Extreme events and historical regime shifts in the mangrove-salt marsh ecotone

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Regime shifts

• A regime shift is a transition from one ecosystem state to another
Regime shifts in coastal wetlands

• Salt marsh to mudflat

• Salt marsh to mangrove
Mangrove increase in the ecotone, 1984-2011

- Based on analysis of Landsat images
- 25.25° to 29.75°N
- Increase or Decrease in mangrove area

\[ r^2 = 0.67 \]
\[ p < 0.01 \]
Mangrove increase vs. decrease in the ecotone, 1942-2014

Rodriguez et al. 2016
### Timeline: major FL freezes, 1835-present

<table>
<thead>
<tr>
<th>Year</th>
<th>Minimum temp. in St Augustine</th>
<th>Days below freezing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940</td>
<td>-11.1°C</td>
<td>3</td>
</tr>
<tr>
<td>1962</td>
<td>-10.0°C</td>
<td>2</td>
</tr>
<tr>
<td>1977</td>
<td>-10.0°C</td>
<td>3</td>
</tr>
<tr>
<td>1981</td>
<td>-7.8°C</td>
<td>3</td>
</tr>
<tr>
<td>1982</td>
<td>-6.1°C</td>
<td>2</td>
</tr>
<tr>
<td>1983</td>
<td>-8.9°C</td>
<td>3</td>
</tr>
<tr>
<td>1985</td>
<td>-12.2°C</td>
<td>4</td>
</tr>
<tr>
<td>1989</td>
<td>-8.3°C</td>
<td>5</td>
</tr>
<tr>
<td>2010</td>
<td>-3.3°C</td>
<td>4</td>
</tr>
<tr>
<td>2018</td>
<td>-3.9°C</td>
<td>3</td>
</tr>
</tbody>
</table>

*Freeze event*

**Major freeze event**

*Impact Freeze*

-14°C
-10°C

From John Attaway 1997
*From John Attaway 1997*

A History of Florida Citrus Freezes

Rodriguez et al. 2016
(1942-2014)

Cavanaugh et al. 2014
(1984-2011)
...before 1942?

Going back in time, we can’t use remote sensing or aerial photos

But, we can use historical records...

- naturalists’ journals
- flora/fauna surveys
- personal journals
- correspondences
- maps and charts
- herbarium specimens
- Etc.

- Bartram 1774: *Avicennia*, St Augustine
- Michaux 1788: *Avicennia* and *Rhizophora*, St Augustine
- Vignoles 1823: *Rhizophora* islands, 20 km north of Ponce Inlet
- Audubon 1835: *Rhizophora* islands, 50 km north of Ponce Inlet
- Motte 1836: *Rhizophora* islands (dead), New Smyrna
- Muir 1867: *Avicennia* clumps, St Marys River
- Nicholson 1928: *Avicennia* trees (dead), Merritt Island

Current northernmost, *Avicennia* and *Rhizophora* clumps
Can hurricanes drive mangroves northward?

- Propagule surveys along beaches along Florida’s Atlantic coast
- October 2014, no hurricane
- October 2017, 5 weeks after Hurricane Irma
Red mangrove propagule density on Florida beaches—no hurricane

![Graph showing Rhizophora propagule density vs. Latitude with data points circled at 30.5 degree latitude]

Oct 2014
Red mangrove propagule density on Florida beaches—post hurricane Irma

![Graph showing Rhizophora propagule density by latitude, with data points for October 2014 and October 2017.]
Black mangrove propagule density on Florida beaches—no hurricane

![Graph showing Avicennia propagule density](image_url)
Black mangrove propagule density on Florida beaches—post Hurricane Irma

Avicennia propagule density

Propagule density (props/m)

Latitude

Oct 2014

Oct 2017
Conclusions

• Mangroves and salt marshes have both dominated coastal wetlands in Florida at different times
• Freezes favor salt marsh dominated-systems
• Hurricanes may favor mangrove-dominated systems
• Future work: track mangrove establishment after hurricanes
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Questions

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