Project Narrative

<u>Motivation</u>: Marsh vegetation plantings are an integral part of Louisiana's coastal restoration strategy. There are 122 marsh plantings listed in the projects currently being evaluated for the 2023 Louisiana Coastal Master Plan (CPRA, 2021). We often think of vegetation's role in land building as a simple one: vegetation provides additional friction, slows water currents, and causes sediment to deposit. This mechanism has been widely observed, including a recent study in the Wax Lake Delta (Styles et al., 2021). However, both field and laboratory studies demonstrate a complex relationship between vegetation, flow, and sediment (Nepf, 2012 and references therein). Dense vegetation can divert sediment-laden water and prevent it from flowing into vegetated areas, as observed in Cupits Gap in the Mississippi River Delta (Burgos 2021) and in the Sacramento-San Joaquin Delta (Lacy et al., 2021), and at high flows, wakes behind vegetated patches can cause scour, resuspending sediment (Chen et al., 2012; Duggan-Edwards et al., 2020). These conflicting results imply a level of control over the marsh planting outcome – surface elevation decrease or increase – depending on the vegetation-flow interaction. **We propose studying how physical properties of vegetation (i.e., shape, height, stem width, branching, flexibility, etc.) modify the in-situ flow and sediment regime, focusing on two species: *Zizaniopsis miliacea* (Giant cutgrass) and *Eleocharis cellulose* (Spikerush).**

Vegetation plantings cost thousands of dollars per acre, and by understanding the impact of the physical properties of vegetation, we can determine species-specific planting configurations and spacings, more efficiently using restoration funds. This work takes a first step towards that goal by collecting data on the vegetation properties of two key species, along with how they modify current velocities, waves, and suspended sediment in a natural environment. By improving our understanding of these dynamics, we will enhance our ability to work with nature and natural processes to build and sustain coastal ecosystems, a core objective of the Coastal Master Plan.

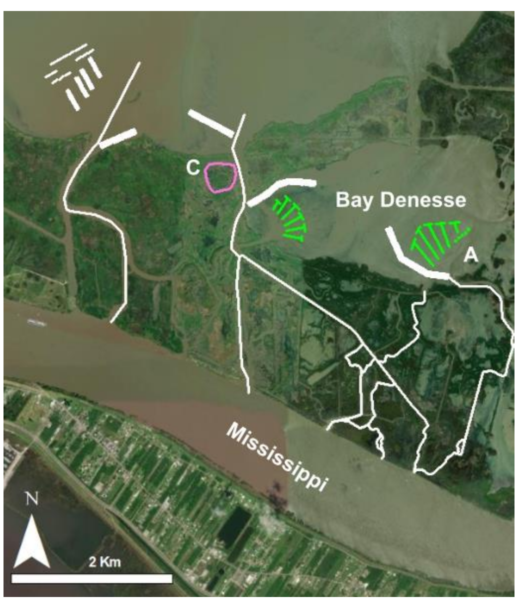

Figure 1: Overview of the Bay Denesse Living Laboratory. Green lines indicate location and configuration of Giant cutgrass plantings. Pink line (area C) indicates where marsh has naturally infilled. Figure courtesy of C. Esposito.

<u>Study Site</u>: The proposed project will take place in Bay Denesse, an open-water bay that receives flow diverted from the Mississippi River. Portions of the area have filled in naturally (area C, Figure 1). It is the focus of many restoration activities by Duck's Unlimited and CWPPRA, and a "Living Laboratory" is currently forming around this site. The Living Laboratory is bringing together restoration practitioners, researchers, and students to collaborate on enhancing our restoration techniques. The proposed project will make use of a planned CWPPRA vegetation planting of Giant cutgrass. Spikerush is already found in the area (unpublished data, USGS LULC). Bay Denesse is relatively protected; the proposed site has a fetch of about 1.5 km, giving the opportunity for fetch-limited wave generation, which can resuspend sediment. Bay Denesse is an excellent site for this project because it is an analog to the Mississippi River diversions underway as part of the Coastal Master Plan and the vegetation planting is funded.

<u>Research Methods</u>: There are two components of the proposed work: a vegetation survey and hydrodynamic observations. Vegetation patches of each species will be selected at the field site and monitored over the course of

a growing season. Non-destructive techniques (i.e., photogrammetry and direct measurement) will be used to capture the natural temporal variability in the vegetation. Vegetation adjacent to the selected patches will be sampled and taken back to the lab for more detailed analysis (e.g., solid-volume fraction, branching order, Young's modulus). Vegetation sample collection will occur at the beginning and end of the growing season to describe the end-member behavior of vegetation properties. Time series of current velocity, waves, water depth, and turbidity will be collected in the headwaters of the vegetation patches. Turbidity, waves, and water depth will be collected along a transect within the vegetation patches. Turbidity will be measured using optical backscatter sensors and will be calibrated with in-situ water samples to calculate suspended sediment concentration (SSC). Waves and water depth will be measured with bursting, high-frequency pressure sensors, and current velocity will be measured by acoustic doppler velocimetry (ADV).

Two platforms were installed in November 2021 at the site as part of the Living Laboratory infrastructure. A suite of hydrodynamic instruments will be deployed at these platforms beginning in February 2022, which will provide important ancillary data for the proposed project. The student will also be able to use this data to ensure all settings are appropriate for accurately capturing the dynamics and make any adjustments needed. We will acoustically map bathymetry during every field visit to determine changes over time, as well as survey elevation in and immediately around the vegetation patches and along the instrument transect using an RTK-GPS.

Broader Impacts for Student: By working in the Bay Denesse Living Laboratory, the student will interact with a range of researchers from multiple disciplines, in addition to restoration practitioners and fellow students. This collaborative environment will allow them to gain insights from multiple perspectives of the landscape and provide additional professional development and networking opportunities. The student will author a peer-reviewed publication, participate the Living Laboratory meetings, and present findings at State of the Coast Conference and a national conference.

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