Hampton Inn Downtown
St. Paul, Minnesota

Upper Mississippi River Restoration Program Coordinating Committee

Quarterly Meeting

May 24, 2023

Agenda
with
Background
and
Supporting Materials

Hampton Inn and Suites
St. Paul

Upper Mississippi River Restoration Program Coordinating Committee

May 24, 2023

Agenda

Tuesday, May 23 Partner Quarterly Pre-Meetings

3:30 – 4:45 p.m.	Corps of Engineers
3:30 – 4:45 p.m.	Department of the Interior
3:30 – 4:45 p.m.	States

Wednesday, May 24 UMRR Coordinating Committee Quarterly Meeting

Time	Attachment	Topic	Presenter
8:00 a.m.		Welcome and Introductions	*Sabrina Chandler,* USFWS
8:05	A1-A11	Approval of Minutes of March 1, 2023 Meeting	
8:10	B1-B4	Regional Management and Partnership Collaboration ▪ FY 2023 Fiscal Update and FY 2024 Outlook ▪ Environmental Justice ▪ Strategic and Operational Plan Review ▪ Implementation Issues ▪ Report to Congress Update	*Marshall Plumley*, USACE
9:20		Break	
9:30		Ecological Status and Trends	
	C1-C4	▪ Long Rollout	*Andrew Stephenson*, UMRBA
9:40		Communications ▪ UMRR Communications Team ▪ External Communications and Outreach Events	 *Rachel Perrine*, USACE *All*
10:15		UMRR Showcase Presentations ▪ GIS StoryMaps ▪ HREPs in a Time of High Water, High Prices, and Innovative Ideas	 *Kevin Hanson*, USACE-MVP *John Henderson*, USACE-MVP
11:30		Lunch	

(Continued on next page)

Wednesday, May 24   UMRR Coordinating Committee Quarterly Meeting
(Continued)

Time	Attachment	Topic	Presenter
12:30 p.m.		Program Reports	
	D1-D60	▪ Long Term Resource Monitoring and Science	*Jeff Houser*, USGS
		– LTRM FY 2023 1st Quarter Highlights	
		– USACE LTRM Update	*Karen Hagerty*, USACE
		▪ A-Team Report	*Matt O'Hara*, IL DNR
	D61-D67	▪ LTRM Implementation Planning Update	*Jeff Houser*, USGS
1:45		Program Reports (Continued)	
		– Habitat Restoration District Reports	*Angela Deen, Julie Millhollin, Brian Markert*, USACE
2:45	E1-E13	Other Business	
		▪ Future Meeting Schedule	
2:50 p.m.		Adjourn	

[**NOTE**: The UMRR Coordinating Committee will meet from 3 – 4:00 to discuss next steps to develop recommended actions to address implementation issues.]

ATTACHMENT A

Minutes of the March 1, 2023
UMRR Coordinating Committee Quarterly Meeting

(A-1 to A-11)

Minutes of the
Upper Mississippi River Restoration Program
Coordinating Committee

March 1, 2023
Quarterly Meeting

Virtual

Thatch Shephard (on behalf of Brian Chewning) of the U.S. Army Corps of Engineers called the meeting to order at 8:01 a.m. on March 1, 2023. UMRR Coordinating Committee representatives in attendance were Mary Stefanski (USFWS) (on behalf of Sabrina Chandler), Mark Gaikowski (USGS), Chad Craycraft (IL DNR), Randy Schultz (IA DNR), Megan Moore (MN DNR), Matt Vitello (MO DoC), Jim Fischer (WI DNR), Rich Vaughn (NRCS), and Travis Black (MARAD). A complete list of attendees follows these minutes.

UMRR Coordinating Committee Membership

Thatch Shephard welcomed Dr. Vanessa Perry as Minnesota's new UMRR Coordinating Committee member. UMRR Coordinating Committee members and partners thanked Megan Moore for contributing many years to the UMRR program as an LTRM field station lead as well as Minnesota's representative to the Coordinating Committee. Her expertise, dedication to the UMRS ecosystem, and commitment to partnership has contributed significantly to the success of UMRR. Moore expressed appreciation for her time with the program and the partnership and highlighted the meaningful work.

Minutes of the November 16, 2022 Meeting

Randy Schultz moved and Jim Fischer seconded a motion to approve the draft minutes of the November 16, 2022 UMRR Coordinating Committee meeting as written. The motion carried unanimously.

Regional Management and Partnership Collaboration

FY 2023 Fiscal Update

Marshall Plumley reported that the FY 23 Consolidated Appropriations Act, enacted on December 29, 2022, appropriated $55 million to UMRR. UMRR has obligated over $27 million, or 49 percent, of its $55 million FY 23 funds, as of March 1, 2023. In addition to additional several project awards, UMRR recently awarded a support services contract to UMRBA, marking a continuation of an over three-decades long relationship. Plumley remarked that UMRR was well prepared to invest the additional $22 million in appropriations above its $33 million appropriation in recent years. The program's obligation through the first half of this fiscal year constitutes nearly the entire program in previous years. Plumley expressed appreciation to all partners involved in implementing the UMRR program.

The FY 23 plan of work for UMRR at $55 million is as follows:

- Regional Administration and Program Efforts – $1,550,000
  - Regional management – $1,280,000
  - Program database – $100,000
  - Program Support Contract – $120,000
  - Public Outreach – $50,000

- Regional Science and Monitoring – $15,450,000
  - Long term resource monitoring – $5,500,000
  - Regional science in support of restoration – $8,350,000
  - Regional science staff support – $200,000
  - Habitat evaluation (split across three districts) – $1,275,000
  - Report to Congress – $125,000
- Habitat Restoration – $38,000,000
  - Rock Island District – $11,148,000
  - St. Louis District – $13,502,000
  - St. Paul District – $13,250,000
  - Model certification – $100,000

FY 2024 Budget Outlook

Plumley reported that the President's FY 24 budget is anticipated to be released on March 9, 2023. [Note: The President's FY 24 budget released on March 9, 2023 includes $55 million for UMRR.]

WRDA 2022

Plumley reported that the enactment of WRDA 2022 on December 15, 2022 increased the annual authorized appropriation for UMRR to $90 million, with $75 million for HREP and $15 million for LTRM. This increase reflects the excellent work of program partners and support from Congress. In response to a suggestion from Kirsten Wallace, the Coordinating Committee called upon itself to develop implementation scenarios at various potential appropriation levels. Plumley welcomed the conversation, while noting the Corps' restrictions on providing certain information prior to the Administration's budget release. Jim Fischer said scenario planning would be helpful as partner agencies plan their capacity to provide their respective roles through UMRR under its increased authorization as well as other river-related programs such as the Navigation and Ecosystem Sustainability Program (NESP). Shephard said the Corps has received record budgets in recent years and will have to consider capability across all programs and projects. Wallace encouraged the UMRR Coordinating Committee to coordinate with the NESP Coordinating Committee as much as possible and appropriate in order to more effectively and efficiently advance the region's strategic ecological goals.

Recalling previous discussions of UMRR and NESP's collaborations, Fischer encouraged UMRR and NESP to coordinate their approaches to develop their respective ecosystem restoration plans. Kraig McPeek expressed agreement, acknowledging the importance of making the most effective use of people's time as the most valuable resource to the program.

UMRR Ten-Year Plan

Plumley said the UMRR 10-year plan illustrates the implementation schedules for 24 projects, now including Clarence Cannon, Gilead Slough, and Reds Landing all in the St. Louis District. The schedule will continue to be refined as more details and specificity on projects becomes available. Plumley said this planning tool is useful for developing work plans among UMRR's partner agencies.

Environmental Justice

Plumley recalled that the UMRR Coordinating Committee had an informal conversation about environmental justice in May 2022, prompting the Corps to brief the Committee about USACE environmental justice policy at its August 2022 quarterly meeting, including anticipated new guidance. In response, the UMRR Coordinating Committee called upon UMRR to integrate environmental justice into the planning, design, and construction of habitat projects. In November 2022, the Coordinating Committee established an environmental justice *ad hoc* committee. Plumley reported that the *ad hoc* committee met on January 25, 2023 for the purposes of sharing agency perspectives on approaches, best practices, methods, and tools related to environmental justice. The *ad hoc* committee discussed how UMRR currently approaches environmental justice through habitat rehabilitation and enhancement projects. Participants included agency personnel specializing in diversity, equity, and inclusion with limited prior experience with UMRR. Marshall Plumley shared his observations from the January 25 meeting relating to the following themes:

- Policy and guidance vary but EJ values are evident
- Access(ability)
- Recruitment
- Trust
- Connections
- Sense of place
- Respect & dignity
- Quality of life
- Compensation
- Climate Change/EJ Intersection
- Participation is a promise
- Regional community engagement
- Being part of the community is the best way to make conservation work
- Natural resource values are changing
- Proactive instead of just avoidance

Plumley noted that, while all agencies value environmental justice, the range of policy and guidance across the partnership varies considerably. Plumley said USACE will provide a summary of the meeting to the UMRR Coordinating Committee and other meeting participants.

The UMRR Coordinating Committee has requested a subsequent meeting to reflect on the January 25 meeting and to consider how to incorporate environmental justice criteria at the outset of the next HREP selection process.

Plumley added that NGO partners, such as The Nature Conservancy, have expressed an interest and willingness to contribute to these conversations. In response to a comment from Thatch Shepard, Plumley reflected on Kat McCain's previous involvement with UMRR and suggested that she could add value to this discussion. Plumley pointed to some screening tools with environmental justice criteria that could be incorporated at the outset of the next HREP identification and selection process. Vanessa Perry expressed appreciation for these conversations and her eagerness to participate, acknowledging the importance of building relationships with communities and sharing the potential benefits of projects to them.

Strategic Plan Review

Plumley reported that, on February 21, 2023 via email, Andrew Stephenson submitted a review request to the UMRR Coordinating Committee members of the draft the UMRR 2015-2025 Strategic Plan Review Report. The report includes important partner insights and will inform priorities for UMRR in the near term as well as in the next strategic plan. Comments are requested by March 20, 2023. Following the review, the UMRR Coordinating Committee will be asked to discuss the report in-depth and prioritize actions over the next two years.

Implementation Issues Assessment

Plumley reported that the UMRR Coordinating Committee finalized its analysis on a suite of implementation issues. UMRBA submitted the final issue papers to the Committee on November 11, 2022. Prior to that, on September 21, 2023, UMRBA staff disseminated a survey to Committee members asking for their suggestions for advancing or resolving various options associated with each paper. The UMRR Coordinating Committee will evaluate these "future actions" in conjunction with the 2015-2025 UMRR Strategic Plan review meeting in late March or April 2023 as mentioned above. Plumley is consulting with the Mississippi Valley Division regarding the Corps' responses to the survey.

2022 Report to Congress

Plumley reported that USACE Headquarters is reviewing the draft 2022 UMRR Report to Congress prior to transmitting it to Congress. UMRR Coordinating Committee members received a draft version in November 2022 following which additional letters of support were received and incorporated into the report. Plumley expressed appreciation to all partners who provided a letter of support.

The Corps is drafting a press release and a four-page flyer that will be sent to the UMRR Communications and Outreach Team (COT) for review in the near future. Recalling the success of the coordinated press release related to the publication of the UMRR long term ecological status and trends report, Fischer asked if a similar effort would be employed for the 2022 Report to Congress. Plumley said the Coordinating Committee could elect to coordinate on the initial report release and employ communications pulses around the embedded case studies.

UMRR HREP Workshop

Plumley said workshops are being planned for both HREP and LTRM elements in winter 2023 or spring 2024. The last HREP workshop was held in 2019 and brought together all HREP practitioners as well as field station staff to share information.

HREP Selection Process

Plumley said the 10-year implementation plan provides insights on the timeline for initiating planning on new projects under the consistent funding. The plan may need to be adjusted under lower or higher funding scenarios. The UMRR Coordinating Committee has established a recurring schedule for implementing HREP selection processes every five years with the next effort scheduled to be completed in 2025. Planning for the 2024 cycle may begin this year.

Plumley recognized that the NESP Coordinating Committee has also identified a need for project selection in the near term. A joint project selection process was employed in 2010 and may be considered. Stephenson noted that field crews may have opportunities to track restoration needs this summer for the anticipated selection process. Plumley said there have been discussions regarding tools that can be used and made more widely available for tracking restoration needs. Fischer recalled that various data collection platforms are now available for UMRR and NESP and said it would be useful to identify efficiencies and improved approaches across them. Plumley agreed and welcomed discussion on streamlining across platforms.

UMRR Strategic Planning

Plumley said UMRR's next strategic planning process is scheduled to occur in FY 2024. Scoping that effort will begin later this year.

Communications

Status and Trends Flyers

Andrew Stephenson provided an update on the development of five flyers related to findings of the Ecological Status and Trends of the Upper Mississippi and Illinois Rivers Report. The development of the flyers includes multiple reviews by report authors, the A-Team, and COT. Flyers are complete that describe the condition and trends of the UMRS fisheries, floodplain forests, and sedimentation. The water quality flyer is in final design and the aquatic vegetation flyer is under review by the A-Team and COT.

In the near term, UMRBA plans to share the completed flyers will be shared with Congressional offices during planned visits on March 2-3, 2023 and with the Upper Mississippi River Conservation Committee during its March 20-24, 2023 meeting. A coordinated release of these flyers is being planned; a survey was distributed to the COT soliciting feedback on draft objectives, strategies, messages, and audiences for the release. Initial feedback from the UMRR Coordinating Committee calls UMRR partner agency staff and leadership to serve as the primary audience. The Committee suggests that distribution should include email and in-person events such as open houses, groundbreaking/ribbon cutting events, quarterly meetings, Hill visits, and various regional and national meetings. Fischer thanked Stephenson for leading the development of the flyers, noting that Wisconsin DNR will use them in outreach activities. Houser agreed, noting the flyers are well done and expressed appreciation for how closely Stephenson has worked with report authors to develop them.

COT Update

Marshall Plumley provided an update on the UMRR Communications and Outreach Team (COT), which continues to meet monthly. The COT is reviewing the remaining two status and trends flyers. Plumley expressed appreciation to Stephenson and UMRBA staff for developing the flyers and coordinating the review process across the whole partnership. Stephenson expressed appreciation to program partners for their engagement in developing the flyers.

This spring, the COT will focus on reviewing the draft press release and flyer for the 2022 UMRR Report to Congress. As specific messages are developed, the team will consider other engagement opportunities as well. Sabrina Chandler presented to the COT on initial plans to celebrate the 100th anniversary of the UMR National Wildlife and Fish Refuge in 2024. Plumley said the COT may be able to assist UMRR as it develops strategies for engaging disadvantaged communities.

External Communications and Outreach

Communication and outreach activities in the second quarter of FY 2023 include the following:

- UMRBA staff will be meeting with congressional offices March 2-3, 2023 to discuss ecosystem restoration on the river, including UMRR and NESP.
- The Upper Mississippi River National Wildlife and Fish Refuge is planning the 100th anniversary to occur in 2024 and will share information as it is available.
- The Lower Mississippi River Subbasin Committee is hosting a webinar on Tuesday, March 7, 2023 regarding the lower Mississippi river restoration feasibility study. Angie Rogers and Michael Trone will present.
- USFWS will be commemorating the Endangered Species Act’s 50th anniversary in 2023.

— On March 1-3, 2023, Mark Gaikowski is scheduled to attend the MRCTI Capital Meeting and to meet with several Congressional offices. Gaikowski plans to speak to UMRR's science and monitoring efforts in support of ecosystem restoration on the Upper Mississippi River System.

— USGS hosted a virtual Mississippi River Science Forum on February 15-16, 2023. There were 31 presenters from 27 organizations including the Prairie Island Indian Community President Johnny Johnson, Department of Interior Assistant Secretary for Water and Science Tanya Trujillo, and USGS Director Dave Applegate. There were more than 200 attendees on both days. Jeff Houser and Sara Schmuecker presented on the state of science and data gaps in the UMRS, including using the HNA II and Resilience efforts. The presentation highlighted the value of the UMRR to the Mississippi River.

Thatch Shepard suggested considering how outreach efforts could be coordinated with existing Earth Day events. Vanessa Perry said she will work with Minnesota's internal team to relay future communications and outreach efforts.

UMRR Showcase Presentations

Lower Pool 13 HREP

Julie Millhollin, USACE, presented on the Lower Pool 13 HREP. USFWS is the project sponsor. After the initial site visit in 2019, the PDT rescoped the project into multiple phases with phase I focused on the southwest corner of the pool and submerged aquatic vegetation (SAV) and phase II of the project focused on water level management and emergent aquatic vegetation. The area of phase I is an important stopover site for migrating waterfowl including canvasbacks. LTRM data shows an overall increase of SAV in Pool 13 since 1998, but a decreasing trend since 2006. Poor water clarity caused by upstream suspended sediment load and resuspension of bottom sediments, due to wind driven wave action, negatively affects aquatic vegetation. The pattern of increased flooding has resulted in reduced recruitment of native tree species and an increase in prevalence of invasive species. The objectives of phase I are to restore and enhance submerged aquatic vegetation and habitat and floodplain forest diversity and habitat. The existing flow velocity conditions highlight potential locations of features to reduce wind impacts. The project will increase diving duck habitat by 1992 acres and forest habitat by 535 acres at an estimated cost of $38.8 million. Round mounds, chevrons, and submerged islands downstream of a breached island will reduce waves and allow SAV to re-establish. Forest plots will use dredge material to build up three islands in the channel. Once a cultural survey of forest plots is completed, the report will be finalized, and the project will move into design. Planning for phase II is beginning.

UMRS Topobathy Acquisition

Jayme Strange, USGS UMESC, provided an update on the UMRS Topobathy acquisition. Topobathy is the combination of lidar and bathymetry datasets. LiDAR is used to categorize spatial topography of the floodplain and lidar point clouds have been used to identify gaps in floodplain forests. LiDAR was last flown in 2008 through 2011. Bathymetry quantifies water depth and is critical for aquatic habitat rehabilitation for overwintering habitat, mussel habitat, and modeling flow velocities. Topobathy data is used for river ecosystems and hydraulic and hydrological modeling of the watershed and multiple iterations can detect changes over time. Topobathy underpins many LTRM science products and activities including models related to flood inundation, forest succession, sediment suspension, wind and wave action, and HEC-RAS. The current topobathy data spatial extent is bluff to bluff of the UMRS and temporally extends from 1989 to 2011. Weak points of the current topobathy data include combining multiple datasets, datum transformation troubles, LiDAR breaklines, and interpolation. A working group of USGS and USACE experts are developing cost and effort estimates for the acquisition plan to align with Sciencebase and other data storage areas and expect the project to take five to six years. Data acquisition will be supported by both UMRR and NESP. The team is evaluating data quality at the 3DEP or Q2 levels. Other efforts are underway to acquire Lidar Q2 data nationally. The team will look to leverage a variety of information streams currently available including E-hydro surveys for dredge purposes as well as the experts at the USACE Center of Expertise for Photogrammetric Mapping. Strange said that technology improvements warrant exploring multiple options for acquisition and will require ground truthing. Stephenson said the USGS Next Generation Water Observing System (NGWOS) is conducting surveys in the Illinois River Basin to better understand groundwater movement and storage. Matt Vitello said Missouri has an effort to update state data by 2027 that could be leveraged as part of this update. In response to a question from Stephenson, Strange said new technology may be able to better assess the shallow terrestrial-to-aquatic transition areas but deeper areas would require hydroacoustics. USGS is able to get better data at shallower areas than ever before and can now to go to depths of one meter. Matt Mangan added that St. Louis District collected Lidar in winter 2020 to 2021. Karen Hagerty said the acquisition may start this fiscal year.

Habitat Restoration

Angela Deen reported that MVP's planning priorities include Big Lake – Pool 4, Reno Bottoms, and Robison Lake. A kick-off meeting for Robinson Lake was held in January and a public meeting is anticipated to occur in May. Eight alternatives, including one no action alternative, were identified for Big Lake – Pool 4 and a TSP will be developed this spring. The Reno Bottoms feasibility report was approved, and the project will transition to plans and specs with a kick-off value engineering study. The other design priority for MVP is Lower Pool 10, which will use an AE firm for design and engineering during construction. Increased appropriations for UMRR allowed two contract options to be awarded on McGregor Lake HREP. The project has used 500,000 cubic yards of granular material and is a beneficial use success story. O&M manuals were completed for Harpers Slough, Bass Ponds, and Conway Lake HREPs. MVP initiated a performance evaluation report for the Trempealeau HREP where harmful algal blooms have been problematic. In response to a question from Andrew Stephenson, Deen said the District is working to complete 14 storymaps this year. Deen suggested having the storymap leads present at the May 23, 2023 UMRR quarterly meeting. Deen said that last year the team focused on developing storymaps for older projects, but that this year's focus was on active projects. She added that the District is also updating webpages to include storymaps, project fact sheets, and FAQs, for improved awareness and access to current information for the public.

Julie Millhollin reported that MVR's planning priorities include Lower Pool 13 Phases I and II, Green Island, Pool 12 Forestry, and Quincy Bay. A public meeting for Lower Pool 13 Phase I was held in November and the team is working to finalize the feasibility report. The Quincy Bay and Pool 12 Forestry PDTs are finalizing costs estimates and beginning HEP modeling. The Green Island PDT is preparing for a TSP meeting in April 2023. Steamboat Island stage II is in design and has completed 65 percent review. MVR has four projects in construction, Beaver Island, Steamboat Island Stage I, Keithsburg Division Stages I and II, and Huron Island Stage III. The Beaver Island contractor is on site and the Steamboat Stage I contractor is scheduled to start tree clearing in early March. The Keithsburg Stage I contractor has demobilized from the site while assessing potential eagle nest activity. Construction at Huron Island is complete and ERDC is surveying vegetation and will conduct additional plantings this summer and assessment in September 2023. Lessons learned from this project will be applied to future projects. In response to a comment from Stephenson regarding a consistent aesthetic across District HREP progress maps, Thatch Shephard requested Plumley address that for the May 23, 2023 UMRR quarterly meeting.

MVS's planning priorities include West Alton Islands and Yorkinut Slough. Feasibility planning continues at both projects. A TSP was completed for Yorkinut Slough in February and Division quality control review is underway. MVS's design priorities include Harlow Island, Oakwood Bottoms and Crains Island. Harlow Island Stage II was initiated with a focus on earthwork and backwater. Oakwood Bottoms has three plans and specs packages nearly complete including a pump station, well pumps, and water control/earthwork that could be ready to advertise soon. Crains Island Stage II plans and specs are entering review. MVS has three projects in construction: Crains Island Stage I, Piasa and Eagles Nest Stage II, and Clarence Cannons. Construction at Crains Island Stage I is mostly complete with some remaining warranty work on a drainage channel that had sediment slide. A contract was awarded for Piasa and Eagles Nest Stage II for side channel excavation and island construction. The material from the excavation is expected to be used for island construction. At Clarence Cannon, earthwork on a berm setback continues. Other MVS activities include drafting new fact sheets and a flood damage assessment on Swan Lake HREP. In response to questions from Mark Ellis, Brian Markert said that at Piasa and Eagles Nest that there was an existing side channel with good flow and depth diversity, but that a shift in water volume between it and the main channel brought rapid accumulation of sediment that raised concerns the side channel may close off. Markert added that no side channels will be created at Clarence Cannon, but that there are historic meanders in the project area that may provide some depth diversity.

Long Term Resource Monitoring and Science

FY 2023 1st Quarter Report

Jeff Houser reported that accomplishments of the first quarter of FY 23 include publication of the following manuscripts:

- *Understanding ecological response to physical characteristics in side channels of a large floodplain-river ecosystem*
- *Flood regimes alter the role of landform and topographic constraint on functional diversity of floodplain forests*
- *Survival and Growth of Four Floodplain Forest Species in an Upper Mississippi River Underplanting*
- *New Records of Spotted Bass, Micropterus punctulatus, within the Mississippi River Basin, Illinois*

In response to a question from Andrew Stephenson, Houser said that an LTRM all-hands meeting is scheduled for April 11-13, 2023 in Muscatine.

USACE LTRM Report

Karen Hagerty said UMRR's LTRM FY 23 budget allocation is $7 million ($5.5 million for base monitoring and $1.5 million for analysis under base) with an additional $6.85 million available for "science in support of restoration and management."

Hagerty said high priority funding items for science in support of restoration (as presented to the UMRR Coordinating Committee at its November 16, 2022 quarterly meeting) total $1,283,150 and include:

- LTRM balance: $302,060
- Ecohydrology: $469,970
- LC processing (last year): $335,240
- Proposal adjustments: $45,610
- Macroinvertebrate contaminants: $77,480

Hagerty requested the UMRR Coordinating Committee endorse funding three additional items as follows:

- Establishing an herbarium: $22,010
- Future landscape modeling: $600,140
- Equipment (FS, UMESC): $659,270

Chad Craycraft moved and Matt Vitello seconded a motion to endorse the three additional items totaling $1,281,420. In response to a question from Fischer, Houser explained that UMESC and the field stations have an equipment refreshment cycle that helps plan purchases of boats, motors, computers, and this year the UMESC water quality lab equipment. Houser added that, although not reflected in the current request amount, field stations were asked to provide equipment needs over the next few years to be addressed with the increased program funding. In response to a question from Nick Schlesser, Houser said the current equipment costs include some items that would have been funded in out-years as well as some equipment that broke unexpectedly. Fischer expressed support for equipment needs and the herbarium but requested additional information on the future landscape modeling including the principal investigator (PI). Houser said that item would help support John Delaney's work for three years. Delaney has worked with Molly Van Appledorn to pull three separate models together to develop a classification model for expected future changes on the floodplain and with Danelle Larson on mapping the vulnerability of SAV and where it is expected to change. Fischer expressed his confidence in Delaney's work and the critical nature of the research considering climate change and noted he has no objections. Vanessa Perry requested that budgets be included in the scopes of work that are presented to the Coordinating Committee for consideration. The motion passed unanimously.

Hagerty presented additional items that will be presented to the UMRR Coordinating Committee for its consideration in May 2023, including advancing the following four priority FY 22 science proposals totaling $1,550,000:

— Scoping and vetting new technology and methods for use in future hydrographic and topographic surveys
— Avian associations with management in the UMRS: filling knowledge gaps for habitat management
— Filling in the gaps with FLAMe: Spatial patterns in water quality and cyanobacteria across connectivity gradients and flow regimes in the Lower Impounded Reach of the UMR
— Substrate stability as an indicator of abiotic habitat for the UMR benthic community

Hagerty said remaining FY 23 science in support funds will be used support updated topobathy in conjunction with NESP. Hagerty said she will request endorsement of these items at a future meeting when budgets are finalized.

A-Team Report

Scott Gritters said the A-Team's February 3, 2023 meeting focused on the following items:

— Updates to the A-Team Corner and the Corps webpages regarding LTRM information
— Chair rotation
— A-Team's role in HREP/LTRM integration
— UMRR program updates – e.g., environmental justice and LTRM implementation planning
— Identifying areas for conservation and restoration of submerged aquatic vegetation
— 2022 UMRR LTRM status and trends report flyers
— Illinois River Biological Field Station

Gritters said the A-Team discussions on HREP and LTRM integration highlighted that the subject is challenging due to agency differences and because not all HREPs are the same and they are not all built solely on data available. Gritters put forth the importance that PDTs are aware of the information available. The A-Team can be available to respond to any information needs. Gritters encouraged the A-Team to continue to be a forum for discussions on this topic.

Danelle Larson presented new efforts to create accurate, predictive model of ecosystem states to define an SAV-state, unvegetated-state, vulnerable, and those with restoration potential. Average depth, suspended solids, substrate, and distance to nearest SAV are the main drivers to predict vegetation. Next steps are to create an online, interactive tool for researchers and managers to learn, discuss, and apply adaptive management.

Gritters expressed appreciation for the UMRR status and trends flyers and the review process, noting the many potential use for the flyers.

Gritters expressed appreciation to many for their involvement in the A-Team during his tenure as Chair, including Hagerty, Houser, Jennie Sauer, Plumley, Stephenson, LTRM component PIs, and A-Team representatives. Gritters said UMRR should be extremely proud of the science it is producing, and the people involved.

The next A-Team meeting is scheduled for April 19, 2023, in La Crosse, in conjunction with the Mississippi River Research Consortium. The meeting will be the first in-person A-Team meeting in a few years. Matt O'Hara, Illinois DNR, will assume the chair position. Hagerty, Houser, Stephenson, Megan Moore and others expressed appreciation for Gritter's leadership of the A-Team, noting the special focus on people in the program that he brought.

LTRM Implementation Planning

Jeff Houser and Max Post Van der Burg provided a briefing on the LTRM implementation planning process. Houser reported that, over the past several months, the *ad hoc* LTRM implementation planning team has drafted objective statements and identified and prioritized information needs. Post Van der Burg explained a structured decision-making process based around the qualitative value of information (QVoI) was employed to evaluate and compare information needs. The team developed a scoring matrix considering the relevance of information needs to both ecosystem understanding and assessment as well as management and restoration along with the depth of current knowledge, cost, opportunity to learn, urgency, and unique capacity of LTRM to address the information need. The team developed an optimization spreadsheet and algorithm to evaluate the efficacy of different funding strategies – e.g., annual, three-year, or five-year funding blocks.

Houser said the team will meet on March 2, 2023 to review the optimization results and conduct a participatory modeling exercise to determine if the assumptions incorporated into the algorithm adequately reflect the group's opinions. The team is planning to report its recommendations for information needs to the UMRR Coordinating Committee at its May 24, 2023 quarterly meeting. Following the Committee's endorsement of information needs, the *ad hoc* team plans to develop in-depth work plan proposals and associated costs. Vanessa Perry and Thatch Shephard expressed support for that tiered approach to endorsement. Marshall Plumley expressed appreciation for the group's work and noted that 25 years ago we could not have imagined the work we are doing now and this group is being asked to consider the information we will need to do work 20 years from now.

Other Business

Thatch Shephard reported the Mississippi River Commission will conduct its annual spring high-water inspection trip on the Mississippi River, March 27- 31, 2023.

Jim Fischer reported that Dr. Patrick Kelly was hired as the new Wisconsin Field Station Team Leader. Wisconsin has not had someone in this position since Terry Dukerschein in 2010. Having a dedicated field station team leader again will help to build on success of efforts in the past. UMRR Coordinating Committee members welcomed Dr. Kelly.

Jim Fischer shared that Kraig Hoff, a Wisconsin DNR field operations specialist passed away on February 14, 2023 after a 19-year battle with brain cancer. As an avid outdoorsman, Hoff loved hunting, fishing, golfing and many other outdoor activities. He dedicated his career to working at the LTRM field station.

Upcoming quarterly meetings are as follows:

- May 2023 – St. Paul
  - UMRBA quarterly meeting – May 23
  - UMRR Coordinating Committee quarterly meeting – May 24

- August 2023 – La Crosse
  - UMRBA quarterly meeting – August 8
  - UMRR Coordinating Committee quarterly meeting – August 9

- October 2023 – St. Louis
  - UMRBA quarterly meeting – October 24
  - UMRR Coordinating Committee quarterly meeting – October 25

With no further business, Randy Schultz moved, and Jim Fischer seconded a motion to adjourn the meeting. The motion carried unanimously, and the meeting adjourned at 2:32 p.m.

ATTACHMENT B

Regional Management and Partnership Collaboration

- **UMRR Quarterly Budget Reports (4/14/2023)** *(B-1 to B-3)*
- **UMRR 10-Year Implementation Plan (FY 22 thru FY 23)** *(B-4)*

UMRR Quarterly Budget Report: St. Paul District

FY2023 Q2; Report Date: Fri Apr 14 2023

Habitat Projects

Project Name	Cost Estimates			FY2023 Financials			
	Non-Federal	Federal	Total	Carry In	Allocation	Funds Available	Actual Obligations
Bass Ponds, Marsh, and Wetland	-	$6,300,000	$6,300,000	-	-	-	$116,941
Conway Lake	-	$7,413,000	$7,413,000	-	-	-	$8,123
Harpers Slough	-	$13,675,000	$13,675,000	-	-	-	-$260,615
Lower Pool 10 Island and Backwater Complex	-	$17,000,000	$17,000,000	-	$3,248,000	$3,248,000	$288,380
Lower Pool 4, Big Lake	-	$18,000,000	$18,000,000	-	$550,000	$550,000	$214,104
McGregor Lake	-	$23,550,000	$23,550,000	$183,743	$6,600,000	$6,783,743	$7,418,000
Reno Bottoms	-	$10,000,000	$10,000,000	$59,603	$200,000	$259,603	$163,464
Robinson Lake, MN	-	$12,000,000	$12,000,000	-	$550,000	$550,000	$71,481
Total	-	$107,938,000	$107,938,000	$243,346	$11,148,000	$11,391,346	$8,019,878

Habitat Rehabilitation

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
District Program Management	-	-	-	$181,515
Total	-	-	-	$181,515

Regional Program Administration

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
Habitat Eval/Monitoring	-	-	-	$75,202
Total	-	-	-	$75,202

	Carry In	Allocation	Funds Available	Actual Obligations
St. Paul Total	$243,346	$11,148,000	$11,391,346	$8,276,595

UMRR Quarterly Budget Report: Rock Island District

FY2023 Q2; Report Date: Fri Apr 14 2023

Habitat Projects

Project Name	Cost Estimates			FY2023 Financials			
	Non-Federal	Federal	Total	Carry In	Allocation	Funds Available	Actual Obligations
Beaver Island	-	$25,288,000	$25,288,000	-	$300,000	$300,000	$80,064
Green Island, IA	-	$16,600,000	$16,600,000	$23,581	$400,000	$423,581	$316,247
Huron Island	-	$15,773,000	$15,773,000	$65,698	-	$65,698	$13,470
Keithsburg Division	-	$29,643,000	$29,643,000	-	$6,600,000	$6,600,000	$234,510
Lower Pool 13	-	$25,288,000	$25,288,000	$48,000	$400,000	$448,000	$244,590
Lower Pool 13 Phase II	-	-	-	$21,336	$600,000	$621,336	$115,860
Pool 12 (Forestry)	-	-	-	$53,705	$600,000	$653,705	$257,839
Pool 12 Overwintering	-	$20,870,822	$20,870,822	$1,598	-	$1,598	$1,598
Quincy Bay, IL	-	-	-	$12,312	$600,000	$612,312	$306,298
Rice Lake, IL	$7,280,000	$13,459,763	$20,739,763	$115,525	-	$115,525	-
Steamboat Island	-	$41,977,000	$41,977,000	-	$3,952,000	$3,952,000	$5,979,632
Total	$7,280,000	$188,899,585	$196,179,585	$341,755	$13,502,000	$13,843,755	$7,550,108

Habitat Rehabilitation

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
District Program Management	-	-	-	$107,364
Total	-	-	-	$107,364

Regional Program Administration

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
Adaptive Management	-	$200,000	$200,000	$95,615
Habitat Eval/Monitoring	$450	$1,275,000	$1,275,450	$78,262
Model Certification/Regional HREP	-	$100,000	$100,000	-
Public Outreach	-	$50,000	$50,000	$5,316
Regional Program Management	$2,993	$1,500,000	$1,502,993	$651,353
Regional Project Sequencing	-	$125,000	$125,000	$30,685
Total	$3,443	$3,250,000	$3,253,443	$861,231

Regional Science and Monitoring

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
Long Term Resource Monitoring	-	$5,500,000	$5,500,000	$2,492,008
Science in Support of Restoration/Management	-	$8,350,000	$8,350,000	$1,560,895
Total	-	$13,850,000	$13,850,000	$4,052,903

	Carry In	Allocation	Funds Available	Actual Obligations
Rock Island Total	$345,198	$30,602,000	$30,947,198	$12,571,606

UMRR Quarterly Budget Report: St. Louis District

FY2023 Q2; Report Date: Fri Apr 14 2023

Habitat Projects

Project Name	Cost Estimates			FY2023 Financials			
	Non-Federal	Federal	Total	Carry In	Allocation	Funds Available	Actual Obligations
Clarence Cannon	-	$29,800,000	$29,800,000	-	$950,000	$950,000	$87,383
Crains Island	-	$36,562,000	$36,562,000	-	$1,900,000	$1,900,000	$59,065
Gilead Slough	-	$11,000,000	$11,000,000	-	$350,000	$350,000	$61,200
Harlow Island	-	$37,971,000	$37,971,000	-	$325,000	$325,000	$70,323
Oakwood Bottoms	-	$29,000,000	$29,000,000	-	$575,000	$575,000	$587,911
Piasa - Eagle's Nest Islands	-	$26,746,000	$26,746,000	$31,151	$8,300,000	$8,331,151	$7,185,229
West Alton Missouri Islands	-	-	-	$21,510	$425,000	$446,510	$175,756
Yorkinut Slough, IL	-	$8,500,000	$8,500,000	$13,681	$375,000	$388,681	$289,274
Total	-	$179,579,000	$179,579,000	$66,342	$13,250,000	$13,316,342	$8,516,141

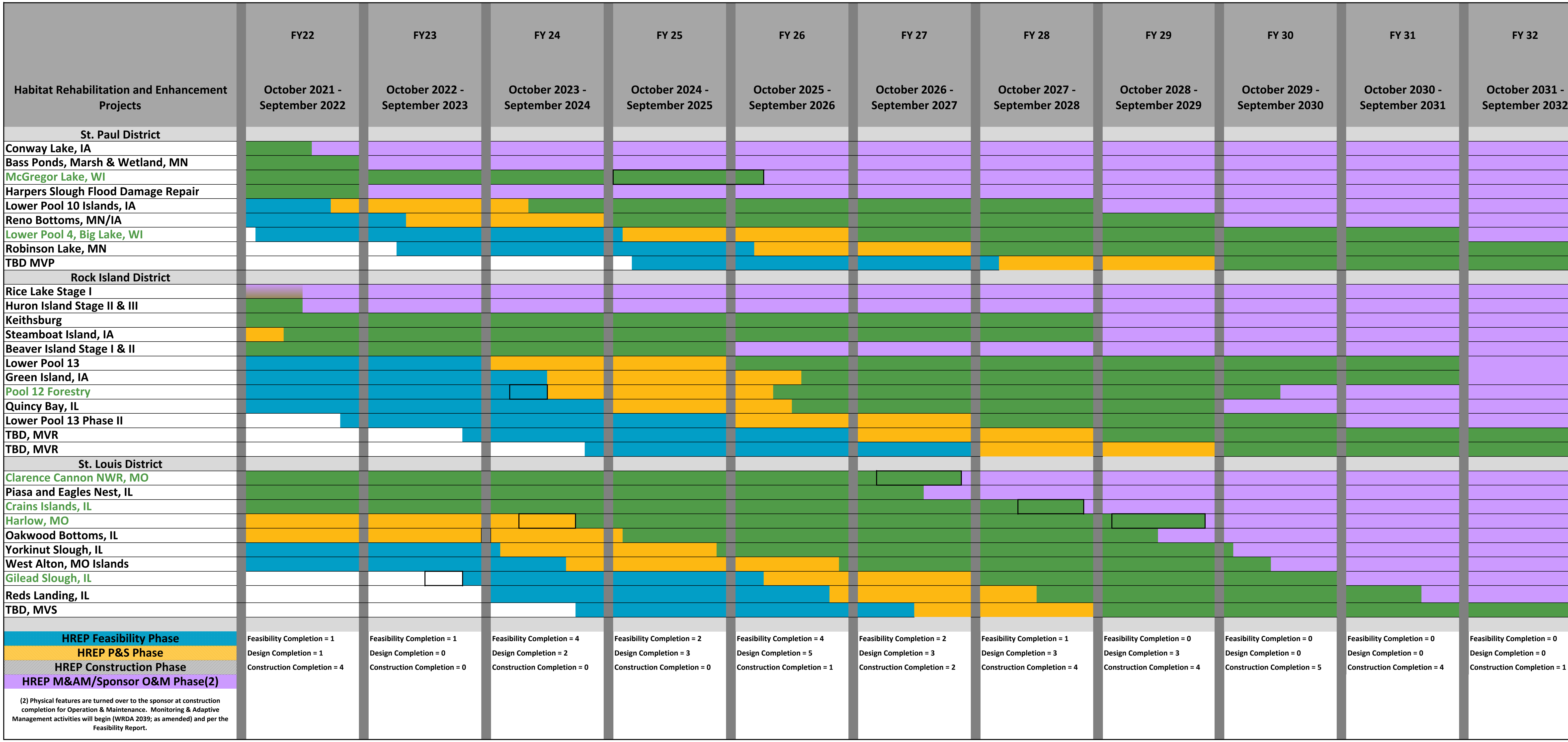
Habitat Rehabilitation

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
District Program Management	-	-	-	$313,007
Total	-	-	-	$313,007

Regional Program Administration

Subcategory	FY2023 Financials			
	Carry In	Allocation	Funds Available	Obligations
Habitat Eval/Monitoring	-	-	-	$287,187
Total	-	-	-	$287,187

	Carry In	Allocation	Funds Available	Actual Obligations
St. Louis Total	$66,342	$13,250,000	$13,316,342	$9,116,335


Habitat Rehabilitation and Enhancement Projects
FY22
October 2021 - September 2022
FY23
October 2022 - September 2023
FY 24
October 2023 - September 2024
FY 25
October 2024 - September 2025
FY 26
October 2025 - September 2026
FY 27
October 2026 - September 2027
FY 28
October 2027 - September 2028
FY 29
October 2028 - September 2029
FY 30
October 2029 - September 2030
FY 31
October 2030 - September 2031
FY 32
October 2031 - September 2032
St. Paul District
Conway Lake, IA
Bass Ponds, Marsh & Wetland, MN
McGregor Lake, WI
Harpers Slough Flood Damage Repair
Lower Pool 10 Islands, IA
Reno Bottoms, MN/IA
Lower Pool 4, Big Lake, WI
Robinson Lake, MN
TBD MVP
Rock Island District
Rice Lake Stage I
Huron Island Stage II & III
Keithsburg
Steamboat Island, IA
Beaver Island Stage I & II
Lower Pool 13
Green Island, IA
Pool 12 Forestry
Quincy Bay, IL
Lower Pool 13 Phase II
TBD, MVR
TBD, MVR
St. Louis District
Clarence Cannon NWR, MO
Piasa and Eagles Nest, IL
Crains Islands, IL
Harlow, MO
Oakwood Bottoms, IL
Yorkinut Slough, IL
West Alton, MO Islands
Gilead Slough, IL
Reds Landing, IL
TBD, MVS
HREP Feasibility Phase
HREP P&S Phase
HREP Construction Phase
HREP M&AM/Sponsor O&M Phase(2)
(2) Physical features are turned over to the sponsor at construction completion for Operation & Maintenance. Monitoring & Adaptive Management activities will begin (WRDA 2039; as amended) and per the Feasibility Report.
Feasibility Completion = 1
Design Completion = 1
Construction Completion = 4
Feasibility Completion = 1
Design Completion = 0
Construction Completion = 0
Feasibility Completion = 4
Design Completion = 2
Construction Completion = 0
Feasibility Completion = 2
Design Completion = 3
Construction Completion = 0
Feasibility Completion = 4
Design Completion = 5
Construction Completion = 1
Feasibility Completion = 2
Design Completion = 3
Construction Completion = 2
Feasibility Completion = 1
Design Completion = 3
Construction Completion = 4
Feasibility Completion = 0
Design Completion = 3
Construction Completion = 4
Feasibility Completion = 0
Design Completion = 0
Construction Completion = 5
Feasibility Completion = 0
Design Completion = 0
Construction Completion = 4
Feasibility Completion = 0
Design Completion = 0
Construction Completion = 1

ATTACHMENT C

Ecological Status and Trends Flyers

- **Water Quality (2023)** *(C-1 to C-2)*
- **Aquatic Vegetation (2023)** *(C-3 to C-4)*

Water Quality has Improved in the Upper Mississippi and Illinois Rivers but Challenges Remain

Photo courtesy of KathiJo Jankowski

In many areas of the Upper Mississippi River System, water quality is adequate to support a diversity of life such as aquatic plants, breeding and migratory birds, and aquatic animals, such as fish and mussels. However, sediment and excess nutrients from urban and agricultural lands continue to affect water quality across the river system.

How do human actions affect water quality of the river?

Humans can introduce sediment and excess nutrients to rivers in a variety of ways such as through agriculture, urban development, stormwater runoff, and wastewater treatment plants. Excess sediment, made up of sand, silt, soil, and other materials, can bury healthy mussel beds, reduce the depth of backwater lakes, and reduce water clarity. Murky water affects the distribution and abundance of aquatic plants and fish that rely on good visibility for foraging or vegetation for habitat.

Nitrogen and phosphorus are key nutrients for plant growth. Excess nutrients have caused nuisance blooms of algae, overabundance of plant life, and loss of animal life in rivers. Algal blooms can interfere with river recreation and reduce oxygen availability, which threatens the survival of aquatic organisms. Under certain conditions, algal blooms resulting from excess nutrients have harmed human health.

What actions can help improve water quality?

- Improvements to wastewater treatment practices and processes have reduced nutrient contributions to the water.
- Agricultural producers can increase application of best management practices to reduce sediment and nutrient pollution from their fields.
- More restoration projects focused on wetlands and better connection between the river and floodplain can further reduce excess nutrients and sediment in the river through natural processes.
- In such a large watershed, realizing benefits from management actions takes time and requires extensive efforts at broad scales.

Monitoring water quality indicators helps us to understand the health of the river.

Indicators like phosphorus, nitrogen, and total suspended solids help us understand impacts to habitat suitability.

mvr.usace.army.mil/UMRR

Upper Mississippi River Restoration
Leading · Innovating · Partnering

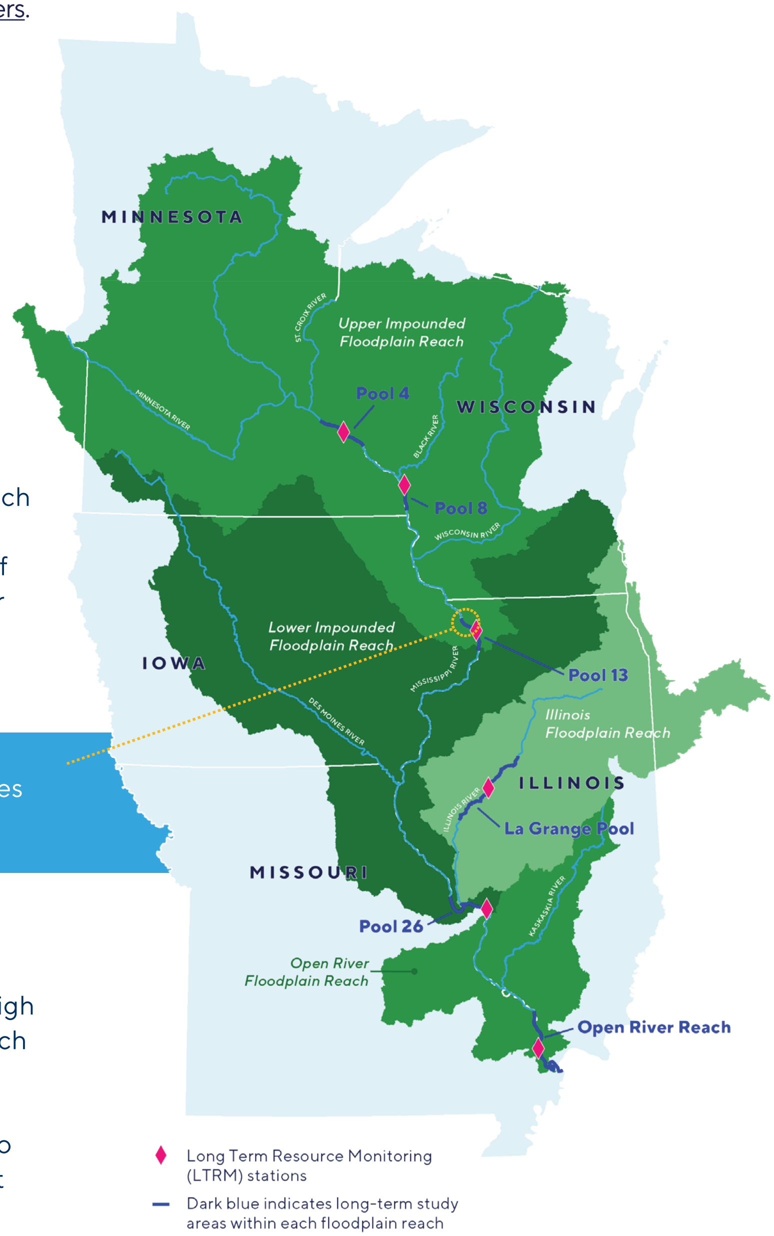
Water Quality has Improved in the Upper Mississippi and Illinois Rivers but Challenges Remain

This fact sheet is a summary of the long term changes observed from 25 years of monitoring water quality (1994-2019) reported in the Ecological Status and Trends of the Upper Mississippi and Illinois Rivers.

- **Total phosphorus** decreased in all long-term study areas (see map) except Open River and La Grange Pool (see table below). Concentrations continue to exceed US EPA water quality criteria frequently in all study areas.

- **Total nitrogen** increased in the Upper Impounded and Open River Reaches of the Upper Mississippi River and decreased in the La Grange Pool of the Illinois River. Concentrations remain above US EPA water quality criteria throughout most of the river system.

- **Total Suspended Solids (TSS)**, a measurement of how much sediment and other matter is suspended in water, decreased over time in most parts of the river. However, concentrations of TSS increase from north to south in the Upper Mississippi River System and remain too high to sustain aquatic plants in the La Grange Pool, Pool 26, and the Open River.



The Maquoketa River in Iowa flows into Pool 13 and contributes the most TSS of all tributaries analyzed in this report.

Changing hydrology alters water quality conditions
Climate change and human activities have altered the environment within the Upper Mississippi and Illinois Rivers. High flow events are more common and severe than in the past, which could diminish benefits from improved watershed practices as well as wash more sediment and nutrients into the river, decreasing water quality. Multiple agencies are collaborating to improve and implement watershed practices, reduce sediment and nutrient inputs, and improve overall water quality.

Take a Closer Look at the Data

	INDICATOR	UPPER MISSISSIPPI RIVER					ILLINOIS RIVER
		Upper Impounded			Lower Impounded	Unimpounded	
		Pool 4	Pool 8	Pool 13	Pool 26	Open River	La Grange
WATER QUALITY	Main Channel Suspended Solids*	▼	▼	■	▼	▼	▼
	Main Channel Nutrients*						
	Nitrogen	▲	■	▲	■	▲	▼
	Phosphorus	▼	▼	▼	▼	■	▲

*indicates flow-normalized concentration

▲ Significant Long-Term Increase ▼ Significant Long-Term Decrease ■ No Trend

Aquatic Plants Recover and Water Clarity Improves in Portions of the Upper Mississippi River

Upper Mississippi River Restoration
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Photo courtesy of USFWS

Over the past two decades, aquatic plants have made a remarkable recovery in the Upper Impounded Reach of the Mississippi River. Long-term monitoring reveals dramatic increases in the amount and diversity of plants. Low water years, improvements to water clarity, and fewer common carp likely contributed to increased plant growth in this reach of the river. The Illinois River and lower reaches of the Upper Mississippi River remain mostly unvegetated in aquatic areas due to a lack of suitable habitat or conditions.

Why are aquatic plants important?

Aquatic plants can improve water quality and are important food and habitat for fish, wildlife, and other aquatic organisms. The Upper Mississippi and Illinois Rivers provide important resting and feeding areas for millions of birds during their migrations. At least 25 aquatic plant species (like wild celery) provide vital energy for waterbirds such as canvasback ducks.

Ongoing restoration and research

The Upper Mississippi River Restoration (UMRR) program continues to prioritize restoration of aquatic plants where they have remained scarce. Recent UMRR studies have improved our understanding of where aquatic plants can grow and where plant restoration is likely to succeed. Successful restoration requires understanding and modifying the variety of river conditions that affect the distribution of aquatic plants.

Aquatic plants are adapted to diverse conditions

Water depth, clarity, and velocity are three main factors which determine the success of aquatic plant species. These factors affect where three types of plants can be found:

EMERGENT PLANTS
such as wild rice occupy shallow areas and are rooted in the bottom of the river, but their leaves and stems extend outside of the water.
Photo courtesy of Alicia Carhart

FLOATING PLANTS
can either be rooted to the bottom of the river with floating leaves such as water lilies or can be free floating, like duckweed and algae.
Photo courtesy of Andrew Stephenson

SUBMERSED PLANTS
such as wild celery grow completely underneath the water to depths where light can reach.
Photo courtesy of Eric Lund

Aquatic Plants Recover and Water Clarity Improves in Portions of the Upper Mississippi River

This fact sheet is a summary of the long-term changes observed from 21 years of monitoring aquatic plants (1998-2019) and two decades of land cover data reported in the Ecological Status and Trends of the Upper Mississippi and Illinois Rivers.

In Pools 4, 8, and 13 of the Upper Mississippi River:

- **Native aquatic plant** diversity and abundance increased. There were more types of both submersed and emergent aquatic plants covering more area. This is likely due to increased water clarity and a decrease in common carp, and years with slower moving water.
- **Free-floating plants** like duckweeds and filamentous algae have remained mostly scarce but have been problematic in certain backwaters. Excess levels of nitrogen and phosphorus can cause these plants to overgrow and form dense mats that decrease oxygen in the water, threatening fish and other aquatic organisms.
- **Water clarity** improved over 25 years of monitoring and the trend was associated with more aquatic plants. However, over the last 6 years, water clarity and plants have declined in Pool 13.

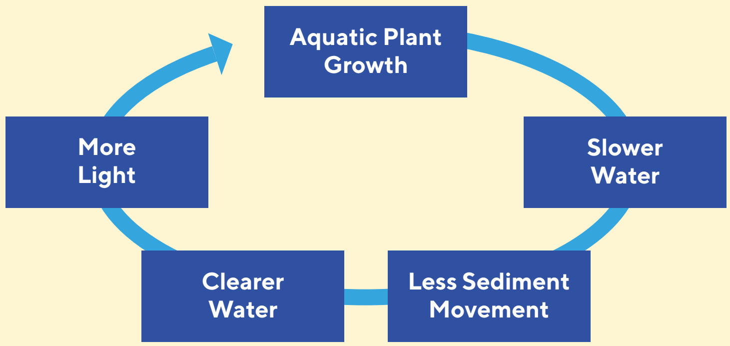
In the Illinois River and lower reaches of the Upper Mississippi River:

- **Native submersed aquatic plants** remain scarce. In some areas, this is likely due to poor water clarity and large changes in water levels during the growing season.
- **Native emergent plants** are generally scarce, but increased in some areas of the Open River and Illinois River Reaches. In Pool 26, water levels were managed to expand the areas in which these plants could grow.
- **Water clarity** remains low within the Lower Impounded, Illinois River, and Open River Reaches.

Aquatic plants need light to survive and grow

Rooted plants slow water down and reduce waves. This limits sediment movement and allows more sediment to deposit on the riverbed, making the water clearer. Clearer water allows light to penetrate further, helping plants to grow in deeper water. Low water years with slower moving water and expanded shallow areas also benefit some plants by improving growing conditions for newly established plants.

Water clarity sustains plants and plants sustain water clarity



ATTACHMENT D

Program Reports

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Aquatic Vegetation Component						
2023A1	Complete data entry and QA/QC of 2022 data; 1250 observations.					
	a. Data entry completed and submission of data to USGS	30-Nov-2022		15-Dec-2022		Lund, Carhart, Fopma
	b. Data loaded on level 2 browsers	15-Dec-2022		28-Dec-2022		Schlifer
	c. QA/QC scripts run and data corrections sent to Field Stations	28-Dec-2022		15-Jan-2022		Sauer, Schlifer
	d. Field Station QA/QC with corrections to USGS	15-Jan-2023		30-Jan-2022		Lund, Carhart, Fopma
	e. Corrections made and data moved to public Web Browser	30-Jan-2023		30-Jan-2022		Larson, Schlifer, Caucutt
2023A2	Web-based: Creating surface distribution maps for aquatic plant species in Pools 4, 8, and 13; 2022 data	31-Jul-2023				Larson, Schlifer
2023A3	Wisconsin DNR annual summary report 2022 that combines current year observations from LTRM with previous years' data, for the fish, aquatic vegetation, and water quality components.	30-Sep-2023				Bartels, Hoff, Kalas, Carhart
2023A4	Complete aquatic vegetation sampling for Pools 4, 8, and 13 (Table 1)	31-Aug-2023				Lund, Carhart, Fopma
2023A5	Pool 4: Graphical summary and maps of aquatic vegetation current status and long-term trends.	30-Dec-2023				Lund
2023A6	Pool 8: Graphical summary and maps of aquatic vegetation current status and long-term trends.	30-Dec-2023				Carhart
2023A7	Pool 13: Graphical summary and maps of aquatic vegetation current status and long-term trends.	30-Dec-2023				Fopma
Intended for distribution						
Manuscript and data release: "Integrating machine learning and ecosystem state concepts: Modeling submersed plant resilience and vulnerability to ecosystem state transitions" (Delaney and Larson, in revision; IP-141445 and IP-149270)						
Manuscript and data release: "Reconstructing missing data by comparing common interpolation techniques: applications for long-term water quality data and beyond" (Larson and others, In USGS review; IP-146440)						

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Fisheries Component						
2023B1	Complete data entry, QA/QC of 2022 fish data; ~1,590 observations					
	a. Data entry completed and submission of data to USGS	31-Jan-2023	28-Feb-2023		Field stations still working on finishing counting containers of fish in the lab.	DeLain, Dawald, Bartels, Hine, Kueter, Gittinger, West, Solomon, Maxson
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	15-Feb-2023	28-Feb-2023		Will be completed immediately after 2023B1a is completed.	Ickes, Schlifer
	c. Field Station QA/QC with corrections to USGS	15-Mar-2023	3/3/2023			DeLain, Dawald, Bartels, Kueter, Hine, Gittinger, West, Solomon, Maxson
	d. Corrections made and data moved to public Web Browser	30-Mar-2023	3/3/2023			Ickes and Schlifer
2023B2	Update Graphical Browser with 2022 data on Public Web Server.	31-May-2023				Ickes and Schlifer
2023B3	Complete fisheries sampling for Pools 4, 8, 13, 26, the Open River Reach, and La Grange Pool (Table 1)	31-Oct-2023				DeLain, Dawald, Bartels, Kueter, Hine, Gittinger, West, Solomon, Maxson
2023B4	IDNR Fisheries Management State Report: Fisheries Monitoring in Pool 13, Upper Mississippi River, 2021-2022. Includes Pool 12 Overwintering HREP Adaptive Management Fisheries Response Monitoring	30-Jun-2023				Kueter
2023B5	Sample collection, database increment on Invasive carp age and growth: collection of cleithral bones	31-Jan-2023				Solomon, Maxson
2023B8(D)	Database increment: Stratified random day electrofishing samples collected in Pools 9–11	30-Sep-2023				Kueter
2023B9(D)	Database increment: Stratified random day electrofishing samples collected in Pools 16–18	30-Sep-2023				Kueter
Intended for distribution						
Manuscript: A synthesis on river floodplain connectivity and lateral fish passage in the Upper Mississippi River (B. Ickes, 2021B11; Submitted to USGS review; IP-123678)						

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Water Quality Component						
2023D1	Complete calendar year 2022 fixed-site and SRS water quality sampling	31-Dec-2022		31-Dec-2022		Jankowski, Burdis, Kalas, Johnson, L. Gittinger, Kellerhals, Sobotka
2023D2	Complete laboratory sample analysis of 2022 fixed site and SRS data; Laboratory data loaded to Oracle data base.	15-Mar-2023		9-Feb-2023		Yuan, Schlifer
2023D3	1st Quarter of laboratory sample analysis (~12,600)	30-Dec-2022		30-Dec-2022		Yuan, Manier, Burdis, Kalas, Johnson, L. Gittinger, Cook, Sobotka
2023D4	2nd Quarter of laboratory sample analysis (~12,600)	30-Mar-2023				Yuan, Manier, Burdis, Kalas, Johnson, L. Gittinger, Kellerhals, Sobotka
2023D5	3rd Quarter of laboratory sample analysis (~12,600)	29-Jun-2023				Yuan, Manier, Burdis, Kalas, Johnson, L. Gittinger, Kellerhals, Sobotka
2023D6	4th Quarter of laboratory sample analysis (~12,600)	28-Sep-2023				Yuan, Manier, Burdis, Kalas, Johnson, L. Gittinger, Kellerhals, Sobotka
2023D7	Complete QA/QC of calendar year 2022 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.	30-Mar-2023		14-Mar-2023		Schlifer, Jankowski
	b. Field Station QA/QC; USGS QA/QC.	15-Apr-2023		7-Apr-2023		Jankowski, Burdis, Kalas, Johnson, L. Gittinger, Kellerhals, Sobotka
	c. Corrections made and data moved to public Web Browser	30-Apr-2023		8-May-2023		Schlifer, Jankowski
2023D8	Complete FY2023 fixed site and SRS sampling for Pools 4, 8, 13, 26, Open River Reach, and La Grange Pool	30-Sep-2023				Jankowski, Burdis, Kalas, Johnson, L. Gittinger, Kellerhals, Sobotka
2023D9	WEB-based annual Water Quality Component Update w/2022 data on Server.	30-May-2023				Schlifer, Jankowski
2023D10	Operational Support to the UMRR LTRM Element. Serve as in-house Field Station for USGS for consultation and support on various LTRM-wide topics	30-Sep-2023				Kalas, Hoff, Bartel, Carhart
2023D11	Phytoplankton dataset updated	30-Dec-2022				Jankowski

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
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	30-Dec-2019	30-Jul-2023		Lead (Fulgoni) took new position	TBD and Jankowski
2020D12	Final LTRM Completion Report: Assessment of Phytoplankton Samples collected by the Upper Mississippi River Restoration Program-Long Term Resource Monitoring Water Quality Component	30-Mar-2021	30-Dec-2023			TBD and Jankowski
Intended for distribution						
Memo, compilation of 3 years of sampling: Water Quality (2009R1WQ; Giblin, Burdis) (Complete, Posted https://umesc.usgs.gov/reports_publications/ltrmp/water/srs/srs_methods.html)						

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Spatial Data Component						
2023SD1	Orthorectification of scanned photos (St. Louis District Mississippi River pools and Open River Reach, and the Illinois River pools)	30-Sep-2023				Strange
2023SD2	Draft LTRM Completion Report 3D Digital Environment from Aerial Imagery using Structure from Motion Workflow Documentation	31-Dec-2023				Finley
2023SD3	Presentation: Implement and Expand Application of UAS Based Emergent Vegetation Mapping Method in LTRM Data Efforts	30-Jun-2023				Finley
2023SD4	Dataset development: Utilizing Existing Technology to produce 3D Geospatial Surfaces of a key Research	30-Sep-2023				Finley
2023SD5	Draft LTRM Completion Report on Implementation of potential Ground Penetrating Radar unit to Increase and Augment Data Collection Ability	30-Sep-2023				Finley
2023SD8	Maintenance ArcGIS server	30-Sep-2023				Rohweder
2023SD7	Data Analysis: Land Cover Change in the UMRS (all available pools, 1989-2020)	30-Sep-2023				De Jager
2023SD8	Draft LTRM Completion Report: Land Cover Change in the UMRS Key Pools	30-Sep-2023				De Jager
2023SD9	Draft LTRM Completion Report: Spatial Data Component Review and Future Objectives	30-Sep-2023				De Jager
2023SD10	Draft LTRM Completion Report: Pattern of Wild Rice Colonization (2022SD7)	30-Sep-2023				Finley
On-Going						
2022SD4	Aerial Thermal Application Completion Report-Posting in 2023	30-Mar-2023			Completed as an informational report, to be loaded to LTRM website.	Finley
2022SD5	Spatial Point Repository Tool of UMRS-Posting in 2023	30-Mar-2023			Completed as informational report, to be loaded to LTRM website.	Finley
2021SD10	Draft Report: Evaluating effects of alternative flooding scenarios on forest succession and landcover in the UMRS.	30-Sep-2021	30-Mar-2023	04-Apr-23	4/4/23 -- submitted to Journal Changing to a manuscript	De Jager
Intended for distribution						
2021SD7 Topobathy 2023 For the Upper Mississippi River System. SOW/Strategic Planning Document available upon request.						
Manuscript: De Jager, N.R., Rohweder, J.J., Van Appledorn, M., Hlavececk, E., Meier, A. In Prep. Mapping where Reed Canarygrass (*Phalaris arundinacea*) is a driver of forest loss in the Upper Mississippi River Floodplain under different future hydrological regimes to identify locations for resisting, accepting, or directing ecosystem change. (2021SD10)						

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Data Management						
2023M1	Update vegetation, fisheries, and water quality component field data entry and correction applications.	30-May-2023				Schlifer
2023M2	Load 2022 component sampling data into Database tables and make data available on Level 2 browsers for field stations to QA/QC.	30-Jun-2023				Schlifer
2023M3	Assist LTRM Staff with development and review of metadata and databases in conjunction with publishing of reports and manuscripts	On-going				Schlifer
UMRR LTRM Team Meeting						
2023TM1	Draft agenda developed	30-Jan-2023	17-Feb-23	3-Apr-2023		Houser, Ickes, Larson, Jankowski, De Jager, and others
2023TM2	Meeting held, Muscatine, IA	April 11-13, 2023		April 11-13, 2023		All LTRM
Status and Trends 3rd edition						
2023ST1	Draft S&T3 Fact Sheet	31-Dec-22	30-Sep-2023		USGS publishing center consulted Nov. 28, 2022	Lead authors additional responsibilities due to vacant branch chief position have delayed this product
Equipment Inventory						
2023ER1	Property inventory and tracking	15-Nov-2023				LTRM staff as needed

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Developing and Applying Indicators of Ecosystem Resilience to the UMRS						
2023R1	Updates provided at quarterly UMRR CC meeting and A team meeting as appropriate	Various				Bouska, Houser
2023R2	Develop collaborative research proposal and work plan to empirically test resilience hypotheses related to Lower Pool 13 HREP	30-May-2023				Bouska
On-Going						
2021R3	Submit resilience assessment synthesis manuscript for peer review publication	30-Mar-2021	30-Sep-2023		Delayed due to change in priorities	Bouska
2021R4	Submit resilience assessment synthesis fact sheet for USGS peer review	30-Sep-2021	30-Sep-2023		Delayed due to change in priorities	Bouska
2022R2	Submit manuscript that investigates associations between general and specified resilience for peer review publication	30-Sep-2022	30-Sep-2023		Changed from manuscript that investigates associations between general and specified resilience in FY21	Bouska

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Landscape Pattern Research and Application						
2023LP1	Draft Report: 2020 Land Cover Change	30-Sep-2023				Rohweder and De Jager
2023LP2	Data Analysis: Thresholds analysis of Reed canary grass habitat suitability.	30-Sep-2023				Delaney and Rohweder
2023LP3	Draft Report: Thresholds analysis of Reed canary grass habitat suitability	30-Sep-2023				Delaney, De Jager, Van Appledorn, Bouska, Rohweder
2023 LP4	Data Analysis: Detecting decadal changes in RCG dominance in wet meadows	30-Sep-2023				Delaney, De Jager, Van Appledorn, Bouska, Rohweder
2023LP5	Map Set: UMRS forest communities	30-Sep-2023				Rohweder and De Jager
2023LP6	Map Set: Aquatic Areas	30-Sep-2023				Rusher, Rohweder, De Jager
On-Going						
Manuscript: Review of Landscape Ecology on the UMR 2016L3; in draft						
Intended for distribution						
Manuscript: Delaney, J.T., Van Appledorn, M., De Jager, N.R., Bouska, K.L., Rohweder, J.J. In Prep. Predicting *Phalaris arundinacea* (reed canarygrass) invasion in forest understories of the Upper Mississippi River floodplain. 2022LP3						

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Eco-hydrologic Research						
2023EH1	Draft report of backwater sedimentation patterns through time to support vulnerability modeling effort	30-Sep-2023				Van Appledorn, Rohweder, DeJager, Kalas
2023EH2	Draft manuscript of reed canary grass, wood nettle, and silver maple seedling distributions and persistence in the UMR floodplain across environmental gradients	30-Sep-2023				Van Appledorn, Kirsch
On-Going						
2020EH02	Submit manuscript of temporal patterns in UMRS inundation regimes for peer review	30-Sep-2021	30-Sep-2023		Delayed due to change in priorities	Van Appledorn, De Jager, Rohweder
2021EH01	Draft manuscript of temporal and spatial trends of large wood in the UMRS and potential eco-hydrologic drivers	30-Sep-2021	30-Sep-2023		Delayed due to change in priorities	Van Appledorn, Jankowski
2021EH02	Draft manuscript of UMRS floodplain forest classification	30-Sep-2021	30-Sep-2023		Delayed due to change in priorities	Van Appledorn, De Jager
Intended for distribution						
Development of UMRS inundation model query tool; Van Appledorn, Fox, Rohweder, De Jager; 2019EH03						
Manuscript: Modeling and mapping inundation regimes for ecological and management applications: a case study of the Upper Mississippi River floodplain, USA; Van Appledorn, De Jager, Rohweder, Jason. (In revision with J Hydrology; IP-102710)						

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Acquisition and Interpretation of Imagery for Production of 2020 UMRS Land Cover/Land Use Data and Pool-Based Orthomosaics						
2023LCU3	Image processing, stereo model development, orthorectification, pool-based mosaicking, image interpretation, automation, QA/QC, and serving of 2020 LCU datasets for Pools 1-3, 7, 11, and 50% of Pool 10, the St. Croix and lower Minnesota Rivers, and the Alton Pool of the Illinois River	30-Sep-2023				Dieck, Strassman
Aquatic Vegetation, Fisheries, and Water Quality Research, Statistical Evaluation						
Intended for Distribution						
Manuscript: Annual summer submersed macrophyte standing stocks estimated from long-term monitoring data in the Upper Mississippi River. (Completed; 2020A8; https://doi.org/10.3996/JFWM-21-063)						
On-Going						
Manuscript: Evidence of functionally defined non-random fish community responses over 25 years in a large river system (Ickes; 2019B13 replacing 2015B17 and 2016B17; Resubmitted to Hydrobiologia, IP-118040)						
Manuscript: A synthesis on river floodplain connectivity and lateral fish passage in the Upper Mississippi River, (Ickes; Submitted River Research and Applications, IP-123678)						
Statistical Evaluation						
Intended for distribution						
Manuscript: Inferring decreases in among-backwater heterogeneity in large rivers using among-backwater variation in limnological variables (2010E1; IP-027392; Gray; in journal review)						
Manuscript: How well do trends in LTRM percent frequency of occurrence SAV statistics track trends in true occurrence? (2016E2; IP-123221; Gray; in journal review)						
Manuscript: Model selection for ecological community data using tree shrinkage priors; Gray, Hefley, Zhang, Bouska; (2017FA2; IP-111931; in revision with Ecological Applications; https://arxiv.org/abs/2005.14303)						
Pool 12 Overwintering HREP Adaptive Management Fisheries Response Monitoring						
2023P13d	Age determination of bluegills	1-Feb-2023		1-Feb-2023		Kueter
2023P13e	In-house project databases updated	31-Mar-2023		31-Mar-2023		Kueter
2023P13f	Made available to program partners via Iowa Fish Mgmt. State report	30-Jun-2023				Kueter
Pool 4 - Peterson Lake HREP Water Quality Monitoring – Pre and Post-Adaptive Management Evaluation						
2022PL1	Summary letter: Describing 2022 monitoring and future work	30-Dec-2022				Burdis, Lund

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
FY18 Funded Science in Support of Restoration and Management Proposals						
Conceptual Model and Hierarchical Classification of Hydrogeomorphic Settings in the UMRS						
2019CM6	Submit Final LTRM Completion report on hydrogeomorphic conceptual model and hierarchical classification system	30-Jun-2020	30-Dec-2022			Fitzpatrick, Hendrickson, Sawyer, Strange
Water Exchange Rates and Change in UMRS Channels and Backwaters, 1980 to Present						
2019WE4	Submit Final LTRM Completion Report	30-Mar-2020	30-Dec-2023			Hendrickson
Intrinsic and extrinsic regulation of water clarity over a 950-km longitudinal gradient of the UMRS						
2019IE3	Submit Draft manuscript	30-Mar-2020	30-Sep-23		PIs determined that to move forward biomass information as needed. Will continue work once biomass model complete. Original Lead author (Drake) resigned from WDNR. Update 5/5/23: Currently undergoing final co-author review.	Carhart and others
Systemic analysis of hydrogeomorphic influences on native freshwater mussels						
2019FM9	Final LTRM completion report (changed to manuscript)	30-Jan-2023				Teresa Newton
Using dendrochronology to understand historical forest growth, stand development, and gap dynamics						
2022DD1	Draft manuscript: Floodplain forest structure and the recent decline of Carya illinoinensis (Wangenh.) K. Koch (northern pecan); Part 2	30-May-2022	TBD			Harley, Ben Van der Myde (USACE contact)
Forest canopy gap dynamics: quantifying forest gaps and understanding gap – level forest regeneration						
2019FG5	Draft Manuscript: Forest canopy gap dynamics: quantifying forest gaps and understanding gap - level forest regeneration in Upper Mississippi River floodplain forests	30-Sep-20	30-Sep-23			Guyon, Thomsen, Meier, Strassman

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Investigating vital rate drivers of UMRS fishes to support management and restoration						
2019VR8	Data set complete (data delivered to Ben Schlifer, physical structures delivered to BRWFS)	30-Sep-2021	31-Dec-23	Mean length at age across all species, years, and field station complete. However, not applied to all fishes yet. Some species have been completed and shared. We have refined code to accomplish this fully now. Catch curves, measures of mortality, recruitment and growth expected to be complete for rest of species by end of year.		Quinton Phelps
On-Going						
2019VR10	Submit draft manuscript (Drivers of vital rates)	31-Dec-2021	30-Sep-23			Quinton Phelps, Kristen Bouska
2019VR11	Submit draft manuscript (Microchemistry)	31-Dec-2021	31-Dec-22	1/15/2023	Delayed by having to make several repairs to mass spectrometer; instrument down-time slowed our progress. In June completed analysis of otolith samples from all LTRM fish to be used in the project. The remaining steps data analysis and writing.	Greg Whitledge
Intended for distribution						
Manuscript: vital rates of Channel Catfish, led by Colby Gainer (MS student) (in review with the North American Journal of Fisheries Management; 2019VR9; Bouska, IP-121915)						
FY19 Funded Science in Support of Restoration and Management						
Reforesting UMRS forest canopy openings occupied by invasive species						
2019ref3	Draft LTRM Completion	30-Apr-2021	30-Dec-22			Guyon and Cosgriff
2019ref4	Final LTRM Completion	30-Sep-2021	30-Jun-23			Guyon and Cosgriff

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
A year of zooplankton community data from the habitats and pools of the UMR						
2019zoo2	Draft LTRM Completion report on utility of zooplankton community monitoring for HREP assessment	30-Dec-2020	22-Dec-2023		Sample collection delayed because of Covid-19 state protocols; zooplankton ID delayed; Fulgoni took new position	Sobotka
2019zoo3	Final LTRM Completion report on utility of zooplankton community monitoring for HREP assessment	30-Jun-2021	30-Jun-2023			Sobotka
2019zoo4	Draft LTRM Completion report on detailing differences between pools and habitats. Report will also investigate the potential investigate the potential impacts of Asian carp on the zooplankton community.	30-Dec-2020	22-Dec-2023			Sobotka
2019zoo5	Final LTRM Completion report on on detailing differences between pools and habitats. Report will also investigate the potential investigate the potential impacts of Asian carp on the zooplankton community.	30-Jun-2021	30-Jun-2023			Sobotka
FY19 Funded Illinois Waterway 2020 Lock Closure						
Pre- and Post-Maintenance Aerial Imagery for Illinois River's Alton through Brandon Lock and Dams, 2019-2021.						
2023IWW	Final LTRM Completion Report (2022IWW)	30-Apr-2023		1-Dec-2022		Strassman
Fish Community Response to the 2020 Illinois Waterway Lock Closure						
2022FSH1	Draft Manuscript: Fisheries and WQ	31-Dec-22	30-Sep-23		Data analysis was more complicated and time intensive than anticipated.	Lamer

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
FY20 Funded Science in Support of Restoration and Management						
Mapping Potential Sensitivity to Hydrogeomorphic Change in the UMRS Riverscape and Development of Supporting GIS Database and Query Tool						
2021HG6	Submit draft LTRM Completion report on hydrogeomorphic change GIS database and query system	31-Dec-2021	30-Sep-2022	07-Oct-2022		Vaughan, Strange, Fitzpatrick, Van Appledorn, USACE core team
2021HG7	Submit Final LTRM Completion report on hydrogeomorphic change GIS database and query tool.	30-Mar-2022	30-Jun-2023		Update 5/5/23: Reconciling peer review comments	Vaughan, Strange, Fitzpatrick, Van Appledorn, USACE core team
Improving our understanding of historic, contemporary, and future UMRS hydrology by improving workflows, reducing redundancies, and setting a blueprint for modelling potential future						
2021HH1	Historic and Contemporary Hydrologic Database Release and Documentation	30-Sep-2021	31-Jul-2023	Delayed due to issues of data acquisition from USACE; expected submission of data and metadata to USGS Fundamental Science Practices 31-Dec-2022		M. Van Appledorn, L. Sawyer
2021HH2	Draft LTRM Completion Report: document database and documentation development steps, database capabilities, and quantitative summaries of the hydrologic regime through time.	30-Dec-2021	31-Jul-2023	Dependent on data acquisition from USACE		M. Van Appledorn, L. Sawyer
2021HH3	Final LTRM Completion Report: document database and documentation development steps, database capabilities, and quantitative summaries of the hydrologic regime through time	31-Mar-2022	30-Sep-2023			M. Van Appledorn, L. Sawyer
2021HH6	Final LTRM Completion Report (Scenarios): This report will serve as the blueprint for modeling future hydrology to be undertaken with future funding opportunities.	30-Jun-2022	30-March-2023	29-Mar-23		M. Van Appledorn, L. Sawyer

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Understanding physical and ecological differences among side channels of the Upper Mississippi River System						
2021SC4	Final report on UMRR management implications submitted for USGS review	30-Sep-2022	30-Mar-2023		Delayed with McCain moving to new position	Sobotka & McCain
2021SC5	Manuscript on benthic invertebrate associations with side channel characteristics submitted for USGS and peer review	30-May-2023				Sobotka & Vander Vorste
Refining our Upper Mississippi River's ecosystem states framework						
Intended for Distribution						
Manuscript: Integrating machine learning and ecosystem state concepts: Modeling submersed plant resilience and vulnerability to ecosystem state transitions. (2021SS10; in USGS review, Delaney and Larson, IP-141445)						
Tool: Submersed aquatic vegetation vulnerability evaluation application (SAVVEA); (Completed, 2021SS10; Delaney and Larson, IP-142969)						
Augmenting the UMRR fish vital rates project with greater species representation for genetics and otolith microchemistry						
2021VR3	Submit draft manuscript (genetics)	31-Dec-2022				Davis, Tan, Lamer
2021VR4	Submit draft manuscript (genetics - mimic/channel)	31-Dec-2022				Davis, Tan, Lamer
2021VR5	Submit draft manuscript (constructing management units)	31-Dec-2022				Bartels, Bouska, Davis, Lamer, Larson, Phelps, Tan, Whitledge
Functional UMRS fish community responses and their environmental associations in the face of a changing river: hydrologic variability, biological invasions, and habitat						
2021FF2	Draft manuscript: "Has large scale ecosystem rehabilitation altered functional fish community expressions in the Upper Mississippi River System?"	30-Sep-2021	30-Mar-2023		Delayed with other priorities such as S&T Report writing and Gatto moving to other agency	Ickes and Gatto
2021FF3	Draft Manuscript: "Why aren't bigheaded carps (*Hypophthalmichthys* sp.) everywhere in the Upper Mississippi River System?"	30-Sep-2021	30-Mar-2023			Ickes and Gatto

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Understanding landscape-scale patterns in winter conditions in the Upper Mississippi River System						
2021WL1	System wide spatial layers of habitat conditions	30-Sep-2022	30-Dec-2023		Lead author on family leave and in a new job	Mooney, Dugan, Magee
2021WL2	Draft manuscript: Landscape scale controls on overwintering habitat in a large river	30-Sep-2022	30-Dec-2023		Lead author on family leave and in a new job	Mooney, Dugan, Jankowski, Magee
2021WL3	Draft manuscript: Response of oxygen dynamics to ice and snow phenology in backwater lakes	30-Sep-2023				Jankowski, Dugan, Burdis, Kalas, Kueter
2021WL4	Draft Manuscript: Patterns in sediment characteristics and oxygen demand across a winter riverine landscape	30-Sep-2023				Perner, Kreiling, Jankowski, Giblin
Forest Response to Multiple Large-Scale Inundation Events						
2021FR3	Technical Report	1-Jun-2022	30-Sep-23		Delayed due to staffing shortages, hiring of new staff at NGREEC	Cosgriff, Guyon, De Jager
FY22 Funded Science in Support of Restoration and Management						
Assessing Forest Development Processes and Pathways in Floodplain Forests along the Upper Mississippi River using Dendrochronology						
2023dendro1	Finalize the scanning of 1,100 tree cores uploaded into DendroElevator	30-Nov-2023				Windmuller-Campione
2023dendro2	Annual summary	31-Dec-2023				Windmuller-Campione and Van Appledorn
2023dendro3	Coordination and scheduling for three to five virtual meetings; Meetings will address current objectives outlined in Activity 3 and future directions	1 March – 31 May 2024				Windmuller-Campione and Van Appledorn
2023dendro4	Draft manuscript – Age data of floodplain forests of the Upper Mississippi River	30-May-2024				Windmuller-Campione and Van Appledorn
2023dendro5	Draft Manuscript – Growth dynamics of silver maple of the Upper Mississippi River	30-Sep-2024				Windmuller-Campione and Van Appledorn

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
2023dendro6	Final report writing, edits on manuscript, and completion of all data storage	30-Nov-2024				Windmuller-Campione and Van Appledorn
Evaluating the LOCA-VIC-mizuRoute hydrology data products for scientific and management applications in the UMRS						
2023Hydro1	LOCA-VIC-mizuRoute data product evaluation	31 June 2023				Sawyer and Van Appledorn
2023Hydro2	LTRM project management team update on evaluation results	31 June 2023				Sawyer and Van Appledorn
2023Hydro3	ECB 2018-14 compliance completion	30-Sep-2023				Sawyer and Van Appledorn
2023Hydro4	Annual update: Year 1	31-Dec-2023				Sawyer and Van Appledorn
2023Hydro5	UMRS projected hydrology data and documentation release	30-Sep-2024				Sawyer and Van Appledorn
2023Hydro6	UMRR webinar on UMRS projected hydrology data release	31-Dec-2024				Sawyer and Van Appledorn
2023Hydro7	Virtual workshop or LTRM project team update for red pathway outcomes	31-Mar-2024				Sawyer and Van Appledorn
2023Hydro8	Draft LTRM completion report	30-Sep-2024				Sawyer and Van Appledorn
2023Hydro9	Final LTRM completion report	30-Dec-2025				Sawyer and Van Appledorn
Putting LTRM's long-term phytoplankton archive to work to understand ecosystem transitions and improve methodological approaches						
2023Phyto1	System-wide phytoplankton community dataset	30-Sep-2023				Jankowski
2023Phyto2	Draft Manuscript: Phytoplankton community composition over the past 20 years in the Upper Mississippi River: distribution of harmful taxa and relationships with environmental trends	30-May-2024				Jankowski and others
2023Phyto3	Draft Manuscript: Relating phytoplankton communities to distinct vegetation recovery trajectories in Pools 4 and 13	30-May-2024				Jankowski and others

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
2023Phyto4	Report: Assessment of FloCam for use on archived and fresh phytoplankton samples for LTRM sampling	30-Mar-2024				Larson, James
2023Phyto5	Draft Manuscript: Comparison of trends captured by microscopy and FlowCam phytoplankton community analysis	30-May-2024				Larson, James
Assessing long term changes and spatial patterns in macroinvertebrates through standardized long-term monitoring						
2023inv1	Field collection of macroinvertebrates	14-Jun-2023				State field station staff
2023inv2	Laboratory identification of macroinvertebrates	30-Aug-2023				TBD
2023inv3	Screening level mayfly tissue analysis	30-Sep-2023				Giblin
2023inv4	Annual summary	31-Dec-2023				Lamer
2023inv5	Complete data entry and QA/QC of 2023 data; 1250 observations.					
	a. Data entry completed and submission of data to USGS (Includes contaminant data)	31-Jan-2024				State field station staff, Giblin
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	15-Feb-2024				Lamer, Schlifer
	c. Field Station and contaminant QA/QC with corrections to USGS	15-Mar-2024				State field station staff, Giblin
	d. Corrections made and data moved to public Web Browser	30-Mar-2024				Lamer, Schlifer
2023inv6	Field collection of macroinvertebrates	14-Jun-2024				State field station staff
2023inv7	Laboratory identification of macroinvertebrates	30-Aug-2024				TBD
2023inv8	Screening level mayfly tissue analysis	30-Sep-2024				Giblin
2023inv9	Annual summary	31-Dec-2024				Lamer

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
2023inv10						
	a. Data entry completed and submission of data to USGS (Includes contaminant data)	31-Jan-2025				State field station staff, Giblin
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	15-Feb-2025				Lamer, Schlifer
	c. Field Station and contaminant QA/QC with corrections to USGS	15-Mar-2025				State field station staff, Giblin
	d. Corrections made and data moved to public Web Browser	30-Mar-2025				Lamer, Schlifer
2023inv11	Draft LTRM Completion report or manuscript on contaminant sampling	30-Sep-2025				Giblin
2023inv12	Field collection of macroinvertebrates	14-Jun-2025				State field station staff
2023inv13	Laboratory identification of macroinvertebrates	30-Aug-2025				TBD
2023inv14	Annual summary	31-Dec-2025				Lamer
2023inv15						
	a. Data entry completed and submission of data to USGS (Includes contaminant data)	31-Jan-2026				State field station staff, Giblin
	b. Data loaded on level 2 browsers; QA/QC scripts run and data corrections sent to Field Stations	15-Feb-2026				Lamer, Schlifer
	c. Field Station and contaminant QA/QC with corrections to USGS	15-Mar-2026				State field station staff, Giblin
	d. Corrections made and data moved to public Web Browser	30-Mar-2026				Lamer, Schlifer
2023inv16	Draft LTRM Completion report or manuscript on macroinvertebrate sampling, trends, etc.	30-Sep-2026				Lamer

UMRR Science in Support of Restoration and Management
FY2014 and FY2015 Scopes of Work
May 2023 Status

Tracking number	Milestone	Original Target Date	Modified Target Date	Date Completed	Comments	Lead
Plankton community dynamics in Lake Pepin						
2015LPP1	Phytoplankton processing; species composition, biovolume	30-Dec-15		22-Oct-15		Burdis
2015LPP2	draft manuscript: Plankton community dynamics in Lake Pepin	30-Sep-16	30-Jun-23		Revisions are in progress following reviews	Burdis, Manier
Predictive Aquative Cover Type Model - Phase 2						
2015AQ1	Develop 2-D hydraulic model of upper Pool 4	30-Sep-15		30-Sep-15		Libbey (MVP H&H)
2015AQ2	Apply model to Pool 4 and resolve discrepancies	31-Dec-15	31-Mar-16	31-Mar-16		Yin, Rogala
2015AQ3	Detailed summary of work for Phases I & II	31-Dec-15		NA	Work terminated with resignation of Dr. Yin. Danelle Larson will re-evaluate vegetation modeling in a future time frame	Sauer (for Yin), Rogala, Ingvalson

FY2024 UMRR Science Proposals

Recommended for Funding

Listed below are four proposals developed as part of the 2022 UMRR LTRM Science Meeting that are recommended by the UMRR LTRM management team for FY2023 Science in Support of Restoration and Management funding. Based on assessments of the proposals by the A-Team (representatives of MN, WI, IA, IL, MO, and USFWS), USGS UMESC, and USACE, these are the highest ranked of the proposals that were not funded in FY2022. These proposals have been satisfactorily revised to address comments provided during review of the proposals originally submitted for consideration in FY2022.

Upper Mississippi River Restoration (UMRR) Science in Support of Restoration and Management Proposal

Title of Project:
Scoping and vetting new technology and methods for use in future hydrographic and topographic surveys: Strategies and recommendations for updating lidar, bathymetry, and detecting geomorphic change.

Preface: Due to increase in funds in fiscal year 2023, USACE and USGS began discussions of system wide topobathy collection that could be contracted through the USACE Center of Expertise. As of January 2023, a Topobathy Data Acquisition plan is in draft mode, and we are optimistic that data acquisition protocols for much of the UMRS will soon be defined and ready for surveying by contractors. However, surveying of backwaters and other shallow areas pose challenges e.g., shallow vegetated backwaters are difficult to navigate and collect accurate sonar data. Also, "green" LIDAR could be used to survey some shallow backwaters, but this method needs to be vetted. Finally, advancements in survey technologies may allow for detection of geomorphic change at fine scales, potentially replacing or complementing our programs backwater sedimentation rate monitoring; this requires field testing of these new technologies to determine the actual level of detection we can expect. The project proposed in this document focuses on developing protocols for data collection in shallow water surveys, once completed these shallow-water protocols will be added to the Topobathy Data Acquisition plan.

Previous LTRM project:
Continuation and maintenance of topobathy dataset (USACE, 2016). This project will also be building off the 'Topobathy strategic plan' work that was completed in FY21 (2021SD7).

This project will use the results found in the project "Determine geomorphic changes in selected side channels of selected reaches using hydroacoustics" as the foundation for the technology comparison (2019GC2, 2019GC3)

The network of backwater sedimentation transects established in 1997 were resurveyed starting in 2017 to provide information for HNA-II under the FY2017 Science in Support of Restoration and Management (SSRM) SOW (2017ST1-4; 2017FAH3). This is a continuing project that builds off previous work from the 2018 UMRR Science Meeting and UMRS topobathy datasets that were disseminated in 2016. The proposed FY22 work expands off the backwater sedimentation transects that were established and measured in 2018 and 2019 (2019GC4-7). Work on 2019GC6, 2019GC7 are incomplete and information from this study (i.e., development of open-water survey methods) are necessary to complete these tasks, allowing for future system-wide monitoring.

Name of Principal Investigator(s):
John Kalas, Wisconsin DNR, 608-781-6365, john.kalas@wisconsin.gov: Backwater survey/sedimentation lead

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Introduction/Background:

What's the issue or question?

As the UMRR program looks forward to future ecosystem assessments, there will be a need to develop new elevation datasets using recent surveys. New and improved elevation datasets for the UMRS could allow for a variety of analyses not previously open to researchers or managers. The LTRM Element uses several tools to survey geomorphology as well as assess geomorphic change within the UMRS e.g., lidar, bathymetry, LCU, backwater sedimentation rate monitoring. While technological advancements can make these surveys, more accurate and efficient, integrating these new technologies and field survey methods requires vetting. Further, geomorphology and therefore habitat conditions within the UMRS can vary dramatically, and a one size fits all surveying approach will not work. For example, topobathy lidar may be effective for surveying shallow areas in some pools but not others; our current back water sedimentation rate monitoring method requires good ice conditions and low discharge, conditions that are rare in many of the lower pools but have also been rare in upper pools in recent years. High water in 2019 precluded these surveys for nearly an entire year. Hydroacoustic surveys in backwaters that support vegetation year-round also pose challenges that need to be addressed and overcome.

We propose to scope and vet new technologies and methods that can be integrated into future topographic and hydrographic surveys, ultimately laying a foundation for a topobathy framework, and maintenance plan (i.e., time interval and priority for updating coverages). Given rapid improvements and decrease in cost of data collection, processing methods and technologies, newer data sets are already available for many parts of the UMRS. It is also possible that newer elevation data sets could be used to systematically monitor river and floodplain elevation changes (e.g., digital elevation model (DEM) of difference analysis in GIS, which is an algorithm subtracting old elevations to new elevations) and the suite of structural and functional aspects of the river system that are connected to elevation (Fig. 1 & 2).

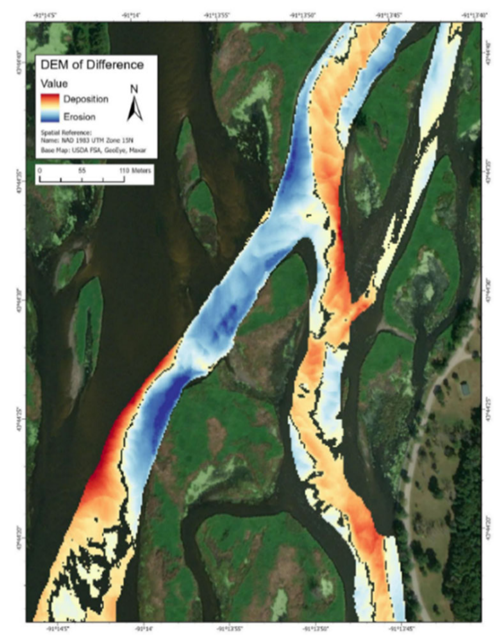

Figure 1. Side channel DEM of difference analysis comparing historical and new bathymetry.

These kinds of analyses have the potential to support outstanding questions about how the UMRS ecosystem is changing through time such as the following:

1. What are the drivers of elevation changes in the UMRS?
2. How much change is occurring and where is it happening?
3. How are elevation changes effecting the distribution of species and their habitats?

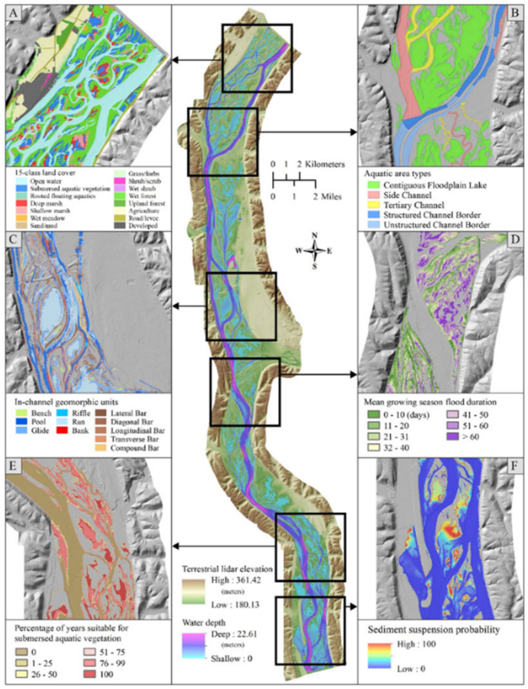

Figure 2. The UMRS topobathy data provides the physical template upon which several models, tools and assessments have been based.

Geomorphic change in the Upper Mississippi River System (UMRS) has long been identified by resource agencies as a concern (GREAT 1980; UMRBC 1982; USFWS 1992). The changes in geomorphic processes are a result of system alteration (e.g., dam construction) and land use changes in the basin (e.g., increased sediment loads). These process changes have a direct effect on riverbed elevation, and thereby water depth. The direct changes in bed elevation, as well as changes in planform features (e.g., island dissection), influence water exchange rates in the river. Water depth and water exchange rates are the most prominent features describing habitat quality in the UMRS, and in some cases, the projected depth changes that threaten habitats in the river (Theiling 2000; De Jager et al. 2018).

Scientists and managers together agree that the UMRS topobathymetric (topobathy) data (merged topography and bathymetry) dataset is foundational information required by multiple federal, state, and private organizational projects that study the river system. There is a high need to update and maintain this information into the future. Our current topobathy coverage is outdated e.g., some of the bathymetry surveys are more than twenty years old, and therefore are made up of a composite of surveys that used older, outdated survey technologies. The following are a list of data issues that could be addressed if UMRS elevation (topobathy) were updated:

1. Data products span from 1989 to 2015. Outdated coverages cause inherent inaccuracies to our assessments and models.
    a. Current systemic topobathy is not a true elevation of the UMRS within a short time frame.
    b. Bathymetry from the earlier years contain higher vertical and horizontal errors due to outdated GPS technologies.
    c. Older datasets do not have metadata attached, and in some cases no information on collection date or water surface elevations during the time of collection.
    d. Vertical datums have changed over this time frame and require datum shifts. These datum shifts may contain an unknown error.
2. Flooded areas were captured in 2010-2011 lidar surveys.
    a. The terrestrial areas that were flooded have no data and have created data gaps.

3. Defined UMRR study area in St. Paul district does not have complete elevation data coverage.
4. Current methods used for backwater sedimentation rate monitoring requires specific environmental conditions that were challenging to meet due to extended high waters and shortened ice-on seasons. With recent improvements in hydrographic surveys, a technology analysis could be completed to determine if this new technology is suitable for monitoring sedimentation rates, potentially reducing data collection costs, and providing flexibility during changing river conditions.

What do we already know about it (based on research within the UMRS or elsewhere)?

UMRS Topographic Data: Since the UMRS topobathy (USACE, 2016) dataset has been developed, USGS 3D Elevation Program (3DEP) has developed specific standards and specifications to follow for data collection (Heidemann, 2018). These standards could be used as a baseline for updating the old lidar that was used for topographic data in the UMRS topobathy. Further, USGS 3DEP offers options with high vertical accuracy, increasing our ability to detect changes in elevations e.g., quality level 0 (QL0) has an absolute vertical accuracy of 9.8cm for non-vegetated at 95% confidence interval, and 15cm for vegetated surfaces. Staff at UMESC have also kept a running list of recent lidar flights that have been flown for states and counties that could easily be integrated into a new topobathy dataset; thus, not requiring any new topographic elevation data collection.

UMRS Bathymetric Data:

Since the dissemination of UMRS topobathy (USACE, 2016), bathymetric surveys have become wide-spread and available across the UMRS. One example of this is the development of eHydro, which provides hydrographic surveys on the UMRS collected by the USACE. Recent publicly available surveys, such as eHydro, could be used to update future bathymetry. Past methods such as Rogala, 1999, are the only documentation we have of UMRS bathymetry data. Not only are hydroacoustic surveys more common, but they also have a higher vertical and horizontal accuracy with improvements in sonar and GPS technologies (e.g., real-time kinematic positioning (RTK) and post processed kinematic position (PPK)) are integrated with sonar technologies for centimeter grade surveys).

- **Main Channel:** USACE is consistently surveying the main channel for navigation and dredge purposes. This data is readily available via eHydro.
- **Side Channel:** A previous UMRR study titled ‘Determine geomorphic changes in selected side channels of selected reaches using hydroacoustics’ was used to explore methods of comparing historical bathymetry to new bathymetry. Side channel surveying methods and DEM of difference methods could be referenced for future bathymetric updates within side channels (Strange et al, 2021). Updated suggestions for change in methods from Strange, 2021 will be incorporated into this study.
- **Backwater:** Bed elevation changes in backwaters are typically at a rate of < 1 cm/yr. Well vetted methods for monitoring sedimentation rates over ice have been established for years. These studies used tapes, sounding poles and differential leveling to detect changes along backwater transects over periods of <20 years (Rogala et a. 2020, Aspelmeier 1994; Rogala and Boma 1996; Rogala et al. 2003). These methods require specific environmental conditions that were challenging to meet due to extended high waters and shortened ice-on seasons. The proposed work in 2019GC4-7 followed similar methods while also adding permanent monuments for vertical and horizontal control, integrated RTK GNSS (precision GPS) and began development of an open-water survey method (which would eliminate the need for suitable ice to conduct monitoring). Since 2020, open-water shallow survey techniques have been tested, and included integration of RTK-GNSS.

How will the proposed work improve our understanding of the UMRS?

Updated and modernized hydrographic and topographic surveys will serve as baseline data allowing us to systematically monitor river and floodplain elevation (i.e., detect geomorphic change) and the suite of structural and functional aspects of the river system that are connected to elevation. However, for us to detect change at meaningful levels, we need precision baseline surveys with high vertical and horizontal accuracy. Findings from side channel comparisons completed in April of 2021 showed the limitations of current UMRS bathymetry data (Strange et al, 2021). The high vertical and horizontal error associated with this dataset lowered its usefulness to detect change. Even though the new side-channel surveys we ran were high precision, we still had to account for the error associated with our current bathymetry dataset. This limited our ability to detect change and only course changes (often 1m or more) could be detected. Updating hydrographic and topographic surveys in the future would allow for a DEM of difference analysis that could quantitatively measure direct geomorphic changes in the UMRS.

Bathymetric data have played a critical role in aquatic habitat rehabilitation and research projects on the UMRS by allowing researchers to quantify water depth and fish overwintering habitat (USACE 2017) and to further model flow velocity and related mussel habitat and population dynamics (Daraio et al. 2010). Topobathy data have allowed for seamless modelling and characterizations at broad scales (e.g., navigation pool scale), including in aquatic-terrestrial transition zones not fully captured by lidar or bathymetric data alone. The following are examples of modelling and mapping efforts that have utilized UMRS topobathy data (Fig. 2): land cover and land use (inset A), water depth and associated aquatic areas modelling (inset B, De Jager et al. 2018), geomorphic modelling and classification (inset C, Vaughan et al. 2021), flood inundation modelling (inset D, Van Appledorn et al. 2020) and related forest succession modelling (De Jager et al. 2019), submersed aquatic vegetation suitability modelling (inset E, Carhart et al. 2021), and wind fetch and wave modelling (inset F, Rohweder et al. 2008). Building on many of these modelling efforts, the systemwide topobathy data set is essential for characterizing the generic aspects of river and floodplain habitats in the most recent UMRR Habitat Needs Assessment (De Jager et al. 2018, McCain et al. 2018).

Findings from this proposed work would provide essential data which could be used in collaboration with other UMRR science working groups to potentially map habitat suitability for fish, vegetation and mussels. Development of the open-water method for backwater sedimentation monitoring, as well as other precision bathymetry methods (e.g., single beam sonar paired with RTK GNSS), will allow expanded monitoring of backwater sedimentation rates throughout the UMRS, which will provide a better understanding of recent rates of geomorphic changes and substrate stability for the UMRS. Ultimately, it will improve our forecasts of future conditions in the UMRS. In addition to understanding past and present rates of geomorphic change, predictions of future river configurations are needed to inform the selection and design of restoration projects.

Further, advancements in lidar and hydroacoustic surveying technology have increased the accuracy and precision of these surveys, which would allow us to assess rates of geomorphic change between survey periods (e.g., DEM of difference analysis). Thus, future updating of the UMRS topobathy coverage will not only give us a new coverage of current conditions, but it will also allow us to gain a better understanding of what aquatic areas (De Jager et al. 2018), or geomorphic features (Vaughan et al. 2021) are most susceptible to changes in elevation. Results from future DEM of difference analysis could help to answer the following questions:

- Where is elevation increasing or decreasing the most or more rapidly? What geomorphic processes are at play in different parts of the river system and could use further study?
- What aquatic areas (De Jager et al. 2018), or geomorphic features (Vaughan et al. 2021) are most susceptible to changes in elevation?
- Are observed changes sufficient to modify habitat suitability for submersed vegetation (Carhart et al. 2021) or fish overwintering, inundation dynamics (Van Appledorn et al. 2020), forest succession (De Jager et al. 2019), or sediment resuspension probabilities (Rohweder et al. 2008)?

The proposed work will specifically address: Backwater open-water method development, technology comparison of standard transects methods to hydroacoustic methods, methods for surveying vegetated backwaters and developing a concise, informed, and organized project plan for updating and maintaining UMRS topobathy into the future.

<u>What is the objective(s) or hypotheses?</u>

Backwater surveys: Could hydroacoustics technologies (e.g., single beam sonar paired with RTK GNSS could provide up a 2cm accuracy in ideal conditions) replace or complement traditional backwater sediment transect surveys? What is the positional accuracy (level of detection between two subsequent surveys) between the two surveying methods: standard transects vs hydroacoustic transects? Studying new technologies and methods for backwater sedimentation transects would allow for a scientific investigation of the efficacy hydroacoustics could play in backwater surveys. An initial literature review will help to determine if other studies have investigated these accuracies. Then, objectives from proposed field work would be to determine future bathymetric and sedimentation transect methodologies to be used in backwaters of the UMRS.

Conduct agency and stakeholder meeting to explore and discuss UMRS Topographic/Bathymetric Updates: Conduct one agency and stakeholder meeting to explore different technological options, determine data standards, protocols, contractors, and an updating schedule for topographic data.

- Is topobathy lidar even feasible for parts of the UMRS (e.g., analysis of steamboat island survey)? Are there areas of the UMRS where topobathy lidar could be collected to cover shallow surveys and decrease the amount of hydroacoustic surveys? Would successive lidar surveys have the needed level of detection to measure sedimentation rates in backwaters over a period of time (e.g., 5 years)?
- What are different options for surveying shallow and/or vegetated areas of the UMRS?
- How can we use results from the 3D Nation Elevation Requirements and Benefits Study (Dewberry, 2022) to develop techniques and methos for backwater/shallow surveying?

Relevance of research to UMRR:
The 2024-2026 project proposed here provides relevance to Focal areas in Theme 1 from the 2022 UMRR Science meeting: better understand the likely long-term changes in geomorphology and hydrology of the river, and consider these potential changes in selecting, designing, and assessing restoration projects. This proposed project will specifically help answer questions that are found in the following Focal Areas:

- Focal area 1.1 & 1.2

Research from this proposed project could also provide corelated factors that relate to Focal areas in Theme 2 from the 2022 UMRR Science meeting: Gain a better understanding of the current associations and interactions among biota, hydrology, and geomorphology that allows us to better forecast how biota will respond to future hydrogeomorphic conditions and inform river restoration and management.

- Focal area 2.3

Elevation data is foundational, and it has been determined from past UMRR science meetings that there is a high need to update and maintain this information into the future. Lidar data has been used to characterize spatial patterns in the topography of the UMRS floodplain (Scown et al. 2015 a and b), identify canopy gaps in UMRS floodplain forests (Sattler and Hoy 2020), and together with river gage data, has been used to develop flood inundation metrics at scales ranging from local restoration sites (De Jager et al. 2013) to river reaches (hundreds of river miles) (De Jager et al. 2015). Results from DEM of difference analysis and backwater sedimentation rate monitoring could be put into models that would show how and to what degree geomorphology of backwaters and side channels are expected to change into the future. Lastly, topographic and bathymetric data are commonly used in applications for Habitat Rehabilitation and Enhancement projects (HREP) and system wide assessments of ecosystem structure and function. Updated elevation methods could help contribute to the improvement or selection of HREPs going into the future. Managers will be able to more easily predict if sedimentation, depth, and elevation are going to change within their project, which could help reduce time and cost of maintenance to HREPs into the future.

Methods:
The project has four components:

1) Year 1: USGS and DNR will begin researching and field testing of modern survey technologies. Develop open water method and begin traditional transect surveys. (2024 Bathy 3, 4, 6-8).

   i) Accuracy requirements for shallow water surveys,

   ii) Transect spacing for different bathymetric resolutions,

iii) Topobathy lidar as a feasible option for future backwater surveying,

iv) Rig shallow-water survey boat with various components to allow for efficient navigation, and holding of position at transect sampling locations e.g., GPS guided trolling motor, shallow-water power anchors.

v) Develop open-water method for surveying backwater transects (using shallow-water survey boat) and begin surveying transects. (2024Bathy 1, 2, 8).

2) Year 2-3: Complete backwater sedimentation rate transect surveys using traditional and modern hydroacoustic methods. Begin accuracy assessment of modern hydroacoustics method and compare to traditional method.

i)Complete backwater sedimentation rate surveys using traditional and modern hydroacoustic methods. Approximately 20 transects in Pool 8 of varying lengths, gradients, and strata will be surveyed using both the open-water and hydroacoustic methods.

ii) Using data collected from the shallow-water survey boat, perform an accuracy assessment that compares open water methods to previous transects .

3) Year 2-3: Complete accuracy assessment between transects surveyed with traditional and RTK-coupled hydroacoustic method (2024Bathy 1, 2, 5, 7).

i) Differences in measured bed elevation between the two methods will be analyzed and error quantified. These measurements will also be used to calculate long-term (~23 years) and short-term (~7 years) sedimentation rates which will be used to assess level of detection performance of the RTK-hydroacoustic method e.g., is it capable of detecting small differences (<10cm) in sedimentation or erosion- what is the expected level of detection of the hydroacoustic method and is it suitable for monitoring backwater sedimentation rates.

ii) Perform site reconnaissance to examine how methodologies could be deployed across the UMRS (2023Bathy3b). The final goal would be to visit all key pools for a site reconnaissance, and adapt methods as needed to overcome challenges posed by pool-specific conditions (e.g., heavily vegetated versus unvegetated, availability of cell coverage, which is required for RTK, etc.).

4) Year-3: Update the Topobathy Data Acquisition plan- the geospatial group at UMESC will use the findings to develop strategies and recommendations for updating lidar, bathymetry, and detecting geomorphic change in the UMRS (2024Bathy 7 & 8).

Data management procedures Project data will be managed with USGS data standards. FGDC metadata will also be established with any data products. Approved data releases will be available on ScienceBase (i.e. Backwater Sedimentation in Navigation Pools 4 and 8 of the Upper Mississippi River data - ScienceBase-Catalog). Also, all reports and publications related to this research will be made available to the public, industry, and scientific community. All data and reports/publications will be linked and accessible from ScienceBase.gov.

Special needs/considerations, if any: None

Timeline:

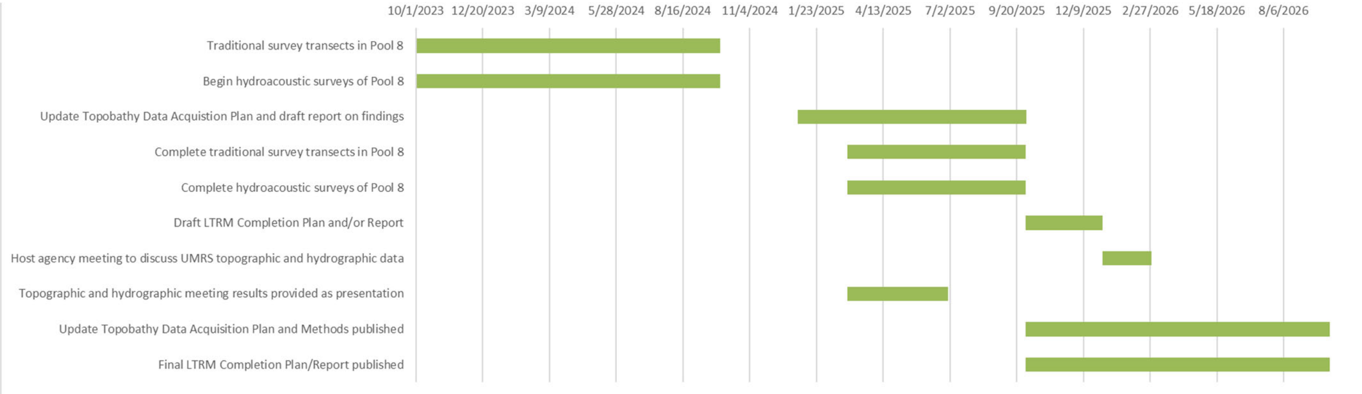

Figure 3. Timeline of data collection and product dissemination

Expected milestones and products [with completion dates]:

Expected milestones with products

Tracking number	Products	Staff	Milestones
2024Bathy1	Develop open-water method and begin RTK surveying transects in Pool 8 that will be used in accuracy assessment/open-water method development.	Kalas and Szura	1 October 2024
2024Bathy2	Begin Hydroacoustic survey of Pool 8 transects that were completed this field season.	Strange and Team	1 October 2024
2024Bathy3	Establish methods, add transect data to current database, start the process of comparing technologies. Current results will be placed in draft LTRM publication.	Strange and Kalas	1 January 2025
2024Bathy4	Draft strategies and recommendations results will be placed in updated Topobathy Data Acquisition Plan.	Strange, Hanson, Vaughan	1 January 2025
2024Bathy1b	Complete RTK surveys of transects in Pool 8 that will be used in accuracy assessment/hydroacoustic method development.	Kalas and Szura	1 October 2025
2024Bathy2b	Complete hydroacoustic survey of Pool 8 transects that were completed during this field season.	Strange and Team	1 October 2025
2024Bathy3b	Perform site reconnaissance to all key pools in the UMRS to examine how developed methods could be deployed across the entire UMRS.	Strange and Kalas	1 January 2026
2024Bathy5	Draft LTRM Completion plan and/or Report on technology comparison.	Strange and Kalas	1 January 2026
2024Bathy6	Host an agency meeting to discuss topographic and hydrographic data collection.	Strange and Team	1 March 2026
2024Bathy6b	Report out results of agency meeting regarding topographic and hydrographic data in presentation.	Strange and Team	30 June 2026
2024Bathy7	Update Topobathy Data Acquisition Plan and shallow methods publication to report out technology comparison.	Strange, Hanson, Vaughan, and Kalas	30 September 2026
2024Bathy8	Final LTRM Completion Plan and/or Report on technology comparison	Strange and Kalas	30 September 2026

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Avian associations with management in the UMRS: filing knowledge gaps for habitat management

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Introduction/Background:

Bottomland forest habitat of the Upper Mississippi River have been in decline since the impoundment of the upper river in the early 1900s (Hauser et al. 2022). Active management of the remaining bottomland floodplain forests in the UMRS (Upper Mississippi River System) focuses on timber stand improvement (TSI) to select for preferred tree species, tree planting to increase structural complexity and age diversity, and invasive species control, all strategies that improve habitat quality for wildlife species of conservation concern and game species. While there have been several short-term studies of birds and mammals throughout the UMRS, there are no large-scale coordinated studies of the response of birds to forest restoration and/or HREPs (Habitat Restoration Enhancement Projects). HREPs being projects that enhance habitat for restoring floodplain systems and maintaining a healthier and more resilient Upper Mississippi River Ecosystem. To effectively manage floodplain forests for wildlife benefits more knowledge of the bird use of these systems, and how they respond to management, is required (Cosgriff et al., 2007; De Jager et al., 2012; De Jager et al., 2016; USFWS 2019). Understanding the use of the current forest communities, and how birds respond to forest management, especially forest stands that foresters consider high quality or regenerating for wildlife, is crucial to effective adaptive management of bottomland forest ecosystems (Battaglia et al., 2002; Cosgriff et al., 2007; De Jager et al., 2012, De Jager et al., 2016; Guyon et al., 2012; Knutson, 1995; Knutson et al., 1996; Nelson and Sparks, 1998; Romano, 2010; Theiling et al., 2000; and Thomsen et al., 2012).

Birds are selective of specific habitat types and are indicators of environmental health and condition (Browder et al., 2002; Deluca et al., 2004; Desgranges et al., 2006; Canterbury et al., 2000; O'Connell et al., 2000; Bryce et al., 2002). Fortunately, birds are relatively easy to study because they have unique species-specific songs and calls, are mobile, often brightly colored, and are not particularly sensitive to the presence of surveyors. Bird use of upland forests habitats and their preferences for structure and plant diversity, are well documented, especially in the upper reaches of the UMRS (Kirsch et al., 2013; Kirsch and Gray, 2020; Knutson et al., 1996; Knutson et al., 2007; Knutson and Klaas, 1997). Floodplain forests differ from upland forests in species composition, structure, or topography, and they can be flooded during the bird breeding season making monitoring difficult at times (De Jager et al., 2012; De Jager et al., 2016; Kirsch et al., 2013).

The decline of bottomland forests is a concern for birds and other wildlife and there is a desire to retain and grow the acreage of bottomland forest in the UMRS (Guyon et al. 2012, Hauser ed. 2022). Bird use of bottomland forest habitats has been a crucial component of the USACE St. Louis (STL) District's adaptive forest management decisions for the past 10 years (Young et al., 2018). Long-term standardized bird monitoring of island sites along pools 24-26 of USACE STL District's has allowed Audubon to determine bird density, occurrence probability and habitat preferences within associated forest types in this lower UMRS reach. This work amplified across the UMRS will not only create defined spatial prioritizations for birds, but also feed into each UMRS region's own specific forest management needs.

Therefore, we propose to assess bird responses to management across floodplain forest communities during the breeding season in the UMRS. We will use the existing USACE and USFWS forest inventory database (i.e. Forest Management Geodatabase (FMG)) to place avian point count surveys that can be related to existing data on forest structure characteristics (i.e. trees per acre, canopy height, number of snags, etc.). Prioritized sites include HREPs (pre-management, defined as not yet complete but with pending on-the-ground management, and post-management, defined as sites that have undergone restoration actions 2-5 years ago), and sites that federal agencies have prioritized for conducted/planned restoration. Since forest management includes both short-term (i.e. timber stand improvements) and long-term impacts (i.e. tree planting), which can take years if not decades to complete, this project will predominately reflect more of those short-term impacts. Our goal is to quantify forest structure features related to bird presence (and, where possible, density) in sites, pre and post management across the UMRS. Such information will allow assessment of the effects of forest restoration and improvements on bird communities that breed in these forests. Currently it is not known how floodplain forest habitat management in the UMRS affects wildlife, and in this study, we propose to fill that knowledge gap for birds. While not directly addressed in this proposal, aspects of this work will also be pertinent to other taxa of concern such as bats.

Project Objectives

We propose to identify bird use of managed forest communities in the UMRS by:

1) Mapping priority forests using current USACE and USFWS forest inventory data across the UMRS and HREP online site mapper, then choosing a variety of sites at different management stages (pre or post-management) that can fit 100-150 bird survey points overall.
2) Surveying breeding birds to document bird species composition and abundance within priority floodplain forests through use of a standardized monitoring protocol that is comparable to other monitoring and research efforts on the UMRS.
3) Determine bird species detection frequencies and – where possible – densities across pre- and post-management sites and districts.
4) Incorporating this new bird monitoring data into fine-scale bird-habitat suitability models developed by Audubon with data on the USACE St Louis District and large-scale spatial prioritization across the UMRS using LTRM datasets.
5) Producing a document with models (i.e. spatial prioritization maps, species-specific relation to habitat variables, etc.) that can be used by all UMRS forest managers to understand effects of management options on forest bird species (Appendix E—available upon request).

Relevance of research to UMRR:

This proposal addresses one of the few data poor focal areas for the UMRR program, wildlife use and forest vegetation dynamics of the UMRS. Research on wildlife response to management on a large scale is sparsely done due to a few factors. Professional expertise is limited, collecting field data is expensive, and there is typically limited coordination amongst professionals over a large scale. Audubon, with experience monitoring breeding bird communities in Missouri and Minnesota, is prepared to lead such work across the UMRS. Understanding how breeding bird communities select floodplain forests and respond to forest management will help us better manage and/or maintain forest characteristics to benefit birds and likely other wildlife taxa, as well.

Our project addresses the following Focus Area:

Focus Area 2.6 Understanding relationships among floodplain hydrogeomorphic patterns, vegetation and soil processes, and effects of wildlife habitat and nutrient export, section d. Understand effects of vegetation dynamics on wildlife use of the UMRS floodplain.

Methods:

Study Area

This project focuses on the major reaches of the UMRS. Including the Mississippi River from its confluence with the Ohio River in Cairo, Illinois to Minneapolis-St.Paul, Minnesota. Using multi-agency attributed forest inventory database and the HREP mapper, we will identify partner-based restoration or priority management areas. Sites will be represented by post and pre-restoration actions. Since forest management and TSI takes a few years to noticeably respond, priority sites chosen as "post-management" should be around 2-5 years post treatment. Site selection will be supported by local foresters with on the ground expertise in floodplain forest silvics and management. See Appendix A (available upon request) for overview of region under consideration.

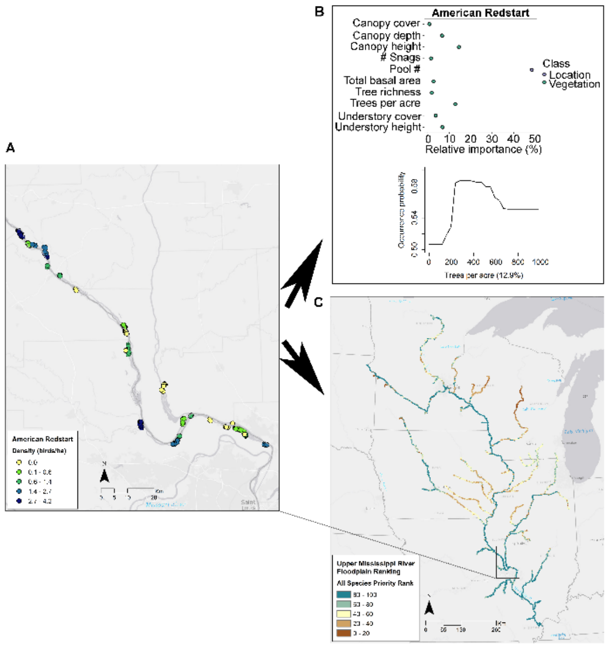
Within the UMRS project area, all sites selected for consideration in this study are priority forest sites as indicated by the partner(s) who conduct on the ground management (i.e. USACE, USFWS, etc.). Sites are indicated as priority under this study based on factors such as dominate forest type, designation as an HREP (past or present), NESP (current or in planning), or pending forest management via on the ground managers, etc. Sites did not need to hit all of these factors to be considered. Sites were then categorized as either pre- or post-management areas (Appendix B, C and D; available upon request) as determined by foresters. Sites considered in this proposal cover 8 pools within the UMRS and hit a handful of different HREPs. This vast array of floodplain forest is owned by different agencies, state and federal spanning the five-state region surrounding the UMR and are cooperatively managed through guidance of the Systemic Forest Stewardship Plan (Guyon 2012).

Sampling Methods

The US Fish and Wildlife Service Landbird Monitoring Protocol for the Midwest and Northeast (Knutson et al. 2008, Reynolds et al. 2016) will be used to conduct point-count surveys at selected forest sites. This standardized protocol is currently used in similar bottomland forest bird studies within the UMRS and will make our data comparable with other datasets in the region. This protocol uses an unlimited distance, full-circle 10-minute survey period identifying all birds seen or heard, distance from observer (measured in meters, using a rangefinder if needed), minute of first detection of each individual, and type of detection (aural, visual, or both, and if the bird was flying over, not alighting in the survey area [flyover]). Survey points will be placed approximately 300 m apart from one another and located approximately 100 m from forest edges (i.e. edge with the main channel of the Mississippi River, urban, or agricultural fields). Bird survey points will also lie within 100 m from existing forest inventory data points on the landscape to relate counts with the existing forest inventory data. Prior to the survey season, technicians and staff will be trained on how to conduct surveys and pertinent bird species identification (ID). Audubon technicians will also undergo boater safety and CPR/First Aid training.

Data Analysis

Our data analysis plan consists of three parts: (1) evaluate bird detection frequencies and, where possible, densities within sites; (2) evaluate fine-scale bird-habitat relationships within identified sites; and (3) update the existing Audubon draft large-scale UMRS spatial prioritization to include the new bird data from the additional UMRS areas covered in this study. We will follow the same suite of methods previously used when estimating UMRS bottomland forest bird densities and habitat relationships (Michel et al., *unpubl. data*; Fig. 1), to ensure comparability.



<u>**Figure 1.** Density estimates for American Redstart in the St. Louis District (A), bird-habitat relationships for American Redstart in the St. Louis District (B), and draft floodplain forest spatial prioritization for the Upper Mississippi River (Michel et al., *unpubl. data*).</u>

<u>*Objective 1: Evaluation of bird detection frequencies and densities within greater UMRS.*</u> We will produce species-specific detection frequencies and, where possible, density estimates for focal bird species at each site(Appendix E; available upon request). We will calculate detection frequencies for all focal bird species detected within each site and forest type, as data allows. Species- and forest type-specific detection frequencies will be calculated as the number of points at which one or more individuals of the species was detected in that forest type, divided by the number of points in that forest type.

We will also estimate point-level bird density within each site for bird species, as data availability allows (as in Fig. 1A). We will combine data from both years and all sites in a single model per species to maximize the number of species with sufficient data for modeling (typically ~40 unique detections in the UMRS; Michel et al. *pers. comm*). Specifically, we will use a formulation of time removal and distance sampling models developed by Sólymos et al. (2013) and implemented in R (R Core Team 2022) using package *detect* (Sólymos et al. 2018). We will estimate point-level abundance corrected by two components of detection probability, availability and perceptibility, using conditional multinomial maximum likelihood estimation. Availability – the probability that a bird provides a visual or auditory cue during sampling and is thus available to be detected – will be estimated using the minute of first observation. Each individual will be counted only once, thus individuals will be ‘removed’ once detected. Perceptibility – the conditional probability that birds available for detection will be detected – will be estimated as a function of distance from observer (Sólymos et al. 2013). We will allow availability and perceptibility to vary among years to account for annual, habitat- or management-related differences. We will use these models to generate point-level density estimates for all surveyed locations, as well as mean densities for each year and site.

Objective 2: evaluate fine-scale bird-habitat relationships within the UMRS. We will model fine-scale bird-habitat relationships using point-level detection-corrected densities and the forest inventory data from the existing forest inventory surveys (as in Fig. 1B). Modeling will be conducted using boosted regression trees, a machine-learning method that is ideal for bird-habitat modeling as it supports inclusion of large numbers of vegetation characteristics (Elith et al. 2008). This method also naturally models non-linear relationships between birds and vegetation characteristics. It also works well to model interactions among predictors (i.e., vegetation characteristics).

Forest birds often have spotty distributions, with many zero or low counts and a few very large counts, a pattern which makes modeling abundance relationships with an unfiltered count dataset. Consequently, we will use a hierarchical "hurdle model" approach, in which we separately fit a presence-absence model that estimates probability of species occurrence, and then an abundance model that estimates abundance only where the species occurred (Oppel et al. 2012, Michel et al. 2020). Models will be built separately for each species, but study sites will be combined – with a binary covariate indicating study site location – to improve model fit.

Fine-scale bird-habitat models will be first used to identify the vegetation structure and composition factors most influencing occurrence and abundance and then quantify the direction and magnitude of their effects on occurrence and abundance.

Objective 3: Update the draft Upper Mississippi River floodplain forest bird spatial prioritization to identify priority areas for conservation and management. We will update Audubon's existing draft spatial prioritization for the Upper Mississippi River watershed (Michel et al., *unpubl. data*; Fig. 1C) to better represent bird-habitat relationships in pre- and post-management sites. To do this, we will integrate the structured point count data gathered here with other structured, semi-structured, and unstructured datasets collected across the basin during the past 10 years. Existing structured point count data that will be incorporated includes surveys conducted annually since 2014 by the Audubon Center at Riverlands and USACE in the St. Louis District; surveys conducted annually since 2017 by William Reiter-Marolf (USFWS) in the Upper Mississippi National Wildlife and Fish Refuge; recent (2015-2022) surveys by Eileen Kirsch (USGS) in pools 4, 8, and 13; and other structured datasets shared by collaborators. We will also incorporate semi-structured and unstructured data collected across the Upper Mississippi River watershed to increase spatial coverage of avian data. Semi-structured data are defined here as data collected according to a standardized protocol but without auxiliary data to correct for imperfect detection (e.g., Breeding Bird Survey). Unstructured data includes citizen science data such as eBird that do not use a standardized protocol. Presence-absence and count data collected during a 10-year period (2016 – 2025) from across the Upper Mississippi Region will be compiled for the nine focal species. Because we are producing a prioritization at the much larger scale of the entire Upper Mississippi River, including areas where forest inventory surveys (used in the modeling described in Objective 2) have not been conducted, we will use coarser-scale remotely-sensed data as environmental covariates for this objective only.

Remotely-sensed environmental datasets including land cover (specifically, the Upper Mississippi River Restoration Program's Long Term Resource Monitoring 2010/11 land cover dataset [USGS Long Term Resource Monitoring 2016]), impervious surface cover (Yang et al. 2018) floodplain inundation frequency and duration (Van Appledorn et al. 2018), elevation (USGS 2017), terrain ruggedness (derived from the digital elevation model), distance from protected areas (USGS Gap Analysis Project 2018), and long-term (1981-2010) climate normals (Mitchell and Jones 2005) will be used as model predictors. Remotely sensed land cover data were collected at a resolution <100m; inundation at a resolution of 4m; elevation and terrain ruggedness at a resolution of 1m; and climate and distance from protected areas at a 1km resolution. Accuracy was visually confirmed but not quantified for the land cover, inundation, and impervious cover data sets. All remotely-sensed covariates will be sampled at a scale of 800 ha (i.e., summarized within 0.1 km buffer using a moving window approach) as many floodplain forest focal bird species exhibit habitat relationships at this scale (Thogmartin and Knutson 2007). We will derive both proportion cover (within 0.1 km buffer) and landscape metrics (mean patch area, cohesion index [a measure of connectivity]; following Michel et al. 2020) from land cover layers to evaluate bird response to bottomland forest extent and connectivity.

Avian data will be analyzed using inhomogeneous point-process models to model unstructured and semi-structured data, a relative abundance model to model structured point count data incorporating distance and time removal, and a joint likelihood to combine the two data types (Fletcher et al. 2019, Miller et al. 2019). The eBird database contains >500 million records, and sample sizes for focal species will likely exceed those of structured point counts by orders of magnitude. To limit the contribution of the eBird data to the integrated models, eBird data will be spatially thinned and down-weighted to balance the structured point count data (Fletcher et al. 2019). Additionally, eBird data will be filtered following best practices to include only records gathered during the survey period (May-June 2024 & 2025) using stationary, area or traveling counts, and records with all species recorded (i.e., complete checklists) that were collected in ≤1 hour and <1 km to maximize consistency of effort (Johnston et al. 2019). Bird data will be combined with the coarser-scale, remotely-sensed environmental covariates described above, sampled from grid cells where bird surveys occurred, to produce estimates of relative abundance for all survey locations. The models will further be used in conjunction with environmental covariates from across the region to produce continuous maps of predicted relative abundance for each species.

We will combine the predicted relative abundance maps for each species to produce a spatial prioritization for the Upper Mississippi River region. We will use Zonation spatial prioritization software (Moilanen et al. 2014) to rank the landscape from zero to one based on its habitat suitability for floodplain forest focal bird species. We will use the Core Area Zonation (CAZ) ranking method because it ensures that every species is represented in the final ranking. We will also explore incorporating connectivity based on dispersal distances in the Zonation procedure which gives preference to areas with a high density of high-quality habitats (Moilanen et al. 2014). The prioritization will weight presence or abundance of at-risk species higher than common species using species weights derived from the Partners in Flight conservation concern scores for summer and winter (Partners in Flight 2021). We will normalize the scores, which range from 1 – 20, using the formula: (X - X min)/(X max - X min). We will define high-priority areas for floodplain forest bird conservation as areas with ranks in the top 20% of all scores (Grand et al. 2019).

Audubon will share all bird and bird-habitat modeling results with regional partners and stakeholders, including USACE, USGS, USFWS, Minnesota DNR, and other interested parties not listed here such as UMRR state partners in MO, IL, IA, WI and MN.

Data management procedures:

Bird data collected under this project will be entered into the Midwest Avian Data Center (MWADC), a node of the larger Avian Knowledge Network (AKN). This network allows robust data storage and access system that can be shared across partner organizations. It is also easy to facilitate projects, data entry, and analysis. The MWADC acts as a regional base for bird monitoring projects within the greater region and is currently used for Audubon's pre-existing bottomland forest monitoring projects out of Missouri and Minnesota.

Special needs/considerations if any:

This large-scale study requires expertise bird survey methods and ID to be conducted in those sites identified. This means creating partnerships and collaborations all along the river, whether that be with state or federal agencies, NGOs, or academic facilities. In order to create these collaborations, we will require time to share this study with outside agencies well before the survey season begins. In the case of severe flooding on any reach along the river (i.e. St. Paul, Rock Island or St. Louis) a no-cost extension to accommodate a delay in monitoring will need to be requested.

Timeline:

October 2023 - April 2024	Initiate pre-season prep work: • Evaluate equipment needs • Coordinate with partners • Review study scope • Select sample areas and sample point locations
May - July 2024	Conduct bird surveys and initiate data entry
August – September 2024	• Finish data entry • Conduct QA/QC • Initiate data analysis
Oct – December 2024	Post season review and results summary
January - April 2025	Initiate pre-season prep work: • Evaluate equipment needs • Coordinate with partners

	• Review study scope
May - July 2025	Conduct bird surveys and initiate data entry
August – September 2025	• Finish data entry • Conduct QA/QC • Initiate data analysis
Oct – December 2025	Post season review and results summary
January – September 2026	• Develop report and presentation of results • Share report with partners and collaborators along the River • Initiate publication process of study

Expected milestones and products [with completion date]:

Initiate bird surveys within the UMRS – May 2024

Complete year one bird surveys within the UMRS and data entry – September 2024

Initiate year two bird surveys within the UMRS – May 2025

Completed bird surveys and data entry; excel tables of all collected data available – September 2025

Full scale report of findings and management suggestions – March 2026

Publication of study - TBD

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Title of Project: Filling in the gaps with FLAMe: Spatial patterns in water quality and cyanobacteria across connectivity gradients and flow regimes in the Upper Mississippi River

Previous LTRM project: N/A

Name of Principal Investigator(s):

Luke Loken

- Hydrologist, USGS Upper Midwest Water Science Center (UMid); 1 Gifford Pinchot Drive, Madison, WI 53726, lloken@usgs.gov
- Oversee purchasing, build sampling platform, train others on equipment, manage staff on data processing, management, and writing.

Rebecca Kreiling

- Research Ecologist, USGS Upper Midwest Environmental Sciences Center (UMESC); 2630 Fanta Reed Rd, La Crosse, WI 54603, rkreiling@usgs.gov
- Project management, oversee budget, supervise support staff, writing, data analysis, assist with data management.

Kathi Jo Jankowski

- Research Ecologist, USGS UMESC; 2630 Fanta Reed Rd, La Crosse, WI 54603, kjankowski@usgs.gov
- Coordinate sampling design, project management, co-supervise postdoc, communication/integration with LTRM/UMRR staff, writing, data analysis.

Emily Stanley

- University of Wisconsin-Madison; 680 N Park St, Madison, WI 53706, ehstanley@wisc.edu
- Consult with project team on research objectives (in kind).

Collaborators (Who else is involved in completing the project):

James Larson

- USGS UMESC; jhlarson@usgs.gov
- Assist with data analysis and writing. Coordinate FlowCam sampling.

Nicole Manasco

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- Assist with field design and site selection including HREP sites.

Ashley Johnson

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- Assist with data collection and field design in Pool 13.

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- Assist with reporting out to UMRBA and other stakeholders.

Introduction/Background:

Water quality in the Mississippi River is complex but fundamental to understanding and restoring riverine habitat. The river at any location reflects a dynamic integration of water originating across a vast and heterogeneous catchment. Moving down river, the catchment area expands, and inputs from tributaries continuously imprint physical, chemical, and biological components on the river. On top of changing hydrologic sources, the river itself varies in connectivity, water residence time, hyporheic exchange, and ecological processing rates (Tockner et al., 2000; Wohl, 2017) allowing longitudinal and lateral variation in several properties (Bouska et al., 2018; 2019; De Jager et al., 2018). Variation in water sources, connectivity, and reactivity combine to create observable patterns in water chemistry, community composition of primary producers, and water quality. Thus, understanding water quality within the Mississippi River and the potential impact of restoration projects require consideration of the influence of tributaries, the degree of connectedness, the reactivity of system, and how all of this varies across flow regimes.

Large differences in water quality, nutrient cycling, phytoplankton communities, and microbial activity exist across lateral gradients in the Upper Mississippi River System (UMRS). Restoration projects often alter the degree of connectedness between habitats, and thus have the potential to alter several aspects of water quality. Backwater sections of LTRM-monitored pools typically have lower concentrations of nitrogen (N) and dissolved oxygen (Houser & Richardson, 2010) and greater concentrations of chlorophyll a (Houser, 2016; Jankowski, 2022) and phosphorus (P) in the summer, resulting in low TN:TP ratios (De Jager & Houser, 2012). Backwaters contain abundant organic matter, creating hotspots of microbial activity and nutrient cycling when and where nutrients are plentiful (Strauss et al., 2004; Richardson et al. 2004; Houser et al., 2015). Connectivity gradients also appear to influence phytoplankton community composition and cyanobacteria abundance. Toxin-producing cyanobacteria may be more abundant in backwater areas with low TN:TP ratios and adequate light (Giblin & Gerrish, 2020; Manier et al., 2021), but whether this pattern is consistent and if it translates to greater toxin production in less connected areas across the extent of the UMRS is unclear. For instance, while toxin concentrations in pools 6-8 are often high in backwaters (Giblin et al., 2022), toxic blooms have primarily been observed in the main channels of the Illinois and Ohio Rivers (Nietch et al., 2022). The location of potentially toxic blooms in the UMRS is understudied and not well known.

Discharge is a major driver of water quality; it can increase delivery of nutrients and material from tributaries and alter connectivity across riverine habitats. Discharge dynamics alter the degree of connectiveness of backwaters to the main channel, which in turn can affect water quality, nutrient cycling, and primary production (Houser, 2016; O'Donnell & Hotchkiss, 2019; Waite et al., in review). As flow increases, connectivity increases between the main channel and backwaters, which can result in flushing and deposition of main channel material and solutes into backwater areas. As flows decrease and backwaters re-isolate, material and nutrients previously delivered can subsequently be processed (Houser & Richardson, 2010). Phytoplankton community assemblages, including the prevalence of toxigenic species, also change with fluctuations in discharge and appear more similar between the main channel and backwaters at higher discharge and greater connectiveness (Decker et al., 2015; Manier et al., 2021). As a result, the timing and frequency of flushing/isolating events combined with variable patterns in hydrologic connectivity and the arrangement of tributary sources collectively influence water quality, but characterizing these dynamics among hydrogeomorphically variable backwaters is challenging and not always scalable.

Eutrophication and harmful algal blooms (HABs) are potential threats to the success of restoration projects, but there are gaps in our understanding of how they vary among and within UMRS reaches. Although we have some understanding of how water quality and phytoplankton community composition change across gradients in connectivity in the UMRS, LTRM assessments and monitoring have largely focused on only 4 of the 26 impounded pools in the river, which were originally selected to represent conditions across the UMRS. Yet given the sheer size and complexity of the river basin and additional investigation and interpretation (e.g., Crawford et al., 2016; Loken et al., 2018a; Carhart et al., 2021, Houser, 2022), it is clear that there is important variation in hydrologic, geomorphic, and biogeochemical properties within the UMRS outside of areas where LTRM has long-term data. For example, these "representative" pools have only a subset of the functional types of UMRS backwaters (De Jager et al. 2018), and three of the pools are located in a single floodplain reach (the Upper Impounded Reach; Lubinski, 1993). This results in a large data gap (~450 river km) between pools 13 and 26 in the Lower Impounded Reach, where two of the largest agricultural tributaries enter the river (Iowa and Des Moines Rivers), and where several Habitat Restoration and Enhancement Projects (HREP) are proposed or in planning stages. Agricultural tributaries to the UMRS deliver elevated loads of sediment and nutrients, especially during high-discharge events (Garrett, 2012; Kreiling & Houser, 2016; Sprague et al., 2011). As a result, there are major threats to habitat conditions in these pools, including noticeable increases in TSS, P, and N concentrations from Pool 13 to Pool 26 (Houser et al., 2010; Loken et al., 2018a) and limited potential for aquatic vegetation due to constant water level fluctuations and limited shallow areas with adequate light conditions (Carhart et al., 2021). Thus, downriver from Pool 13, changes in water sources and morphology may have a pronounced impact on water quality in the lower UMRS, but our understanding of drivers/processes influencing water quality and how that may impact the long-term sustainability of HREP projects in this stretch is incomplete.

Objectives:

To improve restoration planning and more effectively target HREPs in the under-monitored section of the UMRS, more information is needed to assess drivers of variation in water quality and the potential emergence of HABs. Water quality data gathered through the UMRR LTRM monitoring component are extremely valuable for understanding and managing the UMRS ecosystem. However, data are collected in a limited number of pools and information may not be easily extrapolated to pools with a different geomorphology and greater tributary inputs of sediment and nutrients. **Therefore, we propose to enhance the extensive LTRM data set, inform HREP planning, and provide additional monitoring capacity by building and deploying a new platform for collecting high spatial resolution measurements of select water quality parameters in under-monitored areas between Pools 10 and 26 of the UMRS using the Fast Limnological Automated Measurements (FLAMe) platform (Crawford et al. 2015, Figure 1).** We specifically ask, **(1)** how do lateral connectivity, flow regimes, and tributaries jointly influence spatial patterns in water quality within the Upper Mississippi River?, **(2)** how variable are concentrations of chlorophyll *a* (indicator of algal biomass) and phycocyanin (indicator of potentially toxic cyanobacteria/HABS) within the river?, and **(3)** what hydrologic and geomorphic features overlap with elevated densities ("hotspots") of total and potentially toxic phytoplankton? **To answer question (1),** we will use this newly built FLAMe platform to conduct repeat spatial surveys across connectivity gradients, flow regimes, and proximity to major tributaries in six pools of the UMRS - Pools 10, 13, and 18–21. These pools were selected because they have variable and distinct connectivity gradients between the main channel and other aquatic areas and contain confluences with major tributaries that deliver excessive loads of sediment and nutrients to the UMRS. Moreover, four of six proposed sampling pools have proposed HREPs which are currently in the planning process. **To answer questions (2) and (3),** we will use the FLAMe to conduct a single longitudinal survey of the river from Pool 10 to Pool 26. We will measure chlorophyll *a* and phycocyanin in the main channel and in aquatic areas potentially prone to greater phytoplankton densities to assess areas of potential risk for HAB formation. Both of these surveys will overlap with LTRM study pools (e.g., Pool 13 for question (1) and Pools 13 and 26 in questions (2) and (3), and allow understanding gained by LTRM to be more easily translated to the middle and lower reaches of the UMRS. Similar spatial surveys have occurred along the entire extent of the Illinois River in 2022, including the La Grange LTRM study pool, that included mapping across connectivity gradients, through funding from USGS Next Generation Water Observing System. These two efforts could be leveraged to improve our understanding of water quality and HAB formation across the UMRS.

Relevance of research to UMRR:

Many HREPs are constructed to improve water quality for vegetation and fish communities. This project will advance our understanding of how water quality varies across and within pools in the lower impounded reach of the UMRS. Currently, this section of the river is not well-monitored within the LTRM framework but has several proposed HREPs and tributaries that deliver large loads of sediments and nutrients that affect conditions from the UMRS to the Gulf of Mexico (Crawford et al., 2019; Lorenz et al., 2009; Stackpoole et al., 2021). We will evaluate and provide baseline geospatial data layers and maps (e.g., Figure 1) that address how water clarity, dissolved oxygen, chlorophyll a, and cyanobacteria abundance vary among pools, connectivity gradients, and flow regimes, which can also be used to develop and test hypotheses in other sections of the UMRS. Further, the longitudinal mapping campaign aims to identify locations of elevated phytoplankton fluorescence, which we will describe in terms of hydrology and geomorphology to aid future studies on algae bloom formation in the UMRS and other large floodplain rivers. We currently lack a working hypothesis of when and where algae blooms form in large rivers, but given the increased prevalence in nearby lakes and rivers (Illinois River, Ohio River, Lake Superior, Lake Erie), HABS may becoming more common throughout the region and there is no reason to think they are absent from the UMR. Finally, the FLAMe will reside at UMESC for use by UMRR program partners.

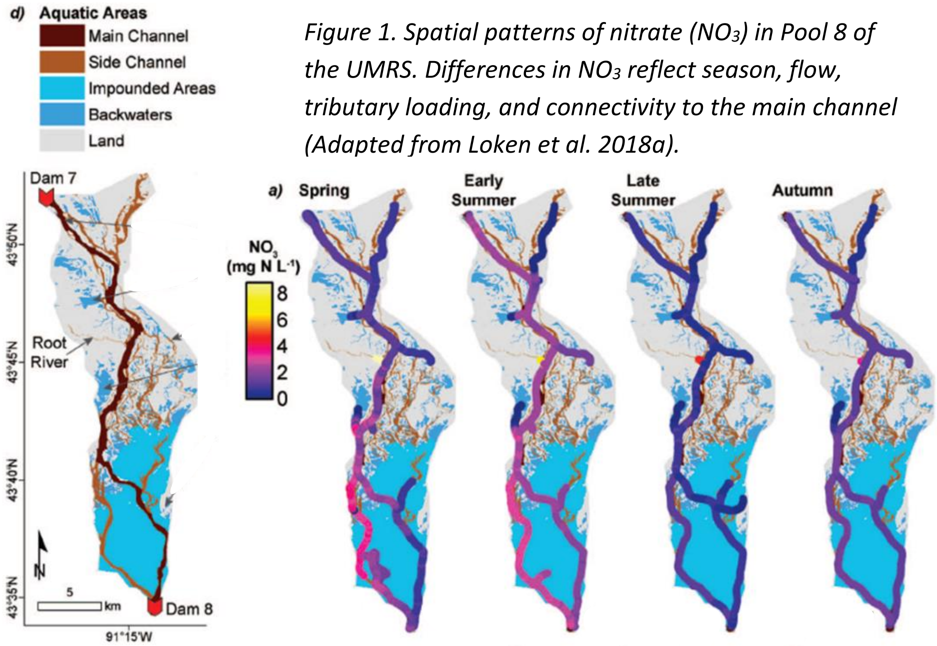

Figure 1. Spatial patterns of nitrate (NO_3) in Pool 8 of the UMRS. Differences in NO_3 reflect season, flow, tributary loading, and connectivity to the main channel (Adapted from Loken et al. 2018a).

This proposed study addresses the following Focal Areas.

- Focal area 1.1 (Question 7 - How does geomorphic setting influence post-project sediment dynamics for HREPs? In particular, what role do tributaries and their proximity to HREPs play?) by mapping pools with major tributaries which may influence water quality of current and planned HREPs.
- Focal area 2.1 Assessing the associations between aquatic areas and biota and biogeochemistry using existing data by using the Habitat Needs Assessment (HNA) data sets (De Jager et al., 2018) for aquatic area delineation and metrics of connectivity, both longitudinal aquatic connectivity and connectivity across aquatic areas.
- Focal area 2.3 (Question 14 - What are the limitations to submersed vegetation in Pools 13-19 and what restoration techniques could re-establish vegetation?) by providing high resolution turbidity data in a relatively unmonitored section of the UMRS, which can be used to select HREP locations to improve water clarity. Additionally, our study design will include backwaters with varying levels of vegetation which will provide data about how water quality and turbidity correlate with occurrence of vegetation.
- Focal area 2.5: Consequences of river eutrophication for critical biogeochemical processing rates and habitat conditions.
- Focal area 2.7: (Question 2 - How are turbidity (inverse of water clarity) and chlorophyll affected by wave energy? How does that response differ between areas within and outside of submersed vegetation beds?). Pools that will be surveyed include Pools 10, 13, and 18-21. The following HREPs are

in planning stage in these pools: Pool 10 - Lower Pool 10 Islands HREP, Pool 13 - Lower Pool 13 HREP, Pool 18 - Huron Island HREP and Keithsburg HREP, Pool 21 - Quincy Bay HREP. In addition, major tributaries to the UMRS which may impact water quality enter Pools 10 (Wisconsin River), 13 (Maquoketa River), 18 (Iowa River), 19 (Skunk River), and 20 (Des Moines River).

Methods:

We will conduct repeated spatial surveys of water quality in the middle and lower impounded reaches of the UMRS using the FLAMe sampling system. The FLAMe is a boat-mounted water intake system that incorporates multiple water quality sensors with global position systems (GPS) to create high resolution maps of surface water quality (Crawford et al., 2015). Water is continually pumped onboard a moving boat to several water sensors, and measurements are made every second as the boat travels across the water surface. **We will build a new FLAMe platform for this proposal that will measure temperature, specific conductivity, dissolved oxygen, pH, turbidity, chlorophyll a and phycocyanin fluorescence (indicators of potentially harmful phytoplankton species), fluorescent dissolved organic matter (fDOM), and nitrate. The FLAMe built with this proposal will also have the capacity to monitor concentrations of carbon dioxide, methane, and pigments of four additional phytoplankton taxa using existing UMid sensors** (Los Gatos Research Ultraportable Greenhouse Gas analyzer and BBE Moldaenke FluoroProbe), which we propose to use during this study. The FLAMe and sensors within this proposal will reside at UMESC and be available for use by others in the UMRR program, and additional sensors can be integrated into the FLAMe system depending on future program needs. Discrete water samples for nutrients (dissolved and total) and phytoplankton FlowCam analysis will also be collected in this effort to support sensor data and understanding of nutrient and phytoplankton dynamics within the UMRS. FLAMe data have been used to evaluate spatial heterogeneity in water chemistry, phytoplankton dynamics, and greenhouse gas dynamics in several lakes and rivers, including the Mississippi River (Butitta et al., 2017; Crawford et al., 2016; Loken et al., 2018a). These studies revealed broad scale spatial patterns of greenhouse gases, nutrients, and turbidity in the Mississippi River (Crawford et al., 2016; Loken et al., 2018a; Turner et al., 2016), but they lack high resolution and repeat mapping across connectivity gradients in the lower impounded reach of the UMRS, and they did not investigate spatial patterns in phytoplankton community composition.

To address study objective 1, we propose to conduct five week-long surveys in 2024. Each survey will include FLAMe mapping in pools 10, 13, and 18-21. These pools were selected because of limited data availability (other than Pool 13), the presence of backwaters and other off-channel aquatic areas (De Jager et al., 2018), planned HREPs, and the location of the Wisconsin, Iowa, and Des Moines Rivers which are major sources of nutrients and sediments to the UMRS (Sprague et al., 2011; Robertson & Saad, 2021). In each of these pools, we will map water quality longitudinally along the entire main channel and laterally across select connectivity gradients. We will establish six lateral transects per pool using the UMRR aquatic areas database (De Jager et al., 2018), originating from the main channel traversing two backwater areas, two impounded areas, and two side channels. Connectivity will be predicted using the aquatic areas database and use of predictive models where available (e.g., Schnoebelen et al., 2012). The six pools (10, 13, 18/19, 20/21) will be mapped on four consecutive days to limit temporal variation and changes in flow dynamics. The five surveys will take place ~monthly between May and September to capture different combinations of main channel and tributary flow regimes. We will time our surveys to target distinct components of the hydrograph derived from historic flow regime data as is feasible (e.g., spring flood, summer base flow). We will analyze differences in FLAMe and discrete data among pools (n = 6), aquatic area transitions (n = 6 per pool), and flow regimes (n = 5) using multivariate and geospatial models.

To address study objectives 2 and 3, we propose one additional continuous longitudinal survey from Pool 10 to 26. This survey will focus on identifying extremes in phytoplankton fluorescence, including detections of HABs. Using the aquatic areas dataset (De Jager et al., 2018) and long term nutrient/phytoplankton data (Giblin and Gerrish, 2020; Manier et al., 2022; Jankowski, 2022), we will identify locations potentially prone to increased phytoplankton densities (elevated nutrients, backwaters, impoundments, near tributary sources, etc.) and locations with or sharing features with prior HAB observations. We will time this survey to coincide with the period of maximum algal biomass for the UMR (July-August) and target a period of the summer in which HABs tend to occur using data from other large rivers in the region (Nietsch et al., 2022), other studies in the UMR (e.g., Giblin et al., 2022, Waite et al, in review), and forthcoming data from the UMRR-funded phytoplankton study (available fall 2023). Similar mapping and analyses took place on the Illinois River in summer 2022, and data between these two efforts can easily be integrated to provide a broader picture of phytoplankton dynamics across the UMRS. In addition to maps of water quality and algae fluorescence, we propose collecting samples for phytoplankton identification and enumeration using the FlowCam (Álvarez et al., 2014). This device is currently at UMESC and is a rapid screening tool to identify phytoplankton community composition to the genus level. FlowCam samples will be processed within 3 days and will expand the range of waters included in the UMESC FlowCam library. This explorative survey will be used to guide potential future investigations specifically focused on the emergence of HABs in the UMRS. Data analysis for this objective will consist of quantifying the spatial patterns and drivers of chlorophyll and phycocyanin across the UMRS with a focus on understanding what drives elevated concentrations. To do so, we will evaluate hydrogeomorphic (area, connectivity, depth , etc.) and biogeochemical (nutrients, turbidity, etc.) commonalities among locations with elevated phytoplankton concentrations to develop and/or extend models of spatial algae bloom dynamics in large rivers.

Data management procedures

Water quality data will be georeferenced, collected on a Campbell datalogger, and displayed in real-time on an onboard computer. Following each sampling campaign, raw data will be uploaded to a cloud directory and processed using the R program language and git repositories developed for other projects (https://github.com/lukeloken/SuperFlamer). This workflow includes several functions that provide initial QA/QC, compile data in consistent and machine-readable formats, and produce plots of timeseries and maps. Once data have been reviewed and approved, data tables (.csvs) and shapefiles will be archived in USGS ScienceBase in a similar fashion to other FLAMe projects (Loken, et al., 2018b; 2018c). To allow easy integration, water chemistry and phytoplankton FlowCam data will be archived in an accompanying ScienceBase child item.

Special needs/considerations, if any:

Water quality sensors are in high demand, some with lead times >3 months. Ordering and FLAMe construction will take place 2023, and field work can start as early as May 2024. This will allow time for initial testing, hiring field assistants, and training.

Timeline:

Time constraints (if any) for beginning project and expected completion date(s):

Date	Milestone
Jan 2023	Project initialized.
Mar-Aug 2023	Sensors and flame components ordered. Staffing needs and personnel identified.
Sep-Oct 2023	FLAMe built and initial testing/training of lead project staff.
May-Sep 2024	Sampling campaign (Objective 1).
Jul-Aug 2024	Larger mapping effort identifying locations of elevated algal fluorescence (Objective 2/3)
Dec 2024	Data reviewed and published.
May 2025	Journal article and/or report complete.
Jun 2025	FLAMe training for interested parties.

Expected milestones and products [with completion dates]:

This project will fill important data and knowledge gaps about water quality changes across pools, connectivity gradients, and flow regimes in the lower impounded section of the UMRS. We will construct a FLAMe platform (Oct 2023) and host a training session (Jun 2025) so that others in the UMRR program will be able to use it in future research and monitoring efforts. We will produce maps and shapefiles illustrating how water clarity, dissolved oxygen, chlorophyll a, and cyanobacteria abundance vary across connectivity gradients and flow regimes within Pools 10, 13, 18-21 (Dec 2024). We will also produce maps and shapefiles of water quality in Pools 10-26, depicting the variation in algal fluorescence across transitions from the main channel through other aquatic areas with potentially elevated phytoplankton densities (Dec 2024). An interpretive journal publication will be generated (May 2025) detailing key relationships among flow regimes, connectivity gradients, and water quality.

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Title of Project: Substrate stability as an indicator of abiotic habitat for the UMR benthic community

Previous LTRM project: No.

Name of Principal Investigators

Teresa Newton, USGS, Upper Midwest Environmental Sciences Center, La Crosse, WI, 608-781-6217, tnewton@usgs.gov; role: synthesize mussel density data, develop statistical relations between substrate stability and mussel density, species richness, and species associations, draft data summaries, completion report, and journal article.

Angus Vaughan, USGS, Upper Midwest Environmental Sciences Center, La Crosse, WI, 608-781-6152, aavaughan@usgs.gov; role: conduct bathymetry and current velocity surveys, generate values for complex hydraulics needed to estimate relative substrate stability across discharges, and co-author journal articles. Angus has the overall data management responsibility for project-related data acquisition, processing, quality control, metadata development and preservation.

Collaborators

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Introduction

What's the issue or question? Resilience is the ability of a community to remain unchanged when subjected to disturbance and is critical to predicting how ecological communities respond to changes in abiotic conditions (Lavergne et al. 2010). A community's distribution across a gradient of changes in abiotic conditions is used to quantify resilience (Sandulli et al. 2021). For benthic organisms, distributions are often responsive to abiotic conditions near the substrate-water interface that result from spatial and temporal variation in discharge and hydrology (Rempel et al. 2000, Merigoux and Doledec 2004). Benthic communities are ideal to assess resilience because of high biodiversity, range of life spans, relatively sessile nature, and variable responses to disturbance (Sandulli et al. 2021). Yet, benthic communities remain relatively unstudied, especially in large rivers. Resilience also provides a framework to assess how benthic communities will respond to increased frequency and magnitude of extreme climactic events (i.e., floods and droughts). The Upper Mississippi River Restoration (UMRR) program seeks to understand how interactions of abiotic and biotic features influence the distribution and density of biota (including native freshwater mussels) in the UMR. Models of physical habitat have consistently shown that substrate stability explains a substantial amount of variation in the presence, density, and survival of mussels in the UMR (Zigler et al. 2008, Newton et al. 2020). However, there are components of substrate stability (i.e., particle size and velocity at the substrate water interface) are rarely measured directly. This proposal will quantify resilience of the benthic community (using mussels as representative taxa) to changes in abiotic conditions, including climate extremes at temporary and sustained temporal scales, and compare methods to quantify benthic habitat.

What do we already know about it? Flow refuges during floods have been observed to influence distributions of benthic communities including mussels (Strayer 1999, Mathers et al. 2021). More recent studies indicated that mussel occurrence is often related to complex hydraulic variables such as shear stress (Hardison and Layzer 2001, Howard and Cuffey 2003). Over the past 15 years, large-scale systematic surveys for mussels have been conducted in Pools 3, 5, 6, 8, 13, and 18 of the UMR, providing a robust database to explore interactions among biota and abiotic conditions. In the UMR, studies suggest that hydrophysical conditions account for >70% of the variability in mussel distributions and prior UMRR-funded research shows mussels are responsive to variation in hydrophysical conditions, especially conditions at the substrate water interface (Steuer et al. 2008, Zigler et al. 2008). Hydrophysical models for mussels based on conditions during floods and droughts were ~25% more predictive than models based on average discharge conditions (Zigler et al. 2008). Prior models of mussel habitat indicate the importance of shear stress derivatives (the tangential force acting on a riverbed) on the distribution and density of mussels (Hardison and Layzer 2001, Howard and Cuffey 2003). However, because shear stress is flow conditional, these models are not readily comparable across geographic locations. Morales et al. (2006) developed a dimensionless parameter to estimate substrate stability (relative substrate stability, RSS) that combined shear force and substrate type. Relative substrate stability is analogous to the dimensionless shields parameter that has been used to compare substrate stability and transport across a wide range of hydraulic and geomorphic settings (Church 2006). Relative substrate stability is defined as:

$$RSS = \tau_0/\tau_c$$

where τ_0 is the shear stress at a given flow rate, τ_c is the shear stress at the onset of substrate movement; RSS >1 indicates substrate movement (i.e., substrate instability). Areas of Pool 16 that remained stable (RSS <1) during medium (2039 m^3/s) to high (3965 m^3/s) flows were spatially coincident with dense and diverse mussel beds

(Morales et al. 2006). Similarly, low values of RSS were associated with high mussel density and species richness (hereafter, richness) (Randklev et al. 2019). Recently, survival of four species of mussels was strongly associated with substrate stability, with significantly higher survival in stable substrates (Newton et al. 2020).

How will the proposed work improve our understanding of the UMRS? The proposed work will provide a framework to examine resilience and quantify habitat for benthic communities in the UMR. Understanding the abiotic factors that support dense and diverse benthic communities may enhance the ecological services these organisms provide to the UMR ecosystem. For example, mussels provide greater ecological services in areas with higher densities (Allen and Vaughn 2011). Although the UMR does contain dense and diverse assemblages of mussels, 54% of the species are listed as threatened or endangered at either the Federal or State level or are a species of greatest conservation need (Tiemann et al. 2015). The lack of information on how changes in abiotic conditions structure the distribution and density of benthic communities in the UMR makes it difficult for managers to make informed conservation or management decisions.

Objectives. (1) Quantify the resilience of mussels to changes in discharge across temporary and sustained temporal scales for three biotic responses (density, richness, species associations); and (2) Compare methods to estimate particle size.

Relevance of research to UMRR

How will the results inform river restoration and management? Quantifying resilience to changes in abiotic conditions is critical for proactive management strategies, especially in dynamic systems like the UMR. Because of their imperiled status, mussels are a significant resource of concern to the U.S. Fish and Wildlife Service, the National Park Service, state natural resource agencies, and non-governmental organizations. For example, the UMR National Wildlife and Fish Refuge Habitat Management Plan specifically lists mussels as a priority refuge resource of concern (USFWS 2019). The information generated here could provide managers another metric (substrate stability) to describe mussel habitat and to prioritize relocation sites and other conservation measures to enhance survival and recovery. Mussels also exhibit biophysical feedbacks whereby high densities increase substrate stability through substrate armoring and increase substrate cohesion through biodeposition (Atkinson et al. 2018). Given that areas with stable substrates are associated with higher density and survival, managers can use this information to manipulate HREP project features to benefit mussels. Successful restoration efforts for mussels will depend on knowledge of where mussels occur, where the highest densities occur, and which abiotic drivers have strong associations with mussels. Data generated from this project may also provide additional information for the USACE's Mussel Habitat Suitability Model being developed by Michael Dougherty and Davi Michl.

How will the proposed work contribute to, or improve, the selection or design of HREPs? HREPs represent important learning opportunities because they manipulate fundamental ecosystem drivers such as depth, connectivity, and velocity. Many of these abiotic conditions also influence substrate stability. Resource managers are often challenged with designing HREPs to achieve a wide range of goals and objectives, while utilizing the best available science to avoid and minimize adverse effects. Given the limited knowledge of what constitutes suitable mussel habitat, resource managers often address these challenges through informed and experience-based assumptions and through trial and error. If substrate stability is strongly associated with mussel density and richness, then the data generated here could be used to evaluate which project features or project alternatives might enhance substrate stability and benefit mussels. Understanding how biota respond to variations in abiotic conditions may reduce adverse effects of HREPS on non-focal species and allow for the development of robust models of benthic habitat.

Linkages to 2022 Focal Areas. The proposed work is directly related to the UMRR 2022 theme 2 “Gain a better understanding of the current associations and interactions among biota, hydrology, and geomorphology that allows us to forecast how biota will respond to future hydrogeomorphic conditions and inform river restoration and management”. This work addresses multiple UMRR focal areas (see table). The proposed research also supports question 1c (What are the effects of hydrologic regime on the distribution and density of UMRS mussels?) of the *Scientific Framework for Research on Unionid Mussels in the UMRS* (Newton et al. 2010) and question 1.4.1 (Does substrate stability predict mussel richness, density, biomass, and/or recruitment at coarse scales?) of the *Scientific Framework for Resilience Research in the UMRS* (Bouska 2019).

Focal area	Relevance of proposed research
1.1 Recent and ongoing geomorphological changes and their implications for future physical conditions	Substrate size and stability data will inform the ongoing hydrogeomorphic classification mapping effort
1.3: Future hydrogeomorphology scenarios and their implications	Develops a baseline of RSS for future comparisons such as how climate change may affect RSS
2.1: Assess the associations between aquatic areas and biota and biogeochemistry using existing data	Provides data and information about the abiotic conditions that affect invertebrate density
2d: How do water quality and substrate characteristics affect invertebrates?	Provides data and information to understand how abiotic conditions affect invertebrate density
2e: What limits invertebrate production and density (possible contributors include…habitat availability…)	Identifies management actions that maintain or increase substrate stability; if most benthic communities reside in a small area and that area has a set of abiotic traits (RSS), this information can be used to set management objectives
3: What are the characteristics of patches of high invertebrate density, and can these characteristics be used to predict other locations of high invertebrate density?	Data and information can be used to evaluate which HREP alternatives could enhance substrate stability and benefit mussels and other invertebrates

Does the work involve an HREP? This work has direct linkages to most HREPs in general, but not to one particular HREP. Adverse effects on mussels are a possible consequence of HREPs. The proposed research could provide a mechanism by which abiotic habitats for mussels are integrated into the design of HREPs, assuming they do not adversely affect habitat features for other biota. Identification of the abiotic drivers that influence mussel density and richness could be used in future HREPs to minimize adverse effects on existing mussel assemblages or areas with threatened and endangered species. While we propose to do this research in Pool 8, we strongly considered Pool 13 to support the ongoing HREP there, but decided against it for the following reasons: (1) our analyses would not be complete in time to directly inform the lower Pool 13 HREP, (2) because RSS is dimensionless, these results are transferable across navigation pools, (3) travel would increase the budget by

~$20,000, and (4) the mussel data in Pool 13 is highly skewed by age 0 *Utterbackia imbecilis* (Paper pondshell) which comprise 46% of the mussels in the pool.

Methods

We are using mussels as representative taxa of the UMR benthic community because they have high biodiversity, are relatively sessile, are long lived, are of interest to resource managers in the UMR, and we can leverage existing biotic (pool-wide mussel surveys) and abiotic (bathymetry and current velocity) data. A UMRR-funded survey for mussels in Pool 8 was conducted in 2019. Data on density (number of live mussels), richness (number of live species), and relative substrate composition are available across 285 sites. Details on the sampling design can be found in Newton et al. (2011).

To calculate RSS, six parameters need to be estimated: shear stress, critical shear stress, shear velocity, current velocity, water depth, and bed roughness. Existing hydrodynamic models for Pool 8 will be used to derive these parameters; (1) 2D RMA-2 models, (2) system-wide hybrid 1D/2D HEC-RAS model (USACE 2020, Brunner 2008), and (3) pool-wide SRH-2D model (Stafne 2012). GIS datasets generated from these models will be used to estimate discharge-specific water depth and depth-average current velocity at discharges of 5, 50, and 95% of the historic exceedance (hereafter Q5, Q50, and Q95). Shear stress and shear velocity can be calculated from the other abiotic variables and standard formulae. However, information on particle size, specifically D50 and D84 (particle size at the 50th and 84th percentile of its size distribution, respectively), are needed to calculate critical shear stress and bed roughness.

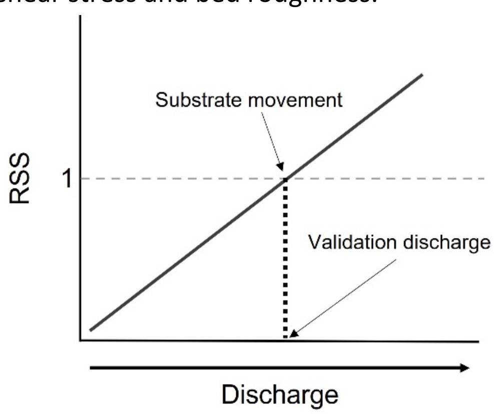

Fig 1. Identification of the discharge at which substrates begin to move (RSS >1).

We will divide the pool-wide mussel data into three quantiles with sites categorized into low, moderate, and high-density (strata). Ten sites in each stratum will be randomly selected and particle size will be estimated using two methods. These methods span a gradient from relatively easy to obtain but of unknown accuracy to more labor intensive and expensive to obtain but more accurate. *Method 1 (sieve analysis)* is the direct assessment of particle size from a substrate sample. Triplicate samples of the top ~10 cm of substrate from each site will be taken with an Ekman dredge, placed in plastic bags, and kept cool until processed. After homogenization, a 200 ± 25 g. subsample will be removed, weighed, and processed for particle size distribution according to Plumb (1981). This method is the 'gold standard' for estimating particle size but is labor intensive and costly. *Method 2 (interpolation)* is the indirect assessment of D50 and D84 from interpolation of visual substrate categories (i.e., 80% sand, 20% silt, made by divers in the mussel survey). Although this method is substantially less refined than method 1, Statzner et al. (1988) recommended use of visual estimates of substrate particle size as an efficient approach. Further, variables such as shear stress are relatively insensitive to changes in roughness for particle sizes of substrate types typically found in the UMR, which are largely sand and silt (Steuer et al. 2008). We will quantify residual differences between methods 1 and 2 to assess the effectiveness of method 2 to quantify particle size.

Estimation of RSS across a discharge gradient between Q5 and Q95 will allow us to identify the threshold discharge at which substrate movement occurs (i.e., RSS >1, Fig 1). An acoustic doppler current profiler (ADCP) will be used to validate if substate movement is indeed occurring based on modeled RSS. Data will be obtained for ~5 min from a stationary boat for five randomly selected sites per stratum. Data from the ADCP will include depth-specific vectors of current velocity, and a measure of the apparent bedload velocity (hereafter, substrate movement, Jamieson et al. 2011). Direct measures of substrate movement (or lack thereof) will enable us to validate predictions of RSS which are needed given the inherent uncertainties associated with estimating critical shear stress (Lorang and Hauer 2003). This approach will also provide an independent measure of the modeled parameters used to compute RSS and allow us to assess how well existing hydrologic models represent hydraulic conditions at ecologically relevant scales.

Three methods will be used to evaluate the effect of RSS on mussel density, richness, and species associations. We will compare stratum-specific mean discharges when RSS > 1 between density and richness strata using ANOVA. To evaluate the effects of temporary and sustained substrate movement on mussel density and richness, we will use stream gauge records in Pool 8 to estimate the number of days each site experienced discharges greater than the threshold where RSS > 1 over the past 9 y (the median age of mussels in Pool 8). Sustained substrate movement will be defined as sites where RSS > 1 more than 50% of total days (> 1643 days), versus temporary sites where the number of days RSS > 1 is below 50% of total days (< 1643 days). To identify the effect of sustained or temporary substrate movement on mussel density and richness, we will use generalized linear mixed effect models to regress density and richness against the number of days a site had an RSS > 1 (Damanik-Ambarita et al. 2016). To compare the effects of particle size, temporary extremes in discharge, and sustained substrate movement on species associations, we will use non-metric multidimensional scaling (Clarke and Warwick 2001). Combining the results from these three analyses we will be able to identify geographic locations which may act as refugia during extremes in discharge and identify potential 'at risk' species to changes in discharge.

Data management procedures

All data generated in this study will be recorded in bound laboratory notebooks, electronic files, or kept in file folders on UMESC servers that are routinely backed up. An electronic study file will be created on the UMESC server in consultation with IT and data management personnel. Data will be proofed against original data for accuracy. Data analyses will be conducted by individual investigators and compiled into synthetic reports, with input from all investigators. Upon project completion, raw data, field notebooks, and electronic files will be stored in the UMESC archives. A Federal Geographic Data Committee compliant metadata file will be created as part of the online USGS documentation process for information products. Data and metadata will be approved for release following the USGS Fundamental Sciences Practices and released to the public in USGS ScienceBase.

Special needs/considerations, if any: none

Timeline

- FY24: conduct quantile analysis to categorize sites into low, moderate, and high density, assemble abiotic data on bathymetry and current velocity, build database template to calculate substrate stability, conduct field work
- FY25: estimate particle size, complete data analysis for abiotic variables, begin building ecological models
- FY26: finish ecological models, data synthesis, and draft completion report

Expected milestones and products:

Products will include annual progress summaries (Dec 2024, Dec 2025), a draft completion report (Dec 2026), presentations at scientific and management forums, and at least one manuscript in the peer reviewed literature. The draft completion report will contain (1) data on which method(s) to estimate substrate stability could best support habitat models of UMR benthos; and (2) models to quantify resilience to temporary and sustained changes in substrate stability (abiotic predictor) that influence density, richness, and species associations (biotic responses).

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Estimated Budgets

Proposal title	PIs	USGS	USACE	States	CESU	Total Estimated Budget
Scoping and vetting new technology and methods for use in future hydrographic and topographic surveys: Strategies and recommendations for updating lidar, bathymetry, and detecting geomorphic change	John Kalas (WDNR); Jayme Strange (USGS)	$292,390		$111,562		$403,952
Avian associations with management in the UMRS: filing knowledge gaps for habitat management	Tara Hohman (Audubon); Eileen Kirsch (USGS)	$53,325	$17,200		$318,251	$388,776
Filling in the gaps with FLAMe: Spatial patterns in water quality and cyanobacteria across connectivity gradients and flow regimes in the Upper Mississippi River	L. Loken, R. Kreiling, and K. Janowksi (USGS); E. Stanely (UW-Madison)	$482,217				$482,217
Substrate stability as an indicator of abiotic habitat for the UMR benthic community	Teresa Newton and Angus Vaughan (USGS)	$351,852				$351,852

UMRR LTRM Information Needs

Selected for Further Development

Date of this version: 2023.05.08

Beginning in March 2022, a core team representing the UMRR LTRM Partnership has been meeting as part of an implementation planning process to prepare for a potential increase in funds made possible by the Water Resources Development Act of 2020. If additional funds are appropriated, this would present an opportunity to expand our understanding of the UMRS and better inform restoration and management.

The LTRM Implementation Planning Team (IPT) initially identified 29 information needs for evaluation using several optimization approaches. These 29 information needs were provided in the UMRR CC read ahead material for the October 2022 and March 2023 quarterly meetings. This document provides a brief description of each of the 11 information needs that have been tentatively selected for further development based on the optimization process developed by the IPT and described at the March 2023 UMRR CC quarterly meeting. At the May 2023 meeting, we will provide a description of how these 11 information needs were tentatively selected and the work currently underway to further develop these 11 information needs.

1.1 Floodplain Ecology: Vegetation Change Across the System

Information need: System-level vegetation change assessments. What is the spatial distribution of different plant species and communities? How have plant species distributions changed over time? What are the main drivers of plant species distribution and change over time? What are the drivers of forest loss across the system? What are the consequences of vegetation change for spatial patterns of forest fragmentation or other general landscape habitat features?

Geographic extent: Reach/UMRS scale. This may need to include some data from south of the UMRS floodplain as we could be seeing range expansion of southern species into the UMRS.

How the information will be used: Better assess and understand past and current plant species distributions and major drivers of vegetation change. Improve management and restoration by understanding mechanisms of vegetation change and preparing for emerging issues. Extend to specific HREPs by identifying hydrogeomorphic conditions for plant establishment and growth (e.g., elevation, soils, inundation).

Measurement or endpoint: 1) Collect (continue collecting) floodplain vegetation data, including forestry data, invasive species, (e.g., reed canary grass, Japanese hops), native herbaceous communities (sedge meadows), possibly explore the use of UAS for specific monitoring of areas. 2) Analyze vegetation data for change over space and time and associated drivers of change, 3) write reports/summaries and deliver maps of forest loss/vegetation change.

1.4 Floodplain ecology: terrestrial and aquatic herpetofauna

Information need: What is the abundance, distribution, and status of reptile and amphibian species within the Upper Mississippi River and Illinois Rivers? Better understand the spatial and temporal distribution of terrestrial and aquatic herpetofauna (i.e., reptiles and amphibians) that depend on the floodplain during different life cycle phases. What drives reptile and amphibian abundances and distribution throughout the UMRS and individual reaches? What, where, and how many non-native herpetofauna are present in the UMRS? Determine habitat use by focal communities through long-term monitoring. Develop habitat suitability models and map spatial prioritization of habitat throughout the UMRS.

Geographic extent: Reach/UMRS scale.

How the information will be used: Assessing ecosystem health by documenting herpetofauna abundance/use of the floodplain, improving management and restoration by identifying project futures that could improve habitat use, and preparing for emerging issues by identifying drivers of herpetofauna use and potential changes in them. Develop a management guide discussing results and management suggestions for reptiles and amphibians. Coupled with current forest inventory datasets and forest-flood interaction findings

Measurement or endpoint: Quantify the status of reptile and amphibian populations (abundance at LTRM study reach scale) and communities and identify relations with various other ecological attributes (e.g., habitat). Identify non-native species and potential/existing invasive status. Data on herpetofauna distribution and use of the floodplain and aquatic areas. A long-term component would establish a robust infrastructure for assessing trends and changes in reptile and amphibian abundances, distributions, and resilience (including species of concern) as well as infrastructure for targeted studies. Before-after-control-impact study design to determine community shifts across management strategies and habitats. Fine-scale reptile/amphibian suitability models. A comprehensive model of herpetofauna spatial prioritization as it pertains to the UMRS. Allow managers to relate habitat decisions to impacts on herpetofauna.

[Note that in selecting information need 1.4 for further development, the IPT considered that the information need regarding birds and bats on the floodplain could be combined with information need 1.4 as an "Upper trophic levels on the Floodplain" information need. The feasibility of doing so is currently being assessed. The original information need related to Birds and Bats on the floodplain is as follows:

1.3 Floodplain ecology: distribution of birds and bats

Information need: Better understand the spatial and temporal distribution of avian fauna (e.g., birds, bats) that depend on the floodplain during different life cycle phases. Determine habitat use by avian and bat communities through long-term monitoring. Develop habitat suitability models and map spatial prioritization of habitat throughout the UMRS.

Geographic extent: Reach/UMRS scale, and/or Reach between Pool 13 and Pool 26 is currently being sampled (Audubon), need for more data farther north.

How the information will be used: Assessing ecosystem health by documenting bird and bat abundance/use of the floodplain, improving management and restoration by identifying project futures that could improve habitat, and preparing for emerging issues by identifying drivers of bird and bat use and potential changes in them. Develop a management guide discussing results and management suggestions for birds and bats. Couple bird data with current forest inventory datasets and forest-flood interaction findings.

Measurement or endpoint: Data on bird and bat distribution and use of the floodplain. Before-after-control-impact study design to determine community shifts across management strategies and habitats. Fine-scale bird-habitat suitability models. Comprehensive model of faunal spatial prioritization as it pertains to the UMRS.]

2.1 Hydrogeomorphic change: Geomorphic trends

Information need: These information needs relate to predictive understanding of geomorphic trends within the rivers and their floodplains and include: 1. Where, how, and to what degree is the geomorphology of the river and floodplain changing and expected to change over planning horizons of decades to centuries? 2. How do these geomorphic changes relate to long-term changes in discharge and episodic weather events? 3. How are geomorphic changes affected by ongoing navigation channel operations, e.g., dredging and placement site operations, wing dikes, closing structures, revetments, etc.? 4. What are the implications for the future spatial and temporal distributions of habitat metrics such as water depth, inundation frequency/depth/duration, water residence time, and physical, biological, and chemical properties of the system? It will be addressed as empirical evaluations based on observed changes in bathymetric (elevation) data (as opposed to -processed-based evaluations in 2.2)

Geographic extent: Reach/UMRS scale. There is a system-wide need, but it may be approached operationally by nesting acquisition at a reach/pool level and scaling up to the system scale. Systemic assessment may be more easily justified for some kinds of data, for example, lidar data for which economies of scale can be achieved in a regular schedule of flights. Because of the time and cost investments required for bathymetric data collection at scales applicable to a range of project needs, bathymetric data may be amenable to targeted, sequential collections. An example might be the prioritization of backwater sedimentation rate monitoring in select areas.

How the information will be used: Understanding geomorphic change, and how it is integrated with future hydrology, is fundamental to assessing ecosystem health and resilience. Understanding the spatial and temporal distributions of geomorphic change will provide essential context for restoration planning and management decisions. Because the geomorphic template of the UMRS will provide fundamental insight into system trajectory, it is likely to be applicable when identifying emerging issues.

Measurement or endpoints: 1. Topo-bathymetric data collected to evaluate geomorphic change are also the foundation for hydrodynamic modeling; hence, a basic endpoint is multiple updates of gridded topo-bathymetric digital elevation models (DEMs) at appropriate resolutions; 2. Raster-based datasets of differences of topo-bathymetric DEMs collected over multiple periods to calculate rates, magnitudes, and locations of recent change; 3. Evaluations of expected rates, magnitudes, and locations of future change based on trends evident in repeated topo-bathymetric DEMs; 4. Statistical models relating geomorphic change and rates of change to covariates including emergent and submergent vegetation communities, factors in contributing watershed areas, channel geometry variables, channel-training structures, restoration projects, and distance to dams.

3.1 Aquatic ecology: Aquatic plant distribution

Information need: What are the factors which limit aquatic plant distribution and (re)establishment throughout the system, especially the unsampled portions of the lower impounded reach (P14-25). Is it individual factors e.g., lack of backwater or shallow areas or a combination of several physical/chemical (natural and/or anthropogenic) factors? What, if any, inputs from the tributaries in this reach contribute to the lack of aquatic plants? How does the hydrologic regime affect aquatic plant community dynamics? What are the implications of shifting seasonality and magnitude of hydrologic extremes? How do invasive species (of aquatic plants or other groups) impact native plant distribution?

Geographic extent: Reach/UMRS scale.

How the information will be used: Assessing status and trends, assessing ecosystem health and resilience. Improving management and restoration.

Measurement or endpoint: same endpoints as in LTRM aquatic vegetation sampling protocol (Yin et al. 2000; plant abundance, plant density, species composition, diversity metrics) and LTRM's water quality protocol (Soballe and Fischer 2004; at least 10 water quality parameters), aquatic plant presence/absence through time, and associated [bathymetry, water level fluctuation] herbivory, turbidity, flocculent sediment, flow, (flow refuge), water level fluctuations, other drivers (association with invasive species), herbicide concentrations, turbidity, flow, sediment composition) above and below tributary confluences.

3.3 Aquatic ecology: mussel distribution

Information need: What are the status and trends of mussel species within the Upper Mississippi River and Illinois Rivers? What, where, and how many non-native mussel species are present within the UMRS?

Geographic extent: Reach/UMRS scale

How the information will be used: Assessing ecosystem health and resilience. Improving management and restoration.

Measurement or endpoint: quantify the status and trends of mussel populations and communities and identify relations with various other ecological attributes (e.g., habitat, water level). Additional metrics (recruitment, survival, growth, diversity) may be needed.

3.7 Aquatic ecology: macroinvertebrate contribution.

Information need: What is the status (composition, abundance, and distribution) of native and non-native macroinvertebrates in the UMRS? What is the contribution and response of macroinvertebrates to ecosystem health and resilience? How will aquatic macroinvertebrates, and the ecosystem services they provide (biofiltration, nutrient cycling, fish forage) be affected by climate-induced changes and future river modifications?

Geographic extent: Reach/UMRS scale. Note: Species composition, structure, and tolerance levels will change across reaches

How the information will be used: Assessing ecosystem health and resilience.

Measurement or endpoint: community-level macroinvertebrate data on large (LTRM-inclusive and outpool reaches of UMRS) spatial and temporal scales capturing soft-substrate communities using benthic ponar and EPT communities using rock bag/plate samplers); trends and changes in macroinvertebrate abundances, distributions, and resilience. Shifts in community composition, abundance, and MBI tolerance values can reflect habitat and reach-wide resilience. Long-term component establishes robust infrastructure for targeted studies (e.g., contaminants, adult emergence, genetics, and microplastics).

3.9 Aquatic ecology: lower trophic contribution

Information need: What are the abundance, distribution, and status of lower trophic organisms (zooplankton and phytoplankton)? What is the lower trophic base contribution and response to ecosystem health and resilience? What, where, and how many non-native plankton are present in the UMRS?

Geographic extent: Reach/UMRS scale. Use existing phytoplankton samples from field stations. And consider specific outpool samples in the future that may have connections to other LT monitoring efforts (e.g., LTEF) or expansion of LTRM. Zooplankton and other lower trophic (e.g., microbes) investigations would require additional sample collection.

How the information will be used: Assessing ecosystem health and resilience.

Measurement or endpoint: Establish baseline abundance, community composition, and spatiotemporal change for lower trophic base and investigate relationships with environmental conditions. Identify non-native species and potential for or existing invasive status.

3.12 Aquatic ecology: river gradients

Information need: Understand status of fish, veg, (including invasive species present in monitoring) and water quality in the stretch of river between Pools 13 and 26.

Geographic extent: Reach/UMR scale

How the information will be used: Assessing ecosystem health and resilience.

Improving management and restoration by expanding understanding.

Measurement or endpoint: LTRM base monitoring data structure and/or other monitoring sources (e.g., FLAMe sensor or satellite data) across similar spatial scales and strata designations. The goal would be to expand LTRM data collection to the understudied reach though with likely less temporal intensity.

4.1 Restoration Applications: habitat conditions

Information need: What are the conditions needed to support species, guilds, and communities that are prioritized for conservation?

For example: What are the critical variables (e.g., substrate stability, velocity, host fish presence/absence, dissolved oxygen, temperature, food availability) driving the distribution and abundance of mussel species? What are the seasonal movement patterns, home ranges, and population bottlenecks of native and non-native fishes? Do fish in the river stay in the river consistently, or do they use tributary habitat during different seasons or life stages?

Geographic extent: Reach/UMRS scale (but products should be useable at project scale)

How the information will be used: Improving management and restoration

Measurement or endpoint: The endpoint of this information need is an improved understanding of the habitat conditions that support the life history needs of priority species (state and federal T&E; state species in greatest need of conservation; USFWS Trust species; national wildlife refuge priority resources of concern). This is a broad need and a working group would ideally be formed to determine which guild(s) and/or community(ies) to be the initial focus of targeted sampling and habitat assessments. Examples include lotic mussels, migratory fish such as blue sucker, paddlefish, and sturgeon, herps, etc. Methods will be taxa-dependent; for example, pit tags and pit tag readers could provide locational information on fish at different times of the year and different life stages.

4.3 Restoration Applications: floodplain vegetation change at HREP scales

Information need: Project-level monitoring to adaptively manage sites and improve forest simulation model parameters (see 1.2). What are the rates of mortality by age of different plant species in relation to built project features (e.g., soil types, elevations, inundation periods)? What are the establishment rates of unplanted species? How do invasives respond to built features?

Geographic extent: Local scale

How the information will be used: Adaptively manage HREP site conditions and plant assemblages as needed. Improve model parameters for future model applications.

Measurement or endpoint: Targeted floodplain vegetation measurements at HREP and other small-scale management sites pre- and post-project across a range of site conditions, HREP feature designs, and floodplain vegetation species and ages. Improved model parameters (reduce uncertainty), improved site conditions for HREPs and better project alternatives selected by improved modelling. Information, lessons learned transferred to other HREPs.

4.5 Restoration Applications: hypothesis testing

Information need: Capacity to use HREPs as opportunities to reduce uncertainties through research designed to test specific hypotheses. One approach is to ask which questions identified in the Research Frameworks can be addressed through intentional study of HREPs. Specific examples include understanding mussel velocity/substrate/shear stress requirements and validating wind fetch/wave models in Pool 13

Geographic extent: Reach/UMRS scale (project-level learning with systemic applications)

How the information will be used: Improving management and restoration

Measurement or endpoint: Improved understanding of assumptions regarding how HREP features/design influence physical and ecological processes. Ideally, a working group would be formed to identify the hypothesis to be tested and design research.

ATTACHMENT E

Additional Items

- **Future Meeting Schedule** *(E-1)*
- **Frequently Used Acronyms (4-29-2022)** *(E-2 to E-8)*
- **UMRR Authorization and Operating Approach (December 2022)**
    - **UMRR Authorization (amended 12/23/2022)** *(E-9 to E-12)*
    - **UMRR (EMP) Operating Approach (5/2006)** *(E-13)*

QUARTERLY MEETINGS
FUTURE MEETING SCHEDULE

AUGUST 2023	
La Crosse, WI	
August 8	UMRBA Quarterly Meeting
August 9	UMRR Coordinating Committee Quarterly Meeting

OCTOBER 2023	
St. Louis, MO	
October 24	UMRBA Quarterly Meeting
October 25	UMRR Coordinating Committee Quarterly Meeting

Acronyms Frequently Used on the Upper Mississippi River System

AAR	After Action Report
A&E	Architecture and Engineering
ACRCC	Asian Carp Regional Coordinating Committee
AFB	Alternative Formulation Briefing
AHAG	Aquatic Habitat Appraisal Guide
AHRI	American Heritage Rivers Initiative
AIS	Aquatic Invasive Species
ALC	American Lands Conservancy
ALDU	Aquatic Life Designated Use(s)
AM	Adaptive Management
ANS	Aquatic Nuisance Species
AP	Advisory Panel
APE	Additional Program Element
ARRA	American Recovery and Reinvestment Act
ASA(CW)	Assistant Secretary of the Army for Civil Works
A-Team	Analysis Team
ATR	Agency Technical Review
AWI	America's Watershed Initiative
AWO	American Waterways Operators
AWQMN	Ambient Water Quality Monitoring Network
BA	Biological Assessment
BATIC	Build America Transportation Investment Center
BCOES	Bid-ability, Constructability, Operability, Environmental, Sustainability
BCR	Benefit-Cost Ratio
BMPs	Best Management Practices
BO	Biological Opinion
CAP	Continuing Authorities Program
CAWS	Chicago Area Waterways System
CCC	Commodity Credit Corporation
CCP	Comprehensive Conservation Plan
CEICA	Cost Effectiveness Incremental Cost Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
CG	Construction General
CIA	Computerized Inventory and Analysis
CMMP	Channel Maintenance Management Plan
COE	Corps of Engineers
COPT	Captain of the Port
CPUE	Catch Per Unit Effort
CRA	Continuing Resolution Authority
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program

CSP	Conservation Security Program
CUA	Cooperative Use Agreement
CWA	Clean Water Act
CY	Cubic Yards
DALS	Department of Agriculture and Land Stewardship
DED	Department of Economic Development
DEM	Digital Elevation Model
DET	District Ecological Team
DEWS	Drought Early Warning System
DMMP	Dredged Material Management Plan
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DOA	Department of Agriculture
DOC	Department of Conservation
DOER	Dredging Operations and Environmental Research
DOT	Department of Transportation
DPR	Definite Project Report
DQC	District Quality Control/Quality Assurance
DSS	Decision Support System
EA	Environmental Assessment
ECC	Economics Coordinating Committee
EEC	Essential Ecosystem Characteristic
EIS	Environmental Impact Statement
EMAP	Environmental Monitoring and Assessment Program
EMAP-GRE	Environmental Monitoring and Assessment Program-Great Rivers Ecosystem
EMP	Environmental Management Program [Note: Former name of Upper Mississippi River Restoration Program.]
EMP-CC	Environmental Management Program Coordinating Committee
EO	Executive Order
EPA	Environmental Protection Agency
EPM	Environmental Pool Management
EPR	External Peer Review
EQIP	Environmental Quality Incentives Program
ER	Engineering Regulation
ERDC	Engineering Research & Development Center
ESA	Endangered Species Act
EWMN	Early Warning Monitoring Network
EWP	Emergency Watershed Protection Program
FACA	Federal Advisory Committee Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FDR	Flood Damage Reduction
FFS	Flow Frequency Study
FMG	Forest Management Geodatabase
FONSI	Finding of No Significant Impact
FRM	Flood Risk Management

FRST	Floodplain Restoration System Team
FSA	Farm Services Agency
FTE	Full Time Equivalent
FWCA	Fish & Wildlife Coordination Act
FWIC	Fish and Wildlife Interagency Committee
FWS	Fish and Wildlife Service
FWWG	Fish and Wildlife Work Group
FY	Fiscal Year
GAO	Government Accountability Office
GEIS	Generic Environmental Impact Statement
GI	General Investigations
GIS	Geographic Information System
GLC	Governors Liaison Committee
GLC	Great Lakes Commission
GLMRIS	Great Lakes and Mississippi River Interbasin Study
GPS	Global Positioning System
GREAT	Great River Environmental Action Team
GRP	Geographic Response Plan
H&H	Hydrology and Hydraulics
HAB	Harmful Algal Bloom
HEC-EFM	Hydrologic Engineering Center Ecosystems Function Model
HEC-RAS	Hydrologic Engineering Center River Analysis System
HEL	Highly Erodible Land
HEP	Habitat Evaluation Procedure
HNA	Habitat Needs Assessment
HPSF	HREP Planning and Sequencing Framework
HQUSACE	Headquarters, USACE
H.R.	House of Representatives
HREP	Habitat Rehabilitation and Enhancement Project
HSI	Habitat Suitability Index
HU	Habitat Unit
HUC	Hydrologic Unit Code
IBA	Important Bird Area
IBI	Index of Biological (Biotic) Integrity
IC	Incident Commander
ICS	Incident Command System
ICWP	Interstate Council on Water Policy
IDIQ	Indefinite Delivery/Indefinite Quantity
IEPR	Independent External Peer Review
IGE	Independent Government Estimate
IIA	Implementation Issues Assessment
IIFO	Illinois-Iowa Field Office (formerly RIFO - Rock Island Field Office)
ILP	Integrated License Process
IMTS	Inland Marine Transportation System
IPR	In-Progress Review
IRCC	Illinois River Coordinating Council

IRPT	Inland Rivers, Ports & Terminals
IRTC	Implementation Report to Congress
IRWG	Illinois River Work Group
ISA	Inland Sensitivity Atlas
IWR	Institute for Water Resources
IWRM	Integrated Water Resources Management
IWS	Integrated Water Science
IWTF	Inland Waterways Trust Fund
IWUB	Inland Waterways Users Board
IWW	Illinois Waterway
L&D	Lock(s) and Dam
LC/LU	Land Cover/Land Use
LDB	Left Descending Bank
LERRD	Lands, Easements, Rights-of-Way, Relocation of Utilities or Other Existing Structures, and Disposal Areas
LiDAR	Light Detection and Ranging
LMR	Lower Mississippi River
LMRCC	Lower Mississippi River Conservation Committee
LOI	Letter of Intent
LTRM	Long Term Resource Monitoring
M-35	Marine Highway 35
MAFC	Mid-America Freight Coalition
MARAD	U.S. Maritime Administration
MARC 2000	Midwest Area River Coalition 2000
MCAT	Mussel Community Assessment Tool
MICRA	Mississippi Interstate Cooperative Resource Association
MDM	Major subordinate command Decision Milestone
MIPR	Military Interdepartmental Purchase Request
MMR	Middle Mississippi River
MMRP	Middle Mississippi River Partnership
MNRG	Midwest Natural Resources Group
MOA	Memorandum of Agreement
MoRAST	Missouri River Association of States and Tribes
MOU	Memorandum of Understanding
MRAPS	Missouri River Authorized Purposes Study
MRBI	Mississippi River Basin (Healthy Watersheds) Initiative
MRC	Mississippi River Commission
MRCC	Mississippi River Connections Collaborative
MRCTI	Mississippi River Cities and Towns Initiative
MRRC	Mississippi River Research Consortium
MR&T	Mississippi River and Tributaries (project)
MSP	Minimum Sustainable Program
MVD	Mississippi Valley Division
MVP	St. Paul District
MVR	Rock Island District
MVS	St. Louis District

NAS	National Academies of Science
NAWQA	National Water Quality Assessment
NCP	National Contingency Plan
NIDIS	National Integrated Drought Information System (NOAA)
NEBA	Net Environmental Benefit Analysis
NECC	Navigation Environmental Coordination Committee
NED	National Economic Development
NEPA	National Environmental Policy Act
NESP	Navigation and Ecosystem Sustainability Program
NETS	Navigation Economic Technologies Program
NGO	Non-Governmental Organization
NGRREC	National Great Rivers Research and Education Center
NGWOS	Next Generation Water Observing System
NICC	Navigation Interests Coordinating Committee
NPDES	National Pollution Discharge Elimination System
NPS	Non-Point Source
NPS	National Park Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRDAR	Natural Resources Damage Assessment and Restoration
NRT	National Response Team
NSIP	National Streamflow Information Program
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
O&M	Operation and Maintenance
OHWM	Ordinary High Water Mark
OMB	Office of Management and Budget
OMRR&R	Operation, Maintenance, Repair, Rehabilitation, and Replacement
OPA	Oil Pollution Act of 1990
ORSANCO	Ohio River Valley Water Sanitation Commission
OSC	On-Scene Coordinator
OSE	Other Social Effects
OSIT	On Site Inspection Team
P3	Public-Private Partnerships
PA	Programmatic Agreement
PAS	Planning Assistance to States
P&G	Principles and Guidelines
P&R	Principles and Requirements
P&S	Plans and Specifications
P&S	Principles and Standards
PCA	Pollution Control Agency
PCA	Project Cooperation Agreement
PCX	Planning Center of Expertise
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PgMP	Program Management Plan

PILT	Payments In Lieu of Taxes
PIR	Project Implementation Report
PL	Public Law
PMP	Project Management Plan
PORT	Public Outreach Team
PPA	Project Partnership Agreement
PPT	Program Planning Team
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RCP	Regional Contingency Plan
RCPP	Regional Conservation Partnership Program
RDB	Right Descending Bank
RED	Regional Economic Development
RIFO	Rock Island Field Office (now IIFO - Illinois-Iowa Field Office)
RM	River Mile
RP	Responsible Party
RPEDN	Regional Planning and Environment Division North
RPT	Reach Planning Team
RRAT	River Resources Action Team
RRCT	River Resources Coordinating Team
RRF	River Resources Forum
RRT	Regional Response Team
RST	Regional Support Team
RTC	Report to Congress
S.	Senate
SAV	Submersed Aquatic Vegetation
SDWA	Safe Drinking Water Act
SEMA	State Emergency Management Agency
SET	System Ecological Team
SMART	Specific, Measurable, Attainable, Risk Informed, Timely
SONS	Spill of National Significance
SOW	Scope of Work
SRF	State Revolving Fund
SWCD	Soil and Water Conservation District
T&E	Threatened and Endangered
TEUs	twenty-foot equivalent units
TIGER	Transportation Investment Generating Economic Recovery
TLP	Traditional License Process
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TSP	Tentatively selected plan
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
TWG	Technical Work Group
UMESC	Upper Midwest Environmental Sciences Center

UMIMRA	Upper Mississippi, Illinois, and Missouri Rivers Association
UMR	Upper Mississippi River
UMRBA	Upper Mississippi River Basin Association
UMRBC	Upper Mississippi River Basin Commission
UMRCC	Upper Mississippi River Conservation Committee
UMRCP	Upper Mississippi River Comprehensive Plan
UMR-IWW	Upper Mississippi River-Illinois Waterway
UMRNWFR	Upper Mississippi River National Wildlife and Fish Refuge
UMRR	Upper Mississippi River Restoration Program [Note: Formerly known as Environmental Management Program.]
UMRR CC	Upper Mississippi River Restoration Program Coordinating Committee
UMRS	Upper Mississippi River System
UMWA	Upper Mississippi Waterway Association
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VTC	Video Teleconference
WCI	Waterways Council, Inc.
WES	Waterways Experiment Station (replaced by ERDC)
WHAG	Wildlife Habitat Appraisal Guide
WHIP	Wildlife Habitat Incentives Program
WIIN	Water Infrastructure Improvements for the Nation Act
WLM	Water Level Management
WLMTF	Water Level Management Task Force
WQ	Water Quality
WQEC	Water Quality Executive Committee
WQTF	Water Quality Task Force
WQS	Water Quality Standard
WRDA	Water Resources Development Act
WRP	Wetlands Reserve Program
WRRDA	Water Resources Reform and Development Act

Upper Mississippi River Restoration Program Authorization

Section 1103 of the Water Resources Development Act of 1986 (P.L. 99-662) as amended by
Section 405 of the Water Resources Development Act of 1990 (P.L. 101-640),
Section 107 of the Water Resources Development Act of 1992 (P.L. 102-580),
Section 509 of the Water Resources Development Act of 1999 (P.L. 106-53),
Section 2 of the Water Resources Development Technical Corrections of 1999 (P.L. 106-109),
Section 3177 of the Water Resources Development Act of 2007 (P.L. 110-114),
Section 307 of the Water Resources Development Act of 2020 (P.L. 116-260), and
Section 8345 of the Water Resources Development Act of 2022 (P.L. 117-263).

Additional Cost Sharing Provisions

Section 906(e) of the Water Resources Development Act of 1986 (P.L. 99-662) as amended by
Section 221 of the Water Resources Development Act of 1999 (P.L. 106-53).

SEC. 1103. UPPER MISSISSIPPI RIVER PLAN.

(a)(1) This section may be cited as the "Upper Mississippi River Management Act of 1986".

(2) To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system. Congress further recognizes that the system provides a diversity of opportunities and experiences. The system shall be administered and regulated in recognition of its several purposes.

(b) For purposes of this section --

(1) the terms "Upper Mississippi River system" and "system" mean those river reaches having commercial navigation channels on the Mississippi River main stem north of Cairo, Illinois; the Minnesota River, Minnesota; Black River, Wisconsin; Saint Croix River, Minnesota and Wisconsin; Illinois River and Waterway, Illinois; and Kaskaskia River, Illinois;

(2) the term "Master Plan" means the comprehensive master plan for the management of the Upper Mississippi River system, dated January 1, 1982, prepared by the Upper Mississippi River Basin Commission and submitted to Congress pursuant to Public Law 95-502;

(3) the term "GREAT I, GREAT II, and GRRM studies" means the studies entitled "GREAT Environmental Action Team--GREAT I--A Study of the Upper Mississippi River", dated September 1980, "GREAT River Environmental Action Team--GREAT II--A Study of the Upper Mississippi River", dated December 1980, and "GREAT River Resource Management Study", dated September 1982; and

(4) the term "Upper Mississippi River Basin Association" means an association of the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, formed for the purposes of cooperative effort and united assistance in the comprehensive planning for the use, protection, growth, and development of the Upper Mississippi River System.

(c)(1) Congress hereby approves the Master Plan as a guide for future water policy on the Upper Mississippi River system. Such approval shall not constitute authorization of any recommendation contained in the Master Plan.

(2) Section 101 of Public Law 95-502 is amended by striking out the last two sentences of subsection (b), striking out subsection (i), striking out the final sentence of subsection (j), and redesignating subsection "(j)" as subsection "(i)".

(d)(1) The consent of the Congress is hereby given to the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, or any two or more of such States, to enter into negotiations for agreements, not in conflict with any law of the United States, for cooperative effort and mutual assistance in the comprehensive planning for the use, protection, growth, and development of the Upper Mississippi River system, and to establish such agencies, joint or otherwise, or designate an existing multi-State entity, as they may deem desirable for making effective such agreements. To the extent required by Article I, section 10 of the Constitution, such agreements shall become final only after ratification by an Act of Congress.

(2) The Secretary is authorized to enter into cooperative agreements with the Upper Mississippi River Basin Association or any other agency established under paragraph (1) of this subsection to promote and facilitate active State government participation in the river system management, development, and protection.

(3) For the purpose of ensuring the coordinated planning and implementation of programs authorized in subsections (e) and (h)(2) of this section, the Secretary shall enter into an interagency agreement with the Secretary of the Interior to provide for the direct participation of, and transfer of funds to, the Fish and Wildlife Service and any other agency or bureau of the Department of the Interior for the planning, design, implementation, and evaluation of such programs.

(4) The Upper Mississippi River Basin Association or any other agency established under paragraph (1) of this subsection is hereby designated by Congress as the caretaker of the master plan. Any changes to the master plan recommended by the Secretary shall be submitted to such association or agency for review. Such association or agency may make such comments with respect to such recommendations and offer other recommended changes to the master plan as such association or agency deems appropriate and shall transmit such comments and other recommended changes to the Secretary. The Secretary shall transmit such recommendations along with the comments and other recommended changes of such association or agency to the Congress for approval within 90 days of the receipt of such comments or recommended changes.

(e) Program Authority

(1) Authority

(A) In general. The Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may undertake, as identified in the master plan

(i) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement; and

(ii) implementation of a long-term resource monitoring, computerized data inventory and analysis, and applied research program, including research on water quality issues affecting the Mississippi River (including elevated nutrient levels) and the development of remediation strategies.

(B) Advisory committee. In carrying out subparagraph (A)(i), the Secretary shall establish an independent technical advisory committee to review projects, monitoring plans, and habitat and natural resource needs assessments.

(2) REPORTS. — Not later than December 31, 2004, and not later than December 31 of every sixth year thereafter, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall submit to Congress a report that —

(A) contains an evaluation of the programs described in paragraph (1);

(B) describes the accomplishments of each of the programs;

(C) provides updates of a systemic habitat needs assessment; and

(D) identifies any needed adjustments in the authorization of the programs.

(3) For purposes of carrying out paragraph (1)(A)(i) of this subsection, there is authorized to be appropriated to the Secretary $75,000,000 for fiscal year 1999 and each fiscal year thereafter.

(4) For purposes of carrying out paragraph (1)(A)(ii) of this subsection, there is authorized to be appropriated to the Secretary $15,000,000 for fiscal year 1999 and each fiscal year thereafter.

(5) Authorization of appropriations.—There is authorized to be appropriated to carry out paragraph (1)(B) $350,000 for each of fiscal years 1999 through 2009.

(6) Transfer of amounts.—For fiscal year 1999 and each fiscal year thereafter, the Secretary, in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, may transfer not to exceed 20 percent of the amounts appropriated to carry out clause (i) or (ii) of paragraph (1)(A) to the amounts appropriated to carry out the other of those clauses.

(7)(A) Notwithstanding the provisions of subsection (a)(2) of this section, the costs of each project carried out pursuant to paragraph (1)(A)(i) of this subsection shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with the provisions of section 906(e) of this Act; except that the costs of operation and maintenance of projects located on Federal lands or lands owned or operated by a State or local government shall be borne by the Federal, State, or local agency that is responsible for management activities for fish and wildlife on such lands and, in the case of any project requiring non-Federal cost sharing, the non-Federal share of the cost of the project shall be 35 percent.

(B) Notwithstanding the provisions of subsection (a)(2) of this section, the cost of implementing the activities authorized by paragraph (1)(A)(ii) of this subsection shall be allocated in accordance with the provisions of section 906 of this Act, as if such activity was required to mitigate losses to fish and wildlife.

(8) None of the funds appropriated pursuant to any authorization contained in this subsection shall be considered to be chargeable to navigation.

(f) (1) The Secretary, in consultation with any agency established under subsection (d)(1) of this section, is authorized to implement a program of recreational projects for the system substantially in accordance with the recommendations of the GREAT I, GREAT II, and GRRM studies and the master plan reports. In addition, the Secretary, in consultation with any such agency, shall, at Federal expense, conduct an assessment of the economic benefits generated by recreational activities in the system. The cost of each such project shall be allocated between the Secretary and the appropriate non-Federal sponsor in accordance with title I of this Act.

(2) For purposes of carrying out the program of recreational projects authorized in paragraph (1) of this subsection, there is authorized to be appropriated to the Secretary not to exceed $500,000 per fiscal year for each of the first 15 fiscal years beginning after the effective date of this section.

(g) The Secretary shall, in his budget request, identify those measures developed by the Secretary, in consultation with the Secretary of Transportation and any agency established under subsection (d)(1) of this section, to be undertaken to increase the capacity of specific locks throughout the system by employing nonstructural measures and making minor structural improvements.

(h)(1) The Secretary, in consultation with any agency established under subsection (d)(1) of this section, shall monitor traffic movements on the system for the purpose of verifying lock capacity, updating traffic projections, and refining the economic evaluation so as to verify the need for future capacity expansion of the system.

(2) Determination.

- (A) In general. The Secretary in consultation with the Secretary of the Interior and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, shall determine the need for river rehabilitation and environmental enhancement and protection based on the condition of the environment, project developments, and projected environmental impacts from implementing any proposals resulting from recommendations made under subsection (g) and paragraph (1) of this subsection.
- (B) Requirements. The Secretary shall
  - (i) complete the ongoing habitat needs assessment conducted under this paragraph not later than September 30, 2000; and
  - (ii) include in each report under subsection (e)(2) the most recent habitat needs assessment conducted under this paragraph.

(3) There is authorized to be appropriated to the Secretary such sums as may be necessary to carry out this subsection.

(i) (1) The Secretary shall, as he determines feasible, dispose of dredged material from the system pursuant to the recommendations of the GREAT I, GREAT II, and GRRM studies.

(2) The Secretary shall establish and request appropriate Federal funding for a program to facilitate productive uses of dredged material. The Secretary shall work with the States which have, within their boundaries, any part of the system to identify potential users of dredged material.

(j) The Secretary is authorized to provide for the engineering, design, and construction of a second lock at locks and dam 26, Mississippi River, Alton, Illinois and Missouri, at a total cost of $220,000,000, with a first Federal cost of $220,000,000. Such second lock shall be constructed at or in the vicinity of the location of the replacement lock authorized by section 102 of Public Law 95-502. Section 102 of this Act shall apply to the project authorized by this subsection.

SEC. 906(e). COST SHARING.

(e) In those cases when the Secretary, as part of any report to Congress, recommends activities to enhance fish and wildlife resources, the first costs of such enhancement shall be a Federal cost when--

(1) such enhancement provides benefits that are determined to be national, including benefits to species that are identified by the National Marine Fisheries Service as of national economic importance, species that are subject to treaties or international convention to which the United States is a party, and anadromous fish;

(2) such enhancement is designed to benefit species that have been listed as threatened or endangered by the Secretary of the Interior under the terms of the Endangered Species Act, as amended (16 U.S.C. 1531, et seq.), or

(3) such activities are located on lands managed as a national wildlife refuge.

When benefits of enhancement do not qualify under the preceding sentence, 25 percent of such first costs of enhancement shall be provided by non-Federal interests under a schedule of reimbursement determined by the Secretary. Not more than 80 percent of the non-Federal share of such first costs may be satisfied through in-kind contributions, including facilities, supplies, and services that are necessary to carry out the enhancement project. The non-Federal share of operation, maintenance, and rehabilitation of activities to enhance fish and wildlife resources shall be 25 percent.

EMP OPERATING APPROACH

2006 marks the 20th anniversary of the Environmental Management Program (EMP). During that time, the Program pioneered many new ideas to help deliver efficient and effective natural resource programs to the Upper Mississippi River System (UMRS). These included the creation of an effective partnership of five states, five federal agencies, and numerous NGOs; a network of six field stations monitoring the natural resources of the UMRS; and the administrative structure to encourage river managers to use both new and proven environmental restoration techniques.

EMP has a history of identifying and dealing with both natural resource and administrative challenges. The next several years represent new opportunities and challenges as Congress considers authorization of the Navigation and Environmental Sustainability Program (NESP), possible integration or merger of EMP with NESP, and changing standards for program management and execution.

We will continue to learn from both the history of EMP and experience of other programs. Charting a course for EMP over the next several years is important to the continued success of the Program. EMP will focus on the key elements of partnership, regional administration and coordination, LTRMP, and HREPs.

The fundamental focus of EMP will not change, however the way we deliver our services must change and adapt. This will include:

- further refinements in regional coordination and management,
- refinement of program goals and objectives,
- increased public outreach efforts,
- development and use of tools such as the regional HREP database and HREP Handbook,
- exploring new delivery mechanisms for contracting,
- continued refinement of the interface between LTRMP and the HREP program components, and
- scientific and management application of LTRMP information and data.

The focus of these efforts must benefit the resources of the UMRS through efficient and effective management.