Water Quality in the Wuamundee Wetland

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ABSTRACT

The purpose of this study is to show the extent nutrient loading from farm runoff has on the Wuamundee Wetland, and the ability of the wetland to intercept and reduce the amount of pollution being released into the Mississippi River. The Wuamundee Wetland is located near Fountain City, Wisconsin. Water samples were collected from three critical points throughout the wetland, and tested for nitrate, phosphorus and ammonia. The results show the specific amounts of these chemicals that are being carried by the Wuamundee Creek that flows through the wetland. Although high levels of these chemicals were not found at the study sites as expected, the data did show a strong decrease in their levels moving away from farmland toward the Mississippi River. Thus the results support the crucial role of wetlands in improving water quality and suggest that these chemicals would be released directly into the Mississippi River if the wetlands were destroyed.

INTRODUCTION

Non-point source pollutants are a serious threat to water quality and can lead to nutrient loading and eutrophication in watersheds. Runoff from agricultural land is considered a major component of non-point source pollution and is the primary focus of this study. As a result of farming practices, an abundance of chemical pollutants are released into the Mississippi River and produce negative effects on the environment. Most of these pollutants do not enter surface water from a single point but from more widely dispersed sources across the landscape.

As precipitation flows across farm fields it gathers and transports many pollutants. Common pollutants include fertilizers such as nitrates, phosphorus, and ammonia. Farmers use these chemicals because they are nutrients that boost plant growth. When too much of a specific substance enters a waterway after a heavy rainfall, it becomes concentrated and thus becomes toxic to organisms. Research conducted by Kenneth D. Simeral (1998) at Ohio State University has shown that when wetlands are located between agricultural land and waterways, the wetlands can remove or reduce the concentration of many pollutants before the water enters the major waterway. This prevents the pollutants from entering a waterway all at once, acting as a buffer between the waterway and the toxic concentration of pollutants from the farmland. Other preliminary studies conducted by Surface Water Quality Specialists Irrigation Branch in Alberta (2001) have shown that constructed wetlands were able to reduce concentrations of ammonia, total phosphorus, total suspended solids and biochemical oxygen demand by up to 90%.

Filtration of pollutants is a natural function of wetland ecosystems, which improves water quality for the benefit of humans and wildlife (Clean Water Network, 1997). Wetlands act in many ways to filter pollutants from the water. Instead of allowing sediment particles to be transported with the flowing water of streams, wetland vegetation improves the clarity and quality of receiving waters by trapping sediment and pollution in its root system. Plant roots remove soluble nutrients, such as nitrate, from subsurface water flow. According to The Clean Water Network (1997) the uptake of nutrients is stored in leaf matter, which decomposes into soils rich in organic material. Woody plants, present in wetlands, provide more long-term storage of nitrogen and phosphorus. In areas of low oxygen, nitrogen is converted to harmless gas and released into the atmosphere through the process of microbial denitrification (Clean Water Network, 1997). Scientific studies have revealed high rates of nitrogen removal from flooded soils, especially in wetlands that experience periodic flooding and drying (Lowrance et al., 1985). Forested wetlands along streams play a crucial role in reducing nutrient loading, particularly in agricultural areas that are polluted with nitrogen and phosphorus. For instance, a riparian forest in the Chesapeake Bay watershed removed about 80% of the phosphorus and 89% of the nitrogen from agricultural runoff entering a stream (EPA, 1995).
The objective of this research is to investigate how efficient the Wuamundee Creek and Wetland is in removing chemicals from a nutrient loaded watershed; specifically with respect to nitrate, phosphorous, and ammonia. The study area is located near Fountain City, WI, along the Mississippi River (Figure 1). This wetland ecosystem is an

excellent site for this study because it is a relatively self-contained watershed that was drastically affected by the addition of a roadway dividing the wetland into two separate areas. The ultimate goal is to show the effects of agricultural practices and land-use planning on the area's water quality, and the overall significance and ability of the wetlands to intercept and naturally reduce the amount of pollution.

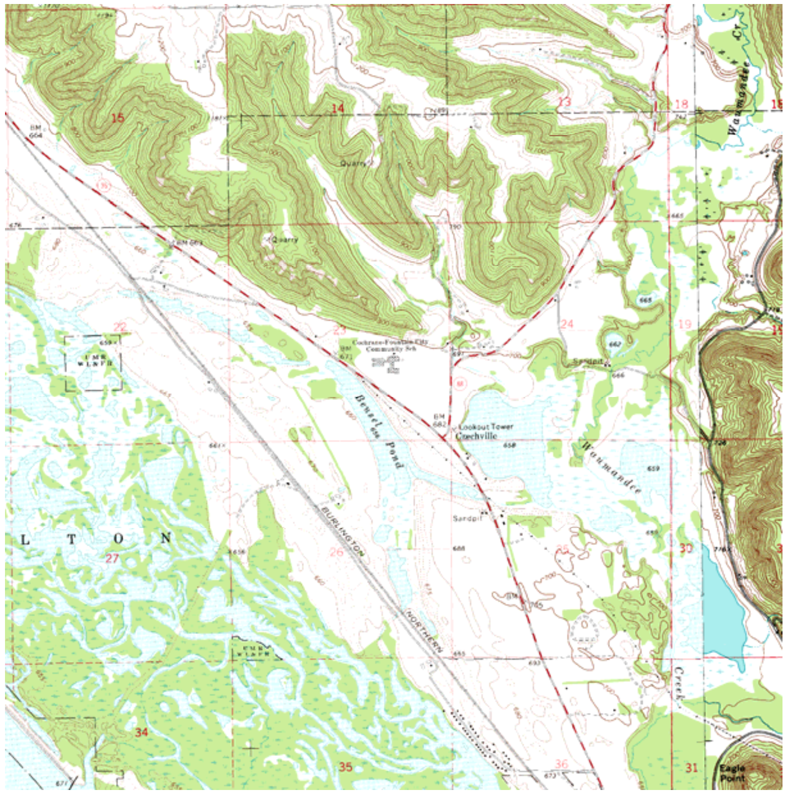

Figure 1. Topographic map of the Waumundee Wetland.

METHODS

In the Fall of 2003 and 2004, phosphorous, nitrogen, and ammonia measurements were taken at three critical locations throughout the wetland. The first collection point was located where the Wuamundee Creek empties into the first of the two wetlands (this point measures the pollution level specifically for the only creek feeding into the wetland area and is also where a farm is located). The second collection point was located at the junction of the two wetlands where the water must pass through a narrow passageway under the highway. The third collection point was located where the second wetland empties into the Mississippi River.

All water samples were taken to the Mississippi River Revival laboratory and analyzed using a spectrometer. Water samples were collected at each of the three collection sites throughout the duration of the study in 100 mL sterile sample bottles. The samples were either tested within 24 hours of collection or preserved with sulfuric acid until ready. If preserved, they were stabilized and then tested within 48 hours. Standards were created and tested for accuracy for nitrate, total phosphorus and ammonia. From this was created a calibration curve for each substance. Standards were re-created and new calibration curves run to achieve the highest r^2 value to reflect the highest possible accuracy. These measurements were then be compared and the differences in results evaluated.

Testing for total phosphorus indicates the amount of phosphorus present in both inorganic and organic forms within a water sample. Phosphorus is of great importance in wetland ecosystems because it is often the nutrient that has the most influence on primary production (EPA, 1995). Measuring for total nitrogen indicates the amount of nitrogen present in both inorganic and organic forms within a water sample. Ammonia is the main form of nitrogen that is produced by the breakdown of organic material and urea. Ammonia and nitrate are commonly used by aquatic plants for growth. Phosphorus and nitrogen are considered the two main nutrients influencing plant metabolism in aquatic systems.

To test for the total phosphorus present in each sample, the ascorbic acid method was used to change all of the types of phosphorus present into one measurable compound. The total phosphorus test is a measure of orthophosphate. Because the sample is not filtered, the procedure measures both dissolved and suspended orthophosphate. The EPA-approved method for measuring total orthophosphate is known as the ascorbic acid method (EPA, 1995). In this method, a powder reagent containing ascorbic acid and ammonium molybdate reacts with orthophosphate in the sample to form a blue compound. The intensity of the blue color is directly proportional to the amount of orthophosphate in the water.

The cadmium reduction method was utilized to test for the presence of nitrates. The cadmium reduction method is a colorimetric method that involves contact of the nitrate in the sample with cadmium particles, which cause nitrates to be converted to nitrites (EPA, 1995). The nitrites then react with another reagent to form a red color whose intensity is proportional to the original amount of nitrate. The red color is then measured with the spectrophotometer, which measures the amount of light absorbed by the treated sample at a specific wavelength. The absorbance value is then converted to the equivalent concentration of nitrate by using a standard curve.

The Nessler method was used to test for the presence of ammonia. Ammonia in water occurs in two forms and this test method measures both forms (EPA, 1995). Ammonia forms a yellow/orange colored reaction with Nessler's Reagent in proportion to the amount of ammonia present in the sample. Rochelle salt is added to prevent cloudiness of the sample. A specific amount of the sample is then placed into a colorimeter tube and measured for absorbance.

RESULTS AND DISCUSSION

The purpose of this study was to assess the Wuamundee Creek Wetland's ability to lessen the overall concentrations of specific substances in the watershed. As shown in the graphs (Figures 2 and 3), there was a reduction in the overall concentrations of phosphorus, nitrate and ammonia from site 1 (nearer to farmland) to site 3 (near the outlet of the Waumundee Creek into the Mississippi River). Thus the expected downward trend of concentrations was confirmed.

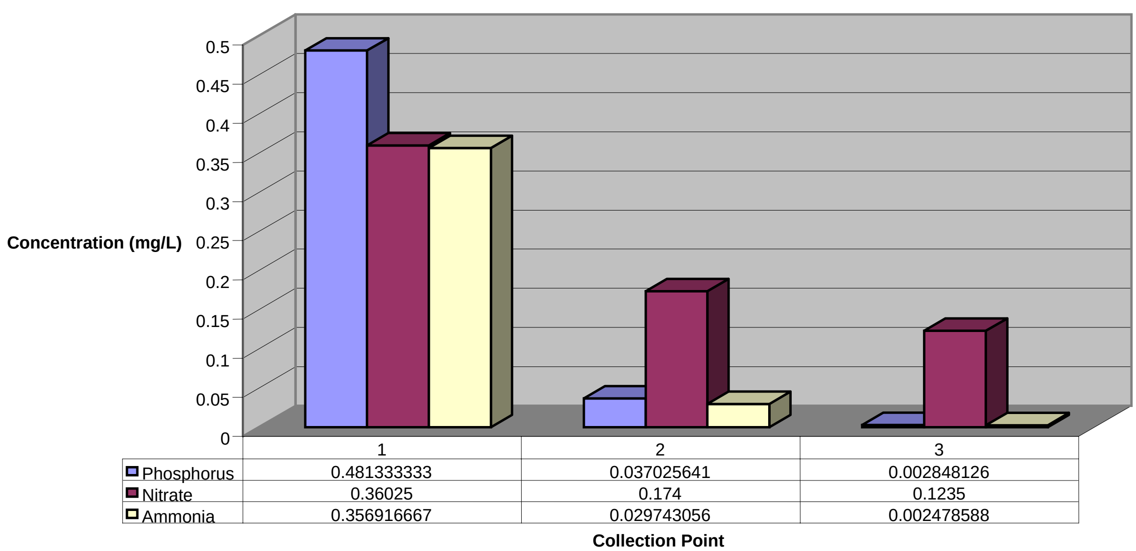

Figure 2. Average concentrations of phosphorus, nitrate and ammonia for each collection site.

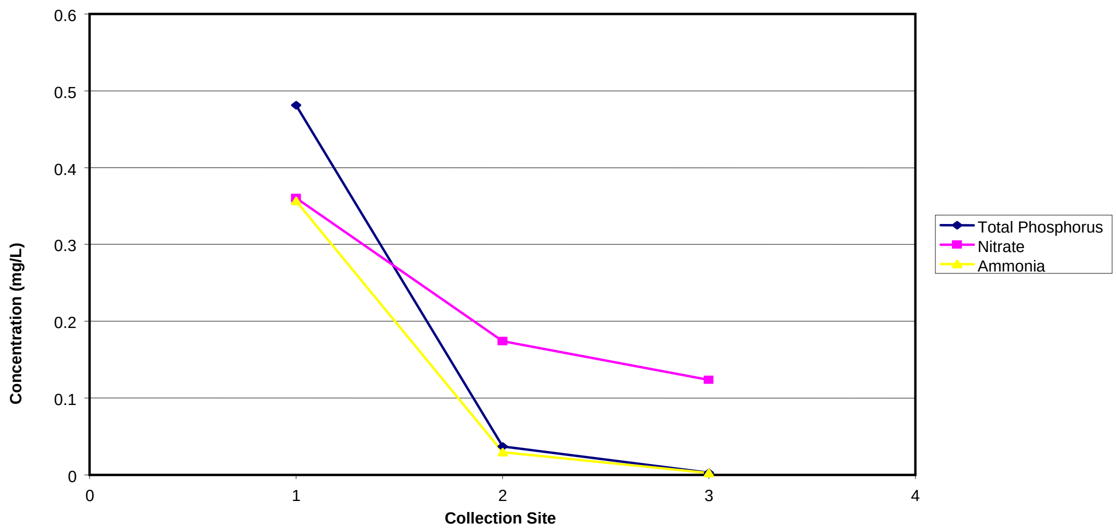

Figure 3. Trend in average concentrations between collection sites.

The data from the testing did not show nearly as high of concentrations as anticipated. The average concentrations of substances being discharged from the wetlands into the river were phosphorus at 0.33 mg/l, nitrate at 0.12 mg/l and ammonia at 0.22 mg/l. The amount of each substance that the EPA considers to impair aquatic life to be 0.61 mg/l of phosphorus, 10 mg/l of nitrogen, and a range around 0.2 mg/l depending on temperature and ph. The average amount of substances being cleaned up from sites 1 and 2 was phosphorus at 0.18 mg/l, nitrate at 0.19 mg/l, and ammonia at 0.86 mg/l. The average amount of substance being removed from the wetland system between sites 2 and 3 was phosphorus at 0.02 mg/l, nitrate at 0.05 mg/l, and ammonia at 0.05 mg/l.

This study suggests that when wetlands are located between agricultural land and waterways such as the Mississippi River, wetlands may aid in reducing the concentration of phosphorous, nitrates and ammonia before the water enters a major waterway. This may reduce the amount of pollutants entering a waterway all at once, therefore acting as a buffer between the waterway and the toxic concentration of pollutants from farmland. Overall, this study demonstrates the impact and importance wetlands have on protecting the main waterways, and how it is of crucial importance that our wetlands be protected and preserved.

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