Science Museum of Minnesota

St. Croix Watershed Research Station

SCWRS Fact Sheet, 2012

Reductions in phosphorus loading in the Sunrise River watershed from wetland mitigation

Issue and Approach

The loading of phosphorus from our lands to our water resources is commonly the single largest cause of eutrophication, where excess algal growth degrades water quality. Wetlands can play a critical role in reducing phosphorus loading to lakes and streams by trapping runoff water and sediment. The Sunrise watershed currently contains many wetlands and with the potential to create or restore many more, a process commonly called wetland mitigation. To estimate the role of wetlands in reducing nonpoint sources of phosphorus, a computerized watershed model was constructed for the Sunrise River watershed by using the Soil and Water Assessment Tool (SWAT). The model results discussed here focus on two outcomes of interest: the Sunrise River's phosphorus loading to the St. Croix River and phosphorus loading to the lakes in the Lakes Improvement District (LID).

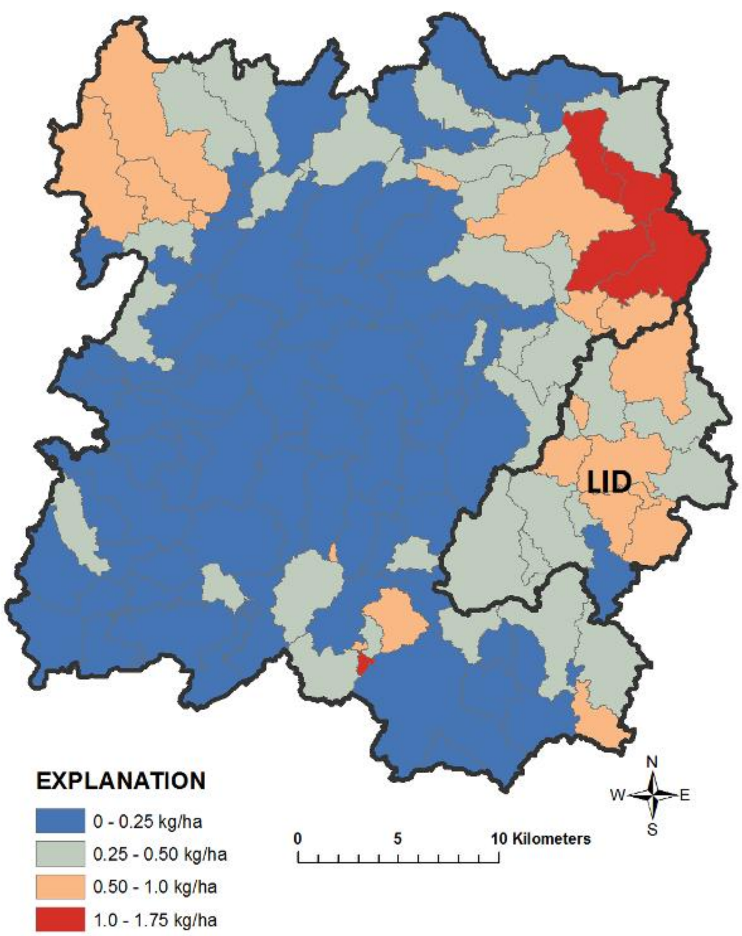

Figure 1. Modeled phosphorus yields in the Sunrise River watershed.

Phosphorus Loading from the Landscape

Model-predicted phosphorus yields (annual load from a unit area) for subwatersheds in the Sunrise are shown in Figure 1 and show high spatial variability. In general, areas predicted to have the highest phosphorus loads are those with tillage agriculture, urban land use, and low infiltration rates.

In the LID, the landscape is closely connected to the lakes and the streams that flow into the lakes. This results in significant loading from all subwatersheds within the LID. However, the extent to which phosphorus landscape inputs contribute to St. Croix River loading depends on where in the watershed they originate. An estimated 40% of the total watershed phosphorus load is generated by areas in upper region of the Sunrise, upstream

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of the North Pool (representing about 50% of the total watershed area). However, most all of this phosphorus from the upper watershed region is trapped in wetlands and lakes, including the North and South Pools. The result is only 5% of the total load at the confluence with the St. Croix River is predicted to originate from upstream of the North Pool. As a result, wetlands scenarios for St. Croix phosphorus reduction considered only subwatersheds downstream of the North Pool.

Wetlands in the Sunrise River Watershed

Wetlands trap phosphorus by settling phosphorus-containing particles or by accumulating organic matter from plants that have incorporated phosphorus into their biomass. Organic matter accumulates when plant growth exceeds decay. The waterlogged soils of wetlands inhibit decay of organic matter, thereby promoting net accumulation in the wetland. However, if water levels are lowered in wetlands by either drought or artificial drainage, decay of organic matter will accelerate and phosphorus can be released, changing the wetland from a phosphorus trap into a phosphorus source.

The Sunrise River watershed contains abundant wetlands. Topographic and land cover analyses estimate that about 10% of the total watershed area is covered by wetlands, with about 40% of the total watershed area draining to wetlands. The extent of the landscape that currently drains to wetlands is shown in Figure 2. For purposes of modeling, Sunrise watershed wetlands were characterized as two functional types: those with closed basins versus those with open basins. Closed basin wetlands are those that exist in upland areas away from streams and drainage ditches and have the capacity to trap nearly 100% of the water, sediments and sediment-borne phosphorus that enters them as surface runoff. Open basin wetlands on the other hand are those riparian or floodplain wetlands that lie near or intersect streams and drainage ditches. Open basin wetlands trap much of the constituents that flow into them, especially in the spring, but also allow a significant portion to pass through and into streams and lakes. For simplicity and keeping in mind these two types work complementarily in the watershed, this fact sheet does not differentiate between the two but refers to both as "wetlands."

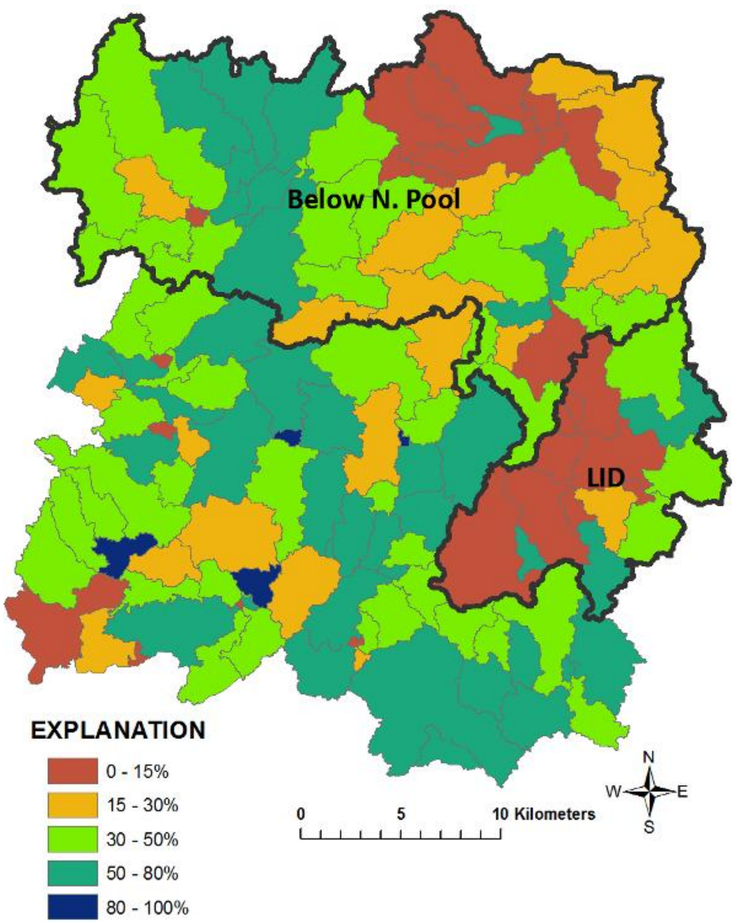

Figure 2. Percent of each subwatershed's area currently draining to wetlands.

Wetlands as a BMP for Reducing Phosphorus

Wetlands play an important role in reducing phosphorus loading to lakes and streams in the Sunrise watershed. The Sunrise SWAT model estimates that existing wetlands reduce phosphorus loading to the St. Croix River and into LID lakes by 25% and 40%, respectively.

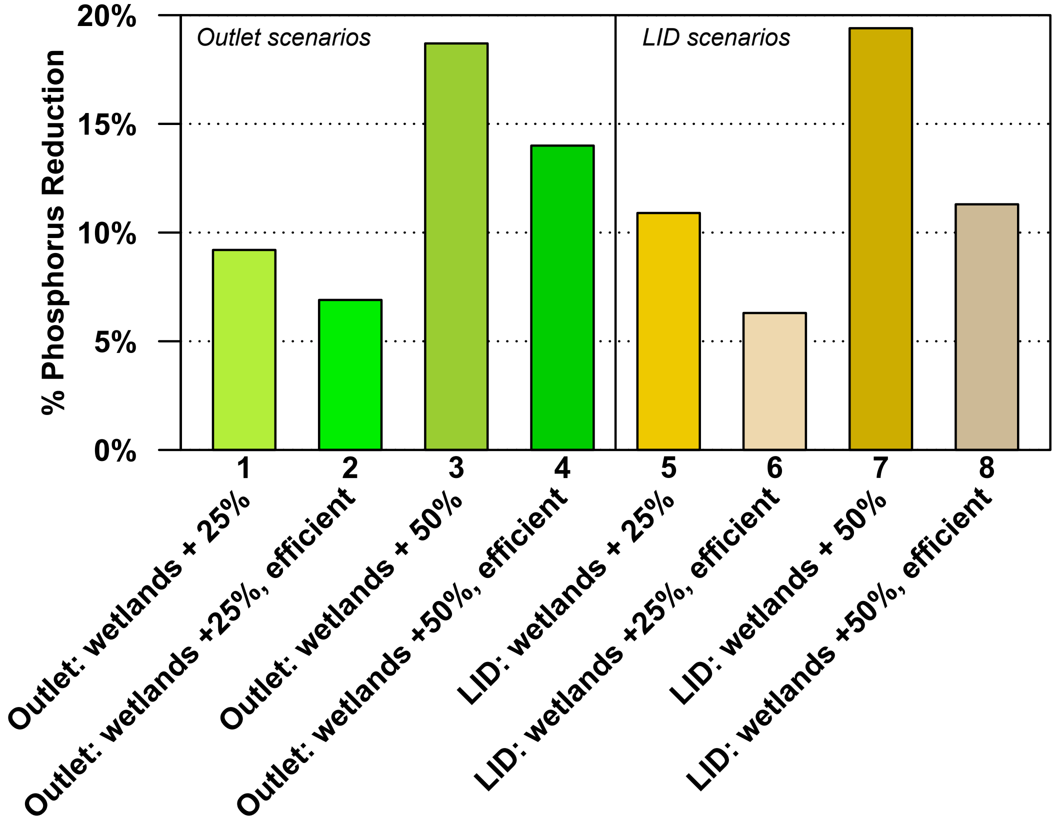

Figure 3. Phosphorus reduction from wetland mitigation scenarios for the Sunrise River outlet to the St. Croix River and for the Lakes Improvement District (LID)

Increasing the number of wetlands in the Sunrise River watershed is predicted to be an effective method to further reduce phosphorus. To simulate this effectiveness, model scenarios were created by increasing the extents of wetlands in subwatersheds (1) downstream of the North Pool (and LID) to reduce phosphorus loads to the St. Croix River and (2) within the LID to reduce phosphorus loads to LID lakes. Results of these model simulations show that increasing the extents of wetlands downstream of the North Pool by 25% and 50% would reduce phosphorus loading to the St. Croix River by 9% and 19%, respectively (See Figure 3). Likewise, increasing extents of LID wetlands by 25% and 50% reduced phosphorus loading to lakes by 11% and 19%, respectively.

In alternative scenarios, increases in wetland extent of 25% and 50% were simulated as previous but only in those subwatersheds where both phosphorus yields and current wetland phosphorus reduction were highest (arbitrarily chosen as the upper 50%, see Figure 4). These results are shown in Figure 3 and labeled as the “efficient” scenarios. The efficient scenarios showed that in the case of loading from the Sunrise River outlet to the St. Croix River, 75% of the total predicted reduction could be achieved by only increasing wetland extents by 50% when compared to the non-efficient scenarios. This effect in the LID was less pronounced and was only slightly more efficient than the non-efficient scenario (58% reduction for 50% increase in wetland extent when compared to non-efficient).

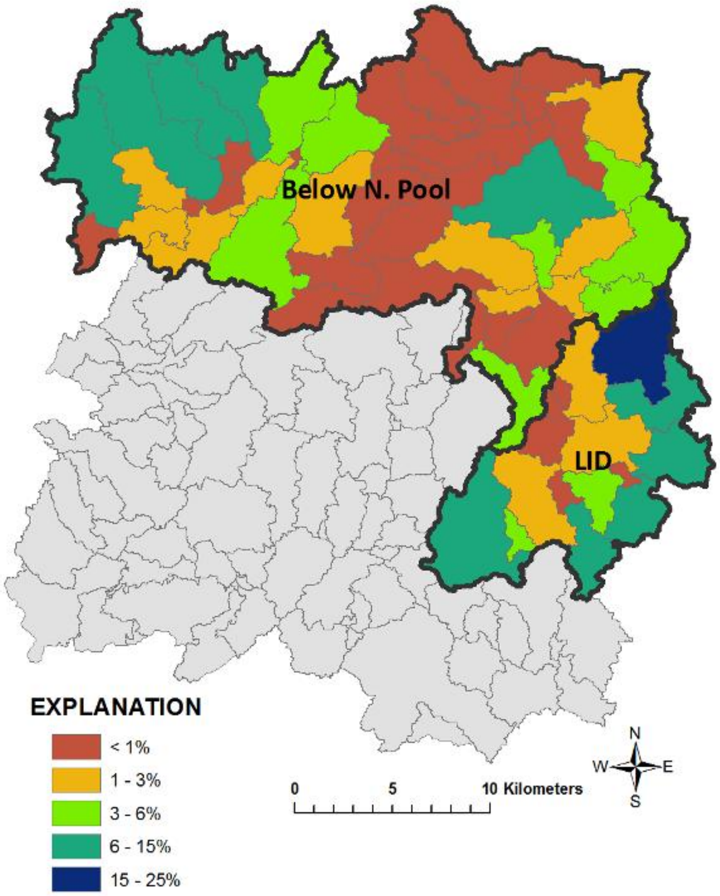

Figure 4. Distribution of phosphorus reduction from wetland mitigation scenarios for the Sunrise River outlet and Lakes Improvement District (LID) focus areas.

Percentages indicate the proportion of the total phosphorus reduction each subwatershed contributes in the associated area of focus. Subwatersheds with the highest percentages would be likely targets for efficient mitigation efforts. Note that subwatershed percentage in the Below North Pool and LID areas each add up to 100%.

Conclusions

The potential for wetland mitigation in the Sunrise River watershed to reduce phosphorus loading is considerable. When utilized as part of combined effort that includes agricultural and urban BMPs, the effects could be substantial. It is important to note that wetlands also provide other benefits such as nitrogen and sediment removal, flood attenuation and wildlife habitat. This suite of benefits makes wetland mitigation in the Sunrise River watershed a valuable and viable tool for resource managers. From a management perspective, increasing the extent of wetlands can take two forms: (1) restoration or creation of wetlands that will receive runoff from areas of the landscape not currently draining to wetlands or (2) increasing the area draining to existing wetlands, thereby increasing their utilization. Depending on the area of the landscape and socio-economic factors therein, it is probable a combination of both of forms would be most practical.

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