A Comparative Assessment of Sediment Characteristics and Benthic Infaunal Communities along the NE and SW Regions of the Lake Pontchartrain Estuary

Introduction: The Lake Pontchartrain Estuary is a vital coastal basin that is linked to both important recreational and commercial fisheries located in southeast Louisiana. There is a paucity of dense spatial data available on the variable physical and chemical sediment characteristics that make up the basin. In particular, the greatest sediment variability can be seen from the center of the estuary (low bulk density) towards the northeast shore of the estuary which contains the highest bulk density indicative of sandy sediments (Fig 1). It is clear that the northeastern nearshore environment is a particularly unique benthic environment when compared to the muddier Lake Pontchartrain sediments (Fig 1. It has been found that infaunal abundance is higher in sandy sediments with some mud (60-80% sand) (Bedford and Lee, 1994; Jaber 2022). The infauna distribution is critically important for food web controls on fisheries, in particular, benthivores or bottom-feeding fish like the Gulf sturgeon.

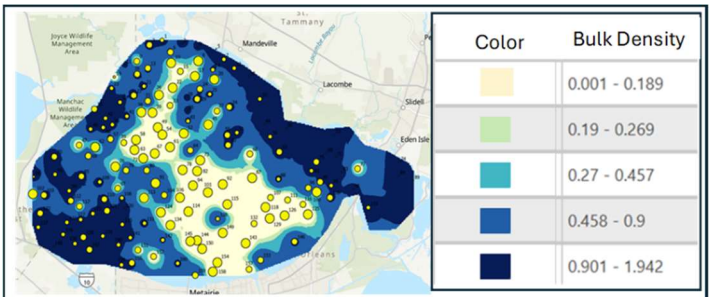

Figure 1. Distribution of sediment bulk density of the 0-5 cm sediment interval in the Lake Pontchartrain Estuary. The NE nearshore benthic habitat is sandy with high bulk density (dark shading).

Relevancy to CPRA and the 2023 Coastal Master Plan: It is critical to characterize the infauna of the northeast shore of the Lake Pontchartrain estuary because of the value of the sediment. High bulk density sediment can support a diverse benthic population but can also be valuable for restoration activities because the sand is compatible with dredging, marsh creation projects, and barrier island nourishment. Very recently, a study examined benthic communities in Lake Borgne in response to dredging (Johnson, M., 2024). In the study of Lake Borgne, portions of the estuary with sandier sediments supported high biomass of clams and other species that serve as food for endangered Gulf sturgeon (Glaspie, unpublished). Consequently, it is important to characterize the infauna along the sandy northeastern shore of Lake Pontchartrain as this habitat might be critically important to important fish species. Previous benthic studies had stations separated by large distances similar to our Fig 1 (Porrier et. al, 2009). This study will provide high-resolution information on the relative variance in sediment characteristics and benthic infauna along the sandy northeastern shore of Lake Pontchartrain. In addition, we will understand if the muddier sediments of the estuary would be able to support similar benthos and hence potentially similar fish species.

Methodology and Study Site Selection: We propose to delineate two areas in the Lake Pontchartrain estuary for investigation of sediment characteristics and infaunal biomass and assemblages. One area will be within the northeast nearshore environment (indicated in Fig 1 as the dark-colored region) and one area will be located in the muddier sediments found in the south-central nearshore region (identified in Gih 1 by the lighter color). The exact areas will be finalized in consultation with CPRA staff who are aware of the areas with the highest occurrence of juvenile Gulf Sturgeon from a previous study. The goal of this study will then be to compare and contrast the two regions. Based on work conducted in Alabama, we hypothesize that the south-shore muddier sediments will be dominated by polychaetes while the sandier north-shore sites will have higher biomass and a more variable infaunal composition (Byrnes et al, (2006).

For sediment characterization: we will employ a piston corer to collect the top 0-5 cm and 5-10 cm sediment intervals at no less than 30 stations, spatially distributed, within each of the two sites for a total of 120 (60 stations x two depth) sediment samples. The sediments will be characterized for moisture content (for floored sediments = porosity), bulk density, organic matter content by loss-on-ignition, total organic C, total N on a CNS analyzer and total P by ignition followed by acid digestion (Andersen 1976). In addition, extractable nutrients of the sediments will be determined using a 1 M KCL extraction with analysis on a Seal Analytical Discrete Nutrient Analyser as well as total metals of the sediment, analyzed by acid digestion and subsequent analysis on ICP-MS. Metals will include Ca, Mg, Al, Fe, Sn, Pb, Ni, Cu, Cr, Co and Cd. Using a wet sieve technique, the weight percent sand will be determined by weight after washing the sediment grouped into the mud fraction (silt and clay) through the sieve. A subset of samples will be analyzed on a laser particle analyzer to determine the relative percent of silt and clay within the mud fraction. In order to understand the oxygen dynamics of the sediments for supporting infauna, all surface 0-5 cm sediments will undergo a Sediment Oxygen Demand (SOD) test in the laboratory. Briefly, 3-5 g of field moist sediment will be weighed and added to 250 mL opaque BOD bottles filled with lake water that has been bubbled with room air for 30 minutes to achieve O_2 saturation. A reading will be taken at time 0 with a self-stirring DO probe, after which, the bottles will be capped and continuously stirred by the magnetic stirrer for 24 hours. The cap will be removed and the DO probe inserted to obtain a final DO reading. Oxygen consumption will be expressed as mg O_2 g sediment^{-1} hr^{-1} for a relative measure of sediment oxygen demand (Wood et al, 2017). The SOD rate will then be correlated to the measured soil characteristics to determine sediment drivers of potential oxygen stress. The higher SOD measurements are expected to correlate with finer sediment grain sizes and higher organic matter content. All measurements will be mapped (see Fig 1) to produce a much smaller spatial map with far greater station density for the two locations.

For infauna characterization: A petite ponar sediment grab will be used to collect sediments for infauna. We will select a subset of the sediment characterization stations, once the sediment characteristic variability has been mapped. Samples will be sieved through a 500-micron mesh and the infauna preserved in 95% ethanol stained with rose Bengal, which provides a stain to facilitate removing the animals from other organic debris. Samples will be sorted and identified to the family level. Ash-free dry weight will be determined as a measure of benthic macrofauna biomass in each sample. Our goal will be to distinguish patterns within each site and then to compare the distributions between the sandier northeastern site and the muddy southern site. Triplicate samples at each station will be collected recognizing that infauna spatial distribution can be very patchy. To assess the potential for patchiness, we will employ a Hummingbird Helix 9 Chirp Mega DI GPS G2N side-scan will be used to determine the bathymetry and bottom roughness of the submerged bed at the study sites. A YSI EXO3 Sonde will be used to collect the following environmental data at each sampling site: bottom temperature, bottom salinity, bottom dissolved oxygen, surface chlorophyll, and bottom chlorophyll.