Land Stewardship Project Fact Sheet #7

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How Farms Can Improve Water Quality

Minnesota studies show how working farmland can have a positive impact on water resources.

Two watersheds

The Minnesota River's contribution of sediment to the Mississippi's Lake Pepin has increased more than 12-fold since 1830. The Minnesota flows through an area composed of particularly fine-grained soils, which throughout geological history have been prone to erosion. But it is no accident that this relatively recent 12-fold increase in sedimentation parallels the development of intensive farming in the Minnesota River basin.[1]

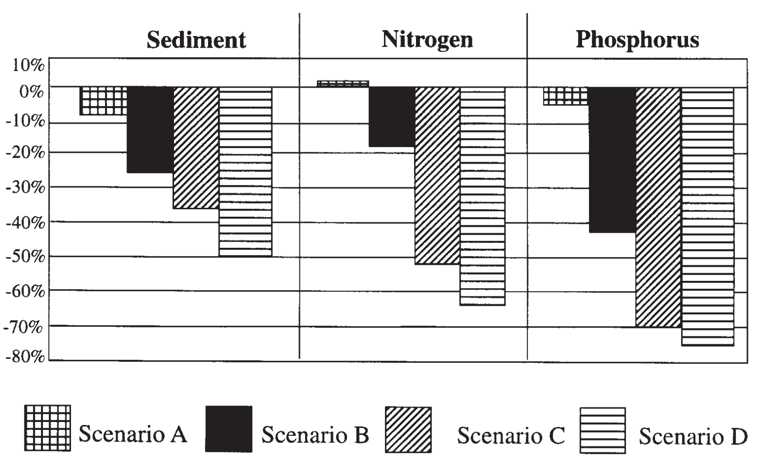
Perhaps humans can't control the soil structure of the Minnesota River basin, or the slope of the land on a watershed-wide basis. But, says Minnesota Cooperative Fish and Wildlife Unit stream ecologist Bruce Vondracek, we can change the hydrology of a particular area—the amount of water that flows over and under soil—and at what speed it makes that journey. Studies and anecdotal evidence show that land covered with perennial plants such as grasses, hay crops and trees is much less prone to erosion when compared to acres planted to annual crops such as corn and soybeans. Perennial plant cover slows down the water flow, provides year-around protection from the soil-loosening effects of rainstorms, and gives precipitation a chance to soak into the soil structure. What would happen if perennial plant systems were returned to an agricultural watershed? How much of a change in the landscape would it take to reduce sedimentation to more sustainable levels?

Recently, Vondracek and two other researchers studied fish habitat in two Minnesota watersheds: Wells Creek and the Chippewa River. The study was part of a research initiative called "The Multiple Benefits of Agriculture: An Economic, Environmental & Social Analysis" (see "Multiple Benefits of Agriculture" sidebar).[2]

Wells Creek flows through steep land in southeast Minnesota before draining directly into the Mississippi. The Chippewa flows through the flat former prairies of western Minnesota before hitting the Minnesota River.

The researchers used modeling to predict what would happen to sediment loading in the two watersheds based on four land use scenarios. The scenarios ranged from extension of current farming trends in each watershed (Scenario A: fewer and larger farms, with increased acreage in row crops and the loss of small and medium-sized livestock farms) to conversion of row crop acres to year-round permanent plant cover such as grass, hay and trees (Scenario D). Under this last scenario, land would be rotationally grazed for livestock production, diverse cropping rotations would be implemented to build soil quality, and prairies and wetlands would be restored. For the modeling study, all land use activities were simulated over a 50-year period (1950 through 1999).

***Figure 1*: Change from Baseline in Chippewa Study Area**



Modeling in the Chippewa River watershed has shown that replacing intensive row cropping with more diverse cropping systems, forages and grass-based livestock production can dramatically reduce sediment, nitrogen and phosphorus pollution. *Source: "The Multiple Benefits of Agriculture: An Economic, Environmental & Social Analysis." Nov. 2001, Land Stewardship Project* [2]

A dramatic reduction

What Vondracek and his colleagues found was that land use changes led to ***reductions in sediment loading of up to 84 percent in Wells Creek and 49 percent in the Chippewa River***.[3] These land use changes also produced other water quality benefits (see *Figure 1*). How did the reductions come about? The presence of permanent, year-around vegetation on the land was the key.

By getting more perennial vegetation on the land in the form of grasses, hay crops and trees, ***water runoff was reduced as much as 35 percent in both watersheds***. That meant more water was percolating into the soil and less was rushing to the waterways, carrying soil and other contaminants along the way.

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Restoring wetlands and other natural areas also helped reduce runoff considerably, according to modeling. The study only looked at sediment coming from farm fields, not the soil that erodes directly from riverbanks. But in theory less water rushing over fields should make for more stable riverbanks.

This is one of the first studies to look at the possible impacts the duration of sediment exposure can have on fish. The study indicated that a flush of huge amounts of suspended sediment during and after a storm event might not have as much of a negative impact on fish health as lower levels of suspended sediment present over a longer period of time. Fish can tolerate relatively high concentrations of sediment for a short time, but if the sediment lingers after a thunderstorm, the tolerance level drops dramatically. The critical factor is that fish become more sensitive the longer they are exposed to suspended sediment.

The Minnesota Pollution Control Agency has proposed listing a stream as "impaired" for turbidity if it exceeds 46 milligrams of suspended sediment per liter of water. This is part of a larger effort on the part of environmental regulatory agencies to set "total maximum daily load"—TMDL for short—requirements for certain pollutants. Vondracek's study, which was published in the *Journal of the American Water Resources Association*, concluded that the Pollution Control Agency's proposed TMDL for sediment would be exceeded 30 days a year in the systems they studied.[3] That means such a limit may be too high if it is meant to protect fish health. Vondracek says a better way to set levels is to take into consideration the duration of the sediment exposure, not just how much is entering a river system on any given day.

BMPs & perennials

If the kind of chronic sedimentation that harms fish is to be controlled on a consistent basis, tweaking current farming practices using conservation measures called "best management practices" (BMPs) may not be enough in all watersheds. In Vondracek's study, when BMPs such as conservation tillage and the establishment of strips of permanent vegetation (called riparian buffers) were used in the Wells Creek watershed, "lethal" concentrations of suspended sediment—levels high enough to kill fish—***went down an astounding 63 percent***. However, in the Chippewa River such practices did not significantly affect the negative impacts sediment levels had on fish. The Chippewa's soil structure and the extent to which it is being farmed intensively makes reducing its sediment problems tougher, says Vondracek.

So does environmental protection in a place like the Chippewa River watershed mean idling massive tracts of land? Not necessarily, says the biologist. In the 1990s, Vondracek worked on the Monitoring Team, a research initiative that brought together farmers, scientists and government officials. A three-year Monitoring Team study of six farms practicing managed rotational grazing in southeast Minnesota found that this technique can significantly reduce the amount of sediment flowing into a waterway.[4] The study also found that a stream degraded by overgrazing starts to recover as it flows through a rotationally grazed area (for more on grazing, see LSP Fact Sheet #3). "I saw how working farmland could have a positive impact on watershed health," says Vondracek.

Sources

[1] Kelley, D. and E. Nater. "Historical Sediment Flux from Three Watersheds into Lake Pepin, Minnesota, USA,'' March-April 2000, *Journal of Environmental Quality*. Vol. 29, pages 561-568

[2] Boody, G. and M. Krinke. *The Multiple Benefits of Agriculture: An Economic, Environmental & Social Analysis*. Nov. 2001, Land Stewardship Project, White Bear Lake, Minn.

[3] Vondracek, B., J. Zimmerman and J. Westra. "Setting an Effective TMDL: Sediment Loading and Effects of Suspended Sediment on Fish,'' Oct. 2003, *Journal of the American Water Resources Association*. Vol. 39, No. 5, pages 1005-1015

[4] Sovell, L.A., B. Vondracek, J. A. Frost and K. G. Mumford. 2000. "Impacts of Rotational Grazing and Riparian Buffers on Physicochemical and Biological Characteristics of Southeastern Minnesota, USA, Streams." *Journal of Environmental Management*. 26 (6): 629-641.

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This fact sheet is brought to you by the members and staff of the Land Stewardship Project, a private, nonprofit organization devoted to fostering an ethic of stewardship for farmland and to seeing more successful farmers on the land raising crops and livestock. For more information, call 651-653-0618 or visit www.landsteward shipproject.org.

Multiple Benefits of Agriculture

The Multiple Benefits of Agriculture research project used the Agricultural Drainage and Pesticide Transport model, new methods to estimate fish health, contingent valuation, and sociological methods to examine the impacts of four scenarios of agricultural land-use in southern Minnesota.

A multidisciplinary research team guided the Project. Farmers, rural residents, academics, and nonprofit and government staff served on the Project's steering committee. Key players in the research were the University of Minnesota's Department of Applied Economics, the University of Minnesota's Department of Fisheries and Wildlife, Bemidji State University, the Minnesota Department of Natural Resources, Minnesota State University-Mankato, Iowa State University, the Institute for Agriculture and Trade Policy, and the Minnesota Institute for Sustainable Agriculture. The Land Stewardship Project directed the research initiative.

For a copy of *The Multiple Benefits of Agriculture: An Economic, Environmental & Social Analysis*, call 651-653-0618 or e-mail lspwbl@landstewardshipproject.org. The report and an executive summary are also available at www.landstewardshipproject.org/programs_mba.html.