Monitoring for Change: Water Quality in the Guana River System

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This summer we have seen headline after headline of algal blooms in shades of red, blue, green, and brown in Florida waterways. From declarations of states of emergency, reductions in tourism, to the crippling and deadly effects of some of the more toxic blooms along southwest Florida’s coast.

What causes these phenomena?

Algal blooms of this nature are the result of a variety of conditions such as rain events, stagnant waters, warm temperatures, and increased sunlight availability - Florida is the sunshine state after all. However, a large factor contributing to the frequency of algal blooms is eutrophication.

Eutrophication is the feeding of a waterbody, or the enrichment of water by excess nutrients resulting in an increase in algal biomass.

Phosphorus and nitrogen are the most important nutrients for plants to grow. In small amounts they are beneficial to many ecosystems. Thus, they are used in many agricultural and gardening practices for that same purpose. During the rainy season, many of these nutrients are then washed into our inland waterways and estuaries, where they are taken up by aquatic plants for reproduction and growth.

Although nutrient pollution has made headlines recently, this has been an issue for coastal and inland waters for decades. In 2000, it was estimated that 60 percent of coastal waters in the United States were moderately to severely affected by nutrient pollution.*

Above: Algae in northern Guana Lake taken by Silas Tanner, GTMNERR SWMP Technician. Right: Dead fish on the north side of Guana Dam during a fish kill in Guana Lake in August 2016. Photo taken by GTMNERR staff.
Plankton are the base of aquatic food webs. They, like terrestrial plants, are photosynthetic (containing pigments like chlorophyll $a$) and can harness the energy from the sun to create their own food. They are then the main source of food for many aquatic animals.

So, why are more nutrients a bad thing?

Eutrophication does not always trigger a bloom of toxic algae like the Florida Red Tide ($Karenia brevis$) or brown tides, but it often leads to detrimental ecological impacts in coastal waters. Unfortunately, when plankton (algae) bloom, oxygen in the water gets depleted as the dead algae sink in the water column and are decomposed by bacteria. Hypoxic (oxygen poor) conditions often physically stress many of the animals in our estuaries, but anoxic (completely depleted of oxygen) conditions can kill them. Beyond ecological impacts, algal blooms can be devastating to coastal economies. They often disrupt tourism and adversely affect recreational and commercial fisheries.
How does all of this relate to us in northeast Florida?

The Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) is part of a national program and is one of 29 reserves around the country. The cornerstone of the National Estuarine Research Reserve System is its System-Wide Monitoring Program (SWMP) - a national monitoring program that is set up to track long-term change and short-term variability in water quality and eutrophication in our nation's estuaries.

When the SWMP was implemented at the GTMNERR in 2002, four long-term water quality monitoring stations were established. These sites are located in the Tolomato and Matanzas rivers as well as Pellicer Creek, the largest source of freshwater to the GTM estuary.

The SWMP has been a great resource for baseline data in the main waterways of the GTM estuary as the four stations have actively been collecting 15-minute water quality data (and monthly nitrogen, phosphorus, and chlorophyll data) since 2002, but the limited number of sites and unique characteristics of each waterway leads to a lack of data in many other areas (the GTMNERR is comprised of over 74,000 acres of aquatic, wetland, and upland habitats).

Right: Map of sampling sites in the Guana system and the GTMNERR SWMP Station at Pine Island. Stations noted with "DEP" are additional stations staff began sampling after the one-year pilot study. These stations are sampled only five times per year.

Unfortunately, one of these areas lacking long-term data is near the northern office of the GTMNERR.

Rich in history, the Guana ecosystem is a fundamental part of the northeast Florida community, especially popular for outdoor recreational activities including bird watching, paddle sports, fishing, and waterfowl hunting. The headwaters of the Guana River originate in Ponte Vedra Beach and the river system runs parallel to the Tolomato River, with the two rivers joining 7 miles north of the St. Augustine Inlet.

In 1957, the Florida Fish and Wildlife Conservation Commission (FWC) constructed a water control structure, Guana Dam, in the Guana River to create suitable conditions for duck hunting. The impoundment formed by Guana Dam is referred to as Guana Lake and encompasses 2,400 acres of wetlands, including brackish and freshwater grasses. To this day, Guana Lake is still managed by FWC.
due to decreased water quality and human health risks, Florida’s Department of Agriculture and Consumer Services has restricted harvest since the mid-1980s. Through efforts by members of the Oyster and Water Quality Task Force (OWQTF) of the Guana, Tolomato, and Matanzas Rivers, it was realized that a lack of regular sampling has led to a scarcity of knowledge about current water quality conditions in the Guana ecosystem.

To ever be able to measure change in this ecosystem, baseline information was needed, especially to inform coastal management.

Inspired by momentous community interest and a common research priority, multiple sponsors including the Audubon Society and the Friends of the GTM Research Reserve, generously funded water quality sampling and subsequent laboratory analyses for a one-year pilot study, which began in July 2017. Monthly sampling, a collaboration between GTMNERR and Northeast Florida Aquatic Preserves, occurred during high outgoing tides at sites within the Guana Lake and Guana River (see map on previous page).

Water samples were collected at each site and sent to a laboratory for analysis of nitrogen, phosphorus, chlorophyll a, and bacteria (Enterococcus and fecal coliforms) concentrations.

Nitrogen, phosphorus, and chlorophyll a are indicators of eutrophication, so why collect data on bacteria? Fecal indicator bacteria (FIB) are bacteria such as *Escherichia coli* (E. coli) and *Enterococcus*, which live in the gut of warm-blooded animals and are introduced into the environment through fecal matter. Most FIB are harmless to humans, but the presence of FIB indicates that pathogens also found in fecal matter, which are harmful to humans, may also be present.

Above: Jimmy Tomazinis, Biologist with the Northeast Florida Aquatic Preserves, collects water samples in Guana River.
Florida’s Department of Environmental Protection (DEP) determines legal water quality standards for each state waterbody. **In the Guana system, there are multiple waterbody types:** the Lake is a Class III Estuary and the River is a Class II Estuary. As such, they have different water quality standards per statute 62.302.530.

*Enterococcus* (left) and *Fecal coliform* (right) data from one-year pilot study of water quality in the Guana system. Horizontal lines represent threshold levels. *Enterococcus*: Dashed line (35 MPN): Geometric mean (min 10 samples) in any 30-day period. Solid line (130 MPN): No more than 10% of samples. *Fecal coliform*: Dashed line (43 CFU/100mL): no more than 10% of samples may exceed this value. Solid line (14 CFU/100mL) is median value.

Bacterial levels at the stations **generally did not exceed** the water quality standards for their associated waterbody. However, high levels were observed in months following large rainfall events, such as Hurricane Irma in the October 2017 sampling event.

The average concentrations of nutrients and chlorophyll *a* were concerning at some sites. When comparing these sites to the GTMNERR SWMP station at Pine Island, the site in the middle of Guana River was comparable. Pine Island is a good reference site because it is nearby in the Tolomato River and data go back to 2003 (Table).

**Table:** Average concentrations of nutrient analyses of the one-year pilot study of water quality in the Guana system (July 2017-June 2018). Lake sites (Micklers, Lake Middle, and Lake South) are Class III estuarine waters. River sites (River North and Guana River) are Class II estuarine waters. Waterbody classification determines the water quality threshold values.
Where are we now and what is next?

Florida’s DEP assesses water quality in state waterbodies every 5 years. (More info on the assessment process can be found at https://floridadep.gov/dear/watershed-assessment-section.) DEP could only use data prior to July 2017 for that assessment and had insufficient data to assess Guana waterbodies. Because of the 5-year cycle, DEP was not considering sampling Guana waterbodies this year to be a high priority, but we reached out and shared our recent concerning results.

We have now partnered with DEP, Northeast Florida Aquatic Preserves, and FWC to continue monthly sampling at the five original stations as well as five additional stations five times per year. Additionally, we will also be collecting genetic samples to determine if bacteria are from human or non-human sources. It is also possible to determine the specific animal sources (dog, deer, pig, gull, etc.), which will inform more specific management practices.

Collecting baseline data and further investigating the potential sources (and quantity) of nutrients into the Guana system will further our understanding of eutrophication using an impounded estuarine system. Guana is an ideal system to study the effects and sources of eutrophication due to clear input (water control structure at Mickler Road) and output (Guana Dam) points and a gradient of land development from north to south throughout the watershed. Stay tuned for more information as we continue sampling. We also plan to seek funding for a hydrodynamic study and a graduate research assistant.

References:

Interested in learning more about water quality standards? Visit: www.flrules.org

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