National Park Service
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South Florida Natural Resources Center
Everglades National Park

S-332 Detention Basins: Understanding Phosphorus Transport into Everglades National Park

Background

A series of detention basins was constructed in the late 1990s by the U.S. Army Corps of Engineers along the eastern boundary of Everglades National Park, just north of Taylor Slough, to control seepage from the park into the L-31N and C-111 canals (Fig. 1). Water from the L-31N canal is pumped into these detention basins to create a hydrologic ridge that minimizes surface water and groundwater flow leaving the park. A major concern for the park in this area is the fate and transport of total phosphorus (TP) due to the operational management of the detention basins. The main source of water and TP is the L-31N canal from which water is pumped into the S-332B-N, S-332B-W, S-332C, and S-332D series of detention basins (Fig. 1). This TP may move westerly or southwesterly downstream into Taylor Slough and may cause nutrient enrichment in the park.

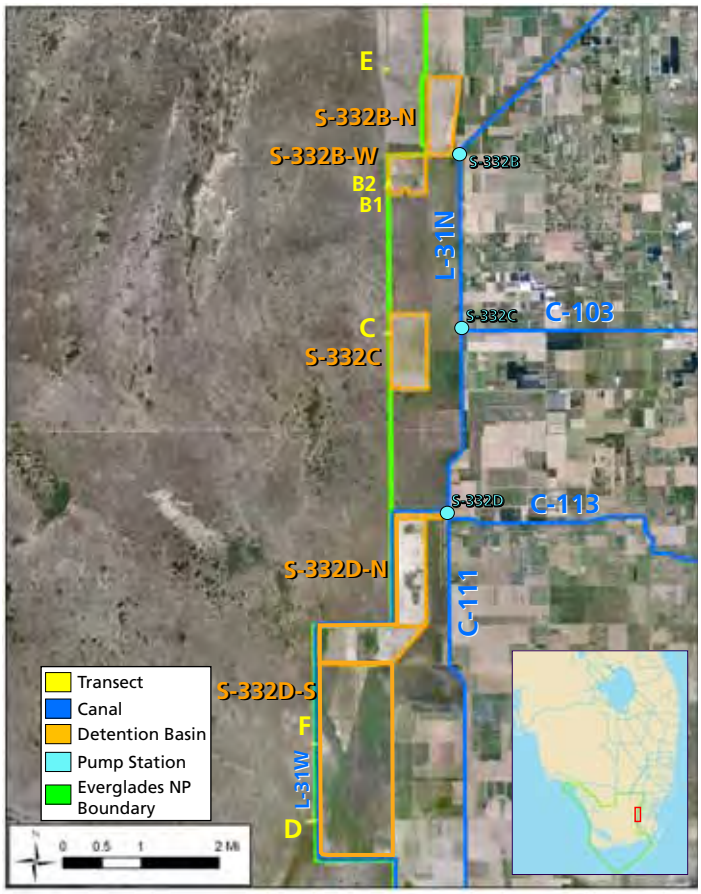

Figure 1. S-332 detention basins, as configured in 2007, and monitoring transects.

Project Objectives

The purpose of this project was to determine TP retention and subsurface movement in the S-332 detention basins. During the 3-year project, measurements of biomass and phosphorus in biota, water, and soils in the detention basins were recorded before and during the wet seasons. Groundwater quality was measured throughout the year. Combined with hydrologic information, these data were used to estimate an annual TP budget for the basins in order to analyze TP retention in the basins and possible TP incursions into the park. Specific tasks included:

- Determine the amount of TP within the S-332 detention basins.
- Evaluate water quality and community composition on transects in the park at the outfall of basins.
- Construct a TP fate and transport model for the surface-water / shallow groundwater system.

Key Findings & Management Implications

In the first wet season survey in 2005, producers were grouped into three broad categories of emergent macrophyte, submersed aquatic vegetation (SAV), and periphyton. Microtopographic variation within basins produced patchy distributions with stands either dominated by periphyton or by macrophyte. Plant-dominated plots contained 200-300 g/m^2 of plant material on a dry-weight basis (dwb), with the highest values in basins C and D-N. These values were somewhat low compared to values obtained from the natural marl prairie, probably because of differences in successional age. Plant communities were dominated by an abundance of cattails (*Typha domingensis*) with a mixed variety of subdominants including annual water aster (*Aster subulatus*), duck potato (*Sagittaria lancifolia*), and red ludwigia (*Ludwigia repens*). Periphyton plots contained a mix of periphyton and SAV, together accounting for about 200-400 g/m^2 on a dwb. The periphyton biomass and SAV biomass were highest in basin C, with the SAV biomass being dominated by smooth water hyssop (*Bacopa monnieri*), smallfruit primrose-willow (*Ludwigia microcarpa*), and muskgrass (*Chara sp.*).

Soils were generally shallow (0-6 cm) and were deepest in basin B. Water depths averaged 60-80 cm throughout the basins. Concentrations of TP in water were low in basins B-N, B-W, and D-N (5-6 µg/L) and were somewhat high in basin C (7-15 µg/L). The TP concentration in soil was less than 500 µg/g (soils with TP >

500 μg/g are considered impacted) in basins B-W and D-N but ranged from 510-1,200 μg/g in basins B-N and C. TP concentrations in periphyton averaged 280 μg/g throughout the basins, which was high relative to concentrations in the adjacent marl prairie. The highest concentrations were observed near the water source (inlet) in basin B-W. On a mass per area basis, soils contained the majority (98%) of the TP in the system, ranging from 15-25 g/m^2. In different basins, TP, when correlated with biomass and soil depth, had a positive relationship.

Drought conditions combined with minimal water deliveries during the wet season of 2006 caused the basins to be entirely dry for the extent of the wet season, which reduced the TP input from pumping operations. The lack of water reduced periphyton cover and biomass to less than a quarter of values observed in 2005. SAV was entirely absent and emergent vegetation increased in density by 3-5 times in all of the basins. TP content in the plants and periphyton did not differ among years but the plant component contributed a greater proportion to the TP budget in 2006 than in 2005. Soils were shallower in 2006 than 2005 owing to less water input and compaction due to drying, and the concentration of TP in soil was also lower in 2006 than 2005.

During 2007, which was another dry year with minimal water deliveries to the basins, values of all the parameters were similar to those in 2006. Soil compaction continued, and concentrations of TP in soils did not significantly increase. A final sampling in the early wet season of 2008 showed increased water levels at some sites, but overall a similar pattern in vegetation, periphyton, and soils to those observed in previous dry years.

Groundwater levels indicated that the direction of groundwater flow is predominantly east and southeast away from the park. TP concentrations were highest in groundwater during winter when little or no water is pumped into the basins. The times of high TP concentration in groundwater tended to occur in response to rain events, which in general were short-lived. From 2006 through 2008, the concentrations of TP in the groundwater within the basins seemed to reach a stable concentration of less than 20 μg/L.

Nutrient enrichment tens of meters into the park was evident on all field transects. Nutrient gradients expanded into the park over time, consistent with observed ongoing periphyton enrichment. The data from periphyton and vascular plant tissues demonstrated some interannual variability in TP concentrations in tissue, which is probably related to the amount of water in the system each year and to the duration of pumping into the detention basins.

A three-dimensional groundwater/surface-water flow and solute-transport model was developed by HydroGeoLogic (2010) to investigate the groundwater flow patterns and TP transport in and around the detention basins in response to pumping operations and natural climatic conditions. The model results showed that most of the water and its associated TP that entered the basins via either pumping or rainfall tended to leave the basins as groundwater flowing in an easterly direction toward the L-31N and C-111 canals, with the remaining water and its associated TP migrating westward into park. The westerly groundwater flow and TP migration from detention basins tended to be episodic when heavy precipitation coincided with high pumping rates. Such typical episodic events indicated that nutrient enrichment of the park from canal discharges into the basin may potentially extend several thousand feet westward.

Aerial view, looking north, of ponded detention basins. Photo by Lori Oberhofer, NPS.

Recommendations for Future Studies

Episodic water and TP incursions westward into the park from detention basins may potentially be causing nutrient enrichment in park boundary regions. Further research is needed including:

- Monitoring of soil, water, and biota to investigate the incursions and the associated impact on the park.
- Modeling of water and TP transport to quantify the impact of incursions and manage detention basins to minimize the impacts.

References

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For additional information visit:
www.nps.gov/ever/naturescience/cesiwq1.htm

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