

Historical Trends Affecting Accumulation of Sediment and Phosphorus in Lake Pepin

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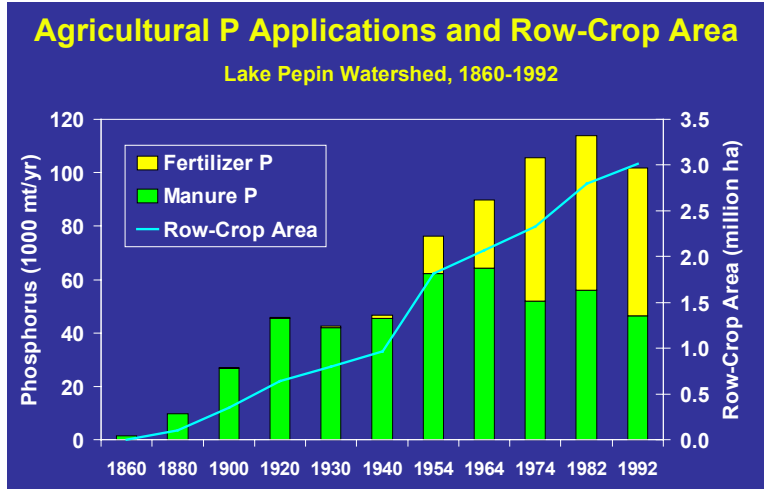


ABSTRACT

This study was conducted to collect historical land use information that would help explain the historical patterns in accumulation of sediment and phosphorus in Lake Pepin. Engstrom and Almendinger (2000) found that since 1830, sediment accumulations in Lake Pepin have increased more than ten fold, while phosphorus inflows to Lake Pepin have increased more than fifteen fold. A wide range of historical factors including cropping systems, phosphorus applications from fertilizer and manure, human and animal populations, river flows, and phosphorus discharges from wastewater treatment plants were studied using statistical methods. The results showed that sediment losses from the Minnesota River Basin are significantly correlated with historical increases in row-crop production acreage, river flows, and basin population. Total phosphorus accumulations in the sediments of Lake Pepin are significantly correlated with increased phosphorus discharges from the metropolitan-area wastewater treatment plants, increases in row-crop acreage, and increases in river flows. Total phosphorus inflows to Lake Pepin are significantly correlated with increased river flows, increases in row-crop acreage, and increases in phosphorus fertilizer applied to agricultural lands.

At current rates of deposition, Lake Pepin will be filled in with sediment within about 300 years (Engstrom and Almendinger, 2000). Approximately 85% of this sediment arises in the Minnesota River Basin (Nater and Kelley, 1998). Sediment delivery ratios from water erosion of cultivated uplands and stream-bank erosion in the Minne-

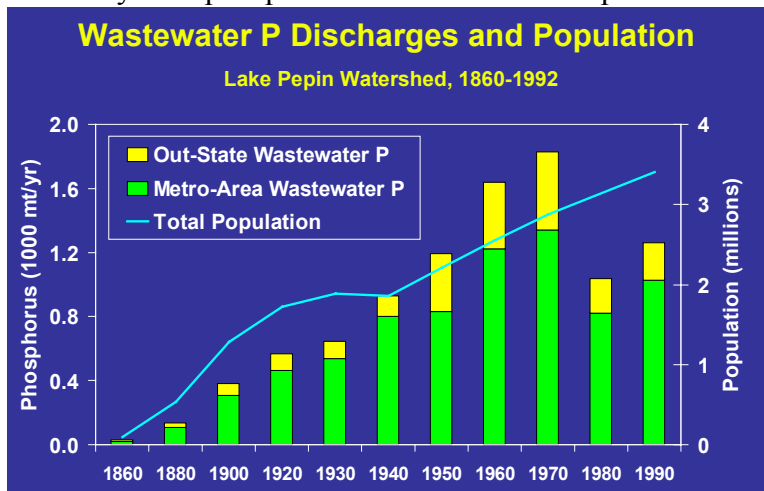
sota, Upper Mississippi, and St. Croix River Basins to Lake Pepin are estimated to be less than 4%.



Historically, from 23-47% of the phosphorus entering Lake Pepin originates in effluent discharged from wastewater treatment plants. The corresponding amounts transported to Lake Pepin from fertilizer, manure, soil erosion, and other diffuse sources ranged from 53-77%. Although this is the majority of the contribution, it is a small fraction (roughly 2%)

of the 100,000 tons of fertilizer and manure phosphorus applied annually to agricultural lands in the Minnesota, Upper Mississippi, and St. Croix River Basins. Even though this is a small percentage, it (along with phosphorus from wastewater treatment plant effluent and sediment-bound phosphorus accumulated in Lake Pepin) is enough to cause eutrophication in Lake Pepin, especially during dry years.

At the peak of phosphorus discharges from wastewater treatment plants in 1974, all wastewater treatment plants upstream of Lake Pepin discharged roughly 1,830 tons/yr of total phosphorus (47% of the phosphorus entering Lake Pepin). After the ban on phosphate detergents, this load decreased to about 1,225 tons/yr total phosphorus in 1992 (23% of the phosphorus entering Lake Pepin). Surprisingly, the large decrease in phosphorus loads from wastewater treatment plants after the ban on phosphate detergents was accompanied by a significant increase in phosphorus inflows into Lake Pepin. It is not clear why total phosphorus inflows to Lake Pepin have increased dramatically since



1974, since neither phosphorus fertilizer nor manure applications increased significantly after 1974. It is possible that the decrease in phosphorus discharge from wastewater treatment plants due to the ban on phosphate detergents was offset by increased erosion and river flow from the Minnesota River Basin during the wetter climate of the 1980s and 1990s.