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Long-term (11 years) study of water balance, flushing times and water chemistry of a coastal wetland undergoing restoration, Everglades, Florida, USA

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ABSTRACT

Upstream water diversions have significantly reduced freshwater flow to coastal wetlands of the Everglades. The purpose of this research was to investigate the water balance, flushing time, and water chemistry of Taylor Slough; one of the main natural waterways of the coastal Everglades, during its early stages of restoration. Both the water balance and flushing times were calculated on a monthly basis from 2001 to 2011. Surface water chemistry was analyzed using 3-day composite samples collected every 18 h. Current restoration efforts have been able to increase surface water inputs to southern Taylor Slough, but rainfall was still the dominant water input. Flushing times varied between 3 and 78 days, with the highest values occurring in December and the lowest in May. Flushing times were negatively correlated with evapotranspiration (*ET*), but were longer when surface water volume exceeded *ET* and shorter when *ET* exceeded water volume. Surface water concentrations of calcium and chloride along with total nitrogen and total phosphorus were negatively correlated with flushing times. The results herein suggest that in coastal wetlands with low quantities of surface water inputs, *ET* and surface water volume influenced by rainfall are the most dominant factors influencing flushing times and water chemistry. Increased surface water inflows with additional restoration efforts would be expected to increase surface water volumes into southern Taylor Slough, thereby increasing flushing times and decreasing ion and nutrient concentrations.

1. Introduction

Since drainage first began in the 1880s, urbanization and water management practices have altered the natural flow of the Everglades with most cases resulting in a decrease of water flow across the system (Fennema et al., 1994). Efforts to improve the condition of the Everglades have progressed slowly since the passage of the Comprehensive Everglades Restoration Plan (CERP) in 2000, which includes approximately 60 projects that are to be constructed in the following 30 years (Sklar et al., 1999). One of the main goals of CERP is to increase freshwater flow into Florida Bay through its main contributor, Taylor Slough (Sklar et al., 1999). Demands for flood control in areas east of ENP have created a difference in water levels between canals bordering the park and lands east of the park resulting in water seeping out of the Everglades (Harvey and McCormick, 2009; Sullivan et al., 2013). Several restoration projects were completed in 2001 with the aim of increasing surface water flows into Taylor Slough, and include raising and lengthening of Taylor Slough Bridge (TSB) and the completion of the S332 detention basins with additional pump stations (Surratt et al., 2012; Sullivan et al., 2013) in the northern portion of Taylor Slough (Fig. 1). Given that most of the additional water to be diverted into Taylor Slough is from canals (L-31N; L-31W) that border agricultural areas, there is concern that the additional water will also deliver ions and nutrients, particularly nitrogen and phosphorus into what has historically been an oligotrophic wetland. Earlier studies have determined that the dominant sources of phosphorus into Taylor Slough were from atmospheric deposition (Sutula et al., 2001), and marine sources (Childers et al., 2006) including brackish groundwater discharge (Price et al., 2006; Koch et al., 2012). However, ecosystem level changes in northern Taylor Slough, such as the emergence of cattail (*Typha domingensis*; Surratt et al., 2012) and loss of periphyton biomass (Gaiser et al., 2013) suggest nutrient enrichment has been taking place in response to restoration efforts (Sullivan et al., 2013).

Previous hydrologic studies of southern Taylor Slough were limited either in time to ~1.5 years (Sutula et al., 2001; Zapata-Rios and Price, 2012) or in spatial domain (Koch et al., 2012; Michot et al., 2011). The aim of this current study is to investigate the long-term (11 years) effects of restoration on the water balance, flushing time, and water

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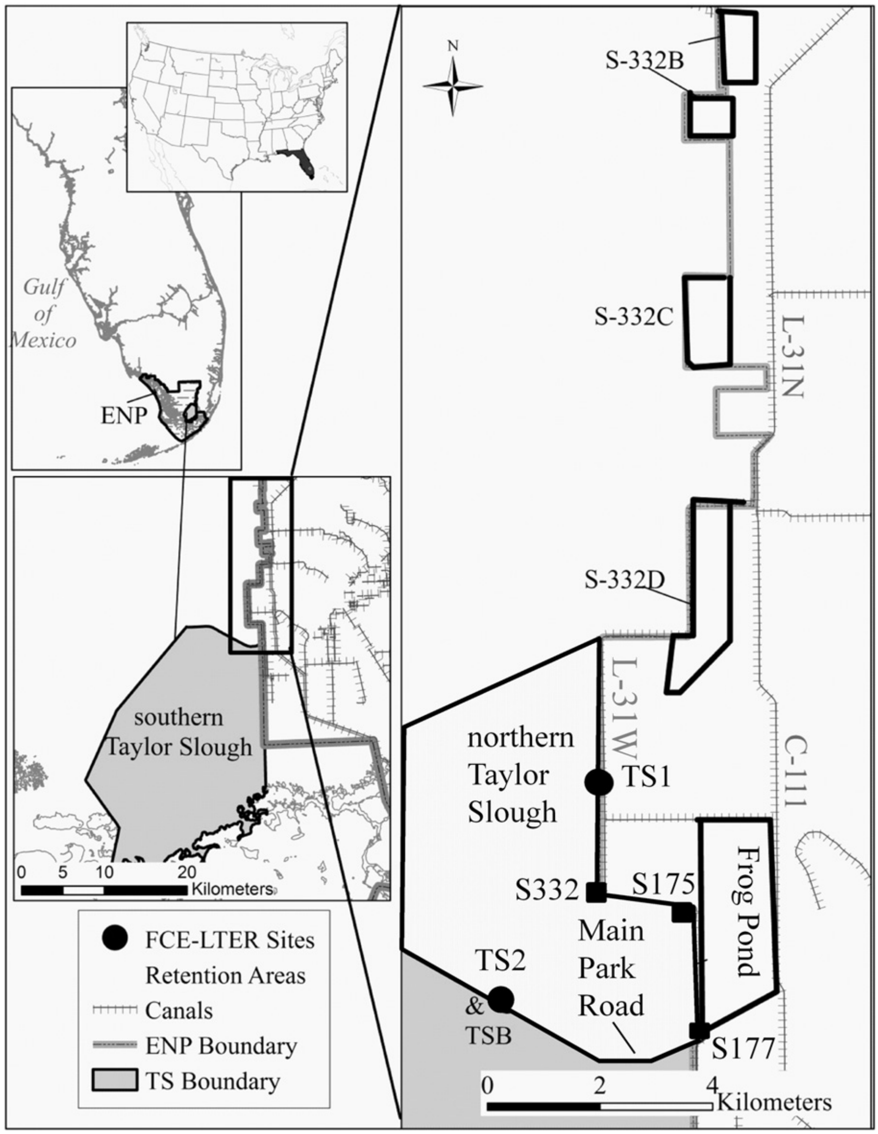

Fig. 1. Location of southern Taylor Slough with an inset of the area in northern Taylor Slough where the S332 detention areas and Taylor Slough Bridge (TSB) restoration projects have been completed.

chemistry of all of southern Taylor Slough. Understanding past and present hydrological and geochemical conditions of Taylor Slough will not only give insight to the success of current and future restoration efforts, but may also provide an understanding of how other variables such as climate change and sea level rise may affect the study area. Specific objectives of this research are to: (1) determine the water balance and water flushing time of southern Taylor Slough from 2001 to 2011, and (2) observe possible correlations between flushing times, surface water chemistry, and nutrient data. The work performed herein, will help improve understanding of Taylor Slough's hydrologic components in response to restoration efforts. Understanding the hydrologic conditions of a wetland ecosystem is also important for discerning other important variables such as productivity, organic matter accumulation, nutrient cycling and transport to name a few (Sutula et al., 2001).

2. Site description

Taylor Slough is the smaller of the two main natural waterways situated in the Everglades, and discharges into Florida Bay. Taylor Slough extends approximately 20–30 km from the northern end along the northeastern boundary of ENP down to Florida Bay (Fig. 2) (Armentano et al., 2006; Zapata-Rios, 2009). The area has wet (June–October) and dry (November–May) rainfall seasons. The headwaters begin at the L-31W canal (Fig. 1). Construction of the L-31W canal in the late 1960s reduced the natural flow of water into Taylor Slough (Kotun and Renshaw, 2014), with the S332D pump station now being the major contributor of water flow to northern Taylor Slough. The Main Park Road physically divides the northern and southern regions of Taylor Slough (Fig. 1). The southern region encompasses the largest area and is the focus of this work. Southern Taylor Slough covers an area of 446 km^2 and is bounded by the Main Park Road to the north, the L-31W canal to the east, the Buttonwood Embankment boarding Florida Bay to the south, and a slightly elevated topographic border to the west (Zapata-Rios and Price, 2012; Fig. 2). Taylor Slough surface water from the north flows south beneath the Main Park Road through the Taylor Slough Bridge (TSB) as well as a number of culverts under the road. The C-111 canal, as indicated by water flows