

Design, Monitoring, and Adaptive Management Strategies for Hybrid Sanctuary/Harvestable Oyster Reef Restoration - Kathy Sweezey

The Nature Conservancy has implemented an innovative subtidal oyster reef restoration design in Texas by incorporating both sanctuary and harvestable areas into a single project. Beezley Reef was the most recent restoration utilizing this hybrid approach and the first of its kind in Galveston Bay, Texas. At 40-acres in size, approximately 25-acres were restored with the goal of opening to commercial oyster harvest and 15-acres were restored with the goal of serving as a broodstock sanctuary reef that supplies larvae to the nearby harvestable reefs. This hybrid sanctuary/harvestable approach to oyster reef restoration supports the ecology and economy of our bay by creating additional habitat for numerous marine species, filtering millions of gallons of water each day, and supporting local fisheries.

The Nature Conservancy, Galveston Bay Foundation, and Texas Parks and Wildlife Department have developed and implemented a monitoring and adaptive management plan for Beezley Reef to document the outcomes of this restoration. The adaptive management plan has been a crucial piece to this project and will continue to be instrumental in identifying causes for change in the condition of the reef and adjusting management strategies to optimize reef success. Additional enhanced monitoring conducted by Harte Research Institute has helped to identify outcomes of this unique design and, combined with the results from ongoing monitoring efforts, will guide future restoration strategies.

Quantifying the enhanced biomass production provided by restored oyster reefs within coastal lagoons of New England - Eric Schneider

Restoration practices that create or augment marine habitat may be used as a management tool to improve ecosystem function and enhance ecosystem services. For example, restoration of ecosystem-forming bivalves, such as Eastern oysters (*Crassostrea virginica*), may be used to enhance ecosystem services such as improved water quality, shoreline stabilization, and enhanced fish biomass production. Determining how much habitat is needed to meet restoration goals can be challenging without quantitative estimates of the ecosystem services provided per unit of restored habitat. We derived estimates of enhanced biomass production per square meter of restored oyster reef by applying species-specific growth and mortality models to fish and mobile macroinvertebrate species whose densities were increased from oyster reef restoration in two coastal lagoons in Rhode Island, U.S.A. Of the 43 taxa collected, production of eight species of fish and three species of macroinvertebrates were enhanced by oyster reef creation. We estimated that each square meter of restored oyster reef resulted in, on average, an estimated additional 18.44 (SD = 4.817) juvenile fish and crustaceans, totaling 248.83 (SD = 81.069) g per year of enhanced gross biomass productivity. These results represent a conservative estimate of the potential enhanced biomass production from oyster reef restoration in the New England region of the U.S.A. that is equivalent to estimates in the

South Atlantic, but less than oyster reefs in the Gulf of Mexico. Combined, these estimates help inform what restoration is needed to meet goals based on ecosystem services.

Permitting the Barrier Beauties Oyster Farm in Galveston Bay, TX - Kelsey Calvez

In 2019, Texas passed House Bill 1300 which authorized cultivated oyster mariculture practices in Texas waters. In 2020, FNI's coastal team led the effort to permit one of the first oyster mariculture farms in Texas, now known as Barrier Beauties, located in East Galveston Bay. This effort involved close collaboration between FNI, TPWD, and our client, On Point Consulting, to identify suitable sites for the farm and navigate the process of applying for a Cultivated Oyster Mariculture Permit. A suitability analysis was performed to determine proximity to sensitive environmental features, including seagrass beds and adjacent reefs, and other constraints, including water depth and proximity to oil/gas wells and navigation channels. Side scan sonar was utilized to record high-resolution imagery of the bay bottom. In-situ observations were collected to confirm the presence of seagrass and existing oyster reefs and oyster habitat, including oyster shell fragments. Because our team led one of the first mariculture permit applications, FNI's efforts helped shape the rules and regulations of the program that are in place today. Barrier Beauties has been acknowledged for its focus on sustainable practices and providing ecological benefits to the Galveston Bay System by relieving pressure on natural oyster reefs to help meet market demands. This presentation will review the process of helping permit the Barrier Beauties Oyster Farm, where that farm stands today, and the lessons learned throughout the process.

Tracking the Natural Replenishment of Mississippi's Eastern Oyster Reefs After a Fisheries Disaster - Katherine Glover

In 2019, the Bonnet Carre spillway had the longest opening since its construction. This historical flooding event led to a decrease in salinity within the Mississippi Sound that persisted until mid-July, a period typically showing high levels of oyster spawning. Mississippi oyster reefs lost approximately 96.9% of oysters in the western MS Sound and about 63.8% in the eastern MS Sound. While the loss of a major commercial fishery is cause for worry, the long-term effects must be considered. Oyster reefs provide habitat for many marine species and coastal protection from storm surge and erosion. The structure and stability of these reefs combat natural degradation with the recruitment of new individuals from annual spawning. Reef assessments performed in the subsequent years showed minimal recruitment of oyster spat to reefs which triggered the development of a spat settlement and recruitment monitoring program.

The Mississippi Department of Marine Resources (MDMR) pinpointed multiple sites within their state waters that historically showed high numbers of spat settlement to observe the spatial-temporal variation in oyster reef recruitment after a catastrophic fishery disaster. Preliminary results from 2022 and 2023 show a significant increase in spat across all sites, specifically 10,000% between the two years. Through this project, we aim to determine localized oyster

settlement trends and understand the driving factors of survival of oyster reefs when faced with natural and man-made disasters. These findings will improve the effectiveness of oyster restoration along the Mississippi Coast.

Oyster Larvae Preferences: Considerations for Designing Restoration Substrate - James Barclay

In substrate-limited systems, oyster reef restoration can be improved by a greater understanding of the role of complexity in substrate design to promote recruitment and survival of oysters. Different complex substrates have been shown to influence oyster larval settlement, but it is unclear what drives greater larval settlement. Here, we tested the effects of substrate morphology, complexity, and hydrodynamics by manipulating settlement tiles for the Sydney rock oyster (*Saccostrea glomerata*) in New South Wales, Australia. Photogrammetry from a natural oyster reef was used to 3D print a natural mimic as one tile treatment; a tile with similar complexity to the natural mimic was created by filtering out the oyster related roughness; and the hydrodynamically similar tile was based on similar local flow effects seen on an OpenFOAM model. These three tiles and a control flat tile were deployed in a flume settlement experiment and field recruitment study to test larval preferences. Understanding larval preferences in a controlled environment and how this changes when post-settlement factors are tested in multiple estuaries provides a thorough investigation into the impact of substrate composition. The aim of this study is to help understand the mechanism that is driving oyster settlement which will foster greater efficiency in future substrate design.