Combining high resolution models with biological data to create estuarine metrics that can be integrated into water management plans for Apalachicola Bay

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APALACHICOLA BAY OYSTER FISHERY

- 2012: Oyster populations collapsed
- 2013: Wild oyster harvest declared a Federal Fishery Disaster
- 2015-2017: $millions invested in >500 acres of oyster restoration
- Harvest continued
- Oyster populations declined further
- Reefs were severely degraded
- 2020: Fishery closed for 5 years

Apalachicola Bay System Initiative (ABSI)

Funded in 2019 by Triumph Gulf Coast Inc. and Florida State University

ABSI Overarching Goals

Use Research and Community Engagement to:

- **Understand why Apalachicola Bay oyster populations continued to decline despite significant restoration - and develop a pathway for recovery**
- Determine whether loss of oyster populations is causing a decline in overall ecosystem health?
- Develop a science-based adaptive restoration and management plan for the Apalachicola Bay System

What Happened to the oysters?

Droughts Reduced River Flow

↓

Increased Salinity

↓

Increased Predators, Parasites and Disease

↓

Increased Mortality, especially juveniles

↓

Recruitment failure

Shell Removed

Insufficient Replenishment

↓

Habitat Degradation

Oyster population collapse

Combined effects of suboptimal environment and habitat limitation

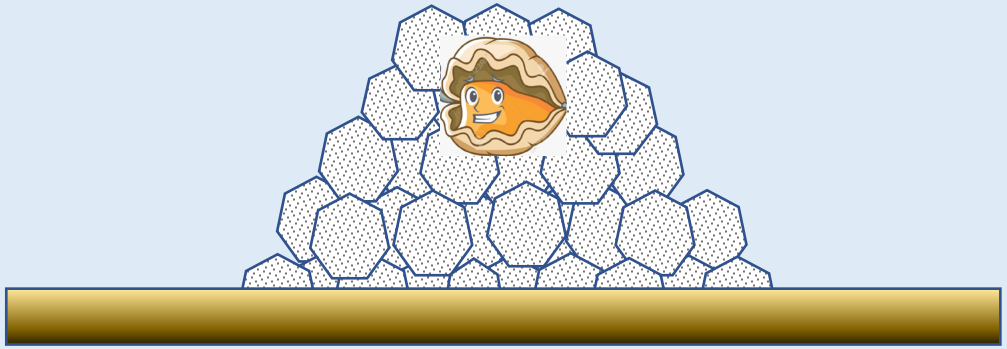
Oyster Habitat Restoration

Past Restoration Efforts

Used a thin layer (3-8 cm) of shell or small rock
Material not persistent
Oysters vulnerable to burial, suffocation or hypoxia

ABSI Restoration Experiments

Created higher reefs to lift the oysters into clean water
Used larger material to create a more stable foundation



2021 ABSI Experiment

2 locations: West and Eastern Bay

3 treatments, 5 replicates:

- Shell
- Small rock (5 cm)
- Large rock (12-18 cm)

Reef height 50 cm
Reef footprint 10 m x 10 m

2023 ABSI Experiment

1 location: Eastern Bay

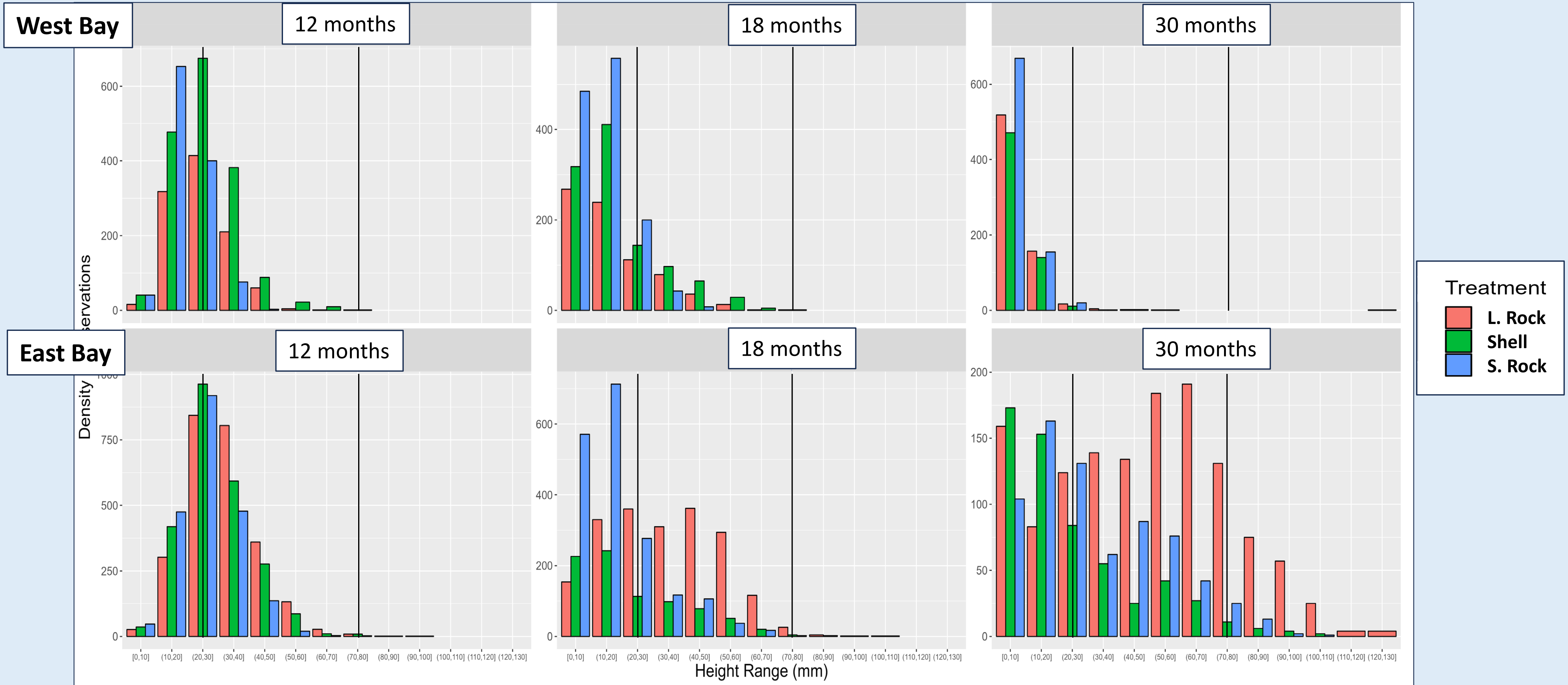
4 treatments, 4 replicates:

- Large rock (12-18 cm)
- Concrete (10-15 cm)
- Large rock with layer of shell
- Concrete with layer of shell

Reef height 38 cm
Reef footprint 15 m x 8 m

Results from 2021 Experiment

Shell: quickly dispersed and buried
Small rock: good spat set, few large oysters
Large rock: best overall, larger oysters, stable substrate
East Bay performed better than **West Bay**

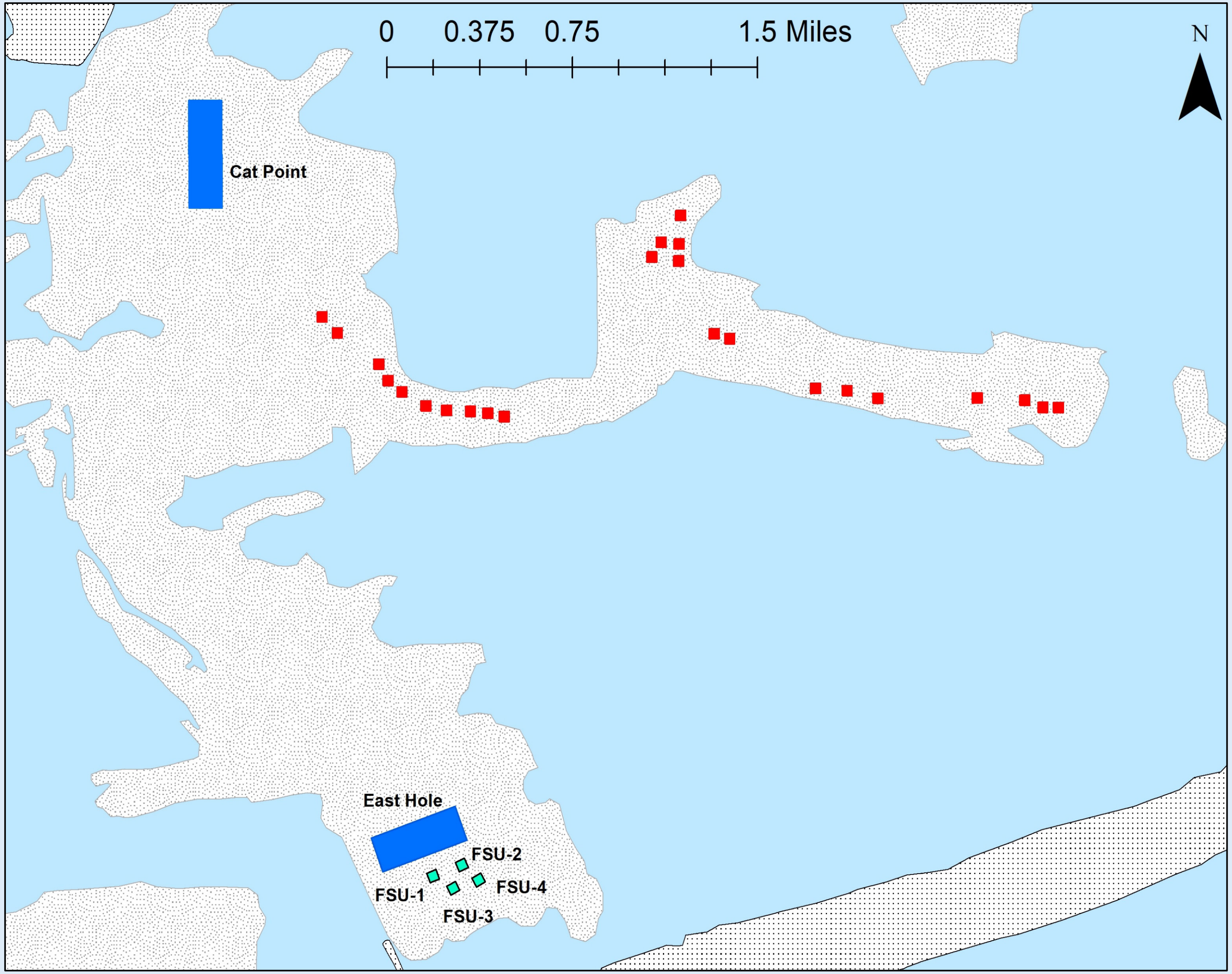


Fish and Wildlife Commission Oyster habitat restoration Spring 2024

- Limestone rock 10-20 cm

- 28 experimental 1-acre reefs each 30 cm or 60 cm high

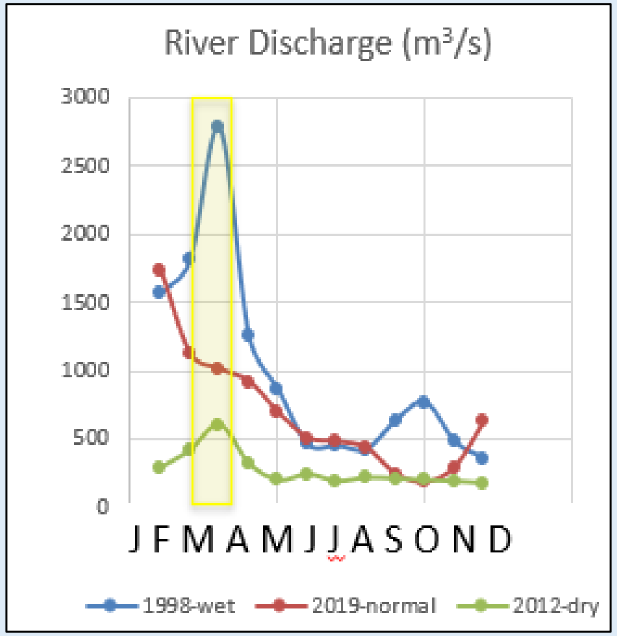
- 2 larger areas (~25 acres) each 15 cm high



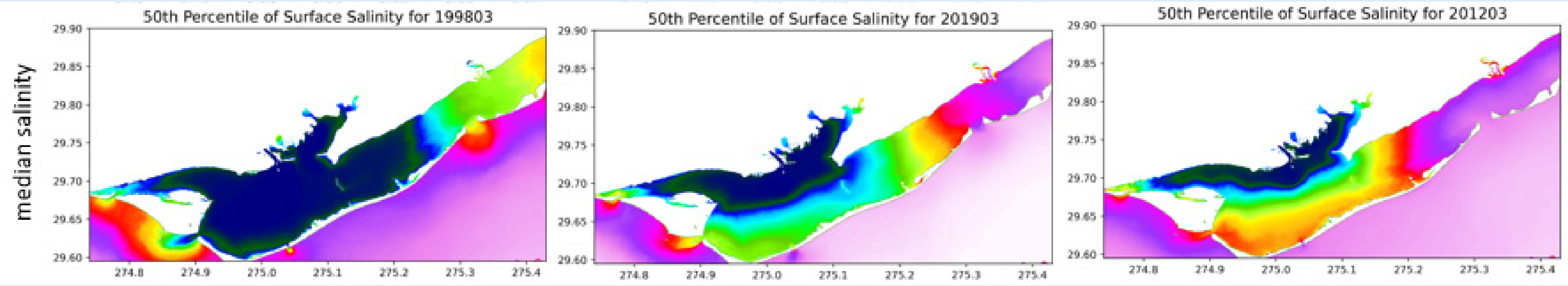
Understanding the Environment

ABSI Bio-physical model: Hydrodynamics and larval biology

1. Develop a high-resolution hydrodynamic model for the lower Apalachicola River, Apalachicola Bay, and surrounding coastal regions
2. Apply the model to develop simulations for past and future climate scenarios and **alterative management scenarios**
3. Characterize the variability of hydrographic properties throughout the bay for the different flow scenarios
4. Perform simulations of oyster larval dispersion to quantify larval survival and recruitment distribution
5. Apply model outputs to develop habitat suitability model for oysters



Maps of median salinity during wet, normal, and dry March

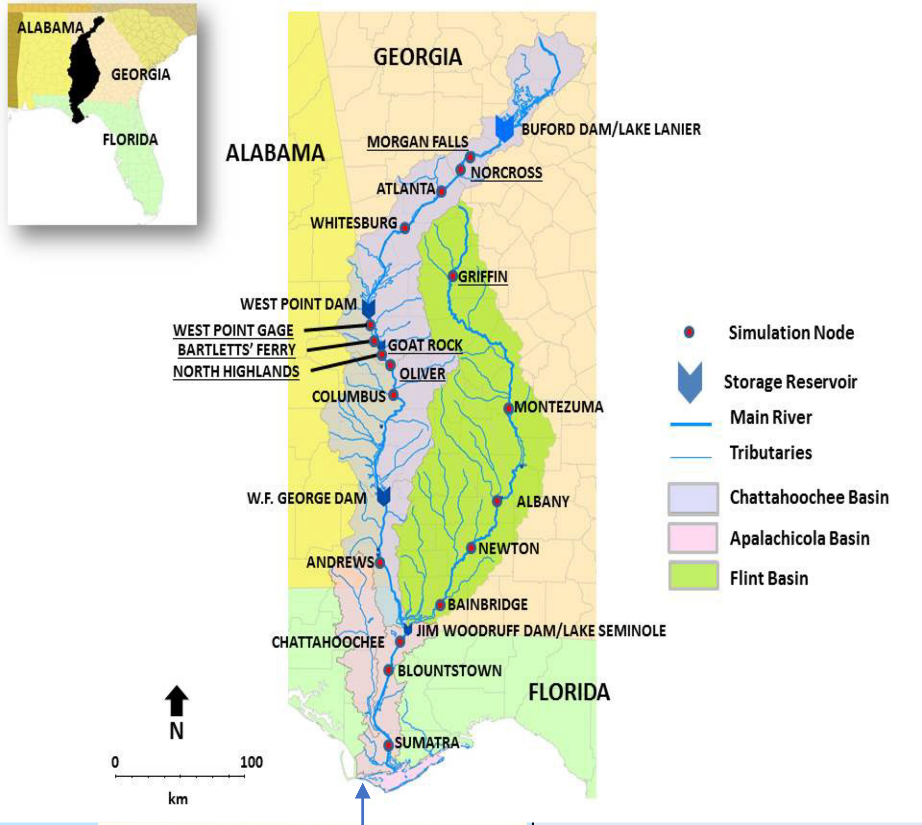


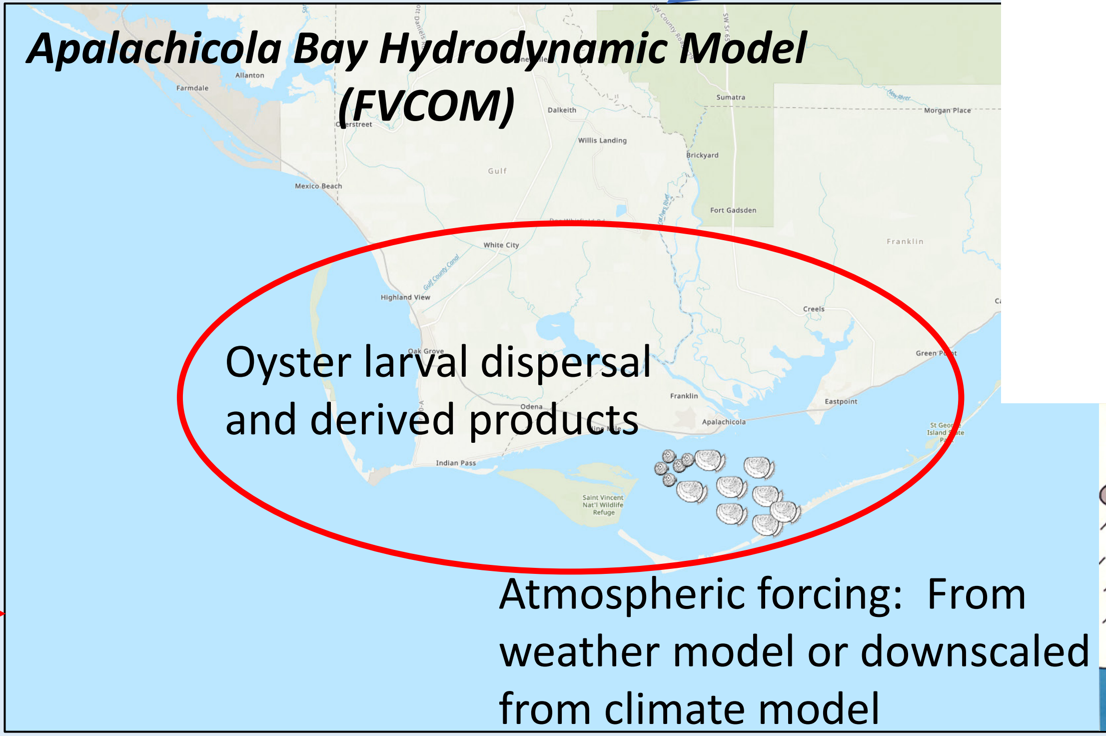
Wet (1998) Normal (2019) Dry (2012)

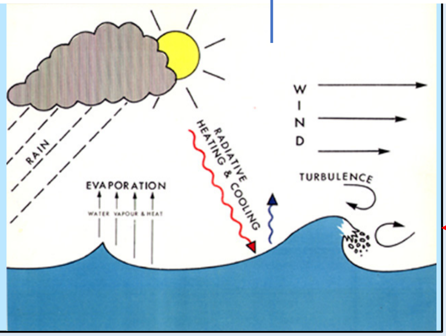
Credit: S. Morey and X Chen, FAMU

Combined River Discharge and Hydrodynamic Model

ACF watershed and Apalachicola River flow from ACF STELLA Model (S. Leitman) and downscaled FVCOM (K. Jones)







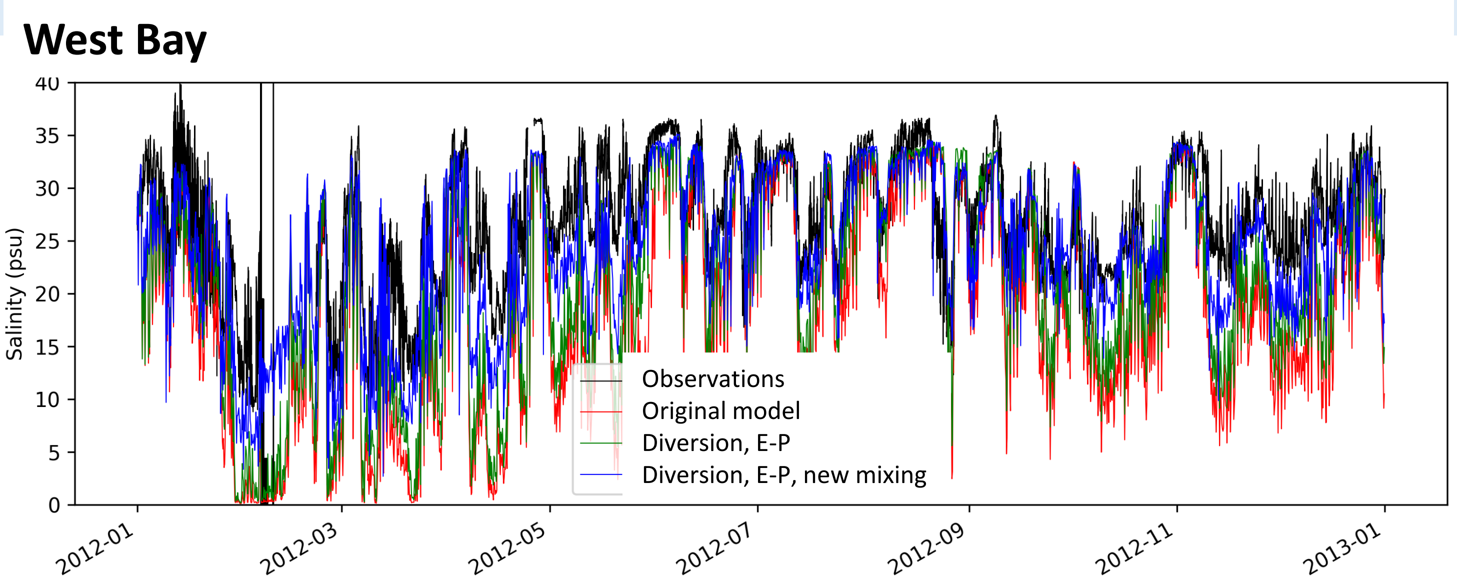
Forcing at boundary:

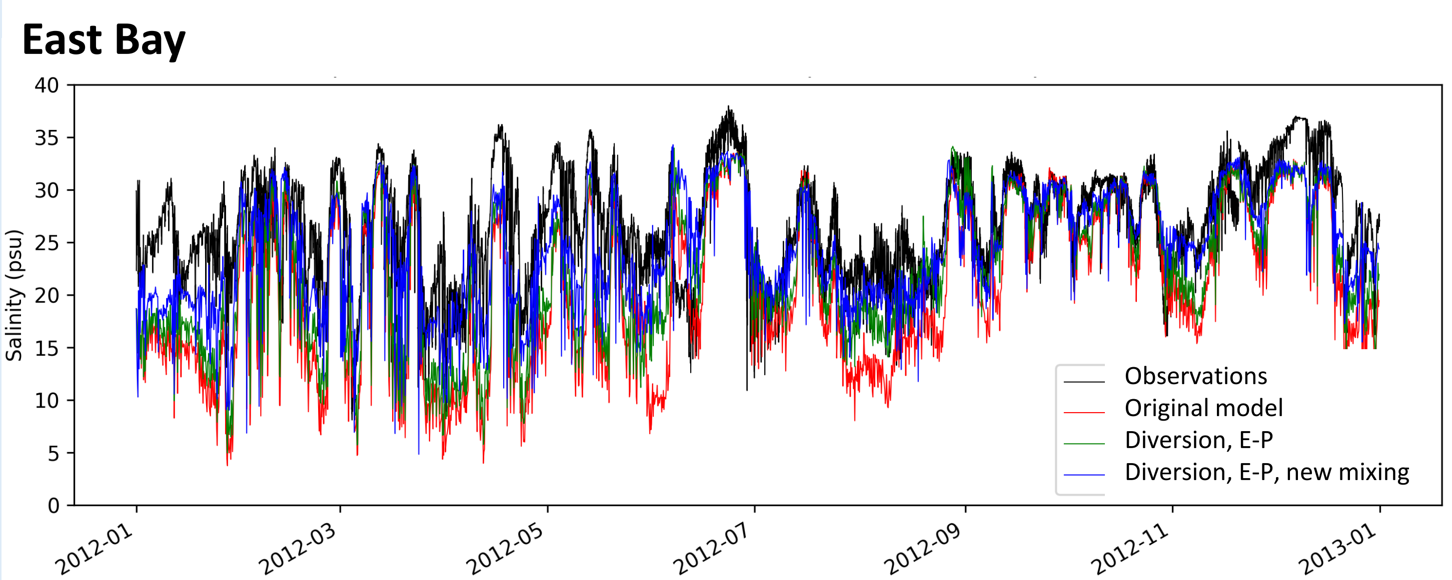
- Currents
- Temperature
- Salinity
- Water elevation (tides)

From Gulf of Mexico hydrodynamic model

Credit: S. Morey and X Chen, FAMU

Salinity Model vs. Observation in 2012 (Dry Year)





Model predicted consistently lower salinity than instrument data

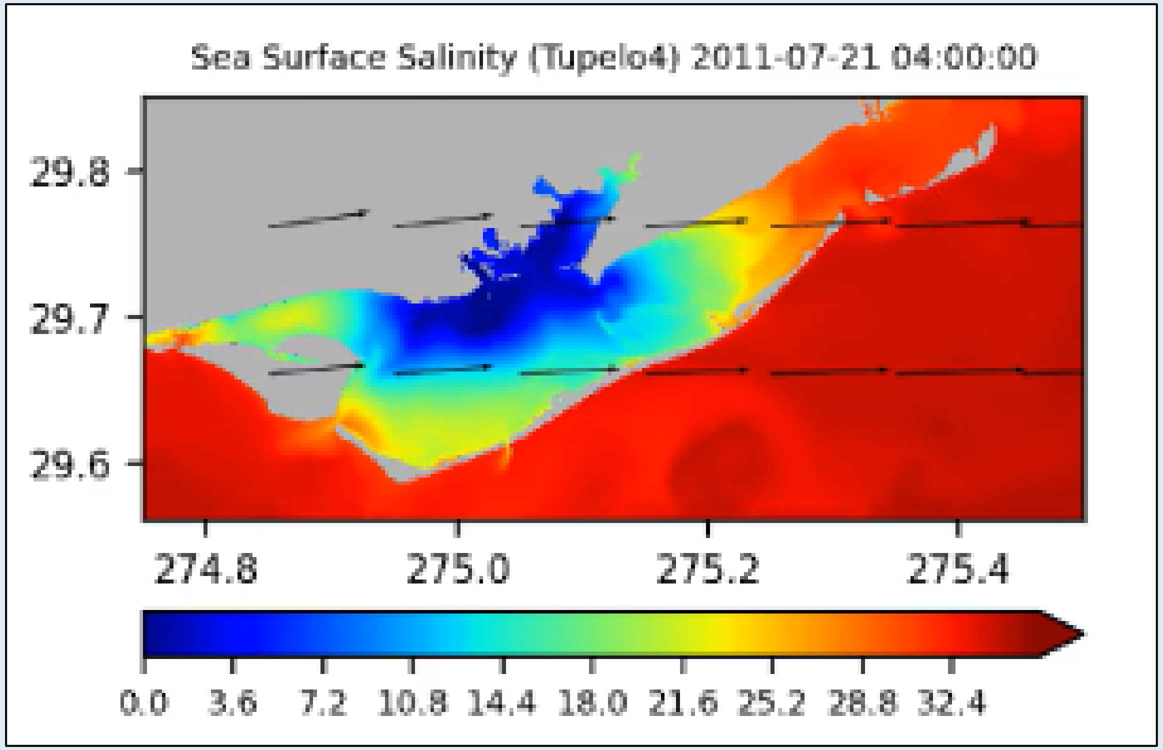
Anomalies greater during dry years

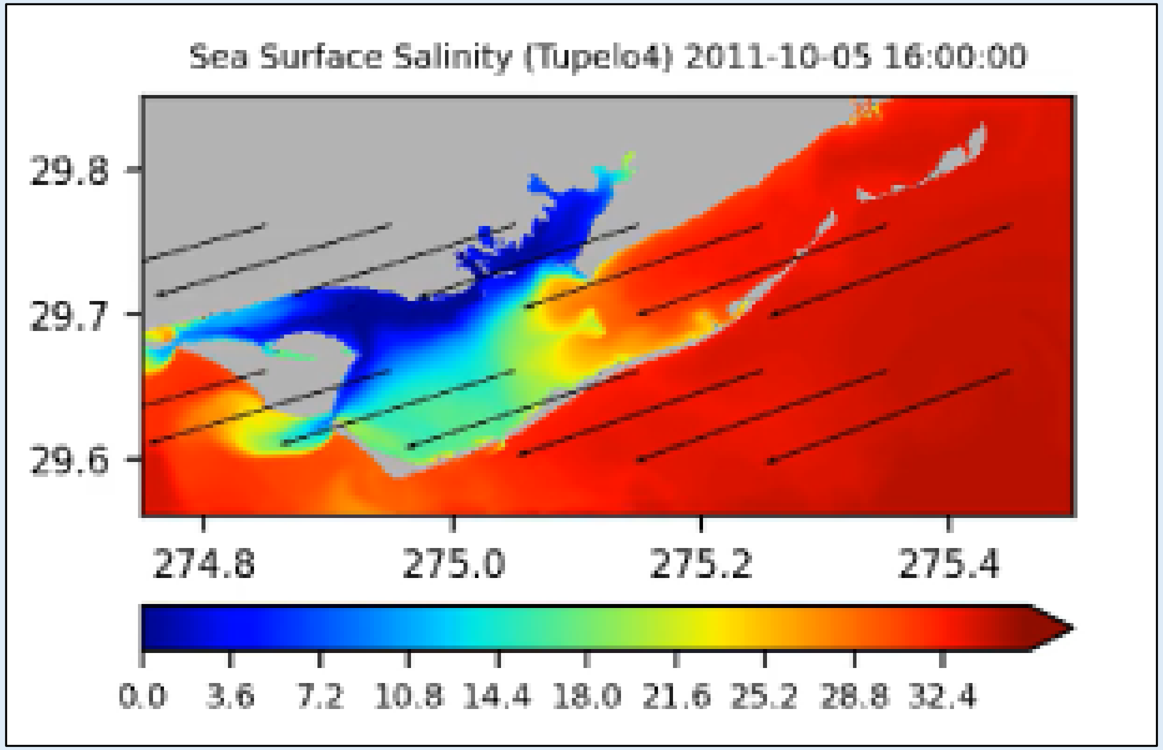
Problem: model predicted conditions favorable for oysters when they were not

Model resolved by incorporating balance of evaporation/precipitation, water column mixing and **diversion of water into Lake Wimico**

Credit: S. Morey and X Chen, FAMU

Seasonal changes in wind direction drives freshwater residence time





Prevailing winds in the spring/summer are from the west, which retains freshwater in the Bay for several weeks

Prevailing winds in the fall are from the east, which rapidly pushes freshwater out of the Bay

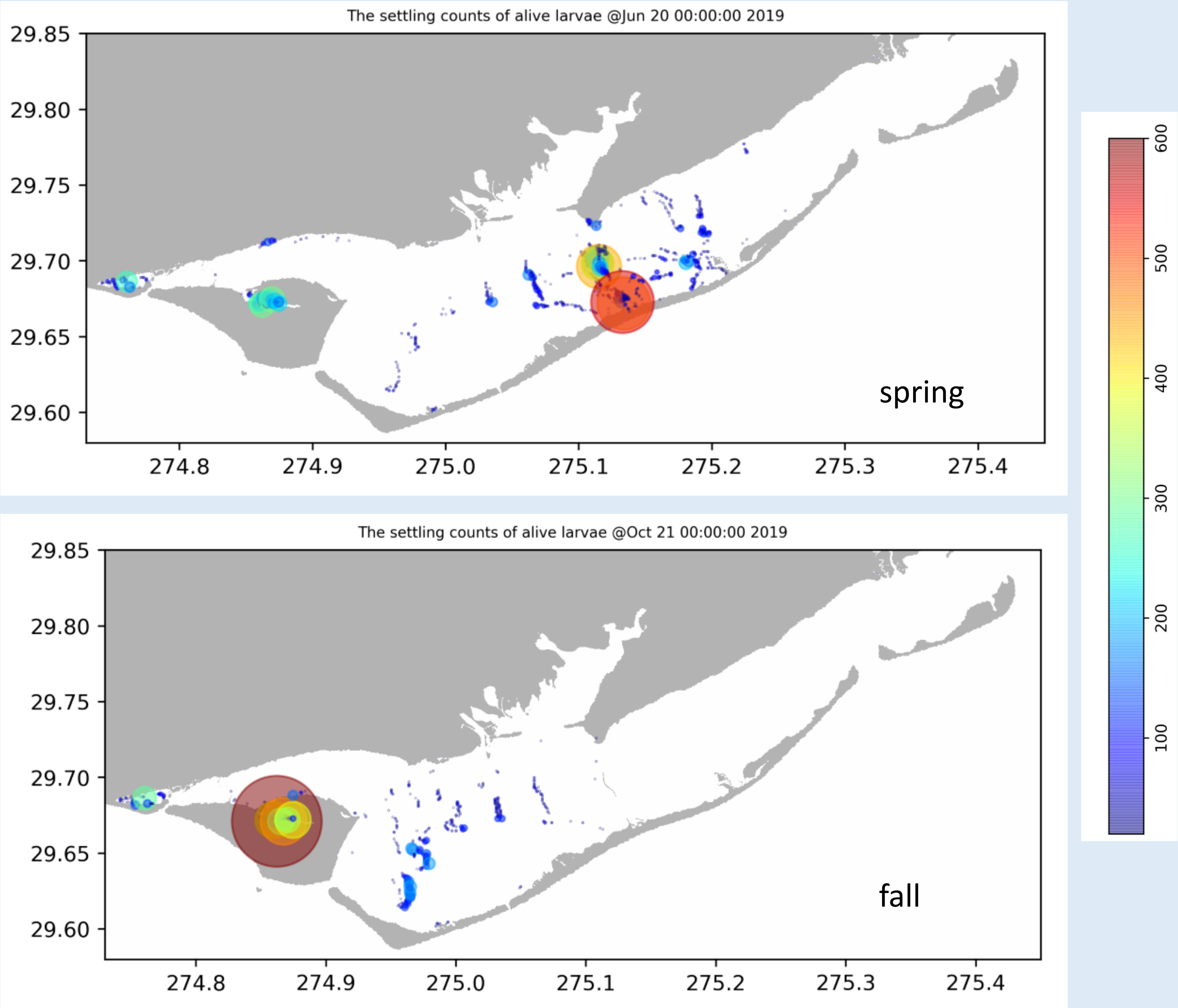
Individual-Based Larval Model (FVCOM I-State Configuration Model – FISCM)

- Larvae simulated as Lagrangian particles, each representing a group of larvae that travel together within 3-D velocity field.
- Larval groups released from historic oyster bars during spawning periods (May-June or September-October) every 6 hours for 30 days
- Simulations run for 60 days
- Model parameterized with oyster larval physiological data

Credit: S. Morey and X Chen, FAMU

Seasonal differences in larval recruitment

Shift in larval settlement patterns to the west during fall season



Credit: S. Morey and X Chen, FAMU

Model Applications and Next Steps

Assess quantity and timing of freshwater needed to optimize salinity footprint and flow fields during oyster spawning periods

Develop a series of estuarine metrics that will help identify optimal conditions for multiple species in the ACF (e.g. Oysters, Tupelo trees, Gulf Sturgeon)

Identify potential flow scenarios that can extend optimal ecosystem-wide conditions under dry, normal and wet climate periods

Work with ACOE and other management entities to develop regional water management plans

Apply hydrodynamic model to other applications e.g. fisheries management

Acknowledgements

Collaborators

Steve Morey and Xu Chen

Florida Agricultural and Mechanical University

Steve Leitman

Florida State University (Emeritus)

Ken Jones

Rhumbline Consultants

Funding

Triumph Gulf Coast Inc.

TRIUMPH GULF COAST