Iowa

Walnut Creek
Section 319
National Monitoring Program Project

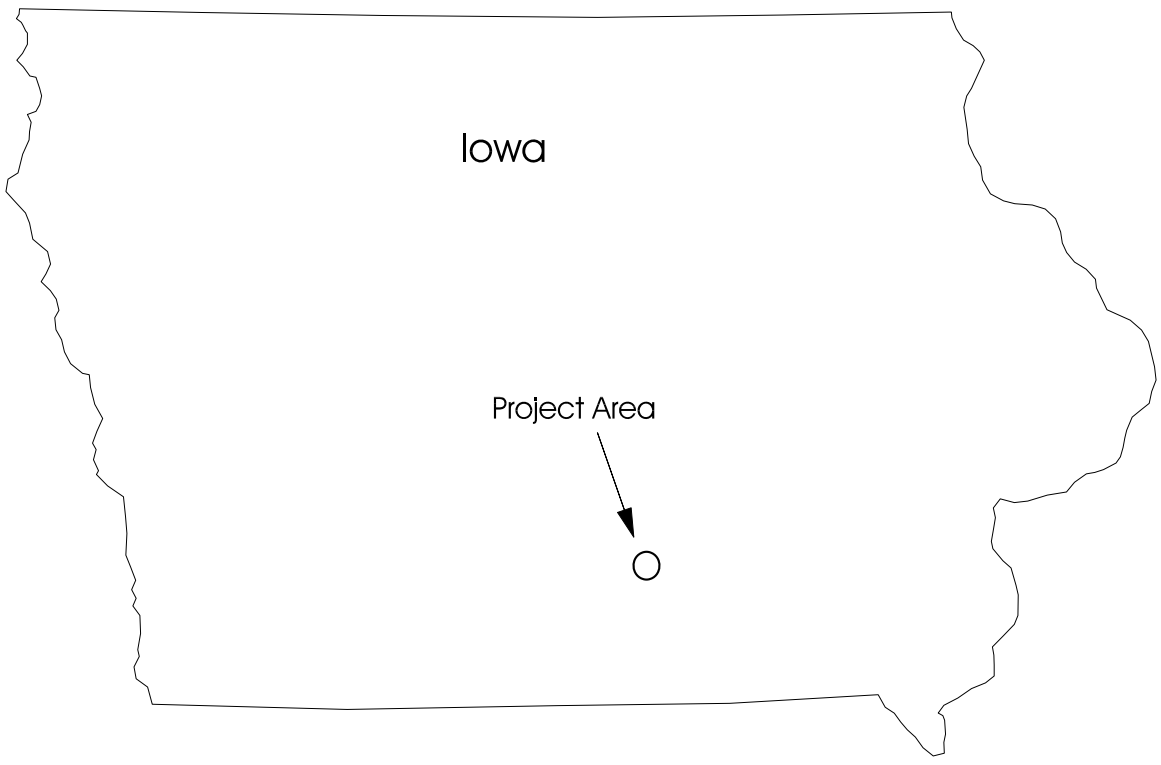

Figure 17: Walnut Creek (Section 319) Project Location

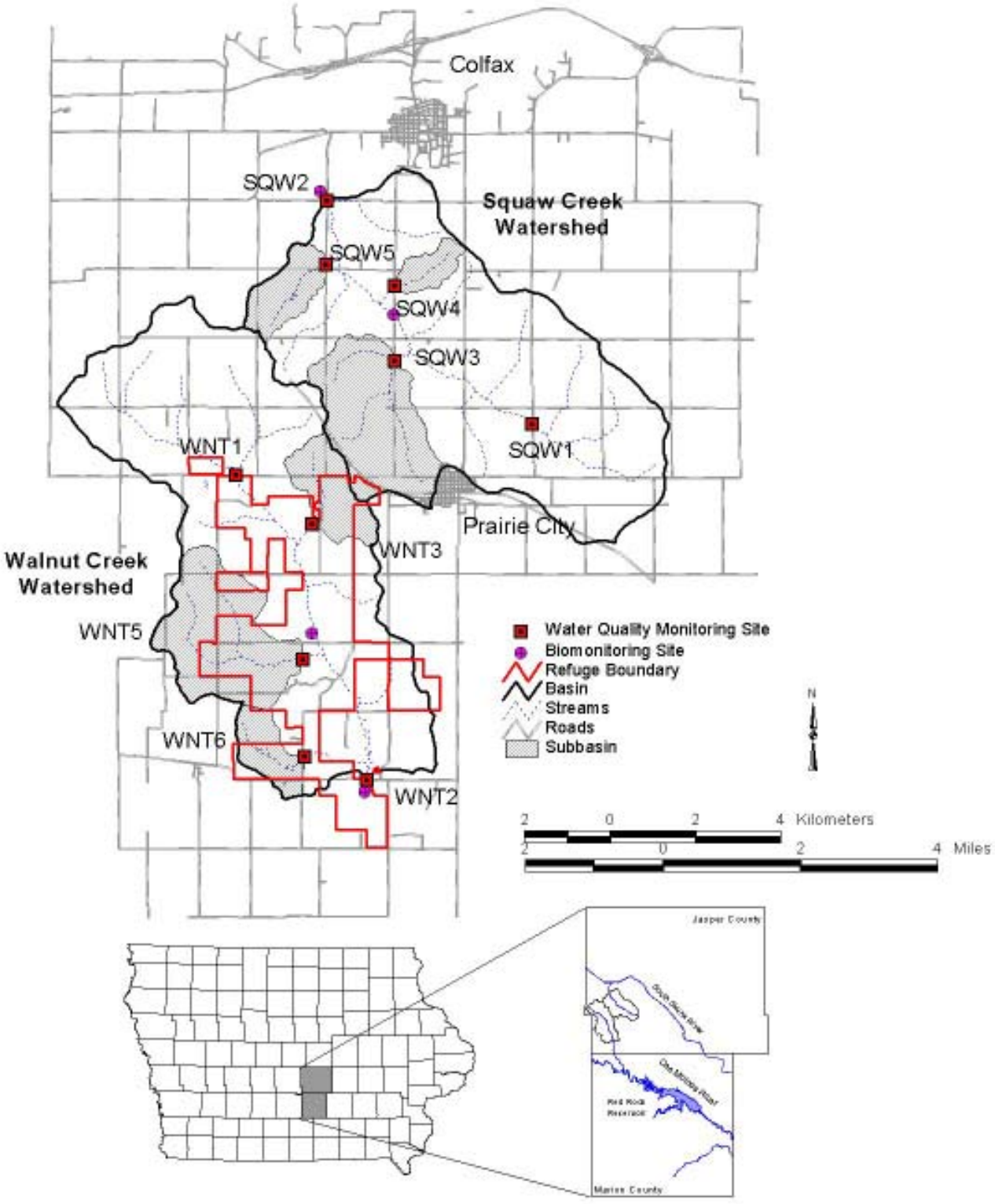

Figure 18: Water Quality Monitoring Stations for Walnut Creek (Iowa)

PROJECT OVERVIEW

The Walnut Creek Watershed Restoration and Water Quality Monitoring Project conducted between 1995 and 2005 was designed as a nonpoint source monitoring program in relation to the watershed habitat restoration and agricultural management changes implemented by the U.S. Fish and Wildlife Service (USFWS) at Neal Smith National Wildlife Refuge and Prairie Learning Center (WNT) in central Iowa. The watershed is being restored from row crop to native prairie.

There were two components to the land use changes being implemented by USFWS: ecosystem resources restoration to prairie/savanna and mandatory (contractual) use of improved agricultural management practices on farmlands prior to conversion. The majority of the Refuge area is being seeded to tall-grass prairie with savanna components where applicable. In the riparian areas, 100 foot-wide vegetative filter strips will be seeded along all of the streams in the Refuge that are not allowed to revert to wetlands. Riparian and upland wetlands will also be restored or allowed to revert to wetlands by the elimination of tile lines.

The USFWS management team also controls cropland management within the WNT Refuge. Farming is done on a contractual, cash-rent basis, with various management measures specified; some are flexible, some more prescriptive. The measures include soil conservation practices; nutrient management through soil testing, yield goals, and nutrient credit records; and integrated pest management. Crop scouting for pest management is mandatory for all farms on Refuge lands, as are no-till production methods. Insecticide use is highly restricted and herbicide use is also controlled in order to minimize adverse impacts on non-target plants and animals.

The project utilized a paired watershed approach as well as an upstream/downstream assessment. The treatment watershed is Walnut Creek, the paired site is Squaw Creek. Both watersheds are primarily agricultural dominated by row crop, mainly corn and soybeans. Although no specific water quality objectives have been set for this project, the intent of the USFWS is to restore the area to pre-settlement conditions, circa 1840. In general, the decrease in active row crop agriculture should lead to reductions in nutrients and pesticides in Walnut Creek.

Three gaging stations for flow and sediment were established, two on Walnut Creek and one on Squaw Creek. Both creeks were monitored for biological and chemical parameters. Both the main creek and several tributaries are included in the sampling scheme.

The Walnut Creek monitoring project was completed on September 30, 2005. A final report for the project was completed in April 2006 and is available online at http://www.igsb.uiowa.edu/gsbpubs/pdf/tis-49.pdf.

PROJECT BACKGROUND

Project Area

The project area, located in central Iowa (Figure 18), consists of a total of 24,570 acres. The Walnut Creek Basin is the treatment watershed (12,860 acres) and the Squaw Creek Basin (11,710) is the control watershed (Figure 18). Both creeks have been channelized in part. Both are characterized by silty bottoms and high, often vertical, banks. Deposition of up to 4 feet of post-settlement alluvium is not uncommon.

Relevant Hydrologic, Geologic, and Meteorological Factors

The total project area is located in the Southern Iowa Drift Plain, an area characterized by steeply rolling hills and well-developed drainage. Dominant soils are silty clay loams, silt loams, or clay

loams formed in loess and till. Average annual rainfall for the project area is approximately 32 inches. Both creeks have been extensively channelized and are incised into their valleys. Two to six feet of post-settlement alluvium is present in both valleys. Stream gradients in the main stem vary from 0.01 to 0.002. Basin characteristics of Walnut and Squaw creek watersheds are very similar:

Basin Characteristics	**Walnut Creek**	**Squaw Creek**
Total Drainage Area (sq mi)	20.142	18.305
Slope Class:		
A (0-2%)	19.9	19.7
B (2-5%)	26.2	26.7
C (5-9%)	24.4	25.0
D (9-14%)	24.5	22.2
E (14-18%)	5.0	6.5
Basin Length (mi)	7.772	6.667
Basin Perimeter (mi)	23.342	19.947
Average Basin Slope (ft/mi)	10.963	10.981
Basin Relief (ft)	168	191
Relative Relief (ft/mi)	7.197	9.575
Main Channel Length (mi)	9.082	7.605
Total Stream Length (mi)	26.479	26.111
Main Channel Slope (ft/mi)	11.304	12.623
Main Channel Sinuosity Ratio	1.169	1.141
Stream Density (mi/sq mi)	1.315	1.426
Number of First Order Streams (FOS)	12	13
Drainage Frequency (FOS/sq mi)	0.596	0.710

Land Use

In 1990, land use in both Walnut and Squaw Creek watersheds was dominated by row crops of corn and soybeans, with 69.4 percent row crop in Walnut Creek and 71.4 percent in Squaw Creek. From 1990 to 2005, major changes in land cover occurred in both watersheds. Squaw Creek showed an increasing trend of row crop land use whereas row crop in Walnut Creek significantly decreased. In Squaw Creek, a 9.2 percent increase in row crop area from 1990 to 2005 was likely due to the passage of the Freedom to Farm Act in 1996 that appeared to have substantially increased row crop production. Lands previously categorized as grasslands enrolled in the Conservation Reserve Program (CRP) were converted to row crop production. This trend was particularly evident in two monitored subbasins (SQW4 and SQW5) where the row crop percentage increased by 26 and 29 percent. In Walnut Creek watershed, row crop land use decreased from 69.4 to 54.5 percent between 1992 to 2005 as a result of prairie restoration by the USFWS at the Neal Smith refuge. From 1992 to 2005, an average of approximately 222 acres of prairie were planted each year. As of 2005, 3,023 acres of land in Walnut Creek watershed were planted in native prairie, representing 23.5 percent of the watershed. In the subbasins, restored prairie accounted for 14.3 to 45.9 percent of the land area. In Squaw Creek, nitrogen applications increased 12.8% over 1990 N applications whereas nitrogen applications in the Walnut Creek watershed decreased 21.4%. Pesticide applications in Walnut Creek watershed were reduced by nearly 28 percent compared to levels in 1990.

Water Resource Type and Size

Walnut Creek and Squaw Creek are warmwater streams located in central Iowa.

Water Uses and Impairments

Walnut Creek and Squaw Creek are designated under the general use category. No designated use classification has been assigned to Walnut Creek.

Walnut Creek drains into a segment of the Des Moines River that is classified as Not Supporting its designated uses in the Iowa Department of Natural Resources' (IDNR) water quality assessments; Squaw Creek and the Skunk River are classified as Partially Supporting. Assessments in this area cite agricultural nonpoint source as the principal concern.

Walnut and Squaw creeks are affected by many agricultural nonpoint source water pollutants, including sediment, nutrients, pesticides, and animal waste. Water quality in these streams is typical for many of Iowa's small warmwater streams: water quality varies significantly with changes in discharge and runoff. Streambank erosion has contributed to significant sedimentation in the creeks.

Pollutant Sources

Sediment — streambank erosion, cropland erosion, gully erosion, animal grazing
Nutrients — crop fertilizers, manure
Pesticides — cropland

Pre-Project Water Quality

Three pre-project water quality studies were completed. The US Fish and Wildlife Service collected data during the pre-implementation period in 1991. The Tri-State Monitoring Project collected data in the Walnut Creek basin from 1992 to 1994. Two sets of storm event samples were collected in 1995.

In 1991, nitrate-nitrogen concentrations ranged from 14 to 19 mg/l with a mean of 16. Atrazine concentrations were from 0.24 to 1.2 ug/l. The Tri-State data were similar, with nitrogen from 5 to 44 mg/l, averaging 14.5 mg/l and atrazine from 0.1 to 2.7 ug/l. The event sampling in 1994 had fewer samples, but nitrogen ranged from 2.1 to 11.0 mg/l (avg. 6.1) in Walnut Creek and from 0.1 to 20 (avg. 10.0) in the tributaries. Atrazine in the main stem of Walnut Creek ranged from <0.1 to 0.3 ug/l and was higher in the tributaries (up to 3.1 ug/l).

Primary biological productivity is low and the condition of the fish community is poor.

Water Quality Objectives

Maintain or exceed water quality criteria for general use waters. The long-term goal of the US Fish and Wildlife Service is to restore this area to pre-settlement conditions.

Project Time Frame

April, 1995 to September, 2005

PROJECT DESIGN

Nonpoint Source Control Strategy

In general, best management practices (BMPs) for row crop production include specific erosion control measures along with nutrient and pesticide management. In the Walnut Creek watershed, the primary land treatment activity was removal of cropland from production by converting it to native tall grass prairie. Wetlands and riparian zones were also restored. Limited nutrient and pesticide management was expected for the remainder of the Walnut Creek watershed.

Project Schedule

Management Unit	Pre-BMP Monitoring Dates	BMP Installed	Date Installed/ Established	Post-BMP Monitoring Dates
Squaw Creek (control)	June 1991 – September 1994	None	None	June 1994 – Current
Walnut Creek (treatment)	May 1991 – September 1994	Restoration of prairie/ savanna; Improved management practices (filter strips, no till, restricted pesticide use)	1992 – Current	June 1994 – September 2005

Water Quality Monitoring

A paired monitoring design was used (Figure 18). For the paired watershed design, the outlets of Walnut Creek (treatment) and Squaw Creek (control) watersheds were monitored. Each watershed had stations upstream and downstream in order to differentiate natural processes from land use changes. Gradual changes in water quality were compared to evaluate land treatment effectiveness.

Parameters Measured

Biological

Fecal coliform (FC)
Macroinvertebrates
Fisheries

Chemical and Other

Chloride (Cl)
Common herbicides
Dissolved oxygen (DO)
Nitrate (NO_3)
pH
Specific conductivity
Sulfate (SO_4^-)
Turbidity

Covariates

Precipitation
Water Discharge

Sampling Scheme

The outlets at Walnut and Squaw Creeks were gaged, as was an upstream station on the main stem of Walnut Creek. At these three stations, water discharge and SS were monitored daily, and data compiled for storm event statistical evaluation.

Ten stations were monitored biweekly to monthly in March through September. Four stations were sampled once in August, October, December, and February.

Modifications Since Project Start

The number of chemical parameters measured had been reduced. Chemical parameters that showed little variability or were not detected during five years of monitoring were not retained for future chemical monitoring.

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

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired	Walnut Creek[T] Squaw Creek[C]	NO_3 Pesticides Turbidity SS	Precipitation Water Discharge	Biweekly/ Monthly; Storm events	Habitat/fisheries annually; Macroinv. bimonthly	Unknown
Upstream/ Downstream	Walnut Creek[T]	NO_3 Pesticides Turbidity SS	Precipitation Water Discharge	Biweekly/ Monthly; Storm events	Habitat/fisheries annually; Macroinv. bimonthly	Unknown

T = Treament watershed
C = Control watershed

Progress To Date

The monitoring project was completed in September 2005. Water quality monitoring data from the project will be available on STORET at http://wqm.igsb.uiowa.edu/iastoret/. Flow and suspended sediment measurements are available for downloading from the USGS at http://waterdata.usgs.gov/ia/nwis/sw.

DATA MANAGEMENT AND ANALYSIS

All United States Geological Survey (USGS) data are reported in WATSTORE, the USGS national database. The project used Arcview for tracking and quantifying land use changes. Statistical analyses on water quality data for trend detection were completed as deemed necessary. Water quality parameters and land use activities were tracked using Nonpoint Source Management System (NPSMS) software. Data management and reporting was handled by the Iowa Department of Natural Resources Geological Survey Bureau (IDNR-GSB) and follows the Nonpoint Source Monitoring and Reporting Requirements for Watershed Implementation Grants. All water quality data are entered into STORET.

NPSMS Data Summary

Not available.

Final Results

Suspended Sediment

Suspended sediment concentrations and loads varied widely during the 10-year monitoring period. Total annual sediment export ranged from 3,706 to 18,367 tons in Walnut Creek and from 893 to 20,456 tons in Squaw Creek, with higher average annual loss higher in Walnut Creek (8,384 tons) than Squaw Creek (8,044 tons). Sediment transport through Walnut and Squaw creek watersheds was very flashy, evidenced by most of the annual suspended sediment load occurring during intermittent high flow events. While single day discharge events typically accounted for six to eight percent of the annual discharge, single day suspended sediment loads accounted for 25 to 37 percent of annual sediment total. The pattern of rapid conveyance of discharge and sediment loads is typical of incised channels. Greatest sediment transport typically occurred in May and June of each year, when on average these months accounted for 59.2 and 68.2% of the total annual load in Walnut and Squaw Creek watersheds, respectively. Annual sediment loss was similar in both watersheds, averaging 0.69 and 0.65 tons/acre, respectively, with annual sediment yield significantly related to annual discharge.

Suspended sediment concentrations were similar in Walnut Creek and Squaw Creek, with average and median values of 104.1 and 46.0 mg/l at WNT2 and 90.1 and 42.7 mg/l at SQW2, respectively. Suspended sediment concentrations most commonly ranged between 20-50 mg/l, with concentrations within this range approximately 35 to 39 percent of the time. Trends in daily sediment concentrations and loads were mixed and reflected the variable nature of sediment transport. One regression model indicated a decreasing trend in sediment concentrations and loads over time was observed at WNT2 whereas another model indicated an increase over time. A GIS-based RUSLE model suggested that prairie reconstruction in Walnut Creek watershed reduced sheet and rill erosion by more than 50% compared to Squaw Creek. Field mapping suggested that streambank erosion contributes greatly to sediment export in Walnut Creek (up to 50% of total) compared to Squaw Creek (14% of total).

Nitrate

Nitrate concentrations have ranged between <0.5 to 14 mg/l at the Walnut Creek outlet (WNT2) and 2.1 to 15 mg/l at the downstream Squaw Creek outlet (SQW2). Mean nitrate concentrations were 1.7 mg/l higher at SQW2 than WNT2, and highest at the upstream monitoring sites in both watersheds, averaging 11.2 mg/l at WNT1 and 12.4 mg/l at SQW1. Monthly nitrate concentrations exhibited clear seasonality, with higher concentrations occurring during May, June and July. Both Walnut and Squaw Creek watersheds have shown a similar temporal pattern of detection, with higher concentrations observed in the spring and early summer months coinciding with periods of application, greater precipitation and higher stream flow. Total export of nitrate from Walnut Creek (WNT2) was lower than Squaw Creek (SQW2) averaging 22.0 and 26.1 kg/ha, respectively. The average flow-weighted concentration of nitrate was 8.6 mg/l in Squaw Creek and 10.4 mg/l in upper Walnut Creek but was 4.9 mg/l in lower Walnut Creek.

During the 10-year project, nitrate concentrations significantly decreased in Walnut Creek watershed, both at the watershed outlet and in monitored subbasins. At the Walnut Creek outlet (WNT2), the trend analysis indicated that nitrate concentrations decreased 0.119 mg/l/year or 1.2 mg/l over 10 years when the Squaw Control watershed was utilized as a covariate. Nitrate concentrations decreased 3.4, 1.2 and 2.7 mg/l at WNT3, WNT5 and WNT6 subbasins, respectively. Nitrate concentrations increased 1.9 mg/l over 10 years in the downstream Squaw station SQW2 and 1.1 mg/l over 10 years in the upstream Squaw station SQW1. All subbasins in the Squaw Creek increased in nitrate concentrations, with subbasins SQW4 and SQW5 having quite dramatic increases. Over the 10-year monitoring program, nitrate in surface water in SQW4 and SQW5 subbasins increased 11.6 and 8.0 mg/l, respectively.

Pesticides

Atrazine and DEA were the most commonly detected herbicides in both watersheds with detection frequencies greater than 70 percent. Acetochlor was occasionally detected (up to 27 percent) whereas alachlor and metolachlor were rarely detectable (less than 5%). Cyanazine detections were also rare during the last five years of the project. Concentrations of atrazine often exceeded 1 ug/L during high streamflows in late spring/early summer; however, overall median concentrations of atrazine and DEA were less than 0.3 ug/l. May and June accounted for approximately 80 percent of the export load of atrazine, and the period of April through July accounted for 96 percent of the annual atrazine load. Statistical changes in herbicide concentrations over time were mixed, since both decreasing and increasing trends were observed. Sites WNT3 and SQW2 had decreasing trends in atrazine concentration with respect to time whereas sites WNT5, WNT6, and SQW5 had increasing trends in DEA concentration with respect to time. Other sites had no herbicide trends over time.

Fecal Coliform Bacteria

Fecal coliform bacteria were detected frequently above the EPA water quality standard of 200 count/ 100 ml in both watersheds. Elevated detections were occasionally observed at all monitored watersheds with highest fecal coliform counts occurring at any time between May and October during high stream flow periods associated with rainfall runoff. No changes in fecal coliform concentrations were observed during the 10-year monitoring project at downstream Walnut Creek (WNT2). Increases in fecal coliform concentrations were noted in two Walnut subbasins.

Phosphorus

Phosphorus (P) monitoring began in Water Year 2001 and thus five years of monitoring data were available for project reporting. Annually, median P concentrations were consistent, ranging between 0.14 to 0.2 mg/l at SQW2 and 0.17 to 0.2 mg/l at WNT2 for water years 2001 to 2005. The range in annual median P concentrations varied between 0.06 to 0.2 mg/l at all sites. Phosphorus did not change in any of the main stem streams in either Walnut Creek or Squaw Creek. The only statistically significant trend in phosphorus was an increase in the SQW3 subbasin and a decreasing trend in SQW5. Lack of phosphorus concentration trends in five years of monitoring in the watersheds was not unexpected given the episodic transport and variability in P concentrations detected in water.

Biomonitoring

Quantitative collections from Squaw Creek and Walnut Creek had poor macroinvertebrate colonization during the project. Taxa richness metrics for Walnut Creek initially showed consistent improvement until 2001 after which metrics have steadily declined to lower levels than project inception. The metric measures of community balance showed similar positive trends with values decreasing until 2002, after which values have increased to levels at or higher than project inception levels. However, many of the positive changes in the macroinvertebrate community appeared to be driven by the habitat modification (addition of coarse substrate for a bridge crossing) that occurred at the Walnut Creek sampling site. Metric means were calculated for both streams. Data did not show consistent trends in either watershed. Except for 2001 when large differences were evident, patterns of the four quantitative metrics have been similar between Walnut Creek and Squaw Creek.

Thirty-one species of fish from eight families were collected from Walnut Creek and twenty-two species of fish from six families were collected from Squaw Creek since 1995. The fish community in both streams was dominated by minnows and most of the minnow species collected are considered abundant to common in Iowa streams. Walnut Creek FIBIs ranged from 15 in 1995 to 40 in 1996 and 2002 whereas FIBI scores for Squaw Creek ranged from 21 in 2000 to 38 in 1997. FIBI scores for Walnut or Squaw Creek did not show any visual improvement or decline since 1995. Most FIBIs calculated for Walnut Creek and Squaw Creek were considered fair.

INFORMATION, EDUCATION, AND PUBLICITY

The WNT's educational commitment and resources will allow for educational and demonstration activities far beyond the scope of those that could typically be accomplished by 319 projects. Of particular note, the linkages between land use changes and water quality improvements will be an integral part of these educational efforts. In addition, existing curriculum creates opportunities for interested visitors to acquire, enter, and interpret hydrologic and water quality data from the watershed. Both streamside and visitor center-based activities and educational stations are planned. Information presentations could readily be tailored to school, environmental, or agricultural interest groups. The Neal Smith NWR hosts thousands of visitors annually.

USFWS will utilize the WNT as a demonstration area for landscape restoration projects. Information will be disseminated to visitors and invited groups, the public (through published reports), and the news media. Of broader interest, the project is also serving as a demonstration site for riparian restoration and small wetland restoration. Having a linked water quality evaluation program makes these demonstrations more effective for general use and translation to a broader audience.

Progress To Date

The Neal Smith NWR Prairie Learning Center opened in the spring of 1997. Tours have been done for a variety of different groups, including students from grade school through college; scientists from several institutions, including Iowa and several other states and counties; Iowa and U.S. legislators; and members of the farming community and general public.

In September 1998, the Walnut Creek watershed was a field trip tour stop for the 6th National Nonpoint-Source Monitoring Workshop. Formal oral and/or poster presentations have been given at several meetings around the Midwest both to scientific groups and to the general public.

Information on the project is contained on the IDNR-GSB web page as well as a web page maintained by the USFWS. Several contacts have been made via this avenue.

During the school year, approximately 150 school children participate in environmental education activities presented by refuge staff each week day. Improvement in water quality is part of one of the displays at the center.

TOTAL PROJECT BUDGET

The estimated budget for the Walnut Creek Section 319 National Monitoring Program project for 1995 through 2005 was:

Project Element	Funding Source ($)			
	Federal*	USFWS	State	Sum
Proj Mgt	249,200	NA	113,196	362,396
I & E	13,000	NA	1,000	14,000
L T	NA	500,000	NA	500,000
WQ Monit	772,500	NA	29,800	802,300
TOTALS	1,034,700	500,000	143,996	1,678,696

*from Section 319 NMP funds
Source: Keith Schilling, 2000 (personal communication)

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

None.

OTHER PERTINENT INFORMATION

Participating Agencies and Organizations:

- Iowa Department of Natural Resources
- U.S. Fish and Wildlife Service
- U.S. Geological Survey — Water Resources Division
- University of Iowa Hygienic Laboratory
- Farm Service Agency
- Iowa Department of Natural Resources — Environmental Protection Division
- U.S. Environmental Protection Agency

PROJECT CONTACTS

Administration

Keith E. Schilling
Iowa Department of Natural Resources
Geological Survey Bureau
109 Trowbridge Hall
Iowa City, IA 52242
(319) 335-1422; Fax: (319) 335-2754
Internet: kschilling@igsb.uiowa.edu

Land Treatment

Pauline Drobney
Walnut Creek National Wildlife Refuge and Prairie Learning Center
P.O. Box 399
Prairie City, IA 50228
(515) 994-2415; Fax: (515) 994-2104

Water Quality Monitoring

Keith E. Schilling
Iowa Department of Natural Resources
Geological Survey Bureau
109 Trowbridge Hall
Iowa City, IA 52242
(319) 335-1422; Fax: (319) 335-2754
Internet: kschilling@igsb.uiowa.edu