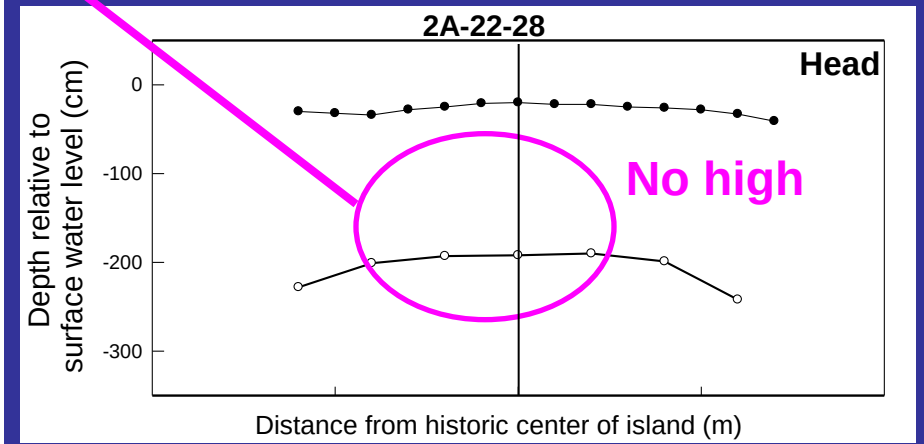
- No large trees and short (<2 m) sawgrass observed.

Results

- Data supports the 3 theories of island formation
- Many islands still show evidence of historic edge boundary

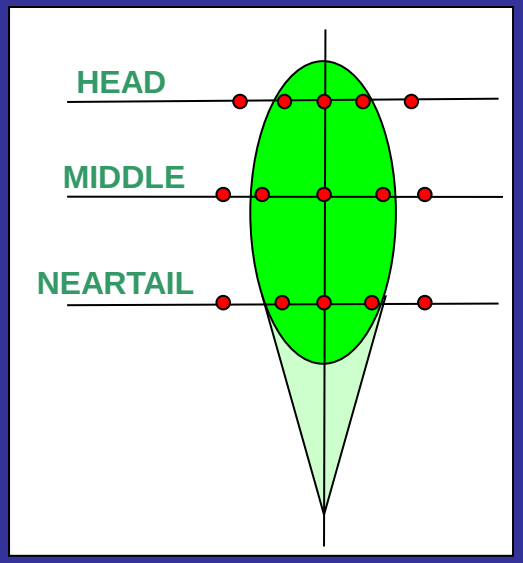


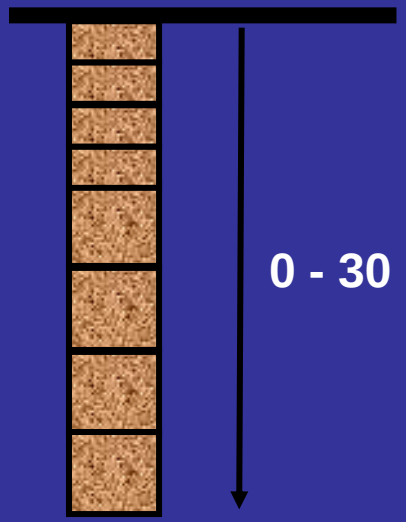




2. Soil Core Collection

- Total: 150 short cores collected (15/island)
- Cores cut in 2.5 cm intervals for top 10 cm, 5 cm intervals from 10-30 cm
- Parameters analyzed: bulk density, %C, %N, %P, $\delta^{13}C$, $\delta^{15}N$





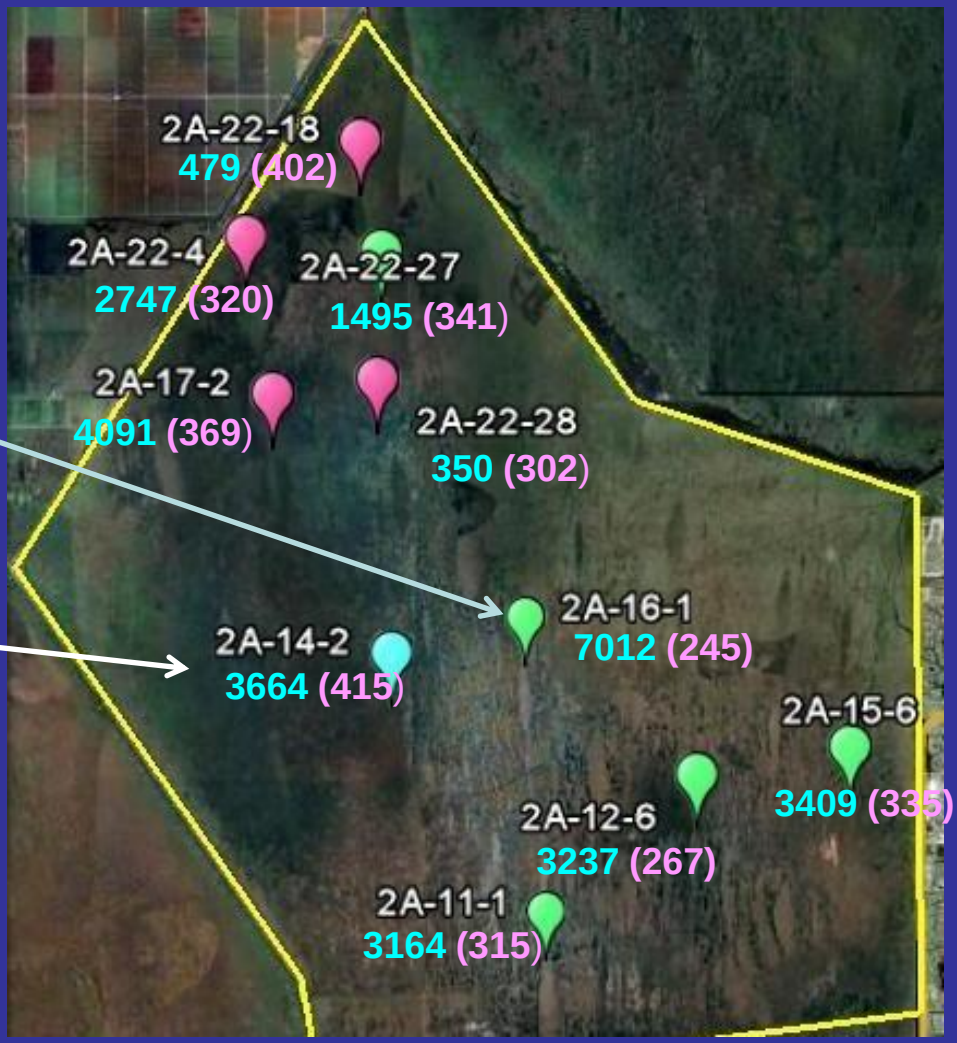
Results

Total Phosphorus distribution in 10 Live and Ghost Tree Islands and the surrounding marsh

- Island : 350-7010mg/kg
- Slough: 245-415mg/kg

Highest TP = 84477 mg/kg (2A-16-1, head, 25-30cm)

Lowest TP = 34 mg/kg (2A-14-2, neartail, 25-30cm)



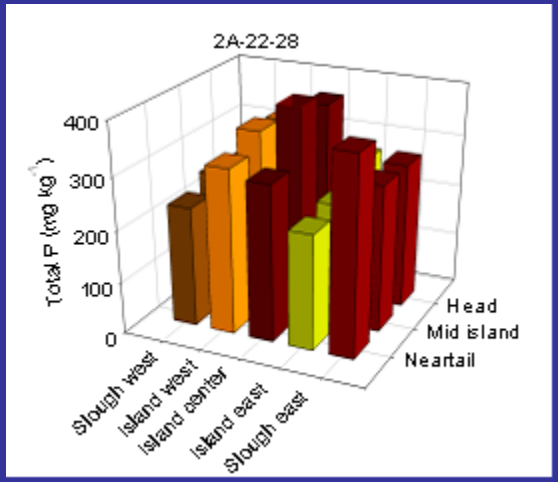
Legend:
White: island name
Blue: island soil TP(mg/kg)
Red: slough soil TP(mg/kg)

Results

- The Everglades is a Phosphorus-limited system. Phosphorus availability drives productivity.
- Everglades tree islands are “phosphorus hotspots”.
- Island restoration may be more likely if high P is observed.

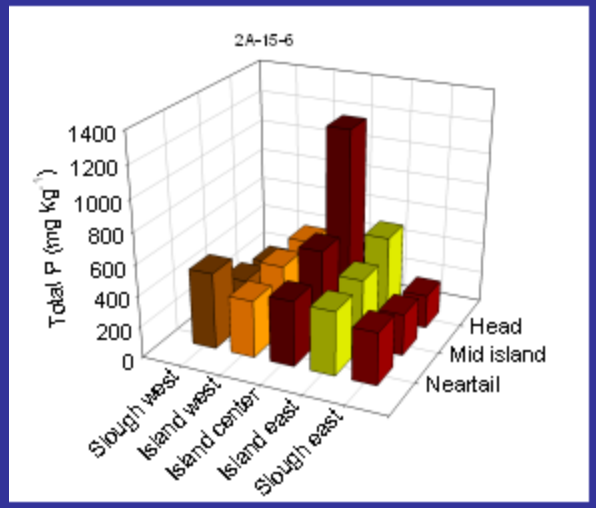
“Phosphorus hotspot”: TP concentration tree island soils >1000 mg/kg (twice as high as the soil TP concentration in pristine marsh)

- Two islands did not have a P-hotspot.

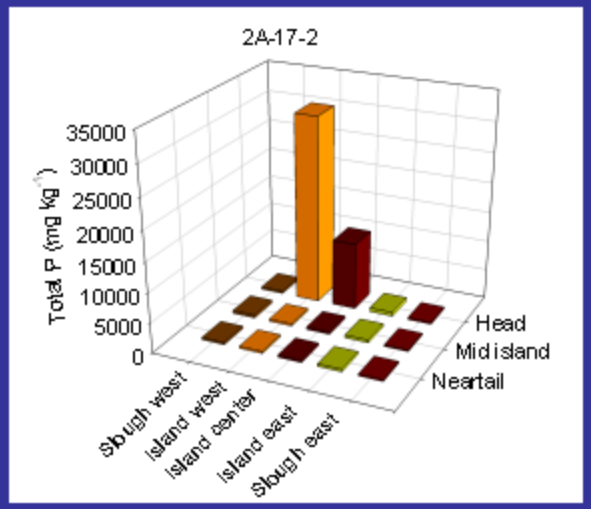


Results

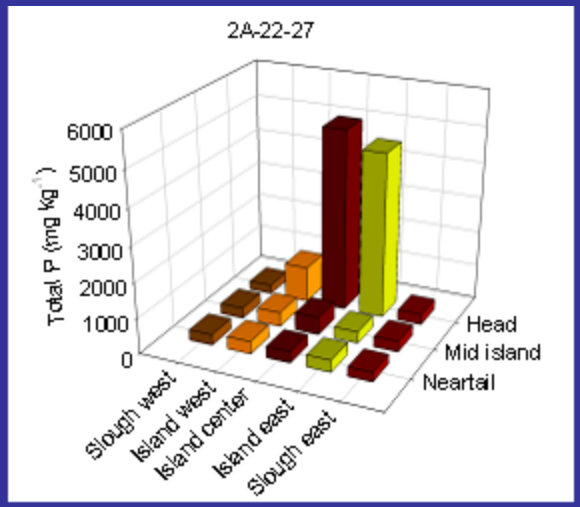
- Eight of the 10 islands had ≥1 P-hotspots at the head.



One Hotspot (n = 2)



Two Hotspots (n = 3)

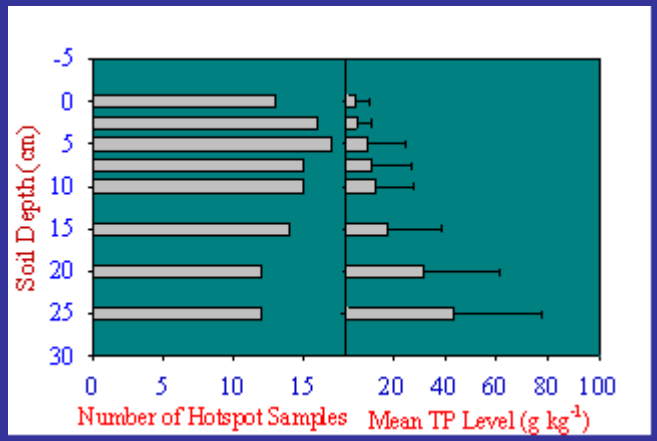


Three Hotspots (n = 2)

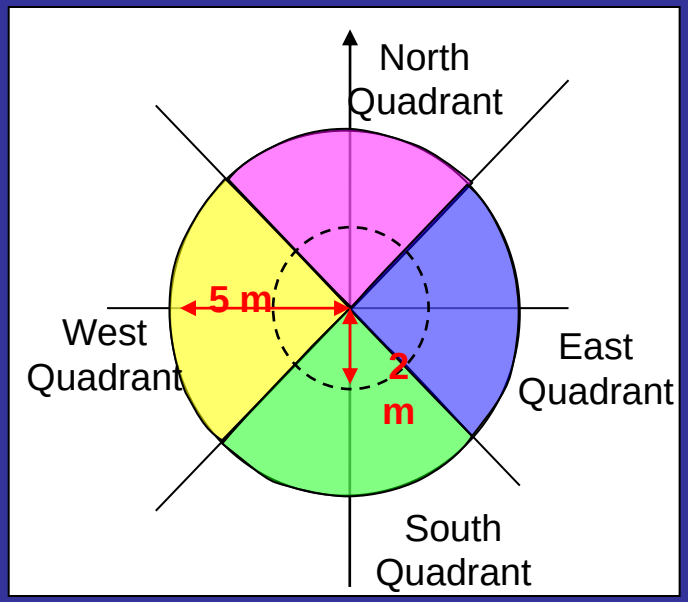
- P concentrations increased with depth at the head.

Fish bones

Bird guano



3. Vegetation Assessment



At soil core collection locations:

- Average height, dominant species, canopy condition, emergent species, exotics
- vegetation height, % cover
- wildlife utilization

- 450 vegetation samples collected, dried and bagged for nutrient analyses.

RESULTS

- Canopy ranged from 10-20% cover and was 1-2 m tall.
- Woody species were limited only to the head of the islands.
- Middle and neartail of islands was sawgrass (13-51% cover).
- Dominant species were willow (*Salix caroliniana),* bayberry (*Myrica cerifera*), and sawgrass.

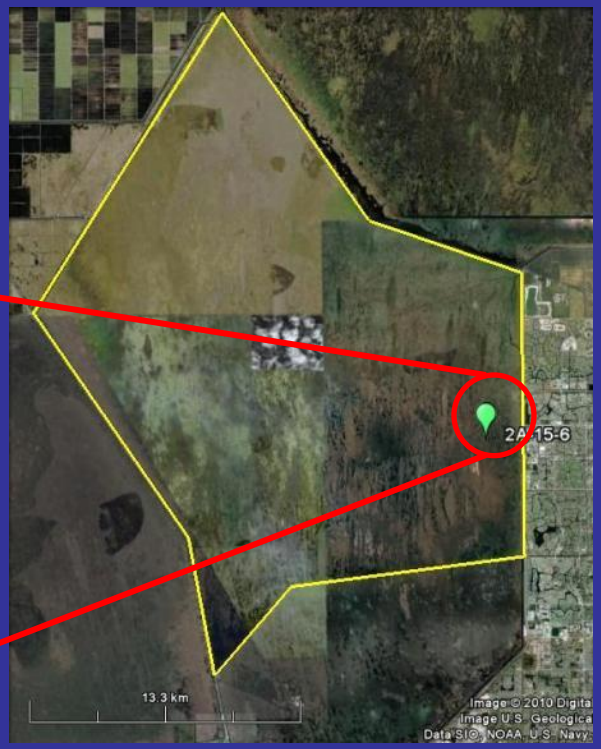
Islands with woody species present may have a greater success in being restored.

Neartail of 22-4.

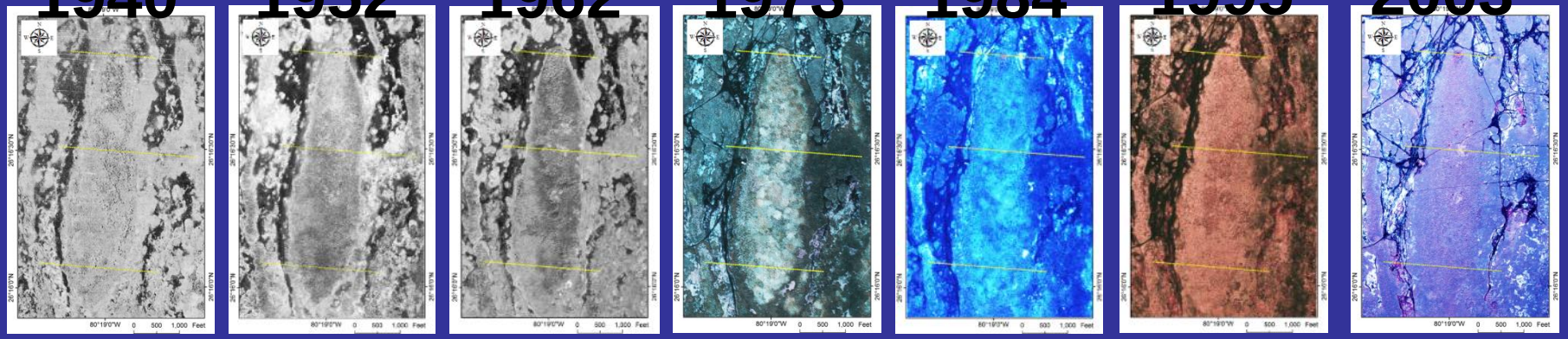
Average island vegetation height.

4. Aerial Assessment

- Focused on Dineen's Island (2A-15-6)
- Examined changes in island extent over time

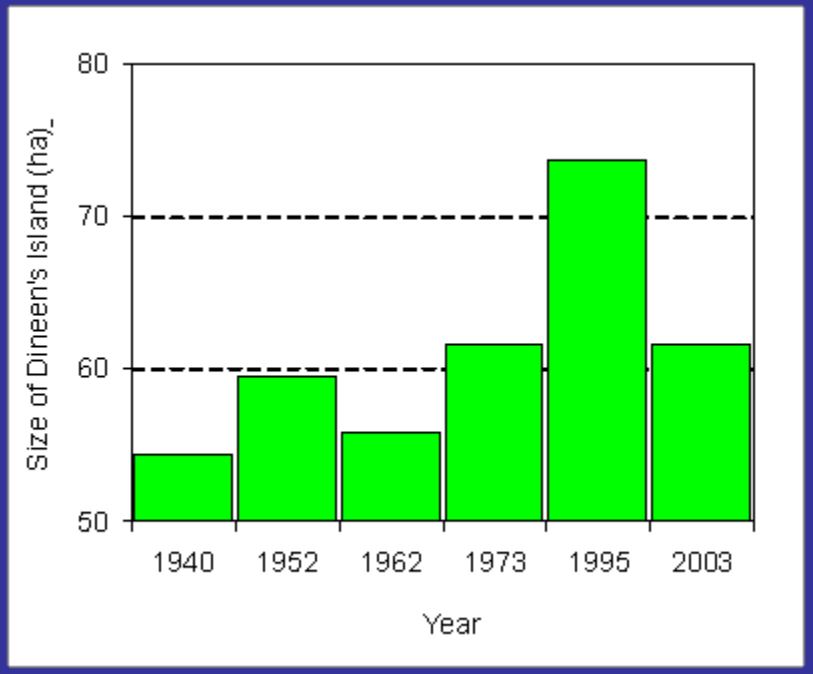


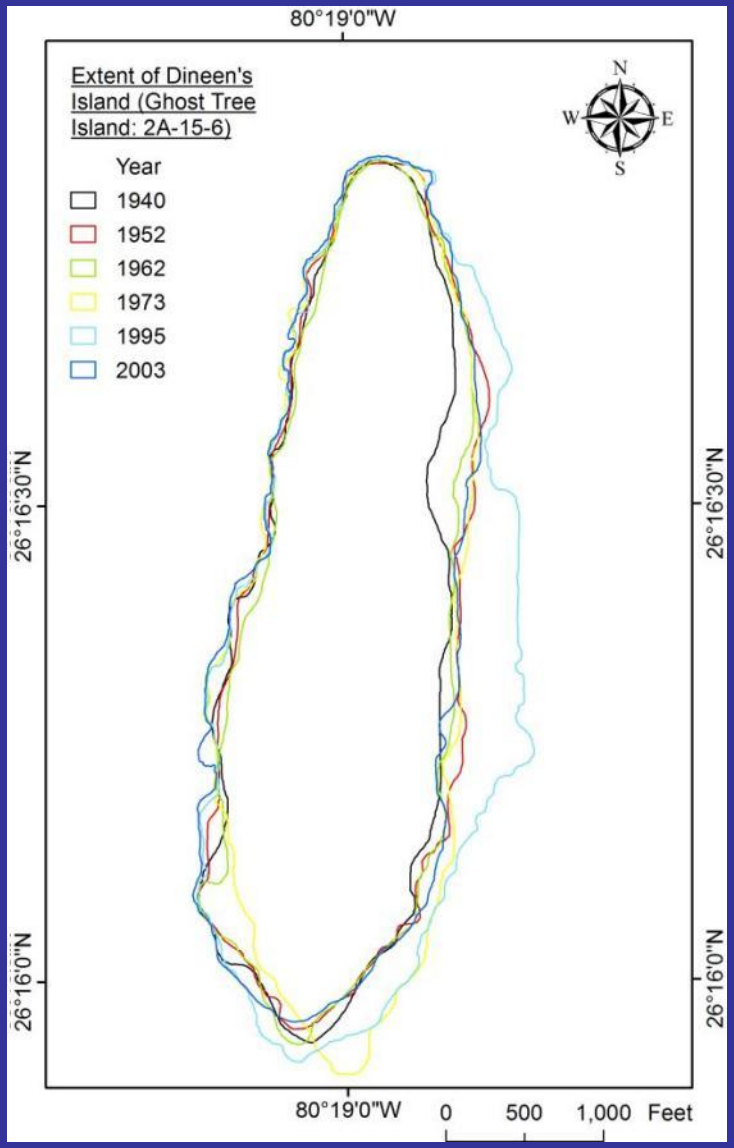
1940 1952 1962 1973 1984 1995 2003



Results: temporal patterns

- Inter-decadal fluctuations of Dineen's island areal extent observed
- Eastern boundary appears more dynamic than western edge

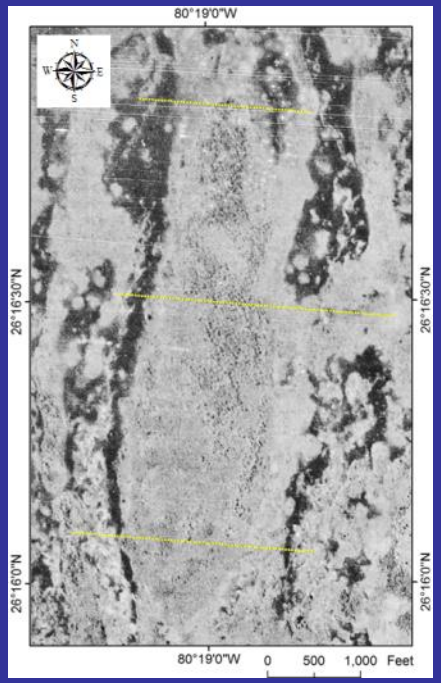




Temporal patterns

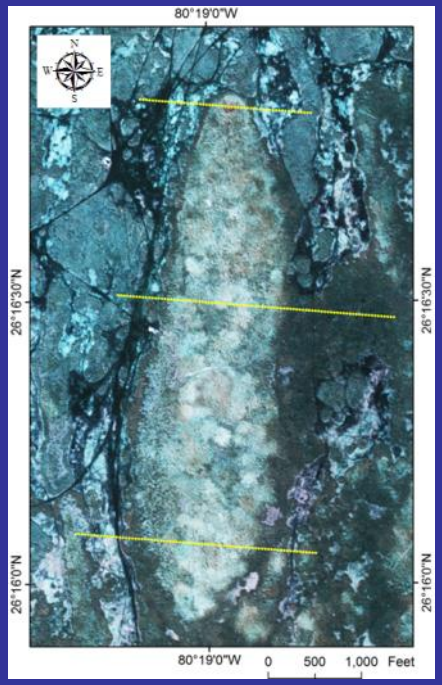
- Dineen's Island woody tree extent has declined (1940-present)
- Community phase shifts observed between decades

1940



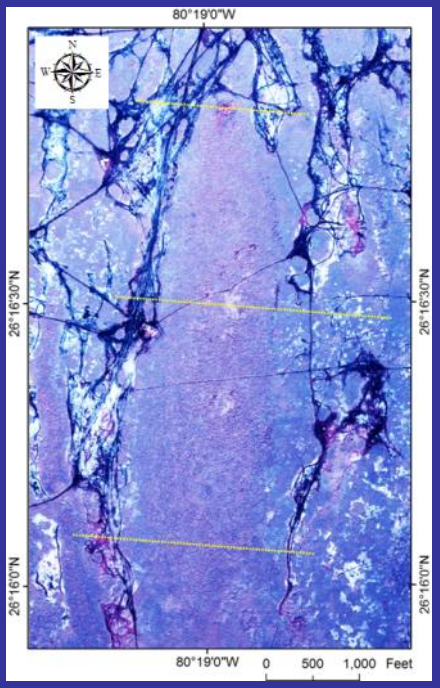
Woody plants throughout island

1973



Cattail dominated island

2003



Sawgrass dominated island

Results

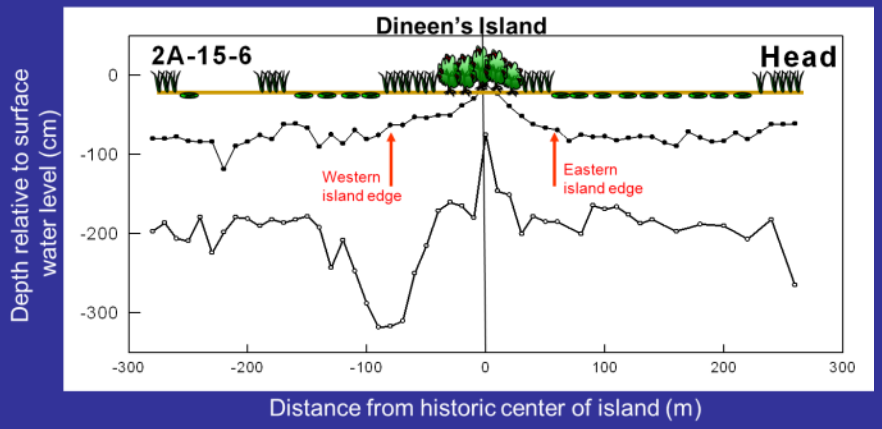
1. Long-term datasets provide insight into shifts in areal extent
2. Community-level changes are clearly captured at decadal time scales

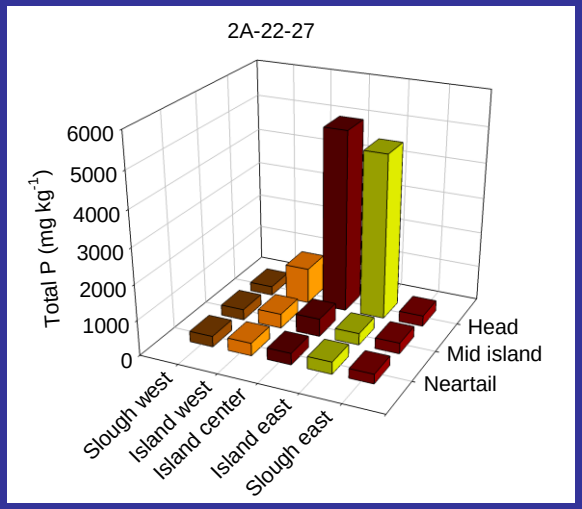
Tree island in WCA 3. Note the woody tree extent down the length of the island.

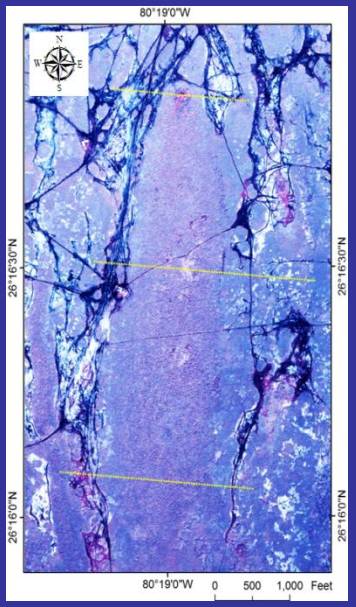
Ghost tree island in WCA 2. Note only the trees on the head of island.

Implications for Restoration

- There is still remnant vegetation and soil microtopography on some ghost islands.
- Islands with elevated soils and bedrock topography, high TP levels, and with remnant woody vegetation at the head may be suitable for restoration efforts.
- Restoration efforts have to be accompanied by long-term hydrologic changes.







Next step?

- Identify criterion for successful restoration of drowned ("ghost") tree islands in WCA 2A.
- Identify restoration end-points.
- Implement adaptive restoration practices?

Cypress island

Live tree islands → **Loss of island structure and function** → **"Ghost" islands**

RESTORATION

Acknowledgements

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