Project Summary Form

Louisiana Sea Grant

RFP Title

Coastal Science Assistanship Program 2018

Project Number	Project Title
	Water and Sediment Fluxes in Restored and Unrestored Marsh Shorelines

Initiation Date	Completion Date
06/01/2018	05/31/2021

Award Number	Sub Program

Principal Investigator	Total Months effort

Other Investigators	Total Months effort

Keywords

marsh shoreline, restoration, sediment, erosion, marsh accretion, shoreline protection

Sea Grant Classification(s)

Focus Areas

Introduction: Estuarine shorelines and their proximal wetlands are highly utilized by marine and terrestrial organisms, supporting vital nursery grounds and providing important ecosystem services that go beyond storm surge protection and wave attenuation for coastal communities (Barbier et al., 2013). Shoreline erosion is a natural process in most coastal and estuarine environments, but is widely viewed as undesirable. In saltmarshes, recent research suggests that edge erosion is a major threat to the sustainability of these valuable ecosystems, even in the absence of sea level rise (SLR). Additional research has shown that while wave attack can cause marsh edge retreat exceeding 1 m/yr, the material yielded can be reworked and resuspended to the marsh surface, aiding the vertical accretion of the marsh platform and its sustainability. *The balance of marsh loss from edge erosion versus related benefits presents a knowledge gap that this proposal aims to address.* The ability of coastal marshes to maintain position and function ultimately depends upon the vertical accretion of the marsh (or the build-up of both organic and inorganic material to offset vertical or horizontal deficits from SLR). In Louisiana, >4500 km^2 of wetland have been lost over the past 80 years, particularly within interdistributary bays (e.g., Barataria, Terrebone, Breton Sound) due to a complex suite of natural and anthropogenic factors such as subsidence, wave attack, growth faulting, and fluid withdrawal among others. The 2017 Master Plan is committed to improving flood protection and storm buffering by employing restoration techniques such as bank stabilization, structural protection, marsh creation, and sediment diversions. Restoration targets span different shoreline environments from back-barrier or beach to estuarine settings; hence it is critical that resource managers understand the key governing processes that contribute to the continued and sustainable management of these ecosystems. Often, the well intentioned approach to "protect" a shoreline drives the use of hard structures, or stabilization methods, rather than restoration of the natural processes. In addition, while the short-term benefits may be obvious and measureable, the restoration method applied can have significant long-term consequences that are more difficult to evaluate. For example, bank stabilization using engineered structures such as rock debris (e.g., rip rap) or oyster shell reefs is intended to decrease the horizontal retreat of eroding marsh shorelines. However, it is relatively unknown how these structures affect the vertical stability of the proximal and surrounding marshes; in fact, these structures could be negatively impacting the vertical accretion of the marsh platforms directly inboard of the structure, particularly in regions where new sediment delivery from fluvial source is scarce. *The second aim of this proposal is to investigate the impact of different shoreline restoration methods on natural marsh accretion processes.* <u>We hypothesize: 1) that the vertical accretion of marshes inboard of shoreline protection structures is on average less than their natural counterparts, 2) more organic material accretes behind protected shorelines, however not at rates sufficient to offset local relative sea-level rise, and 3) that sediment fluxes on the marsh platform from proximal marine basins are a function of the exchange that is afforded by the type of protection structure used.</u>

Relevance: CPRA and the Coastal MasterPlan have, and continue to routinely perform shoreline stabilization and/or restoration along both estuarine and backbarrier settings. Our analysis will provide insights into the short-term benefits, and longer-term response of proximal marsh platform, and identify key transport pathways toward the sustainability of the marsh when these methods are used. Ultimately, our results will inform restoration decisions, identify regional trends in shoreline dynamics and aid in prioritizing future locations for restoration.

Summary of Methods and Approach: To understand the physical processes of wetland sedimentation and accretion, we will conduct a series of field-based, in-situ, field experiments that will deploy a suite of hydro-acoustic and optical sensors, install sediment tiles and collect cores on the marsh platform. The deployments will take place during well-established seasonal cycles of winter storm activity. Cold fronts are important drivers of winds, waves, and water level changes in coastal systems; they are especially important in the northern Gulf of Mexico due to the micro tidal regime, and provide a predictable proxy for the impacts/benefits of larger events where inundation and therefore sediment influx is higher. Moreover, cold fronts strike the northern Gulf Coast on a regular basis, every 5 - 10 days from October through April, the variation in wind speed, direction and atmospheric pressure induce appreciable variations in water level, and have energies that allow for the safe deployment and recovery of equipment. We propose to conduct our research at 2-3 sites where different restoration/stabilization methods were employed, and choose proximal locations suitable for control experiments with completely natural (i.e., unprotected) shorelines.

Vertical accretion for protected/unprotected shorelines: Radioisotopes ^{210}Pb and ^{137}Cs will be measured from ~1 m deep cores extracted from marsh platforms adjacent to protected and unprotected shorelines to constrain the long-term inorganic accretion over the past 50-100 years. Analysis of geotechnical properties with depth (organic vs inorganic content, bulk density, % water, and grain size) will also help constrain differences between the sites, specifically if there have been significant changes since engineered structures were emplaced. We also propose to evaluate the short-term vertical accretion using sediment tiles and marker horizons placed on the marsh surface and retrieved seasonally (i.e., after winter cold fronts/tropical storm event), coupled with shallow cores that can be sampled for ^{7}Be, a short-lived radioisotope that signifies recent sedimentation. This information will be coupled with the shoreline monitoring-observational data (described below) and help provide a spatial-temporal framework that can be used to inform shoreline protection and mitigation efforts by coastal managers at Coastal Protection and Restoration Authority in Louisiana.

Water and Sediment Fluxes at the marsh boundary: At each site, we will collect data from two or three stations along a shore-perpendicular transect, with one station on the marsh platform, one near or on the marsh edge, and one station in the proximal bay at water depths of ~0.5 – 0.7 m and 1.5 – 2 m respectively. At the shallow station (inland), we will measure water levels and velocity. At the marsh edge we will deploy Nortek Acoustic Doppler Velocimeter to help develop a time series of the 3-dimensional components of velocity. To understand how changes in local velocity and regional hydrography impact local sediment dynamics and evaluate the water and sediment exchange, we will deploy a suite of optical backscatter sensors (OBS) at each location. The OBS will be calibrated with in situ samples of total suspended solids concentration to relate background measurements of backscatter intensity to sediment concentration. Additionally each tripod will be equipped with temperature, conductivity, and pressure sensors to observe fundamental oceanographic conditions. At the seaward station (~2 m water depth), we will deploy a Teledyne RDI Acoustic Doppler Profiler, an OBS3+ for sediment concentration, and a SeaBird Electronics CTD. Wind waves eroding the marsh edge will release unknown volumes of sediment and influence the local sediment flux into our study areas. To facilitate the calculation of sediment budgets on the control sites and determine sediment released locally, we will use erosion pins installed on each of the marsh edge terraces to document (with mm accuracy) short-term erosion rates and compute sediment volumes. The time-dependent measurements of the shore normal velocity component and water surface elevation and backscatter will be correlated to the elevation of the marsh platform or opening to the marsh (if the shoreline is stabilized with interment structures or reefs), and the regional forcing (storms or non-storms) to establish a record of depth and duration of marsh inundation. Establishing the inundation depth, local velocity, and sediment concentration proxy, will allow us to compute instantaneous sediment fluxes at each site as a function of time. These fluxes will be compared with the accretion and deposition rates amongst restoration sites and control sites. The control sites will allow us to draw conclusions as to the natural impact on accretion resulting from edge erosion, and comparison with the restoration sites will provide evidence of the efficacy of each method.