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Periphyton as a potential phosphorus sink in the Everglades Nutrient Removal Project

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ABSTRACT

Phosphorus uptake and release by periphyton mats were quantified in the Everglades Nutrient Removal Project (ENRP) to evaluate the potential for periphyton P removal. Short-term P uptake rates were determined by incubating cyanobacteria (*Oscillatoria princeps* and *Shizothrix calcicola*) and Chlorophycean (primarily *Rhizoclonium* spp.) algal mat samples for 0.5–2 h under ambient conditions in BOD bottles spiked with soluble reactive P (SRP). Cyanobacterial mats removed P more than twice as fast (80–164 $\mu g\,P\,h^{-1}\,g^{-1}$ AFDM) as Chlorophycean mats (33–61 $\mu g\,P\,h^{-1}\,g^{-1}$ AFDM) during these incubations. In a longer term study, fiberglass cylinders were used to enclose 1.8 m^2 plots within the wetland and were dosed weekly for 7 weeks with: (1) no nutrients; (2) SRP (0.25 $g\,P\,m^{-2}\,week^{-1}$); or (3) SRP plus nitrate (0.42 $g\,N\,m^{-2}\,week^{-1}$) and ammonium (0.83 $g\,N\,m^{-2}\,week^{-1}$). Phosphorus uptake rates by this periphyton assemblage, which was dominated by the chlorophytes *Stigeoclonium* spp. and *Oedogonium* spp., were measured weekly and were similar among nutrient treatments on most dates, indicating that the algal storage compartment for P was not saturated despite repeated P additions. Decomposition rates and P loss by cyanobacteria and Chlorophycean mats were determined by measuring biomass loss and SRP release in darkened BOD bottles over 28–42 day periods under anaerobic and aerobic conditions. First-order aerobic and anaerobic decomposition rates for cyanobacterial mats ($k = 0.1095$ and 0.1408 day^{-1}, respectively) were 4–20-fold higher than rates for Chlorophycean mats ($k = 0.0066$ and 0.0250 day^{-1}, respectively) and cyanobacteria released considerably more P back to the water column. Our findings suggest that periphyton can be an important short-term sink for P in treatment wetlands and that retention is strongly affected by the taxonomic composition of the periphyton assemblage.

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1. Introduction

Nutrient retention in freshwater wetlands is attributed to sediment accretion and chemical sorption processes (Nichols, 1983; Reed et al., 1995; Richardson et al., 1997; Reddy et al., 1999; Verhoeven and Meuleman, 1999). The principal biological mechanism for long-term phosphorus (P) removal is the accretion of macrophyte detritus in anoxic sediments with low mineralization rates (Richardson and Craft, 1993; Kadlec and Knight, 1996). While algal and microbial biomass has been acknowledged as a potentially important short-term sink for P in wetlands, the working assumption is that these biological compartments play a minor role in long-term P retention due to high turnover (e.g., decomposition)

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rates (Richardson and Craft, 1993; Richardson et al., 1997).

low chlorophyll a and soluble reactive P [SRP] concentrations (median values = 10 and 4 $\mu g\,L^{-1}$, respectively) and a history

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Page 1 / 11