REMOTE SENSING + ECOLOGICAL EXPERIMENTATION TO DETECT & EXPLAIN MANGROVE RANGE EXPANSION

John Parker

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Mangrove wetlands

~75% of the world’s tropical coastlines

$1.6$ trillion/year in ecosystem services

(another shameless picture of charismatic megafauna)
‘Mangrove’ is a saltwater lifestyle, not a (plant) family

~60,000 tree species
~70 mangrove species
~0.1% of trees are mangroves
NO COLD MANGROVES

AT/SST: Mean Monthly Winter Minimums (BIOCLIM/MODIS)
2010 cold snap in Florida
1980s sign, Merritt Island National Wildlife Refuge
Poleward expansion of mangroves is a threshold response to decreased frequency of extreme cold events

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Mangrove area expanded within the ecotone, 1984-2011

Cavanaugh et al. 2014 PNAS

An Expanding Range
Mangroves are spreading north as milder winters keep the trees from freezing.

CHANGES IN MANGROVE AREA
From 1984 through 2011

Researchers examined 28 years of satellite imagery to measure changes in coastal mangrove forests.

Source: Proceedings of the National Academy of Sciences
Temperature threshold
< -4°C in winter = reduced mangrove cover in summer

2014 PNAS
Simulated ‘freeze’ events

-11°C, -10, -8, -6, -4 -2, 0
SPECIES-SPECIFIC RESISTANCE TO FREEZING AIR = RANGE-LIMITS

Avicennia
Rhizophora
Laguncularia

Proportion of Original Yield

Air Temperature (°C)

-4°C

2015 Global Change Biology
Projected mangrove distributions in 2060

**Avicennia germinans**
- Projected mangrove habitat
- Current mangrove habitat
- Estuarine and marine wetlands

**Rhizophora mangle**

**Laguncularia racemosa**

2015 Global Change Biology
Georgia: 1/3 of all eastern US saltmarsh
Expansion/contraction of mangroves and saltmarsh habitats

Matanzas Inlet

29°43'
Mangrove/marsh oscillation at the edge
MANGROVE RANGE LIMITS ~

COLD AIR
RANGE LIMITS ~ COLD WATER?

SST: Avg Winter Minimums (MODIS)
Propagule Survival in Cold Water

RANGE-LIMITS ~ COLD WATER

Proportion Survival

Water Temperature (°C)

Avicennia
Rhizophora

16.2°C (MWSST)
RANGE-LIMITS ~ ARIDITY*COLD WATER?

ARIDITY Index
(precip/PET)
GROWTH-CHAMBER EXPERIMENTS:

HUMIDITY*CHILLING
Survival ~ Aridity*Chilling*Species

Chilled air/water (10°C)

Avicennia Rhizophora

Proportion Survival

Days After Planting
What envt factors define mangrove ranges?
Take Home
1. Range limits = physiological limits
2. Multiple, interacting drivers
3. Remote sensing & ecological expts both needed to predict mangrove response to climate change
Fort Matanzas: ca. 1740, guards southern flank of St. Augustine, FL, the oldest city in the US (est. 1565)
**Land cover change analysis 2003 vs. 2010:**

- **70% increase in mangrove area**
- **12% decrease in salt marsh area**
- **6% increase in wetland area**

Doughty et al. 2015

<table>
<thead>
<tr>
<th>VEGETATION CLASS</th>
<th>2003</th>
<th>2010</th>
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<tbody>
<tr>
<td>Mangrove</td>
<td>1,516</td>
<td>2,555</td>
</tr>
<tr>
<td>Salt Marsh</td>
<td>5,182</td>
<td>4,531</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6,698</td>
<td>7,086</td>
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Carbon sequestration
Nobody loves mangroves. They're stinky, they're muddy, they're not particularly nice to look at and really, if a few thousand hectares of mangroves died on a remote part of the NT coastline, why should we care?
“Nobody loves mangroves. They’re stinky, they’re muddy, they’re not particularly nice to look at and really, if a few thousand hectares of mangroves died on a remote part of the NT coastline, why should we care?”
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