State of the Reserve 2015
"Science to Management"

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.

“Effects of Fire in the Coastal Strand: Students and Mentors Using Science to Inform Management”

Barbara Blonder
Associate Professor, Natural Sciences and Director of Undergraduate Research
Flagler College

Bio: I am in my 11th year at Flagler College. Highlights of my years here include helping to build a science program from one full-time faculty member to six, capped with the highly successful launch of our Coastal Environmental Science major in 2013. My research and training has taken many paths. Just before coming to Flagler College, I worked for The Nature Conservancy in both Putnam County (Dunns Creek State Park, developing management and fire management plans) and the Outer Banks of North Carolina. I also worked for the North Carolina NERR as a Stewardship Coordinator. I achieved Florida Certified Burn Boss certification while working for the Florida Park Service earlier in my career, and prior to that worked at the Kennedy Space Center on Gopher Tortoises. I began my career working at the Florida Marine Research Institute on Spiny Lobsters in the Florida Keys. Although I never planned such a broad trajectory, I am proud to have developed system-level insights in approaching ecosystem research and management. I am passionate about biodiversity, and truly enjoy infecting my students with the same enthusiasm.

Abstract: Several years ago, Flagler College Natural Sciences faculty members met with members of the GTMNERR staff to discuss partnership research opportunities. Among these research needs, Coastal Strand Fire Ecology was identified as an unmet priority. In January, 2013, GTM Research Reserve staff conducted a prescribed burn on almost exactly one-half (south end) of the Coastal Strand on the east side of A1A, leaving the other half (north end) unburned. The burn clearly exhibited intense fire behavior, as would be expected in a scrub-like ecosystem dominated by saw palmetto and oak. As such, an ideal control vs. treatment in situ ecological experimental opportunity presented itself.
In July, 2013, we decided to attempt a trial line-intercept sampling effort to determine whether it would be feasible to engage an entire Biodiversity and Conservation Capstone Research class in comparing biodiversity indicators in these burned and unburned sites.

We were successful in sampling in this extremely dense natural community, and therefore decided that we would proceed with this ambitious endeavor to make this ecological experiment the focal point of the class research requirement.

By the third week of class (mid-September, 2014), 15 students mentored by two Flagler College Natural Sciences Department members were actively collecting data on a weekly basis through November, 2014. There were 6 research topics: 1) comparison of vegetative diversity on the foredune; 2) comparison of vegetative diversity on the backdune; 3) comparison of cryptic faunal diversity (insects, reptiles, and amphibians); 4) tree mortality and vigor of red bay; 5) tree mortality and vigor of live oak; and 6) preparation of a fire fuel model to inform future prescribed fire planning and implementation.
Preliminary results of these research efforts will be presented, with emphasis on how this research can be used to inform Reserve management of this distinctive and threatened ecosystem.

"The Role of Habitat on Nekton Communities in a Northeast Florida Estuary"

Shannon Dunnigan
Graduate Student
University of North Florida

Bio: Shannon Dunnigan received her Bachelor's of Science degree in Biological Sciences with a concentration in Marine Biology from the Florida State University in Tallahassee, FL in December of 2012. Since then she has participated in research affiliated with Mote Marine Laboratory, Sarasota FL and the NMFS NOAA Fisheries Lab in Panama City, FL on projects ranging from studies in red tide toxins to fisheries-independent surveys for stock assessment purposes. She is now a graduate student at the University of North Florida working on a Master's of Science degree in Biology investigating fish and invertebrate assemblages within the Guana Tolomato Matanzas National Estuarine Research Reserve.

Abstract: Native oyster reefs provide a variety of ecosystem services such as water filtration, shoreline defense, and serve as habitat for many coastal and marine animals. It is currently estimated that 85% of oyster reefs have been lost worldwide. Due to this decline and the economic and ecological value of oysters to their respective systems, many efforts have been made at restoring oyster reefs in hopes of re-establishing these shellfish populations. The Friends of the GTM Research Reserve organization installed a living

shoreline of artificial oyster and fiber-coir logs with the goal of ceasing or reversing the erosion along the Guana Peninsula within the Guana Tolomato Matanzas National Estuarine Research Reserve. The use of these living shorelines also has the added benefit of providing habitat for many coastal species. Through a grant from the Atlantic Coastal Fish Habitat Partnership, monthly seine and gill net surveys were conducted to assess the nekton communities utilizing the artificial reef and natural reefs within the Tolomato and Guana Rivers surrounding the Guana Peninsula. A 20-ft bag seine provided an active method of capturing small to mid-size species within the artificial reef and adjacent unstructured habitats. The gill net provided a passive method of sampling the larger transient species in natural reefs, the artificial reef, and unstructured habitats within both the Tolomato and Guana Rivers to provide further insight into the differences in community composition within the area. CPUE for seine (# fish/60m2) and gill net (#fish/soak time), and Shannon-Weiner diversity index among habitats and seasons were used to analyze the effect of habitat on the nekton communities. There were some differences in CPUE and diversity seasonally and among treatments. Further sampling may be needed in order to fully understand the communities present within this system and the role habitat plays in their abundance.

“Ecological Characteristics of Spoil Islands Along the Atlantic Intracoastal Waterway and Their Potential to Support Maritime Forest Communities”

John Baker
Coastal Ecologist
Former Guana Tolomato Matanzas National Estuarine Research Reserve Graduate Research Fellowship Recipient and University of Florida Ph.D. Student.

Bio: John Baker graduated in 2014 with a Doctor of Philosophy in the Department of Environmental Engineering Sciences at the University of Florida. In 1996 and 1998, he earned a Bachelor of Science in zoology and a Master of Education in science education from University of Florida, respectively. He has worked as a botanist for the Florida Fish and Wildlife Conservation Commission, field technician on multiple projects for the Center for Wetlands at the University of Florida, and volunteer for the United States Fish and Wildlife Service on Kodiak Island in Alaska. His research interests include the ecology and management of maritime forest and coastal ecosystems, restoration and creation of upland and wetland ecosystems, hydrology of upland and wetland communities, and

prevention and reversal of desertification. John is planning on applying his knowledge and skills to help protect, restore, create and improve upland and wetland ecosystems and provide habitat for the plants and animals they support.

Abstract: Maritime forests are woodlands that have developed under the influence of salt spray and salt water inundation on barrier islands, hammock islands and estuarine shorelines. In northeast Florida, maritime forests are also found on numerous dredged spoil islands along the Atlantic Intracoastal Waterway. Spoil islands support early successional maritime forest and unforested elevated interior areas or barrens that generally support drought tolerant herbs, grasses, cacti, with very few shrubs or trees. Spoil islands also provide habitat for many maritime forest and coastal animals. In order to investigate the potential of spoil islands to serve as high quality refuges for maritime forest species, succession on barrens was accelerated by planting live oak seedlings and red bay seeds. Multiple planting amendments increased the growth of planted seeds and seedlings. Based on this research, spoil islands are serving as refuges for maritime forest plant and animals and offer excellent opportunities to accelerate their transition into higher quality maritime forest communities.

“Salt Marsh Dynamics in the GTMNERR: A Year in Review”

Pamela Marcum
Biologist
GTM Research Reserve

Bio: Pamela Marcum has been lead biologist with the GTM Research Reserve since January 2014. She earned a B.S. in Biology from Arizona State University and a M.S. in Coastal Zone Management and Marine Biology from Nova Southeastern University. Prior to working with the Reserve, Pam spent the past 10 years studying southeastern coastal ecosystems from

Georgia to the Florida Keys including coral reefs, seagrass beds, mangroves, and salt marshes.

Abstract: The importance of, and need to, protect salt marsh ecosystems is well documented. To better understand salt marshes within the GTMNERR, and evaluate how this dynamic ecosystem fluctuates throughout the year, GTMNERR researchers spent the last year conducting detailed monthly monitoring of salt marsh sediment and vegetation at six sites. Immediate goals of this research were to identify inter-annual (seasonal) and spatial patterns in the salt marshes of the GTMNERR. These results will be used to develop future research and monitoring efforts including a sentinel site plan that serves to provide standardized monitoring and evaluation of salt marsh responses to various environmental stressors, like storm events and sea level rise. Ultimately, this research serves as a springboard for the development of best management practices to better protect and preserve this valuable ecosystem.

“Living at the edge: effects of climate change on mangrove range limits”

Dr. John Parker
Senior Scientist
Smithsonian Environmental Research Center

Bio: Research Ecologist at the Smithsonian Environmental Research Center since 2007. My research interests include the impacts of biodiversity on ecosystem function, herbivory and invasive species, and the consequences of climate change.

Abstract: Mangrove populations around the world are expanding at their range edges, contributing to the growing predominance of tropical species in temperate zones. Rising global temperatures were thought to be generally responsible for these shifts, but work has recently shown that it is not rising temperatures per se, but rather the reduction in the number of freeze events experienced at the range edge. Here, through a series of ecophysiological investigations, we further show that the mangrove species with the most northern distribution in Florida, the black mangrove Avicennia germinans, has the highest resistance to freezing temperatures, followed by moderately freeze-resistant red mangroves Rhizophora mangle, then the least-resistant white mangroves Laguncularia racemosa. All three species become more resistant to freezing at the edge of their ranges, although this appears to be phenotypic plasticity rather than genetic adaptation to freezing temperatures. Interestingly, all three species also appear to converge on a common, relatively freeze-resistant phenotype at the edge of the ranges, indicating that common selective pressures can lead to common phenotypes, even across three species from three different families. More recently, we have begun to investigate the potential for mangroves to enhance their own recruitment into these edge populations through the creation of warmer microclimates created by mangrove trees living within the salt marsh. Overall, our results point to climate change as a predominant factor enhancing the recent and rapid expansion of mangroves into the GTM and beyond.

“Spatio-Temporal Changes in Mangrove and Saltmarsh at the North-Eastern Coast of Florida, USA”

Wilfrid Rodriguez
Research Associate
Smithsonian Environmental Research Center, Edgewater, Maryland

Abstract: General circulation models predict warming trends and changes in temperature and precipitation patterns that have the potential to alter the structure and function of coastal habitats. The purpose of this study was to quantify the effect of these climate drivers on mangrove and saltmarsh ecosystems. The study was conducted in a mangrove/saltmarsh ecotone at Guana Tolomato Matanzas Research Reserve, Flagler County, FL. We used time-series of high-resolution multispectral satellite imagery (1995 – 2013) to characterize the landscape and to quantify the expansion of mangroves and the associated loss of saltmarsh. The Normalized Difference Vegetation Index (NDVI) was used to map and classify vegetation changes at the site. NDVI derivatives were used as input to FRAGSTATS to quantify changes in landscape structure using a number of class- and landscape-level metrics. To assess how ecological processes would influence landscape patterns, landscape metrics were treated as dependent variables and temperature and precipitation were treated as independent variables. Results of land cover classification showed an increase in mangrove extent of 79 % (8.61ha), with a concomitant decrease in saltmarsh area of 67 % (8.28 ha) between 1995 and 2013. The rate of change was highest between 2008 and 2013, 1.21 ha/yr (+ 25 %) and -1.13 ha/yr (- 6 %) for mangrove and saltmarsh, respectively. Landscape pattern analysis showed a marked change in heterogeneity and fragmentation from 2004 to 2013, with the largest change in 2008. At the class-level: total area, percent of landscape, and largest patch index metrics in mangrove habitat showed a significant ($R2 = 0.999$; $R2 = 0.999$; $R2 = 0.997$; $P = 0.027$; $P = 0.027$; $P = 0.050$, respectively) negative response with increased temperature and precipitation. At the landscape level, the overall trend was a decreased response with precipitation vs an increased response with temperature.

“Patterns of terrestrial arthropod diversity in the mangrove-marsh ecotone on the Atlantic coast”

Alexander J. Forde
PhD Candidate
Department of Entomology, University of Maryland, College Park

Bio: Alexander Forde is a PhD student at the University of Maryland studying factors that affect interactions between mangrove trees and the insects that feed on them and use them for habitat. He has been conducting research on plant-herbivore interactions for 9 years and started this line of research while he was working on his Bachelor’s degree at Carleton College in Northfield Minnesota. Currently he is investigating 1) how insect herbivores may be impacting the encroachment of mangrove trees into salt marshes in Northern Florida 2) how insect communities at the scale of individual plants and landscapes are changing as mangroves expand their geographic range poleward, and 3) how insectivorous birds, refuges, and productivity jointly impact mangrove-insect interactions.

Abstract: Recent climate change and human-mediated dispersal are causing widespread shifts in spatial patterns of species occurrence and abundance. These range shifts can have significant impacts on the structure and function of local communities. Mangrove trees are one important group of species expanding their spatial distribution polewards in response to climate change. Along the Atlantic coast of Florida, forests of mangroves in the south gradually transition into salt marshes in the north, forming a habitat gradient, also know as an ecotone. During the past several decades, in response to milder winters, mangroves have substantially increased their dominance within this ecotone, and are extending the historical ecotone northward as they invade novel marsh landscapes.
In order to better understand how animal diversity varies within mangrove-marsh gradients, and predict how diversity in contemporary marshes may change as they are invaded by mangroves, we sampled terrestrial arthropod communities (insects and spiders) at sites along the Atlantic coast of Florida in the summer of 2014. We used a hand-held vacuum sampling device to collect arthropods from marsh or mangrove plants at sites within the ecotone, as well as in “pure” forest and marsh habitats. While sample processing and specimen identification are ongoing, several interesting patterns are already apparent.

The communities of arthropods in marshes and mangrove forests differ greatly, as expected, but the communities living on mangroves imbedded within marshes in the ecotone are also very distinct from both trees in forests and neighboring patches of marsh plants. Additionally, communities on individual mangrove trees are affected by isolation within ecotone sites: mangroves growing in dense clusters host higher abundances of generalist (marsh-associated) herbivores, signaling the possibility of density dependence in local mangrove population dynamics.

"Babies having babies: a method of mangrove range expansion"

Dr. Emily Dangremond
Post-Doctoral Research Fellow
Smithsonian Environmental Research Center

Bio: Emily Dangremond is a postdoctoral research fellow working with Candy Feller at the Smithsonian Environmental Research Center. Her research focuses on ecological and evolutionary patterns at the range edge of mangroves, which are expanding poleward. She received her Ph.D. from the University of California, Berkeley, in 2013. Her previous research examined factors contributing to the rarity of the mangrove Pelliciera rhizophorae, a rare species endemic to Central and South America.

Abstract: Currently, mangrove species are expanding their ranges poleward into higher latitude temperate salt marshes. GTM is ideally located near the northernmost mangroves, allowing observations of ecological changes at the range edge. The reproductive traits of mangroves have changed at the range edge, with plants becoming reproductive at a young age, a phenomenon called precocious reproduction. In 2012, a common garden experiment was established at GTM with red (Rhizophora mangle) and black mangroves (Avicennia germinans) from five different source populations. Seedlings were randomly assigned to a shade or sun treatment, with shadecloths covering half of the plots in the common garden.

Overall, black mangroves did not survive the transplanting well, but red mangroves did. Seedling survival in the common garden was not significantly different among source populations (log-rank test, red mangrove: $X2= 8.6$, $df = 4$, $p= 0.073$; black mangrove: $X2=5.8$, $df= 4$, $p = 0.217$), with 45-60% of red mangrove seedlings and 20% of black mangrove seedlings surviving to 2 years. Survival and growth did not differ between shade and sun

treatments. Red mangrove seedling growth was significantly different among populations (ANOVA, df = 4, F = 10.62, p = <0.001), with seedlings from the northernmost population growing 4 cm less, on average, than seedlings from other populations.

Precocious reproduction increased with latitude, with only 3% of seedlings from the southernmost population at 25.5°N flowering, and 38% of seedlings from the northernmost population at 29.9°N flowering. We also see precocious reproduction in naturally-occurring mangroves at the range edge. This precocious reproduction may allow mangroves to increase the rate of their expansion poleward.

"Genetic diversity of the red mangrove (Rhizophora mangle L.), an expanding foundation species, within the GTMNERR"

John Paul Kennedy
Link Fellow
Smithsonian Marine Station

Bio: John Paul Kennedy graduated this summer from Florida Atlantic University with a Masters of Science in Biological Sciences. His thesis research characterized patterns of connectivity among red mangrove (Rhizophora mangle L.) populations in the Caribbean, West Africa, and Florida. As a Link Fellow at the Smithsonian Marine Station, he expanded on this research by comparing the extent of red mangrove population connectivity along both coasts of the Florida peninsula.

Abstract: Florida mangroves are expanding past their historical range limits into areas previously dominated by salt marsh. The introduction of these mangrove foundation species can have extensive ecological impacts. Measuring genetic diversity within and connectivity among populations of these expanding mangroves offers insight into potential associated community diversity and resilience to environmental changes. We quantified neutral genetic diversity within red mangrove (Rhizophora mangle L.) populations along the extent of this species' contemporary distributional range in Florida, including those at the leading edge of expansion on the west and east coast (Cedar Key and St. Augustine, respectively). East Florida red mangroves are generally more genetically diverse than those

from West Florida. Also, along the east coast, genetic diversity is associated with proximity to inlets. Compared to leading edge red mangroves on the west coast, those in St. Augustine, from Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), are substantially more genetically diverse and exhibit greater connectivity to other Florida populations. Within the GTMNERR southern component, high levels of genetic diversity are present within individuals north of the Matanzas Inlet (near Ft. Matanzas National Monument) and low diversity is found within a small number of individuals south of the inlet (River to Sea Preserve). The leading edge of red mangrove expansion (near Vilano Bridge) is also characterized by low genetic diversity. Future management efforts should focus on preserving the genetic diversity north of the Matanzas Inlet and further research needs to assesses diversity patterns of the black mangrove (Avicennia germinans), the predominant mangrove species within the GTMNERR.