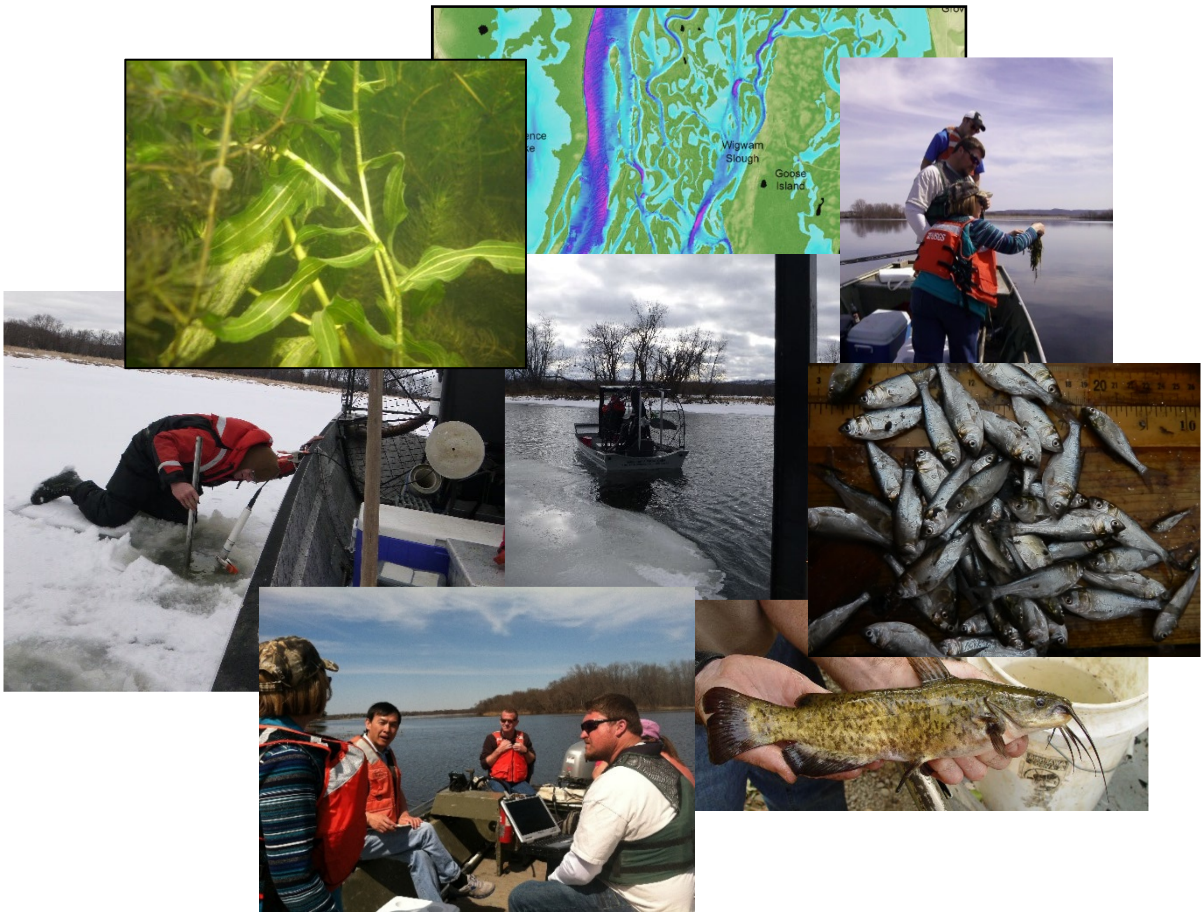
Long Term Resource Monitoring

FY19 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 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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FY19 UMRR LTRM (Base Monitoring) Scope of Work

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
2019A1	Complete data entry and QA/QC of 2018 data; 1250 observations.		
	a. Data entry completed and submission of data to USGS	Lund, Drake, Bales	30 November 2018
	b. Data loaded on level 2 browsers	Schlifer	15 December 2018

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

Intended for distribution
LTRM completion report: FY05-07 data--Analysis and support of aquatic vegetation sampling data in Pools 6, 9, 18, and 19 (2008APE4a; Yin) (With Sauer for revision)
LTRM completion report: Have the recent increases in aquatic vegetation in Pools 5 and 8 been the result of water level management drawdowns, HREPs, or natural fluctuations? (2009APE1a; Yin) (With Sauer for revision)
LTRM completion report: A statistical model of species occupancy using the LTRM aquatic vegetation data (2013A7; Yin) (With Sauer for revision)

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
2019B1	Complete data entry, QA/QC of 2018 fish data; ~1,590 observations		
	a. Data entry completed and submission of data to USGS	DeLain, Bartels, Bowler, Ratcliff, Gittinger, West, Solomon, Maxson	31 January 2019
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	Ickes, Schlifer	15 February 2019
	c. Field Station QA/QC with corrections to USGS	DeLain, Bartels, Bowler, Ratcliff, Gittinger, West, Solomon, Maxson	15 March 2019
	d. Corrections made and data moved to public Web Browser	Ickes, Sauer, and Schlifer	30 March 2019
2019B2	Update Graphical Browser with 2017 data on Public Web Server.	Ickes, Sauer, DeLain, Bartels, Bowler, Ratcliff,	31 May 2019

		Gittinger, West, Solomon, Maxson, Schlifer	
2019B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River Reach, and La Grange Pool (Table 1)	Ickes, DeLain, Bartels, Bowler, Ratcliff, Gittinger, West, Solomon, Maxson	31 October 2019
2019B4	Summary Letter: Floodplain fisheries sampling	West	31 October 2019
2019B5	IDNR Fisheries Management State Report: Fisheries Monitoring in Pool 13, Upper Mississippi River, 2018	Bowler	30 June 2019
2019B6	Sample collection, database increment, Summary letter on Asian carp age and growth: collection of cleithral bones	Solomon, Maxson	31 January 2019
2019B8(D)	Database increment: Stratified random day electrofishing samples collected in Pools 9–11	Bowler	30 Sept 2019
2019B9(D)	Database increment: Stratified random day electrofishing samples collected in Pools 16–18	Bowler	30 Sept 2019
2019B10	Database increment and Summary letter: Evaluating the Fish Community in a rare Backwater Habitat in the Middle Mississippi River 2019	West	30 Dec. 2019
On-Going			
2018B10	Summary Letter: Open River Chevron Dike monitoring	West	31 Oct 2018
2018B11	Summary letter: Evaluating the Fish Community in a rare Backwater Habitat in the Middle Mississippi River 2017	West	31 Oct 2018
Intended for distribution			
Completion report: LTRM Fisheries Component collection of six darter species from 1989–2004. (2006B13; Ridings) (under revision)			
LTRM Completion report, compilation of 3 years of sampling: Fisheries (2009R1Fish; Chick et al.) (under revision)			
LTRM Fact Sheet: Tree map tool for visualizing fish data, with example of native versus non-native fish biomass (2013B16) (under revision)			

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).

New Products

2019D11 & D12: Assessment of Phytoplankton Samples collected by the Upper Mississippi River Restoration Program-Long Term Resource Monitoring Water Quality Component

Phytoplankton are the foundation of aquatic food webs and are a collective of bacteria, protists, and single-celled plants found in both freshwater and marine systems. Relatively few studies have evaluated phytoplankton communities in river ecosystems compared to other aquatic ecosystems (Ochs et al. 2013). Even fewer exist for the Upper Mississippi River System (UMRS; Kireta et al. 2012, Manier 2014, Decker et al. 2015), but many are out of date or have focused more on total biomass or growth than community characterization (e.g., Baker and Baker 1981, Cary 1972, Huff 1976, Bukavekas et al. 2011, DeBoer et al. 2018). Phytoplankton communities have been shown to be an important component of UMR food webs (DeLong and Thorp 2006, Larson et al 2015, Fritts et al 2018) and their utility in assessment of river conditions is well documented (e.g., use of diatoms - Stevenson et al. 2010, Kireta et al. 2012). In addition, there is some evidence of increasing prevalence of hazardous algal blooms (HABs) in several portions of the UMRS (Pishgadamian 2018; UMRBA 2017).

The Upper Mississippi River Restoration Program's Long Term Resource Monitoring (LTRM) element has been collecting phytoplankton samples since 1993 as part of the water quality component. This sample archive has the potential to provide rich information on basic ecological patterns of phytoplankton communities, responses to various ecosystem changes (e.g., changes in turbidity) and invasions (e.g., Zebra mussels, Asian carp). To date, only a small portion of the full phytoplankton sample archive has been identified and analyzed, however. Manier (2014) evaluated summer samples from 2006-2009 from backwaters, impounded, and main channel areas of Navigation Pools 8 and 13 and the main channel of Pool 26. Decker et al. (2015) analyzed samples collected during spring and summer from 1999-2002 and 2004 from Lawrence Lake and the main channel in Navigation Pool 8. Additionally, samples from three main channel and four backwater fixed sites in Navigation Pool 8 were analyzed through the summer and fall of 2009 and 2011 (S. Giblin, in prep), and samples from four sites in Lake Pepin (Navigation Pool 4) have been analyzed for the summer through fall of 2012-2014 (R. Burdis, in prep), but these data have not yet been published.

This low number of processed samples likely reflects the very time-consuming process of IDing these samples using microscopy, for which the LTRM phytoplankton methods of preservation and storage were designed. Samples consist of unfiltered water stored in amber Nalgene™ bottles (125mL), and preserved with Lugol's iodine, which typically allows for samples to be kept for up to 10 years (Pomroy 1984), though many recent laboratory protocols recommend less than a year (ASTM 2012). Samples are preserved with approximately 0.2mL of Lugol's iodine solution per 60mL of sample with the intention of giving the sample a "weak brown color" (Soballe and Fisher 2004), and stored for an undetermined amount of time. However, the volume of Lugol's iodine that is added to 125mL of river water can range between 1-3mL (J. Fulgoni, personal observation). Additionally, the use of Lugol's iodine can lead to biased biomass or biovolume results due to changes in cellular dimensions and cells rupturing at acidic Lugol's iodine concentration greater than 2.0% (Mukherjee et al. 2014). The effects on biovolumes can differ among groups of phytoplankton (Menden-Deuer et al. 2001, Hawkins et al. 2005, Williams et al. 2016). Typically, soft-bodied organisms like cyanobacteria and crytpophytes have the shortest shelf-life, but their viability can depend on how well they were preserved (e.g., concentration of preservative, type of storage container, tight seal). Green algae tend to have an intermediate shelf-life followed by diatoms, which can persist in storage for many years (J. Beaver, pers. comm). Assessment of river conditions using diatoms is well documented, thus samples with only viable diatom communities will still contain valuable information (e.g., Stevenson et al. 2010).

To date, there has been no systematic evaluation of the condition of the program's phytoplankton sample archive, and several samples have been sitting for substantially longer than 10 years. Typical signs of sample degradation include fungal growth and cell decomposition. Although samples that have been colonized by fungi are only viable for identification of diatoms, The state of cell decomposition and potential for species ID is best assessed by a trained phytoplankton taxonomist, who can quickly assess the state of the sample based on experience with fresh samples.

Therefore, we aim to assess over what time period our samples are viable for community analysis, and propose the following questions: 1) Have samples been compromised by fungal growth?, 2) Over what time period are samples viable for species identification? Future work would address whether there are alternative or better options for storing and preserving phytoplankton samples (e.g., archive microscope imagery of slides; Strassman et al. 2015)

If these samples generate data, we could potentially address several interesting ecological questions, for example:
What is the community structure of phytoplankton along a spatial and temporal gradient in the UMRS? For example, where and when do we see high abundances of toxin-producing cyanobacteria?
Are phytoplankton communities sensitive indicators of ecological shifts after HREP construction?
Has the invasion of Asian carp altered the phytoplankton community of the UMRS?
Do diatom communities reflect land use driven changes in silica concentrations across habitats and time in the UMRS?

<u>Methods and Approach</u>

<u>A) Assessment of samples for fungal growth.</u>
A subset of the complete sample archive will initially be screened for fungal growth at UMESC <u>starting in December 2018</u>. Fungal growth is common to samples that have been stored for long periods of time, have not been sealed well, or were not preserved properly. Fungal growth is typically obvious to the naked eye, and appears as grey-white amorphous material at the base of a sample bottle (J. Beaver, pers. comm). Fungi do not compromise analysis for diatoms, but identification of non-diatom species would not be possible. This assessment will require some lab technician help (see below) to review a subset of the older samples.

We propose to focus on samples collected more than 10 years ago (1993-2008) because they are more likely to have grown mold given how long they have been stored. This assessment will initially (Dec-Jan) focus on samples from spring and summer in the main channel, but survey across all reaches (as detailed in Table 1) to correspond to samples we intend to send for species identification (below). Once students have completed those samples we will move on to other seasons and strata (~summer 2019). We have the students document whether samples contain mold and assess whether fungal growth is time-dependent (e.g., increase prevalence in older samples), random across samples, or related to other factors that could influence preservation status (e.g., systematic variation among field stations that suggests different preservation procedures). We will also have students do a visual assessment of sample color as an indicator of Lugol's content. We will develop an explicit protocol for lab personnel and we will take photos to confirm what we're seeing with BSA Environmental. No samples will be discarded.

B) Sample Assessment & Identification

Following the fungal assessment, we will start by sending a range of uncompromised samples from approximately 2008-2018 for assessment of condition and species ID by BSA Environmental Services, Inc. The earliest year included will depend on whether sample had fungal growth. BSA has identified several other batches of LTRM samples (R. Burdis and S. Giblin, pers. comm.). It is generally thought that samples much older than ~10 years will only be viable for diatom analyses, but we will leave it up to the analysts to decide on the viability of the sample for full species identification.

Table 1 shows which samples we will select for analysis by BSA and the associated costs. We would initially only send samples from spring and summer for analysis since the phytoplankton would be at higher concentrations than in fall and winter, making them easier to assess for condition. We have chosen to assess samples from all reaches but only one strata for this initial assessment in order to maximize spatial coverage across the UMRS. This will both allow us to assess how community composition (longitudinal gradient in composition) affects preservation as well as indicate whether there are differences among field stations in preservation status. Communities have also been shown to differ among strata, which could affect their longevity, therefore, future work should evaluate side channel and backwater samples.

Sample assessment will proceed in two steps. First, BSA will do an initial screening of samples to assess sample decomposition (concentrate sample, scan for condition). We will request that they work through samples iteratively, starting with samples from 2008 (10 years old). If degradation is not present, we will have them work backwards in time to the earliest date at which fungus was not present. If degradation is present, then we will have them work forwards in time up to 2018 to see at what stage it samples start to degrade. Costs for samples for which only assessment is done will be $20. Second, if the sample is in good condition, the analyst will proceed with the species identification so as not to risk losing the information still present in the samples (Total cost $120/sample, assessment cost included).

Table 1. Samples to be sent out for assessment and identification.

Seasons	**Strata**	**Reaches**	**Replicates**	**# Samples per year**	**Estimated Sample ID cost**	**ID Cost per year**	**ID Cost for 10 years**
Spring & Summer	Main Channel	All	2	24	$120	$2,880	$28,800

Next steps/Future Work

This assessment will generate information about how long our samples are viable for full community analysis. We plan to use that information in a number of ways. First, once we have a sense of the rate at which our samples degrade, we can target the vulnerable samples for other potential archiving methods, such as the microscope image-based archive method described by Strassman et al. (2016), or prioritize them for processing and identification as funds are available. Other methods of archiving would require additional research, testing, and funding, therefore, are not included in this proposal. Second, we will need to do a broader assessment of how to handle phytoplankton collection, preservation and storage going forward. We have many more samples than we can analyze (26,650) and are constantly adding to the archive. Therefore, it would be worthwhile to either test out preservation methods if we continue collecting them as is, plan to archive them for more permanent storage (as indicated above), or consider the merit of other methods of community characterization such as phytoplankton eDNA analysis.

Expected Outcomes

We expect that this assessment will give us a better understanding of how long our samples are viable for full phytoplankton composition analysis or for diatoms only. This is the first time that LTRM phytoplankton samples will have been fully assessed for viability. Also, if a subset of our samples generate data over the longer time frame, that would allow us to evaluate both how phytoplankton communities have varied over space and time in the UMR as well as whether and how the invasion of Asian carp has altered phytoplankton communities. The effect of Asian carp has not been well-studied in comparison to their effect on other trophic levels (e.g., zooplankton, fish; DeBoer et al. 2018 and references therein), and would be interesting to address in light of the large HAB event that occurred on the Illinois River in summer 2018 (Pishgadamian 2018).

We will prepare a completion report by the middle of FY2020 to summarize our findings from this initial assessment.

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Products and Milestones

Tracking number	Products	Staff	Milestones
2019D1	Complete calendar year 2018 fixed-site and SRS water quality sampling	Jankowski, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	31 December 2018
2019D2	Complete laboratory sample analysis of 2018 fixed site and SRS data; Laboratory data loaded to Oracle data base.	Yuan, Schlifer	15 March 2019
2019D3	1st Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Cook, Fulgoni	30 December 2019
2019D4	2nd Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	30 March 2019
2019D5	3rd Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	29 June 2019
2019D6	4th Quarter of laboratory sample analysis (~12,600)	Yuan, Manier, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	28 September 2019
2019D7	Complete QA/QC of calendar year 2018 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 2019
	b. Field Station QA/QC; USGS QA/QC.	Jankowski, Rogala, Burdis, Kalas, Kueter, L. Gittinger, Kellerhals, Fulgoni	15 April 2019
	c. Corrections made and data moved to public Web Browser	Rogala, Schlifer, Jankowski	30 April 2019
2019D8	Complete FY2018 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 2019
2019D9	WEB-based annual Water Quality Component Update w/ 2018 data on Server.	Rogala	30 May 2019
2019D10	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 2019
2019D11	Summary letter: Assessment of Phytoplankton Samples collected by the Upper Mississippi River Restoration Program-Long Term Resource Monitoring Water Quality Component	Fulgoni and Jankowski	30 Sept 2019
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 August 2020
On-Going			
2017D10	Final LTRM Completion report: Evaluation of water quality data from automated sampling platforms	Soeken-Gittinger, Lubinski, Chick, Houser	30 May 2019

Intended for distribution
Completion report: Examining nitrogen and phosphorus ratios N:P in the unimpounded portion of the Upper Mississippi River (2006D9; Hrabik & Crites) (under revision)
Completion report, compilation of 3 years of sampling: Water Quality (2009R1WQ; Giblin, Burdis) (under revision)
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).

2019LC3: 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)

- Assess eCognition's ability to identify and classify floodplain vegetation to the 31-class level. This software has become the standard for automated and semi-automated land cover classification. The software must be 'trained' on vegetation class signatures initially but it can use that that training and ancillary datasets to derive land cover classes from digital aerial imagery. We hope to assess is usefulness at distinguishing floodplain land cover classes for future mapping efforts. Evaluating the newest 2018 versions of Feature Analyst and eCognition to assess how well current algorithms are able to correctly identify land cover classes. (in progress, 35% 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 (40%).

- 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 study report is in final draft (90%).

Products and Milestones

Tracking number	Products	Staff	Milestones
2019LC1	Maintenance ArcGIS server	Hlavacek, Fox, Rohweder	30 September 2019
2019LC2	Aerial Photo scanning (ILR)	Hlavacek	30 September 2019
2019LC3	Updates on progress for land cover products listed.	Robinson	New progress reported in the quarterly activities. Percent complete updated 30 Sept 2019.

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.

Product Description

Products and Milestones

Tracking number	Products	Staff	Milestones
2019M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.	Schlifer	30 May 2019
2019M2	Load 2018 component sampling data into Database tables and make data available on Level 2 browsers for field stations to QA/QC.	Schlifer	30 June 2019
2019M3	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 2019, the basic approach to the third Status and Trends report will be developed, a basic outline produced, and vetted with the UMRR CC and A-Team.

Methods:

The following will be completed:

1. A basic outline of the content of the report including clear identification of the purpose of the document and its intended audience, will be produced for review and discussion by the A team and UMRR CC
2. Identification of staff that will participate in producing the document

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
2019ST1	Initial Draft outline	Houser, Hagerty, Jankowski, Ickes, Larson (others as needed)	31 July 2019
2019ST2	Draft outline of Third Status and Trends	Houser, Hagerty, Jankowski, Ickes, Larson (others as needed)	30 September 2019

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
2019QR1	Submittal of quarterly activities	All LTRM staff	30 January 2019
2019QR2	Submittal of quarterly activities	All LTRM staff	13 April 2019
2019QR3	Submittal of quarterly activities	All LTRM staff	13 July 2019
2019QR4	Submittal of quarterly activities	All LTRM staff	12 October 2019

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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.

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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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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.

Donated Product: A product produced by others, without including the LTRM staff and without investment of UMRR funds.