Progress Report

May 2004 – April 2005

Lower Fox River Watershed Monitoring Program

University of Wisconsin-Green Bay

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Arjo Wiggins Appleton, Ltd

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Program Overview

The *Lower Fox River Watershed Monitoring Program* is a multi-year monitoring and assessment program in and around the Fox River Watershed. It includes high school students and teachers, university students and researchers and scientists from federal and local agencies. The three components of the program are 1) a school-based monitoring program designed to enhance student, teacher and community understanding and stewardship of the watershed; 2) studies of phosphorus and sediment sources and export in key watersheds; and 3) studies linking stream ecological integrity and land use.

The overall project goal is to establish a long-term monitoring program that will provide high quality data that can be used to make resource management decisions and predict impacts on the ecosystem. The program began in summer 2003 and is scheduled to last through mid-year 2007.

This report highlights major milestones and activities that were accomplished during year two of the Lower Fox River Watershed Monitoring Program grant. Summaries of these accomplishments were recently reported at the Second Annual Watershed Symposium held jointly with the Fox Wolf Watershed Alliance Stormwater Conference at Northeast Wisconsin Technical College, March 9, 2005. Included with this report are copies of PowerPoint and poster presentations given at the symposium. Electronic versions of most of these presentations are also available at the project website (*www.uwgb.edu/watershed/*).

The following sections of this report provide a list of Program partners, a summary of student-teacher monitoring activities, preliminary event monitoring results, stream biotic integrity monitoring, a list of presentations given by Program staff, highlights of Program extensions, and a list of Program personnel.

Program Partners

University of Wisconsin - Green Bay

Department of Natural and Applied Sciences

Cofrin Center for Biodiversity

University of Wisconsin – Milwaukee

Department of Biological Sciences, Stream Ecology Lab

United States Geological Survey, Water Resources Division, Middleton, WI

Green Bay Metropolitan Sewerage District

Oneida Nation

Appleton East High School

Green Bay Preble High School

Green Bay Southwest High School

Luxemburg-Casco High School

Markesan Public Schools

Student-Teacher Monitoring Program

The school-based portion of the Lower Fox River Watershed Monitoring Program (the Program) is a collaborative effort between area high school teachers and their students, UW-Green Bay, UW-Milwaukee, and agency researchers. The overall goals of the school-based program are: (1) to improve student, teacher and community stewardship and understanding of watershed and land use impacts on water quality and stream ecosystems; (2) to enhance teacher ability to teach watershed science; and (3) to contribute to the development of a long-term water quality database.

UW-Green Bay staff that contributed to the program during its second year included Dr. Kevin Fermanich, project director; Paul Baumgart, watershed analyst and monitoring coordinator; Jessie Fink, graduate research assistant; Jill Fermanich, outreach/education assistant; Dr. Robert Howe, Director of the Cofrin Center for Biodiversity; and Kathy Groves, graduate assistant in biodiversity. UW-Milwaukee contributors included Dr. Timothy Ehlinger, co-project director; and Lori Schacht DeThorne, watershed technician. In autumn 2004, Mary Clifford replaced Lori as watershed technician.

The four teachers teams that had been established during the first year of the program remained during the second year, with the exception that Kevin Hendricksen (Green Bay Preble High School) replaced Wes Ebert as Charlie Frisk's teacher partner, when Wes Ebert moved from the area. Each pair of teachers continued to work in their selected sub-watershed within the Fox Basin. Eight teachers from five area high schools participated in the Program during its second year of operation. The teacher teams were: Lynn Hudock Terrien and Rick Berken (Green Bay Southwest High School); Kara Pezzi and Ryan Marx (Appleton East High School); David Burbach and Andy Cassidy (Markesan High School); and Charlie Frisk (Luxemburg-Casco High School) and Kevin Hendricksen (Green Bay Preble High School). Lynn Hudock Terrien serves as the teacher coordinator of the school-based monitoring activities and as a liaison between the project and the participating teachers.

Approximately 85 students from the five high schools participated in the program this year. Participation in the monitoring program was generally as an extracurricular activity. Students participated as part of a club or research team, and met outside of class to do such things as receive training on the monitoring methods, prepare presentations for the annual symposium, and develop their research topics. The frequency of meetings also varied: some groups met weekly, others monthly, and others met on a less formal schedule or clustered their meetings around the times of the monitoring events.

The major activities involving the teachers and the school-based monitoring program during this year included teacher training, field monitoring activities, the second annual watershed symposium, development of a course that high school students can take for college credit, and meetings with other citizen-based various outreach or collaborative or activities.

1. Teacher Training

- Teacher Workshop, July 19-21, 2004. A three day workshop for teachers was held from Monday, July 19 to Wednesday, July 21, 2004 at UW-Green Bay. Eight teachers and two members of the general public attended the workshop. The purpose of the workshop this year was to provide a review of certain monitoring techniques and to provide more information on data access and analysis and use of the program website. On the first morning of the workshop, an optional overview of water quality monitoring techniques was held. This served as a review for any teachers desiring more practice, and also introduced the program to the new teacher in the program (Kevin Hendricksen) and to two attendees from the general public who were interested in the program (Becky Nutt of the Oneida Nation and Roy Aiken of the Door County Land Trust). The training was based on the Student Watershed Research Project (SWRP), a watershed monitoring program based out of Portland State University in Oregon. During the second year of the program, each teacher team received two pairs of binoculars, a Garmin GPS 72 personal navigator, two copies of *Birds of Eastern and Central North America,* by Roger Tory Peterson, a copy of *Aquatic Entomology: The Fisherman's and Ecologist's Illustrated Guide to Insects and Their Relatives*, by W. Patrick McCafferty, and a copy of *Guide to Aquatic Invertebrates of the Upper Midwest,* by R.W. Bouchard, Jr. A copy of the teacher training workshop program is attached in Section 2 of this report.
- After-school training sessions were given to teachers and students on request. In January, Jess Fink gave a training session to Lynn Terrien, Rick Berken and their students at Southwest High School on the use of Eco-Watch software.

2. Second Year Field Monitoring Activities (June 2004 – May 2005)

Each pair of teachers and their students performed several rounds of monitoring within their selected sub-watershed. Student-teacher teams performed monitoring activities at two or more monitoring locations within their sub-watersheds. In June, student/teacher teams performed bird monitoring at several locations in their watersheds along with birding experts from the community (Joan Berkopec, Robert Meade) or the Cofrin Center for Biodiversity (Nick Walton). Also in June, teachers and their students monitored for water quality parameters (streamflow, temperature, dissolved oxygen, pH, turbidity, conductivity, soluble reactive phosphorus, ammonia, and nitrate) and macroinvertebrates. The teams monitored water quality again and performed a stream habitat assessment in July. In September, water quality was monitored, and some teams also performed an optional macroinvertebrate survey. The teams began performing amphibian monitoring again in April of this year, which will continue through June.

One of the goals of the first year was to develop a workable monitoring program. Over the course of that year, comments and ideas were solicited from

teachers on how to clarify or modify methods and data sheets to best suit their needs. In February, revised methods were finalized. They were issued to teachers at the student symposium on March 9.

Real-time and hourly averaged sonde data is now available to teachers and students via a link on the Program website to a server on the UW – Milwaukee website. They can use the data to observe and compare water quality parameters collected before or after their sampling trips.

3. Student Watershed Symposium (March 2005)

The annual student symposium was held March 9, 2005, at Northeast Wisconsin Technical College. This year, the symposium was held in conjunction with the Fox-Wolf Watershed Alliance Stormwater Conference. The poster and closing sessions were held jointly with the Stormwater Conference. The symposium/ Stormwater conference brought together student-teacher teams, program partners, and water resources professionals to learn about overall Program activities and research projects, and to exchange ideas and compare data from the various watersheds. The symposium began with a plenary session presentation by Dr. Tim Ehlinger of the University of Wisconsin at Milwaukee entitled '*Linking Watershed Landscapes to Aquatic Ecosystems.*' This was followed by concurrent sessions in which student teams gave presentations or attended roundtable discussions. The presentations (10-15 minutes each) were about proposed research questions that student teams planned to investigate over the next monitoring season(s). The presentations were either in PowerPoint or poster format.

At the roundtable discussions students, teachers and water resource professionals discussed selected watershed issues. Project staff presented a scenario or problem to the entire group, and then posed three questions. The group then broke into three smaller groups to discuss the questions, and then reconvened as a large group to discuss each group's answers. At the joint poster session, students interacted with and received comments from the water quality professionals on their proposed research. Students, teachers and stormwater professionals also learned about LFRWMP activities through a series of eight posters put together by project staff.

The closing session was also held jointly with the FWWA Stormwater Conference. Fifty-two students and teachers attended the symposium, along with approximately 22 community, university, and agency representatives. An additional 60 to 70 professionals attended the FWWA Stormwater Conference and had the opportunity to view the student posters and hear the LFRWMP project update from Drs. Kevin Fermanich and Tim Ehlinger during the closing session. Copies of the symposium brochure and program are included in Section 2 of this report. A list and examples of student presentations are in Section 3.

4. Course for College Credit

A course based on the monitoring activities that the high school students perform to meet the requirements of the Lower Fox River Watershed Monitoring Program was developed and approved through the Department of Natural and Applied Sciences and the Office of Outreach and Extension at UW–Green Bay. Students participating in the program can take this course during their senior year of high school for one college credit. The course is entitled *Stream Ecosystem Monitoring Field Experience*, and will be offered during spring semesters. A course syllabus is included in Section 2 of this report.

5. Collaboration with other citizen-based monitoring groups

Kevin Fermanich and Jill Fermanich represented the Lower Fox River Watershed Monitoring Program at a Workshop on Citizen-Based Monitoring for the Fox-Wolf Watershed. The workshop was hosted by the University of Wisconsin – Oshkosh on October 9, 2004. The goal of the workshop was to assess the interests and capacities of organizations with regard to citizen-based natural resources monitoring in the Fox-Wolf Watershed.

Program staff met with Kris Stepenuck, coordinator for Water Action Volunteers (WAV) in November 2004 to introduce the Lower Fox River Watershed Monitoring Program to her and to discuss project activities.

Teachers Kara Pezzi and Lynn Terrien were observed by several UW-Green Bay students as part of their teacher-in-traning observation requirements to be completed before they begin student teaching.

Preliminary Monitoring Results – Annual Flow, Precipitation, TSS and Phosphorus: WY 2004

Study Overview and Background

Five USGS continuous monitoring stations within the 1,580 km^2 Lower Fox Basin have been installed directly through the project. The following stations will provide 3 years of data beginning in October 2003 and ending September 30, 2006:

1) Duck Creek at CTH FF (276 km^2), upgraded with sampler (co-sponsored by Oneida Tribe)
2) Baird Creek at Superior Road (54 km^2)
3) Apple Creek at CTH U / Campground (117 km^2)
4) Ashwaubenon Creek at Creamery Road (~48 km^2)
5) East River at Monroe Street (374 km^2) - (co-sponsored by the GBMSD)

Stream flow and water-quality gaging stations were installed on three streams (Apple Creek, Ashwaubenon Creek and Baird Creek). A water-quality sampler was installed at Duck Creek. An acoustic velocity meter (AVM) and water-quality sampler were installed at East River. Stream flow measurements were made at all sites to determine stage–discharge relations. Over 480 water-quality samples were collected during events and low flow conditions and analyzed for suspended solids and total phosphorus. Over 210 samples were analyzed for dissolved phosphorus. The USGS computed daily total phosphorus (TP) and total suspended solids (TSS) loads for each stream, and will estimate dissolved phosphorus (DP) loads. TSS concentrations have also been correlated with turbidity data from sondes operated by UW-Milwaukee. Four rain gauge-logger units were installed at the USGS stations by the USGS, and 11 tipping bucket rain gauges and loggers have been installed throughout the basin by UWGB.

Objectives

1) Better understand cause/effect through event and continuous monitoring.
2) Compare flow, phosphorus, and suspended sediment concentrations and loads from different source areas (e.g. urban, urbanizing, and rural/agriculture).

Preliminary Results

According to the Green Bay National Weather Service Station, the second wettest May on historical record was recorded in 2004 (211 mm). With 3-times the normal precipitation, this rainfall was responsible for excessive runoff and loads in May and early June. However, total annual precipitation in WY2004 (813 mm) was only 10% above normal (741 mm). Annual stream flow ranged from 33 to 43% of total precipitation.

Apple, Ashwaubenon and Baird Creeks had similar median TSS concentrations of approximately 127 mg/L, which is 2.5 times greater than the median value from previous studies. Much lower TSS concentrations of about 67 mg/L were determined

for Duck Creek and East River; however, it should be noted that East River samples were typically composites of four samples per day. Maximum TSS concentrations ranged from 960 mg/L at Duck to 2,700 mg/L at Baird.

High TP concentrations were found in all streams. TP median concentrations ranged from 0.28 in Duck Creek to 0.70 mg/L in Ashwaubenon Creek. About 25% of Ashwaubenon Creek samples were greater than 0.93 mg/L. Samples in excess of 2 mg/L TP were collected from all sites.

Annual median DP to TP fractions ranged from 49-57%. Median DP was 40-54% of TP during events and greater than 70% DP during low flow.

Annual loads were highly event driven: 13 days accounted for 80% of the TSS load and 67% of the TP load from Apple Creek. Baird Creek was less influenced by events: 13 days accounted for 67% of TSS and 52% of TP loads. Excluding Apple Creek, March, May and June accounted for 87-96% of the TSS load and 81-88% of the phosphorus load in the 2004 USGS water year.

Annual TSS yields from Apple, Ashwaubenon and Baird were similar: 0.93, 0.70, 0.72 t/ha, respectively. TSS yields were 0.33 t/ha from Duck and 0.55 t/ha (partial year) from the East River. Annual TP yields from Apple, Ashwaubenon and Baird were similar: 1.9, 2.0 and 2.3 kg/ha, respectively. TP yields were 1.1 kg/ha from Duck and 1.7 kg/ha from the East River (partial year).

See presentations in Section 5 and posters in Section 6 of this report for more details regarding preliminary flow and water quality monitoring results.

WY 2004 monitoring data from this project were published in the following USGS publication:

Water Resources Data, Wisconsin, Water Year 2004
Water-Data Report WI-04-1, Middleton, WI

Summary of Biological Integrity Monitoring
UW – Milwaukee

The biological integrity of the five study streams in the Lower Fox River were evaluated by sampling fish, invertebrates and assessing stream habitat. Fish were sampled in July 2003 and 2004 during summer low flow conditions using a stream or backpack electrofisher. At least two stations were sampled in each watershed. Fish were identified, counted, weighed and measured, and then returned to the stream unharmed. An Index of Biological Integrity (IBI) was calculated using standardized protocols developed by the Wisconsin DNR. Invertebrate replicate samples were collected from riffles in each stream using Hess samplers. The Family Biotic Index (FBI) was used to calculate a water quality rating. Habitat data for the study streams were collected in 2003 and 2004 and scores were calculated according to the Wisconsin DNR Guidelines for Evaluating Fish Habitat in Wisconsin Streams. This method incorporates eight parameters including hydrology, substrate, fish cover, and riparian vegetation. Results: IBI scores ranged from 10 (very poor) to 30 (fair), with most streams rated “poor”. These numbers indicate that these streams are facing significant stress from their watersheds. In general, habitat scores rated from fair to good for all streams in both 2003 and 2004. This suggests that the low fish IBI scores are likely the result of poor water quality rather than the result of poor habitat conditions alone. Most of the invertebrate species found were tolerant to organic pollution (i.e. high FBI values) and as a result the study streams were rated as either fairly poor or poor in both years. This indicates that there are significant stresses in the ecosystem that are affecting the aquatic invertebrates. These data also suggest that water quality factors, like low oxygen levels, may be responsible for the low integrity of the biological community.

See the poster entitled *Biological Monitoring of the Lower Fox River Watershed* in section 6 of this report for additional details.

Presentations by the LFRWMP Team

(Copies of presentations can be found on the Program website under "activities and resources." Select presentations and posters are also found in Sections 5 and 6 of this document.)

Second Annual Watershed Symposium, March 9, 2005 at NWTC:

1. Plenary Session: Linking Watershed Landscapes to Aquatic Ecosystems, Tim Ehlinger, UW-Milwaukee.
2. Fox Watershed Monitoring Program: 2004 Update, Kevin Fermanich, UW-Green Bay and Tim Ehlinger, UW-Milwaukee.
3. Poster: The Lower Fox River Watershed Monitoring Program, UW-Green Bay, UW-Milwaukee, and USGS.
4. Poster: Lower Fox River Watershed School-Based Monitoring Program, UW-Green Bay and UW-Milwaukee.
5. Poster: Preliminary Monitoring Results – Annual Flow, Precip., TSS and Phosphorus: WY 2004, UW-Green Bay and USGS.
6. Poster: Biological Monitoring of the Lower Fox River Watershed, UW-Milwaukee.
7. Poster: Stream Sampling Methods Used for the Lower Fox River Watershed Monitoring Program, UW-Green Bay, UW-Milwaukee, and USGS.
8. Poster: Water Quality Monitoring on the East River, Green Bay Metropolitan Sewerage District.

9. Phosphorus and Sediment Sources and Impacts in the Lower Fox River Subbasin: What's Next? Bud Harris and Kevin Fermanich. Presentation to the WDNR, Madison, WI, April 6, 2005.
10. The Effects of Urbanization on Baird Creek, Jessie Fink. Presentation to the Baird Creek Preservation Foundation Board of Directors, March 28, 2005.
11. Phosphorus and Sediment Export in Streams in the Lower Fox River Watershed, Kevin Fermanich, Paul Baumgart, and Dave Graczyk. Wisconsin Chapter of the American Water Resources Association Meeting, Delavan, WI. March 3-4, 2005.
12. The Effects of Urbanization on Baird Creek, Green Bay, WI, Jessie Fink, Kevin Fermanich, and Timothy Ehlinger. Wisconsin Chapter of the American Water Resources Association Meeting, Delavan, WI. March 3-4, 2005. (Award for Top Student Oral Presentation)
13. Poster: Total Suspended Solids-Turbidity Correlation in Northeastern Wisconsin Streams, Timothy Randerson, Jessie Fink, Kevin Fermanich, Paul Baumgart, and Timothy Ehlinger. Wisconsin Chapter of the American Water Resources Association Meeting, Delavan, WI. March 3-4, 2005. (Award for Top Student Poster Presentation)

14. "Fighting for Fishes" and everything else dependent on water resources…, Kevin Fermanich. UW-Green Bay; Research Council Faculty Lecture Series. December 2004.
15. Poster: Developing a Relationship between Total Suspended Solids and Turbidity in Northeast Wisconsin Streams, Jessie Fink, Kevin Fermanich, and Timothy Ehlinger. Midwest Environmental Chemistry Workshop, Madison, WI. October 15-17, 2004.
16. Lower Fox River Watershed Monitoring Program Update, Paul Baumgart. Fox-Wolf Watershed Alliance Fall Research Meeting, UW-Oshkosh. October 6, 2004.
17. Field Tour: Water Quality Monitoring on Baird Creek, Jessie Fink. Advertised and open to the public (approximately 20 participants). September 12, 2004.

Program Extensions

A number of initiatives that extended Program activities to other projects and groups took place during the second year. They included (1) a thesis project on the effects of urbanization on Baird Creek; (2) investigation of phosphorus forms at different spatial scales; (3) determination of the utility of real-time turbidity measurement for estimating sediment loading; (4) participation in a community watershed visioning forum; and (5) participation in the Baird Creek BioBlitz. Details of these initiatives follow.

1) The Effects of Urbanization on Baird Creek, Green Bay, WI. This project was a Master's thesis completed by Jessie Fink, a graduate student in the Environmental Science and Policy Program at UW-Green Bay. Her project assessed how nonpoint source pollution from urban development is affecting the water quality and channel morphology of Baird Creek. The project is closely linked to the biotic, continuous, and rainfall-event monitoring activities of the larger monitoring program. The project was presented at the Wisconsin chapter meeting of the American Water Resources Association (AWRA) in March 2005, and the thesis document is available electronically on the Program web site. The abstract and Table of Contents of the thesis can be found in section 4 of this report, as well as the abstract from the AWRA presentation.

2) Phosphorus Forms at Different Spatial Scales. This project is part of a Master's thesis by Erika Sisel, a graduate student in the Environmental Science and Policy Program at UW-Green Bay. Dissolved and total phosphorus concentrations are being compared at different scales (multi-field < 2 km^2, 10-40 km^2, and watershed ~100 km^2) within the Apple Creek watershed. Targeted event sampling was conducted upstream of the LFRWMP USGS-cooperative monitoring station. A summary of the study follows in this report section.

3) Turbidity-Total Suspended Solids Relationships. An undergraduate student majoring in Environmental Science at UW-Green Bay and graduate student Jessie Fink analyzed real-time turbidity data and discrete TSS samples from WY2004 to estimate instantaneous sediment concentrations based on turbidity. This project was presented as a poster at the Wisconsin AWRA meeting in March 2005, a copy of which can be found in section 6.

4) Dr. Timothy Ehlinger, Paul Baumgart, Jessie Fink represented the LFRWMP in a planning initiative for developing a Watershed Stewardship Assessment for Baird Creek. Posters from the 2004 Annual Watershed Symposium were displayed at a meeting hosted by the Lake Michigan Forum and the Delta Institute at the Woods Golf Course on June 29, 2004. Also, feedback was provided on the final report document issued for the project in November 2004.

5) LFRWMP staff volunteered at the Baird Creek BioBlitz on July 31, 2004. The BioBlitz was a one-day scientific expedition and community outreach event organized by Great Lakes Forever. Scientists led the public in identifying species living in the Baird Creek Greenway, including plants, insects, fish, birds, fungi, and mammals. Program staff assisted in mapping BioBlitz boundaries, identifying aquatic insects, and leading hikes to discuss stream water quality.

Phosphorus Forms and Fate in the Lower Fox River Watershed

Study Overview and Background

The effectiveness of phosphorus reductions strategies such as grass filter strips and detention basins may depend on whether phosphorus (P) is in the dissolved or particulate phase as it leaves the source area. Dissolved phosphorus (DP) is the phosphorus that passes through a 0.45 µm filter when a water sample is filtered. Total P is comprised of DP and particulate P. Ortho-P (PO_4^-) is the dominant form of DP. Understanding the form in which P leaves source areas and is transported by streams is critical for predicting the fate of P using computer simulation models.

Early modeling efforts in the Fox-Wolf Basin (NEWWT modeling with SWRRB, 1993) assumed that 11% of the P coming from agricultural sources in the Lower Fox Basin was in the dissolved form. Fox-Wolf Basin 2000 monitored tributaries from 1999 to 2002 to assess SWAT model predictions, and found that this assumption was not supported by the observed data or by analysis of existing USGS and WDNR data sets. Concentrations of DP in streams from rural areas were found to range from 40 to 75% of the TP concentration. Analysis of P loads by the USGS showed that the proportion of DP from the Upper East River and Duck Creek ranged from 59 to 75% of the TP load.

This study was initiated to answer questions related to P forms in runoff by tracking the ratio between DP and total phosphorus from farm, to channel/ditch, and to stream using targeted sampling throughout the flow path.

Objectives

- Compare dissolved and total phosphorus at different scales throughout a watershed.
- Identify phosphorus and sediment sources at multiple spatial scales.
- Analyze trends at all sites and relative trends between sites over time.

Procedures

The study area is located in the 140 km^2 Apple Creek watershed (Figure 1). Eleven source area sites and four integrator sites were monitored for up to 5 runoff events from March to June in 2004. Source area sites are located in streams draining primarily rural land uses. The drainage areas of these small subwatersheds ranged from about 0.25 to 2.5 km^2. Four of the source area sites are located downstream of another source area site. Integrator sites (I-3, 4, 6, 7) collected stream flow from larger drainage areas ranging from 12 to 85 km^2. Grab samples were collected close to the peak flow during each event. Tape-down measurements were also made to determine the relative intensity of the flow event. Data collected through the overall monitoring project at the Apple Creek main stem at CTH U (117 km^2; # 4085046) was also utilized for comparison purposes. All samples were analyzed for TSS, TP and DP at the GBMSD lab.

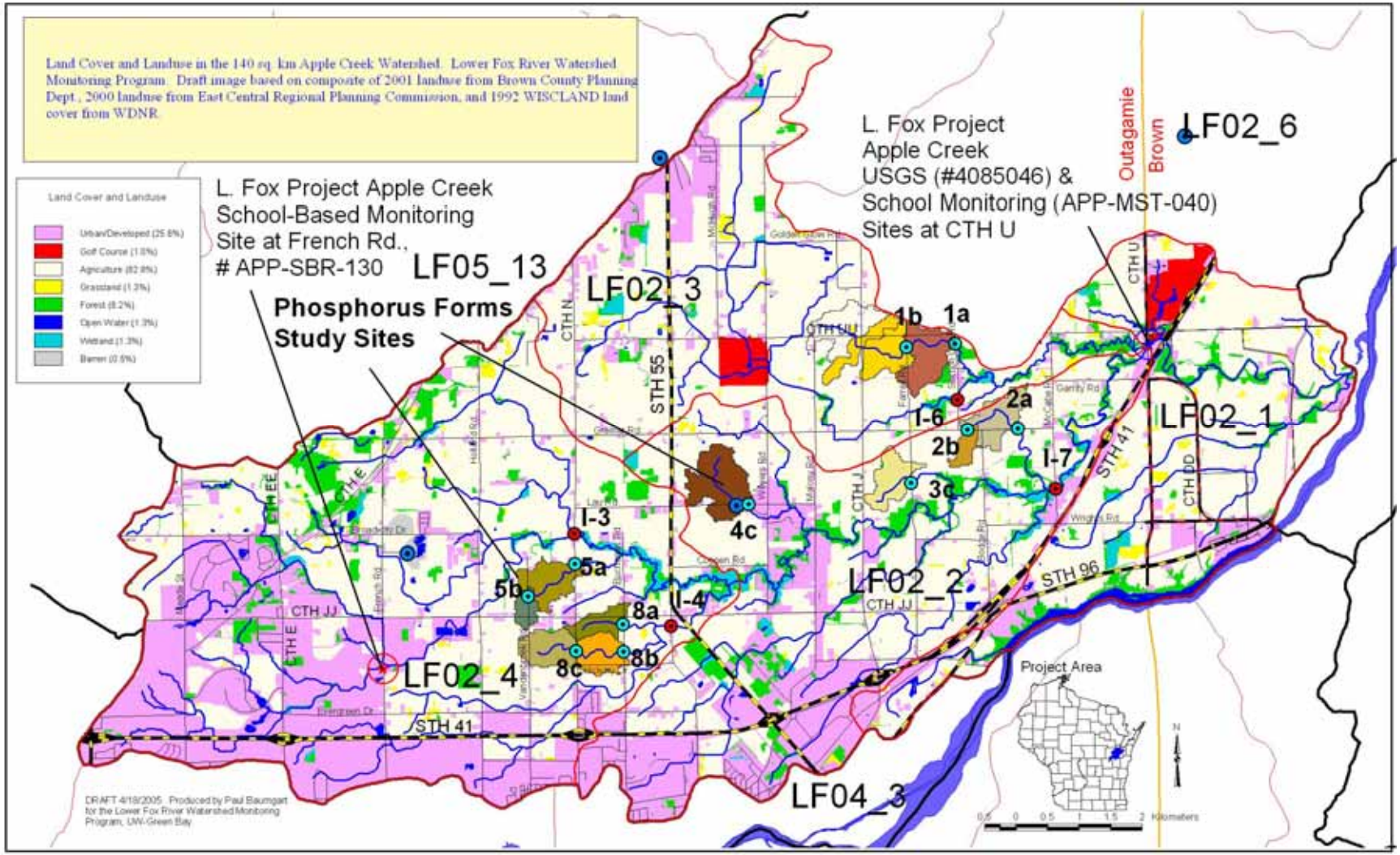

Figure 1. Monitoring locations and preliminary drainage areas associated with source area monitoring sites in the Apple Creek Watershed.

Preliminary Results

Box plots of total P, DP and the fraction of DP are shown in Figures 2, 3 and 4, respectively, for samples collected closest to the peak discharge at source area, integrator and main stem monitoring sites. The horizontal lines in each box plot mark the minimum point, the 25th, 50th, and 75th percentile points, and the maximum point of the data. The dashed line marks the mean. Mean TP was 0.56 mg/L from source areas (5 events), 0.43 mg/L from integrator sites (4 events), and 0.63 mg/L at the main stem. Mean DP was 0.20 mg/L from source areas, 0.18 mg/L from integrator sites, and 0.20 mg/L at the main stem. Mean DP concentrations at 5a (0.04 mg/L) and 5b (0.06 mg/L) were much lower than measured at the other monitored sites. TP was also lower at these sites, even though TSS was similar to the other sites and a good correlation between TP and TSS was determined for the entire source area data set (R-squared = 0.70). It is hypothesized that soil P levels may be lower within subwatersheds 5a and 5b, but further investigation may uncover the precise reason for this disparity. The mean percentage of DP was 40% from source areas, 44% from integrator sites and 31% from the main stem. The DP to TP ratio of peak flow samples collected from the main stem were consistently lower than samples collected at source area locations. Perhaps not coincidently, TSS concentrations of main stem peak flow samples were also consistently greater than source area samples.

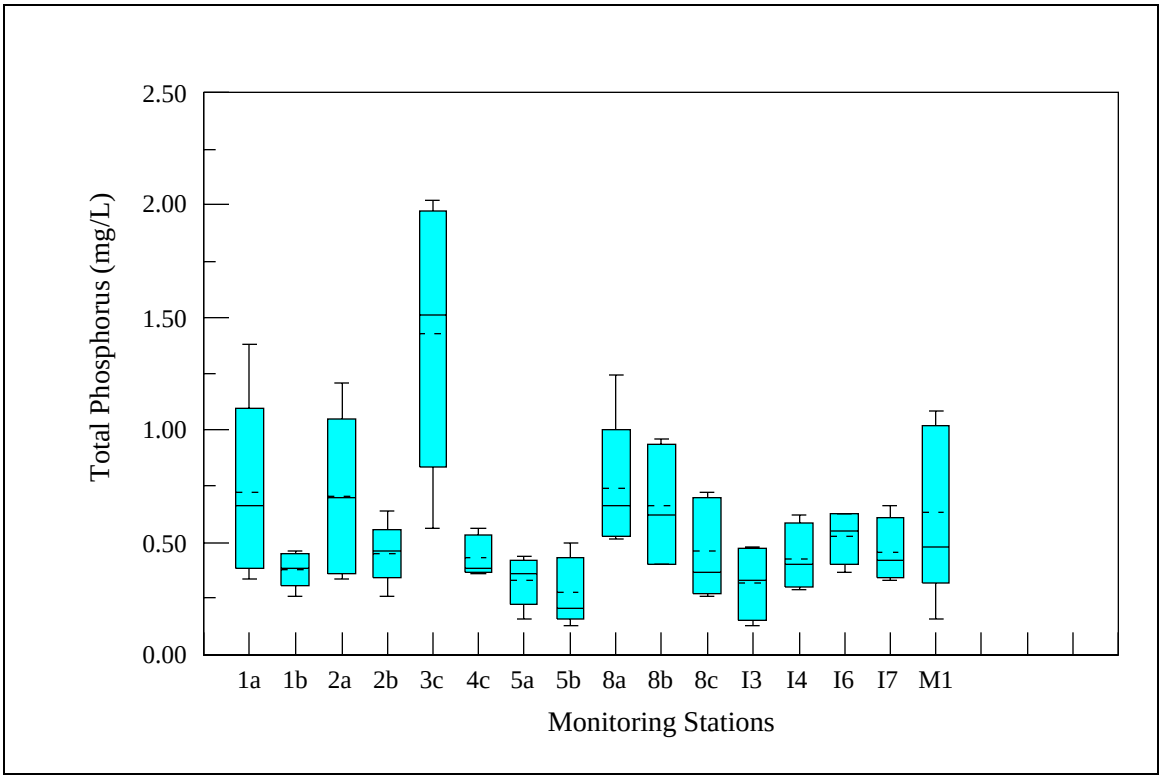

Figure 2. Total phosphorus concentrations (mg/L) in Apple Creek tributaries.

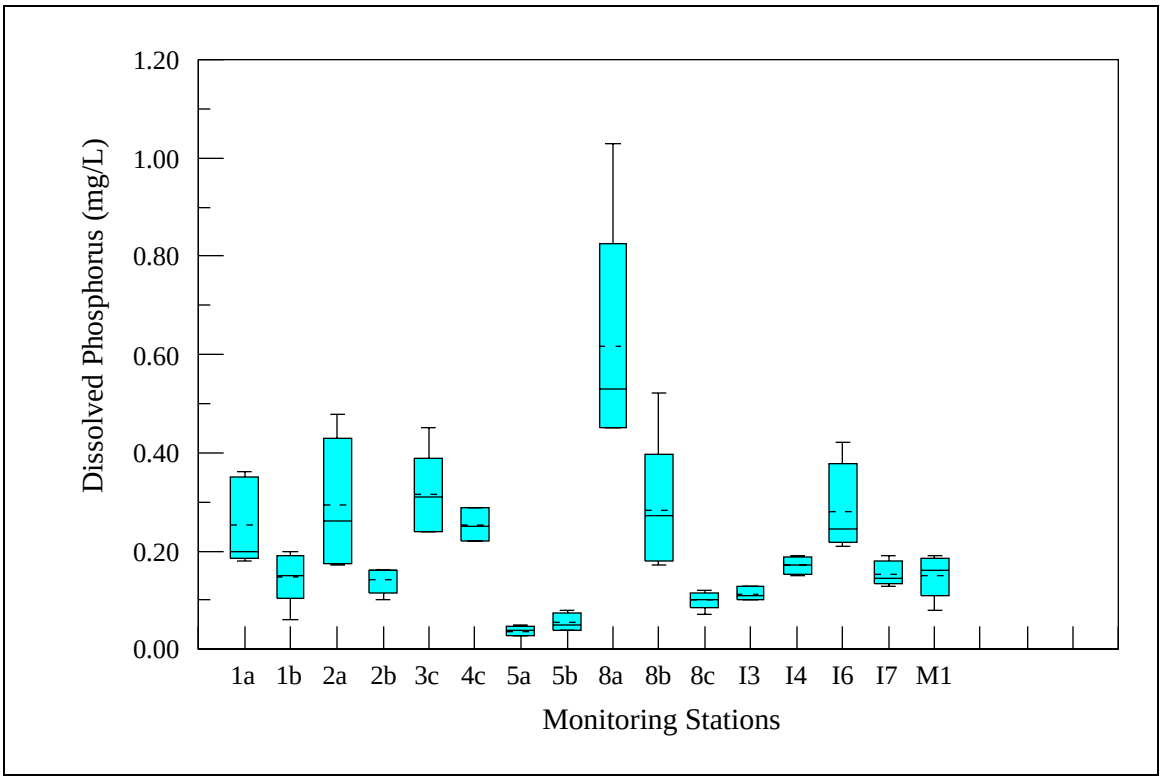

Figure 3. Dissolved phosphorus concentrations (mg/L) in Apple Creek tributaries.

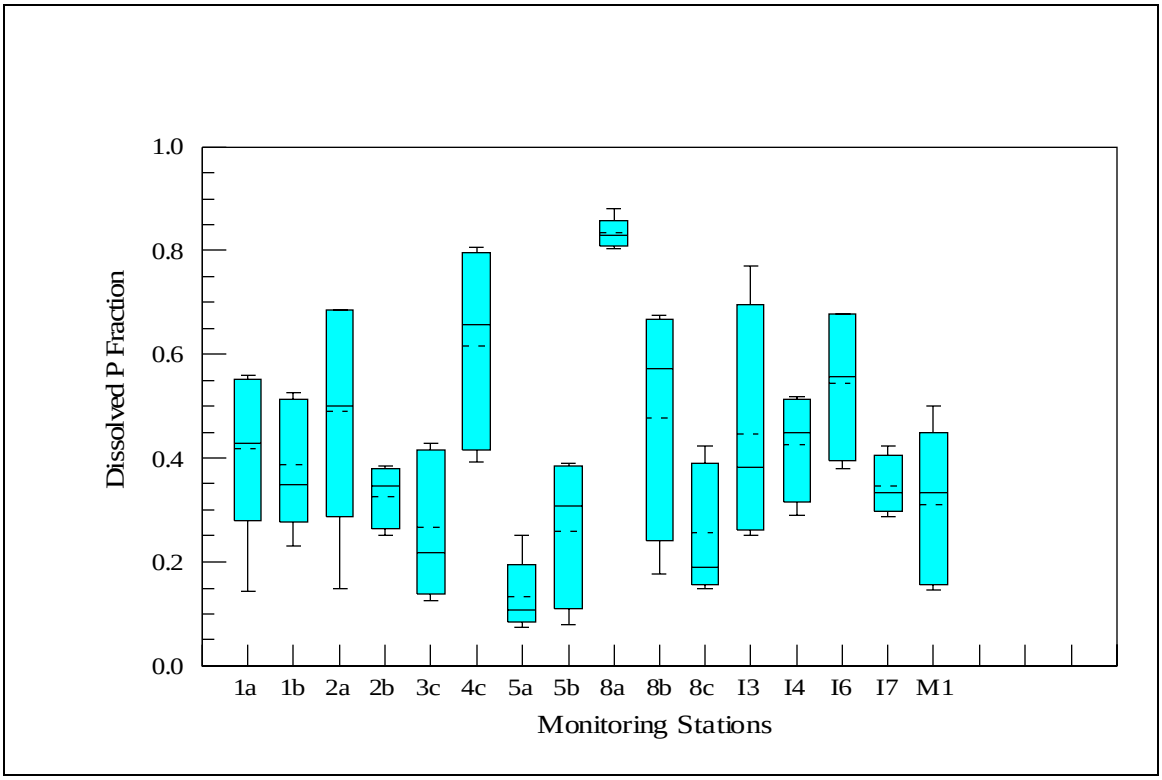

Figure 4. Fraction of dissolved phosphorus measured in Apple Creek tributaries.

Program Staff

Program Director - Dr. Kevin Fermanich, Department of Natural and Applied Sciences, UW-Green Bay: Dr. Fermanich oversees portions of the school-based monitoring activities, develops procedures, supervises water quality research projects, coordinates activities between partners, reports project results, and interfaces with the community.

Co-Director/Principal Investigator - Dr. Timothy Ehlinger, Department of Biological Sciences, UW-Milwaukee: Dr. Ehlinger directs the stream ecosystem integrity activities, including operation of the continuous monitoring sondes, invertebrate and fish sampling, and development of student stream biological monitoring procedures. He also serves as an instructor for the summer workshops and assists in the publication of project results.

Watershed Analyst/Assistant Researcher - Paul Baumgart, UW-Green Bay:
Paul provides GIS, data management, and watershed modeling expertise to the project. He coordinates and oversees cooperative monitoring activities with the USGS, GBMSD and Oneida Nation, assists with teacher-student methods development and workshop training sessions, and contributes to the design and implementation of supplemental stream monitoring activities.

Senior Environmental Technician – Mary Clifford, UW-Milwaukee:
Mary oversees deployment, calibration, maintenance, and data management activities associated with the automated, continuously-logging YSI sondes.

Program Assistant (Outreach/Education) - Jill Fermanich, UW-Green Bay:
Jill serves as the primary contact for the teachers in the school-based monitoring program, and assists in the development of the monitoring manual and QA/QC procedures. She also plans and organizes the annual Summer Teacher Workshop and the Student Watershed Symposium.

Master Teacher - Lynn Terrien, Green Bay Southwest High School:
As Master Teacher, Lynn acts as a liaison between the different schools participating in the monitoring program and the universities. Lynn reviews and develops curricula, assists with the procedures manual development, helps plan the summer workshop, and coordinates activities between schools.

Graduate Research Assistant - Jessie Fink, UW-Green Bay:
Jessie provides a variety of support services for the project, including assistance in school-based monitoring activities and training, QA/QC of school-based water data, maintenance of the website, and servicing of USGS automated samplers. She recently completed her thesis research on the effects of urbanization on water quality in Baird Creek. Jessie also served on the Board of Directors of the Baird Creek Preservation Foundation.

Riparian Fauna Monitoring Experts – Dr. Robert Howe and Graduate Student Kathy Groves, Cofrin Center for Biodiversity, UW-Green Bay: Dr. Howe and Kathy develop bird and frog monitoring protocols and training materials and provide hands-on training for student-teacher teams.

Student Technicians – UW-Green Bay (2) and UW-Milwaukee (3):
Students assist with servicing of the USGS automated samplers, low-flow manual sampling, processing of samples for delivery to GBMSD, and monitoring of stream habitat, fish, and benthic macroinvertebrates.