State of the Reserve

GUANA TOLOMATO MATANZAS NATIONAL ESTUARINE RESEARCH RESERVE

PRESENTATIONS AND PROGRAM SUMMARY

FEBRUARY 28, 2020

The Guana Tolomato Matanzas National Estuarine Research Reserve (GTM Research Reserve) is comprised of a network of public lands managed by the GTM Research Reserve, Florida Fish & Wildlife Conservation Commission, Flagler County, St. Johns River Water Management District, Florida State Parks, the Florida Forest Service, and the National Park Service. The map to the left illustrates the boundary extent of the GTM Research Reserve.

For more information, contact the GTM Research Reserve Visitor Center.
904-823-4500
www.gtmnerr.org
https://floridadep.gov/rcp/nerr-gtm

A LETTER FROM THE DIRECTOR

Welcome to the GTM Research Reserve's State of the Reserve!

This is the 10th State of the Reserve symposium since 2010. The GTM Research Reserve serves an important role in understanding human impact to natural resources and in guiding coastal communities to appropriately respond to sea level rise and climate change. This science-based approach steadily contributes to our collective understanding of the status and trends of water quality and habitat conditions within the Reserve.

The Reserve's science guides its education and stewardship programs leading to improvements in our techniques and awareness needed to protect eroding salt marshes and dunes, detect and respond to red tide, and to facilitate monitoring of threatened archaeological resources. As a practical example, after over thirty years of closure of shellfish harvesting in the Guana River, increased monitoring by Reserve staff and volunteers has contributed to the opening of portions of the Guana River for oyster harvesting.

Another important theme highlighted in this year's State of the Reserve is the continuation of long-term sentinel monitoring of salt marshes, mangroves, oyster reefs, phytoplankton, marine mammals, gopher tortoises, and water quality to establish baseline conditions necessary for proactively managing these valuable natural resources. This year's State of the Reserve symposium will also highlight cutting edge virtual reality technologies to bring these habitats and science to people less able to visit the Reserve.

Thank you for attending the State of the Reserve. Continuing and enhancing existing projects, and initiating new projects, are only possible with the generous support and hard work of many dedicated community leaders, volunteers, scientists, and educators. Special thanks this year goes to the University of North Florida's Coastal and Marine Biology Flagship Program for co-sponsoring this event, along with the Friends of the GTM Reserve.

Sincerely,

Michael A. Shirley

Michael Shirley, Ph.D.
Director, GTM Research Reserve

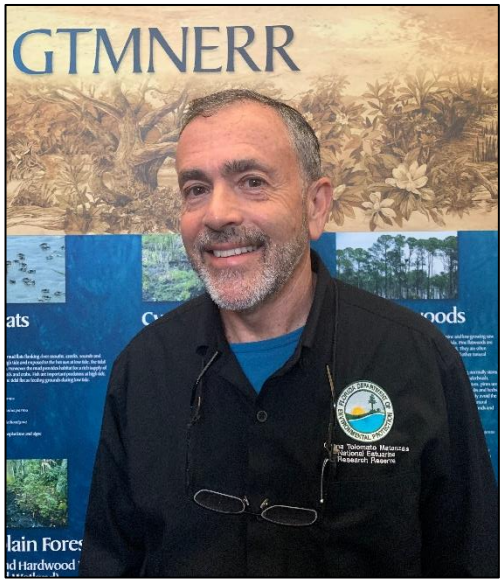


TABLE OF CONTENTS

FEATURED PROJECTS OF 2019, *PRESENTED AT THE 2020 SYMPOSIUM*..... 4

ADDITIONAL RESEARCH AT THE GTM RESEARCH RESERVE, *PRESENTED AT THE 2020 POSTER SESSION*..... 18

LONG-TERM MONITORING SHOWS EVIDENCE OF CLIMATE CHANGE..... 22

FRIENDS OF THE GTM RESERVE..... 26

ACKNOWLEDGEMENTS..... 27

Photo taken by Abigail Kuhn, GTM Research Reserve, Coastal Training Program Specialist

State of the Reserve 2020 Coordinators
Event Facilitator Kaitlyn Dietz, Coastal Training Program Coordinator
Chief Program Editor Abigail Kuhn, Coastal Training Program Specialist
Program Editor Patrician Price, Public Information Officer
Program Printing Foxtrot Creative Studio

Cover photos taken by*: Linda Burek (Guana Peninsula), Stattie McCluskey (view from Capo Tower), Jessica Lee (looking out from a GTM Research Reserve beach lot), and Linda Burek (oyster reef with snowy egret)*

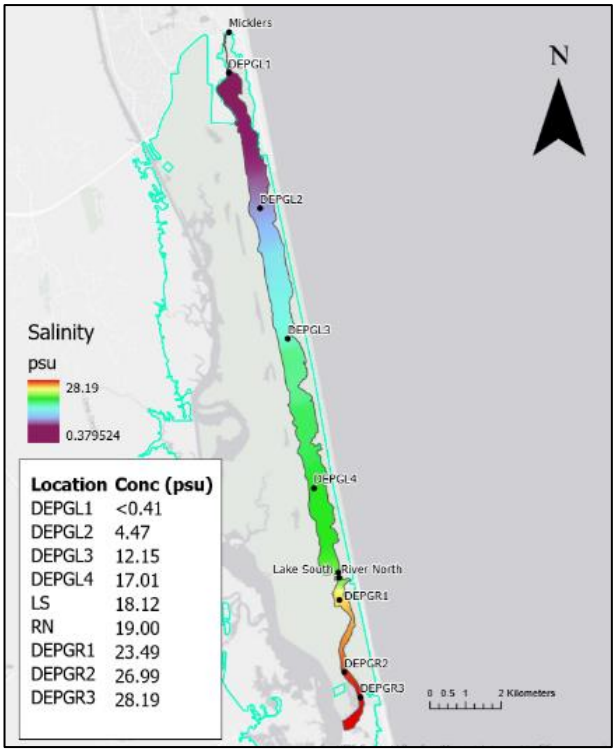
Special thanks to the GTM Research Reserve staff and volunteers who support the Reserve programming efforts especially the symposium planning committee: Nikki Dix, Ph.D., Shannon Dunnigan, Scott Eastman, Candace Killian, Ellen Leroy-Reed, Shannon Rininger, Lia Sansom, Mike Shirley, Ph.D., and Josephine Spearman.

FEATURED PROJECTS OF 2019

These projects were presented as featured projects of 2019 at the 2020 State of the Reserve.

SPATIAL AND TEMPORAL WATER QUALITY TRENDS OF AN IMPOUNDED ESTUARY

With the reopening of recreational oyster harvesting in Guana River, the need to establish a water quality baseline and better understand the effects of nutrient loading within the Guana system has become a priority. Current monitoring practices consist of monthly analysis of nutrient samples and water quality parameters collected from 10 sample sites south (Guana River) and north (Guana Lake) of the Guana Dam. However, variability between these sites is unknown, and the dam's impact on water quality is not well established. This project intends to implement a different type of data collection strategy in conjunction with the current monitoring practices in order to provide a holistic view of the water quality trends within the Guana system. In order to collect continuous data along the entirety of the Guana system, a flowcell system housing multiple water quality sensors (temperature, conductivity, salinity, dissolved oxygen, turbidity, and total algae) from a handheld water quality meter equipped with GPS was engineered in such a way that it could be attached to various water vessels. This technique allows for data to be collected at continuing intervals along the system, resulting in vector data with over 500 data points per spatial survey. Using GIS, spatial visualization of present water quality conditions can be modeled. Although this project is ongoing, an interesting outcome has been discovered in which pockets of variability (that would otherwise go unnoticed with the current monitoring practices) exist in the Guana system, especially north of the dam.



Location	Conc (psu)
DEPGL1	<0.41
DEPGL2	4.47
DEPGL3	12.15
DEPGL4	17.01
LS	18.12
RN	19.00
DEPGR1	23.49
DEPGR2	26.99
DEPGR3	28.19

Salinity gradient throughout Guana Lake and Guana River

Flowcell system on a GTM Research Reserve vessel

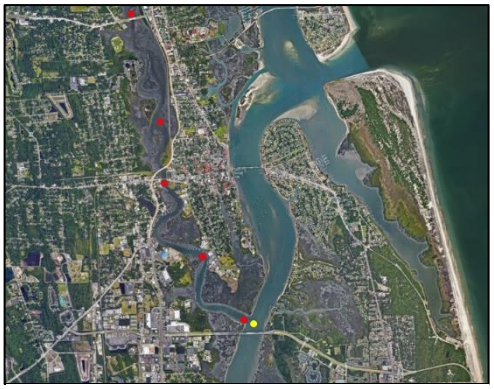
PRESENTER: Jessica Lee, Guana Fellow, University of North Florida

Jessica Lee is studying environmental biology as a graduate student at the University of North Florida in Dr. Nikki Dix's lab. Her interest lies in freshwater and estuarine ecology as well as the impact of anthropogenic factors on those aquatic environments. She was awarded a graduate fellowship through the Friends of the GTM Reserve so that she could run the Guana Water Quality Project at the GTM Research Reserve and conduct her research on the Reserve as well. By studying the spatial and temporal water quality trends of the Guana system, she hopes to help the Reserve continue to establish a water quality baseline for the system while investigating the downstream implications of its impounded waters.

Co-authors: *Nikki Dix, Shannon Dunnigan, GTM Research Reserve*

AN INVESTIGATION OF WATER QUALITY PARAMETERS IN THE SAN SEBASTIAN RIVER

Sampling in the San Sebastian River



A map of sampling sites throughout the San Sebastian River

While regular water quality monitoring occurs monthly at the GTM Research Reserve SWMP site at the confluence of the Matanzas River and San Sebastian River near downtown Saint Augustine, historically much less water quality monitoring has taken place further up the San Sebastian River. With potential significant impacts from stormwater runoff, industrial waste, and recent coastal development along the shore of the San Sebastian River, it is critical to examine potential impacts on water quality in the area. This presentation will highlight an ongoing monthly water quality monitoring effort initiated in May 2019 within the natural sciences department at Flagler College. Led significantly by the efforts of undergraduate student researchers, regular monthly monitoring has occurred at five sites in the San Sebastian River for the analysis of major nutrients, chlorophyll-*a*, fecal coliform bacteria, turbidity, and total suspended solids. Preliminary results include a decoupling between ortho-phosphate and ammonium and nitrate, with both ammonium and nitrate showing non-conservative behavior and order-of-magnitude increases in the area near downtown at King Street Bridge. Ortho-phosphate, however, shows more conservative behavior, increasing upstream. Chlorophyll-*a* values indicate enhanced phytoplankton biomass moving upstream and fecal coliform data show elevated values upstream as well. These data will be used to discuss possible sources of nutrients and fecal coliform bacteria and the relationships to other water quality parameters.

PRESENTER: Matthew Brown, Ph.D., Associate Professor, Flagler College

Preceded by an undergraduate B.Sc. degree in chemistry (Old Dominion University), Dr. Matthew Brown completed an M.Sc. (oceanography) at the University of Hawaii and a Ph.D. (ocean sciences – marine chemistry) at University of California Santa Cruz. Prior to beginning his doctoral work, Dr. Brown worked for two years as an oceanographic research specialist where he took part in several major oceanographic cruises related to the US CLIVAR program. To date, Dr. Brown has spent over 300 days at sea, performing shipboard analysis of both macronutrients and dissolved trace metals. Now in his ninth year at Flagler College, Dr. Brown currently serves as chair of the natural sciences department and teaches courses in environmental science, oceanography, aquatic chemistry, and global climate change. With the help of undergraduate students, he finds purpose and enjoyment in continuing research in the fields of water quality and marine chemistry, particularly in the areas of water quality and nutrient chemistry. He worked for two years with various GTM Research Reserve researchers on a water quality project in relation to the restoration of the Summerhaven River south of Matanzas Inlet and currently is involved with a monitoring study in the San Sebastian River.

Co-authors: *Melissa Southwell, Chris Blanco, Madison Friduss, Harrison Hobbs, Tennasyn Porter, Flagler College*

WARMING A WETLAND WITH MORE MANGROVES: THE FIRST YEAR OF FINDINGS FROM THE WETFEET PROJECT

Aerial view of southern WETFEET project site near the Matanzas Inlet

The GTM Research Reserve community is aware that mangroves are continually encroaching into salt marshes across the Reserve. Though we are beginning to understand some consequences of more mangroves, the implications of this shift and sustained climatic warming for the resilience of wetland habitats remains unknown. At three sites, we deployed warming chambers (PVC boxes surrounded by clear film) on both marsh-dominated and mangrove-dominated plots to investigate how warming influences plant growth and surface elevation with respect to sea level rise. Warming chambers have warmed the air temperature by an average of 2°C, which is similar to the climate change that is predicted for northeast Florida. We are measuring plant growth, soil dynamics, and associated benthic communities to understand how plant and temperature changes are affecting the rest of the ecosystem. We are also using a Marsh Elevation Model to examine how mangrove growth and sediment trapping influence surface elevation with respect to sea level rise. We have found that warming strongly increases mangrove growth after one year, especially at the most northern site. Neither warming nor mangrove presence changes decomposition rates in soils, meaning that warming or mangroves are not likely to decrease surface elevation. Preliminary findings also suggest that warming stimulates increased algal biomass. Early elevation model runs show that mangroves have a capacity for maintaining surface elevation with respect to sea level rise and that young mangroves may be especially able to increase elevation. The **W**arming **E**cosystem **T**emperatures in a **F**lorida **E**cotone **E**xperiencing **T**ransition (WETFEET) findings described above, and those that will result from an associated Coastal Vulnerability Index Model, will help inform Reserve management in the face of climate change and sea level rise.

PRESENTER: Gabriela Canas, Graduate student, University of North Florida

Gabby Canas is a first-year master's student in the coastal biology department at the University of North Florida, studying estuarine ecology under the advisement of Dr. Nikki Dix. She is also currently a Dolores Auzenne Fellow. Her thesis is focused on the effects of climate change and shifting vegetation range on benthic algal communities. In 2016 she graduated from the University of Florida with a degree in interdisciplinary marine science. After graduating she worked as an environmental educator at Marineland Dolphin Adventure before working at the GTM Research Reserve in the education department. She is now field technician for the WETFEET project where she is actively involved in onsite research as well as the development of virtual reality-based education content to communicate project topics.

Co-authors: *Emily Geoghegan, Villanova University; Chuck Hyde, Villanova University; Candy Feller, Smithsonian Environmental Research Center; Nikki Dix, GTM Research Reserve; Adam Langley, Villanova University; Jim Morris, University of South Carolina; Samantha Chapman, Villanova University*

EFFECTS OF CHANGING VEGETATION ON COMMUNITY STRUCTURE, ECOSYSTEM FUNCTIONING, AND PREDATOR-PREY INTERACTIONS AT THE SALTMARSH-MANGROVE ECOTONE

The saltmarsh-mangrove ecotone

Working hard on excluding predators in the field

Decreasing frequency of freeze events due to climate change is enabling the poleward range expansion of mangroves. As these tropical trees disperse poleward, they are replacing herbaceous saltmarsh vegetation. These vegetation types are typically viewed as having similar ecosystem functions such as providing high-quality habitat. However, few studies have investigated how predation regimes, community structure, and ecosystem functions are shifting at the saltmarsh-mangrove ecotone. In this study, we manipulated predator access to marsh and mangrove creekside habitats to test their role in mediating vegetation and invertebrate structure and stability in a two-year-long experiment. We also conducted a survey to evaluate how shifting vegetation is modifying structural complexity, invertebrate communities, and ecosystem functioning at the ecotone. Excluding larger (>2-cm diameter) predators had no effect on vegetation or invertebrate structure or stability in either saltmarsh or mangrove habitats. The survey revealed the two habitat types consistently differ in structural metrics, including vegetation height, inter-stem distance, and density, but support similar invertebrate and algal communities, soil properties, and predation rates. We conclude that although mangrove range expansion immediately modifies habitat structural properties, it is not altering larger predator consumptive effects, community stability, community composition, and some ecosystem functions at the ecotone.

PRESENTER: Julie Walker, Graduate assistant, University of Florida

Julie Walker is a Ph.D. student co-advised by Dr. Todd Osborne and Dr. Christine Angelini. She is part of the University of Florida and Smithsonian Institution partnership as a Marine Conservation Fellow. Her current research interests are studying the ecological impact of climate induced range shifts of tropical mangrove trees into neo-tropical wetlands, with a regional focus on the mangrove-saltmarsh ecotone in St. Augustine, Florida. Julie's future research goals include expanding her area of study to include ecological significance of loss and changes to foundation species across the globe as a result of anthropogenic stress.

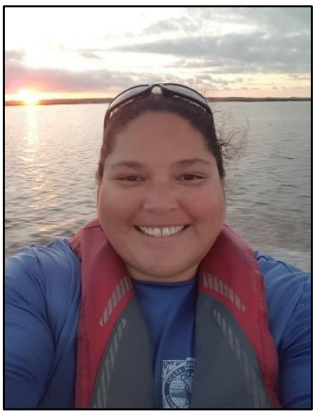
Co-authors: *Christine Angelini, Ilgar Safak, Andrew H. Altieri, Todd Z. Osborne, University of Florida*

GTM RESEARCH RESERVE SENTINEL SITE UPDATE: HOW WILL THE MARSHES OF PELLICER CREEK RESPOND TO SEA LEVEL RISE?

Shore-to-upland transect located in Pellicer Creek

Salt marshes are a valuable resource for coastal communities, providing physical protection, recreation, and habitat to many economically valuable species; however, these ecosystems are under threat from rising sea levels. The National Oceanic and Atmospheric Association created the Sentinel Site program to monitor the effects of sea level rise on coastal ecosystems and the National Estuarine Research Reserve System adopted this program as a complimentary component to the System-Wide Monitoring Program (SWMP). SWMP was designed to monitor long-term changes in water quality, weather, and vegetation communities in coastal ecosystems across a broad geographic scale. In 2017, the GTM Research Reserve began implementation of the first Sentinel Site component in Pellicer Creek. As of fall 2019, installation of requisite infrastructure is near completion and initial monitoring of vegetation communities has been completed. Infrastructure includes existing water quality and weather monitoring instruments, marsh sediment elevation tables and marsh vegetation plots along the creek edge, plus newly installed shore-to-upland transect platforms and vegetation plots. Plans are underway to install permanent benchmarks for elevation surveys and a water level gauge. A preliminary site characterization will be presented in the context of long-term monitoring plans. Ideas for research collaborations, management applications, and public engagement are welcome.

PRESENTER*:* Pam Marcum, Biologist, GTM Research Reserve



Pamela Marcum has been the lead biologist with the GTM Research Reserve since January 2014. She earned a B.S. in biology from Arizona State University, an M.S. in coastal zone management and marine biology from Nova Southeastern University, and is pursuing a post-baccalaureate in Statistics from the University of North Florida. Prior to working with the Reserve, Pam was involved in several research and education programs studying southeastern coastal ecosystems including coral reefs, seagrass beds, mangroves, and salt marshes.

Co-author: *Nikki Dix, GTM Research Reserve*

EXPERIMENTAL EVIDENCE FOR LOCAL ADAPTATION OF OYSTERS TO ENVIRONMENTAL STRESS BUT NOT PREDATION PRESSURE IN THE GTM RESEARCH RESERVE

An oyster reef with cages to exclude predators at some plots

Project team works on a plot of oyster reef.

Maintaining sustainable oyster populations in the GTM Research Reserve depends on understanding how oyster larval dispersal and environmental gradients favor or inhibit local adaptation of oysters. While high larval dispersal and genetic connectivity among oyster populations throughout the Reserve could facilitate restoration efforts (e.g., transplanting oysters from healthy reefs to degraded reefs), less larval dispersal among oyster populations and/or strong environmental gradients that promote local adaptation could inhibit the success of such restoration efforts. To address this knowledge gap, we conducted a reciprocal transplant experiment with juvenile oysters from a site with high predation risk and low environmental stress (Butler) and from a site with low predation risk and high environmental stress (Pellicer). After one month, regardless of the oysters' site of origin, juvenile oyster survival was higher at Butler than Pellicer. Although oyster survival within Butler did not depend significantly on site of origin, oyster survival within Pellicer did, with oysters originally from Pellicer having a 20% higher survival than oysters originally from Butler. Because survival at Pellicer was not increased by excluding predators, this difference in survival between Butler and Pellicer oysters was due to an environmental stress. Of the surviving oysters, those from Pellicer grew more than oysters from Butler, but this difference in growth was larger at the high stress site (Pellicer). Thus, larval dispersal and the environmental conditions at Pellicer are likely promoting local adaptation of oysters in terms of post-settlement survival and growth. This will be important for resource managers to consider in the development of future conservation and restoration plans. The experiment will be maintained and repeatedly sampled over the next year to determine whether the oyster growth and survival results remain consistent across oyster size, age, and seasonality.

PRESENTER: Adrienne Breef-Pilz, Research Assistant, Northeastern University

Adrienne Breef-Pilz is a research assistant for Dr. David Kimbro at Northeastern University. She is currently managing the projects in the GTM Research Reserve looking at non-consumptive effects on oyster reefs as well as the instruments for the water quality portion of the projects. Prior to joining the lab, Adrienne completed her master's in marine biology from Northeastern University through the Three Seas Program. Before pursuing her master's, Adrienne worked for the New England Aquarium in both their research and husbandry departments. Her favorite part about working in the GTM Research Reserve is being on the water in the morning when the water is still.

Co-authors: *David Kimbro, Nicole Peckham, Allison Noble, Jain Cresap, Northeastern University*

STAKEHOLDER-DRIVEN MODELING TO UNDERSTAND OYSTER POPULATION SUSTAINABILITY

The eastern oyster (*Crassostrea virginica*) is an important species in Florida estuaries because it provides numerous ecosystem services and supports local oyster fisheries. Within northeast Florida, especially within the GTM Research Reserve, local harvesters and scientists are concerned that harvest closures related to water quality are affecting oyster population sustainability by intensifying harvesting pressure in remaining open areas. However, there is also concern that other ecological factors (e.g., increasing salinity and predation) may have a greater effect than harvest on oyster population sustainability.

Project team collecting data in the field to be used for the model.

We used an integral projection model to estimate sustainability – quantified in terms of expected lifetime reproductive output of a new recruit – at nine sites spread throughout GTM Research Reserve. The model was parameterized using field experiments and population surveys at each site. The results were extrapolated to additional sites based on the physical parameters of those sites and estimated correlations between physical parameters and oyster demographic rates.

Our analysis revealed substantial spatial variability in sustainability across the estuary, due to covariation in both survival and mortality risk driven by salinity, flow, and the presence of an oyster predator. Importantly, some of the most productive sites are those currently used most heavily by harvesters, while some sites that are protected from harvest have relatively low sustainability. These results provide insight into the sources of spatial variability in oyster demography within the estuary and guidance for sites that could be effective targets for restoration. End-users engaged throughout the project by providing data, asking management scenario questions for modelers to explore, and comparing model results with on-the-ground observations. GTM Research Reserve staff have also been trained to re-run the model when more data become available or when new questions arise.

PRESENTER: Laura Storch, Ph.D., Postdoctoral scholar, Oregon State University

Laura Storch is a postdoctoral scholar at the Coastal Oregon Marine Experiment Station at Oregon State University. She received her Ph.D. in applied mathematics from the University of New Hampshire and was previously a postdoctoral fellow at William & Mary. She is interested in using mathematics to inform sustainable management and conservation of vulnerable populations and ecosystems and using new mathematical tools to study ecological problems.

Co-authors: *J. Wilson White, Oregon State University; Nicole Peckham, David Kimbro, Northeastern University; Kaitlyn Dietz, Nikki Dix, GTM Research Reserve*

VIDEO MONITORING AND IN SITU DATA TO STUDY BOAT TRAFFIC IN THE INTRACOASTAL WATERWAY

Video monitoring has become a useful and cost-efficient tool in the monitoring of coastal systems. The ability to obtain a visual record of a location and be able to take quantitative measurements of change and daily activities is instrumental for those entrusted with protecting coastal ecosystems.

We designed an automated solar-powered video monitoring system to assess boat activity in the Tolomato River, part of the Intracoastal Waterway. The video was analyzed to assess the boater composition that utilizes this highway to the ocean by comparing the video data with *in situ* sensors monitoring the wakes produced by the boats.

The design of this experiment is to utilize the endless opportunities provided by video analysis to understand boat composition and boater behavior coupled with the wakes produced by those boats and the potential impacts on the estuarine ecosystems.

Monitoring was possible using a video system located at this tower on the Guana Peninsula.

PRESENTER: Lauren Brisley, Ph.D. Student, University of Florida

Lauren is a first year Ph.D. student in the coastal engineering department. She is studying boat traffic in the highly traversed Intracoastal Waterway through a solar-powered video monitoring system to understand the interactions between boat wakes and coastal ecosystems. Lauren is working with the Naval Research Laboratory to explore image analysis with the goal of creating a framework to automate data collection from video.

Co-authors: *Christine Angelini, Ilgar Safak, University of Florida; Margaret Palmsten, U.S. Naval Research Laboratory*

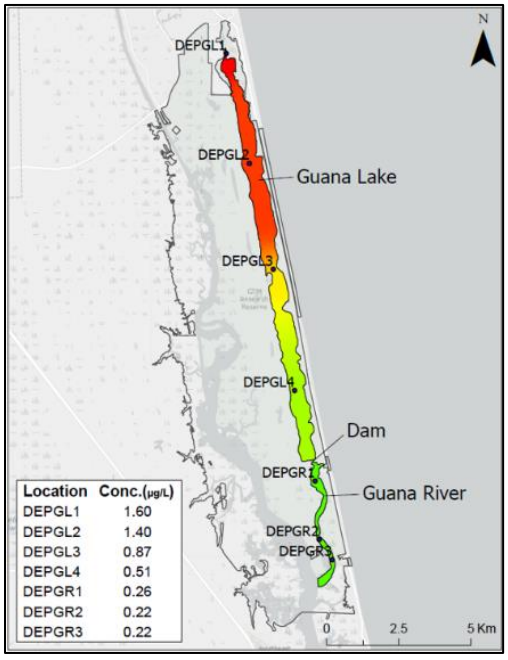

Have you checked out
our research blog?
www.NERRdsonthewater.com
NERRdS
ON THE WATER


ADMINISTRATION COMMUNICATION RESEARCH STEWARDSHIP EDUCATION & OUTREACH
BECOME A
GTM NERR
VOLUNTEER
You'll make a difference no matter
what you choose!
READY TO LEARN MORE?
Contact Shannon Rininger
Shannon.Rininger@floridadep.gov

ESTABLISHING A WATER QUALITY BASELINE IN THE IMPOUNDED GUANA RIVER ESTUARY

Humans have relied on the natural resources of the Guana River for thousands of years. In the mid-18th century, Guana River supported a 1,000-acre rice plantation while also supplying mud to revitalize fallowed indigo fields at another plantation. After the plantations were abandoned, the river was known for abundant fish, shrimp, and oysters until the mid-20th century when the state of Florida dammed a portion of the river to create waterfowl hunting opportunities. This created "Guana Lake", an impounded estuary still managed by the state for waterfowl hunting and fishing. In the 1970s, just prior to many wetland protecting regulations, areas north of the "lake" were developed into what is now a world-famous golf course community. In 1985, the oyster fishery south of the "lake" was closed due to high bacteria levels. Today, Guana River is protected within the GTM Research Reserve and the Guana River Marsh Aquatic Preserve with an Outstanding Florida Water designation. Since 2017, this highly altered system has been the focus of a publicly- and privately-funded water quality project aimed at assessing the current ecosystem condition. Monthly water samples and periodic source tracking surveys revealed high levels of nutrients and phytoplankton biomass, regular occurrence of potentially harmful algal blooms, and a clear gradient of human influence from north to south. Collecting baseline data and further investigating the potential sources and quantity of nutrients in the Guana River system will inform management efforts and further our understanding of eutrophication in impounded estuarine systems.

Collaborative field sampling with the Northeast Florida Aquatic Preserves, FWC, and GTM Research Reserve staff



A spatial view of sucralose concentrations throughout Guana Lake and Guana River

PRESENTER: Nikki Dix, Ph.D., Research Coordinator, GTM Research Reserve

Nikki Dix has been the research coordinator at the GTM Research Reserve since 2013. Her research interests involve understanding how estuaries respond to natural and anthropogenic change with the intent of informing natural resource management. Nikki has a Ph.D. from the University of Florida where she was supported by a NERR fellowship to study responses of plankton and oysters to eutrophication in the GTM estuary. As research coordinator at the GTM Research Reserve, Nikki establishes research priorities and oversees long-term monitoring in the context of regional, state, and national objectives. Monitoring includes abiotic (e.g., salinity, temperature, oxygen, rainfall, nutrients) and biotic (e.g., salt marsh vegetation, mangroves, plankton, oysters) parameters within the Reserve to provide foundational information about how the ecosystem changes over space and time. Nikki also facilitates activities of visiting researchers and works to develop collaborations between scientists, managers, educators, and the public.

Co-authors: *Shannon Dunnigan, GTM Research Reserve; Jessica Lee, University of North Florida; Jimmy Tomazinis, Northeast Florida Aquatic Preserves*

CHALLENGES AND OPPORTUNITIES FOR SUSTAINING SOUTHEASTERN U.S. COASTAL WETLANDS AND OYSTER REEFS

Estuaries face many threats, including increased boat wakes from an increase in boat traffic.

Formed at the interface between land and sea, estuaries experience both the seaside pressures of increasing sea levels and storminess and watershed impacts that are shifting the quality and quantity of freshwater and sediments imported from upstream sources. Boating, shoreline hardening, harvesting pressure, and other signatures of human activity are also increasing in estuaries as populations swell in coastal counties. Given this rapidly shifting landscape of pressures, the most important factors now threatening estuaries are uncertain.

This study seeks to quantify changes in human population density, developed land and wetland area, and relate these to shifts in perceptions of critical threats to coastal wetlands and oyster reefs across the southeastern United States (North Carolina to Mississippi). In the region, coastal population increased on average by 7.8%, with some counties experiencing >33% population growth, while almost 1% of undeveloped lands were developed, and 5% of wetland area was lost on average. Correspondingly, estuarine experts representing a breadth of sectors cited development, shoreline hardening, and upstream modifications to freshwater flow as the most important threats facing coastal wetlands and residential or commercial development, upstream modifications to freshwater flow, and overharvesting as the most important threats facing oyster reefs. The analysis of the survey responses also highlighted that far more research is needed to quantify on how changes in precipitation with climate change, shoreline hardening, and sea level rise are affecting the stability and functionality of coastal ecosystems. Sustained collaboration among scientists, engineers, and managers as well as engagement of coastal homeowners, recreators, and municipalities will be essential for creating advanced and actionable research products to address these gaps and sustain vibrant estuaries across this region and others in the face of global change.

PRESENTER: Christine Angelini, Ph.D., Assistant Professor, University of Florida

Fascinated with nature and alarmed by the degradation of natural systems, Dr. Angelini pursued an education in ecology and conservation as an undergraduate at Brown University, where she received her bachelor's degree in marine biology in 2007. She moved south to further develop her skill set in experimental community and conservation ecology as a Ph.D. student under Brian Silliman at the University of Florida. Working in salt marshes, maritime forests, coastal hammocks, and oak savannas across the southeastern U.S., her dissertation research explored how interactions among foundation species drive patterns in biodiversity, ecosystem functioning, and resilience from the local patch to larger landscape scale. Dr. Angelini's research is focused on the role of habitat-modifying organisms in shaping marine and terrestrial food webs and contaminant fate and transport; cost-effective and durable approaches to restoring degraded oyster reefs, sand dunes and salt marshes; mechanisms of ecosystem recovery from disturbance; and the effects of top predator expansion on nearshore ecosystem structure and function, as well as a number of other community and conservation ecology related topics.

Co-authors: *Tricia Kyzar, University of Florida; Ilgar Safak, University of Florida; Just Cebrian, Mississippi State University; Mark W. Clark, University of Florida; Nikki Dix, GTM Research Reserve; Kaitlyn Dietz, GTM Research Reserve; Rachel Gittman, East Carolina University; Raymond Grizzle, University of New Hampshire; John M. Jaeger, University of Florida; Kara Radabaugh, Florida Fish and Wildlife Conservation Commission; Annie Roddenberry, Florida Fish and Wildlife Conservation Commission; Alexandru Sheremet, University of Florida; Carter Smith, Duke University; Eric L. Sparks, Mississippi State University; Benjamin Stone, South Carolina Department of Natural Resources; Gary Sundin, South Carolina Department of Natural Resources; Michelle Taubler, University of Florida*

ST. AUGUSTINE'S BOTTLENOSE DOLPHINS: A 10 YEAR COMMUNITY PARTNERSHIP BETWEEN FLAGLER COLLEGE AND ST. AUGUSTINE ECO TOURS TO STUDY AND ASSESS DOLPHIN POPULATION DYNAMICS

This 10 year study focused on the resident bottlenose dolphin (*Tursiops truncatus*) population that inhabits a 16-mile stretch of the Intracoastal Waterway. Flagler College undergraduates studying coastal environmental science performed mark/recapture and water quality sampling techniques in order to take up the reins of a long-term study on local dolphins. At each dolphin sighting along our transect, each encountered dolphin was non-invasively "marked" by capturing a photo of its unique dorsal fin. Each sighting also provided the GPS coordinates, number of individuals in the group, the direction of their movement, habitat type, and behavioral state. Water quality parameters, including temperature, salinity, and depth, were also recorded at each sighting. To date, over 70 records including over 300 sightings of dolphin groups, have allowed for the "re-capturing" of known individuals through subsequent sightings of the same individuals. After 10 years, these efforts have produced a robust and valuable database which can now be used to formulate and answer important questions about the dolphins that share their home range with us humans.

Flagler College undergraduate students assist with data collection.

Left: A dolphin pod in St. Augustine
Right: A dolphin mother and calf in the Intracoastal Waterway

PRESENTER: Terri Seron, Ph.D., Associate Professor, Flagler College

Dr. Seron is an associate professor of biology in the natural sciences department at Flagler College in St. Augustine, Florida. She grew up in Connecticut and completed her bachelor of science degree in ecology and evolutionary biology at the University of Connecticut. She received her Ph.D. from the University of Florida where she combined molecular biology with fisheries and aquatic sciences. Her current research focuses on the molecular ecology of estuarine organisms. Her interests span from the smallest molecules of DNA and proteins all the way up to the largest fish in the ocean, the whale shark. The uniting theme of her research is conservation of marine species. DNA and protein sequences are used to determine species identity as well as the degree of genetic diversity within a species. In addition to teaching, Dr. Seron is committed to engaging students in underwater scientific research by designing international study abroad curricula focused on coral reef ecosystems. Dr. Seron used undergraduate research as the centerpiece for the development of a new coastal environmental science major that was launched at Flagler College in Fall 2013.

Co-authors: *Zach McKenna, St. Augustine Eco Tours*

SHORELINES AND SHIPWRECKS: HERITAGE MONITORING SCOUTS EFFORTS AT THE GTM RESEARCH RESERVE

In 2016, the Florida Public Archaeology Network partnered with the GTM Research Reserve to implement a citizen-science based monitoring program for archaeological resources, Heritage Monitoring Scouts (HMS Florida). The program aims to track changes at sites in the face of potential climate change impacts.

In the past three years, the program has grown to include over 130 volunteers and has yielded 43 monitoring forms across 12 sites. In addition, partnerships with the St. Augustine Lighthouse Archaeological Maritime program has also aided in more intense documentation of several sites at the Reserve, including the recording of two new sites, the Pellicer Creek Canoe and the Spring Break Wreck.

This presentation details findings through three years of cultural resource monitoring at the GTM Research Reserve, highlighting investigations at Shell Bluff Landing as well as research on the Spring Break Wreck.

Lighthouse Archaeological Maritime Program (LAMP) staff document elements of the Spring Break Wreck in 2018.

A view of the Minorcan well located at Shell Bluff Landing on the Guana Peninsula

PRESENTER: Emily Jane Murray, Public Archaeology Coordinator, Florida Public Archaeology Network

Emily Jane Murray earned a master's degree in anthropology from Brandeis University where she focused on public archaeology and site museums in northeast Florida and a bachelor's in communications from Flagler College. She has excavated sites throughout the southeastern United States and created numerous outreach tools including videos, activities, and museum displays. She currently works as a public archaeology coordinator for the Florida Public Archaeology Network Northeast Region and serves as president of the Florida Anthropological Society, chair of the St. Johns County Cultural Resources Review Board, and is a founding member of the Florida Chapter of the Association for Gravestone Studies. Her interests include Florida's prehistoric archaeology, historic cemeteries, and public archaeology and interpretation.

Co-authors: *Allyson Ropp, St. Augustine Lighthouse Archaeological Maritime Program; Sarah E. Miller, Florida Public Archaeology Network*

MORE THAN JUST A GOLD STAR: HOW MIDDLE AND HIGH SCHOOL STUDENTS CAN CONTRIBUTE VALUABLE DATA FOR SCIENTIFIC RESEARCH

Students assist with water quality data collection.

The GTM Research Reserve's Living Labs Series is a set of informal environmental education programs for middle and high school students that replicates ongoing research projects conducted by the GTM Research Reserve's research and stewardship programs. Participating students complete short monitoring sessions that collect data on environmental and water quality parameters, estuarine biodiversity, plankton, and beach profile measurements. The goal of these programs is to provide realistic, science-based experiences, encouraging students to share valuable information, and inspire conservation-based behaviors and actions.

The Florida Data Science for Social Good (FL-DSSG) project provided a unique opportunity to investigate the accuracy and reliability of the data collected by the students. The FL-DSSG team, consisting of faculty and student interns from the University of North Florida and industry mentors, analyzed environmental and water quality data, as well as biodiversity data collected by GTM Research Reserve students from 2012-2019. The FL-DSSG team compared student data to data gathered from manual and mechanical instruments used by the GTM Research Reserve's research and stewardship departments, citizen scientists, mechanical dataloggers used by the National Oceanic and Atmospheric Administration, and mechanical dataloggers used by the Florida Department of Environmental Protection. The compared measurements included standardized quality analysis and quality control measures. Results showed positive correspondence in comparing student-collected data to professionally- and mechanically-collected data, concluding that their data can be considered reliable and useful to scientists. The project highlights the potential benefits of citizen science program data for future research programs.

PRESENTER: Josephine Spearman, Education Coordinator, GTM Research Reserve

Josephine Spearman has worked at the GTM Research Reserve for six years. She began as a volunteer, then environmental educator, and now serves as the education coordinator. She holds a bachelor's degree with a concentration in biology, along with minors in English, environmental studies, and psychology. Josie has had a lifelong love of learning, nature, and being outdoors. She enjoys the many facets of being education coordinator at the Reserve, including collaborating to interpret various projects into education programs and adapting those programs and technologies into inspiring experiences and conservation efforts for adults and students.

Project Assistants: *Dr. Karthikeyan Umapathy, Dr. Dan Richard, University of North Florida*

Co-Authors: *Ashlee Larramore, Avinash Namilla, Abigail Conwell, University of North Florida, FL-DSSG Project*

ADDITIONAL RESEARCH AT THE GTM RESEARCH RESERVE IN 2019

These projects were presented as posters at the 2020 State of the Reserve.

Analysis of Bottlenose Dolphin Social Structure in St. Augustine, Florida
Bottlenose dolphins (*Tursiops truncatus*) are found throughout the world's oceans with complex social structures consisting of sub-adults, male pairs, female bands, and nursery groups. In 2011, a dolphin database was created in order to store and organize all local dolphin observations and associated study parameters. The research consists of a dorsal fin photo recapture study that is conducted along a 16-mile transect, running eight miles north and south of the St. Augustine Inlet. Every dolphin sighting in the 2011-present database was analyzed to determine the dolphin social structures present in St. Augustine. Bottlenose dolphin sightings ranged from 1-24 individuals. Nursery groups, defined by a mom-calf pair and at least one additional dolphin, vary in size seasonally, increasing in size in the springtime when new calves are born. This research was conducted under a letter of authorization issued by the National Oceanic and Atmospheric Administration.

Savannah DeBauche, ***Flagler College***, Maggie Boselowitz, Emma Gougeon, Tennasyn Porter, Haley Wilson, Zack McKenna, Jennifer Jakush, Terri J. Seron

Assessing virtual reality technology as an environmental education teaching tool for use in classrooms
The National Estuarine Research Reserve System's Estuaries 101 curriculum was created as a national effort to advance ocean and estuarine literacy by building on and integrating educational and scientific resources across the entire system. Lessons were designed as an effort to bring estuarine concepts into K-12 classrooms. However, the lessons are limited in their capability of exposing students to realistic, estuarine experiences. Virtual Reality (VR) technology provides students with this authentic experience by facilitating a first-person perspective. But, there is little known about VR's effectiveness when used to convey curriculum information within the classroom. This study seeks to evaluate the VR program developed by the GTM Research Reserve. Using 360-degree panoramic stills, a robust interactive program was created to address multiple curriculum standards for fourth grade students. This two-hour program was delivered to multiple classrooms within St. Johns County and assessed using pre- and post-surveys. Survey results showed that students scored significantly higher on surveys taken after the VR program was delivered compared to before. Students also increased their positive responses to questions focused on their environmental attitude after the program. These results show that VR technology is an effective tool for conveying environmental curriculum. Although survey responses showed positive results, more investigation is needed to assess the effectiveness of VR, especially when compared to traditional in-class environmental education programs. In the future, the Reserve hopes to expand the program to include opportunities for students with special needs.

Kaitlyn Campbell, ***GTM Research Reserve***, Gabriela Canas, Josephine Spearman

Do hurricanes impact our local waterways more than other storm events? A case study on the impact of hurricanes and precipitation on nutrient export and ecosystem metabolism in Pellicer Creek
It is well known that hurricanes cause damage to property and natural systems in coastal areas throughout Florida. However, coastal waterways can have variable responses to hurricane impacts depending on hurricane intensity and proximity. Additionally, hurricanes are not as common as nor'easters and thunderstorms and the impact that these storms have on nutrient cycling and ecosystem metabolism comparatively is still unknown. In the past five years, hurricanes Matthew, Irma, and Dorian have impacted St. Augustine, Florida. Each of these hurricanes was a category 2 or weaker and within the past five years, several minor storms have also impacted the northeastern Florida coast. In order to assess the impact of these storms and hurricanes, nutrient data collected by the GTM Research Reserve and United States Geological Survey (USGS) stream discharge data were used to calculate export of dissolved organic carbon (DOC), ammonia-N, nitrate, ortho-phosphate, and TKN from Pellicer Creek in St. Augustine, Florida. Net ecosystem metabolism (NEM), community respiration (Rt), and gross primary production (Pg) were also calculated using the "SWMPr" package in R. Monthly data was divided into groups based on monthly precipitation. Low precipitation (group #1) was monthly precipitation < 50-mm, high precipitation was monthly precipitation > 150-mm (group #2), and hurricane months comprised the last group (group #3). Nutrients and ecosystem metabolism were compared between groups using PCA and Kruskal-Wallis tests. Nutrient export was not significantly different between storm groups, but DOC export on average was higher in group 2 (approximately 150-kg day^{-1}) than in groups 1 or 3 (#1- 60-kg day^{-1}, #3- 50 $kg\text{-}day^{-1}$). Groups 1 and 2 were significantly different from group 3 in NEM. Therefore, it might be more important for future research to observe biological characteristics on longer timescales than chemical properties.

Tracey Schafer, ***Whitney Laboratory for Marine Bioscience***, Nikki Dix, Shannon Dunnigan, Todd Osborne

Exploring patterns of thermal acclimation of leaf respiration in a marsh-mangrove ecotone

At the global scale, respiration is the second largest flux of carbon behind photosynthesis and ~50% of respiration comes from leaves. Respiration is also a key parameter for global models that predict climate-carbon cycle interactions. However, coastal systems, which represent a significant portion of productivity, are poorly represented in these models. This project focuses on better understanding aboveground carbon fluxes of *Spartina* and mangroves in relation to temperature over space, time, and with warming. We will present preliminary data on how carbon fluxes from leaves acclimate to seasonal temperature changes at sites that differ in seasonality and whether carbon flux responses to temperature differ for smooth cordgrass (*Spartina alterniflora*) and black mangrove (*Avicennia germinans*). We will also present data on whether warming inside chambers alters how species respond to temporal and spatial changes in temperature. By developing this data, we are providing novel information that has both local and global implications.

Matt Sturchio, ***University of North Florida***, Jeff Chieppa, Mike Aspinwall

Gopher tortoise population remains stable and/or increases

Gopher tortoises are a keystone species but are threatened by habitat loss and degradation. Gopher tortoise burrows modify the environment and provide refuge to over 350 other species, including the endangered indigo snake. The gopher tortoise population at the GTM Research Reserve has been stable since the first survey was conducted in 2005, while gopher tortoise populations in general have been in decline throughout their native range from South Carolina to Louisiana to south Florida. A survey of suitable environments with well-drained sandy soils was conducted at GTM Research Reserve to monitor the population of gopher tortoises in this protected area. Surveyors walked the coastal dunes, dam, and northern peninsula, and searched for gopher tortoise burrows, which were recorded on a handheld GPS and labeled as "active", "inactive", or "abandoned" based on the appearance of the burrow apron and opening. There were 567 burrows found where 77 "active" or "inactive" dune burrows were internally scoped with a burrow camera to determine occupancy status. Population estimates were calculated using three correction factors to create a probable range of the gopher tortoise population in the dunes (148-268), dam (22-40), and northern peninsula (18-41). Data was compared to prior surveys conducted at the GTM Research Reserve to determine that the gopher tortoise population has remained stable or is slightly increasing.

Maddie Paris, ***former intern at the GTM Research Reserve***

Identifying microplastic abundances and hotspots in the Guana, Tolomato, and Matanzas rivers in northeast Florida

Plastic never fully disappears, but instead breaks into smaller pieces referred to as microplastics (≤ 5 mm length). Microplastics have been found in populated and remote locations around the globe, including Antarctica, the Marianas Trench, and Mount Everest. Current research has shown that microplastics may contain or attract chemicals and other pollutants which can accumulate in the food chain. This is important since the biological and toxicological effects of ingesting these plastics are not fully understood. Researchers are trying to better understand where microplastics are accumulating and sources/sinks. The goal of this project is to identify microplastic abundances and hotspots in the Guana, Tolomato, and Matanzas (GTM) rivers in northeast Florida. This project also investigates the polymer composition and quantity of microplastics at each sample site. Water samples were collected from surface waters at nine sites across the GTM river system, with three sites in each river. Five replicate water samples were collected at each site in one liter bottles. Samples were then vacuum-filtered and analyzed under a stereo microscope (40X). The duration of this project extends from January 2020 to April 2020. Samples will be collected monthly, at the beginning of each month. The project is on-going and preliminary results will be presented. It is hoped that the results of this project will help bring awareness of plastic pollution to resource managers and the community.

McKenna Keplinger, ***University of Central Florida***, Casey Craig, Linda Walters

View from trails Photo taken by Cindy Taylor, GTM Research Reserve volunteer

Gopher tortoise Photo taken by Linda Burek, GTM Research Reserve volunteer

Living shorelines can dissipate boat wakes and increase sediment deposition...sometimes
Erosion is a pressing problem experienced by coastal communities and ecosystems. This study investigated sediment particle size to assess a living shoreline's ability to dissipate boat wake energy and prevent shoreline erosion along the Tolomato River. Treatment sites had break walls (stacked crepe myrtle branches) located at the lowest intertidal elevation and gabions (constructed oyster reef) upslope from the break wall. Sediments were sampled with a 2-cm thick petri dish 40-cm behind the breakwalls, gabions, and in front of the marsh edge. Control sites were located downstream from the treatment sites and sediments were sampled there at equivalent elevations. Organic matter was removed from the sediment and samples were sieved to analyze the mass percent of coarse sand (500-µm), medium sand (250-µm), fine sand (125-µm), very fine sand (63-µm), and silt and clay (< 63-µm). We found more silt and clay behind the treatments than the controls at one site, while at the other sites there was no significant difference in silt and clay between the treatments and controls.

Amie Acevedo, *Flagler College*

Mangrove distributions along shore-to-upland gradients in a salt marsh-mangrove ecotone
The GTM Research Reserve is located at the transitional ecotone between *Spartina alterniflora* dominated salt marsh and *Avicennia germinans* dominated mangrove communities. Due to the ecological and economical importance of the services provided by estuarine wetlands, it is essential to understand the extent of the transition from a salt marsh to mangrove dominated ecosystem. Past research has focused on the northward movement of mangroves and their faunal associates; however, little research has focused on lateral or horizontal expansion. In 2012, the GTM Research Reserve established two shore-to-upland transects at two locations, each containing five evenly spaced vegetation plots. Plots were evaluated for vegetation cover and canopy height of all species present, mangrove stem densities and diameters, and tree architecture measurements of select individual mangrove trees. Results from this research will provide information on local mangrove populations and can potentially identify changes related to local or large-scale environmental events.

Alee Knoell, *GTM Research Reserve*, Pam Marcum, Nikki Dix

Phytoplankton community structure and water quality in the GTM Research Reserve
One of the main focuses of the National Estuarine Research Reserve System (NERRS) is to monitor water quality in estuaries around the United States. While abiotic data is integral to this continual monitoring, phytoplankton have shown to be accurate indicators of water quality conditions. In related studies, phytoplankton communities have changed drastically with changing water quality parameters. A monthly water quality monitoring project that began with community interest in July 2017, the Guana Water Quality Project has reported frequent high levels of chlorophyll a (a proxy for phytoplankton biomass) in Guana Lake during two years of monthly sampling. In addition to collecting water for nutrient, bacteria, and chlorophyll a concentrations, water was also collected for plankton identification by the GTM Research Reserve. These samples were collected and preserved with Lugol's solution, aliquots placed into a chamber to settle for an hour before an inverted compound light microscope was used for species identification and counts. Though plankton in these samples have been collected and identified since the Guana Project began in July 2017, they have not been analyzed for correlations with observed water quality parameters. This study aimed to compare the results of the monthly plankton monitoring data in the Guana project examining species presence, abundance, and community structure with observed patterns in water quality conditions. Preliminary results have shown blooms of *Prorocentrum minimum*, *Skeletonema* spp., and *Navicula* spp. in the Guana System, and with this data we may be able to find a link between the water quality parameters that are measured and the plankton community structure we find.

Isabella Kitzis, *University of North Florida*, Paige Priester, Shannon Dunnigan, Nikki Dix

Red tide mitigation in Florida: Are there alternatives to using phosphatic clay?
The purpose of this experiment is to discover if there are any alternatives to using phosphatic clay that could efficiently remove harmful algae, but not zooplankton, from marine waters. This experiment used cultured algae and brine shrimp (*Artemia*) as a substitute for field-collected water samples. Liters of pre-cultured algae from Premium Seafood Incorporated were obtained and transported to lab area. The algae was stored in a refrigerator to keep algae alive. The salinity of the culture was recorded using a refractometer. Five 1-liter glass beakers were filled with 1 liter of algae and labeled (C, K, B, S, A). A camera was set up on a tripod in front of the beakers. Each sediment was put into a separate sieve. The beakers were photographed while the hemocytometer was loaded. This process was repeated for each sediment type. The experiment was replicated using freshly hatched brine shrimp along with the algae and sediment.

Taylor Willis, *Valley Ridge Academy*

Synthesizing monitoring and research data to assist local and regional decision makers

Compiling and synthesizing water quality and environmental data into one easy-to-access tool can be a significant challenge for anyone who does not regularly work with that data. The data is typically provided by a multitude of monitoring agencies usually in different formats, including or excluding different parameters, and covering different time periods. Environmental monitoring data is accompanied by a range of codes and nomenclature that describe its reliability or lack thereof. Test names may be different across agencies for the same tests and what is tested changes over time. Additionally, there is no one place to get monitoring data *and* information about area features either impacted by or impacting the element being monitored. All of this makes it nearly impossible for citizens or community leaders to understand what's happening with the natural resources in their neighborhoods and makes participating in local decision making frustrating. The 'Land Use and Water Quality Data Within the GTM Research Reserve' webpage is a publicly accessible storymap that provides a wealth of data on local and regional interests relevant to water quality and oyster habitat within the GTM Research Reserve boundaries. The page provides information on locations of water supply, stormwater treatment and outfalls, wastewater treatment and outfalls, points of interests such as schools, hospitals and parks, locations of research projects, areas of potential sea level rise, and records of the Reserve's SWMP monitoring data. Visitors to the site can turn layers in the pages off or on, filter for items of interest, and download supporting data. This single, public source synthesizes monitoring and research data, and other relevant features into an easy to use tool that enables local and regional decision makers to make more informed decisions affecting the areas natural resources.

Tricia Kyzar, ***University of Florida***, Oyster and Water Quality Task Force

The distribution and abundance of St. Augustine's Intracoastal bottlenose dolphin population (*Tursiops truncatus*)

The abundance and distribution of bottlenose dolphins (*Tursiops truncatus*) has been studied worldwide in order to assist conservation efforts and monitor potentially negative human impacts. Under a letter of authorization issued by the National Oceanic and Atmospheric Association, photo identification of the local dolphin population in the St. Augustine estuarine ecosystem has been conducted eight miles north and south of the St. Augustine Inlet. The objective of this research was to determine the quantity of "hotspots" and to gain an understanding of the "hotspots" in which local dolphins tend to congregate. Each hotspot was determined to support a greater number of dolphins per unit area. These preferred areas were discovered through mapping GPS coordinates that were recorded during each dolphin sighting since 2011. One favored hotspot is represented by a confluence of rivers bordered by a large sandbar, which may assist in feeding efforts. Water quality parameters in the hotspots were retrieved from the GTM Research Reserve database for further characterization. The numerous observations of dolphins in hotspots has also revealed heavy amounts of boat traffic in those areas. Conservation efforts of dolphins, based on this research, may include boat traffic speed limits and no wake zones, especially in these hotspots.

Vaishnavi Gundakaram, ***Flagler College***, Adam Burkhardt, Luke Reid, McKenna Kovatch, Zach McKenna, Jennifer Jakush, Terri J. Seron

Winter population ecology of shrimp in an estuarine tidal marsh

Estuaries are productive ecosystems that provide crucial habitats for endangered and migratory species, as well as serve as hotspots for fisheries. The GTM Research Reserve serves a vital function for estuarine research in Northeast Florida. When the Reserve was first established in 2009, a Site Profile Outline was done which listed the aquatic species present within the Reserve. Since then there has not been any published research at the Reserve targeted at shrimp species identification and populations, which are an important piece in the trophic web. Previous literature suggests that there may be a link between shrimp populations and fluctuations in temperature and salinity. Shrimp at the Reserve were captured as bycatch from the Guana River side of the Guana Dam, four nights a week at low tide from December 2018 to February 2019 using dip nets during the standardized sampling for American eel. Abiotic data was taken using a YSI. Shrimp were observed for species, size, and abnormalities. It was found that there were four species of shrimp present in the Guana River, three from the *Palaemonetes* genus and one from the *Litopenaeus* genus. Only two of the species had been previously documented at the Reserve. Several females were carrying embryos, and members of the population being parasitized by a bopyrid isopod. Preliminary results show that population numbers of shrimp increase as temperature and salinity increase, but the scope of this study needs to be expanded.

Isabella Kitzis, *University of North Florida*, Kelly Smith

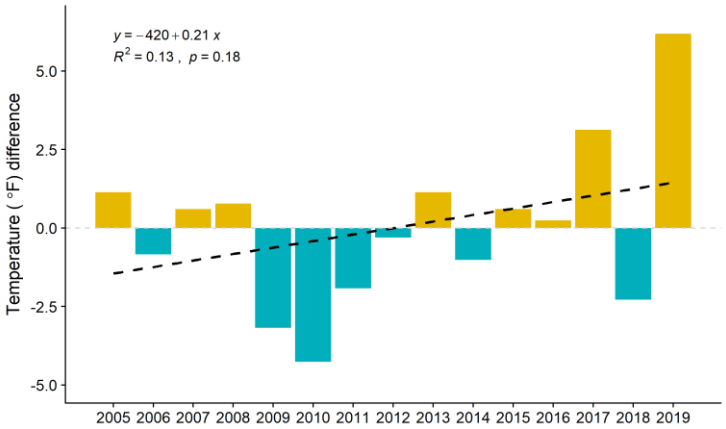
LONG-TERM MONITORING SHOWS EVIDENCE OF CLIMATE CHANGE

Shannon Dunnigan, GTM Research Reserve, System-Wide Monitoring Program Manager

The GTM Research Reserve's System-Wide Monitoring Program (SWMP) is the core long-term monitoring effort of the Reserve. This is a national program through the National Estuarine Research Reserve System (NERRS) that uses standardized protocols and equipment to track long-term change and short-term variability in United States' estuaries. As such, each of the 29 NERRs participate in the SWMP.

WARMER WINTERS

SWMP data collected within the GTM Research Reserve over the last 15 years shows an increase in minimum air temperature in recent years. Within the last five years, only one minimum temperature reached below the 15-year average minimum (28.7°F), and that was in 2018. That year brought the US several named winter storms and even some snowfall in Florida!



Deviation of annual air temperature minimum from 15-year average minimum

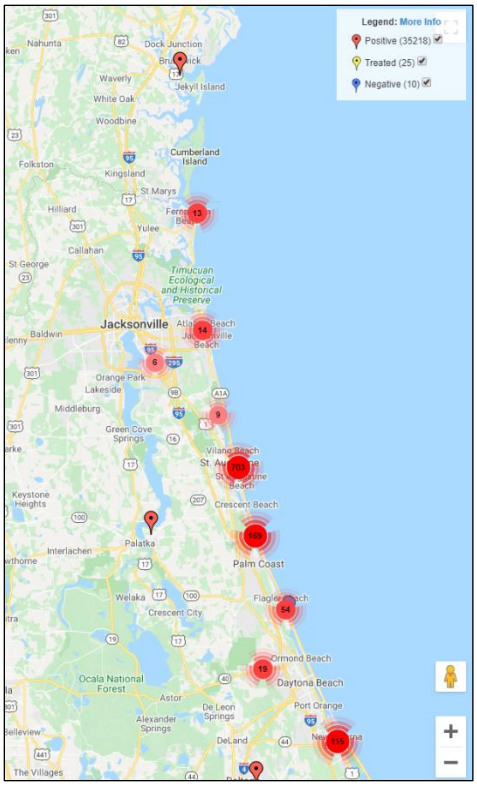
This past year in 2019, the GTM estuary experienced a very warm winter, one of the warmest in quite some time. The lowest temperature recorded at the Reserve's weather station was 34.9°F, 6.2°F warmer than the 15-year average minimum! According to the 2019 Global Climate Change Report from NOAA National Centers for Environmental Information, 2019 was the second warmest year on record. Additionally, out of the 10 warmest years on record, nine of them have occurred since 2005.

Why are minimum temperatures important? The northernmost range of many tropical species is controlled in the southeastern US by freezing winter temperatures. Ranges expand in response to a decrease in the intensity and duration of winter temperature extremes, freeze events.

Brazilian pepper, *Schinus terebinthifolius*

Brazilian pepper (*Schinus terebinthifolius*), introduced to Florida in the 1800s as an ornamental plant from Brazil, is one of Florida's most widespread invasive non-native species. This tropical plant outcompetes many of the native flora and can form a monospecific forest that has negative implications for wildlife. A recent study quantified a freezing temperature threshold of -11°C (or 12.2°F) for the northern range limit of Brazilian pepper that would result in mortality and control of the species. However, the study also found that although short term freeze effects due to less severe freezing temperatures (-1 to -7°C; 19 to 30°F) can cause minor damage to the plant, it was found to recover quite rapidly.

EDDMapS (Early Detection & Distribution Mapping System) show records of Brazilian pepper on the Guana peninsula as early as 2002, but larger trees and more frequent records have occurred in the last 10 years. In this database, the northernmost tree was reported in the Jekyll Island area of coastal Georgia by Georgia



Brazilian pepper reported range in northeast Florida, EDDMaps.

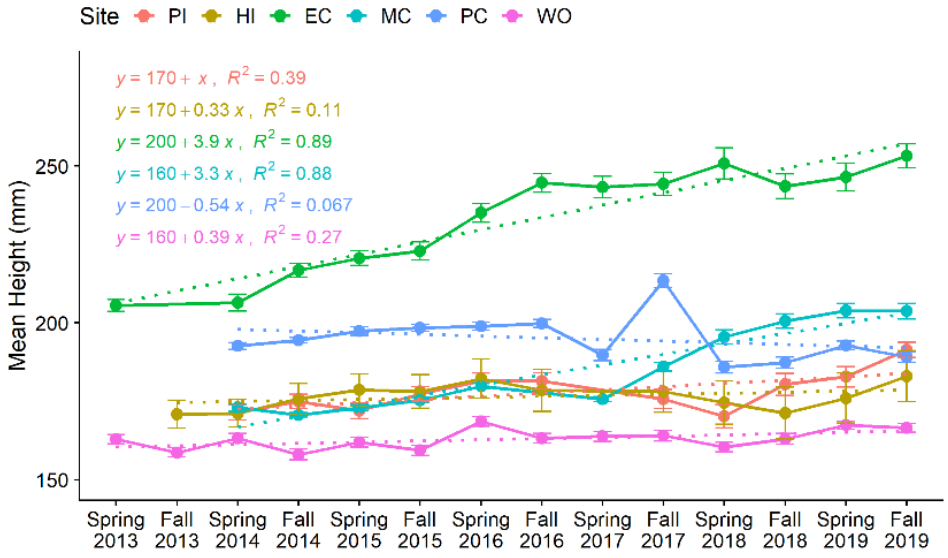
Department of Natural Resources in June 2014; however, the majority of the records exist in the Fernandina Beach area of Amelia Island, FL.

Considering the positive global trend in temperature (0.18°C; 0.32°F), tropicalization of northeast Florida is likely to continue. In addition to Brazilian pepper, another group of tropical species actively expanding northward are mangroves. These salt-tolerant trees are found in estuaries all over south Florida (and in many tropical regions of the world). In Florida, the three main species of mangroves are the red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*) and the white mangrove (*Laguncularia racemose*). The Reserve is located right in the salt marsh-mangrove ecotone (transitional zone for ecosystems).

Like Brazilian pepper, the northern range of mangrove species is controlled by winter extreme temperatures, particularly the duration of days colder than -4°C (24.8°F). Past researchers at the Reserve documented and published the location of the northernmost red mangrove within the Reserve boundaries back in 2014. Since then, red mangroves have been found north of the St. Johns River.

RISING SEAS

Federal studies show that average sea surface temperatures have increased since the 1980s, partly because excess heat in the atmosphere is stored within the oceans. As water warms, it expands, leading to rising sea levels. Long-term records from Mayport, Florida show an increase of 2.6-mm per year, with much higher rates in the last decade. Scientists around the globe are trying to understand what effect rising sea levels have on important ecosystems, like coastal wetlands.



Change in average height (mm) of surface elevation tables (SETs) at six long-term monitoring sites in the GTM Research Reserve: PI, Pine Island; HI, Hat Island; EC, East Creek; MC, Moses Creek; PC, Pellicer Creek; WO, Washington Oaks

GTM Research Reserve has been measuring the surface elevation of marshes using deep-rod Surface Elevation Tables (SETs) installed in 2013 at six sites within its boundaries. The elevation of these marshes has generally remained constant over the years except for two sites: one in Moses Creek (MC) and one near East Creek (EC) in the Matanzas River. This is troubling as this suggests that these marshes are not likely to keep up with rising seas. The site with the most gain in elevation (3.9-mm per year), East Creek, has experienced a

Photos of one of the SWMP platforms in East Creek taken in 2011 (Left) and 2019 (Right). Growth of mangroves around the platform is quite evident.

large increase in the presence and height of black mangroves! Mangroves are better than salt marsh grasses at building surface elevation because their deep, intricate root system lifts the surface up.

A recent collaborative research project at the Reserve with researchers from Villanova, University of Louisiana at Lafayette, and the Smithsonian Environmental Research Center seeks to better understand the differences in mangroves and salt marsh species within these ecotones, particularly as they relate to warming temperatures. Some of their sites are located near the Reserve's long-term marsh monitoring platforms.

As the SWMP continues to monitor abiotic and biotic conditions within the GTM estuary, the collaboration of the Reserve with visiting scientists enables further understanding of how the ecosystem landscape is changing and what this may mean for our futures on our coasts.

Left to right: Red, black, and white mangroves
Illustrations courtesy of NOAA

Related talks at State of the Reserve

9:45-10:00 *Warming a Wetland with More Mangroves: The first year of findings from the WETFEET project* by Gabriella Canas

10:00-10:15 *Effects of Changing Vegetation Composition on Community Structure, Ecosystem Functioning, and Predator-Prey Interactions at the Saltmarsh-Mangrove Ecotone* by Julie Walker

10:30-10:45 *GTM Research Reserve Sentinel Site Update: How will the marshes of Pellicer Creek respond to sea level rise?* by Pam Marcum

References

EDDMapS. 2020. Early Detection & Distribution Mapping System. The University of Georgia-Center for Invasive Species and Ecosystem Health. Available online at http://www.eddmaps.org/

Osland MJ and LC Feher. 2019. Winter climate change and the poleward range expansion of a tropical invasive tree (Brazilian pepper-Schinus terebinthifolius). Global Change Biology 00:1-9 DOI: 10.1111/gcb.14842

Williams, AA, SF Eastman, WE Eash-Loucks, ME Kimball, ML Lehmann, and JD Parker. 2014. Record Northernmost Endemic Mangroves on the United States Atlantic Coast with a Note on Latitudinal Migration. Southeastern Naturalist 13(1)56-63

https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature.

https://www.ncdc.noaa.gov/sotc/global/201913

For additional information, please contact Shannon Dunnigan, Shannon.Dunnigan@FloridaDEP.gov.

RESOURCES AVAILABLE

When collaborating with the GTM Research Reserve, there are many resources that the Reserve can provide and/ or assist with coordinating.

1 LONG-TERM DATA

The Reserve's core monitoring program, SWMP, has been collecting water quality, meteorological, and nutrient data since 2002.

2 BASELINE HABITAT DATA

The Reserve has habitat maps and monitoring data for saltmarshes, oysters, sea turtles, butterflies, gopher tortoises, plankton, migratory birds, and fisheries.

3 BOATS & CAPTAIN SUPPORT

There are several vessels and certified boating captains that can be made available for visiting researchers.

4 TRAIL VEHICLES

The Reserve has over 15 miles of trails on the Guana Peninsula that transect several habitats. There are several trail vehicles that can be made available for visiting professionals.

5 HOUSING & FACILITES

Dorm space is available at the northern and southern offices. There is also facility space for meetings including an auditorium and classroom, as well as lab space.

6 OUTREACH & K-12 EDUCATION

The Reserve has regular programming for K-12 classes that visit the Reserve. There is also opportunity to go into classrooms with our virtual reality headsets and participate in festivals, programs, and outreach events throughout the community.

7 COMMUNITY ENGAGEMENT

The Reserve engages with the northeast Florida community though public events, stakeholder programming, quarterly newsletters, social media, the Friends of the GTM Reserve, and our over 250 volunteers.

8 INTER-AGENCY COLLABORATION

With the Management Advisory Group, the Friends of the GTM Reserve, the Coastal Training Program, and other professional workgroups such as the Oyster and Water Quality Task Force and the Northeast Estuarine Restoration Team, there are plenty of opportunities to work with other agencies and organizations.

9 PROFESSIONAL DEVELOPMENT

The Reserve provides opportunities to all staff, interns, volunteers, and visiting investigators for professional training as requested.

For more information, please contact the GTM Research Reserve's Research Coordinator, Dr. Nikki Dix (Nikki.Dix@FloridaDEP.gov).

FRIENDS OF THE GTM RESERVE

On behalf of the board of directors and members of the Friends of the GTM Reserve, I'd like to welcome you to the 2020 State of the Reserve!

Since its inception, the Friends have sponsored this symposium because we believe in sharing the Reserve's findings with community stakeholders. This will ensure the decisions we make about our coastal ecosystems are based on science and fact. A very special thank you to our donors who give generously year after year to fund programs like State of the Reserve.

The Reserve serves as a special place where people convene to better understand the health of our ecosystem. Through collaboration, the GTM Research Reserve has become a leader in bringing together community stakeholders and sharing the science that our leaders need to make decisions about the health of our environment. Through programs like the State of the Reserve symposium, we continue to foster a culture of collaboration and show the value of science-based education and stewardship.

We sincerely hope you enjoy your time at the Reserve today and that you leave with a greater understanding of how valuable science and data are to all of us and the critical need we have for places like the GTM Research Reserve to exist and flourish for many decades into the future.

Remember, this is YOUR Reserve and with your support, even more can be accomplished. Consider becoming a Friend of the GTM Reserve and pledge your commitment to science in our community.

Ellen M. Leroy-Reed, *LEED AP*
Executive Director
Friends of the GTM Reserve

ACKNOWLEDGEMENTS

Along with the GTM Research Reserve staff, the following groups aided in providing information, education and recreation thousands of visitors in 2019:

The GTM Research Reserve Management Advisory Group is composed of representatives from agencies affiliated with the Reserve, landowners within the Reserve, and concerned citizens. The group meets quarterly to advise, report and review activities within the Reserve.
The current MAG members and their affiliations are:

Commissioner Barry Benjamin, St. Augustine Port, Waterway, and Beach District
The Honorable Carl Blow, Florida Inland Navigation District
Wade Brenner, Florida Fish & Wildlife Conservation Commission
Jeffrey Darr, Florida Department of Agriculture and Consumer Services, Division of Forestry
Commissioner Henry Dean, St. Johns County Commission
Kimberly Decker, St. Johns County Citizen
Commissioner Charles Ericksen, Jr., Flagler County Commission
Chris Farrell, St. Johns County Citizen Representative
Commissioner Leanna Freeman, City of St. Augustine
Vince Seibold, St. Johns River Water Management District
Susie Hetrick, Florida Department of Transportation
Kelly Rankin Legault, Ph.D., Army Corp of Engineers
Ellen Leroy-Reed, Friends of the GTM Reserve
Jen Lomberk, St. Johns County Citizen
Maia McGuire, Ph.D., UF/IFAS SeaGrant
Todd Osborne, Ph.D., Flagler County Citizen
Renee Paolini, Florida Department of Environmental Protection, Division of Recreation & Parks
Eric J. Smith, Ph.D., St. Johns County Citizen
Kelly J. Smith, Ph.D., Duval County Citizen
Steve Swann, Duval County Citizen
Tim Telfer, Flagler County Citizen
Frank Usina, St. Johns County Citizen
Gordon J. Wilson, National Park Service
Eric Ziecheck, St. Johns County Citizen, *Chair*

The Friends of the GTM Reserve is a non-profit citizen support organization established to support and enhance environmental education, stewardship of natural and cultural resources, and scientific research of the GTM Research Reserve through volunteer initiatives, citizen involvement and community partnership. The Friends are hosting the reception at the 2020 State of the Reserve.
The current board members are:

Mark Ryan, President
Julie Edwards, Vice President
Amanda Ryan, Secretary
Chuck Snavely, Treasurer
Sherry David
Drew Frick
David Green
Courtney Hackney, Ph.D.
Laura Hinds
Amanda Morrow
John Reed
Eric Smith, Ph.D.
Steve Swann
Mark Wood

Ellen Leroy-Reed, Executive Director
Donna Zerbe, Administrative Assistant

NOTES