CSAP Application - John R. White LSU

Project Narrative: Coastal Restoration efforts in Louisiana are relying on river re-connection with the coastal basins in order to deliver sediment to these subsiding systems. Coincident with the water will be nutrients but also freshwater. Modeling efforts conducted in preparation for the Mid-Barataria Sediment diversion has shown that the salinity of basin will be significantly lowered during the period of operation. What is completely unknown is the effect of this freshwater pulse, or in some places, substantially lower salinity, on the ambient porewater salinity. This is a critical knowledge gap as changes in the salinity will affect the macrophytes as well as the microbial pool associated in this very active layer of soil (0-10 cm). Our earlier research has shown that just one week of a salt pulse over freshwater wetland soil affected the porewater salinity down to 10 cm (Figure 1) with the effect seen greatest at the surface decreasing with depth (McKee et al, 2016). While this research demonstrated that a salt pulse from a hurricane storm surge can affect the salinity of the porewater, it is unknown as to what the reverse situation will be when a sustained freshwater pulse in the surface water is overlying a brackish or saline wetland soil.

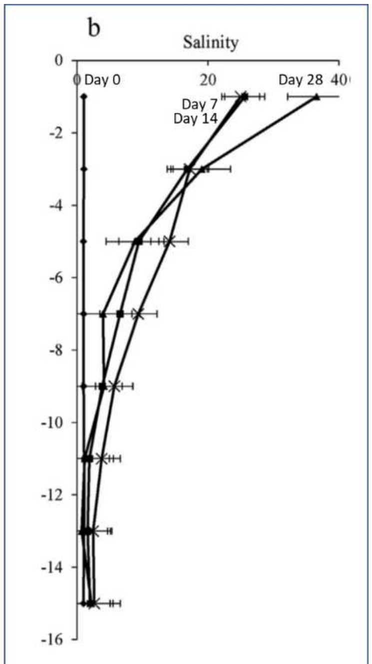

Fig 1. Salinity with depth in fresh Marsh imposed with salinity pulse

Because soil microbes regulate many biogeochemical cycles in coastal wetlands, any temporary alteration in microbial activity could negatively impact their expressed ecological function. Furthermore, soil microbial populations are typically adapted to either freshwater conditions (hyper-osmotic regulators) or saline conditions (hypo-osmotic regulators), and can experience osmotic stress during salinity shifts that interrupts cellular function, growth, or even lead to cell integrity (Frankenberger and Bingham, 1982; Hart et al., 1991; Saviozzi et al., 2011; Rath and Rousk, 2015). For example, a series of batch incubations using wetland soil from Breton Sound demonstrated that freshwater imposed on brackish soil significantly reduced dentification potential of the soil over 11 days (Marks et al, 2016). There are implications for changes in flux of nutrients, microbial process of denitrification (process of removing river nitrate to improve water quality or N mineralization rates (process making N available to plants. While so much research has been focused on increasing salinity in fresh and brackish marshes due to the concern over storm surge and sea level rise, there are almost no studies investigating the opposite which will affect large regions of Barataria Basin and Breton Sound through Mississippi River Diversions.

The research plan will focus on two major objectives 1) collect replicate intact soil cores from several salt marsh, brackish marsh and fresh marsh (control) in Barataria Bay and impose continually pumped freshwater conditions at the surface and sample cores destructively to create fine scale measurements of shifts in salinity over time, 2) determine the impact of fresher conditions on the microbial processes of denitrification, which improves water quality by removing river nitrate, and N mineralization, which provides bioavailable N to the plants in the rootzone.

The soil cores will be placed in a large polyethylene box in the lab and maintained at constant temperature in a water bath. Each core will have a hole drilled 15 cm from the soil:water interface and peristaltic pumps will flow filtered river water into each core continuously, spilling out the hole to maintain a constant water column while providing turnover of the water column mimicking a flowing diversion (McKee et al, 2016). Given that fresh conditions will not be seen in the entire basin, we will set up a lower salinity water tank to be flowed into cores collected from salt marshes. We will determine exact salinity treatments based on the 50 year runs of the basin-wide model funded by the state of LA. There will be 5 replicate cores for each location and salinity treatment. Cores will be destructively sampled over time into 1 cm intervals and will have porewater conductivity, extractable nutrients (N and P) and a determination of denitrification and mineralization potential for the top 10 cm. There is another method that can be used for porewater salinity that can be used, porewater sippers. One issue with this approach is that removing porewater forces the surface freshwater faster into the soil. The impact of the freshening of the porewater on the two microbial processes of denitrification and mineralization will be done in batch incubations with soil from the control cores, once the changes in salinity with depth data are collected from the core experiment. We will work with CPRA and The Water Instute of the Gulf which has been modeling water flow and salinity to select the sites most likely impacted by the river water.

Relevance to the Coastal Master Plan: This proposed research project is well aligned with the Coastal Master Plan which seeks to employ river reconnection through sediment diversion which are at a much large scale (flow rate, receiving area affected) than has been done in the past. This data will be of great value to the water quality and ecosystem modeling that has been ongoing by the state as part of the forecasting of the sediment diversion effects on the Basin. This data has the potential to impact both water quality modeling and vegetation response to changes in salinity due to river reconnection.

References

Frankenberger, W.T., and J.F.T. Bingham. 1982. Influence of salinity on soil enzyme activities. Soil Science Society of America Journal. 46:1173–1177.

Hart, B.T., P. Bailey, R. Edwards, K. Hortle, K. James, A. McMahon, C. Meredith, and K. Swadling. 1991. A review of the salt sensitivity of the Australian fresh-water biota. Hydrobiologia 210:105–144.

McKee, M., J.R. White L.A. Putnam Duhon. 2016. Simulated Storm Surge Effects on Freshwater Coastal Wetland Soil Porewater Salinity and Extractable Ammonium Levels: Implications for Marsh Recovery after Storm Surge. Estuarine, Coastal and Shelf Science. 181-338-344.

Marks, B.W., L.G. Chambers, J.R. White. 2016. Effects of Fluctuating Salinity on Potential Denitrification in Coastal Wetland Soils and Sediments. Soil Science Society of America Journal 80:516-526.

Portnoy, J.W., and A.E. Giblin. 1997. Biogeochemical effects of seawater restoration to diked salt marshes. Ecol. Appl. 7:1054–1063.

Rath, K.M., and J. Rousk. 2015. Salt effects on the soil microbial decomposer community and their role in organic carbon cycling: A review. Soil Biol. Biochem. 81:108–123.

Saviozzi, A., R. Cardelli, and R. Di Puccio. 2011. Impact of salinity on soil biological activities: A laboratory experiment. Commun. Soil Sci. Plant Anal. 42:358–367.