Evaluating trophic position and carbon dynamics in created coastal marsh ecosystems using stable isotopes

Katelyn Lamb*, Paola Lopez-Duarte, Jill Olin, Charles Martin, Brian Roberts, Erick Swenson, Linda Hooper-Bui, Michael Polito

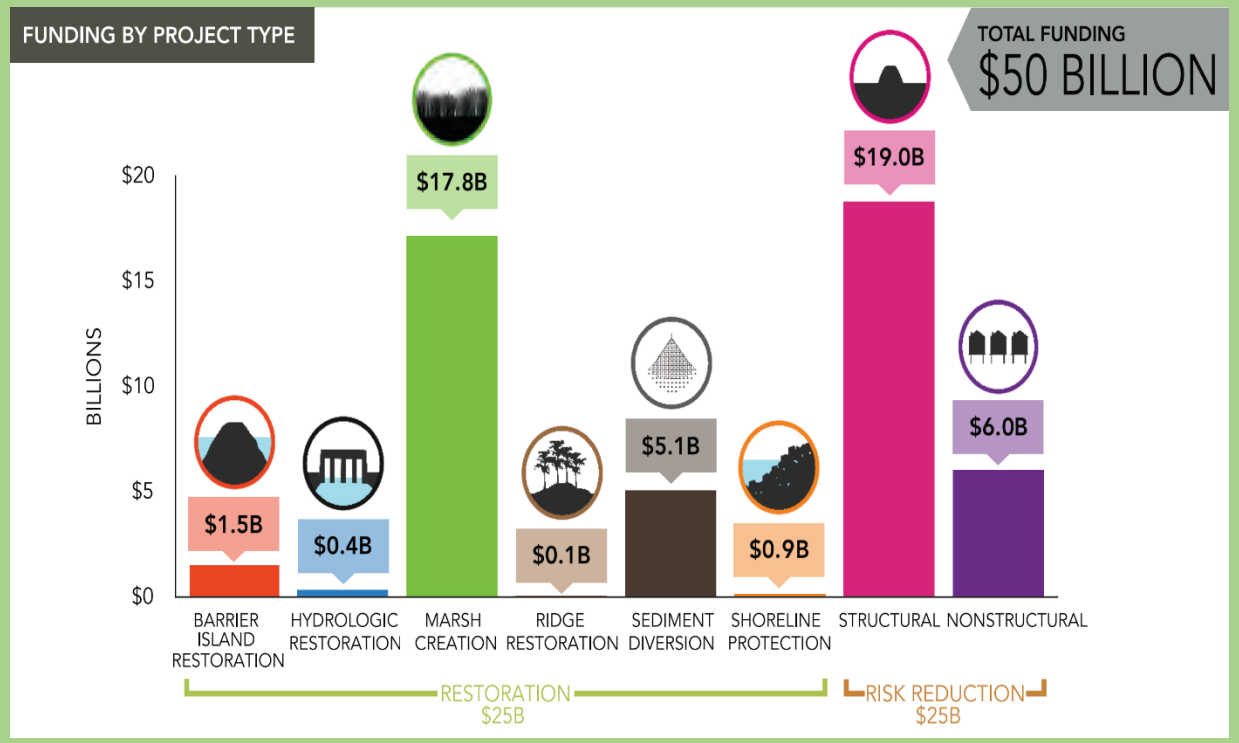
Louisiana is losing its boot (i.e. coastline)!

From the early 1930s to 2000, Louisiana lost an area close to the size of Delaware.

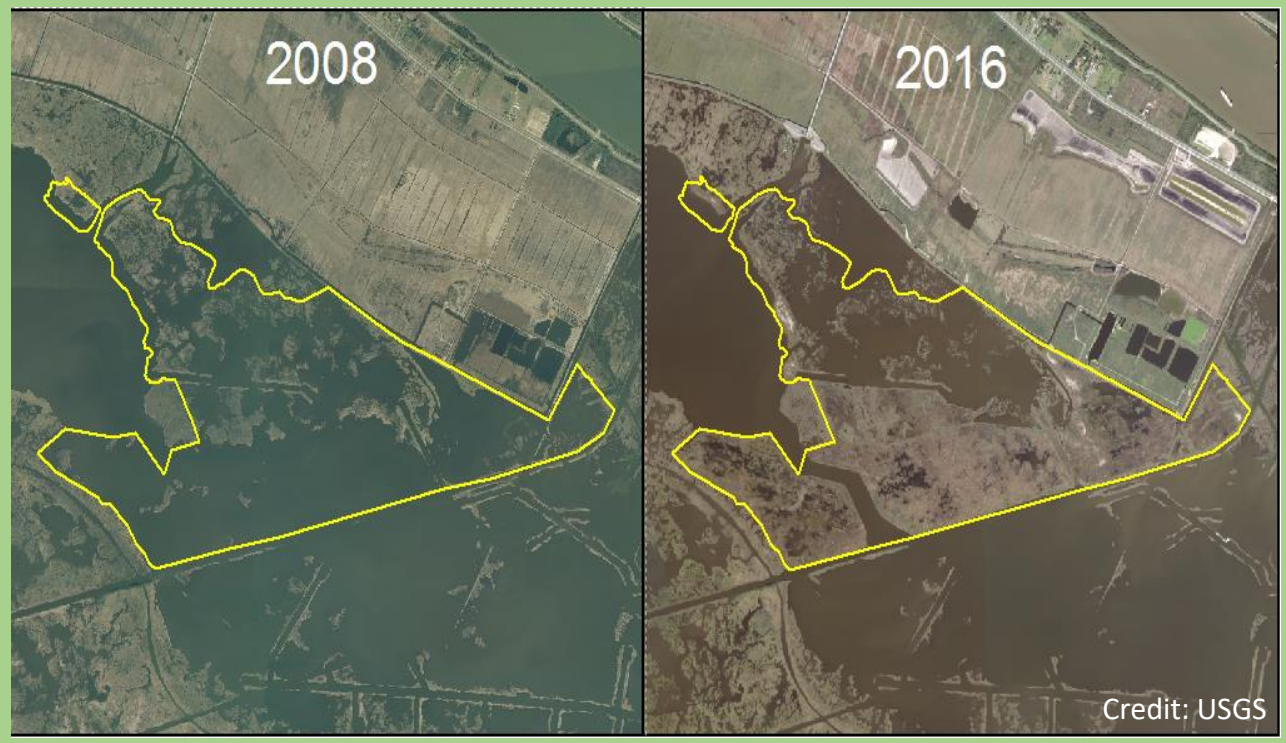
Land creation is expensive

(but it works)

2017 Louisiana Coastal Master Plan Project Budget



Lake Hermitage Marsh Creation Project Area



It looks like a marsh and smells like a marsh, but does it function like a marsh?

Most monitoring efforts evaluate structural characteristics such as:

- Dominant vegetation
- Elevation
- Soil and water chemistry
- Nekton abundance

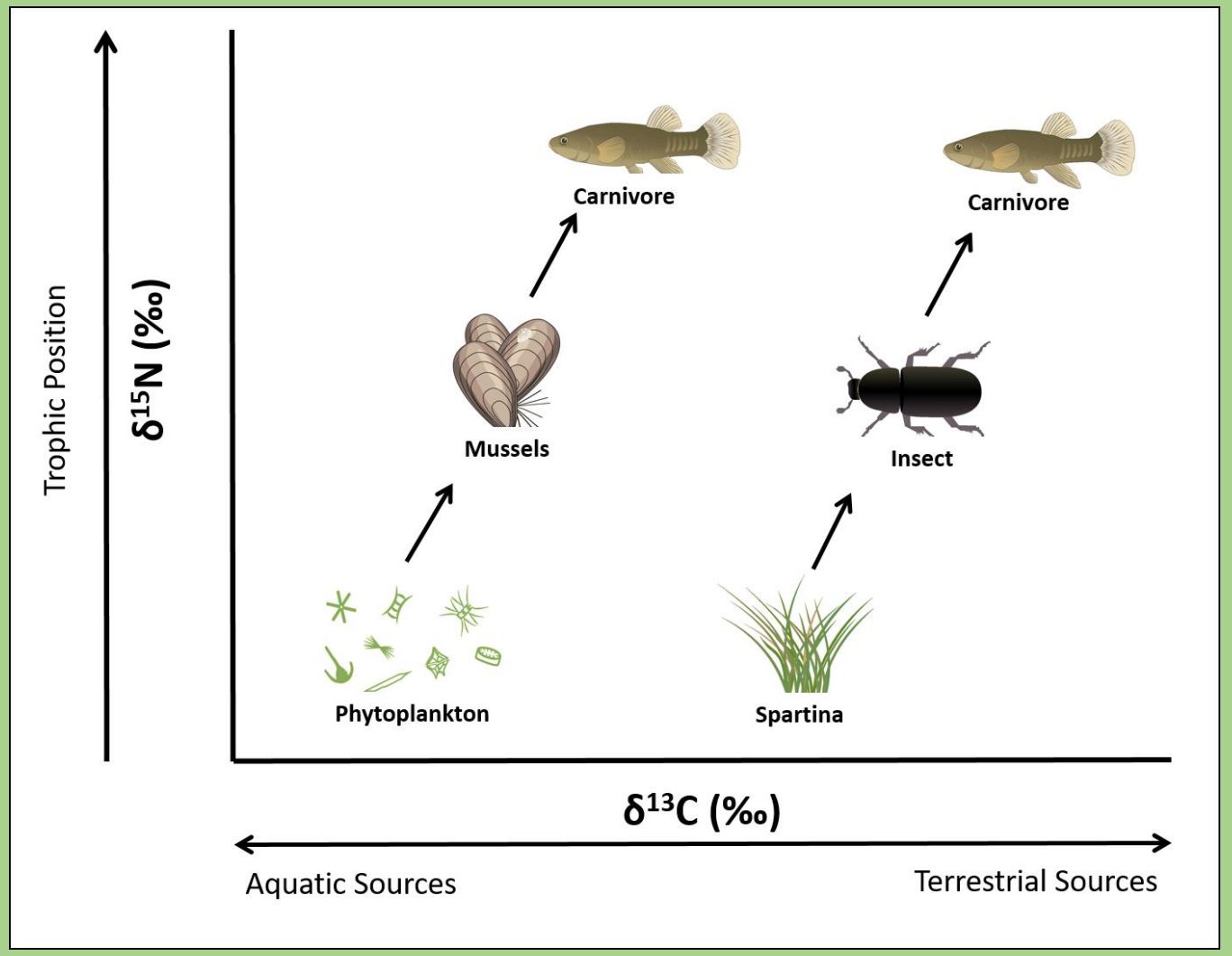
<u>Limitation</u>:
No method directly examines functional qualities like the flow of energy and nutrients through the food web.

Stable isotope analysis (SIA) as a measures of marsh function

"You are what you eat."

$\delta^{15}N$ is a proxy for trophic position (TP).

$\delta^{13}C$ traces basal carbon source utilization.



Objectives

Objectives

Created vs. Natural Marshes: Food Web Edition

1. Compare the trophic structure of invertebrates and marsh fishes collected from created and natural marshes.

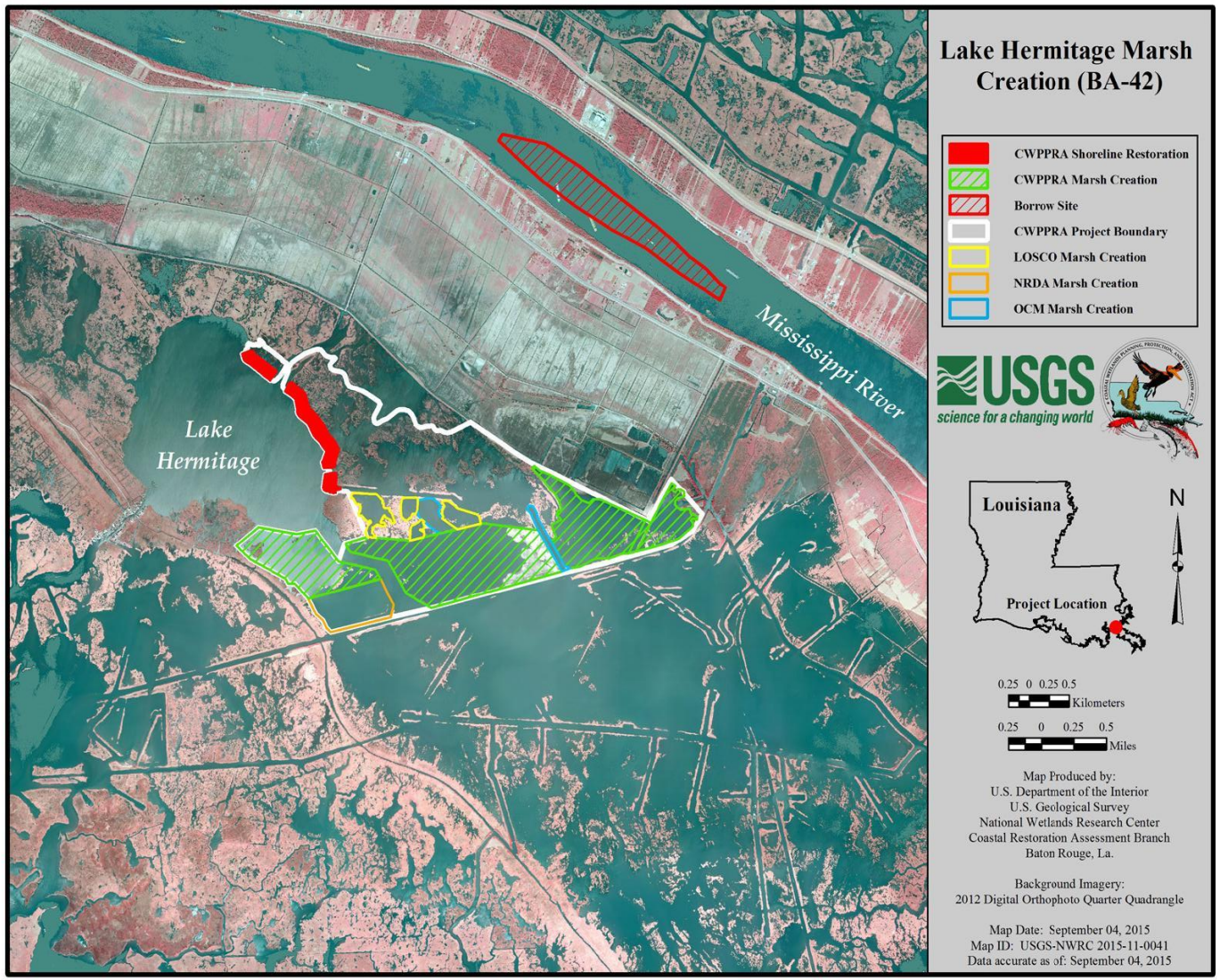
2. Compare the relative importance of terrestrial and aquatic carbon sources to the food webs at created and natural sites.

Study Area

Lake Hermitage Marsh Creation Project Area

Located in West Point a la Hache Plaquemines Parish, LA

Two created sites and two natural, reference sites sampled in May 2018



Methods

Field Sampling & Tissue Collection

Primary Producers

- C_4 Plants: *Spartina alterniflora*
- C_3 Plants: *Juncus roemerianus, Phragmites australis*
- Phytoplankton: POM, BMA

Primary consumers:

- Barnacles
- Ribbed Mussels
- Oysters
- Blissids
- Leafhoppers

Consumers:

- Brown Shrimp
- Blue Crab
- Grass Shrimp
- Gulf Killifish
- Inland Silverside

Consumers were dissected and muscle tissue was collected

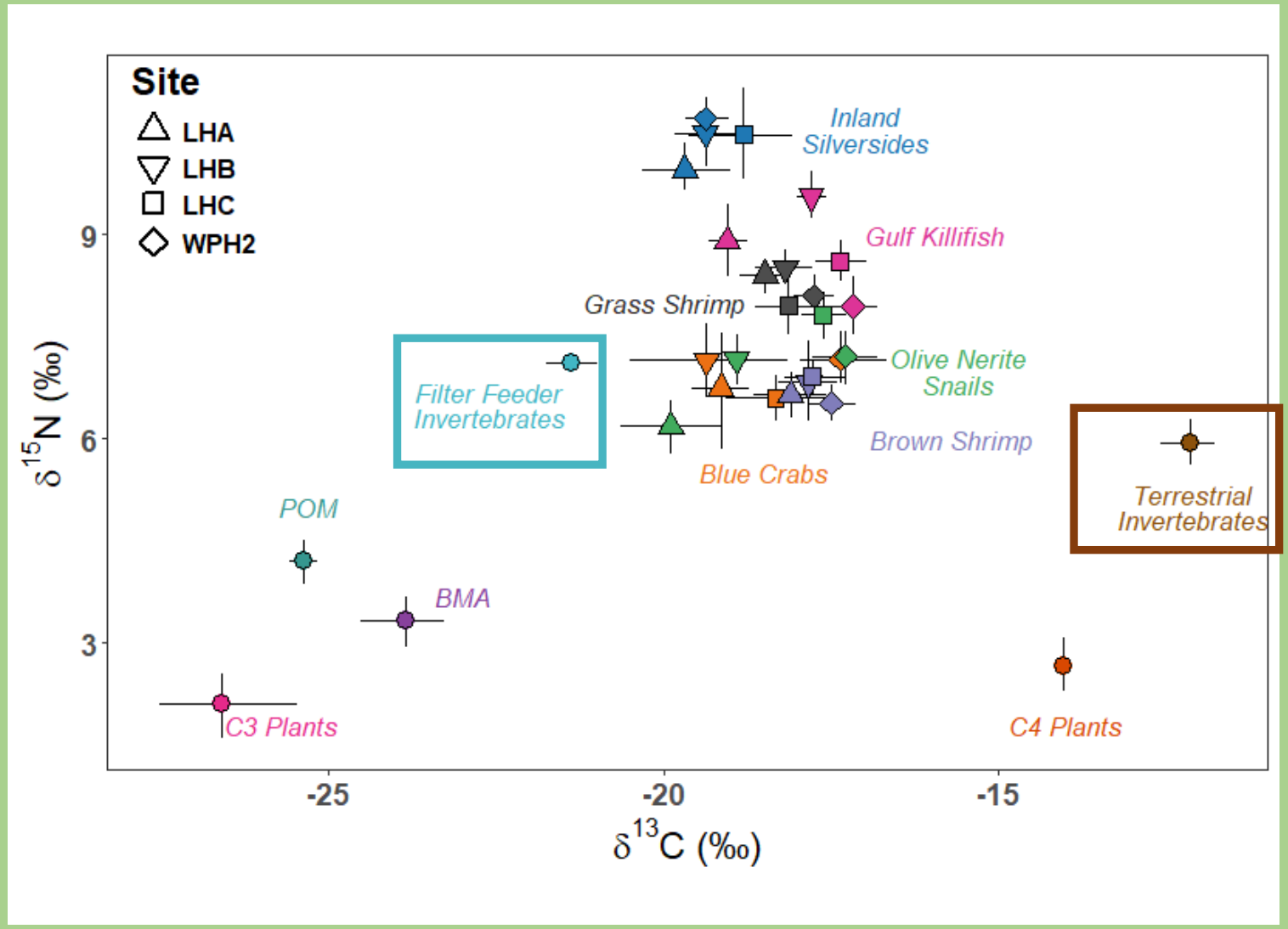
Average sample size, $N = 12$

Data Collection & Analysis

- Bulk Stable Isotope Analysis (SIA)
  - $\delta^{13}C$, $\delta^{15}N$
- tRopthicPosition (Quezada-Romegialli et al. 2017)
  - Trophic position (TP)
  - Relative Carbon Use (α)
    - Aquatic baseline: filter-feeders (barnacles, ribbed mussels, & oysters)
    - Terrestrial baseline: insects (blissids & leafhoppers)

Results

Consumer isotope values fall between the aquatic and terrestrial baselines



Consumers have similar trophic positions at created and natural sites

Olive nerites at both created sites differed significantly from natural sites:

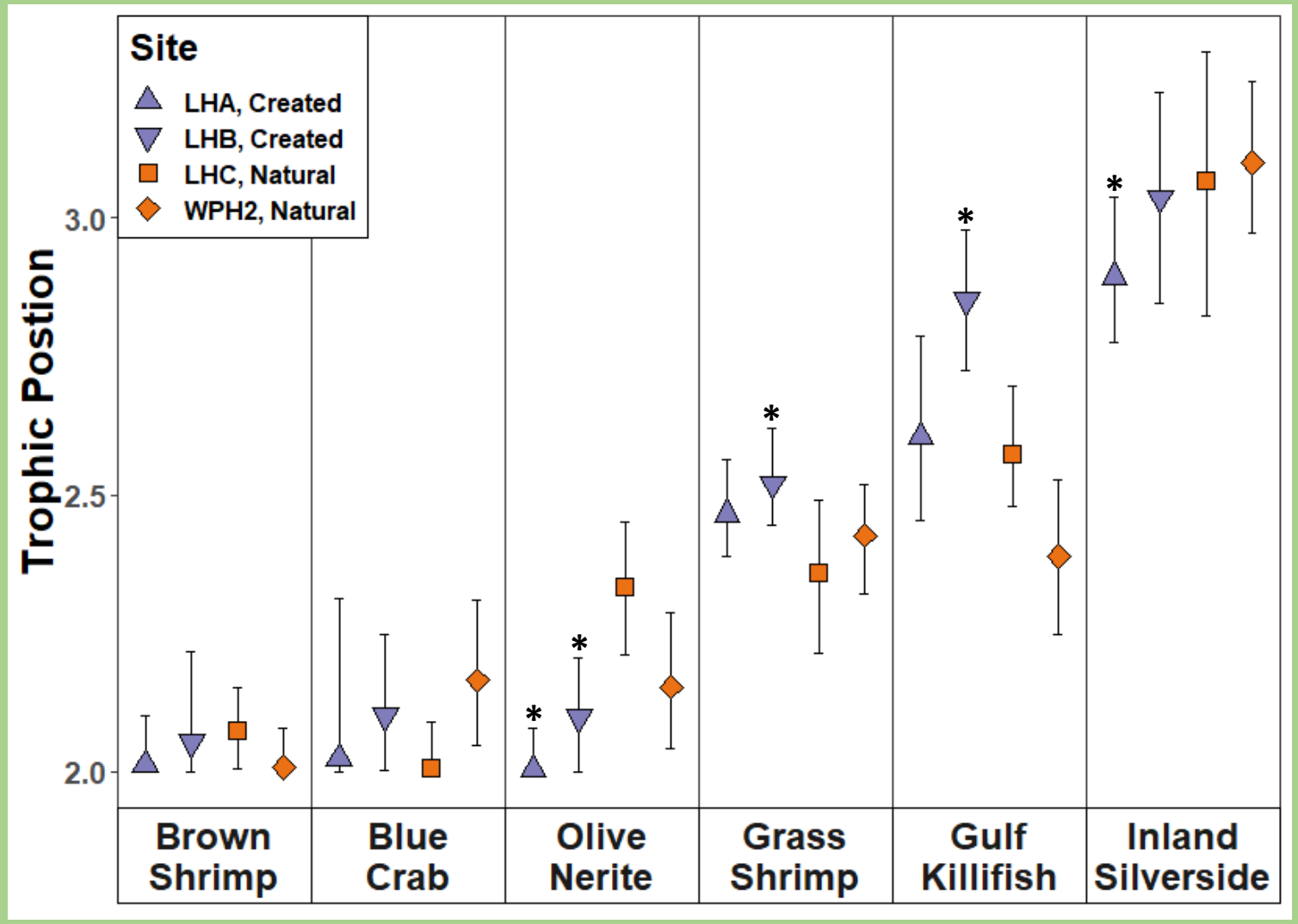
$$TP_{created} < TP_{natural}$$

Grass shrimp and **gulf killifish** from one created site (LHB) differed significantly from natural sites:

$$TP_{created} > TP_{natural}$$

Inland silversides from one created site (LHA) differed significantly from the natural sites:

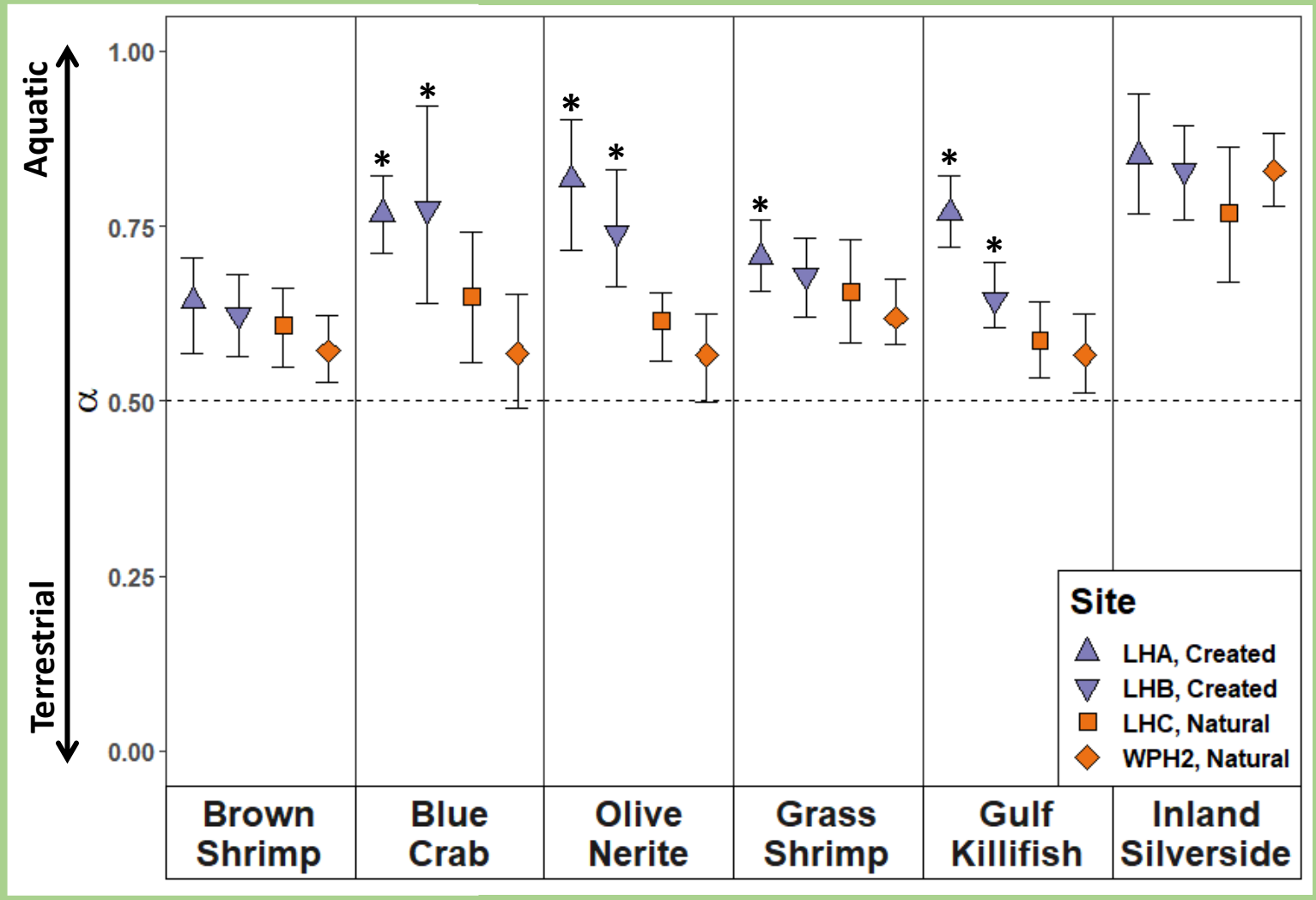
$$TP_{created} < TP_{natural}$$



All consumers primarily utilize aquatic carbon but…

Consumers from natural marshes show a significant shift towards the terrestrial baseline

Inland silversides and **brown shrimp** showed no differences across sites.



Do created marshes function like natural marshes?

1. There were few differences in trophic structure between created and natural sites. When differences were detected, the direction of the difference was inconsistent.

2. Consumers at created sites utilize a smaller proportion of terrestrial carbon, while others show no change.

Results preliminarily suggest functional differences in carbon dynamics in created marshes

Two working hypotheses developed based on preliminary results

H_1: Differences in carbon dynamics at created sites are due to an underdeveloped reservoir of terrestrial detritus.

Next Step: Compare soil organic matter content and SIA across sites.

Two working hypotheses developed based on preliminary results

H_2: Structural characteristics, such as elevation and inundation, control connectivity on the marsh platform and consequently habitat utilization of marsh nekton.

Next Step: Use elevation mapping data, water level recordings, and drone imaging to estimate and compare inundation and connectivity across sites.

Implications for Restoration

This study will identify important structural properties that impact marsh function, in order to guide future restoration and monitoring practices

Results of this study will be incorporated into an ecosystem model that will inform stakeholders of the ecological progression and trajectory of created marshes in LA

Acknowledgements

Questions?

Funding

NOAA RESTORE

Project PIs

Michael Polito
Paola Lopez-Duarte
Jill Olin
Charles Martin
Brian Roberts
Erick Swenson, Linda Hooper-Bui
Annette S. Engel
Nancy N. Rabalais

Field Team

Mario Hernandez
Rohit “Ro” Kalvakalvaa
Allison Benelli
Maggie Shaw
Whitney Scheffel
Scott Alford
Eddie Weeks

Lab Work:

Hayat Bennadji
Thinh Huynh
Joseph Daigle
Katerine Kjos
Philip Brahana
Noah Jeffers
Madalyn Mouton