Thinking about oysters…
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- Exploited populations
  - Regulations to alter mortality rates ($d > b$)
  - Spatial, seasonal, size regulations
  - Sustainable harvest clear management objective
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- Exploited populations
  - Regulations to alter mortality rates \((d > b)\)
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- Restoration targets
  - What happened to extant populations?
  - Many hypotheses…
    - Habitat loss, habitat modifications, FW flows overexploitation, climate change, demonic intrusion
  - “Restoration” objective
    - Historical levels? Self-sustaining? Bird habitat? Harvestable?
Thinking about oysters…

- Restoration activities and management actions should be viewed as tests of hypotheses about ecosystems
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- Restoration activities and management actions should be viewed as tests of hypotheses about ecosystems.

- Results from these tests can be used to determine the “best” policy – including restoration or management actions.
Thinking about oysters...

- Cedar Keys – extant oyster communities, viable commercial fishery, significant local/regional interest in oyster resources
- Observed changes in distribution and densities of oyster resources
Thinking about oysters…

- Hypotheses developed with cooperators and stakeholders:
  - Declines in freshwater inputs
    - Leading to changes in recruitment and predation
  - Overharvest
  - Sedimentation
  - Boat traffic
  - Disease
  - Climate change (storms, temperature)
Thinking about oysters…

• Hypotheses we can begin to test:
  – Declines in **freshwater** inputs
    • Leading to changes in **recruitment** and **predation**
  – Overharvest
  – Sedimentation
  – Boat traffic
  – Disease
  – Climate change (**storms**, temperature)
Measuring oyster bar density, size class, growth rates, bar attributes
We choose four localities (locales) that represent a gradient of freshwater inputs from north of the Suwannee River to Waccassa Bay.

At each locale we chose three sites that range from inshore, nearshore, and offshore to capture a range of wave energy levels.

Within each site, we have 3 replicate bars that we have established fixed transects that we revisit regularly and sample.

Our program is designed around what we perceived were gradients in energy (storms) and dominant freshwater inputs (Suwannee River). These are two of our key hypotheses we propose drive oyster population dynamics in CK.
Arrows are pointing to the four “Locales”

The push pins are the closest towns, Cedar Key and Horseshoe Beach
At each locale we sample three different “sites” that represent areas of oyster bar that receive varying levels of wave action.
Within each locale we have three randomly chosen oyster bars that we have established transects on. We revisit these transects to assess oyster populations.
These transects are made by driving two pieces of rebar into the oyster bar at opposite ends of the bar. The two pieces are the same distance apart on each end of the bar. We wrap survey string around the survey bar to create a “belt”. We measure the length of the belt with a tape.

We walk along this belt and count the number of whole, live, oysters in the belt. If the string crosses an oyster, it has to be more than 50% inside the line to be counted.
Using the transect and the tape measure to establish a “number line” along the grid, we randomly select locations along the bar by generating a random number “along” and “away” from the bar.
At these locations we place a ¼ m quadrat on the ground and count and measure all the live and dead oysters.

We do this for a minimum of 100 measurements per oyster bar.

Overall our response metrics of interest are:

- Size structure to infer growth, survival, and recruitment.
- Proportion of oysters live and dead as a measure of viability.

These metrics are then examined spatially and temporally as part of a monitoring program that we are conducting to allow us to establish a baseline to test restoration actions such as...
Experimental monitoring of spat distribution and survival…
Can we take larval supply out of the equation?
• Huge question in areas where oyster populations are extirpated.
• Is this an issue in CK?
Is there a gradient in spat settlement? Survival? What is the role of predation?
<table>
<thead>
<tr>
<th></th>
<th>Corrigan's Reef</th>
<th>Lone Cabbage Reef</th>
<th>Horseshoe Beach</th>
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<tbody>
<tr>
<td>Inshore</td>
<td>77.7</td>
<td>58.5</td>
<td>67.7</td>
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<tr>
<td>Nearshore</td>
<td>22.2</td>
<td>4.4</td>
<td>3.5</td>
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<tr>
<td>Offshore</td>
<td>29.5</td>
<td>8.8</td>
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</table>
December oyster density (m²)

<table>
<thead>
<tr>
<th></th>
<th>Corrigans Reef</th>
<th>Lone Cabbage Reef</th>
<th>Horseshoe Beach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inshore</td>
<td>28.53</td>
<td>23.42</td>
<td>31.32</td>
</tr>
<tr>
<td>Nearshore</td>
<td>13.16</td>
<td>0.91</td>
<td>5.30</td>
</tr>
<tr>
<td>Offshore</td>
<td>7.69</td>
<td>4.06</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Density observations...

- Density consistently highest at inshore reefs, lowest offshore
- Corrigan’s and Horseshoe sites usually highest density
- Let’s look at two sites through time...
Viability?
Viability?

- Most oysters alive (>50%)
- Highest proportion live generally inshore, lowest offshore
Size structure?
• Some season variation in size related to spat..
• Similar size range between live and dead
Inshore Reefs

Corrigan's Reef - Trip 1

Cedar Key - Trip 1

Horseshoe Beach - Trip 1

Lone Cabbage - Trip 1

Corrigan's Reef - Trip 2

Cedar Key - Trip 2

Horseshoe Beach - Trip 2

Lone Cabbage - Trip 2

Corrigan's Reef - Trip 3

Cedar Key - Trip 3

Horseshoe Beach - Trip 3

Lone Cabbage - Trip 3

Corrigan's Reef - Trip 4

Cedar Key - Trip 4

Horseshoe Beach - Trip 4

Lone Cabbage - Trip 4

Corrigan's Reef - Trip 5

Cedar Key - Trip 5

Horseshoe Beach - Trip 5

Lone Cabbage - Trip 5
Our observations so far...

- CK region oyster reefs have diverse size structure, stable densities, and apparently high viability
- Size structure indicates multiple year classes
- Evidence for recruitment this year
- Stable proportion live:dead...
Power to detect change...
Informing restoration program…

- Documentation of areas of recent loss
- Surrounded by areas of viable oyster bars
- Relatively natural coastlines
- Fewer people
- Dedicated user groups
- Ongoing collaborations with industry, agency, NGO, academic partners