



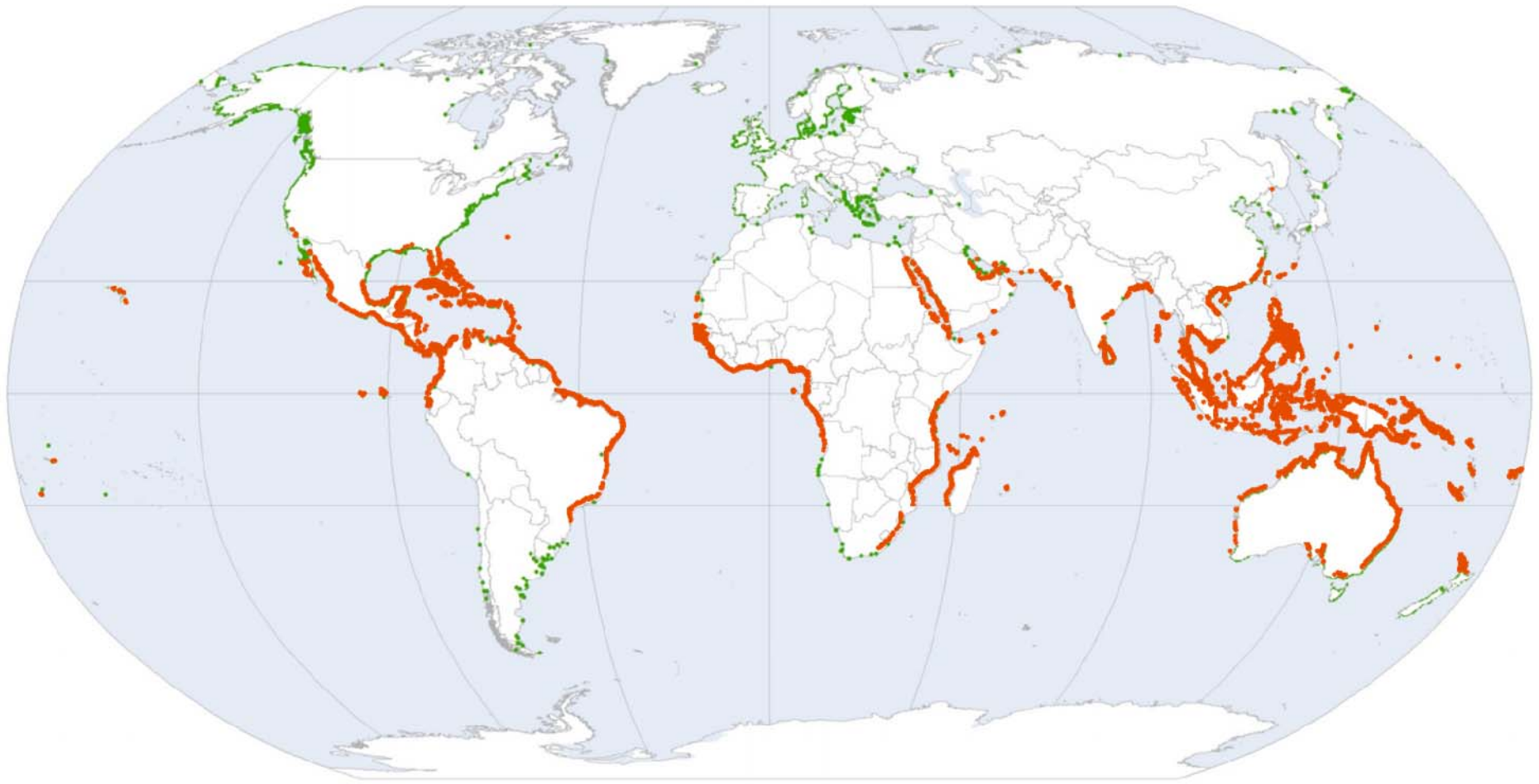
## How will mangrove encroachment and eroding impoundments impact coastal protection?

### A Case Study in the Merritt Island National Wildlife Refuge

Cheryl Doughty<sup>1</sup>, Kyle Cavanaugh<sup>1</sup>, & Samantha Chapman<sup>2</sup>

<sup>1</sup>UCLA <sup>2</sup>Villanova University





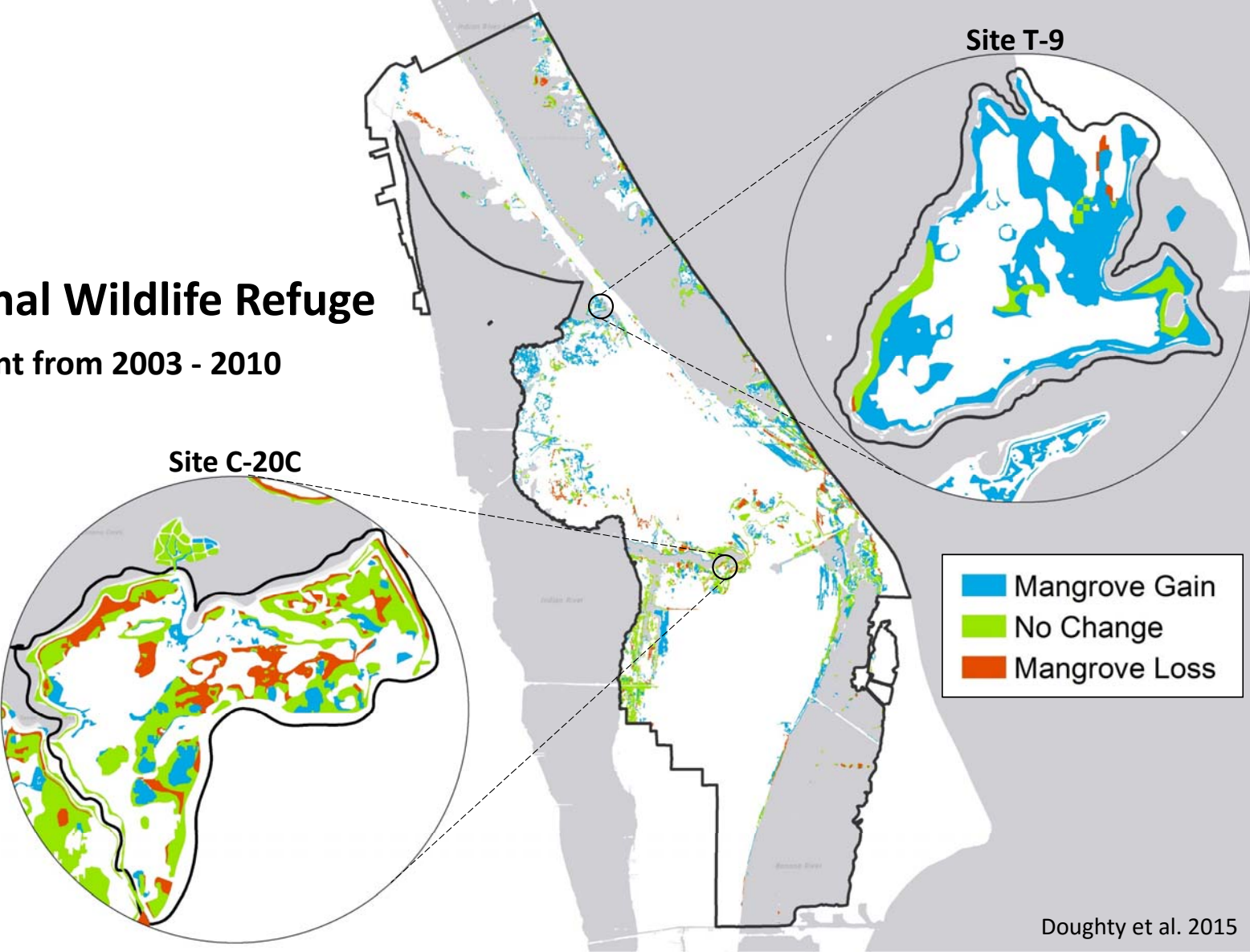
**— MANGROVE**

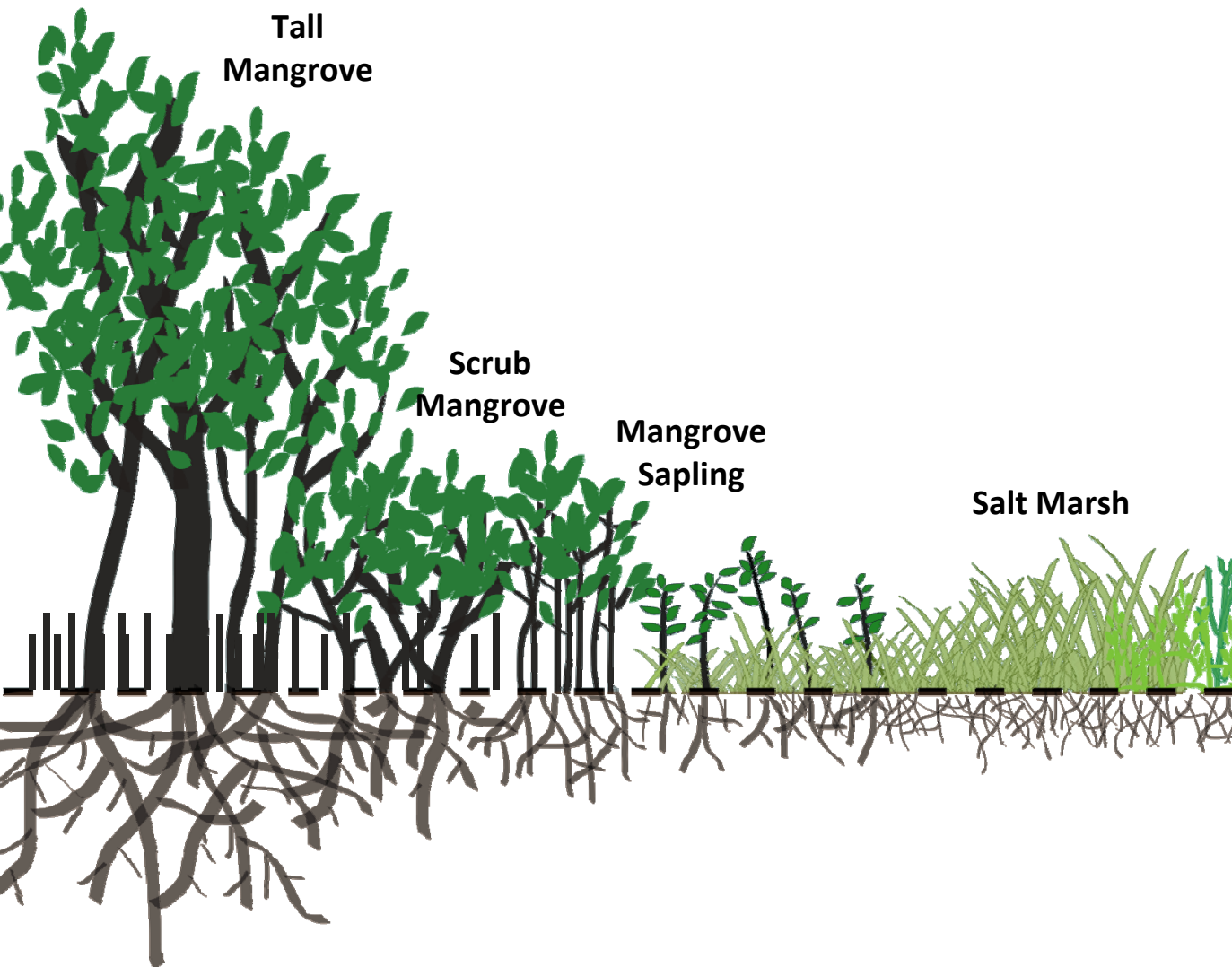
**— SALT MARSH**

Mangrove distribution adapted from Spalding et al. 2010;  
Salt marsh distribution compiled by UNEP and WCMC

# Merritt Island National Wildlife Refuge

+ 69% in mangrove extent from 2003 - 2010

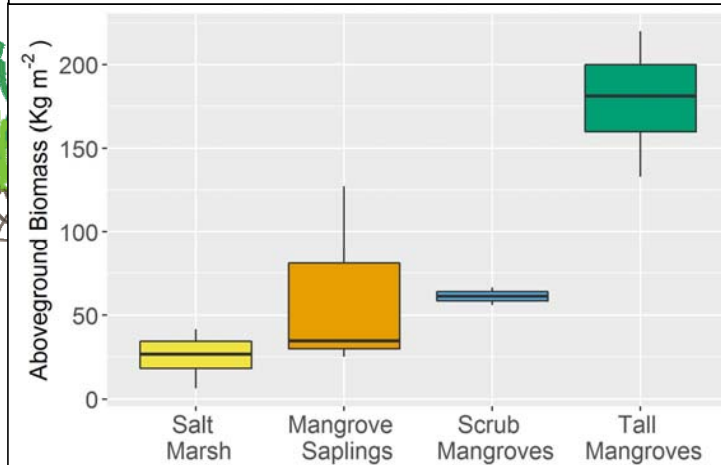


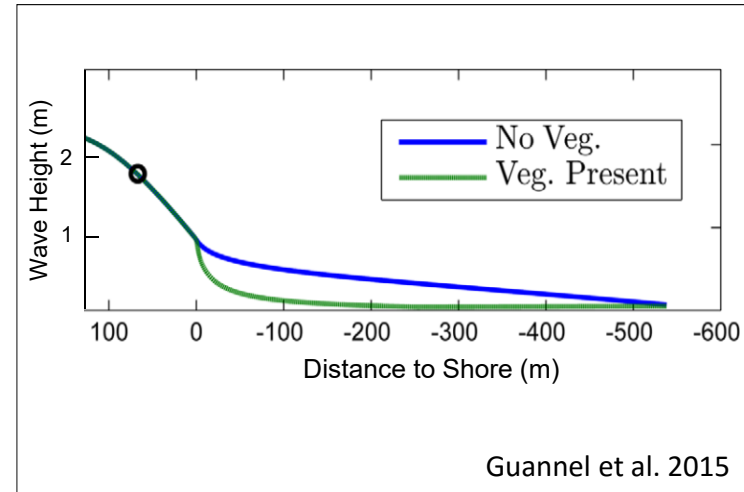
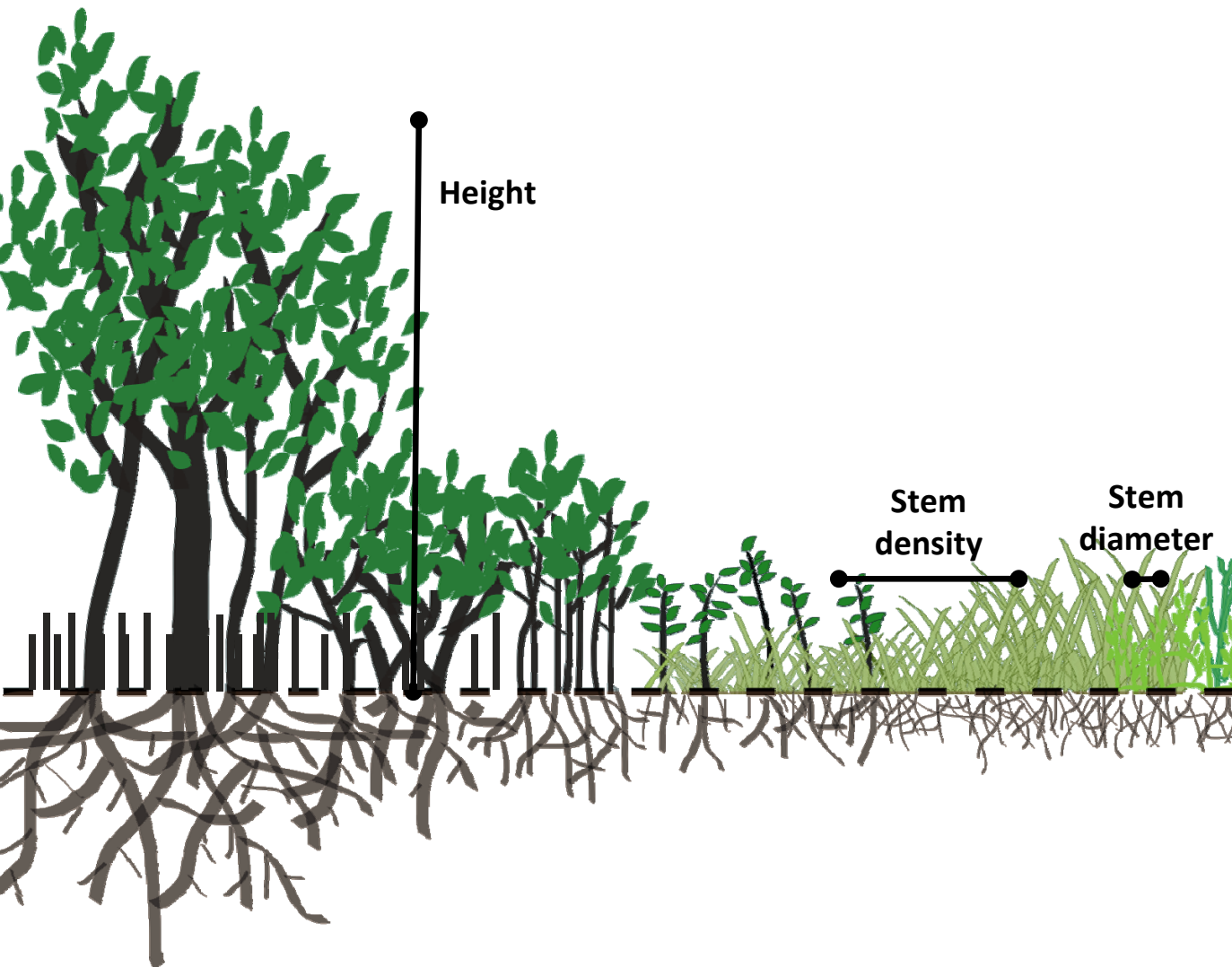


## Mangrove expansion impacts wetland carbon storage

- + 22% total wetland carbon storage
- Driven primarily by aboveground biomass

Doughty et al. 2015





## Plant structure influences coastal protection

- Dampens waves
  - Increases drag force
  - Slows water velocity
- Secures soils
  - Decreases bed shear stress
  - Sediment deposition

## Additional factors will play a role in coastal protection

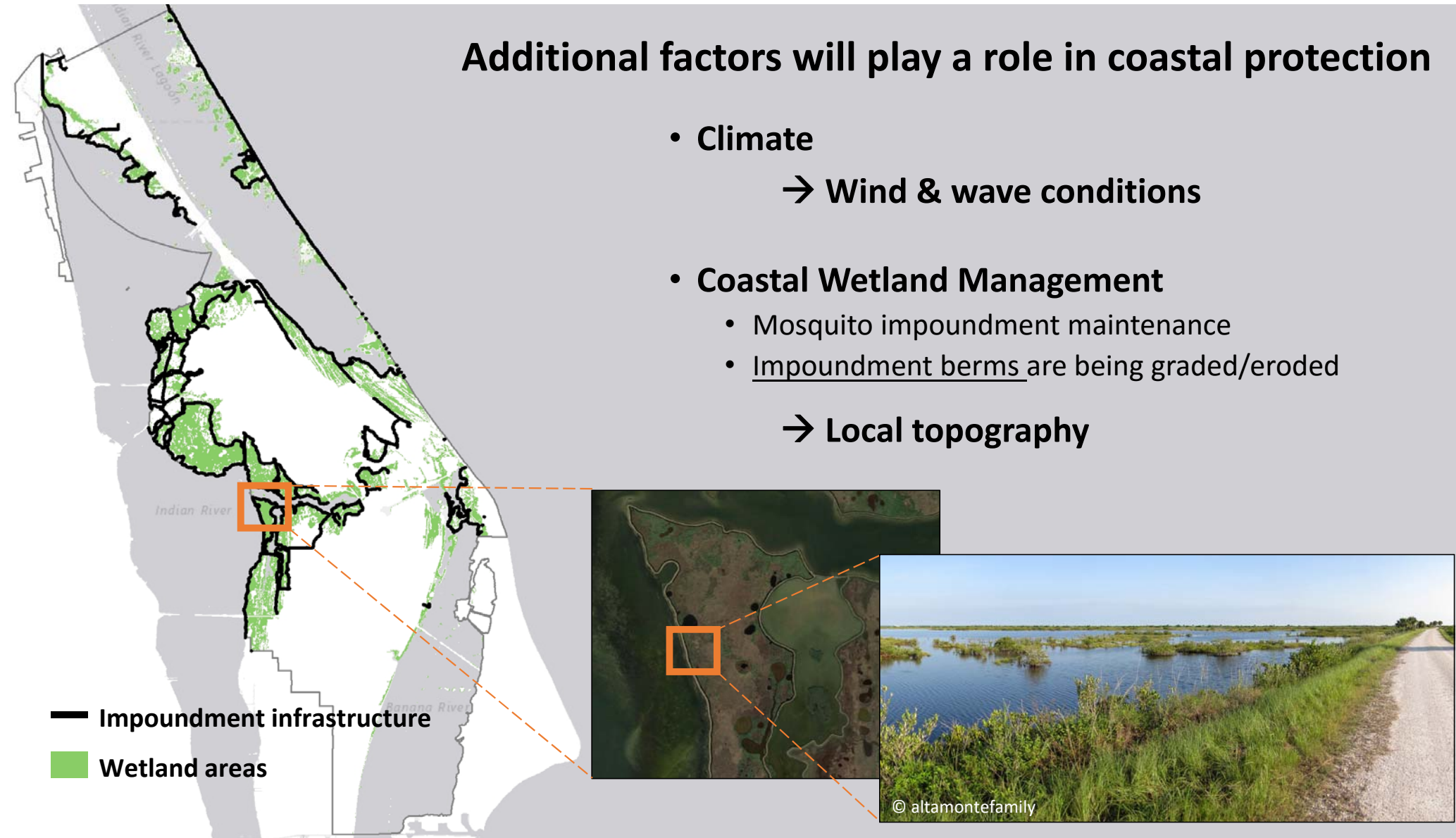
- **Climate**

→ Wind & wave conditions

- **Coastal Wetland Management**

- Mosquito impoundment maintenance
- Impoundment berms are being graded/eroded

→ Local topography



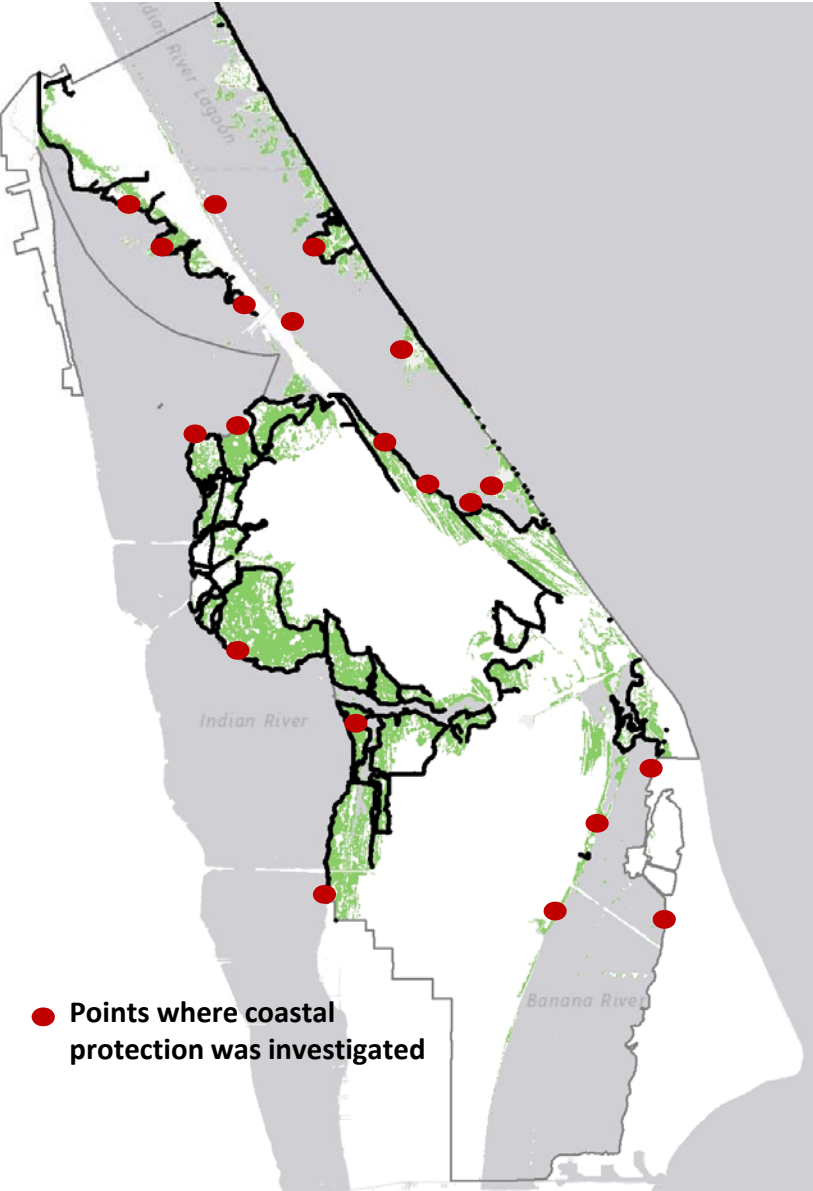
— Impoundment infrastructure

■ Wetland areas

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A photograph of a coastal wetland. In the foreground, there are dense stands of tall, thin reeds. To the right, there is a large, leafy mangrove bush with small white flowers. In the middle ground, a single tree stands in the shallow water. The background shows a calm body of water under a clear sky.

**How will habitat conversion and impoundment  
state impact coastal protection?**



● Points where coastal protection was investigated

### Model scenarios

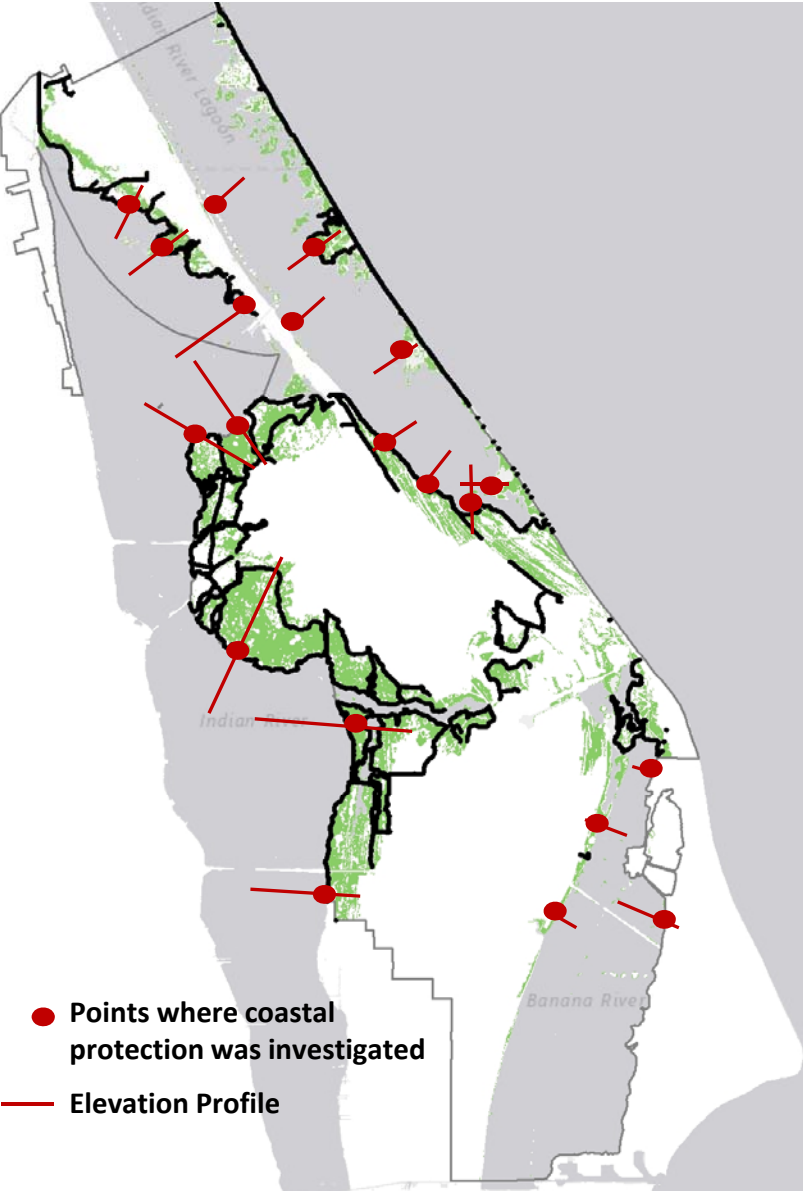
- Habitat conversion: Mangrove, Saltmarsh
- Berm state: Intact berm, Graded berm



Mangrove Reversion to Salt Marsh





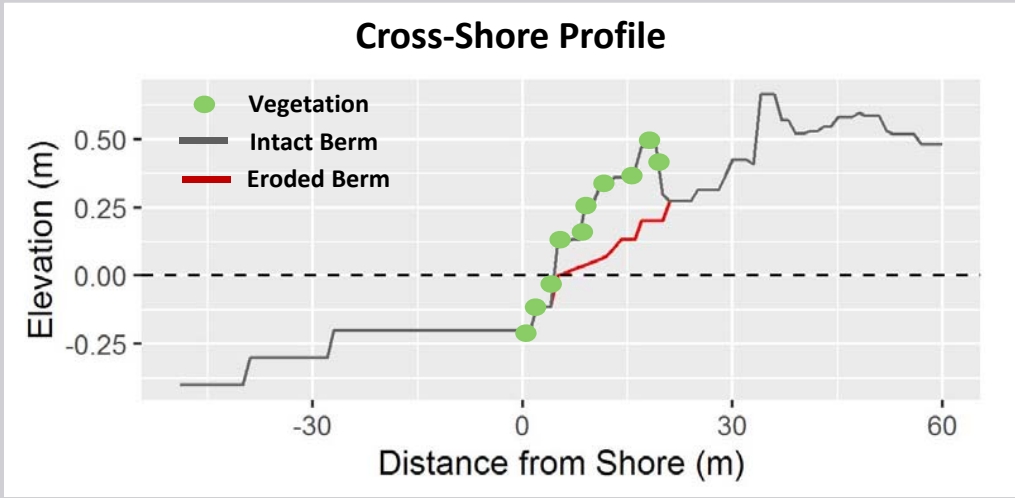


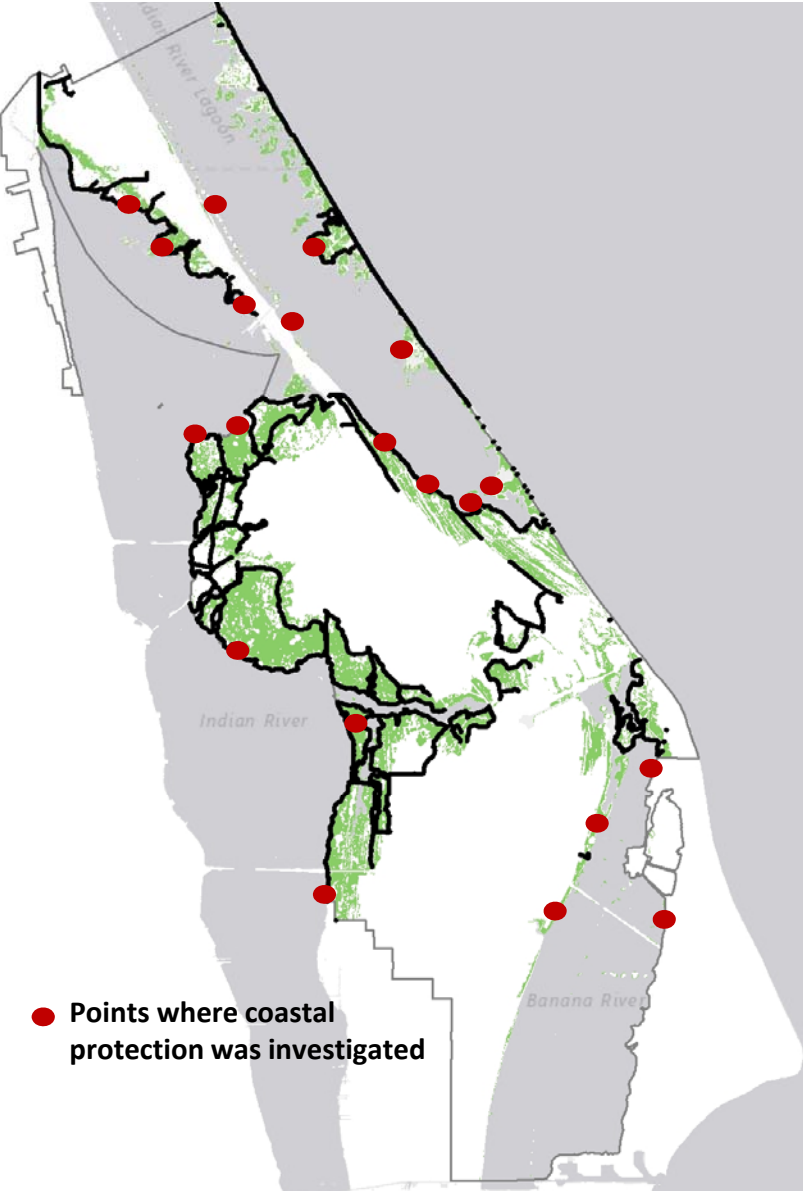
**Model scenarios**

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- Berm state: Intact berm, Graded berm

**Wave Attenuation**

- **Wave evolution model**
  - Dissipation due to breaking (Baldock et al. 2007)
    - Topography, Wave data
  - Dissipation due to vegetation (Mendez & Losada 2004)
    - Vegetation characteristics from field observations





### Model scenarios

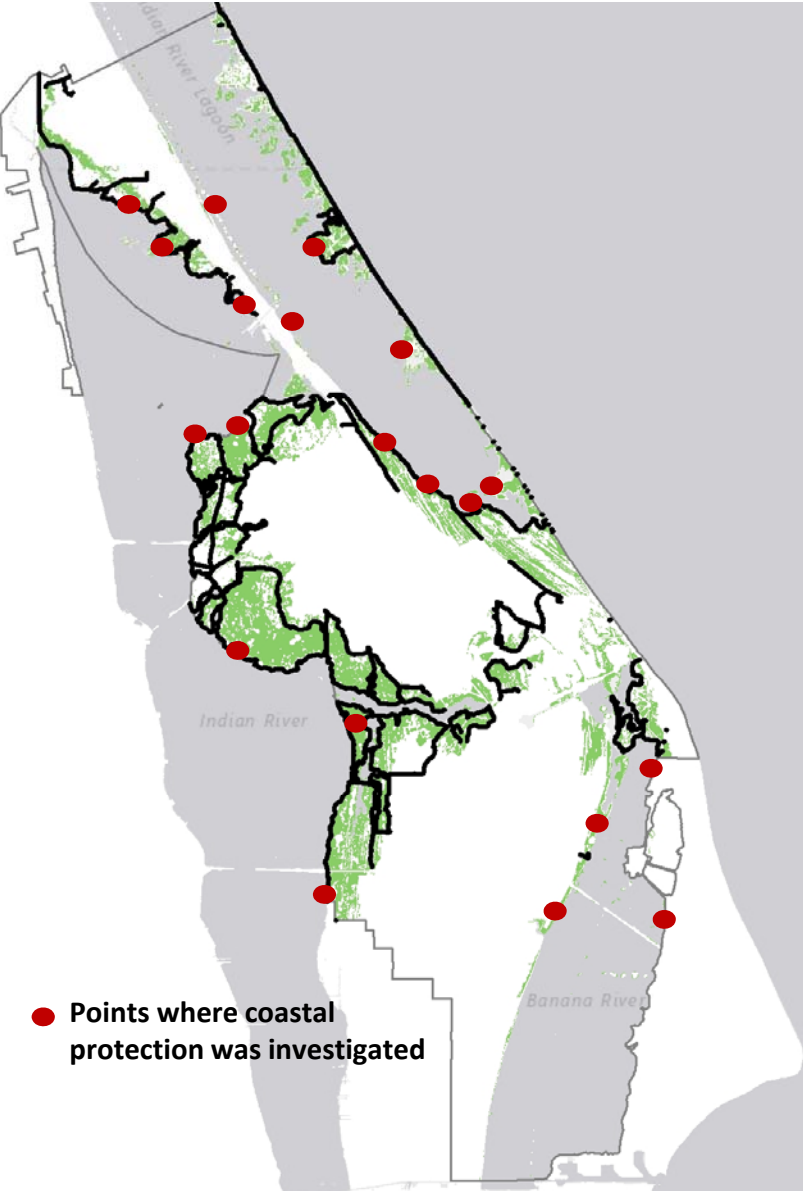
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### Nearshore Bed Erosion

- Wave run-up (USACE 2002)
- Bed Scouring (Whitehouse et al. 2004)



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**Wave Attenuation**

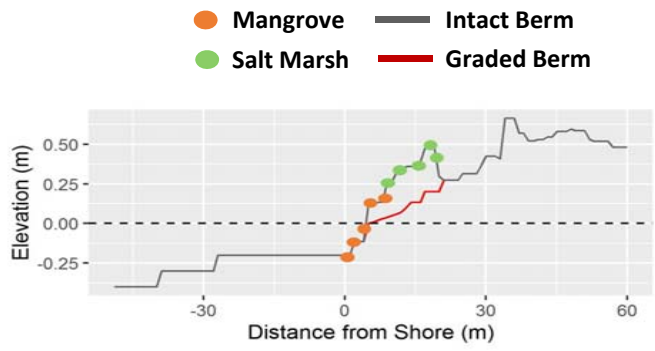
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**Nearshore Bed Erosion**

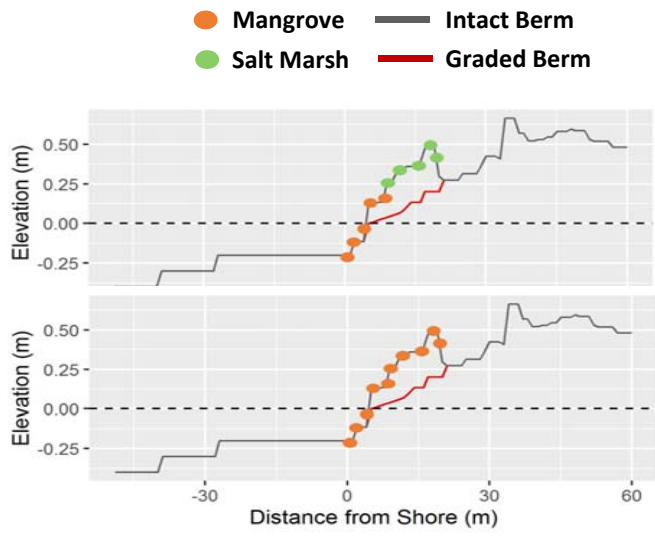
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**Ecosystem Service Valuation**

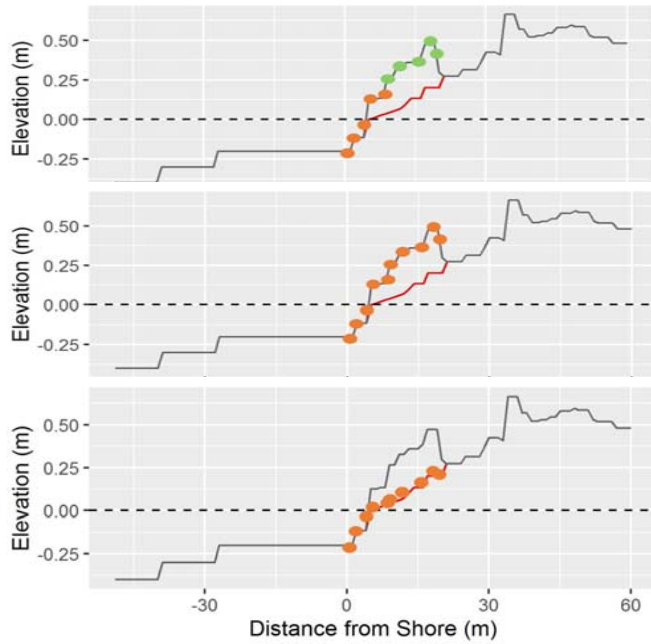
- Avoided erosion
  - Area of substrate saved compared to a no vegetation baseline
- Property value (\$25 USD m<sup>-2</sup>)



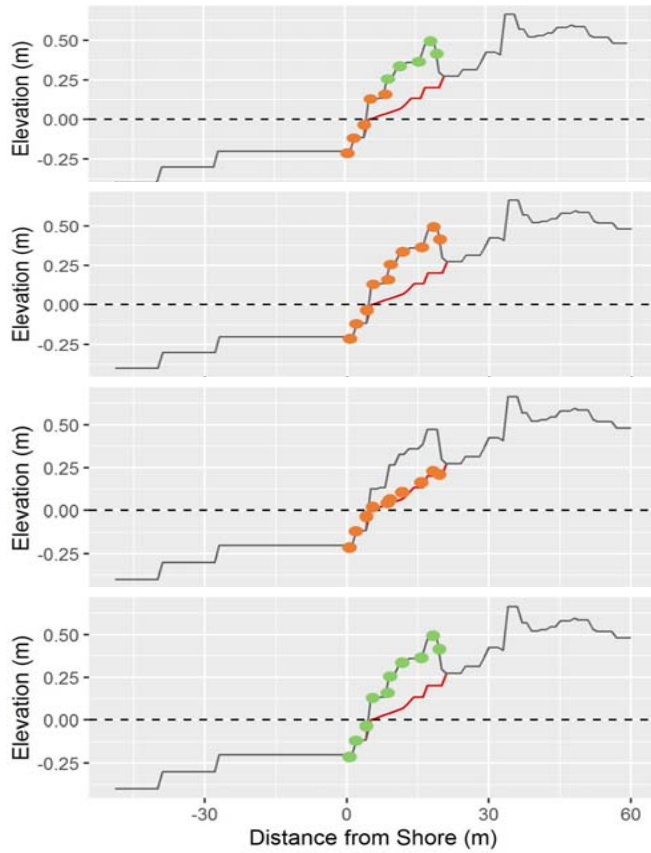
Scenario	Avoided Erosion (baseline = no veg)	Erosion Protection Value (USD m <sup>-2</sup> )
Current	6.2 %	\$1265



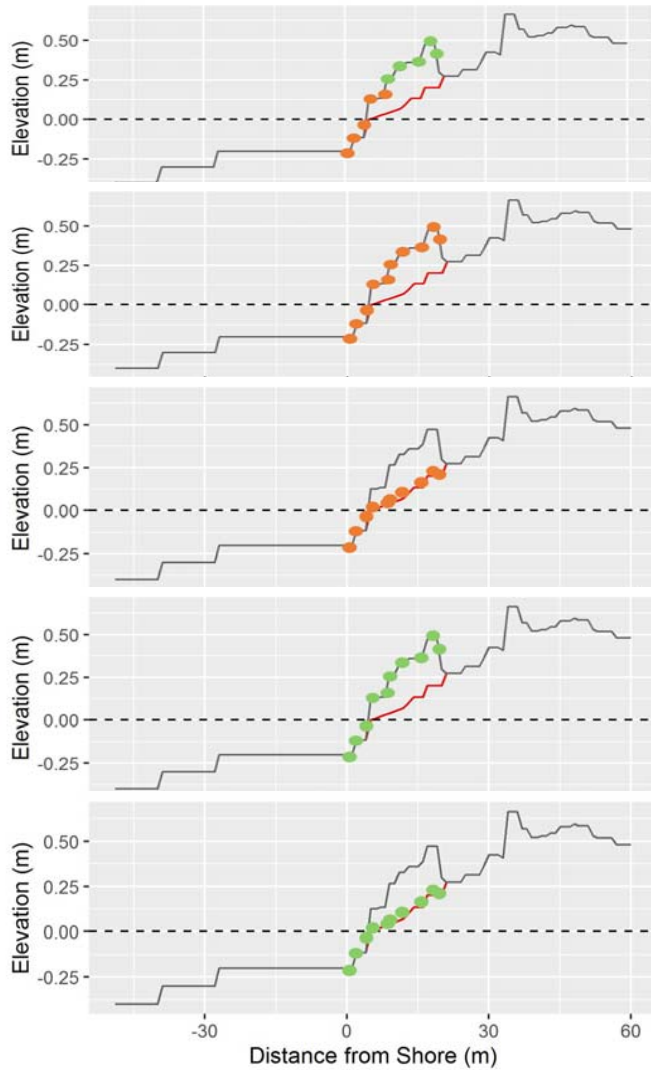
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Mangrove + Graded Berm	7.8 %	\$1750



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Salt Marsh + Intact Berm	4.7 %	\$1048
Salt Marsh + Graded Berm	4.8 %	\$1114



## How will habitat conversion and impoundment state impact coastal protection?

### Wave Attenuation

- Wave breaking due to the presence of vegetation was 3x higher in mangroves

### Avoided Erosion

- Mangroves prevented 3% more erosion than salt marshes compared to a baseline of no vegetation

### Valuation

- Mangroves are estimated to be worth \$600 more per m<sup>2</sup> than salt marsh in terms of erosion prevention
- Graded berms help to reduce erosion and make vegetated wetlands areas \$100 more valuable than intact berms





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