Mangrove mortality after Hurricane Ian in Charlotte Harbor

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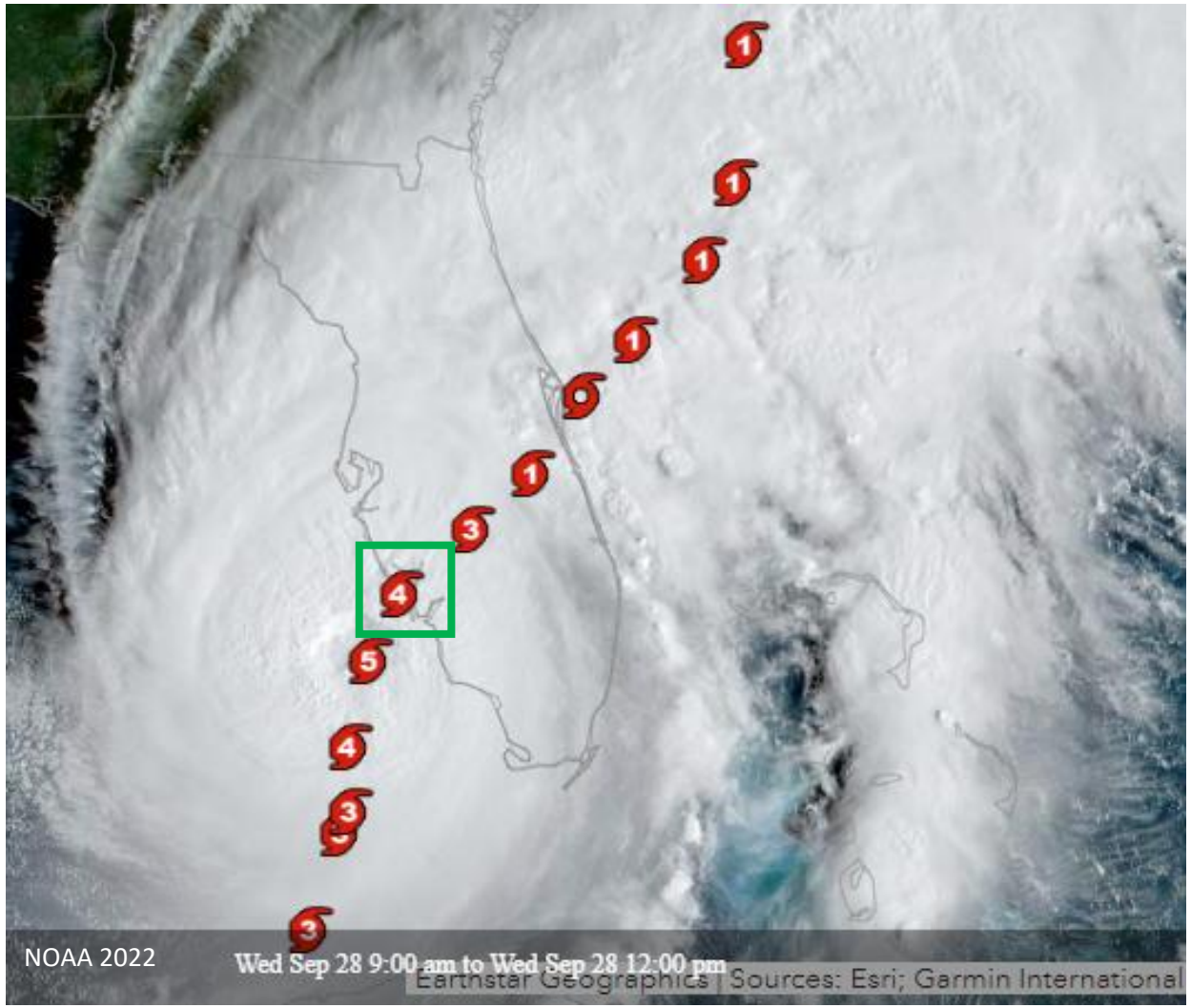
Hurricane Ian-September 28, 2022

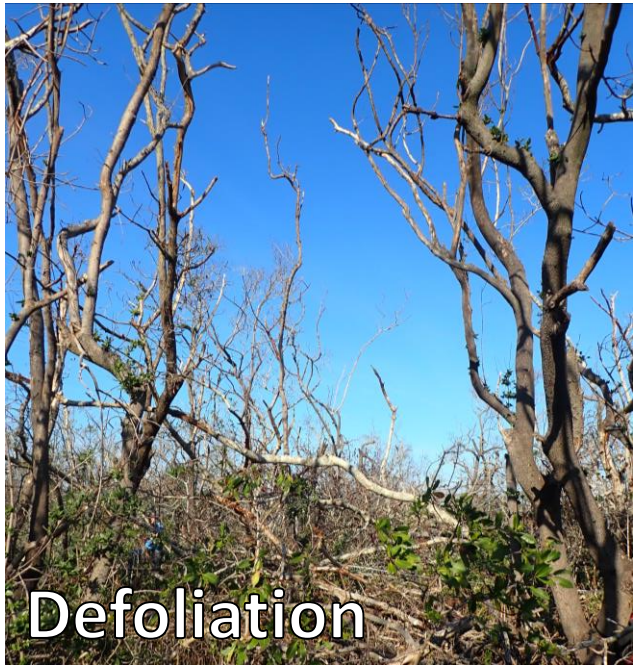
- Made landfall as a high-end category 4 storm in Charlotte Harbor, FL on September 28, 2022 (NOAA 2022)
  - **10-15 ft** storm surge (3-4.5 m)
  - Up to **27”** of rain (0.7 m)
  - Sustained winds of 150 mph (130 kt)



Stressors to Mangroves

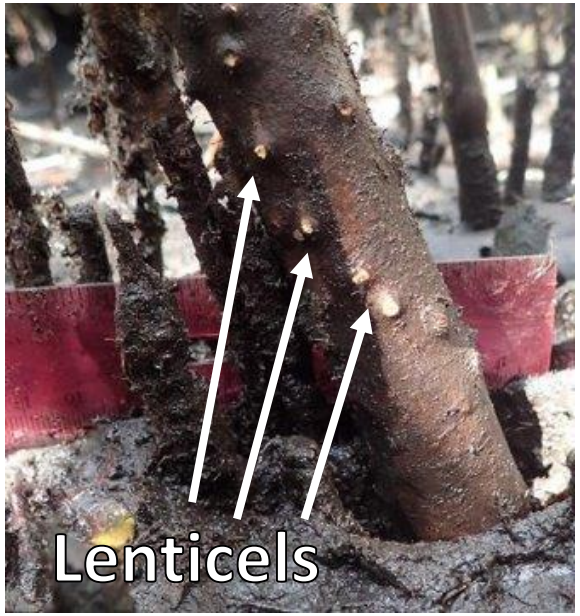
Short-term stressors

- Branch/trunk snapping
- Tree uprooting
- Defoliation of canopy
- Sediment erosion



Long-term stressors

- Storm surge deposit
  - Carbonate mud or sand
  - Can smother lenticels, impeding gas exchange
- Altered hydrology
  - Storm and non-storm related
- Sulfide toxicity



Hydrology in mangroves is also altered by road impoundment

- Natural mangrove forests should be inundated <30% of the time (Lewis III 2005)
- Roads or berms can cut off tidal flow resulting in stagnant water, causing mangrove stress or mortality (Radabaugh et al. 2021)

Hurricanes compound stress in impounded mangroves

Signs of stress in mangroves

Discolored water

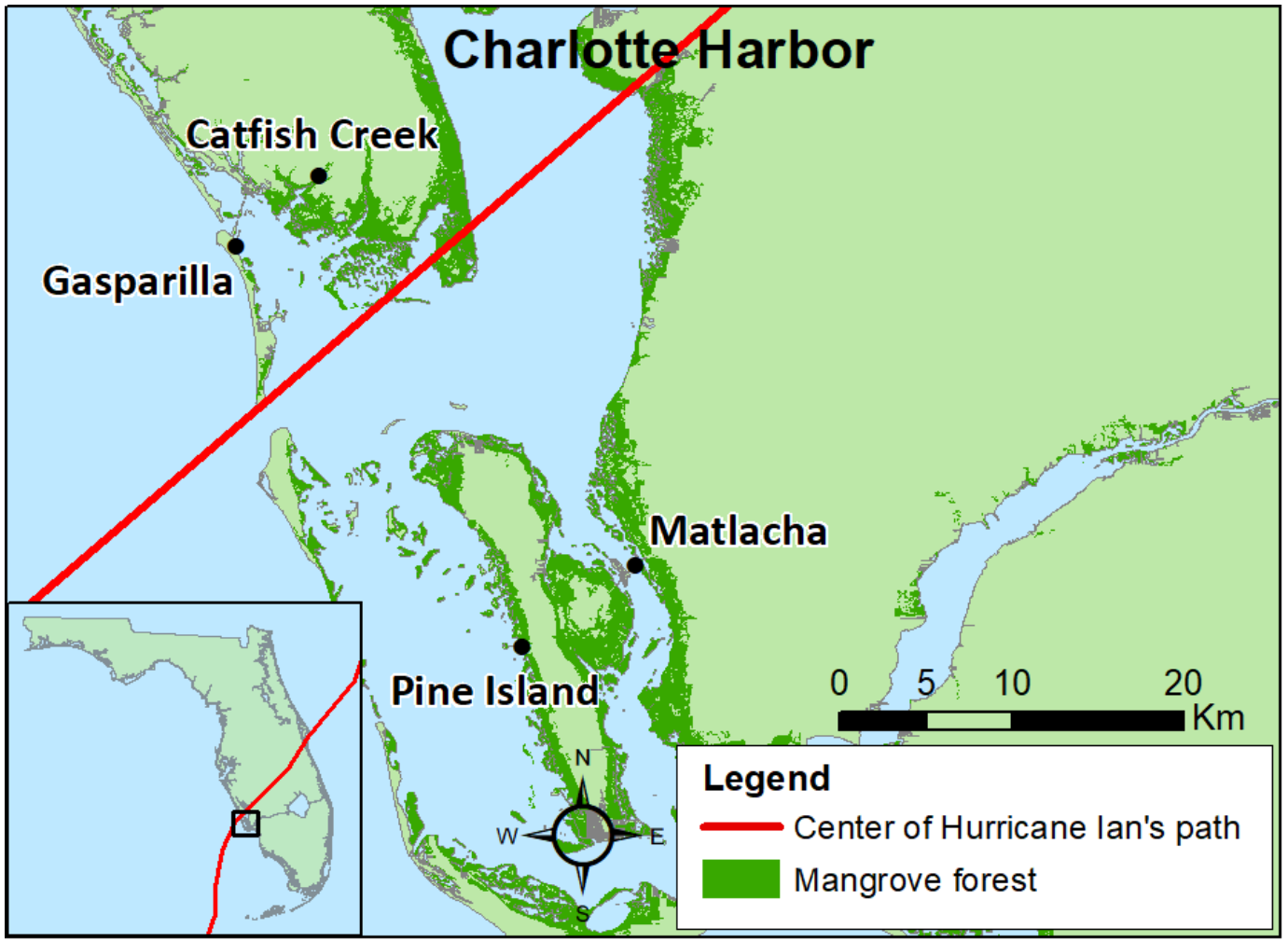
Epicormic growth

Adventitious roots

Fungus galls

Objective

Examine how ***short-term damage*** in the presence of ***long-term stressors*** impact the rate of recovery in mangrove forests



10 x 10-m monitoring plots were established in the fringe and basin forests in Charlotte Harbor (n=8)

Plot Sampling Metrics

Geological

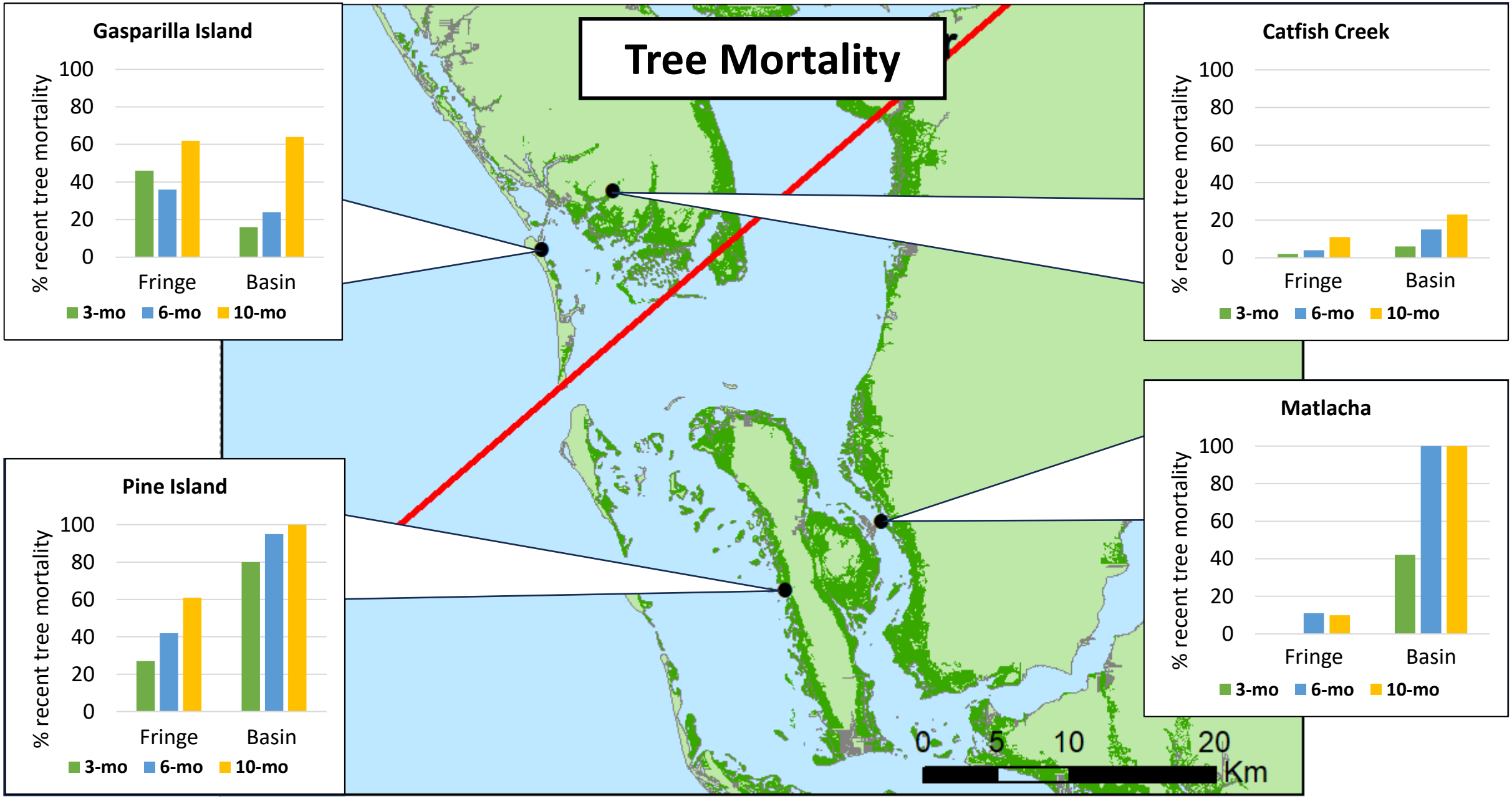
- ***Storm surge deposit thickness***
- Soil shear strength
- Elevation

Biotic

- DBH of trees
- Signs of tree stress
- ***Tree mortality***
- Seedling & sapling composition and density
- Canopy cover

Hydrological

- Hydroperiod
- ***Porewater sulfides***
- Salinity and depth of standing water



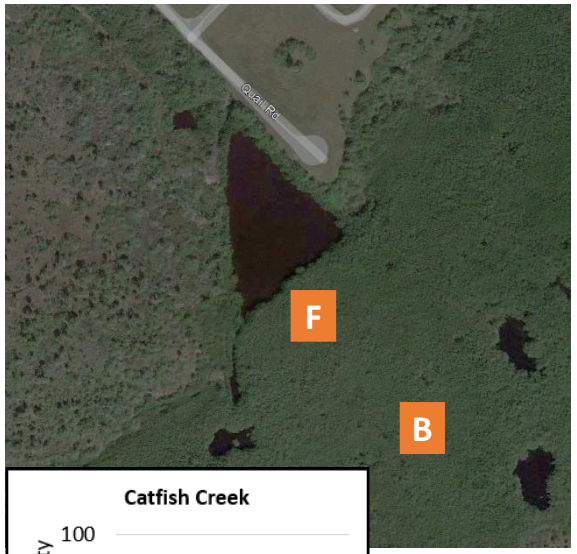
No statistical difference in tree mortality over time (LM, all $p > 0.05$, $n = 24$)

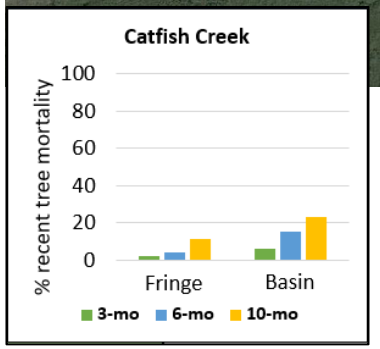
Delayed Tree Mortality

- Tree mortality increased in all plots though magnitude varies
- Plots with greatest increase in mortality had long-term stressors

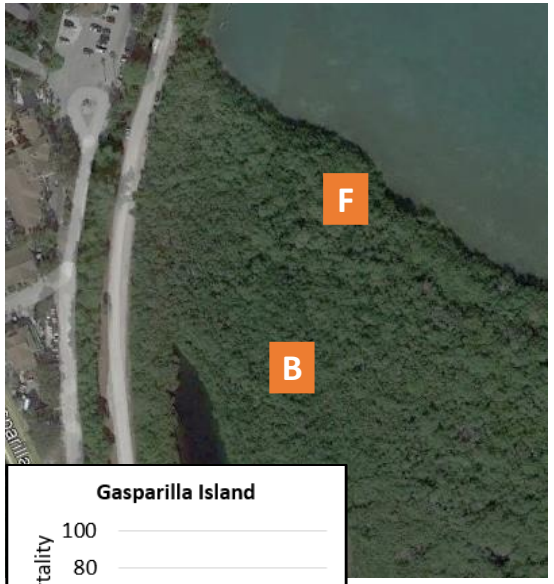
Increasing level of road impoundment

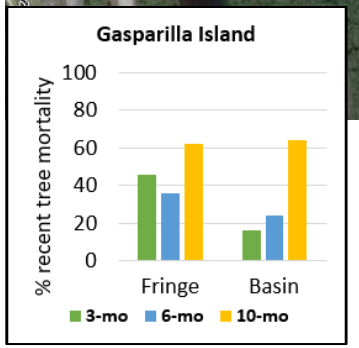
Catfish Creek



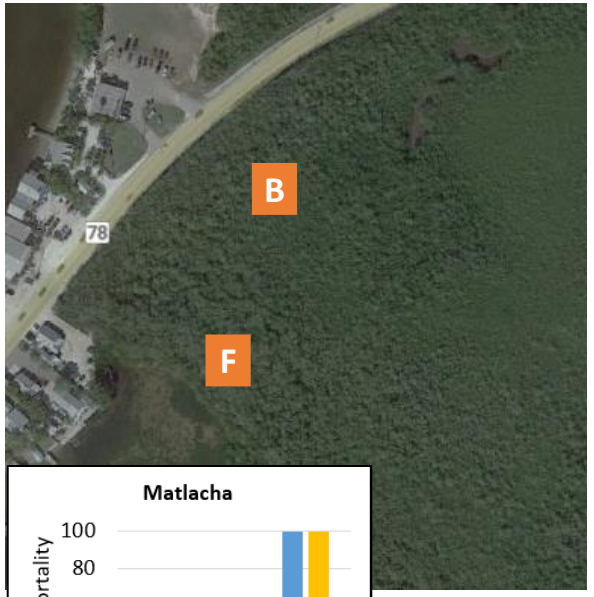


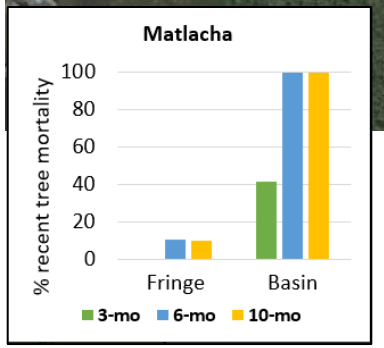
Gasparilla Island



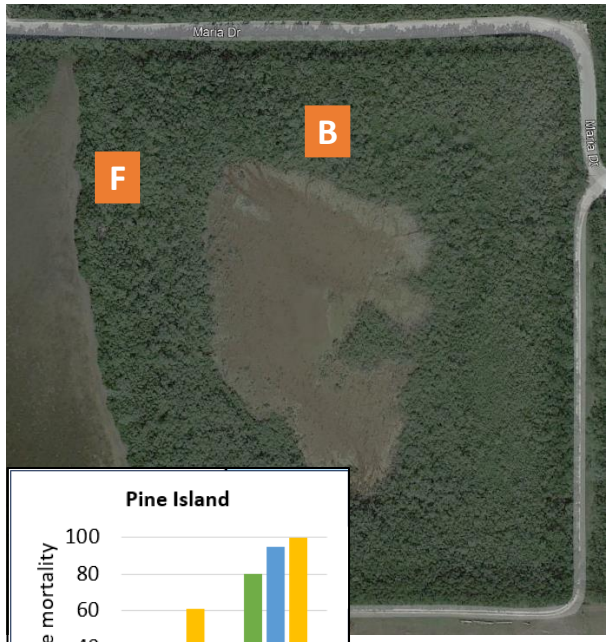


Matlacha





Pine Island



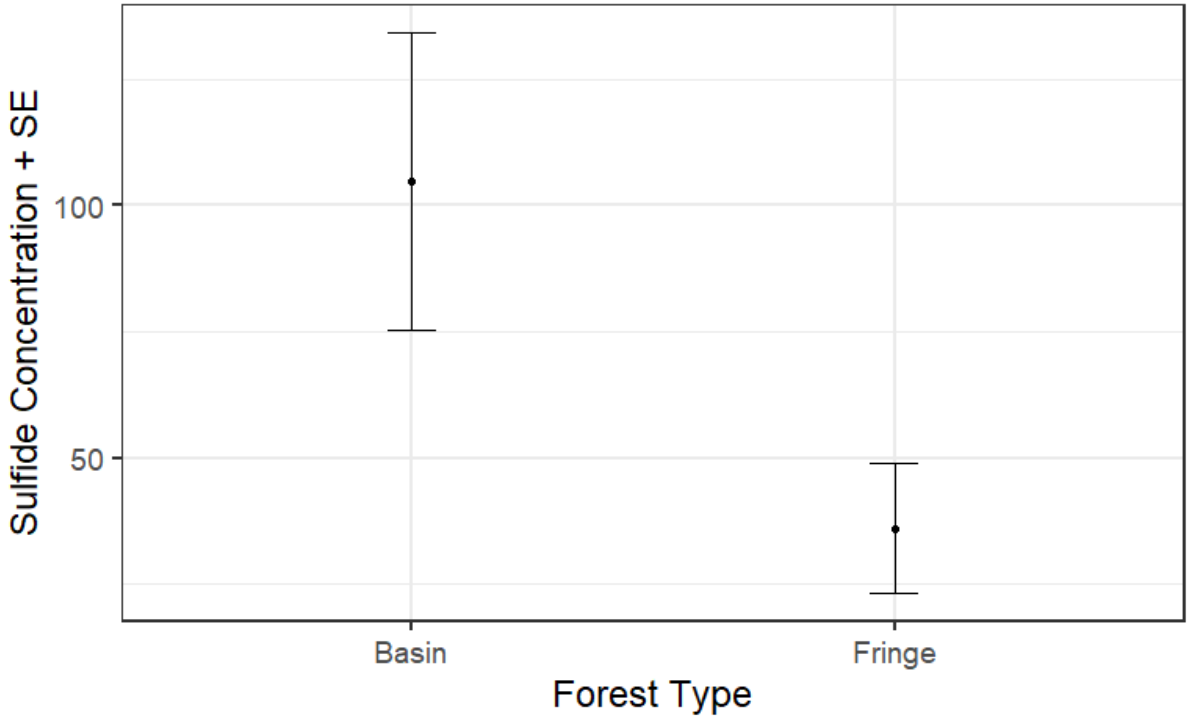
Storm Surge Deposit

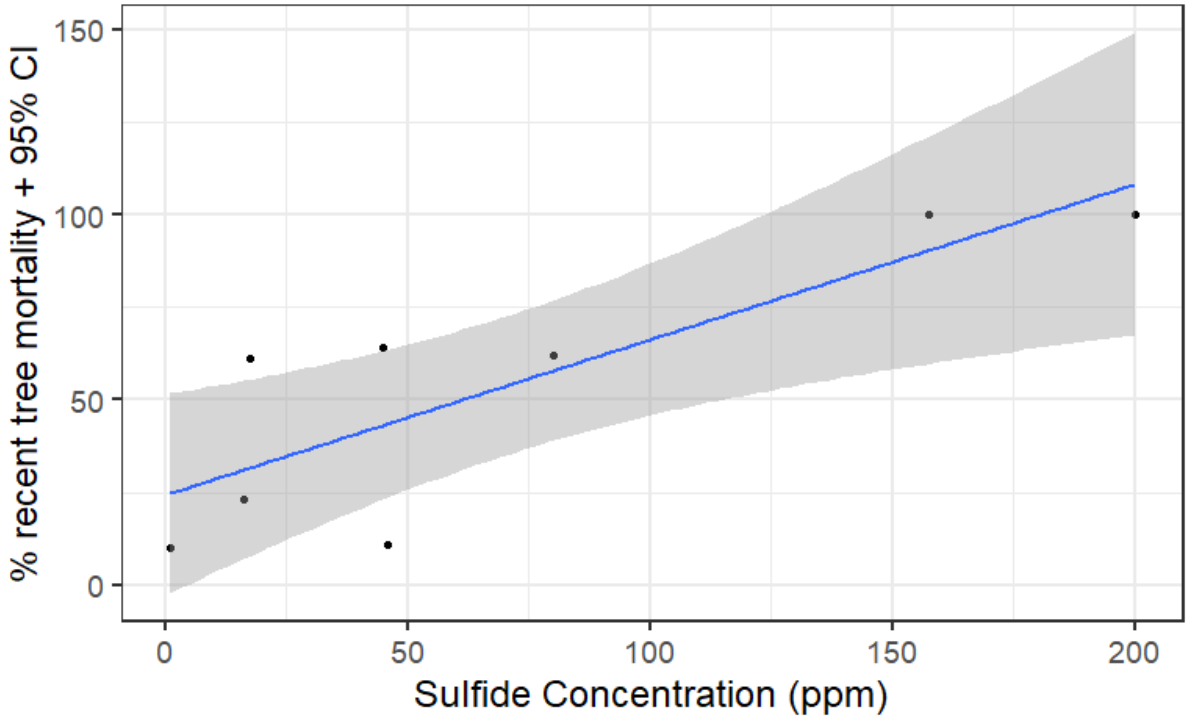
Storm surge deposits import nutrients and help elevation keep pace as sea level rises (Castañeda-Moya et al. 2010, Krauss et al. 2014, Breithaupt et al. 2017)

- Matlacha was the only forest in Charlotte Harbor with storm surge deposit (Fringe: 4.6 cm, Basin: 3.55 cm)
- After Irma (2017), mangroves in the Ten Thousand Islands with larger storm surge deposits experienced more delayed mortality (Radabaugh et al. 2020)

Sulfides in Charlotte Harbor

Sulfides are toxic to mangroves and have negative impacts on plant metabolism and physiology (McKee et al. 1988, Perez-Ceballos et al. 2022)





Significant positive correlation between recent tree mortality and porewater sulfide concentration 10 months post-storm (LM + 95% CI, p = 0.01, n = 8)

Conclusions

- Charlotte Harbor mangroves are still experiencing delayed mortality from Ian after 10 months
- Magnitude of mortality is influenced by existing stressors coupled with storm impacts
  - **Mangroves with more long-term stressors experienced higher delayed mortality after the hurricane**
  - Storm surge deposit only found in Matlacha
  - Sulfide toxicity is contributing to forest mortality
- Monitoring will continue in 6-month intervals
  - Long-term stress=long-term monitoring!

Acknowledgements

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Site Access

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Monitoring

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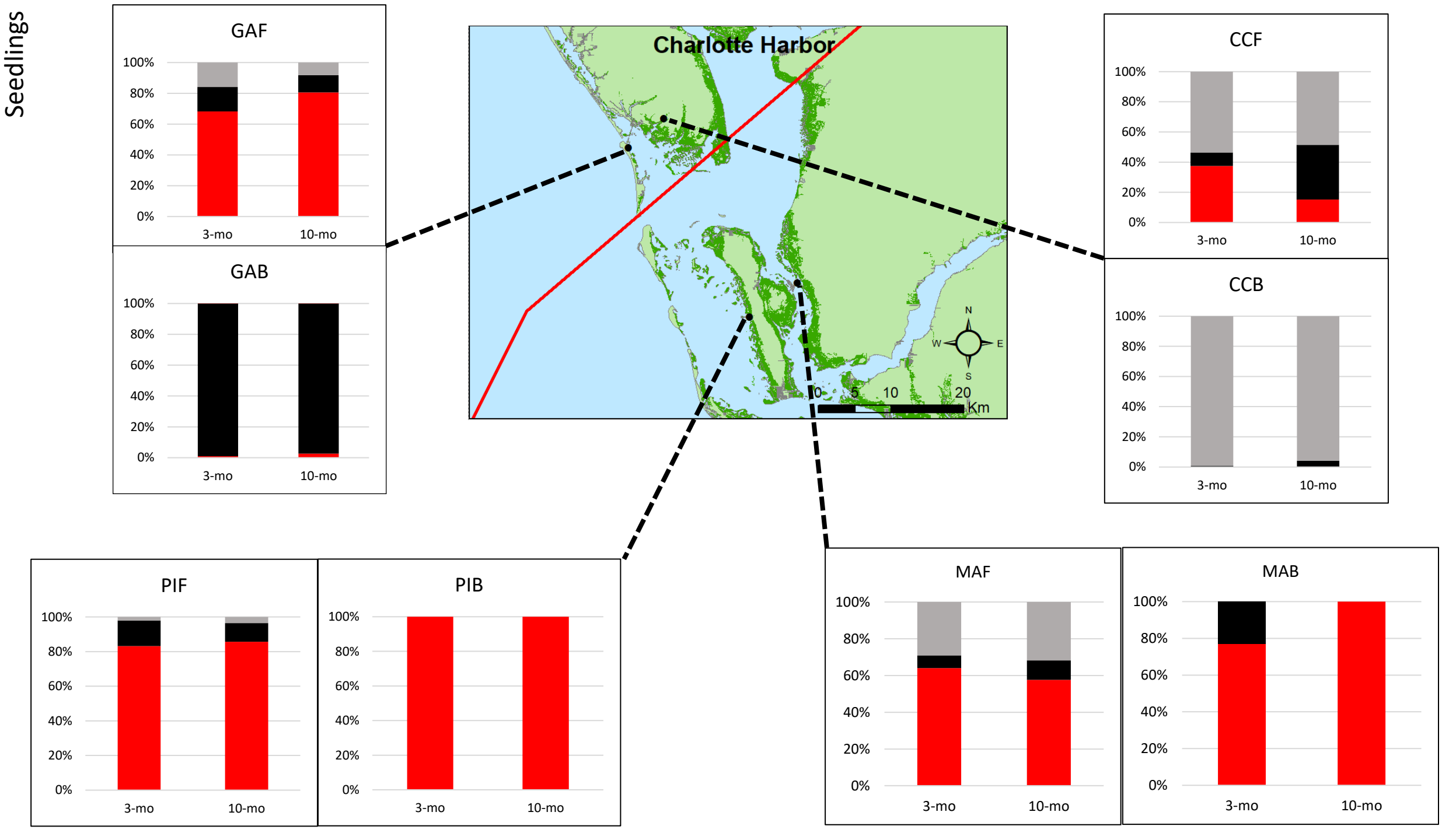
Seedlings
GAF
GAB
CCF
CCB
PIF
PIB
MAF
MAB
Charlotte Harbor
100%
80%
60%
40%
20%
0%
3-mo
10-mo
N
W
E
S
0
5
10
20
Km