How will mangrove encroachment and eroding impoundments impact coastal protection?

A Case Study in the Merritt Island National Wildlife Refuge

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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

Guannel et al. 2015
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

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**Map Diagram**

- Impoundment infrastructure
- Wetland areas

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How will habitat conversion and impoundment state impact coastal protection?
Model scenarios

- Habitat conversion: Mangrove, Saltmarsh
- Berm state: Intact berm, Graded berm
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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
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Nearshore Bed Erosion
- Wave run-up (USACE 2002)
- Bed Scouring (Whitehouse et al. 2004)
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Ecosystem Service Valuation
- Avoided erosion
  - Area of substrate saved compared to a no vegetation baseline
- Property value ($25 USD m⁻²)
Scenario Avoided Erosion
(baseline = no veg)

<table>
<thead>
<tr>
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**Diagram:**
- **Legend:**
  - Orange: Mangrove
  - Gray: Intact Berm
  - Green: Salt Marsh
  - Red: Graded Berm

**Graph:**
- **Y-axis:** Elevation (m)
- **X-axis:** Distance from Shore (m)
### Scenario Avoided Erosion

**Erosion Protection Value (USD m⁻²)**

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**Legend:**
- **Mangrove**
- **Intact Berm**
- **Salt Marsh**
- **Graded Berm**
**Scenario Avoided Erosion**

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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 m² 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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