LTRMP FY11 Scope of Work

Outcome 1, Output 1.1

Outcome 2, Output 2.1

Outcome 2, Output 2.2

Long Term Resource Monitoring Program

Aquatic Vegetation Component
Outcome 1; Output 1.1[1]

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

Methods

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

Products and Milestones

Tracking number	Products	Staff	Milestones
2011A1	Complete data entry and QA/QC of 2010 data; 1250 observations.		
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Bierman	30 November 2010
	b. Data loaded on level 2 browsers	Schlifer	15 December 2010
	c. QA/QC scripts run and data corrections sent to Field Stations	Sauer	28 December 2010
	d. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Bierman	15 January 2011
	e. Corrections made and data moved to public Web Browser	Sauer, Schlifer, Caucutt	30 January 2011
2011A2	WEB-based annual Aquatic Vegetation Component Update with 2010 data on Public Web Server.		
	a. Develop first draft	Sauer	28 February 2011
	b. Reviews completed	Popp, Dukerschein, Bierman, Sauer, Yin	28 March 2011
	c. Submit final update	Sauer	18 April 2011
	d. Placement on Web	Sauer, Caucutt	31 July 2011
2011A3	Complete aquatic vegetation sampling for Pools 4, 8, and 13 (Table 1)	Popp, Dukerschein, Bierman	31 August 2011
2011A4	Web-based: Creating surface distribution maps for aquatic plant species in Pools 4, 8, and 13; 2010 data	Yin	31 July 2011
2011A5	Final Draft LTRMP Report: Ecological Assessment of High Quality UMRS Floodplain Forests (2007APE12)	Chick, Guyon, Battaglia	30 September 2011
2011A6	Final Draft:		
Intended for distribution			
Completion report: LTRMP Aquatic Vegetation Program Review (Heglund; 2007A9)			
Manuscript: Importance of the Upper Mississippi River Forest Corridor to Neotropical Migratory Birds (Kirsch, 2007APE1)			

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

Literature Cited

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

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

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

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

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

Personnel

Dr. Yao Yin will be the principal investigator.

Fisheries Component
Outcome 1; Output 1.1

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

Methods

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

Products and Milestones

Tracking number	Products	Staff	Milestones
2011B1	Complete data entry, QA/QC of 2010 fish data; ~1,590 observations		
	a. Data entry completed and submission of data to USGS	Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	31 January 2011
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	Schlifer	15 February 2011
	c. Field Station QA/QC with corrections to USGS	Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	15 March 2011
	d. Corrections made and data moved to public Web Browser	Sauer and Schlifer	30 March 2011
2011B2	Update Graphical Browser with 2010 data on Public Web Server.	Sauer, Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	31 May 2011
2011B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River, and La Grange Pool (Table 1)	Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	31 October 2011
2010B4	Draft revision and update of the LTRMP fisheries component procedures manual	Sass, Ratcliff	28 February 2011
2008B9	Draft manuscript: Standardized CPUE data from multiple gears for community level analysis (a previous manuscript was submitted and rejected by the journal, 2006B5; 2008B9 is a revised manuscript)	Chick	31 January 2011

2006B6	Draft manuscript: Spatial structure and temporal variation of fish communities in the Upper Mississippi River. (Dependent on 2008B9 acceptance into journal)	Chick	30 September 2011
2007B4	Draft completion report: Proportional biomass contributions of Non-native fish to UMRS fish communities	Ickes	30 January 2011
2007APE3	Draft LTRMP report: Testing the Fundamental Assumption underlying the use of LTRMP fish data: Does variation in LTRMP catch-per-unit-effort data reflect variation in the abundance of fishes?	Chick	30 March 2011

Intended for distribution
Manuscript: Evaluation of a Catch and Release Regulation for Largemouth Bass in Brown's Lake, Pool 13, Upper Mississippi River (2007B7; Bowler)
Completion report: LTRMP Fisheries Component collection of six darter species from 1989–2004. (2006B13; Ridings)
Manuscript: O'Connell, M.T. with A.M. Uzee-O'Connell and Valerie A. Barko. (in press) Occurrence and predicted dispersal of bighead carp (*Hypophthalmichthys nobilis*) in the Mississippi River System: Development of a Heuristic Tool in D. Chapman and M. Hoff (editors). Asian Carp Symposium Proceedings, American Fisheries Society Symposium. (2005APE13; Barko)
LTRMP Report: An Evaluation Of Macroinvertebrate Sampling Methods For Use In The Open River Reach of The Upper Mississippi River; Kathryn N. S. McCain, Robert A. Hrabik, Valerie A. Barko, Brian R. Gray, and Joseph R. Bidwell (2005C2)
LTRMP report: Relationship of juvenile abundance of select fish species to aquatic vegetation in Navigation Pools 4, 8, and 13 of the Upper Mississippi River, 1998-2007 (2007B5; 2009B5; Popp and DeLain)
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. (McCain, 2007B8)
Completion Report: A Proposal to restore Specific Monitoring Elements to the LTRMP (Year 1 of restored monitoring; 2007APE8)

[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

Brian Ickes will be the principal investigator.

Water Quality Component
Outcome 1; Output 1.1

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

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

Methods

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

Fixed site sampling

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

Stratified random sampling

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

In situ data collection

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

Laboratory analyses

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

Products and Milestones

Tracking number	Products	Staff	Milestones
2011D1	Complete calendar year 2010 fixed-site water quality sampling	Houser, Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	31 December 2010
2011D2	Complete laboratory analysis of 2010 fixed site and SRS data; Data loaded to Oracle data base.	Yuan	30 March 2011
2011D3	Complete data entry, QA/QC of calendar year 2010 fixed-site and SRS data.	Rogala. Popp, Dukerschein, Bierman, Chick, Sass, Hrabik	30 May 2011

2011D4	Complete FY11 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 2011
2011D5	WEB-based annual Water Quality Component Update with 2010 data on Public Web Server.	Rogala	30 June 2011
2011D6	Draft manuscript: "Relationships among nutrients, connectivity, sediment characteristics, metaphyton and submersed aquatic vegetation in the Upper Mississippi River." (From 2009APE3)	Houser	15 April 2011
2005APE26	Final draft LTRMP report: retrospective, cross-component analysis for Pool 26	Chick	30 November 2010
2010D6	Draft manuscript on changes in substrate, water quality, aquatic vegetation, zooplankton, and fish community from Geomorphic Reach 1 (above Lake Pepin) to Geomorphic Reach 3 (below Lake Pepin).	Popp	30 December 2010

Intended for distribution
Completion report: Examining nitrogen and phosphorus ratios N:P in the unimpounded portion of the Upper Mississippi River (2006D9; Hrabik & Crites)
Completion report: Lake Pepin zooplankton and water quality data (2006D7; Popp & Burdis)
Manuscript: Comparison of zooplankton in the UMR between channel and backwater strata (2009D6; Burdis) (submitted to Hydrobiologia 26 August 2010 under the title "zooplankton dynamics in main channel and backwater habitats of the UMR"
LTRMP report: Main channel/side channel report for the Open River Reach. (2005D7; Hrabik)
Completion report: Evaluation of Factors Influencing Metaphyton Abundance and Distribution on Navigation Pools 4, 8, and 13 of Upper Mississippi River (Giblin, 2009D7)
Manuscript: "Relationships among nutrients, connectivity, sediment characteristics, metaphyton and submersed aquatic vegetation in the Upper Mississippi River." (Houser, 2009APE3)
Manuscript: Primary production, and dissolved oxygen dynamics in UMRS backwater lakes and main channel. (2007D8, Houser)

Literature Cited

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

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

Personnel

Dr. Jeff Houser will be the principal investigator.

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

In FY2010, systemic digital aerial photography was collected in cooperation with USFWS Region 3. The main task under Land Cover/Land Use will be in processing these data (See Development of 2010 Land Cover/Land Use GIS Database and Aerial Photo Mosaics)

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

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

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

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

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

3. Continue to update the detailed spreadsheet of all LTRMP aerial photography currently housed at UMESC, including date, pool location, format (color infrared, natural color, black-and-white), scan status (yes/no, dots per inch), interpreted status, photo scale, and extent of coverage (partial or complete). This document will be updated as necessary. The photo inventory browser is currently under development. This online application utilizes Adobe Flash to provide the user with an interactive geographical overview of the Upper Mississippi River with links to a large

selection of aerial photos. In addition to this, an updateable Excel spreadsheet will also be available to post online that is organized by year, then pool.

Products and Milestones

Tracking number	Products	Staff	Milestones
Intended for distribution			
Completion Report: Assessment of high-resolution digital imagery for UMRS vegetation mapping and software-based vegetation classification (2007APE13; Robinson)			

Personnel

Larry Robinson will be the principal investigator.

Development of 2010–2011 Land Cover/Land Use GIS Database and Aerial Photo Mosaics
Outcome 1; Output 1.1

Development of the 2010–2011 Land Cover/Land Use (LCU) Geographic Information System (GIS) database will provide a third systemic dataset to compare the 1989 and the 2000 systemic coverages. Though a crosswalk was needed to compare 1989 and 2000 since different vegetation classification systems were used, the 2000 and 2010 LCU datasets will use the same classification and classifiers, making them directly comparable. Once completed, the 2010–2011 dataset will be invaluable in assessing and evaluating long-term vegetation trends and habitat changes over the past 20 years, and in assessing the current state of floodplain vegetation.

Objectives
Develop a 2010/11 LCU GIS database for Pools 1-26, the Open River Reach, the entire Illinois River, and the navigable portions of Minnesota, St. Croix, and Kaskaskia Rivers of the UMRS. Note: Extensive flooding on the Middle Mississippi River below the Quad Cities required aerial photography on Pools 14-Open River to be postponed until the late-summer of 2011.

Methods
Aerial photographs Pools 1-13 and the entire Illinois River were collected in color infrared (CIR) in August of 2010 at 8”/pixel and 16”/pixel respectively using a mapping-grade Applanix DSS 439 digital aerial camera. These CIR aerial photos will be orthorectified, mosaicked, compressed, and served via the UMESC Internet site. The CIR aerial photos will be interpreted and automated using a 31-class LTRMP vegetation classification (see Attachment A). The 2010/11 LCU database will be prepared by or under the supervision of competent and trained professional staff using documented standard operated procedures and will be subject to rigorous quality control (QC) assurances (NBS, 1995). The LTRMP trend Pools, 4, 8, 13 on the Mississippi River and the entire Illinois River will be processed. The trend pools whose imagery will be collected in late summer 2011 (Pool 26 and Open River South) will follow and be automated and interpreted beginning in FY12 pending funding.

Systemic Flight of UMRS - Fly the entire UMRS in CIR at 8”/pixel for Pools 1-13 and at 16”/pixel for Pools 14-26 and the Illinois River.

- Orthorectify, Mosaic, and Serve the 2010 CIR Aerial Photography - UMESC has the capability to compress and mosaic high-resolution scans of the 2010 imagery. These georeferenced photos would provide a base map on which existing LCU data and future LCU data could be overlaid. These photos also offer the ability to do visual-based land use or habitat analysis. These photos would be made available, by pool or reach, through UMESC's internet home page.

- Trend Pool Automation of 2010 Systemic Aerial Photography – Trend Pools 4, 8, 13 on the Mississippi River and the entire Illinois River will be interpreted using the same 31-class vegetation classification system used to classify the 2000 systemic aerial photography (see Attachments A). Year 2010 LCU databases will be prepared by or under the supervision of competent and trained professional staff using documented standard operated procedures and will be subject to rigorous quality control (QC) assurances (NBS, 1995). The LTRMP study areas will be processed first, beginning with Pools 4, 8, 13, and the La Grange Pool of the Illinois River.

Products and Milestones

Tracking number	Products	Staff	Milestones
2011V1	Acquire late-summer digital aerial photographs for Pools1-13 on the Mississippi River and the entire Illinois River	Robinson	1 October 2010
2011V2	Complete orthorectified photo mosaics of all imagery collected in 2010 (Task B).	Robinson	28 February 2011
2011V3	Complete 2010 databases for UMR Pool 13 and La Grange Pool	Robinson	30 April 2011
2011V4	Complete 2010 databases for UMR Pools 4 and 8	Robinson	30 June 2011
2011V5	Complete 2010 databases for UMRS Alton, Peoria, Starved Rock, Marseilles, Dresden, Brandon, and Lockport.	Robinson	31 August 2011
2011V6	Acquire late-summer digital aerial photographs for Pools 14-Open River South	Robinson	30 September 2011

Personnel

Larry Robinson will be the principal investigator.

ATTACHMENT A
LTRMP 31-Class General Vegetation Classification, Version 1.0

CODE	CODE DESCRIPTION	HYDROLOGY DESCRIPTION	DESCRIPTION
OW	Open Water	Permanently Flooded Non-Forest	Open Water; Default to Anderson Classification
RFA	Rooted Floating Aquatics	Permanently Flooded Non-Forest	Permanently flooded temperate or subpolar hydromorphic rooted vegetation
SV	Submerged Aquatic Vegetation	Permanently Flooded Non-Forest	Permanently flooded temperate or subpolar hydromorphic rooted vegetation
DMA	Deep Marsh Annual	Semipermanently Flooded Non-Forest	Semipermanently flooded temperate or subpolar grassland
DMP	Deep Marsh Perennial	Semipermanently Flooded Non-Forest	Semipermanently flooded temperate or subpolar grassland
MUD	Mud	Seasonally Flooded Non-Forest	Seasonally/Temporarily flooded mudflats
SMA	Shallow Marsh Annual	Seasonally Flooded Non-Forest	Seasonally flooded temperate or subpolar grassland
SMP	Shallow Marsh Perennial	Seasonally Flooded Non-Forest	Seasonally flooded temperate or subpolar grassland
SM	Sedge Meadow	Temporarily Flooded Non-Forest	Temporarily flooded temperate or subpolar grassland
WM	Wet Meadow	Saturated Soil Non-Forest	Saturated temperate or subpolar grassland
DMS	Deep Marsh Shrub	Semipermanently Flooded Shrubs	Semipermanently flooded cold-deciduous shrubland
SMS	Shallow Marsh Shrub	Seasonally Flooded Shrubs	Seasonally flooded cold-deciduous shrubland
WMS	Wet Meadow Shrub	Temporarily Flooded Shrubs	Temporarily flooded cold-deciduous shrubland
SS	Shrub/Scrub	Infrequently Flooded Shrubs	Temperate cold-deciduous shrubland
WS	Wooded Swamp	Semipermanently Flooded Forest	Semipermanently flooded cold-deciduous closed tree canopy
FF	Floodplain Forest	Seasonally Flooded Forest	Seasonally flooded cold-deciduous closed tree canopy
PC	Populus Community	Seasonally Flooded Forest	Seasonally flooded cold-deciduous closed tree canopy
SC	Salix Community	Seasonally Flooded Forest	Seasonally flooded cold-deciduous closed tree canopy
BHF	Bottomland Hardwood Forest	Temporarily Flooded Forest	Temporarily flooded cold-deciduous closed tree canopy
CN	Conifers	Infrequently Flooded Forest	Rounded-crowned temperate or subpolar needle-leaved evergreen forest
PN	Plantation	Infrequently Flooded Forest	Plantation
UF	Upland Forest	Infrequently Flooded Forest	Lowland or submontane cold-deciduous closed tree canopy
AG	Agriculture	Infrequently Flooded Non-Forest	Annual row-crop forbs or grasses
DV	Developed	Infrequently Flooded Non-Forest	Developed; Default to Anderson Classification
GR	Grassland	Infrequently Flooded Non-Forest	Tall sod temperate grassland
LV	Levee	Infrequently Flooded Non-Forest	Levee; Default to Anderson Classification
PS	Pasture	Infrequently Flooded Non-Forest	Perennial Grass Crops
RD	Roadside Grass/Forbs	Infrequently Flooded Non-Forest	Roadside Grass/Forb; Default to Anderson Classification
SB	Sand Bar	Temporarily Flooded Non-Forest	Temporarily flooded sand flats
SD	Sand	Infrequently Flooded Non-Forest	Dunes with sparse herbaceous vegetation
NPC	No Photo Coverage	n/a	No Photo Coverage; n/a

VEGETATION MODIFIERS
Density A = 10-33% B = 33-66% C = 66-90% D = > 90%
Height* 1 = 0-20 ft. 2 = 20-50 ft. 3 = > 50 ft. *Trees only

Thematic accuracy assessment and validation for the Upper Mississippi River System floodplain from 2010/2011 land cover/land use data

The USGS-Upper Midwest Environmental Sciences Center (UMESC) has been responsible for development of several land cover/land use (LCU) systemic data sets of the Upper Mississippi River System (UMRS) floodplain (1989, 2000). These efforts were funded by the Environmental Management Program's Long Term Resource Monitoring Program (LTRMP). Development of systemic data sets include the acquisition, processing, and serving of high resolution aerial photography and land cover/land use spatial data sets (http://www.umesc.usgs.gov/data_library/land_cover_use/land_cover_use_data.html). In 2008, the EMP reached a collaborative agreement with the U.S. Fish and Wildlife Service's Region 3 Office to collect high-resolution digital imagery of the entire UMRS floodplain in 2010/2011 for LTRMP. The UMESC will help acquire, process, and serve this imagery, as well as produce and serve the 2010/2011 LCU systemic data set of the UMRS floodplain.

While the 1989 and 2000 LCU systemic data sets have not gone through a traditional thematic accuracy assessment in the past, the end products have been of high quality. For each systemic data set produced (1989, 2000, 2010/11), extensive field reconnaissance/groundtruthing is performed before photointerpretation to learn, test, and verify image signatures as they relate to the vegetation types. Questionable areas on the imagery are visited and the plants or land features observed in the area are recorded for reference. This procedure verifies vegetation signatures on the photographs with those on the ground. In addition, once the photointerpretation is complete, the final LCU data set undergoes extensive quality assurance/quality control to ensure the imagery is mapped correctly.

Since the last LCU systemic data set was developed, there has been a growing interest in completing thematic accuracy assessments (AA) for the LTRMP LCU spatial data sets. The objective of an AA is to measure the probability that a particular location has been assigned its correct vegetation class. An AA estimates thematic (map class) errors in the data, giving users information needed to determine data suitability for a particular application. At the same time, data producers are able to learn more about the nature of errors in the data. Thus, the two views of an AA are "producers' accuracy," which is the probability that an AA point has been mapped correctly (also referred to as an error of omission), and "users' accuracy," which is the probability that the map actually represents what was found on the ground (also referred to as error of commission). Producers' and users' accuracies can be obtained from the same set of data by using different analyses.

A pilot thematic accuracy assessment study was completed on an UMRS 2001 LCU spatial data set of Pool 8 (May 2002). At the genus level, results of this study calculated the overall accuracy produced with a kappa index to be 83.8%. At the General Wetland Vegetation Map Class (Dieck and Robinson 2004) level, the overall accuracy was calculated with a kappa index to be 88.5%. Currently, the goal is to expand on this work and complete a thematic accuracy assessment on select pools throughout the UMRS using LCU data from the 2010/2011 LCU spatial data sets of the UMRS.

STUDY AREA AND GENERAL WORK PLAN

This Scope of Work describes an AA for Pools 13 and La Grange. During a thematic accuracy assessment, random points are generated based on area of each natural/semi-natural map class. Field crews are sent into the field to record the vegetation type at each of the selected sites. (Note that there will be issues with accessing private property.) This data would then be brought back to the office, entered into a database, and compared to the map by two individuals not involved with the mapping of the LCU spatial data set. The types of errors are then identified and a contingency table is produced showing the map class errors and what they were missed to.

If continued funding is available in FY12 and FY13, validation will also be utilized to produce accuracy results of a LCU spatial data set. Validation is not a true verification of map class type in the field, however can provide the user of the map with useful information that is very similar to a field accuracy assessment. Validation would involve generating random points based on area for all map classes. Two individuals not involved with the mapping would review each of the points onscreen and record an agreed upon map class. This data would then would be entered into a database and compared to the map. The types of errors are then identified and a contingency table is produced showing the map class errors and the map classes they were missed to.

All of the pools selected for AA or Validation will be in different geomorphic reaches of the UMRS and have different levels of land cover complexity, with the intent to extrapolate results from these pools to other pools with similar landscape complexity and to give a holistic view of the accuracy of the LCU spatial data sets throughout the UMRS.

Accuracy Assessment

Project study areas identified for a field accuracy assessment are Pools 13 and La Grange, UMRS. These are LTRMP focal pools and LTRMP field station staff associated with these pools have the appropriate skills to conduct the field portion of the accuracy assessment. By targeting these pools, travel costs can be minimized.

Once a pool's LCU spatial data set is finalized, a thematic accuracy assessment will be performed on that pool to determine the accuracy of the map classes. All General Wetland Vegetation Map Classes (Dieck and Robinson 2004) representing National Vegetation Classification Standard (NVCS) natural/semi-natural types (Table 1) (FGDC 2008) will be assessed using the stratified random sampling scheme described in the Thematic Accuracy Assessment Procedures: Version 2.0 (Lea 2010). UMESC staff will use these guidelines to determine the appropriate buffer and the number of sites for each map class in each pool.

Table 1. The General Wetland Vegetation Map Classes with their respective map codes representing National Vegetation Classification Standard natural/semi-natural types.

Map Class	Map Code
Submersed Vegetation	SV
Rooted Floating Aquatics	RFA
Deep Marsh Annual	DMA
Deep Marsh Perennial	DMP
Shallow Marsh Annual	SMA
Shallow Marsh Perennial	SMP
Sedge Meadow	SM
Wet Meadow	WM
Deep Marsh Shrub	DMS
Shallow Marsh Shrub	SMS
Wet Meadow Shrub	WMS
Scrub-Shrub*	SS
Wooded Swamp	WS
Floodplain Forest	FF
Populus Community	PC
Salix Community	SC
Lowland Forest	LF
Conifers*	CN
Plantation*	PN
Upland Forest*	UF
Grassland*	GR
Pasture*	PS
Mudflat	MUD

Sand Bar	SB

***** Represents classes typically located on private lands and will require extensive work to gain permission to access

The number of samples needed for each map class (theme) take into account both the statistical and operational aspects of sampling and will be determined for each pool, as suggested in the following scenarios (Lea 2010):

- Scenario A:The class is abundant. It covers more than 50 hectares in total area. The map class receives the maximum sample size of 30.

- Scenario B:The class is relatively abundant. It covers at least 8.33 hectares, but no more than 50 hectares in total area. The map class receives a sample size of 0.6 observations per hectare of the map class (= one observation for every 1.67 hectares of map class area). (This ratio allocates observations at a density rate equal to 30 observations per 50 hectares).

- Scenario C:The class is relatively rare. It covers less than 8.33 hectares in total area. The map class receives 5 observations (the recommended minimum sample size).

UMESC will buffer each sampling site from the polygon boundary to eliminate the possibility that the observed area (a circular area approximately the size of the minimum mapping unit) is of mixed map class identity due to (1) confusion as to whether the observation area is wholly contained within the map class, (2) positional error due to GPS error and (3) allowable positional error in the map data. The National Map Accuracy Standard requirement for positional accuracy of 1:24,000 scale products is 12.2 meters (FGDC, 1998).

To calculate the required buffer distance, the square root of the sum squares of these error sources will be calculated with the following formula:

$$\text{Buffer Distance} = \sqrt{R^2 + F^2 + M^2}$$

where R is the radius distance of the observation area, F is the expected (e.g., 90th percentile) field positioning (GPS) error distance, and M is the standard requirement (maximum positional error distance in the map) for positional accuracy.

The minimum mapping unit (MMU) for the 2010/2011 LCU spatial data sets north of Lock & Dam 13, UMRS is 0.4 ha (1 acre). Given this MMU, the radius length of a circular 0.4 ha area is 36 meters, representing the value of R. The value of F is generalized to 15 meters, and the value of M is generalized to 12 meters. Therefore, a buffer distance of 41 meters will be applied to the interior polygon boundaries north of Lock & Dam 13.

The minimum mapping unit (MMU) for the 2010/2011 LCU spatial data sets south of Lock & Dam 13, UMRS and the Illinois River is 1.0 ha (2.47 acre). Given this MMU, the radius length of a circular 1.0 ha area is 56 meters, representing the value of R. The value of F is generalized to 15 meters, and the value of M is generalized to 12 meters. Therefore, a buffer distance of 59 meters will be applied to the interior polygon boundaries south of Lock & Dam 13, UMRS and the Illinois River.

Once the number of sites is determined and the buffer is applied, random AA points will be generated for each map class using Hawth's Tools for ArcGIS (Beyer, H.L. 2004), or equivalent tool. These AA-site

coordinates (UTM projection, Zone 15 or Zone 16, using NAD83) will be provided to the field crews to upload into GPS receivers to navigate. UMESC will provide the field crews with 1:12,000-scale hard-copy maps displaying the locations of the accuracy assessment sites, land stewardship, and the pools boundary overlaid on the CIR imagery.

Field observation data will be collected by field station staff. At the start of the project, UMESC staff will support the collection of accuracy assessment points, assist in planning and liaison with field station staff, and lead the training for the field crews. In addition, UMESC will complete a mid-season field visit with the field crews to ensure data collection standards are being maintained. Field crews will navigate to the pre-selected AA sites using GPS and the hard-copy maps. Using a field key (Appendix 1), the field crews will determine the appropriate General Wetland Vegetation Class. Field crews will assess a circular area approximately the size of the minimum mapping unit. It is important for the crews to do this assessment in a single vegetation community (i.e., not crossing into another vegetation type). In instances where the point selection process is not able to select points with an adequate distance from other vegetation polygons because the vegetation type was in a very small or linear polygon, the hard-copy maps with AA points will include lines that mark the interpreted boundaries between two map classes.

Within the target assessment area, crews will record GPS coordinate location in the field, dominant species, environmental data, and pertinent comments on the LTRMP Accuracy Assessment Field Form (Appendix 2). The field key will direct the crew to the General Wetland Vegetation Class that best fits the site, and the map class will also be recorded. If the area was not homogeneous (containing more than one General Wetland Vegetation Class), a second General Wetland Vegetation Class can also be listed on the data sheet. Lastly, problems encountered while keying out the AA point will also be recorded.

Throughout the field season, the LTRMP Accuracy Assessment Field Forms will be sent to UMESC where data entry will be done by students. The data will be entered into an Access database, developed by UMESC staff. The database will subsequently be reviewed by a second individual for data entry errors. Once the data entry is complete, UMESC staff will complete a spatial join of the AA data with the LCU shapefile layer, and two individuals not involved with the initial mapping process will complete an analyses of the map's accuracy. During this process, the class determined in the field is compared to the designation on the map for each point. If map and field determinations are conflicting, then an attempt is made to reconcile the difference. Differences may occur when points fall in transition zones between map class types or in areas that are too small to map. GPS errors also account for some discrepancies. These kinds of errors, termed false errors, are corrected, reconciling the land cover map with the field determinations.

After false errors have been identified and reconciled, a contingency table is generated (Table 2). The contingency table shows the accuracy of each map class (along with 90% confidence intervals), with the users' accuracy reflecting errors of inclusion (commission errors) and producers' accuracy reflecting errors of exclusion (omission errors) for each map class. The width of each confidence interval is affected by the sample size used to derive the point estimate. The contingency table also shows the frequency of agreement and placement of disagreements among map classes, as well as the overall accuracy of the map. The goal is to meet the standard of 80% accuracy set by the National Park Service (Environmental Systems Research Institute et al. 1994; Lea 2010) across all assessed map classes.

Table 2. Example of an accuracy assessment contingency table. Columns tabulate the producer's accuracy by showing errors of exclusion (omission errors) present in the map. Rows tabulate the users' accuracy by showing errors of inclusion (commission errors) present in the map. The overall accuracy of the map is also reported.

		FIELD SAMPLES - REFERENCE DATA																		COMISSION			
	MAP CODES	SV	RFA	DMP	SMA	SMP	SM	WM	DMS	SMS	WMS	SS	FF	PC	SC	LF	UF	GR	PS	TOTAL	USERS' ACCUR-ACY	90% Confidence Intervals	
																						-	+
MAP DATA - PREDICTION DATA	SV	11						1			1									13	85%	64%	105%
	RFA		13								1									14	93%	78%	108%
	DMP			6																6	100%	92%	108%
	SMA			1	9	1														11	82%	58%	105%
	SMP					10														10	100%	95%	105%
	SM						5													5	100%	90%	110%
	WM							0												0	x	x	x
	DMS								11											11	100%	95%	105%
	SMS	1			1					25	3									30	83%	70%	96%
	WMS				1						28									29	97%	89%	104%
	SS											2	1							3	67%	5%	128%
	FF												3							3	100%	83%	117%
	PC													1						1	100%	50%	150%
	SC														5					5	100%	90%	110%
	LF															2				2	100%	75%	125%
	UF																2			2	100%	75%	125%
	GR																	1		1	100%	50%	150%
	PS																		1	1	100%	50%	150%
OMISSION	Total	12	13	7	11	11	5	1	11	25	33	2	4	1	5	2	2	1	1	147			
	PRODUCERS' ACCURACY	92%	100%	86%	82%	91%	100%	0%	100%	100%	85%	100%	75%	100%	100%	100%	100%	100%	100%	135			
	90% Confidence Interval -	74%	96%	57%	58%	72%	90%	-50%	95%	98%	73%	75%	27%	50%	90%	75%	75%	50%	50%	Total Samples = 147			
	90% Confidence Interval +	109%	104%	115%	105%	110%	110%	50%	105%	102%	97%	125%	123%	150%	110%	125%	125%	150%	150%	Total Correct = 135			

OVERALL ACCURACY = 91.8% KAPPA INDEX = 90.7% KAPPA INDEX LOWER 90% CONFIDENCE LEVEL = 86.4% KAPPA INDEX UPPER 90% CONFIDENCE LEVEL = 95.0%

Products and Milestones

There are no product deliverables for FY11 (see time schedule below). Pool 13 and La Grange Pool accuracy assessment will begin in summer FY11. Other work will be in FY12 and FY13 pending funding.

A draft LTRMP Completion Report that includes an accuracy assessment contingency table for Pool 13 and La Grange Pool, a validation contingency table for Pools 8, 13, and 26, and a comparison of the two methods (thematic accuracy assessment & validation) will be delivered 30 September 2013.

TIME SCHEDULE

Pool	Method	Start Date	End Date
13	Accuracy Assessment	Summer 2011 (FY11)	Summer 2012 (FY12)
13	Validation	Fall 2011 (FY12)	Summer 2012 (FY12)
26	Validation	Fall 2012 (FY13)	Summer 2013 (FY13)
OR South	Validation	Fall 2012 (FY13)	Summer 2013 (FY13)
La Grange	Accuracy Assessment	Summer 2011 (FY11)	Summer 2012 (FY12)

Personnel

Jennifer Dieck will be the principal investigator.

References

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Lea, C. 2010. Thematic Accuracy Assessment Procedures. Version 2.0. National Park Service Vegetation Inventory. National Park Service, Fort Collins, CO.

May, M.S. 2002. Thematic map accuracy assessment of Pool 8, Upper Mississippi River: A pilot study. MSc Thesis, St. Mary's University of Minnesota, Winona, Minnesota.

Appendix 1. Classification key for the General Wetland Vegetation Classification System. (Dieck and Robinson, 2004).

Note that the key gives examples of some, but not all, of the predominant vegetation types in the UMRS. The user of the key may need to extrapolate from the examples given and link certain species (e.g., *Polygonum*) to a similar hydrology. The user of the key will also look at the actual percent of the relative cover for each vegetation type. This will determine which of the 31 general classes best describes the area observed. For example, the vegetation in an area may have a total cover of 90%, with a relative cover of 60% *Sagittaria* and 30% *Scirpus*. The dominant vegetation type will determine which of the 31 general classes would best describe the area. In this example, Deep Marsh Perennial would best describe the area observed because *Sagittaria* is the dominant vegetation type. A more specific list of the predominant species and common 31 general classes associated with the genera found in the UMRS are in Appendix 3.

Classification key	Map code
1a Vegetation <10% of the area	**2**
2a Aquatic - Open water, or Lemnaceae sparse enough to see <10% submerged vegetation present, or Lemnaceae too dense to see submerged vegetation	**OW**
2b Terrestrial	**3**
3a Residential homes, homesteads in rural settings, farmsteads, industrial complexes, parks, locks and dams, marinas, boat launches, rip-rap, or newly constructed artificial islands	**DV**
3b Exposed mud or sand	**4**
4a Mudflat	**MUD**
4b Sand	**5**
5a Sand bar	**SB**
5b Sand dunes, sand spoil banks, beaches, and other sandy areas that are upland	**SD**
1b Vegetation >10% of the area (not including Lemnaceae)	**6**
6a Includes residential homes, homesteads in rural settings, farmsteads, or parks	**DV**
6b Does not include residential homes, homesteads in rural settings, farmsteads, or parks	**7**
7a Shrub cover <25% of the area and tree cover <10% of the area	**8**
8a Submerged vegetation >10% of the vegetation; all other life forms <10% of the vegetation	**SV**
8b At least one nonsubmerged species >10% of the vegetation, submerged vegetation may be present or absent	**9**
9a Rooted-floating aquatics (e.g., *Nelumbo, Nymphaea, Nuphar*) >50% of the vegetation	**RFA**
9b Annual or perennial emergents or perennial grasses/forbs >50% of the vegetation	**10**
10a Annual or perennial emergents >50% of the vegetation	**11**
11a Rooted floating aquatics >10% of the vegetation	**DMP**
11b Rooted floating aquatics <10% of the vegetation	**12**
12a Deep marsh species (e.g., *Pontederia, Sagittaria, Sparganium, Typha, Zizania*) >50% of the vegetation	**13**
13a Annuals (e.g., *Zizania*)	**DMA**
13b Perennials (e.g., *Pontederia, Sagittaria, Sparganium, Typha*)	**14**
14a One or two species; may include rooted-floating >10% of the vegetation	**DMP**
14b One species >50% of the vegetation and species other than rooted-floating or deep marsh >10% of the vegetation; or three or more deep marsh species	**SMP**
12b *Carex* or shallow marsh species (e.g., *Bidens, Cyperus, Echinochloa, Eleocharis, Lythrum, Phragmites, Scirpus)* >50% of the vegetation	**15**
15a *Carex* >50% of the vegetation	**SM**
15b Shallow marsh species >50% of the vegetation	**16**

16a Annuals (e.g., *Bidens, Cyperus, Echinochloa, Eleocharis*) **SMA**

16b Perennials (e.g., *Lythrum, Phragmites, Scirpus*) **17**

17a *Lythrum* >50% of the vegetation **18**

18a Only *Lythrum* present **SMP**

18b *Lythrum* >50% of the vegetation and one or more species >10% of the vegetation **WM**

17b Shallow marsh species other than *Lythrum* >50% of the vegetation **19**

19a One species or a combination of species >50% of the vegetation; except when *Phragmites* >50% of the vegetation and *Phalaris* >10% of the vegetation **SMP**

19b *Phragmites* >50% of the vegetation and *Phalaris* >10% of the vegetation **WM**

10b Perennial grasses or forbs >50% of the vegetation **20**

20a Landscape altered for human use **21**

21a Areas for agricultural or livestock use **22**

22a Cultivated fields for crops **AG**

22b Pastured area used for production of livestock **PS**

21b Areas not for agricultural or livestock use **23**

23a Roads or railroads including grass, forbs, or shrubs in rights-of-ways **RD**

23b Levees (continuous dikes or embankments) **LV**

20b Landscape not altered for human use **24**

24a Wet soils (e.g., *Amaranthus, Leersia, Phalaris, Solidago, Spartina*) **WM**

24b Dry soils **GR**

7b Shrub cover >25% of the area or tree cover >10% of the area **25**

25a Shrub cover >25% of the area and tree cover <10 % of the area **26**

26a *Salix* >50% of the vegetation **SC**

26b Other shrubs >50% of the vegetation **27**

27a Shrubs growing in standing water or with annual or perennial emergents **28**

28a Shrubs (e.g., *Cephalanthus, Decodon*) growing in standing water or with deep marsh species (e.g., *Pontederia, Sagittaria, Sparganium, Typha, Zizania*) **DMS**

28b Shrubs growing with shallow marsh species (e.g., *Bidens, Cyperus, Echinochloa, Eleocharis, Lythrum, Phragmites, Scirpus*) **SMS**

27b Shrubs growing with perennial grasses or forbs **29**

29a Wet soils (e.g., *Alnus, Cornus, Sambucus*) **WMS**

29b Dry soils **SS**

25b Tree cover >10% of the area **30**

30a Cultivated areas (e.g., orchards or pine plantations) **PN**

30b Noncultivated areas **31**

31a *Populus* or *Salix* >50% of the vegetation **32**

32a *Populus* >50% of the vegetation **PC**

32b *Salix* >50% of the vegetation **SC**

31b Other trees >50% of the vegetation **33**

33a Coniferous trees >50% of the vegetation (e.g., *Pinus, Juniperus*) **CN**

33b Deciduous trees >50% of the vegetation **34**

34a Trees growing in standing water (e.g., *Taxodium, Nyssa*) **WS**

34b Trees not growing in standing water **35**

35a	Trees growing on wet soils	**36**
36a	Trees growing on alluvial soils; usually dominated by *Acer*	**FF**
36b	Trees growing on moist, well-drained soils; usually dominated by *Quercus*	**LF**
35b	Trees growing on dry soil	**UF**

Appendix 2. Long Term Resource Monitoring Program Accuracy Assessment Field Form.

Accuracy Assessment Field Form
Long Term Resource Monitoring Program

1. AA Site #: _____ 2. Date: _____ 3. Time _____

4. Primary Observer: _____

5. Assisting Observer: _____

6. GPS Accuracy (Meters) DOP: _____ EPE: _____

7. Picture Numbers: _____

8. UTM Easting: _____ 9. UTM Northing: _____

10. UTM Zone: _____ 11. Datum: _____

12. Proximity to Actual Point:

a. At Point _____
b. Within 20M _____
c. Within 50 M _____
d. Inaccessible _____

14. Diagram of Area of Assessment:

13. Explain if NOT 'At Point': _____

15. Map Code: _____

16. Second Map Code (if there is doubt about first Map Code call): _____

17. Problems with identifying or keying the Map Class:

Yes ☐ No ☐

18. If Yes to #17, explain:

_____

_____

19. Hydrologic Regime

a. **Permanently Flooded** (Water Present all year round)
b. **Semipermanently Flooded** (Water present throughout the growing season, except in periods of extreme drought)
c. **Seasonally Flooded** (Water present for most of the growing season)
d. **Temporarily Flooded** (Water only present early in the growing season)
e. **Saturated Soil** (Soils that are saturated with water during the growing season)
f. **Infrequently Flooded** (Water rarely present)

OPTIONAL FIELDS (AS NEEDED):

20. Dominant/characteristic species in tree layer (~ 1 – 5 species, where layer is present)

_____

21. Dominant/characteristic species in shrub layer (1 – 5 species, where layer is present)

_____

22. Dominant/characteristic species in herbaceous layer (1 – 5 species, where layer is present)

_____

Other comments (if needed) _____

Appendix 3. Predominant species and common 31 general classes associated with the genera found in the UMRS (Dieck and Robinson, 2004).

Genus	Species represented	Common 31 classes
Acer	*A. negundo, A. rubrum, A. saccharinum*	FF, LF, UF
Alnus	*A. glutinosa, A. serrulata*	WMS
Amaranthus	*A. albus, A. rudis, A. tuberculatus*	WM
Amorpha	*A. fruiticosa*	WMS
Betula	*B. nigra*	FF, LF
Bidens	*B. cernua, B. frondosa*	SMA
Carex	*C.* spp.[1]	SM
Carya	*C. cordiformis, C. illinoensis*	LF, UF
Cephalanthus	*C. occidentalis*	DMS, SMS
Cornus	*C. alternifolia, C. amomum, C. drummondii, C. stolonifera*	WMS, SS
Cyperus	*C. erythrorhizos, C. esculentus, C. odoratus, C. strigosus*	SMA
Decodon	*D. verticillatus*	DMS, SMS
Echinochloa	*E. crusgalli, E. muricata, E. walteri*	SMA
Eleocharis	*E. obtusa, E. palustris*	SMA
Fraxinus	*F. nigra, F. pennsylvanica*	WS, FF
Juniperus	*J. virginiana*	CN
Leersia	*L. lenticularis, L. oryzoides, L. virginica*	WM
Lythrum	*L. alatum, L. salicaria*	SMP, WM
Nelumbo	*N. lutea*	RFA
Nuphar	*N. lutea, N. variegata*	RFA
Nymphaea	*N. odorata, N. tuberosa*	RFA
Nyssa	*N.aquatica, N. sylvatica*	WS
Phalaris	*P. arundinacea*	WM
Phragmites	*P. australis*	DMP, SMP, WM
Pinus	*P. resinosa, P. strobus*	CN, PN
Platanus	*P. occidentalis*	LF
Polygonum	*P.* spp.	SMA, DMP, SMP, WM
Pontederia	*P. cordata*	DMP
Populus	*P. deltoides*	PC, FF
Quercus	*Q.* spp.	FF, LF, UF
Sagittaria	*S. latifolia, S. rigida*	DMP, SMP
Salix	*S. exigua, S. nigra*	SC, SMS, WMS, FF
Sambucus	*S. canadensis*	WMS
Scirpus	*S.* spp.	SMP
Solidago	*S.* spp.	WM
Sparganium	*S. eurycarpum*	DMP, SMP
Spartina	*S. pectinata*	WM
Taxodium	*T. distichum*	WS
Typha	*T. angustifolia, T. latifolia*	DMP, SMP
Ulmus	*U. americana, U. rubra*	FF, LF, UF
Zizania	*Z. aquatica*	DMA

[1] spp. is used when more than four dominant species are present

Bathymetry Component
Outcome 1; Output 1.1

The overall goal of the LTRMP Bathymetry Component is to complete a system-wide GIS coverage of UMRS bathymetry used to quantitatively and qualitatively assess the suitability of essential aquatic habitats. Presently, eight pools (Pools 4, 7, 8, 9, 13, 21, 26, and La Grange Pool) are complete, six pools (Pools 5, 10, 18, 24, 25, Alton Pool, and the Middle Mississippi reach) are over 80% complete, six pools (Pools 15, 17, 20, 22, and Peoria and Marseilles Pools) are between 60 and 80% complete, and the remaining eleven pools are less than 60% complete. Although LTRMP did not collect data under outcome 1; output 1.1 in FY2010, funding from the American Recovery and Reinvestment Act of 2009 allowed the systemic coverage to be collected. Under Output 1.1, the LTRMP will maintain some level of expertise to provide basic assistance with using the existing bathymetry data.

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

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

Personnel

Jim Rogala will be the principal investigator.

Statistical Evaluation
Outcome 2; Output 2.1

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

Guidance for management includes assistance with modifications to program design, with standardizing general operating procedures, and with estimating power to detect changes and trends. For example, LTRMP's focus on long term rather than on annual changes has important implications for program design.

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

Product Descriptions

2011E1: Summer water temperature in the Upper Mississippi River (UMR; Navigation Pools 4, 8, 13 and 26) is estimated to have increased by an average of 0.31°C per year over the period 1993 through 2003 [95% confidence interval: (0.28, 0.35) °C]. We propose to update this result by incorporating temperature data through 2010, and to also address associations between water temperature and both air temperature and water discharge

Products and Milestones

Tracking number	Products	Staff	Milestones
2011E1	Draft completion report: An assessment of trends in water temperature in the UMR as functions of water discharge and mean air temperature (using LTRMP water temperature data)	Gray	30 September 2011
2010E1	Draft manuscript: Inferring decreases in among- backwater heterogeneity in large rivers using among-backwater variation in limnological variables	Gray, Rogala, Houser	30 December 2010
2010E2	Draft manuscript: Among-lake variability in limnological characteristics of backwaters of the Upper Mississippi River	Gray, Rogala, Houser	28 February 2011

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

Personnel

Dr. Brian Gray will be the principal investigator.

Data Management
Outcome 2; Output 2.1

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

Methods

Data management tasks include, but are not limited to:

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

Products and Milestones

Tracking number	Products	Staff	Milestones
2011M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.	Schlifer	30 May 2011
2011M2	Load 2010 component sampling data into Oracle tables and make data available on Level 2 browsers for field stations to QA/QC.	Schlifer	30 June 2011

Personnel

Ben Schlifer will be the principal investigator.

Additional LTRMP Products

Tracking number	Milestone	Target Date	Lead
2008APE4a	Draft completion report: FY05-07 data--Analysis and support of aquatic vegetation sampling data in Pools 6, 9, 18, and 19	30-Jan-11	Yin
2008APE1a	Draft completion report: Developing an empirical framework for reconstructing and modeling UMRS floodplain disturbance histories: Year 1, historic data extraction and summaries.	30-Mar-11	Ickes
2008APE1b	Model development (2008APE1b)	30-Mar-11	Ickes
2008APE2	Final draft LTRMP technical report; Setting quantitative fish management targets for LTRMP monitoring (Draft submitted 28 July 2010)	30-Sep-11	Sass
2008APE5	Final draft LTRMP Technical Report; Experimental and Comparative Approaches to Determine Factors Supporting or Limiting Submersed Aquatic Vegetation in the Illinois River and its Backwaters	30-Sep-11	Sass
2009APE1a	Draft manuscript for USGS internal review: Have the recent increases in aquatic vegetation in Pools 5 and 8 been the result of water level management drawdowns, HREPs, or natural fluctuations?	15-Jan-11	Yin
2009APE3a	Final draft completion report based on analysis of LTRMP water quality and vegetation data entitled "Associations between selected WQ variables, metaphyton, SAV and connectivity in backwaters as inferred from LTRMP data."	30-Mar-11	Houser
2009R1WQ	Draft completion report, compilation of 3 years of sampling: Water Quality Data	30-Nov-10	Giblin et al.
2009R1Fish	Draft completion report, compilation of 3 years of sampling: Fisheries Data	30-Mar-11	Chick et al.
2009LCU1	Draft contract report: Aerial Imagery Processing and Classification Training for the Upper Mississippi River System 2010 Land Cover/Land Use Project (2009 SOW; Robinson)	30-Dec-10	Dieck and Robinson
2011OP2	Final draft Science Management Plan	28-Feb-11	Johnson
2010OUT2a	Draft completion report: Temporal evaluation of factors influencing metaphyton biomass, distribution and composition within Upper Mississippi River Backwaters	31-May-11	Giblin
2010OUT2b1	Draft manuscript: The influences of landscape variables across multiple spatial scales on the community composition of floodplain forests	30-Sep-11	DeJager
2010OUT2b2	Draft manuscript: The influences of landscape variables across multiple spatial scales on spatial and temporal variation in water quality measurements	30-Sep-11	DeJager
2010OUT2c	Draft summary report: Nutrients, connectivity and primary production in the UMR: The role of phytoplankton community composition	31-Dec-10	Houser
2011OUT2d1	Final draft aquatic vegetation research plan	31-Aug-11	Yin
2011OUT2d2	Final draft landscape patterns research plan	31-Aug-11	De Jager
2010VT1	Redesign of LTRMP Web pages (Continuation of 2009APE7A)	30-Dec-10	Rogala, Sauer
2010VT2	Maintenance and enhancement of LTRMP Graphical Browsers	30-Dec-10	Schlifer, Caucutt, Langrehr
Intended for distribution			
Manuscript: The calculation of landscape metrics to derive measures of land change and the description of temporal changes in these measures			
Manuscript: Markovian analysis of land change (DeJager, 2009APE4b)			

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

Component	Study Area						Summary of data collected[1]
	4	8	13	26	La Grange	Open River	
Aquatic Vegetation	450 stratified random sample sites over growing season.	450 stratified random sample sites over growing season.	450 stratified random sample sites over growing season.	—[2]	—[2]	—[2]	Species, abundance, frequency, distribution, depth, substrate, detritus
Fisheries Added fish monitoring for 2010–2014	~160 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites. 1st period, June 15 – July 31, 82 samples	~180 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites. 1st period, June 15 – July 31, 82 samples	~200 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites. 1st period, June 15 – July 31, 100 samples	~180 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites. 1st period, June 15 – July 31, 92 samples	~270 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites. 1st period, June 15 – July 31, 120 samples	~165 samples; 2 periods: Aug. 1–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites. 1st period, June 15 – July 31, 82 samples	Species; catch-per-effort; length; subsample for weight, age, & diet; secchi; water depth, temperature, velocity, conductivity; vegetation density; substrate; dissolved oxygen
Water Quality Added water quality monitoring for 2010–2014	135 stratified random sites done in each episode (winter, spring, summer, and fall); 14 fixed sites[3] 14 fixed sites in Pools 4 biweekly during July and August.	150 stratified random sites done in each episode (winter, spring, summer, and fall); up to 19 fixed sites[3] 4 historic + 2 new fixed sites, biweekly from April through August.	150 stratified random sites done in each episode (winter, spring, summer, and fall); 12 fixed sites[3] none	121 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites[3] none	135 stratified random sites done in each episode (winter, spring, summer, and fall); 11 fixed sites[3] none	150 stratified random sites done in each episode (winter, spring, summer, and fall); 9 fixed sites[3] none	Suspended solids, major plant nutrients, chlorophyll a, silica, pH, secchi, temperature, dissolved oxygen, turbidity, conductivity, vegetation type & density, wave height, depth, current velocity, depth of snow/ice, substrate, phaeophytin, phytoplankton (archived),
Land Cover/Land Use	Land Cover/Land Use digital aerial photography will be acquired in 2010 and processed in subsequent years. Systemic land cover data for the Upper Mississippi River System is collected approximately every 10 years. To date, systemic land cover has been mapped twice through the Long Term Resource Monitoring Program, in 1989 and 2000.						

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