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Research Brief

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PHOSPHORUS REMOVAL AND SOIL STABILITY WITHIN EMERGENT AND SUBMERGED VEGETATION COMMUNITIES IN TREATMENT WETLANDS

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Phosphorus (P) removal by treatment wetlands is an integral part of Everglades protection and restoration. In south Florida, nearly 20,000 hectares of treatment wetlands, termed Stormwater Treatment Areas (STAs), have been or are being constructed on former agricultural lands to reduce P loads carried by agricultural drainage waters (Figure 1). These waters drain the Everglades Agricultural Area, a 200,000-acre region of drained Everglades muck soils that is currently in sugarcane, winter vegetable and sod production. Flow-through operation of STAs has reduced P concentrations in drainage waters since 1994, however further refinements of the treatment wetland technology are necessary to achieve outflow total P concentrations of 10 μg L^{-1} . These low P levels are required to protect Everglades marshes from excessive P loads and eutrophication.

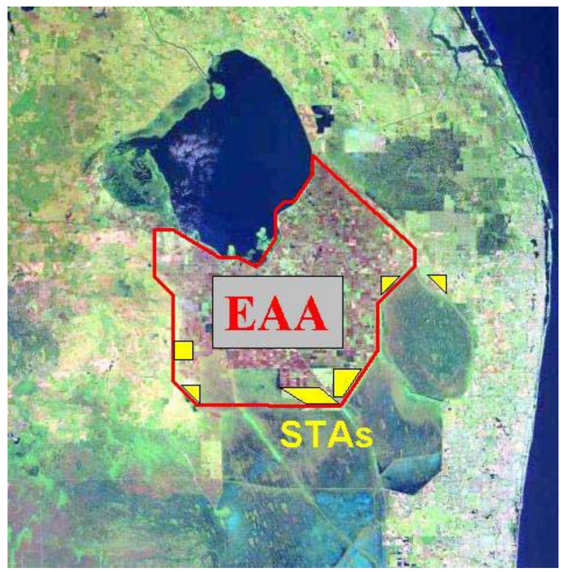

Figure 1. The Everglades Agricultural Area (EAA), and Stormwater Treatment Areas (STA) which remove phosphorus from stormwater runoff prior to discharge into the Everglades.

Performance objectives for the STAs include achieving low surface water total P (TP) concentrations and forming stable P pools in newly accrued wetland soils. The effects of water column shading by emergent (cattails, *Typha* spp.) and submerged (*Najas guadalupensis*) vegetation communities on P cycling and retention were explored in STA-1W, which was constructed in 1993. The physicochemical aquatic environments within these two vegetation communities were hypothesized to differentially affect community metabolism, which in turn would affect biological P uptake rates and P stability in accrued soils.

Muck soils beneath emergent aquatic vegetation (EAV) were P-depleted over eight years of operation in STA-1W, while the muck soils beneath submerged aquatic vegetation (SAV) beds were P-enriched. An extensive cattail root system can hinder long-term P storage by mobilizing P from enriched soils, which may have reduced P concentrations in the muck soils buried beneath EAV. The stability of P within newly accrued soils (Figure 2) was also dependent on plant community type. Soils (0-4 cm layer) in SAV communities contained significantly more P in "stable" pools (residual organic, Ca/Mg-bound and fulvic/humic acid-bound P forms) than soils in EAV. Precipitation of $CaCO_3$ from Everglades agricultural drainage waters is driven by SAV photosynthesis and may have enhanced soil P sorption. Because of similar pools of exchangeable P, however, the two soil types each released P to an oxygenated water column at similar flux rates. Vegetation type affected overall P accrual in new soils and composition of buried soils, but rates of P mobilization from the soil into the overlying water were similar between community types.

Figure 2. Newly-accrued wetland soil beneath emergent (*Typha*) vegetation in STA-1W, a treatment wetland.

Cattail biomass persists as leaf litter and detritus to a greater extent than *Najas* tissues. Dense EAV stands accumulate oxygen demand, reduce light penetration and can result in anaerobic conditions. Primary production by SAV resulted in higher water column community metabolism in those areas than shaded EAV areas. Using intact soil cores, cattail (*Typha*) litter and associated microbial biomass retained P mineralized from soils under aerobic water column conditions (Figure 3). In soil-less litter incubations, however, P immobilization and retention was found to be much lower under anaerobic conditions than under aerobic conditions.

In summary, community metabolism was influenced by water column shading in EAV communities, which reduced water column $CaCO_3$ precipitation and Ca-bound soil-P pools, and reduced oxygen supply to microorganisms in that community. Managing for SAV and eliminating dense EAV stands from treatment wetlands may reduce surface water TP concentrations. Phosphorus-polluted areas within the northern Everglades may also be contained or restored by increasing light penetration to the water column, in order to enhance soil P sorption capacity through $CaCO_3$ precipitation and increase photo-synthetic oxygen supply to the aquatic microbial communities.

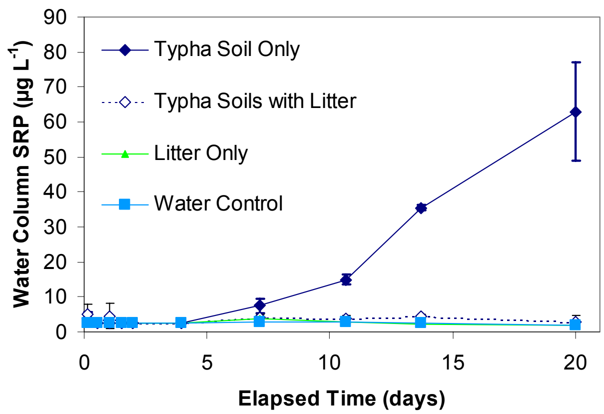

Figure 3. Soluble reactive phosphorus (SRP) concentrations in floodwater incubating above *Typha* soils, litter, soil and litter, or alone, under dark aerobic conditions for 20 days.

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