The ecological benefits and potential risks of mangrove restoration within the Texas salt marsh-mangrove ecotone

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Marsh $\rightarrow$ Mangrove

- Gulf of Mexico coastal wetlands are transitional between marshes and mangroves
- Mangrove expansion rate may be accelerating
  - Temperature
  - Sea level rise
  - Atmospheric CO$_2$
- Focus on Texas
Over last 20 years:
Mangroves expanded by 74%
Marshes decreased by 24%

Are mangroves expanding on the Texas coast? Yes!

Courtesy W. Highfield, Armitage et al. *in review*
Coastal wetland restoration in TX mostly focuses on low elevation salt marsh
  – May be vulnerable to sea level rise
  – Is planting mangroves in restoration sites a solution?

What is the ecological trade-off between mangroves and marshes? Do we know enough?

Answers may be site-specific
  – Areas of rapid, late-stage mangrove expansion (central TX coast)
  vs.
  – Areas of early-stage expansion (Galveston Bay)
1. Can mangroves be successfully planted in restoration sites in Texas?
   - Success and failure stories in an early-expansion area

2. What is the current state of knowledge of the net ecosystem tradeoff between mangrove and marsh habitats in Texas?
   - Large-scale manipulative experiment in a late-stage expansion area
• Goal: Extend shoreline to create more roosting & nesting habitat

• What didn’t work?
  – Planting too low

1. Mangrove restoration
• What didn’t work?
  – Planting too high: high tides limited access to appropriate elevation, but planting went ahead anyway
• What did work?
  – Planting within established marshes...
  ... with a protected shoreline
When planting mangroves in restoration projects...

- Elevation needs to be right – not too high, not too low
- OK to plant within existing or restored marsh vegetation

But...

...should we be undertaking mangrove restoration in Texas at all?
→ Mangroves are increasing, marshes are decreasing

• What are the species- and process-level implications of this vegetation shift?
  – Nursery habitat
  – Iconic species habitat
  – Carbon & nitrogen cycles
  – Erosion/shoreline stabilization

Approaches:
  1. Comparisons among stands of marshes and mangroves
  2. Experimental mangrove removal/marsh revegetation

2. Mangrove vs. marsh
Large-scale mangrove removal experiment will help us understand the consequences of this shift

→ Adaptive management of coastal resources

→ Inform wetland restoration design
2. Mangrove vs. marsh

Team members: Guo, Weaver, Hughes, Dastidar, Whitt, Wieski, Sigren, Onsgard, Lee, Bowers, Moulton, Li
Weather stations

2. Mangrove vs. marsh
Mangrove effects on microclimate are non-linear.

Wind advection

Adj $R^2 = 0.77$
$P < 0.01$

Shading

Adj $R^2 = 0.63$
$P = 0.01$

2. Mangrove vs. marsh

Courtesy H. Guo
Leaf litter bags

2. Mangrove vs. marsh
Decomposition rates higher in mangrove stands

- Warmer soil temperature
- More trapped wrack

Coastal Cellulose Decomposition

Treatment: Cleared, Mangrove

Decomposition Grams per Day

Courtesy J. Kominoski & S. Charles
Bird surveys

2. Mangrove vs. marsh
Wading birds prefer plots with fewer mangroves.

**Fall**

![Histogram of bird observations in Fall](Fall_histogram)

**Late Spring**

![Histogram of bird observations in Late Spring](Late_Spring_histogram)

Courtesy A. Whitt

2. Mangrove vs. marsh
So... should mangroves be restored?

Early results: differences in microclimate, carbon cycling, fauna
→ Benefit closely linked to target outcome of restoration project
→ Net ecosystem benefits...?