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Development of a suitability index tool for coastal Louisiana to inform site selection for oyster based living shorelines that both enhance estuarine oyster metapopulations and promote shoreline stabilization

PI: Megan La Peyre (School of Renewable Natural Resources, LSU AgCenter)

Project Description

Estuarine systems provide multiple ecological, physical and socio-economic benefits to coastal communities throughout the world. Wetlands, submerged vegetation and biogenic reefs within estuarine systems are declining globally as a result of sea level rise, extreme events and other factors. Louisiana supports some of the largest extents of coastal marshes in the United States, but also the highest rates of relative sea level rise and wetland loss with more than 4,800 km^2 lost since the 1930s and an additional 4,500 km^2 predicted to be lost in the next 50 years. In addition, Louisiana historically supports extensive oyster populations, accounting for 30-40% of the U.S. oyster production, but has experienced significant declines in production. The connectivity between the wetlands and more submerged oyster reefs provide positive feedback loops critical to a resilient system. This connectivity is what the use of living shorelines, or engineered oyster reefs seeks to capture to enhance coastal resilience (La Peyre et al. 2015; Morris et al. 2021; Chowdhury et al. 2021).

Diversions and marsh creation are two of the most common techniques currently used by managers to protect and restore coastal habitats in Louisiana. Key to the success of these however, is ensuring connectivity among healthy estuarine systems which impact sediment availability, wave energy, and support fisheries production. While Louisiana focuses on marsh vegetation condition and extent as baseline success indicators, restoration focused on their ability to remain productive depends on numerous factors; including their interactions with biogenic structures (i.e., oyster reef development), wave energy exposure, and flooding. As this recognition has grown, so too has the global (and local) interest in the use of nature-based shoreline solutions.

Often referred to as "living shorelines", nature-based shoreline solutions represent a paradigm shift where managers work with rather than against natural nearshore processes with the goal of curbing additional loss of important habitats, reducing risk and improving coastal resilience. Within Louisiana, fringing oyster reefs for shoreline protection have been included as a key strategy in the state restoration Master Plan, and explicitly identified as a restoration approach for recent NRDA (Natural Resource Damage Assessment) strategic frameworks (i.e., Deepwater Horizon NRDA Trustees, 2017). In Louisiana alone, over a dozen such projects have been completed, with the recent completion of one of the largest in the world, where an estimated 14 mile living shoreline to protect a land-bridge in Biloxi marsh (Eloi Bay). While a primary goal of these living shorelines is to protect the adjacent marsh, this goal is dependent on the development of sustainable oyster reefs. Recent work in the La Peyre lab developed a map for Breton Sound Estuary that combined the likelihood of oyster survival, based on an oyster HSI, with the likelihood of shoreline protection, based on field data from previous studies in coastal Louisiana to identify areas most suitable to successful living shorelines (La Peyre et al. 2015). As monitoring data indicate that many constructed living shorelines have fallen short of reducing shoreline erosion, or to develop a sustainable oyster population, the

collection and assessment of data from across Louisiana's coast to identify the characteristics of sites with successful living shorelines would be valuable in supporting the development of estuarine coastal resilience.

A recent global review of living shorelines, of which Dr. La Peyre co-authored concluded that living shorelines provide a useful tool to assist in coastal resilience in the face of climate change and sea level rise, but that proper site selection, determined by physical, chemical and biological factors, along with adjacent habitats and bottom types was essential (Chowdhury et al. 2021). Another recent review of modeling and suitability tools for oysters for the Gulf of Mexico estuaries, led by Dr. La Peyre, identified several dozen models available for understanding oyster population growth, survival and recruitment, but none targeted at multiple goals of oyster population sustainability and shoreline protection – both key to implementing effective living shorelines (La Peyre et al. 2021). Here, we propose to (1) collect survey data from across Louisiana's existing living shoreline reefs on oyster population status, water quality, and shoreline movement, and (2) use these data to develop a habitat suitability model to identify sites likely to support both oyster population enhancement and sustainability and marsh edge stabilization.

This work will address the key CPRA mandate of developing a comprehensive protection and restoration plan for coastal Louisiana, contributing directly to efforts to achieve their goals to "use natural processes to promote a sustainable coastal ecosystem." This student-led project specifically aims to inform the master plan by documenting the potentially large, but unmeasured role of living shoreline reefs in supporting oyster population enhancement under a range of energy conditions, and across the estuarine metapopulation, and document the role of living shoreline reefs in enhancing fisheries production. Given the importance of the connectivity of wetlands, oyster reefs and other submerged habitats, this project would directly inform implementation of living shorelines to support estuarine resilience. Dr. La Peyre is requesting funding to support a MS student that will be co-advised with Dr. Jeffrey Plumlee in the School of Renewable Natural Resources at LSU. The recruited student would specifically address two broad and related questions about the impacts of living shorelines on oyster metapopulation enhancement, and shoreline stabilization, and develop a suitability tool to inform future site selection. In addition, with Dr. Plumlee, in his role as the Sea Grant Fisheries Extension Specialist, the recruited student will develop products to engage and inform stakeholders on nature-based shoreline solutions. Stakeholder engagement with the goal of modifying behaviors is the ultimate goal of extension activities and a critical component of the recruited students' responsibilities. We expect that the student will play an active role in the design of their thesis project.

The student will survey existing living shorelines across Louisiana, constructed between 2008 and 2023. Reefs will be surveyed during the same season, quantifying oyster population density and size structure, adjacent habitats, water, among other factors. Using historical aerial photography and satellite-based data, shoreline movement will be assessed at each site, and historic water quality, wave and wind data collected. These data, along with available monitoring data, will be used to develop a habitat suitability model that combines both oyster population sustainability and marsh stabilization, resulting in a tool developed for managers. This tool will be shared widely through interactive modules, fact sheets, and face to face

presentations with stakeholders, including managers and non-profit agencies involved in living shoreline work. Combined, this work will form the core of the recruited students' thesis.