GEOMORPHOLOGY AND WATERSHED STUDIES OF THE CANNON RIVER AND ITS TRIBUTARIES: PRAIRIE CREEK I

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Students in the 2001 Minnesota Keck Project completed three projects within the Prairie Creek watershed, one of the larger tributary watersheds of the Cannon River, itself a tributary of the Mississippi River (figure 1).

GEOLOGICAL

Figure 1: Index map of the Cannon River watershed, showing the location of Prairie Creek

BACKGROUND

The Cannon River is near the eastern margin of the ~14,000 year old deposits of the Des Moines Lobe of the Laurentide ice sheet. The topography west of the river is hummocky, with many wetlands and lakes. The major tributaries draining this area may have initially been subglacial conduits draining the Des Moines Lobe. By contrast, the areas east and south of the Cannon River (including the Prairie Creek drainage) have at most a thin cover of Wisconsinan till above older till and bedrock. Some of these areas are covered with loess. Some drainages in this region are choked with glacial outwash, delivered by the subglacial conduits; others are entrenched in bedrock. In 2001, we studied three sites in Prairie Creek, east of the Cannon River (figure 1, figure 2). Glaciofluvial erosional topography near the western headwaters of Prairie Creek shows clearly that subglacial lakes drained catastrophically from west to east across the present course of the Cannon River (Patterson and Hobbs, 1995). The south-eastern headwaters incise Ordovician bedrock in the vicinity of Nerstrand Big Woods State Park. The lower reaches of Prairie Creek valley are choked with outwash.

The local bedrock is Ordovician and nearly flat-lying. Most of the section is carbonate rocks and sandstone, including (from top to bottom) the Decorah Shale, the Platteville limestone, the Glenwood Shale (less than two meters thick) and the St. Peter Sandstone. The Platteville Formation is commonly exposed in stream knickpoints up to 10 m in height.

ENVIRONMENTAL BACKGROUND

The Cannon River watershed (1460 square miles) is a major river system, one of only a few in Minnesota protected under the state's Wild and Scenic Rivers Act. Although much of its drainage area is currently agricultural, the watershed also contains the growing cities of Owatonna, Faribault, Northfield and Cannon Falls (figure 1). The Cannon River is included in the U.S.G.S. National Water Quality Assessment Program (NAWQA) of the Upper Mississippi River Basin.

In recent years, Prairie Creek has attracted attention and monitoring because of the high non-point source pollutant loadings in the vicinity of Nerstrand Big Woods State Park (Minnesota Pollution Control Agency, 1998; Markus, 1998, Zischke and Robbins, 1998). Sediment, especially suspended sediment, has been identified as one of the major pollutants of the Cannon River system. The others are coliform bacteria and nutrients such as phosphates and nitrates, both associated with residential developments (septic and sewer systems) and agriculture. It is not clear whether the pollutants are running off from agricultural land (including feedlots), from rural houses with septic system or if they have natural sources. Attempts to determine the sources of the pollutants (particularly coliform bacteria) are now underway in a cooperative project between Carleton College biologists and the University of Minnesota. Simultaneously, the local NRCS office in Rice County has started a study of the agricultural best management practices (BMPs) by farmers in the watershed.

Other groups concerned about water quality in Prairie Creek include a watershed protection group, the Cannon River Watershed Partnership, which brings together local government officials (such as County water planners), land owners, research scientists, and other residents. The Minnesota Department of

Table 1: Analytical Methods

Method	Units, Sensitivity	Instrument
• Salinity	• ppt	• YSI 130 SCT meter
• Temperature	• Tenths of degrees, C	• YSI 130 SCT meter
• Conductivity	• µs = microsiemens	• YSI 130 SCT meter
• Current velocity	• M/s ± 0.01	• Marsh-McBirney current meter
• Transparency	• cm ± 2	• Transparency tube
• Location	•	• Trimble GeoExplorer II
• pH	• ± 0.02 - ± 0.05	• Orion Research SA250 pH meter
• Phosphate	• mg/l ± 0.05	• Ion chromatograph (Dionex 600), Hach DR890 colorimeter – PhosVer 3 (8048)
• Nitrate	• mg/l ± 0.05	• Ion chromatograph and Hach DR890 colorimeter – Cadmium Reduction (8309)
• Nitrite	• mg/l ± 0.05	• Ion chromatograph and Hach DR890 – High Range ferrous sulfate (8153)
• Sulfate, chloride	•	• Ion chromatograph
• Fecal coliform	•	• 3M Petrifilm

Natural Resources, which operates Nerstrand Big Woods State Park and the adjacent Scientific and Natural Area (SNA) also has great interest in the environmental history of the area, for interpretive purposes and because the State Park's water features are heavily used in the summer.

METHODS

Standard geomorphologic field methods were used to measure stream cross-sections, hillslope and gully profiles and determine discharge. Information on water quality methods is given in the table above. Water samples for each group were collected and tested on a single day. Chemical tests were chosen to give a variety of basic measurements, in part seeking the best and simplest ones to monitor in the future and in part replicating ones of public interest that had been measured in the area (e.g. transparency, coliform). We were especially pleased with the anion results from the ion chromatograph, which allowed students to test for sulfate, chloride and fluoride, in addition to nitrate, nitrite and phosphate.

STUDENT PROJECTS

Students worked in three areas of the upper Prairie Creek watershed, two in the State Park and SNA and one on private land. Although the streams in the project areas are quite different, the projects had several common features:

- All involve biogeomorphology in some way: comparing gully morphology on slopes draining forest and draining agricultural fields (formerly prairie); comparing stream morphology in wooded vs. grass reaches; evaluating the effectiveness of different riparian tree species at preventing erosion; evaluating the effects of wild animals on coliform concentrations.
- All involve multiple sources of water, including springs from bedrock, surface flow and agricultural tile drainage.
- All involve some kind of land use decision, from plugging tiles, to altering vegetation, to developing remedies for coliform contamination.
- Two projects explicitly involve effects of agricultural drainage on water chemistry and physical characteristics of the streams. The third shows the limits to which agricultural drainage can be cleansed by passage through a protected area (the State Park).
- Two projects involve effects of stratigraphic differences on stream morphology.

PROJECT SYNOPSIS

Students worked together for the first several days of the program, scouting possible project sites and being introduced to the natural and agricultural history of the upper Prairie Creek watershed. Once projects were chosen by the three groups of students, weekdays were mainly devoted to field work and lab work and evenings to more lab work, library research, and computer analysis of data.

We took three day-long field trips. On the first trip, we participated in a “mussel rescue” mission on the Mississippi River near LaCrosse, Wisconsin. The Army of Corps of Engineers lowered the elevation of one of the pools between two locks on the river. Our task was to move native mussels into deeper water, cleaning their shells of attached zebra mussels in the process. Since our projects dealt with the upper reaches of a Mississippi tributary, it seemed appropriate to spend a day immersed in some of the environmental and management problems of the main river. The second trip was to Taylors Falls, Minnesota (and neighboring Wisconsin) where several unconformities help reveal the late Precambrian to Holocene history of the state. Our third day trip took us to the University of Minnesota to examine old aerial photos in the University's map library, to tour the St. Anthony Falls Hydraulics Lab (a truly spectacular facility), and to visit some of the geology exposed in St. Paul. Students also spent an afternoon volunteering on a local organic CSA (Community Supported Agriculture) farm and tried (unsuccessfully) to help the Minnesota Twins reverse their precipitous August slump. Abstracts and posters were 95% finished at the end of the program. One of the final project events was a public presentation of project results to an audience of about 25 land managers and local citizens at Nerstrand Big Woods State Park.

CONCLUSIONS

In typical fashion, all the projects turned out to be more complex than imagined. We discovered that coliform counts did not decrease linearly as Prairie Creek passes through Nerstrand Big Woods State Park; in fact, a major source of coliform contamination (or at least retention of coliform) may be at a perfectly natural beaver dam. We discovered plenty of sources of silt and clay for Prairie Creek, but no fine-grained alluvial deposits, at least in the tributaries and reaches we studied in detail. We discovered that a tract of successional woodlands, including some large and beautiful individual trees, may not be the best vegetation type to control bank erosion. And we discovered that agricultural drainage tiles may affect adjacent stream valleys long after vegetation has been converted from agricultural to other uses unless the tiles are deliberately removed or plugged.

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Figure 2: Index map of Prairie Creek watershed, showing study sites

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