

GUANA NUTRIENTS BUDGETS & BIVALVES

Newsletter of the NERRS Science Collaborative Project

"Assessing the Current and Potential Role of Shellfish for Improving Water Quality"

Our Final Newsletter

It is with wholehearted appreciation that the "Guana Nutrients: Budgets and Bivalves" project team extends our thanks to you for your active participation and collaboration. Since the development of the pre-proposal in 2019, we have grown as individuals, expanded the GTMNERR's capacity, strengthened existing relationships- and formed new ones, and enhanced the practice of collaborative, natural, and physical sciences within the Guana Estuary.

This final newsletter will share:

- the datasets collected throughout this project,
- recommendations for water quality targets and restoration goals, and
- impacts that this project has had on the reserve, stakeholders, and the Guana Estuary.

We hope to continue conversations around opportunities for managing nutrient loads into the Guana Estuary, identify the sources of organic nitrogen, consider harvesting in-lake vegetation, supporting and enhancing shellfish populations, and using restoration aquaculture in water quality restoration efforts.

Through continued collaborations, we work towards further understanding of the physical, chemical, and biological characteristics of the unique Guana Estuary to aid in the development of a water quality restoration plan.

For the estuary,
The Guana Nutrients: Budgets and Bivalves
Project Team



Project team members Justina Dacey and Dr. Hallie Fischman in the field.

Datasets

What data was collected and where can you access it?

Here are summaries of the data collected throughout the project and where you can access it. If you have any questions, please contact project lead, Dr. Ashley Smyth at ashley.smyth@ufl.edu.



SHELLFISH



Bivalves both play a crucial role in filtering nutrients within the Guana River. During the project, data revealed that mussels have higher weight specific filtration rates than oysters, but are limited by shorter inundation periods. Bivalves have potential to facilitate carbon and nitrogen storage and removal from the Guana River which was estimated through the creation of oyster, mussel, marsh, and mudflats maps. This project documented invasive hog trampling and rooting in the marsh as well as excrement containing mussels. Previously, land managers worked to eradicate hogs; however, this study indicates that though they reduce primary and secondary productivity, hogs enhance denitrification. [Access oyster maps and invasive hog data here.](#)



SEDIMENTS

Stable isotope analysis was performed to understand how nutrients transformed throughout the system. Plant and sediment samples indicated that sources, such as fertilizers, varied seasonally and were affected by weather patterns. Isotope signatures from sediment indicate that plant material is accumulating in the lake which could add to nitrogen input. Net denitrification and nitrogen fixation rate measurements from sediment showed changes in salinity affects nitrogen processes. [Data available through nerrssdata.org.](#)



WATER QUALITY

Real-time sensors recorded nitrate, temperature, and conductivity at the Mickler's Weir to provide continuous water quality data at the inflow point of Guana Lake. Monthly water quality samples were taken throughout the Guana Estuary showed as salinity and temperature increased, there was more nitrogen retention than removal. Studies conducted phytoplankton's response to different nitrogen forms. Phytoplankton showed largest growth response to treatment using urea and phosphate, demonstrating organic N should be considered in nutrient management strategies. Nearly two-thirds of the total N storage in the Guana River is driven by oysters and shellfish remove approximately 7% of the total N load in the water column annually. [Data available through nerrssdata.org.](#)



MANAGEMENT

Managing nutrients at the source are still key for water quality restoration in the Guana Estuary. Recommended management actions include: controlling and mediating nutrient input north of Mickler's weir, using mechanical methods for vegetation management, managing hog population, and investigating restoration aquaculture practices (installation and removal of shellfish).

Resources for you to use

In addition to the data collected, the project team developed resources including publications, articles, presentations, and lesson plans that you are welcome to use. Publications are in review and will be available on the project website (www.nerrsciencecollaborative.org/project/Smyth20). If you have any questions, please contact project lead, Dr. Ashley Smyth at ashley.smyth@ufl.edu.

PUBLICATIONS

- Dix, N., Roorbach, O., Fischman, H.S., Lee, J., Dunnigan Kimmel, S., Maldonado, M., Mathis, S., Angelini, C., Reisinger, A.J., & Smyth, A.R. (2024). Assessing Water Quality in the Impounded Guana Estuary: A Baseline with Implications for Future Management. SSRN. <http://dx.doi.org/10.2139/ssrn.4955210>
- Fischman, H.S., Smyth, A.R., & Angelini, C. (2024). Invasive consumers provoke ecosystem-wide disruption of salt marsh functions by dismantling a keystone mutualism. *Biological Invasions* 26, 169–185. <https://doi.org/10.1007/s10530-023-03167-4>
- [Oyster Beds in Florida GIS Layer](#)
- [How do oysters remove nitrogen?](#)
- [What's an impairment and what can you do?](#)
 - A handout about the Guana Estuary water quality impairments, the impairment process, and the options for water quality restoration. This handout has been shared with UF Extension agents and Riverkeepers throughout Florida to customize for their local waterbodies.

PRESENTATIONS

- [Identifying Hot Spots and Hot Moments of Denitrification in the Guana Estuary, Jenna Reimer, University of Florida](#)
- [Sediment nitrogen cycling and phytoplankton nutrient limitation in an urbanizing estuary, Justina Dacey, University of Florida](#)
- [Water Quality in the Guana Estuary: From Monitoring to Management, Nikki Dix, GTMNERR](#)
- [Denitrification and the Fate of Nitrogen in the Guana Estuary, Ashley Smyth, University of Florida](#)
- [Mussels and Oysters in the Guana River, Hallie Fischman, University of Florida](#)
- [Current and Future Threats to Water Quality in the Guana Estuary and Looking Forward for Solutions, AJ Reisinger, University of Florida](#)
- [Identifying Nitrogen Management Strategies in the Guana Estuary Using Nutrient Budgets and Bivalves, Ashley Smyth, University of Florida](#)
- [Benthic and Pelagic Responses to Nitrogen Inputs in an Urbanizing Estuary, Justina Dacey, University of Florida](#)
- [Identifying Control Points for Nutrient Management in the Guana Estuary Using Stable Isotopes, Jenna Reimer, University of Florida](#)

LESSON PLANS

- [Do invasive hogs alter species relationships in saltmarshes?](#)

Recommendations

A final product of the “Guana Nutrients: Budgets and Bivalves” project is a list of water quality restoration recommendations for the impaired waters of the Guana Estuary. To ensure that the recommendations are relevant and actionable, the project team worked with members of the GTMNERR Technical Advisory Group to identify best management practices (BMPs) to incorporate into scenario testing that reduce estimated pollutant inputs into the Guana Estuary. Based on data collected from the project team and stakeholder engagement, below are the recommendations.

Manage nutrient loads above weir

The Guana Estuary watershed is 71% natural land and 29% developed (of which 26% is categorized as highly developed). There are 2 golf courses and 3 WWTF. Based on projected development, there could be a 60-80% increase in nitrogen loads from the Ponte Vedra community. It is imperative to consider new ways to manage stormwater.

Create local model for scenario testing

The Pollution Load Estimation Tool (USEPA) can estimate load reductions associated with BMPs; however, BMP implementation would need to be applied at a large scale and could cost \$250-\$350M. A locally-based model would identify locally-relevant BMPs.

Invest in load and discharge data

Physical challenges limited the collection of hydrological discharge data. Without this data, it was difficult to identify how a change in watershed management alters nutrients. Through a strong collaboration with Alberto Canestrelli, University of Florida, modeling data was collected and is utilizing nutrient data from this project to develop a hydrodynamic model. It is recommended to install gauge systems at Mickler’s weir and upstream in Ponte Vedra.

Identify organic nitrogen sources

There is a lot going on in the Guana and many contributing factors to water quality. Nitrogen levels are high and are mostly in the dissolved organic form which is from the breakdown of organic matter, and possibly from stormwater.

Manage hog populations

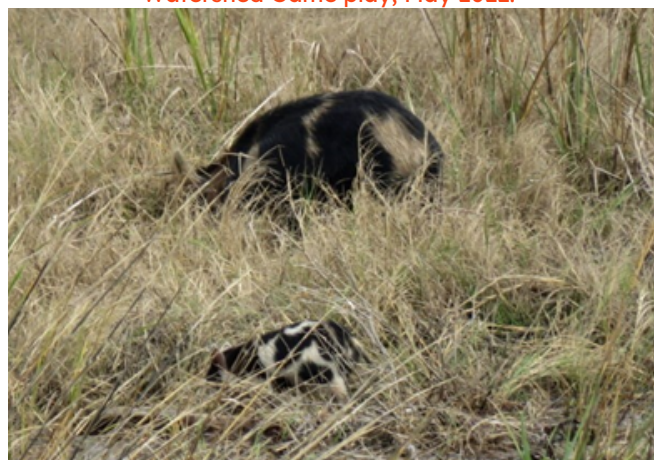
Feral hogs, (*Sus scrofa*), consume mussels and trample cordgrass which reduces marsh primary and secondary productivity; however, they enhance denitrification. It is important to manage hog populations, but populations do not need to be completely eliminated.



Project team members exploring the headwaters of the Guana Estuary, May 2022.



Guana Estuary stakeholders and project team members discussing management opportunities during The Watershed Game play, May 2022.



Feral hogs consuming mussels along the Guana Estuary.

Recommendations, continued...

Harvest in-lake vegetation

Plant biomass stores nitrogen and traditional vegetation management actions have the potential to release nitrogen back into the water. It is important to consider alternative vegetation removal methods that would permanently remove plant nitrogen from the system.

Avoid extreme changes in salinity

By varying the salinity within the system, there is a potential for nitrogen fixation to be increased which produces nitrogen. By limiting the extreme changes of salinity, the ecosystem function can be preserved by reducing nitrogen.



Above: Project team members, Jenna Reimer and Dr. Shirley Baker, checking the nitrate sensor at the Mickler's Weir. Below: Project team member, Justina Dacey, explaining sediment fluxes. Right: Project lead, Dr. Ashley Smyth, comparing sediment samples.



Support & enhance shellfish populations

Both oysters and mussels play a crucial role in cleaning water. Over 6% of upstream nitrogen is assimilated into shellfish shell and tissue each year (mostly by oysters north of harvest area). Mussels have a higher weight-specific filtration rate, but their overall contributions are limited due to shorter inundation periods. Compared to saltmarsh and flats, bivalves double denitrification rates.

Consider restoration aquaculture

Oyster populations in the Guana River are not at carrying capacity and the system can support additional bivalves. Through restoration aquaculture in the upper half of the Guana where 72% of oyster population is found and harvesting in the southern end of the Guana where only 5.3% of mudflats have dense reefs, harvesting can continue to shape the oyster population in Guana River.

Continue to collect data and engage with the community

Many actions can be taken to slow the transport of or treat nutrients before they enter the Guana Estuary. It is crucial to maintain communication between entities and the community.



Beyond the Dam: Creating Connections for the Health of the Guana

The Guana Nutrients: Budgets and Bivalves project not only collected water quality and shellfish data within the Guana Estuary but also established a path for increased research and monitoring as well as providing “advocacy ammunition.” One of the greatest impacts on coastal health and resilience that this NERRS Science Collaborative funded project has had is expanding and deepening external relationships of the reserve and partners and producing innovative data and products that will strengthen water quality restoration efforts throughout Florida. This project fostered connectedness between people and data.

The project team invited a handful of you, our Guana Nutrients: Budgets and Bivalves stakeholders, to explore the impacts of the project through a facilitated discussion organized by the NERRS Science Collaborative. Thank you for sharing the impacts of this project on your efforts, coastal health, and resilience.

- **The Story of “Planning”** The Guana Nutrients: Budgets and Bivalves project goal was to dig deeper into nitrogen dynamics and potential remediation options after waterbodies were designated impaired. The project team and GTMNERR provided many professional development opportunities to connect people and knowledge. New relationships have been established, and existing relationships have been strengthened which have expanded the GTMNERR and partner’s understanding on concepts, facilitated spin-off projects, allowed for data exchange with other visiting researchers, and created a network of expertise to rely on for future proposals.
- **The Story of “Learning and Adapting”** Opportunities to join researchers in the field strengthens relationships and provides space for knowledge exchange with subject-matter experts. By learning about sampling efforts and management actions, land managers are able to assess how management actions can impact multiple ecosystem processes. Additionally, it highlights the importance of seeing the study system before you try to understand it. These relationships are now resources to bounce ideas off, practice techniques with, explore management options that support additional ecosystem benefits, and identify future research connections.
- **The Story of “Advocacy Ammunition”** Stakeholder meetings, including the GTMNERR’s Technical Advisory Group, and the State of the Reserve provided the space for stakeholders from varying backgrounds who managed many different things come together to connect dots, learn from each other, and build relationships. The data shared during these meetings validated “all of the things we thought we knew” and more. By having robust data on water quality, potential solutions, and recommendations have enabled organizations to advocate for the Guana.
- **The Story of “Data and Management”** The data collected from this project (e.g., water quality, shellfish mapping, nutrient budgets, etc.) provides information necessary for assessing ecosystem health and the health of bivalve populations within the GTMNERR, and can fill a gap in existing databases and may indicate a need for increased monitoring and/or management to ensure good water quality within this system is achieved and maintained. The work on the nutrient budget for the Guana has implications for similar waterbodies and could be useful in other shellfish dominant systems as a springboard for further, more system-specified research.
- **The Story of “Flux”** When the Guana Nutrients: Budgets and Bivalves project’s initial plan to develop a linked biogeochemical-hydrodynamic model stalled, they connected with a hydrodynamic modeler who had been working on a hydrodynamic model but was missing essential data on shellfish, particularly their filtration rates. This new interdisciplinary partnership has expanded each researcher’s networks, setting the

Reflections

stage for future projects and proposals. What began as a practical need for data evolved into new ideas and advances that can help manage and protect water quality in Guana and beyond.

- **The Story of “Authentic Connections”** In general restoration conversations focus on “generalities,” speaking in broad terms without breaking down the specific roles of the different components (sediment, water, oysters, mussels, etc.). However, this project was different because it set out to quantify individual components and uncover their connections. Throughout the project, the project team didn’t just present clean, edited results; they openly discussed their process—what was working, what wasn’t, the challenges they faced, and what surprised them. These updates helped stakeholders recognize the importance of studying the individual components. The combination of robust data, honest discussions, and regular check-ins gave this stakeholder confidence that the project’s results could have meaningful change on coastal health and resilience.

These impact stories demonstrated the importance of collaboration, transparency, and adaptability in achieving impact. By leveraging Reserve capacity, the project fostered authentic connections and has empowered individuals and organizations. The project has created a ripple effect of positive outcomes for the Guana Estuary and beyond. Although it was not intentional at the onset of this project, the collaborative science approach offers a powerful model for advancing ecosystem management and resilience.



Two stakeholders sharing their impact story on a listening walk.