Report for 2000MN9G: In Situ measurement of denitrification in agricultural streams

There are no reported publications resulting from this project.

Report Follows

Project No.: **C-01**

Title: ***In situ* measurement of denitrification in agricultural streams**

Investigators: **Patrick Brezonik, Water Resources Center; Lorin Hatch, Department of Fisheries and Wildlife, University of Minnesota**

Period: **9/1/00–8/31/01**

Introduction

Nitrate contamination of ground water and streams is common in landscapes dominated by agricultural activities. Associated impacts of this pollution range from local violations of drinking water standards designed to prevent methemoglobinemia to national concerns (e.g., Gulf of Mexico hypoxia). Significant quantities of nitrate are exported from agricultural lands through drainage ditches and low-order natural streams, but our understanding of nitrogen transport and transformation in these agricultural streams is far from complete. Denitrification may be an important mechanism for nitrate removal in these streams, and this would mitigate water quality and health hazards downstream. Several methods can used to measure denitrification, but the most common ones involve laboratory experiments with sediment cores, where conditions are not conducive to obtaining *in situ* rates.

Our main goal is to assess in situ denitrification rates in agricultural streams and determine how these rates vary with stream stage, flow, and temperature. We will compare *in situ* results obtained by acetylene blockage, ^{15}N tracer, ^{15}N natural abundance ratios, and mass balance methods. Part of our field work will use in-stream mesocosms for assessments. We will make measurements over a range of discharge and stage and make a preliminary assessment of the usefulness of artificial stream level manipulations to enhance denitrification. Field work is being conducted in the eastern Minnesota River Basin, an agricultural area with high nitrate levels in its streams and rivers.

Our project has two principal objectives, both of which will provide important information to scientists concerned with evaluating the transport and fate of agricultural nitrogen losses from fields to downstream ecosystems:

(1) evaluate stream denitrification measurement methods;
(2) determine how denitrification rates vary with stream stage, discharge, and temperature.

Activities

We initially selected the Sand Creek system in the Lower Minnesota River major watershed for part of our work, but for logistic and technical reasons, we have since selected an alternative site (Beauford Ditch) in Blue Earth County, MN. This site provides better opportunities for mass balance measurements than the Sand Creek system, and is closer (~ 20 miles west) to the Waseca site (which we are still including in our study). Figure 1 shows for site locations. Beauford Ditch discharges are several times larger than those in the Waseca Ditch, allowing us to assess denitrification under higher discharge situations. Beauford Ditch also has an older, downstream section which has vegetation both on the banks and in-stream, as well as a new ditch section upstream of the vegetated section that was constructed in 1999. This upstream section is devoid of any vegetation. Comparison of the two sections with respect to mass balance and stable isotope analysis will allow us to assess the impact of in-stream vegetation on nitrogen dynamics. We since installed three piezometers adjacent to the ditch at each of the three locations.

Although our project starting date was September 2000, we were unable to find and hire a suitable research assistant until spring 2001. Fortunately, we found such an individual before the summer 2001 field season began. This individual is involved in the field and laboratory studies underway this summer, and he will continue to be associated with the project in fall 2001. However, he will be paid from a fellowship starting in fall, and thus we have hired an additional research assistant to work on the project beginning in fall 2001.

Figure 1. The Minnesota River Basin and research sites.

Our focus for summer/fall 2001 consists of mass balance and stable isotope studies at both the Waseca and Beauford locations. We are conducting 24-hour studies under low and medium flow conditions using autosamplers to collect a series of upstream and downstream samples during four time periods: afternoon, evening, nighttime, and morning. Based on velocity and discharge measurements, we estimate transit time for a given slug of water between upstream and downstream locations. Our goal is to sample the same slug of water downstream that was sampled upstream minutes (or hours) earlier. For example, mid-July transit times between the two Waseca sampling stations (400 m apart) was 160 minutes. We also are collecting and processing water samples along both streams for stable N isotope analysis under low and medium flow conditions this summer and will analyze the samples for $\delta^{15}N$ values this fall.

Future Research

We currently are designing mesocosms for in-stream estimation of denitrification rates by use of ^{15}N tracer techniques We have consulted with our project USGS representative, Frank Triska (Menlo Park, CA) via e-mail and conversations at the February 2000 ASLO conference (Albuquerque, NM) and the June 2000 NABS conference (La Crosse, WI). Light and dark mesocosms will be fitted with battery-powered stirrers for field use. We are also building probes to monitor sediment redox changes over 24-h periods according to depth into the stream bottom sediments. Additional consideration is being given to conducting a solute dynamics study at the Waseca site using a combined chloride/nitrate drip approach. We anticipate that the new research assistant initially will focus on collecting sediment cores at both the Waseca and Beauford locations for use in laboratory experiments on factors affecting denitrification rates in the stream sediments. These experiments will use ^{15}N tracer additions and the acetylene-blockage method to measure rates of denitrification in the intact cores.