Long Term Resource Monitoring Program
Scope of Work–FY2006

Minimum Sustainable Program

Additional Program Elements

Long Term Resource Monitoring Program
Minimum Sustainable Program
Scope of Work–FY2006

Aquatic Vegetation Component

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). 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 in FY06, 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.

Product Descriptions

2006A2: The 2005 Web-based Annual Component Update shall contain a summary of aquatic vegetation data collected in 2005.

2006A4: Address review comments and submit draft manuscript: Evaluation of Aquatic Macrophyte Community Response to Island Construction in the UMR (See FY05 SOW). Target Journal is *Lake and Reservoir Management.*

2006A5: Assessment of non-sampling error. Nonsampling error is the error that arises from the imperfect implementation of a survey design and consists of frame error, nonresponse error, and measurement error. These three sources of error may contribute to the variance and bias of an estimate and may jointly prevent the accurate estimation of population trends. The nature of the nonsampling errors under one or more components will be explored to evaluate whether adjustment for nonsampling errors is necessary.

2006A6: Enhancement of analysis on backwater effects on chlorophyll *a* by specifically looking at associations between SAV and chlorophyll along longitudinal gradients within Pools 4, 8, and 13.

2006A7: Conduct a science review of the vegetation component 5 years post-establishment of the SRS method. It is prudent for any long-term monitoring program to periodically undergo review (Hirst 1983; McDonald et al. 1998; Strayer et al. 1986). Following reviews of the LTRMP fisheries (Ickes and Burkhardt 2002), water quality (Houser et al. *in prep*), and macroinvertebrate components (Sauer *in prep*), we will review the vegetation program metrics and methods in light of the goals and objectives for vegetation monitoring.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006A1	Complete data entry and QA/QC of 2005 data; 1250 observations.	Popp, Dukerschein, Kirby, Sauer, Hansen	
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Kirby	1 October 2005
	b. Data loaded on level 2 browsers	Hansen	10 October 2005
	c. QA/QC scripts run and data corrections sent to Field Stations	Sauer	30 October 2005
	d. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Kirby	15 November 2005
	e. Corrections made and data moved to public Web Browser	Sauer, Hansen, Caucutt	30 November 2005
2006A2	WEB-based annual Aquatic Vegetation Component Update with 2005 data on Public Web Server.	Popp, Dukerschein, Kirby, Sauer, Heglund	
	a. Develop first draft	Sauer	15 February 2006
	b. Reviews completed	Popp, Dukerschein, Kirby, Sauer, Heglund, Yin, Cox	28 February 2006
	c. Submit final update	Sauer, Heglund	31 March 2006
	d. Placement on Web with PDF	Sauer, Caucutt, Cox	30 July 2006
2006A3	Complete aquatic vegetation sampling for Pools 4, 8, and 13 (Table 1)	Popp, Dukerschein, Kirby	31 August 2006
2006A4	Address review comments and submit draft manuscript: Evaluation of Aquatic Macrophyte Community Response to Island Construction in the UMR	Dukerschein, Yin, Gray, Heglund	30 January 2006
2006A5	Contract report: nonresponse, frame and measurement errors	Rogala, Gray	30 August 2006
2006A6	Submit progress report on enhancement of analysis on backwater effects on chlorophyll *a*	Rogala	30 August 2006
2006A7	Guidance to the UMESC-LTRMP management team on scientific review of the vegetation component	Heglund, Yin	30 August 2006
2005GLIDE3[2]	Submit LTRMP draft report: Establish baseline of SAV distribution and index of abundance	Chick, O'Hara	31 January 2006
2005GLIDE4[2]	Submit LTRMP final draft report: Establish baseline of SAV distribution and index of abundance	Chick, O'Hara, Heglund, Gray	30 September 2006

[1]Tracking number sequence: Year, last letter of USGS BASIS task code "BNBLA", ID number
[2]Delayed FY05 products

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

Jennifer Sauer will be point of contact.

Fisheries Component

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, 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 160 and 270 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 2 sampling periods (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.

Additional work under the MSP by Mr. Ickes will include work on the Status and Trends report and APE #11.

Product Descriptions

2006B2: The Web-based Annual Component Update shall contain a summary of fisheries data collected in 2005.

2006B4: Researcher framework for testing a hypothesis of over-winter habitat limitation on limnophilic fish. This document will detail a framework for research into an over-arching hypothesis of winter habitat limitation on the production of limnophilic fishes in the Upper Mississippi River System (UMRS). The goal of this document is to lay a foundation of background material, outline a sequence of pertinent research questions, and identify approaches and methodologies for study. This framework is expected to direct research into this topic through the auspices of the LTRMP.

2006B5: Standardizing catch-per-unit-effort data from multiple gears for community level analyses. See FY04 SOW for description. Submit manuscript; target Journal: Canadian Journal of Fisheries and Aquatic Sciences.

2006B6: Spatial structure and temporal variation of fish communities in the Upper Mississippi River. See FY04 SOW for description. Submit manuscript; target Journal: Canadian Journal of Fisheries and Aquatic Sciences.

2006B7: Enhancement of Graphical Fish Data Browser: Incorporate additional graphics such as length frequency and tables that fish managers are requesting into the Fish Graphical Database.

2006B8: Exploratory Analysis of LTRMP dataset through 2004 to expose habitat-related factors that are potentially limiting backwater fish communities. This will be a two-step process, involving use of ARCVIEW software in step 1 to identify known overwintering areas for bluegill and largemouth bass on a basemap of Pool 8 and plot buffer zones of increasing size around the specific overwintering sites. The second step will be to independently plot LTRMP catch rate data for adult bluegill and largemouth bass on the maps and visually examine patterns of catch rates related to the overwintering sites and their buffer zones. The process will be performed for both summer and fall fish data collections. It is anticipated that collections with higher catch rates will be located in areas close to known overwintering areas or where buffer zones between overwintering areas overlap. This pattern is likely to be more distinct in fall than in summer.

2006B9: Exploratory Analysis of LTRMP fish dataset and EMAP fish dataset through 2004 to make protocol-related inferences. Calculate Index of Biotic Integrity (IBI) scores or additional fish community assessment metrics on fish data using Wisconsin DNR methods (Lyons 2001) for Mississippi River sites sampled by EMAP and LTRMP. (2004 and 2005 Wisconsin DNR nowadeable IBI's will be calculated under EMAP funding). Compare scores within and among navigation pools or reaches to determine if any differences in scores are evident with different sampling methods.

2006B10: Multi-year fish report on Pool 4. This report focuses on fisheries data collected in with Pool 4. Spatial patterns and trends will be explored.

2006B11: LTRMP Fish Autecology 10-year Report. The report focuses on trends in frequency of occurrence, length-frequency distributions, rate of gain, and relative abundance of Upper Mississippi River Fish.

2006B12: Catfish analysis: Analyze catfish trend and length frequency data from Pool 26 and Open River Reach

2006B13: Large river darters. The range, distribution, and habitat use by rare large river darters in the LTRMP study reaches will be explored.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006B1	Complete data entry, QA/QC of 2005 fish data; ~1,590 observations	Sauer, Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik, Hansen	
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik	31 January 2006
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	Hansen	10 February 2006
	c. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik	1 March 2006
	d. Corrections made and data moved to public Web Browser	Sauer, Hansen, Caucutt	15 March 2006

2006B2	WEB-based annual Fisheries Component Update with 2005 data on Public Web Server.		Sauer, Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik, Johnson		
	a. Develop first draft		Sauer, Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik		30 April 2006
	b. Reviews completed		Sauer, Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik, Johnson, Knights, Cox		15 May 2006
	c. Submit final update		Sauer, Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik		31 May 2006
	d. Placement on Web with PDF		Sauer, Caucutt, Cox		31 August 2006
2006B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River Reach, and La Grange Pool (Table 1)		Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik		31 October 2006
2006B4	Submit draft framework for over-wintering fish as part of the Additional Program Elements proposal process		Ickes		31 October 2005
2006B5	Submit draft manuscript: Standardized CPUE data from multiple gears for community level analysis.		Chick, Minchin, Ickes, Pegg, Barko, Chick, J.H., P.R. Minchin, B. Ickes, M.A. Pegg, and V.A. Barko.		31 January 2006
2006B6	Submit draft manuscript: Spatial structure and temporal variation of fish communities in the Upper Mississippi River.		Chick, Ickes, Pegg, Barko, Hrabik, Herzog, Johnson, Cox		28 February 2006
2006B7	Enhancement of the fish graphical browser		Dukerschein, Ickes, Sauer		30 September 2006
2006B8	Summary report: Habitat-related factors that are potentially limiting backwater fish communities		Dukerschein		15 May 2006
2006B9	Summary report: LTRMP-EMAP protocol related inferences		Dukerschein		31 August 2006
2006B10	Draft MDNR report: Multi-year fish report on Pool 4		Popp		30 September 2006
2006B11	LTRMP Fish Autecology 10-year Report		Kirby, Bowler, Ickes, Johnson, Cox		30 April 2006
2006B12	Submit draft manuscript: Catfish analysis		Hrabik		30 June 2006
2006B13	Submit draft report: Large river darters		Hrabik		1 August 2006
2005B5[2]	LTRMP report titled: Fish life history database report		Dukerschein, Ickes, Johnson, Cox		31 August 2006
2005B8[2]	Contract report titled: "Non-native fishes in the Upper Mississippi River System: A Synthesis of Information from the Long Term Resource Monitoring Program" to COE and USGS. (FY04 SOW) Irons et al.		O'Hara, Popp, Chick, Ickes, Kolar, Hrabik, Johnson		30 May 2006
2005B12[2]	Complete and distribute USGS open-file report on fish analysis. (FY02 SOW)		Ickes		30 March 2006
2005APE11[2]	Submit final draft LTRMP report: Analysis of fish age structure and growth in the Illinois River		O'Hara, Chick, Johnson, Cox		30 April 2006
2005APE13[2]	Submit draft OFR: Asian Carp in the Mississippi River		Barko		30 June 2006
2005APE14[2]	Submit draft manuscript: Asian Carp in the Mississippi River:		Barko		30 September 2006

[1]Tracking number sequence: Year, last letter of USGS BASIS task code "BNBLB", ID number
[2]Delayed FY05 products

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

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 FY 2005 (Table 1).

Stratified random sampling

Stratified random sampling will be conducted at full effort levels (same as FY2005) for 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 laboratory analysis will be collected at all fixed sites and at approximately 35% of all stratified random sampling locations as specified in the sampling design. Sampling and laboratory analyses will be performed following LTRMP protocols (Soballe and Fischer 2004) and Standard Methods (American Public Health Association 1992). Laboratory analyses will consist of nitrogen (total N, nitrate/nitrite N, ammonia N), phosphorus (Total P, SRP), chlorophyll, silica and total and volatile suspended solids. We will not collect data on major cations and anions in water samples in FY2006.

Additional work under the MSP by Dr. Houser will include work on the Status and Trends report, manuscript preparation, and APE #15.

Product Descriptions

2006D5: <u>Analyses of spatial and temporal patterns in UMRS water quality</u>. Submit draft manuscript that describes temporal and spatial variation in selected nutrients and chlorophyll *a* concentrations in five study reaches of the UMRS using quarterly data collected from 1993 to 2002. The following questions will be addressed: (1) Are there consistent differences among aquatic areas (e.g., main channel and off-channel areas (backwaters))?; (2) what temporal patterns occur within these aquatic areas?; and (3) what is the relative importance of spatial and temporal components in the total variance?

2006D6: <u>Evaluation of new Hydrolab Turbidity Probe</u>: Addition of turbidity probes on LTRMP Hydrolab multiparameter instruments would result in saving field and data entry time as well as obtaining direct field turbidity measurements and the capability to continuously monitor turbidity in various monitoring and research applications. We have the opportunity to test this probe for a year and compare it to our current Hach turbidmeter method, usually done in the lab. Data collection would require very little time because the dissolved oxygen, pH, conductivity and temperature measurements are already being taken from the same instrument. Equipment costs are being contributed by another program. We propose to record both types of turbidity measurements throughout winter, spring, and summer (we did not receive the turbidity probe back from Hach in time to do fall, 2005 measurements). We hope to begin initial testing in late January 2006 and to complete measurements by early August 2006. Data from the new method will be entered into MS Excel throughout the year and a draft report containing graphs and an evaluation of how results from the new probe compare to the standard LTRMP Hach.

2006D7: Lake Pepin zooplankton and concomitant water quality data. Zooplankton samples have been collected in Lake Pepin in conjunction with the LTRMP water quality sampling effort since 1993. This level of effort has resulted in a long-term zooplankton data set from Lake Pepin and a concurrently collected water quality data set that should allow cross-component analysis. Analysis of this zooplankton data will provide temporal insight at two scales, within year and between years over approximately a 13 year period. Zooplankton abundance will be correlated with discharge along with water quality parameters that might be expected to be linked to zooplankton, such as chlorophyll, transparency, suspended solids, and perhaps nutrients. Although discharge may be important in controlling the population, it appears fairly certain that zooplankton are significantly impacting water quality at times in Lake Pepin through grazing.

2006D8: Effectiveness of wetland creation in an Iowa tributary stream as a management tool for reducing nitrogen loading in an Upper Mississippi River backwater: a case history of Rock Creek. Preliminary analysis of data collected by the LTRMP from Shricker Lake revealed elevated total nitrogen (TN) and ammonia nitrogen (NH_3-N) levels. Iowa DNR staff determined that Rock Creek, a tributary flowing directly into Shricker Lake, was the primary source of the elevated nitrogen levels. Additional investigations determined that the nitrogen point-source for Rock Creek was groundwater contaminated by a producer of agricultural nitrogen products. In 2000, a wetland was created in middle Rock Creek in an effort to mitigate the high nitrogen levels. Preliminary analysis of water quality observations collected by the LTRMP indicated that nitrogen levels have decreased in Rock Creek below the wetland, but are unchanged above the wetland. As of 2003, nitrogen levels remained elevated in Shricker Lake. We propose an in-depth analysis of Rock Creek and Shricker Lake water quality observations collected by the LTRMP with emphasis on observed impacts of the mitigating wetland. We also propose an evaluation of water quality observations in Shricker Lake with emphasis on observed trends in nitrogen parameters before and after the construction of the mitigating wetland.

2006D9: Effects of discharge on selected water physical and chemical parameters in the main channel of the open Mississippi River. This report will expand on the analysis underway for "Main channel/side channel report for the Open River Reach" (2005D7) and include a GIS overlay to determine effects of mesohabitats within strata on selected parameters.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006D1	Complete calendar year 2005 fixed-site water quality sampling	Houser, Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik	31 December 2005
2006D2	Complete laboratory analysis of 2005 fixed site and SRS data; Data loaded to Oracle data base.	Yuan, Hansen	30 March 2006
2006D3	Complete data entry, QA/QC of calendar year 2005 fixed-site and SRS data.	Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik, Hansen	30 May 2006
2006D4	Complete fixed site and SRS sampling for Pools 4, 8, 13, 26, Open River, and La Grange Pool (Table 1)	Popp, Dukerschein, Kirby, Chick, O'Hara, Hrabik	30 September 2006
2006D5	Submit draft manuscript describing results of analyses of spatial and temporal patterns in UMRS WQ.	Houser	15 September 2006

2006D6	Submit draft contract report: Evaluation of new Hydrolab Turbidity Probe	Dukerschein	30 September 2006
2006D7	Submit draft report: Lake Pepin zooplankton and water quality data	Popp	30 September 2006
2006D8	Summary of analysis on effectiveness of wetland creation	Kirby	30 July 2006
2006D9	Effects of discharge on selected water physical and chemical parameters	Hrabik	1 August 2006
2005D7[2]	Draft report: Main channel/side channel report for the Open River Reach.	Hrabik	1 June 2006
2005D9[2]	Water Quality component update on-line	Houser, Rogala	15 February 2006
2005D10[2]	Water Quality component review	Houser, Johnson, Cox	30 April 2006
2005APE24a[2]	Submit final draft LTRMP report: retrospective, cross-component analysis for Pool 26	Chick, Johnson	28 February 2006
2005APE24b[2]	LTRMP report: retrospective, cross-component analysis for Pool 26	Chick, Johnson, Cox	30 September 2006
2005APE28[2]	Complete Water Quality Fixed Site Graphical Browser	Caucutt, Houser, Rogala	30 March 2006

[1]Tracking number sequence: Year; last letter of USGS BASIS task code “BNBLD”; ID number
[2]Delayed FY05 products

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.

Statistical Evaluation

A commitment to statistical support for the LTRMP is essential: it 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 ensuring that LTRMP staff aren't forced to waste time searching for appropriate statistical methods or don't have to revise methods and results following a faulty analysis. The statistician is also responsible for ensuring that newly developed statistical methods are incorporated into LTRMP analyses when appropriate. This guidance would include assistance for A.P.E. 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 effects 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, no matter which group (UMESC, field stations, Corps, etc.) is conducting the analyses. The statistician is also responsible for reviewing all LTRMP documents that contain a statistical component for accuracy and to ensure that quality of analyses are consistent among products. A primary goal of statistical analyses is to avoid drawing inappropriate conclusions that might lead 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

2006E1: Work with LTRMP leadership over the next six-months on power to detect change through a series of short, educational writings posted on the LTRMP Statistics Homepage, one-on-one meetings with interested individuals and, given interest, a formal briefing to LTRMP management (USACOE and UMESC).

2006E2: Document describing methods for estimating power-to-detect trends in prevalence (presence/absence) data: Methods for estimating power to detect trends in continuous data from the LTRMP water quality component are moderately well established, while an analytical method for estimating power to detect trends in LTRMP fish and macroinvertebrate count data is in review. This effort will describe estimating power to detect trends in a third kind of data collected by LTRMP personnel, that of presence/absence or prevalence data; the document will also address power to detect trends in prevalence data that have been corrected for nondetection. Both the vegetation and fisheries components report prevalence data.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006E1	Power to detect change	Gray, Heglund, Johnson, Houser, Ickes, Sauer, Rogala	30 August 2006
2006E2	Submit draft document describing methods for evaluating power-to-detect trends in prevalence data	Gray, Heglund	15 September 2006

[1]Tracking number sequence: Year; last letter of USGS BASIS task code "BNBLE"; ID number

Personnel

Dr. Brian Gray will be the principal investigator.

Data Management

The objective of data management of the LTRMP is to provide for data collection, data correction, data archive, and data 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[1]	Products	Staff	Milestones
2006M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.	Hansen	30 May 2006
2006M2	Load 2005 component sampling data into Oracle tables and make data available on Level 2 browsers for field stations to QA/QC.	Hansen	30 June 2006

[1]Tracking number sequence: Year; last letter of USGS BASIS task code "BNBLM"; ID number

Personnel

Mr. David Hansen will be the principal investigator.

Land Cover/Land Use with GIS Support

Although LTRMP will not collect data under the minimal sustainable program, the Program will maintain program expertise, manage existing data, and provide limited on-demand GIS technical assistance.

- 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, 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 and oversee the aerial photo library of over 50,000 print and digital images.

- Maintain and update over 20 million acres of land cover/land use and aquatic areas data spanning the late-1800s through the year 2000.

- Assist in the maintenance and updating of the USGS-Upper Midwest Environmental Sciences Center's (UMESC) web-based data repository.

Product Descriptions

Although the primary focus of this component is to provide technical assistance and maintain existing databases, as time allows the following LTRMP projects can be completed:

General Class Crosswalk of the 1989 LCU: Top priority when time is available.
All data for 1989 have been joined into a single coverage and crosswalked to the General Class vegetation classification system (31-15-7 Classes). To facilitate comparison between the 1989 and 2000 LCU data, each dataset will be clipped to a common extent and served as a separate datasets. These data will be served as NAD83 shapefiles. UMESC will continue to serve the original datasets for both 1989 and 2000 LCU.

Modification and Enhancement of 2000 LCU
To supplement the crosswalked and clipped 1989 LCU data, all data for the 2000 systemic data set has been joined into a single coverage and will be clipped to a common extent. These data will be served as NAD83 shapefiles. When using the General Class categories, these data can be directly compared to each other at the 31-class, 15-class, and 7-class levels.

Year 2000 Color Infrared Mosaics of Pools 4, 8, 13, 26, and selected areas of the Open River Reach and the Illinois River's La Grange Pool
Most aerial photointerpretation is georeferenced to the earth using gray-scale DOQQs. The DOQQs are based on leaf-off small-scale (1:40,000) photography and contain very little aquatic vegetation ground control, resulting in alignment errors. A DOQ mosaic derived from the peak biomass, color infrared photos (at 1:24,000-scale) collected systemically by the USACOE in the late-summer of 2000 will provide a more accurate

method of georeferencing vegetation in these problem areas. The 2000 mosaics will be referenced to USGS-produced DOQs and maintain the same accuracy requirements.

Web-based GIS Tutorials for Working with LTRMP Data Sets
This task will complement the vast amount of LTRMP spatial data served by UMESC. It will show users graphically, and in simple terms, how to download and manipulate spatial data. Manipulations will include instructions for reprojecting both raster and vector data to other coordinate systems (Latitude/Longitude) and datums, clipping multiple data sets to a common boundary, and crosswalking UMESC and other vegetation data (GIRAS, NWI) to a common class. Other GIS tips and tricks will be described as time allows.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2005V3[2]	LTRMP report titled: Upper Mississippi River Vegetation Change (1989-2000) (FY03)	Lohman	30 December 2005
2005APE18[2]	HNA GIS Query Tool compatible with ArcMap 9.0	Fox	30 December 2005

[1]Tracking number sequence: Year; last letter of USGS BASIS task code "BNBLV"; ID number
[2]Delayed FY05 products

Personnel

Dr. Kirk Lohman will be the principal investigator.

Bathymetry Component

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, La Grange) are complete and nine pools (Pools 5, 5A, 10, 11, 15, 17, 18, 20, Peoria) are over 50% complete (some over 80% complete). In addition, the Middle Mississippi Reach is about 90% complete. Although LTRMP will not collect data under the minimal sustainable program, the Program will maintain some level of expertise to provide basic assistance with using the existing LTRMP 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

Personnel

Mr. Jim Rogala will be the principal investigator.

Macroinvertebrate Component Wrap-up

Following guidance from the A-Team and EMP-CC, the macroinvertebrate component has been dropped from the LTRMP. Potential work to address issues of interest to the Partnership may be proposed as Additional Program Elements.

Product Descriptions

2006C1: Evaluation of the Long Term Resource Monitoring Program's Macroinvertebrate Component. The report discusses the history and sampling design of the component and the results of an evaluation survey and workshop conducted with LTRMP partners. Data from a Web-based survey and workshop of resource managers was compiled to assess general support and identify issues or concerns about the component were the first steps to help assess general support and identify issues or concerns about the macroinvertebrate component. Suggestions for a future design of the macroinvertebrate component are included (i.e., the continuation of monitoring soft-sediment macroinvertebrates and the addition of long term monitoring of native mussels.)

2005C2: Open River Macroinvertebrate Report: Although the target organisms selected for monitoring are ecologically important, the physicochemical nature of the Open River Reach (ORR) is unique from the five other LTRMP study areas. As a result, relative abundance of these organisms is often low and restricted by the availability of preferred habitats in the ORR. The purpose of this study was to evaluate several macroinvertebrate capture methods in an unimpounded reach of the Mississippi River to determine the most effective way to characterize macroinvertebrate community structure.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006C1	LTRMP report titled: "Evaluation of the Long Term Resource Monitoring Program's Macroinvertebrate Component"	Sauer, Johnson, Cox	28 February 2006
2005C2[2]	Open River Macroinvertebrate Report (Outstanding product)	Hrabik, Johnson	15 August 2006

[1]Tracking number sequence: Year; last letter of USGS BASIS task code "BNBLC"; ID number
[2]Delayed FY05 product

Annual LTRMP Summary Report

Communication is a cornerstone of the LTRMP. We must communicate the accomplishments of the program to partners, customers, decision makers, politicians, and the general public in a way that is simple and effective, and that makes the program relevant to their needs. Each LTRMP project communicates its results in some form, which yields a variety of products available through various outlets. The program needs a single product that summarizes and highlights its accomplishments annually in a format that is easy to read and widely available.

Methods

A Web-based report will be produced that summarizes, synthesizes, and highlights the accomplishments of the LTRMP for FY05 and shows how these accomplishments are important to river management. Types of information that may be included are monitoring efforts, applied research results, analyses, GIS tools and products, data syntheses and interpretations, unusual or newsworthy events, lessons learned, efficiencies gained, substantive changes in operation/organization, updates to long-term ecological trends, and examples of how LTRMP information is making a difference. The aim will be to report accomplishments in an informative manner that relates science to management. The report will concentrate primarily on system-level information, although noteworthy accomplishments at smaller scales will be included. The report will build on previous annual summary reports, the LTRMP Report to Congress, and the USGS Status and Trends report (USGS 1999) and will become the basis for contributions to the next Report to Congress.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006S1	2004 annual LTRMP Web-based summary report on-line	Heglund, Johnson, Sauer, Gaugush, Houser, Ickes, Yin, Caucutt, Cox	30 March 2006
2006S2	Draft 2005 annual LTRMP Web-based summary report	Gaugush, Houser, Ickes, Yin, Heglund, Johnson	30 September 2006
2005S2[2]	Draft Web-based summary report submitted for USGS review (2000 & 2001) (FY02 SOW)	Johnson, Sauer, Heglund	28 February 2006
2005S3[2]	Final draft Web-based summary report completed and submitted to COE (2000 & 2001) (FY02 SOW)	Johnson, Sauer, Heglund	31 May 2006

[1]Tracking number sequence: Year; last letter of USGS BASIS task code "BNBLV"; ID number
[2]Delayed FY05 products

Literature Cited

U.S. Geological Survey. 1999. Ecological status and trends of the Upper Mississippi River System 1998: A report of the Long Term Resource Monitoring Program. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. April 1999. LTRMP 99-T001. 236 pp.

Table 1. LTRMP sample collection for FY05.

	Study Area					
Component	**4**	**8**	**13**	**26**	**La Grange**	**Open River**
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.	—	—	—
Fisheries	~160 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sample sites.	~180 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sample sites.	~200 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sample sites.	~180 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sample sites.	~270 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sample sites.	~165 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sample sites.
Water Quality	135 stratified random sites done in each episode (winter, spring, summer, and fall); 14 fixed sites during 2005.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 13 fixed sites during 2005.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 12 fixed sites during 2005.	121 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites during 2005.	135 stratified random sites done in each episode (winter, spring, summer, and fall); 11 fixed sites during 2005.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites during 2005.

Report Definitions

Draft: A draft that has been reviewed by the UMESC Center Director and a Branch Chief which is ready for review by USGS, COE, A-Team, or blind review, as needed.

Final draft: The report is completely through the USGS review/revision process and is ready to go to the USGS editorial group for production.

Reports not identified as drafts: (e.g., LTRMP report titled: Multi-year Synthesis of the Macroinvertebrate Component from 1992–2002 for the Long Term Resource Monitoring Program's) indicates a final printed version or Web-based report is on-line. For other products (i.e., manuscripts) this indicates submission to a journal.

APE #8: Development of two-dimensional numerical hydraulic models for Mississippi River Pool 13 and Illinois River La Grange Pool in support of the LTRMP

Principle investigator/Project leader:
Marvin Martens CEMVR-ED-HH

Introduction/Background: The primary objective is to numerically model selected Mississippi River and Illinois River Pools in order to develop the capability to relate hydraulic parameters for various alternative conditions to requirements for diverse biota enhancement. Two-dimensional flow models provide good simulations of current velocity patterns and water surface elevations for selected conditions. These numerical models provide water level management tools required for Habitat Needs Assessment (HNA) by presenting or quantifying information related to the following:

1. System-wide high resolution topographic data
2. System-wide bathymetric data
3. Substrate type characterization
4. Habitat spatial structure metrics
5. Areas of inundation
6. The existing and pre-impoundment hydrologic regime
7. Analysis of seasonal habitat availability.

Model information is essential for characterizing aquatic habitat conditions as related to the hydrologic regime for floodplain habitats. The numerical models provide tools to evaluate and maximize opportunities for success in planning and designing as well as monitoring habitat improvement projects. The development of two-dimensional numerical hydraulic pool models will provide timely management tools as "on-the-shelf" models in support of the LTRMP. Numeric models have previously been developed for a number of pools and reaches on the Upper Mississippi River and Illinois Waterway for other projects. Refinement of these models offers an opportunity to develop appropriate tools for LTRM purposes economically and efficiently. Previous models were limited by the general lack of availability of off-channel bathymetric data. However, as part of ongoing efforts under the LTRM program, detailed bathymetric data for off-channel areas is available or being collected. In addition, most of the models were constructed to examine low to moderate flow conditions when the river remains within its banks, and little attempt has been made to include overbank flows in the two-dimensional models. Overbank flow is related to higher less frequent flows and are of significant interest since these flows are influential in changing conditions along bank lines and backwaters. The entire floodplain may be defined as the area inundated by the 100-year flood event and may include a much greater area than that inundated by the 2-year event. Area and frequency of inundation predicted by the model can provide a valuable frame of reference to that observed by the monitoring program. For LTRMP, models should extend to the land-water interface created by the 2 year frequency flood event. If it is desired to examine higher flood flow conditions, the overbank areas within the models will be extended for specific study areas. This will add significant costs. However, in general extending the models to the 100-year flood level is not expected to add much valuable information for LTRMP purposes compared to that provided by 2-year models.

Relevance of research to UMRS/LTRMP: It is desired to eventually have calibrated, two-dimensional models for all of the navigation pools on the UMRS and to incorporate the velocity and depth information derived from the models into GIS to assist in Habitat Rehabilitation and Enhancement Projects (HREP) decision making and design. Specific objectives will include:

- Develop calibrated, two-dimensional hydrodynamic models to assist in HREP assessments related to the Brown's Lake, Pleasant Creek, Potters Marsh, Smith Creek, and Spring Creek projects in UMRS navigation Pool 13 and Banner Marsh, Lake Chautauqua, and Rice Lake projects in Illinois River LaGrange Pool.

- Develop a common set of hydrologic conditions for significant events ("representative flows" – 50% annual duration, typical over-wintering conditions, ordinary high water, etc.) based on flow duration, frequency, and profile elevation.
- Produce water depth, velocity and inundation datasets for specified hydrologic conditions
- Develop GIS database of model input and output datasets to be used by querying tools in combination with the HNA databases.

Methods to be Employed: The models will be constructed by the Hydrologic Engineering Section of the Rock Island District, Corps of Engineers (CEMVR-ED-HH) using the Surface-Water Modeling System (SMS). The hydrodynamic model to be used in this effort is RMA2 (RMA = River Management Associates). This is considered a powerful model in that it is robust and stable with well accepted accurate results when properly calibrated. A three dimensional model may be considered more powerful but would involve significantly greater costs.

Pool 13 and the LaGrange Pool will be enhancements to the existing Pool models. The models were originally constructed using existing pool-wide bathymetry collected through the LTRMP for Pools 13 and LaGrange in 1997 and 1998, respectively. The model will be updated with newer bathymetric and floodplain topographic datasets, where available. Models will include existing channel regulating structures, utilizing the best available information about each structure. The existing models are inappropriate for use by the LTRMP in that they do not represent the existing conditions in adequate detail to establish and quantify the relationships between the monitored parameters and the project features. These relationships are what lend credibility to the monitoring process. If accurate relationships between physical forces and project design parameters to impacts on the biota are not established then monitoring has no relationship to habitat enhancement. Monitoring is then reduced to a passive activity with minimal interest to the observer only.

Calibration and verification of the models will be to prototype measurements of stage, water surface profiles, current velocities and flow distributions already available or collected as part of this effort. The Water Quality and Sedimentation Section (CEMVR-ED-HQ) will make the prototype measurements of velocity and flow distribution with an Acoustic Doppler Current Profiler.

Model outputs will be converted to shapefiles or coverages for use with ESRI ArcGIS software package. Model outputs may include inundation boundaries, velocity magnitudes, contours, etc.

Model and Survey Data Specifications: The hydraulic numerical models will be calibrated to elevation (accuracy of 0.2 feet), flow (5% accuracy) and velocity measurements (accuracy of 0.3 fps)**.** Model Mesh resolution will be limited to a maximum of 300-foot element size. The mesh near regulating structures, in narrow side channels and near specific study areas will be refined as necessary. The hydrographic surveys will be assembled from navigation channel maintenance surveys, dam periodic inspection surveys, and environment management project surveys. The horizontal accuracy of the hydrographic survey data is the accuracy usually attributed to the US Coast Guards Differential GPS (DGPS). The published accuracy of this system is +/- 9 feet (horizontal). The vertical accuracy is published as being +/- 0.5 ft as per ASPRS Class III Standards as stated in the USACE EM1110-1-1000, dated 31 March 1993.

The floodplain digital terrain models have been developed from 1998 aerial photography and photogrammetry. This data will be used to extend the models, as requested, to incorporate the floodplain and islands above the 2 year water surface. Mississippi and Illinois River floodplain ("bluff-to-bluff") digital terrain model data was designed to adequately define elevated roads, railroads, levees and major topography changes. The data was compiled so that spot elevations on well-defined features would be within 0.67 feet (vertical) of the true position (as determined by a higher order method of measurement) 67% of the time. The 0.67 feet (vertical) is as per ASPRS Class I Standards as stated in the USACE EM 1110-1-1000, dated 31 March 1993.

Tasks:

1. Participate with stakeholders in an outreach workshop/meeting.
2. Gather and evaluate existing topographic, hydrologic and GIS datasets necessary for building and calibrating a two-dimensional model.
3. Obtain supplemental bathymetric information, as needed.
4. Obtain ADCP Measurements of prototype velocities and flow distributions.
5. Build and calibrate a two-dimensional hydrodynamic, numerical model.
6. Select and simulate Steady-state river conditions for significant flow conditions using the calibrated model.
7. Develop GIS database of datasets used to construct/calibrate the model and model output.
8. Document model development and results.
9. Results and product dissemination (LTRMP webpage links and fact sheets).

Budget: $94,000

Expected products: Hydraulic numerical models that will provide water level management tools that will present or quantify information required for HREP decision making and design. The relevance and importance of the proposed two-dimensional modeling is based on providing a tool to relate the changes in observed monitoring parameters to the physical impacts of project features and operational procedures. Product development and dissemination will be facilitated by participation in outreach workshop meetings with water resource stakeholders and web page links.

Timeline:

Task	**Timeline***
1 - Participate in workshop / meeting	1 week
2 - Gather existing datasets	1 week
3 - Supplemental bathymetric information	
4 - ADCP Measurements	4 week
5 - Two-dimensional hydrodynamic model	10 week
6 - Steady-state simulations	12 week
7 - GIS database of model output	14 week
8 - Documentation report / ITR	16 week
9 - Product dissemination	1 week
Total	

* Date Complete in weeks after receipt of funding.

APE #11: Testing for a relationship between LTRMP catch-per-unit-effort data and fish abundance (number/biomass per unit area) estimates from block nets

Principle investigator/Project leader: Dr. John Chick

MODIFIED FOR FY06—portion of original proposal funded. (Attached below is full proposal for reference.) In 2006, work will focus on procurement of permits for the application of chemicals from states of Illinois, Minnesota, and Wisconsin.

Introduction/Background:
Most of the techniques available for sampling fishes, including all those used in the Long Term Resource Monitoring Program (LTRMP), provide catch-per-unit-effort data as an indicator of abundance. An underlying assumption of the use of CPUE data is that a relationship exists between CPUE and the actual abundance (numbers of biomass per unit area) of fishes (Arrequin-Sanchez 1996). In general, the relation between CPUE and abundance is depicted as a linear relationship of the form:

$$C/E = qN$$

Where: C/E = catch per unit effort for a particular species
N = is the true abundance (i.e., number per area) for that species
and q = is the gear-specific catchability coefficient.

Several other assumptions follow logically from this assumed relationship. For example, comparisons of CPUE data among different locations and/or through time necessarily assume that catchability (q) is constant across space and through time (though it is extremely rare for researchers to state or consider these assumptions). It is important to note, however, that the relationship between CPUE and abundance is an assumed relationship, and actual tests for this relationship are rare because of the difficulty of obtaining accurate abundance estimates of fishes.

The few techniques available for directly estimating abundance of fishes include mark-recapture methods and the use of fish toxicants (primarily rotenone) in artificial (i.e., block nets) or natural (i.e., coves) enclosures. Significant relationships have been found between CPUE data from boat electrofishing and mark-recapture abundance estimates for largemouth bass (Hall 1986; McInerny and Degan 1993) and young-of-the-year walleye (Serns 1982, 1983). Mark-recapture techniques, however, pose logistical difficulty when multiple species and size classes are of interest. Rotenone sampling within block nets is an effective method for estimating abundance for multiple species and size classes (Timmons et al. 1979, Shireman et al. 1981), and this technique has been used to validate abundance estimates from throw traps (Kushlan 1981; Jacobsen and Kushlan 1987; Jordan et al. 1997) and CPUE data from airboat electrofishing (Chick et al. 1999). Nevertheless, CPUE data from most techniques, including passive techniques such as fyke nets and mini-fyke nets, have not been evaluated against abundance data.

We propose to test for relationships between CPUE data (following LTRMP methodology) from boat electrofishing, fyke nets, and mini-fyke nets with abundance estimates from block-net rotenone sampling in backwater habitats. For each LTRMP gear, we will identify species with strong CPUE relationships (based on regression analysis) with abundance estimates. Additionally, residual analysis will be used in an attempt to identify environmental factors influencing the relationship between CPUE and abundance.

Relevance of research to UMRS/LTRMP:
The LTRMP has a strong tradition of critically evaluating the methodology it has adopted. We propose to continue this process by assessing the fundamental assumption underlying the use of all LTRMP fish data: variation in LTRMP CPUE data reflects variation in the actual abundance of

fishes. Additionally, this project will result in the collection of accurate abundance estimates for fishes in backwater habitats. These data are rare, and could be useful for a variety of other projects.

Methods:
This project will be conducted at three reaches of the UMRS: 1) Minnesota (Pool 5), 2) Pool 26, and 3) the La Grange Reach of the Illinois River. At each of these reaches, we hope to identify three-pairs of backwaters for sampling. We will spend the first year of the study identifying pairs of backwaters with similar morphometry and comparable CPUE data from historic LTRMP collections. Field sampling will take place during the second year of the study. For each pair, we will conduct rotenone sampling and LTRMP electrofishing in one backwater, and LTRMP fyke and mini-fyke netting in the second backwater. If three pairs of backwaters cannot be identified in a particular reach, than we will seek to replicate through time in a reduced set of backwaters.

Within one of each backwater pairs, three ¼ acre block nets (3-mm mesh to match mini-fyke nets) will be deployed in random locations, and rotenone will be applied within the nets following standard procedures (Davies and Shelton 1983). Immediately following the application of rotenone, fish will be collected from within the nets (one boat with at least two dipper) for a minimum of one-hour till no additional fish are observed surfacing. Additional collections will be made for two days (three collections in all). Potassium permanganate will be applied outside of the nets to deactivate rotenone leaking through the mesh, and will be applied within the nets after the second fish collection. As rotenone sampling is taking place, a second crew will conduct three electrofishing samples at random locations (though locations too close to the rotenone samples will not be selected), following standard LTRMP methodology (Gutreuter et al. 1995). We believe that LTRMP electrofishing and block-net sampling can be conducted in the same backwater, but fyke and mini-fyke nets samples could not be effectively sampled in this same backwater on the same day. Therefore, on the same day the three block nets are deployed within the first backwater of a pair, three fyke nets and three mini-fyke nets will be deployed at random locations in the second backwater of the pair.

The full sampling regime for the first day will require a minimum of three boats (an electrofishing boat and two nets boats) and at least an eight-person crew. Immediately after reaching the first backwater, the electrofishing crew will begin sampling. One net boat will begin deploying the block nets, and the second net boat will begin deploying the fyke and mini-fyke nets in the second backwater. Once the fykes and mini-fyke nets are deployed, that crew will begin applying rotenone to the block nets, and the second net boat and crew will begin collecting fish from within the block nets. Both net crews will assist in processing fishes from the block nets. In this way, block-net and LTRMP samples can be collected (or nets deployed) on the same day. All fish collected from block nets will be discarded following appropriate regulations for each state.

Linear regression analysis will be used to test for relationships between LTRMP CPUE data and abundance estimates from block nets. For each gear, we will limit our analyses to those species identified as being sampled with adequate power in backwater habitats by the Lubinski et al. (2001) power analysis. Residual analysis will be used to identify environmental factors influencing CPUE-abundance relationships.

Budget: $1,301 Budget includes full cost accounting.

Expected products:
The first year of the study will be devoted to obtaining necessary permits.

Timeline for completion:

Tracking number	Products	Milestones
2006APE11	Permits for application of chemicals	30 September 2006

Literature Cited:

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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

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Timmons, T.J., W.L. Shelton, and W.D. Davies. 1979. Sampling of reservoir fish populations with rotenone in littoral areas. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 32(1978):474–485.

APE #13: Variation in chlorophyll *a* and inorganic suspended solids in backwater lakes of the Upper Mississippi River

Principal investigator/Project leader: Brian Gray

Introduction/Background: Chlorophyll and total suspended solids are important aspects of UMRS water quality. Chlorophyll concentration represents a simple measure of algal abundance, an indicator of the amount of biological production at the base of the river food web. Chlorophyll concentrations are also of interest because excessive algal abundance may lead to hypoxia in backwater areas (because of high rates of algal decomposition). High suspended solid concentrations are frequently cited as a top water quality concern in the river. Suspended solids affect macrophytes and algae by decreasing the depth of light penetration in water column. Thus patterns of chlorophyll and suspended solids concentrations are an integral part of our understanding of the water quality and productivity of the Upper Mississippi River System (UMRS).

In FY05, we confirmed that backwater lakes may be used as approximate study units for research performed using LTRMP data: Depending on pool, 20 to 50% of the variation in both chlorophyll a and ISS levels was associated with backwater lakes (rather than with sampling or annual sources of variance). These findings confirm i) that backwater lakes may be treated as partially-independent study units and ii) that models of backwater lake data that don't account for backwater lakes will have incorrect false negative error rates. Preliminary FY05 work also demonstrated that as much as 20%, 15% and 10% of the variation in chlorophyll associated with backwater lakes was associated with ISS, vegetation levels and a surrogate for water residence time, respectively. Similarly, up to 40% and 20% of the variation in ISS associated with backwater lakes was associated with vegetation levels and the water residence time surrogate, respectively.

We also intend to investigate whether variation in chlorophyll and ISS levels among backwater lakes, adjusted for discharge, has declined measurably over the 13-year study period. If trends in backwater lake variation are evident, this would provide quantitative indirect evidence that backwater lakes are becoming less differentiated. Such changes in among-lake variance would be a source of concern because decreasing diversity among backwaters may suggest decreasing habitat diversity at the backwater lake scale.

Relevance of research to UMRS/LTRMP: Both the States and the USEPA are interested in understanding what leads to high chlorophyll and total suspended solids concentrations in rivers. In addition, Iowa, Minnesota, Wisconsin and Illinois are interested in the impacts that tributaries from their lands have on algal abundance and suspended solids in the Mississippi River.

Substantial variance in chlorophyll and suspended solids associated with differences among backwater lakes implies that comparative study of those lakes will enhance our understanding of the causes of patterns in the levels of these and other variables observed in the UMRS. This approach lends itself well to understanding the effects of management actions (e.g., HREPs) at the backwater lake scale, which to date has not been done with LTRMP data.

Work in FY05 on the precursor to the current proposal developed statistical tools and data sets for analysis of the LTRMP water quality data. That work also led to preliminary conclusions regarding possible causes of variability in chlorophyll and suspended solids among backwater lakes within the backwater strata of the LTRMP study reaches. The highlights of these FY05 findings will be encapsulated in a Project Status Report due 30 Aug 2005. However, the FY05 APE proposal suggested that details not provided in the PSR, as well as further findings, would be provided in a subsequent year. These "further findings" are detailed in the methods below and include investigations into trends in backwater lake variation. This FY06 proposal will provide those findings and will elaborate on their implications for future research using backwater lake data from large rivers.

Methods:

1. Refine existing models of the proportions of variation in chlorophyll *a* and suspended solids levels that correspond to annual, backwater lake, and sampling (residual) scales in Pools 4, 8 and 13. Refinements will include the addition of 2004 and 2005 data, increased attention to spatial covariance, and investigation into how backwaters vary as a function of area. Further develop models that link proportions of variation to reach discharge, macrophyte levels and water residence time covariates. These models are linear mixed models that address variation at sampling, backwater and backwater stratum scales; covariates are centered at the appropriate scale/s.
2. Determine, using linear or nonlinear models of variance, whether backwater lake variance estimates for chlorophyll a and ISS, after adjusting for reach discharge, have declined over the 13-year sampling period

Special needs/considerations: none

Budget: $30,925 Budget includes full cost accounting.

Expected products:
Manuscript submitted to peer-reviewed journal titled approximately "Chlorophyll *a* and inorganic suspended solids in backwater lakes of the upper UMRS: Backwater lake effects and their associations with selected environmental predictors".

Timeline for completion:

Tracking number	Products	Milestones
2006APE13	Submit draft manuscript on Chlorophyll *a* and inorganic suspended solids in backwater lakes of the UMRS	30 August 2006

APE #15: Vegetation, primary production, and dissolved oxygen dynamics in UMRS backwater lakes

Principle investigator: Dr. Jeff Houser

Introduction/Background:
Large floodplain river ecosystems are highly productive and support abundant populations of fish and waterfowl. These populations are supported in part by primary production of algae and macrophytes (aquatic vegetation) within the river ecosystem. Epiphytic algae (growing on the macrophytes) and phytoplankton (suspended in the water column) are consumed by invertebrates which in turn are a critical resource for UMRS fish populations. Thus, areas with high rates of primary production may support larger or faster growing fish populations than areas with lower rates of primary production. In addition, energy (in the form of organic matter) exported from vegetated areas is likely an important fuel for riverine production. We understand some aspects of the patterns in standing stock (biomass at any give time) of macrophytes and phytoplankton. Turbidity and water level fluctuations affect distribution and abundance of macrophytes (Yin and Langrehr 2005). There are differences among strata in algal biomass (Houser 2005) because of differences in light extinction, mixing depth, residence time, and nutrients. However, actual rates of primary production in the UMRS are poorly known.

Primary production is one of the main drivers of oxygen concentration dynamics in aquatic ecosystems (Wetzel 2001). Photosynthesis produces oxygen and energy which is subsequently used to synthesize organic material. Subsequent decomposition of this organic material consumes oxygen, as does macrophyte and algal respiration. As a result, areas with high rates of primary production have the potential for high dissolved oxygen concentrations during the day, when photosynthesis rates are high, and low dissolved oxygen concentrations at night, when there is no photosynthesis, but algae, macrophytes and bacteria continue to respire.

Therefore, primary production is a critical ecosystem process which supports upper levels of the food web (e.g. fish and waterfowl) and also regulates dissolved oxygen concentration, a critical determinant of habitat suitability for most fish. Yet direct measurements of rates of primary production in the UMRS are almost never made (Owens and Crumpton’s 1995 measurements in Lake Onalaska are the only ones of which we are aware).

We propose a study of primary production that will examine how rates of primary production differ among aquatic areas which will increase our understanding of where “hotspots” of primary production are located and may allow us to estimate overall primary production in the UMRS. In the first year we will measure primary production in at least four backwater lakes: two “high vegetation” backwater lakes and two “low vegetation” backwater lakes. We start with an intra-backwater comparison because it is within this stratum that the largest variability in dissolved oxygen and algal biomass (measured as chlorophyll *a*) are found (Houser 2005). If time and equipment allow, we will measure rates of primary production in areas representative of additional LTRMP strata. In subsequent years (pending appropriate funding) we will measure rates of primary production in representative areas of each of the LTRMP aquatic areas (main channel, side channel, backwater, impounded) to generate estimates of overall primary production in the river and to better understand oxygen dynamics in each of these areas. This will also augment the LTRMP monitoring by providing important information on the relationship between chlorophyll, which LTRMP measures at all water quality sites, and primary production which is not measured by the core monitoring program.

We will address the following specific questions:
1. How do rates of primary production and dissolved oxygen dynamics differ between “high vegetation” and “low vegetation” backwater lakes during summer?

2. How are rates of primary production and oxygen dynamics affected by short term fluctuations in solar irradiance, temperature, wind, and water level during summer?
3. What are the relative contributions of water column and macrophyte based primary production to overall primary production in backwaters?

Relevance of research to UMRS/LTRMP:
The proposed research will increase our understanding of an important link between vegetation and water quality. By increasing out knowledge of the relationship between vegetation, dissolved oxygen and primary production, will improve our understanding of the role of vegetation in determining habitat suitability. We will develop techniques to assess river primary production that could be applied in a range of habitats within the river and could be used to evaluate the overall effect of future HREPS on local primary production and dissolved oxygen dynamics. HREPS often manipulate factors that can directly affect primary production (e.g., residence time) and are often designed to result in changes in macrophyte abundance. Thus, ecosystem primary production may show a strong response to some HREPs and may be used as an additional criterion for evaluating the effects of certain HREPs. The proposed research may also improve our interpretation of the dissolved oxygen data collected by LTRMP. LTRMP takes single readings of dissolved oxygen at each sampling site. Understanding how the daily dissolved oxygen cycle differs among sites with different characteristics (e.g., vegetation abundance) will provide additional context for these point measurements of dissolved oxygen.

Methods:
Ecosystem primary production:
Ecosystem primary production will be measured in at least four backwater areas: two with abundant vegetation and two with little or no vegetation. Sites will be selected to maximize site similarity and contrast in vegetation. Primary production and respiration will be calculated from open water dissolved oxygen measurements using single station diel oxygen curve analysis (Odum 1956) as modified in Owens and Crumpton (1995). A small monitoring station will be deployed in each sampled backwater lake to record wind velocity, solar irradiance, and dissolved oxygen (at 0.2 m) at regular intervals (e.g., every 10 minutes). Water level loggers will be used to record changes in water level. Deployment will be focused on the period of peak macrophyte production. Chlorophyll *a*, turbidity, total nutrient concentrations, and light extinction will be measured weekly during deployment. Additional dissolved oxygen loggers will be deployed with the monitoring station so that DO concentrations from several depths and at several points along a transect from the center of the backwater lake to its perimeter will be recorded at regular intervals over the deployment period. The dissolved oxygen data at several depths and along a transect collected at regular intervals will provide information on the spatial and temporal variability in primary production and will be combined to calculate overall primary production for each sampled backwater lake. Maximum and minimum DO for each day will also be extracted from the DO data set and will provide information on the spatial variability in DO max and min and indicate what proportion of the sampled backwater lakes experiences hypoxic or anoxic conditions.

Water column primary production:
Water column primary production (and respiration) will be measured at the same time as the ecosystem scale measurements using the light/dark bottle method (Strickland and Parsons 1972; Parsons et al. 1993). Comparison of water column primary production with ecosystem primary production will indicate the proportion of primary production that occurs in the water column versus macrophytes and sediments.

Budget: $93,723 Budget includes full cost accounting.

Expected products:
1. Data set containing dissolved oxygen concentration, wind velocity, solar irradiance, and water level at high temporal resolution; calculated rates of daily primary production for the sampled backwater sites; daily max/min dissolved oxygen concentrations; and chlorophyll, turbidity and nutrient data for each sampled backwater.
2. Draft summary of data.

Timeline for completion:

Tracking number	Products	Milestones
2006APE15a	Field data collection completed	30 September 2006
2006APE15b	Database	30 September 2006

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APE #17: Investigate effects of newly completed HREPs (Lake Chautauqua NWR, Banner Marsh State Fish and Wildlife Area) in La Grange Pool on fish production using LTRMP and HREP data

Principle investigator/Project leader: Dr. John Chick/Matt O'Hara

Introduction/Background:
Data collected for biological monitoring on the La Grange Reach through the LTRMP and biotic responses to HREP projects (specifically Lake Chautauqua NWR) have not been integrated to assess local, regional, and/or reach level responses to date. In the past decade two areas (Lake Chautauqua federally controlled and Banner Marsh state controlled) were proposed as Habitat Rehabilitation and Enhancement Projects (HREP) in the La Grange Reach of the Illinois River. Although these HREP areas are located in the Illinois River floodplain they differ in their construction and overall objectives. The Lake Chautauqua HREP main objective was to reestablish the south cell as a moist soil management unit providing habitat for migrating waterfowl while the north cell would be permanently wetted to provide habitat for diving ducks and fish. Previous research has been conducted at Lake Chautauqua to assess biological responses to the HREP. This included monitoring larval fish production and escapement from the south cell into the Illinois River. The objective of the Banner Marsh HREP was to provide improved water control to this isolated marsh habitat to benefit fish and waterfowl. This included installing of pumping stations and sureing existing levees to protect the area from the Illinois River. Limited research was conducted in this area.

Prior assessments of these projects have not included effects to the Illinois River either at a local or reach level. Therefore, we propose to evaluate existing LTRMP and HREP data within the La Grange Pool to determine if measurable affects can be detected at various local scales within LaGrange Reach. We would expect see a positive response in fish abundances in the area of Lake Chautauqua with its connectivity while in the area of Banner Marsh we would not expect any response. The Banner Marsh area would act as a control site due to its isolation and limited influence to the Illinois River

Relevance of research to UMRS/LTRMP:
Determining biotic community responses to habitat improvement projects is a critical management element for the UMRS and the available data from the LTRMP are now in a position to help elucidate some of these issues. Additionally, there have been measured improvements in the biotic communities in the actual HREP projects themselves, but little work has been performed beyond these sites to determine the larger impact at local, regional, or reach scales.

Methods:
We will analyze larval fish data collected from Lake Chautauqua to predict potential fish contributions in the Illinois River. The LTRMP fish monitoring data we will be used to test potential fish responses at three distinct spatial scales: 1) localized habitats immediately adjacent to the HREP site(s), 2) regional sections of the river (e.g., 10-km buffer around HREP site(s), and 3) reach level impacts. The exact size of these scales will be determined on the availability of data. The HREP monitoring in La Grange Reach, especially at Lake Chautauqua NWR, has historically followed sampling designs and protocols similar to the LTRMP.

We will test for changes in community composition and structure in the Illinois River using fish data from main channel and side channel habitats. Multivariate techniques (ANOSIM, NMDS, etc.) as well as use more common univariate techniques will be used to assess species specific changes in abundance as well as changes in water quality to determine if there has been an overall measurable impact at the three spatial scales. Our hypothesis is that production of fish in Lake Chautauqua increases fish abundance within LaGrange Reach. We would not expect increases in fish abundances surrounding the isolated Banner Marsh HREP. Also, reach level impacts will consist of temporal analyses pre and post construction of the HREP areas. Ancillary data, such as LTRMP water quality and macroinvertebrate sampling may be used to explain results.

Special needs/considerations:
This proposal is can serve as a pilot to similar work that will encompass the entire UMRS and its associated HREP sites. However, there is a need to get methodologies, analysis techniques, etc. properly arranged before taking on the entire data set.

Budget: $42,600 Budget includes full cost accounting.

Expected products:
Expected products for this project include an LTRMP report outlining the results of the analyses and future submission of a manuscript for publication in a peer-reviewed journal.

Timeline for completion:

Tracking number	Products	Milestones
2006APE17a	Draft LTRMP Technical Report	30 June 2006
2006APE17b	Submit final draft report	30 September 2006

APE #21: Developing Indicators of Southern Bottomland Hardwood Forest Condition within the Upper Mississippi River Ecosystem

Principal investigator/Project leader: Dr. Loretta L. Battaglia; Dept. of Plant Biology, Southern Illinois University, Carbondale
LTRMP contact: Dr. Valerie Barko

Introduction/Background:
The Upper Mississippi River (UMR) and its floodplain were hydrologically connected prior to European settlement (Sparks *et al*. 1998) and periodic floods linked the river channel to the floodplain (Galat *et al*. 1998), contributing to high ecosystem productivity and diversity (Junk *et al*. 1989, Ward et al. 2002). Further, these floodwaters supplied the floodplain with nutrients, water, and sediments, which influenced the fluvial geomorphological processes of this system (National Resource Council 2002). Because of this historic connectivity between the UMR main channel and its floodplain, species inhabiting this system are highly adapted to and dependent upon hydrologic regimes. The timing, periodicity, and extent of flooding events for nutrient cycling, migration corridors (Junk *et al*. 1989), dispersal avenues (Schneider and Sharitz 1988), and regeneration opportunities (Sharitz and Mitsch 1993, Yin and Nelson 1995, Sparks 1998) are important selective mechanisms that have shaped the evolution of floodplain species complexes. In forested portions of the floodplain, tree growth (Keeland and Sharitz 1995, Young *et al*. 1995), as well as litterfall and forest productivity are strongly related to hydroperiod, while net primary productivity of floodplain plant communities contributes a substantial portion of the detrital food web base, which supports both the aquatic and terrestrial components of the river-floodplain system (Vannote et al. 1980).

Today, many floodplain areas are no longer connected with the main river channel because of channel maintenance structures and levee systems (Rasmussen 1979; Barko et al. 2004a). This has caused erratic flood pulses ranging from continuous (e.g., impoundments) to inverted (Sparks 1998; Barko et al. 2004b). Forests in floodplains immediately upstream of a lock-and-dam station are often permanently flooded (Sparks et al. 1990), with reduced productivity (Young *et al*. 1995, Megonigal et al. 1997), shifts in species composition, loss of diversity (Yin and Nelson 1995), and high mortality if the stand is semi-permanently or permanently flooded (King 1995). Other areas have been dewatered and may no longer function as wetlands. Further, species that depend upon replenishment of sediments during flood pulses are declining (English et al. 1997), such as plants that require moist soil on mudflats to germinate and some shade-intolerant trees that require open sandbars for seedling establishment. Altered hydrologic regimes can also facilitate invasion of exotic species.

The goal of this project is to develop biological indicators for forested floodplains using structural and functional attributes of floodplain vegetation. Specific objectives include 1) development of vegetation-based indicators of bottomland hardwood forest condition using data collected from bottomlands located between UMR RM 0 - 364.4 and 2) field-testing these indicators for assessing bottomland forest health across the lower UMRS (IL, and MO). We define a healthy bottomland hardwood forest as one that maintains characteristic plant community structure and ecosystem function, has a high proportion of native to exotic species, and retains some degree of connectivity with the river.

Relevance of research to UMRS/LTRMP:
The lack of bioassessment criteria, combined with a poor understanding of the ecological condition of UMRS bottomland forests, is a major impediment to our ability to assess the condition of this system. Development and application of flooded forest health indicators will enhance adaptive resource management (ARM) decision-making with respect to the needs of and the major threats to the UMRS by providing managers and researchers a means to quantify resources and evaluate their degree of function. Moreover, neither the LTRMP nor the EPA E-MAP routinely assesses floodplain forest health, so development of indicators would greatly facilitate biological

assessments of these resources for both monitoring programs. Our goal is to identify metrics that will have general applicability for the southern portion of the UMRS focus area. We will include several HREP sites located within our focal reach, such as Bay Island (Pool 22) and Gardner Division (Pool 21), to evaluate their bottomland forest restoration success. The results of our project will provide a bottomland forest assessment tool that is essential to apply ARM in the UMRS.

Methods:
Site Selection
A criterion in choosing our set of sites for indicator development is that they include representatives of quasi-natural forest areas as reference sites, as well as those that have been moderately to highly degraded or disturbed (Brinson 1993). Indicators should prove useful for both identifying ecological characteristics of sites and describing the current range of bottomland forest conditions. Indicators we develop will be used to establish the current status against which future change, restoration efforts, and ARM can be evaluated. Study sites will be located within an area extending from UMR RM 0 - 364.4 and sites will be stratified based on impoundment status and whether they fit into reference or disturbed categories.

Proposed conservation areas based on the above criteria include Gardner Division, Adams Co., MO (Pool 21), Fox Island, Clark Co, MO (Pool 20), Horseshoe Lake Conservation Area, Alexander Co., IL (unimpounded), and Donaldson Point Conservation Area, New Madrid Co., MO (unimpounded). Gardner Division is an HREP site totaling 2549 hectares (ha) along river miles 332.5-340.2. Fox Island is an HREP site totaling 850 ha along river miles 353.6-358.5. Horseshoe Lake Conservation area is 4308 ha. Donaldson Point Conservation area is 2341 ha.

Field Sampling
There are few existing published data sets on floodplain plant communities in the UMRS, and indicators of the ecological integrity of the floodplain are needed to assess the condition of our current resources and provide a benchmark for future bottomland forest evaluation, restoration, and ARM. The first phase of vegetation indicator development will consist of data collection from field sites. Using aerial photos of each conservation area, we will grid the bottomland areas and divide them into two categories: reference and disturbed stands. We will randomly select five grid cells containing reference stands at each area (total = 20). Similarly, we will randomly select ten grid cells containing disturbed stands (*i.e.*, not reference; total = 40). At each of the 60 selected grid cells, we will establish a 20 x 50 m plot, each with nested 100 m^2, 9 m^2, and 1 m^2 subplots (Peet *et al*. 1998) for sampling structural and functional bottomland attributes. Use of nested plots is widespread in vegetation sampling and is considered to be an efficient approach for quantifying and comparing community structure and diversity.

Structural and compositional attributes are useful indicators for evaluating the ecological health of a system (NRC 2000). In each plot, we will measure plant community attributes including native species richness and number and abundance of exotic invaders. Stems of saplings (>1.5m height) and trees will be counted and measured (diameter at breast height – DBH). In addition, we will identify all species present in the nested subplots and compile a complete species list. Based on these data from the nested subplots, we will construct a species-area curve for each plot and then use the curves to compare the scale at which richness plateaus. Severely impaired sites generally have reduced native richness, low abundance of rare and sensitive species, and higher abundance of exotic species. We will also calculate the Floristic Quality Index (FQI), which combines several of these measures (e.g., species richness, number and abundance of exotic species). This index has been used effectively in wetlands and other communities to assess the "naturalness" of a site (U.S. EPA 2002ab, Lopez and Fennessy 2002). The FQI requires a "coefficient of conservatism" for each species. Many states have begun to assemble these coefficients, and we will work with state agencies to compile these coefficients for species in the UMRS focus area so that we may include FQI as a candidate metric.

Functional attributes will also be measured at each site. These measures of ecosystem function have been shown to be useful indicators (Day et al. 1997), particularly for assessing cumulative impacts of stressors (Gosselink and Lee 1989). We will examine annual growth rates for long-lived forest species using tree-ring analysis. Twenty trees will be randomly selected from each plot, ten that are < 15 cm DBH and ten that are ≥ 15 cm DBH will be selected. A cross section will be taken from the smaller trees, and individuals ≥ 15 cm DBH will be cored. Annual growth increments will be measured under a stereoscope using an Incremental Measuring Machine. Rings will be measured from the center outward and to the nearest 0.01 mm. Production will be estimated at each site using annual growth ring increments and published allometric regression equations for bottomland species (see Megonigal et al. 1997).

Soil indicators, including organic matter (OM) content and nutrient content (total Nitrogen (N) and Phosphorus (P)) will also be assessed. Two soil samples will be taken at each site using an AMS Standard Soil Auger Bucket (5.08 cm diameter). One of these samples will be used to determine organic matter, measured as loss on ignition in a muffle furnace. Organic matter content has been successfully used as a measure of forest development and ecosystem maturity (Giese et al. 2003). The other soil sample will be used to determine total N and P. Bottomland forests typically have high nutrient levels, but they may exhibit nutrient enrichment in response to land use changes in the watershed, particularly in agricultural landscape (U.S. EPA 2002ab). These techniques will be useful for detection of shifts in composition and site productivity (U.S. EPA 2002ab) that might occur, for example, because of altered hydrology.

Indicator development
Once the data have been collected, we will analyze the candidate metrics (Table 1) and determine which ones (or a combination thereof) are the most useful for assessment of the biological health of our selected floodplain communities. Ideally, we want metrics that are consistently predictive of ecological condition. Low variability among reference sites is another desirable feature. We will directly compare reference to disturbed sites for most metrics (denoted by an "*", Table 1). Where there are statistical differences, we will quantify the degree to which disturbed and reference sites differ. We will then divide the disturbed sites into three categories (good, fair, and poor) according to how much they deviate from the average reference condition. It is possible that we some categories will not be represented, e.g., there are no poor sites.

Trends in species composition will be explored using non-metric multidimensional scaling (NMDS), a widely used ordination technique. Groups that are revealed by ordination analysis will be statistically compared using analysis of similarity (ANOSIM; Clarke 1993), a non-parametric multivariate technique. Connectivity to the river will be assessed based on management records of each area and interviews with site managers. Sites will be assigned to one of four categories: 0 = no overbank connection to river; 1 = infrequent and unpredictable connection; 2 = periodic overbank flooding; and 3 = annual, seasonal overbank flooding.

This work represents, to our knowledge, the first attempt to develop ecological indicators for bottomland hardwood ecosystems. We will use four steps to evaluate our candidate metrics, as recommended by EMAP (Barber 1994). We will assess each metric according to the following criteria: 1) conceptual soundness, 2) implementation, 3) response variability, and 4) interpretation and utility. This scheme should help us to identify the most informative, useful, and efficient metrics. Ultimately, we hope to identify and construct indicators that are useful for the assessment of ecological condition of UMRS floodplain communities.

Budget: $80,676 Budget includes full cost accounting.

Expected products:
LTRMP draft report

Timeline for completion:

Tracking number	Products	Milestones
2006APE21	Submit LTRMP draft report	30 September 2006

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Table 1. Candidate vegetation metrics for assessing floodplain wetland condition (adapted from EPA (2002ab). An * univariate metrics for which we will use discriminant function analysis. †Species composition will be compared using standard multivariate community analyses (see above). ‡Connectivity to the river will be assessed qualitatively.

Metric Type	Metric
Structural	Species Richness*
	Native: Exotic Richness Ratio*
	Floristic Quality Index (FQI)*
	Average DBH ± Standard Error*
	Basal Area*
	Stem Density*
	Species Composition†
Functional	Production (based on annual growth data)*
	Nutrient Status (N&P)*
	Organic Matter (OM)*
	Connectivity to River‡

APE #27: LTRMP water quality graphical browser for stratified random sampling sites

Principle investigator: Mike Caucutt

Introduction/Background: An online Graphical Water Quality Database Browser will provide synthesized Long Term Resource Monitoring Program (LTRMP) water quality data visually so that the public and natural resource managers can easily evaluate the availability of water for various human and ecosystem uses by examining the status and trends of selected water parameters (e.g. dissolved oxygen and total suspended solids).

Relevance of research to UMRS/LTRMP: This tool will enhance scientific communication and raise awareness of the importance of the Upper Mississippi River System (UMRS) with state, federal, and non-governmental partners and the general public. We expect that researchers, natural resource managers, and the public will all benefit greatly from enhanced access to critical UMRS data. (See http://www.umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html for the LTRMP Fish Graphical Browser, the prototype for the Water Quality Database Browser.)

Methods: The LTRMP, begun in 1988, uses consistent, standard methods to monitor and evaluate long-term changes in selected physical, chemical, and biological characteristics of the UMRS. The LTRMP water quality staff collects basic information on selected physical and chemical features of the UMRS to aid in the interpretation or prediction of long- and short-term patterns that affect water availability for human and ecosystem uses.

Since 1993, LTRMP water quality monitoring activities have generated more than 33,000 observations with data on selected parameters. The data focus on a subset of limnological variables (i.e., physicochemical features, suspended sediment, and major plant nutrients) significant to aquatic habitat in this system. The Department of the Interior (DOI), through the USGS Upper Midwest Environmental Sciences Center (UMESC) in La Crosse, Wisconsin, is the principal agency responsible for implementing the LTRMP, providing day-to-day management and administration of funds received through the partnership. The UMESC team of scientists and database experts has spent years and resources developing the prototype for graphically modeling LTRMP data. The UMESC has an investment of over $ 250 K in the technology development of this application, but an unfortunate FY05 a budget shortfall has curtailed this project.

The specific water quality variable that the browser would query and graph are:
Temperature, Dissolved oxygen, Total suspended solids, Total nitrogen, Total phosphorous, Chlorophyll a, with variables of reach, season, and stratum.

A partnership with the University of Wisconsin – La Crosse (UW-L) has been created specifically to enhance the LTRMP component database query tools. This partnership provides USGS with a programmer who will use the open source programming language Practical Extraction and Reporting Language (PERL) with the DBI (Database Interface) module along with Java applets to create an application that query the LTRMP sampling database and return the query parameters and results to the user via a standard web browser and ftp server. This is an open source method of programming and no licensing is required. The hardware infrastructure (web server, ftp server, Oracle database) is already in place for this proposal to function.

Currently the LTRMP water quality data is served through the web via an online database browser. The user can select criteria such as field station, barcode, stratum class, and a multitude of parameters and field lists. The user has the option to have the data be downloaded in a 'Fixed Column Length Format', 'Comma Delimited Format', or an 'ArcView Compatible Format'.
This method is useful for agencies, scientists, and educational institutions to download the data and use in whatever statistical/graphical application they use. The Graphical Water Quality Browser not

an attempt to replace the current method, (web logs show this method is used by many different users throughout the world), but to enhance and broaden the users ability to access the LTRMP data. This type of product can present LTRMP data in an intuitive, universally accessible manner that alleviates the requirement of substantial post-processing by users as well as an intricate knowledge of the statistical sampling design, thereby enhancing the usefulness of the data to resource decision makers and the general public.

Budget: $41,183 Budget includes full cost accounting.

Expected products: A graphical water browser for LTRMP Water Quality SRS sites

Timeline for completion:

Tracking number	Products	Milestones
2006APE27	Graphical water browser for LTRMP Water Quality SRS sites on-line	1 September 2006

APE #29: Next generation forest on the UMR floodplain

Principal investigators: Dr. Patricia Heglund and Dr. Yao Yin

Introduction/Background: The forest we witness today on the floodplain of the Upper Mississippi River is the product of intensive anthropogenic activities that included logging, conversion of prairie/forest land to farmland and then reforestation, and altered surface and underground hydrology (Yin et al. 1998, Nelson et al. 2000). A major portion of the forest was established after the installation of the navigational lock and dam system during the 1930s and 1940s. Compared with its historical counterpart, today's forest consists of fewer flood-intolerant species, especially mast-producing oaks and hickories, and less age differentiation between stands.

Relevance of research to UMRS/LTRMP: Scientific prediction of the species composition of the forest over the next 50 years would provide useful information in the management of the forest resources of the floodplain. The Long Term Resource Monitoring Project staff conducted an initial survey of forest composition in 1995 following the flood of 1993. This major flood reset the clock of forest succession providing us with the perfect opportunity to monitor succession. We propose to use the predictions developed in 1995 and to re-examine forest vegetation now that 10 years have elapsed since the flood. These new data would be used in validating and recalibrating model predictions. This test of the predictions using new data will demonstrate science leadership and response ability of the LTRMP. The information could be used to in affirm or modify ongoing forest management strategies in the UMRS.

Methods: Field data will be collected in the Open River reach near Cape Girardeau, Missouri, Pool 26, and Pool 17. At each reach a total of 45 randomly selected sites will be selected. At each site, the vegetation will be stratified into canopy, understory, and ground layers and the species composition of each layer of vegetation will be determined. The results will be compared with the results of 1995 (Yin et al. 2000).

Budget: $94,222 Budget includes full cost accounting.

Expected products: Completion of field survey

Timeline for completion:

Tracking number	Products	Milestones
2006APE29	Field data collection	30 September 2006

APE #30: Aquatic Vegetation and Water Quality Response to a Second Year of Water Level Drawdown in Navigation Pool 5 of the UMR

Project Leader: Walt Popp

Introduction/Background:
The UMR has lost much of its once abundant aquatic vegetation following decades of impoundment and poor light penetration due to high loads of inorganic suspended solids (Fischer 1995, Kimber et al. 1995). Aquatic vegetation is one of the key drivers of the UMR ecosystem, providing habitat for fish and wildlife and improving water quality. Much of the habitat in formerly productive, large contiguous backwaters of the river, such as Weaver Bottoms in Pool 5, is now severely degraded (Fremling et al. 1976, Davis et al. 1991, Nelson 1998). Where once there had been thousands of swans and canvasbacks stopping-over in the fall to feed on the abundant arrowhead and wild celery in Weaver Bottoms, there are now only a few dozen waterfowl due to the decline of emergent and submersed vegetation. Analysis of years of LTRMP water quality data indicates worse water quality at the outlet of Weaver Bottoms than at the primary inlet (R. Burdis, personal communication 2005).

Relevance of research to UMRS/LTRMP:
Through the Water Level Management Task Force, state and federal resource management agencies in the St. Paul District have begun to experiment with water-level management as a tool to re-establish aquatic vegetation and improve water quality. Small-scale drawdowns in a few Mississippi River pools have shown biological benefits similar to those reported for lakes and reservoirs (Kenow et al. 2001, Kenow et al. 2001). A pool-wide drawdown of 1.5 ft was conducted in 2001 and 2002 in Pool 8. A 1.5 ft pool-wide drawdown is being conducted on Pool 5 during the summer of 2005 and a second year of drawdown is also planned for Pool 5 in 2006.

By mimicking the natural low flow hydrograph during the summer period, managers hope that the dormant seeds of emergent plants will germinate as sediments dry-out, oxygenate, and consolidate (Dunst et al. 1974, Galinato and van der Valk 1986, Sparks et al. 1990, Heerdt and Drost 1994). However, the short-term and long-term effects of the drawdown on submersed plants remain uncertain.

As adaptive management becomes more of a requirement for restoration projects on the river, more information will be needed on the long-term effectiveness of drawdowns in re-establishing emergent vegetation and their effect on submersed vegetation and water quality. Studying the response of vegetation and water quality in Pool 5 after two years of drawdown will advance our understanding of a drawdown's usefulness in restoring the physical and biological structure of a large, severely degraded backwater, a feature that was not part of the Pool 8 drawdown study. The LTRMP has been monitoring water quality in Pool 5 since 1993 and submersed vegetation since 1999 using the protocols referenced below, so a significant set of pre-drawdown data is available for comparison.

Methods:
The Lake City LTRMP Field Station and US Fish and Wildlife Service will conduct a pool-wide survey of submersed and floating-leafed vegetation frequency, abundance, and species richness at 350 sites in Pool 5 in August 2006, following protocols described in Yin et al. (2000). Analysis of the data will be done by staff at UMESC in FY 2007.

Sampling of random sites on newly exposed substrate will be conducted by MN DNR Fisheries to determine the presence, abundance and biomass of pioneering vegetation, following protocols described in part in Kenow (1999), but with a change in the method of sampling site selection that was initiated in 2005. Analysis of the data will be conducted by UMESC staff in FY 2007.

Arrangements for aerial photos of Pool 5 to be taken during the summer of 2006 will be made by UMESC staff. Interpretation and analysis of changes in emergent vegetation will be done in FY 2007.

Water quality will be monitored by the Lake City LTRMP Field Station, following the protocols described in Soballe and Fischer (2004), at six fixed sites in Pool 5 (the major inlet and outlet of Weaver Bottoms, the mouth of the Whitewater River, and at three sites along a transect across the river below Lock & Dam 5) on a biweekly basis during ten sampling episodes from late May through September. Lab analysis would be provided by UMESC. Data analysis will be done by Lake City LTRMP Field Station staff in FY 2007.

The same protocols referenced above will be used in 2005 to monitor vegetation and water quality during the first year of the Pool 5 drawdown.

Analysis:
The objective of this study is to determine the effects of the drawdown on select water quality parameters, and on abundance, frequency and species richness of emergent, submersed, and floating-leafed vegetation. However, because this project is funded for one year and field work is conducted right up to the end of the fiscal year, analysis of the data will need to be done the following fiscal year (FY 2007) and will be contingent on future funding.

Budget: $32,842 Budget includes full cost accounting.

Expected products:
Aerial photos
Vegetation and water quality sampling

Timeline for completion:

Tracking number	Products	Milestones
2006APE30a	Aerial photos taken	31 August 2006
2006APE30b	Vegetation and water quality sampling completed	30 September 2006

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APE #34: Identifying potential controls on abundance and size structure of centrarchids and diversity of fishes in off-channel areas in the Upper Mississippi River: Aquatic vegetation and seasonal refuge

Principle investigator: Brent Knights

Introduction/Background: Off-channel areas (e.g., backwaters) are central to the productivity and diversity of large floodplain rivers like the Upper Mississippi River (UMR) and thus much ecosystem restoration focuses on these areas. System changes to accommodate navigation and development in the floodplain and watershed of the UMR have altered, eliminated, or added off-channel areas (OCA). Remaining OCAs are affected by altered hydrology (i.e., magnitude, duration, frequency, and timing of connectivity with the main channel), turbidity and sedimentation regimes. These hydrologic and physical alterations are reflected in the physicochemical and biological template (i.e., habitat) that in turn, regulate for productivity and diversity of aquatic communities in OCAs of large rivers (e.g., Vannote et al. 1980; Poff et al. 1997; Stanford et al. 1996). One key component of this template is aquatic vegetation because it functions as habitat to meet life history requisites (i.e., energy, survival, and reproduction) for a large number of aquatic organisms (Janecek 1988; Petr 2000) including many keystone biota (e.g., invertebrates and epiphytic algae) and biota of special interest to humans (e.g., fishes and ducks). The importance of aquatic vegetation as an indicator of ecosystem health in the UMR and other aquatic systems has long been recognized (e.g.., GREAT Studies). In some portions of the UMRS, aquatic vegetation has nearly been completely lost from remaining OCAs and ecological consequences are observable (e.g., lower abundance and diversity of small bodied cyprinids and altered size structure of panfishes; Ickes et al. *in press*). Other key components of the OCA template relevant to mobile aquatic biota like fish are refuge or connectivity to refuge from seasonally adverse conditions including low oxygen, high flow, high or low temperatures (e.g., Sheehan et al.1990; Pitlo 1992, Knights et al 1996) and lack of food resources or for reproduction. Interrelated measures that reflect availability of seasonal refuge may include water depth, dissolved oxygen concentration, water velocity, temperature, connectivity, and shoreline development. A better understanding of the biological (e.g., diversity and productivity of vegetation) and physicochemical (e.g., refuge or connectivity to refuge) characteristics of OCAs that drive biological production and diversity in aquatic communities would greatly benefit restoration efforts in large floodplain rivers. Therefore as a next step, the proposed work will address the following questions: Are fish diversity and centrarchid abundance and size structure indices derived from LTRMP data related to vegetation or refuge/connectivity metrics in off-channel areas? Because it is based on observational rather than experimental data, this research will only be a next step down the road to identifying candidate variables as controlling factors for further directed study under an adaptive management framework where confounding factors can be better controlled. We chose centrarchids as a response variable because of their importance both ecologically based on abundance in LTRMP samples and as a game fish in the UMR system as indicated by past creel surveys in the system. As well, centrarchids are a primary focus of past restoration efforts. We chose fish diversity as another endpoint because of its obvious ecological and societal importance as a general indicator of anthropogenic impacts on ecosystems.

Relevance of research to UMRS/LTRMP: One of the primary goals of the LTRMP is to gain a better understanding of the ecology of UMRS to help inform management. The proposed research will be a next step in identifying important biological (i.e., diversity and abundance of vegetation across spatial and temporal scales) and physicochemical (i.e., refuge or connectivity to refuge) characteristics of OCAs that affect abundance and size structure of centrarchids, and diversity of fishes. This approach builds on past research and monitoring related to centrarchids (e.g., Sheehan et al.1990; Pitlo 1992, Knights et al 1996, and Gutreuter 2005) and other fishes (Ickes et al. *in press*) in the UMRS. The research will also be a test of the application of LTRMP data at management-relevant scales (i.e., the scale of most restoration efforts), whereas recent work has focused at Pool scales and above. This research will act as the next step to answering the question of what makes a good backwater from the standpoint of production and diversity of fishes. The results will be used to identify candidate predictors for future directed research that should eventually inform restoration efforts. This approach also answers the call for integrated analysis of LTRMP data in that we anticipate using fish and vegetation data.

Methods: This is an expansion of the FY2005 analysis of LTRMP data under the minimum sustainable program, where we are examining relations between key physicochemical variables (refuge / connectivity metrics) and centrarchid abundance and size structure and fish diversity among off-channel areas in Pool 8. We propose to expand this analysis in FY2006 to include other LTRMP reaches and vegetation metrics as predictor variables in addition to refuge/connectivity metrics. In FY2005 under MSP, we will make progress on 1) delineating individual off-channel aquatic areas defined as contiguous off-channel strata areas bordered by main or secondary channels in Pool 8 with ArcGIS; 2) defining and deriving time-integrated management-relevant indices of fish diversity and centrarchid abundance and size structure (e.g., 10-year average and variance of diversity, abundance, and size structure indices) for individual OCAs with LTRMP data; and 3) defining and deriving time-integrated physicochemical indices related to seasonal refuge or connectivity to seasonal refuge for individual OCAs from GIS coverages of physical attributes. In FY2006 under APE, we will complete the steps initiated in FY2005 for Pool 8, complete these steps for other key LTRMP reaches, and define and derive time-integrated (i.e., mean and variance) indices of aquatic vegetation abundance and diversity for individual OCAs with LTRMP vegetation data and GIS coverages of aquatic vegetation to be used as predictor variables. We will use an information-theoretic (Burnham and Anderson 2001; Gutreuter et al 2004) modeling approach to determine which combinations of biological (i.e., vegetation) or physicochemical (i.e, refuge/connectivity) metrics of off-channel areas best relate to fish diversity and abundance indices. With this approach, a set of *a priori* models (working hypotheses) are constructed based on available information from the literature or expert opinion. These models are then compared by calculating an information criteria for each model to determine which model or models are best supported based on the empirical data in hand…in this case LTRMP observational data. This approach is useful in identifying the most probable working hypotheses of those compared. Future experimental research controlling for confounding factors will be needed to further test the importance of these variables in controlling the response variables. For example, we will compare the set of models in the table below to determine what models are best for describing the abundance of quality sized bluegills, black crappies, and largemouth bass in off-channel areas in Pools 4, 8, and 13.

Model*	AIC_c	Δ_i	r^2	p
Full model $CPUE_{q\_fish}$ = SI + Con + Bat + VegS + VegF				
Full model w/out Bat $CPUE_{q\_fish}$ = SI + Con + VegS + VegF				
Physicochemical model $CPUE_{q\_fish}$ = SI + Con + Bat				
Physicochemical w/ just SI and Con $CPUE_{q\_fish}$ = SI + Con				
Vegetation model $CPUE_{q\_fish}$ = VegF + VegS				
Vegetation model w/ just VegS $CPUE_{q\_fish}$ = VegS				

*$CPUE_{q\_fish}$ is mean catch per unit of effort of quality sized fish of a given species; SI is Shoreline development index; Con is connectivity as the amount of border as channel; Bat is area greater than 1 m deep; VegS is the abundance or coverage of submersed aquatic vegetation; VegF is the abundance or coverage of floating aquatic vegetation.

We will use shoreline development indices within off-channel areas (OCA) as an index of refuge, primarily from flow, along with a measure of connectivity as indicated by the amount of channel that borders an off-channel area. Together these should be indicative of the lentic character of an OCA. OCAs with more channel border and lower shoreline development will be less lentic than OCAs with less channel border and greater shoreline development. Depth will also be considered an index of refuge because of its potential importance in winter (flow, temperature, oxygen refuge) and summer (oxygen, temperature).

We will use percent coverage of submergent and rooted floating vegetation derived from the 1989 and 2000 land-cover data. As well, we will use measures of mean vegetation density derived from LTRMP stratified random sampling.

With the information criteria method, the "best" model is considered to be that with the minimum Akaike Information Criterion (AIC_c) corrected for a large number of parameters relative to sample size,

$$AIC_c = -2\log_e(L(\hat{\theta})) + 2K + 2K(K+1)/n - K - 1$$

where K denotes the number of estimable parameters in the model, $L(\Theta)$ is the maximized log-likelihood, and n is sample size (Burnham and Anderson 2001). The other models in the set were assessed relative to the "best" model with Δ_i

$$\Delta_i = AIC_{ci} - \min AIC_c$$

and by Akaike weights (w_i),

$$w_i = \exp(-\Delta_i / 2) / \sum_{r=1}^{R} \exp(-\Delta_r / 2)$$

where Δ_i, AIC_{ci}, and w_i pertain to the ith model. Models with Δ_i less than 2 have substantial support, whereas models with Δ_i greater than 10 have essentially no support (Burnham and Anderson 2001). Akaike weights (w_i) are approximations of the probability that a particular model is the "best" model in an entire set of models.

Special needs/considerations: The PI will coordinate with Dan Wilcox to ensure that the work is complimentary with other ongoing LTRMP research on centrarchids. UMESC will provide matching base funds from the Productivity Pathways.

Budget: $48,471 Budget includes full cost accounting.

Expected products: Draft contract report including introduction, methods, results, discussion, management implications, and suggested future work in regards to the analysis initiated under MSP in FY2005 and expanded by this APE. Presentations at regional (e.g., UMRCC fish tech meeting) and national (e.g., AFS) meetings.

Tracking number	Products	Milestones
2006APE34	Draft contract report	1 September 2006

APE #42: Importance of the Upper Mississippi River Forest Corridor to Neotropical Migratory Birds

Principle investigators: Dr. Eileen Kirsch

Introduction/Background: Neotropical and short distance migrant birds spend 2-4 months per year in transit between summer and winter habitats (Keast and Morton 1980). There is growing concern and interest in bird habitat use during migration so that conservation efforts can target important migration habitat and landscapes (Moore et al 1995, Petit 2000).

Riparian areas in the arid west have long been touted as important habitats for breeding neotropical and short distance migrant birds (Knopf et al. 1988, Finch 1989, Finch and Ruggerio 1993, Rosenberg et al. 1991) and more recently for these birds during migration (Finch and Yong 2000, Flannery et al. 2004, Skagen et al. 2005). But in eastern deciduous forest landscapes, neotropical and short-distance migrant birds may not use riparian areas preferentially over upland habitats during spring (Rodewald and Matthews 2005). However, Upper Mississippi River System wetlands, backwaters, and extensive forests on the floodplain, and the adjacent bluff slope and bluff top forests form a nearly continuous habitat corridor through the central portion of the United States which is otherwise nearly completely converted to row-crop agriculture. This continuity of forest along the UMR in a highly agricultural portion of the US may serve as a corridor for migrating birds. Thus, it is thought that the Mississippi and Illinois River corridors provide an important link between southern wintering grounds and northern breeding grounds for neotropical and short distance migrant birds.

Human made structures such as the lock and dam system, HREPS, wind power generators, and cellular telephone towers can modify pathways and eliminate or reduce the quality of stopover sites resulting in decreased survival and productivity. Additionally, modifications to the Mississippi and Illinois rivers over the past 100 years have resulted in changes to the natural hydrographs and the rivers connectivity to the surrounding landscape. These modifications have resulted in changes in tree species composition, as well as distribution, structure, and abundance of floodplain forests. National Wildlife Refuges and Corps of Engineer Districts spend hundreds of thousands of dollars annually in the restoration of forest habitats within the floodplain and in the adjacent uplands. To date, projects have been site specific and there have been few attempts to take a landscape approach to siting projects or to monitor the results of individual forest restoration projects. More importantly, restoration efforts have occurred without the benefit of knowing where migrant birds (and breeding birds for that matter) tend to congregate, what habitats they use, when they arrive and depart, what their physiological conditions are in relation to resting and refueling habitats, and if there are any physical barriers to migration. As a result there is little information about the migratory pathways and timing of migration to use in the development of habitat restoration projects, siting communication towers and in the development of wind power generation or other technologies. Both the U.S. Fish and Wildlife Service and the Corps of Engineers would benefit greatly from a system-wide evaluation of stop over habitats along the Mississippi and Illinois Rivers up to the Great Lakes and Boreal Transition Regions.

Relevance of research: Migration ecology of landbirds simply is not well understood, yet. Although it has been assumed that UMR corridor is important for migrating songbirds, this has never been demonstrated. Further, there are few data on how neotropical and short distance migrant birds use the corridor. In addition, there is no information regarding the location and habitat type of specific stopover sites. It may be that birds use the full length of the river floodplain and adjacent uplands forests during migration without regard or with little detectible regard to specific habitat types or locations. The importance of the floodplain forests of the river corridor in relation to the adjacent upland forest remnants needs to be documented along the UMRS. Different species of birds may be using different types of forests or different forest types may provide better food resources for migrants than others. Land managers along the UMRS would benefit greatly from the development of guidance on where to initiate restoration efforts and what species are most likely to benefit from their efforts. The Driftless Area and the Upper Mississippi River System may be important for migrating Wood Thrush, Veery, Golden-winged Warbler, Connecticut Warbler, Cerulean Warbler, Rose-breasted Grosbeak, and Black-billed Cuckoo—species of conservation concern in Partners in Flight Conservation Regions 16 and 20 (Upper Great Lakes Plain and Boreal Hardwood Transition) (Knutson et al. 2000, PIF 20, http://www.blm.gov/wildlife/pl_20sum.htm [date accessed February 2005).

Ten years of NEXRAD images are available for the upper Midwest covering the UMRS. Others have studied the utility of NEXRAD for monitoring bird movements and potential for detecting migration habitat "hot spots." It is possible to use this technology to help UMRS resource managers locate potential important habitat areas for migrating birds. Our goal is to examine the available NEXRAD data and collect NEXRAD data for 2006-2007 and combine that information with land use/cover GIS data, data from ground based surveys and bird netting/banding to better understand movement patterns, species composition, physiological condition, and habitat associations of migratory birds from the Mark Twain National Wildlife Refuge Complex north to the upper reaches of the Upper Mississippi Wildlife and Fish Refuge Complex and east along the Illinois River Wildlife and Fish Refuge Complex. Land managers and industry will benefit from the databases and tools developed from this work to optimize the siting of future energy projects, cellular telephone towers, and habitat restoration and enhancement projects.

We will address several questions with a fully funded study. Are there habitat hot spots for migrating landbirds associated with the UMRS? Do species and abundances of migrating birds in upland and floodplain forests differ? Does body condition of migrating birds differ between floodplain forest and upland forest? What are the local forest habitat structure variables that may influence species composition or body condition differences? What are the habitat features of migration hotspots that may be amenable to management to increase the habitat suitability of other locations?

Methods: This proposal can be funded at 3 different levels. Methods for the full study follow in the next few paragraphs and will allow us to address all the research questions presented above. Lower levels of funding will necessitate a lower level of effort. The 2nd budget option includes only ground based surveys along the UMRS. This level of effort will still provide ground breaking data on migratory bird use of the floodplain versus upland habitats, as well as habitat data that will be useful for management. The 3rd budget option includes radar and GIS data but includes the ground truthing effort for only a small area of the UMRS, most likely Pools 6-9, where preliminary work has already started.

Archived weather surveillance radar (WSR-88D, or NEXRAD) data will be acquired from seven locations from 1995-2005 (Minneapolis, MN, La Crosse, WI, Quad Cities IL and IA, St. Louis, MO, Central Illinois and Paducah, KY). Data from Des Moines, IA, Chicago, IL, NEXRAD sites may also be useful. From each radar location we will examine images from April and May for the 1 hour period following dusk, the period of "exodus" for migrating landbirds. We will also acquire weather information for each radar scene. Potential important bird habitat will appear as rapidly expanding nearly circular areas of high reflectivity emanating from focal land areas (Gauthreaux and Belser 2005).

On the ground, migrating birds will be sampled using line transect surveys (i.e., Rodewald and Matthews 2005, Hanowski et al.1990) and mist netting/banding (Ralph et al. 1993). The ground-based study area currently includes the UMRS (Mississippi and Illinois Rivers) floodplain and uplands up to 16km (10 miles) from the floodplain. With additional funding, ground study sites will be chosen from National Wildlife Refuge or Corps of Engineer lands with crews located at Mark Twain, Illinois River, and Upper Mississippi National Wildlife Refuge Complex headquarters (see Study Area, below).

Survey transect locations will be randomly selected and distributed equally among floodplain and upland forests. The final list of random sites to be included will be selected based on accessibility and logistical considerations. Each transect will be 150m long. Surveyors will record all birds seen and heard along transects, as well as estimated distances to birds, while walking at a pace of approximately 1 km/ hour. Thus, each transect should take about 10 minutes to complete. Transects will be surveyed two to three times per week from early April until the end of May. A total of 30 survey transects with good access can reasonably be surveyed by a crew of four in a single morning with ideal weather. After each survey, the degree of leaf-out in canopy, subcanopy, and understory trees and shrubs will be recorded (Rodewald and Matthews 2005). Additionally time of day and simple weather data will be collected during each survey, such as temperature, wind, sky and precipitation conditions. In early June, after surveys are completed, detailed information about forest structure will be collected at 50m intervals along the transect. Point-center quarter sampling will be used and the species and estimated height, dbh, and distance to the center of the quarter will be recorded for canopy and understory trees. The number of snags within 50m of the sample point over 10cm dbh will be counted.

Banding stations will be set up in several of these random locations, but they must be accessible and have suitable habitat for setting up mist nets (an abundance of low shrubby vegetation). Thus sites to be selected for banding will be accessible by 4 wheel drive vehicle or boat and all possible net locations must be in close proximity, which rules out extremely small patches of forest (which may be selected randomly for transect surveys). Pairs of floodplain and upland banding stations will be run simultaneously, and station pairs will be located in similar latitudes. Each pair of banding stations will be run at least once a week from early April through the end of May using standard banding protocols (USGS Bird Banding Manual; Smith et al. 1997, DeSante et al. 2005). All banding data will be reported to the Bird Banding Laboratory within 45 days of conclusion of the field portion of the study. Support staff will be used to extract birds from the nets and will be trained in banding ethics, proper extraction, restraint, and handling techniques (Smith et al. 1997, DeSante et al. 2005). Each banding station will consist of 10, 12m long by 3 meter high, 4-shelved 30mm mist nets. Nets will be opened at sunrise and closed 6 hours later. Nets will be checked every 40 minutes. Nets must be placed near shrubby vegetation on a site, or birds can see the nets and will avoid capture. Along with recording species, sex, and body condition (Pyle 1997, Eggler and Williams 2000), we will collect blood from selected species to evaluate blood chemistries (Gugliemlo et al. 2002, McWilliams et al. 2002). For example, plasma lipid profiles can indicate whether a bird is gaining or losing weight and ratios of these chemistries provide an index of habitat quality (Gugliemlo et al. 2002). The degree of leaf-out will be recorded during each banding session at the location of each odd numbered net. More detailed habitat data will be collected at banding stations in early June using the MAPS protocol (De Sante et al. 2005). Weather conditions at banding stations will be recorded hourly during each banding session.

Along with randomly selected survey areas, locations of some survey transects and banding stations will be based on any evidence of migration habitat “hotspots” as detected from archived NEXRAD. Should any hotspots in or on the UMRS be detected in archived radar data, we will sample in the location and at random points within 5km of the presumed hotspot, including upland and floodplain forests within that 5km radius.

We propose to conduct this pilot study wherein we will develop the use of radar technology in combination with the ground surveys of migratory songbirds and in association with the new USGS/FWS interagency program to advance migratory bird conservation and management using weather surveillance radar technology (Dr. Rick Kearney, USGS, Reston, VA, Pers. comm). We plan to assemble and test a prototype GIS database of 1) radar imagery, 2) the Long Term Resource Monitoring Program of the Upper Midwest Environmental Sciences Center’s landuse/landcover data and refuge landcover data, 3) landuse/landcover data from the USGS' National Landcover Database (NLCD) and GAP databases to fill in gaps in the LTRMP's coverage, and 4) data from ground-based surveys of migratory bird species, timing, duration, and habitat use during spring.

We plan to examine the utility of the combined datasets in identifying important stopover locations. Once the process has been developed and tested on specific areas within the Upper Mississippi and Illinois Rivers our goal is to seek additional funding to conduct a basin-wide effort that includes the Middle and Upper Mississippi, Illinois, Ohio and Missouri Rivers.

The network of 151 NEXRAD radar stations in the contiguous United States presents a unique (and free) opportunity to monitor bird migration over this broad area. We propose to use two types of NEXRAD products (base reflectivity and base velocity images) to delimit stopover areas during spring and fall migration in a few locations of the Upper Mississippi Refuge Complex wherein we have Long Term Resource Monitoring Program and NLCD data and on-going spring migration surveys (USGS-UMESC) along the Mississippi Illinois River corridors. A second test site will include the Mark Twain Refuge Complex and a third site, as time and funding permits, within the Illinois River Refuge Complex. Reflectivity images will be processed to emphasize areas of relatively high bird density and the resulting imagery will be converted to rectangular raster format and imported into ArcInfo. The maps showing relative density of birds departing from stopover areas can then be compared with land cover maps based on classified Landsat data. Where available, data from ground surveys will be used to interpret the radar images and to examine habitat associations and the physiological condition of birds for more detail. Only a few radar studies have been conducted around the Great Lakes (D. Bonter unpubl. data; R.H. Diehl unpubl. data) but little has been published (Belser and Gauthreaux 2005; Diehl, et al. 2005) and we propose to work with these scientists to incorporate these data as we begin our efforts.

Study Area: Initially we will begin our focus for the radar work one section each on the Upper Mississippi National Wildlife and Fish Refuge, Mark Twain National Wildlife Refuge, and Illinois River National Wildlife and Fish Refuges – beginning with locations wherein we have over 10 years of Long Term Resource Monitoring Program landcover and other data from several studies of migratory birds and then moving to other areas of the corridor. Ground surveys for migratory birds will be conducted on the Upper Mississippi and Illinois River on or adjacent to refuge, Corps of Engineers lands, or private (with permission).

Special needs/considerations: This collaboration will necessitate participation from each refuge in overseeing field crews and consulting on GIS questions.

APE's 21, 29, 42, and 51 as well as the NESP Forestry Partnership all relate to floodplain forest issues. USGS and the USACOE believe that these projects need coordination among the Principle Investigators to ensure that the studies are all part of a larger Forest Science Plan for the UMRS and that communication among the scientists is occurring. Results from a Floodplain Forest Workshop hosted by USGS in March 2005 were the springboard for the development of a draft Forest Science Plan for the UMRS. Dr. Eileen Kirsch at UMESC will be the lead to incorporate these APE studies into the draft Forest Science Plan and facilitate communication among the research scientists and river forest managers.

Budget: $155,284 Budget includes full cost accounting.

Expected products: For this single year effort a note in a peer reviewed ornithological journal and a protocol for the process of integrating radar imagery, Landsat data, and ground survey data. Two to 3 presentations at regional meetings (MRRC, UMRCC), and a presentation at a national meeting (Cooper Ornithological Society or The Wildlife Society). GIS database of survey locations and species lists and abundances. Radar maps of the study sites.

Timeline for completion:

Tracking number	Products	Milestones
2006APE42a	Ground surveys on Upper Mississippi River and Mark Twain and Illinois River Refuges. Monitor migration with radar.	30 June 2006
2006APE42b	Draft contract report on protocol	30 September 2006
2006APE42c	Submit note to a peer reviewed ornithological journal	30 September 2006

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APE #43: Assessment of the Rake Method for the Estimation of Submersed Aquatic Vegetation Levels

Principal investigator: Brant Deppa, Winona State University
LTRMP Management contact: Dr. Patricia Heglund

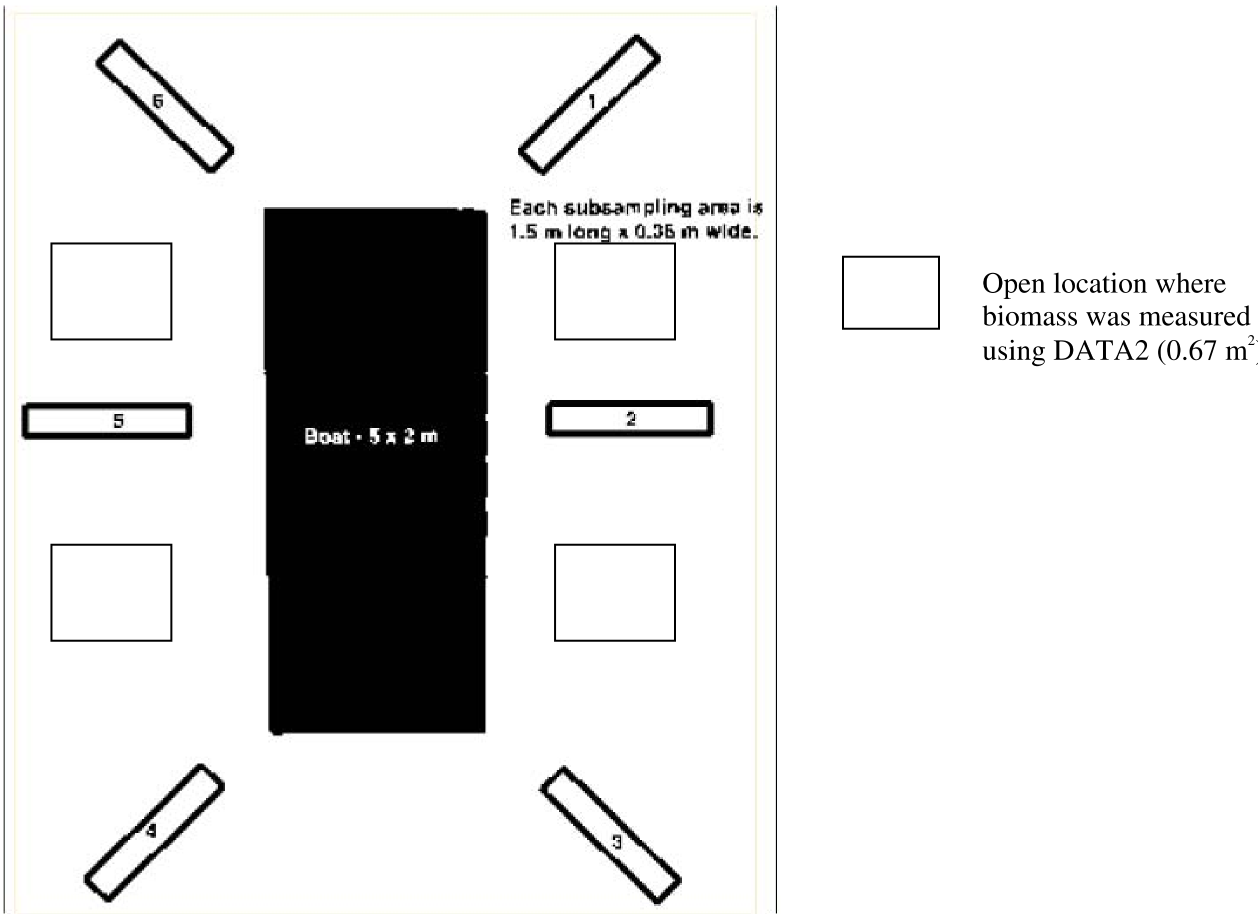
Introduction and Background:
The Long Term Resource Monitoring Program's method for sampling submergent and emergent aquatic vegetation is based on the use of a double-pronged rake. The "rake method" described in Yin et al. (2001) generates scores which are ordered categories used to approximate abundance and/or density of aquatic vegetation. This method has been used by the Long Term Resource Monitoring Program (LTRMP) since 1998. The rake method was selected to expand the sampling coverage from focal backwater areas (transect based-sampling) to the entire pool and the desire to produce annual poolwide estimates that would enable between-year comparisons and detection of trends. Initially there was strong resistance against this proposed change out of fear the workload would be too large to be manageable. Collecting subsamples of biomass was not up for discussion and program staff currently balance travel time (between sites) and sampling time (time spent at a site) to sample approximately 400-500 locations per pool per year. A major question was and remains, if the crew spends 30 minutes traveling to a site, should it just record presence/absence of SAV (by species), or spend a few more minutes to collect additional data that might better reflect SAV growth at the site? If the latter is true, what is the best and most cost-effective method for doing so? As with all components of the LTRMP, we are interested in periodically reviewing approved methods in light of their stated purpose and to make recommendations for the program based on this review.

Briefly, the sampling method is as follows. A boat is taken to a sampling location. At each of six subsampling locations surrounding the boat, a garden rake is then passed over the sediment and the level of retained plant material on the rake is scored using a six-level ordinal scoring scheme. Increasing score values represent increasing levels of biomass on the rake; score = 0 (no plants on rake) and a score $\geq$ 1 (plants observed on rake) are used to define prevalence. The method has been adopted by the Great Rivers EMAP program and by the U.S. Army Corps of Engineers in conjunction with a number of States. The national and regional significance of all three programs requires that we treat data arising from the LTRMP rake method with care.

Relevance of research to LTRMP:
These ordinal data have been used to estimate both prevalence (aka percent occupancy, percent frequency) index and model-based abundance index statistics. As stated earlier, there is an interest in exploiting the extra-prevalence rake data collected by the LTRMP and other programs to better characterize the vegetation of the study pools through annual poolwide estimates of abundance that would enable between-year comparisons and detection of trends. We will analyze the ordinal and categorical rake data as they are, i.e. as ordinal/categorical data, using analytical methods designed explicitly for these data types.

Prior to unqualified acceptance of the use of the rake data for reporting changes in prevalence, it needs to be determined whether we can adequately defend their use. Concerns include that the rake data derive from a rake observed above the water and not directly from the medium of interest (e.g., river, lake); the importance of observer effects in defining community- and species-specific score ratings; that species-specific scores may depend on biomass levels of other species; whether the rake method yields extra-prevalence information (e.g., something akin to biomass) that is categorically less expensive—for a given precision—than measuring biomass itself; and whether plant material, especially that associated with low-growing or minor species, is missed (particularly in dense stands). Additionally, we ask the following questions. Is percent frequency of SAV presence a good indicator for status and trend analysis? What is the best method to analyze the rake matrix (1X6 vector, i.e., (r1,r2,...,r6) for each site)? Is the abundance index of Yin et al. (2001) a better indicator than the presence/absence indicator? Is there a better index? Does the abundance index agree with biomass data on trends (between-year comparisons)? And finally, Should the crew continue to spend extra time per site collecting the rake matrix data, or should they use the time to visit more sites for presence/absence data, or should they spend some time collecting biomass samples?

We have two reference data sets available for our rake data. One (DATA1; Y.Yin unpublished data) pairs biomass (ostensibly, biomass not removed by rake plus biomass removed by rake) with rake scores, while the second (DATA2) includes biomass measured at each of the four "open locations" defined by the six rake subsampling locations per sampling site (see figure below). The effects of previous rake sampling may influence the resulting biomass estimates in DATA1 while interpolation error will be an issue with DATA2. DATA1 includes data from one sampling season, while DATA2 includes data from five or six seasons with sampling locations re-randomized between seasons. Both datasets derive from Pool 8.



Methods:

1. Determine misclassification bias with respect to measured biomass for rake scores by comparing rake scores to the biomass measurements using DATA1. This will be done for the two most abundant species (based on measured biomass), two species that have intermediate abundance, and two species that have low but nonzero abundance. These comparisons will also take into account (where possible): separate observers, substrate category (e.g. 'silt-clay' or 'sand

with silt-clay'), water depth (e.g., "shallow" and "deep" to be defined), and for DATA2, for two separate years holding other relevant covariates constant.

2. Estimate correlations among biomass and rake score outcomes (separately) across each of the subsampling locations within the primary sampling units. This will be done for both presence-absence (i.e. rake scores $\geq$ 1 and rake scores = 0) and for the actual rake scores. This analysis will be done for species or communities with prevalence near 0.5, for median rake scores near 3 and as much as possible and reasonable, holding covariates constant. This will be done for both datasets.

3. Estimate cross-correlations among biomass and rake scores across sampling locations within primary sampling units, i.e. the correlation between the biomass estimate at location 1 with rake scores at locations 1 – 6, etc. This will be done for most prevalent species or communities as in (2) above.

4. Evaluate the importance of any uncertainties found in 1, and correlations found in 2 for applying the methods in Royle and Link (2005) to the rake data.

5. Comment on whether the rake method might be used to estimate biomass by supplementing the current protocol with biomass measurements at a subset of sampling locations. We will describe how population estimates of biomass would directly be estimated from such a dataset.

And lastly, using information from above we will specifically comment on the following questions:

6. Is percent frequency of SAV presence a good indicator for status and trend analysis?

7. What is the best method to analyze the rake matrix (1x6 vector, i.e., r1, r2….r6) for each site?

8. Is the abundance index of Yin et al. (2001) a reasonable indicator for status and trends monitoring? Is there a better index?

9. Does the abundance index agree with biomass data on trends (between-year) comparisons?

10. Should the crew continue to spend extra time per site collecting the rake matrix data, or should they use the time to visit more sites for presence/absence data, or should they spend some time collecting biomass samples?

Budget: $38,242 Budget includes full cost accounting.

Expected products:
Draft reports from the above set of analyses will be provided separately and regularly throughout the fiscal year 2006 (October 1st through September 30th). A combined report, integrating and including all the previously-reported analyses, will be provided for UMESC review by August 30th, 2006. This report will be formatted for submission to the intended botanical, monitoring or biometrics journal.

Timeline for completion:

Tracking number	Products	Milestones
2006APE43	Submit draft report	30 August 2006

APE #49: Identification of Hydraulic Characteristics of Habitats Selected by Riverine Fishes

Project Leader: Dr. Steve Gutreuter

Introduction/Background:
The navigation channels of the large rivers of the U.S. support vital commercial shipping and ecological services that include a unique fish fauna. The Mississippi River is a unique ecosystem in that it supports exceptionally large number of fishes (~240 species; Fremling et al. 1989) that rivals some large tropical rivers in biodiversity (Welcomme 1979) including the Zambesi (~158 species), Rio Negro (~220 species) and Orinoco (~320 species). Although the fish species richness of the Mississippi River has been stable, with the exception of the addition of exotic species, commercial navigation may have altered patterns of abundance and production of some valuable riverine species. For example, towboats may kill both juvenile (Kilgore et al. 2001) and adult fishes (Gutreuter et al. 2003). Recent research indicates that disturbance by tow traffic substantially alters at least the spatial distribution of some important riverine fishes including shovelnose sturgeon, channel catfish and sauger, and may affect abundance and production (Gutreuter et al. *In prep*.). It is clear from studies of abundance of fishes in the main and secondary channels of the Upper Mississippi River that channel-dwelling fishes have spatially “clumped” distributions as measured by the negative binomial dispersion parameter (Dettmers et al. 2001; Gutreuter et al. *In prep.*) , implying that preferred habitats occur in discrete patches. That clumping would also explain the infrequent observation of entrainment mortalities (Gutreuter et. al. 2003).

The apparent selection of relatively small patches implies that some channel-dwelling fishes select relatively narrow ranges of hydraulic, geomorphic and structural features that are bioenergetically favorable (Guench et al. 2001). The development of the ability to predict microhabitat selection by important channel-dwelling fishes would provide river managers with the means to assess the relative merits of alternative restoration strategies and perhaps even to devise practical means to minimize adverse effects of commercial shipping on channel-dwelling species.

Relevance of research to UMRS/LTRMP:
Goal 1 of the original LTRMP Operating Plan prescribed research on effects of navigation on the UMRS ecosystem (USFWS 1992). Since then it has become increasingly apparent that river channels are broadly important to the biodiversity and production of fishes and therefore merit restoration (Galat and Zweimüller 2001). Historically, the Environmental Management Program of the Upper Mississippi River has enhanced or restored habitat for various organism in backwater aquatic areas. However, there is growing interest in channel restoration and enhancement, including the development of strategies to mitigate adverse effects of commercial navigation on fishes (USACE 2004).

Methods:
We propose research in two phases. This proposal describes the first phase, which will produce statistical models to predict microhabitat selection by key riverine fishes based on hydraulic, geomorphic and structural features. The second phase would consist of validation of the predictive models in an outlying year.

During this first phase, we would combine three sampling methods to identify the hydraulic, geomorphic and structural features selected by channel-dwelling fishes. Each method plays an essential role in developing the understanding needed to predict microhabitat selection by important riverine fishes, and the combination is critical to success. Our goal is to deploy the set of methods during both relatively low and high discharge, as conditions permit. First, we would identify areas of channel in Pools 16 and 26 of the Mississippi River that are presumptively heavily and lightly occupied by fishes using dual- or multibeam sonar. Detailed bathymetric data and water-velocity models exist for both of these pools. Sonar allows rapid preliminary identification of occupancy, but does not self-verify that particular sonar reflections are, in fact, fishes, nor can it measure species composition. Next, we would map local bathymetry and water velocities using and acoustic Doppler profiler and a survey-grade acoustic depth sounder. Last, we would confirm occupancy and measure species composition by trawling, as conditions safely permit. We have extensive experience and success trawling in Pools 16 and 26 and therefore information on gross historic patterns of occupancy.

We would then develop predictive statistical models of habitat use from these data. Candidate models include those that accommodate both suitable and unsuitable habitat by modeling variable frequencies of occupancy (Agarwal et al. 2002; Gray 2005). Out-of-sample prediction error would be assessed using bootstrapping (Efron and Tibshirani 1993).

Budget: $150,107 Budget includes full cost accounting.

Expected products:
Database containing velocity, bathymetric and biological records.

Timeline for completion:

Tracking number	Products	Milestones
2006APE49	Database completion	30 September 2006

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APE #51: Development of a floodplain forest restoration database for the UMRS: a tool for future coordinated forest management planning

Principle investigators: Dr. Eileen Kirsch

Introduction/Background:
The UMR is a highly altered and used system. Not only have the forests along the UMR endured logging and agricultural and urban development, but the river also has a long history of habitat alteration to aid in navigation (Yin et al. 1997). The most recent and ongoing chapter in this development, was the installation of a system of 27 locks and dams on the Mississippi River from Minneapolis, Minnesota to St. Louis, Missouri (finished in 1941) and operation and maintenance of the 3-m deep navigation channel, which continues to affect aquatic and terrestrial habitats (Fremling and Claflin 1984). Development of the navigation system, and the building of levees with agricultural conversion behind levees, resulted in the loss of thousands of acres of floodplain forest (UMRS Habitat Needs Assessment 2000).

The remaining floodplain forest is undergoing changes as a result of altered river hydrology. Tree diversity is declining (Yin 1999, Urich et al. 2002). The silver maple community is considered late successional in this system, and often includes green ash (*Fraxinus pennsyvanica*), elm (*Ulmus* spp.), river birch (*Betula nigra*), and cottonwood as codominants or part of the subcanopy and understory. However, many trees, particularly mast producing species, which formerly were more common, either cannot become established naturally or they cannot grow where they used to because of raised water tables (Yin et al. 1997, Yin 1999). Communities of pioneering species (cottonwood [*Populus deltoides*] and willow [*Salix* spp.]) are becoming less common because the bare substrate they require for germination is rarely deposited or exposed (Yin and Nelson 1995, Knutson and Klaas 1997). Silver maple (*Acer saccharinum*), although dominant in the 1800's, has increased in dominance and the trend is towards a monoculture (Knutson and Klaas 1998).

Furthermore, severe reduction in forest area and conversion to more grassland/savannah habitat is possible (Yin et al. 1997, Knutson and Klaas 1998, Yin 1999, Urich et al. 2002). Much of the forest canopy is composed of even aged silver maple trees 55-75 years old and there are few saplings and seedlings of silver maple and other species in the understory (Yin 1999, Urich et al. 2002). The life expectancy of silver maple is 125 years. In some areas, large silver maples and cottonwoods have been blown down or have died leaving gaps in the canopy (Fox et al. 2000, Urich et al. 2002). Without management intervention an aggressive grass, reed canary grass (*Phalaris arundinacea,* hereafter *Phalaris*), often colonizes these gaps preventing germination and growth of any tree seedlings (Knutson and Klaas 1998, Urich et al. 2002). As the even aged silver maple forest senesces, *Phalaris* may take over the understory, further retarding tree regeneration, which would result in a savannah-like habitat and eventually to losses of large areas of forest.

Relevance of research: Three COE districts, 2 National Wildlife Refuge Complexes, 5 states and several NGOs are interested in maintaining the ecological integrity of floodplain forest and the its critical role in overall UMRS ecosystem health. The COE has been asked to develop a systemic forest management plan through the Navigation and Environmental Sustainability Program (NESP), which should be authorized by Congress for 2006. USFWS Refuges are very interested in forest management to maintain wildlife habitat and in development of a forest management plan that focuses on restoring, monitoring and managing floodplain forest to fulfill habitat goals set out in their Comprehensive Conservation Plans (CCP). Many forest management, restoration, and or monitoring projects by federal, state, and private landowners have been undertaken or are on-going all along the UMRS. And, many of these projects were made possible through the Habitat Rehabilitation Program (HREP). Although these efforts are typically a coordinated effort involving many partners, information on locations, management undertaken, and follow-up monitoring is not available in a central location and common format so that it is easily accessible to river managers and biologists who must develop future forest management plans and management actions. A necessary first step in a systemic forest management plan is to draw together all the available information on what work has been done, where, and what effects the management has had on habitat and wildlife. The COE has extensive geo-referenced forest inventory data and several sources including UMESC, UMRNW&F Refuge Complex, Mark Twain Refuge Complex, and COE have information on breeding and migrating landbirds in forest and other terrestrial habitats. These data sets will also be included to provide a comprehensive view of current conditions of the forest and associated wildlife. Such a comprehensive database can inform future management decisions and form the seed of an adaptive management plan that will involve many partners.

Methods: All data on forest management projects available within the UMRS will be compiled and referenced spatially. Such data will include agency identifier, locations, dates, size of project areas, treatments, pre treatment conditions, management goals, and any auxiliary site information available (soils, elevation, etc.). Monitoring data collected from project sites will also be included. Data will be stored in GIS and Access databases. A web-based interface will be developed so that partners can view and query the data.

Special needs/considerations: This work will be conducted in coordination with the USFWS's Biological Monitoring Team located in La Crosse, WI.

Budget: $116,071 Budget includes full cost accounting.

Expected products: Georeferenced database available to agency partners served over the web at UMESC or other appropriate facility. Two presentations at regional meetings (MRRC, UMRCC).

Timeline for completion:

Tracking number		Products		Milestones
2006APE51		Draft database with metadata and summaries		30 September 2006

Literature Cited:

Fremling, C. R. and T. O. Claflin. 1984. Ecological history of the Upper Mississippi River. Pp. 5-24 *In*: Contaminants in the Upper Mississippi River, Proceedings of the 15th Annual Meeting of the Mississippi River Research Consortium. (J. G. Wiener, R. V. Anderson, and D. R. McConville, eds.). Butterworth Press, Boston, Massachusetts.

Knutson, M. G., and E. E. Klaas. 1997. Declines in abundance and species richness of birds following a major flood on the Upper Mississippi River. Auk 114: 367-380.

Knutson, M. G., and E. E. Klaas. 1998. Floodplain forest loss and changes in forest community composition and structure in the Upper Mississippi River: a wildlife habitat at risk. Natural Areas Journal 18:138-150.

Urich, R., G. Swanson, and E. Nelson (editors). 2002. Upper Mississippi and Illinois River floodplain forests: desired future and recommended actions. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Yin, Y., J. C. Nelson, and K. S. Lubinski. 1997. Bottomland hardwood forests along the Upper Mississippi River. Natural Areas Journal 17:164-173.

Yin, Y. 1999. Floodplain forests, p 9.1 to 9.9. *In* U.S. Geological Survey, Ecological status and trends of the Upper Mississippi River System 1998: A report of the Long Term Resource Monitoring Program. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. April 1999. LTRMP 99-T001.

APE#52: Status and trends of waterbirds on the Upper Mississippi River

Principle investigator/Project leader: Melissa Meier

Introduction/Background:
In 2005, the LTRMP began development of a "UMRS Status and Trends" report. The report focuses primarily on information collected through the LTRMP; however the USFWS also has interest in the status and trends of waterfowl, shorebirds, and wading birds all of which are not monitored by the LTRMP. We propose to supplement chapters in the status and trends report that document historic and current use of UMR habitat during migration and nesting.

Relevance of research to UMRS/LTRMP:
The wildlife and habitat goal of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge) states that habitat management will support diverse and abundant native fish, wildlife, and plants. To manage for diversity and measure the effectiveness of management actions, status and trend information is needed. A wealth of information has been collected by the USFWS on the wildlife and fish species of the UMRS. This information, when synthesized and combined with information collected by the LTRMP would provide a more holistic picture of the fish and wildlife status and trends of the UMRS.

Many waterbird monitoring projects by the Refuge have been undertaken or are on-going all along the UMRS. These efforts are typically a coordinated effort involving many partners. Much of the information however has not been combined and synthesized and reported on so that it is easily accessible to river managers and biologists who must develop future waterbird management plans and management actions.

Methods: The first step in developing a status and trends report on waterbirds is to draw together all the available information on what work that has been done by the Refuge. In coordination with the USFWS Bio-monitoring Team, we will compile long-term waterbird monitoring data collected by the Refuge into a database along with other information such as UTM, river mile, acreage of unit, hunted/non-hunted, vegetation/invert data, etc. We will also identify other survey datasets for the region and the protocol they use when sampling waterfowl.

In addition to collecting data on waterbirds, various state and federal agencies have collected macroinvertebrate data in Pools 2–14 on a rotating schedule for 10 plus years per using procedures similar to those of LTRMP. These data are collected in high waterfowl use areas and are used to help managers determine waterfowl food availability during the fall migration. Macroinvertebrate information also will be compiled into a database.

We will provide a report summarizing the potential of this combined waterbird dataset to produce information on the status and trends of waterbirds on the Refuge. Macroinvertebrate information in relationship to waterfowl feeding areas also will be discussed.

If feasible, we will propose the development of a status and trends report for FY07. The report would provide an assessment of waterbird status and trends where applicable, how they relate to the state of the ecosystem, and describe future pressures.

Budget: $47,288 Budget includes full cost accounting.

Expected products:
1. Database of Refuge waterbird and macroinvertebrate information
2. Summary report

Timeline for completion:

Tracking number	Products	Milestones
2006APE52a	Completion of database	31 July 2006
2006APE52b	Submit draft summary report	30 September 2006

Data Visualization Tools

The LTRMP Data Visualization Tools are online tools that search the LTRMP database and return the results in a graphical format. They provide quick visual access to data for each component in a user friendly format. The results can address many common questions about the resource without requiring additional data processing by the user.

Product Descriptions

Graphical Fish Database Browser – online September 2003
Graphical Vegetation Database Browser – online October 2005

- Annual 2005 sampling data will be added to the Oracle tables for the fish and vegetation graphical browsers.
- Enhancement features that incorporate additional graphics such as length frequency and total catch tables will be added to the graphical fish browser.

Water Quality Graphical Browser for Fixed Sampling Sites
All LTRMP water quality sampling data from fixed and stratified random sampling will be viewable using an on-line graphical browser.

Upper Mississippi River Land Cover Viewer – online March 2005
The viewer allows users to quickly create maps of the Upper Mississippi River Land Cover data.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2006Tools1	Maintenance of graphical fish browser. Update annual sampling tables.	Schlifer, (Under MSP: Sauer, Caucutt)	30 September 2006
2006Tools2	Enhancement of the graphical fish browser.	Schlifer, (Under MSP: Dukerschein, Ickes, Sauer, Caucutt)	30 September 2006
2006Tools3	Maintenance of graphical vegetation browser. Update annual sampling tables.	Schlifer, (Under MSP: Sauer, Caucutt)	30 September 2006
2006Tools4	Complete Water Quality Fixed Site Graphical Browser (Pools 8, 13, and Open River in review)	Schlifer, Kratt, Caucutt (Under MSP: Houser, Rogala)	30 March 2006
2006Tools5	Complete Water Quality Fixed Site Graphical Browser (Pools 4, 26 and La Grange)	Schlifer, Kratt, Caucutt (Under MSP: Houser, Rogala)	30 March 2006
2006Tools6	Maintenance of Land Cover Viewer ArcIMS server	Nelson	30 September 2006

Budget**:** $50,000

Team Leader: Mr. Mike Caucutt

Glide Path

2006Glide1: Development of Rapid Assessment Methods for Aquatic Vegetation

Aquatic vegetation has been monitored in Pool 26 for the LTRMP program for over 12 years. Unfortunately, budget cuts have forced a programmatic decision to end routine monitoring of aquatic vegetation Pool 26. Aquatic vegetation in Pool 26 has been sparse since the 1993 flood. Historic observations suggest that several years of low-water conditions may be needed to re-establish aquatic vegetation in this reach. The goal of this project is to develop an alternative sampling strategy that could be put into place adaptively when signs of recovery occur. Specifically, a sampling strategy needs to be developed that can respond to observations of aquatic vegetation in Pool 26 (i.e., from other components or other projects) and determine whether a recovery is taking place. If it appears that a recovery is occurring and vegetation stays established for 2–3 years, this information could be used to evaluate whether aquatic vegetation monitoring in some form should be reinstated in Pool 26. The primary method we wish to investigate is the use of depth finders to locate aquatic vegetation (Maceina and Shireman 1980) in combination with LTRMP rake sampling. We will also attempt to use modified adaptive sampling approaches that have been developed for other ecological and natural resource issues (Thompson 2003).

***Timeline*:** 15 June 2006 to 14 June 2007. Draft report by June 14, 2007.

***Personnel*:** Rob Cosgriff (Authorized 3 months on APE#29, 1 month FY06 Glide, 5 months FY07 Glide)

References

Maceina, M. J. and J. V. Shireman. 1980. The use of a recording fathometer for determination of distribution and biomass of hydrilla. Journal of Aquatic Plant Management 18 (Jul): 34–39.

Thompson S. K. 2003. Special issue on adaptive sampling. [Editorial Material] Environmental and Ecological Statistics. 10(1):5–6.

***Budget*:** FY06 Glide—$5,975

Status and Trends Report

Communication is a cornerstone of the LTRMP. We must communicate the accomplishments of the program to partners, customers, decision makers, politicians, and the general public in a way that is simple and effective and that makes the program relevant to their needs. Each LTRMP project communicates its results in some form, which yields a variety of products available through various outlets. The program needs a single product that summarizes and highlights its accomplishments in a format that is easy to ready and widely available.

Product Description

For this document, status and trends of the UMRS will be addressed with objective, technically sound, and applicable indicators for the condition of the river ecosystem. The report will be limited to indicators that can be directly assessed by LTRMP component data and hydrologic data. Indicators are selected components of the ecosystem that are ecologically important, valued by humans, and used to evaluate changes in the ecosystem. This Report is an indicator-based approach to describing the status and trends of the Upper Mississippi River System using the data collected by the LTRMP. A set of indicators was developed for use in this Report and a first draft of the report was prepared in FY05.

Products and Milestones

Tracking number[1]	Products		Milestones
2006S&T1a	Draft report available for technical review (30 day review period)		1 March 2006
2006S&T1b	Final draft report submitted for editorial review		1 May 2006
2006S&T1c	Report printed and distributed		TBD

Personnel

USGS has the lead responsibility for the development of the Status and Trends Report. However, this will be a collaborative effort among all LTRMP partners.

The primary points of contact for the development of the report will be Bob Gaugush (USGS - UMESC) and Marvin Hubbell (USACE – Rock Island District), who will be working closely to coordinate the development of the Report.

Budget: $200,000

Bathymetry

The overall goal of the LTRMP Bathymetry Component is to complete a system-wide GIS coverage of bathymetry used to quantitatively and qualitatively assess the suitability of essential aquatic habitats.

- Eight pools are complete (4, 7, 8, 9, 13, 21, 26, La Grange).
- Nine pools are at least 50% complete (5, 5A, 10, 11, 15, 17, 18, 20, Peoria).
- Middle Mississippi Reach is about 90% complete.

Corps Districts (MVS, MVR, MVP) will be responsible for all data gathering.
USGS-UMESC will house the data and serve as LTRMP coordinator for the Corps' data gathering efforts.

There are two modes of operating to fulfill LTRMP needs:

a. Survey gaps in pools identified as priorities by LTRMP (based on data needs for projects and existing pool coverages). This is preferred by LTRMP, but is logistically more difficult for USACE crews to do.
b. Survey gaps in association with areas that O&M surveys are needed. This is more efficient for USACE survey crews, but will produce fewer "completed" pools in the near term.

Products and Milestones

Tracking number	Products		Milestones
2006BATHa	LTRMP Bathymetry coordinator will send maps of LTRMP bathymetry data gaps to all 3 Corps district contacts, available as shape files		31 January 2006
2006BATHb	The districts will provide an estimate of their capability, i.e. the number of survey days to be completed with the funding, to POC (cc M. Hubbell)		14 February 2006
2006BATHc	Anticipated Schedule from each District POC to primary POC (cc M. Hubbell)		1 March 2006
2006BATHd	FINAL DATA CALL to primary POC		30 September 2006
2006BATHe	Brief (~1 page) summary report (where, what, how, when, $) (J. Rogala and 3 District POCs) to J. Sauer (cc M. Hubbell)		30 September 2006

Primary POC: Jim Rogala

Corps District POC:
MVS (St. Louis): Keith Short (Keith.L.Short@mvs02.usace.army.mil)
MVR (Rock Island): Mike Cox (Michael.D.Cox@mvr02.usace.army.mil) (Alois Devos thru Feb 06)
MVP (St. Paul): Mark Upward (Mark.S.Upward@mvp02.usace.army.mil)

***Budget*:** $170,000 (split 30%/40%/30% among USACOE Districts and/or adjusted for capability)

LTRMP field equipment refreshment

Investment in equipment refreshment over the past several years has been sporadic due to limited annual budgets. Equipment refreshment was identified by the partnership as a priority under the recently completed 5-year planning effort, with a minimum investment of $ 57,000 annually. In FY2004, an initial effort began to develop an equipment refreshment needs plan, prioritizing items as High, Medium, or Low need. That effort will be expanded to include both short and long-term field equipment needs for refreshment. This tool will provide the program a better vision to accommodate program needs related to safety, obsolete, and unserviceable equipment. A well-planned strategy offers significant program benefits such as reliability, availability and readiness.

Budget**:** $109,140

Appendix A: FY06 Budget Summary

		FEDERAL	NON-FEDERAL	COE	TOTAL
MSP	Aquatic Vegetation Sampling	$ 263,045	$ 206,080	$ -	$ 469,125
	Fisheries Sampling	$ 228,145	$ 839,720	$ -	$ 1,067,865
	Water Quality Sampling	$ 502,083	$ 767,200	$ -	$ 1,269,283
	Statistical Evaluation	$ 118,970	$ -	$ -	$ 118,970
	Bathymetric Component	$ 19,323	$ -	$ -	$ 19,323
	Land Cover/Use	$ 126,507	$ -	$ -	$ 126,507
	Data Management	$ 431,790	$ -	$ -	$ 431,790
	Science Management Support	$ 205,989	$ -	$ -	$ 205,989
		$ 1,895,852	**$ 1,813,000**	**$ -**	**$ 3,708,852**
Bathymetry		$ -	$ -	$ 170,000	$ 170,000
Glide Path		$ -	$ 5,975	$ -	$ 5,975
Status & Trend Report		$ 124,000	$ -	$ 76,000	$ 200,000
Visualization Tools		$ 50,000	$ -	$ -	$ 50,000
COE APE Management		$ -	$ -	$ 49,600	$ 49,600
UMESC APE Management		$ 49,600	$ -	$ -	$ 49,600
Equipment Refreshment		$ 35,719	$ 73,421	$ -	$ 109,140
APE's	#8 - Development of two-dimensional numerical hydraulic models for Mississippi River Pool 13 and Illinois River La Grange Pool in support of the LTRMP	$ -	$ -	$ 94,000	$ 94,000
	#11 - Testing for a relationship between LTRMP catch-per-unit-effort data and fish abundance (number/biomass per unit area) estimates from block nets	$ 700	$ 601	$ -	$ 1,301
	#13 - Variation in chlorophyll a and inorganic suspended solids in backwater lakes of the Upper Mississippi River	$ 30,925	$ -	$ -	$ 30,925
	#15 - Vegetation, primary production, and dissolved oxygen dynamics in backwater lakes	$ 89,504	$ 4,219	$ -	$ 93,723
	#17 - Investigate effects of newly completed HREPs in La Grange Pool on fish production using LTRMP and HREP data	$ 6,196	$ 36,404	$ -	$ 42,600
	#21 - Developing Indicators of Southern Bottomland Hardwood Forest Condition within the Upper Mississippi River Ecosystem	$ 6,295	$ 74,381	$ -	$ 80,676
	#27 - LTRMP water quality graphical browser for stratified random sampling sites	$ 41,183	$ -	$ -	$ 41,183
	#29 - Next generation forest on the UMR floodplain	$ 25,703	$ 53,519	$ 15,000	$ 94,222
	#30 - Aquatic Vegetation and Water Quality Response to a Second Year of Water Level Drawdown in Navigation Pool 5 of the UMR	$ 24,593	$ 8,249	$ -	$ 32,842
	#34 - Identifying potential controls on abundance and size structure of centrarchids and diversity of fishes in off-channel areas in the UMR: Aquatic vegetation and seasonal refuge	$ 48,471	$ -	$ -	$ 48,471
	#42 - Importance of the UMR Forest Corridor to Neotropical Migratory Birds	$ 155,284	$ -	$ -	$ 155,284
	#43 - Assessment of the Rake Method for the Estimation of Submersed Aquatic Vegetation Levels	$ 38,242	$ -	$ -	$ 38,242
	#49 - Identification of Hydraulic Characteristics of Habitats Selected by Riverine Fishes (UMESC)	$ 115,107	$ -	$ -	$ 115,107
	#49 - Identification of Hydraulic Characteristics of Habitats Selected by Riverine Fishes (WRD)	$ 35,000	$ -	$ -	$ 35,000
	#51 - Development of a floodplain forest restoration database for the UMRS: a tool for future coordinated forest management planning	$ 116,071	$ -	$ -	$ 116,071
	#52 - Status and trends of waterbirds on the Upper Mississippi River	$ 47,288	$ -	$ -	$ 47,288
		$ 780,562	**$ 177,373**	**$ 109,000**	**$ 1,066,935**
TOTAL EMP LTRMP		**$ 2,935,733**	**$ 2,069,769**	**$ 404,600**	**$ 5,410,102**

Appendix B: Minimum Sustainable Program Condensed Budget. Includes full cost accounting. (In thousands)

AQUATIC VEGETATION SAMPLING

Salaries	FTE	Total
UMESC	1.25	$ 182.7
States	2.67	$ 188.0
Sub-total salaries	**3.92**	**$ 370.7**
Travel/Ops		
UMESC		$ 80.4
States		$ 18.0
Sub-total travel		**$ 98.4**
COMPONENT TOTAL		**$ 469.1**

FISHERIES SAMPLING

Salaries	FTE	Total
UMESC	1.60	$ 205.9
States	11.79	$ 769.6
Sub-total salary	**13.39**	**$ 975.5**
Travel/Ops		
UMESC		$ 22.3
States		$ 70.1
Sub-total travel		**$ 92.4**
COMPONENT TOTAL		**$ 1,067.9**

WATER QUALITY SAMPLING

Salaries	FTE	Total
UMESC	3.70	$ 424.7
States	11.13	$ 685.8
Sub-total salaries	**14.83**	**$ 1,110.5**
Travel/Ops		
UMESC		$ 77.4
States		$ 81.4
Sub-total travel		**$ 158.8**
COMPONENT TOTAL		**$ 1,269.3**

STATISTICAL EVALUATION

Salaries	FTE	Total
UMESC	0.61	$ 104.1
Travel/Ops		$ 14.9
Component Total		**$ 119.0**

BATHYMETRIC COMPONENT

Salaries	FTE	Total
UMESC	0.15	$ 19.4
Component Total		**$ 19.4**

LAND COVER/USE

Salaries	FTE	Total
UMESC	1.00	$ 122.1
Travel/Ops		$ 4.5
Component Total		**$ 126.6**

DATA MANAGEMENT

Salaries	FTE	Total
UMESC	2.50	$ 298.5
Travel/Ops		$ 133.4
Component Total		**$ 431.8**

SCIENCE MANAGEMENT SUPPORT

Salaries	FTE	Total
UMESC	1.18	$ 191.2
Travel/Ops		$ 14.9
Component total		**$ 206.1**

Appendix C: Additional Program Elements Condensed Budget. Includes full cost accounting. (Thousands)

#8 - Development of two-dimensional numerical hydraulic models

Salaries	Total
USACOE	$ 94.0
Component total	**$ 94.0**

#11 - Testing for a relationship between LTRMP catch-per-unit-effort data and fish abundance

Salaries	Total
UMESC	$ -
States	$ -
Sub-total salary	**$ -**
Travel/Ops	
UMESC	$ 0.7
States	$ 0.6
Sub-total travel	**$ 1.3**
COMPONENT TOTAL	**$ 1.3**

#13 - Variation in chlorophyll a and inorganic suspended solids in backwater lakes

Salaries	Total
UMESC	$ 28.8
Travel/Ops	
UMESC	$ 2.1
Sub-total travel	**$ 2.1**
COMPONENT TOTAL	**$ 30.9**

#15 - Vegetation, primary production, and dissolved oxygen dynamics in backwater lakes

Salaries	Total
UMESC	$ 61.7
Travel/Ops	
UMESC	$ 32.0
COMPONENT TOTAL	**$ 93.7**

#17 - Investigate effects of newly completed HREPs in La Grange Pool

Salaries	**Total**
UMESC	$ 5.9
States	$ 31.6
Sub-total salary	**$ 37.5**
Travel/Ops	
UMESC	$ 0.4
States	$ 4.7
Sub-total travel	**$ 5.1**
COMPONENT TOTAL	**$ 42.6**

#21 - Developing Indicators of Southern Bottomland Hardwood Forest Condition

Salaries	**Total**
UMESC	$ 6.0
States	$ 59.2
Sub-total salary	**$ 65.2**
Travel/Ops	
UMESC	$ 0.3
States	$ 15.2
Sub-total travel	**$ 15.5**
COMPONENT TOTAL	**$ 80.7**

#27 - LTRMP water quality graphical browser for stratified random sampling sites

Salaries	**Total**
UMESC	$ 41.2
COMPONENT TOTAL	**$ 41.2**

#29 - Next generation forest on the UMR floodplain

Salaries	**Total**
UMESC	$ 9.4
States	$ 50.1
USACOE	$ 15.0
Sub-total salary	**$ 74.5**
Travel/Ops	
UMESC	$ 16.4
States	$ 3.3
Sub-total travel	**$ 19.7**
COMPONENT TOTAL	**$ 94.2**

#30 - Aquatic Vegetation and Water Quality Response to a Second Year of Water Level Drawdown

Salaries	Total
UMESC	$ 13.8
States	$ 6.7
Sub-total salary	**$ 20.5**
Travel/Ops	
UMESC	$ 10.8
States	$ 1.5
Sub-total travel	**$ 12.3**
COMPONENT TOTAL	**$ 32.8**

#34 - Identifying potential controls on abundance and size structure of centrarchids and diversity of fishes in off-channel areas

Salaries	Total
UMESC	$ 43.3
Travel/Ops	
UMESC	$ 5.2
COMPONENT TOTAL	**$ 48.5**

#42 - Importance of the UMR Forest Corridor to Neotropical Migratory Birds

Salaries	Total
UMESC	$ 87.4
Travel/Ops	
UMESC	$ 67.9
COMPONENT TOTAL	**$ 155.3**

#43 - Assessment of the Rake Method for the Estimation of Submersed Aquatic Vegetation Levels

Salaries	Total
UMESC	$ 16.2
Travel/Ops	
UMESC	$ 22.0
COMPONENT TOTAL	**$ 38.2**

#49 - Identification of Hydraulic Characteristics of Habitats Selected by Riverine Fishes

Salaries	Total
UMESC	$ 95.7
USGS WRD Middleton	$ 29.2
Sub-total salary	**$ 124.9**
Travel/Ops	
UMESC	$ 19.4
USGS WRD Middleton	$ 5.8
Sub-total travel	**$ 25.2**
COMPONENT TOTAL	**$ 150.1**

#51 - Development of a floodplain forest restoration database for the UMRS

Salaries	Total
UMESC	$ 108.6
Travel/Ops	
UMESC	$ 7.4
COMPONENT TOTAL	**$ 116.0**

#52 - Status and trends of waterbirds on the Upper Mississippi River

Salaries	Total
UMESC	**$ 42.8**
Travel/Ops	
UMESC	$ 4.5
COMPONENT TOTAL	**$ 47.3**

APE Science Management

Salaries	Total
USACOE	$ 49.6
UMESC	$ 49.6
COMPONENT TOTAL	**$ 99.2**

Equipment Refreshment

	Total
UMESC	$ 35.7
States	$ 73.4
COMPONENT TOTAL	**$ 109.1**

Visualization Tools

Salaries	Total
UMESC	$ 50.0
COMPONENT TOTAL	**$ 50.0**

Bathymetry

	Total
USACOE	$ 170.0
COMPONENT TOTAL	**$ 170.0**

Status and Trends Report

Salaries	Total
UMESC	$ 119.8
USACOE	$ 76.0
Sub-total salary	**195.8**
Travel/Ops	
UMESC	$ 4.2
COMPONENT TOTAL	**$ 200.0**

Glide Path

Salaries	Total
States	$ 5.9
COMPONENT TOTAL	**$ 5.9**