Vegetative stress and early indicators of peat collapse in mangrove forests with altered hydrology in Tampa Bay, Florida

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Altered Hydrology:
Harbinger of Mangrove Stress

- Blocked water flow can cause stagnant water and stress mangroves

Signs of Stress

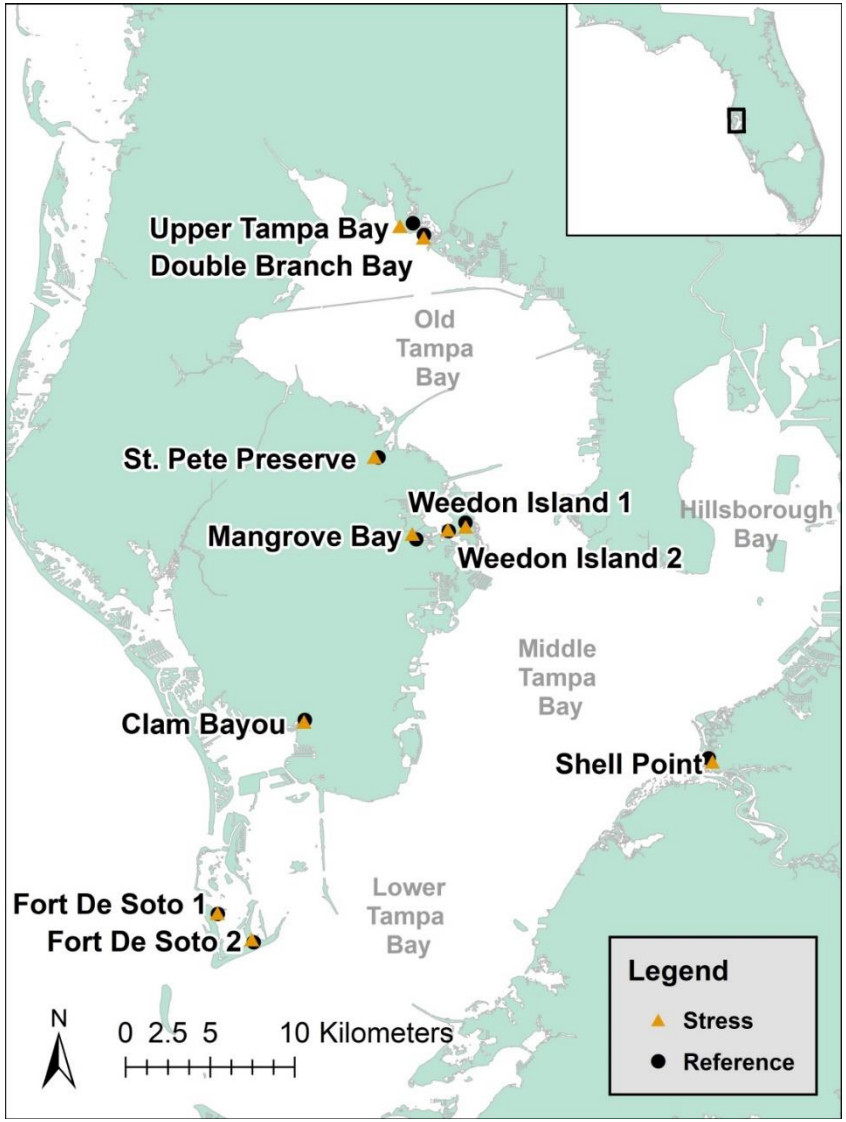
- Adventitious root growth
- Risk of peat collapse due to vegetation mortality and increased decomposition
- Continued stress can lead to die-offs known as mangrove “heart attacks” (Lewis et al. 2016)

Objectives:

1) Identify key indicators of mangrove stress prior to mortality

2) Examine the forest substrate for early evidence of peat collapse

Sample Locations



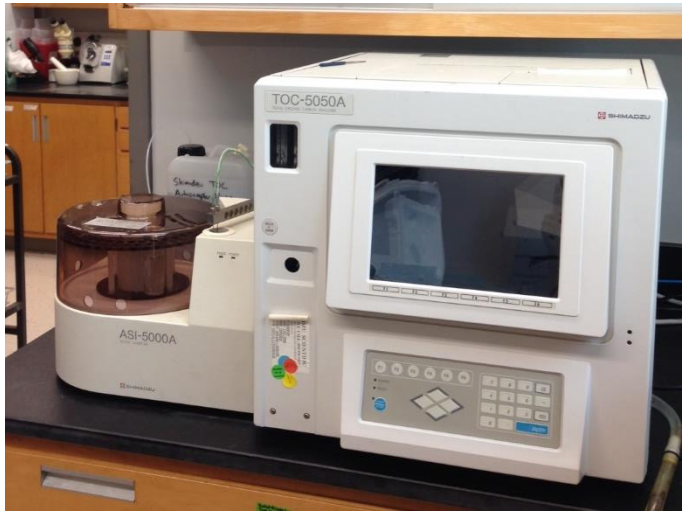
- Ten sites with visual indicators of stress
- Stressed and reference transects at each site
- Sites included natural and restored mangroves
- All highly altered hydrology (mosquito ditches, road construction)

Methods: Field Sampling

15-m transects extend from water body into the mangrove forest

- Five 50-cm cores retrieved along transect
- Soil samples taken grain size
- Porewater salinity & depth recorded
- Water samples collected for dissolved organic carbon (DOC) analysis
- Vegetation data recorded
- Root in-growth bags left underground for 7 months

Lab Analyses



- Porewater DOC analyzed on Shimadzu instrumentation (TOC 5050A)
- Root bag dissection
- Loss-on-ignition (LOI) combustion (550° C) process to determine soil organic matter content

Multiple Types of Stress

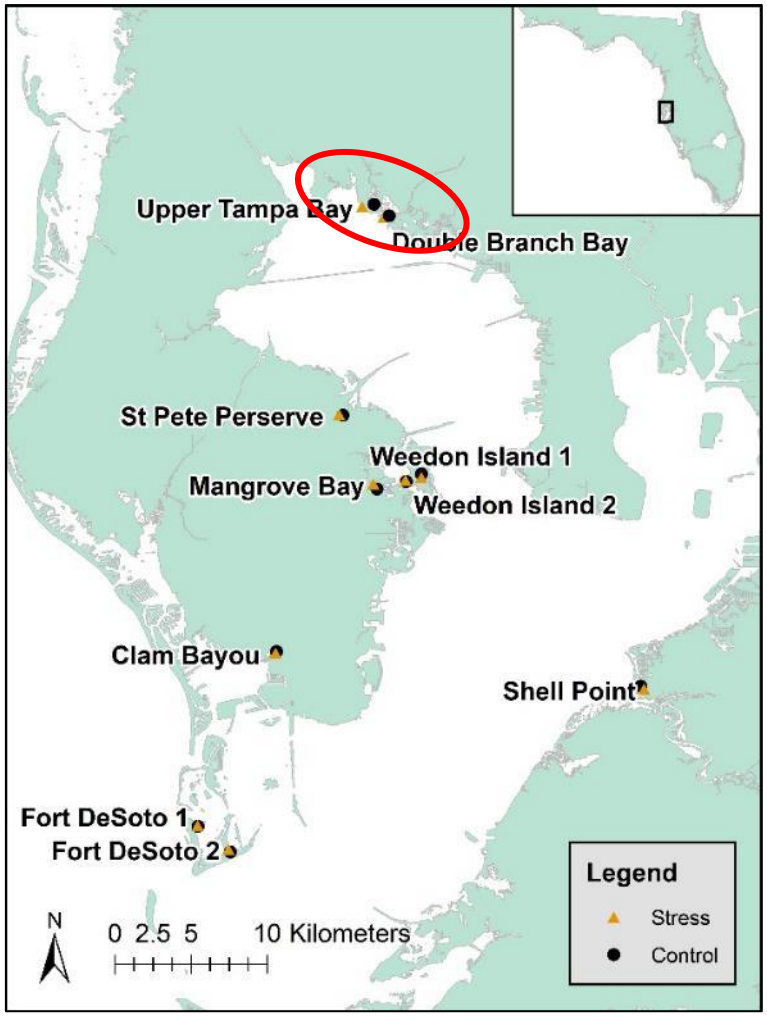
Reference site core:

Hydrologic stress core:

Burial stress core:

- **Hydrologic stress** = Loose peat under stagnant, discolored water (mangrove “heart attack”)
- **Burial stress** = dense, sandy substrate and no stagnant water

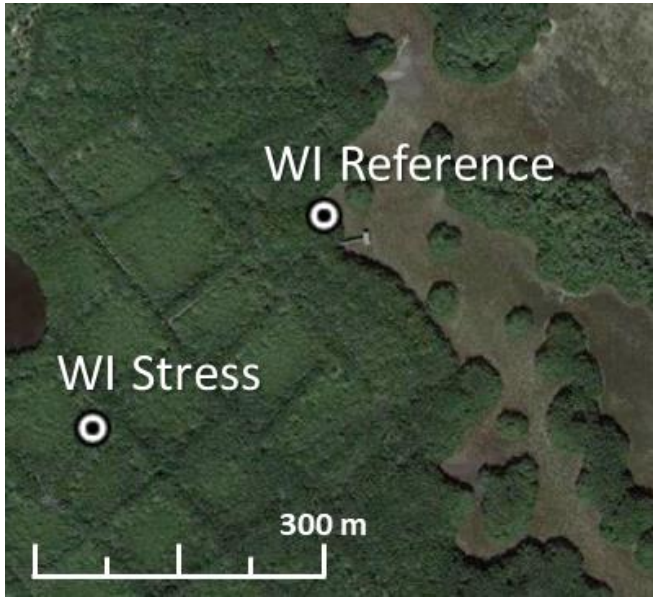
Results – Burial Stress Sites



Feb. 2016

Jan. 2017

Results – Hydrologic Stress Sites



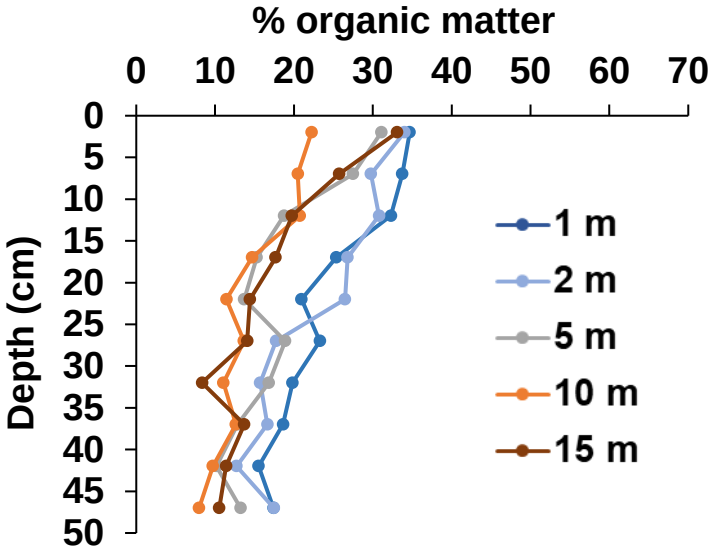
- Extensive adventitious root growth
- Discolored standing water

Site type	DO (mg L^{-1})	TOC (mg L^{-1})	DOC (mg L^{-1})	Salinity
Reference	3.7 ± 2.3*	14 ± 9*	13 ± 9*	23 ± 7
Hydrologic stress	1.1 ± 1.3*	27 ± 8*	22 ± 7*	25 ± 11

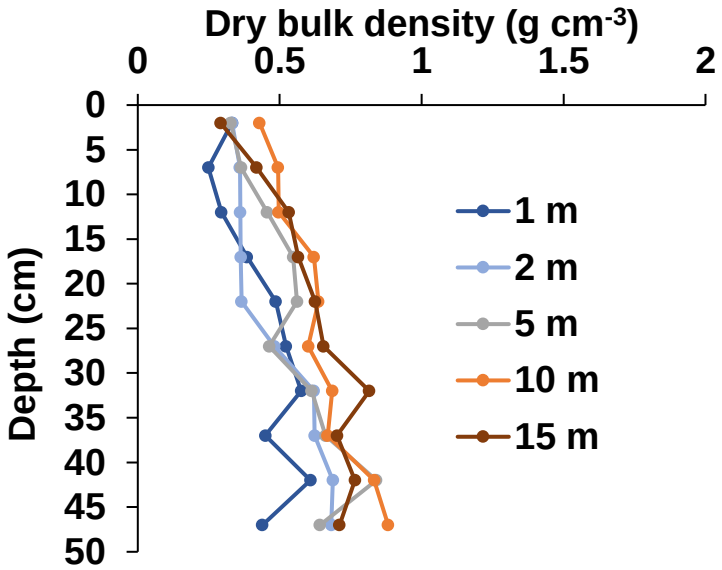
*Significant difference t_2 test, $df = 16$, $p < 0.05$

Hydrologic stress core:

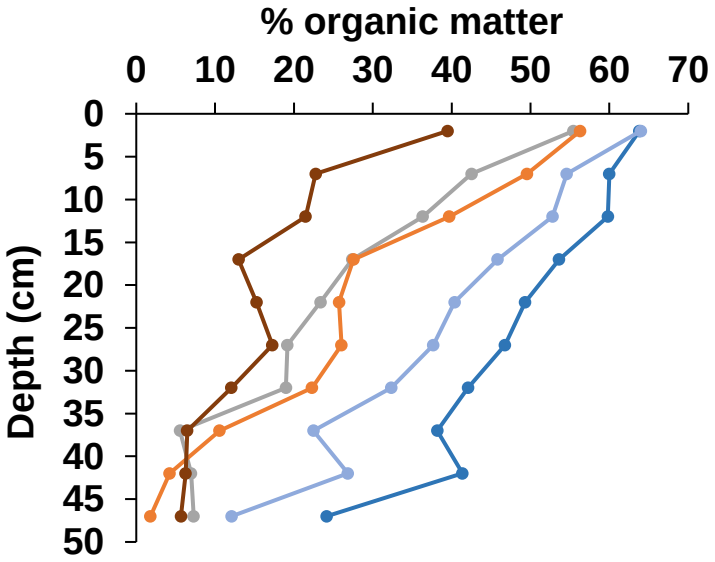
Reference sites (n = 10 sites)



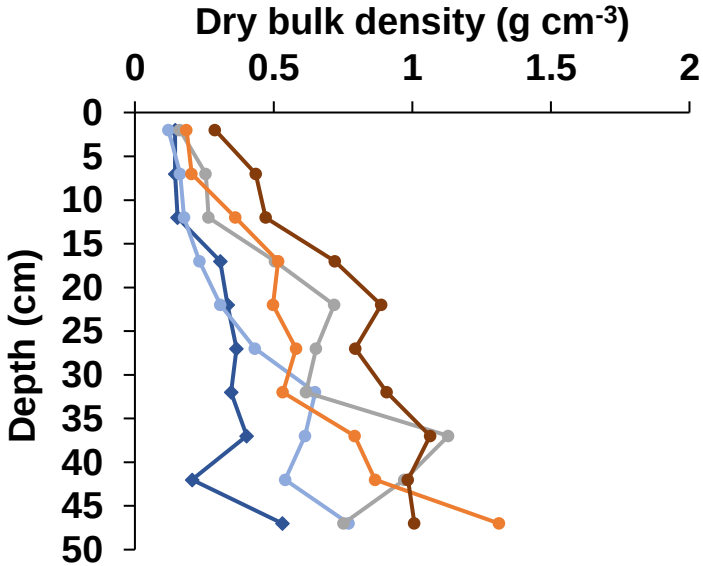
6 % large debris (> 4 mm)



Hydrologic stress sites (n = 8 sites)

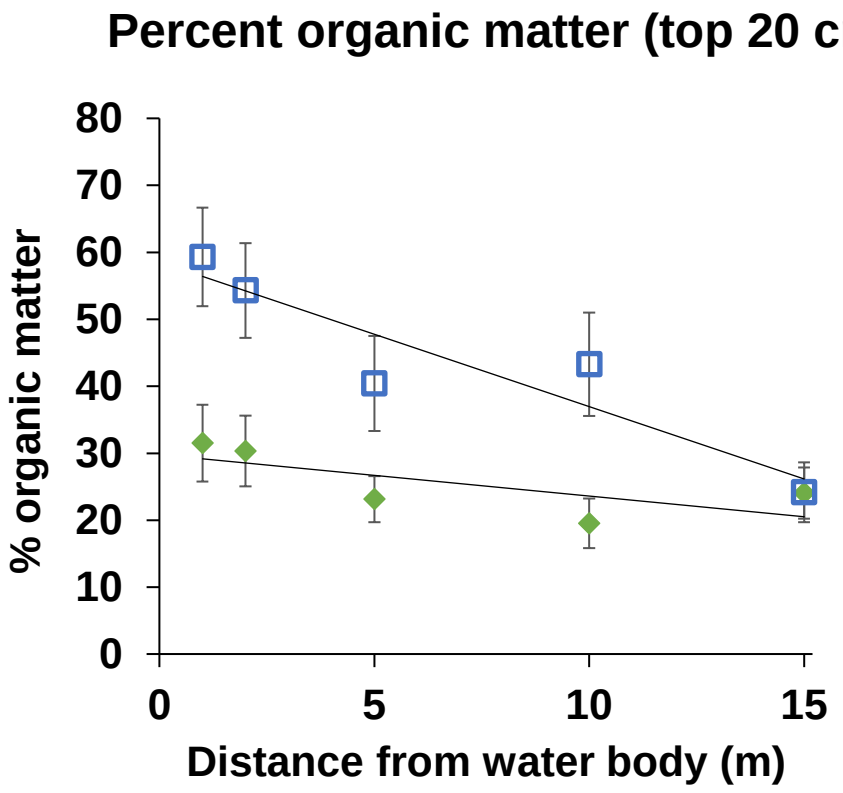


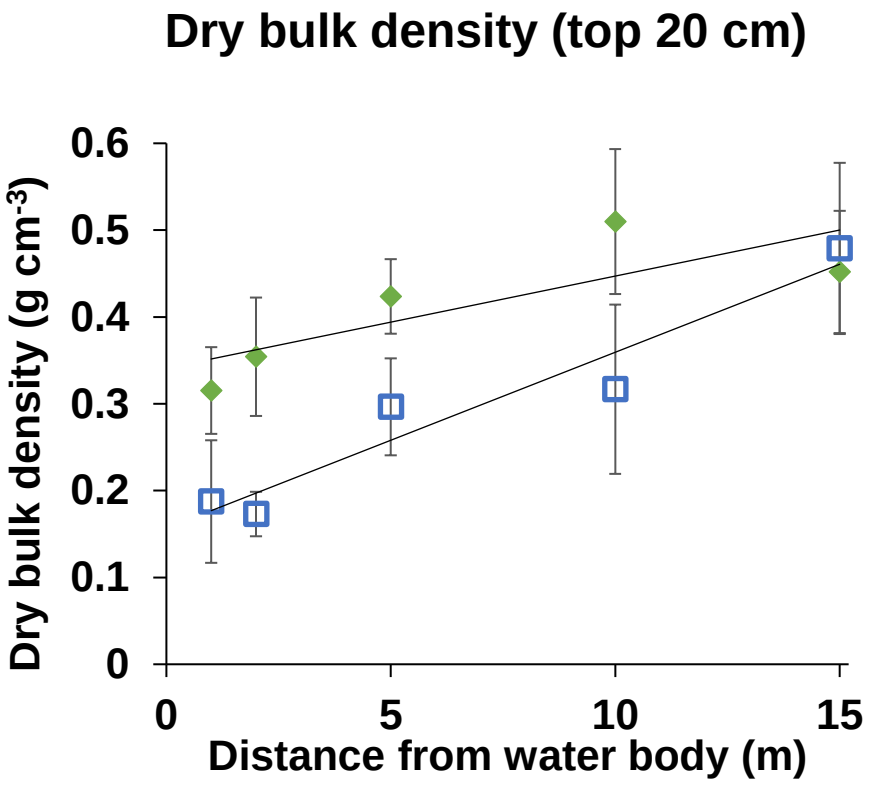
20 % large debris (> 4 mm)



Radabaugh et al. submitted Estuarine, Coastal and Shelf Science

Results – Soil Structure





Reference sites

Hydrologic stress sites

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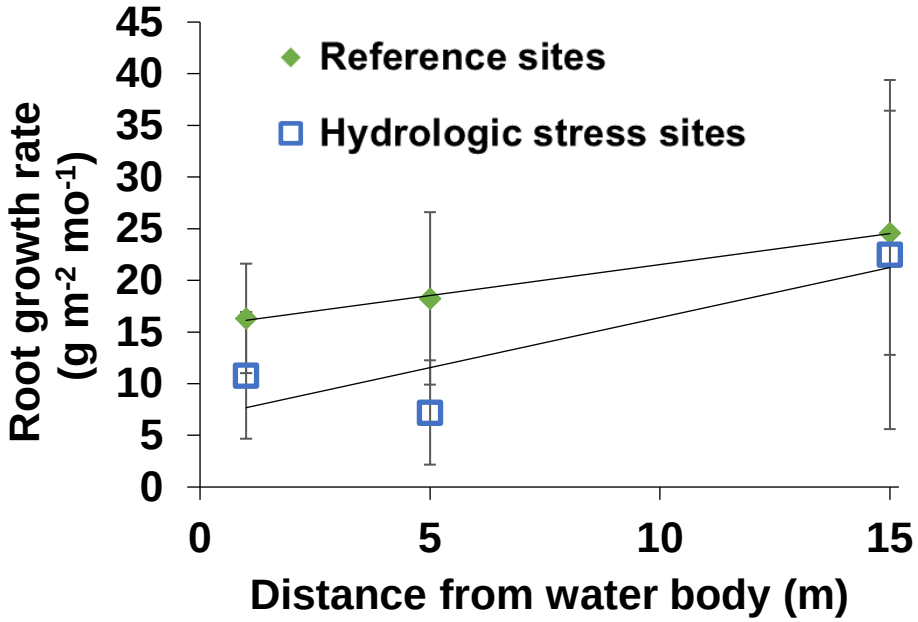
Results – Root Growth Rate



- Root growth rates widely variable between sites (error bars denote SEM)
- Root growth rates not significantly different

Indicators of Mangrove Stress

- Stagnant pools of discolored water
  - Low pH, low DO, high TOC, and high DOC
  - Some lack water in dry season
- Adventitious roots
  - Also present at burial stress sites
- Low-density substrate with high %OM
  - May be precursor to peat collapse
  - No signs of peat collapse (no high-density zones in soil profile)
  - Elevation was not measured

Possible Future Peat Collapse

- Roots are major component of substrate
  - Should root death occur, substrate is vulnerable to peat collapse
- Sites with restricted water flow likely also receive minimal allochthonous deposits

Conclusion

- Signs of mangrove stress apparent before mortality
- Blocked tidal flow can often be remedied
- Timeline unknown on degradation of sites
- Stress exacerbated by sea-level rise and hurricanes

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