

APPENDIX I

Summaries of Completed Projects of the Lower Osage River Protection and Enhancement Program

The following information is a compilation of project summaries that are considered completed under the LORPEP. The entries are organized by project number, which depicts the year the project began (first two digits) followed by a numerical identifier (digits following the dash). Annual and final reporting for completed and ongoing projects have been provided in previous LORPEP reports (published annually from 2008 to the present) and can be obtained from the U.S. Fish and Wildlife Service at: 101 Park DeVille Drive, Suite A, Columbia, Missouri 65203 (Phone: 573-234-2132). Ongoing projects are listed in the main body of this annual report.

Project 08-1. Develop a Geographic Information System (GIS) database (using ArcMap software) to map major aquatic habitat features, land use, and existing/ongoing restoration efforts with respect to the distribution of aquatic resources in the LOR.

Summary: The GIS database was created by the USFWS and the MDC and will be used for future planning and prioritization of proposed restoration projects on the LOR. This database will also be used to track completed restoration efforts in the future. GIS Layers include: islands and side channels, flow conveyance around islands, island access, island vegetation type, location of training structures, floodplain features, water willow beds, gravel bars, bank erosion, mussel survey data, fish survey data, fish habitat, Natural Heritage Data (including federally and state-listed species), designated natural areas, propagated mussel release sites, long-term monitoring sites, gravel mines, National Pollutant Discharge Elimination System permit sites, landfills, and hazardous waste sites, land cover, land use, transportation system, soil types, public lands, aerial photography, topographical maps, National Wetland Inventory, and river miles. This database is updated as new information becomes available and restoration projects are completed. It is maintained by the USFWS in the Missouri Field Office.

Project 08-2. Conduct field surveys to collect data needed to create GIS layers that are not currently available.

Summary: The baseline field surveys were completed between 2010 and 2012. The final report was submitted to the USFWS on January 30, 2013, and attached to the 2012 LORPEP report in Appendix II (Lobb and Lueckenhoff 2013). The main objectives of this project were to: 1) Collect information on low-flow macrohabitat availability in the river, 2) determine locations and configurations of training structures, 3) assess training structure influence on hydraulic connectivity between the main channel and secondary habitats at low-flows, and 4) perform limited testing of methods for evaluating effects of training structures on aquatic habitat. These surveys are being used to inform and expedite our decisions regarding LORPEP expenditures and future management activities, measures, and monitoring.

Project 08-3. Create new GIS layers using field collected data.

Summary: Using field data from Project 08-2, new and remaining data layers were incorporated into the GIS database in 2013 in the appropriate format. Layers currently include mussel beds, river-wide fish macrohabitat features, rock crossings, training structures, and their hydraulic affects to habitat connectivity at various flows. GIS data will continue to be collected in future years as a monitoring or management tool for a variety of LORPEP projects. These data layers are maintained by the USFWS in the Missouri Field Office.

Project 08-4. Develop and describe ranking criteria and a process that will be used to prioritize future proposed restoration projects.

Summary: A framework for evaluating and selecting potential habitat improvement projects on the LOR was developed and included in the LORPEP 2013 annual report. It was created to provide a general planning and decision-making process by which potential habitat protection, enhancement or improvement projects can be identified, prioritized, and pursued based on their feasibility and ecological benefits within the LOR. This project selection method will help maintain transparency between partners and ensure that sponsored research and relevant spatial data are being used to make informed, well-reasoned decisions. This tool will significantly enhance our abilities to prioritize and pursue projects from the vast restoration and protection opportunities and effectively utilize the limited funding available for the LOR. The most recent framework for evaluating and selecting potential habitat improvement projects is found in Appendix II of the 2013 Annual LORPEP Report.

Project 08-6. Develop and initiate long-term monitoring methods and protocols for freshwater mussels.

Summary: Long-term monitoring of freshwater mussel populations in the LOR is required by Article 412 of the current Osage Project license. Developing appropriate sampling methods for the Osage River is essential to produce data that is unbiased, consistent, and statistically comparable over time. The goal of long-term monitoring in the LOR is to track the metapopulation dynamics of mussel communities over time with a focus on understanding the status of federally listed and other species of conservation concern. During the monitoring period, data regarding habitat, population status, and recruitment of mussel species will be collected at multiple sites in the LOR.

The prerequisite field work for this project was completed in 2014, including reconnaissance searches for mussel beds and the establishment (i.e., delineation) of 18 long-term monitoring sites (Roberts *et al.* 2014). Preliminary quantitative sampling was also conducted at established monitoring sites to determine if the delineation process was successful (Roberts *et al.* 2014). The monitoring protocol was completed in 2014 and updated in 2015 (Simmons *et al.* 2015). A second update has been completed in 2021 (Simmons *et al.* 2021). This plan may be further updated in the future as changes are needed based on new information. Reporting from the implementation of this plan will be provided annually under Project 15-1.

Project 10-1: Conduct a genetic study on the federally endangered Scaleshell and Pink Mucket mussel to inform future propagation efforts.

Summary: Molecular genetic techniques are valuable tools to inform mussel conservation and address genetic concerns in propagation plans. The genetic structure of a population is an important consideration when establishing brood stock for propagation and developing plans to release artificially propagated animals into a receiving wild population. In this study, microsatellites were used to develop a fine-scale picture of genetic variation and estimate the degree of genetic differentiation and interchange between populations of Scaleshell and Pink Mucket mussels. The primary objective was to estimate both within and between population genetic structure, as well as other demographic parameters such as effective population size using non-invasive techniques and species-specific microsatellite markers. Only partial LORPEP funding was used because this study was also needed for other recovery work outside of the Osage River. However, it is an important component of the LORPEP mussel propagation program (Project 08-5). This project was completed by Iowa State University and is entitled “Determination of population genetic and ecological variation in the Scaleshell (*Leptodea leptodon*) and Pink Mucket (*Lampsilis abrupta*).”

The final report for this project (Roe and Chong 2015) was included in Appendix III of the 2015 Annual LORPEP report. A summary of the findings and recommendations are detailed below. Analysis of mitochondrial DNA (mtDNA) and microsatellites data have suggested that all Scaleshell samples examined comprise a single population that displays slight differentiation at the river basin level. The distribution of mtDNA haplotypes supports the general pattern observed using nuclear microsatellites. Based on our data, the gene flow among Scaleshell populations was substantial, and the recent discovery of adult Scaleshell in Illinois and Arkansas, where it was considered extirpated, might be evidence of dispersal of glochidia by the host fish. This interpretation is also supported by the fact that Scaleshell from Arkansas and Illinois both exhibited the same haplotype that was common in the Missouri populations. High dispersal ability due to a highly mobile host fish provides Scaleshell with the potential capability to naturally repopulate regions where it has been locally extirpated. A small number of Scaleshell populations surveyed included juvenile mussels indicating recent reproductive success. If propagation and restoration projects are undertaken for Scaleshell within Missouri, broodstock should be sourced from populations located within the same drainages as the restoration site. Restoration strategies should also seek to increase the genetic diversity of broodstock mussels used for propagation and should avoid using closely related individuals as broodstock to avoid activities that negatively affect the effective population size. Additional conservation activities should focus on identifying environmental factors that appear to be limiting the spread of Scaleshell populations (i.e., habitat requirements).

The genetic data examined for Pink Mucket populations reveals higher genetic diversity at both mtDNA and nuclear loci than was seen in Scaleshell. Within Missouri, the presence of several shared haplotypes appears to indicate weak to modest gene flow between the sample sites. The microsatellite (nuclear) data suggest a similar pattern.

Overall, the data indicate substantial gene flow between sample populations of Pink Mucket, and even the degree of genetic differentiation observed between the Tennessee and Missouri populations was quite low. Presumably this level of connectivity is largely due to the dispersal of glochidia by the host fish(es). The generally high levels of genetic diversity (intermediate between Scaleshell and Fragile Papershell, *Leptodea fragilis*), and low inbreeding ($FIS = 0.15$) observed can be interpreted as populations that are not at immediate risk of loss of genetic diversity. Populations of Pink Mucket should be monitored to determine if recruitment is occurring, as lack of recruitment could eventually result in a loss of populations due to eventual senescence and death. Additional research should be conducted to determine the degree of connectivity between all extant populations because Pink Mucket populations are in several other drainages. Such information should be viewed as important for identifying potential sites for re-introduction that would facilitate maintaining connectivity between all remaining populations of Pink Mucket.

Project 10-2.1: Lower Osage River Lock and Dam #1 Pallid Sturgeon Monitoring Project

Summary: The intent of this work was to determine if Pallid Sturgeon (*Scaphirhynchus albus*) were utilizing the Osage River above the confluence of the Missouri River and assess the level of fish passage at Lock and Dam #1. Sampling was conducted between river km 8.8 and 19.5 (RM 5.5 to 12.2) in 2010 and between river km 15 to 19 (RM 9.9 to 12.1) in 2011. Trotlines baited with nightcrawlers were the focused sampling method used during mid-April through mid-May with 12-24 hour soak times. Data from all captured fish were recorded. Trotlines were reset at Pallid Sturgeon capture locations. Three hatchery stock Pallid Sturgeon and one Pallid Sturgeon/Shovelnose Sturgeon hybrid were captured in 2010. Eleven Pallid Sturgeon were collected in 2011. Three bore hatchery markings, the remaining eight are presumed wild as genetic analysis did not match any parental lineages on file. Two of the eight unmarked Pallid Sturgeon were deemed Pallid Sturgeon/Shovelnose Sturgeon hybrids. Other captures of note were 46 Lake Sturgeon and two American Eel. The final report was included in Appendix VI of the 2011 Annual LORPEP report (Herman and Hill 2012).

Project 10-2.2: Evaluation of Bank Erosion within Selected Reaches of the Lower Osage River.

This study was conducted by MDC in 2017 to generate data to help prioritize and select potential habitat improvement projects. Bank erosion was evaluated based on Ameren's existing LiDAR data of erosion rates in the LOR. Knowing the location of the most active bank erosion and stream deposition may influence what habitat projects will be considered in the future and the prioritization of those projects. Results from this analysis were included in Appendix II of the 2018 LORPEP annual report.

Project 10-2.3: Lower Osage River Protection and Enhancement Program, Project Prioritization Report.

In 2018, the USFWS entered into a MOU with Ameren Missouri to contract Inter-fluve, a river restoration and water resources engineering company, to assess the physical conditions of the LOR and prioritize previously identified potential aquatic habitat

restoration projects. Because there are finite LORPEP funds, the number of habitat enhancement projects will be limited. Therefore, it is important to identify and select the most beneficial and cost-effective projects. This cost/benefit analysis was performed to determine the feasibility, costs, and to help the LORPEP working group prioritize each of the potential LORPEP projects. Inter-fluve used existing and field collected data on habitat conditions at the sites and gathered information from informal meetings with several landowners to better describe site characteristics, identify impairments, and develop engineering solutions. A scoring matrix was developed for ecological benefit and feasibility at each potential project site along with a conceptual opinion of probable construction cost. The final report for this project was included in Appendix III of the 2018 LORPEP annual report.

Project 11-1: Evaluation of Habitat for Mussels and Their Fish Hosts in the Lower Osage River.

Summary: This project provided information on the characteristics of habitat for mussels and their obligate fish hosts in the LOR to help identify and prioritize measures needed to protect, restore, and create fish and mussel habitat. Work included: mapping habitat availability and monitoring fluctuations in river level, temperature, and dissolved oxygen at selected sites and sampling for presence of mussel fish hosts at selected mussel beds and reintroduction/augmentation locations. This project began on August 12, 2011, as a five-year cooperative agreement between the USFWS and MDC. The final report for this project was included in Appendix II of the 2017 LORPEP annual report.

Project 14-1: Develop a GIS data repository accessible to primary LORPEP partners.

Summary: A repository for GIS spatial data pertinent to LORPEP was pursued to make this information easily available to LORPEP partners. This data includes aerial photography, topography, results from pertinent research (i.e., erosion assessments), and riverine faunal and habitat inventories. After investigating the feasibility of data sharing between LORPEP partners, no viable option was found. It was decided that as coordination of potential habitat enhancement projects between LORPEP partners continues under Project 10-2, alternative methods of disseminating this information will be used. Currently, information related to LORPEP is available and posted to the FERC e-library website at: www.ferc.gov/docs-filing/elibrary.asp. Some spatial data layers are only available in digital format at the USFWS in Columbia, Missouri.

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