Minnesota Pollution Control Agency

Regional Environmental Management

Minnesota River Study Shows Reductions in Key Pollutants

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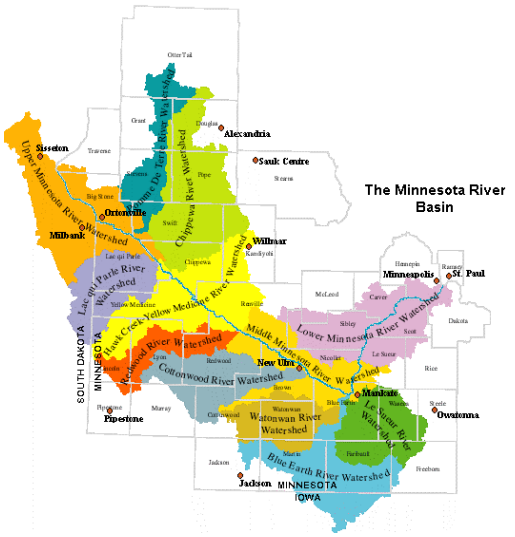
Ten years ago Governor Arnie Carlson issued a challenge to make the Minnesota River fishable and swimmable by 2002. Following his September 1992 proclamation, local, state, and federal agencies and organizations began to focus and coordinate their efforts on the Minnesota River and its tributaries. Scientists determined that the Minnesota River was polluted with sediment, nutrients such as nitrogen and phosphorus, oxygen-demanding materials, and bacteria. Today, activities in nearly every major watershed in the Minnesota River Basin are moving the clean up forward. Although the Minnesota River has not yet met Governor Carlson's challenge, a recent study indicates that water quality has improved.



The study examined pollutant concentrations at three sites: the Minnesota River at Fort Snelling and Jordan and the Blue Earth River at Mankato (Table 1). The site at Fort Snelling measures the impact of the nearly 17,000 square-mile basin. The site at Jordan, located on the fringe of the metropolitan area, is flanked upstream by generally rural land use and downstream by urban land use. The Blue Earth River receives flow from the Watonwan, Le Sueur, and Blue Earth River watersheds, encompassing 3,500 square miles. Several studies have identified the Lower Minnesota, Blue Earth, and Le Sueur watersheds, in particular, to be major sources of pollutants to the Minnesota River.

Because of the great variability of in-river pollutant concentrations annually and seasonally, very few statistically significant trends were found for the period 1992 - 2001. An exception was at Fort Snelling where phosphorus decreased approximately 32 percent and ammonia decreased approximately 46 percent from 1992 – 2001. However, when viewed over a longer period of record going back to the 1970s or earlier, a number of trends do stand out. Biochemical oxygen demand has decreased by approximately 34 percent at both of the Minnesota River sites. Phosphorus showed similar reductions at Fort Snelling. Total Suspended Solids (TSS) also decreased 30 to 40 percent at Jordan and Fort Snelling. Likewise, data from the Blue Earth River at Mankato showed approximate 40 percent reductions in Biochemical Oxygen Demand (BOD), phosphorus, and TSS.

A 1996 University of Minnesota Department of Soil, Water and Climate study found similar reductions in TSS and phosphorus loads (Mallawantantri, Mulla, and Seeley). The study examined MPCA, USGS, and Metropolitan Waste Control Commission data from 1974 to 1994 at the mouths of the

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Pomme de Terre, Chippewa, Yellow Medicine, Redwood, Cottonwood, Watonwan, Blue Earth rivers, and the Minnesota River at St. Peter. After removing climatic effects, the study cited improved crop and land management practices as reasons for the reductions.

Methods

This study analyzed data from water chemistry grab samples collected biweekly by the Metropolitan Council on the Minnesota River from 1976 through 2001 and monthly by the Minnesota Pollution Control Agency on the Blue Earth River from 1967 through 2001. In order to reduce variability in the data and separate out the effects of both streamflow and season, locally weighted scatterplot smoothing (LOWESS) regression analyses were performed to model the relationships between pollutant concentrations and those two factors. Seasonal Kendall Trend Tests were then performed on the residuals from the LOWESS models to look for changes in pollutant concentrations over time. Trends that were found to be statistically significant (at a 95% confidence level) are shown below.

Minnesota River Trends (trends are all decreases in percent, effects of season and stream flow were removed in the analysis)

	Minnesota River at Fort Snelling	Minnesota River at Jordan	Blue Earth River at Mankato
BOD – percent reduction per year	1.6	1.7	2.1
BOD – percent reduction for time period	34	34	41
TSS – percent reduction per year	1.9	1.5	1.9
TSS – percent reduction for time period	40	31	38
Phosphorus – percent reduction per year	1.6	No significant trend	1.8
Phosphorus – percent reduction for time period	35	No significant trend	37
Ammonia – percent reduction per year	6.3	7.1	Trend Analysis not possible because of changes in lab methods
Ammonia – percent reduction for time period	82	84	
Nitrate/nitrite	No significant trend	No significant trend	No significant trend
Time period	1976 – 2001	1977 – 2001	1967 – 2001

Biochemical oxygen demand

Biochemical oxygen demand decreased by approximately 1.6 to 1.7 percent per year, on average, at the Minnesota River sites (Fort Snelling and Jordan). This would approximate a 34 percent reduction over the entire time period (Table 1). Similarly, data from the Blue Earth River at Mankato showed a reduction of approximately two percent per year, roughly a 40 percent reduction in BOD for the time period. Data were available at the Jordan station from 1977 to 2001 and at Fort Snelling from 1976 to 2001. Data for the Blue Earth River at Mankato covered a longer time period from 1967 to 2001. A possible reason for the reductions is that there were many wastewater treatment plant upgrades.

Phosphorus

Phosphorus decreased 1.6 percent per year, on average, at Fort Snelling and 1.8 percent per year, on average, in the Blue Earth River at Mankato, reductions of about 35 and 37 percent, respectively (Table 1). There was not a statistically significant reduction in phosphorus on the Minnesota River at Jordan.

Reasons for the decreasing phosphorus trend include changes in detergents, wastewater treatment, and land use. In 1977 phosphates in laundry detergents were banned. Also, many wastewater treatment facilities in the Minnesota River Basin discharge less phosphorus to the river than they did 15 years ago. Some facilities have received phosphorus limits, setting a maximum on the concentration of phosphorus discharged. Limiting phosphorus from wastewater treatment facilities will likely have more of an impact in the future because the limits have been implemented only recently, in the past five years. In agricultural areas fertilizer and manure application methods have changed, too. More nutrient sources are applied below the soil in a band along the row instead of broadcast on the surface. Phosphorus readily attaches to soil particles and is transported to surface water with eroded soils via runoff.

Total suspended solids

TSS decreased by 1.5 to 2 percent per year, on average, at all three locations, a decrease of approximately 30 to 40 percent over the time period (Table 1).

One likely reason for the reduction is an increase in the use of conservation tillage. This practice leaves more residue on fields to hold the soil in place. In the 1980s, 5 to 10 percent of fields had the suggested 30 percent residue as a rotational average (or equivalent protection). An estimated 44 percent of corn and soybean fields followed the recommendations as of 2000, according to survey results compiled by the Minnesota Board of Water and Soil Resources. Wastewater treatment plants also made TSS reductions over the time period.

Ammonia

The largest pollutant reductions in this study were for ammonia, a reduction of approximately 6.3 percent per year, on average, at Fort Snelling and 7.1 percent annually at Jordan. This equates to an 82 to 84 percent reduction over the entire time period (Table 1). Ammonia trend analysis for the Blue Earth River at Mankato was precluded by changes in laboratory analytical methods during the period.

The amount of ammonia discharged by wastewater treatment facilities was significantly reduced over the time period by adding nitrification to the treatment process. Nitrification converts ammonia to nitrate.

Precipitation

A complicating factor is that Minnesota's precipitation increased during the decade of the 1990s compared to the long-term average. Higher precipitation has resulted in runoff, increased river flows, and increased pollutant loading. However, in the case of sediment, erosion rates have decreased. In 1996, the MPCA compared water quality from the decade of 1986-1995 with data for the 1970s (Klang, et. al). The study showed a 25 percent reduction in sediment carried by the river during typical flow conditions (excluding the flood year of 1993). A University of Minnesota study (also in 1996) evaluated the same data but focused on the months of May through August from 1968 – 1994 and found decreases in sediment loads in about the same amount as the MPCA (Mallawantantri, Mulla, and Seeley).

Trends indicate progress, but there is more to be done

Minnesotans have reason to be optimistic about these trends. Taken as a whole, they indicate that people are working together to improve the water quality of their namesake river. While its problems are serious, improvement is possible. However, much work remains to be done to restore the health of the Minnesota River and its tributaries. For example, the study indicated no trend in the concentration of nitrate-nitrogen. Other studies indicate that nitrogen is increasing and that the Minnesota River Basin delivers up to 70 percent of the state's contribution to the zone of hypoxia (low oxygen) in the Gulf of Mexico. Although concentrations of phosphorus and TSS have decreased, further reductions are needed to improve water quality in the Minnesota River and downstream on the Mississippi River, Lake Pepin in particular. The need for further reductions is referenced in Minnesota's draft 303(d) list that the MPCA issued in July and will finalize in fall 2002 (Table 2). This list identifies waters that do not meet water quality standards and requires a plan to meet the standards. There are 228 reaches in the Minnesota River Basin on the list (7 biota, 27 fecal coliform bacteria, 39 turbidity, 6 ammonia, 9 low oxygen, 1 chloride, 105 mercury, and 34 PCBs). Each major watershed has at least one reach that does not meet standards; the Lower Minnesota River Watershed includes over 28 reaches (when mercury and PCBs are included). These reaches are not the only waters in this basin that fail to meet water quality standards. Budget and time constraints prohibit assessment of all waters. Hence, waters on the list represent only a portion of those not meeting water quality standards.

This publication was reviewed by the Minnesota River Basin Data Review Team. The Data Review Team is coordinated by the Minnesota River Basin Data Center. Members include:

- Coalition for a Clean Minnesota River
- Metropolitan Council
- Minnesota Board of Soil and Water Resources
- Minnesota Department of Agriculture
- Minnesota Department of Natural Resources
- Minnesota Pollution Control Agency
- Minnesota River Basin Joint Powers Board
- Natural Resources Conservation Service
- University of Minnesota
- U.S. Geological Survey

Table 2. Reaches on draft 303(d) list by watershed. Table does not include mercury or PCBs.

	Biota	Fecal coliform	Turbidity	Ammonia	Low oxygen	Chloride	**Total**
Pomme de Terre		1	1		1		**3**
Upper				1			**1**
Lac qui Parle					1		**1**
Hawk/Yellow Medicine		3	4				**7**
Chippewa		1	1	2			**4**
Redwood	3	1	3	1	1		**9**
Cottonwood		1	1				**2**
Middle		3	6				**9**
Blue Earth	3	4	7	2	2		**18**
Watonwan		1	2				**3**
Le Sueur	1		3				**4**
Lower		12	11		4	1	**28**
Total	**7**	**27**	**39**	**6**	**9**	**1**	**89**