State of the Reserve 2016
"Ecosystem Services"

Summary

The studies in this document represent but a few of the many research, monitoring, education and conservation activities that take place or have taken place over the past ten years at the GTM NERR. Some programs are of a short duration, but most are ongoing and lend themselves to future research and monitoring needs and practices, and they contribute to the growing body of scientific knowledge.

For further reading, the Site Profile of the Guana Tolomato Matanzas National Estuarine Research Reserve, published August, 2009, Frazel, Inc., provides an environmental overview of the GTM NERR estuaries and terrestrial ecosystems represented within the reserve; outlines ongoing research and monitoring; and identifies site-specific needs and practices. The Site Profile also includes a description of biotic habitats; an overview of the reserve programs and partnerships; a summary of research conducted within the reserve; and suggestions for future research and monitoring. The GTM NERR Management Plan can be found online via a web search under GTMNERR.

“Disease Survey of Crassostrea virginica Oysters Along a north to South Gradient in the GTMNERR”

Nicholas Brandimarte, Student, FAU

Researchers in the GTMNERR have observed oyster population declines in a north to south gradient. Water quality, predation, disease, and nutrition are possible factors contributing to this decline. No disease surveys have previously been conducted on oysters located within the GTM Reserve. The disease that is most prevalent and of most concern in oyster mortalities in Florida waters is the protisan parasite, Perkinsus marinus (Dermo). The focus of this project was to determine whether the disease might be contributing to population decline.

Oysters were collected from 3 sites (30 per site) within 3 regions (north, central, south) of the GTM in June 2015, for a total of 90 oysters per region, 270 oysters overall. Oysters were cleaned, measured and weighed. Rectal tissue was excised and placed in Rays Fluid Thioglycollate Culture Method (RFTM) for P. marinus determination. Gill tissue was placed into 95% ethanol and examined for the presence of the haplosporidian parasite, Bonamia spp. Using polymerase chain reaction (PCR). A cross section of tissue was placed in Davidson’s fixative and prepared H&E slides were examined to determine the sex ratio of collected oysters. P. marinus prevalence was high, averaging 65% in the north and central regions, and 58% in the south region, but varied by site, particularly in the northern (55-75%) and central (50-82%) regions. Average dermo intensity as ranked using a Mackin scale (0-5) was low, but higher in the northern (1.16) and central regions (0.91) than in the southern region (0.75), but varied by site, particularly in the northern (0.8-1.8) and central (.62-1.3) regions. The parasite Bonamia spp. Was not detected at any site. This study indicates that the presence of P. marinus alone does not account for the decline in oysters in a north-south gradient within GTM.

“An Investigation of Water Quality and Phytoplankton Biodiversity Associated with a Restored Oyster Reef within the Guana Tolomato Matanzas Estuary System”

Dr. Matthew T. Brown, Assistant Professor of Natural Sciences, Flagler College

In conjunction with a monthly fish biodiversity seining program at Flagler College, beginning in October 2014 water samples were collected and phytoplankton tows were conducted monthly at 4 sites within the Guana Tolomato Matanzas River Estuary System. The objective of the study was to initiate and carry out a long-term monitoring of water quality parameters (nutrients, chlorophyll-A, and dissolved trace metals) and dominant phytoplankton taxa in parallel to the fish biodiversity data being regularly collected. The sites sampled for this study are distinct from the 4 sites regularly sampled by GTMNERR staff and thus provide increased coverage of water quality characteristics within the estuary system. To date, all samples have been analyzed for chlorophyll-A, dissolved nitrate + nitrite, ammonium, and phosphate. In addition, dominant phytoplankton taxa have been identified for all sites. Focusing specifically on the theme of "Ecosystem Services" with regard to oyster reefs, results show differences in both chlorophyll-A and dominant phytoplankton biomass present as well as nutrient concentrations at a restored oyster reef site (Wright's Landing) at the GTMNERR when compared to other sites. These results will be discussed within the context of ecosystem services provided by oysters and potential impacts on the health of the GTM estuary system. In addition, water quality data will be presented that argues for the potential re-opening of oyster beds that were closed to harvesting years ago due to poor water quality.

“2015: “The Year of the Oyster” at the GTMNERR”

Dr. Nikki Dix, Research Director, GTM NERR

The story of how 2015 became “the year of the oyster” at the GTMNERR illustrates the NERR System’s ability to integrate research, stewardship, and education to address natural resource management issues of local, regional, and national importance. The global decline in oyster populations is a management concern at all geographic scales. Florida in particular has experienced dramatic declines in oyster fisheries recently. At the same time, oysters have increasingly become the subject of national research and restoration efforts as the ecosystem services they provide become widely recognized and appreciated. Oysters in northeast Florida, however, had not been examined by scientists or resource managers until recently, even though populations are extensive in this region. Community concerns about local oyster population declines were brought to the GTMNERR in hopes of raising awareness about issues and promoting research. The NERR responded by developing an oyster monitoring program, targeting internship projects, convening stakeholders, and raising the profile of oyster sustainability as a critical management issue in the region. Results of these efforts include scientific data, a situation report, and a community-supported action plan aimed at improving water quality and other issues related to oyster sustainability in northeast Florida.

“Comparison of macrobenthic fauna between restored and unrestored intertidal habitats”

Shannon Kelley Dunnigan, Graduate Student, University of North Florida

Oyster reefs are declining worldwide, as well as the economic and ecological value of oysters to their respective systems. Numerous restoration efforts have been undertaken in hopes of re-establishing these shellfish populations. This study evaluated a restoration project within the Guana Tolomato Matanzas estuary in northeast Florida to determine whether artificially created reefs provide similar quality habitat to adjacent natural reefs by comparing the abundance, diversity, and community composition of benthic macrofauna between restored and unrestored intertidal habitats. Benthic macrofauna were quantified using plastic settlement trays deployed in triplicate at each site and sampled monthly for a year. Community structure differed by habitat, which was confirmed through an analysis of similarity. High abundances of Petrolisthes armatus on the natural reef sites largely contributed to dissimilarity in community composition between the natural

reef and the restored site. Constructed oyster reefs created immediate habitat for resident species and enhanced habitat value compared to unstructured mud bottom.

“Oyster reef enhancement (ORE) modules: an environmentally responsible method for restoring oyster habitats”

Jose M. Nunez

Oyster reef habitats are essential components of estuarine ecosystems that provide diverse ecosystems services such as water quality improvement, shoreline protection, and habitat / refugia for many taxa. Oyster communities are increasingly threatened by multiple stressors, including water quality degradation, disease, predation, and reduction in suitable substrate for colonization. Available methodologies to restore oyster reef habitats and their associated ecosystem services are diverse and may require site or goal specific modifications. Unfortunately, many techniques in use today include non-biodegradable

components such as plastics that may contribute to the overall loading of plastics into the aquatic environment. This pilot project explores the utilization of lightweight, easy to produce, oyster reef enhancement modules constructed from a concrete/organic matrix, that are structurally stable, and provide diverse micro-habitats for the recruitment of oyster spat and associated oyster reef biota.

The design leverages biodegradable materials and vertical orientation of oyster cultch to maximize spat recruitment and habitat complexity while providing shoreline stabilization. Modules are easy to make and transport, making them ideal for volunteer-based oyster reef restoration initiatives. We present preliminary results on oyster spat recruitment, reef stability, and associated biological diversity. The potential for using these modules to stabilize shorelines (living shorelines) will also be discussed.

“The Secret Lives of Filter Feeders: Estimating Oyster Filtration Rates in the Guana Tolomato Matanzas National Estuarine Research Reserve”
Carrie Schuman

Oysters have been lauded for being “ecosystem engineers” as well as providing a variety of ecosystem services including storm protection, habitat stabilization, provision of microhabitat, and carbon sequestration. Other services like improved water quality and control of harmful algal blooms are closely linked to oyster

filtration. Frequently, filtration rates attributed to oysters (and bivalves in general) have been the result of laboratory studies. These observations may then be incorporated into models meant to simulate the system-wide level impact of oyster reefs. There is controversy as to how well lab data can be applied to systems of interest, and the studies that have extended this exploration to in situ, field-based measurements are limited.

I will be presenting preliminary data from field work within the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR) meant to estimate feeding rates of oysters within the area. Two subquestions also examined were 1) does oyster filtration differ between high and low points on reefs? and 2) What are the effects of clustering/aggregating oysters on these rates?
Sediment trap methods were adapted from Yu and Culver (1999) and Sroczyńska et al (2012). Control sediment traps collected background sedimentation. Experimental traps containing oysters collected biodeposits - oyster-produced faeces and pseudo-faeces (rejected food particles) - in addition to background sedimentation. Results were applied to a formula that estimated feeding rates. During three iterations of a large-scale experiment, traps were deployed at high and low points on nine reefs for two week periods within the reserve. Smaller experimental plots examined the production of biodeposits while varying oyster density.

Initial results suggest oysters may be filtering less than would have been estimated using methods applied in past studies. This may speak to a need for conservation and restoration if managing for particular oyster function in a region.

“Distribution, patterns and impacts of feral hog activity in southeastern salt marshes”

Sean J Sharp, Graduate Student, University of Florida

Large consumers engineer their environment through the physical effects of their large bodies on soils and plants, potentially impacting ecosystem services like nutrient cycling and erosion control. In southeastern salt marshes, feral hogs (Sus scrofa) trample, root, and wallow, actions that flatten and uproot vegetation and create small depressions that pool water. Although feral hogs are frequently found in the southeast US coastal region, there have been few studies on the spatial extent and variation in their disturbance impacts in salt marshes. Here we examine feral hog disturbance distribution, features (e.g. size and composition), and severity (i.e. percent vegetation loss) across 16 salt marsh sites from Florida to South Carolina. We surveyed hog damage in salt marshes by scanning aerial imagery, ground-truthing potential sites, characterizing adjacent land cover, and analyzing vegetation and soil biogeochemistry within damaged and adjacent unaffected areas. We also compared the effect of different mimicked hog activities (i.e. trampling, rooting and wallowing) on vegetation health, soil biogeochemistry and carbon and nitrogen cycling by manipulating 2m × 2m plots in the GTM NERR. In our survey we found the occurrence of feral hog disturbance is linked to adjacent upland habitat and results in vegetation removal or mortality and significantly decreases soil structural strength. In our experimental plots, hog wallow and mixed disturbance treatments resulted in the highest vegetation loss and degradation of soil structure compared to control treatments. Although we are still working to identify whether hogs shift salt marshes from carbon sinks to sources, our current results suggest that the loss of vegetation and soil structure from disturbance could lead to alarming shifts in important biotic and abiotic feedbacks, inhibiting recovery of vegetation and associated ecosystem services.

“Engineering community change from the bottom-up: mangrove expansion alters detrital invertebrate community composition through novel habitat provision and detrital inputs”

Rachel S. Smith

Tropical mangrove species are expanding into temperate saltmarshes worldwide, representing a global, climate-driven transition. Along the north Florida coast, black mangrove Avicennia germanins is rapidly moving into saltmarshes, and the northern range limit of this species is located within the Guana-Tolomato-Matanzas estuary. Both mangroves and saltmarsh are detrital-based systems that perform similar ecosystem functions, but these two ecosystems differ greatly in provided habitat structure, as well as the frequency, quantity and quality of detrital inputs. We were interested in how changed habitat context and the presence of novel detrital inputs affect detrital invertebrate community composition following mangrove expansion. Litter from both black mangrove and the dominant saltmarsh species, smooth cordgrass Spartina alterniflora, was placed in mangrove and saltmarsh habitat locally within the GTM estuary, as well as across a regional gradient of mangrove density from West Palm Beach, FL to Savannah, GA. Detrital invertebrate community composition was assessed after 3 months, and habitat context and identity of detrital input were shown to be important drivers of invertebrate community composition at both the local and regional scale.

Specifically, invertebrates were more abundant in saltmarsh detritus within both mangrove and saltmarsh habitats, and overall, more invertebrates were observed in saltmarsh relative to mangrove habitat. Crabs were the primary driver of the observed community changes, and an additional structural mimic experiment showed that crabs utilize both saltmarsh and mangrove detritus primarily for structural habitat refuge. Overall, our work suggests that mangrove expansion into saltmarshes may change detrital invertebrate composition by altering both habitat context and the structural qualities of detrital inputs.