Sustainable Rivers Program

In Progress Review

FY 2023

US Army Corps of Engineers

The Nature Conservancy

2/21/2024

Prepared for U.S. Army Corps of Engineers, The Nature Conservancy, and other organizations involved with Sustainable Rivers

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Overview

The Sustainable Rivers Program (SRP) is a national partnership between the U.S. Army Corps of Engineers (USACE) and The Nature Conservancy (TNC). The mission of SRP is to improve the health and life of rivers by changing dam operations to restore and protect ecosystems, while maintaining or enhancing authorized uses and other project benefits.

SRP began in 1998 with an initial collaboration to improve the ecological condition of Green River, Kentucky. The SRP was formally established in 2002 and involved 8 river systems. At the end of fiscal year (FY) 2023, SRP worked in 23 USACE districts and 7 divisions. Individual projects affect more than 90 USACE reservoirs, 40 rivers, and 12,000 river miles (RMs) (Figure 1). This continuously growing program is the largest scale and most comprehensive program for implementing environmental flows (e-flows) below USACE reservoirs. Five new rivers joined the SRP in FY 2023: Bayou Courtableau and the Alabama, Arkansas, Tombigbee, and Minnesota rivers.

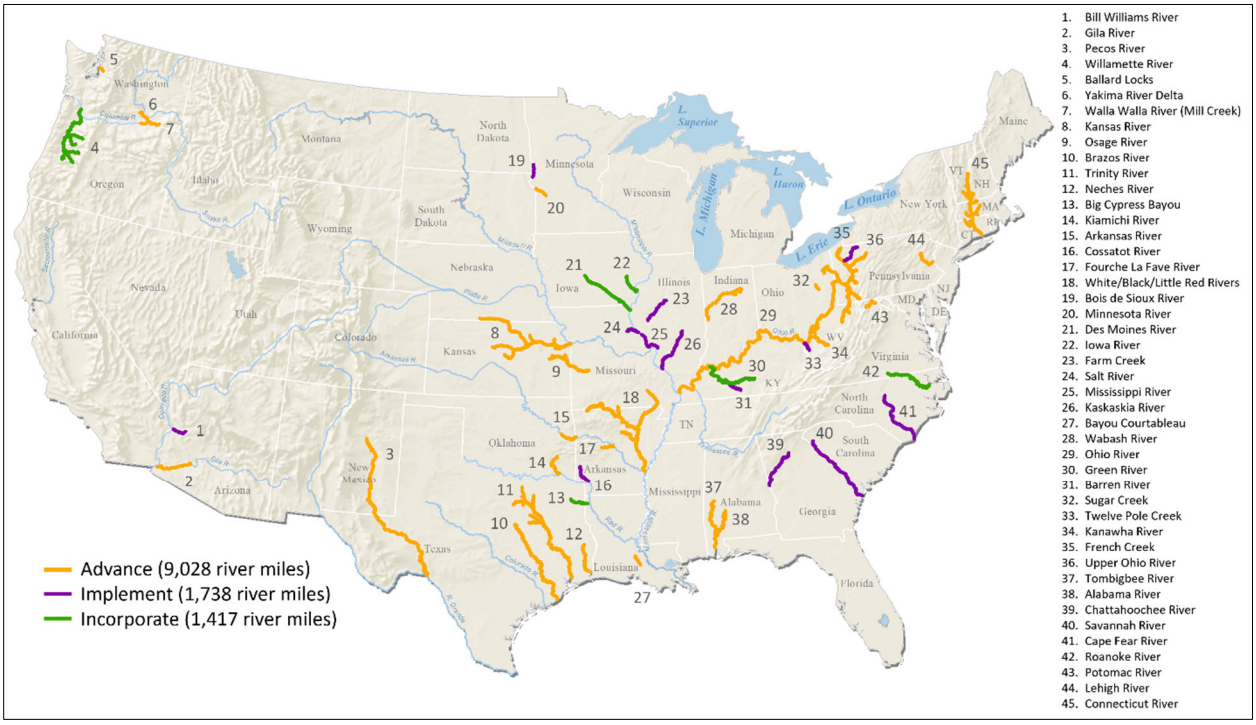

Figure 1. Status of rivers engaged in the Sustainable Rivers Program at end of FY 2023.

E-flows are defined as the quantity, timing, and quality of water flows required to sustain ecosystems. For reservoir operators, e-flows manifest as management decisions manipulating water and land-water interactions to achieve ecological or environmental goals.

The SRP multi-step process for e-flows has three key phases: advance, implement, and incorporate (Figure 2). Advancing e-flows involves engaging stakeholders in a science-based process to define the flow needs of riverine ecosystems. Implementation involves testing the effectiveness and feasibility of the defined flows. Incorporation involves including e-flow strategies in reservoir operations policy, such as water control manuals (WCMs). Searching for e-flow opportunities at general multiple purpose reservoirs with storage space for flood risk management and other conservation purposes was the founding objective of SRP and remains the key focus. In recent years, the SRP began exploring other

reservoir-oriented actions with potential to produce environmental benefits. SRP initiatives have expanded to explore opportunities for pool level management and related environmental improvement strategies at lock and dam projects, and for actions to modify the land/water interface at dry dam projects to provide environmental benefits.

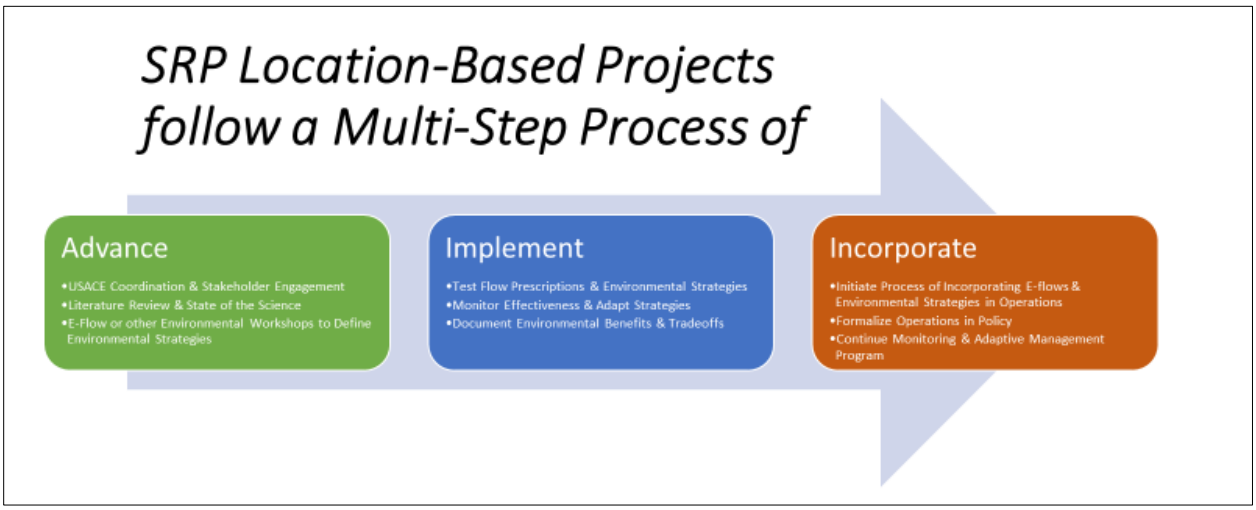

Figure 2. Sustainable Rivers Program location-based process.

As in previous years, SRP funds will be used to accomplish a combination of programmatic and location-based work in accordance with the following principles: 1) build capacity within the water management community to implement environmental strategies with little or no direct funding from SRP; 2) engage partners to focus on sustainability and avoid conflict; and 3) advance innovative efforts to implement environmental strategies.

In broad terms, programmatic work focuses on how best to generate more environmental benefits from water resources infrastructure while location-based work focuses on advancing, implementing, and incorporating environmental strategies at specific facilities. The two are complementary with each generating new ideas, honing SRP methods, and demonstrating the benefits of environmental actions. Individual pieces of programmatic and location-based work are characterized by the leads for those efforts per the task categories described in Figure 2 for organizational and communications purposes.

Ideas for programmatic work originate from and are shaped by several influences. Regional and national SRP meetings, other USACE programs, strategic directions of SRP's governmental and non-governmental partners, and especially interactions with and commonalities amongst location-based work teams are all important sources. Staff involved with SRP programmatic support refine and initiate ideas as SRP capacity allows.

This document details the status of SRP programmatic and location-based work and provides short backgrounds, FY 2023 progress, proposed FY 2024 work, and future visions of active SRP projects. In addition, the four projects are highlighted as a distinct category of SRP programmatic work: SRP-Science. Project updates were compiled based on discussions during meetings with district SRP teams in October and November 2023 and supporting information. The Deliverables and Milestones Spreadsheet (Appendix A) and SRP Tasks and Status Spreadsheet contain these project updates as well (Appendix A-SRP Yearly Report). Appendix B provides a summary of funding and expenditures for FY 2023. Other information and publications are available on the SRP Hydrologic Engineering Center (HEC) and TNC

websites at: https://www.hec.usace.army.mil/sustainablerivers/publications/ and https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/sustainable-rivers-project/, respectively.

SRP Highlights FY 2023

The SRP experienced exciting, rapid growth due to budget increases. Initially, the budget increased from $500 thousand to $5 million, then earned a spot as a part of the President's budget for $5 million in FY 2023, and ultimately received $7 million through Congressional appropriations. More funding allowed for changes at the program level and the ability of SRP to fund larger, multi-year location-based efforts. The SRP program added five new sites in FY 2023: Bayou Courtableau and the Alabama, Arkansas, Tombigbee, and Minnesota rivers. The location-based teams provide some of the most exciting aspects of the program each year and FY 2023 was no exception. Many teams executed e-flow and stakeholder workshops that help identify environmental actions, which drive SRP growth.

Five SRP location-based sites transitioned to the Implementation Phase of their e-flows programs: the Bois de Sioux, Chattahoochee, Cossatot, Kaskaskia, and Salt rivers. One of the largest success stories in FY 2023 occurred in Wilmington District (SAW) with multiple test pulses from B. Everett Jordan Lake on the Cape Fear River allowing fish passage over the three downstream locks and dams. This was an improvement from FY 2022 where test pulses allowed fish to migrate over only two of the three dams. Figure 3 visualizes broad efforts for FY 2023. Other sections of this report detail accomplishments.

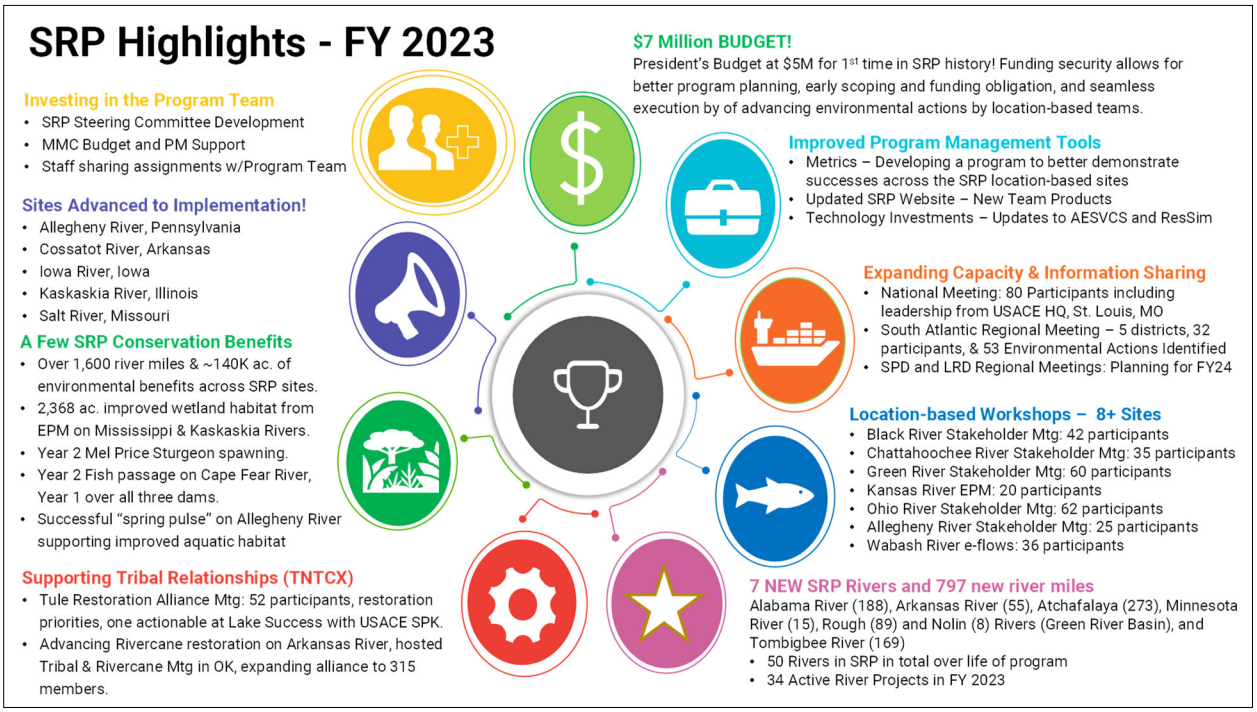

Figure 3. Sustainable River Program highlights in FY 2023.

Recently, the SRP funded USACE Tribal Nations Technical Center of Expertise (TNTCX) on two efforts on cultural keystone species to support tribal relationships – tule and rivercane. SRP projects with TNTCX include formation of alliances for rivercane and tule, identifying restoration opportunities for both species, and moving restoration ideas forward by establishing new partnerships via a Cooperative

Ecosystem Studies Unit (CESU) effort for rivercane and with Sacramento District (SPK) for tule. The Rivercane Restoration Alliance grew to 315 members, an increase of about 25 people from the previous year. TNTCX signed the cooperative agreement with the University of Alabama-Alabama Water Institute to assist with the planned rivercane restoration project on the Arkansas River at Robert S. Kerr Dam. This includes an important genetic study that will inform the rivercane restoration options. Regarding tule, TNTCX formed a collaboration with SPK on exploring restoration opportunities at the Richard L. Schafer Dam (Lake Success) near Porterville, California. This project site is located close to the Tule River Indian Tribe of California Reservation and tule is an important plant to the Tule River Indian Tribe and many other Tribes located throughout California.

The SRP team planned and held a national informational meeting, updated the website with new products, hosted the South Atlantic Regional Meeting, and developed metrics to better document successes of environmental actions funded by SRP. The SRP team continues to collaborate with USACE Headquarters (HQ), Institute of Water Resources (IWR) leadership, and the public on program specifics. As part of this collaboration, a new SRP Steering Committee was created along with a Steering Committee Charter and SRP Governance Plan. In addition, information sharing with the USACE Operations Division and the Engineer Research and Development Center (ERDC) has increased to ensure that funds are leveraged across USACE centers to maximize environmental benefits and research and development opportunities. SRP engaged USACE's Mapping, Modeling, and Consequences (MMC) program management team to track progress and finances at SRP location-based sites and streamline proposal submissions by USACE districts during the request for proposals (RFPs) process.

The national meeting was held in May 2023. Meeting objectives were:

- Review SRP's accomplishments and formulate a framework for the next 20 years.
- Share location-based site successes, explore new ways to document impacts and account for accomplishments, and explore new ways to heighten execution and achieve tangible results.
- Explore other USACE tools and programs that may improve the effectiveness and efficiency of SRP location-based sites considering increased funding.
- Review SRP location-based projects in different phases of the multi-step process and visit one in the Implementation Phase.
- Discuss how to improve efficiency of reaching the Incorporate phase.
- Highlight partner contributions, strengthen relationships, build new ones, and increase collaboration across the enterprise.

Action items from the national meeting fell in the following categories:

- Communication and collaboration: Update the SRP Communication Plan and host regular webinars among other things.
- Contracting: Provide templates and explore support by IWR Contracting Officer Representatives among other ideas.
- Technology: Explore a web-based application for RFP, tools for easy document sharing across partners, an SRP calendar, partner with other USACE groups and tools, etc.
- Tribes and other stakeholders: Support collaboration through USACE centers and expertise.
- Monitoring and metrics: Finalize the draft metrics approach, distribute to and educate the SRP location-based teams on the metrics, and continue to test and hone metrics.

Several of these action items have been initiated, including establishing a web-based portal for the RFP application process and establishing a quarterly webinar for location-based teams to share information,

and refinement of a metrics framework for SRP (Figure 4) to better encourage communications, applicability, and accuracy across the SRP, including across sites and types of environmental actions supported (e-flows, Environmental Pool Management [EPM], and physical habitat improvement).

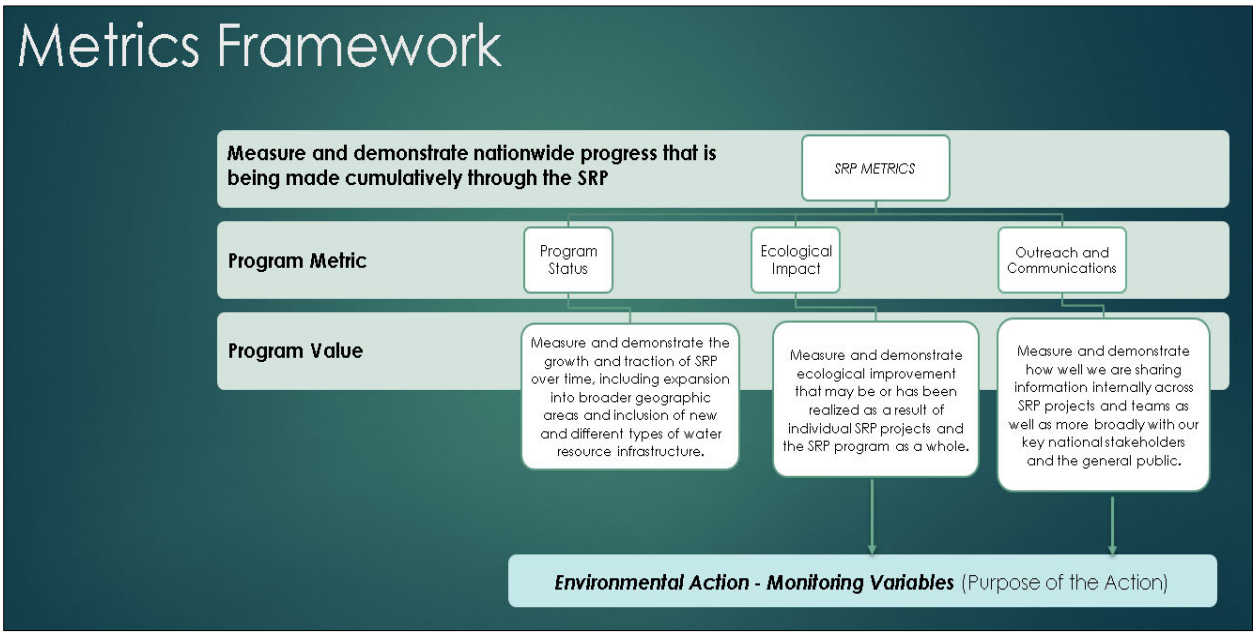

Figure 4. Metrics framework for the SRP.

Programmatic Work

Programmatic work in FY 2023 was comprised mainly of program support, technologies, and validation of environmental strategies.

Program Support

Program support includes administration of the program, partner engagement, capacity growth, and location-based efforts assistance (outreach, implementation, and innovation). Program support is key to understanding and communicating the portfolio of structures involved (distribution and relevant characteristics of structures) and the spectrum of possible environmental actions (enabling setting and other considerations). Programmatic work includes organizing regional Operations and Water Management meetings as well as the following type-specific activities (see pages 6 through 7 in the program management plan [PMP]). In FY 2023, SRP organized one regional meeting, the South Atlantic Regional Operations and Water Management Meeting, where five USACE districts worked to identify potential environmental opportunities. This regional meeting resulted in 53 actionable environmental ideas. In addition, a national meeting was held in St. Louis, Missouri, in May 2023 where 80 participants reflected on the history and future of SRP.

Technologies

Technologies includes investments in ecological and water resource software applied broadly within SRP as well as technical support for software applications led by location-based teams. Software enhancements benefit SRP modelers and others using the tools for ecological applications. Ongoing technologies efforts include ecological software development (formulation of ecosystem management

alternatives, ecological time series analyses, and spatial habitat mapping) and engineering software development (real-time water quality modeling).

Formulation of River Management Alternatives

Environmental strategies promoted by SRP generate environmental benefits by changing the operation of water resource infrastructure. The advance, implement, and incorporate process guides SRP work. As part of the advance phase, groups of scientists, engineers, water managers, operators, and stakeholders work together to formulate alternative ways to manage the infrastructure and associated aquatic systems.

Several types of software are used during alternative formulation, including the Regime Prescription Tool (HEC-RPT). HEC-RPT is a communications tool and contributes to the early stages of planning by formalizing ideas and expert knowledge into alternatives that are easily visualized and considered in more detailed modeling tools. Contributions of HEC-RPT to the formulation process include simple navigation and visualization of hydrologic data, tracking of hydrologic condition, electronic creation and shaping of alternatives, documentation of justifications and uncertainties associated with alternatives, simple comparisons of alternatives from different management perspectives, and assistance with integrating different perspectives into a single unified alternative.

HEC-RPT is used by SRP location-based teams during definition of e-flows and is a key facilitation software for e-flows workshops. Recent applications have generated development ideas for the software, including more user-control of ordering spatial locations and focal ecosystem aspects, added user-control of hydrologic time series display, custom displays of alternatives per location and hydrologic condition, allowing alternative formulation in terms of elevations and stages in addition to flows, and allowing alternative formulation in user-specified data types and units. These enhancements are being supported by SRP to improve program capabilities during alternative formulation. In 2023, developmental versions of HEC-RPT were used by the Wabash, Kansas, Neches, Brazos, and North Branch Potomac rivers' teams. A new version of HEC-RPT should be released to the public in 2024.

Ecological Time Series Analyses

Time series analyses are a fundamental part of technical support for a wide range of ecological and engineering projects. Time series analyses are used throughout the SRP process. During the advance phase, time series analyses are used to assess hydrological and ecological status and trends. During the implementation phase, time series analyses are used to explore alternatives that are not easily done and monitored in real-world operations. During the incorporation phase, time series analyses are used to measure the degree of adherence to operational alternatives and, ultimately, to reassess status and trends of new ecological trajectories.

SRP teams commonly use two types of software to perform time series analyses—Indicators of Hydrologic Alteration (IHA) and the Ecosystem Functions Model (HEC-EFM). Both statistically assess time series to gain insights about an array of ecosystem dynamics with the fundamental goal of supporting restoration and stewardship of managed aquatic systems. HEC-EFM applications in support of SRP are diverse, ranging from statistical assessments of historical hydrologic conditions to modeling ecosystem responses to ecologically designed outflows from reservoirs.

SRP is supporting HEC-EFM enhancements that enable use of multiple variables to assess ecological conditions. This multivariate approach, where condition can be based on constellations of variables such as water depths, velocities, and temperatures, will allow for more complex time series analyses

investigating connections between operational decisions and ecosystem responses. Multivariate features are now ready for use. A new version of HEC-EFM should be released to the public in 2024.

Spatial Habitat Mapping

Habitat mapping is performed in support of ecosystem restoration projects, habitat conservation plans, and investigations related to species of interest. It is also an effective platform for communications, producing visual displays of habitat distributions, connectivity, and sometimes functionality across landscapes or within aquatic systems. Habitat mapping is less common, and often lags time series analyses and alternative formulation in the SRP process, but the approach has excellent potential as an information source for ecosystem restoration and management and to further inform development of alternatives and communication of expected benefits.

As a spatial endeavor, habitat mapping is underpinned by geographic information systems (GIS) and there are many GIS software options. The Environmental Systems Research Institute, Inc. (ESRI) produces several GIS software options as part of the Arc suite of tools. GeoEFM, which is a spatial accessory for HEC-EFM, works with Arc software and offers several features related to management of spatial data sets, computation and comparisons of habitat areas, and assessment of habitat functionality.

SRP supports GeoEFM enhancements for features that allow users to generate habitat suitability maps, display spatial statistics, and assess habitat functionality in terms of how much habitat and the configurations of habitat that species of ecological communities need to survive and reproduce. These habitat mapping features are expected to be ready for use in calendar year 2023. A new version of HEC-GeoEFM should be released to the public in 2024.

Real-time Water Quality Modeling

The largest investment of FY 2023 funds related to technology involved development of engineering software, specifically adding real-time water quality (WQ) modeling to a reservoir simulation model, HEC-ResSim. HEC management decided to fund this effort. The software effort progresses and promotes environmental sustainability at reservoirs. Real time WQ modeling is critical due to its direct impact on drinking water, water treatment, public safety, and the economy. It also improves the safeguarding against accidental and intentional contamination. These funds allowed for important bug fixes and improvements to the WQ module and major progress towards integrating WQ into the real time modeling platform.

Science (Validation)

The success of SRP is a function of ecological improvements in river health, which are of key importance to gage. The health of a natural system is very difficult to measure due to uncertainties in understanding ecological concepts, changing influences of water management, and time required for ecological responses to become measurable. Through SRP-Science, SRP seeks to cultivate scientific understanding of the connections between reservoir operations and ecosystem responses for select rivers in unique ecoregions around the United States. Development of scientific knowledge is leveraged through implementation of e-flow prescriptions at SRP sites, which alters land-water interactions thereby stimulating ecosystem responses that can be studied and quantified using field monitoring protocols and analysis. If operational changes are studied, resulting knowledge can be used to improve prescriptions and perpetuate a culture of adaptive management, both locally and more broadly across USACE, as results are shared. Monitoring does not need to be exhaustive to be effective and requires constructive, informative, and timely guidance from science practitioners to dam operators.

The SRP-Science Initiative began in FY 2020 and continues with annual funding of four regional efforts, including the Des Moines River, North Carolina rivers (Cape Fear and Roanoke), Upper Ohio River Basin (Allegheny River), and Willamette River. These current-study and adaptive-management efforts are intended to promote implementation of environmental strategies at reservoirs across USACE by reducing uncertainties about flow-ecology responses and quantifying and communicating benefits of e-flows. Additional rivers may be included in the SRP-Science Initiative in the future as they enter the incorporate phase of the SRP process and demonstrate transferability to other rivers.

Des Moines River, IA – (SRP-Science)

SRP-Science activities on the Des Moines River and Lake Red Rock include agreements with the USGS Cooperative Research Unit at Iowa State University (ISU) and partnerships with the Iowa Department of Natural Resources (DNR) fisheries, Rock Island District (MVR) Operations, the MVR Water Control Center, ERDC, Ecosystem Management and Restoration Research Program (EMRRP), and Engineering with Nature (ENW) program. Field work began in 2021 to evaluate how dam operations can influence fish recruitment below the Red Rock Dam. The effort created momentum with partnering agencies and resulted in the Iowa DNR conducting fish recruitment studies on the lower Des Moines River that focus largely on sturgeon spawning.

Des Moines River has completed the SRP process to advance, implement, and incorporate e-flows and EPM into reservoir operations. Work now includes location-based work and SRP-Science efforts to better understand ecological responses to operations, including outflows and environmental pool management (EPM) for ecological benefits. Guided by the Des Moines River Adaptive Management and Monitoring Plan (AMMP), efforts are focused on achieving understanding and solutions for the eight identified flow or pool level recommendations.

MVR planned a spring pulse in cooperation with MVR Water Control, the Iowa DNR, and researchers at ISU in May 2023. This pulse was immediately followed by a natural precipitation-driven pulse. This is the third year of deliberate, planned e-flow pulses and two downstream research projects studying the effects. The first project sampled ichthyoplankton and zooplankton on the lower Des Moines River in 2021 and on the Iowa River in 2022. The second project was estimating the impact of e-flows on the recruitment and survival of freshwater mussels below Red Rock Dam. A total of 210.6 hours of visual and tactile searching was conducted at 26 sites in the Des Moines River in 2022, with 13 upstream and 13 downstream from the dam. Quadrat sampling was also completed at 13 sites along the Cedar River and 3 sites in the Wapsipinicon River (Iowa), and sampling for mussels into fall of 2023. This concludes the second and final field seasons for the study.

The Iowa Geological Survey-University of Iowa, the Iowa Institute of Hydraulic Research (IIHR) Hydroscience & Engineering, and ERDC completed a three-year effort to study the geomorphology of the Red Rock delta and nitrate-nitrogen reduction in Lake Red Rock. Support for this research was funded by SRP and EWN). Three papers were generated. The first was Sedimentology of a Delta Formed by Agricultural River Discharge into a Flood Control Reservoir and it characterized the sediments and geomorphology of the Red Rock Reservoir delta, the region where the Des Moines River becomes part of the Lake Red Rock flood-control reservoir. The second is titled, Long-term Nitrate-Nitrogen Reductions in a Large Flood Control Reservoir and used 42 years of water quality data to conclude that natural processes in the delta and reservoir reduced the nitrate-nitrogen load by 12.4 percent. The study presents potential opportunities to utilize EPM to reduce the nutrient loading of the Des Moines River to the Mississippi River, which is the primary source hypoxic zone in the Gulf of Mexico. The third is Potential for Managing Pool Levels in a Flood Control Reservoir to Increase Nitrate-Nitrogen Load Reductions in Large Midwestern River (draft) and concludes that certain intentional environmental pool

(e-pool) strategies could further reduce nitrate-nitrogen in the reservoir equivalent to installing approximately 650 edge-of-field conservation practices in the watershed annually.

Waterbirds: Historically, the Red Rock delta has silt-laden and nutrient rich waters from the river that enters the lake. The rich sediments and chemicals fall out to a create muddy, marsh-like aquatic habitat that provides sanctuary for migrating shorebirds. The third and final year of SRP-funded studies produced, Waterbird and Vegetation Response to Reservoir Water Management in Central Iowa, which documents the number and species of waterbirds utilizing the delta during summer-drawdown of the lake. The drawdown exposes mud flats that are quickly colonized by a variety of vegetation and produces high-energy seed sources for waterfowl before being flooded in the fall for migrating waterfowl. The use and energy cycle were characterized by species composition and documented in this report (Figure 5).

The inset shows local movements (Dinsmore and Fasbender, 2023 Annual SRP Report).

Figure 5. Migratory Tracks of Tagged Pectoral Sandpipers at Red Rock Lake, 2023.

Herptiles: Another study funded by SRP and EMRRP in 2022 and 2023 focused on improved conditions for reptiles and amphibians by testing an e-pool strategy to hold the fall pool rise until ice-out in the spring. It was thought this could limit potential harm to brumating herptiles. This work is ongoing.

Shorebirds: Another SRP-funded study, Shorebird tracking in response to Sustainable Rivers Program Environmental Flows, attempts to understand how long shorebirds remain at the delta, their habits, and where they go. This study utilized a new generation of satellite tags to track the local and continental movements of a sample of pectoral sandpipers. A real-time publicly accessible web interface was developed to share the movement of the birds, https://faculty.sites.iastate.edu/cootjr/iowa-pectoral-sandpiper-stopover-study. Of the 45 species seen, 23 were shorebirds, 10 were waterfowl, and 12 fell into other waterbird groups. Greater than 185,000 individual waterbirds were counted. In 2024, the team expects to expand studies at two new sites: one in Minnesota and one in Missouri.

Shovelnose Sturgeon: Iowa DNR listed the shovelnose sturgeon as a Species of Greatest Conservation Need and is considered a native species indicative of environmental health, plus has recreational and commercial value. In 2012, approximately 37,000 shovelnose sturgeon died, while in 2023, about 21,000 died. Both events were due to low flow and high-water temperature and understanding the reproduction of this long-lived, slow-growing species is important to potentially modifying operations to support its survival. In partnership with Iowa DNR-Fisheries and ISU, an array of 29 telemetry receivers were purchased and used to tag and monitor sturgeon movement. 2023 kicked off the three-year study by ISU researchers, Effect of Reservoir Operation on Fish Reproduction, Movement, and Survival in the Des Moines River System. The study has two objectives. The first objective is to compare spring migration phenology of shovelnose sturgeon using the acoustic telemetry system in two Mississippi River tributary systems: one with and one without experimental flows. This will help determine how e-flows may influence movement, location, timing, and reproduction. The second objective is to monitor behavioral movements and habitat selection in relation to flows and temperature during the summer when water temperatures are warmest.

Public Outreach and Education: One of the key aspects of Des Moines River project has been to foster awareness and education regarding the natural resources in the region and the efforts funded by SRP, TNC, EWN, and partners. The Des Moines-ERDC team hosted a coordination forum at Red Rock Dam where student researchers, professors, professional scientists, and the Des Moines SRP gave presentations and shared information about Des Moines River SRP activities. An article featuring the work was published in the USACE Stewardship News Bulletin. The Des Moines River SRP joined two ISU Master of Science students to present this research at the Joint Meeting of the Iowa Wildlife Society and the Iowa Chapter of the American Fisheries Society in Ames, Iowa, on 1 through 2 March 2023.

The Des Moines River SRP also lends support to MVR on the Iowa River-Coralville Lake AMMP development and stakeholder coordination discussed later in this document.

North Carolina Rivers, VA and NC (SRP-Science)

There are two North Carolina rivers in SRP, the Roanoke and the Cape Fear. The Roanoke River is one of the original rivers in SRP and is now in the incorporate phase of the process. In 2016, the WCM was amended to allow for quasi-run-of-river operations when USACE enters flood operations. Building on the momentum of the Roanoke River, the Cape Fear River was added to SRP in FY 2017. The Cape Fear River is in the implement phase of the SRP process, actively conducting and monitoring e-flow releases.

Their status in the SRP process and semblance to other Atlantic coastal plain rivers make the Roanoke and Cape Fear compelling candidates for scientific exploration. SRP-Science efforts in these two rivers entail formal work with the USGS across four topics: creating a long-term adaptive management plan for

both rivers, learning about bank stability after high flows on the Roanoke River to learn how to reduce the stress on the system with the new operational flexibility, studying algal blooms and water quality in relation to flows using advanced technologies and techniques, and investigating how climate change is influencing the timing and magnitude of inflows into reservoirs.

As part of creating stakeholder engagement with real-time adaptive management, the Cape Fear River FY 2023 SRP-Science-funded, real-time water quality gauges were installed in one location at two depths: one sensor at the surface and one sensor 2 meters below the surface. The sensors were placed 135 miles downstream of B. Everett Jordan Dam, where harmful algal blooms have occurred and where four counties are supplied drinking water. The sensors measured dissolved oxygen, pH, chlorophyll a, phycocyanin, conductance, and temperature. By having these measurements at two depths, the team collected real-time river stratification and other conditions that implied algal growth. The results were posted real-time on the USGS Water for the Nation website and enabled extensive dialogue between the USACE and basin stakeholders.

Algal blooms are most likely to occur in dry times. After refining how to manage water quality e-flows between 2020 and 2021, TNC and USACE began B. Everett Jordan Dam-only water releases in 2022 through 2023. In this case, there is no rain or upper basin weather ahead of an e-flow water release. Rather, TNC and USACE analyze the amount of water in B. Everett Jordan Dam, the future weather forecast, and the potential drought conditions in the basin. If constraints allow, USACE releases approximately 3,000 cfs from B. Everett Jordan Dam for approximately 24 hours. Detailed analysis and special conditions are required for this type of water release, as USACE must balance the current water releases with the need to conserve water in the event of drought.

1. TNC and USACE confer weekly on basin conditions. Flows below 1,800 cfs at Taylor Lake Dam (NID NC00128) and air temperatures above 80 °F raise the team's awareness. The team checks real-time gauges to look for river temperature stratification, elevated dissolved oxygen, and elevated pH (which imply algal growth).
2. The team has enabled an active group called Eyes on the River, which includes four utilities, the North Carolina Department of Environmental Quality (NCDEQ), some industry, and USGS. The group is regularly on the river and sends reports if any algal scum is detected.
3. If algal scum is reported, NCDEQ is contacted to determine if it is a harmful algal bloom or another type of algal bloom.
4. In any bloom situation, USACE employs forecasting tools to show how much water is required to conduct an e-flow release, the effect of a release on water elevation in B. Everett Jordan Lake, and the effect of a release on drought contingency protocols.
5. Ahead of a water release, the utilities are provided the USACE modeling results. The group and NCDEQ collectively decide whether to implement a water quality e-flow release. All water quality releases are communicated to a broad stakeholder list.

TNC and USACE conducted B. Everett Jordan Dam-only water releases in both 2022 and 2023. In 2022, the team sent 3,000 cfs for a little over 24 hours (Figure 6). Researchers documented the desired effect, which was the water at Taylor Lake Dam (135 miles from B. Everett Jordan Lake) was mixed and remained de-stratified for a week. In 2023, bloom-like conditions occurred (although not harmful algal blooms) and the basin stakeholders again agreed to try an e-flow water release. The team attempted to use less water to test the thresholds of an effective water quality e-flow, sending 1,000 cfs out of Jordon Dam for 24 hours. This e-flow improved the basin conditions, but the effect only lasted a day.

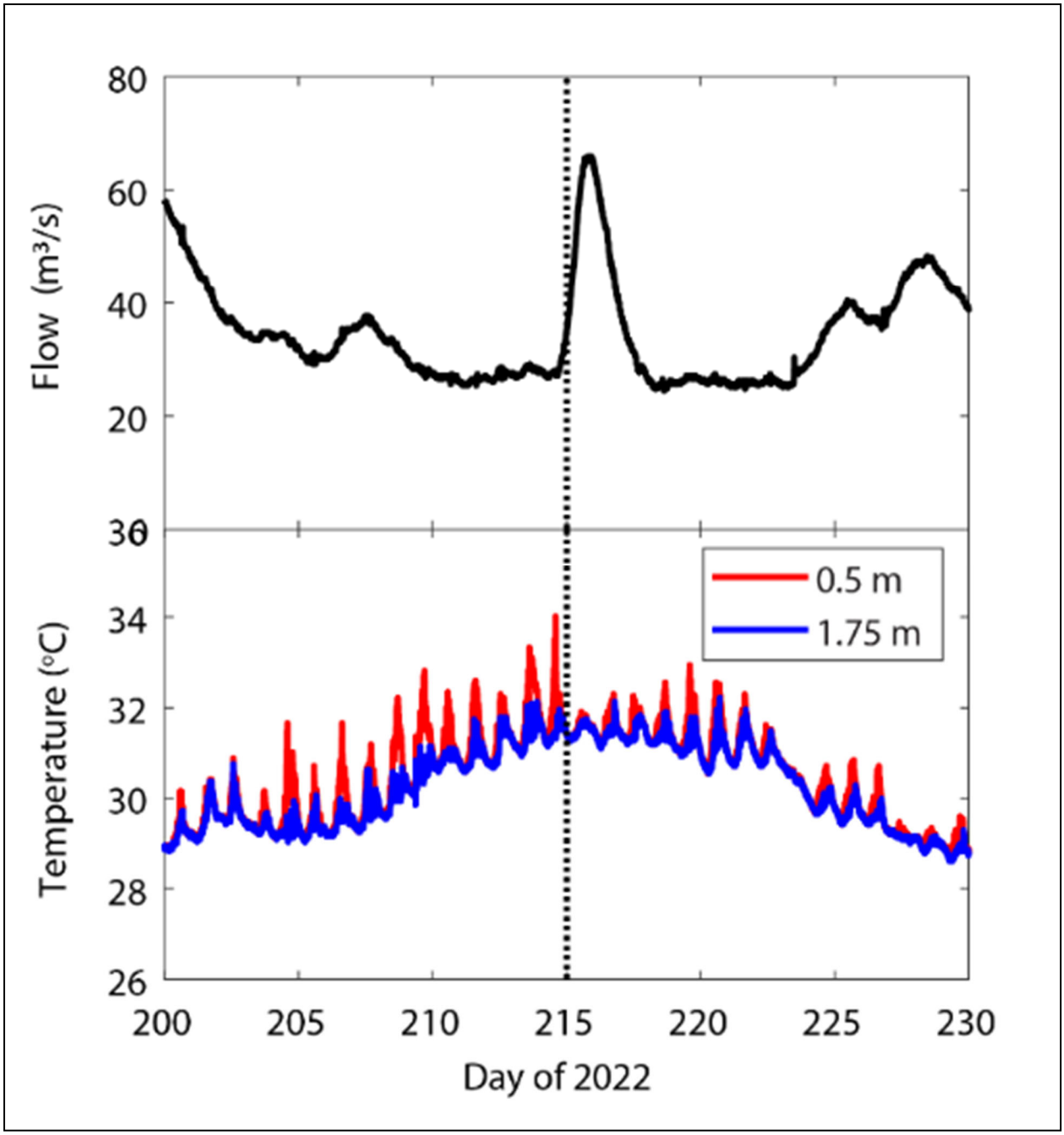

Figure 6. A pulse release from B. Everett Jordan Dam successfully mixed water at Taylor Lake Dam.

As part of the adaptive management work, TNC, USGS, and USACE began studying how climate change models can be downscaled to local river results. USGS ran the Precipitation Runoff Modeling System (PRMS) with several global climate change scenarios. Results were backcast more than 30 years and forecast to 2100. Backcast results were compared to historical data. Early results show that global change models can detect monthly trends in the Cape Fear and Roanoke rivers with decent accuracy. The group is currently analyzing the forecasted climate change results to help USACE understand the timing and intensity of future weather and if it will require different management actions.

Upper Ohio River, PA – (SRP-Science)

SRP support for e-flow efforts in the Upper Ohio River Basin began in 2014. After flow targets were defined for various watersheds, focus shifted to translating basin-wide e-flow recommendations into operating recommendations at reservoirs across the region.

In September 2020, the SRP team held the Kinzua Dam provisional ecosystem flow recommendations workshop. USACE staff and 40 river scientists attended. The SRP team prepared an AMMP for implementation of e-flows at Kinzua Dam, including summaries of the biological surveys conducted in the Allegheny River and knowledge gaps limiting implementation.

SRP-Science in the Upper Ohio River Basin, specifically work in the Allegheny River for FY 2023, continued with formal work by USGS that focused on summarizing findings of a pilot study (2021 to 2023). The product will result in a USGS Open-File Report (OFR) to characterize stage fluctuations, river velocity, and water temperatures within mussel beds, as well as understand water quality variation at the nearest USGS stream gage and link these river conditions to reservoir management. USGS also developed a survey method and modeling approach for aquatic biota and their required habitat. The goal of this effort is to develop a survey methodology and modeling approach for the upper Allegheny River and a monitoring program to test implementation of operational changes through the target river reach downstream of Kinzua Dam. This approach will be applied in FY 2024.

In FY 2023, the team also implemented a spring pulse of water from Kinzua Dam to the Allegheny River on 30 March through 31 March (Figure 7). During this event, approximately 15,000 cfs of water were released from the Kinzua Dam, providing near-bank full flows. This pulse evaluated the effects of e-flows in the National Wild and Scenic River reach of the Allegheny River. Spring pulses are implemented to mimic the natural hydrologic frequency, magnitude, and duration of spring rain events. The implementation of this spring pulse will enhance riverine habitat through disturbance processes (sediment, detritus, seed movement, etc.) and provide environmental cues for aquatic life.

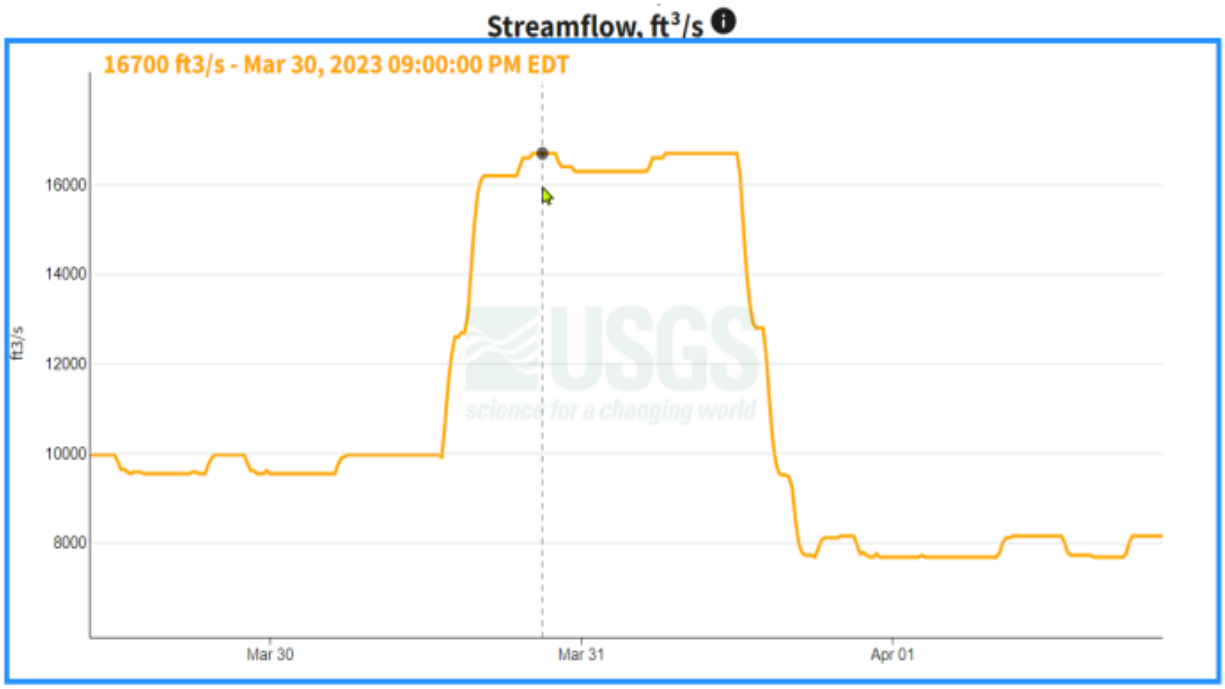

Figure 7. Spring Pulse from Kinzua Dam 2023.

The team collected water samples from five sites along the river before the pulse began and during the event. These water samples are still being analyzed, but the team expects that they will provide information about sediment disturbances. Additionally, the team coordinated with a University of Pittsburgh class that sampled a range of potential environmental indicators including nutrients, sediment, and soil water in the riparian buffer.

In FY 2024, the SRP-Science team will continue to provide information that refines the environmental prescriptions on the Allegheny River and transfer lessons learned to other basins within the Upper Ohio River system. Additionally, the Pittsburgh District (LRP) will initiate investigation of climate change impacts on the system and how it may influence the ability to implement e-flow changes at the Allegheny River and other basins in the Upper Ohio River Basin.

Willamette River, OR – (SRP-Science)

Through SRP, USACE and TNC have worked together since 2006 to determine e-flow requirements downstream of USACE dams in the Willamette River Basin and identified opportunities to restore key aspects of the natural flow regime. The work reached a pivotal milestone in July 2015 when a Memorandum for the Record (MFR) was signed, thereby incorporating e-flows into the operational guidance (i.e., WCMs) for several basin reservoirs (Figure 8).

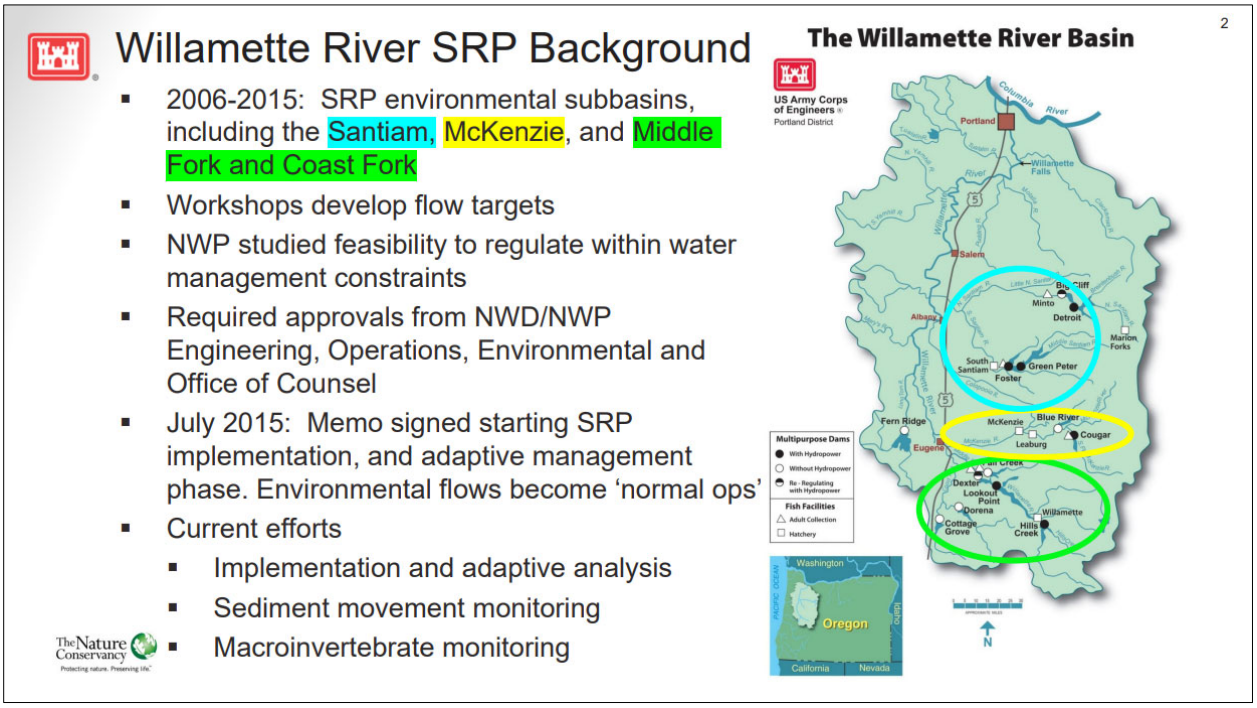

Figure 8. History of Willamette River SRP efforts.

In 2020, SRP-Science efforts were initiated to assess implementation of e-flow targets in the Willamette River Basin, evaluate ecological implications of flow objectives, and develop communication products that can support the implementation and adaptive refinement of prescriptions for the basin and other watersheds. USACE water management and natural resources management staff, in conjunction with other co-managers and stakeholders, will use the results of this SRP-Science work eventually to determine if e-flow prescriptions can or should be adjusted to meet ecological requirements.

SRP-Science efforts focused on development of a simple, streamlined process for annually reporting SRP implementation, describing which targets were met, the context for those targets, ecological benefits, lessons learned, and recommendations for future monitoring and adaptive management. The district partners with USGS to conduct scientific monitoring, data analysis, and reporting. USGS began acoustical monitoring and sediment collection in FY 2021 with installation of hydrophones in the North Santiam River near Mehama, Oregon, and the McKenzie River near Bellinger, Oregon. The goal of the study is to identify streamflow rates which mobilize sediment. In FY 2022, the sediment study continued along with initiating a pilot macroinvertebrate monitoring effort to help develop models for taxa within the basin, assess variability of model performance, and evaluate operation scenarios. In FY 2023, USGS and Portland District prepared the Willamette River Monitoring and Environmental Flow Assessment describing the process of identifying and testing e-flows and monitoring efforts from water years 2008 through 2022. Water year hydrographs of observed (regulated) flows were compared to e-flow targets.

Overall, it was found that:

- Summer low flow targets were usually exceeded.
- Lower winter high water SRP targets were achieved.
- Substantial subbasin variability between achieving targets and having different targets and objectives between basins.
- Variability of timing outside explicit time windows may have skewed the estimate of success. As a result, future efforts will not be as prescriptive in terms of time window and focus more on whether the physical process intent has been met.
- Majority of targets met are high flow targets.

Key take-aways of this effort:

- A quantifiable e-flow compilation, assessment process, and tools were developed. These tools can be reproduced by USACE and the SRP program to summarize USACE annual water management operations and success in meeting e-flow objectives.
- A machine-readable compilation database (spreadsheet format) and associated R script are now available for use. Compiled data will be posted on a USGS Science Base-Catalog website.
- Results of this work indicate many SRP workshop flow targets are being met under normal operations. Under the SRP's post implementation, adaption framework, future water management could explore ways to achieve high water e-flow benefits, as well as inspire new science studies that could point the way to less impactful e-flow targets that would achieve the same goal without the detrimental consequences of releasing higher flows for longer durations.
- Operations are not regulating for summer flow targets and that could be reevaluated and refined to achieve a specific ecological outcome. If the operation were predicated on achieving a specific ecological benefit not easily achieved by other means, then regulating lower outflows at the right place, at the right time may be palatable to management.
- The tools and flow compilation databases will benefit USACE as it continues to improve e-flow objectives and overall water management in the Willamette River Basin.

The Willamette River SRP team did not submit a proposal to initiate new work in FY 2024, however, ongoing work by USGS and the district will be completed. The SRP management team and the district plan to meet in early FY 2024 to brainstorm if any additional monitoring or analysis would be beneficial to the SRP program when or if e-flows can be implemented on the Willamette River.

Location-based Work

In FY 2023, three SRP location-based RFPs were announced: general, locks and dams, and dry dams. The SRP received and reviewed 56 proposals on behalf of 28 rivers, including 13 new rivers and funded 20 teams as shown in Table 1.

SRP identifies and executes location-based work via the following process: 1) evaluate program objectives and topics of interest to determine if adjustments are needed, 2) highlight objectives and topics as part of a RFP, 3) compile and prioritize responses, 4) scope priority tasks, 5) arrange funding and other logistics, and 6) perform work. The annual In-Progress Review (IPR) reports summarize status, including work completed in each FY and anticipated work in the coming FY for those funded projects. IPR reports are available at https://www.hec.usace.army.mil/sustainablerivers/publications/.

This section is organized alphabetically by river as shown in Table 1. Subheaders are titled according to "river name (facility), state abbreviation – district abbreviation (infrastructure type)". Infrastructure type is "Gen" for general multi-purpose reservoirs, "LD" for locks and dams, or "DD" for dry dams. Water infrastructure that do not fit any of those categories (e.g., diversions) are included in "Gen". Previously funded projects which are still in progress have provided updates at the end of the report under Other Sustainable River Program Advancements.

Table 1. FY 2023 Location-based efforts.

SRP Supported Rivers (facilities) - FY 2023	District Name
Alabama River* (Claiborne and Millers Ferry locks and dams)	Mobile District (SAM)
Bayou Courtableau* (Henderson Lake)	New Orleans District (MVN)
Black River (Clearwater Dam)	Little Rock District (SWL)
Cape Fear River (Jordan Dam)	Wilmington District (SAW)
Cossatot River (Gillham Dam)	Little Rock District (SWL)
Des Moines River (Saylorville and Red Rock dams)	Rock Island District (MVR)
Gila River (Painted Rock Dam)	Los Angeles District (SPL)
Green River (multiple reservoirs)	Louisville District (LRL)
Kansas River (e-flows; multiple reservoirs)	Kansas City District (NWK)
Kansas River (e-pools; multiple reservoirs)	Kansas City District (NWK)
Kaskaskia River (Carlyle, Shelbyville, and Jerry F. Costello)	St. Louis District (MVS)
Lake Washington Ship Canal (Ballard Locks)	Seattle District (NWS)
Minnesota River* (Highway 75 Dam)	St. Paul District (MVP)
Mississippi River (Melvin Price Locks and Dam)	St. Louis District (MVS)
Mitigate hydropower peaking (multiple reservoirs)	St. Louis District (MVS)
Potomac River (Jennings Randolph Lake)	Baltimore District (NAB)
Salt River (Clarence Cannon Dam)	St. Louis District (MVS)
TNTCX Rivercane Restoration*	Multiple Districts
Tombigbee River (multiple reservoirs)*	Mobile District (SAM)
Upper Ohio River (Kinzua Dam)	Pittsburgh District (LRP)

*New location-based effort in FY 2023

Alabama River (Claiborne and Millers Ferry), AL - SAM (LD)

The Mobile River Basin is the result of the Alabama and Tombigbee rivers' confluence. The Mobile River continues to flow for approximately 45 miles to the Gulf of Mexico. Together the basin forms the fourth-largest river system in the country and supports a high diversity of aquatic species (fish, mussels, amphibians, and reptiles) and bottomland habitats. The Alabama River itself has supported over 180 fish species with a relatively high proportion of endemic species. Claiborne Lock and Dam and Millers Ferry Lock and Dam are located on the Alabama River at RMs 72.5 and 133, respectively. These are the lowermost dams on the Alabama River and are operated by SAM with authorized missions for navigation, recreation, and fish and wildlife conservation.

Under current operations only a small number of fish are able to pass over Claiborne Lock and Dam during flooding and none can pass over Millers Ferry Lock and Dam. Due to the low number of commercial lockages, Claiborne and Millers Ferry locks and dams were identified for study to improve operations for migratory fish passage within the Mobile River Basin. SAM has assembled an inter-disciplinary team comprised of USACE personnel, federal, state, and non-government entities.

Status of Fiscal Year 2023 Work

SRP support in FY 2023 was used to gather baseline data on operations and ecological conditions and develop recommendations for operational alternatives to evaluate in subsequent years. The goal of the project was to inform water management at the Claiborne and Millers Ferry locks and dams to better support aquatic species in the entire Alabama River System.

During 2023, an interagency team conducted baseline biological data on the Lower Alabama River under current operational regimes. The SAM, USFWS, TNC, Alabama Department of Environmental Management, and the Geological Service of Alabama sampled the river above and below Claiborne and Millers Ferry locks and dams using electrofishing, beach seining, and trawl netting. The biological sampling showed trends of decreased species numbers progressively upstream.

Anticipated Work in Fiscal Year 2024

One trawl sampling event was conducted in November 2023 below Claiborne Lock and Dam. Upon receipt of FY 2024 funds, SAM will install fish attractants at each lock and dam. During the fish movement period (January through May 2024), SAM and partners will use gill nets and mark recapture techniques to monitor fish movement through the locks using a variety of attractant regimes. The Alabama Department of Environmental Management will assist SAM by tagging additional fish via electrofishing. SAM Operations Division has committed to preforming an increased number of lockages during the migration season and tracking the operational burdens. Upon completion of the experimental lockages, SAM will examine the navigability of the locks versus the operational burden.

Future Vision

USACE operates three locks and dams in the Alabama River. If the experimental lockages and attractants prove viable, SAM Operations Division will continue the processes. The team will integrate the operations into the water management SOP.

This project has multiple phases that span fiscal years. The first phase (FY 2023) focused on gathering baseline data on operations and ecological conditions and developing operational alternative

recommendations for evaluation. The second phase (FY 2024) includes continued ecological data collection and initiation of alternative operations evaluations. The third phase includes completion of alternative evaluations to assess efficacy at improving fish passage (FY 2025). The fourth phase includes development of implementation plan to allow permanent operational changes (FY 2026).

Bayou Courtableau (Henderson Lake), LA - MVN (Gen)

The Atchafalaya River Basin is one of the most ecologically important places in the country, yet it is a complex system that requires thoughtful interventions that balance multiple constraints. The SRP Atchafalaya project team spent 2021-2022 compiling science and evaluating multiple structures in the basin for opportunities. Due to litigation and sensitive issues, the SRP Atchafalaya team recognizes the need to work in less controversial parts of the basin to get basin stakeholders familiar with e-flow concepts, modeling, and changes to management. Throughout 2022, the team looked at multiple existing water control structures in the Atchafalaya River Basin to identify opportunities to modify current flows, within the structures' existing authorizations, to improve downstream ecological conditions in areas that could serve as a learning ground for other control structures in the Atchafalaya. The team identified Bayou Courtableau as a potential structure that could be studied and re-operated to improve the downstream Henderson Lake.

Bayou Courtableau Basin is about 50,000 to 60,000 acres and is hydrologically separated from the rest of the Atchafalaya River Basin. Bayou Courtableau historically flowed naturally into the Atchafalaya River prior to the construction of the West Atchafalaya River Basin Protection Levee (WABPL). The Bayou Courtableau Control Structure was built as a part of the WABPL to regulate flow into the Atchafalaya River. During wet winter months, when the Bayou Courtableau Control Structure is open, excessive water from the North (via Bayou Cocodrie, Bayou Little Teche, and Bayou Teche) flows through the Bayou Courtableau Control Structure and down the Grimmet Canal into the Atchafalaya River Basin towards Henderson Lake. These flows travel slowly as water is attenuated as it moves through the Bayou Courtableau Control Structure. This muted conveyance of water creates environmental issues in Henderson Lake and the 50,000 to 60,000 acres of surrounding areas in the Atchafalaya River Basin. For example, areas downstream toward Henderson Lake are experiencing water issues such as low dissolved oxygen, decreased fish and wildlife habitat including for crawfish that support the largest fishery in the basin, and overall decreased health of surrounding floodplain vegetation.

In FY 2020, the first SRP support in Atchafalaya River Basin occurred. The effort consisted of developing alternatives and understanding operational flexibility for the Atchafalaya River Basin by identifying stakeholders, evaluating a sound process for stakeholder engagement, and identifying hydrology models and other tools that could be utilized for evaluation of ecological opportunities. Additional work was funded in FY 2022 and FY 2023 to review scientific data and evidence and assess current operations and authorizations to determine e-flow recommendations. In FY 2023, the SRP funded efforts were focused on using the Bayou Courtableau Control Structure to familiarize the Atchafalaya River Basin stakeholders with the science and process of assessing environmental opportunities. After gaining support and valuable input, USACE has continued moving forward with field data collection and modeling efforts.

Status of Fiscal Year 2023 Work

The Atchafalaya River SRP team continued coordination among USACE, TNC, the Governor's Office of Coastal Activities, and the Louisiana Coastal Protection and Restoration Authority (CPRA) through three

teams: Core Management Team, Science Team, and Stakeholder Team. The Core Management Team met approximately monthly from May through September. The Science Team met in June and in September 2023. Throughout these engagements, the team was able to further refine the modeling needs, identify data gaps, and discussed existing water control structures in the Atchafalaya River Basin to identify opportunities to modify current flows, within the structures' existing authorizations, to improve downstream ecological conditions in areas that could serve as a learning ground for other control structures in the Atchafalaya River Basin. The team confirmed that the Bayou Courtableau Control Structure should be studied and reevaluate operations to improve Henderson Lake downstream. The Stakeholder Team established an initial stakeholder engagement strategy and stakeholder list and will continue to refine stakeholders with the narrowed focus of the Bayou Courtableau and Lake Henderson areas of the Atchafalaya River Basin. The Core Management Team confirmed with Office of Council that there are no concerns with focusing on Bayou Courtableau.

Anticipated Work in Fiscal Year 2024

The MVN team will focus new work on Bayou Courtableau and Henderson Lake within the Atchafalaya River Basin through improving investigating opportunities which will improve water conveyance by utilizing an existing model developed by a contractor and adding additional data as needed. The goal of this work within current water control structure authorizations in the Atchafalaya Basin Floodway is to perform and monitor experimental e-flows within three years to test a potential water management change to the structures to benefit the environment. The proposed flow will incorporate considerations for navigation and flood risk reduction, in alignment with existing authorizations. FY 24 effort will also continue to familiarize and engage the Atchafalaya River Basin stakeholders with the science, modeling, and discussions of flexibility within the current authorizations to move from the Advance Phase to the Implement Phase.

Future Vision

In the future, SRP aims to strategically build a coalition of scientists, stakeholders, and local and state government support for identifying, implementing, and monitoring environmentally beneficial actions in the Atchafalaya River Basin over time.

Black River (Clearwater) - SWL (Gen)

The Black River forms in southern Missouri near Centerville and flows about 40 miles before being impounded by Clearwater Dam. After leaving Clearwater Dam, the river flows southeasterly into the Mississippi Embayment near Poplar Bluff, Missouri. Once in the Mississippi Embayment, the Black River flows southwesterly parallel to the edge of the Ozark escarpment until joining the White River near Newport, Arkansas. Tributaries of the Black River generally flow from the west, where there are sources in Ozark Mountain springs. A number of public forested wetlands are maintained along the river. These include Allred Lake Natural Area, Coon Island Conservation Area, Big Cane Conservation Area, and the Dave Donaldson Wildlife Management Area. These wetland areas of the Black River support several fish and wildlife species that rely on sufficient water being in the stream for survival.

The Natural Resources Commission of the Arkansas Department of Agriculture (ANRD) is responsible for the management and protection of water and land resources for the health, safety, and economic benefit of the State of Arkansas. Part of this responsibility lies in the development and implementation of the Arkansas Water Plan (AWP). Title 24 Section 2405.2 of the AWP suggests specific

recommendations for ANRD to follow when allocating surface water withdrawals for non-riparian use. Withdrawal recommendations typically leave water flowing in the Black River to support fish and wildlife species that depend upon the water in the stream for their survival. Minimum flows below Clearwater Dam are currently set to a constant rate (fixed target).

Clearwater Dam is currently using a WCM dated 1995 for dam releases. So long as USACE operates within the bounds of the 1995 WCM, flow releases from Clearwater Dam can be made to support minimum e-flows (variable target, function of season and ecological need) for the Black River to support the fish and wildlife dependent on river flows.

This study has three major components:

1. To work with ANRD and stakeholders to develop minimum e-flows.
- To investigate the impact of groundwater withdrawal and recharge within the basin. In order to fully understand the hydrologic system, including minimum environmental flows, this component of the hydrologic regime must be understood. The Black River SRP team intends to work with Arkansas State University (ASU) via a Planning Assistance to States effort to study groundwater dynamics related to Black River flows. SRP funding would support only knowledge collaboration and integration of ASU's findings into a State of the Science report for Black River. ASU is also planning to investigate pondberry (*lindera melissifolia*), an endangered species that only grows in wetland habitats and is nearly extinct in Arkansas. ASU's pondberry study is expected to begin in FY 2024 and take approximately 2 years.
2. To simulate and analyze various operational suggestions/changes to determine dam operation impacts on minimum e-flows to the Black River.

The Black River is new to the SRP. Clearwater Dam is a multi-purpose reservoir in SWL. This scope follows a traditional path for the start of an SRP site.

Status of Fiscal Year 2023 Work

During FY 2023, the SWL Black River SRP team met with more than 40 stakeholders from Missouri and Arkansas for a project kick-off meeting. An overview of the SRP process and discussion of project outcomes occurred, reservoir operations at Clearwater Dam were introduced, and climate and streamflow trends and groundwater/surface water connections within the Upper Black River were presented. At the end of the meeting, a question-and-answer session was held, and meeting notes were sent to all participants.

Anticipated Work in Fiscal Year 2024

New work funded by SRP in 2024 includes the completion of the State of the Science Report. The report will detail the current available data and literature for the Black River, identifying flow-dependent fish, mussels, and other species in the Black River, examining changes in these species over time, and looking at alterations in the flow regime that potentially could have caused these changes.

Future Vision

After completion of the State of the Science Report, the SWL Black River SRP team will hold an e-flows workshop and define flow prescriptions to support the flow-dependent fish, mussels, and other species

that were identified in the State of the Science Report. Implementation, of the flow prescriptions identified during the environmental flows workshop, will begin as soon as conditions allow.

Cape Fear River (B. Everett Jordan), NC - SAW (Gen and LD)

In North Carolina, the Cape Fear River serves people and wildlife, making its water quality and water quantity of utmost importance to the region. USACE management on the Cape Fear River includes B. Everett Jordan Dam and its lake, three locks and dams, and dredging operations. These facilities are collectively managed for a diverse set of purposes including water supply, flood risk management, water quality, navigation, recreation, and fish and wildlife conservation. These same structures are barriers to diadromous fish; and the National Oceanic and Atmospheric Administration estimates that commercial fish landings have decreased 87 percent since the 1800s.

SRP work on the Cape Fear River began in FY17 by engaging and convening stakeholder groups to develop a conceptual framework of environmental opportunities to improve habitat for diadromous fish and potentially managing water quality issues. Eager partners worked together to develop the State of the Science Report on the ecology and hydrology of the Cape Fear system in preparation of the e-flows workshop held in Fall 2019. Together the USACE and regional river experts developed flow regimes for consideration at Cape Fear River dams to improve conditions for diadromous fish and potentially diffuse algal blooms before they become hazardous.

The Cape Fear River entered the Implement Phase of SRP in FY 2020, and continues now, with multiple test pulses conducted, to assist fish migration to their upstream spawning habitat in the spring and then to improve water quality in the river in summer. Innovative monitoring techniques were used to evaluate these pulses. For fisheries, this includes tagging fish, advanced telemetry, and environmental DNA (eDNA) studies. For water quality, it includes satellite imagery, an autonomous underwater vehicle, and continuous thermistors throughout the water column.

The Cape Fear River SRP e-flow Implementation Phase witnessed both one of the wettest springs on record and one of the driest summers, yet it has demonstrated successful strategies for fish passage and water quality improvements, refining the hydrology required for each. The Cape Fear River SRP team has also grown to include larger stakeholder and agency contributions to the development and monitoring of our pulses, to include the NCDEQ and several water utilities on the river.

Status of Fiscal Year 2023 Work

Multiple test pulses were conducted in the spring 2023 to support fish passage over the three lock and dams on the Cape Fear River. Our research team expanded the monitoring efforts of previous years to a greater length of the river, engaged in additional tagging, and orchestrated longer durations of monitoring to gain better knowledge on durations and magnitude of successful e-flow pulses for fish passage. The team also added eDNA analysis for sturgeon, an important endangered species in the Cape Fear River. The team monitored movement of diadromous fish in response to the spring pulses using advanced telemetry, traditional electrofishing, and eDNA methods, and provided preliminary results indicating successful passage over all three lock and dams with pulses. The SRP team, including researchers, presented to several basin groups on this successful effort.

Weather and basin conditions only allowed one water quality pulse in summer 2023, but this pulse was notable as it used the conservation pool in B. Everett Jordan Dam and required coordination with basin

water quality and water supply stakeholders and approval by NCDEQ. This is an important step towards the incorporation phase of SRP e-flow strategies since the NCDEQ owns the entirety of the conservation pool and will be essential in discussions regarding incorporating e-flow pulses officially into operations at B. Everett Jordan Dam. The team of researchers monitored the pulse using real-time gaging, specialized monitoring equipment, remote sensing, visual reports, and data collection from the water supply entities, and event-specific sampling, and have provided preliminary results suggesting positive response to the pulse all the way to the furthest lock and dam downstream (135 miles). The team utilized the knowledge gained from a 2022 water quality pulse, improved communication strategies, and refined hydrology, which enabled conditions and thresholds for successful pulses. The SRP team, including researchers, presented the methods and results of water quality pulses to basin stakeholders. Each presentation resulted in valuable additions to the team's researcher network and support for water quality pulses.

The team, led by a TNC partner, continued to analyze data and summarize results of the multi-year fisheries and water quality monitoring in response to e-flow pulses, building a thorough summary of sampling techniques, technologies used, coordination strategies, and implications to fish passage and water quality.

Anticipated Work in Fiscal Year 2024

Work on the Cape Fear River received multi-year funding in FY 2022, allowing the team to continue to focus on data analysis, reporting, and progress toward incorporation. USACE and TNC will reconvene basin stakeholders to review pulses, evaluate lessons learned, and identify any needed information to move Cape Fear River into the Incorporate Phase of the SRP process. Within the next year, the team plans to identify and initiate the necessary steps to incorporate effective e-flow prescriptions into USACE operating principles.

Future Vision

USACE operates four dams in the system and plans to continue implementation of the Cape Fear e-flow prescription. Assessment and adaption of these flows will focus on the movement of diadromous fish, connection of river flows with off-channel floodplain habitat, and conditions of summer flow that support juvenile fish movement and potential dispersal of algal blooms. Additional environmental actions will be based on outcomes associated with testing e-flows. The team's overarching goal is to incorporate effective e-flows into USACE operating principles. Cape Fear River is in the SRP-Science program and is on mark to collect and share important data on e-flows, fish eDNA, vegetation/water level interactions, water quality, and more with teams across the enterprise.

Cossatot River (Gillham) - SWL (Gen)

Gillham Dam is a USACE reservoir located on the Cossatot River, a tributary of Little River and part of the larger Red River system in Arkansas. Authorized missions include flood risk management, water supply, environmental stewardship, and recreation. SWL is currently updating the water control plan for Gillham Dam.

The Cossatot River is in its third year of the SRP. The Cossatot River is regulated by Gillham Dam, which is located approximately 44 miles upstream from its confluence with Little River. Gillham Dam is a multi-purpose reservoir in the SWL and is in the SRP Implementation Phase. The SWL SRP team focused on

implementing the lower magnitude e-flow recommendations formulated in 2022 and will investigate feasibility of the higher magnitude e-flows formulated in 2022.

The Cossatot River became part of SRP in 2020. Since initiation, a literature review and research report were completed, a flow recommendations workshop was held, and a flow recommendations document was produced. These all are typical steps for the advance phase of the SRP process. The current work focuses on the implementation phase of the SRP process.

Implementation of changes identified via the SRP process can have positive and lasting impacts on aquatic ecosystems, including several threatened and endangered species, while also reducing the effects of flooding in the watershed and sustaining other uses of Cossatot River waters in southwest Arkansas. To promote implementation, dialogue with water managers and operators will need to continue focusing on shaping, identifying implementation opportunities for, communicating about, and coordinating lower magnitude e-flows tentatively deemed feasible by the SWL SRP team. For the higher e-flow components tentatively deemed unfeasible, determinations need to be made regarding actions that would be required to make those flows feasible.

For example, small pulses (less than 2,500 acre-feet and/or less than 3-day duration) are likely feasible without modification to the water control plan because volumes and release magnitudes fall within the normal operational ranges associated with small and frequent storms. SRP funds would be used to develop materials that clarify how e-flow releases can be shaped and timed in association with enabling hydrologic conditions (rain events) to benefit downstream ecosystems while operating within the confines of the water control plan.

Higher e-flow releases (generally 2,500 acre-feet to 11,000 acre-feet and/or more than a 3-day duration) may require storage reallocations and environmental compliance work before implementation. Very high e-flow releases (outflows greater than 3,000 cfs) would be constrained by Gillham Dam's outlet works and require physical modifications to the dam or storing water until pool levels generated spillway flow, neither of which are likely nor recommended as part of SRP work. SRP funds would be used to identify the actions per e-flow component that would be required to make these e-flows implementable.

Status of Fiscal Year 2023 Work

During FY 2023, implementation began on the Cossatot River. Several small releases were made beginning in mid-May to support rabbitsfoot mussel (an endangered species) fertilization, infestation, and excystment. Additionally, one to two summer flushing flows were implemented along with a fall pulse to support the winged mapleleaf mussel (an endangered species) fertilization and host infestation.

Along with implementation, game cameras were installed below the dam, to capture images of the river rise and fall during implementation. These images will be overlain with the hydrograph for a visual of Cossatot River implementation for use as audio or video media for the SRP website.

Anticipated Work in Fiscal Year 2024

For FY 2024, the Implementation Phase will continue along with the further capturing of photos displaying implementation. Furthermore, the actions required to make e-flows for higher e-flow releases implementable must be completed.

Future Vision

The SWL Cossatot River SRP team will continue implementation by promoting coordination between water managers and operators, while focusing on shaping and identifying implementation opportunities for, with communication and coordination related to the lower magnitude e-flows. If deemed feasible during the FY 24 effort, higher magnitude e-flows will be considered for implementation.

Des Moines River (Saylorville and Red Rock), IA - MVR (Gen)

The Des Moines River watershed drains about 1,350 square miles (3,496 square kilometers) of flat to gently rolling agricultural land that once was glaciated in Minnesota and Iowa. Saylorville Dam and its reservoir became operational in 1977 and is located upstream from the City of Des Moines, Iowa. Red Rock Dam became operational in 1969 and is located approximately 50 miles downstream of the City of Des Moines, Iowa. These USACE dams are operated for flood risk management, recreation, water supply, and fish and wildlife conservation.

Des Moines River dam operations alter river flow by increasing summer flows, lowering spring flows, reducing peak flows, and substantially reducing connectivity to floodplain features like oxbow lakes. River scientists documented the changes to the river from impoundments and were looking for options to improve conditions for fish and wildlife habitat. Around 2015, MVR began the process of updating the WCM at both dams, which provided the opportunity to evaluate and add environmental considerations. SRP helped support USACE and stakeholders included e-flows and e-pool strategies in the WCM update. At the same time, SRP supported the development of the Des Moines River AMMP. This is a product of the e-flows workshop from 2016, resulting in a summary report that identified eight river flows and reservoir-level management practices to improve conditions for aquatic biota, terrestrial habitats, and water quality. The reservoir WCM now includes seasonal conservation bands for the reservoir that will support aspects of the natural flow regime to benefit fish and wildlife.

Status of Fiscal Year 2023 Work

Des Moines River SRP has completed all three phases to advance, implement, and incorporate e-flows and e-pool into reservoir operations. Work now includes location-based work and SRP-Science efforts to better understand ecological responses to operations, including outflows and pool level management for ecological benefits. Guided by the SRP-supported Des Moines River AMMP, efforts are focused on achieving understanding and solutions for the eight identified flow or lake pool recommendations.

MVR coordinated a planned a spring pulse in May 2023 that was immediately followed with a natural precipitation-driven pulse. While the second pulse was mere good luck, the first pulse was planned after consulting with MVR Water Control, the Iowa DNR, and researchers at ISU. This is the third year of deliberate, planned e-flow pulses.

There are two downstream research projects that are linked to the pulses. One is the Downstream Responses to Experimental Flow Releases from Red Rock Dam. The researcher leading this study sampled ichthyoplankton and zooplankton on several occasions on the Lower Des Moines River in 2021 and 2022, and on the Iowa River, which serves as a reference site without a planned pulse. The two field seasons and lab analysis are completed for this project.

The second SRP-supported downstream research is titled, Estimating the Impact of Experimental Flow on the Recruitment and Survival of Freshwater Mussels below Red Rock Dam. A total of 210.6 hours of

visual/tactile searching was conducted at 26 sites in the Des Moines River in 2022, with 13 of those above Red Rock Dam and 13 downstream from the dam. In 2023, quadrat sampling was completed at 13 sites along the Cedar River (Iowa) and 3 sites in the Wapsipinicon River (Iowa), according to the annual report, with more river sampling for mussels planned into fall 2023. This will conclude the second and last field season with completion of the Master of Science thesis occurring by summer of 2024.

The Iowa Geological Survey-University of Iowa, the IIHR Hydroscience & Engineering, and USACE's ERDC completed a three-year effort to study the geomorphology of the Red Rock delta and nitrate-nitrogen reduction in Lake Red Rock. Support for this research was garnered from SRP and EWN. Three papers were generated as result of this collaborative effort. One titled, Sedimentology of a Delta Formed by Agricultural River Discharge into a Flood-Control Reservoir, Iowa, characterized the sediments and geomorphology of the Red Rock Reservoir delta, the region where the Des Moines River becomes part of Red Rock Dam's flood-control reservoir. Another was titled, Long-term Nitrate-nitrogen Reductions in a Large Flood Control Reservoir and was published in the Journal of Hydrology. This study used 42 years of water quality data and concluded that natural processes in the delta and reservoir reduced the nitrate-nitrogen load by 12.4 percent. This presents potential opportunities to utilize pool management to reduce the nutrient loading of the Des Moines River to the Mississippi River, which is the primary source of the Delaware-sized hypoxic zone in the Gulf of Mexico. Also known as the Dead Zone, this region of the gulf is where it is difficult, if not impossible, for marine life to survive. A third paper titled, Potential for Managing Pool Levels in a Flood-control Reservoir to Increase Nitrate-nitrogen Load Reductions in Large Midwestern River, was prepared in a draft form. One of the highlights from this paper concludes that certain intentional e-pool strategies could further reduce nitrate nitrogen in the reservoir that would be the equivalent to installing nearly 650 edge-of-field conservation practices in the watershed every year.

The Red Rock delta is where the Des Moines River meets Red Rock Dam's reservoir. Silt-laden and nutrient rich waters of the river enter the lake. Their rich payloads of sediments and chemicals fall out to a create muddy, marsh-like aquatic wasteland and repositories of landscape abuse. While this area is nearly void of any recreational potential, its vastness and solitude provide a terrific sanctuary for migrating shorebirds. SRP-funded research proves how valuable this area can be for migrating birds. In 2020, the Des Moines River office (Red Rock Dam and Saylorville Dam) developed an AMMP. This coincided with an update to each WCM. These documents allowed the team to begin the Implement Phase and the Incorporate Phase with e-flow and e-pool management strategies. The team learned from the third and final year of an SRP-funded study named, Waterbird and Vegetation Response to Reservoir Water Management in Central Iowa, how important and productive this area is. It is a multi-purpose study of waterbird (includes shorebirds) use, stopover ecology, and vegetation response characterization in the delta. This research documents the number and species of waterbirds utilizing the vast delta during the SRP-inspired summer-drawdown of the lake. The exposed mud flats quickly become colonized by a variety of volunteer vegetation species. It is then flooded in the fall for migrating waterfowl in another e-pool strategy. Wildlife biologists knew the volunteer vegetation was highly attractive to migrating waterfowl for its prolific, high-energy seed production, but prior to this study no specific species composition had been characterized.

One of the goals in the Des Moines River AMMP was to "Improve conditions for reptiles and amphibians." Therefore, another e-pool strategy experiment was to pause the fall pool rise until ice-out in the spring. Red Rock Dam formerly had released the fall pool in early December, but lowering the

pool late in the season may harm brumating herptiles. To help ascertain herptile dynamics, Red Rock Dam and ERDC secured research support for reptile brumation habits from EMRRP. 2023 is the second year of this project and SRP e-pool and logistical coordination.

As knowledge is gained about e-pool and e-flow strategies inspired by the SRP sponsored AMMP, more questions arise that prompt the need for new studies. Migrating shorebirds exploit the freshly exposed sediments as the summer drawdown advances. An effort to understand the bird's diet to withstand an exhaustive and demanding migration was not known. In 2023, the SRP supported a three-year research effort to continue waterbird monitoring with the addition of sampling the invertebrate community to determine the diversity and relative abundance of shorebird prey species. A total of 17 waterbird surveys were completed, the first one on 19 July and the last one on 2 October. 45 species were seen with species richness peaking during the last week in August, which correlated with low pool levels.

Of the 45 species seen, 23 were shorebirds, 10 were waterfowl, and 12 fell into other waterbird groups. A total of greater than 185,000 individual waterbirds were counted. Research will continue in fall 2024.

Another similar research idea asks, "How long do shorebirds remain on the delta; where do they go; what are their habits and where do they go when they leave the Red Rock delta to resume their migration?" A 2023 SRP RFP included those life cycle questions and as it was deliberated, an expanded effort included potentially two additional USACE sites that have implemented e-pool strategies. An approved study named, Shorebird Tracking in Response to Sustainable Rivers Program Environmental Flows, includes utilizing a new generation of satellite tags to track the local and continental movements of a sample of pectoral sandpipers. A real-time, publicly accessible web interface was developed to share the movement of the birds: https://faculty.sites.iastate.edu/cootjr/iowa-pectoral-sandpiper-stopover-study. The web page is updated regularly, if the transmitter battery lasts, and displays the truly fascinating path that these tiny, intercontinental, rapid travelers take. The plan for 2024 is to expand to two SRP sites, one in Minnesota and one in Missouri.

The initial SRP funded work on fish reproduction and recruitment in the Lower Des Moines River spawned other questions about autochthonous fish. Shovelnose sturgeon are a Species of Greatest Conservation Need in Iowa (Iowa DNR). Shovelnose sturgeon are a native species indicative of environmental health, with additional recreational and commercial value. Shovelnose sturgeon have experienced two noteworthy (among others) fish kills in the Lower Des Moines River. In 2012, approximately 37,000 shovelnose sturgeon died and in 2023 about 21,000 died. Both events are tied to low flow and high-water temperature. Understanding the reproduction of this long-lived and slow growing species is important. Toward that end, SRP partner Iowa DNR-Fisheries invested in an array of 29 telemetry receivers and tagged shovelnose sturgeon to monitor sturgeon movement. A new three-year study by ISU researchers, with cooperation from the Iowa DNR, was published titled, Effect of Reservoir Operation on Fish Reproduction, Movement, and Survival in the Des Moines River System. This study has two objectives: first, to compare spring migration phenology of shovelnose sturgeon using the acoustic telemetry system in two Mississippi River tributary systems; one with and one without experimental flows. This will help determine how e-flows may influence movement, location, timing, and reproduction. The second objective is to monitor behavioral movements and habitat selection in relation to flows and temperature during the summer when water temperatures are warmest.

One ongoing effort of the Des Moines River SRP is awareness and education. The team seeks to continually inform management and colleagues about the successes and knowledge gained within the USACE enterprise. Additionally, outreach includes partners, stakeholders, and taxpayers so the benefits and justifications are understood for this USACE and TNC proactive initiative. Des Moines, Iowa, has generated regular Sigacts (MVR jargon for significant activities) and storyboards that are submitted to district offices. Select contributions are forwarded to division offices and/or HQ. A presentation of ongoing SRP activities in MVR was provided to MVR Operations Division leadership to ensure adequate engagement and to inform, which in turn spawned unequivocal endorsement for SRP support. Posters are created to highlight SRP activities in the Red Rock Dam Visitor Center.

ERDC helps administer some of the SRP-funded projects in MVR. The Des Moines-ERDC team hosted a day-long coordination forum at Red Rock Dam where student researchers, professors, professional scientists, and the Des Moines SRP team presented and shared information about Des Moines River SRP activities. An article featuring the Des Moines River SRP was published in the Stewardship News, a news bulletin published by USACE. SRP sponsored a national meeting in Saint Louis, Missouri, to offer an opportunity for USACE, partners, and curious potential participants to learn about the program, its benefits, and lessons learned. The Des Moines River SRP team was a program contributor in that outreach as a model of the SRP process.

The Des Moines River SRP joined two ISU Master of Science students to present ongoing research to the joint meeting of the Iowa Wildlife Society and the Iowa Chapter of the American Fisheries Society in Ames, Iowa, on 1 through 2 March 2023. Professional biologists, students, professors, and fisheries enthusiasts learned about the SRP and its beneficial work. While the event was hosted by ISU, participants from many other states and foreign countries attended.

The Des Moines River SRP also lends support to two other SRP-funded projects in MVR. One includes the Iowa River-Coralville Lake AMMP development effort. A final coordination meeting with partners and stakeholders was held near Coralville Dam for the unveiling of the AMMP. Specifics about the plan; the Des Moines Advance, Implement, And Incorporate experience; and SRP were presented. The Iowa River-Coralville Dam AMMP was distributed at the end of 2023. The other SRP-supported project in MVR includes the Farm Creek project, which is a USACE-managed, dry reservoir that drains into the Illinois River and Illinois Waterway. The Des Moines River SRP facilitated in finishing the environmental review so the work could begin.

Anticipated Work in Fiscal Year 2024

New SRP-sponsored research includes two objectives to study shovelnose sturgeon in the Lower Des Moines River. These are described in a report titled, Effects of Reservoir Operation on Fish Reproduction, Movement, and Survival in the Des Moines River System. The first objective is to compare spring migration phenology of shovelnose sturgeon using acoustic telemetry in the Des Moines and Cedar rivers; two Mississippi River tributary systems, one with and one without e-flows. The second objective is to monitor behavioral movements and habitat selection in relation to flows and temperature during the summer period to advance understanding of shovelnose sturgeon summer movement ecology. This information may aid in flow consideration understanding to reduce risk of physiological stress, which leads to mass mortality events of shovelnose sturgeon. While the focal species is shovelnose sturgeon, the team anticipates benefits to lake sturgeon (State Endangered, Iowa) and pallid sturgeon (Federally Endangered) may also be discovered. The acoustic telemetry network is

an in-kind network of receivers established by the Iowa DNR Fisheries Bureau and the U.S. Fish and Wildlife Service (USFWS). A second field season or final reports and theses will occur as mentioned above, plus the completion of work at Farm Creek dry reservoir along the Illinois Waterway-Illinois River. Communication and outreach will continue as in previous years and is detailed in the SRP FY 2024 Scope of Work for MVR.

The Des Moines River SRP team responded with several 2024 RFPs that await greater discernment and discussion once 2024 funding is determined.

Future Vision

The MVR SRP team was initially concerned with how dam and reservoir operations can be managed to minimize negative ecological consequences and maximize positive flow and pool benefits. The product of an e-flows workshop, with scientific experts and resource professionals, provided the flexible framework for a versatile AMMP. This alignment of academics, field personnel, reservoir operators, and hydrologists has already yielded outstanding environmental benefits and scientific knowledge. This collaboration has not occurred to this extent before on the Des Moines River. The Des Moines River SRP team seeks to continue the dialogue between agencies and scientists to affect the most benefit from operations. As the team learns, more questions arise. By viewing the waters of Iowa as a life-sustaining resource, rather than simply landscape overflow and drainage, the riverine ecology seems to respond in-kind. The work on the Des Moines River is invaluable and will continue to transfer knowledge to other reservoirs, locks and dams, and promote exploring e-flows and water level management across the USACE enterprise.

Gila River (Painted Rock), AZ - SPL (DD)

Painted Rock Dam is located on the Gila River, in the southwest part of Maricopa County in the State of Arizona, about 20 miles northwest of Gila Bend, Arizona. Gila Bend is a town located on the U.S. Highway 80, approximately 78 miles southwest of Phoenix, Arizona. The dam site is in a gap between the Painted Rock Mountains and the Gila Bend Mountains where the river is confined to a relatively narrow channel. It is the last dam on the Gila River before its confluence with the Colorado River.

The regulated inflow coming from the upstream projects includes releases made by the Salt River Project System which is comprised of seven reservoirs on the Salt and Verde rivers, releases made by the Coolidge Dam on the upper Gila River operated by the San Carlos Indian Project, and releases made by the New Waddell Dam on the Agua Fria River operated by the Central Arizona Project. The current downstream channel capacity is limited to approximately 10,000 cfs. Painted Rock Dam has a drainage area of 50,800 square miles.

FY 2022 was the first year of SRP support for environmental activities at Gila River to include physical creation of wetland habitats. The team believes that additional wetlands in this region would improve migratory bird foraging, provide additional habitat for resident bird populations that utilize riparian and riparian scrub habitat, and provide ancillary benefits to resident wildlife populations in an otherwise arid environment.

Status of Fiscal Year 2023 Work

The team completed an assessment of the USACE property and discovered four abandoned wells in the upstream flood pool area adjacent to the Gila River. Based on a reconnaissance by the U.S. Bureau of

Reclamation (USBR) well drilling team, the well appears suited for rehabilitation to provide hydrology to new wetland habitats. USBR will gather additional information on the well in January 2024 to ascertain if a pilot wetland of 0.25 to 0.5 acres in size could be supported. Conceptually, the well would run on a solar-powered pump to support a mosaic of constructed perennial and ephemeral wetlands. If successful, the team believes USFWS would be amenable to populating the wetlands with Endangered Species Act (ESA)-listed species.

Internally, the USACE SRP team has initiated environmental analysis, including National Environmental Policy Act (NEPA) compliance work and engineering (occurred at the 30 percent design phase). The team has compiled a list of stakeholders and collaboration began with the Arizona Game and Fish Department and an adjacent landowner. Contact with additional stakeholders is on hold until engineering and feasibility work progresses.

Anticipated Work in Fiscal Year 2024

In FY 2024, the team anticipates completing the remaining environmental work, including NEPA documentation, engineering, and plans and specifications. The team anticipates awarding a contract or Military Interdepartmental Purchase Request (MIPR) to USBR to repair the existing well, purchase and install a solar pump, and purchase a liner and planting material. Once the contract is awarded, the team plans to develop a draft AMMP and initiate discussions with USFWS on using the constructed wetland as habitat for ESA-listed species.

The team will also continue coordination with local non-government agencies as well as other state and federal agencies. Currently partners on the project include Arizona Game and Fish Department, USBR, USFWS, The Water Boys, and Backcountry Hunters and Anglers–Arizona Chapter. There is a high level of support and interest in this project by residents, public land users, and nearby landowners.

Future Vision

The team believes Painted Rock Dam has the potential to serve as an important habitat linkage between up and downstream islands of habitat on the Gila River in this extremely arid climate. In addition, the remoteness of the site reduces the USACE risk of trespass and vandalism on constructed restoration sites and associated facilities. Therefore, if the FY 2024 work is successful, the team would seek to develop a more comprehensive ecosystem restoration plan for the area to include perennial and ephemeral wetlands where suitable sources of hydrology and other conditions are present. For example, four wells were identified upstream of the dam and have the potential to support construction of perennial and/or ephemeral wetlands. Other sites were identified downstream of the dam as has having potential for ephemeral wetlands. The dam is remote and does not support recreational activities, providing an ideal setting for wildlife refugia in an otherwise urban region.

Green River (multiple reservoirs), KY - LRL (Gen and LD)

The Green River Watershed, encompassing approximately 9,230 square miles, is in west-central Kentucky and extends into north-central Tennessee. The headwaters of the Green River originate in Lincoln and Casey counties, Kentucky in the Mississippian Plateau where it then flows in a northwesterly direction for 330 miles through the Western Coal Field region to its confluence with the Ohio River near Henderson, Kentucky. The largest of the twelve river watersheds in Kentucky, six USGS Hydrologic Unit Code (HUC) 8 sub-basins are contained within the HUC 4 Green River Watershed (051100), including the

Barren River, Upper Green, Middle Green, Rough River, Pond Creek, and Lower Green watersheds. The Green River Basin contains four LRL reservoirs: Green River Lake, Barren River Dam, Nolin River Dam, and Rough River Dam. These multi-purpose reservoirs on the main tributaries to the Green River support flood control, water supply, water quality, and recreation use. Each reservoir is guided by project specific WCMs to ensure project compliance with congressionally approved operating purposes.

The Green River is one of the most ecologically significant aquatic systems in the United States containing more than 150 species of fish, more than 70 species of freshwater mussels, and at least 10 endemic aquatic species. At least nine endangered mussel species have been documented in the basin. Additionally, just 110 miles downstream of Green River Dam, the Green River flows, and supplies water into the cave systems of Mammoth Cave National Park, which has one of the highest biodiverse subterranean habitats in the world with 41 cave-adapted organisms. With 6 miles of the Nolin River and 25 miles of the Green River flowing through Mammoth Cave National Park, both the tributaries and main stem river of the Green River Basin directly impact the delicate aquatic ecological communities present in the cave systems below.

The Water Management Section of the LRL operates four federal reservoir projects (Green River Dam, Nolin River Dam, Barren River Dam, and Rough River Dam) as a component of the Green River Basin system. A system of locks and dams originally authorized for navigation purposes were also built for commercial use along the Green and Barren rivers beginning in the 1840s to early 1900s with replacements made in the early to mid-1900s. However, Green River Lock and Dams Nos. 3, 4, 5, 6 and Barren River Lock and Dam No. 1 were recommended to be congressionally deauthorized in 2014, which later spurred the removal of some of these structures. Recent dam removal efforts, both completed (Green River No. 6 in 2017, Barren River No. 1 in 2022) and ongoing (Green River No. 5), have altered the hydrology, hydraulics, and ecology of the green River Basin system. The removed dams benefit fish and mussel populations as well as recreation on the rivers. Potential SRP actions could further benefit these areas once the impact from these lock and dam removals has been established and evaluated.

Status of Fiscal Year 2023 Work

In in August 2023, the team planned and successfully executed a 3-day workshop at Mammoth Cave National Park that brought together 60 stakeholders from various local, state, and federal organizations across the country. During the workshop, participants engaged in networking, presentations, breakout sessions, group discussions, and site visits to understand the past and present state of the basin, as well as brainstorm SRP opportunities for the future of the Green River Basin. The outcome of thoughts, ideas, and information gathered over the three days was summarized into a final report that has been drafted and is under review.

Anticipated Work in Fiscal Year 2024

A submittal was approved for FY 2024 to conduct a series of e-flow workshops for projects in the Green River Basin to determine any areas for improvement in the operations of Barren River, Nolin River, and Rough River dams. Data will be collected alongside the e-flow workshop efforts to inform the data and findings of the workshops. The team also plans to add the Licking River to the SRP in conducting an e-flow workshop for Cave Run Dam located just south of Morehead, Kentucky. All anticipated workshops will be completed by the USACE and TNC team along with local partners. The team is hopeful that implementation of any operational adjustments can begin after each respective workshop is concluded.

Additionally, the team plans to conduct a temperature study on the Salt River downstream of Taylorsville Dam and the Licking River downstream of Cave Run Dam to determine how far any temperature releases from each respective reservoir impact downstream.

Future Vision

The Green River Basin e-flow workshops and the temperature study on the Salt and Licking rivers will have an impact beyond work conducted in FY 2024. Following the completion of 2024 work and the continuation of 2024 work, the team will review the data to work toward informed implementation and eventual incorporation of the findings at each respective reservoir in the program. All future plans and any adjustments will be coordinated with LRL Water Management and Operations to ensure successful implementation.

Kansas River (e-flows; multiple reservoirs), KS and NE - NWK (Gen)

The Kansas River drains almost the entire northern half of Kansas, as well as part of Nebraska and Colorado (53,000 square miles). It is the largest prairie-based river system in the world, with the watershed comprised primarily of grassland, pastures, and row-crop agriculture. The Kansas River serves as a critical drinking water supply for more than 800,000 people. Additionally, the Kansas River is used for irrigation, municipal wastewater and industrial discharges, cooling water for three coal-fired power plants, and as a source of commercial sand and gravel.

There are nine major USACE reservoirs within the lower end of the drainage basin. In total, 18 federal reservoir projects impound water on all major tributaries of the Kansas River and control streamflow in 85 percent of the drainage area. From the confluence, the left bank tributaries and associated reservoirs include the Republican (Harlan and Lovewell in the Upper Republican; Milford in the Lower Republican), Big Blue (Tuttle Creek), and Delaware (Perry). The right bank tributaries and associated reservoirs include the Smoky Hill (Waconda, Wilson, Kanopolis), and Wakarusa Rivers (Clinton). Other reservoirs managed by USBR and the states of Kansas and Nebraska regulate flows in the upper reaches of the basin. USACE reservoirs are authorized for a variety of purposes, including but not limited to flood risk management, recreation, fish and wildlife, irrigation, water quality, and water supply.

Status of Fiscal Year 2023 Work

The Kansas River is in its seventh year of the SRP. This work seeks to implement planning and coordination for incorporation of e-flows described during the first and second e-flows workshops and work to define additional e-flows based on monitoring, coordination, and experimentation to determine hydrologic and hydraulic needs to support habitat improvements. This scope of work includes organization and preparation meetings and workshops, with the goal of discussing the practical potentials for additional flow plans developed for various targets to benefit the basin as a whole using new ecological information for an expanded geographic scope. Any additional e-flow plans would be developed within the constraints of authorized purposes of the reservoirs, water rights, other human-use requirements, and in collaboration with stakeholders. The scope includes implementation planning and coordination through participation in WCM updates; sampling of fish species, macroinvertebrates, and habitat; workshops and modeling to investigate potential oxbow restoration; and monitoring of geomorphology to inform ecological models in support of e-flows. These tasks are ongoing. See the Anticipated Work in Fiscal Year 2024 section for a status update.

Anticipated Work in Fiscal Year 2024

The participation in WCM updates is ongoing and will be timed with the development of alternatives under this process to look for opportunities to include e-flows. The sampling related to fish chronologies was completed in 2023 and data reporting is underway by Kansas State University for submittal. The sampling of fish species, macroinvertebrates, and habitat is ongoing with SRP funding to be used in the 2024 calendar year and reporting to follow. An initial kick-off meeting was held for the oxbow restoration work and planning for the first workshop is underway. The first workshop will include a discussion of sites to investigate, existing information, modeling needs, and proposed restoration. The first year of monitoring of geomorphology to inform ecological models was conducted with a second year to occur in 2024 followed by completion of conceptual model development and model documentation.

Future Vision

The team is currently working to develop an implementation and monitoring plan, which will include the future vision for tracking effects of e-flows when implemented. The first step will be to discuss the current e-flows with interested parties and determine the feasibility of each or if any require refinement. Future work will use this information to determine if adaptive management is needed to include refinement of e-flows and monitoring needs. Once an e-flow is planned for implementation, a monitoring strategy will need to be in place for this and funding requested. Additionally, the updates to WCMs will be important to future implementation of e-flows and trying to provide flexibility for implementation.

Kansas River (e-pools; multiple reservoirs), KS and NE - NWK (Gen)

Harlan County, Kanopolis, Milford, and Wilson dams are located on tributaries of the Kansas River. Authorized missions include flood risk management, recreation, water supply, irrigation, and fish and wildlife management. Reservoirs in the Kansas River Basin have been active with the SRP since FY16 and have accomplished several e-flow workshops and developed e-flow implementation plans. Additionally, NWK received FY 2023 funds to update WCMs for all lake projects in the Kansas River Basin, including the aforementioned four. WCM updates are schedule occur over the next 5 to 10 years with Milford Dam beginning in FY 2023 and Harlan County, Kanopolis, and Wilson dams beginning in FY 2028.

Decades of sedimentation have altered shallow water habitat at reservoirs in NWK. The sedimentation at reservoirs has created, removed, disconnected, and/or fragmented shallow water habitat. Shallow water areas provide migratory shorebirds, waterfowl, fish, reptiles, amphibians, aquatic mammals, and other aquatic organisms habitat for concealment, feeding, and breeding. USGS telemetry data and research indicates that the four lakes are utilized as stopover habitat by migrating whooping cranes (*Grus americana*) and fall within the species 95-percent core migration area. Potential SRP actions could benefit shallow water habitat and the fish and wildlife it supports.

This SRP project will study in-lake water level management strategies for environmental benefits at reservoirs in the Kansas River Basin. Current lake level management plans and WCMs attempt to maximize waterfowl and shorebird shallow water habitat during spring and fall migrations, as well as fish spawning habitat with little known data on actual impacts to habitat.

This funding supports work to determine the lake elevations that offer the greatest amount of shallow water habitat within the context of pool management for all operating purposes. The project team will include Kansas and Nebraska state biologists, TNC, Ducks Unlimited, USACE, and any other key partners/stakeholders. This project has potential synergies with e-flows for the Kansas River Basin and current lake project WCM updates.

Status of Fiscal Year 2023 Work

In FY 2023, the team was able to meet to determine the various habitat criteria for GIS modeling. Once criteria were determined, the team shared the information with GIS specialists that developed various maps for each lake depicting habitat availability and different pool elevations. An e-pools workshop with area managers and scientists was completed. During the workshop, experts were able to develop e-pool sequences for fish and bird species, identify target elevations during the sequence, and develop a lake level management guide curve. This information was applied to the Regime Prescription Tool for fish and birds, respectively. An e-pools workshop summary report has been drafted and is under review.

Anticipated Work in Fiscal Year 2024

In FY 2024, the team plans to add Perry and Tuttle Creek dams in Kansas to the e-pools project. GIS modeling will be completed for all projects that develop spatial relationships for various habitat criteria. E-pools workshops with team and local partners will be completed at Perry and Tuttle Creek dams. Following the workshops, e-pool strategies will be compared to nutrient loading controls, Kansas River e-flow proposals, and climate change models with area experts. A final e-pools workshop will be hosted for stakeholders with interests in water management to include the Kansas Water Office, outgrants, and the public.

Future Vision

Following the completion of 2024 work, the team will review all previous data and reports to combine into a single e-pools management proposal to be implemented with the WCM updates and specifically the Lake Level Management Plans. Coordination with NWK Water Management and the Kansas Water Office will need to occur to ensure successful implementation.

Kaskaskia River (Carlyle, Shelbyville, and Jerry F. Costello), IL - MVS (Gen and LD)

The Kaskaskia River Basin covers 10 percent of the State of Illinois, encompassing parts or all of 22 counties, with 30 main tributaries and 5,840 square miles of drainage. It is a tributary of the Mississippi River, with headwaters just west of Champaign, Illinois, and flows southwesterly across the state for approximately 325 miles to its confluence with the Mississippi River, about 8 miles north of Chester, Illinois, at RM 117.

Carlyle Dam was completed 1967 and Shelbyville Dam was completed in 1970; both were built primarily for flood risk management. The Jerry F. Costello Lock and Dam (originally named the Kaskaskia Lock and Dam) (RM 28) was completed in 1974 to provide a nine-foot navigation channel for a narrower tow barge configuration than those that transit the Mississippi River locks and dams. Flexibility of dam operations offers potential to manage water levels lower during summer growing season to enhance aquatic plant growth.

The Kaskaskia River was identified as a high priority work area for SRP action at the 2019 Midwest Operations and Water Management Meeting. All three dams on the Kaskaskia River were proposed for the SRP by MVS in 2020. In FY 2020, the team analyzed daily flows for the previous 10 years at Kaskaskia River Lock and Dam and upstream releases at Carlyle Dam to determine feasibility of water level management implementation to expose shoreline substrate upstream of Jerry F. Costello Lock and Dam. Water control managers and other stakeholders held meetings with a small group of stakeholders to propose a 0.5-foot water level reduction at the dams to expose river edge for at least 30 days during the summer. The exposed substrate has viable native seeds that will regenerate and provide fish and wildlife habitat, capture suspended sediment, and stabilize the riverbanks. FY 2021 work included public outreach, qualitative vegetation monitoring, approximately half of the desired aerial imagery analysis, and photo documentation of the plant response at Carlyle Dam and on the Kaskaskia River.

Status of Fiscal Year 2023 Work

Drought conditions prevailed throughout 2023, which affected the SRP team's ability to attempt drawdowns throughout the Kaskaskia River system. During mid-summer, the reservoirs needed to hold as much water as possible as a precaution to ensure suitable flows to minimize navigation issues on the Mississippi River and to minimize impacts to water supply. In early fall, the lower Kaskaskia River elevation did drop to a drawdown condition, but this was due to lack of reserves in the reservoirs upstream. However, a drawdown in late summer is too late in the season to generate a plant response. Lockage of recreational vessels was paused on the Kaskaskia River during the late summer to maintain a navigable channel on the Kaskaskia River.

Anticipated Work in Fiscal Year 2024

A joint public outreach meeting for Carlyle Dam and the Lower Kaskaskia River is scheduled for winter 2024. The team proposes to build on the FY 2021, 2022, and 2023 work that included successfully completing water level management efforts at Kaskaskia River locks and dams. Also proposed is a continuation of quantitative vegetation monitoring efforts during implementation to document plant response and biological impact and showcase success to use for future public outreach. The team is adapting environmental drawdown attempts to refine e-flow strategy based on past lessons.

Future Vision

The team continues to learn more about the capabilities and plant response at each of three locations identified for drawdowns on the Kaskaskia River. Lessons learned from each year's attempts will be utilized to inform and refine the future management strategies. Opportunities may exist to implement drawdowns and capture additional ancillary benefits at adjacent state-managed sites, so continued coordination with partners and the public will be necessary to maintain support for the project. Diverse stakeholders, particularly at the reservoirs, underline the importance of continued outreach and communication to ensure the public is informed and that any concerns that arise are addressed promptly. The overarching goal is to identify ecologically beneficial management practices that can be incorporated in the water control plan.

Lake Washington Ship Canal (Ballard Locks) - NWS (LD)

Hiram M. Chittenden Locks and Dam is a lock and dam structure operated by NWS. Located in the heart of a heavily urbanized environment, the Hiram M. Chittenden Locks and Dam and Lake Washington Ship

Canal (LWSC) connects the saltwater Puget Sound to the inland freshwater systems of Lake Union and Lake Washington. Hiram M. Chittenden Locks and Dam are operated to allow commercial and recreational boat traffic to move between Puget Sound and Lake Washington, maintain Lake Washington elevations, provide fish passage, and control salinity intrusion. Operation of the Hiram M. Chittenden Locks and Dam affects water quality within the LWSC due to the exchange of water from Puget Sound into the ship canal during use of the lock chambers as well as influencing the movement of water from Lake Washington through the ship canal that discharges into Puget Sound.

NWS received funding from the SRP during FY 2021 to update and recalibrate an existing 2D CE-QUAL-W2 water quality model to better understand if operations of the Hiram M. Chittenden Locks and Dam and system hydrodynamics could be adjusted to improve water temperatures within the model domain. The completion of this project has provided NWS with the necessary tools to better address managing water temperatures for the benefit of ESA-listed salmon species. Ultimately, the modeling effort and final report will inform future NWS actions and meet the project authorization of environmental stewardship.

The Hiram M. Chittenden Locks and Dam and LWSC are in the Advance Phase of the SRP process. NWS will utilize current SRP funding to have the model reviewed by third-party subject matter experts.

The independent subject matter experts model review shall focus on model development and calibration as well as model sensitivity simulations, with the goal of confirming the model's efficacy. Specifically, the review will assess the model's simulation of hydrologic and water quality conditions in the LWSC, its utilization of available and relevant data, the selection of model specific algorithms, and any shortcomings and possible implications on the modeling results. Upon completion of the independent review, the subject matter experts will submit a report of their findings to the NWS team. The NWS team will then address the findings and update the model as needed.

Furthermore, the subject matter experts and colleagues will assist the NWS team to implement any updates found within their review. Lending their expertise to the process will facilitate further capacity building in CE-QUAL-W2 modeling for the NWS team and ensure refinements to the modeling package are implemented with subject matter expert oversight, thus ensuring technical efficacy and accuracy.

The final product of a reviewed model and final report will help inform potential solutions to address water temperature concerns in the LWSC and Hiram M. Chittenden Locks and Dam.

Status of Fiscal Year 2023 Work

In the beginning of 2023, NWS and the contractor finalized a co-authored report that highlighted the calibration results executed by the contractor and the modeling sensitivity analyses executed by NWS staff. This deliverable, along with the modernized CE-QUAL-W2 model of the LWSC and Hiram M. Chittenden Locks and Dam, enabled the NWS team to close-out the first stage of the project that was launched in FY 2021. Simultaneously, NWS contacted third-party subject matter experts and engaged in a series of negotiations for a multi-phase scope of work. The Economy Act Order (EAO) process was then followed to obtain the services of the subject matter experts. This process concluded before the end of FY 2023.

Anticipated Work in Fiscal Year 2024

Project kick-off occurred on 19 October 2023. The NWS team has provided the subject matter experts with the modeling files, scripts, and reports needed to conduct a thorough review of the model development, calibration, and sensitivity simulations. Phase I of the project is scheduled to conclude by January 2024 and a peer-review of the modeling package will be the deliverable. Based on the findings of the subject matter experts in Phase I, the scope of Phase II will focus to address model updates and refinements. Phase II will entail initial updates completed by the NWS team with the support of the subject matter experts. Technically advanced updates, such as altering the model's computational algorithms, will be conducted by the subject matter experts. Phase II is scheduled to begin by May 2024 and end in January 2025, with final deliverables including any updated modeling files and at a minimum, a Restricted-File Federal Interagency Report (RFFIR).

Future Vision

With a thoroughly vetted model, the NWS team envisions releasing the baseline model and supporting data files into the public domain. Ideally, this will occur via a data release and publication by the subject matter experts currently engaged under the EAO launch at the end of FY 2023. Obtaining the subject matter experts' public stamp of approval positions the NWS team to confidently return to the table with stakeholders comprised of local, state, federal, Tribal, and non-profit entities, and reengage in the conversations on how to address water quality concerns in the LWSC system.

Minnesota River (Highway 75 Dam), MN - MVP (Gen)

The Highway 75 Dam and its reservoir were completed in 1974 as a mitigation feature to the improved outlet at the upstream Big Stone Lake, all of which were part of the Big Stone Lake-Whetstone River Flood Control Project. The improved outlet on Big Stone Lake improved lake conditions during flood events and the Highway 75 Dam and reservoir provided storage to prevent additional flooding downstream. Highway 75 Dam also has a purpose of enhancing the fish and wildlife resources by maintaining a desirable range of pool levels on the Big Stone NWR. The USFWS manages the refuge and prepares an annual operating plan for water levels that is followed as closely as possible by USACE after the spring flooding season.

As a result of the MVP SRP workshops held in FY 2021, and the awareness achieved by the planned Mud Lake drawdown, the USFWS approached MVP requesting that a summer drawdown be considered for inclusion in the operating plan of the Highway 75 Dam. The drawdown would be used to expose mudflats for shorebirds and to improve vegetation for waterfowl. The summer drawdown would also help control invasive common carp. The USFWS has championed such operation for some time and garnered local support for it. They have also preliminarily evaluated the potential effects of a drawdown and determined that they are largely positive, with no currently known substantive adverse environmental or public-use effects.

Status of Fiscal Year 2023 Work

During 2023, the team began coordination with the USFWS to develop potential operating plans for growing season drawdowns. USACE Water Management staff began modeling those plans to determine their probabilities of success.

The team is working toward completion of the necessary development, evaluation, and documentation for a deviation from the 2005 Highway 75 Dam WCM operating plan to include annual growing season

drawdowns. With participation from the USFWS, MVP has identified a viable plan and is drafting an environmental assessment for implementation of a drawdown during spring/summer of 2024. The drawdown would initially be implemented through a deviation from the WCM, pending approval by MVD and then included in the next version of the WCM, as appropriate.

Operating a reservoir with frequent growing season drawdowns would be innovative in MVP. A similar operating scenario is currently being proposed for nearby Mud Lake, which is expected to have numerous environmental benefits. Much of the science for this is already developed and would likely be limited to reviewing existing information on shorebird and waterfowl use, determination of effects to the environment within the study area, limited hydrologic modeling to characterize operating plan performance, and considerations for pre- and post-deviation monitoring.

Anticipated Work in Fiscal Year 2024

An environmental assessment will be completed to fully evaluate the effects of the plan. A public review of the environmental assessment will be completed prior to signing a Finding of No Significant Impact (FONSI), after which a request for a deviation from the current operating plan will be sent to MVD for approval. If approved, the drawdown will be implemented beginning in the spring/summer of 2024.

Future Vision

It is anticipated that the annual growing season drawdown will be successful and then incorporated into the operating manual for the dam, making it a permanent.

Mississippi River (Melvin Price), IL and MO - MVS (LD)

The Upper Mississippi River has been modified for navigation and other purposes for over 100 years through a series of locks and dams constructed in the 1930s and 1940s. The primary purpose of these projects was to construct the 9-Foot Channel Navigation Project. Each lock and dam creates a navigation pool to provide relatively stable water levels during non-flood periods.

The high and relatively stable water levels created by the locks and dams subjected islands in the lower portion of the pools to wave erosion. Many islands disappeared along with the aquatic plant beds adapted to the shallow water. A river restoration program was secured through Congressional action and although critical river restoration has occurred, seasonal variability in flow and water levels has not.

The three USACE districts of the Upper Mississippi River have experimented with modifying operations of the locks and dams to restore some seasonal variability. The districts have reduced water levels during the growing season in some pools to expose mudflats and prompt native seed germination. MVS was successful in using operational flexibility to keep water levels slightly lower in the summer while maintaining the navigation channel. Between 2015 and 2018, SRP supported MVS in monitoring adaptive management activities to demonstrate responses to these lower water levels at specific locations. This SRP funding supports improving the management of the entire system, including more than 30 locks and dams on the Upper Mississippi and Illinois rivers.

The Upper Mississippi River SRP team continued developing an implementation strategy for operationalizing water level management within the system. In FY 2020, the team acquired hourly flow and gage data from locks and dams from 2016 through 2018 during the growing season and performed analysis of the data to determine operational capability for small-scale water level management. The

focus was to identify specific operating bands for each lock and dam on the Upper Mississippi River totaling over 500 RMs. The team quantified potential acres exposed and anticipated success rates for several drawdown scenarios in 14 pools in MVR and 9 pools in MVP. The objective of the Planning Assistance to States (PAS) report is to evaluate opportunities of using systemic water level management on the Upper Mississippi River.

In FY 2021, the Upper Mississippi River SRP team proposed to investigate, compile, and document Upper Mississippi River goals and objectives. In FY 2021, the team completed a report of FY 2020 accomplishments and expanded work by holding remote regional operational workshops for a small group of water control managers. The workshops consisted of 6 meetings totaling 21 working hours between March and July 2021. The members considered programmatic implementation of water level management in the Upper Mississippi River. Participants represented the following agencies: USACE, USFWS, USGS, Upper Mississippi River Basin Association, TNC, Illinois DNR, Iowa DNR, Minnesota DNR, Wisconsin DNR, and the Environmental Protection Agency. The facilitator used Shared Decision Making (SDM) processes and an adaptive management framework to guide the discussions. Input was organized into a detailed report capturing the steps and decisions made during the workshops, and recommendations for characterizing the ecological conditions of pools to aid selecting and prioritizing pools for water level management.

In FY 2022, the Upper Mississippi River SRP team transitioned from overall water level management study to specific scientific efforts to assess habitat and species-specific. These efforts are to facilitate lake sturgeon spawning and shorebird habitat management, as described below.

Mississippi River-Lake Sturgeon, Missouri—St. Louis District

The lake sturgeon is a charismatic fish species that is unique due to its longevity and sheer size. Lake sturgeon, also known as rubbernose sturgeon, can reach 8 feet long, weigh over 200 pounds, and live over 100 years. Lake sturgeon are designated as state endangered species in Illinois and Missouri. In 2015, lake sturgeon were observed spawning in the tailwater of the Melvin Price Locks and Dam, a dam and two locks at RM 200.78 on the Upper Mississippi River, about 17 miles north of St. Louis, Missouri. This site became the first confirmed sturgeon spawning location in Missouri, however some of the specifics around this event are not fully understood. It is known that water temperature, time of year, flow velocity, and substrate are critical to spawning. Ongoing work seeks to collect data necessary to operationalize e-flows for lake sturgeon through targeted operations, collaboratively monitoring lake sturgeon activity and response, and conduct agency coordination and public outreach.

Beginning in FY 2021, MVS completed baseline flow conditions of prior use years in HEC's River analysis System (HEC-RAS) two-dimensional (2D) modeling, sturgeon sampling, tracking and spawn monitoring, as well as development and implementation of an SRP lake sturgeon conservation outreach plan. HEC-RAS was used to simulate existing channel conditions and study velocities affected by gate-bay gate settings during the April 2015 spawning zone and two similar events from 2016 and 2018. The tailwater averages for the 2018 and 2016 events were 405.3 feet and 405.1 feet, respectively. The approximate tailwater elevation relationships between events simulated indicated that tailwater might be the most functional parameter in establishing a relationship between hydraulics and lake sturgeon spawn. These functional relationships can be used as a determining factor for decisions on ideal gate 9 or gate 8 settings. For a tailwater ranging from 403.0 feet to 406.5 feet, the current recommended settings for

gate 8 is 4 to 5 feet, and gate 9 is 2 to 4 feet. A gate 8 and gate 9 opening of 5 feet and 4 feet, respectively, would coincide with the lowest total gate openings within this tailwater range.

Model outputs were used as a starting point for generating recommended gate settings to achieve target flows in the suitable spawning substrate area. Shoreline velocity measurements taken in the field each morning were used to verify suitable flows or used to inform further gate management. Target velocities were maintained and documented for nearly four weeks and resulted in a very successful lake sturgeon spawning season. Active monitoring during the field season identified that the location of suitable spawning velocities shifts on the bankline with various gate settings and suggests that a range of gate settings may achieve target velocities needed to encourage lake sturgeon spawn at the site. The news of the second successful lake sturgeon spawns in 2022 and 2023 generated several wide-reaching news articles and shared media products on the project.

Summary reports are being prepared for the work on lake sturgeon spawning. The team is also further analyzing and refining the model to inform draft operational plan development for eventual incorporation into the WCM updates and the team continues to partner with the Missouri Department of Conservation to capture, tag, and track lake sturgeon in the Melvin Price Locks and Dam tailwater.

Anticipated Work in Fiscal Year 2024

Lake sturgeon spawning success has been achieved at Melvin Price Locks and Dam. Knowledge gained from these spawning events will be utilized to assess all locks and dams on the Upper Mississippi River. MVS will work with MVR, MVP, and other partners to identify additional locks and dams that may offer the potential for managing lake sturgeon spawning habitat. Factors such as habitat quality, ability to manage flows, lake sturgeon presence, and accessibility will be considered to determine viability of a given site. These efforts could lead to the expansion of collaborative efforts at Melvin Price Locks and Dam for implementation at new infrastructure. Additionally, SRP plans to work with the Missouri Department of Conservation to assist with baseline sturgeon monitoring at Mississippi River Lock and Dam 25 near Winfield, Missouri.

Future Vision

SRP plans to manage the entire Upper Mississippi River, over which there are 27 locks and dams spanning several hundred RMs, to maximize beneficial spawning habitat for lake sturgeon and migratory shorebirds while maintaining navigation. The team will apply lessons learned to other pools along the Upper Mississippi River, Illinois River, and others.

Mississippi River-Shorebird Habitat Enhancement, Missouri—St. Louis District

The Upper Mississippi River System is located at the center of one of the primary migratory bird pathways in North America and is historically significant for migratory shorebirds. Many of the species that utilize migratory stopover habitat in this region depend on mudflat habitats, scattered across hundreds to thousands of miles apart, to use as breeding and overwintering areas. Shorebirds depend on shallowly flooded and recently flooded mudflats and sandbars to access invertebrate prey. When mudflats are exposed, extensive shorebird use near Melvin Price Locks and Dam declines quickly due to surface drying. Ongoing work seeks to provide shorebird habitat for migrants more consistently across their spring and fall migratory period (March through June and mid-July through September).

The team was hoping to implement experimental, short-duration water elevation pulses between 0 and 1.2 miles upstream to rehydrate exposed sandbars and mudflats during spring 2022. However, water level manipulations were limited due to river conditions and lake sturgeon spawning needs below Melvin Price Locks and Dam. Due to this challenge, the team instead took advantage of natural pool level fluctuations to gather data on macroinvertebrate densities, sediment conditions, and shorebird use.

Macroinvertebrate samples were taken over several pool fluctuations over several days to evaluate changes in conditions. This was valuable for providing baseline data that shows suitable macroinvertebrate densities are present for shorebird management. Due to the ongoing challenges from multiple projects near each other, with different requirements, the team proposed to move the shorebird habitat evaluation project to the lower Kaskaskia River. This area has multiple oxbows, backwaters, and wetlands that can be influenced by pool management. This site should allow for full evaluation of shorebird habitat enhancement strategies through pool management.

Anticipated Work in Fiscal Year 2024

Summary reports are in progress for this work and additional proposals were submitted to focus on identifying opportunities to support sturgeon spawn throughout the Upper Mississippi River locks and dams and establish a frequency of rehydration needed to maintain suitable habitat for shorebirds.

Future Vision

The team hopes to manage the entire Upper Mississippi River, over which there are 27 locks and dams spanning several hundred RMs to maximize beneficial spawning habitat for the lake sturgeon and increase migratory shorebird habitat while maintaining navigation. The team will apply lessons learned to other pools along the Upper Mississippi River, Illinois River, and others.

Mitigate hydropower peaking (multiple reservoirs) - MVS (Gen)

Hydropower is a valuable resource that some utilities use to meet the peak energy demand of their customers. However, use of hydropower to supply energy during peaks is often associated with rapidly fluctuating water levels in river systems. These fluctuations can cause (or exacerbate) several negative effects, including stranding aquatic species within side channels and on point bars, degrading water quality in some river portions due to a lack of flow, and causing geotechnically unstable riverbanks from saturation that collapse into the river, which results in smothered substrate and high turbidity.

This study seeks to explore the use of utility-scale Battery Energy Storage Systems (BESS) to mitigate the negative effects of hydropeaking. Instead of the energy generated by hydropower always going directly to customers, it could sometimes be stored temporarily in a BESS for use at any time. In theory, a hydropower facility could be connected to a BESS and operated in such a way as to slowly cut their production as demand drops, storing power generated during this period in the batteries for later use. Next time there is a demand surge, the utility will draw upon the power stored in the battery until the it is depleted. This cycle will repeat indefinitely. For short demand surges, the energy stored in the battery may be sufficient to prevent any additional hydropower from being needed. In theory, this concept results in a minimal reduction of energy generated by hydropower. The negative effects of hydropeaking are largely correlated to rapid water level fluctuations, so if these water level fluctuations can be slowed down, then the negative effects would be alleviated.

Work in FY 2023 (and early FY 2024) focused on investigating topics that include, but are not limited to:

- Exploring costs, benefits, challenges, opportunities, and unknowns of implementation
- Identifying basic operational parameters that would be required to achieve environmental benefits
- Researching this technology's applicability to the SRP
- Exploring policy-related implementation concerns
- Outlining what experimental implementation at a hydropower facility would look like
- Identifying basic monitoring parameters to validate a successful implementation
- Considering environmental concerns related to the manufacturing, maintenance, and disposal of batteries used in BESS with insights about net environmental and ecological effects

Due to the inherent unknowns explored by this study, it is expected that this scope will evolve throughout the duration of this study. Any changes to scope are anticipated to remain within one of three identified tasks below and will be captured in the study report.

Status of Fiscal Year 2023 Work

During FY 23, the team explored, learned, summarized, and referenced the topic of hydropower, hydropeaking mitigation, and the concept of hydro-hybrids for the better part of four months. The team documented discoveries and began writing a report that provides context and details surrounding hydropeaking, mitigating it, and how hydro-hybrids (the pairing of a battery with a hydropower generation facility) aid in mitigation.

This research determined that hybrid systems are already used by wind and solar farms. These systems allow intermittent energy from these sources to be stored so that the electrical grid remains reliable. Hydro-hybrids are a variation of those hybrids and are already being used in a limited capacity to provide other benefits to the electrical grid and hydropower facility. Hydro-hybrids have been found to reduce costs and increase revenues, but another benefit recognized by others is a reduction in the negative environmental impacts of hydropeaking. Utilities and Power Marketing Administrations (PMAs) are considering implementing hydro-hybrids at a larger scale, especially as new battery technology enables lower energy storage costs. Therefore, there is a strong nexus for USACE to thoroughly understand the concept and engage with PMAs and utilities to implement this concept within the USACE area of operation. By understanding this tool, USACE can have well-informed conversations with utilities and PMAs during planning to ensure that the result considers the potential environmental benefits that a hydro-hybrid can provide to the downstream ecosystem.

At the end of FY 2023, the report fully met the intent of the original proposal, which was intentionally flexible to accommodate the uncertain nature of this topic and proposal. The original proposal included flexibility to explore planning and implementation considerations as well. With the remaining funds, the team explored detailed considerations of hydro-hybrids relating to the environment, economics, policy, engineering, operations, and social justice. At the end of FY 2023, an additional $20,000 was funded to complete this effort.

Anticipated Work in Fiscal Year 2024

During FY 2024, the team will complete the considerations section of the report and send it for an expert review. Once the reviewers' comments are addressed, the report will be ready to be published.

Future Vision

There is momentum towards the hydro-hybrid outside of USACE, but there is little familiarity (if any) of hydro-hybrids within USACE. Therefore, the team hopes to share this idea among planners and engineers so that this research on the topic may serve as an entry point for future work relating to hydropeaking mitigation on rivers around the nation. In the future, implementation of BESS at a hydropower facility will be a tool that SRP can consider addressing environmental concerns.

Potomac River North Branch (Jennings Randolph), MD and WV - NAB (Gen)

Jennings Randolph Dam is located on the North Branch Potomac River and spans across Garrett County, Maryland, and Mineral County, West Virginia. The dam is located 58 miles upstream of the confluence of the North Branch and South Branch Potomac rivers. Jennings Randolph Dam is operated by NAB and is often operated in conjunction with Savage River Dam, a state-owned project on the Savage River. Jennings Randolph Dam was originally authorized for the purposes of flood control (now flood risk management), domestic and industrial water supply, water quality control, and recreation. Whitewater recreation was added as a project purpose in 1988.

Storage within Jennings Randolph Dam at its summer pool is specifically allocated for both water quality and water supply. Originally, regulating Jennings Randolph Dam for water quality concerns centered around acid mine drainage and industrial pollutants in the watershed. The lake was devoid of fish, and experts determined there never could or would be a fishery in the lake. At that time, reservoir regulation strategies included utilizing the selective withdraw capability of the outlet works to regulate the quality of the releases for pH, conductance, and dissolved oxygen. In addition, the release plan included maximizing the use of the water quality storage within the reservoir to help dilute downstream pollution. During the late summer and fall, when there were extended periods of low flows, sediment and precipitates from industrial effluent and acid mine drainage would settle out in the downstream river channel creating a smothering effect.

To help minimize these adverse effects during extended low flow periods, Artificially Varied Flow (AVF) releases were initiated. AVF releases are pulse flows for removing accumulated organic sediments, thus improving the downstream aquatic environment.

As various remediation efforts were implemented, such as treatment of acid mine drainage and stricter limits on industrial effluents, the overall condition of the North Branch Potomac River watershed improved. Fisheries both in-lake and downstream began to thrive. A thriving cold-water fishery developed downstream of Jennings Randolph Dam, which led to a significant increase in fishing interests and growing recreation businesses. Over the years, the main water quality concern began to shift to the downstream fishery and the ability of Jennings Randolph Dam to maintain cold water releases for that cold-water fishery. Release strategies shifted away from releasing as much as possible to utilizing the water quality storage more conservatively to conserve cold-water storage to maintain downstream temperatures and desired flows for the downstream fishery.

FY 2021 was the first year of SRP involvement in the North Branch Potomac River. Initial efforts were focused on internal coordination with Operations, Engineering (Water Management), and Planning branches at NAB regarding the evolution of the regulation of Jennings Randolph Dam to date, gaining a better understanding of e-flows, and assessing the potential for considering e-flows for Jennings Randolph Dam and the North Potomac River.

Status of Fiscal Year 2023 Work

Efforts in 2023 for the North Branch SRP team focused on continuing to work on the State of the Science report and beginning workshop preparation. The report lacked one important element, the inclusion of historical flow analyses. Team members learned and utilized IHA to complete the development of these analyses. Multiple aspects of the workshop were initiated as well to include identifying locations, potential dates, and a list of groups to invite. The team began to build the workshop agenda, identify roles, and brainstorm breakout group topics as well. Coordination with resource agencies such as Maryland Department of Natural Resources and Maryland Department of the Environment helped gather additional data and sources of information for the workshop. The team recognized the need to utilize HEC-RPT for the workshop and, toward the end of the FY, they acquired and began learning how to use HEC-RPT.

Anticipated Work in Fiscal Year 2024

In FY 2024, the team anticipates completing the State of the Science Report and conducting the e-flows workshop. The anticipated location of the workshop will require additional approvals and the date for the workshop will be determined in coordination with that approval. The goal of the workshop will be to evaluate and identify environmental opportunities to sustain or improve the ecosystem health for the North Branch Potomac River below Jennings Randolph Dam.

Future Vision

The team anticipates that the e-flows workshop will identify potential environmental actions which would then be evaluated for possible implementation. Ultimately, actions determined to be feasible would be incorporated into the Jennings Randolph Dam Reservoir Regulation Manual (RRM) to improve environmental conditions downstream.

Salt River (Clarence Cannon), MO - MVS (Gen)

Lake sturgeon were historically common throughout the Mississippi River and Missouri River basins. However, by the 1900s they became endemic to the Great Lakes. Multiple states have been involved in lake sturgeon reintroduction programs. The Missouri Department of Conservation began stocking lake sturgeon in the Mississippi and Missouri rivers in 1984 but only recently has breeding in the wild been observed and documented. Just below Clarence Cannon Dam, a hydropower dam on the Salt River, lake sturgeon aggregations and assumed breeding was documented from 2016 through 2020.

Status of Fiscal Year 2023 Work

An on-site meeting with the Southwestern Power Administration (SWPA) and the Missouri Department of Conservation was held in spring 2022 to assess water flows under various gate settings and worked with partners on outreach with public. Lake sturgeon use of the area below the Clarence Cannon Re-Regulation Dam was confirmed during what would be expected spawning season, but water conditions, flows, and timing hampered monitoring, and the ability to detect a spawning event. Given late funding, no pilot project effort was scheduled for FY 2022.

Through the summer and fall of 2022, the Corps Water Management System (CWMS) model was updated to assess the various flow regimes observed during the spring site visit and incorporate them into a draft plan to operate the reregulation pool as a temporary storage or buffer system from the

power generation cycles that temper the fluctuations discharged through Clarence Cannon Re-Regulation Dam into the Salt River. A public outreach meeting was held in November 2022 to inform the public of the plans to alter discharge cycles in the upcoming spring spawning season.

In late March 2023, test runs of the modeled discharge cycles were conducted to ground truth the models. The Missouri Department of Conservation was onsite to monitor for lake sturgeon as a trial run before an extended period (3 days) was conducted. Within days of the trial runs, an angler below Clarence Cannon Re-Regulation Dam reported lake sturgeon in the area, and the Missouri Department of Conservation went back onsite to monitor. Lake sturgeon were observed exhibiting normal pre-spawning behaviors, which prompted USACE and the Missouri Department of Conservation to ramp up monitoring efforts to document spawning event. E-flows, based on the CWMS modeling, were carried out through late April for 5- to 6-day stretches at a time, based on water availability and discharge cycles.

At the end of the 2023 spring spawning season, no sturgeon eggs or larva were found, but all the correct behaviors were observed in the sturgeon that were observed onsite, a promising sign of future endeavors. Ramped up monitoring efforts, with a more robust system to detect eggs and larva are recommended in the future.

Anticipated Work in Fiscal Year 2024

Building upon the FY 2023 efforts, in FY 2024 the SRP team plans to host focused meetings with the state and SWPA to discuss a more formalized draft operational plan; continue advancing the pilot project in the spring 2024 if conditions are suitable; increase collaborative monitoring efforts of lake sturgeon activity/response in the area; continue agency coordination and public outreach; and complete a yearly summary report.

Future Vision

Several years of assessing modifications to flow management coupled with lake sturgeon monitoring is anticipated to refine operations. If the project is successful, lessons learned from the Salt River and the Melvin Price Locks and Dam lake sturgeon project could be used to help other districts implement similar projects in their district for sturgeon or other species with similar requirements.

TNTCX Rivercane Restoration, OK - TNTCX (LD)

The USACE TNTCX was created to support USACE's work with federally recognized Tribes across the enterprise to address some of the toughest water resource and environmental challenges in the nation. TNTCX efforts, including this proposal, demonstrate that USACE is honoring the federal government's commitments to Tribal nations for improved services and consultation (WRRDA 2020, Presidential Memo January 2021, DOD Memo February 2021, Presidential Memo November 2022).

FY 2023 work was a continuation of the previously funded FY 2021 SRP rivercane restoration project, which led to the formation of the Rivercane Restoration Alliance (RRA) and included hosting an indigenous approach to rivercane restoration workshop and developing rivercane conceptual ecological models. As a result of the workshop, the RRA identified this proposal as a unique opportunity for rivercane restoration at a USACE lock and dam project.

The FY 2023 work focused on the importance of a cultural keystone plant species, rivercane (*Arundinaria gigantea*). This species is crucial to the continuity and culture of many Native American communities in the Southeastern United States, and it grows from Florida to eastern Texas in the south, parts of the Midwest, and north to New York. In addition to the many environmental benefits of this species, such as erosion control and water quality, the harvested material is utilized for both sacred and mundane cultural practices critical to the cultural continuity of Indigenous lifeways. Although dense stands of cane, known as canebrakes, were once abundant in the southeastern U.S., it is now a critically endangered ecosystem due to agriculture, climate, grazing, fire suppression, water management, and urbanization. USACE projects directly and indirectly contribute to these threats and stressors.

Despite these challenges, USACE is positioned through the management and operation of project lands to have a significant beneficial impact to rivercane revitalization. The goal of this SRP project is to build off of the skills, knowledge, and partnerships fostered during the FY 2021 effort to fully realize the goal of the SRP, which is to identify, refine, and implement environmental strategies at USACE water infrastructure projects. One such project is the Tulsa District (SWT), Robert S. Kerr Lock and Dam in Sallisaw, Oklahoma. This site is unique in that it includes the Sequoyah National Wildlife Refuge (NWR), which was established in 1970 as an overlay project of Robert S. Kerr Lock and Dam and occurs within the boundaries of the Cherokee and Choctaw Nations of Oklahoma.

The goal of this project is to work with SWT, the NWR, and Tribal partners to advance rivercane science and restoration at the project site, test implementation of water management and/or land management practices that promote rivercane restoration, and ultimately incorporate those environmental strategies into a Standard Operating Procedure (SOP) or other appropriate guidance document. All project partners are supportive of the proposal, look forward to the collaboration, and believe studying this cultural keystone species will be applicable to other USACE project lands and other USFWS refuges (e.g., Great Salt Plains Dam and Salt Plains NWR).

Like the previous rivercane project, a collaborative approach with Tribal partners is necessary to incorporate Traditional Ecological Knowledge (TEK) into rivercane restoration at Robert S. Kerr Lock and Dam. Experience shows that conservation and restoration work informed by indigenous knowledge is more successful than traditional engineered (i.e., hardened) solutions—especially given the intimate Tribal and historical ties to the land. Guidance for Federal Departments and Agencies on Indigenous Knowledge (30 November 2022) acknowledges and promotes this approach to federal projects. Specifically, that funds will be used to identify site specific rivercane restoration problems, opportunities, and constraints; develop rivercane restoration alternatives including land/water management recommendations; set up rivercane restoration projects; and develop management recommendations based off findings. Funding will also include travel expenses for TNTCX and Tribal partners, CESU support, participation in related conferences/meetings, and miscellaneous video/printing services for documentation, education materials, and upward reporting.

Status of Fiscal Year 2023 Work

SRP did not provide additional funding support to rivercane efforts in FY 2022. The SRP funded the FY 2023 rivercane restoration proposal that built off the skills, knowledge, and partnerships fostered by the RRA project. The objective was to identify, refine, and implement environmental strategies at the Robert S. Kerr Lock and Dam in Sallisaw, Oklahoma. Funding was received in February 2023 and immediately led to advertising and awarding a CESU agreement with the University of Alabama-Alabama Water Institute

(AWI), a process that took approximately 5 months. Team members also participated in subject matter expert and Tribal engagement opportunities at the Tribal Bridge the Gap Annual Meeting and the Rivercane Gathering Meeting. Both engagements occurred in Oklahoma and allowed for site visits and rivercane exploration at the Sequoya NWR. AWI has completed a project work plan and schedule, initial testing of genetic material collection, and is developing an on-site meeting with the TNTCX, SWT, Tribal, and NWR representatives. They have also initiated Tribal outreach discussions with the Choctaw Nation of Oklahoma, Cherokee Nation, and United Keetoowah Band of Cherokee Indians.

Future Vision

The TNTCX SRP team would like to continue strategically building a coalition of scientists, Tribal communities, artists, federal and state agencies, museums, and rivercane enthusiasts in the RRA and use that forum to support rivercane restoration activities throughout its historic range.

Tombigbee River (multiple reservoirs) - SAM (LD)

The Tombigbee River Watershed drains roughly 1,800 square miles of northeastern Mississippi and western Alabama. High river flows carry large amounts of silt and other sediments, which affect aquatic and terrestrial habitats along the system. These heavy sediment loads reduce water quality throughout the Tombigbee River Watershed. Large sand bars that have developed because of sediment deposition impact flow regimes and the natural course of the Tombigbee River headwaters.

Species found along the Tombigbee River Watershed are in critical habitat areas that have been impacted by the creation of the Tennessee-Tombigbee Waterway. Minimum flow structures maintain, and support mitigation of minimum flow returns to the Tombigbee River. The East Fork reach of the Tombigbee River includes critical habitat area of the Southern clubshell and the orange-nacre mucket and is within the historic range of the Alabama moccasinshell and ovate clubshell mussel species. High stormwater runoff inputs and erosion from regional farmlands into the Tombigbee River have contributed to population decline in these species.

The Old Tombigbee River (Old River) lies adjacent to the Jamie L. Whitten, G.V. “Sonny” Montgomery, John Rankin, Fulton, Glover Wilkins, Thad Cochran, and Aberdeen locks and dams of the Tennessee-Tombigbee Waterway. There are minimum flow structures within the G.V. “Sonny” Montgomery Lock and Dam pool that provide base inflows to the Old River. In addition, G.V. “Sonny” Montgomery and Glover Wilkins locks and dams have off-channel spillways that can move water from the main waterway to the Old River. This occurs when minimum flow structures and local inflows cannot meet the inflow requirements.

During periods of low local inflows, more water is released through the spillway structures to meet minimum flow requirements. This results in backwater effects and out of bank flow conditions which impact native hardwood species growth based on observations from range management personnel and a current flow study conducted by SAM.

SRP support would be used to engage an interdisciplinary team comprised of USACE personnel and other federal, state, and non-governmental entities. SAM seeks to improve operations using existing infrastructure by changing operations at the minimum flow structures and spillways. The goal of this project is to reduce flooding and sedimentation due to backwater effects from current operations.

Alternate operations would allow for reduced backwater flooding while still maintaining the minimum flow requirements during periods of low natural inflows.

The team has identified three phases of data collection work to inform pilot project scenarios for implementation if they are effective at improving hydrological and water quality conditions for aquatic resources and bottomland hardwood species. The first phase focuses on gathering baseline data on operations and ecological conditions and developing operational alternative recommendations to meet ecological objectives and minimum flow requirements (FY 2023). The second phase includes evaluating operational alternatives based on FY 2023 data and continuing to collect targeted data to determine efficacy of alternatives. The third phase includes development of an implementation plan to allow permanent operational changes.

Status of Fiscal Year 2023 Work

SAM and USFWS service, through biweekly meetings, developed a biological monitoring plan to assess conditions in the basin. It was determined that benefits to the bottomland hardwoods would likely be accomplished as an effect of improving the mussel flow regimes. In May 2023, the team conducted a recon trip to examine the gravel bars and mussel habitat on the Old River. In September, the team returned and conducted an in-depth mussel survey over the Old River study area. During this survey, the team learned that mussel habitat was disconnected laterally from the river by lower water levels. In addition, there was a high occurrence of stranded, threatened mussels on the gravel bars. In September 2023, the USACE, USFWS, and the state of Mississippi had an e-flows meeting at the Tennessee-Tombigbee River project office. Participants of this meeting came up with a flow regime goal to increase the lateral habitat conductivity and decrease mussel stranding.

Anticipated Work in Fiscal Year 2024

For FY 2024, SAM has begun experimental flow work. The first experiment occurred by measuring discharge from a minimum flow structure at peak flow to see if it appropriately augments the lower river flows. A meeting in December 2023 between Operations and Water Management determined the appropriate flows over the spillways to give more water to the Old River without negatively affecting navigation. SAM will monitor representative bars during the experimental flows to see how they benefit.

Future Vision

SAM will update and integrate e-flows into its SOP if they provide biological benefits while minimally influencing navigation pools. SAM will continue collecting water quality data and examine how new operations influence the hardwoods stands.

Upper Ohio River (Kinzua and other dams), MD, NY, PA and WV - LRP (Gen)

The Allegheny River is over 315 miles long extending from the state of New York to Pittsburgh, Pennsylvania, where it joins with the Monongahela River to form the Ohio River. Considered one of the most biologically diverse watersheds in Pennsylvania, the Allegheny provides globally important freshwater mussel habitat. Since the 1900s, habitat in the Allegheny River has been degraded by anthropogenic influences, including the placement of navigation structures, bank stabilization efforts, and pollution from industrial sources. There are 8 general reservoirs, one dry dam, and 8 locks and dams, all USACE owned and operated, in the Allegheny River portion of the Upper Ohio basin.

E-flow efforts supported by SRP for the Upper Ohio Basin began in 2014. After defined, flow targets were translated to operating recommendations for reservoirs within the region. In 2020, the SRP team held the Kinzua Dam and Allegheny Reservoir provisional ecosystem flows workshop to review the flow targets and to assist with preparation of an adaptive management and monitoring plan (AMMP) for implementation of the e-flows at Kinzua Dam, including summaries of the biological surveys conducted in the Allegheny and knowledge gaps that limit implementation.

Work in FY 2023 focused on continued refinement of the AMMP and implementation of a spring pulse release from Kinzua Dam per the AMMP and the defined e-flow targets.

Status of Fiscal Year 2023 Work

A spring pulse of water was released from Kinzua Dam to the Allegheny River on 30-31 March 2023 (Figure 7). The peak flows of roughly 15,000 cfs provided near-bank full conditions in the National Wild and Scenic River reach of the Allegheny River. Per the e-flow targets, spring pulses are implemented to mimic the natural hydrologic frequency, magnitude, and duration of spring rain events. Implementation of this spring pulse was intended to enhance riverine habitat through disturbance processes (sediment, detritus, seed movement, etc.) and provide environmental cues for aquatic life.

Refinement of the AMMP involves coordination with conservation partners and preparation of data sets relevant to ongoing e-flow efforts, including survey of submerged aquatic vegetation and use of multispectral imagery to inventory and ground truth riparian vegetation communities. All AMMP-related efforts are intended to inform and promote implementation of e-flows for the Upper Ohio.

Anticipated Work in Fiscal Year 2024

During FY 2024, efforts will focus on leveraging the refined AMMP to implement e-flows at other reservoirs in the Upper Ohio. This will involve additional coordination both internal and external to USACE. The East Branch Clarion River is a potential candidate for implementation. Work with USGS will continue with a focus on better understanding mussel communities. Ongoing work with ERDC will remain focused on vegetation surveys.

Future Vision

Continue to refine e-flow targets on the Allegheny and transfer lessons learned to other rivers within the Upper Ohio River basin. Additionally, LRP will maintain the AMMP and use it to guide future implementation and science-related efforts, including consideration of climate change impacts and associated effects on e-flow operations.

Other Sustainable River Program Advancements

In addition to FY 2023 location-based work, SRP also accomplished tasks funded in FY 2021 and FY 2022 and described in previous IPR reports, https://www.hec.usace.army.mil/sustainablerivers/publications/. The following are other location-based SRP advancements occurring in FY 2023:

- Atchafalaya River Basin, Bayou Courtableau: In 2023, the team focused on using the Bayou Courtableau Structure to familiarize the Atchafalaya River Basin stakeholders with the science and process of looking for environmental opportunities to improve conditions. After gaining support and valuable input, USACE has continued moving forward with field data collection and modeling efforts and submitted an FY 2024 scope of work to SRP to continue work.

- Big Cypress Bayou–Caddo Dam (Lake O' the Pines): The team continued work on Riverware and HEC-EFM modeling effort with PDT, is planning a working meeting in January 2024, and estimated completion in February 2024.
- Brazos River: The team held e-flow workshop on 9 November 2023 and are evaluating input and drafting workshop meeting report.
- Bois de Sioux River: The team completed the final Environmental Assessment (EA) and initiated drawdown in August 2023. Evaluation of the drawdown and report are nearly complete and will be finalized in February 2024, which will complete the funded scope of work.
- Fourche LaFave: The team completed the Fourche LaFave Science Report following review by all contributing authors, as well as an outside independent reviewer.
- French Creek: The Erie County Conservation District continues to review the permit request and Operations Division is working on contracting support documents.
- Gila River: The team worked with partners including USFWS on design plans and an EA for a perennial wetland feature anticipated to benefit wildlife populations. The team held a public information session and garnered support from multiple stakeholder groups interested in providing volunteer labor, parts, and heavy equipment. The team submitted a scope of work to SRP for FY 2024 funding to continue the effort.
- Iowa River: The team held a question-and-answer session for the AMMP in November 2022 and a follow-up AMMP stakeholder workshop in August 2023 and are finalizing the AMMP in February 2024 to complete the funded scope of work.
- Kiamichi River (Sardis Dam): The team finalized Riverware parameterization in February 2023 and initiated planning for e-flows workshop for 2024.
- Neches River: Held stakeholder workshop on 9 June 2023 and an e-flow workshop 12 October 2023 and working on workshop summary report.
- Osage River: The team completed a literature review and gained access to pertinent aquatic databases to continue to grow the comprehensive biological information necessary for the State of the Science report. The team completed and summarized three science team meetings with a diverse stakeholder group including, but not limited to, USFWS, Missouri Department of Conservation, Kansas Wildlife and Parks, Missouri DNR, Kansas Water Office, SWPA, and professors from University of Missouri, Oklahoma State University, and Kansas State University along with USACE Water Management, Natural Resources, Planning, and NWD staff. Discussions covered a wide range of biological and habitat needs, which generally centered around native fish and mussel communities. Information compiled from these activities are necessary to commence e-flow workshop planning early in the new year. Collaborative efforts to research the effects of drought on aquatic habitat, mussel beds, and water quality in the Pomme de Terre River below Pomme de Terre Dam was completed during a short 10-day study by USFWS, Missouri Department of Conservation, and USACE lake project and NWK staff.
- Pecos River: E-Flows Workshop Summary report was being drafted and reviewed in FY 2023. The summary report was completed and finalized and sent out to the PDT and stakeholders in January 2024.
- Roanoke River: eDNA samples from 5 locations during the 2023 spawning season have been collected and processed. Partnering agencies also conducted bi-weekly electrofishing for validation of eDNA results; flows and water quality parameters were also collected to support analysis. Eastern Carolina University held an in-person meeting at the North Carolina Museum of

Natural Sciences with USACE and several state entities to discuss 2021 and 2022 results. Feedback from this meeting is being used to focus 2023 efforts and to support future work.

- Trinity River: The team held workshop on 5 October 2023, prepared drafting ecosystem priorities workshop summary report planned for spring 2024.
- Wabash River: The LRC team developed a State of the Science report based on feedback received during the November 2022 subject matter expert orientation. The State of the Science report served as the basis for the e-flows workshop that LRC hosted in Wabash, Indiana, in July 2023. Following the workshop, the team prepared an e-flows report summarizing the recommendations developed during the workshop. The report was completed and shared with subject matter experts for feedback in September 2023.

APPENDIX A: Deliverables and Milestones - Status and Schedule - 2023

Project: Sustainable Rivers Program (2023)

Baselining Date: 10/10/2023

Note: Numbering below refers to SRP tasks and 1 through 7 are program-level tasks including preparation of RFPs, website development, assistance to location-based efforts, leading SRP meetings, etc. and 8 through 55 are location-based work utilizing FY 2021 through FY 2022 carryover funds and are not included in this table. Location-based efforts funded in FY 2023 begin with task 56, LRL-Green River and continue through 75, MVP-Minnesota River and are provided here. Revised dates reflect schedule at time of the FY 2023 IPR (Table A1).

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 1 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			**Planned**	**Revised**	**Comments**
56. LRL-Green River-FY23					
	Milestone 1:	Effort Started	12-6-22	1-9-23	
	Milestone 2:	Complete research and data gathering for workshop	4-15-23	4-15-23	
	Milestone 3:	Conduct Green River Basin workshop	8-15-23	8-31-23	Workshop dates are August 29–31, 2023.
	Milestone 4:	Complete report and determine ecosystem priorities–Green River Basin workshop summary report	9-15-23	10-31-23	
	Milestone 5:	Effort Finished	9-15-23	10-31-23	
57. NWK-Kansas River (pools)-FY23					
	Milestone 1:	Effort Started	12-8-22	1-9-23	
	Milestone 2:	Shallow water habitat determination meeting	2-15-23	2-28-23	
	Milestone 3:	Develop GIS modeling	6-30-23	8-15-23	GIS work is 7 to 10 days behind schedule. August 9, 2023, is the target deadline for completion of GIS work for review before the e-pools workshop the following week.
	Milestone 4:	Host pool level management for environmental benefits workshop	8-31-23	8-15-23	Workshop is scheduled for the week of August 14, 2023.

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 2 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 5:	Complete workshop summary report	10-31-23		
	Milestone 6:	Effort Finished	10-31-23		
58. LRP-Upper Ohio River-FY23					
	Milestone 1:	Effort Started	12-9-22	1-9-23	
	Milestone 2:	Site reconnaissance for riparian and SAV field surveys	7-31-23	8-25-23	
	Milestone 3:	Complete report for Kinzua spring pulse implementation	9-30-23	8-1-24	
	Milestone 4:	Complete revised AMMP and transfer of deliverables	10-31-23	8-1-24	
	Milestone 5:	Effort Finished	10-31-23	8-1-24	
59. MVS-Kaskaskia River-FY23					
	Milestone 1:	Effort Started	12-9-22	1-9-23	
	Milestone 2:	Implementation of environmental levels at Lake Shelbyville, Carlyle Lake, and Jerry F. Costello L&D, in-person public meeting, and compilation of comments received	10-15-23	8-1-24	FY23 work postponed due to water levels (drought in basin/region)
	Milestone 3:	Complete vegetation surveys and report briefing materials	11-15-23	8-1-24	
	Milestone 4:	Complete drone imagery collection and report briefing materials	12-31-23	8-1-24	
	Milestone 5:	Final vegetation survey, summary report and acres exposed	12-31-23	8-1-24	
	Milestone 6:	Effort Finished	12-31-23	12-31-24	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 3 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
60. MVS-Salt River-FY23					
	Milestone 1:	Effort Started	12-9-22	1-9-23	
	Milestone 2:	Season-end project report	12-31-22	12-31-23	
	Milestone 3:	Onsite meeting and workshop (SWPA, MDC, USACE)	3-1-23	4-19-23	
	Milestone 4:	Pilot project, including onsite fish monitoring and existing conditions assessment	5-31-23	4-21-23	
	Milestone 5:	Complete modeling and agency coordination and outreach (ongoing through end FY22)	10-31-23		
	Milestone 6:	Effort Finished	12-31-23		
61. MVS-Hydropower and batteries-FY23					
	Milestone 1:	Effort Started	12-9-22	1-9-23	
	Milestone 2:	Initiate agency coordination and partner outreach (ongoing through end of FY23)	1-6-23	1-31-23	
	Milestone 3:	Complete report outline	2-28-23	2-28-23	
	Milestone 4:	Complete draft report	8-15-23	8-9-23	Draft is complete.
	Milestone 5:	Complete final report	3-29-24		Completion anticipated in early calendar year (CY) 2024.
	Milestone 6:	Effort Finished	3-29-24		

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 4 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
62. MVS-Mississippi River-LD-FY23					
	Milestone 1:	Effort Started	12-12-22	1-9-23	
	Milestone 2:	Shorebirds-Sediment moisture and invertebrate sampling	12-31-22	3-31-23	
	Milestone 3:	Sturgeon-Complete draft operational data table	3-1-23	10-31-23	Table undergoing edits. Reviews delayed.
	Milestone 4:	Sturgeon-Complete tagging efforts	4-1-23	5-16-23	
	Milestone 5:	Sturgeon-Complete spawn monitoring and fish	5-31-23	5-16-23	
	Milestone 6:	Sturgeon-Conclude validation trials of draft operational data table	10-31-23		
	Milestone 7:	Shorebirds-Analysis of daily release and water surface elevation	10-31-23		
	Milestone 8:	Shorebirds-Perform shorebird use surveys	10-15-23		
	Milestone 9:	Shorebirds-Video/photo station	10-15-23		
	Milestone 10:	Sturgeon-Complete season-end findings summary report including operation table for water control manual	12-31-23		
	Milestone 11:	Shorebirds-Summary report	12-31-23		
	Milestone 12:	Effort Finished	12-31-23		

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 5 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
63. SWL-Black River-FY23					
	Milestone 1:	Effort Started	12-13-22	1-9-23	
	Milestone 2:	Finish identification of partners, stakeholders, and issues report	5-31-23	10-30-23	Milestone 2 will be completed by the end of October 2023. Kick-off meeting is scheduled for 5 September and will have the issues report completed by October 30, 2023.
	Milestone 3:	Complete State of the Science Report, including hydrologic data assessment	5-31-24		
	Milestone 4:	Effort Finished	9-30-24		
64. SWL-Cossatot River-FY23					
	Milestone 1:	Effort Started	12-13-22	2-1-23	
	Milestone 2:	Complete information resources and capacity building for implementation	2-28-23	4-30-23	
	Milestone 3:	Complete report detailing next steps for feasibility of e-flow components	9-30-23	11-30-24	Meeting planned for November through December 2024.
	Milestone 4:	Complete the implementation activities report	12-31-24	12-31-25	Cameras installed June 2023. Implementation occurred May 2023. Additional implementation anticipated spring, summer, and fall 2024 with summary report to follow by end of CY.
	Milestone 5:	Effort Finished	12-31-24	12-31-25	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 6 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
65. SAW-Cape Fear River-FY23					
	Milestone 1:	Effort Started	12-14-22	1-9-23	
	Milestone 2:	Launch contracting process for partner research	1-1-23	2-1-23	
	Milestone 3:	Fish Passage-finalize fisheries research CESU contracts. Prepare equipment. Start Jordan pulses for fish; Communication-draft website design, meet with 1-2 stakeholders	3-1-23	11-15-23	
	Milestone 4:	Fish Passage-equipment deployed and fish tagged; Water Quality-update CESU contracts with UNC Researchers; Communication-get real-time outreach during a pulse	3-31-23	5-1-23	
	Milestone 5:	Fish Passage-field monitoring concluded, eDNA lab analysis and broader telemetry data analysis begin; Water Quality-CESU contracts finalized, equipment deployed and monitoring begins. Start Jordan pulses for water quality; Communication-meet with 1-	6-1-23	8-10-23	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 7 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 6:	Fish Passage-check in with researchers on fish results; Water Quality-field monitoring concludes and lab/data analysis begins. Communication-meet/present to 1-2 stakeholders	9-30-23	8-10-23	
	Milestone 7:	Fish Passage-end of year summary of fish findings complete. Researchers continue to analyze data and work towards a peer-reviewed publication; Water Quality-check-in with researchers on water quality results. Communication-summary of "2023 lessons l	11-30-23		
	Milestone 8:	Fish Passage-CESU contracts updated for another year of work. Supplies purchased. Water Quality-end of year summary of water quality findings complete. Communications-"needs" document to think through needs for deviations completed	12-31-23		
	Milestone 9:	Launch year 2	1-1-24		
	Milestone 10:	Fish Passage-prepare equipment, researchers synched. Start Jordan pulses for fish; Communication-work with PR office to get live info to media during an upcoming pulse	3-1-24		

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 8 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 11:	Fish Passage-field monitoring concluded, eDNA lab analysis and broader telemetry data analysis begin; Water Quality-CESU contracts finalized, equipment deployed and monitoring begins. Start Jordan pulses for water quality; Communication-do a water q	6-1-24		
	Milestone 12:	Fish Passage-check in with researchers on fish results; Water Quality-field monitoring concludes and lab/data analysis begins	9-30-24		
	Milestone 13:	Fish Passage-end of year summary of fish findings complete. Researchers continue to work towards a peer-reviewed publication; Water Quality-check-in with researchers on water quality results. Communication-summary of “2024 lessons learned” present	11-30-24		
	Milestone 14:	Water Quality-end of year summary of water quality findings complete. Communications-“needs” document drafted to summarize ways to get to Incorporate	12-31-24		
	Milestone 15:	Effort Finished	12-31-24		

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 9 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
66. NAB-Potomac River North Branch-FY23					
	Milestone 1:	Effort Started	12-16-22	1-9-23	
	Milestone 2:	Complete initial draft State of Science Report for review	1-15-23	1-15-23	
	Milestone 3:	Complete draft State of Science Report (incorporating review comments) as read ahead for e-flows workshop	3-17-23	10-31-23	
	Milestone 4:	Complete e-flows workshop	4-27-23	10-31-23	
	Milestone 5:	Finalize State of Science Report and workshop summary report detailing e-flow recommendations	9-29-23	12-22-23	
	Milestone 6:	Effort Finished	9-29-23	12-29-23	
67. MVR-Des Moines River-FY23					
	Milestone 1:	Effort Started	12-20-22	1-9-23	
	Milestone 2:	Shorebirds-Coordination of effort with two other field sites in Midwest	1-15-23	1-15-23	
	Milestone 3:	Communications-Initiate processing and editing of time lapse images	1-31-23	1-31-23	
	Milestone 4:	Shorebirds-Initiate CESU contracting process	2-1-23	2-1-23	
	Milestone 5:	Communications-Present SRP supported science efforts at American Fisheries Society annual meeting	3-1-23	3-1-23	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 10 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 6:	Science-Initiate discussions for 2023 e-flows and lake pool with stakeholders	3-15-23	3-15-23	
	Milestone 7:	Shorebirds-Award CESU contract for satellite tagging research and web portal	3-31-23	8-21-23	
	Milestone 8:	Science-E-flows, preparations, and coordination for potential spring pulse	5-1-23	5-1-23	
	Milestone 9:	Science-Initiate 2023 spring and summer field monitoring season	5-15-23	6-28-23	
	Milestone 10:	Communications-Revise or supplement Red Rock Visitor Center displays	6-30-23	8-21-23	
	Milestone 11:	Shorebird-Complete coordination for field activities at 3 separate Corps lakes for studying interstate stopover ecology	7-31-23	7-31-23	
	Milestone 12:	Science-Complete coordination of 2023 summer field season	8-31-23	8-21-23	
	Milestone 13:	Communications-Finalize written communication pieces	9-30-23	8-21-23	
	Milestone 14:	Shorebirds-Complete field work for satellite tagging of shorebirds	10-31-23	10-31-23	Field season 1 (2023) completed. MVR POC and ISU to initiate coordination at two additional Midwestern sites November through December 2023.
	Milestone 15:	Shorebirds-Complete web portal for data visualization	11-30-23	8-21-23	Regularly updated, see https://faculty.sites.iastate.edu/cootjr/iowa-pectoral-sandpiper-stopover-study

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 11 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 16:	Shorebirds-Field season report for 2023	12-15-23		Assume shorebirds and invertebrate study. First season report in progress (October 26, 2023).
	Milestone 17:	Science-Conclude DMR Fish Recruitment Research and final report	12-31-23		Thesis nearly completed; defense not scheduled yet (October 26, 2023).
	Milestone 18:	Shorebirds-Field season report for 2024	12-15-24		Anticipate field activity as late as September 30, 2024.
	Milestone 19:	Shorebirds-Summary report	6-30-25		
	Milestone 20:	Effort Finished	6-30-25		
68. NWS-Lake Washington Ship Canal-LD-FY23					
	Milestone 1:	Effort Started	12-22-22	1-9-23	EAO process required months. Executed right before FY23 ended.
	Milestone 2:	Initial meeting with contractor and NWS team	3-1-23	3-1-23	Kickoff and subsequent milestones shifted due to EAO delays.
	Milestone 3:	All model files and tools are delivered to SME	3-15-23	3-15-23	
	Milestone 4:	Initial review completed by SME and mid-point review meeting held	5-17-23	9-18-23	
	Milestone 5:	Model updates are completed by NWS	7-12-23	12-31-23	
	Milestone 6:	Final model review completed by SME and final review meeting held	8-9-23	6-30-24	The EAO package is still being routed through NWS. Project start date adjusted with the USGS to accommodate this process.
	Milestone 7:	Consultant and NWS attend environmental stakeholder meeting	9-30-23	7-7-24	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 12 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 8:	Complete final report and share as deliverable	12-31-23	7-7-24	Current target deliverable is RFFIR but NWS seeks OPS funding for USGS data release and publication on baseline model-Phase III.
	Milestone 9:	Effort Finished	12-31-23	7-7-24	
69. SAM-Alabama River-LD-FY23					
	Milestone 1:	Effort Started	12-22-22	1-9-23	
	Milestone 2:	Initiate planning and methodology meetings with USACE and external agencies	1-15-23	1-15-23	
	Milestone 3:	Complete baseline fish assemblage data collection under current conservation locking operations	5-31-23	7-31-23	
	Milestone 4:	Compile all data and complete implementation plan for the upcoming year as determined by the PDT through agency coordination	5-31-23	8-30-23	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 13 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 5:	Complete phase 1 monitoring report	9-30-23	12-1-23	Data compilation nearly complete for this FY dataset, trawling was shifted into the fall due to necessary USFWS permits. Number 4 should be complete by August 30, 2023. Numbers 5 and 6 will carry onto December 1, 2023, to allow integration of trawling data into the baseline report. The implementation plan, however, moves forward without that data fully compiled as it relates to success criteria more than the passage operations plan.
	Milestone 6:	Effort Finished	9-30-23	12-1-23	
70. SAM-Tombigbee River-LD-FY23					
	Milestone 1:	Effort Started	1-9-23	2-2-23	
	Milestone 2:	Purchase ISCO 24- bottle sediment samplers	1-31-23	2-28-23	
	Milestone 3:	Deploy sediment samplers and water quality sensors and begin monitoring	2-15-23	6-16-23	
	Milestone 4:	Begin habitat assessment	3-1-23	4-30-23	
	Milestone 5:	Finish habitat assessment	9-30-23	9-30-23	
	Milestone 6:	Cooperating agencies meeting	9-30-23	9-30-23	
	Milestone 7:	Complete baseline report	1-31-24		
	Milestone 8:	Effort Finished	1-31-24		

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 14 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
71. SPL-Gila River-DD-FY23					
	Milestone 1:	Effort Started	1-10-23	1-26-23	
	Milestone 2:	Launch year 2	1-30-23	1-26-23	
	Milestone 3:	Project plan complete	3-15-23	10-15-23	
	Milestone 4:	Send initial outreach letter to TON	3-15-23	11-1-23	
	Milestone 5:	Documents required for purchase and installation of pump and liner completed	4-1-23	12-1-23	
	Milestone 6:	Award contract	8-30-23	1-30-24	
	Milestone 7:	Site visit open to project stakeholders completed	10-30-23	1-30-24	
	Milestone 8:	Comprehensive plan completed	10-30-23	8-31-26	
	Milestone 9:	Effort Finished	12-30-26		
72. MVN-Atchafalaya River-FY23					
	Milestone 1:	Effort Started	1-30-23	2-10-23	
	Milestone 2:	Complete experimental design and E-flow Management and Monitoring Plan	9-30-23	9-30-24	
	Milestone 3:	Complete e-flow implementation, monitoring and associated results report	9-30-24	9-30-25	
	Milestone 4:	Effort Finished	9-30-24	9-30-25	

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 15 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
73. TNTCX-Rivercane restoration-FY23					
	Milestone 1:	Effort Started	2-2-23	2-10-23	
	Milestone 2:	Submit CESU SOI and CAAD	2-15-23	3-12-23	
	Milestone 3:	Hold kickoff meeting	3-31-23	3-15-23	
	Milestone 4:	Site visit/meeting	4-17-23	4-5-23	
	Milestone 5:	Award CESU	6-15-23	7-26-23	
	Milestone 6:	Implement rivercane restoration experiment and observe vegetative response	12-31-24		Genetics work will inform this opportunity. Data collection will begin soon.
	Milestone 7:	Develop water/land management recommendations	3-31-25		
	Milestone 8:	Submit final deliverables	6-30-25		
	Milestone 9:	Effort Finished	6-30-25		
74. NWK-Kansas River-FY23					
	Milestone 1:	Effort Started	2-2-23	6-5-23	
	Milestone 2:	Oxbows-1st Workshop Summary	4-30-23	10-31-23	
	Milestone 3:	Oxbows-2nd Workshop Summary	6-30-23	12-31-23	Oxbow schedule must be crosschecked.
	Milestone 4:	Oxbows-Baseline assessment and restoration measures summary	10-31-23	12-31-23	
	Milestone 5:	Geomorphology-Year 1 data collection complete	10-31-23	12-31-23	
	Milestone 6:	Chronologies-Database with records from all collections	10-31-23		
	Milestone 7:	Chronologies-Summary report	12-31-23		Contract awarded late July. University funding required an additional 4 to 6 weeks.

Table A1. Deliverables and Milestones-Status and Schedule 2023 (sheet 16 of 16)

DELIVERABLES & MILESTONES as of 10 October 2023			Planned	Revised	Comments
	Milestone 8:	Coordination-Meeting notes and presentations prepared and delivered as required	4-30-24		USACE recently completed scoping meeting and began developing alternatives. SRP team will be involved in these discussions to incorporate e-flows and pool management, if possible. Planned to finish in April 2024.
	Milestone 9:	Geomorphology-Year 2 data collection complete	10-31-24		
	Milestone 10:	Turbidity-Database with records from all collections	12-31-24		
	Milestone 11:	Turbidity-Report complete	10-31-25		
	Milestone 12:	Effort Finished	10-31-25		
75. MVP-Minnesota River-FY23					
	Milestone 1:	Effort Started	3-10-23	3-17-23	
	Milestone 2:	Funding of FY22 work and kickoff	4-1-23	4-1-23	
	Milestone 3:	Final EA and memo document completed	9-1-23	11-1-23	USACE and USFWS priorities postponed the date, while still meeting drawdown start date target.
	Milestone 4:	Anticipated start of drawdown	7-15-24		
	Milestone 5:	Project report summarizing activities and associated monitoring	12-31-24		
	Milestone 6:	Effort Finished	12-31-24		

APPENDIX B: Funding and Execution in Fiscal Year 2023 (as of 10/1/23)

In FY 2023, SRP was in the President's Budget (PBud) at $5M and received $7M through appropriations. Funds above the PBud became available to SRP as late as 11 July 2022, though being in the PBud at $5M for the first time in program history allowed program works to start earlier than in past years (in FYs 2020 through 2022, SRP was in the PBud at $500k). Dates of location-based teams first receiving FY 2023 funds to support their efforts are listed as the Milestone 1 dates in Appendix A. Some location-based carryover was planned as execution schedules for that work had tails in FY 2024 (Tables B1 to B5).

Table B1. Allocations and carryover per major program components, Fiscal Year 2023 ($, millions).

Component—FY 2023:	Budgeted	Carryover to FY 2023
Programmatic	2.8	0.5
-Program support	*1.5*	*0.5*
-Technologies	*0.9*	*0.0*
-Validation	*0.5*	*0.1*
-Program balance	*-0.1*	*-0.1*
Location-based	4.1	1.4
-Labor (generated by HEC)	*2.1*	*1.1*
-Repositions, MIPRs, etc.	*2.0*	*0.3*
Total	6.9	1.9

Table B2. Allocations and carryover per major program components, Fiscal Year 2022 ($, millions).

Component—FY 2022:	Budgeted	Carryover to FY 2022	Carryover to FY 2023
Programmatic	2.5	0.7	0.0
-Program support	*1.2*	*0.7*	*0.0*
-Technologies	*0.8*	*0.1*	*0.0*
-Validation	*0.5*	*0.0*	*0.0*
Location-based	2.5	1.8	0.4
-Labor (generated by HEC)	*2.0*	*1.5*	*0.3*
-Repositions, MIPRs, etc.	*0.5*	*0.3*	*0.0*
Total	5.0	2.5	0.4

Table B3. Allocations and carryover per major program components, Fiscal Year 2021 ($, millions).

Component—FY21:	Budgeted	Carryover to FY21	Carryover to FY22	Carryover to FY23
Programmatic	1.9	0.3	0.0	0.0
-Program support	*0.8*	*0.3*	*0.0*	*0.0*
-Technologies	*0.6*	*0.0*	*0.0*	*0.0*
-Validation	*0.5*	*0.0*	*0.0*	*0.0*
Location-based	3.1	1.8	0.8	0.3
-Labor	*1.9*	*1.1*	*0.5*	*0.2*
-Repositions, etc.	*1.1*	*0.8*	*0.3*	*0.1*
Total	5.0	2.1	0.8	0.3

Table B4. Allocations and carryover per detailed program components, Fiscal Year 2023 ($, thousands).

	Budgeted	Obligated	Carryover (labor)	Carryover (reposition)
Programmatic	2,817	2,301	406	110
- Program support	1,472	928	434	110
- HEC	239	204	34	0
- IWR	139	139	0	0
- MVP	102	60	41	0
- MMC	105	83	22	0
- ERDC	16	16	0	0
- IPA	386	386	0	0
- Detail	126	39	77	10
- Regional meetings (2) *	250	0	150	100
- E-opportunities at locks and dams *	110	0	110	0
- Tech	940	940	0	0
- Ecological software development	453	453	0	0
- Engineering software development	487	487	0	0
- Validation (SRP-Science)	521	434	88	0
- North Carolina Rivers	89	72	17	0
- Upper Ohio River	273	238	35	0
- Willamette River	160	124	36	0
- Program balance	-116	---	-116	---
Location-based	4,113	2,695	1,105	314
- LRL - Green River	109	69	27	13
- LRP - Allegheny River	102	57	44	0
- MVN - Bayou Courtableau	160	50	39	71
- MVP - Minnesota River	90	19	71	0
- MVR - Des Moines River	711	686	23	2
- MVS - Kaskaskia River	75	52	23	0
- MVS - Mississippi River	76	65	11	0
- MVS - Mitigate hydropower peaking	80	59	21	0
- MVS - Salt River	70	41	29	0
- NAB - North Branch Potomac River *	86	29	46	11
- NWK - Kansas River (e-flows)	371	175	195	1
- NWK - Kansas River (e-pools)	71	56	14	1
- NWS - Lake Washington Ship Canal	46	46	0	0
- SAM - Alabama River	125	105	18	2
- SAM - Old Tombigbee River	135	86	37	12
- SAW - Cape Fear River *	944	681	184	79
- SPL - Gila River *	201	59	41	101
- SWL - Black River	90	14	76	0
- SWL - Cossatot River	60	7	52	1
- TNTCX - Rivercane restoration	512	340	152	21
Total	6,930	4,996	1,511	424

*As of 10/1/23, these allocations were pending readiness of receiving teams and are included in Budgeted and Carryover values for those efforts: 1) $150k of labor and $100k of reposition funds for regional meetings, 2) +50k of labor for e-opportunities at locks and dams, 3) $11k of reposition funds for NAB-North Branch Potomac River, 4) +$47k of reposition funds for SAW-Cape Fear River, and 5) $101k of reposition funds for SPL-Gila River.

Table B5. Program Administrative Costs, Fiscal Year 2023 ($, thousands)*

	Budgeted	Administrative	Notes (assumptions)
Program support			
-HEC	239	119	50% of budgeted
-IWR	139	69	50% of budgeted
-MVP	102	51	50% of budgeted
-MMC	105	105	100% of budgeted
Validation (SRP-Science)			
-North Carolina Rivers	89	12	CESU fees
Location-based			
-MVR-Des Moines River	711	35	CESU fees
-NWK-Kansas River (e-flows)	371	18	CESU fees
-SAW-Cape Fear River	944	49	CESU fees
-SPL-Gila River	201	6	Contracting fees
-TNTCX-Rivercane restoration	512	12	CESU fees
Totals (program budget, admin, %)	6,930	476	6.9%

*All SRP components with administrative costs are included in this table. Associated budgeted totals are from Table B3.