![Upper Mississippi River Restoration — Leading · Innovating · Partnering]
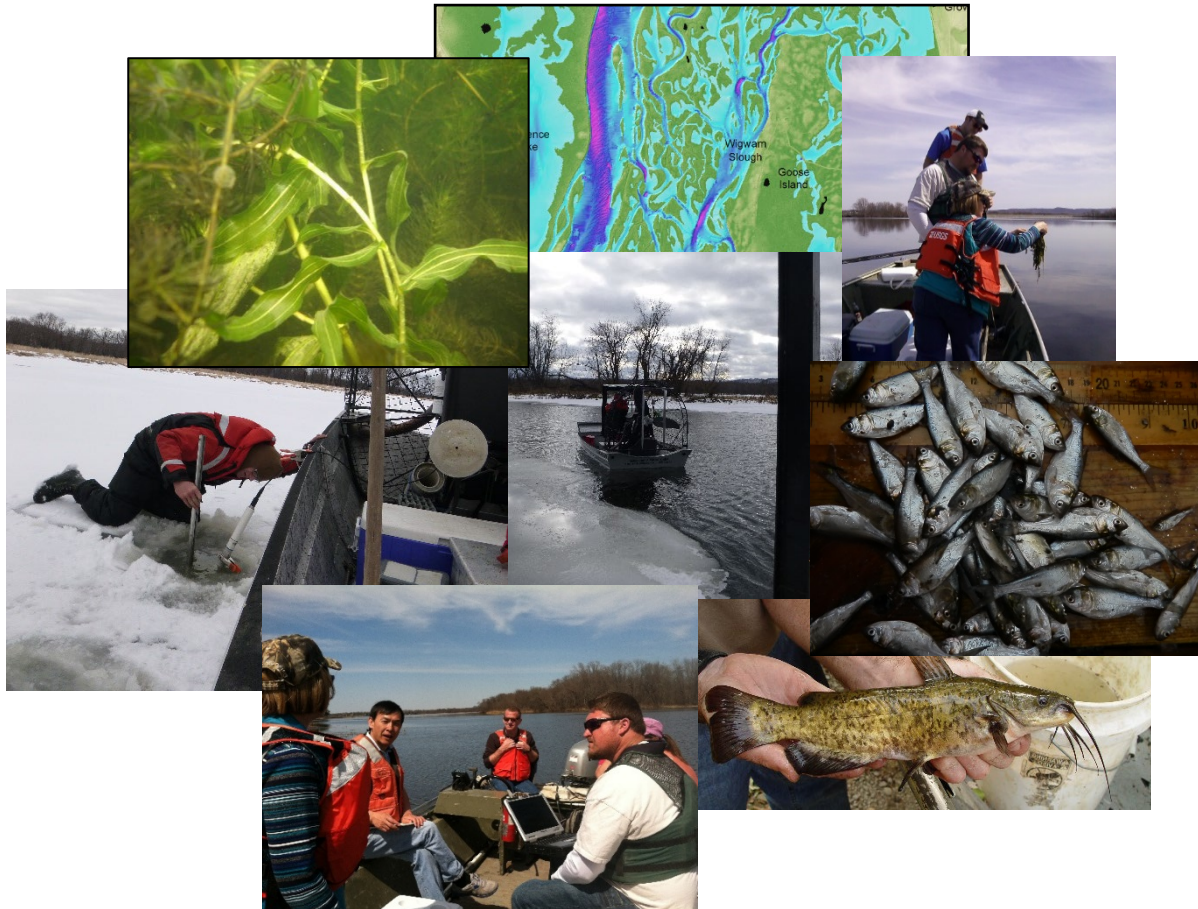
Long Term Resource Monitoring
FY20 SOW

Enhancing Restoration and Advancing Knowledge of the Upper Mississippi River

Addressing the
FY2015–2025 UMRR Strategic Plan

The Upper Mississippi River Restoration (UMRR) Program for the Upper Mississippi River System (UMRS) is the first comprehensive program for ecosystem restoration, scientific research, and monitoring on a large river system in the Nation and the world. The UMRS is one of this Nation's unique natural resources. The ecosystem provides habitat to a wide array of fish and wildlife species distributed among a complex assortment of flowing channels, floodplain lakes, backwaters, wetlands, and floodplain forests. With an ecosystem as diverse and complex as the UMRS, many of its processes and their interrelationships are not well known. One way to help understand this multifaceted system is through environmental monitoring. The UMRR Long Term Resource Monitoring (LTRM) data provides the scientific foundation required for sound management actions, effective river restoration projects, and informed environmental policy decisions for the UMRS.

The value of UMRR LTRM's long term data set continues to grow. It serves as a foundation for the restoration of the UMRS by revealing patterns and trends, establishing benchmarks of the current state for comparison to future conditions, serving as an early warning of change, supporting planning and management through the identification of key issues and trends, and evaluating the effectiveness of restoration and management actions on the UMRS.

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<p style="text-align:center;">**FY20 UMRR LTRM (Base Monitoring) Scope of Work**</p>

This Scope of Work (SOW) describes tasks in support of the US Army Corps of Engineers' Upper Mississippi River Restoration (UMRR) Program Long Term Resource Monitoring (LTRM) element, authorized by Congress in the 1986 Water Resources Development Act and reauthorized in the 1999 Water Resources Development Act, to be performed by the USGS-Upper Midwest Environmental Sciences Center (UMESC) in La Crosse, Wisconsin, and six state-operated field stations (Illinois, Iowa, Minnesota, Missouri, and Wisconsin). This long term monitoring directly supports Upper Mississippi River System (UMRS) understanding, critical for successful UMRS restoration by the UMRR. This SOW complements those work items in the UMRR Science in Support of Restoration and Management FY19 SOW.

A comprehensive monitoring program consists of environmental monitoring, research, systemic data acquisition, modeling, and information delivery to provide a solid scientific foundation upon which resource managers and policy makers base management actions and develop environmental policy.

Aquatic Vegetation Component

The objective of the UMRR LTRM Aquatic Vegetation Component is to collect quantitative data on the distribution and abundance of aquatic vegetation in the Upper Mississippi River System (UMRS) and to conduct research related to aquatic vegetation for understanding its status, trends, ecological functions, and responses to disturbances and UMRR restoration activities. Aquatic vegetation in the UMRS is desirable because of its many values, most notably as food for migratory waterfowl (Korschgen et al. 1988) and habitat for fish. Monitoring data are collected within three LTRM 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

For monitoring aquatic vegetation, sampling will be conducted following the LTRM aquatic vegetation standard sampling protocol (Yin et al. 2000). A total of 1,350 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
2020A1	Complete data entry and QA/QC of 2019 data; 1250 observations.		
	a. Data entry completed and submission of data to USGS	Lund, Drake, Bales	30 November 2019
	b. Data loaded on level 2 browsers	Schlifer	15 December 2019

	c. QA/QC scripts run and data corrections sent to Field Stations	Larson, Schlifer,		28 December 2019
	d. Field Station QA/QC with corrections to USGS	Lund, Drake, Bales		15 January 2020
	e. Corrections made and data moved to public Web Browser	Larson, Schlifer, Caucutt		30 January 2020
2020A2	Web-based: Creating surface distribution maps for aquatic plant species in Pools 4, 8, and 13; 2017 & 2018 data	Larson, Rogala, Schlifer		31 July 2020
2020A3	Wisconsin DNR annual summary report 2019 that combines current year observations from LTRM with previous years' data, for the fish, aquatic vegetation, and water quality components.	Drake, Bartels, Hoff, Kalas, Carhart		30 Sept 2020
2020A4	Complete aquatic vegetation sampling for Pools 4, 8, and 13 (Table 1)	Larson, Lund, Drake, Bales		31 August 2020
2020A5	Pool 4 Graphical summary and maps of aquatic vegetation current status and long-term trends.	Lund		30 Dec. 2020
2020A6	Pool 8 Graphical summary and maps of aquatic vegetation current status and long-term trends.	Drake, Carhart		30 Dec. 2020
2020A7	Web-based: Update software coding for surface distribution maps of aquatic plants	Larson, Rogala		30 September 2020
Intended for distribution				
LTRM completion report: Evaluation of a "Trace" Plant Density Score in LTRM Vegetation Monitoring (New Milestone 2020BIO3a)				

Fisheries Component

The objective of the UMRR LTRM Fisheries Component is to collect quantitative data on the distribution and abundance of fish species and communities in the UMRS and to conduct research related to fishes for understanding resource status and trends, ecological functions, and response to disturbances and UMRR restoration activities. The UMRS is probably the most biologically productive and economically important large floodplain river system in the United States (Patrick 1998; U.S. Geological Survey 1999), and fish are one of the most important goods and services the UMRS provides to humans (Carlander 1954). Fishes within the UMRS are the subject of commercial and recreational fisheries, both of which contribute substantially to local economies (Fremling et al. 1989). Scientists and fishery managers also recognize fish communities as an integrative index for a complex set of physical and biological conditions on the UMRS.

Data are collected within six LTRM 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 (Ratcliff et al. 2014).

Methods

For monitoring fish, sampling will be conducted following the LTRM study plan and standard protocols (Ratcliff et al. 2014) as modified from 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
2020B1	Complete data entry, QA/QC of 2019 fish data; ~1,590 observations		
	a. Data entry completed and submission of data to USGS	DeLain, Bartels, Bowler, Hine, Gittinger, West, Solomon, Maxson	31 January 2020
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	Ickes, Schlifer	15 February 2020
	c. Field Station QA/QC with corrections to USGS	DeLain, Bartels, Bowler, Hine, West, Solomon, Maxson	15 March 2020
	d. Corrections made and data moved to public Web Browser	Ickes and Schlifer	30 March 2020

2020B2	Update Graphical Browser with 2019 data on Public Web Server.	Ickes, DeLain, Bartels, Bowler, Hine, West, Solomon, Maxson, Schlifer	31 May 2020
2020B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River Reach, and La Grange Pool (Table 1)	Ickes, DeLain, Bartels, Bowler, Hine, West, Solomon, Maxson	31 October 2020
2020B4	Summary Letter: Floodplain fisheries sampling	West	31 October 2020
2020B5	IDNR Fisheries Management State Report: Fisheries Monitoring in Pool 13, Upper Mississippi River, 2018	Bowler	30 June 2020
2020B6	Sample collection, database increment, Summary letter on Asian carp age and growth: collection of cleithral bones	Solomon, Maxson	31 January 2020
2020B8(D)	Database increment: Stratified random day electrofishing samples collected in Pools 9–11	Bowler	30 Sept 2020
2020B9(D)	Database increment: Stratified random day electrofishing samples collected in Pools 16–18	Bowler	30 Sept 2020
2020B10	Database increment: Evaluating the Fish Community in a rare Backwater Habitat in the Middle Mississippi River 2020	West	30 Dec. 2020
Intended for distribution			

LTRM Completion report, compilation of 3 years of sampling: Fisheries (2009R1Fish; Chick et al.) (in USGS review; minor grammatical corrections needed then will be posted on LTRM Fish page)

LTRM Fact Sheet: Tree map tool for visualizing fish data, with example of native versus non-native fish biomass (2013B16) (Programming code for TreeMap being re-written; once completed Fact Sheet will be edited)

Water Quality Component

The objective of the UMRR LTRM's water quality component is to conduct monitoring and research 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. 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.

Data are collected within six LTRM 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

For monitoring water quality, 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 LTRM protocols.

Fixed site sampling
Fixed site sampling will be conducted as in FY2006 except for modifications made in 2010 for Pools 4 and 8 (Table 1).

Stratified random sampling
Stratified random sampling will be conducted at full effort levels (same as FY2000) 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 fluorometric chlorophyll and suspended solids (total and volatile) will be collected at all SRS and Fixed sites. Sampling and laboratory analyses will be performed following LTRM protocols (Soballe and Fischer 2004) and Standard Methods (American Public Health Association 1992).

Products and Milestones

Tracking number	Products	Staff	Milestones
2020D1	Complete calendar year 2019 fixed-site and SRS water quality sampling	Jankowski, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	31 December 2019
2020D2	Complete laboratory sample analysis of 2019 fixed site and SRS data; Laboratory data loaded to Oracle data base.	Yuan, Schlifer	15 March 2020
2020D3	1st Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Cook, Fulgoni	30 December 2020
2020D4	2nd Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	30 March 2020
2020D5	3rd Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	29 June 2020
2020D6	4th Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	28 September 2020
2020D7	Complete QA/QC of calendar year 2019 fixed-site and SRS data.		
	a. Data loaded on level 2 browsers; QA/QC scripts run; SAS QA/QC programs updated and sent to Field Stations with data.	Schlifer, Rogala, Jankowski	30 March 2020
	b. Field Station QA/QC; USGS QA/QC.	Jankowski, Rogala, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	15 April 2020
	c. Corrections made and data moved to public Web Browser	Rogala, Schlifer, Jankowski	30 April 2020
2020D8	Complete FY2019 fixed site and SRS sampling for Pools 4, 8, 13, 26, Open River Reach, and La Grange Pool (Table 1)	Jankowski, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	30 Sept 2020
2020D9	WEB-based annual Water Quality Component Update w/2019 data on Server.	Rogala	30 May 2020
2020D10	Operational Support to the UMRR LTRM Element. Serve as in-house Field Station for USGS for consultation and support on various LTRM-wide topics	Kalas, Hoff, Bartel, Drake	30 Sept 2020
2020D12	Final LTRM Completion Report: Assessment of Phytoplankton Samples collected by the Upper Mississippi River Restoration Program-Long Term Resource Monitoring Water Quality Component	Fulgoni and Jankowski	30 January 2021
On-going			
2019D12	Draft LTRM Completion Report: Assessment of Phytoplankton Samples collected by the Upper Mississippi River Restoration Program-Long Term Resource Monitoring Water Quality Component	Fulgoni and Jankowski	30-Dec-2019
2017D10	Draft LTRM Completion report: Evaluation of water quality data from automated sampling platforms	Soeken-Gittinger, Lubinski, Chick, Houser	30-Sep-2017

Intended for distribution
Completion report, compilation of 3 years of sampling: Water Quality (2009R1WQ; Giblin, Burdis) (in USGS review; minor grammatical corrections needed then will be posted on LTRM WQ page)
Manuscript: Nutrients and dissolved oxygen in the UMRS: improving our understanding of winter conditions and their implications for structure and function of the river (2014D12; Houser) (under revision)

Land Cover/Land Use with GIS Support

Although the LTRM will not collect systemic aerial photography data, it will maintain expertise, manage existing data and infrastructure, and provide limited on-demand Geographic Information System (GIS) technical assistance to the UMRR partnership including, but not limited to:

- Aerial image interpretation of selected sites as requested
- Flight planning and acquisition of aerial imagery
- Change detection and habitat modeling
- Georeferenced aerial photo mosaics (pool wide, Habitat Rehabilitation and Enhancement Projects (HREPs), land acquisition areas)
- Georeference and create metadata for 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 data set
- Conversion of GIS data layers to KMZ (Google Earth) formats for ease of viewing and sharing.
- 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 data sets, cropping data sets to common extents, and ensuring that all data sets 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.
- Provide geospatial hardware and software technical support to UMESC staff and partners, as needed.
- Continue to assess advances in computer technology (hardware and software) for accurate and efficient GIS data production.
- Develop plan to implement small unmanned aerial systems technology (sUAS) in UMRS resource monitoring (training, certification, sUAS leasing options).

2020LC2: Orthorectification of scanned photos

Aerial photography of the UMRS was collected in 1975, 1989, 1994, and 2000. Hardcopy prints have been scanned into high resolution digital formats for the long-term preservation and usability of these historical datasets. The next step in making these datasets accessible to researchers and the public in a useable digital format is to orthorectify the scanned images and generate mosaics for each year of acquisition and navigational pool/reach of the UMRS.

2020LC3: Updates on progress for land cover products

Although the primary focus of this component is to provide technical assistance and maintain existing geodatabases (i.e. including new data as it becomes available or is created such as LCU updates, KMLs, or site-specific orthoimagery; ensuring compliant with newest software), *as time allows* work may occur on the following LTRM projects. As work is accomplished for each project, it will be reported in the quarterly activities. When a project is completed, that will be announced to the partners and reported in the quarterly activities. The percentage completion for each project will be updated in each subsequent.

- Continue to update the detailed spreadsheet of all LTRM 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 served on-line and updated as necessary. Existing analog imagery has been inventoried and the systemic sets are being scanned. The master document will be versioned (and updated periodically as scanning continues) and hosted at www.umesc.usgs.gov/data_library/photographs/photographs.html. Orthorectification of these scans for key pools is in progress. (90% complete)

- Complete summaries detailing differences in land cover between 2000 and 2010/11 for the key pools (no change, 60% complete)

- Create a Google Earth help page to assist partners and public in using Google Earth to view and query LTRM data being served in the KMZ format. (no change, 95% complete; undergoing reconciliation)

- Assess automated terrain extraction software (Imagine Photogrammetry Suite) using 3"/pixel imagery or better and compare extracted elevation information to LiDAR-derived digital elevation models. This will help answer the question if using high-resolution aerial imagery can produce digital surface models on par with LiDAR elevation models. This project is in progress and now incorporating Agisoft's PhotoScan Pro, an imaging processing program that also generates extensive 3D point clouds (as well as DEMs and orthomosaics). These 3D point clouds are expected to assist with interpretation of floodplain forest using the 2020 systemic imagery. (50% complete)

- Implement and assess high-throughput distributed processing using HTCondor. This will speed up image processing and analyses using ERDAS and eCognition. Training took place in FY17 and currently are testing image processing software. A Windows-based HTCondor system has been established and awaiting an update to the recently released 2018 HTCondor for ERDAS. This version will be assessed using along with a high-performance virtual machine being established on UMESC's new server. New network cabling and high-speed switches may make this a better option since virtual machines are more user-friendly and offer direct access to familiar GIS programs (testing is also in progress using a virtual machine based at EROS, 60%).

- Assess the utility of thermal infrared aerial imagery on detecting Asian carp spawning locations within the UMRS. A demo thermal camera (that was later purchased by USFWS) was used in the summer of 2017 and a similar USGS thermal camera the late-fall of 2017 for the purpose of mapping the thermal landscape of Pool 8 (Upper Mississippi River: A Pilot Study, see page 45 www.umesc.usgs.gov/ltrmp/documents/Sci_SOW_17_Text7April2017.pdf). If measured temperatures correspond accurately to temps reading from in-situ loggers, the next step will be to collect test thermal imagery of potential carp spawning sites on the Illinois River. This report is complete and in review (100%).

Products and Milestones

Tracking number	Products		Staff		Milestones
2020LC1	Maintenance ArcGIS server		Hlavacek, Fox, Rohweder		30 September 2020
2020LC2	Orthorectification of scanned photos		Hlavacek		30 September 2020
2020LC3	Updates on progress for land cover products listed.		Robinson, Finley		30 September 2020

Bathymetry Component

The overall goal of the UMRR LTRM's 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. Bathymetric survey data has been combined with Lidar data to generate topobathy. This work was completed in FY17. Topobathy contains bed elevation data only, and doesn't include water depth (i.e., bathymetry) information directly.

Previously generated bathymetric coverages will be replaced with coverages derived from topobathy. Water surface elevation coverages at selected discharge conditions were developed in FY17 to complete this work. Bathymetric coverages will be generated for selected water surface elevation conditions and served as they are completed starting in FY18.

The LTRM will maintain some level of expertise to provide basic assistance with using the topobathy and bathymetry data, including, but not limited to:

- Deliver data in non-standard formats, such as raw point data in GIS formats or text files,
- Assist in developing inundation tools that use the topobathy data,
- Calculate summary statistics (e.g., hypsographic curves and volume) for geographical subsets of the data,
- Assist in spatial modeling using the topobathy and bathymetric data.

Data Management

The objective of data management for the UMRR LTRM 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 LTRM database.
- Administer and maintain LTRM hardware, software, and supplies to support LTRM needs.
- Administer, maintain, and update the LTRM public and intranet data browsers to insure access to all LTRM data within USGS security policy.

Products and Milestones

Tracking number	Products		Staff		Milestones
2020M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.		Schlifer		30 May 2020
2020M2	Load 2019 component sampling data into Database tables and make data available on Level 2 browsers for field stations to QA/QC.		Schlifer		30 June 2020
2020M3	Assist LTRM Staff with development and review of metadata and databases in conjunction with publishing of reports and manuscripts		Schlifer		On-going

Status and Trends 3rd edition

UMRR LTRM has completed two previous syntheses of status and trends of the UMRS with the most recent being completed in 2008 (Johnson and Hagerty, 2008). A third Status and Trends Report will provide an opportunity to communicate the important changes that have occurred in the UMRS over the LTRM period of record. During 2020 the analysis and writing will be completed and the draft submitted to SPN.

One or more conference calls and possibly a face to face meeting will be needed for the requisite discussions.

References

Johnson, B. L., and K. H. Hagerty, editors. 2008. Status and trends of selected resources of the Upper Mississippi River System. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, December 2008. Technical Report LTRMP 2008-T002. 102 pp + Appendixes A–B

Products and Milestones

Tracking number	Products		Staff		Milestones
2020ST1	Final Outline including specific indicators that will be included in the report.		All		1 December 2020
2020ST2	Draft Report for partner review		All		28 August 2020
2020ST3	Revised draft to USGS publishing network		All		15 December 2020
2020ST4	Draft S&T3 Fact Sheet		all		30 March 2020

Quarterly Activities

To enhance communication with the UMRR Partnership, LTRM staff at USGS-UMESC and the six state-run field stations will track activities not explicitly listed in this current scope of work. These quarterly activity lists will document activities and accomplishments by Program partners that are not tracked in the milestone table. Activities will include such items as presentations, outreach, technical assistance, data retrieval, and consultation for LTRM Partners including state and federal agencies, NGOs, and academia. These activities demonstrate the value of LTRM data and expert scientific knowledge to clients and customers, and help to identify potential new collaborations that will benefit EMP and river managers. Activity lists will be placed on the web under the A-Team Corner page (http://www.umesc.usgs.gov/ltrmp/ateam.html). This effort addresses a need for increased communication and dissemination of information.

Products and Milestones

Tracking number	Products		Staff		Milestone
2020QR1	Submittal of quarterly activities		All LTRM staff		30 January 2020
2020QR2	Submittal of quarterly activities		All LTRM staff		13 April 2020
2020QR3	Submittal of quarterly activities		All LTRM staff		13 July 2020
2020QR4	Submittal of quarterly activities		All LTRM staff		12 October 2020

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Ickes, B.S., Sauer, J.S., and Rogala, J.T., 2014, Monitoring rationale, strategy, issues, and methods: UMRR-EMP LTRMP Fish Component. A program report submitted to the U.S. Army Corps of Engineers' Upper Mississippi River Restoration-Environmental Management Program, Program Report LTRMP 2014–P001a, 29 p., *http://pubs.usgs.gov/mis/ltrmp2014-p001a/*

Korschgen, C. E., L. S. George, and W. L. Green. 1988. Feeding ecology of canvasbacks staging on Pool 7 of the Upper Mississippi River. Pages 237–250 in M. W. Weller, editor. Waterfowl in winter. University of Minnesota Press. Minneapolis.

Patrick, R. 1998. Rivers of the United States. Vol. IV, Part A - The Mississippi River and Tributaries North of St. Louis. Part B. The Mississippi River and Tributaries South of St. Louis. John Wiley and Sons, Inc. New York. pp. 863.U.S. Fish and Wildlife Service. 1980. Habitat Evaluation Procedure (HEP) Manual (102 ESM). U.S. Fish and Wildlife Service, Washington, DC.

Ratcliff, E.N., Gittinger, E.J., O'Hara, T.M., and Ickes, B.S., 2014, Long Term Resource Monitoring Program Procedures: Fish monitoring, 2nd edition. A program report submitted to the U.S. Army Corps of Engineers' Upper Mississippi River Restoration-Environmental Management Program, June 2014. Program Report LTRMP 2014-P001, 88 pp. including Appendixes A–G, http://pubs.usgs.gov/mis/ltrmp2014-p001

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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.

Table 1. Sampling effort within the UMRR Long Term Resource Monitoring Program element 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	~242 samples; 3 periods: June 15–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~262 samples; 3 periods: June 15–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~300 samples; 3 periods: June 15–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~272 samples; 3 periods: June 15–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~390 samples; 3 periods: June 15–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	~247 samples; 3 periods: June 15–Oct. 30, 6 sampling gears. Mix of stratified random and fixed sites.	Species; catch-per-effort; length; subsample for weight, age, & diet; secchi; water depth, temperature, velocity, conductivity; vegetation density; substrate; dissolved oxygen
Water Quality	135 stratified random sites sampled in each episode (winter, spring, summer, and fall); 14 fixed sites[3]	150 stratified random sites sampled in each episode (winter, spring, summer, and fall); 19 fixed sites[3]	150 stratified random sites sampled in each episode (winter, spring, summer, and fall); 12 fixed sites[3]	121 stratified random sites sampled in each episode (winter, spring, summer, and fall); 11 fixed sites[3]	135 stratified random sites sampled in each episode (winter, spring, summer, and fall); 11 fixed sites[3]	150 stratified random sites sampled in each episode (winter, spring, summer, and fall); 9 fixed sites[3]	Suspended solids, major plant nutrients, chlorophyll a, silica, pH, secchi, temperature, dissolved oxygen, turbidity, conductivity, vegetation type & density, wave height, depth, current velocity, depth of snow/ice, substrate, phaeophytin, phytoplankton (archived),
Land Cover/Land Use	Land Cover/Land Use digital aerial photography was acquired in 2010-2011 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 three times through the UMRR Long Term Resource Monitoring element, in 1989, 2000, and 2010/2011.						

[1]A full list and explanation of data collected by each component is available through the UMRR LTRM 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)

Product Definitions

Draft: A draft that has been submitted to the UMRR LTRM's USGS Science Leader or his designee which is ready for review by USGS, USACE, A-Team, or blind review, as needed. This step begins the process of formal USGS peer-review unless the Science Leader deems the product needs more work by the author(s).

Final draft: A document that the authors have edited based on review comments and has been submitted to the LTRM's USGS Science Leader or his designee.

Intended for Distribution: Indicates a final printed version or Web-based report is awaiting distribution and USGS final approval. For other products (i.e., manuscripts) this indicates submission to a journal. *Staff time is still expended at this stage of the report process.*

Summary Letter: A summary letter is a communication to Corps management and associated staff that provides quick information regarding progress on a project or product. They are often based on preliminary data and analyses, and represent interim information. Summary letters are reviewed internally by UMESC, but do not go through USGS peer review. Thus, they are not citable and should not be widely distributed. Summary letters are used only when a more complete and peer reviewed product is expected after more work on a specific project.

Leveraged Product: A product produced by LTRM staff and others outside of LTRM; may include funding from non-sources.