Wisconsin

Otter Creek
Section 319
National Monitoring Program Project

Figure 54: Otter Creek (Wisconsin) Project Location

Figure 55: Water Quality Monitoring Stations for Otter Creek (Wisconsin)

PROJECT OVERVIEW

The Otter Creek Section 319 National Monitoring Program project is in east central Wisconsin (Figure 54), with a project area of 9.5 square miles. Otter Creek drains into the Sheboygan River, which then drains into Lake Michigan. Land use mainly consists of dairies and croplands.

Otter Creek has a warmwater forage fishery. The fish community is degraded by lack of cover, disturbed streambanks, and siltation. Fecal coliform levels frequently exceed the state standard of 400 counts per 100 ml, and dissolved oxygen often drops below 2 mg/l during runoff events. Fifteen percent of all water oxygen concentration samples fall below the state standard of 5 mg/L. Otter Creek delivers high concentrations of phosphorus and fecal coliform to the Sheboygan River. These pollutants then travel to the near shore waters of Lake Michigan, which serves as a water supply for municipal use and also supports recreational fisheries.

Streambed sediments originating from cropland erosion, eroding streambanks, and overgrazed dairy pastures are reducing the reproductive potential for a high quality fishery with abundant forage fish. Otter Creek is further degraded by total phosphorus and fecal coliform export from dairy barnyards, pastures, cropland, and alfalfa fields.

Critical area criteria are being used to reduce phosphorus and sediment loading to project area streams. Eight of the nine dairy operations in the project area were classified as critical; two of the eight critical dairy operations spread enough manure that their cropland was classified as critical. Streambank critical areas are the 6,200 feet of streambank trampled by cattle.

Land treatment design is based on the pollutant type and the source of the pollutant. Upland fields were treated with cropland erosion control practices to reduce sediment loss. Streambanks have been fenced to limit cattle access, and barnyard structural practices have been installed to reduce nutrient runoff into Otter Creek. Post-BMP monitoring was completed in Summer, 2002. The final project report was completed in 2005.

PROJECT BACKGROUND

Project Area

The Otter Creek watershed area is about 9.5 square miles. The Meeme River watershed is the control watershed, with an area of about 16 square miles.

Project Hydrologic, Geologic, and Meteorologic Factors

Average annual precipitation is 29 inches. Fifteen inches of rain falls during the growing season between May and September. About 42 inches of snow (five inches of equivalent rain) falls during a typical winter.

The topography of the watershed ranges from rolling hills to nearly level. The soils are clay loams or silty clay loams that have poor infiltration and poor percolation but high fertility. Soils are glacial drift underlain by Niagara dolomite.

Land Use

Land Use	%
Agricultural	75
Forest	14
Wetland	6
Other*	5
Total	100

*Includes pasture, grazed woodlot, residential, water, and roads
Source: Corsi et al., 2005

Water Resource Type and Size

Otter Creek is 4.2 miles long with an average gradient of .0047 ft/ft or 25 ft/mile (Figure 53). The creek flows into and out of a small spring-fed lake called Gerber Lake.

Water Uses and Impairments

Otter Creek is used for fishing and for secondary body contact recreation. The fishery is impaired by degraded habitat, while contact recreation is impaired by high fecal coliform counts. Both uses are also impaired by eutrophic conditions.

Pollutant Sources

There are eight critical dairy operations that serve as important pollutant sources. Trampled streambanks and cropland and pastureland receiving dairy manure are also critical sources. Some critical area cropland is in need of erosion control practice installation.

Modifications Since Project Started

None.

Pre-Project Water Quality

The Otter Creek project area is part of the larger Sheboygan River watershed, identified as a Priority Watershed in 1985. The watershed is characterized by streambank degradation due to cattle traffic. Excessive phosphorus, fecal coliform, and sediment runoff originate from manure spreading and cropland. Fisheries are impaired because of degraded aquatic habitat that limits reproduction. Recreation is limited by degraded fisheries and highly eutrophic and organically enriched stream waters.

Water Quality Objectives

The Otter Creek project water quality objectives are as follows:

- Increase the numbers of intolerant fish species by improving the fish habitat and water quality.
- Improve the recreational uses by reducing the bacteria levels.
- Reduce the loading of pollutants to the Sheboygan River and Lake Michigan by installation of best management practices (BMPs) in the Otter Creek watershed.
- Improve the wildlife habitat by restoring riparian vegetation.

Project Time Frame

Spring, 1994 through Spring, 2003

PROJECT DESIGN

Nonpoint Source Control Strategy

Streambank erosion and cattle exclusion practices included shoreline and streambank fencing and stabilization; barnyard management included barnyard runoff management and manure storage facilities; and cropland practices included grassed waterways, reduced tillage, and nutrient and pesticide management.

The Sheboygan County Land Conservation Department obtained funds through a private organization, "Pheasants Forever," to plant and maintain vegetative buffers on 19.8 acres of riparian land for 10 years.

Nine thousand, two hundred feet of streambank fencing have been installed, as well as a significant change in cropping practices to reduce upland soil erosion.

Project Schedule

Management Unit	Pre-BMP Monitoring Dates	BMP Installed	Date Installed/ Established	Post-BMP Monitoring Dates
Otter Creek Watershed	A USGS monitoring station has been collecting water quality data on Otter Creek since 1990. Water quality monitoring funded through the 319 Program began in April 1994. Pre-BMP 1990-1993.	Animal waste utilization, Streambank stabilization, Runoff diversions, Conservation tillage, Clean-water diversions, Barnyard runoff controls, Cattle crossings, Streambank fencing	Majority of BMPs were installed between Oct. 1993- Sept. 1997	Oct. 1999-Sept. 2002
Upstream-downstream monitoring study, within the Otter Creek Watershed	April 1994 – October 1995	Clean-water diversions, Barnyard runoff controls, Filter strip, Cattle crossing, Streambank fencing	October 1995 – November 1995	April 1996 – June 1997

Water Quality Monitoring

Two monitoring studies were conducted in the Otter Creek National Monitoring Program project. They initially included a paired watershed study and an above and below study. Because of significant changes in the control watershed (MR1) that prevented a paired watershed analysis, the data collected at the Otter Creek outlet station (OC1) were evaluated as a on Otter Creek single-watershed before-/ after- design.

Six sampling sites on Otter Creek are shown in Figure 53. The main site on Otter Creek was an outlet station that served as the site for the single station before and after monitoring site. Four fish and habitat monitoring stations are indicated by the numbered dots in Figure 53. The above and below watershed study was conducted using two mainstem sites located above and below a critical area dairy, approximately coinciding with the biological monitoring stations numbered 3 and 2 in Figure 53.

The before-/after- watershed study was used to assess the overall impact of best management practices on water quality. The treatment watershed is 9.5 square miles and was monitored at station OC1. Biological, bacterial, and chemical parameters were monitored; precipitation, along with precipitation and water discharge covariates.

The above and below study of a single dairy that implemented barnyard runoff control structures has been completed. Data on the pollutant loads from the barnyard prior to BMPs are reported in USGS Fact Sheets FS-221-95 and FS-051-98. Findings on this before and after – above and below study were presented at the 1997 National 319 Conference.

Variables Measured

Biological

Fisheries survey
Macroinvertebrate survey
Habitat assessment
Fecal coliform (FC)*

Chemical

Total phosphorus (TP)*
Dissolved phosphorus (DP)
Total Kjeldahl nitrogen (TKN)
Ammonia (NH_3)*
Nitrogen series ($N0_2$-N and $N0_3$-N)
Total suspended solids (TSS)*
Dissolved oxygen (DO)*
pH

*monitored throughout entire project

Covariates

Stream discharge
Precipitation

Sampling Scheme

The schedule for chemical grab sampling and biological and habitat monitoring varied by station and by year. Chemical grab sampling occurred at a time characterized as midsummer-fall for 1990 and 1994 and during spring-midsummer in 1991.

Fisheries monitoring included sampling fish species, frequencies, and biomass. Fisheries data were summarized and interpreted based on the Index of Biotic Integrity (Lyons, 1992). Macroinvertebrate monitoring criteria included macroinvertebrate species or genera and numbers. Macroinvertebrate data were summarized and interpreted using the Hilsenhoff Biotic Index (Hilsenhoff , 1987). Habitat parameters included riparian buffer width, bank erosion, pool area, stream width to depth ratio, riffle-to-riffle or bend-to-bend rating, percent fine sediments, and cover for fish. Habitat information was rated using the fish habitat rating system established for Wisconsin streams by Simonson et al. (1994).

Grab and event-flow samples were used for water chemistry monitoring. Parameters sampled included TP, FC, DO, and TSS.

The following table provides details on the original sampling design for the paired study, the upstream/downstream, and the single downstream station. The monitoring sites are listed for reference. The primary covariates are very similar for each study except for methods used for

macroinvertebrates. The frequency of sampling, the covariates, and the duration of each study are also listed.

The before and after – above and below component of the project has been completed. Automated event flow sampling has been discontinued on Otter Creek.

Monitoring Scheme for the Otter Creek Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of Primary Parameter Sampling	Duration
Paired watershed design	Otter Creek[T] OC1 Meeme River[C] MR1	Fisheries index Macroinvertebrates[H] Habitat FC TP DP TKN NH_3 NO_3 NO_2 TSS DO	Precipitation Discharge	Annually Annually Annually 30 samples per monitoring season; weekly April-Oct.	1990-2002
Upstream/ downstream	Above Dairy[C] OC4 Below Dairy[T] OC2	Fisheries index Macroinvertebrates[F] Habitat Same bacterial & chemical parameters as paired watershed study	Precipitation Discharge	Annually Annually Annually 30 samples per monitoring season; weekly April-Oct.; periodic storm event sampling	1994-1997
Single downstream	Otter Creek OC1	Fisheries index Macroinvertebrates[F] Habitat Same bacterial & chemical parameters as paired watershed study	Precipitation Discharge	30 samples per monitoring season for nutrients only	1990-2002

[T] = Treatment Area
[C] = Control Area
[H] = Hilsenhoff Biotic Index level; kick samples
[F] = Family level; kick samples

DATA MANAGEMENT AND ANALYSIS

Data Management and Storage

All water chemistry data were entered into the Wisconsin Department of Natural Resources (DNR) data management system, WATSTORE (the U.S. Geological Survey national database), U.S. Environmental Protection Agency's Nonpoint Source Management System software (NPSMS), and STORET.

Project Findings

Before/after watershed study. Targeted and implemented land treatment in the Otter Creek Watershed is summarized in the table below. Upland erosion control BMPs included change in crop rotation, reduced tillage, critical area stabilization, grass waterways, and pasture management; tons of sediment controlled were estimated by the RUSLE.

Management practice	Targeted	Implemented
Animal waste management		
Manure storage (#)	4	3
Barnyard runoff (#)	8	8
Milkhouse wastewater treatment (#)	0	2
Streambank protection		
Streambank protection (feet)	6,600	6,220
Fencing (feet)	9,200	9,200
Grade stabilization (#)	4	4
Buffer strips (acres)	0	19.8
Upland management		
Nutrient management (acres)	1,130	1,570
Upland erosion BMPs (tons of sediment)	505	276

Under base-flow conditions, reductions between pre- and post-BMP periods were detected in median concentrations for total suspended solids (TSS) and BOD_5 but not for total phosphorus (TP) or dissolved ammonia nitrogen. Fecal coliform counts during base-flow increased over the study period.

Annual reductions in rainfall storm loads between the pre-and post-BMP periods during the non-vegetative season (Nov through May) were observed for TSS (58%), TP (48%) and dissolved ammonia nitrogen (41%). Differences in rainfall storm loads of these three constituents for the vegetative season (June through October) were not detected. On an annual basis, TSS storm loads were reduced by 58% and dissolved ammonia nitrogen loads were reduced by 41% during the post-BMP period.

Habitat was improved for stream segments that had either natural riparian buffer or where streambank fencing was installed, but not at the station where the riparian area was pasture and no streambank fencing was installed. Biomonitoring results also suggest that BMP implementation in Otter Creek substantially modified fish community structure, but the overall community quality was not improved.

The Sheboygan County Land and Water Conservation Department felt that the most effective BMPs for TSS reduction were the buffer strips, which provide an area for solids to settle before reaching the stream, and streambank fencing that allows for growth of vegetation on the streambank, reducing streambank erosion. The most effective BMPs for nutrient reduction were believed to be streambank fencing that reduced the number of livestock in the stream, barnyard-runoff control systems, manure-storage facilities, and milk house wastewater treatment systems.

The final report on this portion of the project is published as Corsi, et al. 2005. Effects of Best-Management Practices in Otter Creek in the Sheboygan River Priority Watershed, Wisconsin, 1990-2002. Scientific Investigations Report 2005-5009, U.S. Geological Survey, U.S. Department of the Interior and is available at: http://water.usgs.gov/pubs/sir/2005/5009

Upstream/downstream study. A comparison of upstream and downstream loads after the barnyard BMPs were implemented indicates that the BMP systems improved water quality. Post-BMP pollutant loads contributed by the barnyard were significantly lower than pre-BMP loads for:

suspended solids (85%), total phosphorus (85%), ammonia (94%), BOD (83%), and fecal coliform (81%) were statistically lower. The final report on this portion of the project is published as Stuntebeck and Bannerman. 1998. *Effectiveness of Barnyard Best Management Practices in Wisconsin*. USGS Fact Sheet FS-051-98. U.S. Geological Survey, U.S. Department of the Interior and is available at http://wi.water.usgs.gov/pubs/FS-051-98/.

INFORMATION, EDUCATION, AND PUBLICITY

The Sheboygan County Land Conservation Department developed and implemented an effective educational program to reach project dairymen. Project personnel achieved a high level of participation through education, technical assistance, effective communication, and cost-share assistance.

- Watershed tours are held for landowners.
- Watershed newsletters are sent biannually to landowners.
- Annual watershed advisory committee meetings are held.
- Small group tours of BMP installation sites are given for landowners considering installing BMPs.

TOTAL PROJECT BUDGET

Funds through the state of Wisconsin Nonpoint Source Program were used to fund cost-share practices. The estimated budget for the Otter Creek National Monitoring Program project for the period FY00 is:

Project Element	**Funding Source($)**			
	Federal	**State**	**Local**	**Total**
Proj Mgt	NA	5,000	NA	5,000
LT	NA	NA	NA	NA
I&E	NA	5,000	NA	5,000
WQ Monit	25,000	NA	NA	25,000
TOTALS	25,000	10,000	NA	35,000

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

State grants were provided to cover the cost of land treatment technical assistance and information and educational support.

OTHER PERTINENT INFORMATION

Cooperating agencies included the Wisconsin Department of Natural Resources, Department of Agriculture, Trade, and Consumer Protection, Sheboygan County Land Conservation Department, and the U.S. Geological Survey.

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