Turbidity levels at the S-5A Pump Station along the West Palm Beach Canal from 1995-2014

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Introduction

The Florida Everglades is a unique ecosystem in decline. The formation of the Everglades occurred over 5,000 years, but in one century, mankind has reduced it in size by half (SKLAR & FONTAINE 2012). Beyond the spatial loss, the biotic element of the remaining Everglades is also in jeopardy due to adverse changes in water quality and water quantity (ENTRY & GOTTLIEB 2014). The Everglades is characterized as an oligotrophic system whereby fauna and flora have adapted to extremely low levels of nutrients (ENTRY & GOTTLIEB 2014). Minute increases in nutrient availability can alter the form and function of the entire ecosystem (GAISER ET AL. 2011). Nutrient loaded water, originating from urban and agricultural sources, ultimately flows into the Everglades; this influx of nutrients disrupts the historical balance of the ecosystem, including the conversion of sawgrass stands into cattail and the obliteration of periphyton mats (ENTRY & GOTTLIEB 2014). The Comprehensive Everglades Restoration Plan, approved by both the United States Congress and Florida legislature in 2000, outlined new restoration efforts with the focal point on identifying historical hydrological needs of the Everglades (SKLAR & FONTAINE 2012). To accomplish restoration while sustaining urban and agricultural demands, a two tier approach was implemented. First, six constructed wetlands called stormwater treatment areas (STAs) were created north of the Everglades to reduce nutrients and improve water quality (ENTRY & GOTTLIEB 2014). Water flows downstream from Lake Okeechobee through the Everglades Agricultural Area (EAA) and then is diverted to one or more of the STAs (ENTRY & GOTTLIEB 2014). The STAs are engineered to remove nutrients by cycling stormwater through various cells which contain emergent vegetation and submerged aquatic vegetation (ENTRY & GOTTLIEB 2014). Constructed wetlands have been proven to treat all kinds of wastewaters including those serving industrial and agricultural functions (Vymazal & Kropfelova 2008). Second, best management practices (BMPs) were implemented by the agricultural industry to address water quality issues related to erosion and the application of pesticides and fertilizers (Centner et al. 1999).A typical BMP may consist of onsite activities such as implementing erosion controls to limit runoff, timing farm field fertilizer applications so plants are better able to uptake applied fertilizers, and improved recordkeeping as well as the implementation of more thorough offsite water quality measures which include filter strips and riparian buffers (Ribaudo & Joansson 2007). The combination of STAs and BMPs activities led to a large initial decline in nutrient concentrations entering the Everglades from 2005 to 2011 (Entry & Gottlieb 2014). In order to maintain this downward trend, the health and composition of STAs must be top priority for research.

Water with relatively high levels of nutrients from Lake Okeechobee is delivered to six STAs via four major canals (Vedwan et al. 2008). One of these canals, the West Palm Beach Canal (WPBC), was the main focus of this paper (Figure 1), and it is the main source of water delivered to STA-1W and STA-1E. Nutrient-laden water not only disrupts the Everglades ecosystem but correlates to high levels of turbidity which adversely affects the STAs (Curl 1959). Turbidity impacts aquatic plants negatively by affecting primary productivity (Oregon Department of Environmental Quality). To ensure the structure and composition of the STAs are functioning to improve water quality, turbidity must be evaluated before water is pumped into each cell. The S-5A pump station (Figure 1) is the main link between the WPBC and STA 1 E/W. The purpose of this research is to study turbidity levels at the headwaters of the S-5A pump station. The research spans a period of two decades from 1995-2014 and aims to determine if BMPs have reduced nutrients and with it, turbidity in the WPBC. Again, the BMPs are designed to decrease nutrient concentrations in water transported to the STAs, and they should continue to decline in the future if they are working effectively (Entry & Gottlieb 2014). It is hopeful that as BMPs are instituted throughout the EAA, water quality will improve and with it the Everglades ecosystem.

Methods

Site Description

The WPBC was dug in the early 1900s to drain Lake Okeechobee and the Everglades in order to farm the land (The South Florida Water Management District). Today, the WPBC serves as a flood control conveyance system for the EAA (The South Florida Water Management District). The WPBC starts in the town of Canal Point at the S-352 pump station. It runs southeast approximately 32 km (20 miles) and ends at the S-5A pump station, which discharges into STA-1 W/E. Water quality collection and analysis occurs at the headwater, or north section, of the S-5A station.

Data Characterization

Water quality data was obtained from DBHYDRO, the South Florida Water Management District's corporate environmental database, which stores hydrologic, meteorologic, and hydrogeologic data. Turbidity samples were collected monthly; however, if the S-5A pump station was activated, samples were collected biweekly. Field technicians and lab personnel followed the standard operating procedures outlined under the Environmental Protection Agency's' Method 180.1 - *Determination of Turbidity by Nephelometry*.

Statistical Analysis

Turbidity measurements obtained from January 1995 to December 2014 at the S-5A and were exported from DBHYDRO. Quality control datasets such as equipment blanks, field blanks, and replicate samples were removed prior to statistical analysis. A Two-Tailed T-Test was implemented assuming unequal variances. The first dataset included turbidity measurements from 1995-2004, and the second set was turbidity measurements from 2005-2014, with a 95% confidence level.

Results

Turbidity levels at the S-5A station have been decreasing over the two decade period as depicted by linear regression (Figure 2). The decade from 2005 through 2014 (μ = 10.17 NTU) had lower turbidity measurements than the decade from 1995 through 2004 (μ = 14.27 NTU) (Figure 3). The Two-Tailed T-Test conducted proved a significant difference between both decades indicated by the P ($T \leq t$) one-tail and P ($T \leq t$) two-tail values, which were less than alpha (0.05).

Discussion

The results illustrate a decrease in turbidity at the S-5A pump station over two decades and confirm a significant difference between the periods 1995 - 2004 from 2005 - 2014. These findings provide evidence that BMPs are effective in reducing nutrient loading, which in turn, improves water quality. The scope of this research was limited to one major canal, the WPBC, future studies will be necessary at other important discharge locations throughout the EAA to fully understand the positive impact of BMPs.

South Florida is home to approximately 6.5 million people, the region is projected to expand by 26% to 8.2 million people by 2020 (VEDWAN ET AL. 2008). Between 1950 and 2000 agricultural land increased from 9.5 to 27.8%, these changes in population and land use have had significant impacts resulting in an overall decline in water quality and a reduction in lands in their natural state (VEDWAN ET AL. 2008). Achieving restoration in the Everglades while maintaining agricultural and urban systems is the subject of intense debate and the focal point of major scientific and engineering programs (SKLAR & FONTAINE 2012). The efficacy of the STAs and BMPs must continue to be improved while alternative technology and land use options are explored; the future of the Everglades depends on it.

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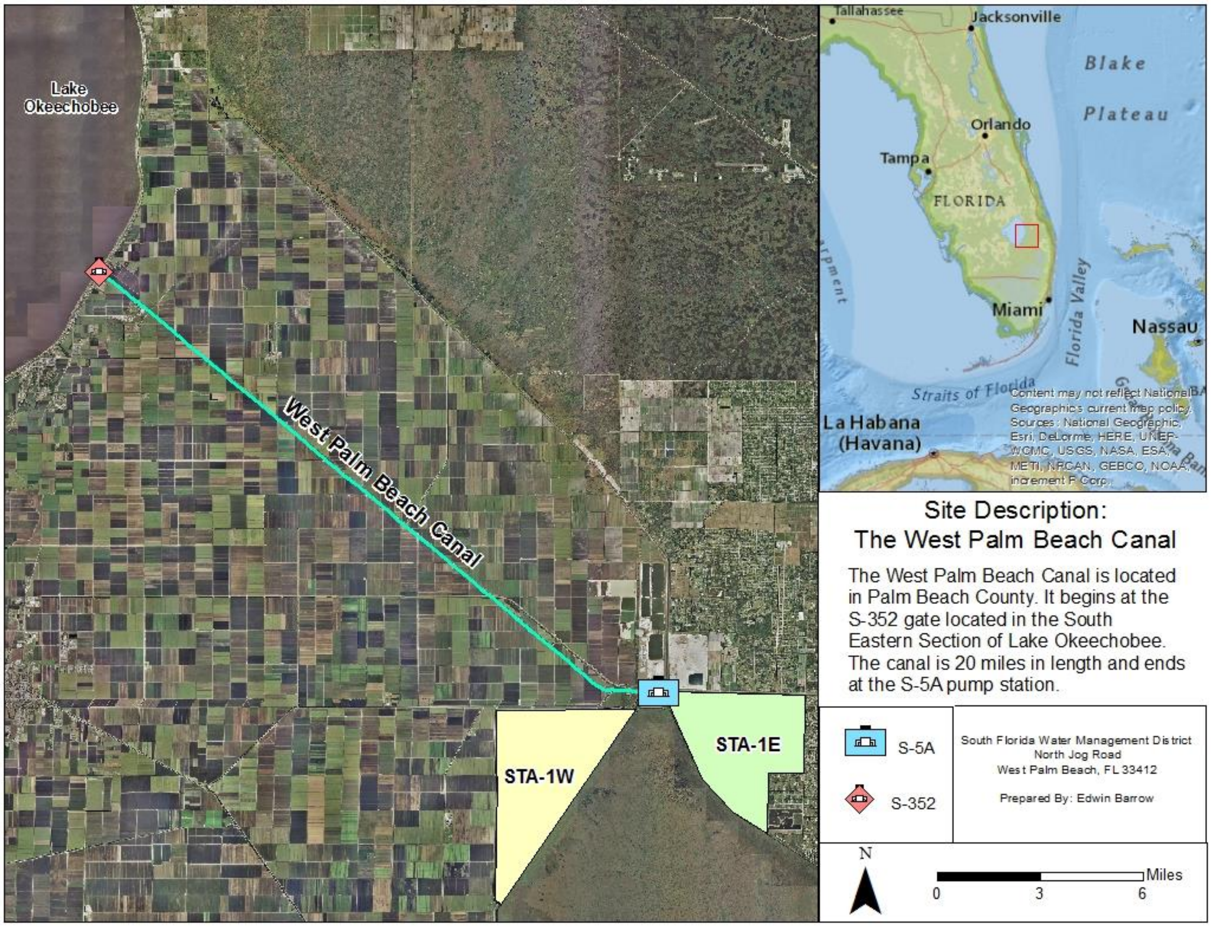

Figure 1. A site description of the West Palm Beach Canal and its corresponding pump stations as it relates to the stormwater treatment areas.

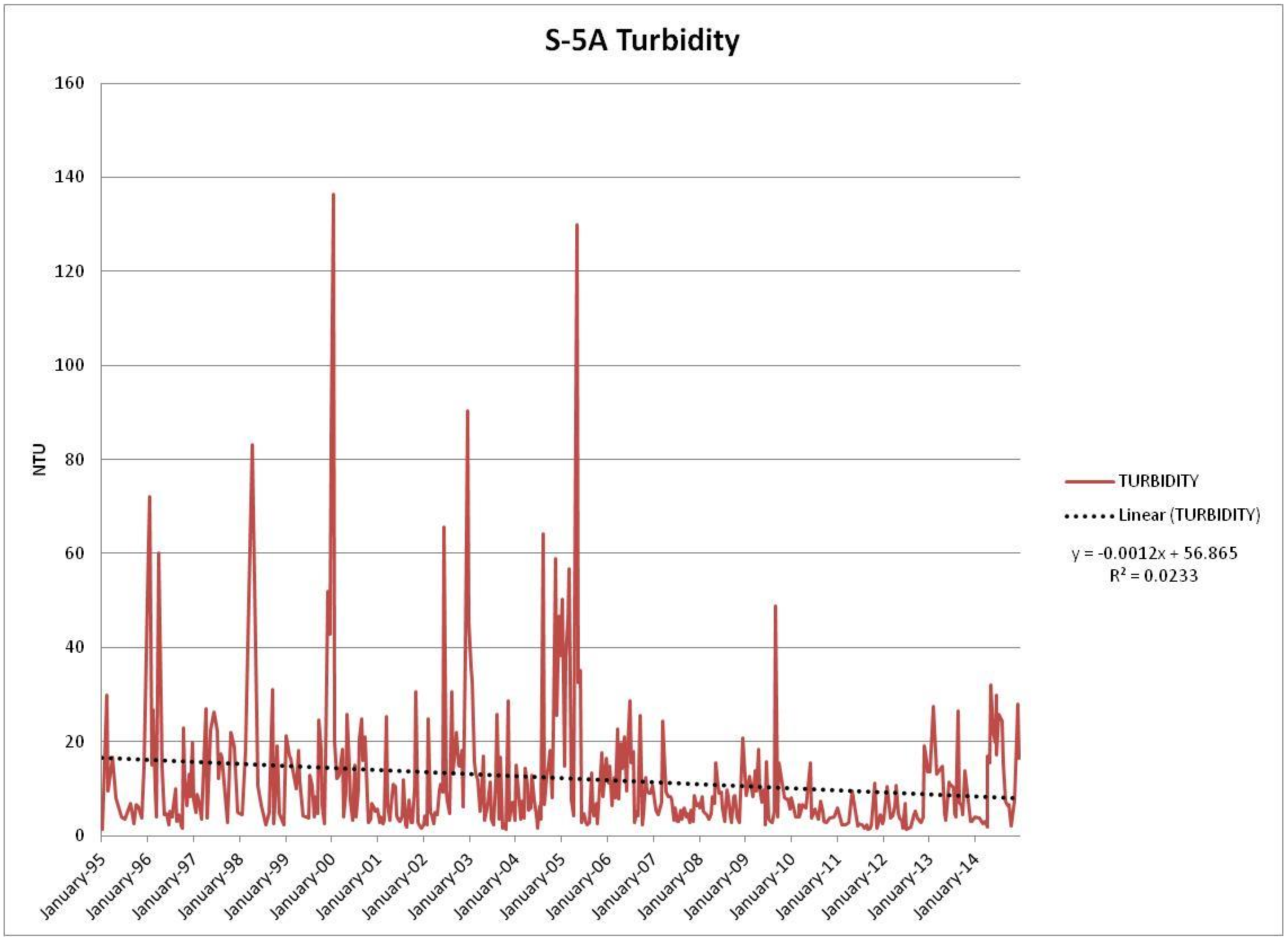

Figure 2. Turbidity levels each year at the S-5A pump station recorded in Nephelometric Turbidity Units (NTU). Samples were collected at the headwaters of the station by SFWMD environmental technicians.

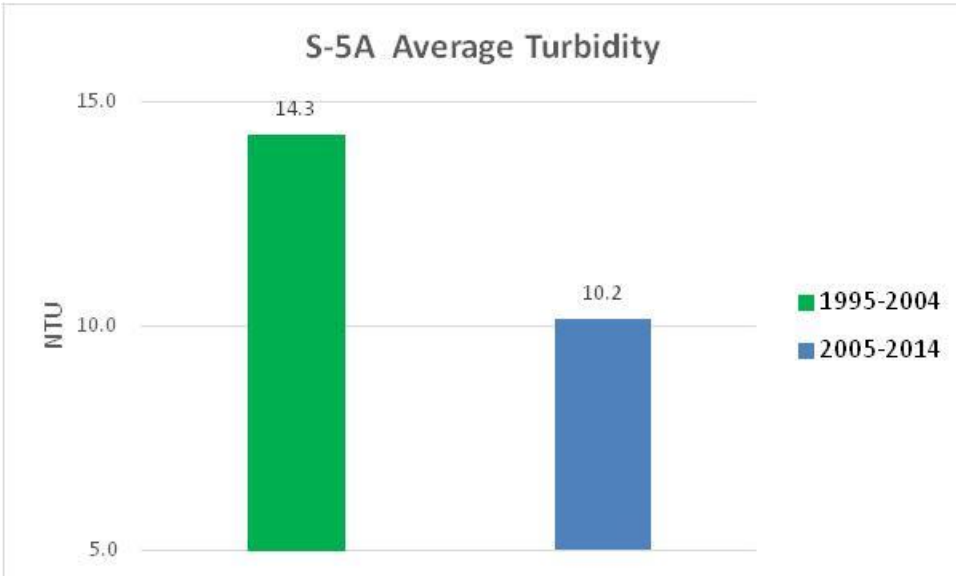

Figure 3. Average turbidity levels by decade at the S-5A pump station. The green column represents 1995 through 2004 and the blue column depicts 2005 through 2014.