Assessing resiliency of coastal seabird communities following coastal restoration and hurricane disturbance

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Louisiana's coastal islands are critical breeding habitats for significant portions of many North American seabird species or subspecies. Some direct impacts of storm events on island habitats are well known, but we know considerably less about the interaction of storm impacts and human management efforts on the populations inhabiting these islands. Island restorations are specifically designed to restore ecosystem function and increase island resilience to future disturbances, typically by re-establishing vegetation beneficial to target species and/or physically hardening islands against storm impacts by establishing rock structures to reduce wave action or increase site elevation. We do not know the degree to which these practices may interact with natural processes that promote overall habitat quality for many seabird species. Past research has documented that storms may halt or reverse successional dynamics, possibly biasing habitat suitability toward some species over others at restored vs. unrestored sites. Additionally, reduced breaches and improved island stability may decrease use of an island by birds if mammalian populations become more resilient to hurricane effects. Storms and overwash have also been hypothesized to depress invasive fire ants in Louisiana, but no comparative assessments have quantified the net impacts on these populations immediately after storms occur. A better understanding of the interaction of storm and restoration impacts will not only provide critical insight into the successional processes that control population dynamics on these islands but also inform future restoration practices to improve conservation outcomes.

On August 29, Hurricane Ida passed through the middle of the Barataria - Terrebonne estuary system of southeastern Louisiana as a strong category 4 storm, and has been characterized as one of the largest and costliest storms ever to hit the United States. Assessment of impacts to coastal restoration projects and the coast in general have not yet begun due to the logistics of working in a storm-ravaged landscape, but past work has made clear that effects of storms on coastal wildlife may not become clear until the following breeding season, when populations must attempt to maintain productivity on islands with reduced vegetative cover and increased erosion.

Extensive pre-storm investigations provide an excellent opportunity to assess the way restored and unrestored islands, and the wildlife that inhabit them, respond to a major storm event. Since 2018, we have conducted intensive studies of the vegetation, mammals, insects, and seabirds on 12 coastal islands in this system. The goal of the research, which ended in 2020 for some components and in 2021 for others, was to determine how restoration project age and location in the coastal landscape affected seabirds and the communities they use for nesting and foraging, with a focus on brown pelicans Of the 12 islands studied, 4 were unrestored and 8 were restored or partially restored at varying times, with 4 restoration projects conducted before 2001, 5 that were conducted between 2001 and 2016, and 3 that were completed since 2016. While storms have affected the region in the past, Ida passed directly through our study site, with 5 islands on the west side of the storm where storm effects are supposedly reduced, and the remainder directly in the path of the storm or immediately to its east, where impacts are often greater. This provides a novel opportunity to quantify how the precise locations of sites with regard to storm trajectories may interact with recent restoration history to shape island outcomes, and our findings will allow us to more confidently predict the long-term impacts of island management strategies in the face of increased disturbance regimes.

Models used in coastal restoration planning, such as in the Master Plan, assume that wildlife will use restored habitats in the same way they use natural habitats, however this assumption is generally untested as there have been few comparisons of bird use of restored and non-restored habitats. Current models also do not fully incorporate differences in wildlife habitat features after storms nor any possible differential responses of restored and unrestored nesting islands to hurricanes. Furthermore, understanding how vegetation success and predators respond

to hurricanes is critical in understanding how seabirds like the brown pelican is going to respond to a storm event. An understanding of these issues is needed to implement adaptive management to improve restoration outcomes.

Objectives-We propose to collect data on vegetation composition, elevation, island size and location, mammalian predator and fire ant populations from the same islands in 2022 and 2023 we sampled in 2018 and 2019, and to a lesser extent in 2021. We will use this data to determine how storm track and past restoration, and the time since restoration, interact to affect the occupancy and abundance of mammalian predators and fire ants, as well as the density and types of vegetative cover. We will also examine how the islands relationships to Ida's track, as well as restoration history, affect which seabirds next on a site. We predict islands experiencing reductions in vegetation density to favor ground nesting species (terns, gulls and skimmers) over shrub nesting species (such as brown pelicans) in terms of colony size. We will also examine how nest success of brown pelicans is affected by the location of this islands in relationship to Ida's track and their restoration history. We predict recently restored islands experiencing hurricane damage will support more pelicans and have more successful nests than sites without recent restoration activity.

Methods and baseline data-This work would leverage the sampling we have already done on coastal islands as part of a Louisiana Center of Excellence Grant. We would use the same methodology used in our previous studies of the islands conducted between 2018 and 2021. Sampling of our 12 study islands would occur during and immediately after the 2022 breeding season. Field work would occur most heavily between February and August, the same months in which we have done our past sampling of these sites. It is likely that not all 12 islands will be accessible, or even exist following the storm, or they may have already had additional restoration, so the sample plan will have to be modified to accommodate conditions in spring 2022. Field sampling in 2023 would depend on findings from the first year of work.

Previously established transects in marsh and dune habitats would be used to determine vegetation composition, density and biomass using plots, cover broads and above ground clipping. These same transects would be used to establish grids of baited traps to quantify fire any abundance. As in previous work, cameras and cover track plates would be used to quantify occupancy and abundance of mammalian predators. As in the past, cameras will be used to estimate nest success and parental attentiveness. Elevational changes would be determined by comparing estimates we obtained in the past using a

Statistical comparisons would be between population and community parameter estimates made before Ida with those made as part of this study in 2022. Island location relative to the storm track and time since the most recent restoration activity on the islands would be used as covariates, with the focus of the analysis on the interactions of the covariates with changes between the pre and post-storm periods.

Relevance to CPRA *and Louisiana's Master Plan* – This research will provide CPRA with information on the consequences of hurricanes on the relationship between island restoration and the creation of habitat for colonial seabirds. The project addresses objectives of the Comprehensive Master Plan in terms of understanding the consequences of barrier island restoration for habitat for wildlife species, while promoting a sustainable coast. The projects to be evaluated as part of this research include past restoration projects and the results will contribute to better outcomes of such efforts across the coast. Wildlife habitat is not only a major component of the ecological services described in the master plan, but the knowledge required will help inform the permitting process. By providing information about how planned restoration might affect colonial seabird species of conservation concern, this research will inform future revisions of the Master Plan. One of the focal species for the Master Plan wildlife models, which I helped develop, is the brown pelican; data collected will fill some information gaps associated with the model for that species.