The Apalachicola Bay System Initiative (ABSI)

The ABSI seeks to gain insight into the root causes of decline of the Apalachicola Bay ecosystem, and the deterioration of oyster reefs

Ultimately, the ABSI will help develop a management and restoration plan for oyster reefs and the long-term health of the bay

ABSI funding is provided by Triumph Gulf Coast Inc. and Florida State University

TABLE OF CONTENTS

Executive summary 1

1. Introduction 6
2. Habitat and environment 6

2.1 Subtidal mapping *6*

2.2 Fresh-water flow dynamics *7*

2.3 Bio-physical model of the Apalachicola Bay System *9*

2.4 Predictive habitat suitability modeling *12*

3. Oyster biology 14

3.1 Genetic structure *14*

3.2 Disease and other stressors *19*

3.2.1 Identifying the impacts of disease on oysters *19*

3.2.2 Understanding disease thresholds in the Apalachicola Bay *20*

3.3.3 Exploring consequences of disease for Apalachicola Bay *20*

3.3 Stress responses and physiological tolerances *21*

3.4 Effect of salinity on juvenile oysters *23*

3.5 Stress responses of oyster early life-stages *24*

4. Oyster ecology 24

4.1 Intertidal monitoring *24*

4.2 Spatial and temporal patterns of intertidal oyster reefs *29*

4.3 Subtidal monitoring *31*

4.4 Intertidal and subtidal recruitment *34*

4.5 Impacts of oyster populations on community development *36*

5. Restoration 37

5.1 Oyster restoration experiments *37*

5.2. Improving restoration success in the bay scallop *40*

6. System ecology 42

6.1 Apalachicola Bay food web and sediments: 1994 vs. 2020 *42*

6.2 Influence of oysters on function and change in coastal ecosystems *47*

6.2.1 Investigating changing benthic sediment characteristics in Apalachicola Bay *48*

6.2.2 Oyster Shell Dissolution Dynamics in Apalachicola Bay Region *49*

6.2.3 Coastal carbon dynamics occurring because of mangrove replacement of regional tidal marshes *50*

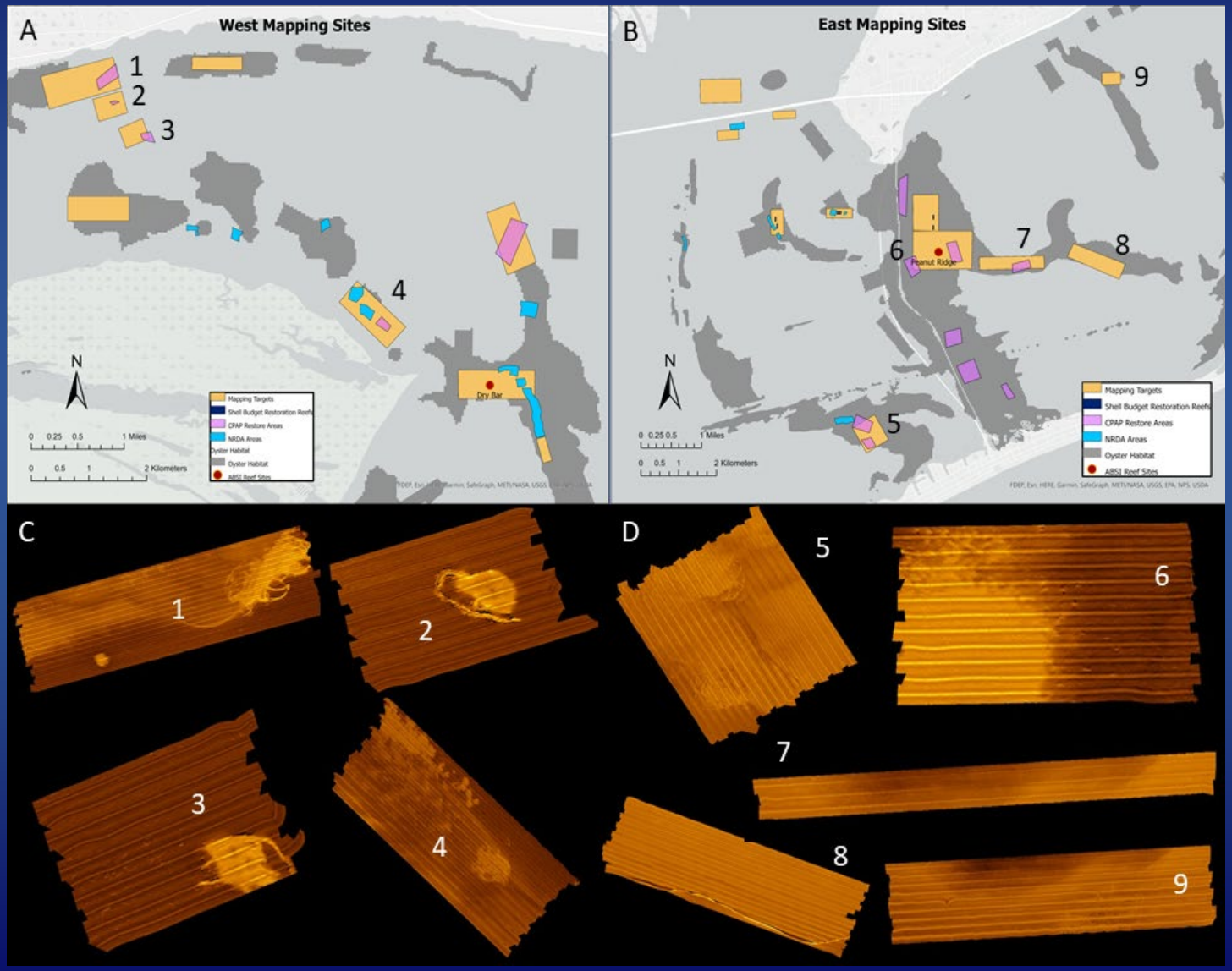
6.2.4 Vulnerability of regional wetlands to sea-level rise and changing sediment delivery from Apalachicola River *51*

6.3 Apalachicola Bay environmental evolution and pollutant status *53*

7. Literature Cited 57

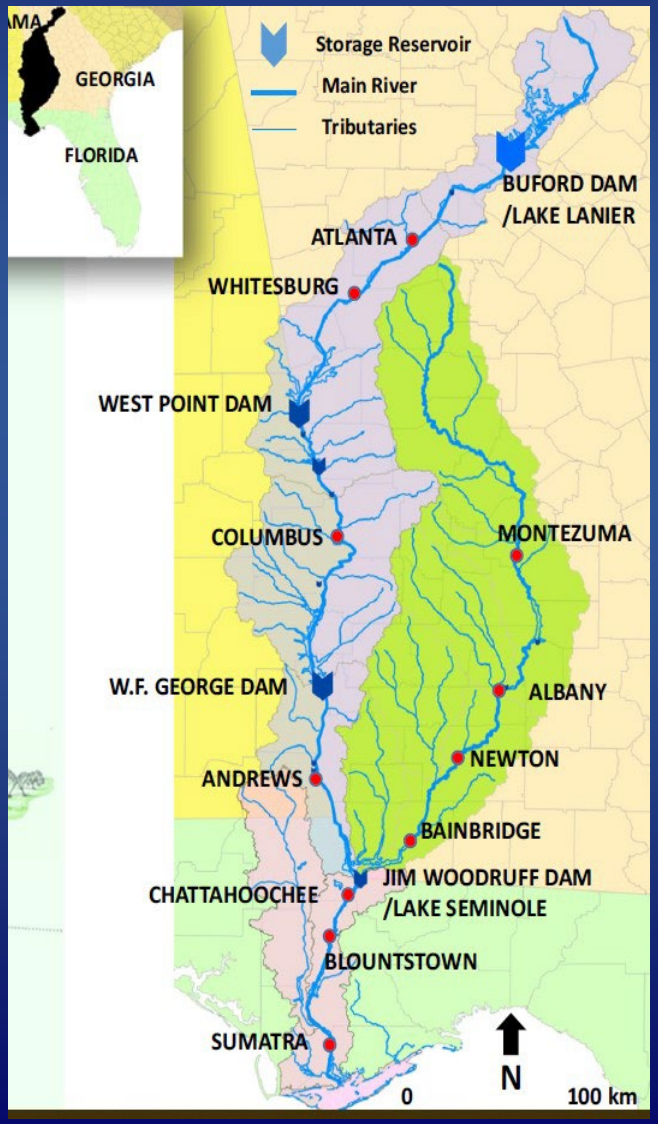
Habitat and Environment

2.1 Sub-tidal mapping



Habitat and Environment

2.2 Fresh-water flow dynamics

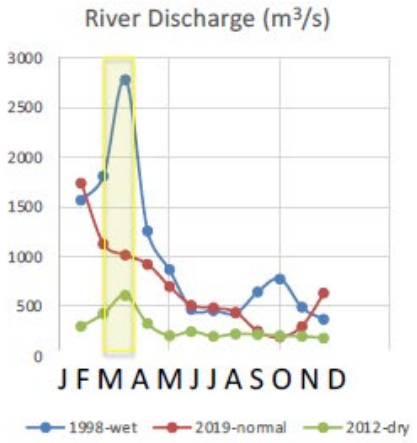


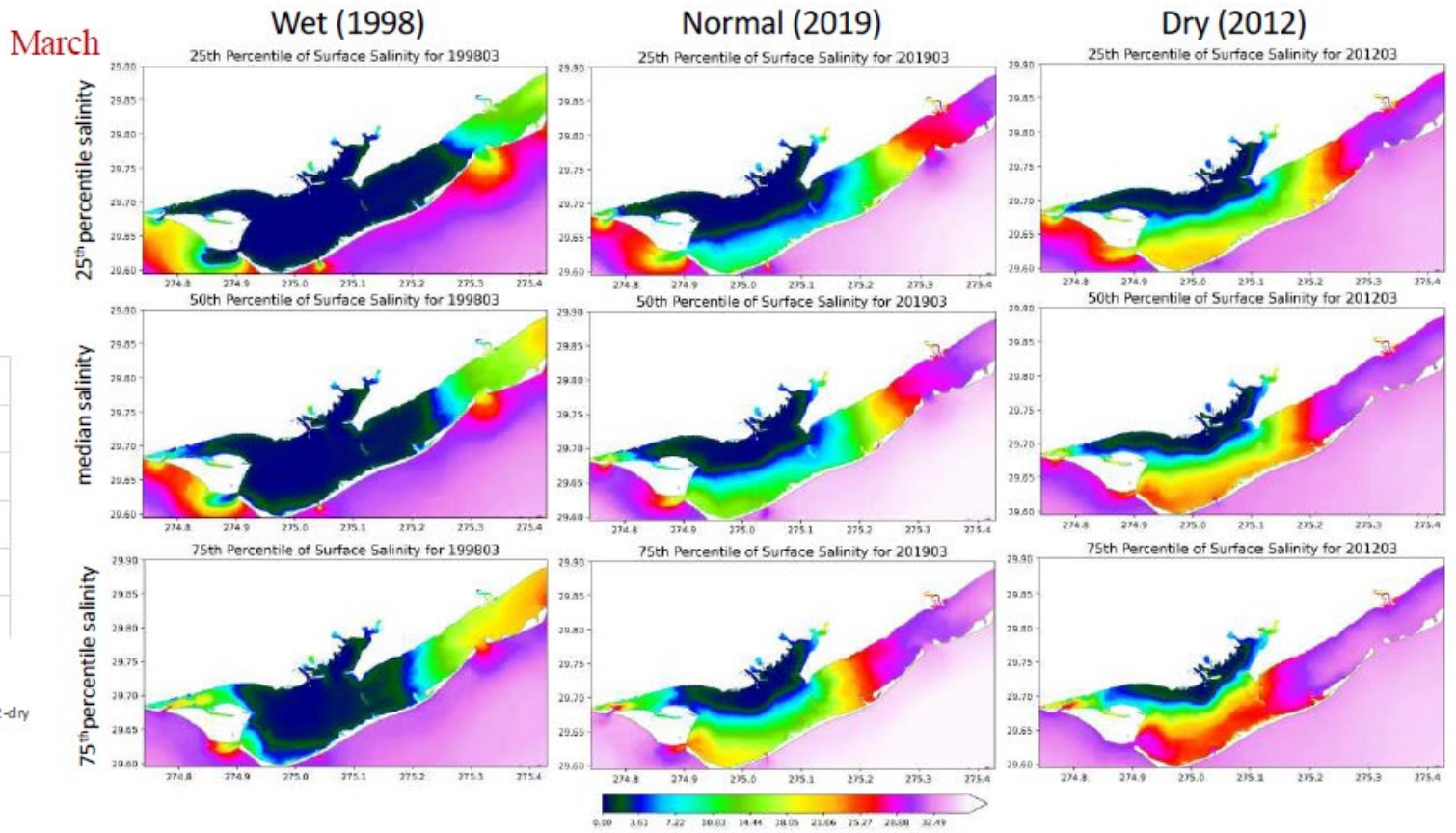
- ACOE water control manual does not consider flows into the estuary
- ACF Stella model used by Dr. Steve Leitman to model fresh-water flow into Apalachicola Bay
- Model has been calibrated with ACOE model
- Effects of future climate on river flows assessed and manuscript close to submission
- Storage and flow analyses indicate there is sufficient storage capacity for management to improve river flow into AB.
- Metrics being developed to define flow regimes that optimize benefit to oyster populations in AB

Habitat and Environment

2.3 Bio-physical model of the Apalachicola Bay System

Maps of salinity quantiles (median, 25th percentile, 75th percentile) corresponding to wet, normal, and dry March.





Habitat and Environment

2.4 Predictive habitat suitability model for oysters

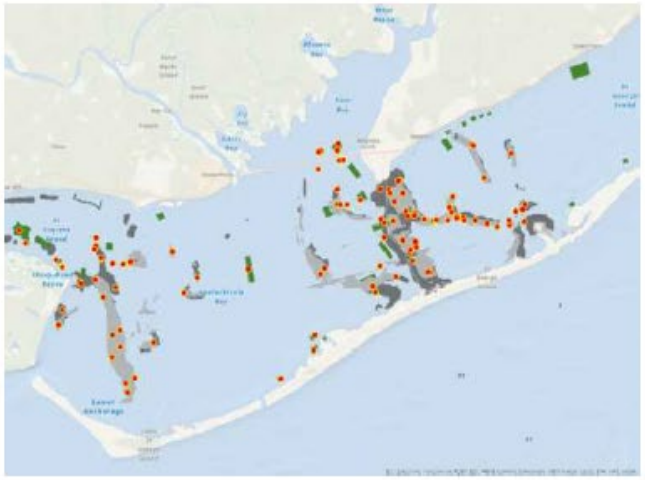
Models will be run under current and projects climate scenarios

Environmental Variables

Salinity
Temperature
Current Direction
Current Velocity
Exposure
Substrate Type
Nutrient content
Sea Level Height
pH
Dissolved Oxygen
Precipitation

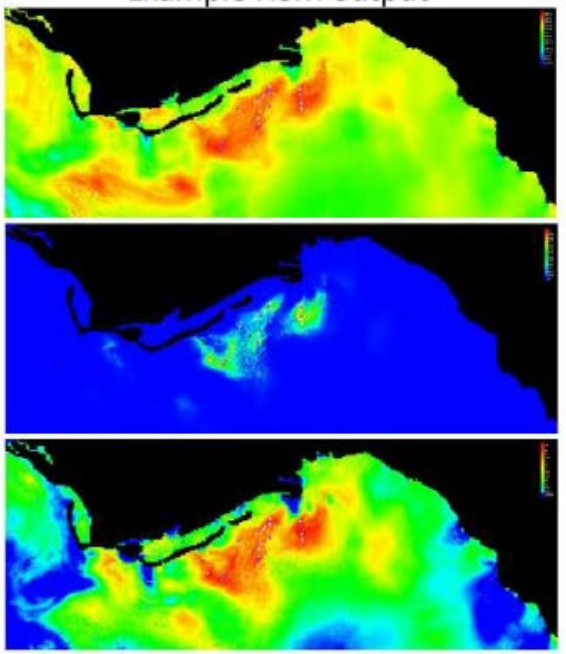
+

Observed Presence/Absence Data



!!!

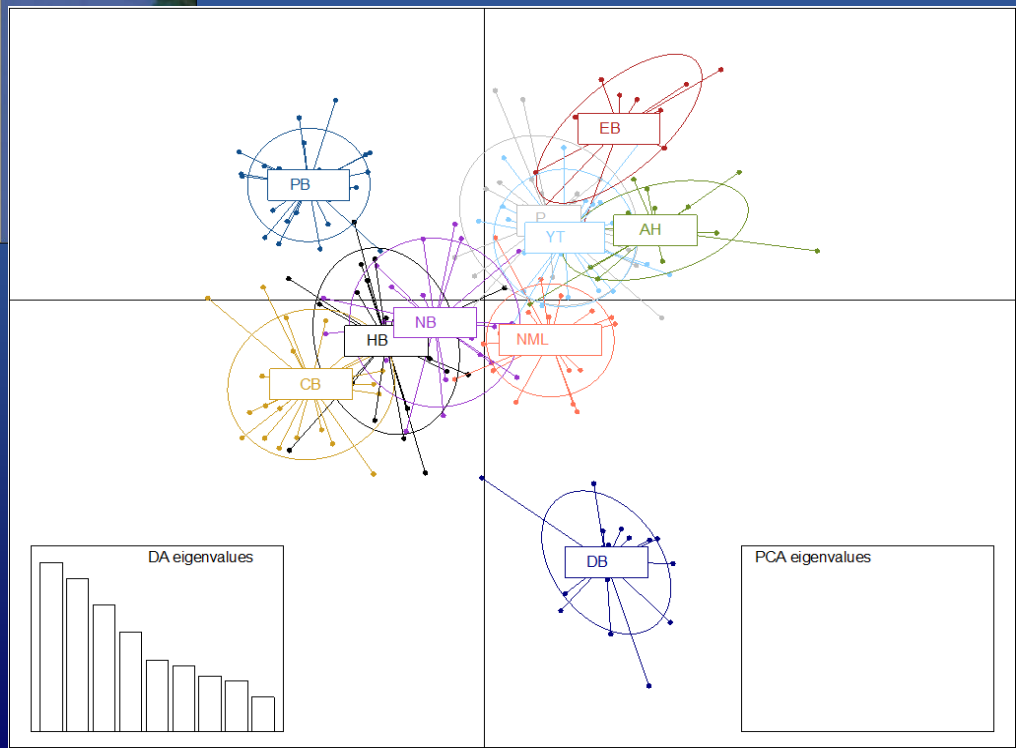
Example HSM output



Statistical Analysis (Models)

Oyster biology

3.1 Genetic structure of oyster populations in the Florida Panhandle

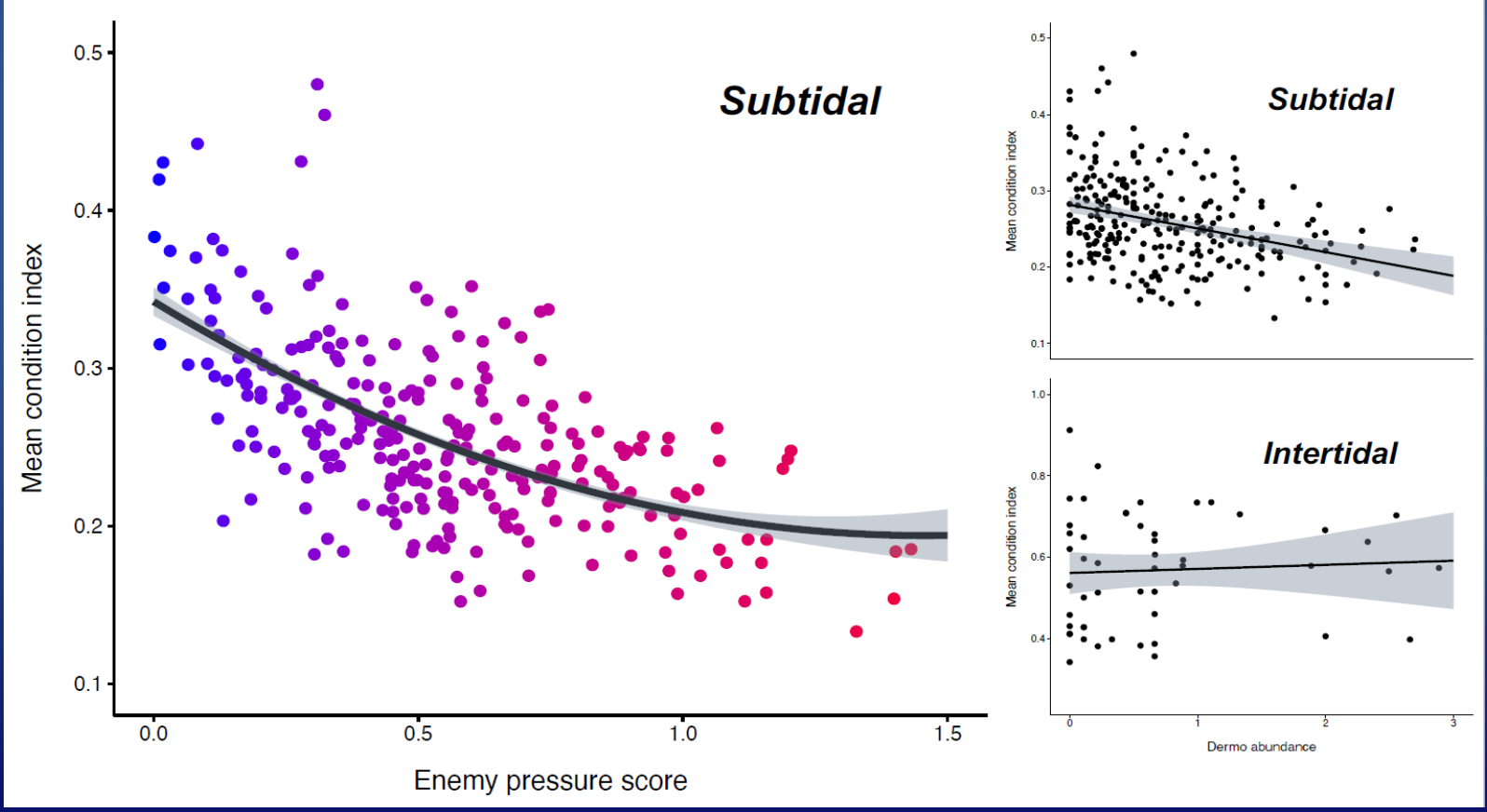


- Some population structuring and IBD
- Populations are not completely mixed
- Additional sequencing underway to resolve outlying populations

Oyster biology

3.2 Disease and other stressors

Oyster disease in the Apalachicola Bay:
Infections as indicators of environmental change, ecosystem diversity, and human risk



Oyster biology

3.2 Stress responses and physiological tolerances

Main objectives:

Short-term and long-term consequences of interacting stressors

Ontogenetic shifts, carry-over effects, and transgenerational impacts

Metabolomics and respirometry to identify energetic and physiological effects

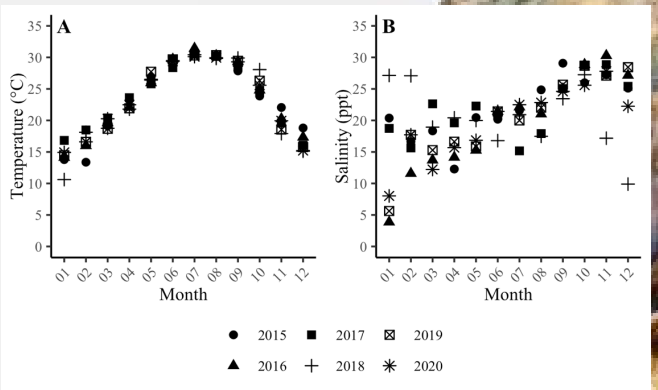
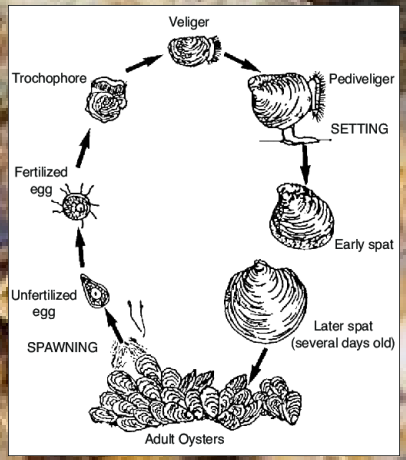
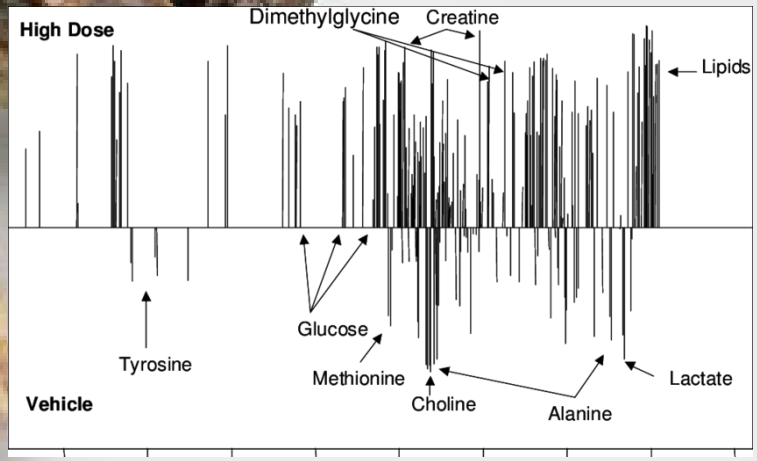


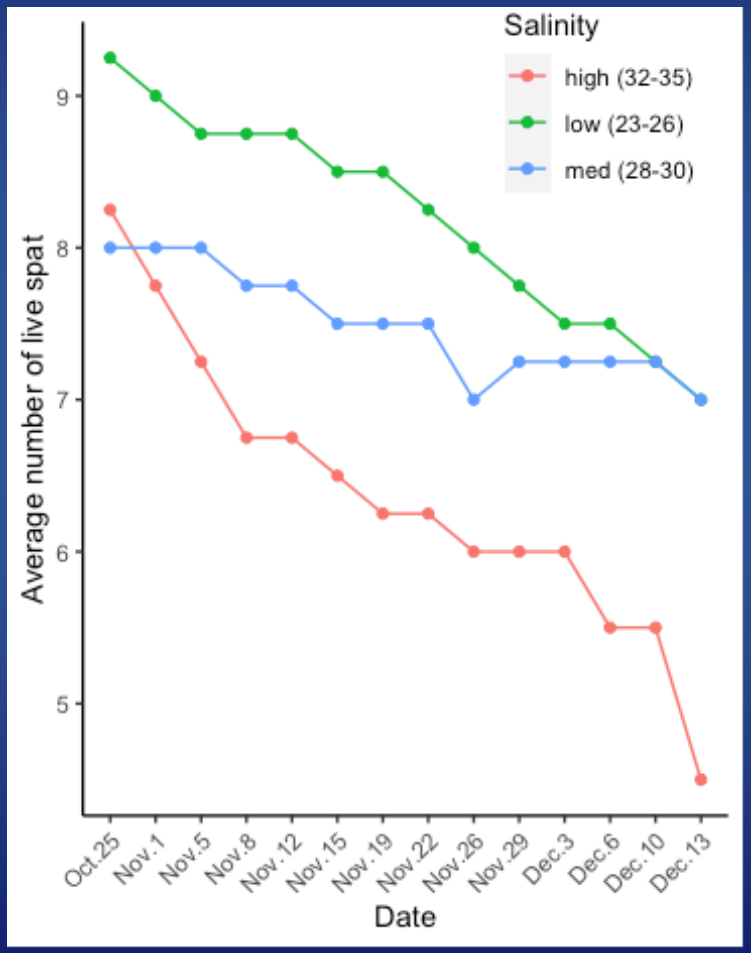
Figure 1: Average monthly temperature (A) and salinity (B) across six years (2015 - 2020). Data downloaded from NOAA NERRS Cat Point Station in Apalachicola Bay, FL.

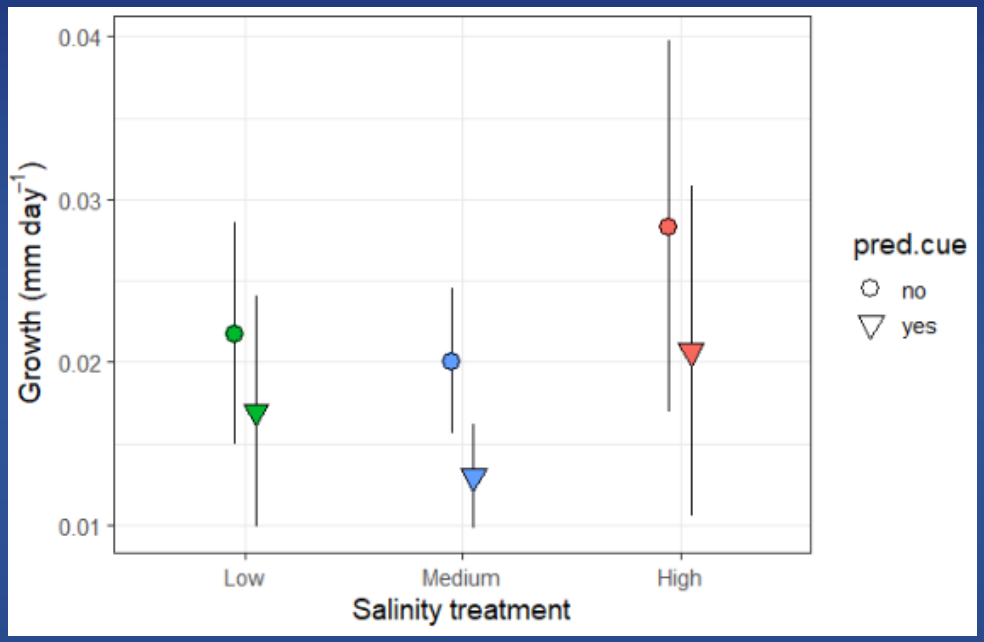




Oyster biology

3.4 Effect of salinity on juvenile oysters – laboratory experiments





Summer

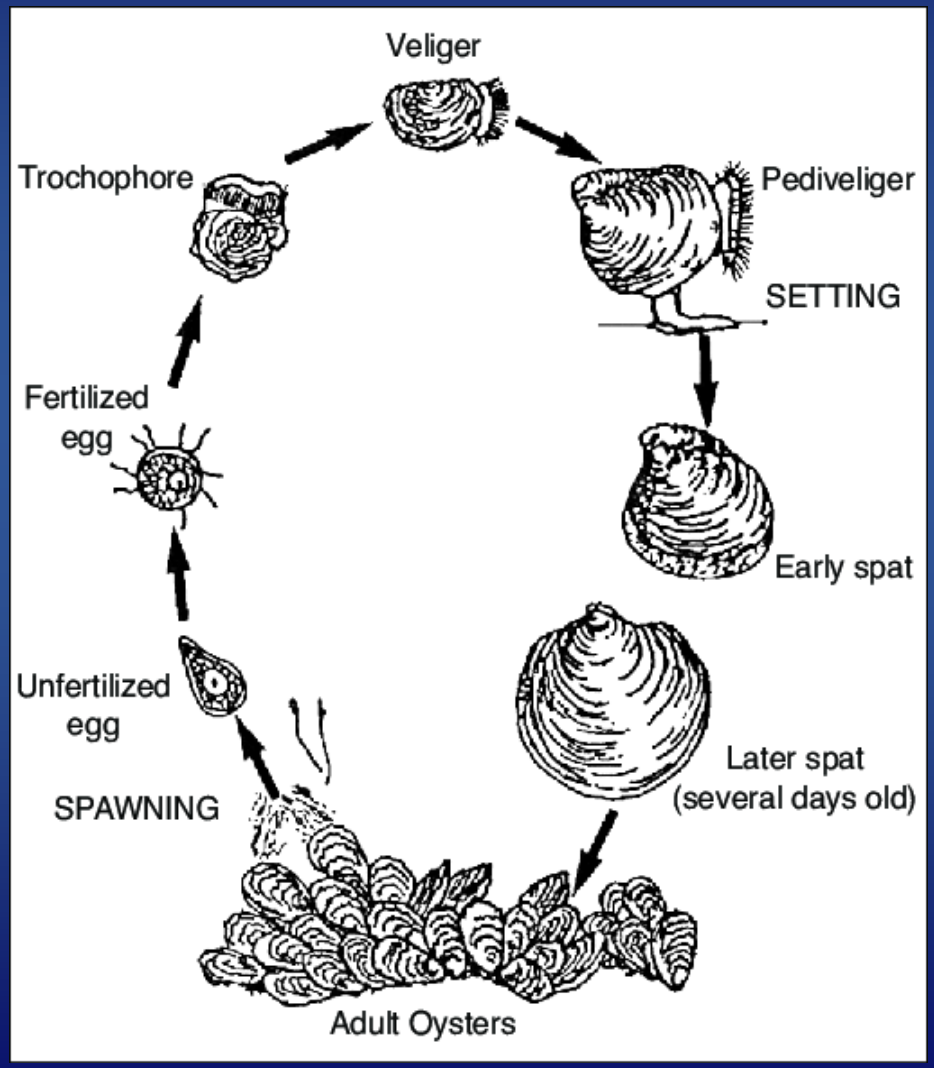
- Field surveys of drill abundance at sites with contrasting salinity regimes.
- Cage studies to assess predation rates, survival of outplant oysters.

Follow up lab studies on drill consumption rates, survival, habitat use across salinity.

Oyster biology

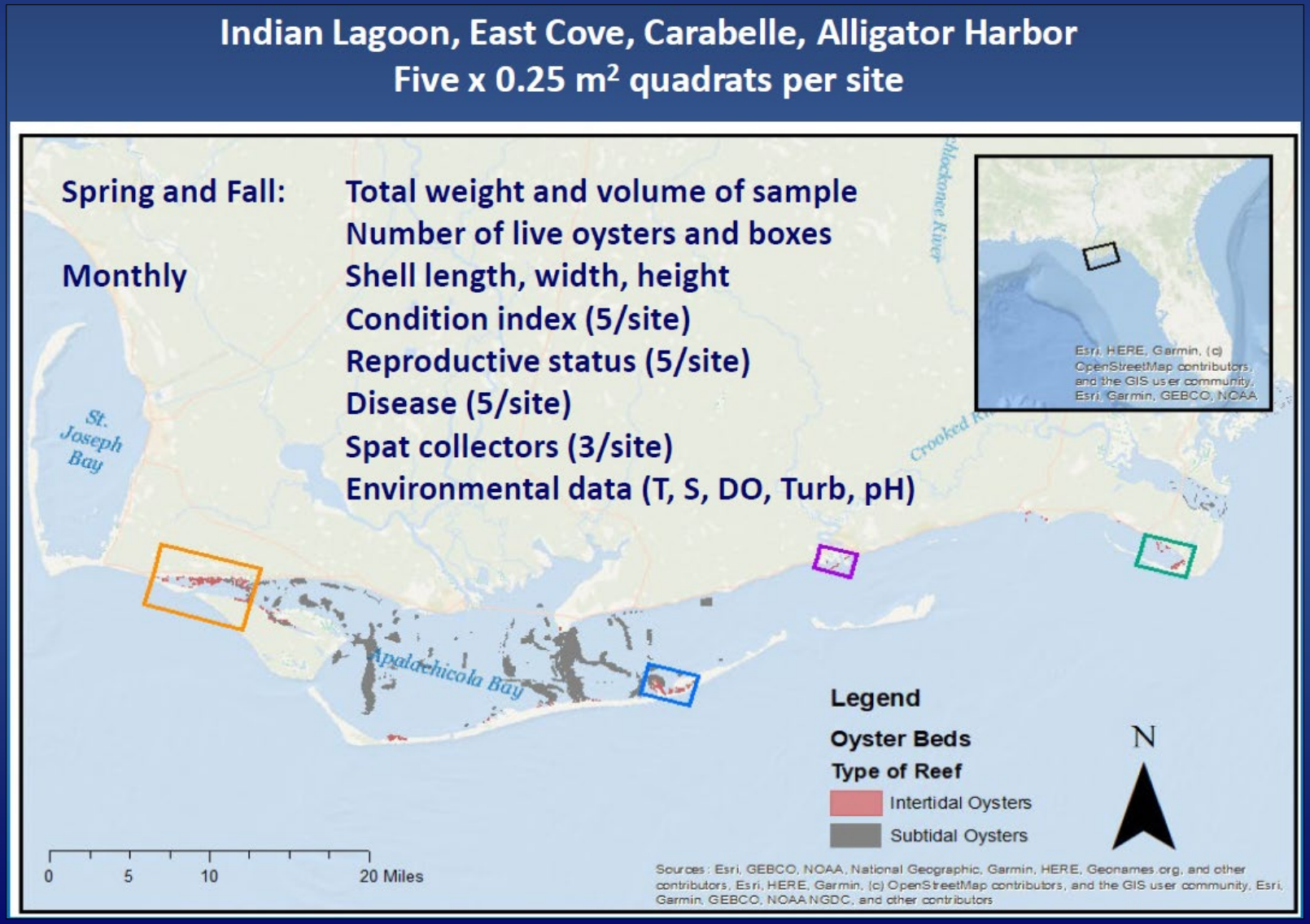
3.5 Stress responses of oyster early life-stages

This is undefined – it's a general dissertation topic for a PhD student who joined FSU in fall 2021



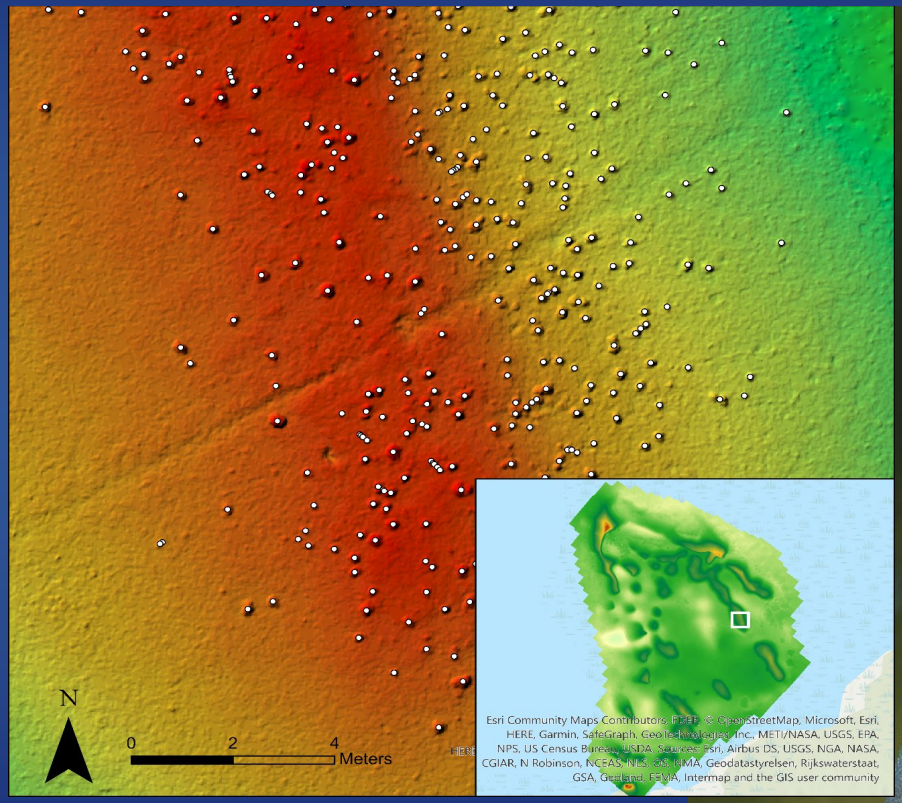
Oyster ecology

4.1 Intertidal monitoring

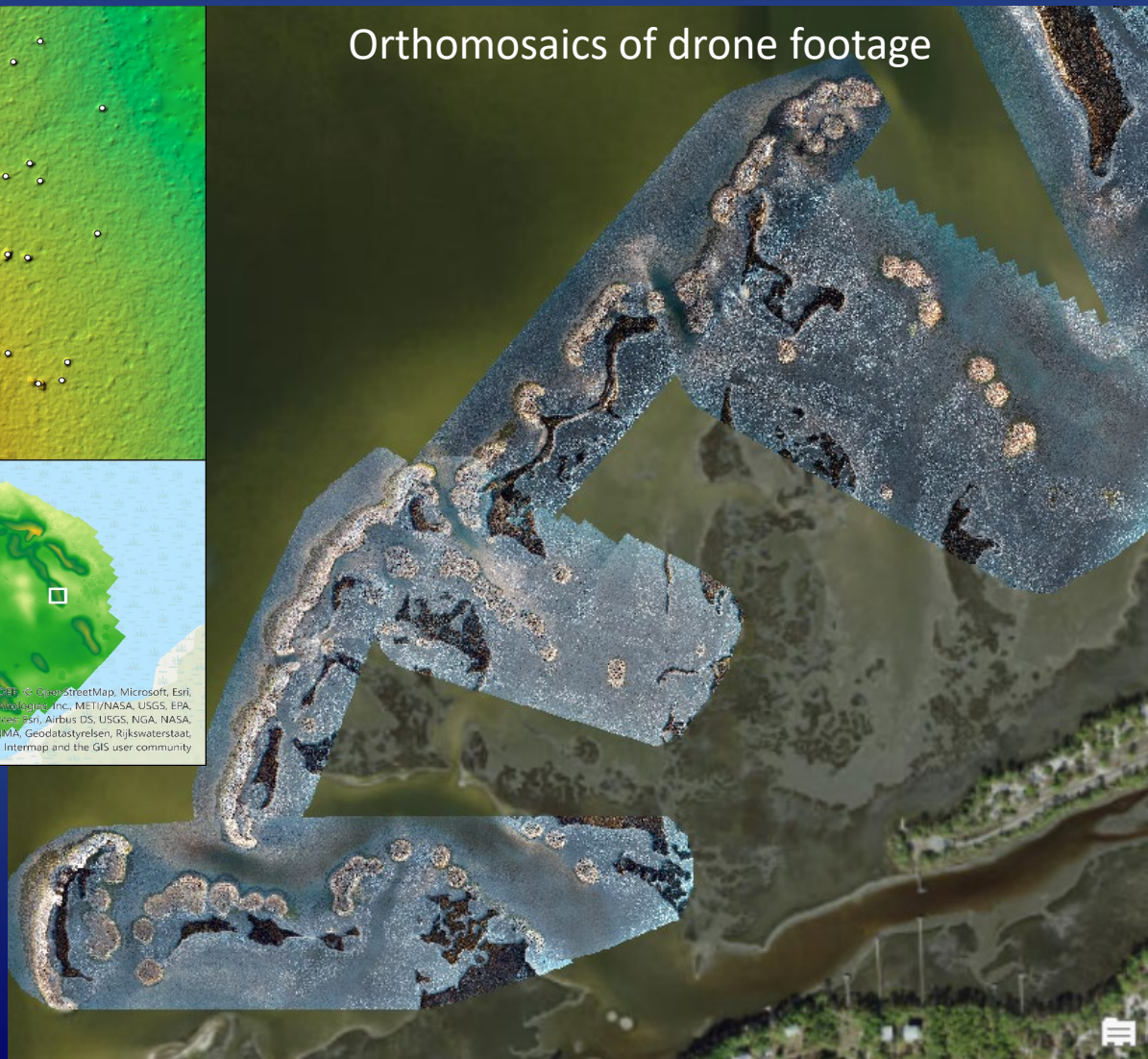


Oyster ecology

4.2 Spatial and temporal patterns of intertidal oyster reefs



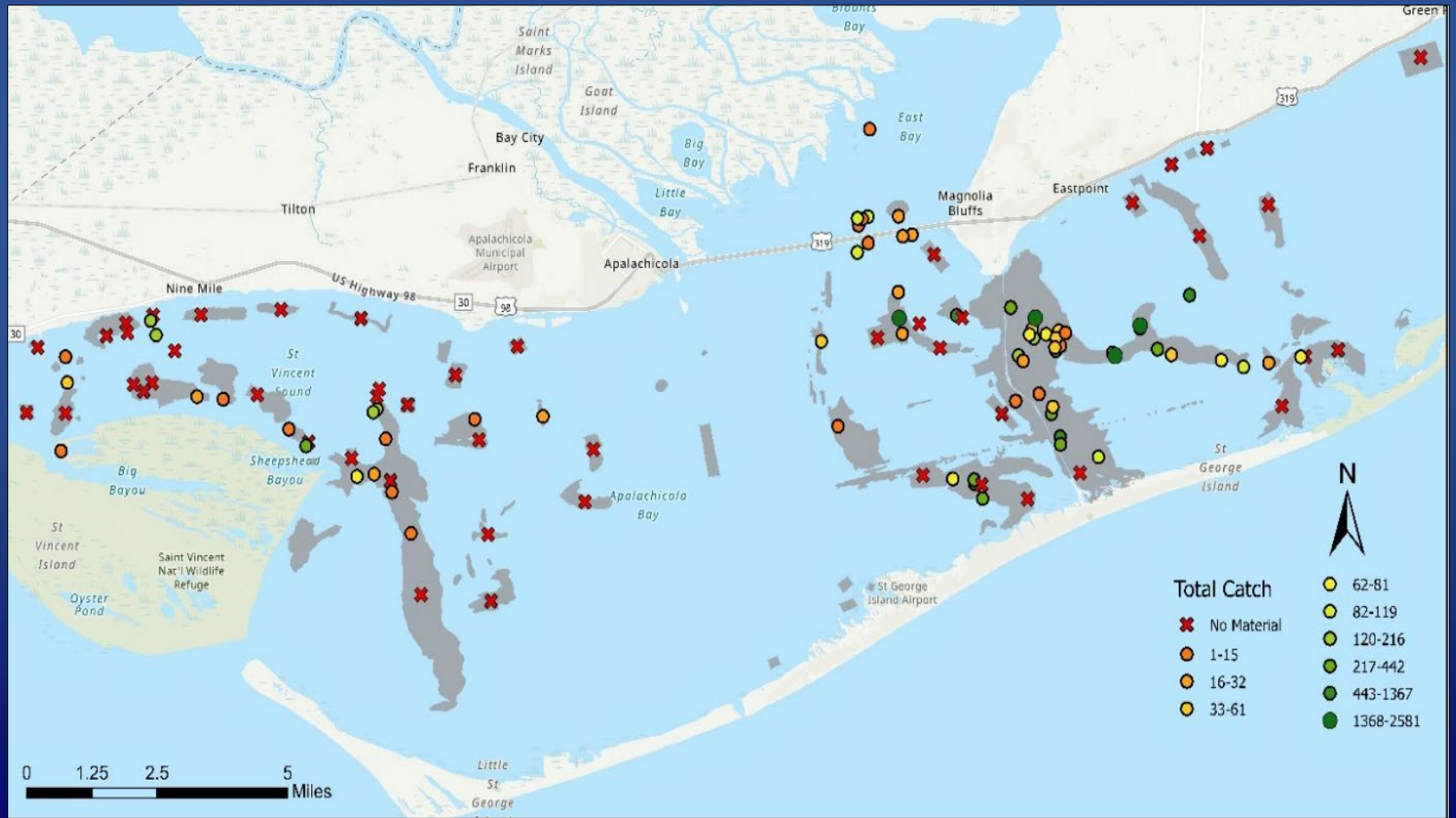
Oyster clusters extracted from digital elevation models using ArcGIS pro



Oyster ecology

4.3 Subtidal monitoring

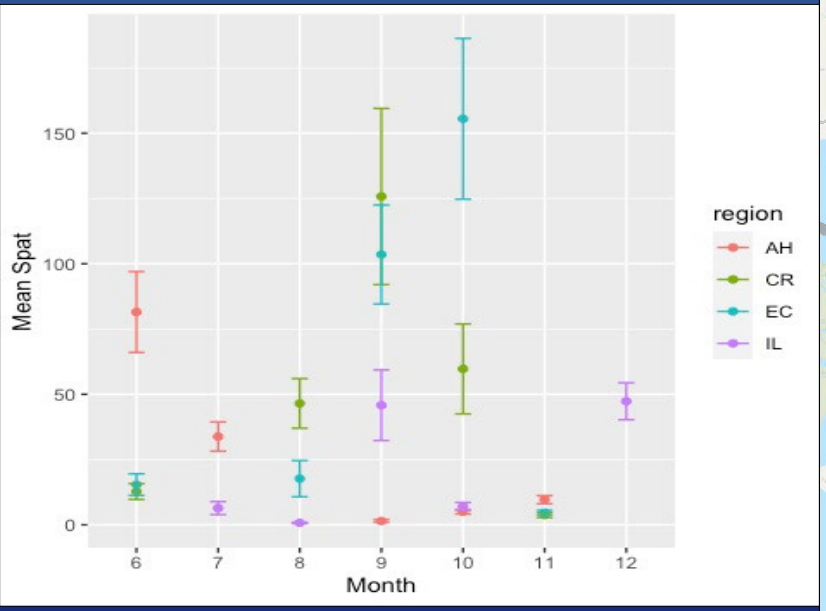
Sampling with hand tongs to cover wide spatial extent
Six replicate samples per site (3 each side of the vessel)
Total volume of material
live oysters, # boxes, shell height of first 100 individuals



Oyster ecology

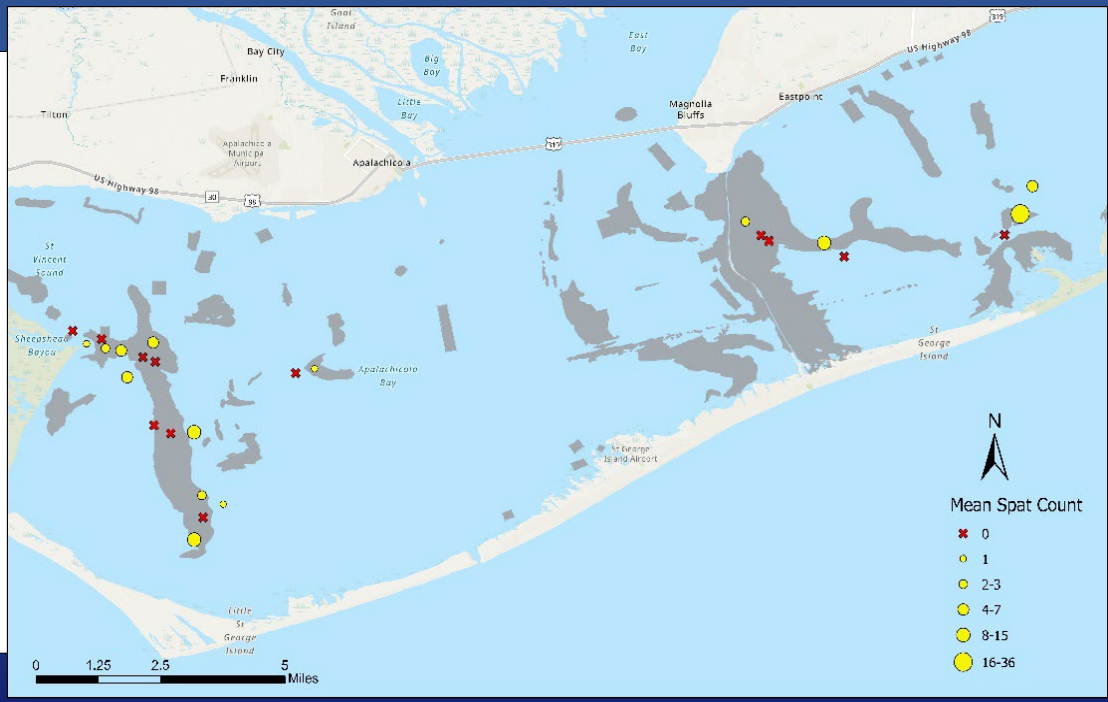
4.4 Intertidal and subtidal recruitment

Intertidal recruitment – mean monthly spat counts from spat traps (3/reef, 5 reefs/site)



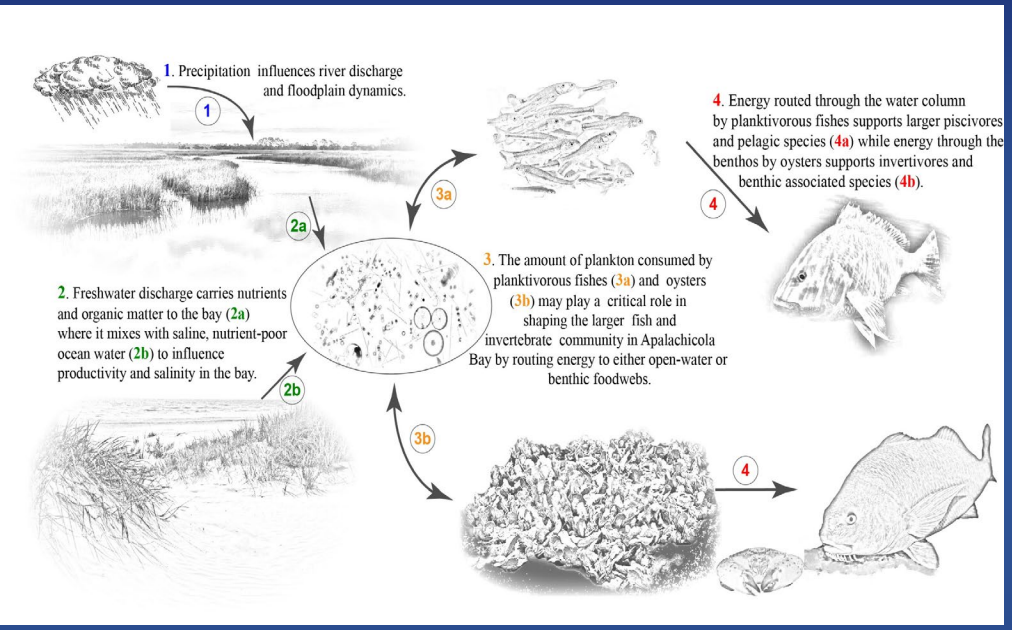
AH – Alligator Harbor, CR – Carabelle River, EC – East Cove, IL – Indian Lagoon

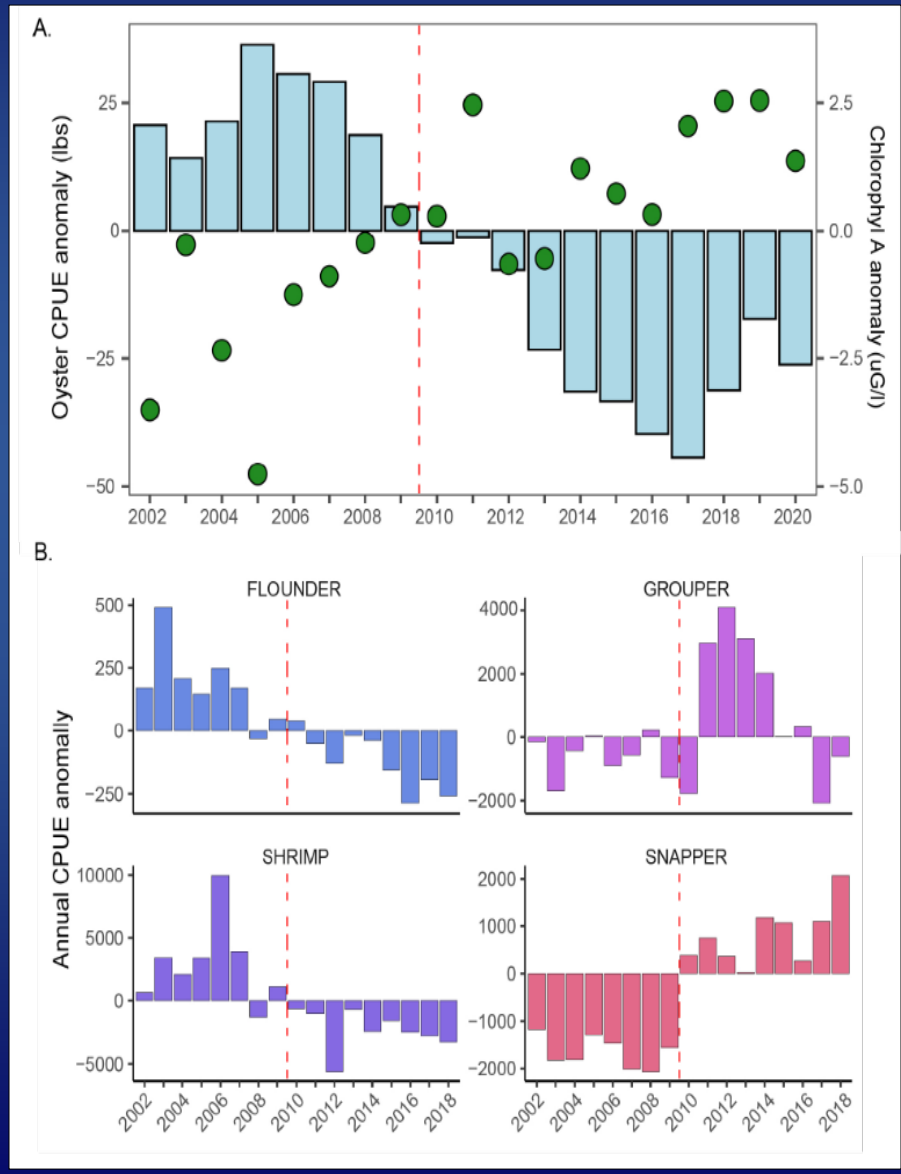
Subtidal recruitment
26 locations in Apalachicola Bay and St George Sound



Oyster ecology

4.5 Impacts of oyster populations on community development



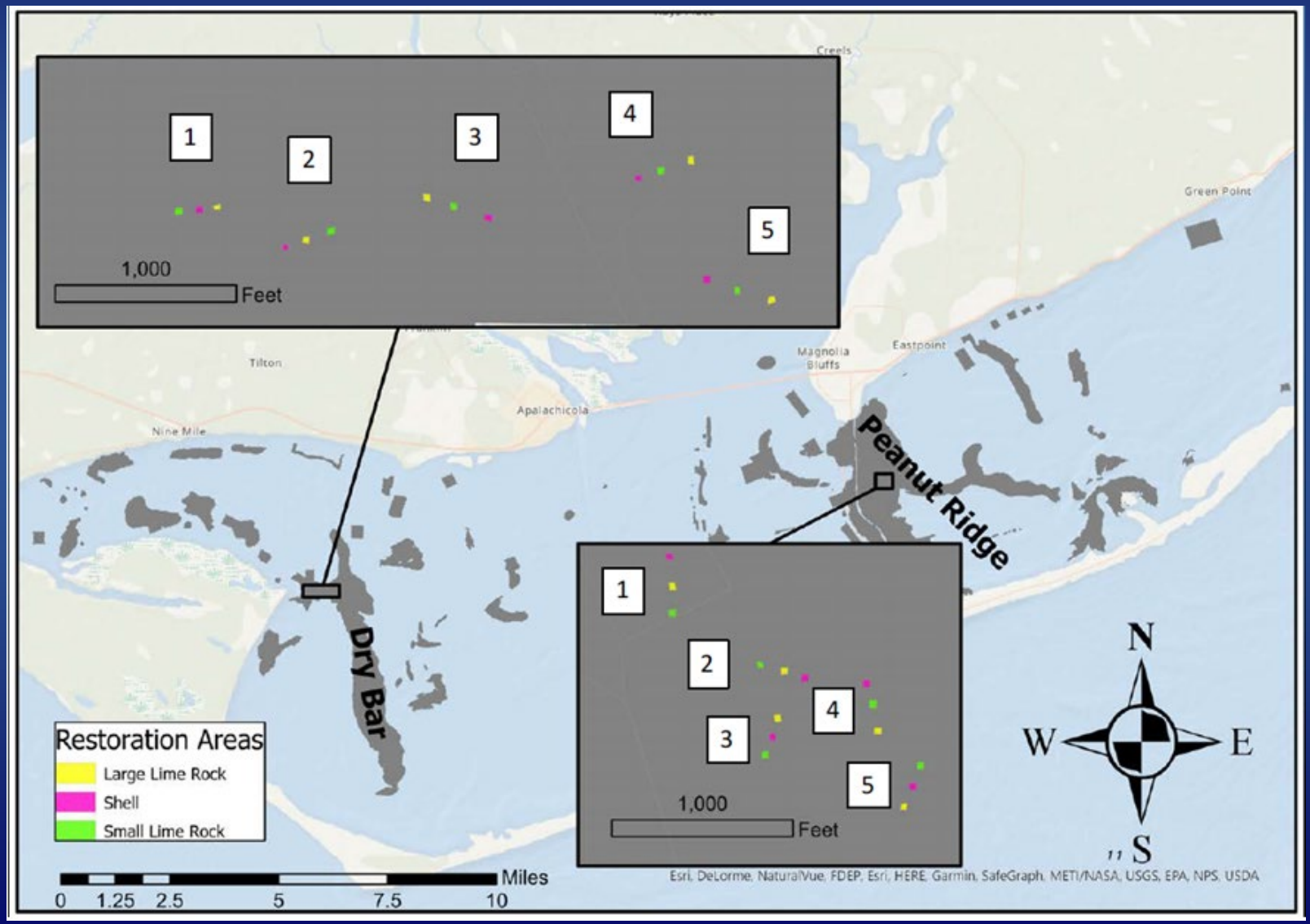


A. Change in annual oyster CPUE and [Chl A] 2002-2020

B. CPUE for other commercial species dependent on benthic (flounder, shrimp) and pelagic (grouper and snapper) food sources

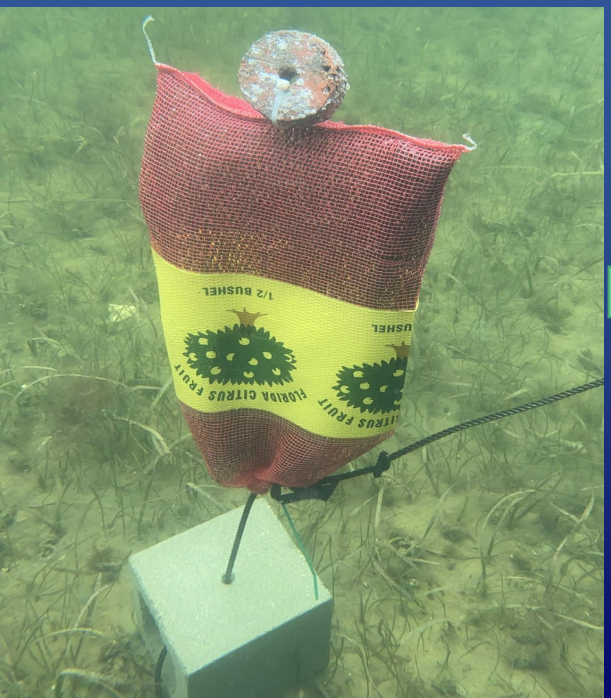
Restoration

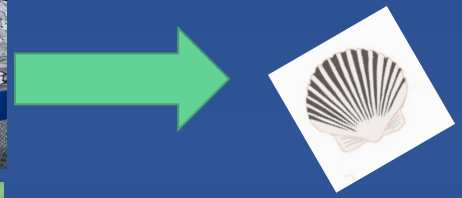
5.1 Oyster restoration experiments

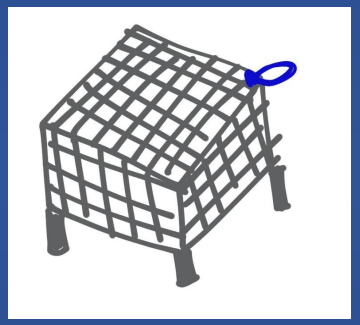


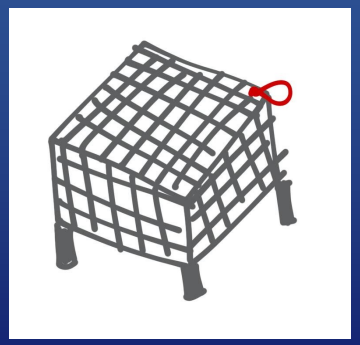
Restoration

5.2 Improving restoration success in the bay scallop







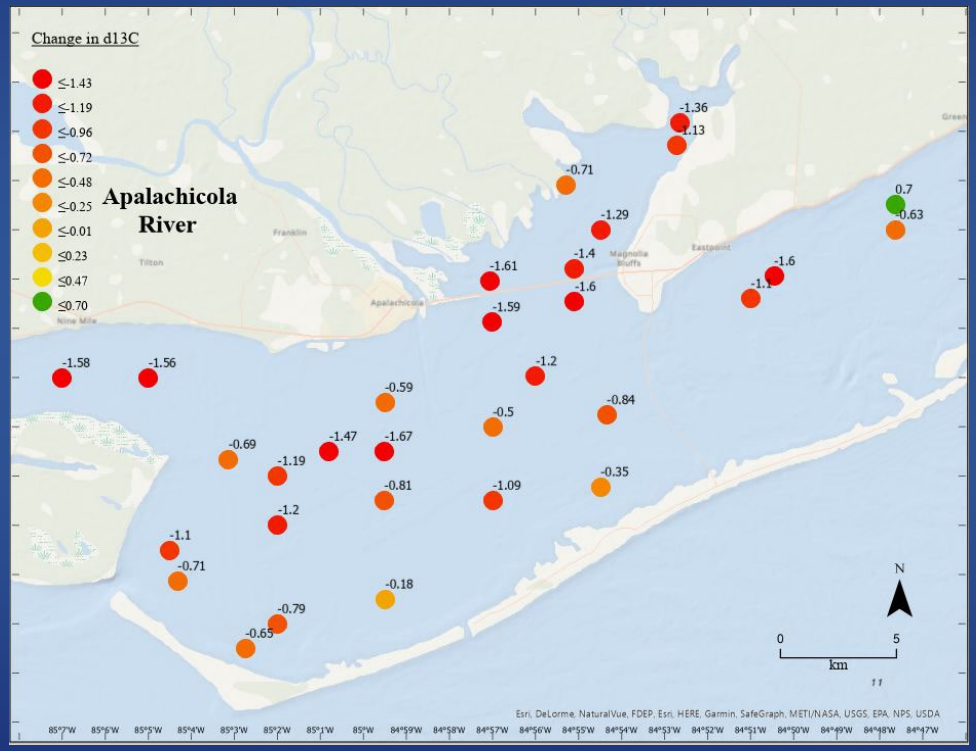


Monitor growth, mortality, shell breaking strength of hatchery vs wild spat

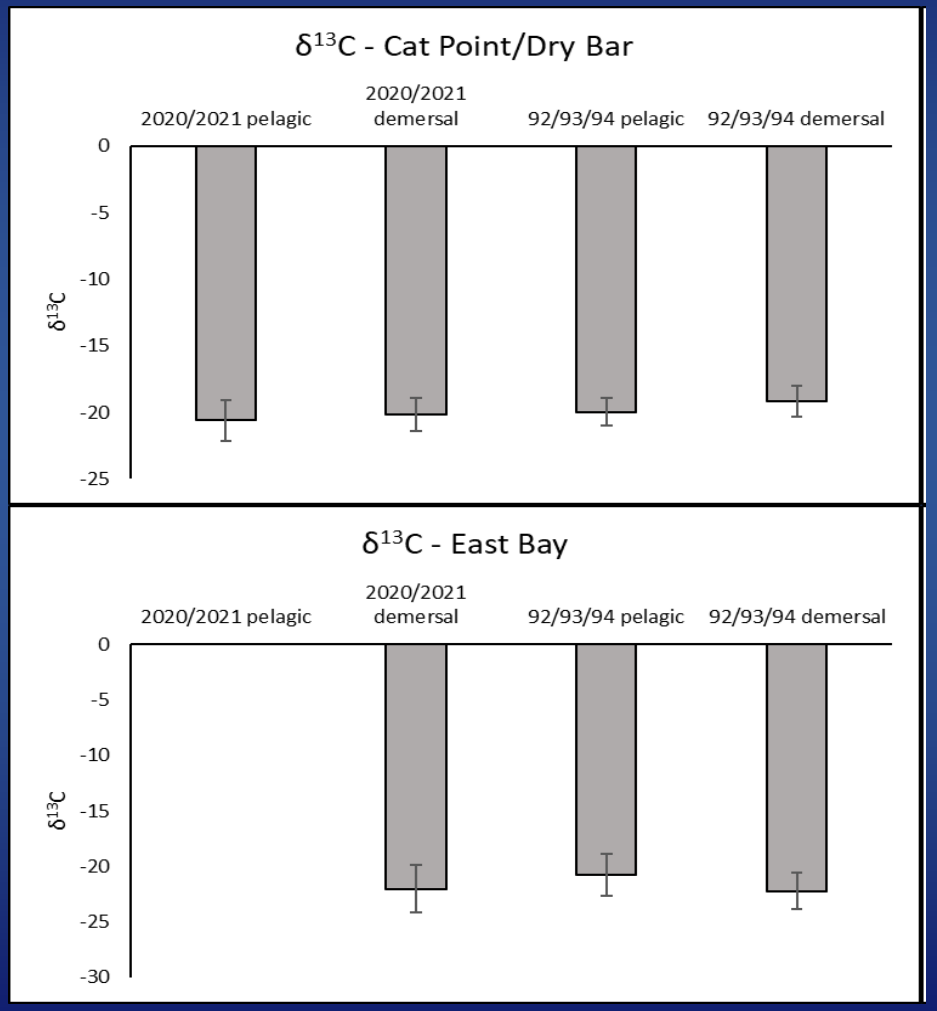
System Ecology

6.1 Apalachicola Bay food web and sediments 1994 vs. 2020 /2021

Changes in $d^{13}C$

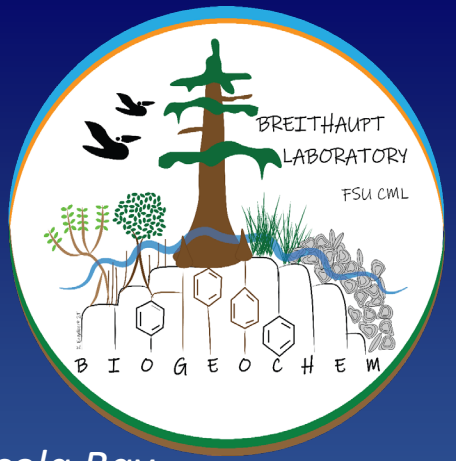


Negative values – more terrestrial input in 2021 vs 1994



NSD between demersal and pelagic fish species from 2021 vs 1994

System Ecology



6.2 Influence of oysters on function and change in coastal systems

1. *Investigating changing benthic sediment characteristics in Apalachicola Bay*
   Sediment organic carbon has increased since 1960s

2. *Oyster Shell Dissolution Dynamics in Apalachicola Bay Region*
   Oyster shells dissolve faster in mesocosms with mangrove soil and subtidal mud

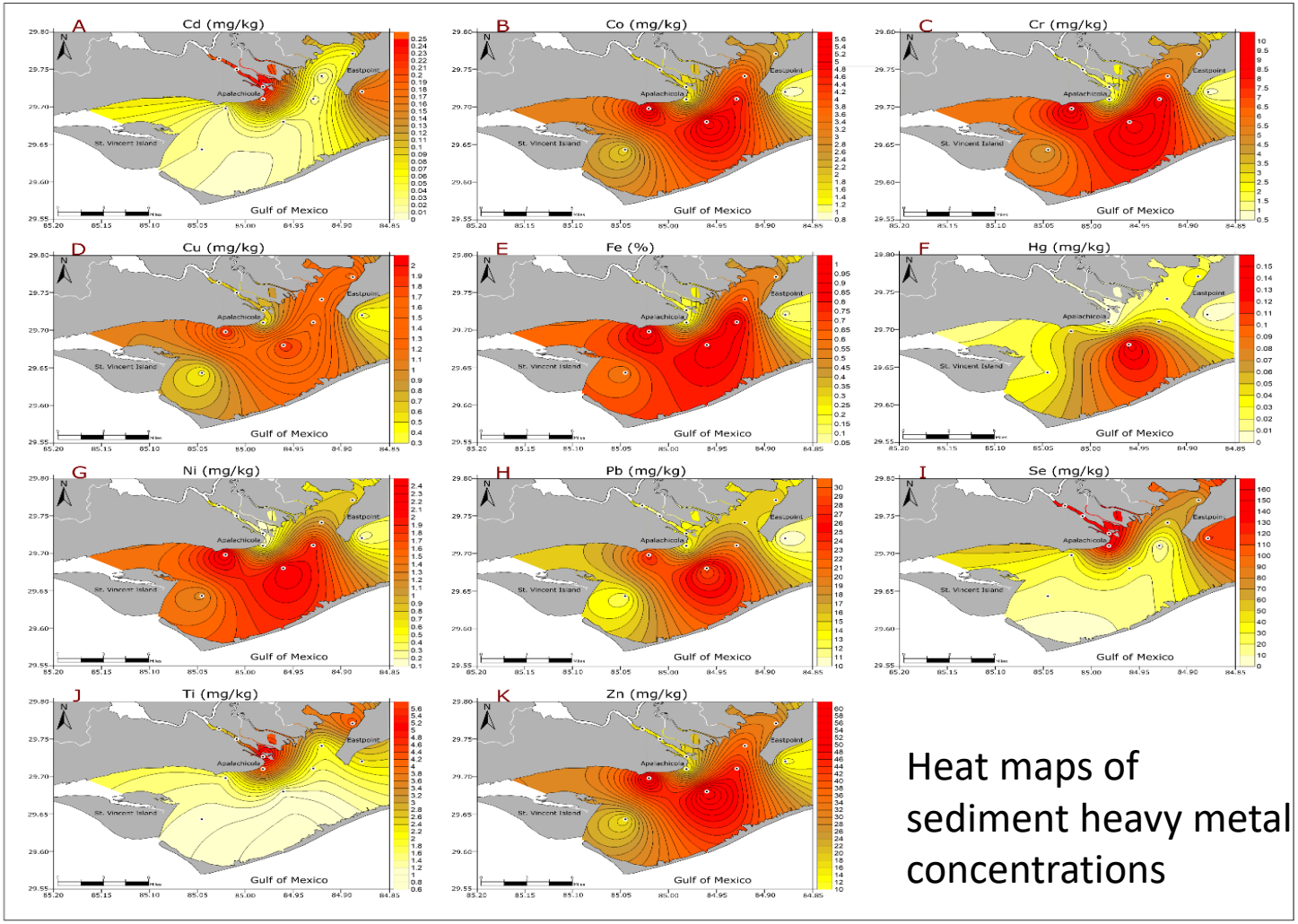
3. *Coastal carbon dynamics occurring because of mangrove replacement of regional tidal marshes*
   Mangroves are not altering soil carbon storage – yet…

4. *Vulnerability of regional wetlands to sea-level rise and changing sediment delivery from Apalachicola River*
   Regional wetland surface elevation dynamics vary by geomorphic setting

System Ecology

6.3 Apalachicola Bay environmental evolution and pollutant status

Assess concentrations of heavy metals and pesticides in sediment cores
Assess temporal changes in foraminifera (bio-indicators) over time



Heat maps of sediment heavy metal concentrations

Priority tasks

Integrate river and estuarine models to run climate and management scenarios

Design and deploy a new restoration experiment

Repeat spat deployment experiment with adjusted methods

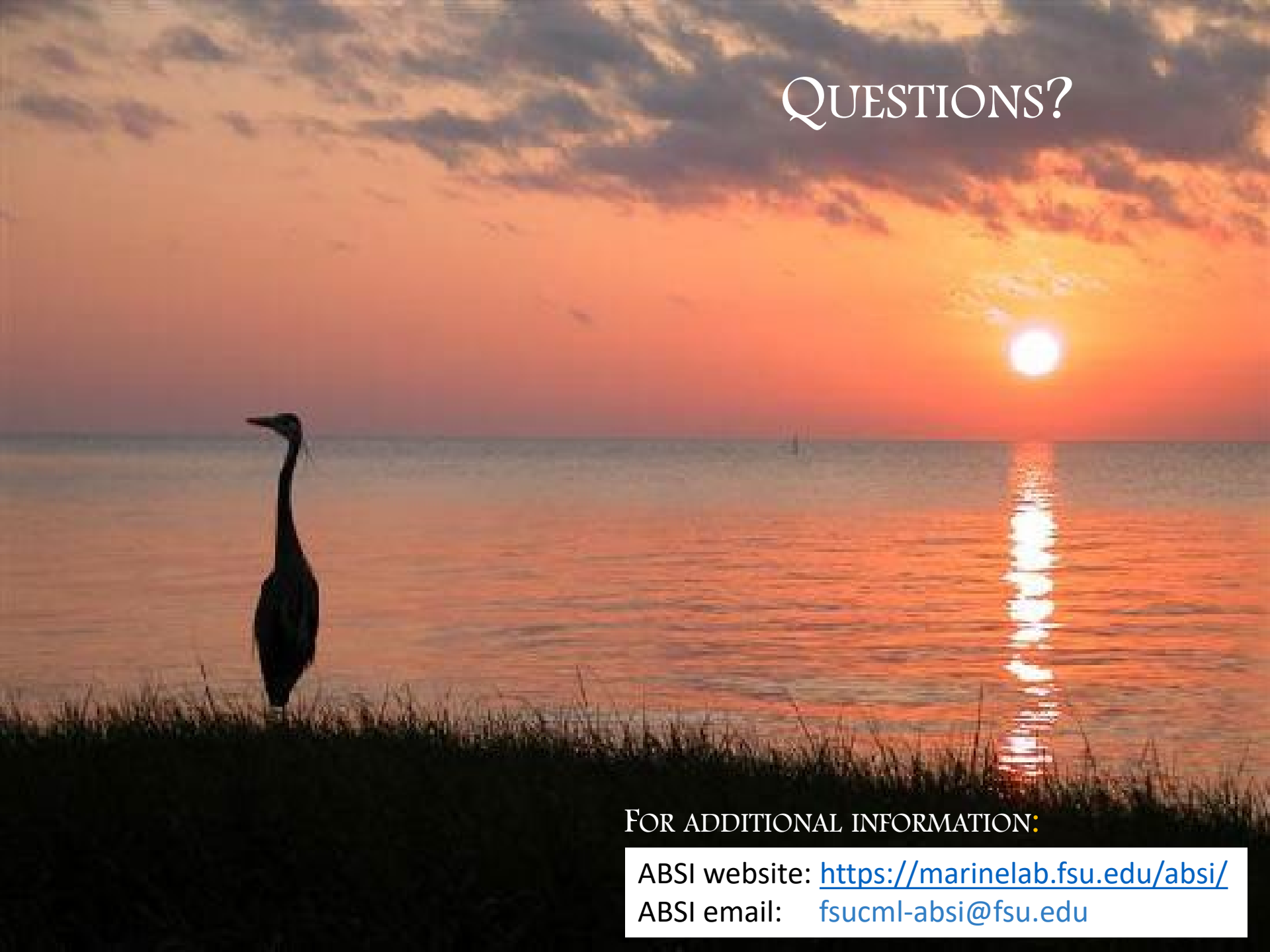
Develop options for interactive tools

SAB input

Identification of data gaps

Suggestions for design of a new restoration experiment, including use of spat on shell

Options/ideas for interactive tools



Questions?

For additional information:

ABSI website: https://marinelab.fsu.edu/absi/
ABSI email: fsucml-absi@fsu.edu

DATA overview

ABSI

- ABSI Data on Access Database (K drive) and ArcGIS Online (cloud service)
- ABSI Intertidal Monitoring
- Spat Trap Data
- Subtidal Tonging
- Cage Study (Survival, Settlement, Heights)
- Experimental Plots (Density, Heights)
- GIS data
  - Past plantings*
  - Recent plantings – accurate
  - Presence absence of oysters
  - Sonde locations
  - Historic bathymetry
  - Points and polygons for all sites
  - And more!
- Water quality (in .csv) Jan 21 –Dec 21 and still collecting data

Partners

- FWC Monitoring Data
  - Raw data (15-20)
  - Ed Camp's Modeling Data (87-18)
- FWC Commercial Landings (86-19)
- FDACS planting data*
- ANERR Data
  - Not stored locally
  - Download from CDMO directly (cumbersome)
  - Or use the r package called SWMPr

* Suspicions that it might be an incomplete dataset.