LTRMP FY10 Scope of Work

Outcome 1, Output 1.1

Outcome 2

Outcome 2, Output 2.1

Outcome 2, Output 2.2

Strategy 1

Long Term Resource Monitoring Program

Aquatic Vegetation Component
Outcome 1; Output 1.1[1]

The objective of the Long Term Resource Monitoring Program (LTRMP) Aquatic Vegetation Component is to collect quantitative data on the distribution and abundance of aquatic vegetation in the UMRS for the purpose of understanding its status, trends, ecological functions, and responses to natural disturbances and anthropogenic activities. Data are collected within three LTRMP study reaches in the UMRS (Pools 4, 8, and 13 on the Upper Mississippi River). Data entry, quality assurance, data summaries, standard analyses, data serving, and report preparation occur under standardized protocols.

Methods

Aquatic vegetation sampling will be conducted following the LTRMP aquatic vegetation standard sampling protocol (Yin et al. 2000). One thousand three hundred and fifty sites will be surveyed, including 450 in Pool 4, 450 in Pool 8, and 450 in Pool 13 (Table 1). The presence/absence and abundance of aquatic plant species at each site will be measured and recorded. Pool-wide estimates of abundance and percent frequency of occurrence will be derived by pooling data over all strata.

Products and Milestones

Tracking number	Products	Staff	Milestones
2010A1	Complete data entry and QA/QC of 2009 data; 1250 observations.		
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Bierman	30 November 2009
	b. Data loaded on level 2 browsers	Schlifer	15 December 2009
	c. QA/QC scripts run and data corrections sent to Field Stations	Sauer	28 December 2009
	d. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Bierman	15 January 2010
	e. Corrections made and data moved to public Web Browser	Sauer, Schlifer, Caucutt	30 January 2010
2010A2	WEB-based annual Aquatic Vegetation Component Update with 2009 data on Public Web Server.		
	a. Develop first draft	Sauer	28 February 2010
	b. Reviews completed	Popp, Dukerschein, Bierman, Sauer, Yin	28 March 2010
	c. Submit final update	Sauer	18 April 2010
	d. Placement on Web with PDF	Sauer, Caucutt	31 July 2010
2010A3	Complete aquatic vegetation sampling for Pools 4, 8, and 13 (Table 1)	Popp, Dukerschein, Bierman	31 August 2010
2010A4	Web-based: Creating surface distribution maps for aquatic plant species in Pools 4, 8, and 13; 2009 data	Yin	31 July 2010
2008APE5(F)	Final draft LTRMP Technical Report; Experimental and Comparative Approaches to Determine Factors Supporting or Limiting Submersed Aquatic Vegetation in the Illinois River and its Backwaters	Sass	30 March 2010
Delayed Products			
2008APE4a	Draft completion report: FY05-07 data--Analysis and support of aquatic vegetation sampling data in Pools 6, 9, 18, and 19	Yin	15 January 2010
2007APE12	Draft LTRMP Report: Ecological Assessment of High Quality UMRS Floodplain Forests	Chick, Guyon, Battaglia	30 December 2009

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[1] Strategic and Operational Plan for the Long Term Resource Monitoring Program on the Upper Mississippi River System, Fiscal Years 2010-2014. 30 June 2009, Developed for the Environmental Management Program Coordinating Committee by the Strategic Planning Team

Intended for distribution
Completion report: LTRMP Aquatic Vegetation Program Review (Heglund; 2007A9)
Manuscript: Importance of the Upper Mississippi River Forest Corridor to Neotropical Migratory Birds (Kirsch, 2007APE1)

Literature Cited

Hirst, S. M. 1983. Ecological and institutional bases for long-term monitoring of fish and wildlife populations. Pages 175–178 in John F. Bell and Toby Atterbury, editors. Renewable Resource Inventories for Monitoring Changes and Trends. Proceedings of an International Conference, August 15–19, 1983, Corvallis, Oregon. College of Forestry, Oregon State University. 737 pp.

Ickes, B. S., and R. W. Burkhardt. 2002. Evaluation and proposed refinement of the sampling design for the Long Term Resource Monitoring Program’s fish component. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, October 2002. LTRMP 2002-T001. 17 pp. + Appendixes A–E. CD-ROM included. (NTIS PB2003-500042)

McDonald L., T. McDonald, and D. Robertson. 1998. Review of the Denali National Park and Preserve (DENA) Long-Term Ecological Monitoring Program (LTEM). Report to the Alaska Biological Science Center Biological Resources Division, USGS. WEST Technical Report 98–7. 19 pp.

Strayer, D., Glitzenstein, J. S., Jones, C. G., Kolasoi, J., Likens, G. E., McDonnell, M. J., Parker, G. G. and Pickett, S. T. A. 1986. Longterm ecological studies: an illustrated account of their design, operation, and importance to ecology. Occasional Publication of the Institute of Ecosystem Studies, No.2. Millbrook, New York.

Yin, Y., J. S. Winkelman, and H. A. Langrehr. 2000. Long Term Resource Monitoring Program procedures: Aquatic vegetation monitoring. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. April 2000. LTRMP 95-P002-7. 8 pp. + Appendixes A–C.

Personnel

Dr. Yao Yin will be the principal investigator.

Fisheries Component
Outcome 1; Output 1.1

The objective of the LTRMP Fisheries Component is to collect quantitative data on the distribution and abundance of fish species and communities in the UMRS for the purpose of understanding resource status and trends, ecological functions, and response to natural disturbances and anthropogenic activities. Data are collected within six LTRMP study reaches in the UMRS (Pools 4, 8, 13, and 26 and Open River Reach on the Upper Mississippi River and La Grange Pool on the Illinois River). Data entry, quality assurance, data summaries, standard analyses, data serving, and report preparation occur under standardized protocols (Gutreuter et al. 1995; Ickes and Burkhardt 2002).

Methods

Fish sampling will be conducted following the LTRMP study plan and standard protocols (Gutreuter et al. 1995), as modified in 2002 (Ickes and Burkhardt 2002). Species abundance, size structure, and community composition and structure will be measured over time. Between 250 and 400 samples will be collected in each study area (Table 1). Sample allocation will be based on a stratified random design, where strata include contiguous backwaters, main channel borders, main channel wingdams, impounded areas, and secondary channel borders. Tailwaters in the impounded reaches and tributary mouths in the Open River will be sampled under a fixed site design. Sampling effort will be allocated independently and equally across 3 sampling periods (June 15–July 31; August 1–September 15; September 16–October 31) to minimize risks of annual data loss during flood periods and to characterize seasonal patterns in abundance and habitat use. Pool-wide estimates of abundance will be derived by pooling data over all strata.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2010B1	Complete data entry, QA/QC of 2009 fish data; ~1,590 observations		
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Bierman, Chick, Sass, McCain	31 January 2010
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	Schlifer	15 February 2010
	c. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Bierman, Chick, Sass, McCain	15 March 2010
	d. Corrections made and data moved to public Web Browser	Sauer and Schlifer	30 March 2010
2010B2	Update Graphical Browser with 2009 data on Public Web Server.	Sauer, Popp, Dukerschein, Bierman, Chick, O'Hara, McCain	31 May 2010
2010B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River, and La Grange Pool (Table 1)	Popp, Dukerschein, Bierman, Chick, O'Hara, McCain	31 October 2010
2010B4	Draft revision and update of the LTRMP fisheries component procedures manual	O'Hara, Irons, Ratcliff	30 September 2010
	Delayed Products		
2008APE1a	Draft completion report: Developing an empirical framework for reconstructing and modeling UMRS floodplain disturbance histories: Year 1, historic data extraction and summaries.	Ickes	30 December 2009
2008APE1b	Model development (2008APE1b)	Ickes	30 December 2009

2008B9	Draft manuscript: Standardized CPUE data from multiple gears for community level analysis (a previous manuscript was submitted and rejected by the journal, 2006B5; 2008B9 is a revised manuscript)	Chick	30 December 2009
2006B6	Draft manuscript: Spatial structure and temporal variation of fish communities in the Upper Mississippi River. (Dependent on 2008B9 acceptance into journal)	Chick	30 March 2010
2007B4	Draft manuscript: Proportional biomass contributions of Non-native fish to UMRS fish communities	Ickes	30 July 2010
2007APE3	Draft LTRMP report: Testing the Fundamental Assumption underlying the use of LTRMP fish data: Does variation in LTRMP catch-per-unit-effort data reflect variation in the abundance of fishes?	Chick	30 April 2010
2007APE8	Final draft: A Proposal to restore Specific Monitoring Elements to the LTRMP (Year 1 of restored monitoring)	Team Leaders	30 March 2010

Intended for distribution
Completion report: Exploratory Analysis of Index of Biotic Integrity Scores Calculated from Datasets Obtained from Three Different Day Electrofishing Protocols (2006B9; Bartels)
Manuscript: Evaluation of a Catch and Release Regulation for Largemouth Bass in Brown’s Lake, Pool 13, Upper Mississippi River (2007B7; Bowler)
Completion report: LTRMP Fisheries Component collection of six darter species from 1989–2004. (2006B13; Ridings)
Manuscript: O’Connell, M.T. with A.M. Uzee-O’Connell and Valerie A. Barko. (in press) Occurrence and predicted dispersal of bighead carp (*Hypophthalmichthys nobilis*) in the Mississippi River System: Development of a Heuristic Tool in D. Chapman and M. Hoff (editors). Asian Carp Symposium Proceedings, American Fisheries Society Symposium. (2005APE13; Barko)
LTRMP Report: An Evaluation Of Macroinvertebrate Sampling Methods For Use In The Open River Reach of The Upper Mississippi River; Kathryn N. S. McCain, Robert A. Hrabik, Valerie A. Barko, Brian R. Gray, and Joseph R. Bidwell (2005C2)
LTRMP report: Relationship of juvenile abundance of select fish species to aquatic vegetation in Navigation Pools 4, 8, and 13 of the Upper Mississippi River, 1998-2007 (2007B5; 2009B5; Popp and DeLain)
Proportional Size Density and Frequency of Occurrence of Flathead Catfish (*Pylodictis olivaris*), Channel Catfish (*Ictalurus punctatus*), and Blue Catfish (*I. furcatus*) in an impounded and unimpounded reach of the Upper Mississippi River. (McCain, 2007B8)
Manuscript: Fishes of the Mississippi River System: a 40 year synthesis of research on one of the world’s great rivers. (2008B8, Ickes)

[1] Tracking number sequence: Year, last letter of USGS BASIS task code “BNBLB”, ID number

Literature Cited

Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. Long Term Resource Monitoring Program procedures: Fish monitoring. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002-1. 42 pp. + Appendixes A–J

Ickes, B. S. and R. W. Burkhardt. 2002. Evaluation and proposed refinement of the sampling design for the Long Term Resource Monitoring Program’s fish component. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, October 2002. LTRMP 2002-T001. 17 pp. + Appendixes A–E. CD-ROM included. (NTIS #PB2003-500042)

Personnel

Mr. Brian Ickes will be the principal investigator.

Water Quality Component
Outcome 1; Output 1.1

The objective of the LTRMP water quality component is to obtain basic limnological information required to (1) increase understanding of the ecological structure and functioning of the UMRS, (2) document the status and trends of ecological conditions in the UMRS, and (3) contribute to the evaluation of management alternatives and actions in the UMRS.

Data are collected within six LTRMP study reaches in the UMRS (Pools 4, 8, 13, 26, and Open River Reach on the Upper Mississippi River and La Grange Pool on the Illinois River). Data entry, quality assurance, data summaries, standard analyses, data serving, and report preparation occur under standardized protocols (Soballe and Fischer 2004).

Methods

Limnological variables (physicochemical characteristics, suspended solids, chlorophyll *a*, phytoplankton [archived], and major plant nutrients) will be monitored at both stratified-random sites (SRS) and at fixed sampling sites (FSS) according to LTRMP protocols.

Fixed site sampling

Fixed site sampling will be conducted as in FY2006 with addition of 14 sites in Pool 4 and 4 historic and 2 new sites in Pool 8 (Table 1).

Stratified random sampling

Stratified random sampling will be conducted at full effort levels (same as FY2006) for fall, winter, spring, and summer episodes (Table 1).

In situ data collection

For both FSS and SRS *in situ* data will be collected on physicochemical characteristics per the standard protocols (Soballe and Fischer 2004).

Laboratory analyses

Samples for chemical analysis (nitrogen (total N, nitrate/nitrite N, ammonia N), phosphorus (Total P, SRP), and silica) will be collected at all fixed sites and at approximately 35% of all stratified random sampling locations as specified in the sampling design. Samples for chlorophyll and suspended solids (total and volatile) will be collected at all SRS and Fixed sites. We will not collect data on major cations and anions in water samples in FY2010. Sampling and laboratory analyses will be performed following LTRMP protocols (Soballe and Fischer 2004) and Standard Methods (American Public Health Association 1992).

Product Descriptions

2010D6: Lake Pepin is a naturally occurring lake, and the widest naturally occurring part of the Mississippi River. A large number of environmental studies have been undertaken on Lake Pepin looking at fisheries, vegetation, and water quality. However, few studies have explored the inter-relationship among components. We will do this as we look at changes in substrate, water quality, aquatic vegetation, zooplankton, and fish community from Geomorphic Reach 1 (above Lake Pepin) to Geomorphic Reach 3 (below Lake Pepin).

Products and Milestones

Tracking number	Products	Staff	Milestones
2010D1	Complete calendar year 2009 fixed-site water quality sampling	Houser, Popp, Dukerschein, Bierman, Chick, Sass, McCain	31 December 2009
2010D2	Complete laboratory analysis of 2009 fixed site and SRS data; Data loaded to Oracle data base.	Yuan	30 March 2010
2010D3	Complete data entry, QA/QC of calendar year 2009 fixed-site and SRS data.	Rogala. Popp, Dukerschein, Bierman, Chick, Sass, McCain	30 May 2010
2010D4	Complete FY10 fixed site and SRS sampling for Pools 4, 8, 13, 26, Open River, and La Grange Pool (Table 1)	Popp, Dukerschein, Bierman, Chick, Sass, McCain	30 September 2010
2010D5	WEB-based annual Water Quality Component Update with 2009 data on Public Web Server.	Rogala	30 June 2010
2010D6	Draft manuscript on changes in substrate, water quality, aquatic vegetation, zooplankton, and fish community from Geomorphic Reach 1 (above Lake Pepin) to Geomorphic Reach 3 (below Lake Pepin).	Popp	30 September 2010
Delayed Products			
2008D8	Final draft manuscript: Primary production, and dissolved oxygen dynamics in UMRS backwater lakes and main channel. (2007D8)	Houser	30 July 2010
2005APE26	Final draft LTRMP report: retrospective, cross-component analysis for Pool 26	Chick	30 March 2010

Intended for distribution
LTRMP report: Sampling of light regime in support of aquatic vegetation modeling (2008D6; Dukerschein, Giblin, Hoff)
Completion report: Examining nitrogen and phosphorus ratios N:P in the unimpounded portion of the Upper Mississippi River (2006D9; Hrabik & Crites)
Manuscript describing results of analyses of spatial and temporal patterns in UMRS WQ. (2006D5; Houser)
Completion report: Lake Pepin zooplankton and water quality data (2006D7; Popp & Burdis)
Manuscript: Comparison of zooplankton in the UMR between channel and backwater strata (2009D6; Burdis)
LTRMP report: Main channel/side channel report for the Open River Reach. (2005D7; Hrabik)
Completion report: Evaluation of Factors Influencing Metaphyton Abundance and Distribution on Navigation Pools 4, 8, and 13 of Upper Mississippi River (2009D7)

Literature Cited

American Public Health Association, American Water Works Association, and Water Environment Federation. 1992. Standard methods for the examination of water and wastewater. 18th edition, American Public Health Association, Washington, D.C. 981 pp. + 6 color plates

Soballe, D. M., and J. R. Fischer. 2004. Long Term Resource Monitoring Program Procedures: Water quality monitoring. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, March 2004. LTRMP 2004-T002-1 (Ref. 95-P002-5). 73 pp. + Appendixes A-J.

Personnel

Dr. Jeff Houser will be the principal investigator.

Land Cover/Land Use with GIS Support
Outcome 1; Output 1.1

In FY2010, systemic digital aerial photography will be collected in cooperation with USFWS Region 3. Processing of this photography will be done in subsequent years.

In addition, we will provide on-demand GIS technical assistance, expertise, and data production to the Environmental Management Program partnership including, but not limited to:

- Aerial photo interpretation
- Interpretation automation into a digital coverage
- Flight planning and acquisition of aerial photography
- Change detection and habitat modeling
- Georeferenced aerial photo mosaics (pool-wide, Habitat Rehabilitation and Enhancement Projects (HREPs), land acquisition areas)
- Georeferenced archival map/plat mosaics (Brown Survey, Mississippi River Commission data, Government Land Office data)
- Produce graphics and summary tables for partnership publications, posters, and presentations
- Conversion of ASCII coordinate data from a GPS to a spatial dataset
- Conversion of all georeferenced data to a common projection and datum for ease of use in a GIS
- Maintain, update, and oversee the aerial photo library of over 50,000 print and digital images.
- Maintain, update, and enhance over 20 million acres of land cover/land use and aquatic areas data spanning the late-1800s through the year 2000. This includes improving existing or developing new crosswalks for comparison of existing datasets, cropping datasets to common extents, and ensuring that all datasets are in a common coordinate system.
- Assist in the maintenance and updating of the USGS-Upper Midwest Environmental Sciences Center's (UMESC) web-based geospatial data repository.

Product Descriptions

Although the primary focus of this component is to provide technical assistance and maintain existing databases, *as time allows* work may occur on the following LTRMP projects:

1. Generate GIS-ready (.xml format) metadata for spatial data being served over the internet. The data being served have metadata included but is in either text format (.txt) or web format (.html). Converting these metadata files to .xml will provide access from within the GIS.

2. Lower Pool 4 and Pool 5 Light Detection and Ranging (LIDAR) data. These data are currently being served, without restriction, by the Corps of Engineers St Paul in ARC Grid format. These data was reformatted to a TIFF DEM and hillshade by UMESC; however the file size is large. To better serve the data it will be converted to 1:24k quad-based data to keep the areas from getting too big, yet still serving the data in an easily recognizable 'wrapper' that can help resource managers assess LIDAR's usefulness to their management efforts.

3. Continue to update the detailed spreadsheet of all LTRMP aerial photography currently housed at UMESC, including date, pool location, format (color infrared, natural color, black-and-white), scan status (yes/no, dots per inch), interpreted status, photo scale, and

extent of coverage (partial or complete). This document will be updated as necessary and served via the internet.

Products and Milestones

Tracking number	Products	Staff	Milestones
2010V1	Acquisition of systemic digital aerial photography	Robinson and Lubinski (FWS)	30 September 2010
Intended for distribution			
Assessment of high-resolution digital imagery for UMRS vegetation mapping and software-based vegetation classification (2007APE13; Robinson)			

Personnel

Mr. Larry Robinson will be the principal investigator.

Bathymetry Component
Outcome 1; Output 1.1

The overall goal of the LTRMP Bathymetry Component is to complete a system-wide GIS coverage of UMRS bathymetry used to quantitatively and qualitatively assess the suitability of essential aquatic habitats. Presently, eight pools (Pools 4, 7, 8, 9, 13, 21, 26, and La Grange Pool) are complete, six pools (Pools 5, 10, 18, 24, 25, Alton Pool, and the Middle Mississippi reach) are over 80% complete, six pools (Pools 15, 17, 20, 22, and Peoria and Marseilles Pools) are between 60 and 80% complete, and the remaining eleven pools are less than 60% complete. Although LTRMP will not collect data under outcome 1; output 1.1, funding from the American Recovery and Reinvestment Act of 2009 will allow the systemic coverage to be collected and is detailed in a separate scope of work. Under Output 1.1, the LTRMP will maintain some level of expertise to provide basic assistance with using the existing bathymetry data.

Provide on-demand technical assistance related to the bathymetric database to the EMP partnership including, but not limited to:

- Deliver data in non-standard formats, such as raw point data in GIS or text files.
- Adjust bathymetry data to selected water surface conditions (presently only available at “flat-pool” conditions)
- Calculate summary statistics (e.g., hypsographic curves and volume) for geographical subsets of the data
- Advise partner agencies on data collection methods and locations that meet LTRMP needs
- Assist in spatial modeling using the bathymetric data

UMESC POC: Jim Rogala

USACE POC: Karen Hagerty

Personnel

Mr. Jim Rogala will be the principal investigator.

Development of an Overall Science Plan
Outcome 2

The LTRMP Science Director (B. Johnson) will lead development of an overall science plan to guide and coordinate work under Outcome 2 in the FY10-14 Strategic and Operational Plan, including how that work relates to Outcomes 1 and 3 in the Plan. This effort will build on efforts begun in FY09 and will consider how previous planning efforts and previous science can be incorporated into the new science plan. The science plan will consider ways to prioritize and sequence analyses and focused research (under the new research frameworks to be developed in FY10), create opportunities for designing and implementing field experiments, generate data and information needed for modeling efforts, and make effective use of LTRMP and HREP capabilities to improve river management.

The science plan will be developed in cooperation with efforts to implement adaptive management under NESP. This work will not replace those efforts under NESP, but will consider how LTRMP can contribute to components of an adaptive management framework.

Products and Milestones

Tracking number	Products		Lead	Milestones
2010SP	Draft Science Plan for LTRMP		Johnson	30 June 2010

Personnel
Dr. Barry Johnson will be the principal investigator.

Statistical Evaluation
Outcome 2; Output 2.1

Statistical support for the LTRMP provides guidance for statistical analyses conducted within and among components, for contributions to management decisions, for identifying analyses needed by the Program, for developing Program-wide statistical projects, and for reviewing LTRMP documents that contain statistical content. The ‘Guidance for statistical analyses’ purpose is designed to save money for the LTRMP, at both UMESC and the field stations, by helping LTRMP staff use data and analytical time more efficiently. The statistician is also responsible for ensuring that newly developed statistical methods are evaluated for use by LTRMP. This guidance would include assistance for LTRMP additional program element projects requiring a minor amount of the statistician's time, but projects needing more assistance would build statistical support into that specific scope of work.

Guidance for management includes assistance with modifications to program design, with standardizing general operating procedures, and with estimating power to detect changes and trends. For example, LTRMP's focus on long term rather than on annual changes has important implications for program design. This is because the number of years of sampling is typically more important than the number of samples per year in increasing power to detect long-term trends (given some minimal number of samples per year).

The statistical component will help ensure that potentially useful analyses of data from within and across components are identified, that methods for analysis are appropriate and consistent, and that, when possible, multiple analyses work together to achieve larger program objectives regardless of which group (UMESC, field stations, COE, etc.) conducts analyses. The statistician is also responsible for reviewing LTRMP documents containing statistical components for accuracy and for ensuring that quality of analyses is consistent among products. A primary goal of statistical analyses is to avoid drawing inappropriate conclusions leading to ineffective or even harmful management actions. Within the UMR, there are a variety of confounding factors and conditions that could produce spurious correlations or lead to inappropriate conclusions regarding cause and effect. Appropriate statistical analysis and interpretation is critical to understanding the limitations of LTRMP data. This, in turn, is critical in efforts to distinguish between natural variation and human effects and in evaluating the long-term effects of management actions, such as HREPs, water level manipulations, or increases in navigation.

Product Descriptions

2010E1: The project 2006APE13 (Among-lake variability in limnological characteristics of backwaters of the Upper Mississippi River) asked whether backwater lakes might be used as study units for the investigation of ecological processes at both sampling and lake scales. However, 2006APE13 also addressed a secondary issue, namely whether we might be able to use LTRMP limnological information to evaluate the common perception that backwater lakes are continuing to increase in connectivity. In this case, this perception may be addressed by asking whether lakes are becoming more similar over time. Our analysis of this question provided modest evidence in favor of increasing similarity among lakes (with time). However, our method of examining this question was simple, and could be improved both analytically and by adding constituents (in addition to chlorophyll a and inorganic suspended solids--both in summer). This effort will report findings using a more complex method, and with the addition of findings using summer temperature and winter inorganic suspended solids.

2010E2: The 2006APE13 contract report documented substantial contributions of backwater lakes to variation in chlorophyll a and inorganic suspended solids (this contract report is available from Karen Hagerty or Jennifer Sauer). This finding confirms that backwater lakes may, under some circumstances, be used as study units for river researchers. We intend to publish these findings in a peer-reviewed journal. Before doing so, however, we want to address why estimates of variance components, such as lake-to-lake variation, occasionally increase after variation associated with covariates (e.g., lake area) is "explained." We plan to address this seemingly counterintuitive phenomenon from both statistical and limnological perspectives.

Products and Milestones

Tracking number	Products	Staff	Milestones
2010E1	Draft manuscript: Inferring decreases in among-backwater heterogeneity in large rivers using among-backwater variation in limnological variables (Elaboration on 2006APE13; See completion report 2006APE13)	Gray, Rogala, Houser	30 September 2010
2010E2	Draft manuscript: Among-lake variability in limnological characteristics of backwaters of the Upper Mississippi River	Gray, Rogala, Houser	30 September 2010

Intended for distribution
Completion report that describes methods of estimating variance components from LTRMP water quality data (2008E1; Gray)

Personnel

Dr. Brian Gray will be the principal investigator.

Data Management
Outcome 2; Output 2.1

The objective of data management of the LTRMP is to provide for data collection, correction, archive, and distribution of a 90 million dollar database that consists of over 2.2 million records located in 195 tables. The 2.2 million data points currently in the system require regular maintenance and upgrading as technologies change. Also, having a publicly accessible database requires a significant level of security. This is accomplished by having the systems Certified and Accredited by a rigorous, formal process by the USGS Security team.

Methods

Data management tasks include, but are not limited to:

- Review daily logs to ensure data and system integrity and apply application updates.
- Develop and maintain field notebook applications to electronically capture data and begin the initial phase of Quality Control/Quality Assurance (QA/QC).
- Administer and maintain the Oracle LTRMP database.
- Administer and maintain LTRMP hardware, software, and supplies to support LTRMP program needs.
- Administer, maintain, and update the LTRMP public and intranet data browsers to insure access to all LTRMP data within USGS security policy.

Products and Milestones

Tracking number	Products	Staff	Milestones
2010M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.	Schlifer	30 May 2010
2010M2	Load 2009 component sampling data into Oracle tables and make data available on Level 2 browsers for field stations to QA/QC.	Schlifer	30 June 2010

Personnel

Mr. Ben Schlifer will be the principal investigator.

Temporal evaluation of factors influencing metaphyton biomass, distribution and composition within Upper Mississippi River Backwaters

Outcome 2; Output 2.2

Introduction/Background: Filamentous algae and duckweed are forms of metaphyton that are common in the Upper Mississippi River (UMR) and can form dense surface mats in backwaters. Metaphyton mats provide relatively little benefit to fish populations (Janecek 1988), impede recreational uses (Hall and Cox 1995), are underutilized by vertebrate and invertebrate herbivores (Neill and Cornwell 1992), can reduce biotic biomass and diversity (Janse et. al. 1998), and can bring about a decline in submersed aquatic vegetation (SAV) in extreme cases (Phillips et. al. 1978, Portielje and Roijackers 1995, Morris et. al. 2003). Duckweed can be an important food source for wildlife and waterfowl (Borman et al. 1997), but at high densities duckweed can have negative effects on aquatic ecosystems (Parr and Mason 2004).

When conditions are favorable, both classes of metaphyton can form dense surface mats that can have negative affects on physiochemical water quality characteristics (Pokorny and Rejmankova 1983, Sullivan 2008). Dense mats of filamentous algae and/or duckweed cover can reduce light intensity beneath the mats (Pokorny and Rejmankova 1983, McDougal et. al. 1997, Morris et. al. 2003). Reduction of light under dense duckweed cover often results in a reduction of temperature and dissolved oxygen (Pokorny and Rejmankova 1983, Parr et. al. 2002, Sullivan 2008). Container studies have indicated that this reduction in light can be an important factor in increased sediment oxygen demand (SOD) under dense duckweed mats (Parr and Mason 2004).

Duckweed and filamentous algae can elicit different dissolved oxygen responses in the underlying water column. The concentration of dissolved oxygen (DO) is frequently reduced beneath duckweed mats due to reduced photosynthesis, increased respiration, and reduced re-aeration (Pokorny and Rejmankova 1983, Sullivan 2008). Furthermore, DO produced by duckweeds is released to the atmosphere rather than the water (Veeningen 1982). A strong reduction in DO can result in the release of ammonium-N and soluble reactive phosphorus (SRP) from the sediment (James et. al. 1995, James et. al. 2008). Increased rates of internal nutrient loading as a result of duckweed-induced water column anoxia have been observed by a number of researchers (Scheffer 1998, Parr and Mason 2004, Sullivan 2008). Negative effects of filamentous algae mats on DO are less pronounced, likely due to the fact that, unlike duckweed, the DO produced by algae is released into the water column (Meijer et. al. 1994, McDougal et. al. 1997).

A number of factors can determine the abundance and distribution of metaphyton in aquatic ecosystems. The majority of research has been conducted on lakes and relatively little is known about factors driving metaphyton dynamics in river systems. Considerable evidence exists linking high rates of external nutrient loading to increased metaphyton production (De Groot et. al. 1987, McDougal et. al. 1997, Szabo et. al. 2005, and Sullivan 2008). A number of researchers have noted the role that highly organic substrates (Parr and Mason 2004, Boedeltje et. al. 2005) and increased water and air temperature (Landolt and Kandeler 1987, Driever et. al. 2005) can play in excessive metaphyton abundance. The abundance and distribution of metaphyton is also affected by pH (Szabo et. al. 2005, Sullivan 2008). Water depth can also be important in determining duckweed abundance (Janse et. al. 1998, Parr and Mason 2004, Boedeltje et. al. 2005, Van Liere et. al. 2007).

Interactions between metaphyton and SAV are complex. Both filamentous algae and duckweed are often associated with SAV but abundant metaphyton can affect species diversity and even persistence of SAV (Goldsborough 1991, Murkin et. al. 1994, McDougal et. al. 1997). Experimental studies of nutrient loading in Dutch agricultural ditches indicated that SAV was dominant at low external nutrient loading but a species shift was observed. At intermediate loading rates SAV developed a horizontal growth strategy and at high loading rates *Lemna minor* became dominant and led to the extirpation of SAV species (Portielje and Roijackers 1995). Experimental mesocosm studies in Australia indicated that moderate to high nutrient loading resulted in a blanketing of the surface by the non-rooted floating species *Azolla pinnata* (Morris et. al. 2003). This profuse coverage of *A. pinnata* resulted in reduced light penetration and dissolved oxygen which resulted in the complete loss of *Vallisneria americana* within four months. This is an important finding, due to the ecological significance of *V. americana* in the UMR (Janecek 1988, Korschgen et. al. 1997).

Optimal growth conditions differ for duckweed and filamentous algae. One striking difference in water quality requirement seems to be pH. Filamentous algae tends to be associated with high pH (McDougal et. al. 1997) while duckweed tends to be associated with low pH (Janes et. al. 1996). Szabo et. al. (2005) indicated that addition of nutrients and reduction of pH was required to remove growth inhibition in duckweeds. Roijackers et. al. (2004) found that planktonic algae inhibited the growth of duckweed via removal of nitrogen, and phosphorus as well as photosynthetic increase of pH, but went on to state that despite these effects, duckweed was likely to outcompete planktonic algae at high nutrient levels. During periods of high summer temperature, it has been found that *L. minor* tends to shade out mats of *Cladophora glomerata*, therefore inhibiting oxygen-dependent electron transport, leading to loss of *C. glomerata* and sudden collapse of DO (Parr et. al. 2002). Some studies seem to indicate that duckweed tends to experience nitrogen limitation more readily than filamentous algae (Scheffer et. al. 2003, Szabo et. al. 2005, Sullivan 2008).

The thick metaphyton mats that occur in the UMR (Sullivan 2008) may have negative effects on the UMR ecosystem. Poor oxygen conditions resulting from dense vegetation can result in reduced density of important UMR fish species (e. g. Lepomis spp.) compared to moderate vegetation (Miranda and Hodges 2000). If external nutrient loading and metaphyton production were to proceed to a threshold at which SAV (*V. americana* in particular) was lost, the ecological implications would be significant (Portielje and Roijackers 1995, Morris et. al. 2003, UMRCC 2003). A substantial loss of *V. americana* within the UMR in the late 1980's resulted in a substantial reduction in use days of canvasbacks, lesser scaup, ring-necked ducks, most dabbling ducks, and American coots (USGS 1999). The ecological ramification of SAV loss would have severe negative consequences for water quality, invertebrates, zooplankton, fish, and birds (Scheffer 1998).

Our previous study of metaphyton (The effects of river nutrient concentrations on metaphyton, submersed aquatic vegetation and dissolved oxygen across a connectivity gradient.) on the UMR centered on the mid to late summer timeframe. The next logical step in understanding the role of metaphyton in the UMR is to investigate early season dynamics and the temporal changes in distribution, biomass and tissue composition. Initial observations from the previous study suggest large changes in biomass at the site and backwater scale through the growing season. Understanding the mechanisms driving these changes require data collection over longer temporal scales (i.e., across the entire growing season). The proposed research would advance our understanding of the factors affecting metaphtyon production and persistence over the entire growing season and allow a broader assessment of its affects on dissolved oxygen and SAV.

Relevance of research to UMRS/LTRMP: The objective of this study is to investigate the factors influencing metaphyton abundance and distribution on the UMR. The 2009 metaphyton study was designed to evaluate the effects of nutrient concentration on metaphyton abundance during mid to late summer conditions by examining the spatial correlations between nutrient concentrations and metaphyton abundance and tissue composition. Generally, dissolved nitrogen concentration decreases and dissolved phosphorus concentrations increase in off channel areas during the course of the summer growing season. The research proposed for 2010 will investigate the temporal correlations between water column nutrients and metaphyton abundance, persistence, and tissue composition during the entire summer growing season (early May to early October). Full growing season sampling will allow us to address the following questions:

1) What are the hydrological, weather and water quality conditions when the emergence of metaphyton occurs in late-spring early summer?
2) How do metaphyton tissue nutrient ratios (N:P, C:P, C:N) and metaphyton biomass respond to changing nutrient conditions through the growing season?.
3) Are particular nutrient concentration thresholds necessary to sustain metaphyton biomass throughout the growing season?
4) Are different nutrients (N and P) limiting metaphyton abundance at different times during the growing season?

The proposed research will enhance our understanding of the role that nutrient concentrations are playing in the formation and maintenance of metaphyton mats on the UMR. These mats are highly visible to the public and, to the extent that they are driven by excessive nutrient inputs to the river, they provide an indicator of ecosystem health that the public can easily comprehend. A late summer evaluation of UMR backwaters in Pools 4, 8 and 13 revealed that 47-78 % of the total backwater area with midday DO concentrations < 5 mg/L was found to be in association with metaphyton cover > 60 % (Giblin et. al. in prep.). A large portion of research regarding the effects of excessive nutrient input on the UMR has focused on hypoxia in the Gulf of Mexico and ignored local eutrophication effects. This project is also important to river managers and Habitat Rehabilitation and Enhancement Project (HREP) design teams looking to produce projects that produce optimal water quality outcomes. It seems feasible that enough can be learned on the topic of metaphyton production to be able to minimize excessive metaphyton biomass and its negative consequences in future restoration projects. For example, proposals that seek to limit nitrogen delivery to the Gulf of Mexico by diverting main channel water into backwaters may have the unintended consequence of promoting metaphyton production and subsequent anoxia under the mats. This project would add to our understanding of the mechanisms driving metaphyton production over a greater temporal range than the previous metaphyton study.

Methods: Standard LTRMP water quality parameters, metaphyton biomass, and metaphyton tissue data will be collected at the four current Pool 8 backwater fixed sites (two Lawrence Lake sites, Target Lake and Stoddard Bay) with varying degrees of connectivity. Sampling will occur bi-weekly from early May through early October. The use of current LTRMP fixed sites will allow us to link data collected with a data stream going back as far as 1988 to further enhance the study and will result in efficient collection of the additional data. Additionally, two highly connected backwaters (Horseshoe Lake and Round Lake) and two poorly connected backwaters (Beiers Lake and Markle Lake) will be sampled monthly (early May through early October) for the same water quality and metaphyton parameters at five randomly generated sites per backwater to observe temporal trends over the growing season based on connectivity, water column nutrients, depth and weather conditions through the growing season. Metaphyton samples will also be collected during LTRMP summer SRS sampling at chemical sites (50 sites- all sampling strata) for the determination of metaphyton biomass and nutrient ratios. This sampling will allow us to examine metaphyton biomass and nutrient ratios under the full range of hydraulic connectivity that exists within Pool 8. Water samples will be analyzed at the UMESC Water Quality Laboratory using standard LTRMP protocols and the standard *in situ* measurements and observations will be made at each site (Soballe and Fischer 2004). A pair of sondes will be deployed in areas of variable metaphyton cover to collect continuous measurements of temperature and DO. This will allow us to analyze diurnal water quality differences based on metaphyton cover. A qualitative rating of density and cover by metaphyton form (algae vs. duckweed) will be made at each site within a 25-m ring around an anchored boat. Additional qualitative density and cover ratings will be made within the same 25- m ring for rooted floating-leaved, emergent, and submersed aquatic plant life forms to track trends in vegetation as metaphyton mats develop. A 20 cm diameter soil screen (0.5 mm mesh) will be used to collect a composite sample at two assigned locations around the boat (center-starboard, center-port) at each sampling site. The metaphyton dry weight will be determined for each composited sample. At sites where insufficient metaphyton is present to examine nutrient ratios at the assigned sampling location, a sample will be collected within 25 m of the sampling site if sufficient metaphyton is present. The distance and direction from the site will be noted and *in* *situ* sonde parameters will be collected to estimate how comparable the tissue sampling site is to the assigned random sampling site. All Metaphyton tissue collected will be analyzed for C, N and P by the University of Wisconsin Soil and Plant Analysis Laboratory. Analysis of nutrient ratios of the metaphyton will give an indication of nutrients that may be limiting metaphyton production. The extended sampling period will allow us to detect changes in these ratios through the growing season.

Timeline: Latest date for beginning of project: May 10, 2010
Expected completion date: October 10, 2010

Products and Milestones

Tracking number	Products	Staff	Milestones
2010OUT2a	Draft completion report: Temporal evaluation of factors influencing metaphyton biomass, distribution and composition within Upper Mississippi River Backwaters	Giblin et al.	27 February 2011

Personnel

Shawn Giblin will be the principal investigator.

Collaborators

Jeff Houser, John Sullivan, Heidi Langrehr, Jim Rogala, Terry Dukerschein

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Effects of landscape patterns on spatial variation in forest community composition and water quality of the Upper Mississippi River System

Introduction/background

The new 5-year Strategic Plan/Operating Plan of the Long Term Resources Monitoring Program calls for focused research plans in several areas. One of these areas is landscape patterns (EMPCC, Strategic Planning Team 2009). A comprehensive research plan for studying the role(s) that landscape patterns play in the Upper Mississippi River System (UMRS) must include, at minimum, the following three components:

> **1**. Quantification of the amount and configuration of different landscape elements (e.g. land cover, land use, habitat, ecosystem types, ecosystem properties) across multiple spatial scales (Allen and Starr 1982; O'Neill et al. 1986; Gardner et al. 1987; O'Neill et al. 1988; Turner 1989)
> **2**. Identification of the causes of landscape patterns (e.g. human land use change, environmental change, management actions, hydrology, impact of dominant organisms) (Paine 1974; Levin 1976; Johnston and Naimen 1990; Holling 1992; Bailey 1996).
> **3**. Evaluation of the consequences of landscape patterns for population and ecosystem processes (e.g. dispersal, recruitment, mortality, and nutrient cycling and energy flow) (Kesner and Meetenmeyer 1989; Turner et al. 1989; Pearson et al. 1996).

The first component allows for quantitative inferences regarding landscape patterns. Such inferences must be made across multiple spatial scales because conclusions drawn at one scale can differ from those at other scales (Gardner 1998). The second component identifies the mechanisms that drive spatial pattern development and alteration, and may, in turn, reveal ways to modify and/or restore particular landscape patterns through management action. The third component yields an understanding of the functional role(s) that landscape patterns play in population and ecosystem dynamics. Based on the functional relationships between landscape patterns and ecological processes, managers ought to be able to identify the types of landscape patterns needed to achieve specific resource management goals.

Over the past year we have developed a framework for components 1 and 2 through prior APE funding (De Jager and Nelson 2008). So far, we have examined the spatially dependent changes in land cover composition of the UMRS using land cover maps from 1890, 1975, 1989, and 2000. We further assessed future trajectories in land cover composition based on land cover transitions from 1975 to 1989 and from 1989-2000 and projected these transitions 50 years into the future (De Jager et al. In review A).

We applied patch-based metrics to quantify habitat fragmentation and connectivity of the terrestrial floodplain of the UMRS (De Jager et al. In Prep A) and applied moving window analyses to quantify multiple-scale patterns of forest cover and aquatic habitat diversity (De Jager et al. In Review B, De Jager et al. In prep B). In two of these studies we identified the main causes of changes in land cover (De Jager et al. In review A) and habitat fragmentation (De Jager et al. In Review B). Those interested in specific results of these studies may contact N. De Jager (email: ndejager@usgs.gov) for more information.

Relevance of research to UMRS/LTRMP

In the next phase of our research, we wish to begin developing a framework for the third component listed above: evaluating the consequences of landscape patterns. By capitalizing on our past efforts to quantify landscape patterns, we can identify locations that differ with respect to the amount and configuration of landscape elements. By linking differences in landscape patterns with other data sets (e.g. USACE forestry data, LTRMP water quality data) we can begin to explore the associations between resource condition and landscape patterns. If it is practical to manage and restore landscape patterns across large areas in order to achieve specific resource management goals, then a number of questions arise. For example: 1) Where should management actions be taken? 2) How much restoration is needed? and 3) What landscape configuration should be considered? These are the questions our proposed research will address for two UMRS components: floodplain forests and water quality.

Methods

Focused Study #1: Effects of landscape patterns of forest cover on plant community composition of floodplain forests

Floodplain forest plant communities are influenced by a number of environmental factors at different scales (Turner et al. 2004). Large river systems typically flow through several ecoregions that encompass a range of land forms, soil types, and climatic conditions. Local species pools may be determined, in part, by such broad-scale physiographic patterns (Baker and Barnes 1999). Floodplain forests are also strongly influenced by flooding (Decamps et al. 1998, Yin 1998). Distance from the river channel, elevation, and topography all influence the effects of flood regime on local species assemblages (Gergel et al. 2002). But floodplain forest community composition may also relate to more local landscape patterns through dispersal limitation or differences in abiotic conditions (Chen et al. 1999). For example, light availability along the edges of fragmented forests influences species composition because exotic species often invade along these margins (Jones et al. 2000; Boulinier et al. 2001; Pearson and Manuwal 2001).

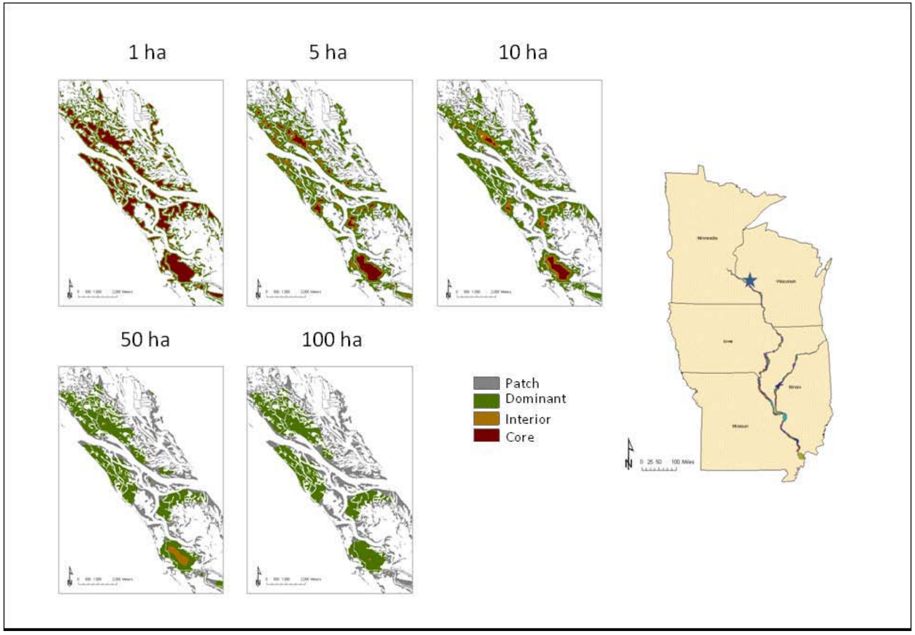

Figure 1: Landscape patterns of forest cover quantified by moving windows, which classify each pixel according to forest cover in the surrounding neighborhood, for multiple neighborhood sizes. Shown here are the distribution of core (100% forested), interior (>90% forested), dominant (>50% forested) and patch (<50% forested) areas with increasing neighborhood size for a portion Pool 5A of the UMR. By linking data regarding forest species composition and successional characteristics with the local amount of forest meeting the criteria for 'core' and proximity to edge, we can begin to examine functional relationships between forest spatial patterns and the condition of forest resources.

In this study, we will examine spatial variation in the species composition of the ground, shrub, and tree layers of existing USACE forest inventory and permanent plot data and link such compositions to landscape patterns. Our main goal in this research is to assess the relative influence of large scale physiographic features (longitudinal position and river reach), hydrologic variables (elevation, distance to impoundment or main channel), and local landscape patterns of forest cover on spatial variation in forest community composition. We will use available Lidar data for elevation, the GPS coordinates of permanent and fixed plot sites for geographic locations and proximity to impoundment or channel environments, and a GIS database that we recently constructed of multiple-scale patterns of forest cover. Our GIS database consists of spatial patterns of forest cover at multiple scales (1 ha to 100 ha) for over 20,000,000 10 m forest pixels for the UMRS. We placed windows (i.e. neighborhoods) of a particular size over each forested pixel and estimated the proportion of pixels within that window that consisted of forest for multiple window sizes. We then classified forested pixels according to forest cover in the neighborhood. Core forest is a 100% forested neighborhood, interior is >90% forested, dominant is >50% forested and patch forest is <50% forested. Figure 1 shows the distribution of these forest classes for a portion of Pool 5A. Note the changes in forest classes with changes in neighborhood size. We can use these changes to determine the spatial scales across which landscape patterns of forest cover influence species composition. Furthermore, we can assess the relationship of distance to forest edge on species composition with this database as well. We anticipate examining variation in the presence of different species as a function of broad-scale physiographic variables, hydrologic variables, and local landscape patterns using stepwise forward regression (Anon. 1996). Similar analyses have been carried out in the riparian zone of the Wisconsin River (Dixon et al. 2002, Turner et al. 2004) but not along the UMRS.

Focused Study #2: Effects of landscape patterns on spatial and temporal variation in water quality measurements

Water chemistry is also influenced by landscape patterns across multiple scales. At regional scales, the composition and size of watersheds influence sedimentation, nutrient enrichment, and contaminant pollution (Burkhead and Jelks 2001, Sutherland et al. 2002, Walser and Bart 1999, Carpenter et al. 1998, Clements et al. 2000, Schulz and Liess 1999). Within floodplain rivers, connectivity of off-channel areas to flow (water-water connections) and the terrestrial landscape (land-water connections) influence water chemistry at more local scales (Gasith and Hasler 1976, Pieszynska 1975, Wetzel 1990, Vanni 1996). Water-water (*ww*) connectivity depends on a suite of landscape variables (e.g. elevation gradient, surface area, geometry, distance to main channel, and channel irregularity). Land-water (*lw*) connectivity is determined by the configuration of aquatic-terrestrial boundaries.

These two types of connectivity may alter water chemistry in different ways. For example, the input of terrestrial matter may come from litterfall, dissolved (DOM) and particulate organic matter (POM) from soil runoff (Minshall 1967, Mulholland 1981, Naimen et al. 1987) and/or detritus, POM, and DOM from flooding (Murphy 1981, Ward 1988, 1989). The local impact of terrestrial inputs on nutrient concentrations, water quality, and/or productivity depends on the location of the drainage, the nature of the terrestrial surrounding, watershed size, amount of terrestrial runoff, and the amount of shoreline connected to the floodplain (Covich 1988, Likens 1984, Meyer and Tate 1983, Schindler er al. 1996, Thom 1981). In floodplain ecosystems, such as the UMRS, high concentrations of detritus, nutrients, and sediments rich in organics are transferred across terrestrial-aquatic boundaries via flooding (Ward 1988 1989, Welcomme 1979). Water -water (*ww*) connectivity determines the quantity of upstream nutrients and sediment transported from the main channel to off channel areas and affects residence time which influences algal abundance, primary production, dissolved oxygen concentrations, and denitrification (Polis et al. 1997).

In this study, we will examine spatial and temporal variation in water quality data derived from the LTRMP water quality component, and relate such variation to a collection of landscape variables including: watershed size and composition, longitudinal position along the river course (i.e. differences among the study reaches), water-water connectivity and land-water connectivity. While the effects of watershed size and composition and longitudinal position on water quality measurements have been examined in the past (Houser et al. In prep), much less is known regarding the local effects of connectivity to flow and to the terrestrial landscape on water quality within navigation pools.

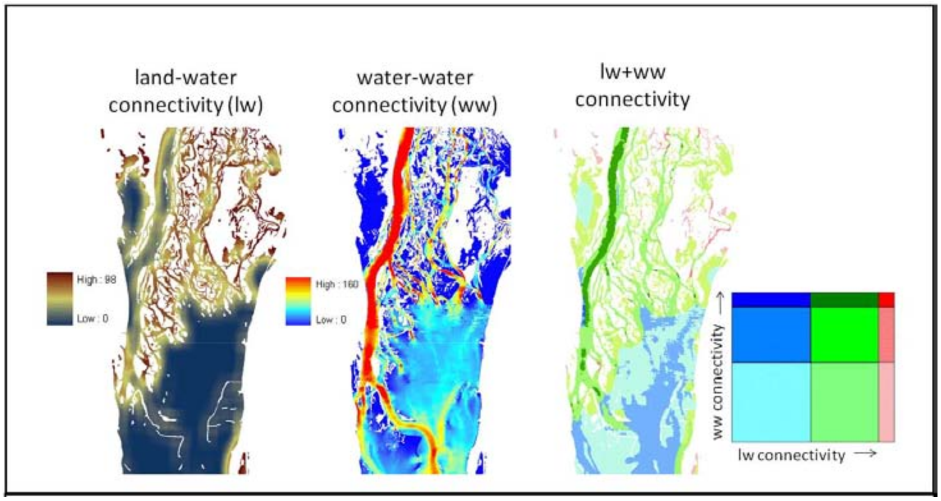

Figure 2. Quantification of land-water connectivity (lw), water-water connectivity (ww), and the combination of lw and ww connectivity. lw connectivity was quantified by the percentage of 50 m radii neighborhoods surrounding each aquatic pixel that consisted of land. ww connectivity was quantified by flow velocity. The geographic distribution of different categories of lw and ww connectivity are shown in the map on the far right with colors coded according to the graph in the lower right hand corner.

We have acquired flow velocity maps for Pools 8 and 13 of the UMR and the La Grange pool of the IWW. We have also started to create a GIS database of the percentage of the landscape surrounding each aquatic pixel that consists of terrestrial floodplain for multiple neighborhood sizes. Shown in Figure 2 are a flow velocity map, a map of the percentage of 50 m radii neighborhoods surrounding each aquatic pixel that consist of land, and a map of various combinations of aquatic (*ww)* and terrestrial (*lw*) connectivity for the middle portion of Pool 8. There is clearly much spatial variation in both *ww* and *lw* connectivity within the pool. This variation is in addition to the widely recognized longitudinal patterns (differences among pools) in water quality. Our main objective is to determine whether spatial and temporal variation in water quality estimates are associated with such local variation in connectivity after accounting for larger scale influences of watershed size, composition, and longitudinal position.

We will assemble 10 years of stratified randomly sampled (SRS) data from the LTRMP water quality component and begin to quantify and visualize spatial patterns of the data beginning with Pools 8, 13, and La Grange. We will address the following questions: 1) How spatially and temporally variable are measurements of nitrogen, phosphorous, dissolved oxygen, and suspended solids? 2) What is the contribution of variation in *ww* and *lw* connectivity to the observed spatial and temporal patterns in these water quality variables? We anticipate examining the variation in water quality data as a function of the landscape variables discussed above using stepwise forward regression (Anon. 1996).

Products and Milestones

Tracking number	**Products**	**Staff**	**Milestones**
2010OUT2b1	Draft manuscript: The influences of landscape variables across multiple spatial scales on the community composition of floodplain forests	DeJager et al.	27 February 2011
2010OUT2b2	Draft manuscript: The influences of landscape variables across multiple spatial scales on spatial and temporal variation in water quality measurements	DeJager et al.	27 February 2011

Personnel

Nate DeJager will be the principal investigator.

Collaborators

Kurt Brownell (Natural Resources Specialist, USACE), Brian Gray (Statistician, USGS), Jeffery Houser (Research Ecologist, USGS), Eileen Kirsch (Research Wildlife Biologist, USGS), J.C. Nelson (Geospatial Biologist, USGS), Jason J. Rohweder (Geospatial Biologist, USGS), Randall R. Urich (Forester, USACE)

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Nutrients, connectivity and primary production in the UMR: The role of phytoplankton community composition

Introduction/Background

Recent APE funded research has examined the differences in biological production and oxygen dynamics among aquatic areas on the river (FY2006APE#15; FY2007APE#6; FY2008 APE#1C). A relevant conclusion from these projects is that there are clear differences in nutrient concentrations among aquatic areas (Houser et al. 2009a; Houser et al. 2009b). Nitrogen concentrations increase with connectivity to the main channel. Phosphorus concentrations are often higher in backwaters than main channel. Despite these clear differences in nutrient concentrations, there were not clear differences in phytoplankton primary production among these aquatic areas. However, there may be important differences in the phytoplankton community that affect the quality of food available to the upper trophic levels. Important questions that follow from these two findings include: How is the phytoplankton community composition responding to these differences in nutrient concentrations? What are the implications for the higher levels of the food web?

Relevance of research to UMRS/LTRMP

The community composition of phytoplankton has important implications for the ecosystem health of the UMR. Research from lakes suggests the quality and quantity of Essential Fatty Acids (EFAs) in zooplankton and fish (an indicator of organism health) is directly related to the dominant algal species forming the base of these foodwebs. Diatoms, chrysophytes and cryptophytes are especially rich in EFAs while bluegreen algae are almost entirely lacking. Preliminary counts of archived LTRMP phytoplankton samples suggest differences in phytoplankton community composition between river channels and backwaters within seasons (see Figure 1), with channels dominated by diatoms and chrysophytes in early summer, and backwaters dominated by bluegreens in late summer. Because blue-green algae are a poor source of food (low EFA concentration), late-summer blooms of bluegreen algae may negatively affect the biological production and health of higher levels of the food web.

Recent research in the UMR indicated fish and many macroinvertebrates from channels contain higher concentrations of EFAs than those from backwaters and suggests that phytoplankton community structure may be an important determinant of variability among aquatic areas in biological production (FY2008APE1C Hydrologic connectivity between off channel areas and the main channel – Richardson et al.; USFWS SSP Ecological effects Asian carp on large river ecosystems – Gutreuter et al., Gutreuter et al. In prep.). Furthermore, the enhancement of bluegreen algal blooms by existing rates of nutrient inputs to the river may be an important mechanism through which the health of the river is impaired. Key to our knowledge of the linkages among nutrients, river productivity and ecosystem health is better understanding of the spatial and temporal variation in phytoplankton community structure in the UMR and how this variation is affected by season, discharge, temperature and nutrient concentrations. LTRMP has an enormous collection of phytoplankton samples that have been collected as part of the Water Quality stratified random and fixed site sampling. Because of funding limitations, few of the phytoplankton samples have been counted. The archived samples provide an excellent opportunity to address questions related to the causes of variability in phytoplankton community composition. Furthermore, the necessary expertise and equipment for counting these samples is now available at the University of Wisconsin-La Crosse.

The goal of the proposed research is to analyze selected LTRMP archived phytoplankton samples to determine variation in phytoplankton species composition and biovolume to evaluate the following hypotheses:

> A. Phytoplankton community composition exhibits seasonal and annual variability due to differences among seasons and years in discharge, nutrient concentrations, temperature and light conditions (e.g., turbidity). This hypothesis will be evaluated by examining the extent to which patterns in phytoplankton community composition have been correlated with annual and seasonal differences in discharge, nutrient concentrations and light conditions over the period of record.
> B. Phytoplankton community composition exhibits persistent spatial patterns within and among study reaches due to differences in current velocity, depth, nutrient concentrations, temperature, and light conditions. This hypothesis will be evaluated by analysis of spatial correlations between phytoplankton community composition and the five predictors above. Variation in phytoplankton species distribution across the flood plain helps determine the distribution of food quality in terms of edibility, lipid quality and quantity, and toxicity.
> C. Phytoplankton community composition reflects local water quality conditions and may therefore be used as a bioindicator of water quality and ecosystem health.

Addressing the above hypotheses will provide useful information for improved management of the river. Understanding the impact of current velocity, depth, nutrient concentration and water clarity will inform decisions regarding management actions that affect the connectivity (and therefore current velocity and nutrient/sediment input) of off channel areas to the main channel. Furthermore, understanding the role of nutrient concentrations in determining phytoplankton community composition will likely illustrate an important local impact of the high nutrient inputs to the river and further emphasize the need to reduce nutrient inputs to the river.

The proposed research will require no additional sample collection, but will exploit the massive LTRMP phytoplankton archive. The counting will be done by a UW La Crosse graduate student that has been trained in phytoplankton identification and enumeration. Generally, it is extremely expensive to have phytoplankton samples counted ($137 to $300 per sample or $275 per hour—this includes no data analysis; www.Phycotech.com). Having the work performed by a trained graduate student will produce substantially more data per cost. Furthermore, the project will be part of a Master's thesis, and the data produced will be analyzed to address the above hypotheses. Finally, phytoplankton samples have a limited, and not well known, shelf life. The proposed work will help to identify how rapidly samples degrade. Furthermore, counting the archived samples sooner rather than later will result in more of the samples yielding useful information.

Methods

Phytoplankton samples will be selected for enumeration such that the selected samples span substantial contrasts in discharge, nutrient concentration, temperature and light conditions across years (to address Hypothesis A), aquatic areas within study reaches (to address Hypothesis B), and study reaches (to address Hypothesis B). Phytoplankton will be counted using standard methods (APHA 1992). Samples selected accordingly will span a broad range of water quality and habitat conditions and will enable the resulting analyses to address Hypothesis C.

Each LTRMP phytoplankton sample was collected as part of either stratified random sampling or fixed site sampling and all relevant water quality data (including exact time and location of collection) are available for each phytoplankton sample. The phytoplankton community composition data will be combined with water quality and discharge data. The resulting data set will be analyzed using appropriate multivariate techniques developed for the analysis of factors affecting community composition (e.g., PRIMER_E, Clarke and Gorley 2006)

Products and Milestones

Tracking number	Products	Lead	Milestones
2010OUT2c	Draft summary report	Houser et al.	31 December 2010

Personnel

Jeff Houser will be the principal investigator.

Collaborators

Bill Richardson, USGS UMESC, wrichardson@usgs.gov;
Roger Haro, University of Wisconsin-La Crosse, haro.roge@uwlax.edu

Other products

University of Wisconsin La Crosse Master's Thesis: December 2011.
Submission for publication in peer reviewed journal: May 2012.

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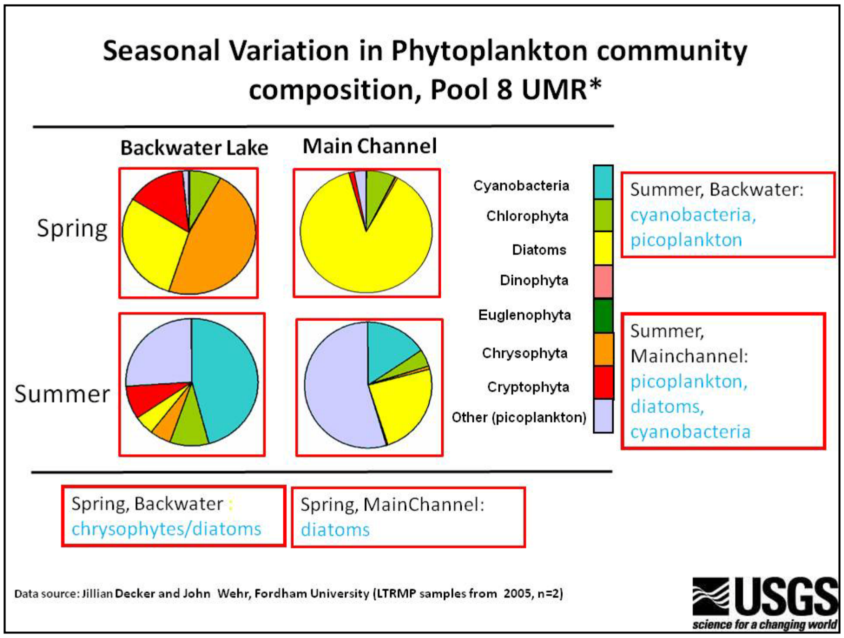
Figure 1.



Data source: Jillian Decker and John Wehr, Fordham University (LTRMP samples from 2005, n=2)

Develop 5-year focused research plans

The current annual time frame for Additional Program Element projects will be replaced with 5-year focused research plans for the four priority research areas determined by the Partnership:

- Native mussels
- Aquatic vegetation
- Landscape patterns in the river corridor
- Connectivity of the river to its landscape.

A draft of the framework for native mussel research was completed in FY09 and is under review. That draft will be finalized in FY10.

In addition, we will develop draft research frameworks for aquatic vegetation, landscape patterns, and possibly connectivity of the river to its floodplain. For each area, we will assign a team leader to form a working group that will develop the draft research framework. The framework for native mussels will be used as a template for the format of the remaining frameworks. Each document will be reviewed, working through the Analysis Team representatives.

Products and Milestones

Tracking number	Products	Lead	Milestones
2010OUT2d1	Aquatic vegetation research plan draft	Johnson et al.	28 May 2010
2010OUT2d2	Landscape patterns research plan draft	Johnson et al.	28 May 2010
2010OUT2d3	Native mussel research plan – final draft	Newton et al.	1 April 2010

Data Visualization
Strategy 1

Redesign of Long Term Resource Monitoring Program Web pages to enhance communication of information on the Upper Mississippi River System (continuation)

Critical to the success of Long Term Resource Monitoring Program (LTRMP) is providing targeted, easily accessible, and usable information to individuals regarding the Upper Mississippi River System. Communicating information from the LTRMP to a wide array of audiences, from LTRMP field technicians, Program advisors, scientists and river managers, politicians, and the general public is a very daunting task especially since these audiences have divergent information needs. In addition to numerous presentations given at regional and national scientific meetings, there are more than 300 scientific reports, graphical data browsers (summarizing multiple years of fish, water quality, and vegetation data), and the LTRMP land cover viewer (which allows users to quickly create maps of the Upper Mississippi River Land Cover data) which are available. Even with this vast amount of information, there is still a perception that the Long Term Resource Monitoring Program is “data rich, information poor”. One tool to help eliminate this perception is the use of the World Wide Web to communicate information.

Currently, the LTRMP Web pages hold a massive amount of data and information aimed at serving the variety of needs of all the aforementioned audiences. This often makes it difficult for users to easily find the information available to meet their needs. The objective of this project is to redesign the LTRMP Web pages to improve the delivery of LTRMP information and increase user-friendliness. Redesign of Long Term Resource Monitoring Program Web pages began in FY2009 and a basic framework was developed. In FY10, the redesign of LTRMP Web pages will be completed with the main audience being UMRS managers and scientists.

Products and Milestones

Tracking number	Products	Lead	Milestones
2010VT1	Redesign of LTRMP Web pages	Rogala	30 December 2010

Maintenance and enhancement of LTRMP Graphical Browsers

Because the LTRMP databases are relatively complex, the utility of serving raw data is often less than satisfactory for river managers not familiar with LTRMP data structure and the statistical sampling design of the program. To assist managers access the data more easily, data is synthesized in an intuitive graphical interface–the Graphical Browsers. Effort is needed annually to add and maintain sampling data the Oracle tables that the LTRMP Graphical Browsers query.

To deliver needed information to UMRS managers, several enhancements will be completed on the vegetation graphical browser which will include added absence data to the vegetation distribution maps.

Products and Milestones

Tracking number	Products	Lead	Milestones
2010VT2	Maintenance and enhancement of LTRMP Graphical Browsers	Schlifer, Caucutt, Langrehr	30 December 2010

Field Equipment Refreshment
Strategy 2

LTRMP field equipment (boats, motors, sampling equipment, etc) need to be well maintained and replaced when necessary to maintain a safe and functional work environment.

Hydrolab MiniSonde 5, Marsh-McBirney flowmeter, and Mustang survival suit	Lake City
Trailer for airboat, Hydrolab MiniSonde 5, Ruggedized Laptop Computer, and Mustang survival suit	La Crosse
Ruggedized Laptop Computer	Bellevue
4X4 Truck	Great Rivers
Kayak, boat motor, Marsh-McBirney flow meter (2), Hydrolab surveyor	Open River Reach
4X4 truck, boat motor, and Mustang gear	Havana

Table 1. Sampling effort within the Long Term Resource Monitoring Program during fiscal years 2010–2014, and data collected by each component.

Component	**Study Area**						**Summary of data collected**[1]
	4	**8**	**13**	**26**	**La Grange**	**Open River**	
Aquatic Vegetation	450 stratified random sample sites over growing season.	450 stratified random sample sites over growing season.	450 stratified random sample sites over growing season.	—[2]	—[2]	—[2]	Species, abundance, frequency, distribution, depth, substrate, detritus
Fisheries	~160 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~180 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~200 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~180 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~270 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~165 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	Species; catch-per-effort; length; subsample for weight, age, & diet; secchi; water depth, temperature, velocity, conductivity; vegetation density; substrate; dissolved oxygen
Added fish monitoring for 2010–2014	1st period, June 15 – July 31, 82 samples	1st period, June 15 – July 31, 82 samples	1st period, June 15 – July 31, 100 samples	1st period, June 15 – July 31, 92 samples	1st period, June 15 – July 31, 120 samples	1st period, June 15 – July 31, 82 samples	
Water Quality	135 stratified random sites done in each episode (winter, spring, summer, and fall); 14 fixed sites[3]	150 stratified random sites done in each episode (winter, spring, summer, and fall); 13 fixed sites[3]	150 stratified random sites done in each episode (winter, spring, summer, and fall); 12 fixed sites[3]	121 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites[3]	135 stratified random sites done in each episode (winter, spring, summer, and fall); 11 fixed sites[3]	150 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites[3]	Suspended solids, major plant nutrients, chlorophyll a, silica, pH, secchi, temperature, dissolved oxygen, turbidity, conductivity, vegetation type & density, wave height, depth, current velocity, depth of snow/ice, substrate, phaeophytin, phytoplankton (archived),
Added water quality monitoring for 2010–2014	14 fixed sites in Pools 4 biweekly during July and August.	4 historic + 2 new fixed sites, biweekly from April through August.	none	none	none	none	
Land Cover/Land Use	Land Cover/Land Use digital aerial photography will be acquired in 2010 and processed in subsequent years. Systemic land cover data for the Upper Mississippi River System is collected approximately every 10 years. To date, systemic land cover has been mapped twice through the Long Term Resource Monitoring Program, in 1989 and 2000.						

[1] A full list and explanation of data collected by each component is available through the LTRMP data web site at http://www.umesc.usgs.gov/data_library/other/ltrmp_monitoring.html.
[2] Aquatic vegetation is not sampled in Pool 26 and La Grange because previous sampling revealed very low abundance, or in Open River due to a lack of suitable habitat.
[3] Frequency of fixed site sampling is bi-weekly in April, May, and June, and monthly in all other months, with no sampling in December and February (i.e., winter sampling in January only).

Appendix A: FY10 Budget Summary

FY 2010 BUDGET SUMMARY

		FEDERAL GROSS	FEDERAL NET	NON-FEDERAL GROSS	NON-FEDERAL NET	COE	TOTAL
Outcome 1; Output 1.1	Aquatic Vegetation Sampling	$ 297,404	$ 204,118	$ 258,881	$ 251,341	$ -	$ 556,285
	Fisheries Sampling	$ 288,027	$ 197,682	$ 1,069,452	$ 1,038,303	$ -	$ 1,357,479
	Water Quality Sampling	$ 616,067	$ 422,827	$ 987,225	$ 958,471	$ -	$ 1,603,292
	Bathymetric Component	$ 20,515	$ 14,080	$ -		$ -	$ 20,515
	Land Cover/Use	$ 201,175	$ 138,073	$ -		$ -	$ 201,175
Outcome 2, Output 2.1	Statistical Evaluation	$ 139,712	$ 95,889	$ -		$ -	$ 139,712
	Data Management	$ 401,268	$ 275,403	$ -		$ -	$ 401,268
	Science Management Support	$ 367,766	$ 252,410	$ -		$ -	$ 367,766
Outcome 2, Output 2.2	Temporal evaluation of factors influencing metaphyton biomass, distribution and composition within Upper Mississippi River backwaters	$ 20,981	$ 14,400	$ 32,339	$ 31,397		$ 53,320
	Effects of landscape patterns on spatial variation in forest community composition and water quality of the Upper Mississippi River System	$ 79,757	$ 54,740				$ 79,757
	Nutrients, connectivity and primary production in the UMR: The role of phytoplankton community composition.	$ 82,361	$ 56,527				$ 82,361
	Develop Research Plans	$ 20,000	$ 13,727				$ 20,000
	Research Management	$ 20,000	$ 13,727				$ 20,000
Outcome 4	Publications	$ 7,250	$ 4,976				$ 7,250
	EMPCC Travel	$ 2,000	$ 1,373				$ 2,000
Strategy 1	Data Visualization	$ 18,056	$ 12,392	$ 2,944	$ 2,858		$ 21,000
	USACE Technical Support					$ 50,000	$ 50,000
FY10 LTRMP TOTAL		**$ 2,582,339**	**$ 1,772,344**	**$ 2,350,841**	**$ 2,282,370**	**$ 50,000**	**$ 4,983,180**