Report for 2001IA1681B: Evaluating the Effectivensss of Restored Wetlands for Reducing Nutrient Losses from Agricultural Watersheds

There are no reported publications resulting from this project.

Report Follows:

Problem and Research Objectives:

This study examines at two levels, the subwatershed and wetland, the effectiveness of wetland restorations for reducing nutrients in agricultural runoff in the Iowa Great Lakes watershed. It has two major research objectives: (1) to monitor nutrient concentrations in the outflow of subwatersheds with different percentages of restored wetlands to determine if restored wetlands have significantly reduced the levels of nutrients in outflows, and (2) to monitor nutrient concentrations in the inputs and outputs of restored wetlands to see how effective they are as nutrient sinks.

Methodology:

(a) Subwatersheds

Outflows from a series of subwatersheds with and without restored wetlands are sampled on a weekly basis. These water samples are analyzed for nitrate, total nitrogen and total phosphorus using standard techniques.

(b) Restored Wetlands

Inflows and outflows from a series of restored wetlands are also sampled on a weekly basis. These water samples are analyzed for nitrate, total nitrogen and total phosphorus.

In order to characterize the developmental status of each restored wetlands, their vegetation and litter compartments are sampled using standard techniques. Each restored wetland is divided into ten zones along its longest axis. Randomly placed quadrats (1 m x 1 m) in each zone are sampled in either late July or early August. The abundance of each plant species in each quadrat is estimated using a cover-abundance scale. The entire quadrat aboveground is then harvested. Harvested plant material is separated into live plants, standing litter, and fallen litter. All biomass samples are dried at 80 C before being weighed.

Principal Findings and Significance:

(a) Subwatersheds

In 2001, sampling of outflows from 10 selected subwatersheds with and without restored wetlands were sampled. Weekly samples were collected from 12 sites in these 10 subwatersheds. All of the water samples have been analyzed for nitrate-nitrogen, total nitrogen, and total phosphorous through the end of 2001. There are four subwatersheds that are mostly cropland (E3, E4, W13, and W14), 2 intermediate subwatersheds with some restored wetlands (G3, W2), and four subwatersheds (G5, W3, W9, and W10) that have restored wetlands and land in set-aside programs.

Since they have been monitored, the outflows from the mostly cropland subwatersheds have had mean nitrate concentrations ranging from 6.25 to 9.60 mg/L while the four subwatersheds with restored wetlands have had mean concentrations of nitrate that ranged from 0.12 to 4.38 mg/L. The two intermediate subwatersheds had mean nitrate concentrations of 3.77 and 5.38 mg/L. Subwatershed W9, which has the highest percentage of its area in wetlands, has had the lowest nitrate concentration (0.12 mg/L) while subwatershed G5 that has a largest percent in CRP had the second lowest nitrate concentration (0.41 mg/L). Watershed E4, which has the second largest percent of its area in cropland, had the highest mean nitrate concentration (9.60 mg/L). Concentrations of nitrates in subwatersheds with restored wetlands are much lower than in those without restored wetlands.

Because water samples were collected weekly during this study, our estimates of total phosphorus concentrations are not as reliable as are those for nitrates. Phosphorus concentrations in runoff are a function of volume of flow with the highest concentrations typically in initial flows after a storm event. By contrast, nitrate concentrations are less dependent on volume of flow. Phosphorus concentrations in runoff are also highly affected by the topography and total area of the subwatershed sampled. This makes comparisons among subwatersheds more difficult. Mean total phosphorous concentrations in the mostly cropland subwatersheds ranged from 0.081 to 0.172 mg/L while in the four subwatersheds with wetlands it ranged from 0.117 to 0.273 mg/L. The two intermediate subwatersheds had total phosphorus concentrations of 0.129 and 0.175 mg/L. Subwatershed W9 with the largest percentage of its area in wetlands had the highest phosphorous concentration (0.273 mg/L). Subwatershed W10 with the highest percentage of its area in CRP had a mean total phosphorus concentration of 0.205 mg/L. Watershed E3 that has the largest percent of its area in cropland had among the lowest mean total phosphorous concentration (0.137 mg/L). Total phosphorus concentrations in the outflows of subwatersheds with restored wetlands have not been lower than in those without restored wetlands. The phosphorus data, however, have not been adjusted for differences in topography and area among subwatersheds. Consequently, these results should be considered tentative.

Although there is significant variation in their effectiveness for removing nitrates from subwatershed to subwatershed, as expected, restored wetlands and land set-aside programs are effective in reducing nitrate losses from subwatersheds. For total phosphorus, thought to be the major nutrient responsible for algal blooms in most lakes, restored wetlands may not to be reducing total phosphorus in the outflows from subwatersheds with the highest percent of their area covered by wetlands.

To determine if inadequacies in sampling might be responsible for the lack of congruence between phosphorus and nitrate reductions in the outflow from subwatersheds, two flow-weighted automatic samplers were purchased in the fall of 2001 and will be placed in the field in 2002. One will be placed on a subwatershed primarily in row crops and the other on a subwatershed with restored wetlands. Negotiations with landowners have been initiated to obtain permission to locate these samplers on private land away from roads and places of public access to reduce the probability that these automatic samplers will be vandalized.

(b) Restored Wetlands

Five wetlands in the Iowa Great Lakes watershed with distinct, easy to sample inputs and outputs were selected in the summer of 2001. Sampling of nutrients in their inflows and outflows began in July 2001 and ended in October because their inflows dried up. Three of the wetlands (7, 8 and 12) are in subwatersheds of West Lake Okoboji while the other two (1 and 16) are in subwatersheds of East Lake Okoboji.

Input concentrations of nitrates ranged from 6.33 to 21.79 mg/L while the output concentrations ranged from 0.05 to 5.84 mg/L. Wetland 7 the largest reduction in nitrate concentrations with mean input concentrations of 21.79 mg/L and output of 0.15 mg/L. Wetland 1 was the least effective with mean input concentrations of 19.65 mg/L and output of 5.84 mg/L. All of the restored wetlands are effective at removing nitrates. Our data are too limited yet to draw any conclusions about phosphorus.

In the summer of 2001, sampling of the vegetation and standing crop of the five selected restored wetlands was initiated. Each wetland was divided into a series of parallel zones and each zone was sampled using a randomly located transect in the zone. Samples were collected in quadrats placed at random intervals along these transects. The cover of each species in each 1m x 1 m quadrat was recorded and then all aboveground vegetation clipped and bagged. All standing crop samples were oven dried and weighed. Altogether over 200 standing crop samples were collected. The mean standing crop in restored wetlands was about 430 g/m^2. This is considerably lower than standing crops found in natural wetlands in northern Iowa, ca. 600 to 1,000 g/m^2 The cover data and vegetation maps derived from recent aerial photography also indicate that the vegetation in restored wetlands is not as well developed as in natural wetlands in the region.

In summary, restored wetlands are not yet as well developed from an ecosystem perspective as natural wetlands. Consequently, their effectiveness as nutrient sinks may still be less than that of natural wetlands. Nitrate losses have been reduced significantly from subwatersheds that contain restored wetlands and set-aside land. Phosphorus losses from these subwatersheds have not shown a similar trend. The reason for this is unclear. It may be due to inadequate sampling of phosphorus in runoff or it may be because restored wetlands are not good sinks for phosphorus. Improved sampling of runoff from subwatersheds with flow-weighted automatic samplers will be initiated to determine of the poor removal of P is a sampling artifact or not.