Guana Project Report

Project Title: <u>Combining high-resolution surveys and numerical modeling to optimize water level management and contain nutrient levels in the Guana River Lake</u>

DEP Agreement Number: G3300
Revision date for this submittal: 01/19/2024
Organizations performing work for this project: University of Florida, GTMNERR
Principal Investigators involved in the project: Stefano Biondi, Daniele Pinton, Alberto Canestrelli, Nikki Dix, Allix North
Anticipated Benefits: By combining numerical models and data collection, we will be able to understand the dynamics of the Guana Lake and identify guidelines for the dam operation, with the final goal of containing nutrient levels in the Lake.

1. Introduction

1.1. <u>Brief Historical Overview</u>

Eutrophication is harming estuaries worldwide. In the majority of the Guana-Tolomato-Matanzas (GTM) estuary, high tidal flushing favors the dilution and transport of nutrients to the sea, and water quality standards for nutrients are met. An exception is Guana River "Lake" (Figure 1), an impounded estuary that receives water from a highly urbanized watershed (i.e., the Ponte Vedra area). A water control structure (i.e., the Guana Dam) separates the natural portion of Guana River from the impounded Guana "Lake" where tidal flushing is reduced, causing accumulation of excess nutrients and algal blooms.

Since the Guana system provides important wildlife habitat and recreation opportunities for the community, and because development pressure in the watershed is a public concern, a public-private water quality partnership aimed at assessing current ecosystem conditions was established in 2017. The resulting study, conducted by GTM National Estuarine Research Reserve (GTMNERR), Guana River Marsh Aquatic Preserve, and Florida Fish and Wildlife Conservation Commission staff, concluded that the Guana system suffers from excess nutrients, regular occurrence of potentially harmful algal blooms, and a clear gradient of human influence from north to south (Dix et al., 2019).

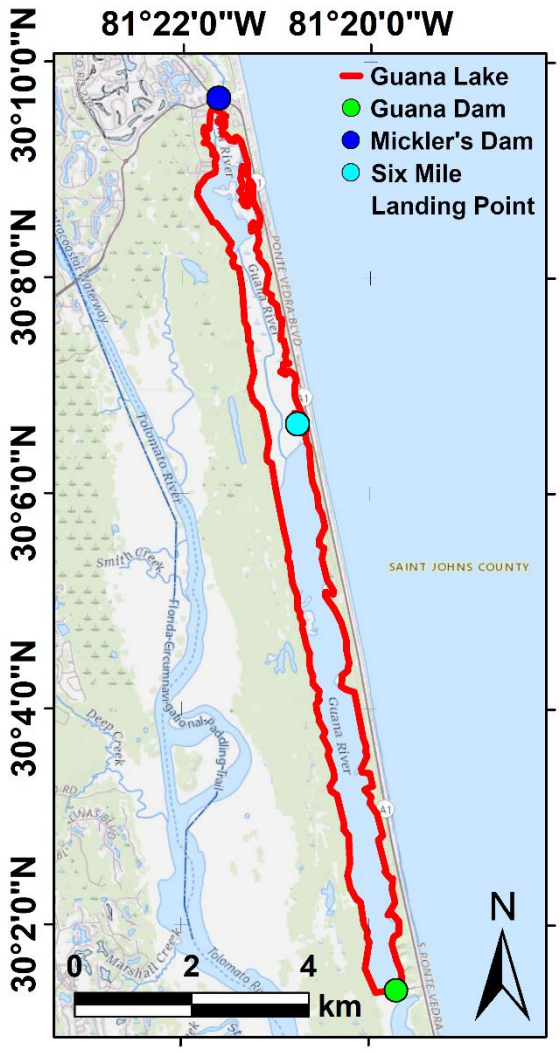

Figure 1. *The Guana Lake, which boundaries are defined by the continuous red line. The Lake is connected to the Guana River in the south, through the Guana Dam (green dot) and in the north, through the Mickler's Dam (blue dot). The Six Mile public landing point is also indicated in the map (light blue dot). On the background, the USGS National Map.*

1.2. Project Purpose and Objectives

The GTM estuary is a highly flushed ecosystem that rarely experiences negative consequences of eutrophication. However, in Guana Lake, tidal flushing varies seasonally to meet specific environmental and recreational needs. As a result, Guana Lake provides an ideal laboratory for exploring different degrees of tidal flushing to reduce nutrient accumulation, meet water quality standards, ensure flood protection, and preserve valued recreational and commercial uses. Dix et al. (2019) suggest that a better understanding of nutrient quantity, sources, and fates throughout the watershed and along a nutrient and salinity gradient in Guana Lake is necessary to develop remediation strategies. This critical need led the GTMNERR to prioritize the development of a detailed hydrologic and pollutant source model for designing remediation and limiting nutrient accumulation.

In the next sections, we will present the results obtained during the first 6 months of a 2-year effort. The long-term (i.e. 2 years) objectives are:

- Develop a coupled hydrological, hydrodynamic, and water quality model for the Guana Lake and its watershed.
- Collect field observations to calibrate and validate the numerical model using the recently purchased YSI HYCAT, an Autonomous Surface Vehicle (ASV) for remote monitoring of water quality, bathymetry, and velocities/discharge.
- Test the feasibility of using the HYCAT for water research and management. Document challenges, limitations, effort, cost, and future opportunities. Develop protocols.
- Host a stakeholder workshop to explain how watershed actions and dam operation impact water quality in the Guana system.

- Collaborate with end-users to develop a water quality remediation plan containing a list of best management practices to fine-tune dam operations and improve water and habitat quality within Guana Lake.

2 Surveys

During the month of September, we deployed salinity and pressure sensors both at the Guana Dam and Mickler's Dam. This will allow to calibrate the discharge coefficient for both weirs.

Figure 2. *position of the pressure and salinity sensors at the two dams*

Each survey has been completed in five days. Here are explained the steps followed to perform the monthly data collection:

Survey	Start day	End day
First month	September 4th	September 9th
Second month	October 2nd	October 6th
Third month	November 5th	November 10th
Fourth month	December 4th	December 8th

- Day 1: sensors calibration and Instrumentation set up;

Figure 2. *ProDSS, YSI EXO2 and Seabird SUNA nitrogen sensor*

The calibration was performed at the GTMNERR lab in Ponte Vedra before each survey. Water quality parameters have been calibrated by using standard samples available in the lab. Calibration logs are available for review.

- Day 2: Data collection (Water quality and bathymetry) in the southern part of Guana lake with HYCAT;
- Day 3: Data collection (Water quality and bathymetry) in the Northern side of the lake up to the Mickler's Dam with HYCAT;

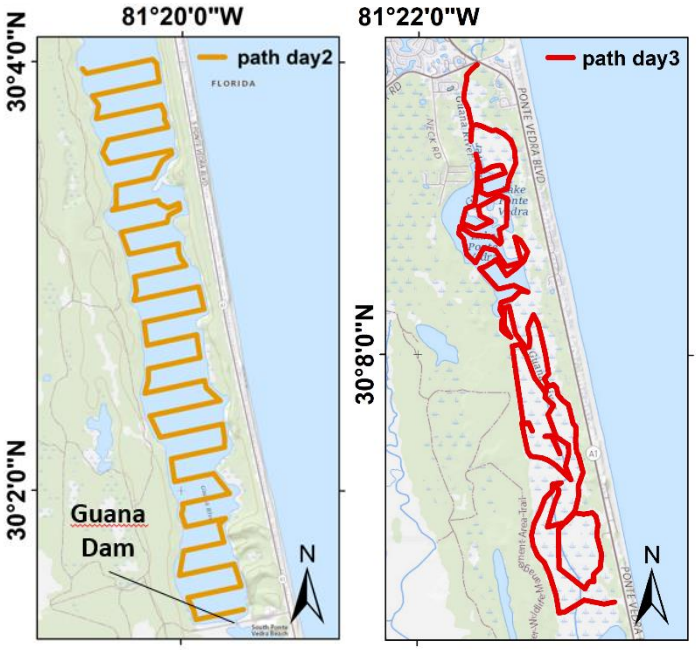

Figure 3. *Path followed for days 2 and 3*

- Day 4 : Salinity, and pressure data collection in the fixed stations
- Day 5: Discharge data collection with transects in the Guana Dam and Mickler's Dam proximity. Post calibration of the sensors and maintanance.

During the month of November, both weather conditions and boat availability didn't allow to get the data for the northern part.

3 Data

Data are delivered as follows in four directiories:

- Calibration logs: excel spreadsheet used to annotate values for calibration and post calibration before and after each survey for ProDSS and EXO2. File are named *Calibration_logs_sensorname.csv*. Pdf file for the calibration performed by others are available in the same directory;
- Field data: this directory is divided by sensor name. (ADCP, SUNA,ProDSS, EXO2). For each sensor, files are named by parameter, location and date of survey (e.g.in the folder ADCP: *Bathymetry_Guana_Lake_Nov_2023.csv*)
- Water samples: Here are available the lab results for water samples analysis. File are named by *water_quality_month_year.csv*
- Weather Data: one single spreadsheet with all the weather data for the 4 months were the survey were performed.

4 Limitations

The most common limitations are due to:

- Vessel connection to the controller and radio antenna. Many working hours were wasted due to lack of connection.
- Environmental issues: When driving a jon boat, several times happened to be stuck in the mud for shallow water conditions. When the lake is draw downed, reaching the sixth mile landing point is quite difficult.
- Weather: Storms, severe wind or rain might significantly affect the survey results. The computer used to remotely ride the HYCAT need to stay in dry conditions and the vessel may have some difficulties in wavy environments.