Effects of River Diversions, Restoration, and Salinity on Fishes and Invertebrate Community Structure in Southeast Louisiana Marshes

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Abstract

Salt marshes are productive ecosystems that provide a variety of benefits, including protection from storms, carbon sequestration, nutrient removal, and food and refuge for the juveniles of many recreationally and commercially important species. Despite these benefits, Louisiana is losing marshes at an unprecedented rate of over 40 km^2 per year, in part due to a lack of sediment supply from freshwater inflow. Several solutions have been proposed to rebuild marshes, including reestablishing the natural hydrology of the Mississippi River and targeted placement of sediments in heavily eroded areas. However, the successional trajectory of fish and invertebrate community structure as it relates to restoration practices and changing salinity patterns due to riverine input, as well as the interactive effects, remains unclear. Here, we present preliminary fish and invertebrate data from marshes near the West Pointe a la Hache siphon. In year 1 of this project, we conducted trawls and suction sampling to quantify the abundance, diversity, and community structure of organisms in a range of natural and previously restored marshes. In years 2 and 3, we anticipate that the siphon will be operational and hypothesize detectable shifts in nekton community structure along both restoration and salinity gradients. These data will provide valuable information for environmental managers to determine best practices for operating diversion structures and marsh restoration methods to maximize fisheries production and will increase our knowledge of anthropogenic impacts, and mitigation efforts, in a rapidly changing ecosystem.

Introduction

- Increasing coastal wetland loss represents a **significant threat** to coastal Louisiana's natural resources.
- Given that salt marshes provide **numerous valuable ecosystem services**, ranging from habitat and food sources to serving as a buffer from high energy storm events, maintaining/restoring these areas is a **priority**.
- Among the many approaches maintaining salt marsh is **building marshes** using dredge spoil and reintroduction of the Mississippi River to **supply freshwater and sediment.**
- Here, we present fish and invertebrate data from **Year 1 sampling** of a 3-year project to determine the interactive impacts of created marshes and Mississippi River water introduction from the West Pointe a la Hache siphon (**FIGURE 1**).
- In Year 1 (May 2018), the siphon is off **providing critical baseline information**.
- Future sampling events will be conducted with the **siphon on**.

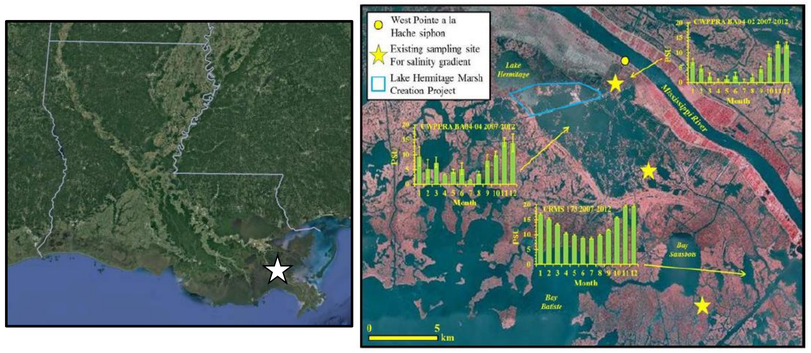

FIGURE 1. Location of the West Point a la Hache siphon (white star) in coastal Louisiana (left), with specific sampling sites (right), including created marshes (blue outline) and natural marshes (yellow stars) along a salinity gradient (E. Swenson).

Objectives

- Examine species composition, relative abundances, and food web structure at **created vs. natural marshes**.
- Examine species composition, relative abundances, and food web structure in natural marshes along a **salinity gradient**.

Trawling

- To quantify off-marsh fishes and macroinvertebrate abundance, we used a 4.9-m otter trawl towed along each banks for 3 minutes at 2-3 knots
- At each site, 8 trawls were conducted at each created and gradient site (48 total)
- Organisms were identified, measured, counted, and the catch was standardized to CPUE

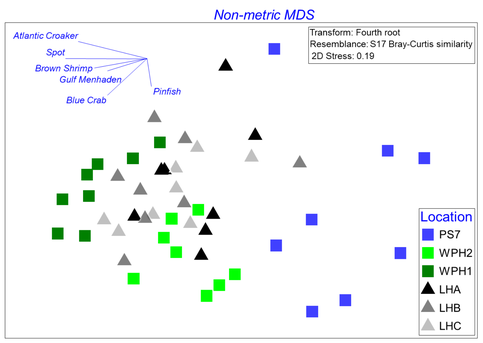

FIGURE 2. Multidimensional scaling plot for community structure at each site indicating significant ($p<0.001$) difference in community structure along the salinity gradient.

Table 1. Mean species CPUE at each site.

	Created Marshes			Salinity Gradient		
	LHA	LHB	LHC	PS7	WPH1	WPH2
Brown Shrimp	31.375	18.125	21.750	8.208	27.292	16.583
Atlantic Croaker	4.875	6.667	4.583	0.625	15.375	1.500
Sand Trout	0.042	0.208	0.167	0.083	2.917	0.792
Least Puffer	0.167	0.208	0.542	0.333	0.125	1.833
Pinfish	4.792	0.667	0.417	0.792	0.500	1.750
Spot	1.292	5.292	3.500	0.333	14.875	4.375
Blue Crab	1.167	0.750	0.750	0.000	0.250	1.125
Gulf Menhaden	3.667	0.792	12.958	0.000	131.625	0.375
Bay Anchovy	4.958	17.792	9.542	0.250	8.167	7.750
Rainwater Killifish	0.000	0.000	0.000	0.000	0.000	0.125
Inshore Lizardfish	0.000	0.042	0.000	0.000	0.000	0.083
Blackcheek Tonguefish	0.000	0.000	0.000	0.042	0.000	0.000
Hardhead Catfish	0.000	0.000	0.000	0.167	0.125	0.000
Baywhiff Flounder	0.167	0.083	0.083	0.042	0.083	0.042
Gafftop Catfish	0.000	0.000	0.000	0.042	0.000	0.000
Sheepshead	0.000	0.000	0.000	0.042	0.000	0.000
White Shrimp	0.000	0.000	0.000	0.042	0.000	0.000
Hogchoker	0.000	0.000	0.000	0.000	0.125	0.000
Black Drum	0.000	0.000	0.000	0.042	0.000	0.000
Xanthidae	0.000	0.000	0.000	0.000	0.000	0.167
Striped Mullet	0.000	0.625	0.042	0.000	0.000	0.125
Atlantic Stingray	0.000	0.042	0.000	0.000	0.000	0.000
Southern Flounder	0.000	0.000	0.042	0.000	0.000	0.000
Ladyfish	0.000	0.000	0.042	0.000	0.042	0.000
Red Drum	0.042	0.042	0.000	0.000	0.000	0.000
Bighead Sea Robin	0.042	0.000	0.000	0.000	0.000	0.000
American Alligator	0.000	0.042	0.000	0.000	0.000	0.000
Naked Goby	0.000	0.000	0.000	0.000	0.000	0.083
Highfin Goby	0.000	0.000	0.000	0.000	0.000	0.042

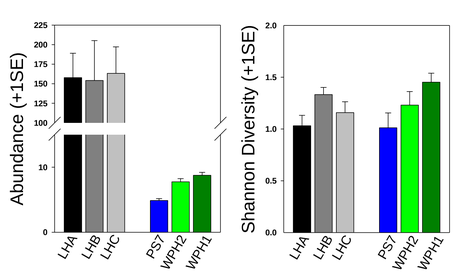

FIGURE 3. Total abundance (left) and diversity (right) at each site.

Suction Sampling

- To quantify invertebrates and small fishes at the marsh edge, we utilized a Venturi-driven suction sampler
- At sites along the salinity gradient (PS7, WPH2, and WPH1), 10 samples were taken at each site (30 total)
- Organisms were stained, sorted, identified, and counted after return to the lab

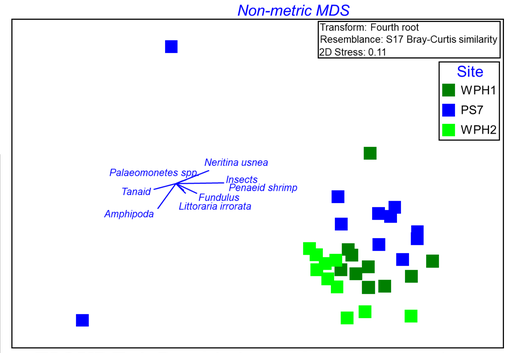

FIGURE 4. Benthic invertebrate community composition along the salinity gradient. Significant differences (ANOSIM, $p<0.001$) exists among sites.

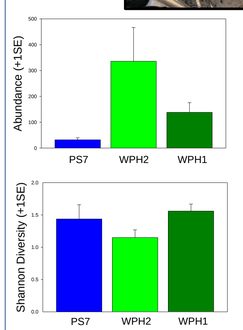

FIGURE 5. Total abundance (top) and diversity (bottom) at each site.

- Community composition of trawl and suction samples varied across salinity gradient sites
- Changes in abundance and diversity in suction samples driven largely by increases in amphipods at WPH2
- Significant differences in community structure among salinity sites are likely to be exacerbated when the siphon is operational
- Future research will be directed at how salinity changes will impact these communities after siphon introduces fresh, MS River water

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