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National Park Service
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South Florida Natural Resources Center
Everglades National Park

Indicators of Ecosystem Response to Hydrologic and Nutrient Change in Northeast Shark River Slough

Background

The Tamiami Trail (U. S. Highway 41), completed in 1928 and running east-west across the southern tip of the Florida peninsula, is one of the primary barriers to the southerly flow of water through the Everglades ecosystem. In addition to reducing historic flow volumes to Everglades National Park by approximately 65 percent, the roadway has also altered the distribution of flow within the Shark River Slough basin. Prior to the existence of the roadway and various elements of the Central and Southern Florida water management project (including 1800 miles of canals and levees and 200 water control structures), 60 percent of average annual flows to the park ran through the eastern section of the slough, known as Northeast Shark River Slough (NESRS), with the remaining 40 percent moving through the western portion of the basin. This distribution is now completely reversed and the change has resulted in dramatic alterations to the landscape. Past studies have shown that water levels are now lower and flooding durations (hydroperiods) shorter in NESRS, while western Shark River Slough now experiences wetter conditions. The open, deep-water slough habitat that once defined the NESRS system has been replaced by shallow waters filled with a monoculture of sawgrass, intermixed with wet prairie grassland and tree islands. Recognition that these ecological changes within the park are unnatural has led to restoration efforts focused on Tamiami Trail. Construction has recently begun on a 1-mile bridge in the roadway at the eastern edge of the NESRS area. An additional 5.5 miles of bridging has been proposed by the National Park Service for the purpose of eliminating hydrologic constraints to the flow of water into NESRS.

Project Objectives

In anticipation of current and future Tamiami Trail modifications, the objective of this project was to establish a network of permanent monitoring sites across existing hydroperiods and nutrient gradients in NESRS. Data collected at the monitoring sites were used to characterize the biogeochemistry of soils and water in the study area and the ecology of the floral and faunal communities, in order to:

• relate the distribution of biota to current variations in hydroperiods, water quality, and soil geochemistry.

• select ecological response indicators that will allow detection of ecosystem change on appropriate temporal and spatial scales as greater volumes of water enter into NESRS as a result of restoration projects.

Key Findings & Management Implications

Thirty permanent sites for ecological monitoring were established in 2006 and sampled for water, vegetation, periphyton (a mixture of algae, cyanobacteria, and other micro-organisms), soils, and consumers (e.g., fish, crayfish) during the wet seasons of 2006, 2007, and 2008. Surveys indicated effects of diminished flow of water into the northern and eastern boundaries of NESRS and elevated total phosphorus (TP) concentrations at sites closest to Tamiami Trail. Water depths were most shallow in the southeastern region of the study area. The TP concentration of the water column averaged 9 μg/L in NESRS; however, sites along the northern boundary were enriched above this characteristically low ambient concentration. The TP concentrations in soil averaged 210 μg/g, however, higher values were observed in the 0-2 cm surface layer in the northeastern portion of NESRS (Fig. 1).

Periphyton cover and volume were high, averaging 70 percent and 3000 ml/m^2, respectively. Periphyton was most abundant in the wetter northeastern and western regions of the study area and sparsest in the driest sites along the southeastern boundary. TP concentrations in periphyton averaged 150 μg/g. Higher eutrophic TP levels (>200 μg/g) were observed in periphyton at three sites on the northwestern edge of NESRS, exhibiting strong and consistent relationships to water depth and phosphorus availability.

The plant communities in the study area were found to consist of a mix of slough and wet prairie taxa, with the former occurring predominantly along the deeper western edge of NESRS and the latter along the southeastern boundary. Spikerush (*Eleocharis* spp.) dominates the slough habitat. The TP concentrations in plants resembled spatial patterns similar to those in soils, with the highest values occurring along the northern boundary of NESRS.

A total of 59 species of aquatic consumers was observed. Densities and species richness increased with water depth and the organic content and TP concentration of periphyton. Only a small proportion of the total fishes captured consisted of exotic species. This proportion may increase however when greater hydrologic connectivity to upstream water conservation areas is established through Tamiami Trail modifications.

The most sensitive indicators of ecosystem response to water depth were found to be soil depth, plant species composition, and consumer density while the most sensitive response indicators of phosphorus enrichment were the organic content of periphyton, plant biomass, and consumer biomass and species composition.

Intensive monitoring was conducted three times a year during the last two years of the study on a subset of eight sites in order to capture any seasonal variation. Four of these sentinel sites were located immediately downstream (south) of Tamiami Trail and the remaining sites were located 1 to 2 km farther downstream. The seasonal sampling revealed higher TP concentrations in the water column at some sites during the dry season, likely caused by higher than normal evapotranspiration rates. Periphyton mass and abundance declined after the first year of sampling in response to a decrease in water depth during this period. Plant density was highest at all sites between July and December (wet season) and lowest between January and June (dry season). No significant seasonal trends in fish abundance, biomass, or richness were observed, although a wet season peak in these parameters did occur in 2007 at most sites, followed by a smaller wet season peak in 2008.

This project also revealed a strong direct response of periphyton organic content and TP concentration to hydrologic and water quality drivers. These occurred simultaneously with changes in vegetation TP content and composition, and consumer community composition and density, relative to changes in these two drivers. These linkages are not only direct but are reinforced through food-web and behavioral interactions, as well as longer-term cascading effects that should be considered when projecting the impacts of hydrologic modifications. An assessment of the entire community (abiotic components, micro- and macro-producers [i.e., plants], and consumers) provides the most robust prediction of change in response to inter-dependencies among ecosystem attributes.

With restoration projects now underway, there is an increased need for an established ecological monitoring protocol in NESRS. The sites sampled in this project, particularly those along the northern boundary of Everglades National Park, provide a spatial network to examine potential impacts resulting from hydrologic modifications. Although sites sampled in the park interior did not indicate nutrient enrichment, increased water deliveries into NESRS from the water conservation areas to the north may increase nutrient levels at these interior locations in the future.

Recommendations for Future Studies

This project provides baseline composite data for NESRS prior to the implementation of restoration projects that are expected to alter the hydrologic regime and that may affect water quality parameters. In order to detect ecological response in NESRS, monitoring needs to be conducted on a regular basis:

• annual, or at least triennial, surveys are needed to assess the effects of restoration projects.

• quarterly surveys of sentinel sites are needed to characterize background system-variability, as well as to monitor effects of restoration projects.

• additional continuous monitoring stations should be deployed on transects downstream of Tamiam Trail modification projects to determine patterns of change in water quality and flow, and biological responses.

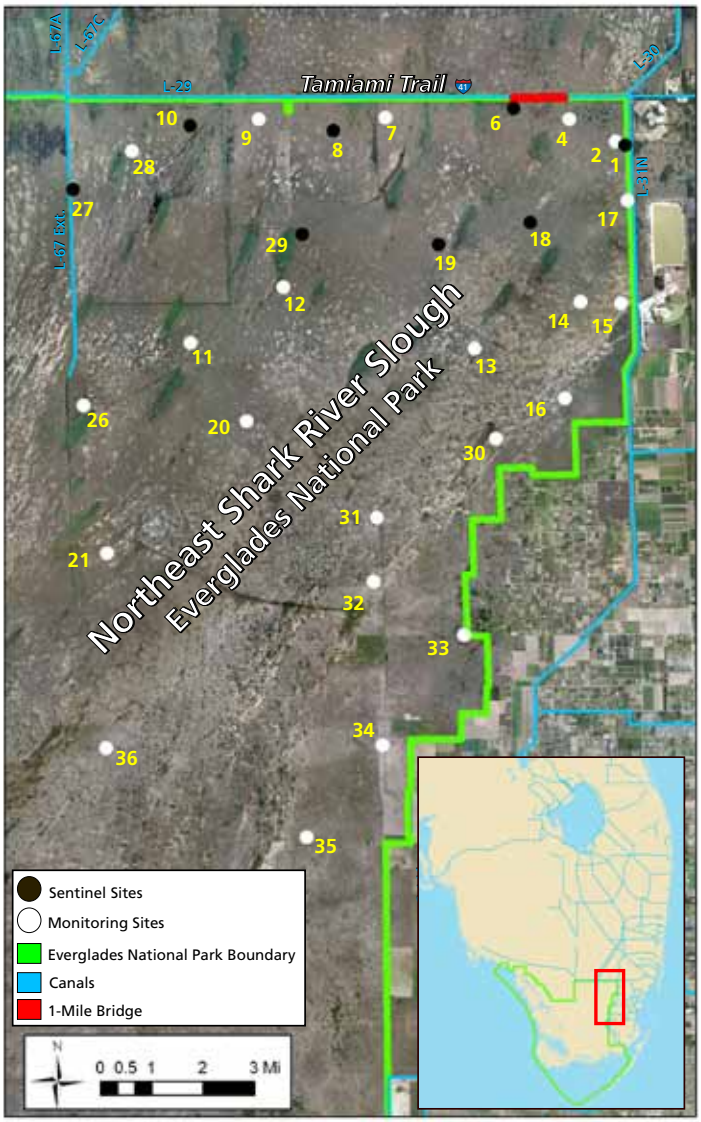

Figure 1. Distribution of monitoring and sentinel sites in Northeast Shark River Slough, Everglades National Park.

References

Gaiser, E. E., L. J. Scinto, J. C. Trexler, D. Johnson and F. Tobias. 2009. Developing ecosystem response indicators to hydrologic and nutrient modifications in northeast Shark River Slough, Everglades National Park. Final Report to Everglades National Park, Cooperative Agreement #H5297-05-0099, May 30, 2009.

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