State of the Reserve 2016
"Ecosystem Services" Poster Presentations

***"The role of spatial heterogeneity in oyster settlement and survival on artificial restoration reefs*."**

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This project tested the hypothesis that oyster reef surface heterogeneity is critical for sustaining oyster spat on artificial reefs used in restoration. While oyster spat abundance initially peaked in low- and high-hole density artificial reefs, after 18 weeks there was a substantial decline in oyster abundance in all treatments except the smooth control reef. These findings suggest that spatial complexity is an important factor for both oyster recruitment and community development, and that incorporating surface heterogeneity in restoration projects can lead to greater oyster settlement and a more diverse associated community.

Oyster reefs are a valuable, but degraded, global resource. Despite numerous restoration efforts, oyster populations remain depressed. One important factor hindering their recovery is predation, which has a particularly strong effect on oyster spat due to their small size and underdeveloped shell. Natural oyster habitat is spatially complex with crevices formed by individuals growing on top of one another; complexity that provides some refuge from predation and thereby enhances oyster spat settlement and survival. To test the hypothesis that such surface heterogeneity is critical for sustaining oyster spat on artificial reefs used in restoration, we constructed concrete reef domes that mimicked this complexity and deployed them along the shore of the Matanzas River in Marineland, FL. Our experiment included three treatments: a smooth control dome, a low hole density dome, and a high hole density dome These 1cm x 4cm (width x depth) holes were designed to prevent predation by crabs and oyster drills. Over five months, we surveyed the total abundance and spatial distribution of oyster spat by counting individuals found inside the holes, outside the holes, and on the bottom of each structure. We also noted development of biofilm and associated species that were found living on the reefs. Oyster abundance peaked after 12 weeks in low- and high-hole density reefs, both of which supported a greater number of spat than the control reefs. Complex reefs also had a thicker biofilm and a greater number of associated species. However, after 18 weeks there was a substantial decline in oyster abundance in all treatments except the control. These findings suggest that spatial complexity is an important factor for both oyster recruitment and

community development, and that incorporating surface heterogeneity in restoration projects can lead to greater oyster settlement and a more diverse associated community.

"The Ecosystem of Learning: Informal versus Formal Science Experiences in Teacher Training."

Sally Blake. Professor, Flagler College.

This study compared pre-service teacher science training experience with, and perceptions of informal versus formal science practicum and intern experiences.
Science learning will be perceived to be higher in informal than formal learning environments.
The sample will consist of preservice teacher interns who have participated in practicum and internships at GTM NERR and at traditional formal educational environments.

An ecosystem of science learning is a complex system of interdependence among educational environments, experiences, teachers and students. In order for a healthy learning environment to develop and survive teachers and students need learning environments that support global learning connections (21st Century Skills). This level of support is often found through informal science experiences. This study compared pre-service teacher science training experiences with and perceptions of informal versus formal science practicum and intern experiences.
For the purpose of this study Formal learning is learning supported by an educational or training institution, controlled by a teacher. or a guide, resulting in a certificate, or by accreditation in the form of recognition of that training. Informal learning is not supported by a traditional educational institution.
NSF (2014) identifies benefits of informal science environments as follows.

• Global – supports global learning connections (21st Century Skills)
• Availability – informal science can happen almost anywhere
• Equity – informal science experiences are open to a wider variety of people, includes weekends and evenings when families are more available
• Compelling experiences – curriculum freedom
• Available workforce – no licensing or certification requirements: scientists and engineers welcome
• Nimbleness – able to keep up with rapid changes in information and adapt
• Less rigid Assessment – able to use multiple forms of assessment

The hypothesis is 1) Science learning will be perceived to be higher in informal than formal learning environments.

The instrument is Blau and Caspi's (2008) questionnaire with minor changes made to adapt the questions to the current population. This questionnaire consists of three aspects of perceived learning. The first is the cognitive aspect, and the two others relate to the affective aspect: emotional aspect and social aspect.

The sample will consist of preservice teacher interns who have participated in practicum and internships at GTM NERR and at traditional formal educational environments.

"Impact of Climate Change-Induced Vegetation Shift on Estuarine Food Web Structure."

Monica C. Camacho. Undergraduate Researcher (NSF REU), Whitney Laboratory for Marine Bioscience, University of Florida. Monica C. Camacho1,2, Tracey B. Schafer2, Todd Z. Osborne2,3

As the mangrove population moves north, there is uncertainty as to how changing the primary inputs of the coastal carbon cycle will affect foodweb structure. The objectives of this work were to determine if mangrove-sourced organic carbon is being incorporated into key marsh detritivores and whether these detrital feeders show a preference for material from black mangroves (*Avicennia germinans*) or smooth cordgrass (*Spartina alterniflora*). The majority of organisms studied, including periwinkle snails, obtained their nutrients from smooth cordgrass, although results suggest that mangrove tree crabs, ribbed mussels, and oysters fed on detritus derived from both plants. Fiddler crabs preferred black mangrove soil.

Coastal wetlands provide numerous ecosystem services including sequestering carbon, removing pollutants from water and providing habitat for numerous species of fish, crustaceans, and mussels. Salt marshes, a prominent wetland form in the Southeastern coastal states is dominated by smooth cordgrass (Spartina alterniflora) which fuels a complex detrital foodweb with seasonal inputs of plant biomass. However, due to less frequent freeze events, black mangrove (Avicennia germinans) coverage has doubled in the last three decades in Northeast Florida's salt marshes. As climate change progresses, there is uncertainty as to how changing the primary inputs of the coastal carbon cycle will affect foodweb structure. Our objectives with this work were to 1) determine if mangrove sourced organic carbon is being incorporated into key marsh detritivores and 2) if these detrital feeders show a preference for detrital material from mangroves or cordgrass. Animal and vegetation tissues along with soil were collected at several

sites within the GTMNERR. Stable isotope analysis was used to determine from which vegetation organisms were obtaining carbon. Feeding trials with fiddler crabs and periwinkle snails were conducted to investigate which vegetation each preferred. The majority of organisms studied obtained their nutrients from S. alterniflora, although results suggest that A. pisonii (mangrove tree crab), G. demissa (ribbed mussel), and C. virginica (oyster) fed on detritus derived from both plants. Furthermore, fiddler crabs preferred A. germinans soil while periwinkle snails preferred S. alterniflora vegetation.

"Oyster Condition Assessment"

Kaitlyn Dietz, Researcher, GTM NERR and NEFL APs. Nikki Dix

To understand the status and trends of local oysters, these researchers are assessing oyster population condition throughout Northeast Florida. Preliminary analysis indicates the percent cover on the majority of the oyster reefs is comprised of dead oyster shell, although the reefs sampled at the southern end of the project area (Flagler County) had a relatively higher percent cover of live oysters. Analysis also indicates there is no regional difference of white barnacle, porcelain crab, or black ribbed mussel density on reefs sampled. However, there is a higher density of gastropods on the most southern reef sampled than any other reefs.

Oysters are a prominent feature of estuaries in northeast Florida and they provide numerous ecological and economic benefits. Besides their importance as recreational and commercial fisheries, oysters provide ecosystem services including water filtration, sediment creation, habitat formation, and shoreline protection. Oyster reefs also influence estuarine hydrodynamics, plankton structure and productivity, and water quality. The prevalence of oysters in northeast Florida suggests that they have even more ecosystem influence than has been documented in other systems. Unfortunately, information on the status and trends of local oysters is scarce and we do not understand the current condition (and value) of our oyster resources. Therefore, the GTM Research Reserve (GTM) and Northeast Florida Aquatic Preserves (NEAP) is assessing oyster population condition throughout northeast Florida.

Through two sampling periods, summer 2015 and winter 2015-16, oyster population structure metrics were collected on 21 and 50 reefs, respectively, throughout Nassau, Duval, St. Johns, and Flagler counties. Summer sampling preliminary analysis indicates the majority of the oyster reefs percent cover is dead oyster shell and a higher percent cover of live oysters within the more southern reefs sampled. Analysis also indicates there is no regional difference of white barnacle, porcelain crab, or black ribbed mussel density on reefs sampled. However, there is a higher density of gastropods on the most southern reef sampled than any other reefs.
This Oyster Condition Assessment project is building upon the current and past research efforts of the GTM Research Reserve and complements oyster mapping efforts conducted by the St. Johns River Water Management District and the University of Central Florida to protect the water quality and restore oysters. The combined information and efforts will support a development of a baseline condition of the northeast Florida oyster reefs and continued/ future monitoring efforts for this keystone species.

"Presence and abundance of microplastics in the Northeast Florida Coastal Environments"

Kelly L. Dobroski. Undergrad. Whitney. Todd Osborne

The goals of this project were to determine whether there is a quantifiable amount of microplastics on local beaches and within the intracoastal waterway, and the spatial extent of microplastics on local beaches and waterways. The highest two waterway concentrations were observed at Matanzas Inlet and just downstream of the St. Augustine Wastewater Treatment Plant outflow. The greatest two fiber concentrations on beaches were found on the northern most GTMNERR beach site and at the Matanzas Inlet adjacent to Fort Matanzas.
Plastic consumer goods have become an increasingly prevalent source of marine pollution globally, with the microplastic fraction (defined as being <5mm in diameter or length) being of special concern. Photodegredation weakens polymer bonds in larger plastic materials resulting in fragmentation to smaller and smaller pieces. Various consumer goods contain microplastic beads or synthetic fibers which also find their way into marine environments. While the

environmental impact of these microplastics is relatively unknown, we conducted a spatial survey of the Matanzas River (ten sites) and local beaches (nine sites) within the Guana Tolomato Matanzas National Estuarine Research Reserve to 1) determine whether there is a quantifiable amount of microplastics on local beaches and within the intracoastal waterway and 2) determine the spatial extent of microplastics on local beaches and waterways. A modified wet oxidation method was developed to remove organic matter from water samples for microplastics enumeration and a standardized soil coring method was utilized to measure abundance in beach samples. The highest water concentration (289.6 fibers L-1) was observed at Matanzas Inlet and is likely due to popularity of the area for recreation. The second highest concentration (271.4 fibers L-1) was observed just downstream of the St. Augustine Wastewater Treatment Plant outflow, suggesting fibers are escaping the treatment process. The greatest fiber concentration on beaches (14,939 per m2) was found on the northern most beach site (North GTMNERR) and the second highest concentration (13,354 per m2) was observed at the Matanzas Inlet adjacent to Fort Matanzas. The abundance of fibers found in these areas, likely sourced from bathing suits and towels, suggests a linkage to recreation activities. Future work on effects of microplastic fibers on marine organisms is necessary to better understand the impact these materials may have on coastal ecosystems.

“Fecal Pollution, Ammonium Concentrations, and Water Quality Indices Within Salt Run: Implications on Shellfish Harvesting. “
Melissa Johnson. Student. Flagler. Matt Brown.

This study assessed fecal pollution indicators in relation to current shellfish harvesting classifications within Salt Run. Fecal pollution indicators were found to gradually increase from the north of Salt Run to the south. Additionally, these bacterial indicators were inversely proportional to salinity and directly proportional to turbidity.

In 1995 many of the shellfish harvesting areas within the Guana Tolomato Matanzas (GTM) estuary system were reclassified as a result of high fecal coliform counts. This led to the closure of the majority of previously open oyster beds to shellfish harvesting. The main objective of this study was to assess fecal pollution indicators in relation to current shellfish harvesting classifications within Salt Run. Surface water samples were obtained in triplicate from eight sites within Salt Run over a range of tidal and weather conditions throughout the late summer and fall 2015 seasons. Also, these sites were located within an array of shellfish harvesting classifications. Four of these sites were classified as "Prohibited," one was "Conditionally Approved," and the final three were "Conditionally Restricted." Fecal coliform counts, ammonium concentrations, and water quality indices within Salt Run were measured at each of these sites. Also, relationships were determined between the various physico-chemical parameters that were observed. Fecal pollution indicators were found to gradually increase from the north of Salt Run to the south. Additionally, these bacterial indicators were inversely proportional to salinity and directly proportional to turbidity. The results of this study in comparison to current water quality standards suggest that the oyster beds within this region should be re-opened to harvesting. However, further research must be done to determine the associated seasonal variation.

"Effect of Spartina alterniflora Harvest on Recovery in Donor Marsh."
Cheryl Mannel. Restoration Coordinator for Northeast Florida Aquatic Preserves.
This study examines marsh recovery under six harvest intensities in order to determine the appropriate harvest rate for a given marsh recovery time. Preliminary results show significant differences in marsh recovery due to harvest intensity. These results will inform best management practices for Spartina harvest based on desired marsh recovery rate.

Salt marshes are a critical habitat in coastal systems which provide buffering from storm surges, carbon sequestration, and habitat for fish, birds, and numerous benthic species. Shoreline erosion is a prevalent threat to estuarine systems. High wave energies can lead to loss of sediment substrate and vegetation which reduces the total area of salt marsh in the system. Planting Spartina alterniflora along impacted and vulnerable shorelines stabilizes sediment and facilitates greater resiliency to environmental stressors. Plugs of Spartina can be purchased from commercial nurseries or harvested from healthy donor marsh. Harvesting Spartina from local sources has been shown to yield better establishment, incurs fewer costs, and has a smaller carbon footprint compared to purchased plugs. In order to avoid negative impacts on donor marsh, best management practices (BMPs) are needed to advise harvest rates. This study examines marsh recovery under six harvest intensities in order to determine the appropriate harvest rate for a given marsh recovery time.

Six harvest intensities ranging from no harvest to 100% harvest were tested on 0.5 m x 0.5 m plots, with three replicates of each treatment (18 treatments per plot). Seasonality was also considered with harvests conducted in both fall and spring for a total of 36 experimental quadrats. These were monitored monthly for three parameters: 1) stem density, 2) percent cover, and 3) average culm height, in order to assess recovery in the donor marsh. Stem density was determined by counting all live stems and new rhizomatous propagules within the plot. Percent cover was determined using SamplePoint software to generate a percent cover based on analysis of a digital image of the quadrat taken monthly during sampling. Average culm height was measured by taking the mean of the five tallest culms within the quadrat. Monitoring continued for 12 months for each season so that a year of recovery data was collected for both fall and spring harvests.

Preliminary results show significant differences in marsh recovery due to harvest intensity. These results will inform best management practices for Spartina harvest based on desired marsh recovery rate.

“The impact of ocean acidification on Eastern Oyster (Crassostrea virginica) populations and implications for restoration techniques.”

Jospehine Moberg. Undergrad, Whitney. Nuñez, J. 1, Osborne, T.Z.

This research addresses effects of ocean acidification on oysters, specifically the eastern oyster, *Crassostrea virginica*. The overarching goal of this work was to provide insight into *C. virginica*'s future as climate change continues to alter the marine environment. Survival of oyster larvae from the Matanzas Inlet were affected at the lowest pH levels while oyster larvae from Pellicer Creek were not. Preliminary data suggests that populations with historical exposure to low pH might be more successful at adapting to changes in ocean acidification.

As atmospheric carbon dioxide levels rise, more of this gas dissolves into the oceans. As a result, estuarine and coastal ecosystems' hydrogen and carbonate ion concentrations drop, as indicated by lower pH. This process known as ocean acidification is a direct result of anthropogenic climate change. The lower pH results in a lack of calcium carbonate, which marine organisms such as corals and mollusks require to build their skeletons or shells. This research addresses effects of ocean acidification on oysters, specifically the eastern Oyster, Crassostrea virginica, a species which contributes tremendous ecosystem services to coastal systems. pH is also suspected of affecting oysters' spawning, egg and sperm viability, embryonic development and larval survival and growth. The overarching goal of this work was to provide insight into C. virginica's future as anthropogenic climate change continues to alter the marine environment. We tested two distinct populations of C. virginica from the northeastern coast of Florida, one from the Matanzas inlet (St. Johns county) and one from the Pellicer Creek aquatic preserve (St. Johns/Flagler counties), both within the GTMNERR to determine how pH levels affect the highly sensitive larval stage of the oyster. We analyzed the responses of veliger stage larvae from these different populations to a range of pH levels (6.5-8.5). Survival of oyster larvae from the Matanzas Inlet were affected at the lowest pH levels while oyster larvae from Pellicer Creek were not. Our preliminary data suggests that populations with historical exposure to low pH might be more successful at adapting to changes in ocean acidification.

“Coastal Expeditions: Human Impact on Marine Ecosystems.”

Alexandra Peterson. Flagler. Kenneth Rainer

Marine debris was collected from the shoreline of beaches primarily in St. Johns County, as well as Flagler County. Throughout this ongoing research project, which began in July of 2012, the primary type of marine debris found has been cigarettes. This information supports the hypothesis that if a person visits a public beach where smoking is permitted, then cigarettes will be the most common type of marine debris found.

Assessing the current amount of debris on beaches and monitoring changes can help solve the problem of marine pollution. By tracking the amounts of marine debris found on various beaches over long periods of time, the types of pollutants that are most prevalent can be identified, possible sources of marine debris can be theorized, and the severity of the issue of marine pollution can be assessed. To further investigate this topic, marine debris was collected from the shoreline of beaches in St. Augustine, Florida. These beaches were located primarily in St. Johns County and secondarily in Flagler County. Throughout this ongoing research project, which began in July of 2012, the primary type of marine debris found has been cigarettes. This information supports the hypothesis that if a person visits a public beach where smoking is permitted, then cigarettes will be the most common type of marine debris found.

“Comparison between Wind-Driven and Boat Driven Waves on the Environment.”
Collin Ries. Graduate Student, UNF

This study, currently in progress, will analyze the difference between wind-driven and boat generated waves and their effects on turbidity and general shoreline disturbance. The results of this study will help to quantify the relative impacts of these two types of waves to shoreline erosion within the GTM boundary.

Waves are a major cause of coastal erosion which in turn impacts the species that live near or along the coastal shorelines. Within the intercostal waterways of the Guana Tolomato Matanzas (GTM) of northern Florida there are two types of waves, wind driven and boat generated waves. This study analyzed the difference between wind-driven and boat generated waves and their effects on the amount of turbidity and disturbance caused by both. Instruments were installed within the southern GTM, South of the Matanzas Inlet. Three capacitance gauges and three pressure gauges were used to measure the incoming wave period and heights, while two turbidity gauges were input in order to measure the disturbance of sediment. A current meter was also installed to assess the effect of currents on the wave field at the site. The results of this study will help to quantify the relative impacts of these two types of waves to coastal erosion within the GTM shoreline.

“Estimating Carbon Accumulation at a Reconstructed Oyster Reef.”

Elizabeth Scarlett. Student, Flagler.

In order to estimate an amount of carbon accumulating behind newly reconstructed oyster reefs at the GTMNERR, we tested the percent of organic matter in surface sediments, measured their bulk density, and took cores to gauge the depth of organic-matter-rich sediments. We calculated that the oyster reefs were accumulating more carbon than the nearby control area where no reefs had been installed.

Abstract: Oyster reefs provide many important ecosystem services, including shoreline stabilization, water filtration, and habitat creation for benthic invertebrates and juvenile fish. Another service, which is often listed but rarely focused on, is an oyster reefs’ ability to sequester carbon. There has been increasing interest in the carbon storage potential of coastal habitats such as salt marshes, sea grass beds, and mangrove forests. These habitats have been collectively described as important sinks for “blue carbon”, carbon that is sequestered by vegetated coastal habitats, due to their shared characteristics of: high primary productivity, low wave energy, and sediment accumulation. Oyster reefs also exhibit many of these characteristics. They act as shoreline stabilizers by dissipating wave energy and they facilitate sediment accumulation by trapping sediments behind them during tidal inundation. In order to estimate an amount of carbon accumulating behind newly reconstructed oyster reefs at the GTMNERR, we tested the percent of organic matter in surface sediments, measured their bulk density, and took cores to gauge the depth of organic-matter-rich sediments. We calculated that the oyster reefs

were accumulating ~42 kg more carbon per a 120 m2 area than the nearby control area where no reefs had been installed. The intended goal of the oyster reef restoration was to improve shoreline stabilization and protect the historical Wrights' Landing site; as well as improve general ecosystem health and fish biodiversity. An added benefit of this restoration project has been an increase in carbon accumulation in the sediments behind the reefs. Future restoration projects should keep in mind the potential economic benefits and ecosystem services that oyster reefs provide. Further research should be done to investigate whether oyster reef habitats should be included as potential blue carbon sinks.

"Soil Carbon Stocks in a Shifting Ecosystem; Climate Induced Migration of Mangroves into Salt Marsh."

Lorae' T. Simpson. PhD Candidate, Whitney & Smithsonian.

This work aims to document carbon storage in the salt marsh - mangrove ecotone and any potential changes in this reservoir that may ensue due to the shifting range of this habitat. Carbon stocks in the GTM Research Reserve versus southern mangrove populations will be compared. This latitudinal gradient provides an exceptional opportunity to document and investigate ecosystem soil carbon modification as mangroves transgress into salt marsh habitat due to climatic change.

Across the globe, coastal wetland vegetation distributions are changing in response to climate change. The increase in global average surface temperature has already caused shifts in the structure and distribution of many ecological communities. In parts of the southeastern United States, increased winter temperatures have resulted in the poleward range expansion of mangroves at the expense of salt marsh habitat. Our work aims to document carbon storage in

the salt marsh - mangrove ecotone and any potential changes in this reservoir that may ensue due to the shifting range of this habitat. Differences in biomass and carbon stocks in the Guana Tolomato Matanzas National Estuarine Research Reserve versus southern mangrove populations will be presented. This latitudinal gradient gives us an exceptional opportunity to document and investigate ecosystem soil C modification as mangroves transgress into salt marsh habitat due to climatic change.

"Habitat Characterization of a Northeast Florida Estuary: Factors that Contribute to Fish Biodiversity."

Esme E. Vazquez. Student, Flagler. McGinley

With this study, we model a variety of factors to determine what habitat characteristics facilitate fish diversity, supporting a larger study of fish biodiversity St. Augustine. Although there was not a clear model, the model of best fit suggested that vegetation cover and anthropogenic influence were positively correlated with fish biodiversity and that organic matter content in the sediment was negatively correlated with fish biodiversity.

With this study, we assess a variety of factors to determine what habitat characteristics facilitate fish diversity. This work supports a larger study of fish biodiversity St. Augustine. Fish populations can serve as an ecosystem service by providing food and recreation. A variety of factors may promote fish populations and biodiversity in ecosystems and specific habitat characteristics may be correlated with higher or lower diversity. The habitat characteristics that we assessed are: the slope of the ecosystem, organic matter content in the sediments, sediment particle size, vegetation cover, distance to nearest inlet, and the proximity to anthropogenic influence, and overall structural complexity of the habitat. A statistical regression model was calculated to determine what habitat factors are closely related with fish diversity. Although there was not a clear model, the model of best fit suggested that vegetation cover and anthropogenic influence were positively correlated with fish biodiversity and that organic matter content in the sediment was negatively correlated with fish biodiversity.