

Synthesis of Phosphorus  
/Seston Fluxes and  
Phytoplankton Dynamics in  
Lake Pepin  
(Upper Mississippi River),  
1994-1996

By

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**ABSTRACT**

We examined overall water quality conditions, nutrient/seston fluxes, and phytoplankton dynamics in Lake Pepin, located on the Upper Mississippi River (UMR), during the years 1994-96. Our most prominent objective was to determine the relative importance of various external and internal sources of phosphorus (P) to the P economy and phytoplankton community of

Lake Pepin.

The Minnesota River accounted for most of the annual suspended seston (~81%), total phosphorus (~44%), and viable chlorophyll *a* (~46%) loads externally to the UMR. The Metropolitan Wastewater Treatment Plant (Metro Plant) dominated loading of soluble reactive phosphorus, accounting for ~45% of the annual load.

Lake Pepin retained, presumably as sediment, a substantial portion of the suspended seston load entering the UMR. It was also a sink for total P; however, net retention of P was much less both annual and seasonally (13 and 9%, respectively), than retention of suspended seston. A large portion of soluble P, which accounts for most of the total P mass, was flushed from the lake rather than retained as sediment or biomass. While total P concentrations generally declined in Lake Pepin from headwaters to outflow, soluble reactive P (SRP) exhibited a trend of increasing concentration from headwaters to outflow with net SRP export during the summer. These contrasting patterns in total and SRP suggested the occurrence of internal P loading and/or transformations in the water column of P from particulate to soluble phases.

Internal loading of phosphorus from profundal sediments, estimated from laboratory incubation systems



under different temperature and redox conditions, averaged  $\sim 7.5 \text{ mg m}^{-2} \text{ d}^{-1}$  during the summer under predominantly oxic conditions over all years. Although this oxic rate is high relative to other eutrophic lakes, it accounted for  $<15\%$  of both the external total P and SRP loads to Lake Pepin, and accounted for only a portion of the net SRP export from the lake during the summer.

Overall, the phytoplankton community did not appear to be limited in its growth by phosphorus, based on measurements of alkaline phosphatase activity. Alkaline phosphatase activity was extremely low, coincident with high concentrations of soluble reactive phosphorus  $> 50 \text{ mg/L}$  in the water column throughout the summer. Increases in viable chlorophyll *a* in the water column could be partially explained by the occurrence of temporary stratification, higher residence time, increased stability, and the storage of heat in the water column, suggesting that physical/hydrological factors were, in part, regulating phytoplankton biomass in Lake Pepin.

