Long Term Resource Monitoring Program
Scope of Work–FY2007

Minimum Sustainable Program

Additional Program Elements

Long Term Resource Monitoring Program
Minimum Sustainable Program
Scope of Work–FY2007

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 River). Data entry, quality assurance, data summaries, standard analyses, data serving, and report preparation occur under standardized protocols.

Methods

Aquatic vegetation sampling will be conducted following the LTRMP aquatic vegetation standard sampling protocol (Yin et al. 2000). One thousand three hundred and fifty sites will be surveyed in FY07, 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

2007A4: Developing submersed aquatic plant bioindicators and biocriteria for the Upper Mississippi River.

> We will test and develop various aquatic vegetation indexes using LTRMP side channel and main channel aquatic vegetation SRS data and 2006 EMAP data. Plant indices to calculate will be chosen from North American, Australian, and European peer-reviewed literature and also from more local possibilities under development.

2007A5: Monitoring floodplain forest regeneration (Glide Path)

> Each of the six LTRMP field stations has been monitoring forest seeds and seedlings at two sites since 1997. The project has never been formalized because a) a very limited amount of resources was allocated to forest monitoring and b) forest seed production and seedling recruitment are so highly variable that short term monitoring data are rarely meaningful. This report will summarize findings in the forest monitoring at Pools 4, 8, 13, and 26, La Grange Pool, and the Open River between 1997 and 2001, including recommendations for future actions. (Rework of manuscript 2005A6 that was pulled from Journal.)

2007A6: 2006 UMR floodplain forest resurvey summary

> This is a continuation and wrapping up of the forest resurvey conducted in 2006 (2006APE29) on three reaches of the UMR floodplain. We will summarize the results to reveal the changes that occurred since the flood of 1993.

2007A7: Creating surface distribution maps for aquatic plant species in Pools 4, 8, and 13

LTRMP vegetation data collected with the stratified random sampling protocol (Yin et al. 2000) since 1998 document the occurrence/absence and abundance of aquatic plant species at investigated sites. We intend to explore the feasibility of creating maps by interpolating the scattered points into surfaces of distribution in which the imbalance in sampling site density among strata and cross years are rectified. The maps, if proven reasonable accurate, will be added into to the Graphical Vegetation Database Browser: (www.umesc.usgs.gov/data_library/vegetation/graphical/veg_front.html)

2007A9: LTRMP Aquatic Vegetation Program Review

In 2006, a review began of the vegetation program metrics and methods in light of the goals and objectives for vegetation monitoring. This report will compile and briefly summarize the findings of two reviews that occurred in 2006.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2007A1	Complete data entry and QA/QC of 2006 data; 1250 observations.		
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Bierman	15 October 2006
	b. Data loaded on level 2 browsers	Hansen	30 October 2006
	c. QA/QC scripts run and data corrections sent to Field Stations	Sauer	15 November 2006
	d. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Bierman	30 November 2006
	e. Corrections made and data moved to public Web Browser	Sauer, Hansen, Caucutt	30 December 2006
2007A2	WEB-based annual Aquatic Vegetation Component Update with 2006 data on Public Web Server.		
	a. Develop first draft	Sauer	15 February 2007
	b. Reviews completed	Popp, Dukerschein, Bierman, Sauer, Yin	28 February 2007
	c. Submit final update	Sauer	31 March 2007
	d. Placement on Web with PDF	Sauer, Caucutt	30 July 2007
2007A3	Complete aquatic vegetation sampling for Pools 4, 8, and 13 (Table 1)	Popp, Dukerschein, Bierman	31 August 2007
2007A4	Draft completion report: Developing submersed aquatic plant bioindicators and biocriteria for the Upper Mississippi River	Dukerschein, Langrehr, Popp, Moore	30 May 2007
2007A5	Draft LTRMP report: Monitoring floodplain forest regeneration (Glide Path)	Chick, Cosgriff	30 September 2007
2007A6	Draft manuscript: 2006 UMR floodplain forest resurvey summary	Yin, Cosgriff, Henderson, Lundh	31 July 2007
2007A7	Web-based: Creating surface distribution maps for aquatic plant species in Pools 4, 8, and 13	Yin (Also see Data Visualization Tools)	31 July 2007
2007A8	Draft LTRMP Report: Development of Rapid Assessment Methods for Aquatic Vegetation (2006Glide1)	Chick, Cosgriff	14 June 2007
2007A9	Draft OFR: LTRMP Aquatic Vegetation Program Review	Heglund	30 August 2007
			Estimated distribution date
LTRMP report: Establish baseline of SAV distribution and index of abundance (2005GLIDE4; Cook)			30 March 2007
Completion report: nonresponse, frame and measurement errors (2006A5; Gray)			30 June 2007
Completion report on enhancement of analysis on backwater effects on chlorophyll *a* (2006A6; Gray)			30 June 2007
Evaluation of Aquatic Macrophyte Community Response to Island Construction in the UMR (Langrehr 2005A5, 2006A4)			Submitted to Lake and Reservoir Management on 2-15-2006 Accepted for publication on 11-18-2006

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

Literature Cited

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

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

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

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

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

Personnel

Dr. Yao Yin will be the principal investigator.

Fisheries Component

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

Methods

Fish sampling will be conducted following the LTRMP study plan and standard protocols (Gutreuter et al. 1995), as modified in 2002 (Ickes and Burkhardt 2002). Species abundance, size structure, and community composition and structure will be measured over time. Between 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.

Product Descriptions

2007B4: Proportional biomass contributions of nonnative fish to UMRS fish communities

> This analysis will use greater than 4 million fish observations collected since 1993 by the Long Term Resource Monitoring Program. Objectives include 1) recast abundance data into relative biomass units using allometric growth equations empirically derived from LTRMP and literature data sources; 2) investigate spatial patterns in the proportional biomass contribution of nonnative species to the overall UMRS fish community; and 3) explore environmental covariates that may be associated with such spatial patterns.

2007B5: Trends in abundance of fish species linked to vegetation

> Examine trends in abundance of fish species since 1998 (when vegetation SRS began) in Pools 4, 8, and 13 which are linked to vegetation for at least part of their life cycle and correlate with SAV trends in these pools. This analysis would help determine whether LTRMP monitoring can detect trends in abundance of some of the uncommon fish species that we might expect to become more or less abundant with increases (lower Pool 4 & Pool 8) or decreases (upper Pool 4) in vegetation.

2007B6: Fish species distribution and frequency of occurrence in the Upper Mississippi River

> The UMRS is rich with fish species when compared to other temperate-freshwater systems of the world. More than 160 fish species have been collected and identified from the mainstem of the UMRS since the late 19th century, and 136 of these species were captured by the LTRMP in collections gathered from 1993–2002. I will use LTRMP data to assess the frequency of occurrence and distributions of species within the UMRS. The objective of this study is to provide a current inventory of fish species in the UMRS and to investigate spatial patterns in the distribution and "commonness" of species in a large temperate river. The goal of this research is to educate fisheries managers and the

general public about the ecological significance of the UMRS fish community, and to provide a means for assessing change in the fish community far into the future.

2007B7: Evaluation of a Catch and Release Regulation for Largemouth Bass in Brown's Lake, Pool 13, Upper Mississippi River

Brown's Lake is a 450-acre backwater of Pool 13, Upper Mississippi River located 10 miles south of Bellevue, Iowa. Due to declines in the fishery observed from 1991–1997, a harvest regulation mandating the catch-and-release of all largemouth bass (*Micropterus salmoides*) was initiated in Brown's Lake on January 1, 1998. The effect of this regulation will be evaluated over a 13-year pre- and post-regulation period using focused research data collected by the Iowa Department of Natural Resources and data collected by the LTRMP. This analysis will focus on the use of LTRMP pool-wide data as a control to allow for assessment of backwater-specific population response (i.e., response to the regulation) in Brown's Lake as detected by Iowa DNR research data.

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2007B1	Complete data entry, QA/QC of 2006 fish data; ~1,590 observations		
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	31 January 2007
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	Hansen	10 February 2007
	c. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	1 March 2007
	d. Corrections made and data moved to public Web Browser	Sauer and Hansen	15 March 2007
2007B2	WEB-based annual Fisheries Component Update with 2006 data on Public Web Server.		
	a. Develop first draft	Sauer, Popp, Dukerschein, Bierman, Chick, O'Hara, Hrabik	30 April 2007
	b. Reviews completed	Sauer, Popp, Dukerschein, Bierman, Chick, O'Hara, Hrabik, Ickes	15 May 2007
	c. Submit final update	Sauer, Popp, Dukerschein, Bierman, Chick, O'Hara, Hrabik	31 May 2007
	d. Placement on Web with PDF	Sauer, Caucutt	31 August 2007
2007B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River, and La Grange Pool (Table 1)	Popp, Dukerschein, Bierman, Chick, O'Hara, Hrabik	31 October 2007
2007B4	Draft manuscript: Proportional biomass contributions of Non-native fish to UMRS fish communities	Ickes	30 September 2007
2007B5	Draft LTRMP report: Trends in abundance of fish species linked to vegetation	Popp, Delain	30 September 2007
2007B7	Draft manuscript: Evaluation of a Catch and Release Regulation for Largemouth Bass in Brown's Lake, Pool 13, Upper Mississippi River	Bierman, Bowler	30 June 2007

2007B8	Draft manuscript: Proportional Size Density and Frequency of Occurrence of Flathead Catfish (*Pylodictis olivaris*), Channel Catfish (*Ictalurus punctatus*), and Blue Catfish (*I. furcatus*) in an impounded and unimpounded reach of the Upper Mississippi River. (Expanded work on 2006B12)	Hrabik, Barko	30 August 2007
2007B9	Final draft report: LTRMP Fisheries Component collection of six darter species from 1989–2004. (2006B13)	Hrabik, Ridings	15 April 2007
2007B10	Final draft OFR: Asian carp in the Mississippi River: their impact on native fish species and predicted dispersal within the system. (2005APE13)	Hrabik, Barko	30 March 2007
2006B5	Draft manuscript: Standardized CPUE data from multiple gears for community level analysis.	Chick	30 August 2007
2006B6	Draft manuscript: Spatial structure and temporal variation of fish communities in the Upper Mississippi River.	Chick	1 September 2007
2006B9	Draft completion report: Exploratory Analysis of Index of Biotic Integrity Scores Calculated from Datasets Obtained from Three Different Day Electrofishing Protocols	Dukerschein, Bartels	30 November 2006
2006B10	Draft MDNR report: Multi-year fish report on Pool 4	Popp, Delain	22 December 2006
2006APE17b	Final draft LTRMP report: Investigate effects of newly completed HREPs (Lake Chautauqua NWR, Banner Marsh State Fish and Wildlife Area) in La Grange Pool	Sass	30 May 2007
2005APE15	Draft manuscript: Occurrence and Predicted Dispersal of Asian Carp (*Hypophthalmichthys* spp.) in the Mississippi River System: Development of a Heuristic Tool.	Hrabik, Barko	15 January 2007

	Estimated distribution date
Completion report: Habitat-related factors that are potentially limiting backwater fish communities (2006B8; Bartels)	30 June 2007
Completion report: Exploratory Analysis of Index of Biotic Integrity Scores Calculated from Datasets Obtained from Three Different Day Electrofishing Protocols (2006B9; Bartels)	30 June 2007
Completion Report: Nonnative fishes in the Upper Mississippi River System: A Synthesis of Information from the Long Term Resource Monitoring Program (2005B8; Irons)	30 March 2007
LTRMP Report: Fish life history database report (2005B5; O'Hara)	30 September 2007
Completion report: LTRMP Fisheries Component collection of six darter species from 1989–2004. (2006B13; Ridings)	30 September 2007
LTRMP report: Analysis of fish age structure and growth in the Illinois River (2005APE11; Sass)	30 September 2007
OFR: Asian carp in the Mississippi River: their impact on native fish species and predicted dispersal within the system. (2005APE13; Barko)	30 September 2007

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

Literature Cited

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

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

Personnel

Mr. Brian Ickes will be the principal investigator.

Water Quality Component

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

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

Methods

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

Fixed site sampling

Fixed site sampling will be conducted as in FY2006 (Table 1).

Stratified random sampling

Stratified random sampling will be conducted at full effort levels (same as FY2006) 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 FY2007.

Product Descriptions

2007D6: Sampling of light regime in support of aquatic vegetation modeling

> This report summarizes the 2003 light penetration study (see SOW FY2003), with emphasis on how the various types of light-related measurements correlate with standard LTRMP methods. This works enhances the preliminary light analysis done in 2005 (2005D6).

2007D7: Pool 5 water quality, pre- and post-drawdown

> This will be a summary on water quality monitoring efforts from the drawdown in Pool 5. (Summary from 2005APE6 and 2006APE30)

2007D8: Primary production, and dissolved oxygen dynamics in UMRS backwater lakes.

> The proposed analysis will increase our understanding of the factors affecting the dynamics of dissolved oxygen concentration and rates of primary production in backwater lakes. (Results from 2006APE15)

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2007D1	Complete calendar year 2006 fixed-site water quality sampling	Houser, Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	31 December 2006
2007D2	Complete laboratory analysis of 2006 fixed site and SRS data; Data loaded to Oracle data base.	Yuan	30 March 2007
2007D3	Complete data entry, QA/QC of calendar year 2006 fixed-site and SRS data.	Rogala. Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	30 May 2007
2007D4	Complete fixed site and SRS sampling for Pools 4, 8, 13, 26, Open River, and La Grange Pool (Table 1)	Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	30 September 2007
2007D5	WEB-based annual Water Quality Component Update with 2006 data on Public Web Server.	Rogala	30 June 2007
2007D6	Draft LTRMP report: Sampling of light regime in support of aquatic vegetation modeling	Dukerschein, Giblin, Hoff	30 June 2007
2007D7	Written summary of progress: Pool 5 water quality, pre- and post-drawdown	Popp, Burdis	30 September 2007
2007D8	Draft report or manuscript (depending on the strength of the findings): Primary production, and dissolved oxygen dynamics in UMRS backwater lakes.	Houser	15 September 2007
2006D5	Draft manuscript describing results of analyses of spatial and temporal patterns in UMRS WQ	Houser	30 June 2007
2006D6	Draft contract report: Evaluation of new Hydrolab Turbidity Probe	Dukerschein, Hoff	30 November 2006
2006D7	Draft completion report: Lake Pepin zooplankton and water quality data	Popp, Burdis	31 July 2007
2005D7	Draft LTRMP report: Main channel/side channel report for the Open River Reach.	Hrabik	30 September 2007
2005APE26	Final draft LTRMP report: retrospective, cross-component analysis for Pool 26	Chick, Johnson	15 July 2007

	Estimated distribution date
Completion report: Evaluation of new Hydrolab Turbidity Probe (2006D6; Hoff)	30 June 2007
LTRMP report: A decade of monitoring on Pool 26 of the Upper Mississippi River: Water quality and fish data with cross component analyses (2005APE27; Chick)	30 September 2007
Completion report: Effectiveness of wetland creation (2006D8; Bierman)	30 September 2007
Completion report: Examining nitrogen and phosphorus ratios N:P in the unimpounded portion of the Upper Mississippi River (2006D9; Crites)	30 September 2007

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

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 LTRMP additional program element projects requiring a minor amount of the statistician's time, but projects needing more assistance would build statistical support into that specific scope of work.

Guidance for management includes assistance with modifications to program design, with standardizing general operating procedures, and with estimating power to detect changes and trends. For example, LTRMP's focus on long term 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, COE, etc.) is conducting the analyses. The statistician is also responsible for reviewing all LTRMP documents containing statistical components for accuracy and to ensure that quality of analyses is consistent among products. A primary goal of statistical analyses is to avoid drawing inappropriate conclusions leading to ineffective or even harmful management actions. Within the UMR, there are a variety of confounding factors and conditions that could produce spurious correlations or lead to inappropriate conclusions regarding cause and effect. Appropriate statistical analysis and interpretation is critical to understanding the limitations of LTRMP data. This, in turn, is critical in efforts to distinguish between natural variation and human effects and in evaluating the long-term effects of management actions, such as HREPs, water level manipulations, or increases in navigation.

Product Descriptions

2007E1: Describe how best to analyze the vegetation component's rake data.

> The vegetation component's rake data yield index statistics suited to the needs of a monitoring program (e.g., vegetation biomass levels at large spatial scales are "low", "intermediate", or "high", or appear to be decreasing or increasing). Whereas this resolution is likely satisfactory for monitoring purposes, it is arguably not ideal for the other major arm of the LTRMP—that of scientific inference. This is particularly true at smaller spatial scales (site, backwater lake and stratum scales). Obvious approaches for analyzing rake data at these smaller scales include treating the multi-category data as clustered by site, or adjusting estimates at the site scale for detection errors. Unfortunately, recent analyses suggest both approaches are required: biomass varies substantially within sites and (as a consequence) so does the probability of detection. As the sampling design does not support the use of both approaches simultaneously, the best use of the data will represent a compromise between ignoring within-site variation in biomass and ignoring biases associated with imperfect detection. This product will help

cross-component and HREP investigators by providing firmer footing for estimating vegetation associations with fish and water outcomes and with HREP effects.

2007E2: Describe how best to assess status and trends at large spatial scales from vegetation component rake data.

As described under 2007E1, the vegetation component yields data that may yield indices of status and trends at large spatial scales. However, status and trends at these scales may be estimated in multiple ways—some of which may be superior to others. Possibilities include indices derived from the sum or average rake score, and summary statistics from models designed specifically for use with categorical data. This product will assist monitoring agencies, and will fall under LTRMP Goal 2.

Products and Milestones

Tracking number[1]	Products	Lead	Milestones
2007E1	Draft completion report describing methods for estimating vegetation levels at small scales using rake data	Gray, McDonald, Harrod, Yin	31 August 2007
2007E2	Draft completion report describing methods for estimating status and trends at large spatial scales from vegetation rake data	Gray, McDonald, Yin	15 September 2007
Estimated distribution date			
Completion report: Methods for evaluating power-to-detect trends in prevalence data (2006E2; Gray)		30 June 2007	
Manuscript: Estimating power to detect trends in grouped count data (2005E3; Gray)		Submitted to Ecology on 12-20-2005 Accepted for publication on 1-17-07	

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

Methods

Data management tasks include, but are not limited to:

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

Products and Milestones

Tracking number[1]	Products	Staff	Milestones
2007M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.	Hansen	30 May 2007
2007M2	Load 2006 component sampling data into Oracle tables and make data available on Level 2 browsers for field stations to QA/QC.	Hansen	30 June 2007

[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 the Long Term Resource Monitoring Program (LTRMP) will not collect data under the minimal sustainable program, the Program will maintain program expertise, manage existing data, and provide limited on-demand Geographic Information System (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, Habitat Rehabilitation and Enhancement Projects (HREPs), land acquisition areas)
- Georeferenced archival map/plat mosaics (Brown Survey, Mississippi River Commission data, Government Land Office data)
- Produce graphics and summary tables for partnership publications, posters, and presentations
- Conversion of ASCII coordinate data from a GPS to a spatial dataset
- Conversion of all georeferenced data to a common projection and datum for ease of use in a GIS
- Maintain, update, and oversee the aerial photo library of over 50,000 print and digital images.
- Maintain, update, and enhance over 20 million acres of land cover/land use and aquatic areas data spanning the late-1800s through the year 2000. This includes improving existing or developing new crosswalks for comparison of existing datasets, cropping datasets to common extents, and ensuring that all datasets are in a common coordinate system.
- Assist in the maintenance and updating of the USGS-Upper Midwest Environmental Sciences Center's (UMESC) web-based 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 initiated and progress made on:

1. Updating the Aquatic Areas (AA) dataset for the trend pools and Open River North using the 2000 systemic LCU data. These LCU data should be a much better base for the AA since they are hydrologically-based and plant dominance-based. A Deep Marsh polygon from the 2000 LCU will always have standing water (except for drawdowns and extreme droughts) whereas the same cannot be said for the 1989 LCU since neither dominance or hydrology were considered, only genus. The trend pools will allow us to work out an accepted protocol, with input from the Corps of Engineers, and the remaining pools can be planned for FY08.

2. Finalizing the crosswalk for the 1975 systemic LCU dataset using the 31-Class classification and begin replacing the non-crosswalked version currently being served. A crosswalk to the 1989 and 2000 LCU datasets has been developed but the 1975 classification system needed further refining due to some code similarities among land cover classes. Once the crosswalk is complete and reviewed, we propose to crosswalk and replace the trend pools coverages currently being served with the updated versions.

All codes will be preserved so the user can select the most meaningful description for their analysis.

3. Reformat and serve the lower Pool 4 and Pool 5 Light Detection and Ranging (LIDAR) data. These data are currently being served, without restriction, by the Corps of Engineers (http://www.mvp.usace.army.mil/gis/default3.asp?theme_id=18) but is not in "user-friendly" formats. We propose to develop and serve this data in various georeferenced GIS formats such as triangulated irregular networks (TINs), digital elevation models (DEMs), hillshade TIFFs, 2-foot contour shapefiles, and other useful products that can help resource managers assess LIDAR's usefulness to their management efforts.

4. Develop detailed spreadsheet of all LTRMP aerial photography currently housed at UMESC, including date, pool location, format (color infrared, natural color, black-and-white), scan status (yes/no, dots per inch), interpreted status, photo scale, and extent of coverage (partial or complete). This document will be updated as necessary and served via the internet.

Products and Milestones

Tracking number[1]	Products	Lead	Milestones
2007V1	Provide quarterly updates to LTRMP management	Robinson	Quarterly

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

Personnel

Mr. Larry Robinson 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, and La Grange Pool) are complete and nine pools (Pools 5, 5A, 10, 11, 15, 17, 18, 20, and Peoria Pool) 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

Products and Milestones

Tracking number[1]	Products	Lead	Milestones
2007T1	Provide quarterly updates to LTRMP management	Rogala	Quarterly

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

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

2005C2: Open River Macroinvertebrates

Although the target organisms selected historically for monitoring under the LTRMP 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
2005C2	Draft LTRMP Report: Open River macroinvertebrates	Hrabik	30 September 2007

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

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
2007S1	2005 LTRMP Web-based summary report on-line	Johnson, Houser, Ickes, Yin,	31 August 2007

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

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Report Definitions

Draft: A draft that has been reviewed by the LTRMP Science Leader or his designee 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.

Table 1. LTRMP sample collection for FY07.

	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 2007.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 13 fixed sites during 2007.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 12 fixed sites during 2007.	121 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites during 2007.	135 stratified random sites done in each episode (winter, spring, summer, and fall); 11 fixed sites during 2007.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites during 2007.

Glide Path Timeline

In 2005, a 5-year plan was developed for the LTRMP assuming a static budget of about $5 million per year over the period. Within this plan, the data collection portion of the Program was reduced to a level that could be accomplished annually over the 5-year period given the budget constraint. This effort, called the "minimum sustainable program," required about $3.7 million in 2005, which will inflate (based on a projected 4.1% annual inflation rate) to about $4.3 million in 5 years. As part of this restructuring, LTRMP staffing levels would be reduced. To ease the transition to lower staffing levels, glide path products were introduced that would allow staff to remain on salary for a limited time while looking for other job opportunities. Initially, glide path dollars were allocated only for FY05. However, because Robert Cosgriff was deployed by the National Guard, the LTRMP Partnership agreed to extend glide path dollars for Mr. Cosgriff until FY07. Details on glide path products can be found in the LTRMP Scopes of Work.

Glide Path 2005

1. ***Field Station Glide Path: 54.5K***

    - Establish baseline of submersed aquatic vegetation distribution and index of abundance for the Illinois River. Lead: Pegg (Thad Cook; 35.1K (gross))

    - Transition of field logistics to USGS. Lead: Dukerschein (Jim Fischer, Heidi Langrehr, Andy Bartels; 19.4K (gross))

2. ***Upper Midwest Environmental Sciences Center Glide Path: 41.7***
    - Pete Boma 16.6K (gross)—See MSP Aquatic Vegetation Component
    - Robert Gaugush—See APE Status and Trends (32.3 K gross moved to S&T budget)
    - Jim Rogala 25.1K (gross): See MSP Statistical Evaluation and APE Model chlorophyll *a*

Total 2005 Glide Path dollars: 96.2K

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Glide Path 2006

- Development of Rapid Assessment Methods for Aquatic Vegetation. Lead: Chick (Rob Cosgriff (Authorized 3 months on APE#29, 1 month FY06 Glide). Continues in FY07.

Total 2006 Glide Path dollars: 5.9K

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Glide Path 2007

- Development of Rapid Assessment Methods for Aquatic Vegetation (see FY05 SOW). Lead: Chick (Rob Cosgriff—5 months FY07 Glide)
- Also see 2007A5 above

Total 2007 Glide Path dollars: $22.7K

END OF GLIDE PATH DOLLARS

2007APE1: Importance of the Upper Mississippi River Forest Corridor to Neotropical Migratory Birds

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 largely 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 habitats that may be important for songbirds during migration. Negative modifications may interfere with migration by eliminating or reducing the quality of habitat birds need for rest and refueling resulting in decreased survival and productivity. Modifications to aid navigation on the Upper Mississippi River System 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 on forest restoration and management 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 habitat requirements of birds during migration and timing of migration to use in the development of habitat restoration projects, habitat management strategies, siting of communication towers and wind power generation projects, and other types of developments. The U.S. Fish and Wildlife Service and the Corps of Engineers would benefit greatly from a system-wide evaluation of habitat use by spring songbird migrants over habitats along the Mississippi River System 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 (other than waterfowl) use the corridor. In addition, there is no information regarding the existence, location and habitat type of specific stopover sites, and if migrating birds use the riverine habitats preferentially over upland habitats. 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, if certain desirable habitat conditions can be managed for, and what bird species are most likely to benefit from forest management and restoration. 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 potentially 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?

Because the landscapes surrounding the UMR vary greatly from St. Louis, MO to Minneapolis, MN, the relative importance of riverine habitats may differ along the river. For example the relative importance of the river in the Driftless region (sampled by Pools 6-9) versus the Prairie Peninsula region (sampled by Pools 16-18). Migrating songbirds may more heavily use the floodplain in the Prairie Peninsula region as compared to the Driftless Area, where forested habitats and surface water away from the floodplain is more abundant. Furthermore, energetic needs of migrant birds may be affected by distance traveled and we may detect patterns in habitat occupancy and body condition along the length of the river as the season progresses.

Methods

This proposal can be funded at 5 different levels. Methods for the full study (ground surveys, bird banding, GIS and radar data layering:1st budget option) follow in the next few paragraphs and will allow us to address all the research questions presented above to represent the entire Impounded Reach of the UMR (Pools 6-9, Pools 16-18 and Pools 24-26). Lower levels of funding will necessitate a lower level of effort. The 2nd budget option includes ground surveys along the UMRS, but increases the study area to include Pools 24-26. The 3rd budget option includes ground surveys along around Pools 6-9 and Pools 16-18, but adds a banding effort in Pools 16-18 (banding in Pools 6-9 is supported by UMESC with other funds). The 4th level of funding supports ground based surveys in Pools 6-9 and Pools 16-18 (This was the funding level for 2006). The 5th budget option includes radar and GIS data but includes the ground survey effort for only a small area of the UMRS, Pools 6-9, where preliminary work started in 2005. Options 2-5 also have a GIS and radar data component.

Archived weather surveillance radar (WSR-88D, or NEXRAD) data will be acquired from 10 locations from 1995-2005 (Minneapolis, MN, La Crosse, WI, Davenport, IA, St. Louis, MO, Des Moines, IA, Lincoln, IL [Central Illinois], Milwaukee, WI, Duluth, MN, Paducah, KY, and Little Rock AR). Data from radar sites distant from the UMR will be used to detect any possible larger scale patterns in bird migration that could indicate the relative use of the UMR. 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 includes the UMRS (Mississippi and Illinois Rivers) floodplain and uplands up to 16km (10 miles) from the floodplain. Ground study sites will be Pools 6-9 in the Upper Mississippi National Wildlife and Fish Refuge, Pools 16-18 and Pools 24-26 which includes portions of the Mark Twain National Wildlife Refuge Complex (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 25m of the sample point over 10cm dbh will be counted. Canopy and subcanopy heights will be estimated from a tree that represents the average in each sampling plot, using a clinometer.

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). 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). Staff will be trained to use the following holds safely: bander's grip, leg hold and ice cream cone grip (Smith et al. 1997). 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 (Guglielmo et al. 2002, McWilliams et al. 2002). For example, plasma lipid profiles can indicate whether a bird is gaining or loosing weight. 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 additionally propose to continue developing 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 will continue to compile data in our GIS database that includes 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 currently are working up the 2006 data and plan to examine the utility of the combined datasets in identifying important stopover locations. Increased funding will allow us to step up to an Upper Mississippi River effort with our final goal of conducting a basin-wide effort that includes the Middle and Upper Mississippi, Illinois, Ohio and Missouri Rivers, should further funding be obtained from other sources as well.

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 few have 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

We will begin our focus for the radar work one section each of 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 along the Upper Mississippi on floodplain forests and upland forests within 10 miles of the river on federal, state and private land (with permission).

Option 5 includes bird banding and transect surveys in and near the UMR between Winona, MN and Lansing IA, only. We will continue to develop the NEXRAD analyses for the entire UMR floodplain.

Products and milestones (Option 5 selected for FY07 work)

Tracking number	Products	Milestone Dates
2007APE1	Draft manuscript detailing the species seen during migration in UMR floodplain forests versus upland forests	30 December 2007

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2007APE2: Asian Carp Effects on Zooplankton Abundance and Composition in Backwater Lakes

Introduction/Background

This project is intended as an add-on to the project proposal submitted by the same authors—"Testing the fundamental assumption underlying the use of LTRMP fish data: does variation in LTRMP CPUE data reflect variation in the abundance of fishes." Two budgets estimates are provided – one assuming this project would be a stand alone project, and one assuming our other project is funded and this project is an add-on.

Statement of Problem and Objectives - Two species of Asian carp, bighead carp *Hypothalmichthyes nobilis* and silver carp *Hypothalmichthys molitrix*, have become established throughout large portions of the Mississippi and Illinois rivers since the mid 1990's. Both of these species are filter feeders, consuming zooplankton and phytoplankton. Because all species of fish depend on zooplankton during their larval stages, the establishment of these two invasive species may have detrimental effects on native fish communities through competitive interactions. The objective of this project is to evaluate changes in the abundance and composition of zooplankton among backwater lakes and to test if these differences correlate with the abundance of Asian carp.

Bighead and silver carp were brought to the United States in the 1970's for use in aquaculture (Freeze and Henderson 1982, Jennings 1988). Subsequently, both species escaped into the Upper Mississippi River System (UMRS) and now have reproducing populations established in portions of the Mississippi, Missouri, Ohio, and Illinois rivers (Jennings 1988, Tucker et al. 1995, Burr et al. 1996). Data from LTRMP monitoring suggest Asian carp abundance in navigation pool 26 of the Mississippi River are increasing exponentially, and that an exceptional year class of bighead carp was produced in the La Grange reach of the Illinois River (near Peoria, IL) in 2000 (Chick and Pegg 2001).

The potential for bighead and silver carp to affect native fishes through direct competition for prey resources needs further study. Bighead and silver carp typically consume zooplankton but are adaptable and will consume zooplankton, algae, and/or detritus depending on environmental conditions (Dong and Li 1994, Xie 2001). Studies conducted in ponds and Asian lakes provide evidence that bighead carp can reduce overall zooplankton abundance and cause changes in the size structure and species composition of zooplankton (Burke et al. 1986, Lewkowicz and Lewkowicz 1991, Xie and Yang 2000, Xie et al. 2000). Diet studies of Asian carp conducted in Pool 26 of the Mississippi River and the La Grange reach of the Illinois River have documented strong overlap with the diet of gizzard shad, and moderate to low overlap with the diet of bigmouth buffalo and paddlefish (Sampson 2005; Chick et al. unpublished data). In these studies, rotifers comprised the majority of the diet of both Asian carp and gizzard shad, whereas bigmouth buffalo and paddlefish primarily consumed crustacean zooplankton (cladocerans and copepods). Rotifers were extremely abundant during this study, and we found no evidence that Asian carp were affecting that zooplankton group. Nevertheless, trends in the abundance of cladocerans with CPUE data for Asian carp suggest that crustacean zooplankton abundance may have been reduced in backwater lakes with high abundance of Asian carp (see Figure 1).

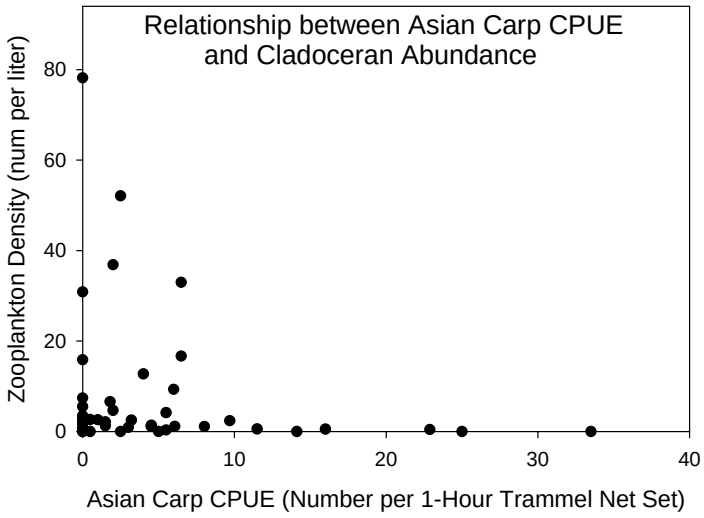

Figure 1. The relationship between the abundance of cladocerans and Asian carp CPUE from trammel net sets (Chick et al. unpublished data). These data were collected from backwater lakes in Pool 26 of the Mississippi River and the La Grange reach of the Illinios River in the spring of 2003 and 2004.

The Asian carp data presented in Figure 1 were collected with trammel nets, which likely provide a rough index of Asian carp density in the backwater lakes that were sampled. A more robust estimate of the actual density (num or biomass per hectare) of Asian carp likely would provide better insight into the influence of bighead and silver carp on zooplankton in backwater lakes of the Upper Mississippi River System. Therefore, we propose an add-on project to our rotenone-day electrofishing project. Specifically, we propose collecting zooplankton samples from the backwater lakes sampled for the rotenone-day electrofishing project.

Relevance of research to UMRS/LTRMP

The UMRS has endured a long history of species introductions, with Asian carp being the most recent additions. In areas where Asian carp have become abundant in the UMRS, observed impacts to humans include reduced wholesale value of commercially harvested fishes (Robert Maher, ILDNR - personal communication), and injuries to boaters and jet skiers from collisions with jumping silver carp. Evidence of ecological impacts of Asian carp on the UMRS are more difficult to document. Given that the LTRMP has produced the most comprehensive monitoring database for large rivers in the world, and has an active research program, it is clear that we will be looked to for information on what threat Asian carp pose to large rivers and other ecosystems. State and federal managers are actively exploring ways to prevent the further spread of Asian carp to the northern portion of the UMRS and to the Great Lakes. Our program needs to be ready to provide the information needed for developing the management plans, including data needed to assess potential ecological risk from Asian carp. This project will directly assess ecological impacts of Asian carp in the UMRS.

Methods

The project will be conducted at three reaches of the UMRS: 1) Minnesota (Pools 4, 5), 2) Pool 26, and 3) the La Grange Reach of the Illinois River. At each of these reaches, multiple backwater lakes (three to six) will be selected for sampling. Within each backwater, three ¼ acre block nets will be deployed in random locations, and fish within the nets will be sampled using rotenone (Davies and Shelton 1983). 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.

We propose collecting microzooplankton (rotifers and copepod nauplii), and macrozooplankton (cladocerans and adult copepods) samples within each of the three block nets set in each lake. Samples will be collected using a pump from three depths (0.5 m below the surface, mid-depth, 0.5 m above the bottom) using the sampling methodology from the US EPA's great rivers EMAP

program which the lead PI helped to develop. This will allow us to have accurate density estimates for Asian carp in the same location as the zooplankton are collected. Given the rareness of actual density estimates of fishes, we feel this is a unique and valuable opportunity to gain insights into the affects of invasive Asian carp on the native biota of the Upper Mississippi River System. Additionally, we will work with Bill Richardson (USGS UMESC), providing samples of fishes and zooplankton for stable isotope/fatty acid analysis.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE2	Draft LTRMP Report	30 March 2008

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2007APE3: Testing the Fundamental Assumption underlying the use of LTRMP fish data: Does variation in LTRMP catch-per-unit-effort data reflect variation in the abundance of fishes?

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, when target species are at very high abundances, or in open systems with species that move great distances. 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 hoop nets, fyke nets and mini-fyke nets, have not been evaluated against abundance data.

We will accomplish three objectives with this study: 1) we will devise a methodology that can be used to evaluate how well catch-per-unit-effort (CPUE) data from LTRMP fish sampling methods relate to the actual density (# or biomass per unit area) of fishes, 2) we will test for a relationship between CPUE from LTRMP day electrofishing and density estimates of fishes from block-net sampling, and 3) we will evaluate how the abundance and composition of fishes in backwater lakes varies with key environmental factors and morphometric features of the lakes.

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 that variation in LTRMP CPUE data reflects variation in the actual abundance of fishes. We hope that the comparison methods used for this study can serve as a framework for testing other LTRMP fisheries techniques (e.g. hoop nets, fyke nets, mini-fyke nets) in future studies (evaluating more than one LTRMP gear at a time is not logistically feasible). Additionally, this project will result in the collection of accurate abundance estimates for fishes in backwater habitats, allowing a unique opportunity to test for patterns in fish biomass per unit area estimates with key environmental variables thought to influence fish population and community dynamics in backwater lakes.

Methods

We propose to test for relationships between CPUE data from LTRMP day electrofishing with desnity estimates from block-net rotenone sampling in backwater habitats. The project will be conducted at three reaches of the UMRS: 1) Minnesota (Pools 4, 5), 2) Pool 26, and 3) the La Grange Reach of the Illinois River. At each of these reaches, multiple backwater lakes (three to six) will be selected for sampling. Within each backwater, three ¼ acre block nets will be deployed in random locations, and fish within the nets will be sampled using rotenone (Davies and Shelton 1983). 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. On the same day the three block nets are deployed within a backwater, three day electrofishing samples will be made at random locations following standard LTRMP methodology (Gutreuter et al. 1995).

The choice of the backwater lakes used to evaluate this relationship will be critical. Ideally, testing relationships between CPUE from day electrofishing and density estimates from block-nets would be done across a range of fish abundances from very low to very high. Because data on actual fish abundances is not available, we are in the process (through a 2005 APE project) of using lake-morphometry data and LTRMP water quality data to identify potentially high and low productivity lakes. This not only will provide an opportunity to select an optimal group of lakes for our catchability analysis, but we will also have the ability to evaluate whether the actual fish abundance estimates conform to our a-priori categories of potential productivity, which will help to evaluate environmental factors affecting fish production in backwater lakes. Residual analysis will be used in an attempt to identify environmental factors influencing the relationship between CPUE and density.

Candidate backwater lakes have been identified for each reach based on minimum and maximum size (Figure 1). We will make a final selection of backwater lakes based on environmental factors and logistical constraints (i.e., the feasibility of accomplishing the sampling in each backwater).

Products and milestones

Tracking number	Products	Milestone Dates
2007APE3	Draft LTRMP Report	30 December 2007

Literature Cited:

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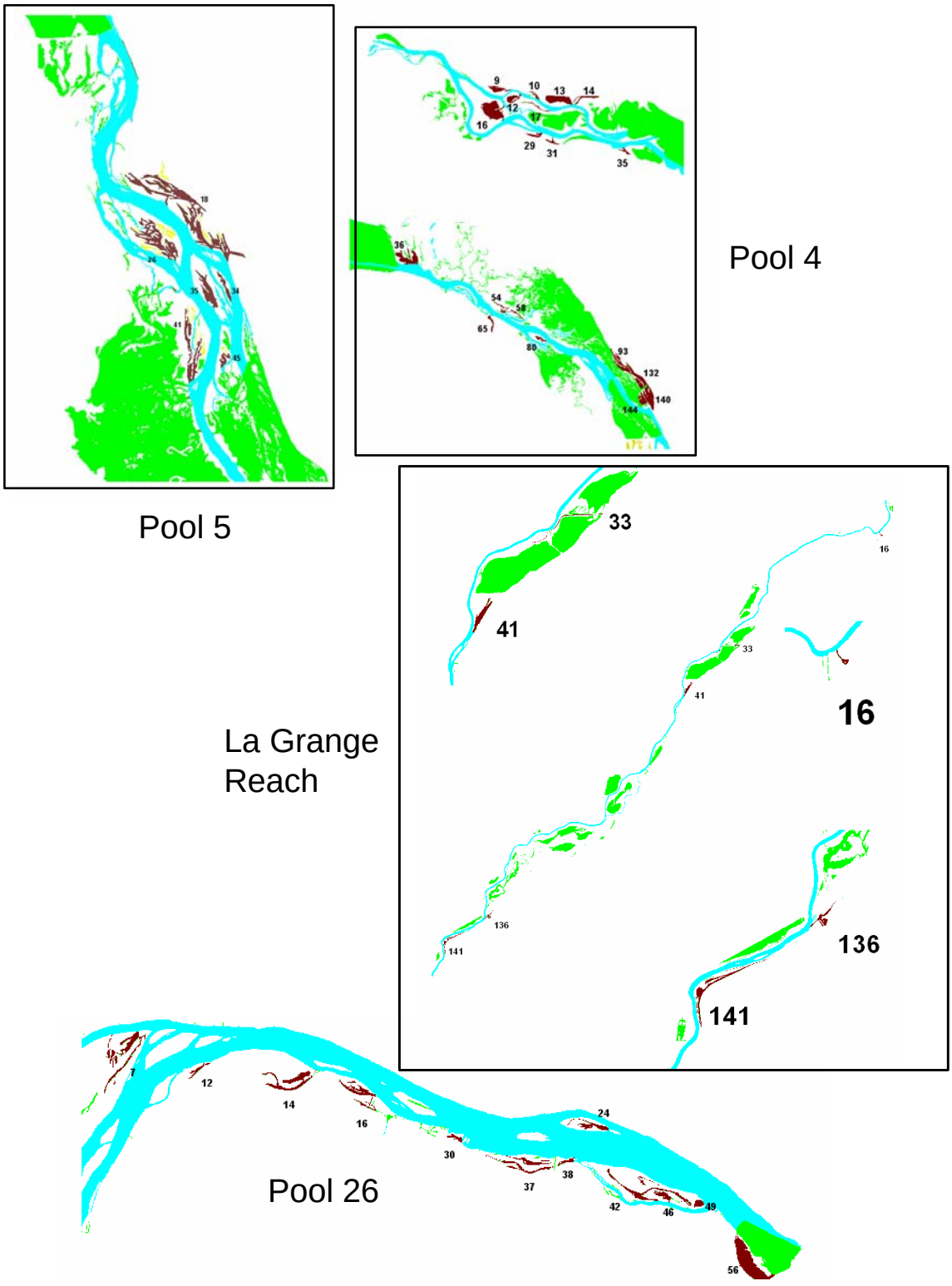
Figure 1. Candidate backwater lakes in Mississippi River Pools 4, 5, 26, and the La Grange Reach of the Illinois River. Lakes were chosen based on minimum size (5 ha), maximum size (100 ha), and connectivity (contiguous, with connection with river < 15% of lake perimeter).



2007APE4: Analysis of waterbird data from the Upper Mississippi River System

Introduction/Background:

The Long Term Resource Monitoring Program (LTRMP) is implemented by the U.S. Geological Survey (USGS) in cooperation with the five Upper Mississippi River System (UMRS) states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), with guidance and overall Program responsibility provided by the U.S. Army Corps of Engineers. The mission of the LTRMP is to develop a better understanding of the ecology of the UMRS and its resource problems. In addition, 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 U.S. Fish and Wildlife Service (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.

One basic problem is our lack of understanding of how and when migratory birds use the river and its habitats throughout the year and how changes in river management might influence bird use of the river. Many waterbird monitoring projects by Refuges 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 never 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 determine appropriate management actions. The first step in developing a status and trends report on waterbirds was to draw together all the available information on what work that has been done by the Refuge (APE #52 – 2006) and summarized in a report to the LTRMP (Meier 2006). In coordination with the USFWS Biological Monitoring Team, we compiled long-term waterbird monitoring data collected by the Refuge and its cooperators into a database along with other information such as UTM, river mile, acreage of unit, hunted/non-hunted, vegetation/invert data, etc. These data are now ready for analyses and interpretation in terms of status and trends. We propose the development of a status and trends report on waterbirds for FY07. The report will provide an assessment of waterbird status and trends where applicable, how they relate to the state of the ecosystem, and describe future pressures.

Relevance of Research to UMRS/LTRMP:

Three Corps districts, 7 national wildlife refuges, 5 states, and several non-government organizations are interested in maintaining the ecological integrity of the river and its role in providing habitat for declining waterbird populations. Many waterbird monitoring projects by federal and state agencies have been undertaken over the past 20 years or are currently on-going all along the UMRS. Some of these projects are funded as part of the Environmental Management Program. However, much of the data has never been analyzed and the various studies have never been compared with each other as a group to see if additional trends emerge about the value of UMR management efforts to migrating and breeding waterbirds.

The long-term goals of the LTRMP are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products. In addition to evaluating existing datasets, this project will make specific recommendations for a more systemic, prioritized bird monitoring program based on limited and uncertain future funding. Monitoring objectives and study design guidance will be developed in coordination with partner agencies to help collect the most critical information needed to improve restoration and management efforts.

Examples of existing waterbird datasets:

Upper Mississippi River National Wildlife and Fish Refuge
Great Blue Heron/Great Egret/Double-crested Cormorant colony surveys—nest counts, 1974-2005; productivity, 1994-2005.
Aerial waterfowl surveys, Pools 4-14, Mississippi River—1950's-2005.
Black tern nest monitoring, Blue and Target Lakes, Pool 8, Mississippi River—1998.

Mark Twain Refuge Complex
Two Rivers Refuge—waterfowl surveys, 2000-2005.
Great River Refuge—weekly waterfowl surveys, 1971-1978; 1985-2004.
Marsh/waterbird counts, 1985-1989.

Minnesota Dept. of Natural Resources
Colonial waterbird surveys—1950's-2003.
Nest counts for colonies of Black-crowned Night Heron, Double-crested Cormorant, Great Blue Heron and Great Egret. Years variable by species.

Illinois Natural History Survey
Average peak abundances in multi-year periods for waterfowl, Illinois and Mississippi Rivers, 1948-2000 (fall); 1955-2001 (spring)
**INHS only made summary data available as they are working on manuscripts with the data.

Methods

We will review all waterbird data sets obtained during FY06 for content and data collection methods. For those datasets with enough information we will conduct standard analyses appropriate to the data (Not all data were available for evaluation prior to submission of this proposal).

Products and milestones

Tracking number	Products	Milestone Dates
2007APE4a	Final database completed	30 January 2008
2007APE4b	Draft LTRMP Report for UMR waterbird data	30 March 2008

Reference

Meier, M. S. 2006. Summary report on developing a database for monitoring status and trends of waterbirds on the Upper Mississippi River. Contract report No. 52-2006, LTRMP.

Principal Investigator: Melissa Meier, USGS

2007APE5: Status and trends of floodplain forests on the Upper Mississippi River

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 there has also been 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). In 2006, floodplain forests in the southern reaches were revisited 10 years after an initial survey was conducted to determine the regeneration rates of floodplain forest. Now that the data have been collected, we are proposing to analyze the data and develop a manuscript for publication on the status and trends of floodplain forest in the southern reaches of the UMRS.

Relevance of research to UMRS/LTRMP

The information will update the prediction on the trajectory of the forest succession. Important questions to be answered includes, 1) Is there sufficient regeneration under the forest canopy to prevent replacement by reed canary grass; 2) Will the next generation forest sustain species diversity at the current level. The information can be used to guide forest management strategies in the URMS.

Methods

Various statistical procedures for hypothesis testing and development of a manuscript for publication.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE5	Draft manuscript	30 March 2008

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2007APE6: Primary production in the UMRS: Contrasts in dissolved oxygen dynamics, primary production, and respiration among aquatic areas of the UMRS

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 (Delong and Thorp 2006). 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 rare.

It is generally believed that the backwaters of the UMRS are important areas of biological production, but the relative importance of these off channel areas and main channel areas in overall river primary production has not been explicitly quantified. There are a few measurements of primary production in the UMRS and these are largely based on light/dark bottle methods in a small number of sites (Baker and Baker 1979, Lange 1988). Owens and Crumpten (1995) estimated primary production within a single backwater lake (Lake Onalaska in Navigation Pool 7) during very low vegetation conditions (during 1990) using open water dissolved oxygen methods. However, comparisons of primary production in channel and off channel areas have not been made, there are no published data comparing water column primary production with ecosystem system primary production (which includes vegetation and sediments), and there is little information on the relationship between primary production and its major drivers (e.g., nutrient concentration, light extinction due to suspended solids).

This proposal is for the second year of what is proposed as at least a three year study. In the first year we developed appropriate methods for estimating rates of ecosystem primary production and respiration in backwater lakes of the UMRS and used these methods to address several questions about primary production in backwater areas. In the second year we plan to expand our work into the main channel and impounded areas. In the third year we hope to expand our work into additional navigation pools of the UMRS.

Specifically, in 2006 we have been focusing on the following:

1. Developing appropriate methodologies for estimating rates of ecosystem primary production and respiration in backwater lakes of the UMRS. We have designed, constructed and deployed monitoring stations that record the data necessary for investigating the factors controlling short term variability in dissolved oxygen concentrations and estimating ecosystem primary production and community respiration. We are also testing methods for estimating primary production in the main channel.

2. Using those methods to collect one growing season of data on primary production in four backwater areas (Target Lake, Lawrence Lake, Stoddard Island complex, and Round Lake).

3. Compare dissolved oxygen dynamics in open water and vegetated areas within backwaters. Within these backwater areas we are deploying multiple DO meters in vegetation beds and open water areas to examine the effect of vegetation on dissolved oxygen dynamics. These oxygen dynamics can be used to: a) Evaluate habitat conditions in vegetation beds over the diel cycle and b) Estimate local primary production in the vegetation beds and open water.

4. Investigate how rates of primary production and oxygen dynamics in backwaters are affected by short term fluctuations in solar irradiance, nutrient concentrations, light extinction, temperature, wind, and water level during summer.

Our 2006 proposal included tentative plans (pending funding) for 2007 that would build on the understanding gained in 2006 in three important ways:

1. First, we will expand our study into main channel and, if logistics allow, into impounded areas. This expansion would address the central question: How do rates of primary production in the backwaters differ from other aquatic areas of the river? This information will increase our understanding of the role of backwater areas in the overall primary production of the UMRS. We expect that backwater primary productivity will be higher than channel production, but that channel primary productivity will be higher than is generally expected for a large river. In addition, collecting information on productivity in a range of aquatic areas will enable us to make an initial estimate of total primary productivity within the upper pools of the UMRS.

2. A second year of data is also likely to provide information on primary production under contrasting hydrologic conditions. Thus far, 2006 is a relatively low discharge year with a small spring flood, low turbidity and extremely abundant vegetation. If 2007 is a higher discharge year, turbidity may be higher and vegetation abundance reduced. This will provide an excellent contrast for understanding the links between spring discharge and summer production. Even if there are only modest differences in river conditions between 2006 and 2007 we will gain useful information concerning the range of productivity that occurs in the system.

3. An additional year of data will provide better data coverage of the gradient of wind, light, and temperature conditions that occur in the river. This will improve our understanding of the effects of wind, light and temperature conditions on primary production in the UMRS.

Relevance of research to UMRS/LTRMP

The proposed research will increase our understanding of the role of backwaters in the overall productivity of the UMRS and how important drives such as nutrients and suspended solids (via their effect on light extinction with depth) affect primary production. Further we hope to develop a predictive model to estimate primary production from a group of commonly measured variables (e.g. chlorophyll, light extinction, nutrients, etc.) which will allow us to link our findings to the extensive LTRMP dataset. Furthermore, HREPS may directly effect some of these factors

such as residence time (e.g., by controlling connectivity of backwaters) or suspended solids (e.g., by construction of islands to reduce wind fetch). To the extent that these factors can be shown to be affected by characteristics that HREPs often manipulate, there may be future interest in monitoring changes in primary production that result from HREP construction.

The proposed research addresses Theme D and E. Under theme D we are addressing "production of biota and rates of biological processes [i.e., primary production] in off channel areas." We propose to estimate primary production in backwater areas and contrast them with primary production in other aquatic areas of the river. This approach will increase our understanding of the role of off channel areas in the overall production of the UMRS, particularly if there are large differences between backwater and channel areas in productivity. We also propose to examine how primary productivity in backwaters and other areas is affected by a range of drivers (see objective 4 above) including nutrients and suspended solids (via their strong influence on the depth of light penetration). This aspect of the project addresses Theme E by investigating the links between nutrients and suspended solids, and rates of primary production and oxygen dynamics.

Methods

Ecosystem primary production:

Ecosystem primary production will be measured in two backwater areas, two main channel sites, and two impounded sites, if possible. Alternatively, we will focus on three backwater and three main channel sites. 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 site to record wind velocity, solar irradiance (above the surface and at two different depths in the water column in order to determine light extinction rates), and dissolved oxygen (at 0.5 m) at regular intervals (e.g., every 15 minutes). Water level loggers will be used to record changes in water level. The stations will be deployed as the spring flood is receding in order to observe the expected divergence of main channel and backwater productivity rates as the connectivity between these areas is reduced by declining water levels. Chlorophyll a, turbidity, nutrient concentrations, and light extinction will be sampled weekly during deployment. Weekly trips to all stations will also be needed for station maintenance and repair.

Dissolved oxygen data collected at short time intervals will be used to estimate ecosystem primary production. Maximum and minimum DO for each day will also be extracted from the DO data set and will provide information on the frequency at which hypoxia occurs.

Water column primary production:

Water column primary production (and respiration) will be measured in the backwater and impounded sites during the weekly sampling 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.

Field work plan and staffing needs:

Based on our experience thus far in 2006, the time required for sampling, station maintenance, light/dark bottle incubations, travel between stations and lab work is such that two people can conduct a full sampling event at about one station per day, four days a week. In 2007 we would like to sample 6 (two MC, BW and IMP). Thus each week, we will fully sample three sites (one from each area) and partially sample the remaining (everything but light/dark bottles—the most time intensive aspect of sampling) sites. This will require two field employees full time for the entire summer. Additional work will be required before the field season in order to assemble and test all of the equipment in the spring and retrieve and refurbish equipment in the fall. Thus we have requested funding one technician for 6 months and a summer student employee in addition to a small number of pay periods for senior staff. This is the level of staffing and funding that was used in 2006 and has worked very well.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE6	Draft manuscript summarizing 2006-2007 data. Approximate title: "Primary production in the Upper Mississippi River: a comparison of channel, backwater, and impounded areas of the river"	15 February 2008

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2007APE7: Association between fish assemblage and off-channel area type in the impounded reach of the Upper Mississippi and Illinois rivers: implications for habitat restoration at management-relevant scales

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 regulates the assemblage and production of fishes in OCAs of large rivers (e.g., Rodriguez and Lewis 1997; Miranda and Lucas 2004; Arrington and Winemiller 2006). A better understanding of the biological and physicochemical characteristics of OCAs that drive fish assemblage type and production would greatly benefit restoration efforts in large floodplain rivers. Previous research has investigated associations between UMRS fish assemblages and environmental covariates at large (>10 km^2) spatial scales using LTRMP monitoring data (Chick et al. 2005; Barko et al. 2005; Ickes et al. 2005). Additionally, Gutreuter (2004) investigated habitat limitations for select components of the UMRS fish assemblage over a 1200 km reach of river. This previous research has proven crucial for defining spatial contexts and spatial constraints on UMRS fisheries resources. However, each study homogenized responses at spatial scales < 10 km^2.

We hypothesize that:

1. Important sources of heterogeneity in select indices of physical, chemical, and biological features within the UMRS exist at spatial scales < 10 km^2 (e.g., OCAs);
2. Spatial patterns in selected sub-assemblages of UMRS fish communities can be explained by spatial differences in physical, chemical, and biological features of OCAs.

Our goal is to model existing observational data (LTRMP fish, vegetation, and water quality; UMRS bathymetry; UMRS land cover/land use) for the purpose of identifying environmental characteristics of OCAs that are most closely associated with fish assemblage type. Because habitat rehabilitation efforts are principally targeted at scales < 10 km^2 in the UMRS, our primary objective is to characterize which environmental features best relate to fish assemblages at this scale.

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 and physicochemical characteristics of OCAs that determine fish assemblage types. This approach builds on the 2006 APE #34 that is assessing the relationships between physicochemical and biological characteristics of these OCAs and abundance of various size classes of centrarchids and species diversity in 42 delineated off-channel areas in pools 4, 8, 13, and the La Grange reach. Although still in progress, preliminary analyses have revealed spatial patterns in size-specific centrarchid abundance which is likely related to variable physicochemical and biological characteristics of these OCAs rather than just zoogeography. This proposed APE will go beyond centrarchid abundance and species diversity and examine fish assemblage types in a multivariate fashion to determine if OCA classifications based on physicochemical and biological characteristics correspond to unique fish assemblages. The results will be used to identify important characteristics of off-channel areas to specific fish assemblages to inform targeted restoration efforts (HREPs). For example, which OCAs possess physicochemical and biological

characteristics conducive to favorable centrarchid populations, which OCA characteristics account for these differences, and are wider fish assemblages similarly influenced by differences in OCA characteristics? This research will also be another test of the application of LTRMP data at management-relevant scales (i.e., the scale of most restoration efforts), whereas most previous 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 desirable fish assemblages. This approach answers the call for integrated analysis of LTRMP data in that we will use fish, vegetation, and water quality SRS data.

Methods

Previously, we have identified 42 OCAs within 4 LTRMP study areas (Pools 4, 8, 13, and the La Grange Reach of the Illinois River). To date, we have derived a large suite of environmental indices that are designed to characterize the physical attributes (e.g., shoreline development index, bathymetry, connectivity, proportion of shoreline in forest), and the biological attributes (e.g., abundance of submersed aquatic vegetation and percent cover of emergent and rooted-floating leaf vegetation) of each OCA. As part of the proposed APE, we will further characterize these 42 OCAs with physicochemical indices derived from the LTRMP water quality data set (e.g., dissolved oxygen, temperature, and total suspended solids). Additionally, we have compiled LTRMP fisheries community data, aliased in spatial extent to coincide with previously identified OCA extents.

Indices that we derive to describe the physical, chemical, and biological attributes in the 42 OCAs will be treated as multivariate observations (environmental matrix). Principal Components Analysis will be performed on the environmental matrix to describe similarities and differences among individual OCAs using ordination methods available in Primer-E software (Clarke and Warwick 2001). Cluster analysis will be performed in an attempt to identify classes of OCAs sharing similar multivariate environmental characteristics. If OCA "types" are apparent in the environmental data (e.g., distinct clusters of OCAs), we will perform post-hoc inferential tests to determine whether these "types" are significantly different enough to defend their use in the future as a new OCA classification scheme.

Non-metric Multi Dimensional Scaling (Clarke and Warwick 2001) will be performed on the fish community data to describe similarity among OCAs in fish assemblage structure. Species loadings on each ordination axis, for each OCA observation, will be used to explore species associations with site differences based on our environmental matrix analysis, described above. To aid interpretation, we will use visualizations known as bubble plots to investigate these associations.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE7	Draft completion report	30 September 2007

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2007APE8: A Proposal to restore Specific Monitoring Elements to the LTRMP

Proposal in Brief

In response to variable and insufficient funding for the LTRMP, a Minimum Sustainable Program was developed in 2004 and implemented in 2005. The objective of the MSP was to develop a five year plan that fit the monitoring program into specified and restricted funding guidelines. Originally, no more than $3.5 mil was to be spent on monitoring each year, with a 3% growth trajectory each year. In years when funding for LTRMP exceeded $3.5 mil, additional program elements would be added including bathymetry, GIS analyses, and focused research projects. Consequently, large cuts to monitoring activity were made to fit into the proposed funding guidelines. The invertebrate component was dropped, vegetation monitoring was dropped from Pool 26 and the La Grange Reach and was reduced by several hundred sites each in Pools 13, 8 and 4. First time period sampling for fishes was dropped for all field stations, and reductions in the number and frequency of fixed site monitoring for water quality were made for all field stations. The five state partners reluctantly agreed to these plans in light of the substantial budget cuts experienced in 2003; however, there has been continued interest on the part of the five state partners to find a proper mechanism to add some of the reduced monitoring activities back into the program in years where funding is sufficient to support these activities. Here, we propose and justify adding specific monitoring activities back to the program. Internal discussions among and within the natural resources departments of the five state partners identified priority monitoring additions as first time period fish sampling for Pool 13, Pool 26, La Grange and the Open River Reach, and restored WQ fixed site monitoring for Pool 4 and Pool 8. The total cost to add these elements back to the program, including all state and USGS overhead, would be $60,534 in FY2006 dollars. We believe that because of the relatively low cost associated with adding these monitoring elements back into the program, funding would allow these data to be collected in many years. Funding allocated in FY2005 allowed for $809,200 to be spent on additional program elements, and funding for FY2006 allowed for $1,066,935 to be spent on additional program elements. We propose that first time period fish monitoring be added back for Pool 13, Pool 26, the La Grange and Open River reaches, and WQ fixed site monitoring would be restored to pre-MSP levels for Pool 4 and Pool 8.

Introduction and Background

Effective monitoring is central to the Long Term Resource Monitoring Program. As reported on the US Army Corp's website for LTRMP:

> "The mission of the LTRMP, as outlined by legislation, the master plan, and program guidance, is to provide resource managers and decision makers with information necessary to maintain the UMRS as a sustainable multiple-use large river ecosystem. The long term goals of the LTRMP were established through extensive Federal and State agency participation. The goals of the program include:
> (1) Develop a better understanding of the ecology of the UMRS and its resource problems;
> (2) Monitor resource change;
> (3) Develop alternatives to better manage the UMRS; and
> (4) Provide for the proper management of long term resource monitoring program information. "

Monitoring data provides for analyses of the ecological status and trends for important natural resources of the Upper Mississippi River, the primary function of the LTRMP (USGS 1999). Identification and analysis of "trends" generally refers to univariate techniques such as linear regression and time series analyses, to identify and predict significant trends through time. The

basic question addressed in trend analysis is whether or not a quantity is increasing or decreasing through time. Identification and analysis of "status" is associated with a broader array of pattern description and hypothesis testing, including both univariate and multivariate techniques to describe differences among specific years, through space, among habitats, or in relation to some specified norm. Analysis of status addresses the ability of the program to serve as an early warning system for managers and to answer questions such as: Does fish community structure vary among reaches? Are dissolved oxygen levels influenced by precipitation events? Is year-class-strength of fishes correlated with river discharge? Trend detection is influenced by the duration of monitoring, with power to detect trends increasing through time (Lubinski et al. 2001). The ability to detect differences in status is affected by the sampling intensity (i.e., the number of samples collected within a year or area) and variance in the data more so than is trend detection. Therefore, our justification for restoring monitoring activities is focused on analysis of status rather than trend detection.

Justification for restoring first time period fish monitoring in Pool 13, Pool 26, La Grange and Open River, in years with Sufficient Funding

To fit within the financial constraints specified for the LTRMP minimum sustainable program (MSP), the first of three time periods of fish monitoring was dropped for all study areas. The ad hoc committee formed to investigate potential reductions in fish monitoring noted that dropping two time periods was not defensible because of the large amount of error associated with analyzing status at the community and population levels under such a reduced level of monitoring. The committee recommended the fish component be dropped entirely if funding could only support one time period of monitoring. Increased variance and some level of error in analyzing status measures at the community and population level also occurred when the first time period was dropped, but the committee felt that a two-time-period monitoring program would still be worth implementing. In FY2005, the MSP was initiated and the first time period of fish monitoring was dropped in all study areas.

Loss of Information under MSP

The two-time period fish monitoring program was implemented strictly in response to financial constraints, not to eliminate redundant sampling as in the gear reductions in FY2002 (Ickes and Burkhardt 2002) or to arrive at a more efficient and scientifically valid program. Whereas the committee preferred to go forward with a two-time-period monitoring program as opposed to dropping fish monitoring from LTRMP all together, dropping the first time period of fish monitoring does reduce the information gathered and diminishes the ability to detect differences in status measures (e.g., year class strength of fishes). The summary for lost information from the ad hoc committee based on an analysis of data collected between 1994 and 2002 included:

<u>Community level status measures</u>

Major patterns in community structure and composition through space and among years were maintained – e.g., differences between upper and lower river reaches were still detectable, 1994 still differed from other years (a 2003 flood effect). Finer patterns, such as differences in community structure among study areas, were still recognizable though somewhat obscured.

<u>Population level status measures</u>

- Standard error around annual mean CPUE increased by • 25% for common species.

- Patterns in CPUE among years for some common species were obscured (potential for false patterns)

- Change in length frequency patterns for some species

- 29% reduction in total catch of stock-size common species

- 15% reduction in annual species occurrence

- Four species would have been missed (i.e., not captured) between 1994 and 2002

This lost information is not trivial and will affect our ability to analyze status measures of fish populations and communities. For example, the following results have been highlighted for the fish component in several recent reports:

- Responses of fishes to the 1993 flood (USGS 1999, USACOE 2004, Ickes et al. 2005)

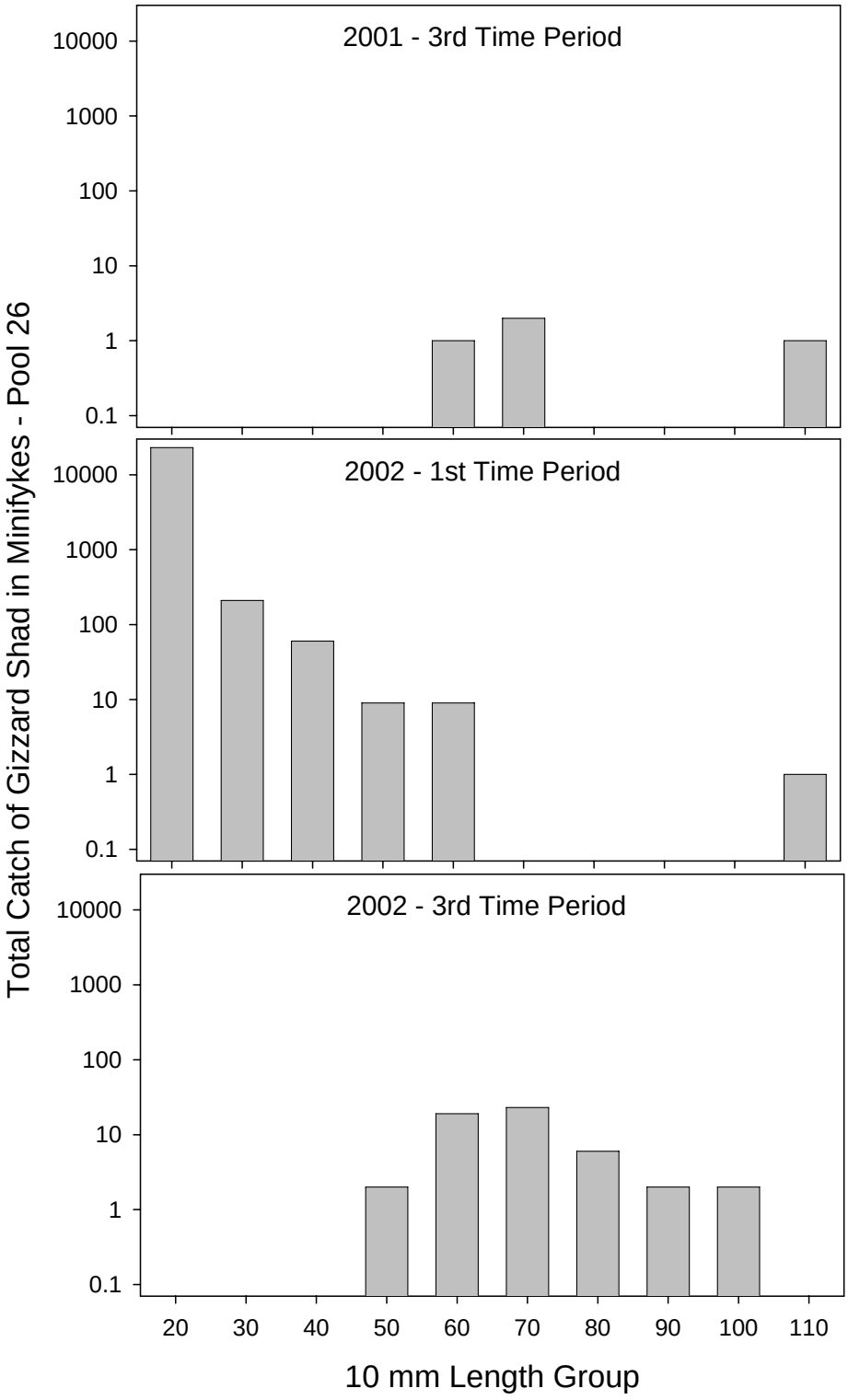
- Detection of invasive and exotic species (USGS 1999, USACOE 2004, Chick et al. 2005, Ickes et al. 2005)
- Detection of community structure differences among reaches and correlations of community structure to habitat measures (USACOE 2004, Barko et al. 2005, Chick et al. 2005, Ickes et al. 2005)

- Spatial distribution of species and correlations of these patterns to habitat (USGS 1999, USACOE 2004, Ickes et al. 2005)

Our ability to achieve similar results to these in the future will all be reduced as a result of dropping the first time period of fish monitoring. Similarly, our ability to answer additional questions recently posed will also be reduced, such as: What processes influence fish production in backwater habitats of the UMRS? What factors influence survival and growth of YOY and juvenile fishes in the UMRS? How are invasive species influencing the UMRS fish community? Etc. We believe that restoring first time period fish monitoring for pools 13 and 26, and the La Grange and Open River reaches, is desirable and could be achieved in most years. For the purposes of answering status based questions, periodic interruption in the string of data does not reduce the usefulness of collecting the information in years when funds are sufficient. This proposal would ensure that for many years to come, the fish monitoring data from Pools 13, 26, and the La Grange and Open River reaches would be as effective as for the period from 1994 to 2004.

In the four lower pools, information from the first time period can indicate the production of a strong year-class. For example, gizzard shad in Pool 26 produced a markedly strong year class in 2002 (Figure 1). Clearly, a comparison of gizzard shad captured in minifykes for the third time period in 2001, and the first time period of 2002, suggests that fishes < 50 mm in length during time period 1 are YOY. The figures suggests a substantial number of YOY fishes were produced in period 1, and CPUE of YOY (as defined by this length criteria) could be compared to previous years to confirm the production of a strong year class. In fact, comparisons with previous years due indicate exceptional spawning success for gizzard shad in 2002. Further analysis of data from the 1st and 3rd time period of 2002 relative to other years could provide insight into how well these fish survived over the course of the summer.

Figure 1. Total catch of gizzard shad less than 120 mm total length from minifyke nets in 2001 and 2002. All data are from LTRMP sampling in Pool 26.



Full LTRMP Water Quality Sampling Design

The Long Term Resource Monitoring Program (LTRMP) Water Quality component monitors and reports status and trends in the water quality of the Upper Mississippi River System. The water quality component focuses on a subset of limnological variables related to habitat quality and ecosystem function that includes physicochemical features, suspended sediment, and major plant nutrients known to be significant to aquatic habitat in this system. The LTRMP is designed to complement, not replace or duplicate the monitoring programs of other state and Federal agencies. It therefore includes some limnological characteristics not routinely monitored in water quality programs and it excludes others that are of concern primarily for human consumption or regulatory purposes (e.g., chemical oxygen demand, biochemical oxygen demand, total coliform bacteria, fecal coliform bacteria, fecal streptococcus, heavy metals, pesticides, and polychlorinated biphenyls).

From July 1988 through June 1993, the LTRMP performed weekly limnological measurements at 15-30 permanently fixed sampling locations in each study area. This approach did not meet the needs of the Program, and in June 1993, a new sampling design was implemented that incorporated biweekly fixed-site sampling (FSS), quarterly stratified random sampling (SRS), and an expanded set of measurements. The design and specific sampling techniques are detailed elsewhere (Soballe and Fischer, 2004)

One of the greatest strengths of the LTRMP water quality program as re-designed in 1993 is the mixed-sampling design, consisting of both fixed and random sites. The mixed design provides information at both broad spatial scales with low temporal resolution (SRS), and at small spatial scales with higher temporal resolution (FSS). The SRS tracks conditions at spatial scales corresponding to sampling strata or larger (i.e., whole pool or sampling reach) and at seasonal to annual time scales or longer. In contrast, the fixed-sites provide information at more frequent intervals (i.e., within season) at specific points of interest such as tributaries, headwaters, tailwaters, and backwaters with high habitat value. The mixed-design offers a fiscally sound compromise between large-scale, high intensity sampling and small-scale, infrequent sampling.

Cuts under the Minimum Sustainable Program (MSP)

Budget problems have plagued the LTRMP for many years due to lack of cost-indexing in the authorizing language, and inadequate annual appropriations. During the 1990's, these problems were dealt with through streamlining of operations and efficiencies gained by implementing practices such as electronic data capture and centralized bottle washing. However in late 1999, program staff were forced to reduce efforts by about twenty-five percent. Numerous additional changes, including a period of no sampling, were implemented between October 2002 and September 2004. In October 2004 the Minimum Sustainable Program (MSP) was implemented and has continued to present. The MSP design was developed solely for the purpose of bringing the program within a subjectively-determined fiscal boundary, rather than a scientifically identified need for reduction. The program as designed in 1993 was in fact a robust program with wide support from EMP partners. In June of 2002, a panel of water quality experts recommended that detailed analyses be conducted before making any changes to the existing water quality program (Soballe and Houser, 2006).

Under the MSP design, cuts were made to the fixed-site portion of the mixed design: several tributaries and all out-pool sites were eliminated, and sampling frequency at the remaining sites was reduced to monthly in summer and bi-monthly (every-other month) in winter. A summary of changes that occurred under MSP is provided (Table 1), but for a full history of changes to the

LTRMP water quality program see the table at
http://www.umesc.usgs.gov/reports_publications/ltrmp/water/tables/table_3.pdf

Table1. Partial Summary of Changes to the LTRMP Water Quality Component

All Pools	1993-1999						Jan 2000 - Sept 2002						Oct. 2004 - Sept. 2006					
Description of changes 1993-2006:	Full 1993 design sampling						Due to budget restraints, reduced overall effort by 25-35%. Frequency of fixed-site sampling reduced to every four weeks at trib sites. Reduced SRS chemistry samples from 1/2 to 1/3 of sites.						Cut overall effort by another ~40% from the 2000 level. FSS reduced to only major tribs, MC and select BWC at reduced frequency. Metals not restored. SRS sampling remained as in 2004.					
Field Station	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
No.of in-pool sites	19	6	10-13	12-13	5-6	7	18	11	13	13	7	7	11	9	7	7	7	6
Frequency in-pool sites	2 weeks						4 weeks transect, 2 weeks others						2 weeks March-May, monthly June-Nov					
No. of Tributary sites	5	5-7	5-13	7	2	6	6	7	13	7	2	6	3	4	4	4	2	5
Frequency tributary sites	2 weeks						Reduced to 4 weeks						2 weeks March-May, monthly June-Nov					
Fixed-site Parameters	in-situ, TN, TP, DIN, SRP, Metals, TSS,						no change						All except metals					
No. of SRS sites	135	150	150	121	150	135	same as 1993-1999						same as 1993-1999					
Frequency SRS	Quarterly						Quarterly						Quarterly					
SRS Parameters	in-situ, TN, TP, DIN, SRP, TSS, Chl, Phyt,						Reduced chem samples from 1/2 to 1/3 of						Same as Jan. 2000					

Information Lost Under MSP

Discontinued sites and decreased sampling frequency at the remaining fixed-sites under the MSP design has seriously diminished an important component of the mixed-design. The SRS data provide excellent spatial information during the major seasonal events (i.e., winter, spring, summer, and fall); however they lack temporal resolution because sampling is *intentionally* conducted during a short window (usually 10-days or less). SRS thus provides a "snapshot" of conditions that is typically reflective of weather patterns over a short preceding time-frame (roughly days to weeks). Over several years of sampling, the average conditions for that time period can be expected to be sampled with good spatial resolution, thereby providing accurate estimates of variability over space for that time-period. While the information is very useful for spatial evaluation of habitat criteria, it does not provide the fine-scale temporal resolution needed to track changes in water quality that affect biota during growing periods.

Water quality factors affecting biota change on a scale ranging from hours to weeks and are frequently event-driven. The bi-weekly monitoring data and focused studies at hourly intervals, have demonstrated that events such as low dissolved oxygen concentrations or high suspended solids occur at intervals that would not be captured by monthly sampling at fixed sites. This is especially true during summer when low-flows and high water temperatures result in periods of anoxia and subsequent release of nutrients from sediments. Additionally, intense summer storms oftentimes result in significant localized runoff events; these events will not be captured at discontinued sites and are more likely to be missed with monthly sampling intervals at the remaining sites. A review of the LTRMP water quality component suggested that episodic phenomena are important to river biota, and that information is needed at fine temporal scales (Soballe and Houser, 2006).

Extreme events are arguably more important to monitor than the average or median conditions. One of the key pieces of information missing from the LTRMP database is water quality data during drought conditions similar to those that preceded the system-wide vegetation decline in 1990. Capturing data during events (e.g., drought, storms, etc.) is important to understand mechanisms driving system-wide change, and a monitoring program with frequent sampling will have a higher probability of capturing events when they do occur.

Another critical loss under MSP is site-specific data necessary for the design and evaluation of habitat projects (both HREP and proposed NESP projects). Some of these needs are highlighted in Table 2. While SRS data may be used under some circumstances to evaluate habitat projects, it is best suited for evaluation of strata and larger areas; point density and sampling frequency may not be sufficient to address the effects of habitat projects, except for cumulatively at the pool-scale.

Fixed-points proximate to the project areas provide site-specific information about water quality changes within season that are important to understanding localized project effects. Fixed sites outside of the target pools (i.e., sites cut under the MSP) are relatively low-cost, and are frequently the only source of data for the project areas.

Finally, the LTRMP has been the major provider of fixed-site water quality data on the Mississippi River, representing 46% of the data in a recent water quality assessment (UMRCC, 2002), thereby emphasizing the importance of that information to River managers not typically associated with the EMP.

An Example of Relevance to River Management

A healthy and diverse submersed aquatic vegetation (SAV) community is an important element affecting fisheries and wildlife, and is an area of intense interest to river managers. A substantial SAV decline occurred system-wide following the 1987-89 drought. Among other possible causative factors, decreased light availability has been cited as a reason for the decline. The UMRCC water quality technical section has recently proposed light criteria necessary to sustain SAV in the Upper Mississippi River (UMRCC, 2003). The authors of the proposal recommend that river managers use the criteria for both the Mississippi River and tributary streams discharging to reaches where SAV development and protection is identified as a management goal. The light criteria are scientifically based values of underwater light availability that are necessary to sustain growth and development of SAV, and are measured either directly as an extinction coefficient, or indirectly as secchi disk depth, total suspended solids, or turbidity. Direct measurements are not routinely made by monitoring programs, so indirect measurements made by the LTRMP in the upper pools are important to evaluation of the criteria and subsequent development of state 305(b) reports as required by the Clean Water Act. In this context, LTRMP monitoring data provide a critical link between monitoring and river management actions.

Proposal for Information Recovery and Data Application

Restoration of some bi-weekly fixed-site monitoring during years of adequate funding will hedge our chances and ability to understand mechanisms driving changes in the UMR system at *a lower cost than any of the FY '07 APE proposals*. Although year-to-year funding for these sites is not guaranteed, it improves the chances of monitoring significant events. Further, each data point collected with routine procedures can be used to compare against historical data, so that no data point is "wasted"; rather it contributes one more point on a continuum of understanding. While important to answer specific questions, one-year research efforts with non-standardized protocols and sites cannot be as easily leveraged against the historical LTRMP database.

Objective:

The UMRCC light criteria recommendation is based on biweekly measurements during the growing season (May 15 to September 15). Under the MSP monitoring is conducted only monthly during the growing season and only at sites located in key pools and their associated tributaries; areas such as Weaver Bottoms that have been intensively managed for SAV are not included under the MSP. The effect of monthly versus biweekly monitoring on the outcome of the criteria is unknown and should be evaluated. We propose to evaluate the effects of two different monitoring frequencies (monthly and biweekly) on the management recommendations that may arise from application of the criteria.

The following fixed-sites are therefore proposed for restoration at two of the LTRMP field stations:

Field Station 1 (Lake City):

1. Restore bi-weekly, fixed-site water quality monitoring in Pool 4 during the summer period by adding 4 more days of sampling (two 2-day sampling episodes – one in July and one in August), resulting in bi-weekly coverage from April through August.

2. Restore monitoring to 6 historical sites in Pool 5 from April through August. This would not result in any additional field days, as the sites would be sampled on the same trips as for the existing sites.

Field Station 2 (Onalaska):

1. Restore bi-weekly, fixed-site water quality monitoring in Pool 8 during the summer period by adding 4 more days of sampling (two 2-day sampling episodes – one in July and one in August), resulting in bi-weekly coverage from April through August.

2. Restore bi-weekly monitoring to 4 historical fixed-sites in Pools 8 and 9 from April through August. This would not result in any additional field days, as the sites would be sampled on the same trips as for the existing sites.

Site details, including rationale and some of the specific intended uses of the data are listed in Table 2.

Table 2. Specific locations and rationale for restored monitoring

Field Station	Pool	Location	Rationale and Specific uses of the data
Lake City	4	Existing sites	Bi-weekly sampling June-August to capture low-flow periods. Fish kills and nuisance algal blooms have occurred during a drought period.
Lake City	5	Inlet & Outlet to Weaver Bottoms	A large degraded backwater area that has had restoration projects implemented. Input/output to the area is important to understanding internal processes. Pool 5 has undergone two years of drawdown, and response monitoring during out-years will provide key feed-back on this experimental management tool.
Lake City	5	Whitewater River	Sediment-laden tributary that empties to Weaver Bottoms.
Lake City	5	LD 5 Transect sites (3)	Output from Pool 5 where several HREP projects are completed, and have undergone two years of drawdown. Response monitoring during out-years will provide key feed-back on response to management efforts
Onalaska	8	Coon Creek	High sediment concentrations input to Pool 8 from a watershed with historic management efforts. Output above Pool 8 HREP phase III, stage 1.
Onalaska	9	Bad Axe River	Tributary to Pool 9 where several HREP projects are in planning stages. Pool 9 has also been selected by the Water Level Management Task Force for drawdown
Onalaska	9	Upper Iowa River	Tributary to Pool 9. The Upper Iowa River delta has been selected by the FWWG for an HREP project, and several others within Pool 9 are in planning stages. The Water Level Management Task Force has also selected Pool 9 for future drawdown
Onalaska	9	Reno Spillway	Output for Pool 8/Input to Pool 9. Embankment projects are in planning stages (NESP or other) that will affect Reno Bottoms in Pool 9. Water quality reflects the impounded portion of Pool 8 where the Pool 8 HREP Phase III islands will be built immediately upstream of this site, changing the sediment re-suspension dynamics. Site is also influenced by the sediment-rich Root River and HREP islands may change associated sediment movements

We propose the following monitoring activities be restored for fiscal year 2007 (proposals to restore these activities in 2008 and 2009 will be submitted in subsequent years):

1. First time period of fish monitoring will be conducted at Pool 13, Pool 26, the La Grange Reach and the Open River Reach.

2. Fixed site water quality monitoring will be restored to Pool 4 and Pool 8 as outlined above.

Objectives

We believe that restoration of the monitoring activities described above will yield multiple benefits to the program, the most important of which likely will be realized in extensive analyses for monitoring program data from the early 1990's to 2009 (when MSP is set to expire). For the purposes of this proposal, however, we will focus on questions and products that can be realized on an annual time frame in accordance with the APE format. For fish monitoring, we will examine the dominant species, defined as the group of species that accounting for the majority (75%) of individuals captured across all four field stations, to address whether strong year-classes were produced. To assess the status of young-of-the-year production for each of the dominant species, a length interval corresponding to YOY will be defined based on comparisons of length data among time periods and mean CPUE and standard error intervals for this YOY length interval in period 1 will be compared to previous years (1994 to 2004) to assess the status of year classes strength (strong - higher mean, non-overlapping standard error; weak – lower mean, non-overlapping standard error, or average – overlapping standard error).

For the water quality component, we will focus on the UMRCC light criteria recommendation, and examine differences in the assessment of this criteria based on monthly versus biweekly monitoring. The effect of monthly versus biweekly monitoring on the outcome of the criteria is unknown and should be evaluated, along with the management recommendations that would arise from application of the UMRCC light criteria. Assessment of underwater light conditions will be made based on secchi disk depth, suspended solids, and turbidity at fixed stations for the growing season (May 15-Sept 15) based on (1) biweekly sampling data and (2) monthly data by dropping the extra sampling events from analyses. A historical analysis of underwater light conditions will be made for select sites to evaluate changes in light penetration through time.

Products:

I. Monitoring data will be added to the LTRMP online database.

II. Project completion report containing:

A. First period fish:

1. Basic catch information
2. List of any species captured only in first time period
3. Assessment of status of young-of-the-year production for dominant species

B. WQ fixed sites:

1. Basic parameter information available for future management assessments and questions
2. Assess the affect of monthly vs. biweekly sampling on the outcomes and potential management recommendations derived from application of the UMRCC water quality light criteria
3. Evaluate effects of additional monitoring on overall variability of the data

Products and milestones

Tracking number	Products	Milestone Dates
2007APE8	Draft completion report	30 December 2007

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2007APE9: Development of sampling designs for estimating mussel abundances associated with HREPs

Introduction/Background: Freshwater mussels are the largest group of endangered animals in North America. Over the past 50 years, about 20 species have been lost from the Upper Mississippi River basin. Mussels are threatened by changes in flow patterns within rivers caused by dams, dikes, and levees; by increases in sediment loads; and by invasive species, such as zebra mussels and Asian carps that compete with mussels for food. Conservation of mussels is of great concern to the States, the Fish and Wildlife Service, and the Corps of Engineers and considerable effort is being expended to assess the effects of proposed habitat rehabilitation projects (HREPs) on mussels. For example, estimates of mussel mortality in 2005 as a result of the drawdown of Pool 5 range from about 100,000 to upwards of several million (WDNR et al. 2005). Similarly, crude estimates of the number of endangered *Lampsilis higginsi* that might be adversely affected by the construction of islands in Pool 11 exceed the incidental take level (500 individuals) identified by the U.S. Fish and Wildlife Service. However, there are two uncertainties in evaluating the potential effects of HREPs on mussels. First, if a given HREP kills some number of mussels, it is usually unknown what proportion of mussels in the pool this represents. For example, if the Pool 5 drawdown killed 100,000 mussels, but there were three million mussels in the pool, then this loss rate *may* be acceptable, given that this represented only 3% of the total mussel population. Second, it is unclear if the short-term loss of mussels may be mitigated by a longer term gain in improved habitat.

Unfortunately, we do not currently have the ability to rigorously assess the importance of the loss of mussels as a result of HREPs. Most surveys of mussels done associated with HREPs involved sampling in the general vicinity of an HREP (e.g., around the footprint of a proposed island or in the dewatered area of a drawdown) and generate data on species composition and abundance at the spatial scale of the HREP. These estimates cannot be used to make inferences at the pool scale because the HREP area cannot typically be presumed representative of the pool. This scale discrepancy is critical because the pool scale represents the effect scale for water-level drawdowns and the scale typically presumed for mussel population analysis in the UMR. Estimates of mussel abundances at both island and pool scales are urgently needed to accurately assess the effects of HREP efforts. Estimates of abundances at the island scale are needed by managers to get high resolution data at the impact site to accurately assess the potential loss of mussels as a result of island construction. Estimates of abundances at the pool scale are needed to put the HREP-level data in perspective with the rest of the pool.

Recently, substantial progress has been made in evaluating sampling designs for mussels in small to medium sized rivers. In these smaller systems, research has suggested that systematic sampling may be appropriate, because it is easy to implement in the field, provides good spatial coverage, and is the preferred design for sampling rare, spatially clustered populations in the absence of prior information on distributions (Christman 2000, Strayer and Smith 2003). Multiple random starts allow valid statistical inference in systematic designs. For example, a study of mussel populations on the Cacapon River, WV, showed that systematic designs were consistently more efficient than stratified random designs, when distances between sampling units were chosen appropriately and > 1 random start was used (Pooler and Smith 2005). Because freshwater mussel populations have patchy distributions at multiple spatial scales, more sampling effort should be allocated in the locations where the organism occurs than where it does not occur (Villella and Smith 2005). Thus, adaptive designs, which allow sampling effort to increase where mussels are found, are promising designs for mussel populations. Examples of adaptive designs are adaptive cluster sampling, sequential sampling, and double sampling for stratification (Salehi and Seber 1997, Strayer and Smith 2003, Salehi and Smith 2005, Villella and Smith 2005).

High cost and difficulty with collecting mussels in large rivers are the central issues separating designs for small to medium sized rivers versus large rivers. The natural approach when a large area must be sampled is to sample in stages. First, divide the large area into medium sized sections or primary sampling units. Second, select primary sampling units using a probability sampling technique. Third, sample within the primary unit. Much of what has been learned about sampling in small to medium sized rivers is directly applicable to the third step, sampling within a primary unit. Thus, the essential challenges to designing surveys for large rivers are 1) how should primary units be defined (i.e., size and shape), 2) how should primary units be selected, and 3) how should sampling effort be allocated within and between primary units?

Relevance of research to UMRS/LTRMP: Over the past 10 years, several attempts have been made to include mussels as a component of the LTRMP, however, the potential costs and the lack of a statistically-rigorous sampling design have generally stalled these efforts. We argue that costs are really unknown because no one has estimated the costs for a statistically-sound sampling program in a large river to get pool-wide estimates of mussel abundances. Under some of the new, more efficient sampling designs, costs may be considerably less than previously anticipated. The proposed research is relevant to the UMRS and the LTRMP because designs for sampling mussels at various scales are urgently needed to provide river managers with tools to rigorously assess the effects of HREPs on mussels. In the longer-term, evaluation of the mussel data generated as a result of the HREPs may be used to refine a sampling plan for the long-term monitoring of mussels in the UMRS.

Methods: We propose to evaluate multiple sampling designs for suitability in obtaining relative density and population estimates at island and pool scales. Most of the accumulated mussel sampling wisdom has been developed for sampling streams. Unfortunately, designs preferred for streams may not be transferable to large rivers because the cost of sampling may be prohibitive, given the large areas to be covered. This work will be done at two spatial scales: (1) the island-scale (the effect scale associated with the footprint of an island HREP) and (2) the pool-wide scale (i.e., spatial scale of most drawdowns). We will use variance estimates from existing quantitative data from studies that employed random sampling (Pool 10, Holland-Bartels et al. 1990; Pool 9, Sietman 2006) and newly acquired estimates from systematic sampling in Pool 5 (to be completed in 2006) to simulate data. Simulated data will be run through various sampling designs (e.g., simple random sampling, systematic sampling with single and multiple starts, probability proportional to size designs, adaptive cluster sampling, two-stage conventional sampling, two-stage adaptive cluster sampling, two-stage sequential sampling, and stratified random sampling) to determine which designs maximize relative efficiency and minimize sampling effort and cost. We will also estimate the costs and precision of estimating mussel abundances within 5, 10 and 20% of the true population.

The proposed work substantially elaborates on existing work by UMESC staff. For example, we were recently asked by the Pool 5 drawdown team to develop a sampling approach for mussels to evaluate the effects of the 2006 drawdown on mussel populations. However, this work on Pool 5 is *preliminary* in that the sampling design was drafted within a short period (about 6 weeks from initial consultation to the sample site estimation) and, consequently, limited data were used to develop the design. The work proposed here will build upon the Pool 5 work in that inferences from the Pool 5 sampling will be including in selecting designs suitable for use throughout the UMR. Thus, the designs proposed in this APE can be used to assess the effects of future HREPs on mussels.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE9	Draft completion report	30 March 2008

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2007APE10: Cumulative HREP effects on ecological characteristics of impounded regions of the Upper Mississippi River

Introduction/Background:

HREPs have been built to partially restore morphometric diversity within the Upper Mississippi River. Despite their cost, however, investigations into the ecological influences of at least island projects using LTRMP data have been limited in scope—being apparently restricted to effects on submersed aquatic vegetation within subsets of the Pool 8 impounded region. We propose to use LTRMP data from the pool with the most island building (Navigation Pool 8) to assess evidence for HREP effects at the impounded stratum scale.

Relevance of research to UMRS/LTRMP:

The proposed study will demonstrate whether HREP effects on ecological characteristics may be discerned at relatively large scales (the region defined as impounded strata of Pool 8) using LTRMP data. Inferences will help those interested in answering the question, 'At what point might the cumulative effects of HREPs be observed at the much larger spatial scales represented by the impounded regions of those pools?'

The cumulative effects of island building on impounded regions may include long-term changes in averages, variances or both. We expect that, as more HREPs were built, i) ecological characteristics in the impounded regions became more similar to those in the backwater regions, ii) ecological characteristics became more variable spatially, and iii) the range of spatial correlation (the area over which ecological characteristics are similar) in the impounded regions decreased. For example, by allowing temporal trends in both annual averages and in sampling variation we may address whether HREP construction has been associated with increased levels of variation (at medium spatial scales), increased variation in vegetation levels (patchiness) or both. We also expect that changes in means and variances were relatively greater in Pool 8 than in a potential reference area (Pool 13) because projects were more extensive in Pool 8.

Methods:

Model cumulative HREP effects on ecological indicators in the impounded region of Pool 8 using LTRMP data from all years through 2006. "Cumulative effects" will be defined as monotonic, multiyear trends in the mean, sampling variance or both.

Associating long-term changes with HREPs requires disentangling HREP-related changes from changes deriving from other temporal effects (such as temperature or discharge): Not doing so risks naively attributing changes due to natural or background sources to island building. As indicated in the letter of intent, we plan to approach this issue by using data from reference regions that are internal to Pool 8 (in addition, to using the impounded region in Pool 13 as a separate reference region). Preliminary reference region selections include the contiguous backwater lake region (where sample sizes are often relatively large) and, for water, the main channel (where local variance is typically relatively low).

For each ecological indicator studied, we intend to build a single model that addresses changes in the mean and sampling variance from the impounded and reference regions. Using models that include all reference regions allows easier comparisons across impounded and reference regions, and across pools.

Continuous (water quality), count (fish and invertebrate) and categorical (vegetation) data will be modeled using linear, count and binomial regression models, respectively. Across both pools, one to two indicators from each of water (e.g., suspended solids), macroinvertebrate (e.g, mayflies), aquatic vegetation (e.g., total SAV, *Vallisneria americana*) and fish (e.g., bluegill CPUE) components will be modeled. The LTRMP component specialists will be asked for further input regarding indicator selection.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE10	Completion report on cumulative HREP effects	30 September 2007

Principal Investigator: Dr. Brian Gray

2007APE11: Aquatic Vegetation and Water Quality Response Two Years after a Summer Drawdown on Navigation Pool 5 of the Upper Mississippi River

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 helping to improve 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 from Pool 5 indicates worse water quality at the outlet of Weaver Bottoms than at the primary inlet (R. Burdis, personal communication 2006).

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 was conducted on Pool 5 during the summer of 2005. The second year of drawdown was begun on June 12th of 2006, but had to be cancelled because of low discharge.

By mimicking the natural low flow hydrograph during the summer period, managers predict 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 long-term effects of a drawdown on emergent vegetation, as well as the short-term and long-term effects on submersed plants and water quality, remain uncertain. The objective of this study is to determine the longevity of a pool-wide summer drawdown's effects on select water quality parameters, and on the abundance, frequency and species richness of emergent, submersed and floating-leafed vegetation.

As adaptive management becomes more of a requirement for restoration projects on the river, more information will be needed by river managers on the long-term effectiveness of drawdowns in re-establishing emergent vegetation and their impact on submersed vegetation and water quality. Continuing to study the response of vegetation and water quality in Pool 5 following a summer drawdown will advance our understanding of a drawdown's effectiveness 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 LTRMP pre-drawdown and during-drawdown data is available for comparison. Aerial photos taken in 2007 would complement the photos taken in 2005 and 2006 and assist in continued assessment of the drawdown's effects on emergent and terrestrial vegetation.

Methods

The Lake City LTRMP Field Station, with assistance from the 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 2007, following protocols described in *Yin et al. (2000)*. Analysis of the data will be done by staff at UMESC or the Lake City Field Station in FY 2008.

Arrangements for aerial photos of Pool 5 to be taken during the summer of 2007 will be made by UMESC staff. True color aerial photos at a scale of 1:10,000 will be taken in mid- to late August during peak plant biomass. The photos will be scanned, orthorectified, and mosaicked into a single image and served to the public via the internet.

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 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 2008.

The same protocols referenced above have been used to monitor vegetation and water quality since monitoring began in Pool 5. Because this project is funded for one year and field work is conducted up to the end of the fiscal year, analysis of the data will need to be done the following fiscal year (FY 2008) and may be contingent to some degree on future funding.

Timeline: Latest date for beginning of project: Expected completion date:

All vegetation sampling would be conducted in August-September 2007.
Aerial photos would be taken in late August 2007.
Water quality sampling would be conducted from late May through September, 2007.
Vegetation and water quality data analysis and reports, along with any aerial photography interpretation and analysis, would have to be done in FY'08 with future APE funds or other external funding.

Expected products [with completion dates]: (Please note that all reports, publications, and manuscripts must go through USGS-Upper Midwest Environmental Sciences Center review.)

Reports for submersed vegetation, emergent vegetation, and water quality will be completed in FY 2008 by UMESC and the Lake City Field Station.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE11	100 true color aerial photos at 1:10,000 scale	31 August 2007

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2007APE12: Ecological Assessment of High Quality UMRS Floodplain Forests

Introduction/Background:
Floodplain forests associated with the Upper Mississippi River System (UMRS) have been significantly reduced in acreage from pre-settlement levels due to timber harvesting, conversion to agricultural cropland, and other land use changes (Yin, 1997). Currently, remaining floodplain forests are significantly affected by the altered hydrological regimes associated with river impoundment. These historical and present day disturbances have contributed to long-term changes in the composition and structure of UMRS floodplain forests (USGS, 1999), as well as negatively affecting their overall health and general condition. A loss of tree species diversity, most importantly the hard mast component (e.g., oaks), has been identified as a prominent management concern in this ecosystem (USACE, 2006). A lack of successful regeneration has also been documented in many areas, which could result in further losses in forest habitat over time. This loss of forest cover and tree species diversity has been projected to continue into the future unless active management of floodplain forests can reverse this trend (Urich et al., 2002).

Floodplain forest restoration is therefore a premier ecological issue in the Upper Mississippi River System, and the lack of natural regeneration of oak and other desirable tree species (Battaglia et al., 2002) is often cited by resource managers as justification for planting targeted species in various floodplain reforestation efforts. However, tree plantings in floodplains using bare root seedlings or direct seeding have often met with mixed results (Stanturf et al., 2001; Dey et al., 2003). In the UMRS, initial assessments indicate that land managers appear to have had a great deal of success using RPM® (Root Production Method) trees for reforestation purposes (Grossman et al., 2003). Regardless of the stock used, but especially with RPM trees, tree plantings can be very expensive for land management agencies working with limited resources. It is therefore essential that methods for rapidly assessing site quality and viability for reforestation and restoration efforts be established for the UMRS. There is also a recognized need for determining when, where and how to apply active management practices in UMRS floodplain forests so as to achieve the degree of success required to justify these actions.

The use of high quality reference sites as targets for ecological restoration efforts is well documented (Allen et al., 2000). There is undeniably a need to delineate and inventory the biological and physical characteristics of remaining high quality URMS floodplain forests for restoration purposes. Complicating this issue, however, is the fact that the underlying landscape (soils, hydrology, etc.) in which UMRS floodplain forests are situated has been so radically altered from a functional standpoint that "restoration" *per se* may be entirely unfeasible in certain locations. For example, mast species may be entirely unsuitable for reforestation in pooled reaches immediately upriver of locks and dams due to their inability to tolerate the continuously elevated water tables encountered in those locations. Species used for reforestation purposes may therefore be best selected by their ability to inhabit specific locations regardless of whether or not they did so historically. In this respect, the use of high quality remnant forests as reference sites may be most useful when their application as such is constrained by a set of diagnostic modifiers appropriate to the functional classification of present day UMRS ecosystems (Comer et al., 2003). What remains unclear is the ability to successfully match potential vegetation communities and individual species with different environmental variables and conditions at localized and/or regional spatial scales. Related to this issue, assessing tree regeneration success is important in determining which set of environmental factors are most important to the continued survival of a diverse assemblage of floodplain tree species.

Relevance:
The objective of this project is to assess the physical and biological characteristics of remaining high quality floodplain forests in the Upper Mississippi River System (UMRS). This assessment will be an integral step towards establishing a suite of baseline ecological reference information that will in turn facilitate future floodplain forest restoration efforts in the UMRS.

It is widely recognized among scientists and resource managers that long-term alterations in the functionality of UMRS floodplain forest ecosystems, primarily related to navigation channel management, have impacted the ecological health of these forests. For example, many UMRS floodplain forests are degrading in quality and progressing towards monotypic stands of silver maple (USGS, 1999). From a scientific perspective, the relationship between various environmental factors that affect ecosystem functionality in floodplain forests and the response of vegetation communities to long-term changes in those factors remains unclear. These relationships need to be clarified in order to facilitate floodplain forest restoration efforts. To address this issue, we first need to define and assess high quality remaining floodplain forests as reference sites to provide targets for reforestation/restoration efforts by land management agencies. Examination of remnant communities that have successful regeneration is particularly desirable as it is critical to determine the environmental requirements for floodplain species in the modern floodplain before developing restoration guidelines. This will require surveying locations with remnant forest communities that represent the desired direction of restoration efforts (e.g., mature bottomland hardwoods with an acceptable level of species diversity).

From a management perspective, agencies responsible for restoring bottomland hardwoods and other vegetation communities in the UMRS need to know which suite of environmental variables are best suited to serve as indicators for appropriate vegetation types in conjunction with the restoration process. However, successfully matching potential vegetation communities and individual species to different environmental conditions requires a stronger foundation of baseline ecological information. This project will facilitate restoration efforts by providing a means to rapidly assess the suitability of particular species to potential sites based on an assessment of site conditions. This will in the long run reduce costs by targeting specific species and/or communities to potential restoration sites, thereby avoiding costly "trial and error" approaches to restoration efforts.

This project directly addresses the floodplain forest theme by incorporating the issues of loss of floodplain forest diversity, long-term alterations in ecosystem functionality, long-term effects of river management on floodplain forests, lack of natural regeneration, reforestation, restoration, active forest management, and the needs of resource managers.

Methods:
Site selection: Criteria for the selection and categorization of study sites in selected portions of the UMRS and the lower Illinois River will be established (e.g., high quality forests should have an assemblage of species that is characteristic of historical precedents for that forest type in terms of composition and diversity, evidence of successful natural regeneration, and little or no evidence of impaired ecosystem functionality). It is anticipated that initial selection of high quality reference sites will likely rely to some degree on recommendations of experienced site managers and other field personnel. It is also anticipated that high quality sites may be difficult to find depending on the threshold set forth in the selection criteria. In this event it may be more feasible to include some sites that are impaired to a certain degree, but that still comprise a functional ecosystem. The inclusion of high profile sites that have been targeted for restoration planning is also a distinct possibility (e.g., Ted Shanks Conservation Area in Pool 24).

Site assessment:
For the purposes of this project, *biological characteristics* will refer to metrics used to describe the vegetation present on study sites. Vegetation to be sampled at each site will consist of overstory trees, understory trees and shrubs, tree regeneration (saplings and seedlings), and herbaceous species. Biological characteristics described by the study will utilize common ecological metrics such as species composition, species richness and diversity, density, overstory basal area, age, structure, and relative presence of invasive species. *Physical characteristics* will refer to quantitative and qualitative environmental parameters that are considered to play an important role

in maintaining floodplain forest ecosystem functionality (e.g., hydrologic regime, connectivity to river, elevation, soil texture, soil total Nitrogen and OM content, photosynthetically active radiation (PAR) available to tree regeneration, and canopy openness).

Data collection related to biological and physical characteristics will utilize a nested plot protocol, replicated at each study site as logistical considerations and spatial constraints permit. Our goal is to locate a minimum of twelve sites in the UMRS that contain high quality floodplain forest, within which we will establish three permanent vegetation plots. The corners of each plot will be marked with rebar, capped with PVC, and tagged with a unique identifying plot code. Plots will be 20x50 m and will contain nested 1x1 m, 3x3 m, and 10x10 m subplots. Cover of herbaceous vegetation will be measured in the $1m^2$ subplots; height of woody seedlings will be measured in the $9m^2$ subplots; diameter at breast height (DBH) of saplings will be measured in the $100m^2$ subplots; and DBH of remaining trees will be measured in the remainder of the plot.

To characterize the canopy conditions in our reference sites, we will take color fisheye canopy photographs 1.5 m from the ground surface at 25 randomly selected points in each 20x50 m plot. We will use the GLA software package for calculating for calculating percent canopy openness of each image, as well as relative PAR available to understory vegetation. A hand-held light meter (AccuPAR Linear PAR/LAI ceptometer, Model PAR-80) will also be utilized to acquire real-time absolute PAR measurements at each of these points.

Eighteen soil samples will be taken from random locations within each 20x50 m plot. Six of those will be subjected to textural analysis using the Bouyoucas hydrometer method in the lab to determine percent sand, silt and clay. Six samples will be analyzed for total Carbon and Nitrogen. Soil bulk density will be determined for the remaining six samples.

Each study site will be characterized by its degree of connectivity to the river by determining its position in the landscape relative to levees and other flood control structures. Hydrologic regime at each site will be characterized by a combination of factors, including flood periodicity, relative position within pool reach (e.g., lower, middle or upper pool), and degree of fluctuation of corresponding average seasonal river elevations.

Elevational gradients are hypothesized to be a statistically significant environmental parameter influencing the composition and structure of floodplain vegetation, but consistently detailed elevational records are generally lacking throughout the URMS floodplain. Therefore, fine-scale elevation data will be obtained at each study site through the use of sophisticated survey equipment such as a Topcon Total Station.

Data analysis: We will use multivariate statistical techniques such as non-metric multidimensional scaling to examine compositional trends in these forest communities. Then we will apply vector fitting and corresponding Monte Carlo permutation tests to test for significance of different environmental variables to the ordinations. These procedures are readily available in several commercial statistical software packages (e.g., DECODA, PRIMER, and PC-ORD). It is hypothesized that elevation, hydrological regime and soil texture (e.g., percent clay) will likely be significantly related to community trends in these ordinations. As they are also likely the most readily accessible and easily measured environmental variables in site specific locations, this will in effect serve to streamline preliminary site assessments by resource managers seeking to re-establish and/or restore vegetation as part of an environmental management program in the UMRS. At any rate, multivariate community ordination should enable us to identify a set of significant, explanatory variables that provide insight into community structure. This will be of use not only to resource managers, but also to other scientists interested in incorporating such information into models designed to facilitate future restoration efforts at local and/or regional scales.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE12	Draft LTRMP Report	30 December 2007

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2007APE13: Assessment of high-resolution digital imagery for UMRS vegetation mapping and software-based vegetation classification

Introduction/Background

Since 1989, the LTRMP has acquired many thousands of frames of aerial imagery at considerable collection, processing, and printing cost. These images were needed to support the development of land cover/land use (LCU) datasets and aerial photo mosaics which were, in turn, used by river resource managers and scientists in monitoring and assessing the river's status.

Development of LCU data is also a time-consuming and expensive process. Stereo pairs are interpreted by hand onto clear acetate overlays. These overlays are scanned, georeferenced or orthorectified, converted from a raster format to vectors, then labeled and converted into a final coverage that can be served over the internet for use in a GIS. Systemic LCU datasets were developed for the UMRS based on photography collected in the late-summers of 1989 and 2000. In addition, numerous other LCU dataset have been created for various UMRS study areas since 1989. Another systemic flight of the UMRS is planned for 2010 with an updated LCU dataset generated from that imagery.

Much of this imagery has been collected in cooperation with Region 3 of the Fish and Wildlife Service. The Region employs a fixed-wing, twin engine Partenavia observation plane mounted with a Zeiss Jena LMK2000 9"X9" that was co-purchased by UMESC in July of 1990. This camera has been a workhorse but is nearing the end of its effective lifespan and has needed frequent repairs the last few years. Because of the failure rate and the Region's ongoing need to collect imagery, it is considering a switch to all digital collection method.

Relevance of research to UMRS/LTRMP

Retiring the 9"X9" film camera and its associated costs (aerial film that fluctuates in price and availability, and its subsequent processing, printing, scanning and storage) in favor an all-digital solution has many advantages to both Region 3 and the LTRMP partnership, should they choose to participate. Digital cameras are smaller, lighter, and are typically bundled with software and hardware that can generate orthorectified images on-the-fly at resolutions that can be tailored to a project's need – from three inches per pixel or better to one meter per pixel or coarser, depending on flying height. All images are stored directly on removable hard drives for immediate download to personal computers. Images are stored as four-band (RGB-IR, or Red, Green, Blue, near Infrared), 12-bit images and can be displayed as either gray-scale, natural color, or color infrared.

As digital image acquisition technology matures, software companies are developing programs that divide and classify these images based on pixel spectral values. These programs need supervision and training to consistently recognize values as land cover classes but offer the possibility of classifying large amount of imagery in a fraction of the time needed to hand-delineate vegetation and convert that information to format suitable for use in a GIS. This process not only facilitates rapid response and documentation of study areas and significant events (i.e.; floods, drawdowns), but also the faster turnaround of classified resource data.

Methods

Ten-inch per pixel digital imagery of the Pool 5 drawdown response was acquired on September 15, 2006 using the Vexcel UltracamD digital camera (11,500 X 7,500 pixels) by Keystone Aerial Surveys, Inc., Philadelphia, PA. Imagery, processed to true color and color infrared, will be orthorectified and mosaicked into a single image for the entire pool. The mosaicked image will be imported in the Feature Analyst (Visual Learning Systems, Inc.) where a subsetted study area will be segmented by spectral values and those values trained to represent vegetation classes.

Additionally, 9”X9” true color aerial photography was acquired on August 22, 2006 at a scale of 1:12,000, which closely approximates the resolution of the UltracamD (9,000 ft X 9,000 ft. vs. 9,583 ft X 6,250 ft.) A photogrammetric scanner will be used to scan the film at 1200 dots per inch to generate an equivalent resolution image. These scans will also be orthorectified to 10 inches pre pixel for comparison purposes. The same subsetted study area will be photointerpreted and generated into an LCU dataset by traditional methods. Both datasets will then be summarized and compared. A report will document the similarities and differences and strengths and weaknesses of each approach. Total time from beginning of image classification to development of final GIS coverage will also be tracked. A report detailing the results of the study and all data generated by the study will be made available to the LTRMP partners.

Products and milestones

Tracking number	Products	Milestone Dates
2007APE13	Draft completion report	31 December 2007

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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 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 was 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.

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. In FY06, a set of indicators was developed for use in this Report and a first draft was prepared. A final draft of the report will be prepared in FY07 with publication late in FY07.

Products and Milestones

Tracking number	Products	Milestones
2007S&Ta	Draft report available for technical review (30 day review period)	15 February 2007
2007S&Tb	Final draft report submitted for editorial review	29 June 2007
2007S&Tc	Report printed and distributed	31 October 2007

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 Barry Johnson (USGS - UMESC) and Karen Hagerty (USACE – Rock Island District), who will be working closely to coordinate the development of the Report.

LTRMP Strategic Planning Process

Develop a 5-year strategic and tactical plan to guide LTRMP implementation from FY2010–2014. The strategic portion of the plan will identify what the program is going to do and the tactical section will explain how in general overarching terms. The tactical portion of the plan will not replace the detailed implementation plans the partnership will need to develop in response to this plan. At the end of the planning process, the objective is to have a five-year plan endorsed by all of the EMP program partner agencies.

DURATION of the PLANNING PROCESS: Discussion begins in February 2007 and the planning process and 5-year LTRMP Strategic/Tactical Plan is anticipated to be completed by July 2008. Report out to EMP-CC in August, presenting the strategic/tactical plan and seeking endorsement from the partnership. Make final changes to the plan (if needed) by September 2008 leaving approximately 12 months to prepare for implementation before FY 2010 commences in October 2009. It is acknowledged that this is an aggressive schedule that will require considerable commitment from all participants and may necessitate some shifts in resources and priorities. However, a relatively short, focused effort will be more efficient, ensure completion in time for partners to make necessary transitions, and leave room for schedule adjustments if warranted during the process.

A. Maintenance and Enhancements of Graphical Browsers
B. Update UMRS Land Cover Viewer with ArcSDE technology
C. Historical Data Delivery

A. Maintenance and Enhancements of Graphical Browsers

The LTRMP Graphical Data Browsers are online tools that query the LTRMP database and return the results to the user's browser in a graphical format. They provide quick visual access to data for the water, vegetation and fish components. Data visualization tools can present LTRMP data in an intuitive, visual format that alleviates the requirement of substantial post-processing by users.

Methods:

- **Update Water, Vegetation and Fish Graphical Browsers -** LTRMP 2007 component data will be incorporated into the Graphical Browsers.
- **Enhance Vegetation Graphical Browser –** The current graphical browser displays vegetation occurrence at point locations where vegetation was recorded based on stratified random sampling. The new browser will provide aerial maps of species distribution based on a geo-spatial extrapolation of the point data, therefore, enhancing the visualization effects of species-habitat correlation.

Graphical Fish Database Browser
Annual sampling data will be added to the Oracle tables that the Graphical Fish Browser queries.

Products and Milestones

Tracking number	Products	Staff	Milestones
2007VTa	Maintenance of graphical fish browser. Update annual sampling tables	Ickes (MSP), Caucutt (MSP), Schlifer	30 September 2007

Graphical Vegetation Database Browser
Annual sampling data will be added to the Oracle tables that the Graphical Vegetation Browser queries. An enhancement will be made on the displaying of graphs and distribution maps.

Products and Milestones

Tracking number	Products	Staff	Milestones
2007VTb	Maintenance of graphical vegetation browser. Update annual sampling tables	Sauer (MSP), Schlifer, Caucutt (MSP)	30 December 2007
2007VTc	Enhance display of graphics for the Graphical Vegetation Browser	Yin (MSP), Schlifer, Caucutt (MSP)	30 December 2007

Graphical Water Quality Browser for Fixed and Stratified Random Sampling Sites
All LTRMP water quality sampling data will be added to the Oracle tables for both fixed and stratified random sampling graphical browsers.

Products and Milestones

Tracking number	Products	Staff	Milestones
2007VTd	Maintenance of Graphical Water Quality Browser Fixed Site (Pools 4, 8, 13, 26, Open River, and La Grange)	Houser (MSP), Schlifer, Kratt, Caucutt (MSP)	30 November 2007
2007VTe	Maintenance of Water Quality Browser Graphical for Stratified Random Sampling sites	Houser (MSP), Rogala (MSP), Caucutt (MSP), Schlifer	30 November 2007

Mike Caucutt will be the principle investigator.

B. Upper Mississippi River Land Cover Viewer

Mapping an area the size of the Upper Mississippi River system provides many challenges and problems; however, the distribution of these data is critical. Using Internet-based mapping software, we are able to view and print the LTRMP Land Cover data. The Upper Mississippi River Land Cover Viewer allows users to quickly create and view maps of the Upper Mississippi River Land Cover data. The ability to perform spatial modeling across a network is a recent development in GIS technology. The current technology used at UMESC is Arc Internet Mapping Server (ArcIMS). With ArcIMS the user is limited to viewing and querying data. ArcServer is a relatively new technology that allows for the creation of web enabled analytical tools that perform functions, such as buffering, clipping, surfacing, and spatial editing. These functions could previously be done only on a desktop GIS. The Land Cover Viewer will be updated using ArcServer technology.

Methods: Data layers will be ported over to the ArcServer and a viewing application will be created.

Products and Milestones

Tracking number	Products	Staff	Milestones
2007VTf	Update Land Cover Viewer ArcIMS server to ArcServer	Fox	30 September 2007

Personnel: Tim Fox will be the principle investigator.

C. Historical Data Delivery

The Surface Processes Research Group (SPRG) at Southern Illinois University, Carbondale (SIUC) along with the United States Geological Survey's (USGS's) Upper Midwest Environmental Science Center (UMESC) will develop a repository for Mississippi River System hydrologic and geospatial data. The purpose of this repository will be to serve data sets compiled by SPRG through UMESC, making them available to research, management, policymaking, and public interests within the Mississippi River Basin.

At present the Surface Processes Research Group's hydrologic database consists of nearly 5.5 million observations of daily stage and 1 million observations of daily discharge from 257 gauging stations along the Mississippi, Lower Missouri, and Illinois rivers. The period of record for most of these stations is greater than 50 years and some exceed 140 years. Many of these hydrologic data are currently not available in any integrated format, or from existing USGS or U.S. Army Corps of Engineers publicly accessible internet databases.

The SPRG's geospatial database consists of at least 50 historic reach-scale map sets and bathymetric surveys which extend back to the early- to mid-1800's. Spatially, these map sets cover most navigable portions of the entire Mississippi River, the Lower Missouri River, and the Illinois River.

Methods:

1) Transfer of the data will occur between SPRG and UMESC via File Transfer Protocol (FTP)
2) Project all rectified map sets in a common geographic coordinate system;
3) Complete metadata for the hydrological and geospatial data;
4) Develop an Internet-based repository and tools for serving these data.

All geospatial data (map sets) will be provided to UMESC in UTM Zone 15, NAD83 projection. Metadata for many of these data sets will also be furnished to UMESC. However, UMESC will provide technical assistance in completing the Metadata to the necessary standards. In addition, UMESC will be responsible for developing and maintaining the repository.

Product description:

The primary product produced from this collaboration will include internet-accessible databases for both the hydrologic and geospatial data for extents outlined above. In addition, this project will serve as a model for developing other virtual data repositories on other river systems.

UMESC will assist with the quality control, formatting, organization, and serving of all spatial data products generated from the database.

Products and Milestones:

Tracking number	Products	Staff	Milestones
2007VTg	Quality control, formatting and organization of historical data. Online delivery of historical data	Lowenberg, Nelson, Caucutt (MSP)	30 December 2007
2007VTh	Develop specifications, purchase and configure ArcGIS Server	Fox	30 June 2007
2007VTi	Construct GeoDatabase and mapping web service	Fox	30 February 2008
2007VTj	Creation of an online viewer (ArcServer) of historical data	Fox	30 March 2008

Personnel: Brian Ickes will be the principal investigator.

LiDAR Acquisition

Recent advances in remote sensing technology now allow for timely and affordable collection of high resolution topographic data. Light Detecting and Ranging (LiDAR) equipment uses aircraft mounted lasers too quickly and accurately measure ground elevation to within 6 inches which is considered its absolute accuracy. Once collected, the topographic information is served in several formats including raw x, y, z point ASCII text, one meter digital elevation models (DEMs), and two foot contour maps.

Iowa is currently moving forward with a program to acquire LiDAR topographic data for the entire state. This has provided an opportunity to partner with them in an effort to obtain a large portion of the UMRS floodplain bordering the state. Partnering with Iowa offers several advantages including being able to obtain the LiDAR data at a much lower price, utilizing a sound and tested LiDAR data collection process for the Midwest, and having the state of Iowa generate DEMs and other final product layers at no cost. This initial effort will focus on collecting data for a UMRS reach bordering Iowa (Navigation Pool 8 through 24). The data will extend from top of bluff to top of bluff to ensure coverage of the entire UMRS floodplain.

Product Description:
High resolution topographic data has regularly been identified as a high priority data need for improved ecosystem restoration and management. As mentioned in the 2000 UMRS Habitat Needs Assessment Report, this information is critical to improving our ability to forecast successional change of UMRS floodplain habitats. The elevation information will enhance restoration project planning and design by allowing the ability to more accurately model hydrologic regimes and system connectivity. Characteristics of inundation frequency, groundwater elevation and geomorphology can also be captured and modeled. When combined with existing bathymetric data, this information would generate a seamless topographic surface for the entire UMRS floodplain allowing researchers and planners to model and compare multiple water management scenarios.

LiDAR data collected for this project will meet FEMA specifications. These specs, available on the FEMA web site (http://www.fema.gov/plan/prevent/fhm/lidar_4b.shtm) and currently in place for selected portions of Iowa, include 1.4 meter postings processed and filtered suitable for generation of 2-foot contours at a 95% confidence interval. Details of Iowa DNR's FEMA specs on data accuracy are also provided below. Data will be flown in the fall of 2007 during leaf off and low water conditions to ensure collection of the most accurate and comprehensive data.

<u>FEMA Specifications for Data Accuracy</u>
Data collected under this Task Order shall have the following accuracy requirements:
1) Vertical Bare earth accuracy shall be 18.5 cm RMS or better
2) Vertical in Vegetation accuracy shall be 37 cm RMS or better
3) Horizontal 1m RMS.
4) No data voids due to system malfunctions or lack of overlap.
5) Dense vegetation data voids minimized by automated and manual removal process
6) Artifact/Feature removal:
   (a) 90% of artifacts or more removed depending on terrain and vegetation,
   (b) 95% or better of outliers removed,
   (c) 95% of all vegetation removed,
   (d) 98% of all buildings removed.

The data for the LTRMP area of interest (blufftop-to-blufftop for Navigation Pools 8-24) will be delivered as filtered, bare-earth ASCII XYZ text files and LAS-format files. These data will then be served by UMESC as ASCII XYZ, 1-meter DEMs and TINs, 2-foot contours, and representations of slope, aspect, and hillshades.

Products and Milestones

Tracking number	Products	Milestones
2007LiDARa	Final extent of data collection identified and specified	31 July 2007
2007LiDARb	LiDAR information provided to POCs (Raw data)	31 January 2008
2007LiDARc	Final topographic data products provided to USGS and USACE POCs by Iowa DNR (Processed data)	30 March 2008

Primary POCs: USACE - Hank DeHaan (Henry.C.DeHaan@mvr02.usace.army.mil)
USGS - Larry Robinson (lrobinson@usgs.gov)
IA DNR - Chris Ensminger (Chris.Ensminger@dnr.state.ia.us)

In FY07, USACE will develop and manage the contract for data acquisition and UMESC has the responsibility for managing the collection and providing consultation as necessary. All initial funds for this effort will be directed towards data acquisition and product generation (2007 LiDARa – LiDARc).

In FY08, UMESC will coordinate the generation and serving of the final LiDAR-derived products. This will be a collaborative effort among USGS, USACE, and the Iowa DNR. Additional funds will be required for serving the data products via the USGS web site.

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.

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.

Survey areas will be identified as priorities by LTRMP and EMP and will based on data needs for projects and specifically itemized pool coverages.

MVS:
Cuivre Island, 263 acres. EMP project completed in 1999. Data will be used to compare post-project condition to pre-project to determine if project features have achieved the desired objective of providing bathymetric diversity for fish habitat (Performance Evaluation Report currently being generated); data will also be used to evaluate rate of sedimentation in area side channel habitat.

MVR:
Huron Island, Pool 18. HREP in feasibility phase. Data used to complete detailed modeling for HREP and Pool Plan under development.

MVP:
North and Sturgeon lakes in Pool 3 are scheduled to be mapped in FY07. This information is required to aid in restoration work.

Products and Milestones

Tracking number	Products	Milestones
2007BATHa	Anticipated Schedule from each District POC to primary POC (cc M. Hubbell)	1 June 2007
2007BATHb	Final data call to UMESC POC	30 Sept. 2007
2007BATHc	Brief (~1 page) summary report (where, what, how, when, $) (J. Rogala and 3 District POCs) to J. Sauer (cc M. Hubbell)	30 Sept. 2007

Corps District POC:
MVS (St. Louis): Keith Short (Keith.L.Short@mvs02.usace.army.mil)
MVR (Rock Island): Nicole McVay (Nicole.M.McVay@mvr02.usace.army.mil)
MVP (St. Paul): Mark Upward (Mark.S.Upward@mvp02.usace.army.mil)

UMESC POC: Jim Rogala (jrogala@usgs.gov)

Landscape ecology indicators applied to the Upper Mississippi River System.

This project will focus on using LTRMP data to develop landscape ecology metrics for the UMRS river corridor and floodplain. These metrics will then be analyzed to determine their relation to ecological processes and to the distribution and abundance of various ecosystem indicators. Metrics will be developed for different locations and time periods, which will encompass a wide range of habitat conditions for comparisons. Both aquatic and terrestrial indicators will be considered. Other data sets outside of LTRMP can be included as needed and as available. The results from this project will help to determine the usefulness of landscape ecology metrics as indicators of ecosystem condition or health and as a means to set target for system rehabilitation. This is expected to be a 2 year project conducted by a post-doctoral researcher. A report in the form of a draft manuscript for publication in a peer reviewed journal will be produced at the end of year 2.

Personnel
USGS has the lead responsibility for this project. The primary point of contact will be Barry Johnson (USGS - UMESC).

Appendix A: FY07 Budget Summary under Continuing Resolution

		FEDERAL	NON-FEDERAL	COE	TOTAL
MSP	Aquatic Vegetation Sampling	$ 271,824	$ 226,591	$ -	$ 498,415
	Fisheries Sampling	$ 254,543	$ 919,022	$ -	$ 1,173,565
	Water Quality Sampling	$ 532,943	$ 838,519	$ -	$ 1,371,462
	Statistical Evaluation	$ 131,681	$ -	$ -	$ 131,681
	Data Management	$ 444,678	$ -	$ -	$ 444,678
	Science Management Support	$ 213,859	$ -	$ -	$ 213,859
	Bathymetric Component	$ 19,344	$ -	$ -	$ 19,344
	Land Cover/Use	$ 130,490	$ -	$ -	$ 130,490
Total		**$ 1,999,362**	**$ 1,984,132**	**$ -**	**$ 3,983,494**

APE's	#1 - Importance of UMR to Neotropical Migratory Birds	$ 203,607	$ -	$ -	$ 203,607
	#2 - Asian Carp Effects on Zooplankton in Backwaters		$ 43,222	$ -	$ 43,222
	#3 - Does LTRMP CPUE Data Reflect Variation		$ 102,486	$ -	$ 102,486
	#4 - Analysis of Waterbird Data	$ 76,932	$ -	$ -	$ 76,932
	#5 - Status & Trends of Floodplain Forest on UMR	$ 81,044	$ 25,000	$ 8,000	$ 114,044
	#6 - Primary Production & Dissolved Oxygen Dynamics	$ 93,752	$ 4,431	$ -	$ 98,183
	#7 - Fish Assemblage & Off-channel type	$ 35,716	$ 2,701	$ -	$ 38,417
	#8 - Restoration of Monitoring	$ 21,816	$ 49,163	$ -	$ 70,979
	#9 - Development of Sampling Design Estimating Mussels	$ 101,464	$ -	$ -	$ 101,464
	#10 - HREP Effects on Ecological Characteristics	$ 38,765	$ -	$ -	$ 38,765
	#11 - Veg & WQ Response to Pool 5 Drawdown	$ 23,528	$ 8,291	$ -	$ 31,819
	#12 - Ecological Assessment UMRS Floodplain Forests		$ 117,898	$ -	$ 117,898
	#13 - Assessment High-Resolution Digital Imagery	$ 29,865	$ -	$ -	$ 29,865
Total		**$ 706,489**	**$ 353,192**	**$ 8,000**	**$ 1,067,681**

Additonal LTRMP Funding	APE Management	$ 41,000	$ -	$ -	$ 41,000
	Equipment Refreshment	$ 15,969	$ 104,803	$ -	$ 120,772
	Status & Trends	$ 144,000	$ -	$ 50,000	$ 194,000
	Stratigic Planning	$ 100,000	$ 25,750	$ 50,000	$ 175,750
	Glide Path	$ -	$ 22,000	$ -	$ 22,000
	Visualization Tools	$ 52,000	$ -	$ -	$ 52,000
	Post Doc	$ 170,000	$ -		$ 170,000
	Bathymetry	$ -	$ -	$ 42,000	$ 42,000
	LIDAR			$ 270,000	$ 270,000
	Pub Hub	$ 5,303	$ -		$ 5,303
Total		**$ 528,272**	**$ 152,553**	**$ 412,000**	**$ 1,092,825**

LTRMP 2007 TOTAL	**$ 3,234,123**	**$ 2,489,877**	**$ 420,000**	**$ 6,144,000**
FY 06 Carryover		$ 40,000		$ 40,000
ADJUSTED LTRMP TOTAL	**$ 3,234,123**	**$ 2,449,877**	**$ 420,000**	**$ 6,104,000**

Appendix B: Minimum Sustainable Program Condensed Budget under Continuing Resolution. Includes full cost accounting.

AQUATIC VEGETATION SAMPLING

Salaries	FTE	Total
UMESC	1.67	$ 243.0
States	3.11	$ 200.4
Total salaries	**4.78**	**$ 443.4**
Travel/Ops		
UMESC		$ 11.8
Enterprise publishing		$ 17.0
States		$ 26.2
Total travel/ops		**$ 55.0**
COMPONENT TOTAL	**4.78**	**$ 498.4**

FISHERIES SAMPLING

Salaries	FTE	Total
UMESC	1.60	$ 206.2
States	11.82	$ 833.6
Total salary	**13.42**	**$ 1,039.8**
Travel/Ops		
UMESC		$ 22.0
Enterprise publishing		$ 26.4
States		$ 85.4
Total travel/ops		**$ 133.8**
COMPONENT TOTAL	**13.42**	**$ 1,173.6**

WATER QUALITY SAMPLING

Salaries	FTE	Total
UMESC	3.60	$ 431.3
States	10.97	$ 741.3
Total salaries	**14.57**	**$ 1,172.6**
Travel/Ops		
UMESC		$ 71.7
Enterprise publishing		$ 30.0
States		$ 97.2
Total travel/ops		**$ 198.9**
COMPONENT TOTAL	**14.57**	**$ 1,371.5**

STATISTICAL EVAL MONITORING DATA

Salaries	FTE	Total
UMESC	0.60	$ 101.6
Travel/Ops		$ 30.0
Component Total	**0.60**	**$ 131.6**

BATHYMETRIC COMPONENT

Salaries	FTE	Total
UMESC	0.15	$ 19.3
Travel/Ops		$ -
Component Total	**0.15**	**$ 19.3**

LAND COVER/USE

Salaries	FTE	Total
Sub-total salaries	1.00	$ 126.1
Travel/Ops		$ 4.4
Component Total	**1.00**	**$ 130.5**

DATA MANAGEMENT

Salaries	FTE	Total
UMESC	2.48	$ 313.4
Travel/Ops		$ 131.3
Component Total	**2.48**	**$ 444.7**

SCIENCE MANAGEMENT SUPPORT

Salaries	FTE	Total
UMESC	1.20	$ 199.2
Travel/Ops		$ 14.7
Component Total	**1.20**	**$ 213.9**

TOTAL MSP	**38.19**	**$ 3,983.5**

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

#1 - Importance of UMR to Neotropical Migratory Birds

Salaries		**Total**
UMESC	0.61	$ 108.5
States		
EROS	0.40	$ 56.2
Sub-total salary	**1.01**	**$ 164.7**
Travel/Ops		
UMESC		$ 38.9
States		
Sub-total travel		**$ 38.9**
COMPONENT TOTAL	**1.01**	**$ 203.6**

#2 - Asian Carp Effects on Zooplankton in Backwaters

Salaries		**Total**
States	0.80	$ 36.8
Sub-total salary	**0.80**	**$ 36.8**
Travel/Ops		
UMESC		
States		$ 6.4
Sub-total travel		**$ 6.4**
COMPONENT TOTAL	**0.80**	**$ 43.2**

#3 - Does LTRMP CPUE Data Reflect Variation in Abundance

Salaries		**Total**
States	1.00	$ 72.0
Sub-total salary	**1.00**	**$ 72.0**
Travel/Ops		
UMESC		
States		$ 30.5
Sub-total travel		**$ 30.5**
COMPONENT TOTAL	**1.00**	**$ 102.5**

#4 - Analysis of Water bird Data

Salaries		**Total**
UMESC	0.98	$ 71.8
Sub-total salary	**0.98**	**$ 71.8**
Travel/Ops		
UMESC		$ 5.1
States		
Sub-total travel		**$ 5.1**
COMPONENT TOTAL	**0.98**	**$ 76.9**

#5 - Status & Trends of Floodplain Forest on UMR

Salaries		Total
UMESC	0.62	$ 20.5
States	0.50	$ 25.0
COE		$ 8.0
Sub-total salary	**1.12**	**$ 53.5**
Travel/Ops		
UMESC		$ 60.5
States		
Sub-total travel		**$ 60.5**
COMPONENT TOTAL	**1.12**	**$ 114.0**

#6 - Primary Production & Dissolved Oxygen Dynamics

Salaries		Total
UMESC	0.82	$ 52.0
States	0.06	$ 4.4
Sub-total salary	**0.88**	**$ 56.4**
Travel/Ops		
UMESC		$ 41.8
States		
Sub-total travel		**$ 41.8**
COMPONENT TOTAL	**0.88**	**$ 98.2**

#7 - Association of Fish Assemblages & Off-Channel Type

Salaries		Total
UMESC	0.23	$ 31.3
States	0.10	$ 2.5
Sub-total salary	**0.33**	**$ 33.8**
Travel/Ops		
UMESC		$ 4.4
States		$ 0.2
Sub-total travel		**$ 4.6**
COMPONENT TOTAL	**0.33**	**$ 38.4**

#8 - Restoration of Monitoring

Salaries		Total
UMESC	0.26	$ 14.3
States	1.00	$ 49.2
Sub-total salary	**1.26**	**$ 63.5**
Travel/Ops		
UMESC		$ 6.0
States		$ 1.5
Sub-total travel		**$ 7.5**
COMPONENT TOTAL	**1.26**	**$ 71.0**

#9 - Development of Sampling Design Estimating Mussels

Salaries		Total
UMESC	0.25	$ 43.6
LSC	0.12	$ 50.6
Sub-total salary	**0.37**	**$ 94.2**
Travel/Ops		
UMESC		$ 7.3
States		
Sub-total travel		**$ 7.3**
COMPONENT TOTAL	**0.37**	**$ 101.5**

#10 - HREP Effects on Ecological Characteristics

Salaries		Total
UMESC	0.22	$ 18.1
Sub-total salary	**0.22**	**$ 18.1**
Travel/Ops		
UMESC		$ 20.7
States		
Sub-total travel		**$ 20.7**
COMPONENT TOTAL	**0.22**	**$ 38.8**

#11 - Vegetation & Water Quality Response to Pool 5 Drawdown

Salaries		Total
UMESC	0.04	$ 4.8
States	0.04	$ 7.1
Sub-total salary	**0.08**	**$ 11.9**
Travel/Ops		
UMESC		$ 18.7
States		$ 1.2
Sub-total travel		**$ 19.9**
COMPONENT TOTAL	**0.08**	**$ 31.8**

#12 - Ecological Assessment of UMRS Floodplain Forests

Salaries		Total
States	0.50	$ 18.2
Sub-contacts		$ 98.8
Sub-total salary	**0.50**	**$ 117.0**
Travel/Ops		
UMESC		
States		$ 0.9
Sub-total travel		**$ 0.9**
COMPONENT TOTAL	**0.50**	**$ 117.9**

#13 - Assessment of High-Resolution Digital Imagery

Salaries		Total
UMESC	0.18	$ 18.9
Sub-total salary	**0.18**	**$ 18.9**
Travel/Ops		
UMESC		$ 11.0
States		
Sub-total travel		**$ 11.0**
COMPONENT TOTAL	**0.18**	**$ 29.9**

TOTAL APE PROPOSALS	**8.73**	**$ 1,067.7**

APE SCIENCE MANAGEMENT

Salaries		Total
UMESC	0.22	$ 41.0
Sub-total salary	**0.22**	**$ 41.0**
Travel/Ops		
UMESC		$ -
Sub-total travel/ops		**$ -**
COMPONENT TOTAL	**0.22**	**$ 41.0**

EQUIPMENT REFRESHMENT

UMESC		$ 16.0
Lake City		$ 11.1
Pool 8		$ 14.3
Bellevue		$ 5.4
Pool 26		$ 21.2
La Grange		$ 5.2
Open River		$ 47.6
COMPONENT TOTAL		**$ 120.8**

STATUS & TRENDS

Salaries		Total
UMESC	0.63	$ 100.8
COE		$ 50.0
Sub-total salary	**0.63**	**$ 150.8**
Travel/Ops		
UMESC		$ 43.2
Sub-total salary		**$ 43.2**
COMPONENT TOTAL	**0.63**	**$ 194.0**

APE SCIENCE MANAGEMENT

Salaries		Total
UMESC	0.22	$ 41.0
Sub-total salary	**0.22**	**$ 41.0**
Travel/Ops		
UMESC		$ -
Sub-total travel/ops		**$ -**
COMPONENT TOTAL	**0.22**	**$ 41.0**

EQUIPMENT REFRESHMENT

UMESC		$ 16.0
Lake City		$ 11.1
Pool 8		$ 14.3
Bellevue		$ 5.4
Pool 26		$ 21.2
La Grange		$ 5.2
Open River		$ 47.6
COMPONENT TOTAL		**$ 120.8**

STATUS & TRENDS

Salaries		Total
UMESC	0.63	$ 100.8
COE		$ 50.0
Sub-total salary	**0.63**	**$ 150.8**
Travel/Ops		
UMESC		$ 43.2
Sub-total salary		**$ 43.2**
COMPONENT TOTAL	**0.63**	**$ 194.0**

STRATEGIC PLANNING

Salaries		Total
UMESC	0.30	$ 100.0
COE		$ 50.0
Sub-total salary	**0.30**	**$ 150.0**
Travel/Ops		
States		$ 25.7
Sub-total salary		**$ 25.7**
COMPONENT TOTAL	**0.30**	**$ 175.7**

GLIDE PATH

Saleries		**Total**
States	0.50	$ 22.0
COMPONENT TOTAL	**0.50**	**$ 22.0**

VISUALIZATION TOOLS

Salaries		**Total**
UMESC	0.36	$ 52.0
Sub-total salary	**0.36**	**$ 52.0**
Travel/Ops		
UMESC		$ -
Sub-total salary		**$ -**
COMPONENT TOTAL	**0.36**	**$ 52.0**

POST DOC

Salaries		**Total**
UMESC	2.00	$ 170.0
Sub-total salary	**2.00**	**$ 170.0**
Travel/Ops		
UMESC		$ -
Sub-total salary		**$ -**
COMPONENT TOTAL	**2.00**	**$ 170.0**

BATHYMETRY

Salaries		**Total**
COE		$ 42.0
Sub-total salary		**$ 42.0**
Travel/Ops		
COE		$ -
Sub-total salary		**$ -**
COMPONENT TOTAL		**$ 42.0**

LIDAR

Salaries		**Total**
COE		$ 270.0
Sub-total salary		**$ 270.0**
Travel/Ops		
COE		$ -
Sub-total salary		**$ -**
COMPONENT TOTAL		**$ 270.0**

PUB HUB

Salaries		**Total**
UMESC		$ -
Sub-total salary		**$ -**
Travel/Ops		
UMESC		$ 5.3
Sub-total salary		**$ 5.3**
COMPONENT TOTAL		**$ 5.3**

ADMINISTRATIVE/TECHNICAL APES	**4.01**	**$ 1,092.8**