Effects of Agricultural Land Retirement in the Minnesota River Basin

USGS, BWSR, LCCMR project
Summary for BWSR Staff and Board - August 2008
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Background

The United States Geological Survey (USGS), BWSR, and the Legislative-Citizen Commission on Minnesota Resources (LCCMR) began a project in 2005 to evaluate the effect of agricultural land retirement (set-aside) on stream quality. The project has continued through a second LCCMR funding cycle.

We are all aware of the substantial amount of time, effort, and money that has gone towards land retirement programs such as RIM, CRP, CREP, and the like, as well as large-scale best management practices (BMPs) such as buffer strips and filter strips. One of the primary goals is water quality improvement. Field scale research, as well as pollution reduction estimation methods, shows the positive effects of land retirement and riparian buffers on water quality. Intuitively, we know these programs are a good idea, and all field-scale indications and estimates back this up.

However, to date there has been little or no evaluation of ***watershed-scale*** improvements to water quality and aquatic biology resulting from land retirement. Furthermore, the efficacy of prioritizing retired lands near streams is unknown.

Methods

Selection

The main objective of the study was to compare water quality and biological conditions in small watersheds **as similar as possible** except for the **amount and location of agricultural set-aside land**. (This is inherently **very** difficult, as all watersheds have differences and no watersheds are identical. Other "lurking variables" such as variations in climate, agricultural practices, retirement acreages, etc. call into question the interpretation of any short-term data set.)

The **Chetomba Creek**, **West Fork Beaver Creek**, and **South Branch Rush River** sub-basins were selected after considering a set of 17 parameters such as slope, basin size, and absence of dams or in-line lakes. The selection required **minimizing** the differences in these parameters, while **maximizing** differences in percentages of land retirements.

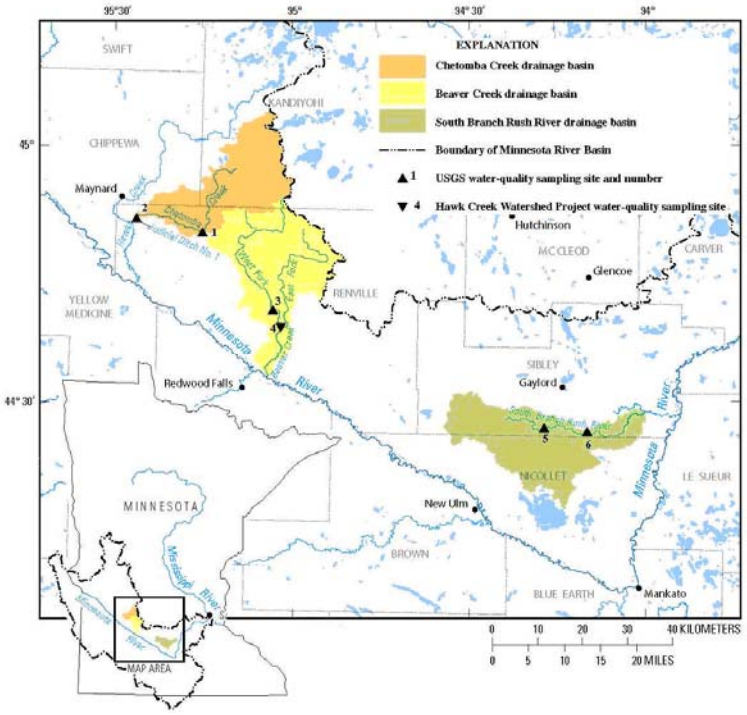

Figure 1: Sampling sites in Chetomba Creek, Beaver Creek, and South Branch Rush River sub-basins, Minnesota River Basin.

Land Retirement Data

Land retirement data were obtained from various sources, and included GIS coverages of CRP, CREP and RIM lands, and some smaller amounts of retired agricultural land in other programs including Pheasants Forever, Wildlife Management Areas, and U.S. Fish and Wildlife Service Waterfowl Production Areas.

Stream flow Measurement

Stream water-surface elevation (stage) was measured at 3 stream-gaging stations. The data were electronically recorded and transmitted by satellite. Stream flow measurements were made approximately every six weeks during the open-water season. A stage-stream flow relation was developed on the basis of stream flow measurements and the stage of the stream at the time of measurement.

Sampling

Water-quality samples were collected manually and with automated samplers between October 2005 and September 2007. Nutrient and Sediment samples were collected for lab analysis, and samples were analyzed on site for conductance, pH, temperature, dissolved oxygen, and turbidity. Continuous, real-time water-quality monitoring was used at 3 stream gaging sites, and data were transmitted via satellite. Biological monitoring included sampling for algae, invertebrates, and fish.

IBI Scoring

Index of biotic integrity **(IBI)** scores were used to measure fish community response and community health. The IBI was calculated using 8 metrics related to the composition and structure of the fish community. The sum of the metric scores is the IBI score, which ranges from 12 to 60 (greater number indicates better aquatic resource quality).

Results

IBI Scoring

In this Study, Index of biotic integrity (IBI) scores increased as local land retirement percentages increased (Figure 2). This relationship showed the best correlation when the percentages were calculated in 50- and 100-foot buffer zones around streams. The correlation decreased as the buffer distance from the stream over which the land retirement percentages were calculated increased.

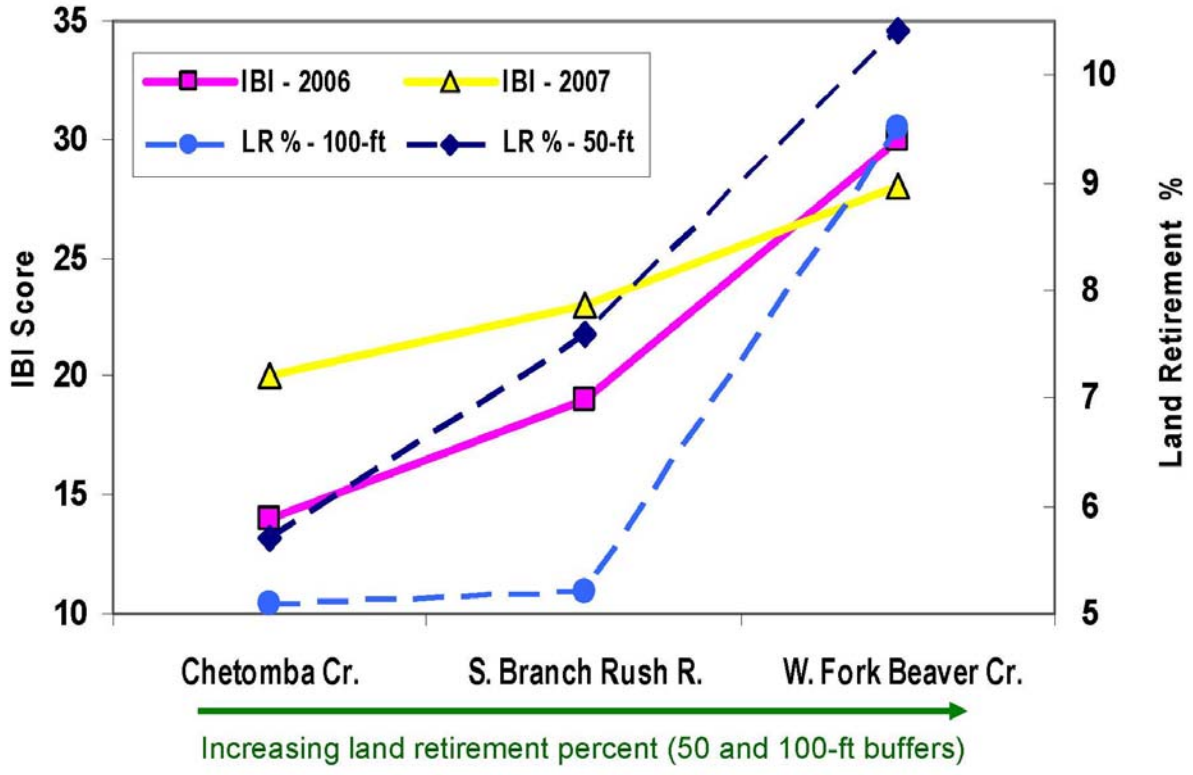

Figure 2: Index of Biotic Integrity (IBI) Scores and Land Retirement percentages in 50- and 100-ft buffers for Chetomba Creek, S. Branch Rush R., and W. Fork Beaver Creek.

Nutrients

Both nitrogen and phosphorus concentrations were lowest in the sub-basin with the highest retired land percentage. Nitrogen concentrations were highest in the sub-basin with little to no land retirement. The data show a trend of decreasing nitrogen and phosphorus concentrations with increasing land retirement percentage, though the correlation is better for nitrogen than for phosphorus (Figure 3). The correlation shows little sensitivity to the buffer distance over which the percentages are calculated.

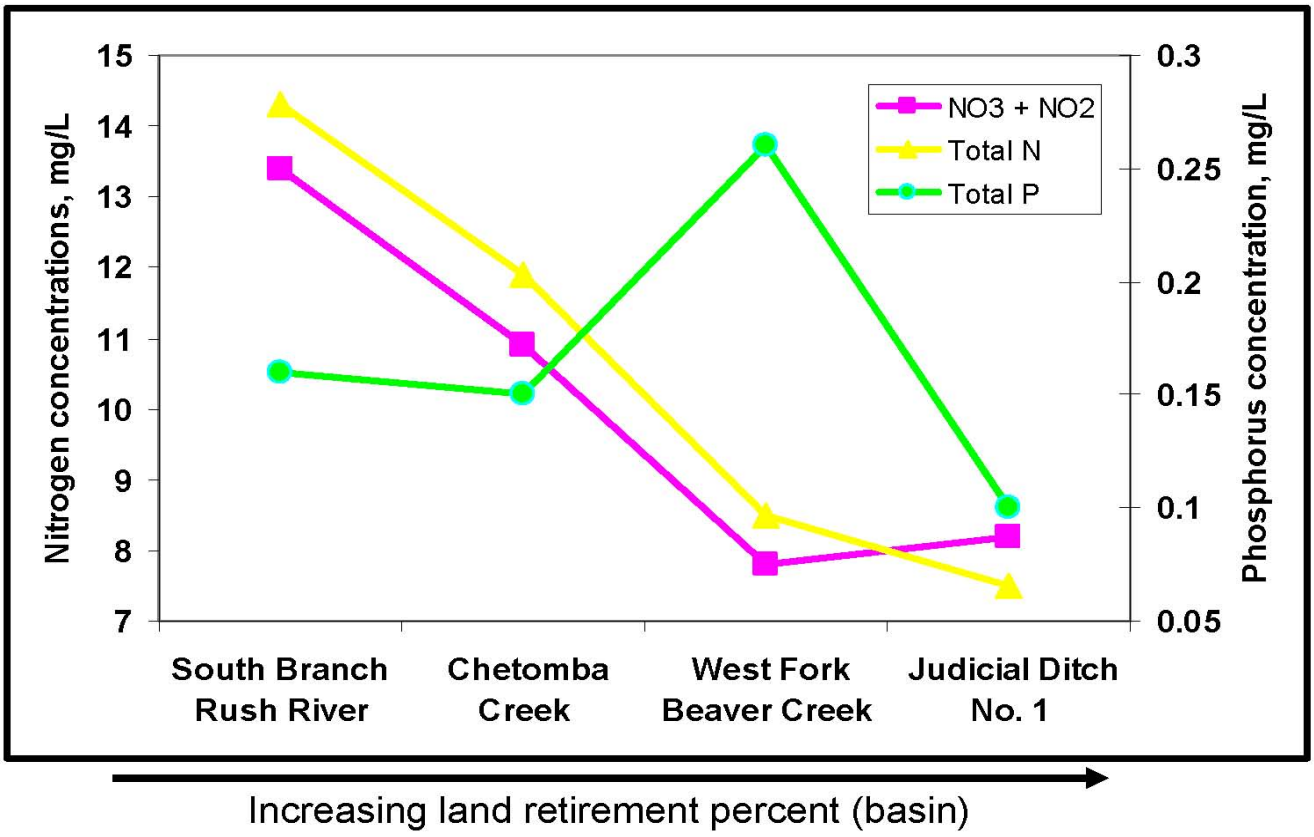

Figure 3: Nutrient results

Summary and Conclusions

Retired land is assumed to improve water quality and aquatic resource quality by reducing surface runoff and reducing agricultural chemical entry into streams. Riparian land (land adjacent to streams) and land near surface water bodies is typically assumed to be of higher priority for retirement. This study strengthened the validity of both assumptions. It showed:

- Increasing Index of Biotic Integrity (IBI) scores with increasing percentage of retired land;
- Decreasing total nitrogen concentrations with increasing percentage of retired land; and
- Lowest nitrogen and phosphorus concentrations in the sub-basin with the highest retired land percentage.
- Better correlation of IBI score with percentage of land retired with decreasing buffer distance from the stream.

Paired watershed studies, such as the one presented here, have their challenges. It is difficult to find watersheds that are similar and impossible to find watersheds with no differences. The relation between land retirement percentage and stream quality is likely affected by the differences among sites. Also, conditions in the Minnesota River basin are highly variable from year to year and therefore it may not be prudent to draw conclusions from such a short term data set.

Continuing the data collection will add important information to this data set. Land retirement contracts are decreasing across the Midwest due to the increase in corn prices. Data from this study should serve as a baseline should land retirement in these basins decrease substantially.

The data from 2006-2007 provide a response that a watershed may have to land retirement. Land owners, scientists, and local, State, and Federal agencies can use this information to improve management of natural resources in the Minnesota River basin, while sustaining economically viable agricultural production.