Spatial Patterns of Phosphorus Concentrations in a Water Conservation Area of the Florida Everglades

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ABSTRACT

One of the functions of wetlands in an agricultural watershed is the wetlands' ability to cycle nutrients within the system and exchange chemicals to surrounding waters, landscapes, and the atmosphere[2]. The Florida Everglades is one of the largest wetlands in the world and is limited by both annual hydroperiods and nutrient loading[3]. The water received by this system flows south from Lake Okeechobee. Excess nutrients from agricultural runoff and urbanization are a major threat to the lake. In attempt to improve water quality, the South Florida Water Management District has implemented a series of Storm Treatment Areas (STAs) designed to remove excess nutrients before they impact our natural wetlands. Ten sampling locations were chosen in WCA-3A starting at a public boat ramp off of interstate-75 (I-75) south the Tamiami Trail (US-41), a distance of about 112.7 km for monthly sampling. In field measurements were taken for water depth, temperature, pH, salinity and dissolved oxygen. Phosphorous analysis was conducted by using The Westco SmartChem 200 discrete Analyzer with EPA method 365.4. The correlation between decreasing dissolved oxygen concentration and an increasing water temperature was well defined in this study. As expected, the wetland was found to be sink of nutrients with well defined inflows and outflows out nutrients. The ending of 2015 showed promising results with low phosphorus concentrations. However, the beginning of 2016 brought an unexpected hurdle, an El Niño that swept across the state. The impact of this storm resulted in much of the greater Everglades being shut down, increased water levels that lead to water releases from Lake Okeechobee into the Gulf of Mexico, Atlantic Ocean as well as the Florida Everglades and an overall change for many biotic and abiotic factors. As a result from the Lake Okeechobee water releases much high phosphorus concentrations were measured than expected.

INTRODUCTION

Phosphorus (P) is often a limiting nutrient in agriculture and is added to many fertilizers to improve crop yield. Phosphorus is usually present in both organic and inorganic forms. As the dissolved inorganic P increases in a wetland, insoluble mineral P can form with iron, aluminum or calcium depending on how acidic or alkaline the mineral soil is within that particular wetland. As a sink function of wetlands, the increase of mineral P significantly decreases the availability of P to environment. An excess of P has also shown to cause eutrophication in many lakes and streams. This process occurs when too much available P (or nitrogen) is present and promotes algal growth. As the algae dies and decomposes anaerobic organisms begin to thrive, depleting the dissolved oxygen in the water. This results in a significant change in the biota. As a result of this, the South Florida Water Management District (SFWMD) has determined a geometric mean of 10 parts-per-billion (ppb) of phosphorus as the standard for determining discharge limits[1]. The objectives of this study are to determine the current phosphorus concentration in Water Conservation Area-3A north of the Everglades National Park and to compare these findings to historical data provided by SFWMD and others and to determine if the P concentrations are routinely below 10 ppb. The results from this study are hypothesized to show a decreasing gradient of phosphorus as the water flows south to The Everglades National Park.

METHODS

Ten sampling locations were chosen in WCA-3A starting at a public boat ramp off of interstate-75 (I-75) south the Tamiami Trail (US-41), a distance of about 112.7 km for monthly sampling (Figure 3). In field measurements were taken for water depth, temperature, pH, salinity and dissolved oxygen. Sampling started in October in 2015 and ended December 2015 when a ban on airboat traffic in the WCA was enacted. The ban was lifted in April of 2016 and sampling was resumed until June 2016. The samples were collected in an acid washed 4oz polyethylene bottles just below the surface water. The samples were kept on ice until they were preserved with acid to a pH 2 at the Everglades Wetland Research Park. The pH, salinity, dissolved oxygen and temperature were measured using an YSI sonde. Water depth was recorded each time at the sampling sites with a meter stick. The water samples were brought back to The Everglades Wetland Research Park for acid preservation, storage and analysis. Samples were preserved within 48 hours of collection and stored for a maximum of 20 days before analysis. Phosphorous analysis was conducted by using The Westco SmartChem 200 discrete Analyzer with EPA method 365.4. Multiple samples were analyzed by the Cape Coral Environmental Resources Division as a secondary laboratory and for professional consistency. Both labs have a detection limit of 2 ppb P.

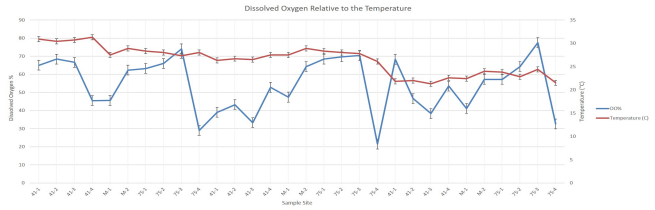

Figure 1. Dissolved oxygen and water temperature from April-June 2016

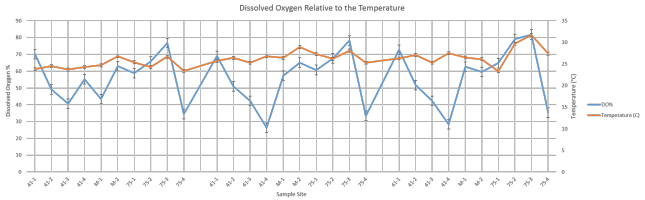

Figure 2. Dissolved oxygen and water temperature from October-December 2015

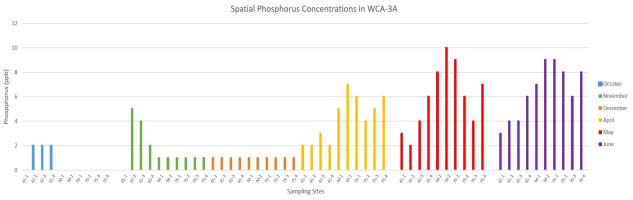

Figure 3. Phosphorus Concentrations in WCA-3A October-December 2015 and April-June 2016

Picture 1. Airboat in WCA-3A

RESULTS

The relationship between of dissolved oxygen and the temperature was very well illustrated with this study. As the water temperature increases the dissolved oxygen in the water decreases. This observation can be seen in both figures 1 and 2. There is one low spike recorded at site 75-4 which may be explained by the location of the site which is in the middle of a high traffic airboat trail. Total P concentrations for the sampling records (Figure 3) illustrate an overall increase of P concentrations. The increase is likely due to the water releases from Lake Okeechobee. An estimated concentration of 1ppb was used when the laboratory low threshold of <2.0ppb was reported. Before the El Niño swept over south Florida and before the water releases of Lake Okeechobee, it is expected that the P concentrations in WCA-3A would remain low. There is a clear pattern between the inflow at the 75-side samples and the outflow at the 41-side samples. As the water flows through the area, the wetland is acting as a P sink and decreased concentrations of P are observed at the end of the sample sites. Since the water releases there is clearly a higher concentration of P throughout the area although SFWMD claims most of the area has remained unimpacted. However, P concentrations near the Miami canal (closest to site M-2) contained P concentrations of up to 20 ppb. Other areas towards the 75-side of the area are reported to have close to 8-10ppm of P as well[5]. The effects of the higher concentrations of P will have to be carefully observed over time.

CONCLUSIONS

Wetlands around the world are disappearing at an alarming rate. Many policies in place today, do not recognize wetlands the way the rest of the world does. For Florida, much of the wetlands have been converted or lost over the decades with the exception of a greater portion of the Everglades. Current efforts of The Everglades Restoration Project, which began in 1994[4], to restore this system are gaining some progress but at a slow rate and not without many hurdles. The current discharge of water from Lake Okeechobee has already began to affect the biota of the Everglades.

Phosphorus is often a limiting nutrient in agriculture and is added to many fertilizers to improve crop yield. Phosphorus is usually present in both organic and inorganic forms. The abundance of each depends of many different factors such as vegetation, soil, and even the surrounding land use. The objective of the STAs is to reduce the phosphorus load downstream to the WCAs'. This study confirmed the relationship between dissolved oxygen relative to water temperature as well as an understanding for spatial phosphorus concentrations. Conservation area-3a is proven to be a sink for nutrients as clear inflows and outflows are defined in this study by a decreasing phosphorous concentration across the wetland. Despite the increasing phosphorus load placed on the WCAs' from Lake Okeechobee water releases, sampled areas were measuring at 10-12 ppb. More recently, SFWMD has measured phosphorus concentrations as high as 20-23ppb. Since the water releases have ceased, it is expected that the high phosphorus concentrations will soon return to normal.

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