US Army Corps of Engineers®
Kansas City District

MISSOURI RIVER RECOVERY PROGRAM

Cora Island Missouri River Recovery Project
St. Charles County, Missouri

Project Implementation Report
With Integrated Environmental Assessment
&
Section 404(b) (1) Evaluation

MAY 2014

THIS PAGE INTENTIONALLY LEFT BLANK

DRAFT

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E 12TH STREET
KANSAS CITY MO 64106-2824

(DRAFT)
FINDING OF NO SIGNIFICANT IMPACT

Missouri River Recovery Program - Project Implementation Report With Integrated Environmental Assessment & Section 404(b) (1) Evaluation

Cora Island Project

Project Summary

The Cora Island Project is a component of the U.S. Army Corps of Engineers (Corps) overall Missouri River Recovery Program. The Corps is working cooperatively with the U.S. Fish and Wildlife Service to achieve the metrics outlined in accordance with the U.S. Fish and Wildlife Service's *2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* (BiOp). It is estimated that approximately 522,000 acres of aquatic and terrestrial habitat were lost as the result of the construction of the Missouri River Bank Stabilization and Navigation Project (BSNP). This loss of habitat has led to serious declines in native fish and wildlife populations and contributed to the threatened and endangered listing of the interior least tern (*Sterna antillarum*), piping plover (*Charadrius melodus*), and the pallid sturgeon (*Scaphirhynchus albus*) under the Endangered Species Act. It is believed that a significant reduction in shallow water habitat (SWH) has adversely affected pallid sturgeon. This project would include construction of three side channel chutes to create shallow water habitat (SWH) to benefit pallid sturgeon. Upon completion, the project would restore approximately 111 acres of SWH. Chute construction and notching an existing non-federal agricultural levee would improve floodplain connectivity to about 1,200 acres of land. The project would maintain all eight of the Congressionally-authorized project purposes of the Missouri River. The project is located 15 miles north of St. Louis in St. Charles County Missouri on the left descending bank of the Missouri River, from about river miles 3 to 7, near the town of West Alton, St. Charles County, Missouri.

DRAFT

Alternatives

Measures that potentially meet the project objective were identified. These measures were screened for acceptability based on more detailed evaluations of whether they contributed to the project objectives, avoided project constraints, and were technically feasible. Measures that remained following the screening were combined to form alternatives and evaluated in more detail. In addition to the "No Action" Alternative, the two alternatives were evaluated in detail. These included Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity, and Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan).

Recommended Plan

The Recommended Plan would result in approximately 42 acres of SWH immediately following construction of three chutes. The chutes would total 24,000 linear feet in length and be constructed to a width of approximately 75-feet and a depth of 5 to 7-feet below the construction reference plan. Over time, natural processes would expand the width of the chutes and result in approximately 111 acres of SWH. At least one rock control structure would be installed to control the ultimate width of the chute and prevent the chute from widening beyond a bottom width of 200 feet. In total, approximately 202 acres of farmed wetlands would be adversely impacted by constructing the chutes. These impacts would be mitigated onsite.

Floodplain connectivity would be improved to approximately 1,200 acres of land that is currently protected by a non-federal levee. This would occur by removing portions of the levee within the chute alignment. In addition, six additional locations would be notched to allow better hydrologic connection with the Missouri River. Existing BSNP dikes adjacent to Cora Island would be modified so that diversion of water through the new chute complex would not result in any changes to existing water level elevations of the Missouri River in the vicinity of the project. Natural regeneration would be the primary method of vegetative restoration on the remainder of the site; however, if needed, plantings would be undertaken to ensure ecological success as part of site Operation and Maintenance.

Summary of Environmental Impacts

The Recommended Plan would result in adverse impact to approximately 202 acres of farmed wetlands. Constructing the chutes and placement of the soil from the top three feet would adversely impact about 61 acres of farmed wetlands. Additionally, the chutes would alter the hydrology on another 141 acres of farmed wetlands. However, features would be incorporated into the design of the Recommended Plan to mitigate for these impacts onsite. Minor, intermediate-term impacts would result from clearing approximately 7 acres of riparian woodlands. Minor, short-term construction related impacts to fish and wildlife would result from noise and visual disturbances. Furthermore, there would be minor, short-term impacts to recreation and aesthetics during and immediately after project construction. Site specific and system wide monitoring have indentified no significant adverse impacts to water quality, aquatic habitat, dependent life forms, or socio-economic resources. Long-term beneficial environmental impacts would result from developing 111 acres of SWH, and improving floodplain connectivity to approximately 1,200 acres of land adjacent to the Missouri River. These benefits would contribute to meeting the requirements of the BiOp and WRDA authorizations.

Mitigation Measures

Impacts to 202 acres of farmed wetlands would be mitigated by constructing earthen berms to maintain suitable hydrology on approximately 141 acres of existing farmed wetlands and to create approximately 61 acres of new wetlands. This would result in no overall net loss of

DRAFT

wetland habitat. These actions would mitigate and offset impacts to wetlands resulting from the Recommended Plan. Minor, intermediate-term impacts to riparian trees and minor short-term impacts to fish and wildlife, recreation, and aesthetics would be greatly outweighed by the long-term environmental benefits of the project. Best management practices would be utilized during construction to avoid and minimize impacts to the aquatic ecosystem. Therefore, no additional mitigation efforts are warranted or proposed.

Public Availability

The proposed project is being circulated to the public and resource agencies through a Public Notice, Number 2014-608, dated May 16, 2014, with a thirty-day comment period ending on June 15, 2014. Information concerning the availability of the Public Notice and draft documents is being e-mailed to entities from both the Kansas City District Regulatory Branch and the St. Louis District Regulatory Branch email distribution lists. During the public comment period, the Public Notice and draft documents are available on the Kansas City District Public Notice website (http://www.nwk.usace.army.mil/regulatory/CurrentPN/currentnotices.htm), the St Louis District Public Notice website (http://www.mvs.usace.army.mil/Missions/Regulatory/PublicNotices.aspx), and the Missouri River Recovery Program website (http://moriverrecovery.usace.army.mil/mrrp/f?p=136:1).

On June 23 – 24, 2009 and March 12, 2010 the Corps held site visits and scoping meetings with representatives from the U.S. Fish and Wildlife Service, state resource agencies, non-governmental organizations and members of the public to solicit input and concerns on the proposed project. A public meeting is also being held during the public comment period to provide information on the proposed project and the Project Implementation Report. This meeting is scheduled on June 4, 2014 from 6:00-8:00 pm at The Audubon Center, 301 Riverlands Way, West Alton, MO 63386.

Conclusion

While both construction alternatives would eventually result in the restoration of approximately 111 acres of SWH, Alternative 3 is identified as the Recommended Plan. This alternative best fulfills the program and site-specific goals for the Cora Island Project. With the incorporation of wetland mitigation, the Recommended Plan represents the least costly, technically feasible, and environmentally acceptable alternative. The “No Action” alternative was not recommended because it would not adequately fulfill the site specific project objectives. The Recommended Plan is consistent with the Corps’ responsibility to meet SWH acreage goals and other requirements outlined in the BiOp.

DRAFT

After evaluating the anticipated environmental, economic, and social effects as described in the Environmental Assessment, I have determined that the Recommended Plan (Alternative 3) for the Cora Island Missouri River Recovery project does not constitute a major Federal action that would significantly affect the quality of the human environment; and therefore, preparation of an Environmental Impact Statement is not required. In addition, I have determined that the Recommended Plan is in full compliance with the requirements of the Clean Water Act Section 404(b) (1) Guidelines.

________________________ _______________________________

Date

Andrew D. Sexton
Colonel, Corps of Engineers
District Commander

DRAFT

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, KANSAS CITY DISTRICT
635 FEDERAL BUILDING
601 E 12TH STREET
KANSAS CITY MO 64106-2824

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers, Kansas City District (Corps) is constructing the Cora Island Project as part of the Missouri River Recovery Program to meet the Shallow Water Habitat (SWH) metrics in accordance with the U.S. Fish and Wildlife Service's (USFWS) *2003 Amendment to the 2000 Biological Opinion BiOp on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* (BiOp). Authorization for the project is from the Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project (Mitigation Project) under authorization of the Water Resources Development Acts (WRDA) of 1986, 1999, and 2007.

The project is located on the left descending bank of the Missouri River, between river miles 3 and 7, near the town of West Alton, St. Charles County, Missouri. A primary purpose of the Cora Island project is to construct SWH in compliance with the BiOp within the 1,342 acre site. The proposed SWH restoration project is consistent with the above project authorizations and BiOp requirements. Following project construction, herbaceous plants would be planted on all disturbed areas to prevent the establishment of invasive species. Long-term, natural regeneration would be the primary method of vegetation restoration for the remainder of the site. However, plantings would be undertaken as part of operation and maintenance of the site, if needed, to ensure ecological success. The Corps would be responsible for the long-term operation and maintenance of the project.

In partnership with the USFWS, who manages the Cora Island as part of the Big Muddy Fish and Wildlife Refuge, the Corps proposes three side-channel chutes on the project site. The proposed project consists of three side-channel chutes that total 24,000 linear feet in length and would ultimately provide approximately 111 acres of SWH. The chutes would be constructed to a width of 75-feet, and five to seven feet below the construction reference plane. The construction reference plane is defined as a sloping datum representing the water surface elevation met or exceeded 75% of the time during the April through November navigation season.

Initially, the chute alignment would be cleared of woody vegetation using heavy construction equipment. Additionally, the top three feet of soil (approximately 380,000 cubic yards) would be placed along the outer limits of the cleared zone to facilitate dredge access. Some of this soil would be used to construct berms to mitigate for 202 acres of wetland impacts. Approximately 130,000 cubic yards of soil from the project would also be placed on the landward side of the L-15 levee on agricultural land and made available to the Consolidated North County Levee District as a good stewardship action. Approximately 1,791,000 cubic yards of remaining soil would be removed from the chute alignments using a hydraulic dredge. Dredged material would be pumped as slurry mixture of water and sediment into the Missouri River in a location and manner that would integrate it into the existing bedload. Through time, and dependent on the

DRAFT

discharge of the river, the chute would be expected to widen to the ultimate bottom width of 200 feet. At least one flow control structure would be constructed of rock to establish the desired channel width until sediment balance is established. Approximately 2.6 million cubic yards of additional earthen material would be integrated into the Missouri River through natural processes. Stockpiled woody debris and standing trees would fall into the river as the channel widened and meandered, resembling natural erosion processes. This would provide additional fish and wildlife habitat benefits. The project would result in approximately 42 acres of SWH at completion of construction and is expected to ultimately provide approximately 111 acres through natural processes.

The following Project Implementation Report with Integrated Environmental Assessment and Section 404(b) (1) Evaluation describes alternatives considered for the project and evaluates their impacts on the human environment. No significant adverse impacts are expected to result from the proposed habitat restoration project. The Project Implementation Report with Integrated Environmental Assessment and Section 404(b)(1) Evaluation is available for public review for 30 days from May 14, 2014. Provided no substantive issues are identified, the District Commander will approve the final documents and Finding of No Significant Impact.

The Corps will hold a public meeting to provide information on the proposed project on June 4, 2014 from 6:00 p.m. to 8:00 p.m. at:

The Audubon Center
301 Riverlands Way
West Alton, MO 63386
http://riverlands.audubon.org

Additional information concerning the project or the public meeting may be obtained from Mr. Whitney K. Wolf, Project Manager, Cora Island Project, Missouri River Recovery Program, by e-mail at whitney.k.wolf@usace.army.mil, by telephone at 816-389-3019, or by writing to:

USACE, Kansas City District
CENWK-PM-CJ, C/O Whitney Wolf
601 E 12th St.
Kansas City, MO 64106

DRAFT

Table of Contents

DRAFT

DRAFT

FIGURES

DRAFT

TABLES

APPENDICES

DRAFT

Chapter 1 – Introduction

The U.S. Army Corps of Engineers (Corps) proposes to construct the Cora Island project as part of the Missouri River Recovery Program to meet the requirements of the U.S. Fish and Wildlife Service's (USFWS) *2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* (BiOp). The project would be completed under the authority of the Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) from Water Resource Development Acts (WRDA) of 1986, 1999, and 2007. The Corps will continue to meet its obligations under the Endangered Species Act by utilizing all of its authorities, including the authorities under WRDA 1986, 1999 and 2007.

A primary purpose of the Cora Island project is to construct shallow water habitat (SWH) as required in the BiOp. Shallow water habitat includes side channels, backwaters, depositional sandbars detached from the bank, and low-lying depositional areas adjacent to shorelines. Key components of SWH are their dynamic nature with depositional and erosive areas; predominance of shallow depths intermixed with deeper holes and secondary side channels, lower velocities and higher water temperatures than main-channel habitats.

Cora Island is located on the left descending bank of the Missouri River, from about river miles 3 to 7, near the town of West Alton, Missouri. The land was purchased from willing sellers by the Corps in 2008. USFWS is the onsite management agency working in partnership with the Corps to develop and implement the plan for this project. The Corps is providing oversight on the planning effort including the construction, monitoring and maintaining the project, and long-term plan to achieve congruence of the site with the WRDA authorization purposes. The Corps would have responsibility for long-term operation and maintenance of the project, and the USFWS would be the on-site management agency. Collectively, the 1,342 acre site would be managed by USFWS as part of their Big Muddy National Fish and Wildlife Refuge.

This Project Implementation Report (PIR) includes an Environmental Assessment (EA) consistent with the National Environmental Policy Act (NEPA). It provides an analysis of alternatives, a detailed description of the Recommended Plan, and environmental impacts for habitat development at Cora Island consistent with the requirements of pertinent federal regulations including NEPA, the Endangered Species Act (ESA), the National Historic Preservation Act (NHPA), and Section 404 of the Clean Water Act (CWA).

1.1 Purpose and Scope

The purpose of this PIR is to evaluate alternatives to restore SWH, floodplain connectivity, and riparian habitat on Cora Island, as part of the Missouri River Recovery Program (MRRP) and in accordance with goals outlined in the BiOp and the WRDA authorization purposes. The Recommended Plan described in this PIR includes site specific measures that implement the Selected Alternative described in the Corps' 1981 *Feasibility Report and Environmental Impact Statement* in 1981 on the original Mitigation Project and the 2003 *Supplemental Environmental Impact Statement* (SEIS) on the Mitigation Project as modified by WRDA99. The 2003 SEIS included the restoration of 7,000 to 20,000 acres of SWH.

DRAFT

Cora Island was purchased by the Corps in fee title from willing sellers in 2008 for the purpose of preserving and restoring portions of the Missouri River floodplain and its fish and wildlife habitat through the construction of SWH, and restoration of floodplain connectivity and riparian habitat. The 1,342 acre Cora Island is located just upstream from the 975 acre Confluence Point State Park and the 4,226 acre Columbia Bottoms Conservation Area both of which are MRRP sites. In addition, the Corps owns and manages, in a unique partnership with the National Audubon Society, 3,700 acres at the Riverlands Migratory Bird Sanctuary. These areas form a substantial tract of natural riverine habitat whose geomorphology reflects the past function of the river's meander belt. The project site is ideal for creation of BiOp recommended shallow water habitats along the Missouri River. Restoration of natural river habitat and functions in this section of the river would meet several BiOp requirements.

The scope of this study is confined to the Cora Island project area (Figure 1). The alternatives considered in this study evaluate SWH, floodplain connectivity, and riparian habitat with the primary focus on SWH construction and wetland preservation. A supplement to this PIR would be necessary if additional acres are proposed for SWH development in the future.

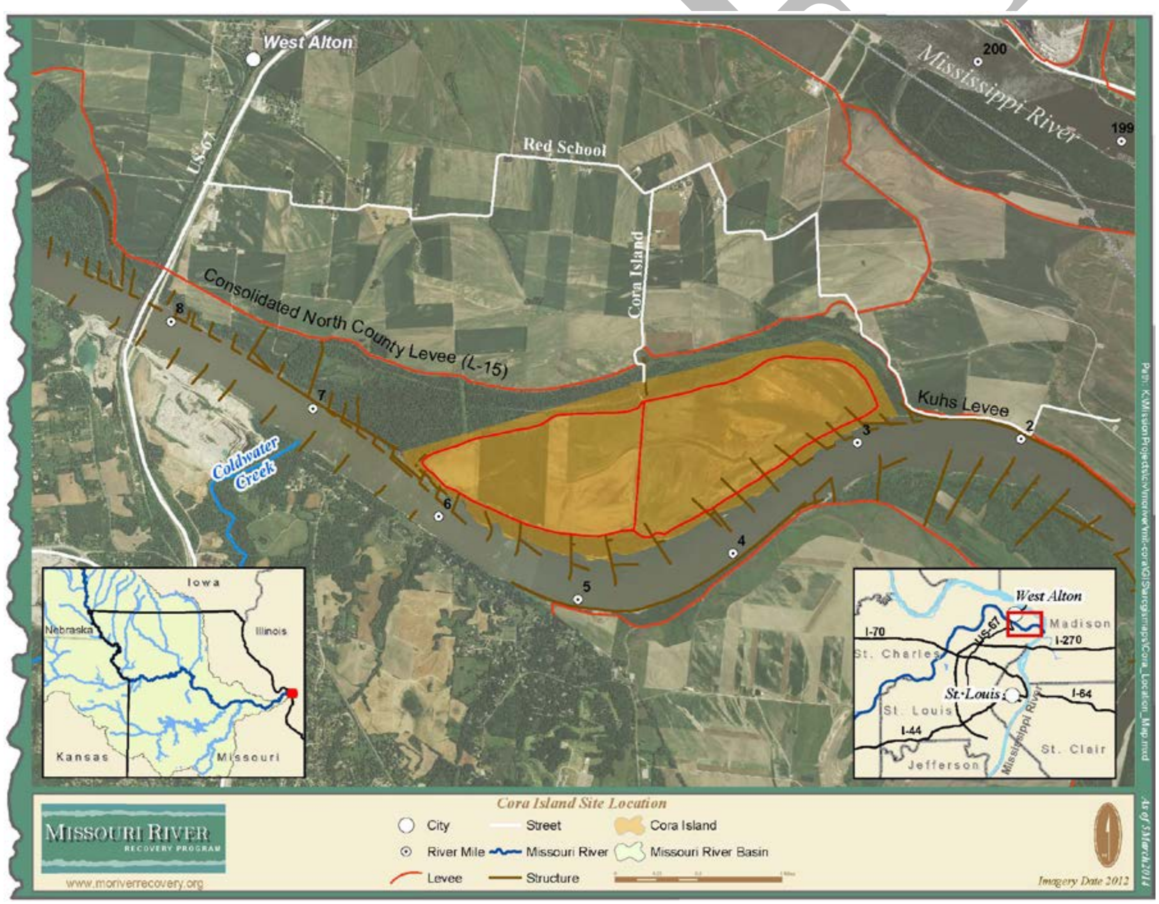


Figure 1: Cora Island, St. Charles County, Missouri.

1.2 Project Authority

Cora Island is proposed as part of the MRRP. The MRRP authority is derived from the Mitigation Project that was initially authorized in Section 601(a) of WRDA86 [Public Law (PL) 99-662]. The authorization included the acquisition and development of 29,900 acres of land, and habitat development on an additional 18,200 acres of existing public land in the lower 735 miles of the Missouri River from Sioux City, Iowa, to the mouth near St. Louis, Missouri, to mitigate for the loss of habitat that resulted from construction, operation, and maintenance of the Missouri River Bank Stabilization and Navigation Project (BSNP). The total amount of land authorized for mitigation by WRDA86 was 48,100 acres. Section 334(a) of WRDA99 (PL 106-53) modified the Mitigation Project by increasing the amount of acreage to be acquired and/or mitigated by 118,650 acres and included the restoration of 7,000 to 20,000 acres of SWH. Therefore, the total amount of land authorized for mitigation is currently 166,750 acres. The Corps prepared a *Feasibility Report and Environmental Impact Statement* in 1981 on the original Mitigation Project of 48,100 acres. After Congress modified the Mitigation Project in WRDA99, the Corps initiated a *Supplemental Environmental Impact Statement* (SEIS) in September 2001 for the additional 118,650 acres. The SEIS was completed in early 2003 and the *Record of Decision* (ROD) was signed in June 2003 (Corps 2003). The proposed project is consistent with the above project authorizations and BiOp metrics.

1.3 Existing Site Characteristics

Cora Island lies three miles upstream of the Missouri River's confluence with the Mississippi River. Its terrain is characterized by a ridge and swale topography that shows a pattern of flooding and drainage that generally flows from west to east. Total relief is approximately thirty three feet with elevations ranging from 402 to 435 feet above sea level in elevation datum NAVD88. Subsequent elevations in the PIR are consistently reported in datum NAVD88. A large swale runs through the center of the island. A road runs through the middle of the site, perpendicular to the river and bisecting the large central swale, at an average elevation of 428 feet. While some flow structures, such as culverts, exist under the road, drainage is still inhibited from the west half of the island to the east. Soils at Cora Island all formed from recent alluvial deposits. They are frequently flooded with ground water that fluctuates with water levels of the river. The eastern half of the site is relatively lower, more frequently inundated, and is prone to wetland functions.

A non-federal agricultural levee surrounds Cora Island. Except during times of high ground water levels or when the levee is overtopped by flooding, no direct connectivity between the island and the Missouri River exists. The levee has only overtopped twice in the large flood events of 1973 and 1993 (as noted by personal communications with previous landowners). The top of this levee is at an elevation of 430 feet. Contrasting the undulating topography in the eastern part of the island, the topography of the western half is less topographically diverse. One large scour hole exists inside the levee on the northern end of the island, where a levee break and deep scouring occurred during the flood of 1993. The bank of the Missouri River is relatively wide and flat compared with upstream sections, and the banks are covered in many places by rip-rap. BSNP river training structures border the property, with mudflats exposed behind them at low river stages.

DRAFT

1.4 Site Selection

The Cora Island Project is consistent with BiOp compliance and the existing authorities. It is located on land owned by the Corps along the Missouri River in the state of Missouri. Cora Island was selected as a potential site for development of SWH based on review of historic and current aerial photography and on-site evaluations. The property was made available by a willing seller and the Corps acquired fee title to the land in 2008. The USFWS is currently the daily maintenance and oversight agency at the project site, and Cora Island has been incorporated into the Big Muddy National Fish and Wildlife Refuge, contributing to regional landscape level habitat restoration efforts.

Chapter 2 – Project Goals and Objectives

2.1 Purpose and Need for Action

As described in the 2003 amended BiOp, loss of habitat and alteration of ecological functions within Missouri and Mississippi Rivers is believed to be the primary cause of declines in reproduction, growth, and survival of endangered pallid sturgeon (USFWS 1993). Over one-half million acres of terrestrial and aquatic habitat have been lost along the lower Missouri River, primarily as a result of the construction and operation of the BSNP, the Missouri River Mainstem Reservoir system, and levees and floodwalls along the lower river. These projects have modified channel morphology, flow regime, water temperature, sediment transport, turbidity, and nutrient inputs of the Missouri River.

The purpose of this project is to restore SWH, floodplain connectivity, and riparian habitat on Cora Island. This would be in accordance with goals outlined in the 2003 amended BiOp and the WRDA authorizations. It is a site specific project as described in the Selected Alternative in the Corps' 1981 *Feasibility Report and Environmental Impact Statement* and the 2003 *Supplemental Environmental Impact Statement* (SEIS).

2.2 Project Goal

The goal of this project is to create habitat to benefit the federally endangered pallid sturgeon by meeting the requirements of the 2003 amended Biological Opinion to avoid jeopardy to this species. This includes the restoration of shallow water habitat, floodplain connectivity, and riparian habitat, and reversion of the site to habitat compliant with WRDA authorities.

2.3 Project Objectives

- Maximize shallow water habitat within the project site. Between 6-17% of the 1,342 acres should be developed into shallow water habitat.

- Improve floodplain connectivity to increase the likelihood of inundation of the project site during high water events.

DRAFT

- Preserve to extent possible, while maximizing shallow water habitat and improving floodplain connectivity, existing desirable habitats such as wetlands and offset unavoidable impacts.

- Implement the WRDA authorities tailored to jeopardy avoidance for listed species.

- Take advantage of good stewardship opportunities.

2.4 Constraints

Fish and wildlife habitat restoration projects completed by the Corps as part of the MRRP are developed and operated within numerous constraints. The following constraints were considered.

Project Authorizations: The Corps acquired the Cora Island site under BSNP WRDA authorities. Therefore, the Corps will ultimately convert the site to land features that offset impacts to the BSNP and plans to achieve that are included in this PIR. While all land acquired under the WRDA authority for fish and wildlife mitigation needs to comply with the provisions and land uses under the authority, current budgetary priorities are focused on BiOp compliance. Accordingly, current plans in this PIR center on expending minimal resources to convert the remaining land (non-SWH) into a use that is consistent with the authority under which it was purchased.

Missouri River Authorized Purposes: Projects completed as part of the MRRP will align with the currently authorized purposes of the Missouri River Mainstem Reservoir System and the BSNP. For the Mainstem Reservoir System these include: flood control, hydropower, navigation, water supply, water quality, irrigation, recreation, and fish and wildlife. For the BSNP these include: bank stabilization and navigation.

Adjacent Private Property: Project alternatives should minimize or avoid any foreseeable effects to adjacent private property.

Easements: Currently easements for a power line and two natural gas monitoring wells exist on the site. The Corps has awarded a contract to relocate the gas monitoring wells off of the site. Designs must avoid impacting the power line easement.

Ownership: Project alternatives should be located on existing Corps or USFWS lands.

Cultural/Tribal Resources: The Corps' BSNP resulted in the preservation in place of hundreds of historic shipwrecks along the Missouri River. The condition of these shipwrecks varies widely from just remnants of the hull to those that are completely preserved intact. Alternatives must avoid impacts to historic shipwrecks and implement measures which avoid and/or preserve in place historic shipwrecks if they are inadvertently discovered during construction.

DRAFT

Public Infrastructure: The Corps implements the MRRP in a manner that does not adversely impact public roads, bridges, levee and drainage systems, sewer lines, drinking water intakes, etc.

Operation and Maintenance (O&M) Costs: Limited funding is available for long-term operation and maintenance.

Real Estate: The Corps must implement the MRRP on existing public lands or on lands that are acquired from willing sellers.

Laws and Regulations: Alternatives would all be designed and constructed to be consistent with Federal, State, and local laws and regulations.

Navigation: Alternatives would all be designed and constructed to prevent impacts to the authorized Missouri and Mississippi River navigation channels. Communication will be maintained throughout construction between Kansas City and St. Louis Districts to ensure an adequate navigation channel is maintained.

Spoil Material: Missouri Department of Natural Resources is concerned about the direct discharge of sediment and soil into the Missouri River. On similar projects, they have requested that the top layer of soil not be directly placed into the river.

Large Trees: Avoid or minimize removal of large trees with exfoliating bark that may provide habitat for species of bats that are listed, or being considered for listing, as federally threatened or endangered. Any removal of large trees should be scheduled during the winter months to avoid effects to bats and migratory birds. If this is not possible, than bat and bird surveys would need to be conducted immediately prior to any tree removal.

Water Quality: Avoid long-term adverse impacts to water quality.

Other Resources: Avoid significant adverse impacts to other natural, cultural, and economic resources. If wetlands are adversely impacted, compensatory mitigation measures shall be incorporated into project design.

2.5 Resource Significance

The Missouri River has played a great role in our Nation's history, provides great social and economic benefits and supports extensive fish and wildlife populations. The importance of the Missouri River is well documented in numerous reports. The most recent to examine the resource significance of the Missouri River was the March 2003, Supplemental Environmental Impact Statement for the Missouri River Fish and Wildlife Mitigation Project located on the Missouri River from Sioux City, Iowa to the mouth near St. Louis, Missouri in the States of Iowa, Nebraska, Kansas, and Missouri. Currently the U.S. Fish and Wildlife Service lists three species found on the Missouri River as threatened or endangered. These include: interior least tern (endangered), piping plover (threatened), and pallid sturgeon (endangered). Being located near the confluence of the Missouri and Mississippi Rivers, Cora Island is also located in a strategic location along the Mississippi River flyway. The flyway is one of the most important

DRAFT

migratory bird routs in North America. There are also other large scale natural areas and conservation efforts occurring near the confluence area. These include the Edward "Ted" and Pat Jones Confluence Point State Park, the Columbia Bottom Conservation Area, and Missouri/Mississippi Rivers Confluence Conservation Partnership.

2.5 Previous Related Reports

The following previous reports are related to this PIR:

- U.S. Army Corps of Engineers, Missouri River Division, 1981. *Missouri River Fish and Wildlife Mitigation Iowa, Nebraska, Kansas, and Missouri Final Feasibility Report and Final Environmental Impact Statement.*
- U.S. Army Corps of Engineers, Kansas City District, 1990. *Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project, Reaffirmation Report.*
- U.S. Army Corps of Engineers, Kansas City District, Missouri River Division, 1990b. *Missouri River Bank Stabilization and Navigation, Fish and Wildlife Mitigation Project, Real Estate Design Memorandum #1*.
- U.S. Army Corps of Engineers, Kansas City District, Missouri River Division, 1992. *Missouri River Fish and Wildlife Mitigation Project, Project Management Plan*.
- U.S. Army Corps of Engineers, Kansas City District, Kansas City and Omaha Districts, 2003. *Missouri River Fish and Wildlife Mitigation Project, Final Supplemental Environmental Impact Statement and Record of Decision*.
- U.S. Army Corps of Engineers, Missouri River Division, 2004. *Missouri River Fish and Wildlife Mitigation Project, Program Management Plan.*
- U.S. Army Corps of Engineers, Kansas City District, Kansas City and Omaha Districts, 2005. *Missouri River Fish and Wildlife Mitigation Project, Draft Program Management Plan*.
- U.S. Army Corps of Engineers, Kansas City District, Kansas City and Omaha Districts, 2006. Project Implementation Report, *Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project, Jameson. Island Unit, USFWS Big Muddy Fish and Wildlife Refuge, Chute Construction Project.*
- U.S. Fish and Wildlife Service, 1980. *Missouri River Stabilization and Navigation Project, Sioux City, Iowa to Mouth Detailed Fish and Wildlife Coordination Act Report*.
- U.S. Fish and Wildlife Service, 1994. *The Big Muddy National Fish and Wildlife Refuge Final Environmental Impact Statement.*

DRAFT

2.6 Agency and Public Coordination

Representatives from the USFWS, Iowa Department of Natural Resources (IDNR), Kansas Department of Wildlife, Parks and Tourism (KDWPT), Missouri Department of Conservation (MDC), Nebraska Game and Parks Commission (NGPC), along with the Kansas City and

Omaha Districts of the Corps comprise the Mitigation Project Agency Coordination Team (ACT), which meets quarterly. The Environmental Protection Agency (EPA), Natural Resource Conservation Service (NRCS), Missouri Department of Natural Resources (MDNR), representatives from MRRIC and others also attend the meetings. The initial responsibility of the ACT was to develop selection criteria for screening and prioritizing general areas to identify willing sellers for potential mitigation sites. The ACT also meets to discuss future activities, priorities, funding, and other issues related to implementing, managing, and monitoring the Mitigation Project. During the early 1990s, USFWS representatives to the ACT worked with the Corps to identify Cora Island as an area for potential acquisition and habitat development.

During the project scoping period, letters were sent to the appropriate Federal and state resource agencies requesting information and comment regarding the project. Agencies provided information on federally listed threatened and endangered species, state sensitive and rare species, species in need of conservation, and critical habitats (refer to section 4.5 for additional information regarding threatened and endangered species). Meetings were held with USFWS staff to obtain input on potential shallow water habitat development at Cora Island. Notes from these meetings are included in Appendix A.

On June 23 – 24, 2009 and March 12, 2010, the Corps held site visits and scoping meetings with representatives from USFWS, state resource agencies, non-governmental organizations and members of the public to solicit input and concerns on the proposed project. Notes from these meetings are included in Appendix A. In addition, a public meeting is being held on June 4, 2014, from 6:00 p.m. to 8:00 p.m. at The Audubon Center, 301 Riverlands Way, West Alton, Missouri 63386.

In January 2011, four Federal agencies (Corps, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service and the National Park Service) completed a position statement (Appendix B) related to development of SWH downstream of Gavins Point Dam. In that position statement the four signatory federal agencies stated their support for development of SWH in furtherance of the requirements to mitigate habitat losses, as specified by the BiOp, and in accordance with their respective statutory responsibilities.

On May 14, 2014, Public Notice No. 2014-608 will be issued jointly by the Corps' - Kansas City and St. Louis Districts, and the Missouri Department of Natural Resource announcing the availability of this draft PIR/EA and draft Section 404(b)(1) Evaluation for a 30-day public comment period. Information concerning the availability of the Public Notice and draft documents is being e-mailed to entities on both the Kansas City District Regulatory Branch and the St. Louis District Regulatory Branch distribution lists. During the public comment period, the Public Notice and draft documents are available on the Kansas City District Public Notice website (http://www.nwk.usace.army.mil/regulatory/CurrentPN/currentnotices.htm), the St Louis District Public Notice website (http://www.mvs.usace.army.mil/Missions/Regulatory/PublicNotices.aspx), and the Missouri River Recovery Program website (http://moriverrecovery.usace.army.mil/mrrp/f?p=136:1). A copy of the public notice and list of recipients are in Appendix C. Comments received during the public comment period will be included as Appendix D of the final document.

DRAFT

2.7 Future Without Project Condition

Without the proposed project, the site would experience no significant increases in SWH. Without increases to SWH, no benefits to the federally endangered pallid sturgeon would accrue. The levee surrounding the island would remain, but without maintenance. As a result, connectivity of the floodplain to the Missouri River would likely remain limited for at least the near future. The USFWS would continue to manage the site primarily for terrestrial species due to the limited connectivity with the Missouri River. Natural regeneration of riverfront forest species is expected to occur, primarily consisting or silver maple, willow, and cottonwood species. This would provide benefits to bats, birds, and, during flood events, some fish species. However, the requirements of the BiOp would not be met at this site.

Chapter 3 – Alternatives

3.1 Introduction

This chapter describes the alternative formulation process and presents the final array of alternatives considered in detail for the Cora Island project. Potential measures that may meet the project objective are described. These measures were then screened for acceptability based on more detailed evaluations of whether they contribute to the project objectives, avoid projects constrains, and are technically feasible. Following the screening process, the remaining measures were combined to form the final array of alternatives. The final alternatives were then evaluated in detail in Chapters 5 and 6 to identify the Recommended Plan.

3.2 Preliminary Measures and Methods Considered

The following measures were considered to meet the objectives for the Cora Island project site.

Chutes – Seven potential chute alignments were considered as preliminary measures. These initial alignments were a compilation of alignments gathered through discussions and scoping meetings with the public and resource agencies. Chutes would be initially excavated to a bottom width of 75-100 feet with control structures to constrain the ultimate chute width to a bottom width of approximately 200 feet. They have an inlet and an outlet so they function as a restored side channel. The chute alignments vary by location, length, sinuosity, and width.

Floodplain Connectivity – This measure consists of removal of portions of the levee and allows the Missouri River to inundate the site on a more frequent basis. This is also necessary if a chute is constructed on the site. Locations of potential notches are illustrated in Figure 2.

Construction Methods – For any measures that would result in excess soil, the following construction methods were considered.

- **Only River Based Spoil Disposal**: This consists of returning spoil, the excavated material not needed for the project, to the main channel of the Missouri River.

DRAFT

- **Only Land Based Spoil Disposal:** This consists of placing the excavated material from the project on land. Spoil could either be side-cast adjacent to excavated chutes, or graded into mounds for topographic diversity.

- **Combination of Land and River Spoil Disposal:** A combination of the two above could be employed.

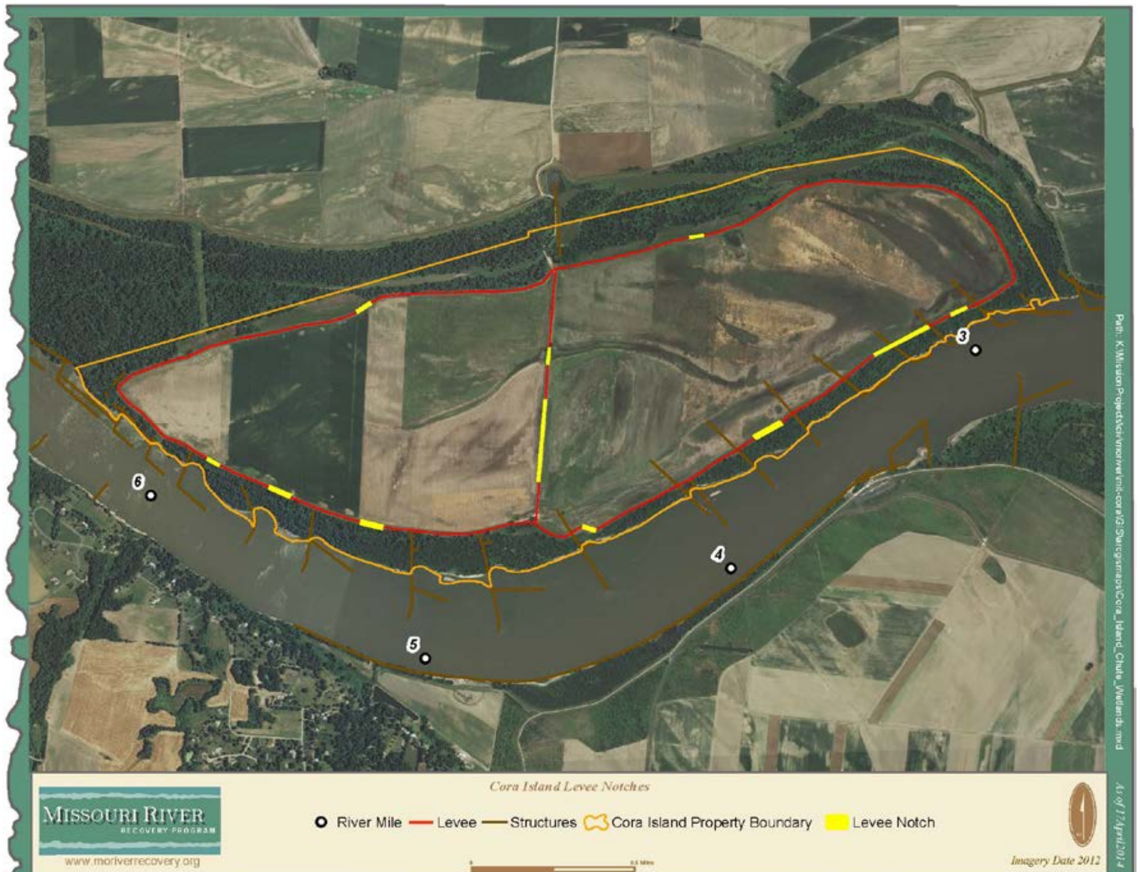


Figure 2: Locations of potential levee notches.

3.3 Preliminary Screening

Project objectives and constraints were used to screen potential measures. The preliminary screening results follow:

Chutes – Chutes meet the definition of SWH. Chutes are flowing side channels adjacent to the main river channel. Chutes are typically constructed to an initial design width and expected to further develop by natural river processes. Allowing the river flows to act on the floodplain along the length of the chute restores the dynamic river processes. Chutes provide important nursery habitat for juvenile native fish and is hypothesized to benefit juvenile pallid sturgeon. The lack of nursery habitat may be limiting pallid sturgeon population growth and recruitment. Created chutes are dominated by juvenile fish (61-75% of all catch was juvenile fishes) (USACE 2009). Older chutes and natural chutes tend to have greater numbers of fish and higher diversity of species than the main channel. The chutes had an average of 57 different species (45-68), with numbers of species generally increasing as the chutes age (USACE 2009). Adult sturgeon are known to travel through constructed chutes when migrating upstream (Aaron Delonay, Ecologist, USGS, personal communications, July 2013).

Seven potential chute alignments are displayed in Figures 3 - 9. All would provide SWH opportunities but some would require additional lands that are currently not owned by either the Corps or USFWS. Eliminating these alternatives (Chute Alignments 2, 3, and 6) leaves four potential alignments. These range in size from approximately15, 000 linear feet of chute and 70 acres of SWH to approximately 2,000 linear feet and 9 acres of SWH. One of these chute options, Chute 3, would connect an existing backwater and require removal of existing BSNP structures which were designed initially to close this structure. If a chute formed on this alignment, it would impact private property so it was also eliminated from further review. The Chute 6 alignment requires extensive digging into the old chute alignment and would cause impacts to existing wetlands. These impacts eliminated this chute alignment from further consideration. The Chute 4 alignment was eliminated from further consideration because it provided less SWH acres than Chute 1 and negatively impacted Chute 1.

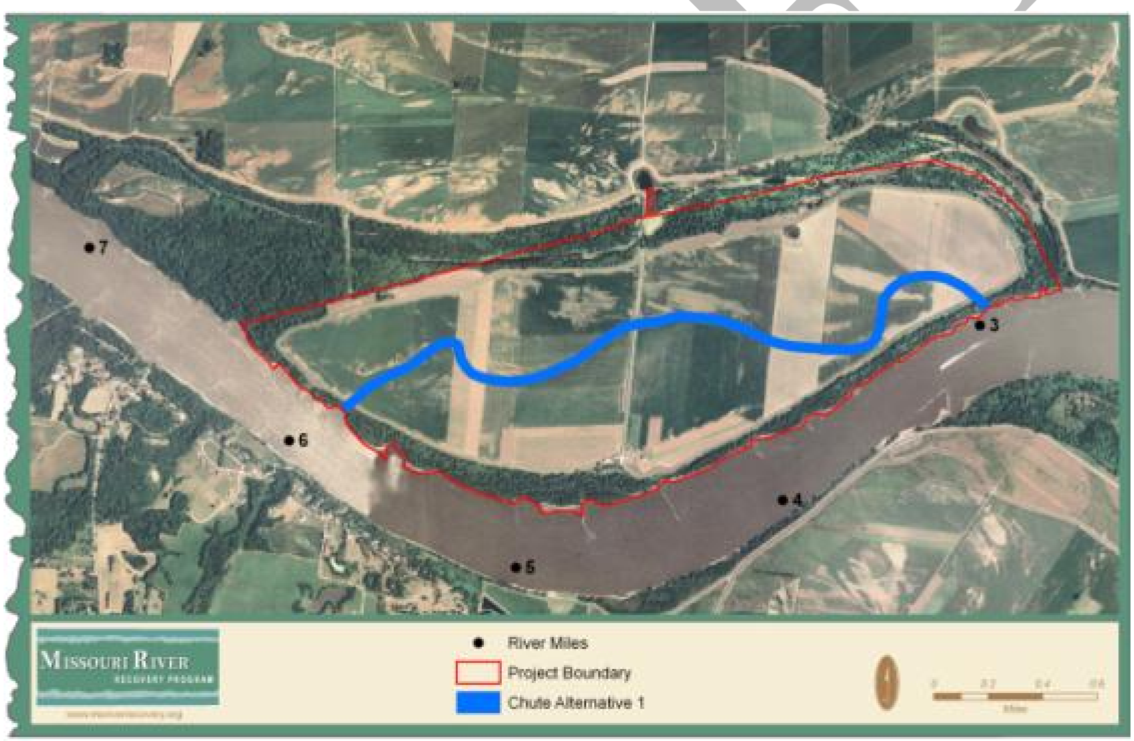


Figure 3: Potential chute alignment 1.

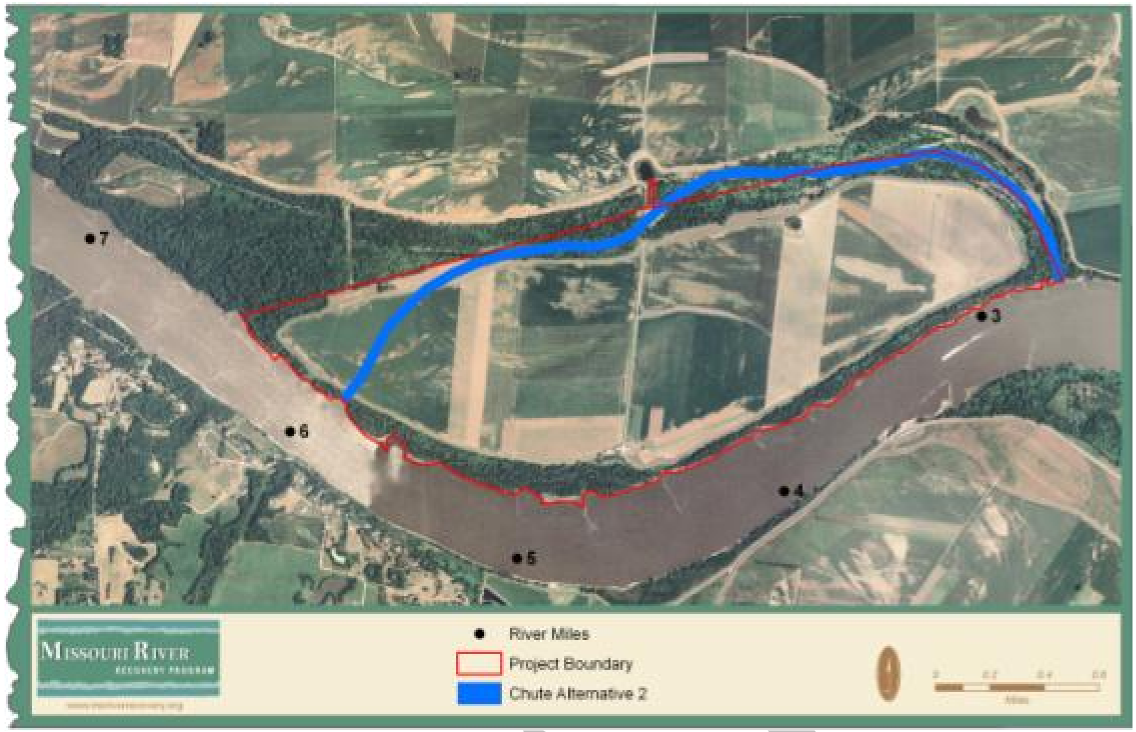


Figure 4: Potential chute alignment 2.

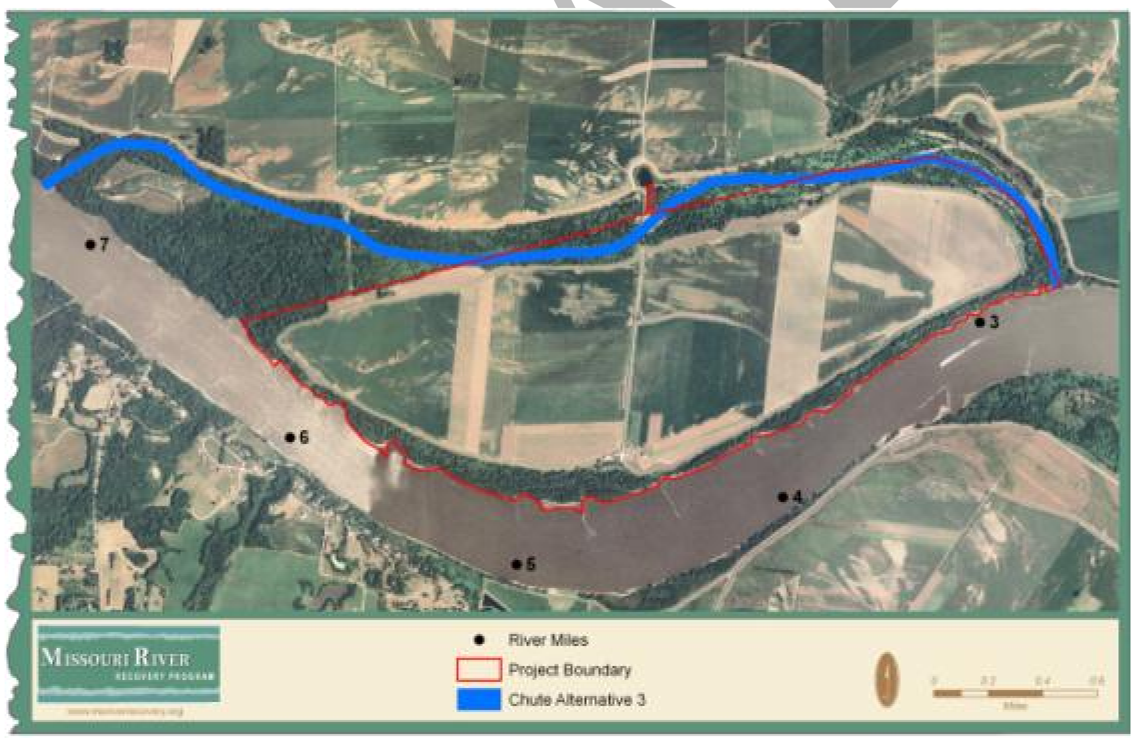


Figure 5: Potential chute alignment 3.

Figure 6: Potential chute alignment 4.

Figure 7: Potential chute alignment 5.

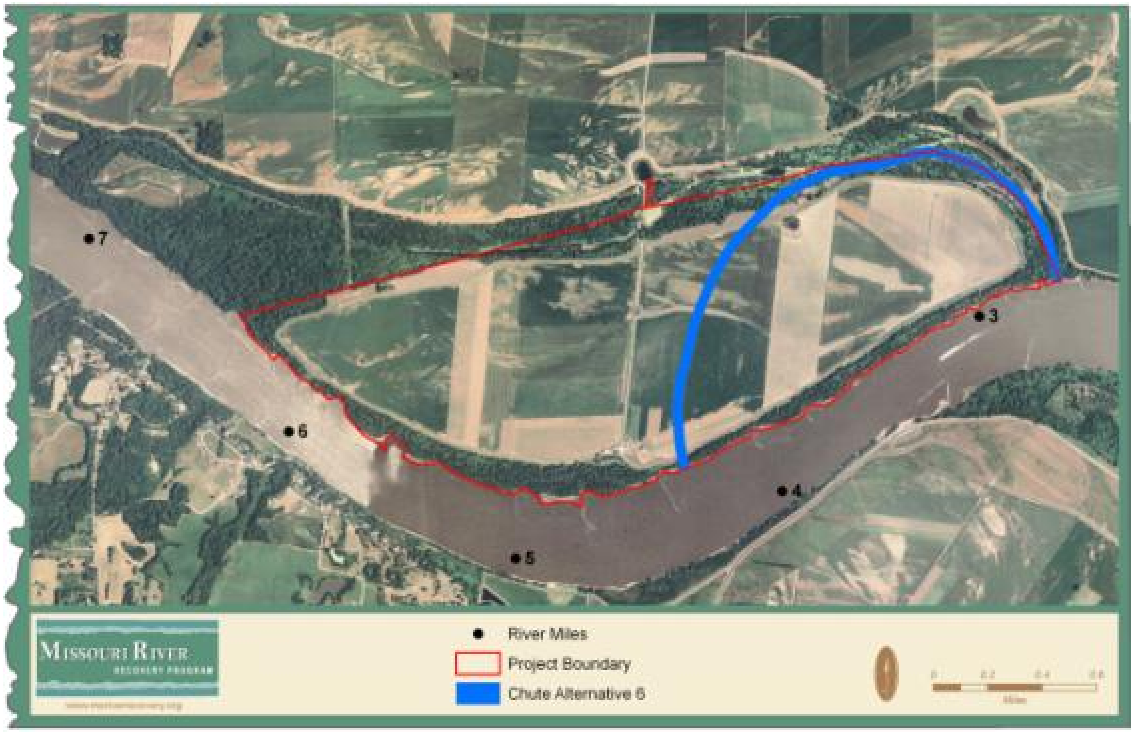


Figure 8: Potential chute alignment 6.

Figure 9: Potential chute alignment 7.

Floodplain Connectivity – Cora Island has a continuous agricultural levee around the site, and it only protects federal lands. Therefore a levee setback would be unnecessary, and degradation of the existing levee would not maximize SWH and thus would not meet project objectives. Four notches in this levee would occur from the preferred chute alignments (Figures 3, 7, and 9). Additional notches would better reconnect the entire 1,342 acres of the island to the river. If the chute alignments are not constructed then notches should be made in the levee (Figure 2). Floodplain connectivity at locations other than the chutes was also moved forward for further consideration.

Construction Methods: The Corps considers a variety of methods for project construction. Each site has unique constraints, typical costs, and environmental factors that must be considered. The following methods were considered for Cora Island:

Only River Based Spoil Disposal – An independent scientific review of the impacts of in-river spoil placement determined that in-river spoil placement as a result of Missouri River SWH development projects is not related to changes in the area of the hypoxia zone in the Gulf of Mexico (National Academy of Sciences [NAS] 2010). In-river spoil placement typically results in lower costs and less adverse environmental impacts. However, the State of Missouri has requested that the top layer of sediment for chutes be deposited on land and not dredged directly into the river. This construction method would not meet that constraint. Therefore, this method by itself was not retained for further consideration.

Only Land Based Spoil Disposal – This method would consist of placing excavated material from project construction activities performed at Cora Island on-land. Spoil placement could include side-casting adjacent to excavated chutes, grading into mounds to provide topographic diversity, or constructed berms to restore wetlands. The Corps has, at other chute construction projects, placed material on land immediately adjacent to the chute and allowed natural river processes to integrate the material into the active river bedload. This construction method was moved forward for further consideration.

Combination of Land and River Based Spoil Disposal – Some of the material would be excavated, side-casted, or used for wetland mitigation features. The rest would be dredged and deposited in the river. This construction method was moved forward for further consideration.

3.4 Secondary Screening

Seven different chute configurations were considered from the individual chute designs. All chute configurations would provide SWH opportunities; however, as mentioned previously, chute alignments 2, 3, and 6 were eliminated as they would require additional lands that are currently not owned by the Corps, USFWS, or the State of Missouri. No single chute alignment maximized the amount of SWH potential on the site. The chute alignment combination of chutes 1, 5, and 7 maximized to the greatest extent SWH on the site. Therefore the configuration of chutes 1, 5, and 7, including two different construction methods were further evaluated (Figure 10).

DRAFT

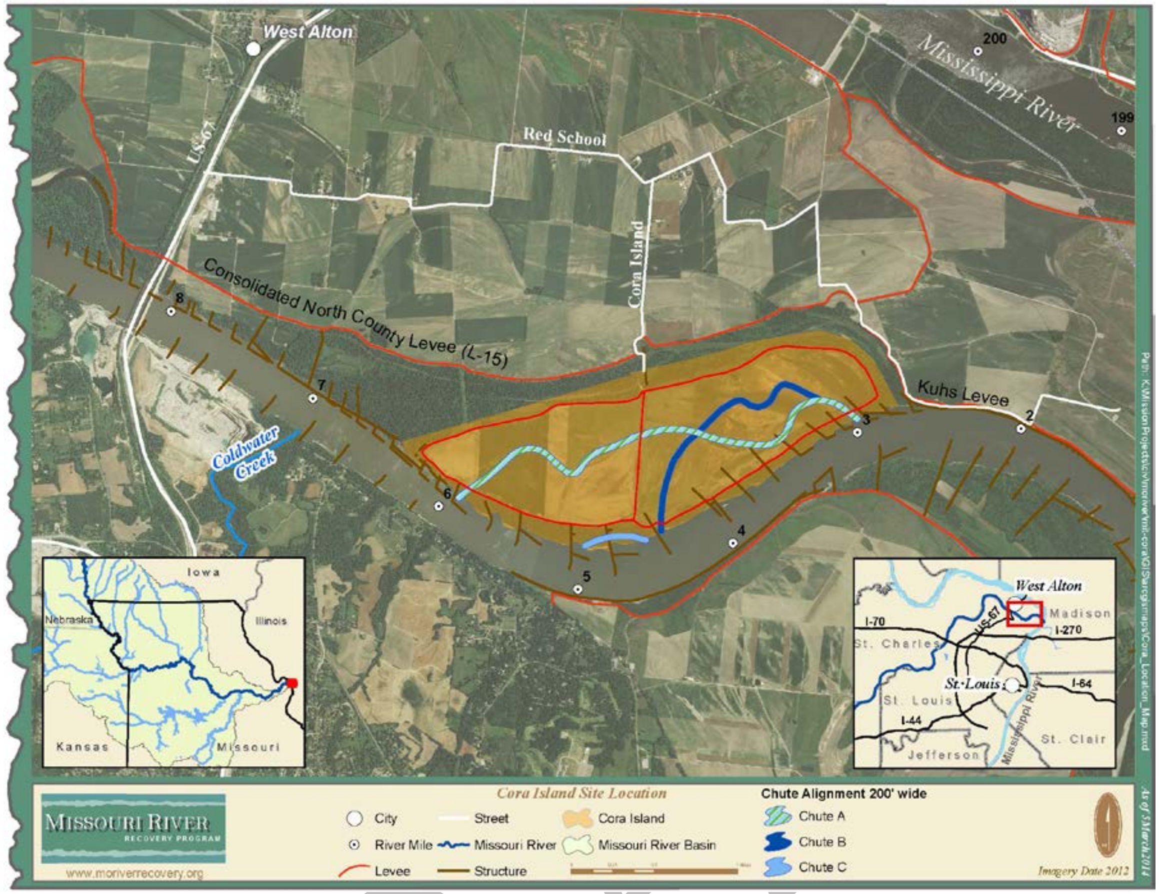


Figure 10: Proposed chute alignments.

3.5 Final Array of Alternatives

The measures that remained following the screening were used to formulate alternatives that were evaluated in detail. In addition to the "No-Action" Alternative, two other alternatives were considered.

Alternative 1 – "No Action"

The "No Action" Alternative would not result in any site modifications to increase the amount of SWH or improve floodplain connectivity to benefit the endangered pallid sturgeon. Through natural succession, it is expected that the existing farm lands would develop into a deciduous forest habitat type. This alternative would not meet the project objectives.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

This alternative would result in approximately 42 acres of SWH at completion of construction that would be designed in a manner in which natural processes would expand this to approximately 111 acres of SWH over time. The rate at which the additional SWH would develop would be dependent on Missouri River discharges. In addition, floodplain connectivity

DRAFT

would be improved to approximately 1,200 acres of land that is currently protected by a levee. All project features are shown in Figure 11.

Three chutes would be constructed to create SWH. The main chute would be 14,500 linear feet in length, the overlapping chute would be 7,800 linear feet in length, and the riverward chute would be 1,700 linear feet in length. The chutes would be excavated to a bottom width of 75-feet, and a depth of five to seven feet below the Construction Reference Plane (CRP). CRP is defined as a sloping datum representing the water surface elevation met or exceeded 75% of the time during the April through November navigation season. A typical chute cross section is illustrated in Figure 12. It is expected that over time natural processes would widen the chute to a width of approximately 200 feet, or until such time that a sediment balance is established within the chute. A rock flow control structure would be installed to control the ultimate width of the chute complex.

The chute alignments would be cleared and grubbed to a width of 200 feet. In total, 2,200,000 cubic yards of soil would be excavated from the chute alignments using heavy construction equipment. Approximately 2,070,000 cubic yards of this soil would be placed adjacent to the excavated chutes. As natural processes widen the chutes, it is expected that the excavated soil not utilized for other purposes and the underlying soil adjacent to the constructed channel, approximately 2,600,000 cubic yards, would eventually be incorporated into the Missouri River bedload. In addition, woody debris would also integrate into the chute and river, providing beneficial habitat features.

Constructing the chutes would adversely impact about 202 acres of farmed wetlands. Around 112 acres would be impacted by the layout of the chutes and placement of excavated soil. An additional 90 acres of wetlands would be impacted as a result of modification to surface water hydrology. Wetland impacts would be mitigated by constructing earthen berms to maintain suitable hydrology on existing wetlands, 90 acres, and to provide new wetlands, 59 acres. The earthen berms would be approximately 4 feet tall. In addition, 53 acres of new wetlands would be constructed between the main chute and the riverward chute as shown in Figure 11. This would result in no net loss of wetland acreage. This soil excavated from the 53 acre wetland area would be placed adjacent to the existing levee as shown in Figure 11.

This alternative would also include minor modifications to approximately 15 existing BSNP structures to increase conveyance and access along the river bank and to newly created shallow water habitat areas, as shown in Figure 11. In addition, three other BSNP structures would be modified to avoid any impacts to water depths on the main channel as a result of water flowing through the chutes. This is an important consideration for the navigation industry.

At the request of a nearby levee district, approximately 130,000 cubic yards of soil from the 2,200,000 cubic yards excavated from the chute would be placed on non-wetland agricultural ground, as shown in Figure 11. The levee district requested this soil for repair and maintenance activities. Providing this soil provides an opportunity for beneficial use of excavated soil.

Floodplain connectivity would be improved because the chutes would bisect the levee in three locations. Notching the levee in five additional locations would further improve floodplain

DRAFT

connectivity. Approximately 100,000 cubic yards of material would be removed to notch the levee. Natural regeneration would be allowed to occur on the site; however, plantings will be undertaken as part of Operation and Maintenance of the site, if needed, to ensure ecological success.

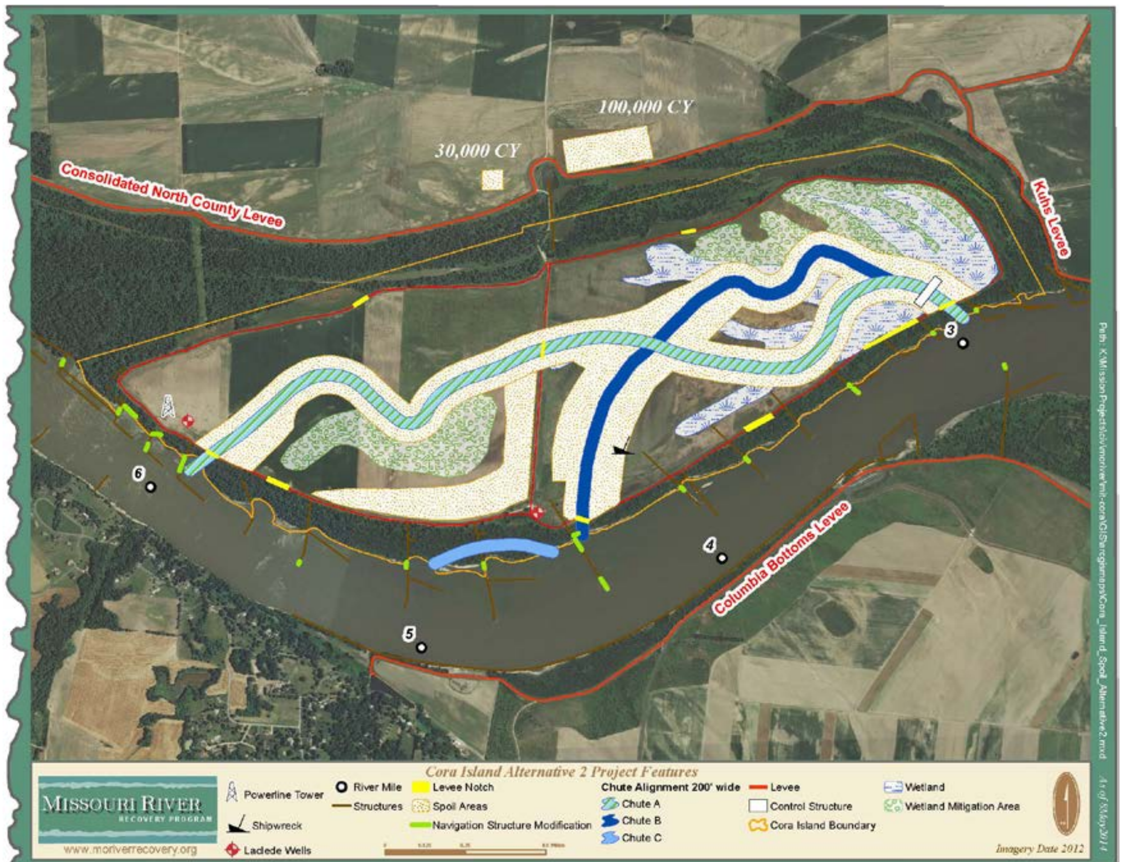


Figure 11: Features included in Alternative 2.

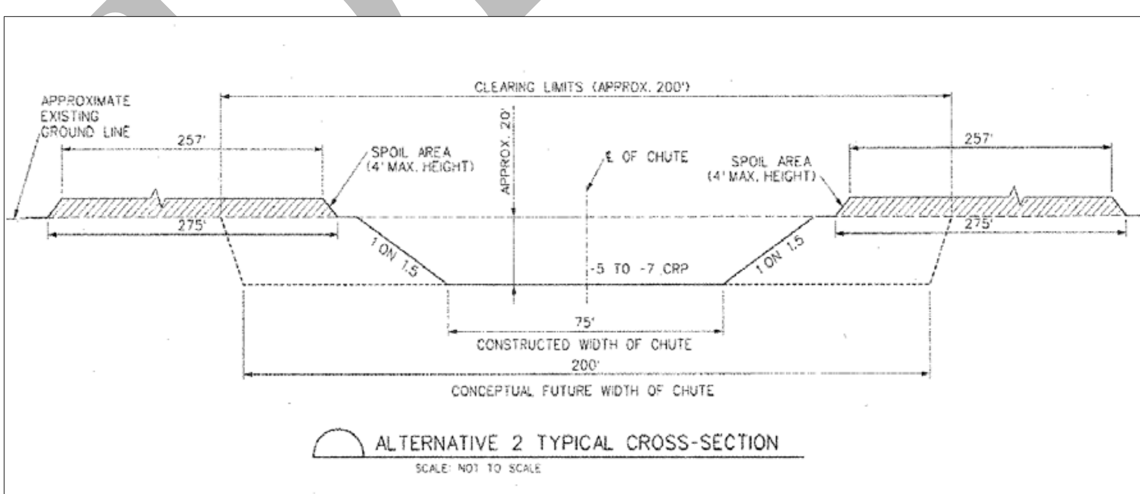


Figure 12: Alternative 2 chute typical cross section.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The Recommended Plan would be similar to Alternative 2, except a combination of land based and river based methods for soil disposal would be utilized, and a difference in the location of mitigated wetlands. This alternative would also result in approximately 42 acres of SWH at completion of construction and through natural processes would increase to approximately 111 acres of SWH over time. In addition, floodplain connectivity would be improved to approximately 1,200 acres of land that is currently protected by a levee. All project features of the Recommended Plan are shown in Figure 13.

For the Recommended Plan, the chute alignments would be cleared and grubbed to a width of 200 feet. The top three feet of soil from the chute alignments, approximately 380,000 cubic yards, would be removed using heavy construction equipment and placed adjacent to the channel. This would meet requests that Missouri Department of Natural Resources (MDNR) has provided on other similar projects in the past, and also allow for more efficient dredging operations. A typical chute cross section is illustrated in Figure 14. The remaining soil in the chutes, approximately 1,791,000 cubic yards, would be removed using a hydraulic dredge. Dredged material would be placed between the existing dike field on the left descending bank and the deep portion of the Missouri River channel. A portion of the dredged material would be immediately transported downriver, and a portion of it would be captured by the dikes. This would slow down the rate at which sediment would be mobilized into the main river channel and reduces any potential impacts to lock structures downstream on the Mississippi River.

Constructing the chutes and placement of the soil from the top three feet would adversely impact about 61 acres of farmed wetlands. Additionally, there would also be impacts to the hydrology on another 141 acres of farmed wetlands. These impacts would be mitigated by constructing earthen berms to create new wetlands and maintain suitable hydrology on existing farmed wetlands so that there would be no overall net loss of wetland habitat. The earthen berms would be approximately 4 feet tall. Up to 200,000 cubic yards of soil excavated from the top three feet of the chute alignments would be used to create earthen berms to mitigate for impacts to farmed wetlands resulting from constructing the chutes. These berms, approximately 4 feet tall, would be constructed to maintain wetland hydrology on farmed wetlands that would be bisected by the chutes. The location of the impacted wetlands, berms, and new wetland areas are shown in Figure 13. All other project features would be similar to Alternative 2.

Following an evaluation of environmental consequences (Section 5) and determination of project cost, this alternative was identified as the Recommended Plan. It is expected that SWH would develop sooner when compared to Alternative 2. It would also result in less soil being stockpiled on the floodplain which would result in a minor impact to floodplain connectivity. All other impacts between the two alternatives would be similar. More detailed discussions are provided in Section 5. Furthermore, Alternative 3 would cost less than Alternative 2. For these reasons, Alternative 3 is identified as the Recommended Plan.

DRAFT

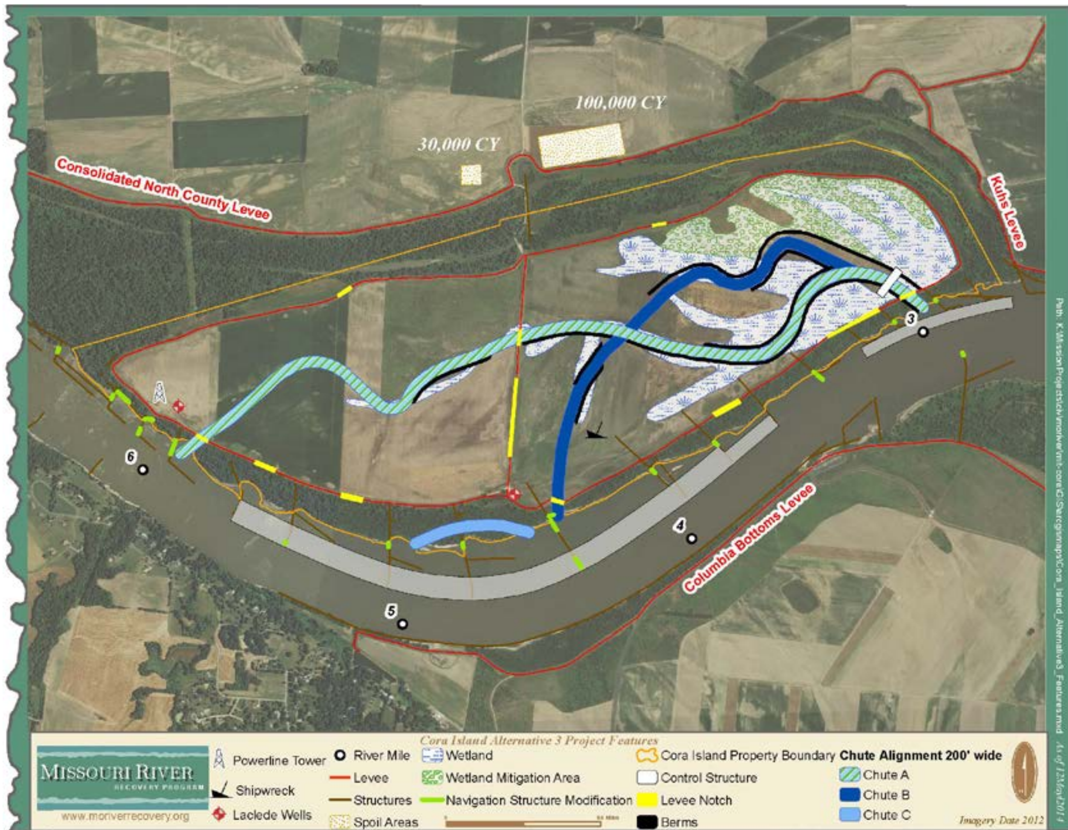


Figure 13: Features included in Alternative 3 (Recommended Plan).

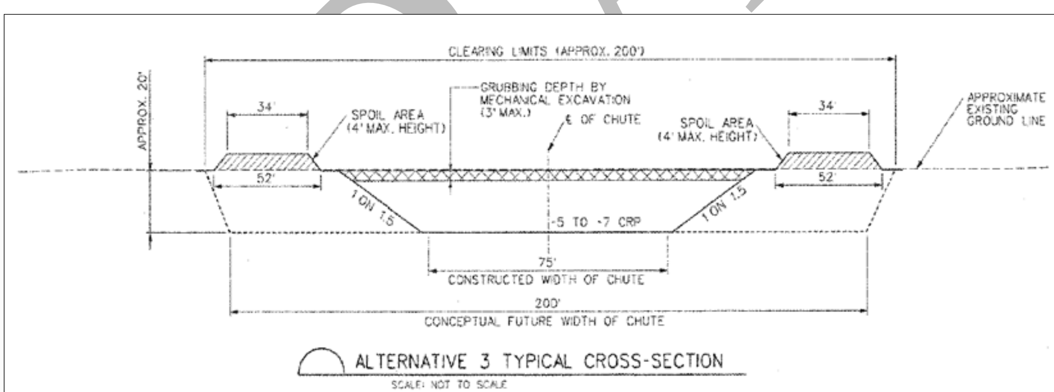


Figure 14: Alternative 3 chute typical cross section.

3.6 Chute Design and Construction Considerations

The typical chute cross sections for Alternatives 2 and 3 are the most appropriate to allow both land based and dredging excavation equipment. The typical construction slopes were used on past projects and are designed to widen. Advantages of this design include maximizing cost efficiency, providing for construction and public safety, and avoiding impacts to water elevations.

Chapter 4 – Affected Environment

4.1 Introduction

This chapter presents the affected environment for the Cora Island Project Site. The affected environment is the baseline against which potential beneficial and adverse impacts caused by the action are evaluated. The existing conditions described in this chapter for Cora Island are based on the current state of the site. Various sources of information were used to compile the affected environment presented in this chapter including: field investigations, geographic information systems data, literature searches, review of maps and aerial photography, agency coordination, and previous reports.

4.2 History of Project Area

Prior to construction of the BSNP, the lower Missouri River was uncontrolled and meandered across the floodplain, creating a highly dynamic environment through the physical processes of erosion, deposition, and accretion. The historic lower Missouri River consisted of numerous islands, channels, sandbars, and slack water that supported vegetation in various stages of succession. Historically, Cora Island was an area where the meander of the Missouri River across the floodplain would have created a constantly changing composition of habitats, due to the processes previously mentioned. Following construction of the BSNP, lands in the area of Cora Island were accreted, claimed, and converted to cropland. At the time of purchase Cora Island was primarily cropland and woodland. The lands were purchased from willing sellers in 2008. The USFWS has managed the site since 2010. Since the area was purchased by the Corps in 2008, the area protected by the levee has been leased and used for crop production.

4.3 Topography and Soils

Cora Island was formed from recent alluvial deposits. The soils are all in low lying elevations, frequently flooded with a water table that fluctuates with the elevation of the river. The area ranges from 402 to 425 feet mean sea level (MSL). The Construction Reference Plane at this location is approximately 404.5 feet. The Cora Island Project contains the following nine soil series: Blencoe and SanDessein which have high clay contents, poor drainage, and occur at the lower elevations; Lowmo and Peers that are silty and loamy textured, well drained, and at the highest elevations; Parkville and Haynie which are silty and loamy, and well drained and occur at middle elevations; Grable, Moville and Treloar – Haynie complexes that are also silty loams and sand, moderately drained, and at middle elevations, see Figure 15 (NASS 2009). Cora Island has 627 acres designated as prime or unique farmland, with an additional 369 acres classified as prime or unique if they were drained (NASS 2009). The BSNP caused significant amounts of human induced alluvial deposition and erosion to occur in a relatively short time (less than 100 years). This deposition ultimately consolidated the shifting sandbars and connected Cora Island to the left descending bank of the Missouri River.

DRAFT

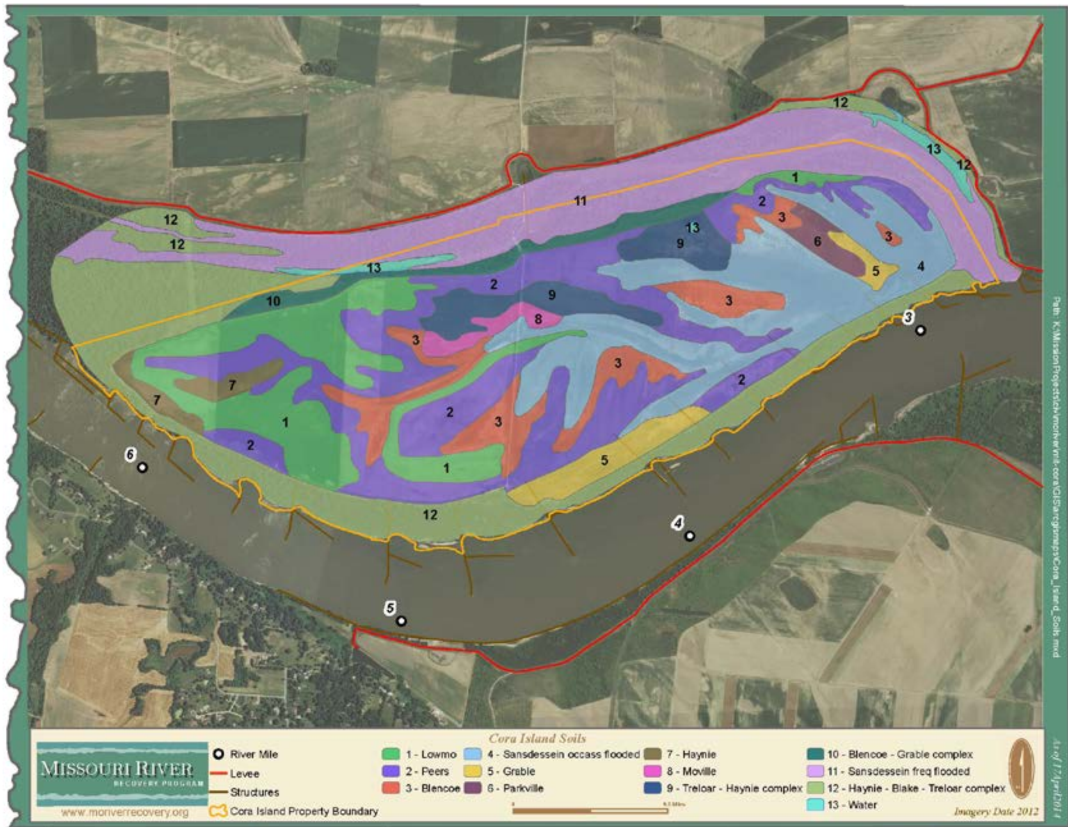


Figure 15: Surface soil types at Cora Island.

Sediment, water, and elutriate samples were collected from the Cora Island project site in April 2012. The approved Field Sampling Plan detailing the sediment sampling is found in Appendix E. Sediment samples were sent to a certified laboratory for analysis. Samples were collected from twenty-five locations along the proposed chute alignments (Figure 16) and the results can be found in Table A. Soil tests showed that total phosphorus concentrations in all of the borings samples (290 to 470 milligrams per kilogram [mg/kg]) were within the observed range of 100 to 6,100 mg/kg for Missouri agricultural soils (Tidball 1984) and within or below the observed range of historical alluvial soils (331 to 500 mg/kg) in areas of the Missouri River floodplain that were not accreted due to the BSNP (Heimann 2014). Similarly, total phosphorus and total nitrogen concentrations from samples collected at Cora Island were within the range of samples collected at other Missouri River SWH project sites (Figures 17 and 18).

DRAFT

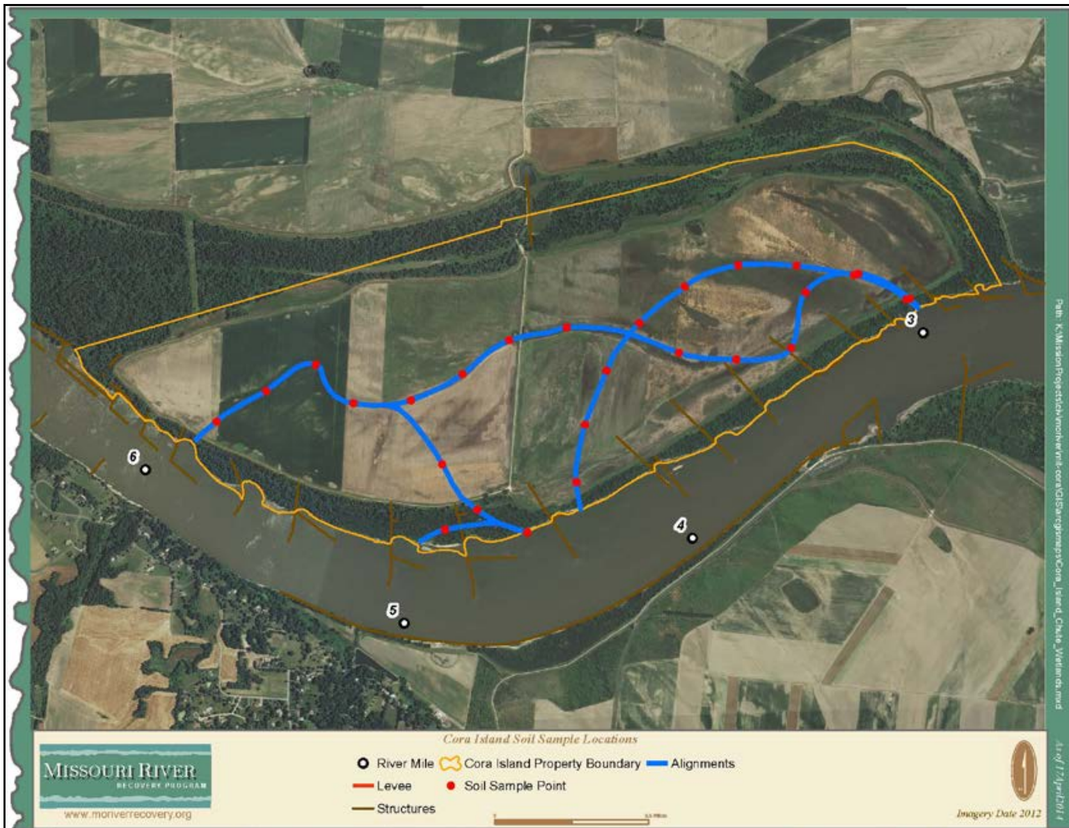


Figure 16: Sediment sampling locations at Cora Island.

Table A: Median and mean (in parentheses) concentrations of analytes measured from 25 sediment samples at the Cora Island Site.

Analyte	Sediment
Ammonia Nitrogen (mg/kg)	4.5 (5.9)
Chlordane (gamma) (ug/kg)	<1.7 (<1.7)
DDT (ug/kg)	0.9 (0.8)
Dieldrin (ug/kg)	0.9 (1.0)
Nitrate/Nitrite as N (mg/kg)	7.3 (7.6)
OrthoPhosphate (mg/kg)	1.5 (2.2)
Percent Solids	78.1 (79.5)
TOC (mg/kg)	4400 (4600)
Total Kjeldahl Nitrogen (mg/kg)	448 (509)
Total phosphorus (mg/kg)	414.5 (403.2)
Metals -- Total (ug/kg)	
Cadmium	<0.3 (<0.3)
Chromium	16.3 (16.1)
Copper	12.5 (11.6)
Lead	11.5 (11.4)
Nickel	18.7 (19.2)
Zinc	59 (60)

DRAFT

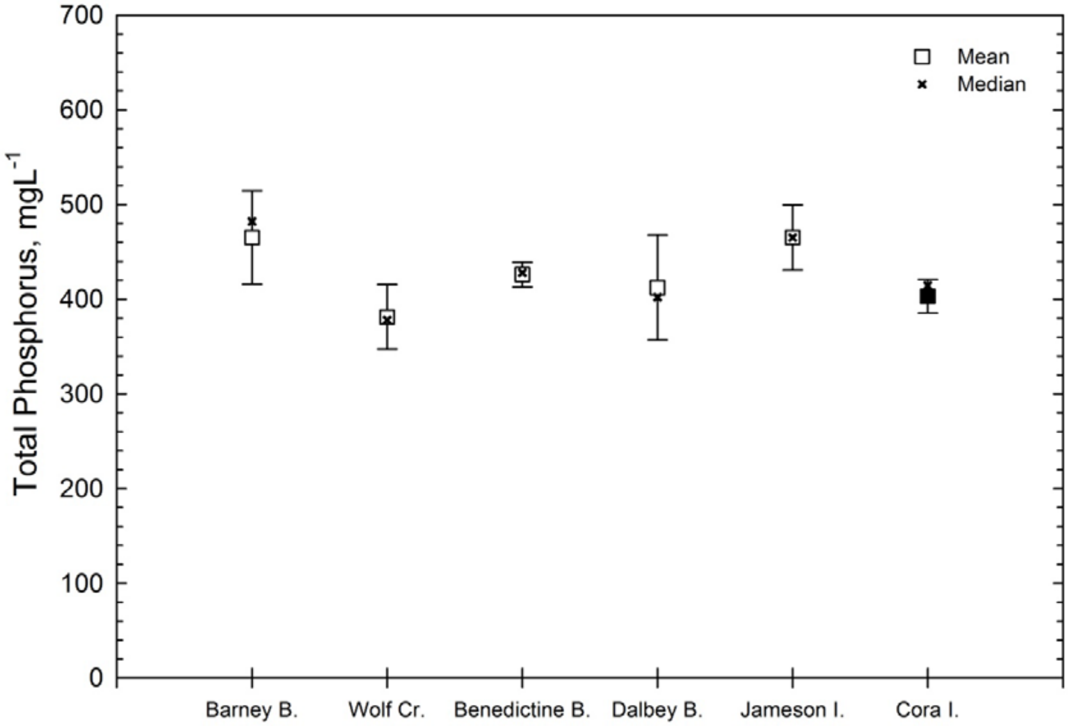


Figure 17: Total phosphorus concentrations in sediment samples collected from multiple SWH construction sites along the Missouri River. Cora Island is shown in black.

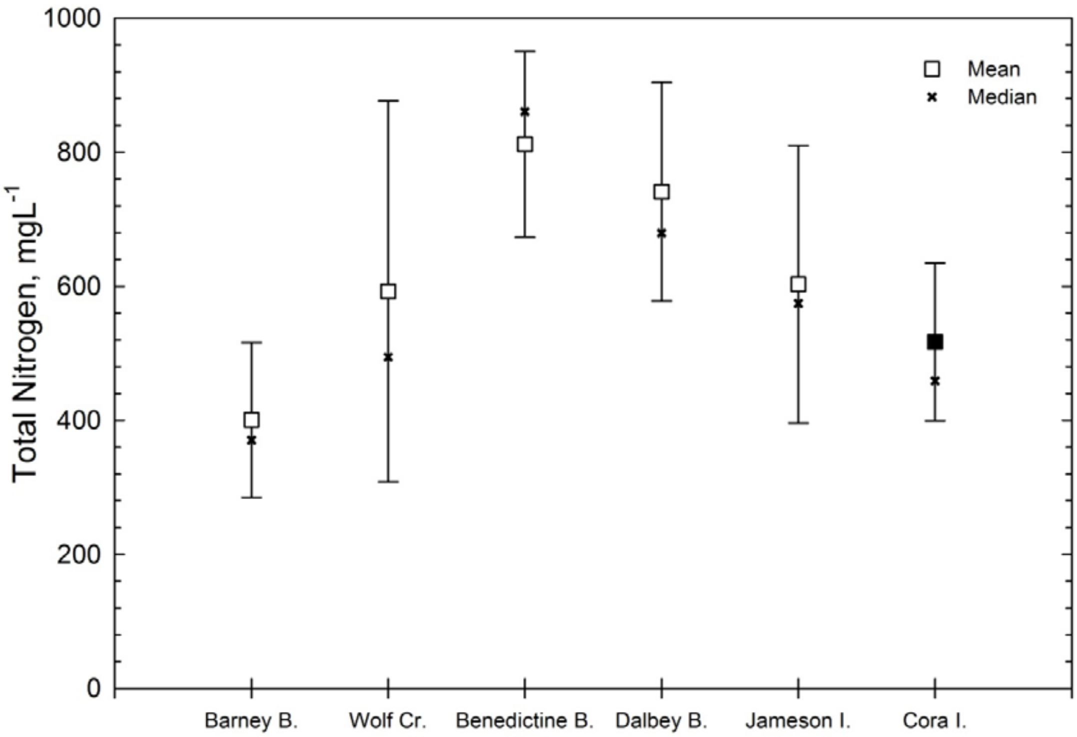


Figure 18: Total nitrogen concentrations in sediment samples collected from multiple SWH construction sites along the Missouri River. Cora Island is shown in black.

4.4 Biological Resources

Biological resources include the native or introduced plants and animals and the habitats in which they occur. The resources discussed in this section include aquatic resources including fisheries; terrestrial/wetland resources including vegetation communities, wildlife populations; and species that are proposed or candidates for, or listed as, threatened or endangered.

4.4.1 Aquatic Resources

The aquatic resources include aquatic habitat, fisheries, and other aquatic biota of Cora Island. Aquatic habitat on Cora Island consists of the Missouri River, a slough, and a scour hole. The Missouri River borders the site on the south while the existing Cora Island slough borders the site on the west, east, and north.

Potential fish spawning areas are located along the shoreline, in backwaters, behind BSNP river training structures, and throughout the floodplain when it is inundated. Suitable fish nursery areas in the Missouri River are limited due to high velocity, turbulent flows, and silt and sand loads (Corps 1994). Construction of dikes and revetments have narrowed and deepened the channel into a fixed location, which has greatly eliminated shallow water habitat and increased water depth and current velocity (National Research Council 2002). In the channelized reaches of the river, fish are associated with revetments and dikes (Corps 2001).

Common fish species in the lower Missouri River include emerald shiner, river carpsucker, gizzard shad, red shiner, shorthead redhorse, carp, and gold eye (Pflieger 1987). Lake, pallid, and shovelnose sturgeon as well as paddlefish are also found in the lower Missouri River (Corps 2001). Recently introduced invasive silver carp and bighead carp now compose much of the biomass in slack water areas.

Sport fish include channel catfish, flathead catfish, blue catfish, white crappie, black crappie, sauger, largemouth bass, bluegill, walleye,and paddlefish (Pflieger 1997). Species important to the commercial fishery on the lower Missouri River include buffalo, carp, and freshwater drum (Corps 1995).

4.4.2 Terrestrial Resources

The majority of Cora Island consists of agricultural lands inside the levee and early successional forest outside of the levee. Table B displays existing terrestrial resources.

Table B: Existing habitat types at Cora Island.

General Habitat Type	Existing Acres
Previously Cultivated	786
Deciduous Forest	223
Levee	76
Grassland	20
Shrubland	9
Barren	2
Developed	Less Than 1
TOTAL	**1117**

DRAFT

4.4.3 Wetland Resources

The Cora Island project site contains approximately 202 acres of farmed wetlands (Figure 19). Because a majority of the project site has been protected by a levee and used for agriculture, wetland habitat has not become established as would otherwise be the case. Outside of the levee there are approximately 23 acres of emergent wetland and less than 0.5 acres of scrub shrub wetlands (Figure 19).

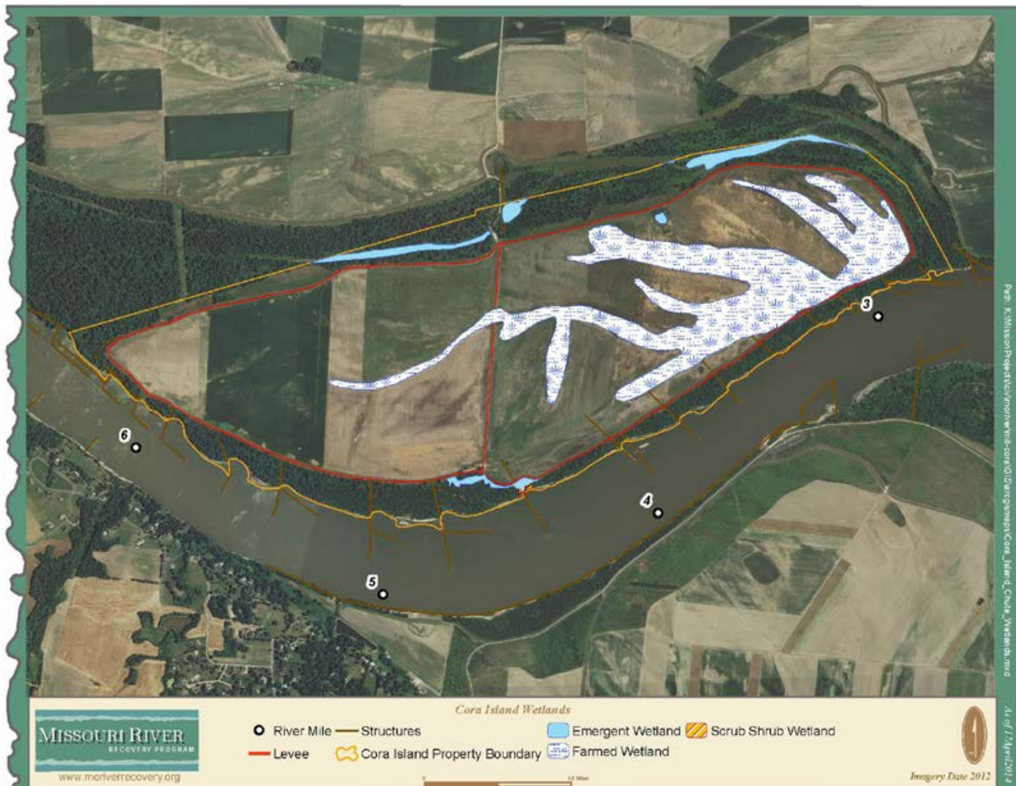


Figure 19: Wetlands located within the Cora Island project site.

4.4.4 Wildlife Resources

Cora Island provides habitat for numerous wildlife species. Common mammalian species likely to occur in remnant bottomland forest and agricultural fields within the area include cottontail rabbit, red fox, coyote and white-tailed deer.

Common furbearers likely to occur within the area include: mink, muskrat, beaver, otter, bobcat and raccoon. Other furbearers expected to occur within the area include: opossum, striped skunk, and long-tailed weasel.

The confluence of the Missouri and Mississippi Rivers is located along an important migratory bird path, the Mississippi Flyway. Birds expected to occur within the area include the game birds: mourning dove, bobwhite quail, and wild turkey. Common songbirds likely to occur within the site include American robin, eastern kingbird, American goldfinch, rose-breasted grosbeak, white-breasted nuthatch, tufted titmouse, black-capped chickadee, blue jay, Eastern phoebe, indigo bunting, red bellied woodpecker downy woodpecker, red-winged blackbird, eastern bluebird, northern cardinal, northern oriole, and brown thrasher, among others. Some of the migratory waterfowl species found in the Cora Island area include wood duck, bluewinged teal, green-winged teal, mallard, gadwall, northern pintail, Canada goose, and snow goose, among others.

Common reptiles found at Cora Island should include: Eastern garter snake, Western ribbon snake, Northern water snake, five lined skink, Eastern yellowbelly racer, prairie kingsnake, speckled kingsnake, Eastern spiny softshell turtle, red-eared slider, false map turtle, Western painted turtle, and common snapping turtle.

Common amphibians found likely found at Cora Island are the Southern leopard frog, bull frog, plains leopard frog, Western chorus frog, Northern spring peeper, Gray treefrog, Blanchard's cricket frog, American toad, and small-mouthed salamander (Johnson 2000).

4.4.5 Invasive Species

Invasive species have the potential to displace native plants and animals. According to Executive Order 13122, Federal agencies may not authorize, fund, or carry out actions that are likely to cause or promote the introduction or spread of invasive species. Invasive aquatic species that are a concern in Missouri which have the potential for introduction into new water bodies as a result of contaminated construction equipment include zebra mussels, quagga mussels, New Zealand mudsnails, purple loosestrife, and Eurasian watermilfoil, among others. Invasive terrestrial species often flourish on recently disturbed land. They may also be transported to new locations on construction equipment. Examples of invasive terrestrial species of concern in Missouri include johnsongrass, reed canary grass, and bromegrass. Invasive plant species are common on disturbed areas in the general project area. Common invasive fish species on the lower Missouri River include, carp, goldfish, grass carp, silver carp, bighead carp, and western mosquitofish.

DRAFT

4.5 Threatened and Endangered Species

Information was requested from USFWS and MDC regarding federal and state threatened, endangered, candidate species, or species of special concern that have potential to occur within or near the Cora Island (Appendix A). Six species were provided (Table C).

Table C: Federally and state listed species with potential to occur at Cora Island.

Common Name	Scientific Name	State Status	Federal Status
Bald Eagle	*Haliaeetus leucocephalus*	Vulnerable [1]	Protected
Pallid Sturgeon	*Scaphirhynchus albus*	Endangered; Critically Imperiled	Endangered
Lake Sturgeon	*Acipenser fulvescens*	Endangered; Critically Imperiled	N/A
Indiana Bat	*Myotis sodalis*	Endangered; Critically Imperiled	Endangered
Northern Long Eared Bat	*Myotis septentrionalis*	Vulnerable	Proposed
Decurrent False Aster	*Boltonia decurrens*	Endangered; Critically Imperiled	Threatened

[1]The State of Missouri provides a list of Threatened and Endangered species as applied by Rule 3CSR10-4.111. In addition, a numerical ranking system (S1-S5) is applied to species of conservation concern and correspond to critically imperiled, imperiled, vulnerable, apparently secure, and secure.

The following information was provided by the USFWS for the pallid sturgeon and can be found in Appendix A: *"The pallid sturgeon is found primarily in the Missouri River and the Mississippi River downstream of its, confluence with the Missouri River. Limited data is available concerning preferred habitats in the Missouri, but adults of the species have been captured across many river habitats, including tributary mouths, sandbars, along main channel borders, deep holes (winter) and along revetments. Small sturgeons have been captured in areas with shoals, island tips, and secondary channels."*

The following information was provided by the USFWS for the Indiana bat and can be found in Appendix A: *"From late fall through winter Indiana bats in Missouri hibernate in caves in the Ozarks and Ozark Border Natural Divisions. During the spring and summer, Indiana bats utilize living, injured (e.g. split trunks and broken limbs from lightning strikes or wind), dead or dying trees for roosting throughout the state. Indiana bat roost trees tend to be greater than 9 inches diameter at breast height (dbh) (optimally greater than 20 inches dbh) with loose or exfoliating bark. Most important are structural characteristics that provide adequate space for bats to roost. Preferred roost sites are located in forest openings, at the forest edge, or where the overstory canopy allows some sunlight exposure to the roost tree, which is usually within 1 km (0.6 mi.) of water. Indiana bats forage for flying insects (particularly moths) in and around the tree canopy of floodplain, riparian, and upland forests."*

DRAFT

The following information was provided by the USFWS for the decurrent false aster and can be found in Appendix A: *"The decurrent false aster is a big river floodplain species that grows in wetlands and along the borders of marshes, lakes, oxbows, roadsides, agricultural fields and levees. It favors sites with moist soil and regular disturbance, (preferably periodic flooding) which maintains open areas allowing sunlight to reach seedlings. It is a perennial plant that blooms from August to October. Seed dispersal is primarily through flooding. Although it once occurred in almost contiguous populations in a 400 km band between LaSalle, IL and St. Louis along the Illinois and Mississippi River floodplains, currently Boltonia is limited in Missouri to St. Charles and St. Louis counties." The closest population occurs on the nearby Confluence Point State Park, immediately downstream.*

Although the bald eagle is no longer a federally listed species, the USFWS did provide the following guidance and can be found in Appendix A: *"Bald eagles use both the Mississippi and Missouri Rivers and adjacent floodplains to nest, feed and roost. In fact, there is at least one nesting territory nearby at Confluence State Park. The bald eagle (Haliaeetus leucocephalus) has been removed from the Endangered Species list; however, protections remain in place under the Bald and Golden Eagle Protection and Migratory Bird Treaty Acts. Therefore, we recommend you survey the project site for bald eagles which have become increasingly common along the river. The period January 1 to March 1 is important for initiating nesting activity; March 1 to May 15 is the most critical time for incubation and rearing of young. If any eagle nests occur in or near the project area, please refer to the National Bald Eagle Management Guidelines at: http://www.fws.gov/migratorybirds/issues/BaldEagle/Mgmt.Guidelines.2006.pdf for recommendations to avoid effects to eagles."* No bald eagle nests, either active or inactive, have been identified within the project site; however, each year, eagles establish new territories and alternate nest sites. If any bald eagle nests become established in the project site, the National Bald Eagle Management Guidelines will be used for recommendations to avoid effects to eagles.

4.6 Water Quality

The Clean Water Act authorizes States to adopt water quality standards to protect "waters of the United States" within their jurisdiction. By legislative design, water quality standards include; designated beneficial uses assigned to each waterbody; both general water quality criteria which are broad prohibitions against poor water quality and specific water quality criteria for individual pollutants or conditions; and an antidegradation policy which, in general, would maintain water quality which is better than minimally required to protect designated uses. Water quality criteria are developed to protect specific beneficial uses assigned to individual waterbodies. In Missouri, the Missouri River is designated for irrigation, livestock watering, protection of aquatic life and fish consumption, whole body contact recreation, secondary contact recreation, drinking water supply and industrial water supply uses. The closest drinking water intake to the project is located 7.5 miles downstream of Cora Island on the Mississippi River at the Chain of Rocks Drinking Water Plant. Missouri's general water quality criteria apply to the Missouri River and Missouri's specific water quality criteria apply to those uses for which the river is designated in the State's standards. At present, the State's water quality standards do not include specific criteria for nutrients or suspended solids applicable to the Missouri River. Waterbodies not in

DRAFT

compliance with the State's water quality standards because of pollutants are placed on a State list of impaired waterbodies and a Total Maximum Daily Load or TMDL is developed.

An approved 2006 TMDL exists for PCBs and chlordane, sediment and fish tissue contaminants on the Missouri River, and is listed in the State's proposed 2012 303(d) list for non-support of its recreational uses based on bacteria levels. The State's water quality standards and lists of impaired waters and TMDL's are subject to Triennial review by EPA.

The State of Missouri does not have specific criteria for solids, total suspended solids, or nutrients (except for ammonia nitrogen) for protection of aquatic life applicable to the Missouri River. Evaluations of these constituents with regards to the State's general water quality criteria, comparisons of upstream and downstream conditions, and with consideration to past TMDLs and the State's proposed 2012 303(d) list. For constituents with numerical standards (i.e. metal concentration) evaluations utilized those State adopted, EPA approved, water quality criteria.

To evaluate baseline conditions and assess if habitat restoration actions would adversely impact water quality, water, soil, and elutriate samples were collected in April 2012 from Cora Island. Water collections were made from surface water immediately upstream of the project site from four locations across the mainstem river to account for potential lateral variability. Water samples were sent to a contract laboratory for analysis. Results
from sampling (Table D) show concentrations of total phosphorus from Cora Island that are within or slightly below the range of total phosphorus concentrations from samples collected at a nearby, long term monitoring locations. Concentrations of total nitrogen (calculated by summing results from total Kjeldahl nitrogen and nitrate/nitrite analyses) in samples collected at the project site were similar to collections taken at other long term monitoring locations (Figure 20). Cora Island water samples were collected on one day and therefore 95% confidence intervals of measured concentrations were not calculated.

DRAFT

Table D: Median and mean (in parentheses) concentrations of analytes measured from elutriate and Missouri River water samples at Cora Island.

Analytes	Elutriate	Water	MO WQS*
Ammonia Nitrogen (mg/L)	0.030 (0.051)	0.031 (0.034)	8.4 (pH 8.0)
Chlordane (technical) (ug/L)	<1.0 (<1.0)	<1.0 (<1.0)	
DDT (ug/L)	<0.05 (<0.05)	<0.05 (<0.05)	
Dieldrin (ug/L)	0.007 (0.023)	<0.05 (<0.05)	
Nitrate/Nitrite as N (mg/L)	1.30 (1.40)	1.0 (1.02)	
OrthoPhosphate (mg/L)	0.094 (0.097)	0.082 (0.082)	
Percent Solids	-	-	
TOC (mg/L)	4.4 (4.6)	5.2 (5.5)	
Total Kjeldahl Nitrogen (mg/L)	0.48 (0.55)	0.91 (0.85)	
Total phosphorus (mg/L)	0.10 (0.11)	0.44 (0.44)	
Total Suspended Solids	-	326 (332.8)	
Metals -- Total (ug/L)			
Cadmium	<0.002 (<0.002)	-	11.6
Chromium	<0.005 (<0.005)	-	1207
Copper	<0.01 (<0.01)	-	32
Lead	<0.004 (<0.004)	-	172
Nickel	<0.015 (<0.015)	-	1017
Zinc	0.006 (0.007)	-	255
Metals -- Dissolved (ug/L)			
Cadmium	-	<0.002 (<0.002)	11.6
Chromium	-	<0.005 (<0.005)	1207
Copper	-	<0.01 (<0.01)	32
Lead	-	0.003 (0.004)	172
Nickel	-	0.015 (0.019)	1017
Zinc	-	0.005 (0.009)	255
Samples	25	4	

* State of Missouri Water Quality Standards for protection of aquatic life (Missouri 10 CSR 20-7.031)

DRAFT

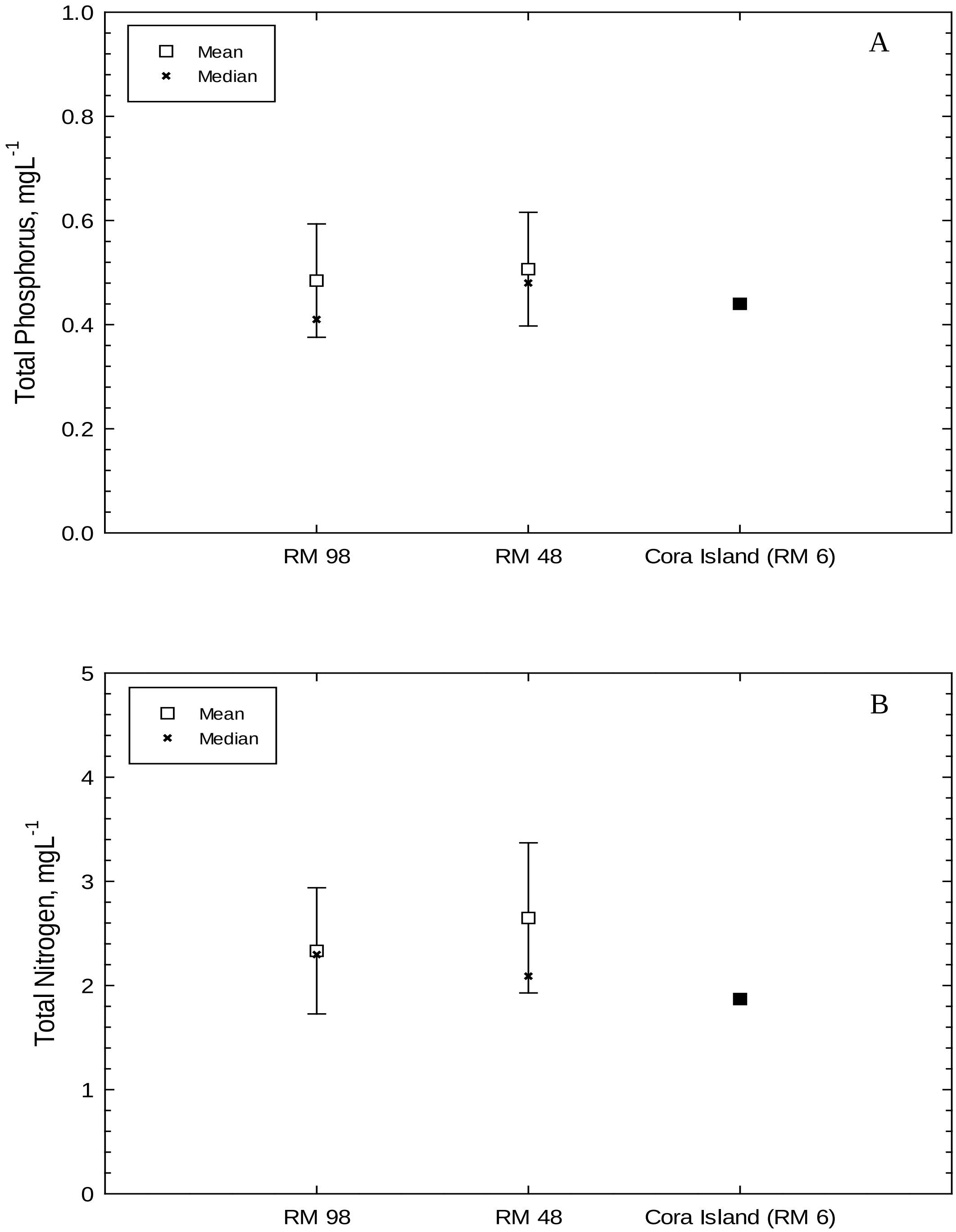


Figure 20: Total phosphorus (A) and total nitrogen (B) concentrations in water samples collected from the Cora Island project site (black) in 2012 and two nearby, long term monitoring stations (white) collected from 2009 to 2012.

All metal concentrations in elutriate samples and Missouri River surface water were compared to the acute criteria for protection of aquatic life for surface water hardness of 250 mg/L which is found in Missouri 10 CSR 20-7 (see Table A). A comparison of the concentrations of select metals in water and elutriate samples to the State water quality criteria for those same metals, shows that none of the samples exceeded State standards.

4.7 Air Quality

Air quality in a given location is described by the concentrations of various pollutants in the atmosphere. The quality of the air is measured against National Ambient Air Quality Standards (NAAQS) set by the EPA. Cora Island lies within the St. Louis Metropolitan Region. Of the six criteria pollutants addressed in the National Ambient Air Quality Standards, the St. Louis Metropolitan Region is currently in attainment for sulfur dioxide, carbon monoxide, lead, and nitrogen dioxide, but not for particulate matter or ozone. The St. Louis area is currently designated by the U.S. Environmental Protection Agency (USEPA) as not meeting the fine particle standard (PM-2.5). The St. Louis area is also designated by the USEPA as not meeting the eight-hour ozone standard, and levels of this pollutant are classified as moderate.

4.8 Noise

Sounds that disrupt normal activities or otherwise diminish the quality of the environment are designated as noise. Noise is categorized as stationary or transient and intermittent or continuous. Cora Island is located in a rural setting. However, in close proximity to the city of St. Louis and is exposed to low flying jet traffic. Existing noise levels in the project area include railroad sounds, aircraft over flights, farm equipment, boats/barges on the Missouri River, firearms discharges during hunting and target shooting, and natural sounds of the wind, flowing water, and wildlife. Lands surrounding the project site include agricultural lands, wetlands, prairie, forest, the Missouri River, the Confluence Point State Park, Columbia Bottoms Conservation Area, and Riverlands Migratory Bird Sanctuary. The last three are considered sensitive noise receptors, commonly defined as the occupants of a facility or location where a state of quietness is a basis for use, such as hospitals, churches, wilderness areas, and residences.

4.9 Historic Properties and Cultural Resources

Cultural resources are defined as any area of past human activity, occupation, or use, identifiable through inventory, historical documentation, or oral evidence. Cultural resources include, but are not limited to, archeological sites, buildings or structures, cemeteries, and traditional cultural properties. In accordance with requirements of Section 106 of the National Historic Preservation Act, the Corps initiated coordination with the State Historic Preservation Officer (SHPO) in October 2012 (Appendix F). In addition, affiliated federally recognized Native American tribes were initiated when the PIR was sent to the tribes on April 10, 2014. .

An archeological background review of the project area was conducted that included an examination of the National Register of Historic Places on-line (NRHP); the Missouri Department of Natural Resources Archeological Viewer; shipwreck location maps (Chittenden 1897 and Trail 1858-1965); Lewis and Clark camp site maps, Missouri River channel location

DRAFT

maps from 1803, 1879, 1894, 1954, and present; as well as pertinent Corps records. No archeological sites are mapped within or near the project area. Historic channel maps show that the proposed project area was entirely crossed by the historic river channel, so prehistoric or early historic archeological sites are unlikely to be present in the project area. Six shipwrecks are mapped in the general project area.

Because of the possible presence of the shipwrecks in the construction area, the Corps contracted with the Center for Archaeological Research, Missouri State University (CAR) to conduct a magnetometer survey of the proposed chute locations to attempt to attempt to detect any potential wrecks that may be impacted by construction and the locations of wrecks as depicted shipwreck maps.

A total of three magnetic anomalies were identified within the proposed chute locations. One of these anomalies (Anomaly 1) appeared to be the debris field of a wrecked steamboat. The other anomalies did not appear to be related to shipwrecks. No anomalies were encountered in the areas of the mapped wrecks. Because Anomaly 1 was not near any particular wreck it could not be determined with any degree of certainty which recorded shipwreck it may represent.

Following the discovery of the possible shipwreck, SHPO staff was notified of the discovery, and project plans were redesigned to avoid the area of Anomaly 1. The Corps proposed to SHPO a minimum 200 foot buffer from the find location and installation of a riprap barrier to prevent encroachment into the area of discovery. The Corps would also develop shipwreck management plan and accidental discovery procedures to be included in the Cora Island management plan and any additional recovery projects that have the potential for shipwrecks. SHPO agreed with these measures in a response e-mail dated October 24, 2012.

With the modification to the project to avoid the area of Anomaly 1, the CAR recommended that the chute construction should have no effect on shipwrecks or historic properties and that the construction should be allowed to proceed. The Corps concurred with the CAR recommendation. The magnetometer survey is well-suited to identify large steamships that contained large amounts of metal, but it is not adequate to find smaller wooden craft. If any such boat or other cultural resource discoveries are made during construction, work in the area of discovery would cease and the discovery investigated by a qualified archeologist. The findings on the discovery would be coordinated with SHPO and appropriate federally recognized Native American tribes.

4.10 Socioeconomic Resources

Socioeconomic resources are the part of the human environment that includes the economic, demographic, and social characteristics of individuals and communities.

4.10.1 Population and Income

Cora Island is located in St. Charles County, Missouri. The 2011 estimated population for St. Charles County was 365,151. St. Charles County experienced a population increase of 1.3 percent from 2010 to 2012 (U.S. Census Bureau 2012). The total of area of cropland in St. Charles County is 156,136 acres (NASS 2009). The amount of Cora Island land currently

DRAFT

farmed by a neighboring landowner under an agricultural lease is 440 acres. There are a total of 644 farms in the county with an average net income of $32,821 (NASS 2009).

In 2008, per capita personal income in St. Charles County was $39,383. This ranked 5th in the State of Missouri and was 108 percent of the state average ($36,356) and 98 percent of the national average ($40,166). In 1998 the per capita personal income for St. Charles County was $26,914 and ranked 5th in the state. The 1998-2008 average annual growth rate of per capita personal income was 3.9 percent in the county. The average annual growth rate for the state was 3.6 percent and for the nation was 4.0 percent (BEA 2008).

Minorities comprised 8.1 percent of the population of St. Charles County in 2009 and 16.1 percent of the population of Missouri in 2009 (U.S. Census Bureau 2009). Persons 65 years old and over comprised 10.4 percent of the St. Charles County population compared to 13.5 percent of the State of Missouri population (U.S. Census Bureau 2009).

The closest community to Cora Island is the town of West Alton, Missouri located approximately two and a half miles to the northwest. The 2010 population estimate for the census block group Cora Island and West Alton are located in is 651. Over 98% of the population is white. And the block group's unemployment rate is 11.8%. The median household income in the block group is $44,306 (Census 2010).

4.10.2 Navigation

The Missouri River from river mile 735 near Sioux City, Iowa to river mile zero near St. Louis, Missouri is maintained and operated by the Omaha and Kansas City Districts of the Corps under the authority and in accordance with requirements of the BSNP. The Kansas City District maintains the BSNP from Rulo, Nebraska to St. Louis, Missouri. The Corps must maintain a 9-foot deep by 300-foot wide navigation channel on the lower 735 miles of the Missouri River including the segment in the project area. In addition, Missouri River flows are managed in part, for commercial navigation on the Missouri River. Navigation on the Missouri River is limited to the normal ice-free season, with a full-length flow support season of 8 months (Corps 2001). At Sioux City, the full-length support season extends from March 23 to November 22 and at St. Louis the full-length support season extends from April 1 to December 1 (Corps 2001).

The Corps routinely monitors the Missouri River navigation channel and coordinates these efforts with U.S. Coast Guard and commercial navigators on the river. In areas where navigation impediments are identified the Corps works with the U.S. Coast Guard and commercial navigators to develop and implement corrective action that would restore and maintain the authorized 9-foot deep by 300-foot wide navigation channel.

The Corps must develop the Missouri River Recovery Program in a manner that does not adversely affect the current congressionally authorized purposes of the Missouri River, including navigation. Designs for SWH are developed to maintain sufficient flow in the navigation channel, and not result in deposition that would result in shoaling within the navigation channel or create other hazards to navigation.

DRAFT

Due to the proximity of the project site to the Mississippi River, coordination will occur between the Kansas City District and the St. Louis District who is authorized to maintain navigation on the Mississippi River. Close coordination will ensure no adverse impacts will occur to the Mississippi River as a result of the project.

4.10.3 Flood Risk Management

There is an extensive flood risk management system (i.e., levees and dams) along the Missouri River, and the Cora Island levee is part of that system. The levee was in the PL 84-99 program until the Corps purchased the entire levee in 2008, when it was removed from the program. The levee was constructed in the 1960's and provided a 1% chance exceedance level of flood risk management. It is a large ring levee, 32,500 linear feet, around the entire island that at the highest point is 435 feet in elevation, or about ten feet tall. The levee has only overtopped twice, in 1973 and 1993 (personal communications with landowner). Levee districts on lands adjacent to Cora Island include the Consolidated North County Levee District, Kuhs Levee District, and the Columbia Bottoms Levee System.

4.10.4 Recreation and Aesthetics

Cora Island is managed by the USFWS as part of the Big Muddy National Fish and Wildlife Refuge. USFWS allows approved recreational activities for the public at the site including hunting, bird watching, hiking, and nature study. The area is a natural stopover for birds migrating along the river corridors. The site is of national significance because of its proximity to the confluence of two of the country's largest and historically significant rivers. It is also located near the historical departure point for Lewis and Clark. The visual aesthetics of Cora Island are typical of many rural areas along the Missouri and Mississippi Rivers. Agricultural lands, riparian woodlands, wetlands, and grasslands are typical of the area. The Missouri and Mississippi Rivers and their confluence are important aesthetic resources to the region and Nation.

DRAFT

Chapter 5 – Environmental Consequences

5.1 Introduction

This chapter presents the evaluation of impacts of the alternatives including the potential for significant impacts on the human environment. It identifies impacts and estimates their potential significance on environmental and socioeconomic resources. The environmental impacts of the implementation and site selection process for habitat development along the Missouri River were conducted previously and evaluated and documented in the *Feasibility Report and Environmental Impact Statement* (Corps 1981) and the *Supplemental Environmental Impact Statement* (Corps 2003). Thus, this PIR only evaluates those impacts anticipated from the construction and operation of the alternatives specific to the Cora Island Missouri River Recovery Project. The "No Action" Alternative considers the existing condition at the site.

The concept of "significance" used in this chapter encompasses several factors, including the magnitude of change from existing conditions and the likelihood of the change to occur. An impact is considered adverse when the outcome of the action results in undesirable effects. A beneficial impact can result if the current condition is improved or if an existing undesirable effect is lessened. Mitigation of adverse impacts can occur through avoiding impacts, minimizing impacts, or replacement of impacted resources. Beneficial and adverse impacts, including unavoidable adverse effects, are discussed in each resource section of this chapter.

5.2 Topography and Soils

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional active shallow water habitat restoration on Cora Island and habitat would result from natural regeneration only. The "No Action" Alternative would have little impact on soils and topography as periodic flooding could have minor impacts on the site.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Alternative 2 would result in approximately 2,171,000 cubic yards of spoil material being stockpiled on the floodplain. This would be the most of any of the alternatives. This would create a minor intermediate-term impact to the topography within the project area. Eventually, the majority of the stockpiled material would likely integrate into the chute and return to the Missouri River. Some soil from excavating the chutes would also be used to create berms to mitigate for wetland impacts. This would create minor long-term impact to topography. The chutes would also result in minor long-term impacts to the existing topography, although it would be a more natural topography than currently exists.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The Recommended Plan would result in 380,000 cubic yards of soil being stockpiled on the floodplain. Up to 200,000 cubic yards of this soil would be used to construct berms to mitigate for wetland impacts. This is more than the No-Action Alternative, but less than Alternative 2. This would result in both minor intermediate-term, and long-term changes to the site topography. Over time, dependent on river flows, the remaining soil would integrate into the river through natural processes. Impacts resulting from the construction of berms to protect wetland hydrology and constructing chutes would be similar to Alternative 2. This Recommended Plan would not result in any adverse long-term impacts to soils or topography.

5.3 Biological Resources

Biological resources include the native or introduced plants and animals and the habitats in which they occur. Aquatic resources include fisheries, and terrestrial/wetland resources include vegetation communities and wildlife populations. Species that are proposed or candidates for, or listed as, threatened or endangered are included in both aquatic and terrestrial/wetland resources. Impacts to these resources would be from the construction and operation of the Cora Island Project. An adverse impact would be significant if the viability of a biological resource of the

DRAFT

area was detrimentally impacted, with little likelihood of reestablishment to its original state or the action results in the taking of a listed threatened or endangered species. The significance of the impact is also dependent upon the importance of the resource and its relative occurrence in the vicinity of the site.

5.3.1 Aquatic Resources

Alternative 1 – "No Action"

The "No Action" Alternative involves no additional active restoration of aquatic habitat on Cora Island. It is assumed that the remnant Cora Island slough would continue to fill in with sediment over time, thus diminishing its benefit as an aquatic resource. The existing levee would remain in place but would not be maintained and would eventually fail, improving floodplain connectivity to over 1,200 acres of the floodplain. However, it is uncertain how long it would take for the levee to fail and it could be a considerable number of years. SWH would most likely not form on site and the adverse impacts of the BSNP, which have severely reduced aquatic habitat diversity, including SWH, and constrained the dynamic natural river processes which create these diverse habitats, would continue.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Alternative 2 would result in long-term beneficial impacts to aquatic resources through the establishment of SWH. Alternative 2 would result in the immediate establishment of approximately 42 acres of shallow water habitat believed to benefit endangered pallid sturgeon. This would eventually develop into approximately 111 acres as natural processes would widen the chute with time. The rate at which it would develop would be dependent on river flows. However, compared to the Recommended Plan, this alternative is expected to take longer for SWH to fully develop because of the greater volume of soil that would be stockpiled adjacent to the chute. This alternative would result in approximately 2,171,000 cubic yards of soil being stockpiles compared to less than 380,000 cubic yards for the Recommended Plan. The large stockpiles of soil, 250 acres, could hinder movement of some aquatic species during flood events if water elevations were at certain levels. This would be a minor temporary impact until such time that the stockpiles of soil would eventually enter the Missouri River through natural processes. This minor impact is preferable to the No-Action Alternative in which no SWH would be constructed and floodplain connectivity would not be improved in the immediate future. Eventually, this alternative would result in the same amount of SWH as the Recommended Plan. It would not result in any significant adverse impacts to aquatic resources.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

Alternative 3 would result in long-term beneficial impacts to aquatic resources through the establishment of SWH. Similar to Alternative 2, this alternative would result in the immediate establishment of approximately 42 acres of shallow water habitat believed to benefit endangered pallid sturgeon. This would eventually develop into approximately 111 acres of shallow water

DRAFT

habitat as the chute would widen with time. The rate at which it would develop would be dependent on river flows. The soil stockpiles adjacent to the chute, less than 35 acres, could hinder movement of some aquatic species during flood events if water elevations were at particular levels. This would be a negligible temporary impact. Eventually, the stockpiles of soil would enter the Missouri River through natural processes. This alternative is preferable to the "No-Action" Alternative in which no SWH would be constructed and floodplain connectivity would not be improved in the immediate future. With time, this alternative would result in the same amount of SWH as Alternative 2, although it would develop in less time than Alternative 2 potentially providing an overall greater benefit to aquatic resources. This alternative would not result in any significant adverse impacts to aquatic resources.

5.3.2 Terrestrial Resources

Alternative 1 – "No Action"

The "No Action" Alternative involves no additional active restoration of Cora Island and the site would undergo natural succession and likely form a deciduous forest habitat consisting of cottonwood, willow, maple, sycamore, and mulberry. However, periodic natural disturbances may impact habitat types at any particular place or time.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

The net change in habitat types that would result from Alternative 2 is shown in Table E. This alternative would result in a minor impact resulting from clearing approximately seven acres of deciduous forest, approximately 3% of the existing deciduous forest within the project site, and three acres of shrubs. This minor impact would be offset by allowing around 335 acres of previously cultivated agricultural land to undergo succession. It is expected that previously cultivated agricultural land would first develop into grassland habitat, and then mature into a shrub habitat and ultimately a deciduous forest habitat type. Periodic natural disturbances in space and time could modify this successional pattern. Another minor impact to terrestrial habitat would result from placing excavated soil within the project area. Over time, these 303 acres of berms and soil would either undergo succession, or erode into the river depending on their location. In total, approximately 451 acres of land that has been recently cultivated would be converted to other habitat types or allowed to undergo natural succession. Alternative 2 would not result in any long-term significant adverse impacts to terrestrial habitat.

DRAFT

Table E: Changes in terrestrial land cover for Alternative 2.

Habitat Type	Existing Acres	Alternative 2 Acres*	Net Change in Acres
Previously Cultivated	786	335	-451
Deciduous Forest	223	216	-7
Berms/Spoil	0	303	303
Levee	76	71	-5
Grassland	20	20	0
Shrubland	9	6	-3
Barren	2	2	0
Developed	Less Than 1	Less Than 1	0

*Due to natural succession and disturbances, these habitat types will likely change over time.

Alternative 3– Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The net change in habitat types that would result from the Recommended Plan is shown in Table F. This alternative would result in a minor impact resulting from clearing approximately seven acres of deciduous forest and three acres of shrubs. This minor impact would be offset by allowing around 653 acres of previously cultivated agricultural land to undergo succession as previously described for Alternative 2. Another minor impact to terrestrial habitat would result from placing excavated soil within the project area in the form of berms and spoil piles. The impacts from the berms and spoil piles would be less than those of Alternative 2 because the acreage would be much less, 35 acres compared to 303 acres. Approximately 113 acres of land that has been recently cultivated would be converted to other habitat types. The Recommended Plan would not result in any long-term significant impacts to terrestrial habitat.

Table F: Changes in terrestrial land cover for Alternative 3.

Habitat Type	Existing Acres	Alternative 3 Acres*	Net Change in Acres
Previously Cultivated	786	653	-133
Deciduous Forest	223	216	-7
Berms/Spoil	0	35	35
Levee	76	74	-2
Grassland	20	20	0
Shrubland	9	6	-3
Barren	2	2	0
Developed	Less Than 1	Less Than 1	0

*Due to natural succession and disturbances, these habitat types will likely change over time.

5.3.3 Wetland Resources

Alternative 1 – "No Action"

The "No Action" Alternative would result in no adverse impacts to existing wetland resources. There would be no immediate increase in floodplain connectivity which could benefit the existing wetland resources on Cora Island. It is expected that overtime, through natural

DRAFT

succession, that the existing 202 acre farmed wetland would ultimately become forested wetland habitat.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Alternative 2 would not result in any net change in the acres of wetland habitat (Table G). Constructing the chutes would adversely impact about 202 acres of farmed wetlands. Around 112 acres would be impacted by the layout of the chutes and placement of excavated soil. An additional 90 acres of wetlands would be impacted as a result of modification to surface water hydrology. Wetland impacts would be offset by constructing earthen berms to maintain suitable hydrology on existing wetlands, 90 acres, and to provide new wetlands, 59 acres. The earthen berms would be approximately 4 feet tall. In addition, 53 acres of new wetlands would be constructed between the main chute and the riverward chute as shown in Figure 11. As a result of mitigating impacts, this alternative would not result in any long-term significant impacts to wetland habitat.

Table G: Changes in wetland habitat types for Alternative 2.

Habitat Type	Existing Acres	Alternative 2 Acres*	Net Change in Acres
Farmed Wetland	202	0**	-202
Mitigated Wetland	0	202	202
Emergent Wetland	23	23	0
Scrub Shrub	Less Than 1	Less Than 1	0

*Due to natural succession and disturbances, these habitat types may change over time.
** Some of the existing farmed wetlands would remain, although berms would be constructed to retain suitable hydrologic conditions following construction of the chutes. Therefore, these wetlands have been grouped in the mitigated wetland habitat type.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The Recommended Plan would not result in any net change in the acres of wetland habitat (Table H). Constructing the chutes and placement of the soil from the top three feet would adversely impact about 61 acres of farmed wetlands. Additionally, there would also be impacts to the hydrology on another 141 acres of farmed wetlands. These impacts would be offset by constructing earthen berms to create new wetlands and maintain suitable hydrology on existing farmed wetlands so that there would be no overall net loss of wetland habitat. The earthen berms would be approximately 4 feet tall. Up to 200,000 cubic yards of soil excavated from the top three feet of the chute alignments would be used to create earthen berms to offset for impacts to farmed wetlands resulting from constructing the chutes. These berms, approximately 4 feet tall, would be constructed to maintain wetland hydrology on farmed wetlands that would be bisected by the chutes. The location of the impacted wetlands, berms, and new wetland areas were shown previously in Figure 13. As a result of mitigating impacts, this alternative would not result in any long-term significant impacts to wetland habitat.

DRAFT

Table H: Changes in wetland habitat types for Alternative 3.

Habitat Type	Existing Acres	Alternative 3 Acres*	Net Change in Acres
Farmed Wetland	202	0**	-202
Mitigated Wetland	0	202	202
Emergent Wetland	23	23	0
Scrub Shrub	Less Than 1	Less Than 1	0

*Due to natural succession and disturbances, these habitat types may change over time.
** Some of the existing farmed wetlands would remain, although berms would be constructed to retain suitable hydrologic conditions following construction of the chutes. Therefore, these wetlands have been grouped in the mitigated wetland habitat type.

5.3.4 Wildlife Resources

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional active restoration of SWH on the Cora Island. No adverse impacts to wildlife would occur. Existing habitat would continue to benefit wildlife resources but minimal improvement in habitat conditions for wildlife that depend on aquatic ecosystems would occur. This alternative would result in approximately 1,200 acres being restored to some natural habitats but would not maximize the sites full habitat potential.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Alternative 2 would have beneficial long-term impacts to fish and wildlife resources by providing approximately 111 acres of shallow water habitat, and improving floodplain connectivity. Compared to the Recommended Plan, it would take longer for SWH to fully develop. Alternative 2 would have minor intermediate-term impacts to wildlife from clearing of 7 acres of riparian woodland. This impact is expected to be minimal, 7 acres is less than 3% of the total woodlands within the project site. Adverse impacts to 202 acres of farmed wetland habitat may also have minor short-term impacts to wildlife. Because wetland impacts would be mitigated to result in no net loss, these impacts would be of a limited duration. The large soil stockpiles from chute construction would impede wildlife movement between terrestrial and the aquatic habitats. This minor impact would be temporary, until such time that the soil stockpiles would enter the Missouri River through natural processes. In addition, depending on timing of construction, activities could displace wildlife from the project site. Wildlife would likely seek resources from neighboring areas such as the Edward "Ted" and Pat Jones –Confluence State Park or Riverlands Migratory Bird Sanctuary. This impact would be minor and temporary. Construction noise would also result in minor short-term impact to fish and wildlife. This alternative would not result in any significant long-term impacts to fish and wildlife. Compared to the "No-Action" alternative, this alternative would provide greater benefits to fish and wildlife. Because it would take longer for SWH to develop compared to the Recommended Plan, the overall benefits would be somewhat less.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The Recommended Plan would have beneficial long-term impacts to fish and wildlife resources by providing approximately 111 acres of shallow water habitat, and improving floodplain connectivity. Compared to the Alternative 2, it would take less time for SWH to fully develop, providing a greater overall benefit to fish and wildlife. The Recommended Plan and Alternative 2 would have similar impacts to fish and wildlife. The Recommended Plan would also result in the clearing of approximately 7 acres for riparian woodland. It would also adversely impact approximately 202 acres of farmed wetlands, although these impacts would be mitigated. Because there would be less land based heavy construction equipment, impacts from noise are expected to be less than Alternative 2. In addition, depending on timing of construction, activities could displace wildlife from the project site. Wildlife would likely seek resources from neighboring areas such as the Edward "Ted" and Pat Jones –Confluence State Park or Riverlands Migratory Bird Sanctuary. Alternative 2 would not result in any significant long-term impacts to fish and wildlife.

5.3.5 Invasive Species

Alternative 1 – "No Action"

Alternative 1 – The "No Action" Alternative would involve no additional active restoration of SWH on the Cora Island Habitat Restoration Project. The "No Action" Alternative would initially benefit invasive plant species. With no additional habitat restoration or USFWS management activities some invasive species such as Canada thistle, reed canary grass, and Japanese hops would increase on the site. Over time though, these herbaceous invasive species would be shaded out by the forestation that would occur through natural regeneration and with levee protection.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Alternative 2 could initially increase the amount of invasive species on the site. The additional disturbance of the woodlands in the riparian areas and the lack of herbicide treatment on the previously farmed areas would allow invasive plant species to establish on some of these areas. In the long term the disturbed areas would be planted to native vegetation or naturally regenerate to floodplain forest and displace the invasive species. Depending on site conditions, some initial invasive species control may be required to ensure planting survival in areas that are colonized by invasive species. Any control actions would be in concordance with the USFWS's invasive species management plan. There are no substantive differences between Alternative 2 and Alternative 3 with regards to invasive species.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The Recommended Plan would have similar impacts to those described for Alternative 2.

DRAFT

5.4 Threatened and Endangered Species

Alternative 1 – "No Action"

Alternative 1 – The "No Action" Alternative would involve no additional active restoration of shallow water habitat on Cora Island. The "No Action" Alternative would not result in construction of SWH which, per the BiOp, the USFWS believes would benefit the pallid sturgeon. This alternative would have a long-term positive impact for Indiana and northern long-eared bats due to the increase in riparian forests through natural regeneration. This alternative would have no impact on decurrent false aster as it is not known to exist at Cora Island.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

The Federally listed endangered Indiana bat (*Myotis sodalis*) and the proposed to be listed northern long-eared bat (*Myotis septentrionalis*) are presumed to occur in the project area because of suitable foraging and/or roosting habitat in and around the project area. This alternative would clear 7 acres of riparian forest. Those impacts would be limited to the removal of potential roost trees and foraging habitat, as no suitable hibernacula occur on the project site. To minimize any potential impact to bats, a survey would be conducted prior to removing any trees that provide suitable roosting habitat if trees are removed during the roosting season. Removal of any trees that threatened or endangered bats may be using would be avoided until such time that they are not being used. Over time, the generation of up to 441 acres of woodlands on lands that have recently been in cultivation would be beneficial for the Indiana and northern long-eared bats, providing additional roosting and foraging habitat.

The creation of approximately 111acres increase of SWH would benefit the decurrent false aster and the pallid sturgeon. The Corps is required to develop SWH and improve floodplain connectivity as described in the BiOp. Over the long-term, the alternative would also improve floodplain connectivity through the creation of SWH, and by notching the existing levee. However, the large stockpiles of soil, 250 acres, could hinder movement of some aquatic species during flood events if water elevations were at particular levels. This would be a minor temporary impact until such time that the stockpiles of soil would eventually enter the Missouri River through natural processes.

Although, no known bald eagle nests are located within the project area, available nesting sites could develop over time. Alternative 2 would not adversely affect pallid sturgeon, Indiana bats, northern long-eared bats, or decurrent false aster.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity (Recommended Plan)

The Federally listed endangered Indiana bat (*Myotis sodalis*) and the proposed to be listed northern long-eared bat (*Myotis septentrionalis*) are presumed to occur in the project area because of suitable foraging and/or roosting habitat in and around the project area. The Recommended Plan would removal of 7 acres of riparian forest, similar to Alternative2. Those

DRAFT

impacts would be limited to the removal of potential roost trees and foraging habitat, as no suitable hibernacula occur on the project site. To minimize any potential impact to bats, a survey would be conducted prior to removing any trees that provide suitable roosting habitat if trees are removed during the roosting season. Removal of any trees that threatened or endangered bats may be using would be avoided until such time that they are not being used. Over time, the generation of up to 653 acres of woodlands on lands that have recently been in cultivation would be beneficial for the Indiana and northern long-eared bats, providing additional roosting and foraging habitat.

The creation of approximately 111 acres increase of SWH would benefit the decurrent false aster and the pallid sturgeon. The Corps is required to develop SWH and improve floodplain connectivity as described in the BiOp. Over the long-term, the alternative would also improve floodplain connectivity through the creation of SWH, and by notching the existing levee. However, the stockpiles of soil, less than 35 acres, could hinder movement of some aquatic species during flood events if water elevations were at particular levels. This would be a negligible temporary impact. Eventually, the stockpiles of soil would enter the Missouri River through natural processes. This impact would be less than Alternative 2 because of the smaller size of the stockpiles.

Although, no known bald eagle nests are located within the project area, available nesting sites could develop over time. Recommended Plan would not adversely affect pallid sturgeon, Indiana bats, northern long-eared bats, or decurrent false aster.

5.5 Water Quality

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional active SWH restoration of habitat on Cora Island and therefore would not adversely affect water quality. While water quality benefits associated with the reduction in soil disturbance from agricultural production at Cora Island would continue, there would be no additional water quality impacts.

Alternative 2 – Restore Floodplain Habitats and Construct Shallow Water Habitat with Placement of Excavated Material on Land

During construction, discharge at the project site would be limited to a minor, incidental amount due to the excavation at the chute inlets, outlets, and control structures. These activities could temporarily increase suspended solids and decrease water clarity and light penetration, however, these impacts would be unavoidable but short-term and minor. Best Management Practices would be implemented to reduce discharges of construction equipment fluids into stormwater runoff from the construction areas. Because the construction activity would impact more than one acre, a National Pollution Discharge Elimination System (NPDES) permit would be required from the State of Missouri. The NPDES permit and associated stormwater pollution prevention plan (SWPPP) would address control issues for pollutants during and after construction and would be prepared by the construction contractor. Construction activities would comply with any

DRAFT

relevant conditions required by the State of Missouri to fulfill the requirements of Section 401 of the CWA that are discussed in section 5.14 Compliance with Environmental Quality Statutes.

Alternative 2 would result in the placement of approximately 2,171,000 cubic yards of material within the meander zone of the proposed chute that would eventually reenter the Missouri River through natural riverine processes. An additional 2,600,000 million cubic yards would also enter the Missouri River via natural processes as the chute continues to widen to ultimate conditions.

To put the quantity of phosphorus in the planned sediment relocation at the Cora Island project into perspective, it is necessary to compare it to the average daily load of phosphorus exported from the Missouri River, which is approximately 110 metric tons per day (as measured at Hermann, MO), and also the load delivered by the Mississippi River to the Gulf, which is 423 metric tons per day based on the annual load of 154,300 metric tons (Heimann et al. 2014; NRC 2011).

To get a comparable value for the Cora Island project, the total amount of planned sediment relocation, the nutrient concentration of the sediment, and the length of time over which the sediment removal would take place must be evaluated. It is estimated that the 2,171,000 cubic yards (1,659,000 cubic meters) of sidecast material would be integrated into the main channel of the Missouri River. The resulting mass of that material is equal to approximately 2.8 million tons (2.6 million metric tons) based on a soil unit weight of 97 pounds per cubic foot (K. Stark, USACE pers. communication).

The median concentration of total phosphorus at Cora Island is 415 parts per million. As such, the rate of removal and placement into the Missouri River main channel was calculated as an average of the total material to be moved divided by the rate at which the material would enter into the river. Assuming all side cast material entered the Missouri River within one year after construction and ultimate conditions are reached within five years, a conservative estimate provided by Heimann et al. 2014, the daily load of sediment, phosphorus and nitrogen that would be delivered to the Missouri River and the Gulf of Mexico was calculated. Based on these assumptions, the amount of sediment entering the system during this time would be approximately 9,000 metric tons/day and would include 3.8 metric tons/day of phosphorus which is approximately 3.4% and 0.9% of the daily phosphorus load of the Missouri and Mississippi Rivers respectively. This sediment also includes 4.1 metric tons/day of nitrogen which is approximately 0.6% and 0.1% of the daily nitrogen load of the Missouri and Mississippi Rivers respectively. It is important to note also that this assumes that all phosphorus and nitrogen is transported through the system, which is not likely, given deposition and possible de-nitrification. Therefore, these estimates most likely over estimate nutrient delivery.

Given the relationship between sediment and nutrients a possible assumption is that water in exiting chutes has higher concentrations of nutrients and total suspended solids, relative to water entering the chute and water in the adjacent mainstem. To test this hypothesis and further understand nutrient and sediment contributions from chutes as they develop, water samples were collected from five constructed SWH chutes in 2009, and four constructed SWH chutes in 2010 and 2011. Results from this monitoring showed that no statistical differences ($p>0.05$) were found among sampling locations for any of the variables indicating that although the chutes do

DRAFT

widen via natural processes, there is no significant change or deviation from typical river loadings resulting from chute development. Similar results were reported by Woodward and Rus (2011) when they examined the contribution of suspended sediment to the mainstem at two constructed chutes. They concluded that "the chutes had no detectable effect on the sediment characteristic in the main channel" (Woodward and Rus 2011). Both of these post construction evaluations suggest that as individual chutes mature they have an insignificant impact on the concentrations of nutrients and suspended sediment in the mainstem of the Missouri River. For more details regarding this monitoring see Gosch et al. 2013 and USACE 2012.

Alternative 3 – Construct Shallow Water Habitat through a combination of Dredging and Onsite Placement (Recommended Plan)

Many of the impacts to water quality discussed under Alternative 2 are applicable to Alternative 3; however, differences exist in the rate of sediment and nutrient delivery to the Missouri River and downstream locations. Alternative 3 would result in approximately 380,000 cubic yards being sidecast within the meander zone of the chute with the remaining 1,791,000 million cubic yards being directly discharged into the Missouri River. An additional 2,600,000 cubic yards would also enter the river as the chute develops to ultimate conditions. Additional discharge at the project site would be similar to those discussed under Alternative 2 with respect to a minor amount discharge due to the excavation at the chute inlets, outlets, and control structures, and incidental discharge associated with excavation. Similar to Alternative 2, a NPDES permit and associated SWPPP would be required.

Elutriate tests are an effective means of evaluating potential impacts of introducing sediment during habitat creation efforts into the mainstem river. Elutriate samples were generated in the laboratory by combining sediment collected from the borings along the proposed chute alignment with water collected from the mainstem Missouri River (USEPA and USACE1998). Elutriate results for the Cora Island site can be found in Table B. Total phosphorous in elutriate samples (0.10 mg/L) was less than total phosphorus in river water samples (0.44 mg/L) collected at the Cora Island site. This suggests that the introduction of sediment from habitat creation projects allows a portion of the phosphorus (in the water column) to bind with introduced sediment particles and is settled out. Phosphorus, subsequently, is then transported through the system with bedload and is re-deposited downstream of the project location.

Total phosphorus in the elutriate samples at the Cora Island site were also compared to samples collected from nearby mainstem water monitoring locations located upstream and downstream of the Cora Island site. At these upstream and downstream monitoring locations, grab samples were collected in monthly intervals between 2009 and 2011, excluding the months of November through February to assess the ambient concentrations in the river. Phosphorus concentrations were significantly lower in elutriate samples collected at all SWH sites, including the Cora Island site, relative to phosphorus concentrations in water samples collected from these mainstem sites. While this comparison does not include either the nutrients in the bedload of the river or in the settleable solids from the elutriate sample, it does allow a comparison of total phosphorus concentrations actually present in the water column and shows that the discharge of slurry during dredging operations would have lower concentrations of phosphorus than what is found under ambient conditions. This further supports our assessment that there would be no nutrient related

DRAFT

adverse effects to native species from dredging.   Figure 21 also shows that phosphorus concentrations are similar among elutriate samples collected at the Cora Island site and other SWH sites.

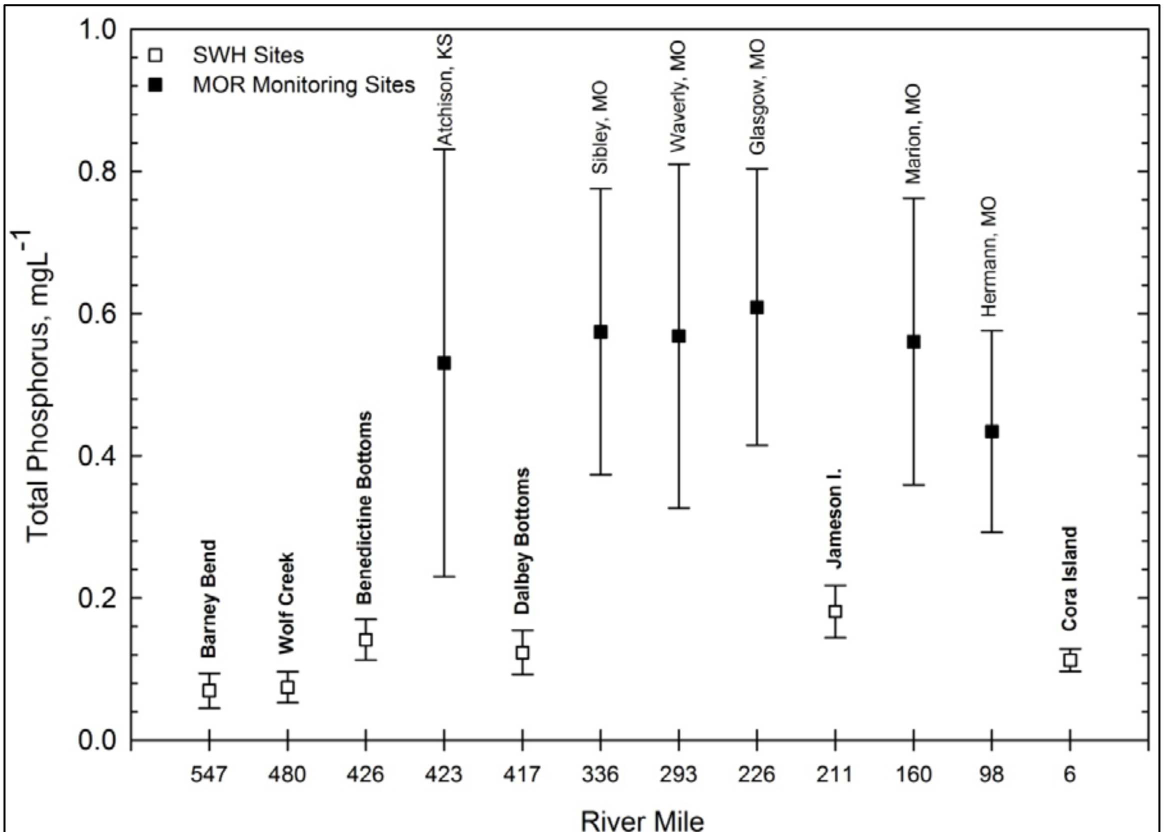


Figure 21: Total phosphorus concentrations in elutriate samples collected from constructed SWH sites (bolded text) and water samples collected from Missouri River monitoring locations.

Total nitrogen in elutriate samples (1.78 mg/L) was similar to total nitrogen in water samples (1.91 mg/L) collected at the Cora Island site (see Table D). Nitrogen concentrations from elutriate samples at the Cora Island site were also compared to samples collected from the same nearby monitoring locations described above (Figure 22). Mean total nitrogen concentration was not significantly different between elutriate samples collected at the Cora Island site and water samples collected at other mainstem sites suggesting that concentration of nitrogen in the water would not depart from ambient conditions as excavated materials enter into the river. Figure 23 also shows that nitrogen concentrations in elutriate samples collected at the Cora Island site were similar to elutriate samples collected at all other SWH sites, except for the Dalbey Bottoms site.

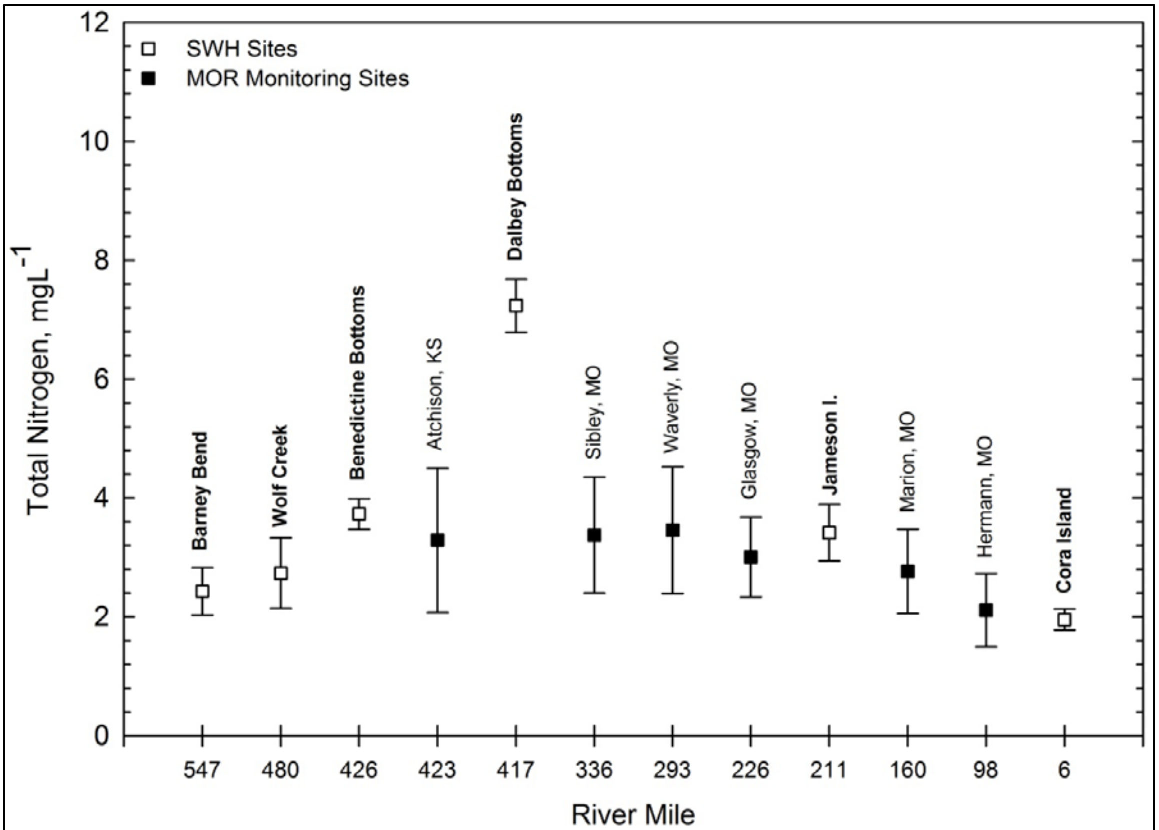


Figure 22: Total nitrogen concentrations in elutriate samples collected from constructed SWH sites (bolded text) and water samples collected from Missouri River monitoring locations.

Based on the above analysis, dredging operations would not cause a departure from upstream or downstream conditions and is consistent with the state of Missouri's general water quality criteria and supports our assessment that there would be no nutrient related adverse effects to native species from dredging.

To estimate delivery of sediments and nutrients to the Missouri River and downstream locations during dredging, the same methodology was used as described in Alternative 2 and adjusted the time scale to account for dredging operations discharging over a period of a single navigation season (243 days). A single navigation season is a conservative estimate and actual construction duration will likely be longer. In addition, these calculations do not include the material that will be stored within the dike fields, but estimates all material being integrated into the bedload during construction. Subsequent discharges will occur when all side cast material enters the river within one year after construction and ultimate conditions occur within five years, a conservative estimate. Dredging operations will discharge sediment at a rate of approximately 9,000 cubic yards/day assuming that the project is constructed within a single navigation season. The resulting mass of that material is equal to 10,800 metric tons/day and would result in approximately 4.5 metric tons of phosphorus/day (4.1% of Missouri River daily load; 1.1% of Mississippi daily load) and 4.9 metric tons of nitrogen/day (0.7% of Missouri River daily load; 0.1% of the daily Mississippi River load).

DRAFT

To estimate delivery of sediments and nutrients to the Missouri River and downstream as the chute continues to develop, we used the same methodology as described above and in Alternative 2 and adjusted the time scale to account for side cast material entering the system within one year after construction and the chute reaching ultimate conditions within five years. During this period sediment will be re-mobilized at a rate of approximately 1,800 cubic yards/day. The resulting mass of that material is equal to 2,200 metric tons/day and would result in approximately 0.9 metric tons of phosphorus/day (0.8% of Missouri River daily load; 0.2% of Mississippi daily load) and 1.0 metric tons of nitrogen/day (0.1% of Missouri River daily load; 0.02% of the daily Mississippi River load). Again, it is important to note also that these analyses assume that all phosphorus and nitrogen is transported through the system, which is not likely, given deposition and possible de-nitrification. Therefore, these estimates most likely over estimate nutrient delivery.

As compared to Alternative 2, dredging operations under Alternative 3 during chute construction would have a greater short term increase in sediment load and suspended solids, decreased water clarity and light penetration, below the project site than Alternative 2. These impacts would be unavoidable but short-term and insignificant. It should be noted that most of the native Missouri River fish species are specially adapted to highly turbid conditions. To evaluate these concerns and to insure that the general criteria for State water quality standards were not exceeded during habitat restoration and to detect any significant change in water quality, turbidity measurements were collected, during dredging operations, at the Rush Bottoms project site in September 2007 (Figure 23). Transects were established 0.5-miles upstream, 100-meters downstream, and 0.5-, 1.0-, and 2.0-miles downstream of the discharge site. The highest turbidity measurement of 112.6 NTU was detected 0.5 miles downstream of the discharge pipe resulting in an increase of 13.7 NTUs from the upper most transect. At this location the mixing plume was not distinguishable from the ambient waters suggesting that dredging does not exceed the State of Missouri's general water quality criteria (Table I, number 3). Evaluation of turbidity differences should also occur in the historical context of Missouri River ecology. Historically, turbidity levels were much higher in the Missouri River (Figure 24) and have decreased by over 50% since 1953 (Blevins 2006). Increases in turbidity due to dredging operations are insignificant when compared to historical conditions suggesting that impacts to native Missouri River species are inconsequential and recovery of native species may necessitate restoration of cut and fill processes to the river.

DRAFT

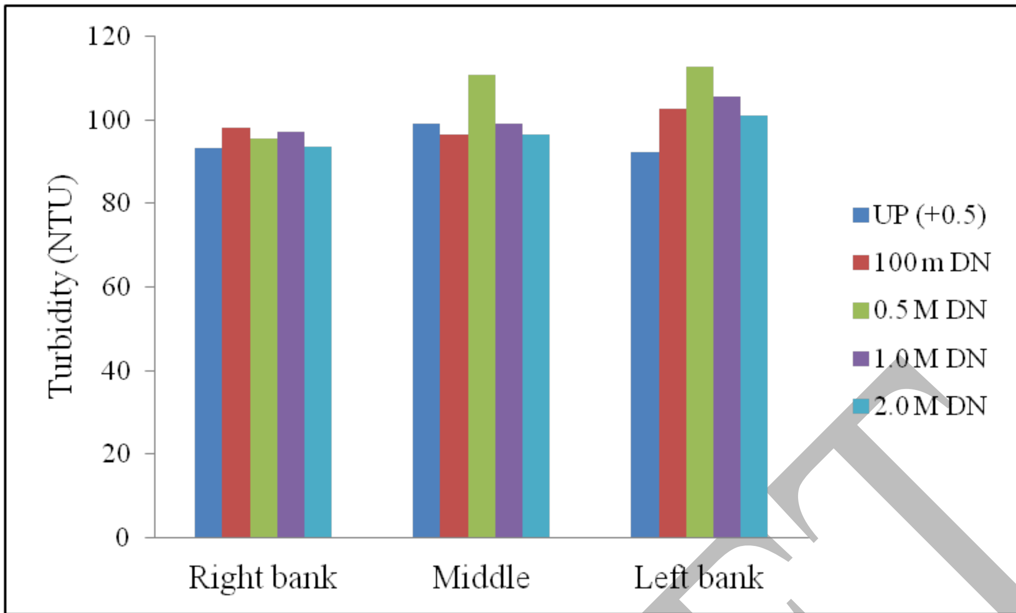


Figure 23: Turbidity (NTU) measurements taken at Rush Bottoms during dredging on 14 Sep 2011. Rush Bottoms is on the Left Descending Bank. UP is upstream and DN is downstream.

Table I: State of Missouri General Water Quality Criteria*

1. Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
2. Waters shall be free from oil, scum, and floating debris in sufficient amounts to be unsightly or prevent full maintenance of beneficial uses.
3. Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.
4. Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal, or aquatic life.
5. There shall be no significant human health hazard from incidental contact with the water.
6. There shall be no acute toxicity to livestock or wildlife watering.
7. Waters shall be free from physical, chemical, or hydrologic changes that would impair the natural biological community.
8. Waters shall be free from used tires, car bodies, appliances, demolition debris, used vehicles or equipment and solid waste as defined in Missouri's Solid Waste Law, section 260.200, RSMo, except as the use of such materials is specifically permitted pursuant to section 260.200-260.247.

*http://dnr.mo.gov/env/wpp/wqstandards/wq_criteria.htm

DRAFT

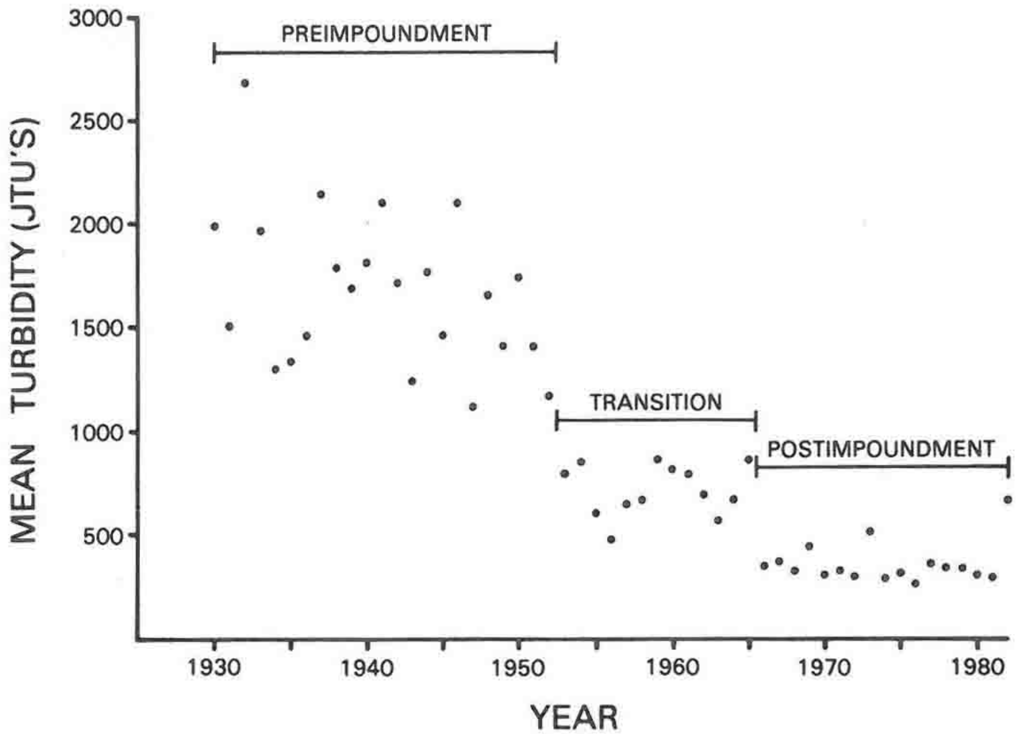


Figure 24: Changes in Missouri River turbidity 1930-1982 at St. Louis, Missouri. From Pflieger and Grace, 1987.

Additional real-time turbidity measurements were conducted at the St. Joseph, Missouri gauge downstream of the Rush Bottom dredging site. Figure 25 shows measurements of turbidity at St Joseph before and after dredging commenced. The St Joseph gauge is located 52 miles downstream of the Rush Bottoms project, and water travel time from Rush Bottom to St Joseph is less than one day. Discharge at Rulo, Nebraska, two miles downstream of Rush Bottom, is also included in the figure. While significant spikes in turbidity were noted following rainfall events upstream of St. Joseph, such as the July 24, 2007 rainfall event that fell over the Big Nemaha, Little Nemaha, Nishnabotna, Tarkio, and Nodaway River Basins, and especially the high flow event of August 9, 2007, no observation of turbidity increase before and after dredging was apparent. Accordingly, turbidity measurements at St Joseph appeared highly dependent on tributary flows following rain events, and independent of dredging at Rush Bottom.

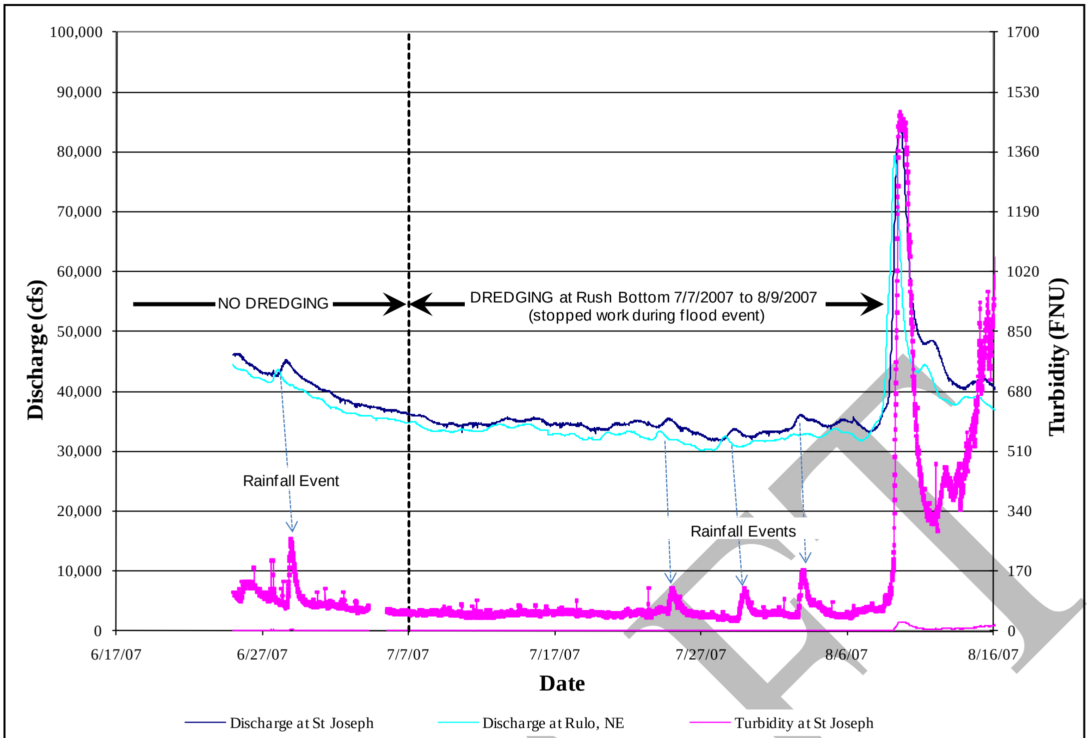


Figure 25: Discharge and Turbidity at St. Joseph, Mo: June to August 2007 (Downstream of the Rush Bottom Chute Project).

While the Corps does not have any reason to believe that introducing inorganic sediment into the Missouri River would cause a decrease in oxygen concentrations and exceed state water quality standards, dissolved oxygen is a water quality parameter of common interest since it is vital for most aquatic organisms. A dissolved oxygen level of 5 mg/L is generally considered protective of warm water aquatic life and is consistent with Missouri water quality criteria. To insure that dredging operations during chute construction do not cause a decrease in dissolved oxygen levels below 5 mg/L, dissolved oxygen measurements were collected simultaneously with the turbidity measurements described above. Results are found in Figure 26. The data show that dredging operations have no impact on dissolved oxygen concentrations and does not exceed the State of Missouri water quality criteria.

DRAFT

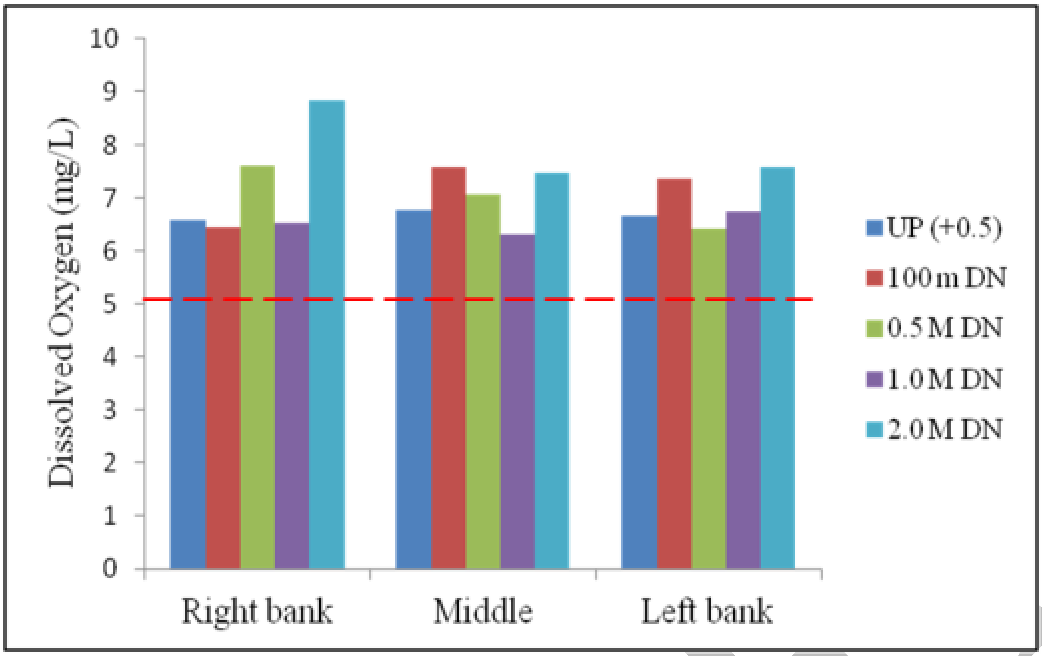


Figure 26: Dissolved oxygen (mg/L) measurements taken at Rush Bottoms during dredging on 14 Sep 2007 (Dashed red line represents the State of Missouri's dissolved oxygen water quality criteria of 5 mg/L). Rush Bottoms is on the Left Descending Bank. Up is upstream and DN is downstream.

5.5.1 Potential Water Quality Consequences – Summary

Implementation of methods to reduce discharges of pollutants in storm water runoff from the construction areas (e.g., Best Management Practices) would occur regardless of any build alternative selected (see Section 5.14 Compliance with Environmental Quality Statutes – Clean Water Act). Construction of the Cora Island Habitat Restoration Project would impact more than one acre, thus requiring a permit for storm water discharge for land disturbances from the Missouri Department of Natural Resources (a National Pollutant Discharge Elimination System (NPDES) permit). The permit and associated storm water pollution prevention plan would address control issues for pollutants during and after construction activities and comply with any conditions recommended by the Corps and Missouri Department of Natural Resources in issuing respectively the Section 404 authorization and 401 water quality certification. Construction activities at Cora Island would not exceed Federal or State water quality standards; therefore no significant adverse impacts would result.

Alternative 1 – "No Action"

The "No Action" Alternative would not adversely affect water quality. No additional sediment would be added to the Missouri River.

DRAFT

Alternative 2 – Restore Floodplain Habitats and Construct Shallow Water Habitat with Placement of Excavated Material on Land

Alternative 2 and the Alternative 3 would add similar amounts of sediment to the bed load of the Missouri River over the life of the project. The difference would be in the timing of addition of material through construction or natural processes. Alternative 2 would add the least amount of sediment during the construction phase of the project. Because approximately 2,171,000 cubic yards of excavated material from initial chute construction would be placed in the meander belt of the chute, then during the intervening years, the sediment additions from Alternative 2 would be greater as the stockpiled material and an additional 2,600,000 cubic yards of other bank material sloughs into the chute. This addition of material to the Missouri River would be so minor as to be undetectable. The stockpiling that would occur in Alternative 2 would have the potential to add sediment to existing wetlands adjacent to the proposed chute alignment.

Alternative 3 – Construct Shallow Water Habitat through a combination of Dredging and Onsite Placement (Recommended Plan)

Given the assumptions on construction duration and discharge location listed in Section 5.5, the Recommended Plan would add 1,791,000 cubic yards of sediment to the bed load of the Missouri River during project construction and an additional 2,600,000 cubic yards over the life of the project. This alternative would ultimately contribute the same amount of sediment to the Missouri River as Alternative 2, but it would occur during a shorter period of time. The Recommended Plan would provide minor short-term benefits to the river by contributing additional sediment, more similar to the conditions that native species are accustomed too prior to the construction of the BSNP and the Mainstem Reservoir System.

A draft Clean Water Act Section 404(b) (1) Evaluation for the Recommended Plan is located in Appendix G. The Corps' preliminary determination, pending completion of the public interest review, is that the Recommended Plan is in full compliance with the Section 404(b) (1) Guidelines.

5.6 Air Quality

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional active SWH restoration of habitat on Cora Island. The "No Action" Alternative would not experience any construction related air quality effects. Current and future air quality impacts to the property would mostly likely attributed to the surrounding area, in particular emissions from city and suburbs of St. Louis.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Increases in fugitive dust (suspended particulate matter) and increases in exhaust emissions from Alternative 2 construction activities would have the greatest adverse impacts of the "Build Alternatives" considered. Alternative 2 would have greater adverse impacts on air quality than

DRAFT

the Alternative 3 because it relies solely on multiple units of heavy construction equipment and moves greater amounts of earthen material greater distances. These impacts would be temporary and would have relatively low emission levels. These pollutants are expected to disperse quickly; therefore, any impact would be minimal.

As described in Section 4.7 Air Quality, the property is within St. Louis's Metropolitan Region and emissions resulting from Alternative 2 would not approximate the daily emissions of the city or its suburbs. However, construction related emissions of Alternative 2 would have negligible negative impacts to the cumulative air emissions of the city. Additional traffic emissions associated to workers traveling to and from the site would also have negligible impacts when compared to traffic of the surrounding area. When necessary, construction access roads would be watered to minimize the escape of fugitive dust during high wind speeds and periods of high construction vehicle activity.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

Increases in fugitive dust (suspended particulate matter) and increases in exhaust emissions from Alternative 3 construction activities would result in the least adverse impacts of the "Build Alternatives" considered. Alternative 3 air quality impacts would be minimized by only using heavy construction equipment for initial clearing and grubbing, and then utilizing a hydraulic dredge to excavate the chute. Once initial clearing and grubbing was complete fugitive dust from construction activity would be minimal. Exhaust emissions would be minimized because after initial clearing and grubbing was complete a single hydraulic dredge would be used to complete chute excavation as opposed to multiple pieces of heavy construction equipment. Alternative 3 would have less adverse impact on air quality than Alternative 2 because only minimal amounts of earthen material would be moved during initial clearing and grubbing and it would be moved a shorter distance. These impacts would be temporary and would have relatively low emission levels. These pollutants are expected to disperse quickly; therefore, any impact would be minimal. As described in Section 4.7 Air Quality, the property is within St. Louis's Metropolitan Region and emissions resulting from Alternative 3 would not approximate the daily emissions of the city or its suburbs. However, construction related emissions of Alternative 3 would have negligible negative impacts to the cumulative air emissions of the city. Additional traffic emissions associated to workers traveling to and from the site would also have negligible impacts when compared to traffic of the surrounding area. When necessary, construction access roads would be watered to minimize the escape of fugitive dust during high wind speeds and periods of high construction vehicle activity.

5.7 Noise

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional SWH restoration on Cora Island. There would be no adverse impacts resulting from increased noise under the "No Action" Alternative.

DRAFT

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

Noise impacts under each of the "Build Alternatives" are considered temporary and construction related. Upon completion of construction the manmade noise levels would return to current levels which are low and would include occasional tractor noise for farming practices or habitat management and possibly when a small motorboat would enter or pass through the chute. The lack of noise is considered important to recreational users and wildlife. Under each of the "Build Alternatives" Corps construction specifications would require the proper installation and maintenance of noise suppressing systems on heavy construction equipment used on site. Construction methods that require the greatest use of heavy construction equipment would have the greatest noise impact as multiple vehicles would have constantly variable engine noise as they continually worked back and forth across the site. Noise would also be generated by the equipment motor, equipment tracks, buckets/blades and back up signal horn.

Adverse noise impact under Alternative 2 would be greater than those of Alternative 3. Relying solely on heavy construction equipment to excavate the chute and to stockpile the excavated material would generate the greatest amount of noise. Noise impacts associated with a heavy construction project under Alternative 2 are considered unavoidable, the additional noise associated with the stockpiling of the excavated material is considered avoidable. Lands surrounding the project site include agricultural lands, wetlands, prairie, forest, the Missouri River, the Confluence Point State Park, Columbia Bottoms Conservation Area, and Riverlands Migratory Bird Sanctuary would provide resources for wildlife and recreation users during construction.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

Alternative 3 would have the least adverse noise impact as multiple pieces of heavy construction equipment would only be used for initial clearing/grubbing, and then a single hydraulic dredge would be used to remove the remainder of the material. A single hydraulic dredge would be expected to produce a much more even noise level when removing material as they are fairly stationary and would be working at the river level. This would be in contrast with highly mobile multiple pieces of heavy construction equipment where there is great variability in noise related to engine speed, equipment tracks, buckets/blades and back up signal horns working on top of the high bank. Noise impacts associated with the Recommended Plan are considered unavoidable. Although impacts from noise are expected to be less for Alternative 3 than Alternative 2, lands surrounding the project site include agricultural lands, wetlands, prairie, forest, the Missouri River, the Confluence Point State Park, Columbia Bottoms Conservation Area, and Riverlands Migratory Bird Sanctuary would provide resources for wildlife and recreation users during construction.

DRAFT

5.8 Historic Properties and Cultural Resources

Alternative 1 – "No Action" Alternative

The "No Action" Alternative would have no effect on any cultural resource in or adjacent to the project area.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

For each of the "Build Alternatives" the Corps, during the design of the Cora Island Habitat Restoration Project, attempted to avoid areas where potential historic shipwrecks and non-accreted lands are mapped. Past channel location maps of the project area dating from 1803 to the present were reviewed to determine the amount of accreted lands at Cora Island. It was determined that all of Cora Island had accreted since the mid to late 1800's. Also some historical accounts describe the formation of Cora Island, the land riverward of the existing Cora Island slough, as having resulted from accretion around a steamboat, the Cora, that sank in 1869 (Dyer 1997). A review of the Kansas City Corps of Engineers "Abandoned Shipwrecks on Missouri River Channel Maps 1879 to 1954" indicated 6 shipwrecks in the vicinity of Cora Island. Given the increased likelihood of encountering a shipwreck on this project, the Corps contracted for a survey using a magnetometer. The magnetometer survey indicated an anomaly that could be a shipwreck in the location of one of the chutes. To avoid construction impacts to the possible shipwreck, the designed location was shifted 200 feet west of the anomaly. In addition, the portion of the chute nearest the anomaly would be armored to prevent post construction chute erosion from impacting the possible wreck.

After the above alignment changes the Corps' determination is that the proposed project would not impact any sites listed or eligible for listing in the National Register of Historic Places in the immediate project area. The Corps would forward these recommendations to the Missouri State Historic Preservation Officer (SHPO) for their concurrence. Even though a magnetometer survey covered the chute alternative, it is possible that unrecorded shipwrecks or other historic artifacts may be present in the area and encountered during construction. If an inadvertent discovery occurs, the Corps would coordinate the find with SHPO and the affiliated Native American Tribes. If this discovery were of Native American human remains, then Section 3 of the Native American Graves Protection and Repatriation Act (P.L. 101-601) would be followed. Should evidence of a historic shipwreck be exposed during construction it would be the Corps intent to avoid any project impacts by shifting the alignment of the chutes. As with any other inadvertent discovery of a historic property this would require additional coordination with the SHPO and potentially a revision of the National Environmental Policy Act evaluation and Section 404(b) (1) evaluation.

The Corps provided the SHPO with a determination of no historic properties affected by the proposed project and the need to conduct an archeological assessment of the non-accreted lands prior to construction on those lands. This concurrence is in Appendix F

DRAFT

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

Impacts for Alternative 3 are the same as Alternative 2.

5.9 Socioeconomic Resources

Socioeconomic resources are the part of the human environment that includes the economic, demographic, and social characteristics of individuals and communities.

5.9.1 Population and Income

Alternative 1 – "No Action"

The "No Action" Alternative would involve no SWH construction activity. The slow natural regeneration on the site would provide small limited economic impacts of increased recreational use for activities such as hunting, fishing, hiking, nature photography, etc. These inputs are anticipated to be relatively small when compared to economic inputs throughout St. Charles.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

None of the "Build Alternatives" including the Recommended Plan would adversely affect the makeup of the local population or their current income levels. Some minor short-term increases in employment could be realized during construction of the project and minor short-term increases in business to support the project workforce and supply necessary construction materials could occur. No adverse impacts to facilities, services, or nearby communities are expected under any of the "Build Alternatives".

As estimated project cost for Alternative 2 are greater than Alternative 3, it has the greatest potential to provide minor short-term increases in employment during construction of the project and to provide minor short-term increases in business to support the project workforce and supply necessary construction materials. No adverse impacts are expected for this alternative, and only minor, short-term increases in employment could be realized during construction of the project and minor short-term increases in business to support the project workforce and supply necessary construction materials could occur.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

As Alternative 3 has the lowest overall estimated project cost of the "Build Alternatives" it has the least potential to provide minor short-term increases in employment during construction of the project and to provide minor short-term increases in business to support the project workforce and supply necessary construction materials. No adverse impacts are expected for this alternative, and only minor, short-term increases in employment could be realized during construction of the project and minor short-term increases in business to support the project workforce and supply necessary construction materials could occur.

DRAFT

5.9.2 Navigation

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional active SWH restoration of habitat on Cora Island. The Corps has determined that the "No Action" Alternative would not result in impacts to navigation.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

No adverse impacts to navigation are expected from construction and operation of the Cora Island Project under any of the "Build Alternatives". Alignment of the chute at the lower end would not affect the high velocities, shoaling, or other navigation issues. The U.S. Congress requires the Corps to maintain a 9-foot deep by 300-foot wide navigation channel on the lower 735 miles of the Missouri River including the segment in the project area. Under Alternative 2, all of the material would be placed on land and would not impact navigation. However, the material would integrate into the bedload of the Missouri River over time. Coordination will be maintained with the St. Louis District to ensure there are no negative impacts from the MRRP project to navigation on the Mississippi River. Lock 27, due to its proximity to the project site and recent sedimentation issues, will be a focal point.

Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

The dredging process has brought to light concerns such as potential sediment build up in the navigation channel and potential water quality concerns. Concerns would be warranted if sediment discharge exceeded the assimilative capacity of the river while dredging was occurring. Dredging normally occurs during navigation season, i.e. times when navigation is supported by releases from the main stem reservoirs to meet dates and targets summarized in Table J.

Under the Alternative 3, sediments removed by a dredge from desired habitat areas would be pumped to the Missouri River channel and allowed to mix with existing river water and sediment load. The location of dredge disposal would consist of placement between the dike field on the left descending bank and the thalweg of the Missouri River. For any discharge to the thalweg, the end of the dredge discharge pipe would be submerged at a location in the water column where mixing and integration into the sediment load occurs quickly. Studies and construction experience from other projects (California Bend, Nebraska and Hidden Lake/Great Marsh) indicate that suspending the discharge four to six feet off the bottom of the river provides for adequate entrainment of the dredge material. To address these concerns, proposed dredging rates and minimum dredge discharges were examined at Hermann and St Joseph, and other river gages, and compared to the dredge discharge schedule previously produced by similar analysis by the Corps Omaha District at Nebraska City. Table K presents a dredge discharge schedule for various river locations, also referred to as the maximum dredge rate in this document. Dredge discharge schedules are implemented to insure that the assimilative capacity of the river is not exceeded and navigation is not negatively impacted.

Recent depth-integrated sediment measurements and proposed maximum dredging rates for Hermann Missouri are provided in Figure 27. Two post-dam data periods are plotted with the dredging data, 1974-1983 and 1991 to 2001. As seen in the figure, 1991 to 2001 data plot below the 1974 to 1983 data at each location, indicating a recent drop in suspended sediment concentrations. Adding the dredging rates in Figure 28 to a power fit of the 1991 to 2001 data does not increase sediment load above the 1974 to 1983 data, and does not exceed normal scatter of the 1974 to 1983 suspended sediment data even at five times the dredging rates. This analysis shows that following the dredging guidelines above, sediment loading in the river would not exceed historical values or the assimilative capacity of the river. Coordination will be maintained with the St. Louis District to ensure there are no negative impacts from the MRRP project to navigation on the Mississippi River. Lock 27, due to its proximity to the project site and recent sedimentation issues, will be a focal point. Dredging disposal during project construction will only occur when flows are conducive on both the Mississippi and Missouri Rivers. St. Louis District has also provided input on the limitations for the dredge discharge based on discharge of the Mississippi River. If the Mississippi River begins to experience sedimentation issues that adversely impact federally maintained navigation features, dredging schedules will be adjusted to reduce impacts or dredging operations at the project site will be postponed until the issues are resolved.

Table J: Normal navigation season opening/closing dates and target flows.

Location	River Mile	Opening	Closing	Full Service Target (cfs)	Min. Service Target (cfs)
Sioux City, IA	732.3	23 March	22 November	31,000	25,000
Omaha, NE	615.9	25 March	24 November	31,000	25,000
Nebraska City, NE	562.6	26 March	25 November	37,000	31,000
Kansas City, MO	366.1	28 March	27 November	41,000	35,000
Mouth near St. Louis	0	1 April	1 December	NA	NA

*Note: Table from USACE RCC (2000) "Releases Needed to Support Navigation"

Table K: Dredge discharge schedule.

Dredge Water & Sediment Discharge (gpm / cfs)	Discharge at Nebraska City (cfs)	Discharge at St Joseph (cfs)	Discharge at Waverly (cfs)	Discharge at Boonville (cfs)	Discharge at Hermann (cfs)
8,000 / 18	25,000	25,000	30,000	32,000	38,000
12,000 / 27	37,500	40,500	55,000	55,000	60,000
16,000 / 36	50,000	50,000	65,000	75,000	100,000
20,000 / 45	62,500	65,000	80,000	95,000	150,000
24,000 / 53	75,000	82,000	110,000	150,000	200,000

*NOTE: Approximately 15-20% solids in dredge discharge

DRAFT

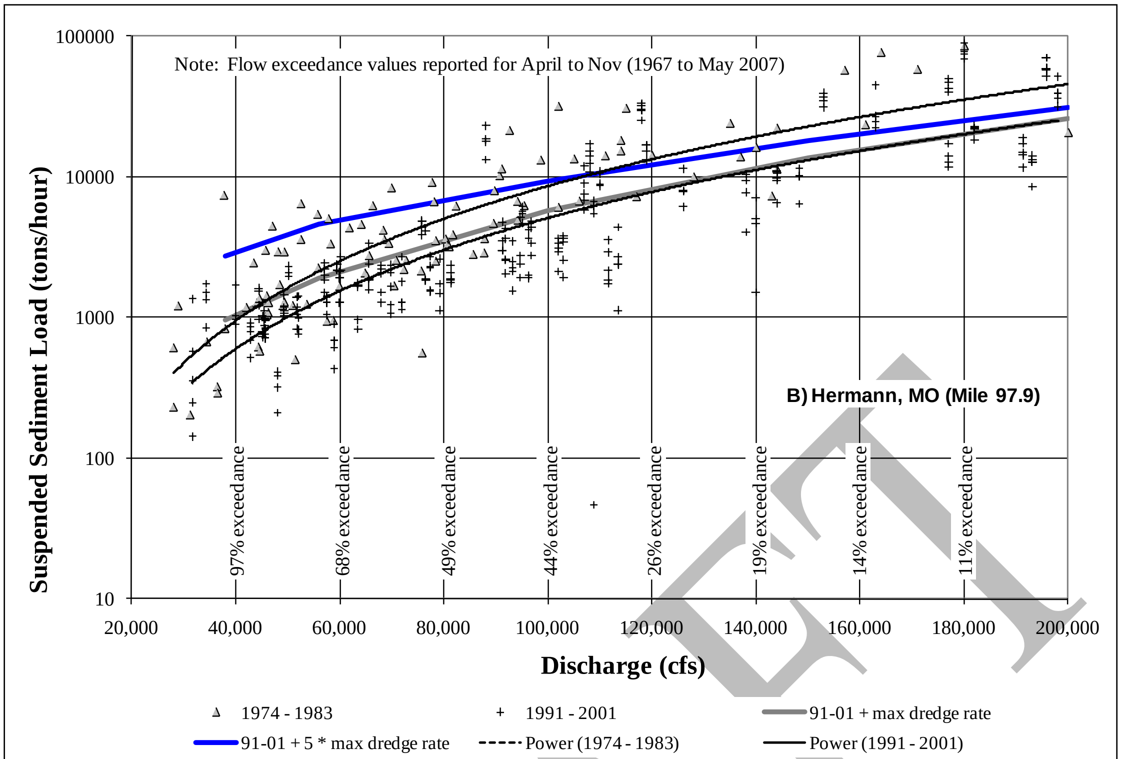


Figure 27: Sediment Measurements and Dredge Rates at Hermann, Mo.

5.9.3 Flood Risk Management

Alternative 1 – "No Action"

The "No Action" Alternative would involve no additional active SWH restoration habitat on Cora Island. Under the "No Action" Alternative no additional construction is anticipated. The Corps has determined that the "No Action" Alternative would not be expected to result in adverse impacts to flood risk management.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

None of the "Build Alternatives" would adversely impact the existing flood risk management systems in the vicinity. Cora Island is protected by a ring levee that would be notched under both "Build Alternatives" and thus remove all flood risk management from the project area. However, this ring levee system does not tie into any of the surrounding levee systems and would therefore have no impact on those flood risk management projects. None of the "Build Alternatives" would involve the placement of excavated material in a manner or location that would divert flows towards any of the surrounding levee systems, reduce channel capacity, or increase flood heights. Actually, the notching of the Cora Island levee system would over time increase channel capacity and minimally decrease flood heights. Impacts to the L-15 levee have also been considered. There is an existing underseepage concern near the project site. Material from the excavation of the project will be beneficially reused and provided to the Consolidated

North County Levee District to address existing underseepage concerns. No substantive differences in impacts to flood risk management systems were identified.

Alternative 3– Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

See narrative above under Alternative 2.

5.9.4 Recreation and Aesthetics

Alternative 1 - "No Action"

The "No Action" Alternative would involve no additional active SWH restoration of habitat on Cora Island. Alternative 1 would have no adverse impacts on recreation or aesthetics. The natural regeneration that would occur at the site would be more aesthetically appealing to outdoor recreationist. The increased public accessibility of the site due to public ownership would also benefit recreation.

Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity

As described above in Section 5.8 Noise, adverse construction noise impacts are greatest under Alternative 2. Aesthetic impacts are directly related to the quality of the recreational experience. Visitors to Cora Island expect to experience quiet or natural sounds and experience natural viewscapes. Alternative 2 would have the greatest aesthetic impacts as the stockpiled earthen material would be placed within the meander process area and beyond (see Figure 11 above) and persist for an extended time, until eventually integrating into the active Missouri River bedload. Although, long term Alternative 2 would create an aesthetically appealing landscape feature reminiscent of the historic meandering side channels and chutes of the pre-BSNP Missouri River, short term impacts would be unavoidable; however the Confluence Point State Park, Columbia Bottoms Conservation Area, and the Riverlands Migratory Bird Sanctuary would provide resources for wildlife and recreation users during construction.

DRAFT

Alternative 3– Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity. (Recommended Plan)

As described above in Section 5.8 Noise, adverse construction noise impacts are smallest under Alternative 3. Aesthetic impacts are directly related to the quality of the recreational experience. Visitors to Cora Island expect to experience quiet or natural sounds and experience natural viewscapes. As described, Alternative 3, of the "Build Alternatives", has the smallest long-term adverse impacts to recreation and aesthetics. It involves only minimal stockpiling of earthen material within the meander process area and would be expected to eventually integrate into the active Missouri River bedload. Short term impacts would be unavoidable due to construction activities; however the Confluence Point State Park, Columbia Bottoms Conservation Area, and the Riverlands Migratory Bird Sanctuary would provide resources for wildlife and recreation users during construction. No significant adverse impacts to recreation /aesthetics are anticipated under the Recommended Plan.

5.10 Summary of Effects

A Comparison of Alternatives which briefly summarizes the effects of the various alternatives is included in Table L.

DRAFT

Table L: Comparison of alternatives for the Cora Island Missouri River Recovery project.

Alternative/ Resource	Shallow Water Habitat (SWH)	T & E Species	Wetlands	Riparian Timber	Floodplain Connectivity	Water Quality	Fish & Wildlife	Flood Risk Management	Navigation	Cultural Resources	Noise	Aesthetics & Recreation	Estimated Costs
Alternative 1 – "No Action"	No increase in acreage.	No benefits to pallid sturgeon.	No adverse impacts.	No adverse impacts.	No improvements.	No long-term adverse impacts.	No adverse impacts. Minor long-term benefits to bats and migratory birds.	No adverse impacts.	No adverse impacts.	No adverse impacts.	No adverse impacts.	No adverse impacts.	$0.00
Alternative 2 – Construct Three Chutes with Land Based Spoil Disposal, and Improve Floodplain Connectivity	Approximately 42 acres at completion of construction, increasing to approximately 111 acres over time. Expected to take longer for habitat to reach maximum size compared to Recommended Plan due to size of soil stockpiles.	Long-term benefits to endangered pallid sturgeon through creation of 111 acres of SWH and improved floodplain connectivity. Benefits less than Recommended Plan because of additional time to maximize shallow water habitat.	Adverse impacts to 202 acres of farmed wetlands. All wetland impacts would be mitigated onsite, resulting in no net loss.	Minor, intermediate-term impacts resulting from clearing of 7 acres. Similar impacts as Recommended Plan.	Long-term benefits through creation of chutes and notching levee. Minor, long-term impacts resulting from stockpiling excavated soil on 303 acres.	No long-term adverse impacts. Minor short-term impacts due to increase in suspended solids and decrease in water clarity and light penetration.	Long-term benefits to fish and wildlife through creation of 111 acres of SWH, improved floodplain connectivity, and natural succession. Benefits to fish and wildlife less than Recommended Plan due to longer duration to maximize SWH and larger stockpiles of excavated soil.	No adverse impacts. Would not result in increased risk of flooding to surrounding areas, or impact existing flood risk management structures (levees) outside project site.	No adverse impacts. BSNP dikes would be modified to maintain existing water elevations of Missouri River.	No adverse impacts expected. Risk of inadvertently uncovering shipwreck compared to "No-Action". Similar risk with Recommended Plan.	Minor, short-term construction related impacts.	Minor, short-term construction related impacts. Minor, long-term impacts resulting from stockpiling excavated soil on 250 acres. Degree of minor impacts greater than Recommended Plan.	$13,142,154
Alternative 3 – Construct Three Chutes with Combination of Land and River Based Spoil Disposal, and Improve Floodplain Connectivity	Approximately 42 acres at completion of construction, increasing to approximately 111 acres over time. Expected to take less time for habitat to reach maximum size compared to Alternative 2 because of smaller soil stockpiles.	Long-term benefits to endangered pallid sturgeon through creation of 111 acres of SWH and improved floodplain connectivity. Benefits greater than Alternative 2 because of shorter time to maximize shallow water habitat.	Adverse impacts to 202 acres of farmed wetlands. All wetland impacts would be mitigated onsite, resulting in no net loss.	Minor, intermediate-term impacts resulting from clearing of 7 acres. Similar impact to Alternative 2.	Long-term benefits through creation of chutes and notching levee. Minor, intermediate-term impacts resulting from stockpiling excavated soil on 35 acres.	No long-term adverse impacts. Minor short-term impacts due to increase in suspended solids and decrease in water clarity and light penetration.	Long-term benefits to fish and wildlife including Federally-endangered pallid sturgeon through creation of 111 acres of SWH and improved floodplain connectivity. Benefits to fish and wildlife greater than Alternative 2 due to less time to maximize SWH and smaller stockpiles of excavated soil.	No adverse impacts. Would not result in increased risk of flooding to surrounding areas, or impact existing flood risk management structures (levees) outside project site.	No adverse impacts. BSNP dikes would be modified to maintain existing water elevations of Missouri River.	No adverse impacts expected. Risk of inadvertently uncovering shipwreck compared to "No-Action". Similar risk with Alternative 2.	Minor, short-term construction related impacts.	Minor, short-term construction related impacts. Minor, long-term impacts resulting from stockpiling excavated soil on 35 acres. Degree of minor impacts less than Alternative 2.	$12,477,370

DRAFT

THIS PAGE INTENTIONALLY LEFT BLANK

DRAFT

5.11 Cumulative Impacts

This project will allow the Corps to continue and meet its obligations under the Endangered Species Act by utilizing all of its authorities, including the authorities under WRDA 1986, 1999 and 2007. Cumulative effects of the Mitigation Project were addressed in the SEIS (Corps 2003). This project would have similar cumulative effects for the follow resource categories as described in the SEIS:

- *Land acquisition*
- *Economic impacts*
- *Recreation*
- *Navigation*
- *Water Resources (including water quality)*
- *Flood Control*

Cumulative effects associated with these resource categories do not need evaluation in the PIR because there are no extraordinary site-specific circumstances that necessitate an additional cumulative impacts analysis. However, there are other cumulative effects not addressed in the SEIS that would result from the construction and operation of the Cora Island Habitat Restoration Project. These include the following:

• Regional increases in fish and wildlife populations resulting from site-specific habitat development activities on the land use. Increases in regional habitat quality should positively correlate to increases in fish and wildlife resources in terms of species diversity and abundance. These would include efforts of the USFWS as part of their Big Muddy National Fish and Wildlife Refuge, NRCS and their Wetland Reserve Program, public (Columbia Bottoms) and private land management programs of the Missouri Department of Conservation, habitat restoration and preservation activities of the MDNR (Confluence Point State Park) and finally efforts undertaken by individuals on private lands to benefits fish and wildlife resources.

• Overall beneficial increases in recreational opportunities both consumptive and non-consumptive provided by the habitat construction to meet BiOp and the WRDA authorizations compliance. The proximity of this site to other state and federal lands being managed for species inhabiting the floodplain provide additive benefits that could not be achieved by this project alone.

• Overall beneficial increases in aquatic habitat that support the pallid sturgeon and other native fish and wildlife species.

• Cumulative effects of sediment reintroduction on sediment transport/availability in the lower Missouri River - The effects of sediment removal by commercial dredging operations from the Missouri River on shallow water habitat were evaluated in *The Missouri River Commercial Dredging Final Environmental Impact Statement*, prepared for the U.S. Army Corps of Engineers, Kansas City District and dated February 2011 as part of a Section 404 Clean Water Act permit application. Limitations established for commercial dredging were developed to ensure that activity does not adversely impact shallow water habitat or dependent life forms. In

DRAFT

addition, criteria established for commercial dredging ensure adverse impacts associated with bed degradation are avoided. The cumulative effect of sediment reintroduction from Missouri River SWH restoration projects could provide minor benefits related to the amount of available sediment in the active bedload. The cumulative effect of increased material in the active bedload from SWH construction projects could provide very minor benefits to commercial dredgers and help offset adverse impacts associated with bed degradation. No significant adverse cumulative impacts to sediment transport/availability in the lower Missouri River were identified.

• Cumulative effects of sediment reintroduction projects on water quality of the Missouri River:

Concerns were raised about the cumulative impact of the total amount of sediment (and potentially associated nutrients) required to enter the Missouri River to develop 20,000 acres of SWH. To fully understand the consequences of sediment re-introduction the cumulative effects need evaluation in the historical context of Missouri River ecology. The Missouri River has undergone significant alterations since the beginning of the 20th century. Six reservoirs were built along the mainstem and the river was channelized on the lower 735 miles as part of the bank stabilization and navigation project (BSNP). In addition to alterations on the mainstem, most of the major tributaries currently have dams and have undergone channel modifications as well. These alterations and hydrologic controls placed on the Missouri River dramatically altered the landscape of the river and caused a decrease in the amount of sediment transported by the river.

According to the National Research Council the historically high concentration of sediment in the Missouri River was possibly as important as the quantity and flow of water given that the sediment is necessary for habitat development for native species and that high sediment concentrations were important to the evolution of native species (NRC 2011). Additionally, sediment from the Missouri River was significant in sustaining coastal wetlands in Louisiana (NRC 2011). The Gulf Coast Ecosystem Restoration Task Force recognizes a sediment deficit and calls for increased and wiser use of sediments for use in habitat restoration projects (2011).

As of 2010, the Corps has developed approximately 3,443 acres of SWH. During the same time period as this construction, suspended sediment loads at St. Louis have continued to decrease (Table M). This indicates that sediment introduced during habitat restoration projects, as well as the natural processes that occur as SWHs mature, have not reversed the decreasing trend in suspended sediment and are immeasurable at this time. As such, any short-term increases in suspended sediment loads from SWH construction, if measureable, are likely masked by the overall declining trend in suspended sediments observed throughout the Missouri and lower Mississippi Rivers.

DRAFT

Table M: Summary of annual suspended sediment data (millions tons / year).

Data Period	Tarbert + RR Landing	St Louis (d/s Mile 0)	Hermann (Mile 97.9)	Kansas City (Mile 366.1)	St Joseph (Mile 448.2)	Omaha (Mile 615.9)	Yankton (Mile 805.8)
1940 - 1948	-	-	-	-	-	163	140
1949 - 1952	510	320	326	328	257	164	133
1955 - 1966	222	107	102	80	60	29	2
1967 - 1976	220	109	95	75	55	28*	0.9*
1977 - 1991	188	116	73	36*	48	18	-
1992 - 2002	172	88	62	51	37	18	0.3*
2003 - 2009	158	63	43	35	24	10	0.2*

*No data available: 1972-1976 at Omaha, 1982-1987 at Kansas City, 1970-2000, 2009 at Yankton
St Louis and Lower Mississippi, all 2009 data from USGS Data Series 593 (Heimann et all 2011)
Omaha and Yankton data from Corps Suspended Sediment Reports 1937-1974
Hermann, Kansas City, and St Joseph data 1948-1976 from Sediment Series 22 (USACE 1980)
Omaha data 1977-1999 from Sediment Series 39 (USACE 2001)
All remaining data from USGS Data Series 530 (Heimann et all 2010)

The introduction of sediment to the mainstem of the river, and associated nutrients, however, needs evaluation within the historical context of the Missouri River when discussing the potential increase in downstream nutrient delivery. The alluvial sediments, and associated nutrients, which are mobilized during SWH construction, are materials deposited from river transport that are in temporary storage in the flood plain. The sediment that would be excavated and placed in the river was once part of the active Missouri River bedload and the area it would be excavated from was once part of the Missouri River channel. Under natural conditions, these materials would have been transported through the system by natural geomorphic processes as the river would flood, rework, remove, and deposit these materials in a dynamic fashion, thus the sediment and phosphorus remobilized as a result of habitat restoration activities are not a net addition to the system (D. Soballe, USACE pers. communication). Given the relationship between phosphorus and sediment, it is likely that historically, there were elevated background concentrations of phosphorus in the Missouri river (prior to the BSNP and the construction of mainstem dams) as part of the natural ecosystem that supported native species (NRC 2011). A comparison of potential phosphorus loads from Corps SWH projects to phosphorus loads required to change the areal extent of the Gulf of Mexico hypoxic zone shows that these projects would not significantly change the extent of the hypoxic zone (NRC 2011). Upper bound estimates summarized by the National Research Council (using data supplied by Jacobson et al. 2009), show the maximum increase in total phosphorus delivery to the Gulf by Corps habitat restoration projects could be 6-12 percent, hypothetically, if a variety of conditions occurred as discussed in the following paragraph. Even at upper bound estimates, these rates on the basin and reach scale are small and temporary during the construction period and likely difficult to detect at the Gulf (D. Soballe, USACE, pers. communication).

While upper bound estimates are useful to understand maximum potential impacts to sediment transport and or nutrient loads, and maximum potential to influence the sediment deficit on the Missouri River, these estimates may overestimate the quantity of sediment that could actually enter the river and be available for downstream transport. Recent analysis by the Corps has shown that it is unlikely that actual SWH sedimentation rates have exceeded 10% of the amount

DRAFT

estimated by Jacobson et al 2009 (C. Bitner, USACE, pers. communication). For example, much of the strategy has been to create SWH through structure modifications, encouraging sediment deposition in the margins of the existing river channel. Some past construction projects have included placing some excavated sediment in areas that would not enter the Missouri River, such as along levees. Additionally, under most conditions, sediment settling and storage processes in the Missouri and Mississippi River channels will attenuate the load and spread delivery to the Gulf over a long period of time (NRC 2011). Assuming excavation rates could increase to the upper level projected by the Corps of 5 million cubic yards per year, and assuming that those projects on average increase in size up to 100% over a ten year period then stabilize, peak annual sediment inputs would approach 13.6 million tons per year (12.1 million metric tons per year), or approximately 1/3 of the Jacobson et al 2009 estimate (Bitner 2011 pers. communication). Subsequent analyses (Heimann et al. 2014) showed that from 1993-2012 the estimated mass of total phosphorus from chutes accounted for 1.9% of Missouri River and 0.5% of Mississippi River total phosphorus loads and the mass of nitrate, the constituent most closely related to gulf hypoxia, was 0,01% or less of the Missouri and Mississippi River nitrate loads. The authors also showed that sediment volumes from chutes, during 1993-2012, accounted for 3.1% and 1.5% of total suspended loads from the Missouri and Mississippi Rivers showing that the sediment introduces from chute SWH restoration is a small portion of the total nutrient and sediment transport in the two rivers (Heimann et al. 2014).

When evaluating impacts to the Gulf hypoxic zone it is also important to understand that addressing nutrients on the Missouri River alone would not solve the hypoxia problem in the Gulf (Zellmer 2011). Additionally, consistent with the January 2011 Federal Position, the Corps is currently working to create a database that will track actual contributions of sediment (and allow estimates of nutrient loads) to the Missouri River from both construction and natural development over time following periodic surveys after construction. Any information gained from this process would help inform future decisions and guide SWH restoration activities.

The Gulf Coast Ecosystem Restoration Task Force states “A comprehensive watershed-based approach to the management of river systems is required to ensure that current and future ecosystem needs are met. Giving ecosystem restoration equal footing with navigation and flood damage risk reduction is an important element of this strategy and should be applied to river management activities across multiple agencies” (Gulf of Mexico Regional Ecosystem Restoration Strategy 2011). Corps SWH projects attempt to address this issue. From a watershed perspective habitat restoration actions along the Missouri River are designed to return the natural form and function lost during the BSNP. Historically, wetlands and off channel habitats would have served as natural nutrient sinks and reduced nutrient delivery to the Missouri River. Corps mitigation projects attempt to emulate these historical features. As these sites mature over time, riparian buffers develop, shallow water develops and these habitat features may begin to serve as natural nutrient sinks, thus reducing nutrient delivery to the mainstem. For example, data collected by the Corps in 2010 showed that constructed backwater SWH sites have statistically lower total phosphorus concentrations relative to adjacent mainstem sites. Based on our analysis no adverse cumulative impacts to water quality were identified.

DRAFT

5.12 Probable Adverse Environmental Impacts Which Cannot Be Avoided

Adverse environmental effects which cannot be avoided include noise disturbance impacts to fish and wildlife resources and recreational users during construction, direct loss of wildlife resources as a result of construction, loss of riparian and wetland habitat that converted to SWH by construction, and aesthetic impacts resulting from the extensive construction area during and after construction.

5.13 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable resource commitments due to construction and operation of the Cora Island Project include the investment of some Federal funds, labor, energy, and construction materials used to plan, design, construct, and monitor the project. During project construction and subsequent natural chute development, sediment would be remobilized and become part of the active Missouri bedload.

5.14 Compliance with Environmental Quality Statutes

This Section contains a summary of the statutory and regulatory environmental compliance requirements and status of the major Federal and state permits and clearances required for the approval and implementation process for the Cora Island Project.

Bald and Golden Eagle Protection Act of 1940, as amended: This order directs anyone under the jurisdiction of the United States, without permitted authority, to possess or harm any bald or golden eagle, alive or dead, or any part, nest, or egg thereof. Implementation of the project would avoid, to the extent possible, long- and short-term adverse impacts associated with bald or golden eagles. No active eagle nests are located on or within the vicinity of the project area of Cora Island.

Clean Air Act, as amended: No aspect of Alternative 3, either short- or long- term, was identified that would result in violations to air quality standards. The environment will not be exposed to contaminants in the quantities and durations required to be injurious to human, plant, or animal life, or property, or which unreasonably interferes with the comfortable enjoyment of life, or property, or the conduct of business.

Clean Water Act (Sections 404, 401 and 402) as amended: The Corps has made a preliminary determination that the project is in full compliance with the Clean Water Act Section 404(b) (1) Guidelines. The preliminary Section 404(b) (1) Evaluation is included as Appendix G of this report. The Corps believes that the information contained in this report would demonstrate that the proposed project is in compliance with the State of Missouri's Section 401 Water Quality Certification. Prior to project approval, the Corps would review comments from the Public Notice then request Section 401 Water Quality Certification from MDNR. Section 401 Water Quality Certification or a waiver is required for project approval. In addition, prior to project construction the Corps would ensure that the construction contractor secures a Section 402 NPDES Permit from MDNR.

DRAFT

Endangered Species Act of 1973, as amended: As previously discussed, the proposed project would not impact any species listed or proposed for listing under this Act.

Fish and Wildlife Coordination Act: This project was coordinated with the USFWS. Project plans were closely coordinated with the ACT, which includes MDC, to ensure that all natural resource concerns associated with the project are and continue to be taken into account. The Corps would continue to coordinate with USFWS and the ACT through project construction and any operation and maintenance action. This report was circulated to these Federal and state resource agencies for their review and comment.

Floodplain Management (Executive Order 11988): Implementation of Alternative 3 would avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of the base floodplain. It also would avoid direct and indirect support of development or growth (construction of structure and/or facilities, habitable or otherwise) in the base floodplain.

National Environmental Policy Act of 1969, as amended: The compilation, public review, and responses to public comment of this PIR with integrated Environmental Assessment fulfill compliance with NEPA.

National Historic Preservation Act of 1966: This undertaking is in full compliance with the National Historic Preservation Act of 1966, as amended and it's implementing regulations, 36 CFR Part 800.

Protection of Wetlands (Executive Order 11990): Alternative 3 would result in the loss of approximately 43 acres of wetland at completion of construction. These areas would be converted to SWH. Benefits to the aquatic ecosystem of restoring SWH and the dynamic natural river processes, which increase floodplain connectivity across the entire site, greatly offset any minor long-term impacts.

Environmental Justice (Executive Order 12898): This order directs Federal agencies to incorporate environmental justice in their decision making process. Federal agencies are directed to identify and address, as appropriate, any adverse environmental inequities resulting from their programs, policies, and activities on minority or low income populations. Within the intent and spirit of Executive Order 12898, no minority or low income populations would be negatively impacted or displaced by any Corps action under any of the alternatives considered in this PIR.

The project is in full compliance with statutory and regulatory environmental compliance requirements and is currently contingent upon finalization of this NEPA/Section 404 CWA review and issuance by MDNR of authorization under Section 401 and 402 of the Clean Water Act.

5.15 Short-Term Versus Long-Term Productivity

Construction activities would likely temporarily disrupt fish, wildlife and human use of the immediate project area. The long-term health and productivity of the fish and wildlife resources

DRAFT

in the project area are anticipated to benefit greatly from the proposed project. Short-term human use impacts would be greatly offset by the long-term benefits to the pallid sturgeon.

5.16 Relationship of the Proposed Projects to Other Planning Efforts

The proposed project is not in conflict with any other planning efforts currently covering the project area. The proposed project is consistent with current planning efforts of the USFWS Big Muddy National Fish and Wildlife Refuge.

Chapter 6 – Other Considerations

6.1 Introduction

Alternative 3 (Recommended Plan) for the Cora Island includes various activities, previously described, to develop endangered species habitat. This section describes the adaptive management for SWH, operations and maintenance plan, real estate considerations, implementation responsibilities, views, cost estimates, schedules, and conclusions and recommendations for Cora Island.

6.2 Adaptive Management Strategy for Restoration of SWH

For nearly 20 years, the Corps has constructed SWH on the Missouri River. Projects include chutes, backwaters, and modifications to the structures which comprise the BSNP. As such, SWH restoration aims to aid in the recovery of pallid sturgeon.

Because uncertainties exist regarding the effectiveness of SWH construction efforts at restoring quality habitats and in turn benefitting pallid sturgeon, an adaptive approach is necessary to ensure that learning from past management actions guides future direction. In 2010, as part of this adaptive process, the USACE took a "step back" from routine monitoring efforts to evaluate the current approach, to consider recent guidance such as the MRRP Adaptive Management Framework and clarified SWH definition provided by USFWS, and to consider recommendations provided by the Aquatic Habitat Working Group (a team tasked by the USACE and USFWS to develop SWH performance metrics).

This "step back" led to the creation of a seventeen-member, multi-agency team comprised of staff from the USACE, USFWS, US Geological Survey, Environmental Protection Agency, Missouri Department of Conservation, Iowa Department of Natural Resources, and Nebraska Game and Parks Commission to develop an Adaptive Management Strategy for Shallow Water Habitat restoration. This collaborative effort would ensure that monitoring efforts are tied to objectives and that learning from management actions can guide future decisions.

The Adaptive Management Strategy for Restoration of SWH is included as Appendix H. Section 4 Monitoring and Assessment outlines the procedures for evaluating SWH, including chutes and backwaters. Section 6.1.4 Site Adjustments provides a decision matrix for site specific adjustments to SWH projects intended to develop over time that is applicable to Cora Island. An important aspect of this matrix is that it compares trends in physical habitat complexity with trends in biological response to determine if change is warranted. Section 3.2 Potential

DRAFT

Adjustments outlines potential adjustments, along with potential estimated costs, that the Corps may take to alter previously constructed SWH sites to ensure that they better achieve the stated objectives.

6.3 Operations and Maintenance Plan

The USFWS, using NWK provided funding, would continue to operate and maintain Cora Island as part of the Big Muddy National Fish and Wildlife Refuge. The Corps would have sole responsibility for operation and maintenance of the Cora Island chutes. Funding for O&M of habitat restoration and the river structures that are part of the SWH restoration project are borne by the Corps. The Corps would create a separate O&M manual for the Cora Island SWH Restoration Project. BSNP modifications and recommendations would be included in this O&M manual.

Need for O&M activities is determined based on annual river inspections, special inspections after major flood events, or in response to reports/requests from the public or government entities. Typical operation and maintenance activities include ensuring that structures constructed as part of the project are consistent with original design criteria and that any damages from flooding which adversely impact operation are repaired. Major design changes and modifications based on recommendations from site monitoring typically fall outside basic O&M, but would be included in future revisions to the O&M Manual. O&M typically involves replacement of lost/displaced rock and minor structure modifications. Estimated costs associated with O&M of the Cora Island Habitat Restoration Project including the chute is estimated at approximately $64,000 per year. No substantial differences in anticipated O&M cost were identified between the two construction alternatives.

6.4 Real Estate Considerations

Cora Island is 1,342 acres and is owned by the Corps. The Corps purchased the land from willing private sellers in 2008. The USFWS currently manages all lands on the site as part of the Big Muddy National Fish and Wildlife Refuge and would continue to do so upon completion of the project. Management of the chute and shallow water areas would fall under the responsibility of the Corps in coordination with USFWS.

6.5 Implementation Responsibilities

The Corps is responsible for study management and coordination with USFWS, MDC, and other impacted/interested agencies. The Corps would prepare and submit the subject PIR and complete all environmental review and coordination requirements. The Corps would also prepare the design plans and specifications, prepare and implement a SWH Adaptive Management Plan and Monitoring and Evaluation Plan, advertise and award a construction contract, perform construction contract supervision and administration, develop an O&M Manual, and ensure O&M is carried out in accordance with the O&M Manual. The Corps would maintain all aquatic and SWH related project features. In the event of flood damages to the project, the Corps would evaluate and complete the work necessary to reestablish project features. The USFWS is responsible for management of the terrestrial portions of Cora Island and they would manage it as a Unit of the Big Muddy National Fish and Wildlife Refuge.

DRAFT

6.6 Cost Estimate

The total estimated cost of the Cora Island Project includes: design, construction, and construction management. See Table N below for a Cora Island cost estimate.

Table N: Cost estimate for the Recommended Plan.

Activity	Cost
Design	$597,412
Construction	$11,714,958
Construction Mgt.	$165,000
Total	$12,477,370

The Cora Island Project is federally funded in its entirety. If Federal funds are not available to accomplish general operations, management and maintenance at the site, then deferment or cancellation of the work would occur. The annual O&M costs are estimated at $64,000. The cost estimate would be updated throughout the life of the project as project features are further defined.

6.7 Schedule

Table O: Project milestones.

Milestones	Schedule
PIR Initiated	OCT 2011
PIR Approved	APR 2014
Plans Initiated	OCT 2011
Plans Approved	JUL 2014
Construction Start	OCT 2014
Construction Complete	OCT 2015

6.8 Conclusions and Recommendations

Following an evaluation of environmental consequences and determination of project cost, Alternative 3 has been identified as the Recommended Plan. It is expected that SWH would develop sooner when compared to Alternative 2. It would also result in less soil being stockpiled on the floodplain which would result in a minor impact to floodplain connectivity. All other impacts between Alternatives 2 and 3 would be similar. The "No-Action" Alternative would not meet the project objectives.

Implementation of Alternative 3 would restore shallow water habitat, improve floodplain connectivity, and benefit the riparian corridor. Construction and operation of the Cora Island Project would not create water quality conditions that would adversely impact native aquatic life or other uses of the river. It would not result in any adverse affects to threatened or endangered species. It would benefit the endangered pallid sturgeon. No cultural or historical resources would be negatively impacted. Impacts to farmed wetlands would be offset onsite as part of the project. Alternative 3 represents the least costly, technically feasible, and environmentally

DRAFT

acceptable alternative. It would not result in any significant adverse impacts to the human environment. For these reasons, Alternative 3 is identified as the Recommended Plan.

6.9 List of Preparers

- Mr. Neil Bass, Biologist, Environmental Resources Section, USACE Kansas City District
- Mrs. Tracy Brown, Geographer, River Engineering and Restoration Section, USACE Kansas City District
- Mr. Todd Gemeinhardt, Limnologist, Environmental Resources Section, USACE Kansas City District
- Mr. Charlie Hanneken, Biologist, Environmental Resources Section, USACE St. Louis District
- Ms. Heather Hill, P.E, Hydraulic Engineer, River Engineering and Restoration Section, USACE Kansas City District
- Mr. Tim Meade, Archaeologist, Environmental Resources Section, USACE Kansas City District
- Mr. Whitney K. Wolf, P.E., Project Manager, Civil Works Program- Kansas City, Project Management Section, USACE Kansas City District
- Mr. Brandon Schneider, Biologist, Environmental Resources Section, USACE St. Louis District
- Mr. Jesse Granet, Environmental Resources Specialist, Environmental Resources Section, USACE Kansas City District.
- Mr. Zachary White, P.E., Project Manager, Missouri River Recovery Program Implementation Manager – Kansas City, Project Management Section, USACE Kansas City District

DRAFT

Literature Cited

Blevins, D.W., 2006. The response of suspended sediment, turbidity, and velocity to historical alterations of the Missouri River: U.S. Geological Survey Circular 1301, 8 p.

Dickerson, K.D., Medley, K.A., Havel, J.A. 2009. Spatial variation in zooplankton community structure is related to hydrologic flow units in the Missouri River, USA. River Research and Applications 26: 605-618.

Dyer, R.L. 1997. Boone's Lick Heritage Volume 5, No. 2: A Brief History Of Steamboating On The Missouri River With An Emphasis On The Boonslick Region.

Gosch, N.J.C., D.M. Morris, T.R. Gemeinhardt, and J.L. Bonneau. 2013. Pre- and Post-Construction Assessment of Nutrient Concentrations at Shallow Water Habitat Restoration Sites on the Lower Missouri River. Journal of Water Resource and Protection 5: 249-258.

Gulf of Mexico Regional Ecosystem Restoration Strategy. 2011. http://www.epa.gov/gulfcoasttaskforce/pdfs/GulfCoastReport_Full_12-04_508- 1.pdf

Hajic, E., Benn, D.W., Anderson, J., Bettis III, E. A., and Lee, D. 2006. Landform sediment assemblage maps for the Mississippi Valley River Miles 125-260 within the St. Louis District. (Contract No. DACW25-03-D-0001 Work Order No. 0009, BCA #1281). Cresco, Iowa.

Havel, J.E., Medley, K.A., Dickerson, K.D., Angradi, T.R., Bolgrien, D.W., Bukaveckas, P.A., Jicha, T.M. 2009. Effect of main-stem dams on zooplankton communities of the Missouri River (USA). Hydrobiologia 628:121-135.

Heimann, D.C., Morris, D.M., Gemeinhardt T.R. 2014. Nutrient contributions from alluvial soils associated with the restoration of shallow-water habitat in the lower Missouri River. *The Journal of Environmental Quality.*

Heitmeyer, M.E. 2008b. An Evaluation of Ecosystem Restoration Options for the Middle Mississippi River Regional Corridor. Greenbriar Wetland Services Report 08-02 for U.S. Army Corps of Engineers St. Louis District, Greenbriar Wetland Services, Advance, Missouri. 82pp.

Jacobson, R.B., Blevins, D.W., and Bitner, C.J. 2009. Sediment regime constraints on river restoration—An example from the Lower Missouri River, in James, L.A., Rathburn, S.L., and Whittecar, G.R., eds., Management and Restoration of Fluvial Systems with Broad Historical Changes and Human Impacts: Geological Society of America Special Paper 451, p. 1–22, doi: 10.1130/2009.2451(01).

Johnson, T.R. 2000. The Amphibians and Reptiles of Missouri. Missouri Department of

DRAFT

Conservation, 2nd Revised and Enlarged edition.

National Agricultural Statistics Service (NASS). 2009. 2007 Census of Agriculture: Missouri State and County Data. U.S. Department of Agriculture (USDA).

National Research Council. 2011. Missouri River Planning: Recognizing and Incorporating Sediment Management. Washington, D.C. National Academies Press.

---------- 2002. *The Missouri River ecosystem: exploring the prospects* of *recovery.* National Academy Press, Washington, D.C.

Pflieger, W.L 1997. The Fishes of Missouri, Revised Edition, Missouri Department of Conservation.

Pflieger, W.L., and Grace, T.B., 1987. Changes in the fish fauna of the lower Missouri River, 1940-1983, in Matthews, W.J., and Heins, D.C., eds., Community and evolutionary ecology of North American Stream Fishes: Norman, University of Oklahoma Press, p 166-177.

Throgmartin, W.E., Gallagher, M., Young, N., Rohweder, J.J., Durbian, F., and Knutson, M.G. 2009. Avian assemblages in the Lower Missouri River Floodplain. Wetlands 29: (2), 552-562.

Tidball, Ronald R. 1984. Geochemical Survey of Missouri. USGS Professional Paper, 954H.

USACE. 2011. Final Environmental Impact Statement. The Missouri River Commercial Dredging Final Environmental Impact Statement. Kansas City District, Kansas City, Missouri.

---------2010. *Missouri River Shallow Water Habitat Accounting Report - 2010*. Kansas City and Omaha District.

---------2009. *Missouri River Fish and Wildlife Mitigation Program Fish Community Monitoring and Habitat Assessment of Off-channel Mitigation Sites.* Kansas City District.

---------2006. *Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Program: Jameson Island Unit*. Kansas City District.

---------2003. *Missouri River Fish and Wildlife Mitigation Project, Final Supplemental Environmental Impact Statement.* Kansas City and Omaha Districts.

----------2001. *Main Report Revised Draft Environmental Impact Statement. Volume 1:*

DRAFT

Missouri River Master Water Control Manual Review and Update Study. Northwestern Division, Omaha, Nebraska

---------- 2000. *RCC Technical Report 2000-A, Missouri River Main Stem Reservoirs: Releases Needed to Support Navigation.* USACE NWD Missouri River Reservoir Control Center, Omaha, NE.

----------1995. *Floodplain Management Assessment of the Upper Mississippi River, Lower Missouri River, and major tributaries. Appendix C: Environmental Resource Inventory.* St. Paul District, St. Paul, Minnesota.

----------1994. *Missouri River Master Water Control Manual Review and Update, Volume 3A: Low Flow Studies, Gavins Point Dam to St. Louis, Missouri*. Missouri River Division.

----------1990. *Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project Reaffirmation Report.* Missouri River Division, Omaha, Nebraska.

----------1981. *Missouri River Fish and Wildlife Mitigation Iowa, Nebraska, Kansas, and Missouri Final Feasibility Report and Final Environmental Impact Statement.* Missouri River Division, Omaha District, Omaha, Nebraska.

USEPA and USACE. 1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Test Manual: Inland Testing Manual. EPA-823-B-98-004, February 1998. U.S. Environmental Protection Agency, Office of Water. Department of Army, U.S. Army Corps of Engineers. Washington, D.C.

USFWS. 2003. Amendment to the 2000 Biological Opinion on the operation and maintenance of the Missouri River Main Stem Reservoir System, operation and maintenance of the Missouri River Bank Stabilization and Navigation Project, and operation of the Kansas River Reservoir System.

----------2000. Biological Opinion on the operation and maintenance of the Missouri River Main Stem Reservoir System, operation and maintenance of the Missouri River Bank Stabilization and Navigation Project, and operation of the Kansas River Reservoir System.

USGS Open-File Report 2007-1080 - Streamflow and Nutrient Fluxes of the Mississippi-Atchafalaya River Basin and Subbasins for the Period of Record Through 2005.

Woodward, B.K., and Rus, D. L., 2011 Characteristics of suspended and streambed Sediment within constructed chutes and the main channel at Upper Hamburg and Glovers Point Bends, Missouri River, Nebraska, 2008: U.S. Geological Survey Open-File Report 2011-1049, 29 p.

DRAFT

Zellmer, S. 2011. Mudslinging on the Missouri and Mississippi Rivers. 29th Annual Water Law Conference. SanDiego, CA. Febuary 23-25, 2011.

DRAFT

APPENDIX A

Public and Agency Scoping

CENWK-PM-PR March 24, 2010

MEMORANDUM FOR RECORD

SUBJECT: Missouri River Mitigation Program - Cora Island Public Meeting on March 12, 2010 meeting notes and comments, Great Rivers Museum Alton, Illinois.

1. The public meeting was held at the Mel Price Lock and Dam Great Rivers Museum on the Mississippi River Alton, Illinois. The meeting started at 600 PM and ended at 800 PM. There were 12 people in attendance. This included 5 representatives from the Corps of Engineers, 3 adjacent landowners, 1 from the US Fish and Wildlife Service, 1 from the Missouri Dept of Conservation, 1 from the Missouri Dept of Natural Resources (MDNR), and 1 representative from Trailnet.

2. One adjacent landowner provided a more accurate contact list for people in their subdivision. They also expressed their desire to see us complete our restoration of the site.

3. Two other landowners expressed their interest in seeing the historic chute being opened up in some form as presented in one of our mapped alternatives.

4. Robert Stout, the MDNR policy representative at the meeting, asked what we planned to do with the spoil at the site if excavation occurred and if we planned on doing an EIS on the project. I explained that if allowed to do so we would use direct disposal into the river of the spoil or otherwise we would do on site stockpiles. Dave explained that the 2003 SEIS covered our activities and that we were doing an EA for the project.

M. Neil Bass
Environmental Resource Specialist

Cora Island Public Scoping Meeting 6/23/09

Attendees:
Melvin Neustadt Jr. (Landowner)
Tony Wolf (MS Valley Duck Hunters Assn)
Mike Farley (Landowner)
Jeanne Deikmann (sp?) (Landowner)
Donna Farley (Landowner)
Meredith Farley (Landowner)
Scott Wilson (Delta Waterfowl)
Jason Farley (Landowner)
Nancy Kuhs (Landowner, across river on bluff)
John Skelton (NWK)
David Hoover (NWK)
Neil Bass (NWK)
Tom Bell (USFWS)
Tom Lange (NWK/MDNR)
Charlie Hanneken (MVS)
Greg Howze (Landowner, across river on bluff)

Neil Bass – Explained the MO River Mitigation Program.

Donna Farley – Can Ag be incorporated into Corps Mitigation Sites?

Neil Bass – It is possible, but there are a variety of factors that influence its presence. Was ag previously on the site, how does the managing agency operate the site, etc.

Mike Farley – Does the FWS have any other sites on the MO river?

Tom Bell – 9 sites, some only accessible by boat. Lands are open to hunting, hiking, foraging. At Cora, envision a need for a drawing to hunt. Also a landing on the river and possibly stairs up the levee.

Donna Farley – Are you removing the levee?

Neil Bass – That is a very good possibility. Nothing has been decided yet and the meetings are being held to see what everyone would like to see on the site before investigations into possible alternatives are made.

Jason Farley – Expressed concern about proliferation of noxious weeds if ag is stoped all at once on the site and plants are allowed to grow up.

Tom Bell – Agrees with Jason Farley. FWS have 3 employees devoted to noxious weed control. It is also a good reason to continue farming the site for the time being and phase in restoration efforts.

Neil Bass – Agreed. Ag should probably be phased out incrementally.

Nancy Kuhs – will there be any buildings left on the site or new buildings.

Tom Bell/Neil Bass – Old buildings will be removed. A storage shed is a possibility on the island.

Melvin Neustadt – Cover crops don't work because of flooding. Flooding also will kill bottomland hardwoods. 85% of the oaks at Confluence have been killed and this is a waster of taxpayer money.
Deer are a problem in the area and this site will only make it worse.
It is great to invite local landowners, but we don't ever use their input and to take into account locals interests.
Discussing article in the Post Dispatch: Ralph Rollins claimed the site will provide flood storage. Melvin Neustadt disagrees. Island has only been flooded once and that was in 93. Article says acquisition of public land in the area is absolutely critical. Melvin disagrees with this as well. There is no mention of problems that it will create for local landowners such as traffic, trespassing, and vandalism. They have seen it increase as other public lands in the area have been acquired. Article says that Cora Island has been managed well for many years, but he disagrees. It has not been farmed for 2 years and it is now full of noxious weeds.

Neil Bass – Agreed with Melvin Neustadt on the flood storage. 1400 acres looks like a lot, but isn't in the grand scheme of things. The site was not purchased for flood control. Ralph Rollins misspoke. If you factor in other districts along the river it could help some.

Melvin Neustadt - Agreed.

Melvin Neustadt – How is this project going to help locals? What is the proper definition of management? Wildlife currently eats his crops and he is concerned about even more because of the project. Really wants to see some ag on the site to help alleviate this, like a 100 acre food plot. Do not plant hardwoods. They will not grow because the site is too wet and flood prone.

Neil Bass - Agency definition of management probably differs from locals. Locals management is something more intensive. Agency management could be letting plants naturally regenerate on the site.

Jason Farley – Concerned about hunters trespassing on property. It is already occurring and the project will increase it.

Tom Bell – FWS posts more signs than are required. Have an officer that patrols. Try to cooperate with locals as best as possible.

Melvin Neustadt – People will go around on their land and trespass still. The officer can not be there 24 hours a day. Need a food plot on the site to keep deer there.

Jason Farley – DNR has expressed in the past that they will not confront hunters illegally on park land unless they are damaging property.

Tom – Hunting will be allowed on the site. There will probably be several hunts and a draw system for them.

Melvin - Cora Island has the best game species in the area.

Neil – Managing agency is primarily responsible for determining the sites activities.

Scott Wilson- How much ag leasing is occurring on the Big Muddy Refuge?

Tom Bell – Most land was acquired after 93. Much of the land was not farmable anymore and a lot had trees on it. Garlic Mustard and Japanese Hops are the primary noxious weeds the have to deal with on their lands. Remaining lands were a mix of land types including ag. Removes about 20 acres a year out of ag eventually phasing it out. 250 acres left. It is hard to get farmers to work where there is no levee protection. 1/3 crop share is typical on refuge lands. Often return some land temporarily to ag in order to restore the wetlands productivity.

Meredith Farley – Would a demonstration farm be possible on the site?

Neil Bass – Probably not because that could be interpreted as a recreation feature which the Corps is not authorized to pay for. Depending on management agency rules it may be possible for that agency to do so.

Melvin Neustadt – Since NWK owns Confluence Point, can they make recommendations to MDNR. Would really like to see a food plot and this would go a long way in easing some of his deer concerns. Also want hunting at Confluence Point. Also need control of noxious weeds and hunting on Riverlands property.

Neil Bass – We can and have recommended certain actions on the site. MDNR, like all agencies, has different mandates. They cannot have agricultural on the site and they need to show that deer are causing severe damage to the park. Probably need to contact Congressional persons to get these changed.

Melvin Neustadt – It is their project bringing in the deer that causes the damage. Have tried several times sitting down with DNR heads in Jeff City and contacting congressional reps. DNR heads to change anything and the reps haven't responded.

Tony Wolf – Represents a grass roots conservation group of 150 public hunters (MS Valley Duck Hunters Assn). Want hunting on the site. Columbia Bottoms is a good example of what they want to see on the site. Adamantly opposed to MDNR managing the site. They don't want it part of the park system.

Nancy Kuhs – Lives on bluff across the river. Concerned about stray bullets from high powered rifles damaging her house or others. Has had damage in the past. Need restrictions on weapons allowed for hunting on the property. Bow hunting is definitely ok.

Tony Wolf – Prohibiting hunting with certain weapons on other sites has been successful.

Tom Bell – Restrictions can be placed on types of hunting permitted.

All landowners present - Would like to see the slough reopened. This would help drainage on the neighboring levee districts.

Tom Bell/Neil Bass – that can definitely be looked at.

Melvin Neustadt – Plans must pay attention to the people that live here and take in their considerations.

Neil Bass – Would definitely try to make everyone as happy as possible. Corps champions adaptive management. If something isn't working, it should be able to be changed.

Tony Wolf – will a public meeting be held about the site again in the future?

Neil Bass – Most likely.

Scott Wilson – Delta Waterfowl also fully supports FWS managing the property and wants hunting allowed.

END OF MEETING

Cora Island Notes 6/24/09

Particpants:
Charlie Hanneken (MVS)
Neil Bass (NWK)
David Hoover (NWK)
John Skelton (NWK)
Tom Lange (NWK)
Tom Bell (FWS)
Ken McCarty (MDNR)
Todd Strole (TNC)
Tom Leifield (MDC)

Notes:
Project has to meet the goals of the partnering agencies and programs.

NWK wants to see the chute opened. MDNR mentioned that this would impact some potential high quality forested habitat and that needs to be taken into consideration when planning.

FWS would like to sit down with the partners, regulatory, Ameristar to dicsuss the neighboring mitigation site. Perhaps a mitigation bank could be developed. The bank would have to be developed before FWS can acuire the property. They are not allowed create a bank.

Need to see if the lidar and soils data cover the entire chute.

Look at unrooting some dikes.

MDNR would like consideration for trails on the site.

FWS would like to better the parking situation and perhaps create a landing. The parking should be one of the first issues addressed.

MDNR suggested looking at Pelican Island data and compare with Cora.

MDC mentioned exotics have been a real problem at Columbia Bottoms.

MDNR would like consideration for areas with *Boltonia decurrens*.

FWS said staff for the sight might be looked in Audobon's future Riverlands site.

TNC mentioned an ecosystem services study that is being done and the possibility of incorporating Cora. Might include small portion of biomass production at site if practical. FWS mentioned several other sites that they would be willing to incorporate that might work even better.

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
ROBERT A. YOUNG BUILDING - 1222 SPRUCE ST.
ST. LOUIS, MISSOURI 63103-2833

REPLY TO
ATTENTION OF

http://www.mvs.usace.army.mil

CEMVS-PD-E 6 June 2010

Charles D. Hanneken
Environmental Analysis Branch - Ecologist
(314) 331-8450
charles.d.hanneken@usace.army.mil

Jane Ledwin
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
101 Park DeVille Drive
Columbia, Missouri 65203

RE: Missouri River Mitigation Site – Cora Island

Dear Ms. Ledwin,

The Kansas City District Corps of Engineers is proposing to perform an ecosystem restoration project at Cora Island as part of the Missouri River Fish and Wildlife Mitigation Program. This program was authorized by the Water Resources Development Acts of 1986 and 1999 to develop fish and wildlife habitat along the lower Missouri River from Sioux City, Iowa to the mouth near St. Louis, Missouri in order to mitigate for the loss of habitat that resulted from construction, operation, and maintenance of the Missouri River Bank Stabilization and Navigation Project. The overall program is managed by the Kansas City District Corps of Engineers. The environmental planning of the project is being managed by the St. Louis District.

The Corps wishes to undertake actions to promote wildlife habitat at Cora Island in a manner consistent with the goals of the Missouri River Mitigation Program. The U.S. Fish and Wildlife Service (USFWS) is the primary partner for this project. As part of the documentation process a draft Project Implementation Report with an integrated Environmental Assessment (EA) is being prepared. This document will be made available for public review and comment upon completion.

As part of the EA, we are addressing issues related to wildlife and habitat. At the earliest convenience, we are requesting that the Fish and Wildlife Service provide us with the federal list of threatened and endangered species for the project area. In addition, please provide any additional pertinent information or comments that you would like considered in the EA. We will include this documentation with the Draft EA that we are preparing. We have provided a fact sheet that synopsizes the type of options for restoring the Cora Island Site currently being examined. Two maps are included within the fact sheet that show current conditions at the site as well as the types of features being looked at.

Thank you very much for your assistance in this matter. Please do not hesitate to contact me with any question or comments.

Sincerely,

Charles Hanneken

From:	Jane_Ledwin@fws.gov
To:	Hanneken, Charles D MVS
Cc:	Tom_Bell@fws.gov
Subject:	Fw: FWS comment on Cora Island Ecosystem Restoration Project, St. Charles County, MO
Date:	Friday, July 20, 2012 3:07:38 PM

Charlie -

Per your request. Surpised I found it. This species list is still current.

Please let me know if you have any additional questions.

Regards -

Jane Ledwin

Inactive hide details for Jane Ledwin/R3/FWS/DOIJane Ledwin/R3/FWS/DOI

Jane Ledwin/R3/FWS/DOI

07/26/2010 09:44 AM

To

charles D. Hanneken@usace.army.mil

cc

Tom Bell/R3/FWS/DOI@FWS

Subject

FWS comment on Cora Island Ecosystem Restoration Project, St. Charles County, MO

Dear Mr. Hanneken:

In an effort to streamline correspondence, I'm providing this email in lieu of a letter as a response to the Army Corps of Engineers (Corps) June 6, 2010, letter, requesting U.S. Fish and Wildlife Service (Service) input regarding information on fish, wildlife, and federally listed species in the area of the proposed Cora Island Ecosystem Restoration Project, RM 3.0 to 7.0, St. Charles County, Missouri, as part of the Missouri River Recovery Program. The Service submits these comments pursuant to the Fish and Wildlife Coordination Act and the Endangered Species Act of 1973, as amended. .

Fish and Wildlife Comments

The Service believes the Cora Island tract offers great opportunity to restore several riverine habitats that were far more abundant historically along the lower Missouri River. With the combination of mature forested floodplains, secondary channels, and a riverine island, this tract will be a valuable addition to the other conservation lands at the Confluence. One of the top priorities for this site should be options to restore high quality aquatic habitats that were lost during channelization. One example would be restoration of the side channel that stretches along the north side of the island. Increasing the connectivity of the island with the river would also restore riverine processes that are currently limited by the levees on Cora Island. The Service looks forward to working with the Corps as we and our conservation partners refine and implement restoration actions on this significant piece of the Missouri River.

Bald eagles use both the Mississippi and Missouri Rivers and adjacent floodplains to nest, feed and roost. In fact, there is at least one nesting territory nearby at Confluence State Park. The bald eagle (Haliaeetus leucocephalus) has been removed from the Endangered Species list; however, protections remain in place under the Bald and Golden Eagle Protection and Migratory Bird Treaty Acts. Therefore, we recommend you survey the project site for bald eagles which have become increasingly common along the river. The period January 1 to March 1 is important for initiating nesting activity; March 1 to May 15 is the most critical time for incubation and rearing of young. If any eagle nests occur in or near the project area, please refer to the National Bald Eagle Management Guidelines at: http://www.fws.gov/migratorybirds/issues/BaldEagle/Mgmt.Guidelines.2006.pdf for recommendations to avoid effects to eagles.

Endangered Species Comments

Three federally listed species may occur in the project area:

Indiana bat (Myotis sodalis), Endangered – From late fall through winter Indiana bats in Missouri hibernate in caves in the Ozarks and Ozark Border Natural Divisions. During the spring and summer, Indiana bats utilize living, injured (e.g. split trunks and broken limbs from lightening strikes or wind), dead or dying trees for roosting throughout the state. Indiana bat roost trees tend to be greater than 9 inches diameter at breast height (dbh) (optimally greater than 20 inches dbh) with loose or exfoliating bark. Most important are structural characteristics that provide adequate space for bats to roost. Preferred roost sites are located in forest openings, at the forest edge, or where the overstory canopy allows some sunlight exposure to the roost tree, which is usually within 1 km (0.6 mi.) of water. Indiana bats forage for flying insects (particularly moths) in and around the tree canopy of floodplain, riparian, and upland forests. If trees suitable for use by Indiana bats are to be removed for the proposed project, the Service recommends a survey be conducted by a qualified biologist to determine the presence or absence of Indiana bats and avoid the potential injury or death to roosting individuals and maternity colonies. Survey efforts should include using a combination of mist nets and bat detection devices [e.g., "Anabat" (© Titley Electronics, Ballina, New South Wales, Australia)]. If it is determined that a survey for Indiana bats is needed, please contact the Missouri Ecological Services Field Office to obtain specific information regarding survey protocol. If surveys indicate that Indiana bats are using trees proposed to be removed during their breeding season (April 1 to September 30) further consultation with the Service under section 7 of the Act will be required.

Pallid Sturgeon (Scaphirhynchus albus), Endangered - The pallid sturgeon is found primarily in the Missouri River and the Mississippi River downstream of its, confluence with the Missouri River. Limited data is available concerning preferred habitats in the Missouri, but adults of the species have been captured across many river habitats, including tributary mouths, sandbars, along main channel borders, deep holes (winter) and along revetments. Small sturgeon have been captured in areas with shoals, island tips, and secondary channels.

Decurrent False Aster (Boltonia decurrens), Threatened - The Decurrent false aster is a big river floodplain species that grows in wetlands and along the borders of marshes, lakes, oxbows, roadsides, agricultural fields and levees. It favors sites with moist soil and regular disturbance, (preferably periodic flooding) which maintains open areas allowing sunlight to reach seedlings. It is a perennial plant that blooms from August to October. Seed dispersal is primarily through flooding. Although it once occurred in almost contiguous populations in a 400 km band between LaSalle, IL and St. Louis along the Illinois and Mississippi River floodplains, currently Boltonia is limited in Missouri to St. Charles and St. Louis counties,

Thank you for the opportunity to provide comments. Please keep us apprised as project planning continues. If you have any questions regarding our comments, please don't hesitate to contact me.

Best regards -

Jane Ledwin

****
Jane Ledwin
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
101 Park DeVille Drive
Columbia, Missouri 65203
Phone 573/234-2132, extension 109
email jane_ledwin@fws.gov <mailto:jane_ledwin@fws.gov>
****

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
ROBERT A. YOUNG BUILDING - 1222 SPRUCE ST.
ST. LOUIS, MISSOURI 63103-2833

REPLY TO
ATTENTION OF

http://www.mvs.usace.army.mil

CEMVS-PD-E 7 June 2010

Charles D. Hanneken
Environmental Analysis Branch - Ecologist
(314) 331-8450
charles.d.hanneken@usace.army.mil

Doyle Brown
Missouri Department of Conservation
2901 W. Truman Boulevard
Jefferson City, Missouri 65109

RE: Missouri River Mitigation Site – Cora Island

Mr. Brown,

The Kansas City District Corps of Engineers is proposing to perform an ecosystem restoration project at Cora Island as part of the Missouri River Fish and Wildlife Mitigation Program. This program was authorized by the Water Resources Development Acts of 1986 and 1999 to develop fish and wildlife habitat along the lower Missouri River from Sioux City, Iowa to the mouth near St. Louis, Missouri in order to mitigate for the loss of habitat that resulted from construction, operation, and maintenance of the Missouri River Bank Stabilization and Navigation Project. The overall program is managed by the Kansas City District Corps of Engineers. The environmental planning portion of the project is being managed by the St. Louis District.

The Corps wishes to undertake actions to promote wildlife habitat at Cora Island in a manner consistent with the goals of the Missouri River Mitigation Program. The U.S. Fish and Wildlife Service (USFWS) is the primary partner for this project. As part of the documentation process a draft Project Implementation Report with an integrated Environmental Assessment (EA) is being prepared. This document will be made available for public review and comment upon completion.

As part of the EA, we are addressing issues related to wildlife and habitat. At your earliest convenience, we are requesting that you provide us with the state list of threatened and endangered species for the project area. In addition, please provide any additional pertinent information or comments that you would like considered in the EA. We will include this documentation with the Draft EA that we are preparing. We have provided a fact sheet that synopsizes the type of options for restoring the Cora Island Site currently being examined. Two maps are included within the fact sheet that show current conditions at the site as well as the types of features being looked at.

Thank you very much for your assistance in this matter. Please do not hesitate to contact me with any question or comments.

Sincerely,

Charles Hanneken

Missouri Department of Conservation
Heritage Review Report

Policy Coordination Unit
P. O. Box 180
Jefferson City, MO 65102
heritage.review@mdc.mo.gov
573-522-4115 X 3367

Mr. Charles D. Hanneken Charles.d.hanneken@usace.army.mil Environmental Analysis Branch-Ecologist Department of the Army St. Louis Corps of Engineers Robert A Young Building – 1222 Spruce St. Louis, MO 63103	***Project type:***	Ecosystem Restoration Project Missouri River Fish and Wildlife Mitigation Program
	Location/Scope:	Cora Island
	County:	St. Louis
	Query reference:	Missouri River Mitigation Site – Cora Island
	Query received:	June 10, 2010 Copy: Doyle Brown

6-16-10
Prepared by: Shannon Cave

This NATURAL HERITAGE REVIEW is not a site clearance letter. Rather, it identifies public lands and sensitive resources known to have been located close to and/or potentially affected by the proposed project. *On-site verification is the responsibility of the project. Heritage records were identified at some date and location. This report considers records near but not necessarily at the project site. Animals move and, over time, so do plant communities. To say "there is a record" does not mean the species/habitat is still there. To say that "there is no record" does not mean a protected species will not be encountered. These records only provide one reference and other information (e.g. wetland or soils maps, on-site inspections or surveys) should be considered. Look for additional information about the biological and habitat needs of records listed in order to avoid or minimize impacts. More information may be found at www.mdc.mo.gov/nathis/endangered/ and mdc4.mdc.mo.gov/applications/mofwis/mofwis_search1.aspx. Contact information for the department's Natural History Biologist is online at http://www.mdc.mo.gov/nathis/contacts/.*

Level 3 (federal-listed) and Level 2 (state listed) issues:
Records of listed species or critical habitats:

The Missouri River is home to a number of species of state and federal concern, including pallid sturgeon (*Scaphirhynchus albus*, federal/state endangered), lake sturgeon (*Acipenser fulvescens*, state endangered), and others. The river's banks and floodplain are places one might encounter gray bats (*Myotis grisescens*, federal & state endangered), Indiana bats (*Myotis sodalis,* federal & state endangered), bald eagles (*Haliaeetus leucocephalus*, state endangered) and others, although there are no specific records within a mile of Cora Island.

Decurrent false aster (*boltonia decurrens*, Federal-list threatened, State-list endangered) is known at several sites within three miles. It lives in moist soils subject to periodic flooding. This species may appear in previously undocumented locations as water-borne seeds are deposited during periods of high water. Ditch banks and flood-prone areas of agricultural fields can support populations of decurrent false aster when shading and competition from other species is minimal. See http://mdc.mo.gov/85 for best management recommendations.

Heritage records identify no designated wilderness areas or critical habitats, but the island is near Columbia Bottom Conservation Area, Pelican Island CA, Confluence State Park and the USACE-managed Riverlands mitigation site.

FEDERAL LIST species/habitats are protected under the Federal Endangered Species Act. ***Consult with*** *U.S. Fish and Wildlife Service, 101 Park Deville Drive Suite A, Columbia, Missouri 65203-0007; 573-234-2132*

Level 1 recommendations: <u>Unlisted</u> species/habitats tracked due to their rarity, but not listed as endangered or threatened or subject to special regulations.

The following records are known within three miles:

Species	Common name	State Rank	County		Location		Last noted
Asio flammeus	Short-eared Owl	S2	St Charles	Columbia Bottom	Land Grant	1765	1998
Bergia texana	Bergia	S2	St Louis	Columbia Bottom	Land Grant	329	1998
Haliaeetus leucocephalus	Bald Eagle	S3	St Louis	Wood River (IL)	Land Grant	10015	2007

State Rank codes: S1 (Critically imperiled); S2 (Imperiled) or S3 (Vulnerable). These are tracked due to their rarity and subject to general regulations in the Wildlife Code.

The state tracks many species not listed as endangered, but sufficiently rare or challenged that special efforts to conserve them may be important to their survival and to avoid future listing. We encourage conservation of them if encountered. The Missouri Wildlife Code protects all wildlife species and it includes no special regulatory requirements for these.

General recommendations related to this project or site, or based on information about the historic range of species (unrelated to any specific heritage records):

- Bald eagles (*Haliaeetus leucocephalus*) may nest near streams or water bodies in the project area. Nests are large and fairly easy to identify. While no longer listed as endangered, eagles continue to be protected by the federal government under the Bald and Golden Eagle Protection Act. Work managers should be alert for nesting areas within 1500 meters of project activities, and follow federal guidelines at http://www.fws.gov/migratorybirds/issues/BaldEagle/NationalBaldEagleManagementGuidelines.pdf if eagle nests are seen. See also MDC's best management recommendations at http://mdc.mo.gov/87.
- Pallid sturgeons (*scaphirhynchus albus*, federal and state listed as "endangered") are big river fish that range widely in the Mississippi and Missouri River system (including parts of major tributaries). Much is unknown about the habitat needs and range of the species, so any project that modifies big river habitat or impacts water quality should consider the possible impact to pallid sturgeon populations. See http://mdc.mo.gov/124 for best management recommendations.
- Streams in the area should be protected from soil erosion, water pollution and in-stream activities that modify or diminish aquatic habitats. Best management recommendations relating to streams and rivers may be found at http://mdc.mo.gov/79.
- Invasive exotic species are a significant issue for fish, wildlife and agriculture in Missouri. Seeds, eggs, and larvae may be moved to new sites on boats or construction equipment, so inspect and clean equipment thoroughly before moving between project sites.
  - Remove any mud, soil, trash, plants or animals from equipment before leaving any water body or work area.
  - Drain water from boats and machinery that has operated in water, checking motor cavities, live-well, bilge and transom wells, tracks, buckets, and any other water reservoirs.
  - When possible, wash and rinse equipment thoroughly with hard spray or HOT water (≧104° F, typically available at do-it-yourself carwash sites), and dry in the hot sun before using again.

These recommendations are ones project managers might prudently consider based on a general understanding of species needs and landscape conditions. Heritage records largely reflect only sites visited by specialists in the last 30 years. This means that many privately owned tracts could host unknown remnants of species once but no longer common.

Pre-screen heritage review requests at http://tinyurl.com/heritagereview. A "Level 1 response" will make further submission to MDC or USFWS unnecessary.

APPENDIX B

Shallow Water Habitat Position Statement

FEDERAL POSITION ON SEDIMENT MANAGEMENT
MISSOURI RIVER RECOVERY, SHALLOW WATER HABITAT CREATION
DOWNSTREAM OF GAVINS POINT DAM

10 JANUARY 2011
(SUPERSEDES THE 14 FEBRUARY 2008 POSITION)

The signatory federal agencies support creation of shallow water habitat (SWH) in furtherance of the requirements to mitigate habitat losses, as specified by the U.S. Fish and Wildlife Service Missouri River Biological Opinions[1], and in accordance with their respective statutory responsibilities. Federal agencies recognize the importance of receiving-water characteristics (i.e., the natural, chemical and physical condition of each specific waterbody and the associated water quality requirements of its resident aquatic life) in relation to the Clean Water Act. The National Academies[2] provided recommendations to the U.S. Army Corps of Engineers for improved sediment management and adaptive processes in association with the Missouri River Recovery Program, including SWH creation projects. In creating SWH, and specifically at sites where sediment contribution to the Missouri River is likely, the signatory agencies shall:

1) Continue to ensure decisions are formulated to enhance and protect native species, aquatic life, and designated beneficial uses. The Missouri River Biological Opinions raised awareness regarding the return of sediment to the Missouri River to support endangered native species. Creation of SWH is for the purpose of benefiting native species adversely affected by the loss of historical physical habitat, loss of natural riverine processes, and reduced alluvial sediment load. The U.S. Army Corps of Engineers has chosen SWH creation methods (dredging, side-cast, etc.) that favor restoration of natural processes to support endangered native species, with regard for pre-project site characterization through soil, water, and elutriate tests, while also maintaining all authorized purposes (e.g. the 1944 Flood Control Act) and compliance with the Clean Water Act.

2) Monitor representative SWH sites to answer key questions such as effects and or benefits of SWH creation on water quality and primary productivity. Recommendations from the National Academies, which stress the importance of learning over time, will be considered when developing monitoring plan(s) and adaptive processes for SWH creation.

3) Continue to implement project activities in compliance with all laws, for example the Clean Water Act (including permit compliance and Section 401 Certification), Fish and Wildlife Coordination Act, Endangered Species Act, National Environmental Policy Act, Water Resource Development Act, Flood Control Act, River and Harbor Act, Wild and Scenic Rivers Act, and Data Quality Act.

[1] U.S. Fish and Wildlife Service (USFWS). 2003. Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System.

[2] National Research Council (NRC). 2010. Pre-publication Copy. Missouri River Planning: Recognizing and Incorporating Sediment Management. Washington, D. C. National Academies Press.

FEDERAL POSITION ON SEDIMENT MANAGEMENT
MISSOURI RIVER RECOVERY, SHALLOW WATER HABITAT CREATION
DOWNSTREAM OF GAVINS POINT DAM

SIGNATORY AGENCIES

U.S. ARMY CORPS OF ENGINEERS

[signature] 1/10/11

Commander, Northwestern Division Date

U.S. FISH AND WILDLIFE SERVICE

[signature] 1/10/11

Acting Regional Director, Region 3 Date

[signature] 1/10/11

Regional Director, Region 6 Date

ENVIRONMENTAL PROTECTION AGENCY

[signature] 1/6/11

Regional Administrator, Region 7 Date

NATIONAL PARK SERVICE

[signature] 1-11-2011

Regional Director, Midwest Region Date

APPENDIX C

Public Notice and Distribution List

PUBLIC NOTICE

US Army Corps of Engineers
Kansas City District

Permit No. 2014-608
Issue Date: May 16, 2014
Expiration Date: June 15, 2014

30-Day Notice

JOINT PUBLIC NOTICE: This public notice is issued jointly with the Missouri Department of Natural Resources, Water Pollution Control Program. The Missouri Department of Natural Resources will use the comments to this notice in deciding whether to grant Section 401 water quality certification. Commenters are requested to furnish a copy of their comments to the Missouri Department of Natural Resources, P.O. Box 176, Jefferson City, Missouri 65102.

APPLICANT: U.S. Army Corps of Engineers – Kansas City District
601 East 12th Street
Kansas City, MO 64106-2896

PROJECT LOCATION (As shown on the attached drawings): The proposed project is located on existing public land purchased in fee title by the U.S. Army Corps of Engineers in St. Charles County, Missouri. This project site is 1,342 acres in size and is located south of West Alton, Missouri. The area is adjacent to the left descending bank of the Missouri River, at river miles 3 to 6. The project is located at latitude 38˚50'04.78" north, and longitude 90˚11'00.97" west. See Figure 1.

AUTHORITY: The project would be completed under the authority of the Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) from Water Resource Development Acts (WRDA) of 1986, 1999, and 2007. The proposed action is regulated by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act (33 USC 1344).

ACTIVITY (As shown on the attached drawings): PROPOSED WORK: The goal of the proposed action is to create habitat to benefit the federally endangered pallid sturgeon by meeting the requirements of the U.S. Fish and Wildlife Service's *2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* to avoid jeopardy to this species. This project would include the restoration of shallow water habitat, floodplain connectivity, riparian habitat, and reversion of the site to habitat compliant with WRDA authorities.

The proposed action would result in approximately 42 acres of shallow water habitat immediately following construction through the creation of three side channel chutes that would total 24,000 linear feet in length. The chutes would be constructed to a width of approximately 75-feet and a depth of 5 to 7-feet below the construction reference plan. Over time, natural processes would expand the width of the chutes and result in approximately 111 acres of shallow water habitat. At least one rock control structure would be installed to control the ultimate width of the chute and prevent the chute from widening beyond a bottom width of 200 feet. In total, approximately 202 acres of farmed wetlands would be adversely impacted by implementing the project. These impacts would be mitigated onsite by creating berms to maintain or develop wetland hydrology in locations adjacent to the chutes.

The top three feet of soil from the chute alignments, approximately 380,000 cubic yards, would be removed using heavy construction equipment and placed adjacent to the channel. Up to 200,000 cubic yards of this material would be used to construct berms for wetland mitigation. The remaining soil in the chutes, approximately 1,791,000 cubic yards, would be removed using a hydraulic dredge and discharged into the Missouri River. The remaining material excavated from the top three feet and an additional 2,600,000 cubic yards would also enter the Missouri River as the chute widens through natural processes. A typical chute cross section is illustrated in Figure 2.

Floodplain connectivity would be improved to approximately 1,200 acres of land that is currently protected by a levee. This would occur by removing portions of the levee within the chute alignment. In addition, six additional locations would be notched to allow a better hydrologic connection with the Missouri River. Existing Bank Stabilization and Navigation Project dikes adjacent to Cora Island would be modified so that the flow of water through the new chute complex would not result in any changes to existing water level elevations of the Missouri River in the vicinity of the project. Natural regeneration would be the primary method of vegetative restoration on the remainder of the site; however, if needed, plantings would be undertaken as part of site operation and maintenance to ensure ecological success. The Corps would have responsibility for long-term operation and maintenance of the shallow water habitat, and the USFWS would be the on-site management agency. Collectively, the 1,342 acre site would be managed by USFWS as part of their Big Muddy National Fish and Wildlife Refuge.

A detailed description of the proposed action is described in Section 3 of the Cora Island Missouri River Recovery Project Implementation Report with Integrated Environmental Assessment. See Figure 3 for an illustration of project features.

WETLANDS/AQUATIC HABITAT: The proposed action would not result in any net change in the acres of wetland habitat. Constructing the chutes and stockpiling the top three feet of soil on land adjacent to the chutes would adversely impact about 61 acres of farmed wetlands. Additionally, there would also be impacts to the hydrology on another 141 acres of farmed wetlands. These impacts would be mitigated by constructing earthen berms to create new wetlands and maintain suitable hydrology on existing farmed wetlands so that there would be no overall net loss of wetland habitat. Up to 200,000 cubic yards of soil excavated from the top three feet of the chute alignments would be used to create earthen berms to mitigate for impacts to farmed wetlands. The berms, approximately 4 feet tall, would be constructed to maintain wetland hydrology on farmed wetlands that would be bisected by the chutes. The location of the impacted wetlands, berms, and new wetland areas are shown in Figure 2. As a result of mitigating impacts, the proposed action would not result in any long-term significant impacts to wetland habitat. In addition, floodplain connectivity would be improved to approximately 1,200 acres of land that is currently protected by a levee. Material excavated during chute construction would be placed into the Missouri River in a location and manner that it would be integrated into the Missouri River bedload and would not be expected to permanently change the bed contour or convert an area to a non-aquatic site. In the past, similar projects have not resulted in any permanent change in bed contours or resulted in area being converted to non-aquatic sites.

APPLICANT'S STATEMENT OF AVOIDANCE, MINIMIZATION, AND COMPENSATORY MITIGATION FOR UNAVOIDABLE IMPACTS TO AQUATIC RESOURCES: The proposed project has been designed to incorporate all practicable measures to avoid, minimize, and mitigate unavoidable adverse impacts to aquatic resources while still meeting the project purpose. The proposed project would mitigate for adverse impacts to 202 acres of farmed wetlands by constructing earthen berms to create new wetlands and maintain suitable hydrology on existing farmed wetlands so that there would be no overall net loss of wetland habitat.

ADDITIONAL INFORMATION: Additional information about this application may be obtained by contacting Mr. Whitney Wolf, Project Manager, U.S Army Corps of Engineers, Kansas City District, ATTN: Project Management Section, 601 East 12th Street, Kansas City, Missouri 64106, by email at whitney.k.wolf@usace.army.mil, or by telephone at (816)389-3315. All comments to this public notice should be directed to the above address.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) OF 1968, as amended: The Corps prepared a *Feasibility Report and Environmental Impact Statement* in 1981 on the original Mitigation Project of 48,100 acres. After Congress modified the Mitigation Project by WRDA99, the Corps initiated a *Supplemental Environmental Impact Statement* (SEIS) in September 2001 for the additional 118,650 acres and including 7,000 to 20,000 acres of shallow water habitat. The SEIS was completed in early 2003 and the *Record* of *Decision* (ROD) was signed in June 2003. The Corps has prepared a Draft Project Implementation Report with Integrated Environmental Assessment and Section 404(b)(1) Evaluation. The Recommended Alternative described in the draft documents includes site specific measures that would be used to implement the Selected Alternative described in the Corps' 1981 *Feasibility Report and Environmental Impact Statement* in 1981 on the original Mitigation Project and the 2003 *Supplemental Environmental Impact Statement* (2003 SEIS) on the Mitigation Project as modified by WRDA99. The Draft Project Implementation Report with Integrated Environmental Assessment and Section 404(b)(1) Evaluation is available online at: http://www.nwk.usace.army.mil/Media/PublicNotices.aspx

The Corps has made a preliminary determination that the proposed project would not result in any significant impacts to the human environment and therefore the proposed project would support a Finding of No Significant Impact (FONSI). The Corps will utilize comments received in response to this Public Notice to complete the evaluation of the project in compliance with the requirements of NEPA, Section 404 of the Clean Water Act, and other Federal, state, and local regulations. The Corps has made a preliminary determination that the proposed project would not be contrary to the public interest and is in compliance with the Section 404(b)(1) Guidelines. The Draft Section 404(b)(1) Evaluation is included as Appendix G in the Project Implementation Report with Integrated Environmental Assessment.

CULTURAL RESOURCES: An archeological background review of the project area was conducted that included an examination of the National Register of Historic Places on-line (NRHP); the Missouri Department of Natural Resources Archeological Viewer; shipwreck location maps (Chittenden 1897 and Trail 1858-1965); Lewis and Clark camp site maps, Missouri River channel location maps from 1803, 1879, 1894, 1954, and present; as well as pertinent Corps records. No archeological sites are mapped within or near the project area. Historic channel maps show that the proposed project area was entirely crossed by the historic river channel, so prehistoric or early historic archeological sites are unlikely to be present in the project area.

It was determined that 6 shipwrecks were in the vicinity of Cora Island. Because of this, the Corps contracted for a survey using a magnetometer. The magnetometer survey indicated an anomaly that could be a shipwreck in the location of one of the chutes. To avoid construction impacts to the possible shipwreck, the designed location was shifted 200 feet west of the anomaly. In addition, the portion of the chute nearest the anomaly would be armored to prevent post construction chute erosion from impacting the possible wreck.

After the above alignment changes the Corps' determination is that the proposed project would not impact any sites listed or eligible for listing in the National Register of Historic Places in the immediate project area. The Corps would forward these recommendations to the Missouri State Historic Preservation Officer (SHPO) for their concurrence. Even though a magnetometer survey covered the chute alternative, it is possible that unrecorded shipwrecks or other historic artifacts may be present in the area and encountered during construction. If an inadvertent discovery occurs, the Corps would coordinate the find with SHPO and the affiliated Native American Tribes. If this discovery were of Native American human remains, then Section 3 of the Native American Graves Protection and Repatriation Act (P.L. 101-601) would be followed. Should evidence of a historic shipwreck be exposed during construction it would be the Corps intent to avoid any project impacts by shifting the alignment of the chutes. As with any other inadvertent discovery of a historic property this would require additional coordination with the SHPO and potentially a revision of the National Environmental Policy Act evaluation and Section 404(b) (1) evaluation.

ENDANGERED SPECIES: The goal of the proposed action is to create habitat to benefit the federally endangered pallid sturgeon by meeting the requirements of the U.S. Fish and Wildlife Service's *2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* to avoid jeopardy to this species.

In compliance with the Endangered Species Act, a preliminary determination has been made that the described work will not adversely affect species designated as threatened or endangered or adversely affect critical habitat. In order to complete an evaluation of this activity, comments are solicited from the U.S. Fish and Wildlife Service and other interested agencies and individuals.

FLOODPLAINS: This activity is being reviewed in accordance with Executive Order 11988, Floodplain Management, which discourages direct or indirect support of floodplain development whenever there is a practicable alternative. By this public notice, comments are requested from individuals and agencies who believe the described work will adversely impact the floodplain.

WATER QUALITY CERTIFICATION: Section 401 of the Clean Water Act (33 USC 1341) requires that all discharges of dredged or fill material must be certified by the appropriate state agency as complying with applicable effluent limitations and water quality standards. This public notice serves as an application to the state in which the discharge site is located for certification of the discharge. The discharge must be certified before a Department of the Army permit can be issued. Certification, if issued, expresses the state's opinion that the discharge will not violate applicable water quality standards.

PUBLIC INTEREST REVIEW: The decision to issue a permit will be based on an evaluation of the probable impact including the cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered including the cumulative effects thereof; among those are conservation, economics, esthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs and, in general, the needs and welfare of the people. The evaluation of the impact of the activity on the public interest will include application of the guidelines promulgated by the Administrator, Environmental Protection Agency under authority of Section 404(b) of the Clean Water Act (33 USC 1344). The Corps of Engineers is soliciting comments from the public; Federal, state, and local agencies and officials; Indian Tribes; and other interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps of Engineers to determine whether to issue, modify, condition or deny a permit for this proposal. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act. Comments are also used to determine the need for a public hearing and to determine the overall public interest of the proposed activity.

COMMENTS: This notice is provided to outline details of the above-described activity so this District may consider all pertinent comments prior to determining if issuance of a permit would be in the public interest. Any interested party is invited to submit to this office written facts or objections relative to the activity on or before the public notice expiration date. Comments both favorable and unfavorable will be accepted and made a part of the record and will receive full consideration in determining whether it would be in the public interest to issue the Department of the Army authorization. Copies of all comments, including names and addresses of commenters, may be provided to the applicant. Comments should be mailed to the address shown on page 3 of this public notice.

PUBLIC HEARING: Any person may request, in writing, prior to the expiration date of this public notice, that a public hearing be held to consider this application. Such requests shall state, with particularity, the reasons for holding a public hearing.

PUBLIC MEETING: The Corps has scheduled an open house Public Information Meeting on the Cora Island Missouri River Recovery Project. This meeting is scheduled on June 4, 2014 from 6:00-8:00 pm at The Audubon Center, 301 Riverlands Way, West Alton, Missouri 63386. This meeting will provide an opportunity for interested stakeholders to receive additional information on the project and provide input for use in completion of the Final Project Implementation Report with Integrated Environmental Assessment.

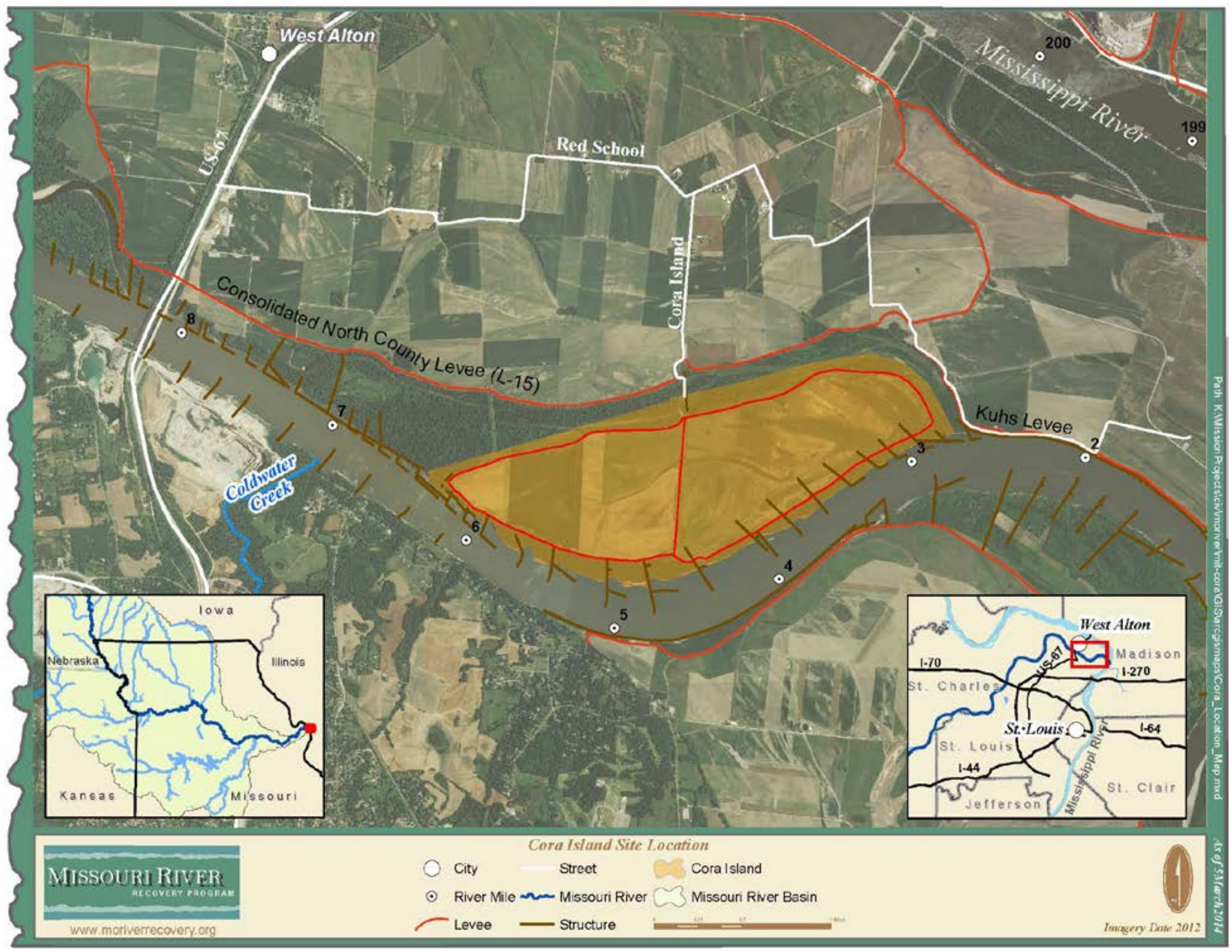


Figure 1: Cora Island, St. Charles County, Missouri.

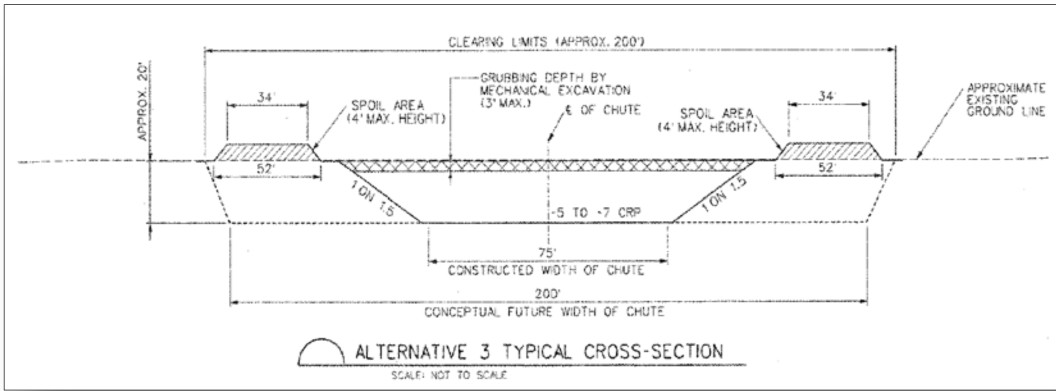


Figure 2: Typical cross section for proposed chute.

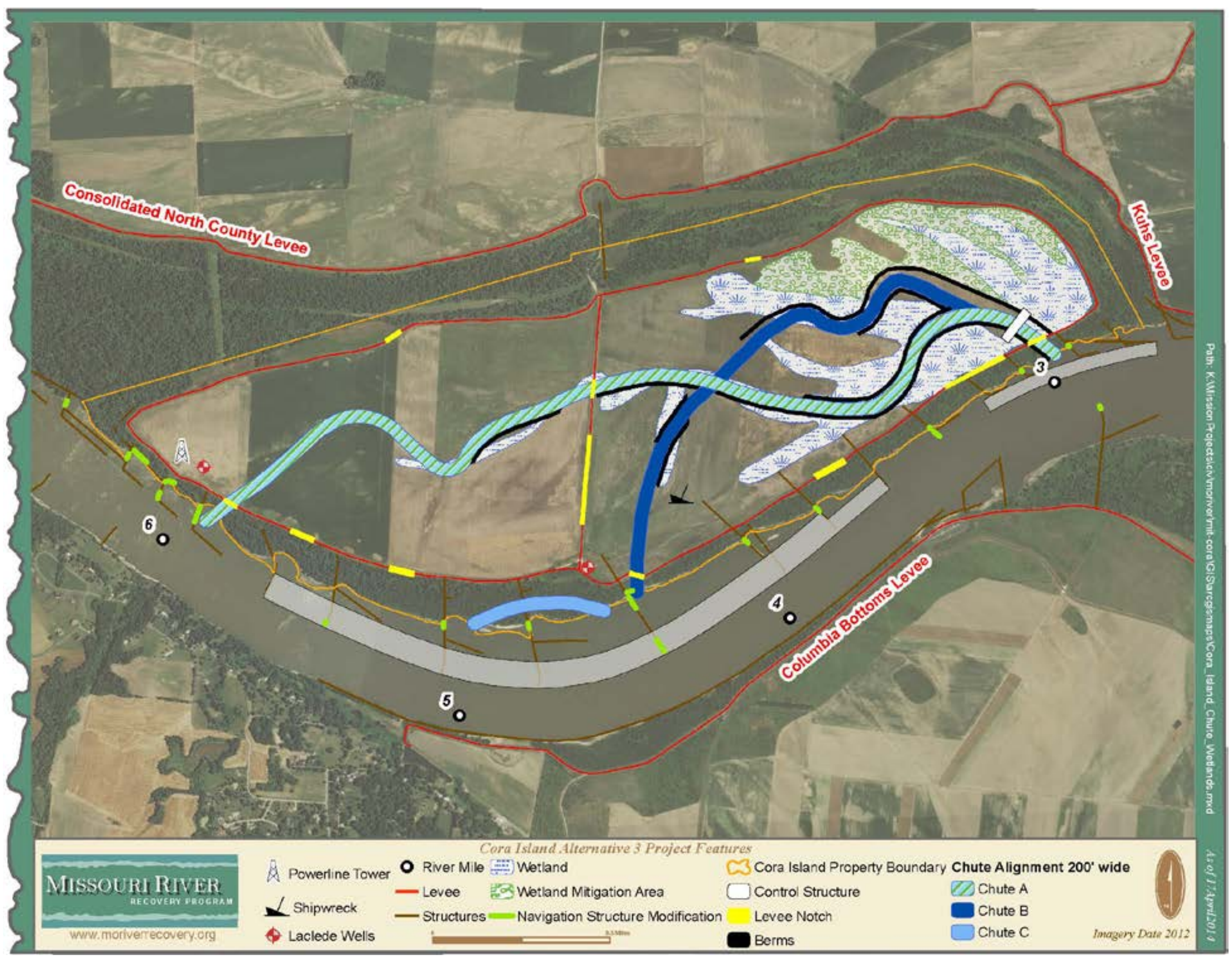


Figure 3: Features included in proposed action.

APPENDIX D

Public and Agency Comments

(Pending)

APPENDIX E

Water Quality Field Sampling Plan

FIELD SAMPLING PLAN

for

2012 Cora Island Site Characterization
Missouri River Mitigation Site Project

Missouri River Recovery Program – Integrated Science Program

Prepared By:

Missouri River Recovery Program (MRRP)
Integrated Science Program
Kansas City District Water Quality Program
U.S. Army Corps of Engineers – Kansas City District

26 March 2012

MORRIS.DANE.M.1399939263

Digitally signed by MORRIS.DANE.M.1399939263
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MORRIS.DANE.M.1399939263
Date: 2012.03.27 12:39:23 -05'00'

USACE – Environmental Engineer
Dane Morris
CENWK-PM-PR

Date

28-MAR-12

USACE – Chief, Environmental Resources Section
Jennifer Switzer
CENWK-PM-PR

Date

Distribution List:

U.S. Army Corps of Engineers – Kansas City District (NWK)

Mike Chapman, PM-C
Kathy Older – ED-GG

TABLE OF CONTENTS

Page

1. PROJECT DESCRIPTION

1.1. BACKGROUND INFORMATION

The U.S. Army Corps of Engineers (USACE) is proposing a project to create shallow-water habitat along the Missouri River at Cora Island (Big Muddy National Wildlife Refuge) as part of the Missouri River Recovery Program (MRRP). The project consists of the creation of shallow water habitat for the benefit of native large river fish, including the pallid sturgeon (*Scaphirhynchus albus*), and provides connectivity with the Missouri River and its floodplain. The project is also designed to help mitigate for the loss of habitat that resulted from the construction, operation, and maintenance of the Missouri River Bank Stabilization and Navigation Project (BSNP). The proposed project involves the construction a series of at least four chutes located throughout the site totaling a distance of approximately 24,600 linear feet. The chutes will be constructed by excavating a pilot channels approximately 75 ft wide with a 2H :1V side-slope. Flow will be allowed into the pilot channels to naturally develop sinuosity and shallow water habitat diversity. Excavated material from construction will be side-cast on-site into spoil piles on both sides of the chutes or directly disposed in the water. It is believed the excavated alluvial material will be primarily sand with some silts and clays.

1.1.1. Project Location

The project site is located along the Missouri River in St. Charles County, Missouri (see Figure 1). This project is located along the right descending bank of the Missouri River between rivers miles (RM's) 2.5 and 6. The site consists of approximately 1,265 acres of land on the northern floodplain. This land is owned by the U.S. Army Corps of Engineers and is managed by the U.S. Fish and Wildlife Service as part of the Big Muddy National Wildlife Refuge System. The site is located directly north of St. Louis, Missouri. Vehicle access is made by driving north on Highway 67 from St. Louis to Red School Road. Go east on Red School Road for 3 miles to Cora Island Road. Travel south on Cora Island Road to reach the site.

1.1.2. Proposed Disposal Plan

Alluvial material will be excavated and side-cast onto spoil piles on both sides of the chute. Upon completion of construction, the pilot chute will be connected to the Missouri River and will be subject to the natural forces of the river.

1.1.3. Permitting Requirements

A National Pollution Discharge Elimination System (NPDES) general permit is required from the Missouri Department of Natural Resources (MDNR). In addition to the general permit, an associated stormwater pollution prevention plan (SWPPP) is required. These permits are required prior to Section 401 certification, which must be obtained from MDNR. This monitoring project plan was developed in support of the proposed project for Section 401 Certification.

1.2. PROJECT/TASK ORGANIZATION AND RESPONSIBILITIES

The USACE's Kansas City District's Water Quality Program and Geology Section staff will conduct the site characterization -- sediment and water quality data -- to facilitate review of the proposed project for Section 401 Water Quality Certification.

<u>Staff Responsibilities and Contacts for Sampling:</u>

Sample Collection and Coordination: Dane Morris
Laboratory Analysis: ARDL, Inc.

1.3. DATA QUALITY OBJECTIVES

The data collected through this monitoring project will be used by the State of Missouri and the U.S. Army Corps of Engineers, Kansas City District, for use in reviewing the proposed Cora Island mitigation project for Section 401 Water Quality Certification.

2. DATA COLLECTION APPROACH

There are no known contaminants of concern at the Cora Island mitigation project site.

2.1. DATA COLLECTION DESIGN

Soil samples will be collected from 25 locations (CI-S1 through CI-S25) for laboratory analysis and elutriate sample preparation / analysis. The preparation and analysis of elutriate samples are a means of quantifying the potential impacts to water column quality. Samples of Missouri River water will be collected at one site (CI-W1) for water quality analysis in the proposed project area. The approximate sample locations are shown in Figure 2. The location of the sampled sites will be determined with a GPS unit in the field during the site recon phase or when samples are collected. The sample numbering is shown in the Field Data Sheet in Attachment 1.

2.2. MEASUREMENT AND SAMPLING METHODS

2.2.1. River Water Samples

Missouri River water samples will be collected from one upstream location, CI-W1, at the project area (RM 6). The samples will be collected in accordance with this FSP or Standard Operating Procedures (SOP) developed by the NWO Water Quality Unit (USACE 2003).

A transect will be established at the river sampling location. Surface samples (0.1 – 0.5m) will be collected at four evenly distributed locations across the transect location by dividing the river into four equal increments. Each of the samples will be analyzed individually by the contract laboratory. In addition to the four individual surface samples collected for this project (1 transects x 4 grabs/transect), one duplicate sample will be collected for laboratory analysis. Sample volume requirements, holding times, and preservation will be specified by the contract laboratory.

In addition to collecting water samples for laboratory analyses, river water will be collected for the preparation of elutriate sample analyses (see Section 2.2.3). This water will be collected from CI-W1 (upstream). The laboratory requires 4 L of receiving water for each 1 L of sediment to ensure sufficient volume to prepare the elutriate samples for analysis. Assuming 1 L of sediment will be collected from each of the 25 locations plus 3 duplicates, 112 L of river water will be collected from Site CI-W1. Approximately 28 L of river water will be collected from each transect location to fulfill this requirement. The 28 liter sub-samples will be combined evenly into six 5-gallon or equivalent large volume containers for use in the elutriate analyses.

At the time river water samples are collected, ambient field measurements will be recorded for temperature, dissolved oxygen, pH, conductivity and turbidity. These measurements will be obtained with a HydroLab DataSonde 5 and Surveyor 4 data logger. A plastic bucket will be used to collect a near-surface water sample at each transect point. The instrument will then be immediately placed in the plastic bucket and the measurements taken. Measurements will be appropriately recorded on a field sheet (Attachment 1). The bucket will be thoroughly rinsed with river water at each sample point prior to filling for measurement to prevent cross-contamination interference.

Discrete water samples for chemical analysis will be collected with a NASCO Swing Sampler. A near-surface sample will be collected by dunking the sampler into the river at a depth of 0.1 – 0.5 m. Water will be poured out of the collection bottle into appropriate sample containers. Samples will be stored on ice in coolers immediately after collection. Samples collected for dissolved metals analysis will be placed initially in unpreserved bottles. After returning to shore, the dissolved metal samples will be filtered through 0.45-micron filters and placed into appropriate pre-preserved bottles. All samples will be packed in coolers with ice for shipment to the laboratory. The water samples will be analyzed for parameters listed in Table 1.

2.2.2. Sediment Samples

Sediment borings will be collected along the chute alignments using a hand auger. All machinery and down-hole sampling equipment will be washed prior to entering and exiting the site. Waste generated from the borings is not considered hazardous and will not need to be containerized. A decontamination pad is not required for this project and wash water will not be containerized.

Sediment samples will be collected at 25 locations (CI -S1 through CI-25) for laboratory analysis and elutriate sample preparation / analysis. The location of the borings will be at approximately 1000-ft intervals along the pilot chute alignment. Continuous sample cores will be collected using the hand auger. Offset borings will be advanced as necessary to obtain enough material to create a composite sample of each borehole with sufficient unsaturated volume to meet laboratory requirements. The borings will be advanced to the depth of approximately 6 feet.

One composite sample will be collected from each location (CI-S1 through CI-S25) and analyzed for the parameters in Table 1. New pre-cleaned buckets or large aluminum baking pans and tools (e.g., Teflon trowels, stainless steel spoons) will be used to prepare each composite sample. After each coring, the sediment from the Macro-Core sampler will be deposited into the collection bucket or pan. When all cores from one site have been collected in the bucket, the contents will be homogenized and transferred to glass jars provided by the laboratory for each analysis. The sample label will be placed on the jar prior to filling with sample. The collected sediment samples will be placed into a shipping cooler with ice for shipment to the laboratory. The coring tools (i.e., cutting shoes, rods) will be cleaned with an Alconox / tap water solution between sample locations and rinsed with distilled water.

At three locations, CI-S1, CI-S16, and CI-S23 discrete samples will be collected at 1 m intervals to the depth of 6 m or until saturation. The discrete soil samples will be placed directly into sample jars provided by the laboratory.

In addition to the composite and discrete samples described above, three duplicate composite sample will be collected for laboratory analysis. Sample volume requirements will be specified by the contracted laboratory.

Each borehole will be properly abandoned in accordance with MODNR well abandonment requirements upon completion of sampling activities. The borehole decommissioning standards are provided by Title 10, Division 23, Chapter 3 of the Missouri Code of State Regulations (10 CSR 23-3.110).the KDHE's well construction rules K.A.R. 28-30-1 through 28-30-207.

2.2.3. Elutriate Samples

Elutriate samples will be prepared by the laboratory in accordance with the "Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual: Inland Testing Manual" (USEPA and USACE, 1998). The elutriate sample will be prepared by using river water from the project area and composite sediment samples collected along the chute alignment. Nineteen elutriate samples will be analyzed for the parameters indentified in Table 1. In addition, two duplicate samples will be collected for laboratory analysis.

The elutriate is prepared by sub sampling approximately 1 L of the dredged material from the well-mixed original sample. The dredged material and unfiltered water are then combined in a sediment-to-water ratio of 1:4 on a volume basis at room temperature (22 ± 2°C). This is best accomplished by volumetric displacement. After the correct ratio is achieved, the mixture is stirred vigorously for 30 min with a mechanical or magnetic stirrer. At 10 min intervals, the mixture is also stirred manually to ensure complete mixing. After the 30 min mixing period, the mixture is allowed to settle for 1 h. The supernatant is then siphoned off without disturbing the settled material, and centrifuged to remove particulates prior to chemical analysis (approximately 2,000 rpm for 30 min, until visually clear).

2.3. Sample Handling, Custody, and Transport

The collected samples will be prepared by staff and shipped via FedEx to the contracted laboratory (ARDL, Inc.) for analysis. A chain-of-custody record will be completed and submitted with the samples delivered to the laboratory (Attachment 2). All samples – water and sediment – will be stored in coolers with ice prior to shipment.

2.4. Parameters to be Measured and Analyzed

The parameters that will be measured or analyzed for the different types of samples are listed in Table 1. Table 2 lists the sampling bottles to be used, holding times, and preservatives for each of the parameters.

2.5. Analytical Methods

Table 1 lists the methods that will be used by the contract lab for sample analyses.

A maximum laboratory turn-around time of 20 days is required to ensure the USACE can stay on schedule regarding the implementation of the restoration project.

2.6. Quality Control

Several types of quality control (QC) will be collected for analysis and the results will be used to assess sampling and analytical precision. These samples will include field duplicates and trip blanks. All field measurements and samples will be collected in accordance with SOPs developed by the USACE's Water Quality Program.

The following table summarizes the type and frequency of these samples to be collected:

Field QA and QC Samples		
QA / QC Sample	**Frequency**	**Analysis Location**
Field Duplicates	1/10 (10 %)	Contract Lab
Trip Blank	1 per day	Contract Lab

3. DATA MANAGEMENT AND REPORTING

All water quality measurements and analyses will be verified, validated, and compiled into an Excel spreadsheet. To assess the potential for water quality impacts from this project, elutriate water concentrations will be compared to upstream concentrations measured at location WC-W1. Soil analytical results will be compared to target values identified in Table 3.

4. PROJECTED COSTS FOR FIELD COLLECTION AND LABORATORY ANALYSIS OF SAMPLES

	Itemized Costs	Total Cost
Field / Office		
PM-PR G5H4620 G5H4621	 $ 8,000 – labor $	$8,000
ED-E G5L0340 G5L0320	 $ 5,000 - labor $	$ 5,000
CT – H	$	$
ED-GG G5L0420 G5L0421 G5L00000 G5L0400	 $ 8,700 - labor $ 16,000 - labor $ 4,100 -labor $ 1,100 -labor	$31,400
Laboratory		
Contract Lab	$34,191 - analytical $ 1000 - shipping	$35,191
Total Cost		**$79,591**

5. REFERENCES

MacDonald, D.D., Ingersoll, C.G., and Berger, A. 2000. Development and evaluation of concensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39:20-31.

Tidball, R.R. 1984. Geochemical survey of Missouri. USGS Profession Paper 954H.

USEPA and USACE. 1998. Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Test Manual: Inland Testing Manual. EPA-823-B-98-004, February 1998. U.S. Environmental Protection Agency, Office of Water. Department of Army, U.S. Army Corps of Engineers. Washington, D.C

USACE. 2003. Collection of Surface Water Samples, SOP Number: WQ-21101. Water Quality Unit, Water Control and Water Quality Section, Hydrologic Engineering Branch, Engineering Division, Omaha District, USACE.

Table 1. Parameters to be measured and analyzed.

Parameter	Method	Samples to be Analyzed [2]		
		Sediment	**River Water**	**Standard Elutriate Water**
Field Measurements:				
Water Temperature (°C)	HydroLab [1]		4	
pH (S.U)	HydroLab [1]		4	
Dissolved Oxygen (mg/l)	HydroLab [1]		4	
Conductivity (umhos/cm)	HydroLab [1]		4	
Turbidity (FTU)	Hydrolab [1]		4	
Laboratory Analysis:				
Total Suspended Solids (mg/l)	EPA 160.2		5	29
Ammonia as N, Total (mg/l)	EPA 350.1 SM 4500-NH3-B,C	47	5	29
Nitrogen – Total Kjeldahl Nitrogen (mg/l)	EPA 351	47	5	29
Nitrogen – Nitrate / Nitrite as N (mg/l)	EPA 353 / 354	47	5	29
Phosphorus – Total (mg/l)	EPA 365.4 or SM 4500-P	47	5	29
Phosphorus – Soluble Reactive (orthophosphorus)	SM 4500-P / EPA 365	47	5	29
Carbonaceous Biochemical Oxygen Demand –CBOD (mg/l)	5210.B		5	29
Total Organic Carbon – TOC (mg/l)	EPA - 365.1	28	5	29
Metals – Total Cadmium, Copper, Chromium, Lead, Nickel, Zinc	EPA – 6010C	28		
Metals – Dissolved Cadmium, Copper, Chromium, Lead, Nickel, Zinc	EPA - 6010B		5	29
Pesticides – Chlordane, Dieldrin, DDt and metabolites	846 8081	28	5	29

[1] Hydrolab or equivalent water quality meter

[2] Includes 10% field duplicate:
Sediment – 25 composite, 3 discrete (x6 m depth), 3 duplicates, 1 matrix spike
Water – 4 grab, 1 duplicate
Elutriate – 25 locations, 3 duplicate, 1 ms

Table 2. Sample containers, required volumes, holding times, and preservatives.

Analyte	Method	Container	Holding Time	Min. Volume	Preservation
Sediment Samples					
Particle Size	sieve	Baggie	28 days	1 Quart	4C
Ammonia	350.1	Glass	28 days	270 mL	4C
Nitrogen – Total Kjeldahl Nitrogen (mg/kg)	EPA 351	Glass	28 days	270 mL	4C
Nitrogen – Nitrate / Nitrite as N (mg/kg)	EPA 353 / 354	Glass	28 days	270 mL	4C
Phosphorus – Total (mg/kg)	EPA 365.2 or SM 4500-P	Glass	28 days	270 mL	4C
Phosphorus – Soluble Reactive (orthophosphorus)	SM 4500-P / EPA 365	Glass	48 hrs.	270 mL	4C
Pesticides (ug/g) – Chlordane, Dieldrin, DDT&Metabollites	SW 846 8081	Glass	14 days	270 mL	4C
Metals – Total Cadmium, Copper, Chromium, Lead, Nickel, Zinc	6010C	Glass	180 days	270 ml	4C
Elutriate Sediment	N/A	Glass		1 gallon water + 1 L sediment	
Water Samples					
Ammonia as N, Total (mg/l)	EPA 350.1 SM 4500-NH3-B,C	Poly	28 days	1L	Sulfuric Acid
Nitrogen – Total Kjeldahl Nitrogen (mg/l)	EPA 351	Poly	28 days	1L	Sulfuric Acid
Nitrogen – Nitrate / Nitrite as N (mg/l)	EPA 353 / 354	Poly	28 days	1L	Sulfuric Acid
Phosphorus – Total (mg/l)	EPA 365.2 or SM 4500-P	Poly	28 days	1L	Sulfuric Acid
Phosphorus – Soluble Reactive (orthophosphorus)	SM 4500-P / EPA 365	Cubitainer	48 hrs.	1L	4C
Carbonaceous Biochemical Oxygen Demand – CBOD (mg/l)	EPA – 5210B	Cubitainer	48 hrs	1L	4C
Total Organic Carbon – TOC (mg/l)	EPA – 9060/415.1	Poly	28 days	250 mL	Sulfuric Acid
Metals – Dissolved Cadmium, Copper, Chromium, Lead, Nickel, Zinc	EPA - 6010B	Poly	6 months	1L	Nitric Acid
Pesticides – Chlordane, Dieldrin, DDt and metabolites	846 8081	Amber glass	7 days	1L	4C
Total Suspended Solids (mg/l)	EPA 160.2	Cubitainer	7 days	1L	4C
Hardness	SM2340B	Poly	6 months	1L	Nitric Acid

Table 3. Target values for laboratory analyzed chemical parameters.

Parameter	Target Values				
	MDL	**PQL**	**Sediment**	**River Water**	**Standard Elutriate Water**
Ammonia (mg-N/L or mg-N/kg)	0.021	0.2		X	
Nitrogen – Total (mg/kg or mg/L)				X	
Nitrogen – Total Kjeldahl Nitrogen (mg/kg or mg/L)	0.1	0.2		X	
Nitrogen – Nitrate / Nitrite as N (mg/kg or mg/L)	0.0083	0.05		X	
Phosphorus – Total (mg/L)	0.007	0.033	0.059 pct(2) 590 mg/L DW	X	
Phosphorus – Soluble Reactive (mg/kg or mg/L)	0.02	0.1		X	
Total Suspended Solids (mg/l)				X	X
Chemical Oxygen Demand – COD (mg/l)	6.9	20		X	X
Total Organic Carbon – TOC (mg/l)	10	100	1.25 pct(2)	X	X
Metals – Total (mg/kg)					
Cadmium	0.0055	0.25			
Chromium	0.014	1			
Copper	0.021	1.5			
Lead	0.041	0.5			
Nickel	0.026	2.5			
Zinc	0.056	2.5			
Metals – Dissolved (ug/L)					
Cadmium	0.1	5		X	See note 4
Chromium	0.38	20		X	See note 4
Copper	6.3	30		X	See note 4
Lead	0.46	10		X	See note 4
Nickel	0.59	50		X	See note 4
Zinc	2.3	50		X	See note 4
Pesticides					
Chlordade					
Dieldren					
DDT&Metabolites					

(1) concensus-based probable effect concentration (PEC) in mg/kg (MacDonald et. Al 2000)
(2) average total concentration in Missouri soils in ppm except as noted in percent (pct)(Tidball 1984).
(3) site-specific target values are being developed
(4) 10 CSR 20-7, Table A – Metals (hardness dependent)
MDL = method detection limit
PQL = practical quantitation limit, the lowest concentration standard analyzed and can be verified
DW = dry weight
Pct = percent, 1 pct = 10,000 ppm

Figure 1. Location map of the Cora Island.

Figure 2. Location of sites to be sampled as parat of the Cora Island Mitigation project; CI-S1 through CI-S25

Attachment 1. Field Sheets for Cora Island Site Characterization Sampling (USACE – MRRP WQP)

FIELD DATA SHEET

Project Name: Cora Island Site Characterization Sampling **Project Number:**

Trip Number: ________________________________

Site Location:____

Site Number: ________________________________ **Date:** ____________________

Collectors: ____

GPS MEASUREMENTS

Projected Coordinate System: NAD 1983 UTM Zone 15N
Linear Unit: US Foot

ID	Longitude	Latitude
CI-S1	2438132.32226	14111863.37840
CI-S2	2438982.51055	14112384.86270
CI-S3	2439830.74438	14112844.91750
CI-S4	2440477.00788	14112174.24560
CI-S5	2441464.44315	14112225.36260
CI-S6	2442353.55671	14112675.75080
CI-S7	2443157.26609	14113261.18970
CI-S8	2444129.87861	14113475.09240
CI-S9	2445383.93577	14113549.20970
CI-S10	2446058.02366	14113042.24050
CI-S11	2447045.62021	14112921.90690
CI-S12	2447982.53891	14113126.29030
CI-S13	2448232.16531	14114081.49890
CI-S14	2449134.29011	14114396.86270
CI-S15	2450019.56521	14113969.31030
CI-S16	2442004.01726	14111129.50390
CI-S17	2442603.16897	14110350.68090
CI-S18	2443461.26824	14109956.36340
CI-S19	2442055.01247	14110005.59250
CI-S20	2444299.96012	14110822.66240
CI-S21	2444448.66812	14111805.62440
CI-S22	2444823.28782	14112732.60700
CI-S23	2446162.96300	14114172.12070
CI-S24	2447079.08385	14114537.72360
CI-S25	2448076.70982	14114532.86210

SEDIMENT & WATER SAMPLE COLLECTIONS				
Sample Type	**Sample ID**	**Sampled Depth**	**Collection Time**	**Sampling Method**
Soil Sample	CI – S1			Composite Core
Soil Sample	CI – S2			Composite Core
Soil Sample	CI – S3			Composite Core
Soil Sample	CI – S4			Composite Core
Soil Sample	CI –S5			Composite Core
Soil Sample	CI – S6			Composite Core
Soil Sample	CI – S7			Composite Core
Soil Sample	CI – S8			Composite Core
Soil Sample	CI – S9			Composite Core
Soil Sample	CI –S10			Composite Core
Soil Sample	CI – S11			Composite Core
Soil Sample	CI – S12			Composite Core
Soil Sample	CI – S13			Composite Core
Soil Sample	CI – S14			Composite Core
Soil Sample	CI – S15			Composite Core
Soil Sample	CI – S16			Composite Core
Soil Sample	CI – S17			Composite Core
Soil Sample	CI – S18			Composite Core
Soil Sample	CI – S19			Composite Core
Soil Sample	CI – S20			Composite Core
Soil Sample	CI – S21			Composite Core
Soil Sample	CI – S22			Composite Core
Soil Sample	CI – S23			Composite Core
Soil Sample	CI – S24			Composite Core
Soil Sample	CI – S25			Composite Core
Soil Sample	CI – S1			Discrete Samples
Soil Sample	CI – S16			Discrete Samples
Soil Sample	CI – S23			Discrete Samples

AMBIENT WATER QUALITY MEASUREMENTS

Site	Time	Temp (°C)	D.O. (mg/l)	pH (S.U.)	Cond. (*u*mho/cm)	Turbidity (NTU)
CI – W1a						
CI – W1b						
CI – W1c						
CI – W1d						
CI – W1e Replicate						

COMMENTS:

AMBIENT WATER QUALITY MEASUREMENTS

Site	Time	Temp (°C)	D.O. (mg/l)	pH (S.U.)	Cond. (*u*mho/cm)	Turbidity (NTU)
CI – W1a						
CI – W1b						
CI – W1c						
CI – W1d						
CI – W1e Replicate						

COMMENTS:

APPENDIX F

Cultural Resources

STATE OF MISSOURI
Jeremiah W. (Jay) Nixon, Governor • Sara Parker Pauley, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

April 21, 2014

Timothy Meade
Cultural Resource Manager
Corps of Engineers, Kansas City District
600 Federal Building
Kansas City, Missouri 64106-2896

Re: Jameson Island & Cora Island Habitat Restoration Projects (COE) Saline & St. Charles Counties, Missouri

Dear Mr. Meade:

Thank you for submitting information on the above referenced project for our review pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which requires identification and evaluation of cultural resources.

We have reviewed the February 2013 report entitled *Intensive A Shipwreck Magnetometer Survey on Jameson Island, Saline County, and Cora Island, St. Charles County Missouri* by the Center for Archaeological Research. Based on this review it is evident that a thorough and adequate magnetometer survey has been conducted of the two project areas. We concur with your recommendation that there appear to be no shipwrecks at Jameson Island. We also concur that Cora Island Anomaly No. 1 has a strong probability of representing a shipwreck, and that there will be **no adverse effect** as the conditions for avoidance and protection as previously discussed have been implemented. We have no objection to the initiation of project activities.

Please be advised that, should project plans change, information documenting the revisions should be submitted to this office for further review. In the event that cultural materials are encountered during project activities, all construction should be halted, and this office notified as soon as possible in order to determine the appropriate course of action.

If you have any questions, please write Judith Deel at State Historic Preservation Office, P.O. Box 176, Jefferson City, Missouri 65102 or call 573/751-7862. Please be sure to include the SHPO Log Number (**031-MLT-14**) on all future correspondence or inquiries relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Mark A. Miles
Director and Deputy State
Historic Preservation Officer

MAM:jd

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
600 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

April 10, 2014

REPLY TO
ATTENTION OF

Environmental Resources Section
Planning Branch

Mr. Mark Miles
Director and Deputy State Historic Preservation Officer
State Historic Preservation Office
Department of Natural Resources
P. O. Box 176
Jefferson City, Missouri 65102-0176

Dear Mr. Miles:

The U.S. Army Corps of Engineers, Kansas City District's (Corps) Missouri River Fish and Wildlife Project is planning a habitat restoration project at Cora Island along the Missouri River in St. Charles County. This project is one component of the larger mitigation project that is being conducted at various locations on the Missouri River. Attached for you review and comment is a copy of the archeological report *A Shipwreck Magnetometer Survey on Jameson Island, Saline County, and Cora Island, St. Charles County, Missouri* prepared by Center for Archaeological Research, Missouri State University (CAR) for the Corps. This letter continues Section 106 coordination for the project at Cora Island that was initiated with your office by e-mail in October 2012. The Jameson Island project was coordinated with your office in March 2012.

The Cora Island project is located on the left descending bank of the Missouri River, between river miles 3 to 7, near the town of West Alton, St. Charles County, Missouri. The project would mitigate a portion of the aquatic habitat that was lost as the result of the construction of the Corps' Missouri River Bank Stabilization and Navigation Project by restoring shallow water habitat. The project would restore a total of 113 acres of shallow water habitat. The proposed project would consist of excavating three chutes totaling approximately 24,000 feet in length (main chute 14,500 feet in length, overlapping chute 7,800 in length, and most riverward chute 1,700 feet in length). The chutes would be approximately 75 feet in width and would be excavated to a maximum depth of approximately 30 feet below ground surface. Through time and dependent on river levels the chutes would be expected to widen and deepen over time. At least one rock grade control structure would be installed to control the ultimate width of the chute and not allow it to become wider than 200 feet during its life span.

An archeological background review of the project area was conducted that included an examination of the National Register of Historic Places on-line (NRHP); the Missouri Department of Natural Resources Archeological Viewer; shipwreck location maps (Chittenden 1897 and Trail 1858-1965); Lewis and Clark camp site maps, Missouri River channel location maps from 1803, 1879, 1894, 1954, and present; as well as pertinent Corps records. No archeological sites are mapped within or near the project area. Historic channel maps show that the proposed project area was entirely crossed by the historic river channel. Because of the recent age of the deposits, prehistoric or early historic archeological sites are unlikely to be present in the project area. Six shipwrecks are mapped in the general project area.

Because of the possible presence of the shipwrecks in the construction area, the Corps contracted with the CAR to conduct a magnetometer survey of the proposed chute locations to attempt to attempt to detect any potential wrecks that may be impacted by construction and the locations of shipwrecks as depicted on the Corps shipwreck maps. The results of the CAR background research and magnetometer survey are included in the attached report.

The magnetometer survey of the proposed Cora Island chute locations and mapped shipwreck locations was conducted by in 2012 by trained CAR personnel. A total of three magnetic anomalies were identified within the proposed chute locations. One of these anomalies (Anomaly 1) appears to be the debris field of a wrecked steamboat. The other anomalies do not appear to be related to shipwrecks. No anomalies were encountered in the areas of the mapped wrecks. Since anomaly 1 is not near any particular wreck it cannot be determined with any degree of certainty which recorded shipwreck it may represent.

Following the discovery of the possible shipwreck, I notified your office of the discovery via e-mail on October 23, 2012. At the time, the Corps recommended rerouting the segment of the chute that would have impacted Anomaly 1. The Corps proposed a minimum 200 foot buffer from the find location and installation of a riprap barrier to prevent encroachment into the area of discovery. At your request, the Corps would also develop shipwreck management plan and accidental discovery procedures to be included in the Cora Island management plan and any additional recovery projects that have the potential for shipwrecks. Your office agreed with these measures in its response e-mail dated October 24, 2012.

The Corps has since redesigned the project in the area of discovery shifting the alignment over 200 feet to the west of the Anomaly 1 find spot and by including the armored protection in project plans. The new alignment was also surveyed by CAR with no anomalies being identified. The management plan and accidental discovery procedures will be developed for the upcoming overall management plan and will be coordinated with your office prior to implementation.

As the project was redesigned to avoid impacts to Anomaly 1 and no other potential shipwrecks were found during the survey, CAR recommends that the chute construction should have no effect on shipwrecks or historic properties and that the construction be allowed to proceed. Given, the findings and redesign, the Corps concurs with this recommendation. It should be noted that the magnetometer survey is well-suited to identify large steamships that contain large amounts of metal, it is not adequate to locate smaller wooden craft. If any such boat or other cultural resource discoveries are made during construction, work in the area of discovery will cease and the discovery investigated by a qualified archeologist. The findings on the discovery would be coordinated with your office and appropriate federally recognized Native American tribes, if appropriate.

Thank you for your consideration in this matter. If you have any questions or have need of further information please contact me at (816) 389-3138 or at timothy.m.meade@usace.army.mil.

Sincerely,

Timothy Meade

Timothy Meade
Cultural Resource Manager

Enclosures

APPENDIX G

Clean Water Act Section 404(b)(1) Evaluation

Cora Island Missouri River Recovery Project
St. Charles County, Missouri

Section 404(b)(1) Evaluation

1. Introduction

This Section 404(b)(1) Evaluation is for the Cora Island Missouri River Recovery Project, St. Charles County, Missouri. The purpose of the project is to meet the requirements of the U.S. Fish and Wildlife Service's (USFWS) *2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System* (BiOp). The project would be completed under the authority of the Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) from Water Resource Development Acts (WRDA) of 1986, 1999, and 2007. This evaluation meets the requirements found in 40 CFR 230, Section 404(b)(1): Guidelines for Specification of Disposal Sites for Dredged and Fill Material.

2. Project Description

a. **Location:** The project (Proposed Action) is located on existing public land purchased in fee title by U.S. Army Corps of Engineers in St. Charles County, Missouri. This project site is 1,342 acres in size and is located south of West Alton, Missouri. The area is adjacent to the left descending bank of the Missouri River, at river miles 3 to 6. The project is located at latitude 38˚50'04.78" north, and longitude 90˚11'00.97" west. See Figure 1.

b. **General Description:** A detailed description of the proposed action is described in Section 3 of the Cora Island Missouri River Recovery Project Implementation Report with Integrated Environmental Assessment. See Figure 2 for an illustration of project features. In summary, the proposed action would result in approximately 42 acres of shallow water habitat (SWH) immediately following construction through the creation of three chutes that would total 24,000 linear feet in length. The chutes would be constructed to a width of approximately 75-feet and a depth of 5 to 7-feet below the construction reference plan. Over time, natural processes would expand the width of the chutes and result in approximately 111 acres of SWH. At least one rock control structure would be installed to control the ultimate width of the chute and prevent the chute from widening beyond a bottom width of 200 feet. In total, approximately 202 acres of farmed wetlands would be adversely impacted by implementing the project. These impacts would be mitigated onsite by creating berms to maintain or develop wetland hydrology in locations adjacent to the chutes.

DRAFT

The top three feet of soil from the chute alignments, approximately 380,000 cubic yards, would be removed using heavy construction equipment and placed adjacent to the channel. Up to 200,000 cubic yards of this material would be used to construct berms for wetland mitigation. The remaining soil in the chutes, approximately 1,791,000 cubic yards, would be removed using a hydraulic dredge. The remaining material excavated from the top three feet and an additional 2,600,000 cubic yards would also enter the Missouri River as the chute widens through natural processes. A typical chute cross section is illustrated in Figure 3.

Floodplain connectivity would be improved to approximately 1,200 acres of land that is currently protected by a levee. This would occur by removing portions of the levee within the chute alignment. In addition, six additional locations would be notched to allow a better hydrologic connection with the Missouri River. Existing BSNP dikes adjacent to Cora Island would be modified so that the diversion of water through the new chute complex would not result in any changes to existing water level elevations of the Missouri River in the vicinity of the project. Natural regeneration would be the primary method of vegetative restoration on the remainder of the site; however, if needed, plantings would be undertaken as part of site operation and maintenance to ensure ecological success. The Corps would have responsibility for long-term operation and maintenance of the project, and the USFWS would be the on-site management agency. Collectively, the 1,342 acre site would be managed by USFWS as part of their Big Muddy National Fish and Wildlife Refuge.

c. **Authority:** The project would be completed under the authority of the Missouri River Fish and Wildlife Mitigation Project (Mitigation Project) from Water Resource Development Acts (WRDA) of 1986, 1999, and 2007. The proposed action is regulated by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act (33 USC 1344).

3. Review of Compliance (§ 230.10 a-d)

a. No practicable alternative to the proposed project would have a less adverse impact on the aquatic ecosystem while meeting the project objectives. Additional information on the impacts of various alternatives to waters of the U.S. can be found in Section 5 of the Draft Cora Island Missouri River Recovery Project, Project Implementation Report with Integrated Environmental Assessment (PIR/EA).

b. The proposed project does not appear to violate any applicable state water quality standards, or applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act. The proposed project is not likely to jeopardize the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, to result in the likelihood of the destruction or adverse modification of critical habitat. Furthermore, the proposed

DRAFT

project would not violate the requirements of any federally designated marine sanctuary.

c. The proposed project would not cause or contribute to significant degradation of waters of the U.S. This includes no adverse effects on human health, life stages of organisms' dependant on the aquatic ecosystem, ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values.

d. Appropriate and practical steps have been taken which will avoid, minimize, and mitigate potential adverse impacts on the aquatic ecosystem.

4. Technical Evaluation Factors (Subparts C-F)

a. Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem (Subpart C)

1) **Substrate:** The placement of excavated material into the Missouri River would avoid existing shallow water habitat areas. The approximately 1,791,000 cubic yards of material to be dredged to construct the chutes would be pumped as slurry of water and sediment into the Missouri River. Dredged material would be placed between the existing dike field on the left descending bank and the deep portion of the Missouri River channel. A portion of the dredged material would be immediately transported downriver, and a portion of it would be captured by the dikes. This would slow the rate at which sediment would be mobilized into the main river channel and reduces any potential impacts to lock structures downstream on the Mississippi River. Excavated earthen material from chute construction would temporarily change the bottom elevation of the river. Placement of excavated earthen material would not result in the permanent conversion of an aquatic site to a non-aquatic site or permanent rising of the bed elevation. In addition to the dredged material, some of the material excavated from the top three feet of the chute alignment and an additional 2,600,000 cubic yards would also enter the Missouri River as the chute widens through natural processes. The Corps has taken actions in project design to adequately minimize adverse effects to the substrate elevation and slope.

2) **Suspended particulates/turbidity:** Based on experience from other similar projects, the proposed plan would result in minor, short-term impacts to suspended particulates and an increase in turbidity during project construction. The clean fill excavated during chute construction and placed in the Missouri River/adjacent wetlands would not violate any general criteria of the Missouri Water Quality Standards, 10 CSR 20-7.037(3) (A)-(H). Suspended particulates and turbidity would increase during construction activities. These increases would be most evident at the discharge point and would quickly fall within baseline conditions in

DRAFT

the mixing zone. Extensive monitoring of existing chutes which are currently developing indicate little if any difference from baseline conditions in the adjacent main river channel. The Corps will continue to monitor water quality at this site during construction and as it develops post-construction. No significant adverse impacts to the chemical and physical properties of the water column were identified.

3) No long-term negative impacts are expected.

4) **Water:** The project would not result in any long-term negative impacts to water quality.

- **a)** **Salinity:** Not applicable.

- **b)** **Water Chemistry:** Minor, temporary, and localized effects to water chemistry (see below) would primarily include an increase in turbidity due to construction activities.

- **c)** **Clarity:** A minor temporary increase in turbidity would potentially occur during construction of the project that could impact clarity. This would be greatest at the discharge point and quickly fall within the existing baseline condition in the mixing zone. Even at the increased level within the mixing zone the clarity would be within baseline conditions of the pre and post-BSNP Missouri River and therefore not expected to adversely impact native species (see Section 5.5 Water Quality of the PIR/EA).

- **d)** **Color:** A minor temporary change in color is possible due to the potential increased turbidity. Similar to Clarity above, any color change would be greatest at the discharge point and would quickly become unnoticeable within a short distance in the mixing zone. Any changes in color would be expected to be within the range that is typically found where natural erosion occurs along the river or out of tributaries during high flow events and therefore not expected to adversely impact native species or result in adverse aesthetic impacts.

- **e)** **Odor:** No impacts are anticipated.

- **f)** **Taste:** Not applicable.

- **g)** **Dissolved Gas Levels:** No changes to dissolved gas levels are anticipated (see section 5.5 Water Quality of the PIR/EA).

DRAFT

h) **Nutrients:** The alluvial sediments and associated nutrients being mobilized to create SWH in the restoration areas of the Missouri River are materials deposited from river transport that are in temporary storage in the flood plain. Under natural conditions, the river would flood, rework, remove, and deposit these materials in a dynamic fashion. The sediment and phosphorus being remobilized now are thus not a net addition to the system. This material, or its equivalent, would have been transported through the system by natural geomorphic processes in an unaltered river. This activity will not adversely affect life forms in the immediate project area or in areas downstream. Even when compared to existing mainstem concentrations, nutrients mobilized to create SWH would have a statistically insignificant impact to the existing mainstem based on elutriate testing (see Section 5.5 Water Quality of the PIR/EA).

i) **Eutrophication:** The Corps concurs with conclusions reached by the National Research Council that the increased phosphorus load from SWH projects are not enough to significantly increase the areal extent of the Gulf of Mexico hypoxic zone nor is it appropriate to suggest that within any given year, Corps SWH creation efforts contribute to the areal extent of the hypoxic zone (NRC 2011).

5) **Current patterns and water circulation:** There are no anticipated changes to normal water fluctuations that would result from the proposed project. Up to 10% of the flow of the Missouri River may be directed through the proposed chutes. BSNP dikes would be modified so that there would not be any change to existing water elevation on the Missouri River within the vicinity of the project as a result of diverting water through the chutes. Excavated or dredged material placed into the Missouri River would not alter flow or circulation patterns substantially as the material would be placed in a manner and location that it would be integrated into the Missouri River bedload. As the chute banks would not be stabilized the natural river processes of the river would be restored along the chute alignment. This would allow the dynamic cut and fill process to create cut banks which would integrate additional sediment and woody debris into the river and create depositional areas where sand bars would form adjacent to the navigation channel. Restoration of this dynamic process is a critical element of the project purpose. Fish and wildlife resources would not be adversely impacted by the resulting change in current patterns and circulation. The project is designed to ensure that flows and sediment transport on the main channel of the Missouri River would not be adversely impacted. It is not anticipated that this would result in any adverse significant changes to the location, structure and dynamics of the

DRAFT

aquatic community, or the rate and extent of the mixing of dissolved and suspended components of the water body.

6) **Normal water fluctuations:** There are no anticipated changes to normal water fluctuations that would result from the proposed project. Up to 10% of the flow of the Missouri River may pass through the proposed chutes. BSNP dikes would be modified so that there would not be any change to existing water elevation on the Missouri River within the vicinity of the project as a result of diverting water through the chutes.

7) **Salinity Gradients:** The proposed project would not impact any salinity gradients. The Missouri River is a freshwater system and this would not change as a result of the project.

b. Potential Impacts to the Biological Characteristics of the Aquatic Ecosystem (Subpart D)

1) **Threatened and endangered species:** The federally listed endangered Indiana bat (*Myotis sodalis*) and the proposed to be listed northern long-eared bat (*Myotis septentrionalis*) are presumed to occur in the project area because of suitable foraging and/or roosting habitat in and around the project area. The proposed action would require the removal of 7 acres of riparian forest. To minimize any potential impact to bats, a survey would be conducted prior to removing any trees that provide suitable roosting habitat if trees are removed during the roosting season. Removal of any trees that threatened or endangered bats may be using would be avoided until such time that they are not being used. This would be coordinated with the U.S. Fish and Wildlife Service. Over time, the generation of up to 653 acres of woodlands on lands that have recently been in cultivation would be beneficial for the Indiana and northern long-eared bats, providing additional roosting and foraging habitat.

   The creation of approximately 111 acres increase of shallow water habitat would benefit the federally threatened decurrent false aster (*Boltonia ducurrens*) and the federally endangered pallid sturgeon (*Scaphirhynchus albus*). Decurrent false aster is found along riverbanks, in wet prairies, in marshes, old fields, roadsides, and mudflats. The Corps is required to develop shallow water habitat and improve floodplain connectivity as described in the BiOp. Over the long-term, the proposed action would improve floodplain connectivity through the creation of SWH, and by notching the existing levee. The proposed action would not adversely affect pallid sturgeon, Indiana bats, northern long-eared bats, or decurrent false aster.

2) **Fish, crustaceans, mollusks, and other aquatic organisms in the food web:** The project would not result in significant adverse impacts to aquatic

DRAFT

organisms. Minor, short-term impacts to the aquatic community may result from the smothering of immobile organisms, direct displacement of organisms, and an increase in turbidity, during project construction. The impacts may affect individual organisms in a limited stretch of the Missouri River, but would be unlikely to have a significant impact on the overall population of any particular species within the river system. Long-term, there would be a positive impact to the aquatic ecosystem by diversifying aquatic habitat by providing approximately 111 acres of shallow water habitat. No significant adverse long-term impacts are anticipated.

3) **Other wildlife:** Wildlife associated with aquatic ecosystems includes resident and transient mammals, birds, reptiles, and amphibians. There would be minor, short-term impacts to these types of wildlife as a result of construction activities. All disturbed land areas would be seeded with native grasses as part of project construction. The project is intended to benefit federally endangered pallid sturgeon and other native fish and wildlife species. No significant adverse long-term impacts are anticipated.

c. Potential Impacts on Special Aquatic Sites (Subpart E)

1) **Sanctuaries and Refuges:** The project area would be managed by the U.S. Fish and Wildlife Service as part of the Big Muddy National Fish and Wildlife Refuge following project construction. The proposed action would benefit the refuge.

2) **Wetlands:** The proposed action would not result in any net change in the acres of wetland habitat. Constructing the chutes and placement of the soil from the top three feet would adversely impact about 61 acres of farmed wetlands. Additionally, there would also be impacts to the hydrology on another 141 acres of farmed wetlands. These impacts would be mitigated by constructing earthen berms to create new wetlands and maintain suitable hydrology on existing farmed wetlands, seen on Figure 4, so that there would be no overall net loss of wetland habitat. The earthen berms would be approximately 4 feet tall. Up to 200,000 cubic yards of soil excavated from the top three feet of the chute alignments would be used to create earthen berms to mitigate for impacts to farmed wetlands resulting from constructing the chutes. The location of the impacted wetlands, berms, and new wetland areas were shown previously in Figure 2. As a result of mitigating impacts, proposed action would not result in any long-term significant impacts to wetland habitat. In addition, floodplain connectivity would be improved to approximately 1,200 acres of land that is currently protected by a levee.

3) **Mud flats:** No mud flats would be impacted by the proposed project.

DRAFT

4) **Vegetated shallows:** No vegetated shallows would be impacted by the proposed project. Because of the velocity of the Missouri River, little to no rooted aquatic vegetation is located within the project area. The proposed action may result in some vegetated shallows in the shallow water habitat areas.

5) **Coral reefs:** The project area does not provide the necessary environmental conditions to support corals.

6) **Riffle and pool complexes:** Because of the low gradient and sandy/silty nature of the Missouri River in the vicinity of the project site, a stable riffle and pool complex does not exist.

d. Potential Effects on Human Use Characteristics (Subpart F):

1) **Municipal and private water supplies:** The project would not impact any municipal or private water supplies. Navigation would not be adversely impacted by the proposed action. Dredge discharge schedules would be implemented to insure that the assimilative capacity of the river is not exceeded and navigation is not negatively impacted.

2) **Recreational and commercial fisheries:** The project would not affect the suitability of any recreational or commercial fisheries. The proposed action is expected to benefit aquatic organisms, including species targeted by recreational and commercial fisheries.

3) **Water-related recreation:** The project would not impair or destroy any resources which support water-related recreation activities. There may be minor, short-term impacts to recreation during project construction due to restricted access on the property. Long-term, creation of chutes may provide additional recreation opportunities.

4) **Aesthetics:** The project may result in minimal impacts to the aesthetics of the area as a result of land disturbance during project construction. This impact will be minimized by planting native vegetation in the areas disturbed by the construction process. At full maturity the creation of the chutes would result a landscape that is more conducive to historical views of river braiding, side channels, and riparian forests.

5) **Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves:** The project would not impact any of the above mentioned property types.

DRAFT

5. Evaluation of Dredged or Fill Material (Subpart G)

a. **General evaluation of dredged or fill material:** Dredged and fill material associated with the project would include clean earthen fill material hydraulically dredged and/or mechanically excavated from the bed and banks of the Missouri River, clean rock riprap obtained from commercial sources or from existing BSNP structures, and woody debris including tree root wads, large trunks and limbs.

b. **Chemical, biological, and physical evaluation and testing:** A detailed description of the results from the soil testing of the proposed fill material can be found in the Sections 4.3, 4.6 and 5.5 of PIR/EA. Additionally, prior experience indicates that commercially available rock fill would be free from chemical, biological, or other pollutants. There is no reason to believe that the earthen material or the clean rock fill would be a carrier of harmful contaminants.

6. Disposal Site Delineation (§230.11 f)

The discharge sites would be the Missouri River and farmed wetlands adjacent to the chute alignments. Dredged material would be placed between the existing dike field on the left descending bank and the deep portion of the Missouri River channel. A portion of the dredged material would be immediately transported downriver, and a portion of it would be captured by the dikes. This would slow down the rate at which sediment would be mobilized into the main river channel and reduce any potential impacts to lock structures downstream on the Mississippi River.

7. Actions to Minimize Adverse Effects (Subpart H)

The Corps has taken steps to minimize impacts that include implementation of project appropriate construction BMPs. Several measures would be implemented during construction to minimize water quality impacts that would include both structural and non-structural BMPs. Structural BMPs include: perimeter controls that may include straw bales and/or silt fencing and earthen berms. Non-structural BMPs would include: keeping heavy construction equipment out of the waterway whenever possible, protecting construction materials, to include petroleum products, from precipitation/ flooding, and stabilizing bare soil by mulching, re-vegetating exposed soil. Utilizing erosion control to prevent sediment from entering existing wetlands adjacent to the chute alignment and preventing deleterious material from entering the adjacent wetlands or the Missouri River are examples of BMPs that would be used to reduce the amount of potential pollutants that reach the water resources adjacent to / downstream of the project area.

DRAFT

8. Factual Determinations (§230.11)

A review of the information in items 4 through 7 of this report indicates that there is minimal potential for long-term environmental effects of the proposed discharge. Additionally, there are not expected to be any adverse cumulative or long-term, secondary impacts as a result of the project.

9. Findings (§230.12)

The proposed Cora Island Missouri River Recovery Project has been evaluated and determined to be in compliance with Clean Water Act Section 404(b)(1) guidelines, with the inclusion of appropriate and practical conditions to minimize pollution and adverse effects on the aquatic ecosystem.

DRAFT

Prepared by: ______________________________ ____________

Mr. Jesse Granet — Date
Environmental Resources Specialist
Environmental Resources Section

Prepared by: ______________________________ ____________

Mr. Todd Gemeinhardt — Date
Fish Biologist
Environmental Resources Section

Reviewed by: ______________________________ ____________

Mr. Jason Farmer — Date
Chief, Environmental Resources Section

Approved by: ______________________________ ____________

Andrew D. Sexton — Date
Colonel, Corps of Engineers
District Commander

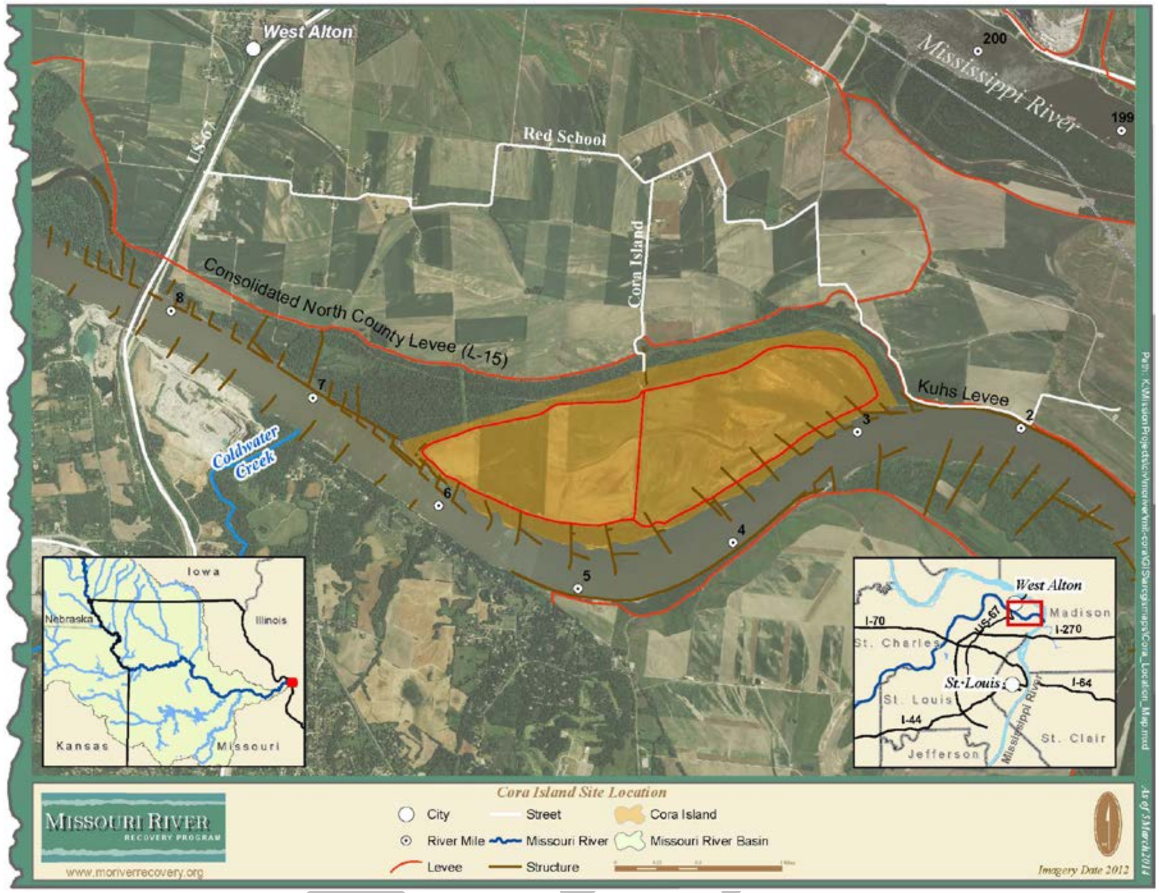


Figure 1: Cora Island, St. Charles County, Missouri.

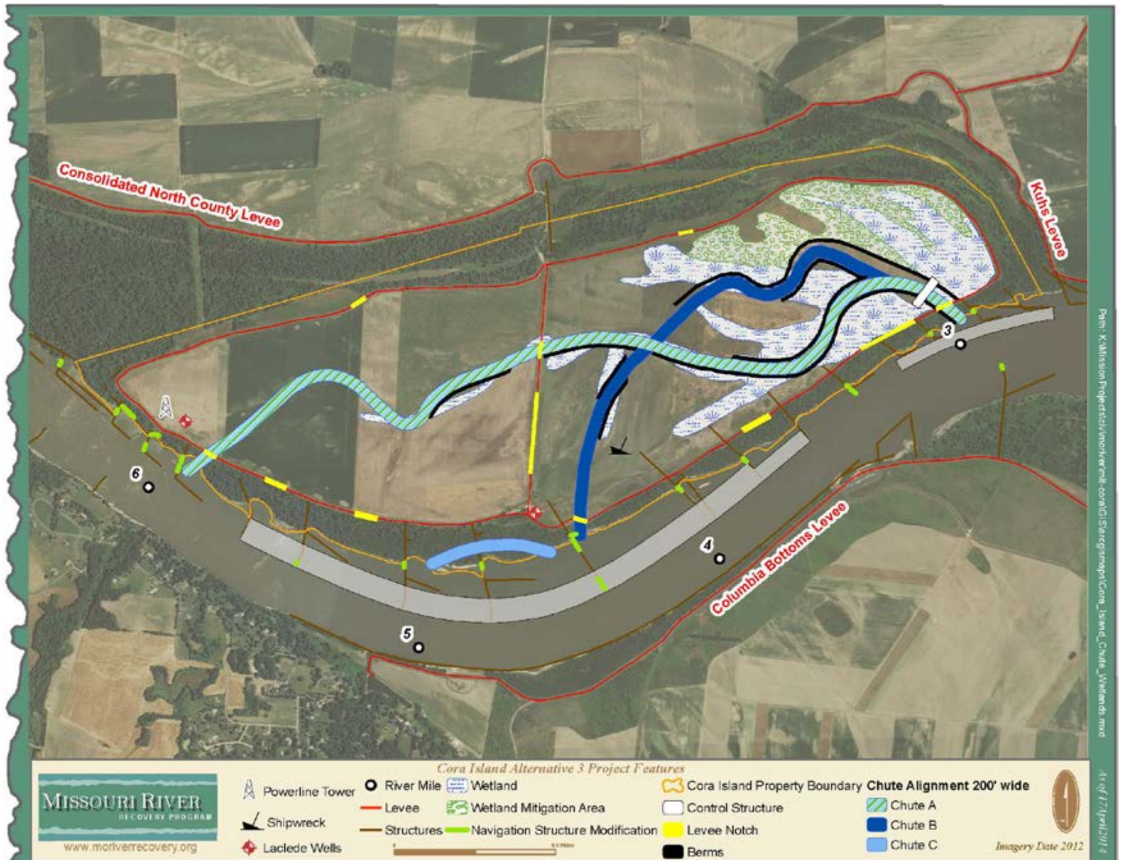


Figure 2: Features included in proposed action.

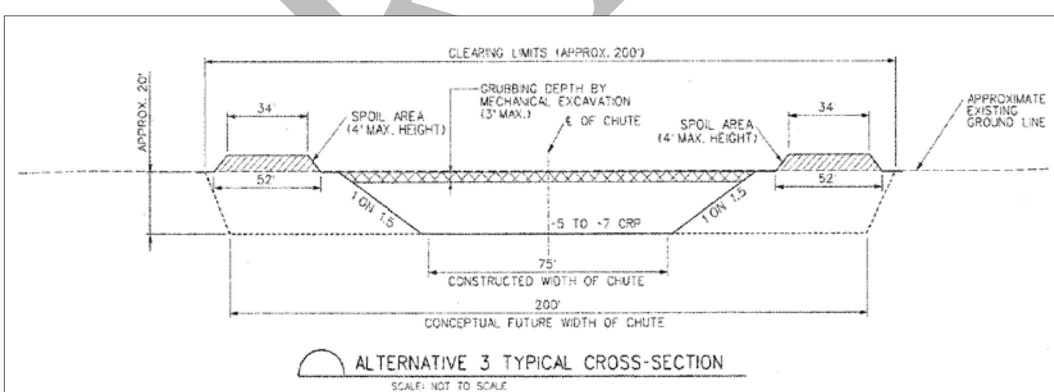


Figure 3: Typical cross section for proposed chute.

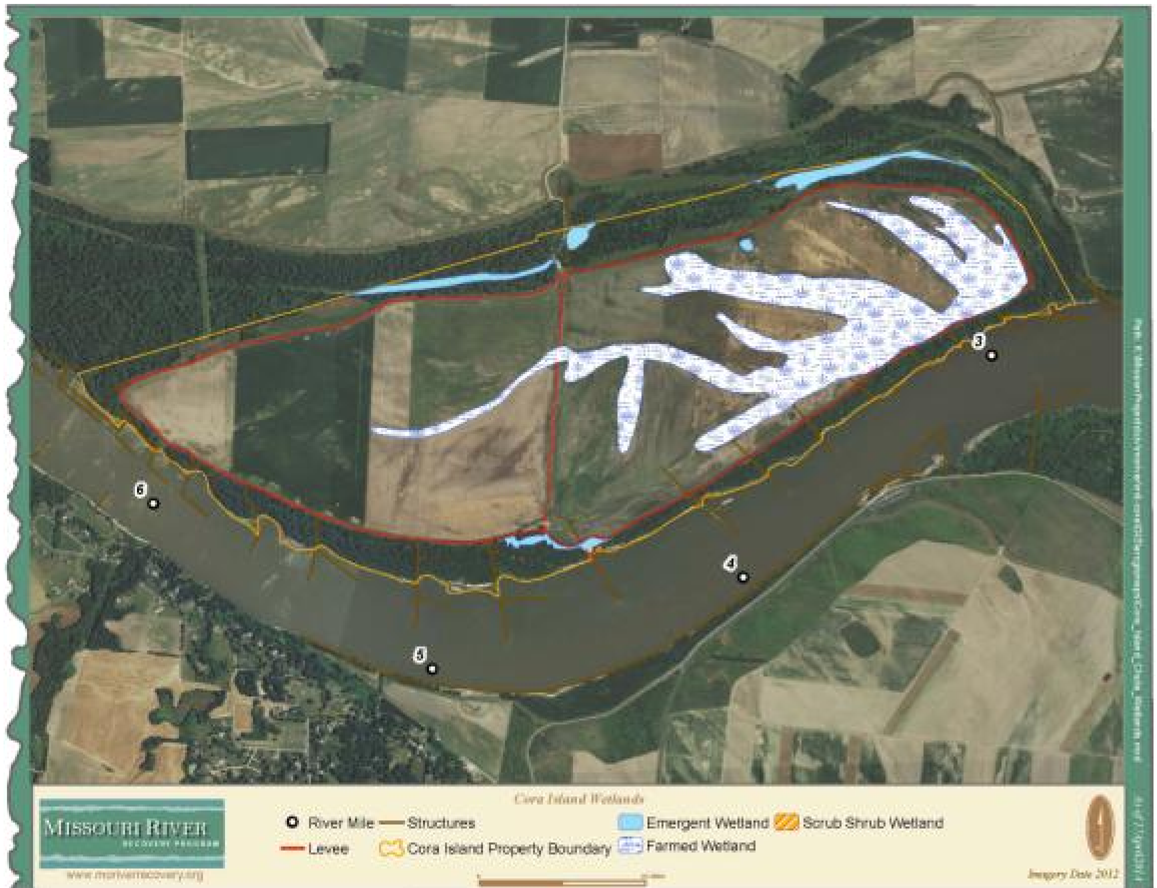


Figure 4: Wetlands located within the Cora Island project site.

DRAFT

APPENDIX H

Adaptive Management Strategy

Adaptive Management Strategy for Creation of Shallow Water Habitat

Version 5.3
Operational Draft
July 2012

Table of Contents

Note to the Reader

The following document describes an Adaptive Management Strategy for Shallow Water Habitat (SWH) developed for the Missouri River Recovery Program. This document is a joint product of the US Army Corps of Engineers (USACE) and the US Fish and Wildlife Service (USFWS). Although other groups and agencies referenced in this document have contributed to its development and may be involved in the implementation process described, this document has not necessarily been endorsed by any of these interests.

1 Introduction

The following Adaptive Management (AM) Strategy addresses the Shallow Water Habitat Program (SWH), one component of the Missouri River Recovery Program (MRRP). The MRRP was developed in response to the *Biological Opinion to the U. S. Army Corps of Engineers operation of the Missouri River Main stem Reservoir System, Bank Stabilization and Navigation Project (BSNP), and Kansas River Projects* released in 2000 and amended in 2003 (USFWS 2000, 2003; hereafter, BiOp) and Bank Stabilization and Navigation Project Fish and Wildlife Mitigation (BSNP Mitigation) authority under which these actions are implemented. Collectively, this authority and the requirements of the BiOp call for implementation of habitat restoration actions, water management actions, and stocking actions to aid in the recovery of three federally-listed species (pallid sturgeon *Scaphirhynchus albus*, piping plover *Charadrius melodus*, and least tern *Sterna antillarum*), one species that has been de-listed (bald eagle *Haliaeetus leucocephalus*), and other native fish and wildlife species. The SWH Program is an effort to implement habitat restoration actions (i.e. shallow water habitat creation) for pallid sturgeon. This AM Strategy will ultimately be a component of a yet-to-be-developed comprehensive AM Strategy for the MRRP.

The high levels of complexity and uncertainty associated with SWH creation efforts and the fact that these efforts are currently underway in response to a prescriptive BiOp (USFWS 2003) with deadlines of completion within the next 10-15 years, warrant immediate and detailed attention to this aspect of the MRRP. As such, this SWH AM Strategy was developed to address the performance of these habitat restoration actions. This suite of management actions is part of the broader MRRP and is related to two of the primary goals of the program:

1) Support recovery of pallid sturgeon by helping to restore a self-sustaining population on the Missouri River in order to ensure that operations on the Missouri and Kansas rivers do not jeopardize the continued existence of pallid sturgeon
2) Improve the quantity and quality of fish and wildlife habitat and increase fish and wildlife populations and recreational opportunity along the Lower Missouri River to mitigate the habitat lost as a result of the Missouri River BSNP

General hypotheses associated with SWH creation are:

- SWH supports recruitment of pallid sturgeon and other native fishes by providing areas for the retention and rearing of larval, young-of-year (YOY) and small-bodied fishes.
- In doing so, SWH creation addresses potential bottlenecks to pallid sturgeon population growth related to poor survival and recruitment of larval/YOY fish.

Figure A depicts a general decision tree which includes numerous specific hypotheses related to SWH. For additional hypotheses, Conceptual Ecological Models, and explanation of this decision tree, see Appendix A.

Figure A: Decision tree for monitoring results related to shallow water habitat.

SWH creation to support pallid sturgeon and other native species is pursuant to compliance with the BiOp and implementation of the BSNP Mitigation Project. Objectives and performance metrics were developed within the scope of the SWH sub-program with these two expressed purposes in mind. Modification of in-channel structures, widening of the main channel, and creation of chutes and backwaters are currently the primary management actions proposed for implementation. Channel widening and chute and backwater creation can only be achieved in areas where the USACE or a cooperating government agency owns the adjacent property, so this limits the areas in which SWH can be created.

This document describes the objectives, performance metrics, management actions, monitoring, and investigations that will be undertaken to implement the SWH sub-program, track progress towards meeting objectives, resolve uncertainties related to implementation, and determine when adjustments to individual sites or to the sub-program are needed to better achieve stated objectives. Objectives developed for this AM Strategy focus on the anticipated physical and biological responses to SWH creation. These objectives and their associated performance metrics are provided in Section 2.

1.1 **Background**

The geographic area for SWH creation (Ponca, NE to the mouth of the Missouri River near St. Louis, MO) corresponds with target river segments 11-15, identified for SWH restoration in the BiOp. This area includes the channelized reach of the Missouri River below the most downstream dam (Gavins Point) with the exception of the unchannelized Segment 10 (Yankton, South Dakota to Ponca, Nebraska) where SWH is already abundant.

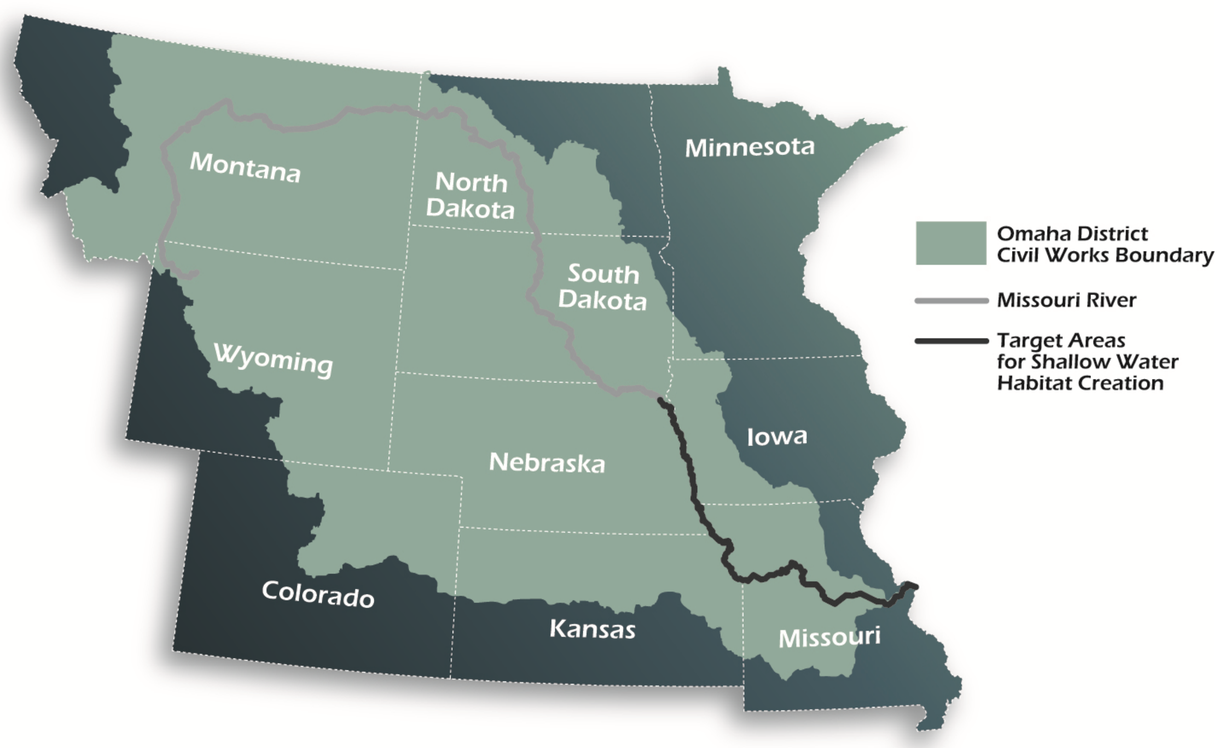


Figure B: Geographic Extent of SWH Program

The Water Resources Development Act of 1986 first granted the USACE authority to undertake SWH creation as part of an effort to mitigate for the impacts of the BSNP on habitat important to native fish and wildlife in the Missouri River from Ponca, Nebraska to St. Louis, Missouri. Four years later, the pallid sturgeon was listed under the Endangered Species Act. This was followed by a 1990 draft Biological Opinion from the USFWS on the operations of the Missouri and Kansas River systems. In 1992, a program was initiated to propagate pallid sturgeon to circumvent the apparent reproduction/early life stage bottleneck to population growth by releasing hatchery-raised fish. Creation of shallow water habitats on the Missouri River began in the mid-1990s with the creation of Hamburg Chute as part of the congressionally-authorized BSNP Mitigation Project. In 1995, a study of Missouri River benthic fishes, including pallid sturgeon, was initiated (Berry and Galat 2001). In 1999, the BSNP Mitigation Project was re-authorized with additional acreage added to the project (USACE 2003). Following this re-authorization, the total acreage of land authorized for acquisition and development was 166,750 acres which includes between 7,000 and 20,000 acres of SWH (USACE 2003). The total project cost for the modified Mitigation Project is estimated to range between $740,000,000 and $1,330,000,000 which includes between $500,000,000 and $900,000,000 of engineering and habitat creation and between $45,000,000 and $80,000,000 for monitoring and evaluation (USACE 2003). Costs for the SWH portion of this estimate are not broken out in the 2003 cost estimate. Between FY 2004 and FY 2012 an average of $18,350,000 was spent per year on SWH and other BSNP habitat mitigation (excluding funds spent on the Yellowstone Intake Project) (USACE 2011).

Additional impetus for creation of SWH occurred with the BiOp. Under Section 7 of the Endangered Species Act of 1973 (ESA), the BiOp presents reasonable and prudent alternative (RPA) requirements for habitat restoration, creation, and acquisition related to restoration of SWH in the channelized portion of the Missouri River. The SWH restoration goal as outlined in the BiOp is to achieve an average of 20-30 acres of shallow water per mile of river. The near term targets of the MRRP were to reach 10% (2000 acres) of the SWH goal by 2005 and 30% (5,870 acres) by 2010. The 2010 and subsequent targets have been setback by as much as 4 years as a result of implementing the Yellowstone fish passage project as outlined in a letter from the USFWS to the USACE dated October 23, 2009. To date, the USACE has created approximately 3,443 acres of SWH, which increased the total available on the Missouri River system to approximately 9,479 acres (Jalili and Pridal 2010). The Missouri River 2011 flood may have affected these SWH areas and acres present and the USACE plans to conduct an assessment of SWH in 2012 when the flood waters recede.

1.2 **SWH Definition**

Shallow water habitat generally refers to main stem and off-channel areas of the Missouri River where water is relatively shallow and current velocities are low. The quantitative definition of SWH found in the BiOp is: *areas where water depth is greater than 0 but less than 5 feet (0-1.5m) and current velocity is less than 2ft/sec (0.6 m/s).* Further clarification was provided in the USFWS letter dated June 29, 2009 to the USACE (Appendix C). This clarification reflects provides additional qualitative description of shallow water habitat attributes (see excerpt below).

> *Shallow water habitats include side channels, backwaters, depositional sandbars detached from the bank, and low lying depositional areas adjacent to shorelines. Key physical components of SWH's are their dynamic nature with depositional and erosive areas, predominance of shallow depths intermixed with deeper holes and secondary side channels, lower velocities, and higher water temperatures than main channel habitats. Several critical questions that large-river ecology research needs to address is the issue of relative habitat size, the importance of SWH location relative to other habitat types, the influence of organic input and deposition and hydrograph influence.*

SWH is hypothesized to benefit young and small-bodied fishes in multiple ways if provided at the right time of year in synchronization with life-stage needs. It can provide areas of very slow current velocities critical for survival and retention of larval fishes (Schiemer et al. 2001). It also provides beneficial thermal conditions for larval fish by providing areas which warm quickly and attain more optimal temperatures for larval fish growth relative to the main channel (Schiemer et al. 2003). SWH provides beneficial feeding conditions by having higher retention rates of organic matter, phytoplankton, and zooplankton, and increased primary and secondary productivity relative to the main channel (Knowlton and Jones 2000; Bunn et al. 2003; O'Neill and Thorp 2011). Availability of these nursery habitats is critical because lack of food availability for larval fishes can result in high mortality within a short time (Gisbert and Williot 2007). SWH also reduces the risk of predation by providing refuge from predators (Schlosser 1991; Copp 1992; Ward and Sanford 1995).

Although the specific connection of SWH to the life history of individual species undoubtedly varies, the commonalities at early life stages across species such as small size, poor swimming ability, vulnerability to predators, and similar feeding requirements has pointed to the importance of SWH across a wide range of fishes (Welcomme 1979; Kwak 1988; Bovee et al. 1994; Scheidegger and Bain 1995; Bowan et al. 1998; Gozlan et al. 1998; Robinson et al. 1998; Schiemer et al. 2000; Freeman et al. 2001).

In the Missouri River, SWH has been found to support high fish species richness, especially for YOY fish (Pflieger and Grace 1987; Tibbs and Galat 1997; Berry et al. 2004; Sterner et al. 2009). As a result of the BSNP, however, surface area of the Missouri River was reduced by 67% and most of this reduction resulted from eliminating relatively productive chute and slack water areas (Morris et al. 1968). Another estimate indicates a loss of over 90% of the shallow water habitat between Ponca, NE and St. Louis, MO as well as a doubling of water velocities (Funk and Robinson 1974; USFWS 2000). These changes have resulted in a river with reduced retention ability (i.e. it is very efficient at moving water, LWD, particulate organic matter, young fish, etc.), loss of the most productive habitats (Morris et al. 1968) and decreased availability of suitable fish nursery/rearing habitats. Similar findings have been reported for other river systems (Gehrke et al. 1993; Jurajda 1995; Humphries and Lake 2000; Aarts et al. 2004). It is hypothesized that diminished pallid sturgeon recruitment and reduced recruitment of other species is due to a bottleneck at the larval/YOY stage caused by loss of these nursery areas (USFWS 2000, 2003). Other competing hypotheses ascribe lack of pallid sturgeon recruitment to lack of adequate numbers of reproductive adults, lack of functional spawning habitat, lack of environmental spawning cues, and lack of egg-incubation habitat (among others). Nevertheless, lack of SWH has arisen as a prominent hypothesis to explain diminished recruitment (Quist et al 2004; Bergman et al, 2008).

It is hypothesized that lack of pallid sturgeon recruitment and reduced recruitment of other species is due to a bottleneck at the larval/YOY stage caused by loss of these nursery areas (USFWS 2000, 2003).

1.3 Summary of SWH-related monitoring and investigations to date

In 2001, the Pallid Sturgeon Population Assessment Program (PSPAP) was initiated to document trends in pallid sturgeon and native fish communities. Monitoring efforts continue to show a diminished lack of natural recruitment in the pallid sturgeon population. Observed population growth results almost entirely from stocking of age 1 fish (USFWS, 2007). Information garnered from pallid sturgeon propagation and related monitoring efforts indicate that juvenile pallid sturgeon will survive if stocked in the system. Additionally, sturgeon tracking efforts indicate that spawning is occurring in the system under a variety of conditions. As there is little natural recruitment of pallid sturgeon in this segment of the Missouri River, this indicates that a likely bottleneck to natural recruitment is between egg fertilization and the YOY stage. The closest tie for this period of life history to the hypothesized function of shallow water habitat is to capture larval drift and provide the right type of food in an area this life-stage occupies. The hypothesis that SWH is limiting to natural recruitment of pallid sturgeon provides a clear focus in the objectives of the SWH AM strategy.

The "Missouri River Fish and Wildlife Mitigation Program Fish Community Monitoring and Habitat Assessment of Off-Channel Mitigation Sites" was conducted from 2006-2008 with an objective to "determine biological performance and functionality of chutes and backwaters and to compare chutes and backwaters in an effort to identify designs most beneficial to native Missouri River fish species" (Sterner et al. 2009). This effort provided evidence that chutes provided habitat for young benthic riverine fishes while backwaters provided habitat for different species of fish such as sunfishes, shads, temperate basses, and sauger. It also provided evidence that natural chutes and older created chutes had more diverse fish communities when compared with younger created chutes. The study also provided evidence that chutes that were longer, wider, shallower, and more sinuous were more likely to have target species present. Evidence was also provided that "juvenile and small-bodied fish utilized shallow water habitats (<1.0 m) over a broad range of water velocities (0.0-1.0 m/s), but large-bodied fishes tended to orient towards relatively deeper water" (Sterner et al. 2009).

In 2006, the Habitat Assessment and Monitoring Program (HAMP) was initiated to evaluate the physical and biological responses to structure modifications/additions designed to increase SWH within the main channel (Hall and Sampson 2009). HAMP used a Before-After/Control-Impact design focused at the river bend level to monitor fish communities and depth/velocity distributions in both "treated" and "control" bends. A 2010 analysis of HAMP data collected to date did not detect any differences in fish catches between treated and control bends and pointed to a need to evaluate explicit hypotheses related to the role of SWH (Schapaugh et al. 2010) to determine why. This analysis also developed numerous recommendations for future SWH monitoring efforts including:

- Develop life-history models connected to habitat metrics for each species of interest
- Collect data linking specific strategies for increasing SWH with productivity at multiple spatial scales
- Repeat the 2007 physical habitat survey to begin estimating rates of change in SWH for different practices, and ensure the information is available to compare with fish sampling data
- Any redesign of the monitoring program must include new power analyses that take advantage of recent methods for analyzing count data and are directly connected to information needs for decision making
- Hierarchical sampling at more than one spatial and temporal scale (e.g. among neighboring bends, at bends, and within bends at creation sites) should be considered in future re-visitations of the sampling design
- Collect additional measures of productivity (linked to life history) that respond quickly and can be detected within each bend.

In 2008, a water quality monitoring program for the MRRP was initiated which is partially aimed at addressing the effects of SWH projects on water quality, especially those related to sediment reintroduction and potential nutrient and contaminants inputs during SWH creation efforts (USACE 2010).

In addition, two conferences were held to identify and prioritize research needs related to pallid sturgeon. The first was held in 2004 in Bloomington, MN (Quist et al. 2004) with the second held in 2007 in St. Louis, MO (Bergman et al. 2008). From each of these conferences, a need for increased research on early life stages was emphasized among priority information needs.

In 2004, the Comprehensive Sturgeon Research Project (CSRP) was initiated to address some of the fundamental research needs for understanding pallid sturgeon reproductive biology (DeLonay et al. 2010). Publications from this ongoing project address reproductive ecology, movements, physiology, habitat use and dynamics, spawning site selection, and population dynamics. These studies have found that pallid sturgeon in the Lower Missouri River grow and mature to reproductive age; they migrate upstream to spawning sites where it has been demonstrated that they are capable of finding each other prior to spawning; spawning has been documented repeatedly on outside, revetted bends, a habitat that is not rare in the channelized portion of the Missouri River. Hatchery released fish have also matured to reproductive age and have been demonstrated to have spawned. Successful fertilization, hatch, drift, and development to young-of-the-year stage from eggs deposited at known spawning sites has not been demonstrated and remains the subject of intensive research (DeLonay et al, 2010). These studies have found that pallid sturgeon mature, they are capable of finding each other prior to spawning, and they spawn. Hatchery released fish have also matured and spawned and appear to survive well. Studies have also found the types of areas where pallids are currently spawning do not appear to be rare. These findings continue to support the idea that a bottleneck is occurring somewhere between the act of spawning and recruitment to age 1, although it is also possible that the number of reproductive adults is inadequate or too broadly distributed spatially to result in measurable levels of recruitmentment.

Numerous other investigations have been undertaken to address uncertainties related to pallid sturgeon including a 2007 study seeking to quantify trophic position of pallid and shovelnose sturgeon, (French 2010), a 2007 effort to address vulnerability of age-0 pallid sturgeon to predation (French 2010), a pair of 2008 pallid sturgeon iridiovirus studies (Beck et al. 2008) (Hendrick et al. 2009), a 2008 study addressing sediment management which related in part to the input of sediment due to SWH projects (Jacobson et al. 2009; NRC 2011), and a 2009 combined laboratory and field study of growth and survival of larval pallid sturgeon (Graeb et al., 2009).

1.4 Uncertainties

There are numerous uncertainties associated with the construction of SWH and the degree to which the management actions may or may not meet the program objectives provided in Section 2 of this Strategy. While many of these uncertainties may be addressed through monitoring (see Section 4), focused investigations (see Section 5) will also be necessary to address uncertainties that cannot be addressed through planned monitoring activities.

1.4.1 Time needed for habitat development

One significant source of uncertainty is the time needed for full development of habitat after a construction activity. As hard constraints to river morphology are altered through restoration activities, natural erosional and depositional processes act to create and maintain SWH. Although these habitats may be primarily erosional at the onset, the river channel and associated SWH should eventually reach a dynamic equilibrium governed by discharge and sediment supply. However, there can be a significant lag time (many years, even decades) between the management action of constructing SWH and the desired condition of the habitat (Jacobson et al 2001; Jacobson et al. 2004). The amount of time needed for development of different types of SWH projects due to hydrogeomorphic processes is somewhat uncertain and depends on flows, project type and design, and location. Understanding the rate and likelihood of habitat progression is critical in understanding expected timeframes for biological responses.

1.4.2 Habitat-benefit relationship

Over 100,000 acres of SWH was lost as a result of the BSNP and to date only a fraction of that has been restored (USACE 2003). The target acreage in the BiOP is 20% of the historic acreage. Benefits of SWH to fish species may be cumulative in nature, non-linear, or governed by thresholds. Population-level benefits to the pallid sturgeon and the native fish community may not be measurable until a significant amount of habitat is restored. It is uncertain how much habitat may be needed in order to begin measuring these benefits through population-level responses.

1.4.3 Benefits to Pallid Sturgeon

It is hypothesized that SWH benefits pallid sturgeon by slowing larval drift/increasing retention of larval fish, by providing nursery areas for larval/YOY fishes, and by increasing production and/or retention of food sources in these areas of the Missouri River. Hypothesized links between SWH creation and the life history of pallid sturgeon are depicted in the CEM and associated hypotheses (Appendix A). Although creating SWH is necessary to restore a semblance of natural form and function to the Missouri River, the extent to which lack of SWH is inhibiting individual species, most notably pallid sturgeon, is uncertain.

1.4.4 Scale of SWH projects

Habitat benefits to species may depend on size, complexity, and connectivity of habitat patches. For Missouri River native fishes, including pallid sturgeon, it is uncertain whether fewer large SWH projects or many small SWH projects have different benefits for target species. Additionally, the potential benefits of clustering SWH in complexes are unknown.

1.4.5 Distribution relative to other habitat types

The current spatial distribution of SWH projects has resulted mainly from where land ownership has provided opportunities for construction and to provide a somewhat even distribution of projects across target segments. The distribution which would optimally benefit pallid sturgeon is uncertain. For example, it is unknown whether projects should be concentrated upstream in areas where SWH is most scarce to aid in slowing larval drift or if instead projects should be concentrated downstream where larval sturgeon would likely “settle” out of the drift on today’s Missouri River. The potential importance of placing projects in specific locations, such as near the mouths of major tributaries, is also unknown. While distributing SWH evenly or proportional to historic distribution may make sense in relation to Mitigation Project objectives, this distribution may not be the most beneficial to pallid sturgeon (or some other native species) in today’s Missouri River.

1.4.6 The amount of habitat that can be restored without impacting navigation

Although SWH experience demonstrates that navigation and SWH restoration can coexist, it is uncertain exactly how much habitat can be restored before too much water is diverted from the main channel and navigation or other authorized purposes on the system are impacted.

1.4.7 Amount of SWH that needs to be restored

SWH addresses recommendations from the 2003 Amended BiOp, which called for restoration of 12,035-19,565 acres of SWH to meet an overall goal of 20-30 acres per river mile (15,060-22,590 total acres). SWH construction also addresses the provisions of the BSNP Mitigation Program which calls for 7,000-20,000 acres of habitat of this type (USACE 2003). It remains uncertain how much of this habitat is needed in order to achieve the ecological objectives and whether there is a linear relation between habitat area and ecological functions. Currently, about 3,443 acres have been constructed with the potential of those projects to produce twice that amount in the future as habitat develops (Jalili and Pridal, 2010). There are approximately 9,479 acres of SWH currently present between Ponca, Nebraska and St. Louis (Jalili and Pridal, 2010)

1.4.8 Relative benefits of different types of SWH

Under natural, historically-documented conditions, SWH existed in many forms including chutes, backwaters, and within-channel habitats. The relative amounts needed and benefits of each habitat type to fish communities are uncertain.

1.4.9 Water Quality

Missouri River basin land-use has been highly altered from its historical condition and water quality has been consequently diminished including increases in nutrients, bacteria, and some contaminants; decreases in sediment load and turbidity, and episodic sags in dissolved oxygen (Blevins and Fairchild 2001; Poulton et al 2003; Turner and Rabelais 2003). Bioaccumulation of PCBs, chlordane, and mercury in sturgeon has resulted in advisories to limit consumption of flesh and to never consume sturgeon eggs (MDHSS, 2011). Nevertheless, two recent studies of contaminants in sediments and associated effects in benthic insect communities identified only a few hot spots of contamination along the Lower Missouri River (Echols et al. 2008; Poulton and Allert 2011). These data indicate that there is potential for water quality and contaminants to adversely influence biological outcomes of SWH projects, but the magnitude of effects are currently unknown. Elutriate testing is currently conducted at all SWH sites prior to the start of construction activities in order to assess whether there is the potential for water quality to be adversely affected due to SWH construction.

Construction of SWH typically involves removing sediment from floodplains to expand the channel or off-channel area. Although floodplain sediments generally have low potential for contamination (Schalk et al. 1997; CDM Federal Programs Corporation 2007), concerns have been raised that delivery of this sediment to the Missouri River could deliver contaminants and excess nutrients. Calculations show that contaminants and nutrients that would be delivered to the Missouri River are low compared to background fluxes and are unlikely to pollute the Missouri River or contribute to Gulf Hypoxia (NRC 2011; Jacobson et al 2009). As a result of ongoing concerns, the USACE is conducting elutriate sampling prior to chute construction to better understand nutrient and contaminant contributions from habitat creation activities.

1.4.10 Interaction between flows and the availability and functionality of SWH

The benefits of restoring some natural form to the Missouri River (SWH construction) are not only dependent on changes to channel form but also the interaction with flows (Jacobson and Galat 2006). Biological outcomes may not be achieved even with desired changes to channel form if flows negatively affect the quantity, functionality, and timing of the SWH created. A more detailed understanding of this interaction in relation to pallid sturgeon, functionality of SWH projects, and authorized purposes may be needed.

2 Objectives

In evaluating SWH projects, one of the main challenges is defining expectations (i.e. what does success look like and how do we determine when it is achieved?). These expectations occur at several levels and each is important. First, it is necessary to understand whether management actions are creating the desired physical habitat characteristics. Much of the guidance for success criteria regarding physical habitat comes from the BiOp and associated clarified definition of SWH which describe target acreages, distributions, and general qualitative characteristics of SWH. Further detail regarding desired physical attributes can be obtained from the best examples of SWH currently present on the Missouri River (i.e. those habitats which best produce the desired biological responses). Since even the best current examples of SWH are altered it will also be important to compare to historic conditions where possible. Historically-documented channel conditions and habitat distribution can provide a reference for the direction of restoration strategies. Additionally, a useful understanding of how processes likely operated in the pre-engineered Missouri River would be beneficial.

Determination of success in restoration of SWH is also dependent on defining a timeframe for evaluation. A long-term monitoring approach is required to assess the proposed performance metrics. For physical aspects of habitat restoration there is a need to understand timeframes required for created habitats to develop through natural processes (e.g. erosion and deposition), to a state of dynamic equilibrium. For example, excavation of a chute pilot channel may only require a few months but development of that pilot channel into a chute which resembles a more natural chute may take decades. The degree to which the desired progression occurs and the time required to achieve such a dynamic equilibrium is uncertain and has been identified as a critical uncertainty. Furthermore, in evaluating biological responses, it is important to understand the state of physical habitat development and the relationship to biological responses.

Next, it is necessary to understand whether the anticipated biological responses are occurring at the project scale. Because system-wide biological responses may not be observable until many SWH projects have been added to the system, project-level responses will be important in evaluating progress in the short term. Guidance regarding these project-scale metrics come from the inter-agency Aquatic Habitat Working Group (AHWG), the BiOp, and clarified definition of SWH, and an abundance of research on the importance and role of SWH in lotic systems. Project-scale metrics are also necessary to evaluate hypothesized linkages between SWH actions and pallid sturgeon identified in the CEM (Appendix A) as well as to evaluate performance of individual project designs. Although project-level responses are expected to occur as habitat develops, the relationship between habitat development and biological response may not be linear.

Finally, if the desired physical and biological responses are occurring at the project scale, the system-wide response (i.e. increasing abundance of pallid sturgeon and other native fishes) must be evaluated to determine if SWH creation is having the desired effect or if other means need to be considered. System-scale changes in populations of pallid sturgeon and the native fish community are likely to have a longer lag time and may occur slowly as more habitat is added to the system. For a very rare, long-lived, late-maturing fish like the pallid sturgeon, some responses may take even longer than those of other native fishes. Moreover, it is possible that populations of pallid sturgeon other native fishes are limited in part by other factors in addition to SWH quantity or quality, or that the relationship to SWH is non-linear or governed by thresholds.

The following objectives were developed to formalize the desired outcomes of the SWH sub-program with respect to both the BiOp and BSNP Mitigation Project goals of benefitting pallid sturgeon and other native species. Where applicable, specific references are made to the connections between these objectives and conceptual life history models for pallid sturgeon. The primary management action of creating SWH is meant to accomplish the fundamental objective of increasing the abundance of pallid sturgeon and other target fishes (Obj. 1) by increasing the overall abundance of SWH throughout the target segments (Obj. 2). SWH creation aims to restore some of the natural form and function of the Missouri River by increasing the physical habitat complexity as measured in changes to key physical parameters (Obj. 3). As a result of physical changes to channel form, biological responses are expected to occur at the project scale (Obj. 4) and as more SWH is added to the system, biological responses are expected to occur at larger scales including increased abundance of pallid sturgeon and other target species (Obj. 1). Progress toward all four objectives will be assessed at multiple scales.

The fundamental objectives related to population growth of pallid sturgeon and other native fishes are supported by "means" objectives related to the desired physical habitat changes and intermediate biological responses.

Fundamental objectives

2.1 System-wide responses of pallid sturgeon and other target fishes

With regard to the goals of implementing the BiOp, increasing abundance of wild pallid sturgeon is a fundamental objective of SWH creation. Although other objectives are important for the BSNP Mitigation Project and for evaluating hypothesized linkages between SWH actions and pallid sturgeon, it is the response in the wild pallid sturgeon population that will ultimately determine success of SWH creation efforts in meeting BiOp compliance.

While targets for these metrics do not exist due to a lack of historic information, targets are framed in terms of population trends in demographics and catch rates that will be monitored over time. It should be noted that the below objectives, performance metrics, and targets refer to wild populations of pallid sturgeon.

Objective 1.1: Increase survival and recruitment of free embryos to exogenously-feeding larval pallid sturgeon
Performance Metrics: Catch rates of larval and YOY pallid sturgeon
Target: Increasing annual catch rates of larval and YOY pallid sturgeon

Objective 1.2: Increase survival and recruitment of YOY pallid sturgeon to age 1
Performance Metrics: Catch rates of YOY and age 1 pallid sturgeon over time, pallid sturgeon population size structure changes over time, changes in growth/condition over time
Target: Increasing annual catch rates of young and small bodied pallid sturgeon

Objective 1.3: Increase survival and recruitment of larval, YOY, and small-bodied big river, native fishes
Performance Metrics: Catch rates of young and small-bodied native fishes over time, changes in size structures of native fish populations over time, changes in growth/condition over time
Target: Increasing annual catch rates of young and small-bodied pallid sturgeon

Means objectives

2.2 Shallow water habitat creation and distribution

These objectives address habitat goals stated in the BiOp and the BSNP Mitigation Project and are used as a measure of progress in continuing the SWH management actions used to meet the fundamental objectives. Estimates of SWH acreage abundance indicate that, as of 2009, approximately 3,443 acres of SWH had been created (Jalili and Pridal 2010). Using acres provided in Table 1 of Jalili and Pridal (2010) from the Acres/Mile (GIS) column, it was derived that in segments 11-15, there are currently approximately 9,479 acres of SWH in these 753 river miles, or approximately 12.6 acres/river mile. While this is currently measured by a combination of surface area with representative bend samples of physical characteristics less than 5 feet deep and less than 2 feet/second) at the 50% exceedance August flow, the methodology outlined in the SWH AM Strategy for evaluating physical habitat changes and project-scale biological responses (Objectives 3 and 4) will provide the basis for future accounting of qualitative aspects consistent with the clarified definition of SWH.

Objective 2.1: Increase abundance of shallow water habitat
Performance Metric: Acres/mile of SWH
Measurement: Bathymetry / aerial photography / structure modification assumptions
Initial Target: 19,565 acres of SWH in the target Missouri River segments by December 31, 2024

Missouri River segments for restoration of SWH derived from the BiOp include:

- Segment 11: Ponca, Nebraska to Sioux City
- Segment 12: Sioux City to Platte River
- Segment 13: Platte River to Kansas River
- Segment 14: Kansas River to Osage River
- Segment 15: Osage River to mouth

Objective 2.2: Distribute SWH amongst target segments
Potential Performance Metrics: Acres of SWH per target Missouri River segment
Measurement: Bathymetry, aerial photography, structure modification assumptions
Initial Targets: Add constructed habitat to all segments in equal proportions to segment lengths

Current distributions of SWH are estimated to vary from 5.6 acres/river mile to 18.4 acres/river mile and tend to increase from upstream to downstream (Jalili and Pridal 2010). A literal interpretation of the BiOp could indicate that all of the target segments should have 20-30 acres per river mile of SWH and that focus should be placed on increasing the amount of SWH in areas that currently have lower amounts of habitat. However, the initial selected target is to add SWH to all target segments in proportion to the length of the segment. This is consistent with the BSNP Mitigation strategy which seeks to restore habitat in each State (Iowa, Nebraska, Kansas and Missouri) in proportion to the amount of Missouri River shoreline that State has. Table 1 uses the existing amount of SWH estimated in 2009 and displays this amount as a function of both acres/mile and total existing acres for each segment. As of 2009, this is estimated to be a total of approximately 9,479 acres, which is a deficit of 10,086 acres that must be restored to achieve a target of 19,565 acres. Distributing this 10,086 acres proportionally to segment length would result in adding approximately 13.4 acres / river mile to the existing SWH in each segment, resulting in a distribution ranging from approximately 19.0 acres / river mile to 31.8 acres / river mile.

It should be noted that investigations are needed to resolve uncertainties associated with the biological implications of SWH distribution. One investigation already undertaken has indicated that SWH is most critical for larval and juvenile sturgeon in Segments 14 and 15 (Delonay et al. 2009). This was based on an analysis of potential drift distances for pallid sturgeon larva. However, this study also describes the existing conditions in Segments 11, 12 and 13 and states that, in these segments, "…lack of marginal habitat probably limits retention of drifting larvae" (Delonay et al. 2009). As such, there may be some benefit to placement of SWH in upstream segments to reduce drift distances of larval pallid sturgeon as well as in downstream segments to provide larval and juvenile rearing habitat. This objective has the potential to affect both the "free embryo to larval stage" of pallid sturgeon due to effects on drift distance, as well as the "larval stage" by providing productive habitat conditions in areas where sturgeon are likely to fall out of drift and start feeding (Wildhaber et al. 2011). Once these uncertainties are resolved, the target for this objective will be updated to reflect the biological needs associated with habitat distribution.

Table 1: Current and Target Distributions of SWH

Segement	River Miles in Segment	Existing SWH Acres / Mile (2009)	Existing SWH Acres (2009)	Acres of SWH to be Restored	Acres / Mile of SWH to be Restored	Total Target Acres	Total Target Acres / Mile
11: Ponca to Sioux City	18	5.6	101	241	13.4	342	19.0
12: Sioux City to Platte River	139.5	5.6	781	1,869	13.4	2,650	19.0
13: Platte River to Kansas River	228	9.4	2,143	3,054	13.4	5,197	22.8
14: Kansas River to Osage River	237.1	17.1	4,054	3,176	13.4	7,230	30.5
15: Osage River to St. Louis	130.4	18.4	2,399	1,747	13.4	4,146	31.8
Total	**753**		**9,479**	**10,086**		**19,565**	

2.3 Physical characteristics of created shallow water habitat

These objectives address physical habitat changes and uncertainties related to whether SWH projects result in the desired physical changes. Analysis of progress will compare physical characteristics of created sites, best-achievable sites, historic conditions where available, and the main stem of the Missouri River. Note that best-achievable SWH has not yet been defined. Best-achievable habitat will be the habitat(s), whether natural or constructed, that best meet metrics set out in the SWH AM strategy. The PDT will define best-achievable habitat after data has been collected and analyzed (see Investigation #2 under Section 5).

Objective 3.1: Emulate depth and velocity distributions of best-achievable habitats
Performance Metrics: Depth and velocity distributions at median August flow levels
Measurement: Bathymetric and acoustic Doppler surveys
Target: Use comparison to best-available habitats

While there may be some initial change following construction, achievement of this objective may require a longer period of time as created habitats develop through erosion and deposition. Also, the time needed to reach a dynamic equilibrium in habitat development may be heavily dependent on the frequency and duration of high flow events. A key component will be to track progress over time to determine whether habitat changes are occurring in the desired direction. Assessing the physical changes which are occurring as a result of management actions will be essential in understanding biological responses. Development of quantifiable metrics and targets for complexity is envisioned as a high-priority supporting investigation that can be accomplished through mining and analysis of existing and historic Missouri River morphology data or through the initiation of physical monitoring of both created and selected reference sites. Initial targets will be developed from collaboratively determined habitats in "best achievable" reference reaches identified along the Missouri River. Identification and measurement of "best achievable" reference reaches is also considered a high priority for supporting investigation. Another potential option for developing depth and velocity distribution targets would be to use a similar process to the one used in the Multi-Criteria Assessment for Habitat in the Missouri River (Stansbury et al, 2009); Stansbury et al note that their methods require reliable indicator values that would have to be collected specifically to meet the needs of the Assessment. While this effort was focused at the bend scale, it indicated that an equal frequency distribution of depth and velocities classes as measured at a site would be the ideal target. Although there are many physical metrics which could provide insight into the changes arising from management actions, the present focus will be on those metrics which are measurable and most closely linked to the ecological functions of SWH.

Depth and velocity have been the primary metrics used to define SWH. Although SWH can include a diversity of depths and velocities (according to the clarified definition provided by the USFWS), these habitats are intended to provide relatively slow, shallow water compared to the main stem. Very slow water velocities (i.e. a few cm/s) are critical for larval fishes especially, as swimming ability typically increases with size (Schiemer et al. 2001). Because of the ease of data collection and interpretation, depths may be used as the primary metric with evaluation of velocities at a subset of locations. Channel morphology is likely an important factor for all life stages of pallid sturgeon (Wildhaber et al. 2007). Additionally, depths and velocities are partially controlling factors for two of the other metrics of physical habitat complexity. Substrate size deposited in SWH is due to a combination of material present and water velocities. Retention of large woody debris (LWD) is due to depths, velocities and channel features.

Objective 3.2: Emulate substrate size composition found in best-achievable habitats
Performance Metrics: Substrate size distributions at median August flow levels
Initial Target: At least 20% silt and 20% sand

Substrate composition is thought to be an important determinant of habitat use by pallid sturgeon (Bramblett and White, 2001) and is a determinant of benthic invertebrate diversity and abundance (Anderson and Day, 1986; Beckett and Pennington, 1986, as cited in Poulton and Allert, 2011). Opportunities exist to affect substrate composition through changes to chute inlet structures, characteristics of notches, and modifications that affect velocity distributions within SWH. This would be measured at the project scale as the management actions proposed are not likely to affect the overall availability of different sediment sizes within the Missouri River below Sioux City, IA. The initial target of 20% silt and 20% sand was developed as part of the Multi-Criteria Assessment (Stansbury et al, 2009) and is likely to be updated based on monitoring results from best-achievable habitats.

Objective 3.3: Emulate the entrainment/retention of large woody debris found in best-achievable habitats

Performance Metrics: Abundance of large woody debris and bank slope at median August flow levels
Measurement: Count of woody debris pieces greater than 50 cm diameter, occurrence / $100m^2$
Initial Target: Use comparison to best-achievable habitats to develop target

Woody debris was historically much more abundant in the Missouri River and provided important habitat for macroinvertebrates as well as native fishes. Woody debris also provides structural complexity which can provide refugia for young fish and invertebrates. Today's Missouri River is very efficient at moving woody debris through the system (Archer 2010). The steep-sided, fast-flowing river provides few places to hold woody debris. Physical characteristics of created SWH should promote entrainment/retention of large woody debris. It should be noted that a laboratory study has shown that pallid sturgeon avoid woody habitat in favor of sandy substrates (Allen et al. 2007). However, there is a connection of LWD to pallid sturgeon life history in its ability to increase local abundance of benthic macroinvertebrates, which are the primary food sources for early life stages of pallid sturgeon (Grohs et al. 2009). In addition, LWD may provide habitat for small-bodied fish which are an important food source for immature to mature adult sturgeon. While the Multi-Criteria Assessment indicated that one acre of LWD per river mile might be a reasonable target (Stansbury et al. 2009), the current plan is to develop targets based on improved understanding of how to measure LWD and monitoring information from best achievable habitats.

Objective 3.4: Increase lateral connection of created habitat between the Median August flow level and the Ordinary High Water Mark (OHWM, defined as "… that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. [USACE, 2005].").
Performance Metric: Elevation profiles (bank slope), wetted area/river stage relationships, lateral movement of bank
Measurement: Use of elevation survey data, bathymetry during high water, development of flow exceedence-discharge relationships, aerial photography to measure extent of bank migration rates
Target: Use comparison to best-achievable habitats

Historically, the amount of SWH increased as river stages increased but today, due to channelization and the incised nature of the Missouri River, the amount of SWH decreases as river stage increases until the high bank is overtopped (Jacobson and Galat 2006). This is due to the loss of gradually-changing bank elevations replaced by steep, high banks. Restoring the direct relationship between river stage and SWH area at project sites is important in providing functionality characteristic of historic SWH at a range of flows and thereby decreasing reliance on specific flow targets (Jacobson and Galat 2006). Desired elevations (i.e. reduced bank slopes) evolve over time through erosion and deposition processes and will need to be evaluated over time and compared to initial conditions as well as the best examples of best-achievable habitats. It should be noted that a separate methodology and target was referenced in the Multi-Criteria Assessment based a measurement of the number of hectare-days inundated in a bend from March-June for the previous ten years (Stansbury et al, 2009). This may require a better understanding of the relationship of flows to floodplain inundation but may be revisited in the future as different potential metric for this objective. It should be noted that lateral connectivity, as it is used in this document, refers to a smaller sub-set of overall floodplain connectivity and the two terms are not synonymous.

Objective 3.5: Achieve chute design widths
Performance Metric: Average top-width
Measurement: Aerial photography
Target: Determined on a per-project basis

For chutes, one of the major types of created SWH, an important factor in their physical progression that may be used to trigger adaptive management adjustments is the achievement of "design width". Chutes are typically constructed as pilot channels with constructed channel widths that are far less than the ultimate desired, or designed, channel width. These projects are intended to widen and deepen over time through natural processes. As these processes occur, it is not anticipated that these projects would emulate the desired physical characteristics of SWH described in objectives 3.1-3.4. However, as these projects continue to widen and approach their design width, it is anticipated that at this point they would move from an erosional state to a depositional state and begin to better achieve objectives 3.1-3.4. However, this typically requires an adjustment to the chute's upstream inlet structure in order to restrict the amount of flow in the chute. This is a critical point in the evolution of chutes where they begin to achieve the desired physical characteristics and, subsequently, the biological responses hypothesized to be associated with these physical characteristics.

2.4 **Project-scale biophysical and biological responses**

These objectives further address functional aspects of SWH. The metrics focus on the project-scale biological responses which are necessary to provide the linkages between SWH and fish. These metrics are necessary not only to assess the quality of created habitat in the short term but to evaluate the hypothesized linkages between habitat creation and broader fish population responses which may have a lag-time.

Objective 4.1: Increase local abundance and species diversity of native larval, YOY, native cyprinids (sturgeon chub, sicklefin chub, shoal chub, blue sucker, sand shiner, Hybognathus spp.) and other target native fishes (sauger, catfishes, paddlefish, shovelnose sturgeon)
Performance Metrics: Abundance of target fishes and size classes, fish community diversity, diversity indices
Measurement: CPUE and length frequencies of target fishes
Target: based on the best examples of SWH and comparisons to other available habitats

Presently, metrics for these objectives have not been formalized as quantitative metrics or targets. Selection of project-scale metrics is based on the hypothesized linkages depicted in the SWH Conceptual Model (Appendix A). Development of quantifiable metrics and targets is envisioned as a supporting investigation. Initial targets will be developed from needs of larval/YOY pallid sturgeon and other native fishes as well as conditions present in "best achievable" reference reaches identified along the Missouri River.

Objective 4.2: Provide appropriate feeding/nursery areas for larval/YOY, and small-bodied fishes by creating SWHs where 1) water warms more quickly and reaches higher temperatures than currently found in main channel, 2) organic matter retention rates are higher than in the main channel, 3) terrestrial vegetation establishes in the transition zone between water line at median August flow and the ordinary high water mark, and 4) benthic invertebrate abundance is higher than in the main channel
Performance Metrics: 1) water temperature, 2) total organic carbon in sediment, 3) vegetation abundance between median August flow and Ordinary High Water mark, 4) benthic macroinvertebrate abundance and composition
Measurement: 1) temperature readings, 2) sediment samples, 3) vegetation survey, 4) plankton tows and benthic grab samples. Water quality data will also be collected to allow for interpretation of results (temperature, turbidity, DO, total suspended solids).
Target: Compare to other habitats and to needs of pallid sturgeon and other target fishes

SWH is intended to provide nursery areas for larval and YOY pallid sturgeon and other native fish in part by providing conditions which retain these small fishes. These types of habitats have been found to be critical for the recruitment and year class strength of larval and YOY fish (Schiemer et al. 2001). As such, it is important to determine if those fish are able to access the habitat and if the created habitat is more suitable than habitats already present. Information on the use of these habitats relative to other habitats by YOY/small-bodied fishes will help evaluate whether quality nursery habitats are being created. Relative abundance of larval fishes in these habitats compared to other habitats will indicate whether created habitats have increased ability to retain larval fish.
Habitats which retain larval/YOY fishes must also provide the right food resources at the right time. A lack of appropriate food, particularly at the larval stage, is often a bottleneck for successful recruitment in fish populations. The success of SWH creation efforts will depend on an ability to provide these conditions. For example, organic matter retention and production/retention of phytoplankton, zooplankton, and benthic invertebrates in these habitats is necessary and must coincide with conditions which also retain drifting larval fishes. Pallid sturgeon diet is thought to shift from macroinvertebrates to fish with increasing size (Grohs et al, 2009). Several studies have shown that mayflies (Ephemoptera) and midges (Chironomidae) (Sechler et al, 2012 and Grohs et al, 2009) may be particularly important prey items for earlier pallid sturgeon life stages.

3 Management Actions

The following section describes the suite of management actions that may be taken to implement the SWH sub-program. Potential adjustments include modifications to previously constructed projects which may be undertaken so projects better meet the stated objectives. Potential future management actions include those things that are not likely to be implemented in the short term due to either high levels of uncertainty, policy challenges, or a lack of authority to undertake the action.

3.1 Primary management actions

There are currently three categories of primary management actions undertaken to restore SWH: structure modifications, construction of new structures, and creation of off-channel habitat.

These management actions are described below and examples of each are provided with additional detail.

3.1.1 Structure Modifications

The following management actions describe modifications to existing Missouri River control structures to restore processes which create shallow water habitat. The cost to modify existing structures is typically between $25,000 and $70,000 per modification and is believed to produce between one and six acres of SWH; a cost of between $4,000 and $70,000 per acre of SWH. Structure modifications are typically less expensive than habitat creation actions such as backwaters and chutes, but there is uncertainty regarding the amount of SWH that will ultimately be formed by structure modifications as well as the amount of time or number of high flow events required for formation/development of the habitat. There is also uncertainty regarding the biological benefits of these actions. Benefits of structure modifications include short construction timeframes, lower construction costs, and they often do not require real estate interests to accomplish. Following is a description of the different types of structure modifications that may be undertaken to increase SWH.

3.1.1.1 Bank notches

A Bank Notch (also referred to as a Type-B notch) consists of excavating a 100’ to 150’ long, 75’ wide section of the high bank along with the under-laying 75’ wide section of buried L-Head or straight out dike. The invert of a bank notch is excavated to 5’ below Construction Reference Plane (CRP) using land-based equipment. CRP is defined as a sloping datum representing the water surface elevation met or exceeded 75% of the time during the April to November navigation season. Bank notches have numerous immediate and long term effects. The immediate effects include the creation of a secondary channel adjacent to the high bank as the water enters the upstream most notch and flows along the bank through the downstream bank notches. Deposition will occur riverward of the secondary channel resulting in sandbar formation and shallowing of the area between the dikes. The resulting habitat has greater depth and velocity variation than the pre-notch condition. The long-term effects are erosion of the high bank and widening of the top-width of the Missouri River. Depending on the size and location of a notch, the flow can be used to erode the bank and increase diversity upstream and downstream of a notch or, if bank line erosion cannot be tolerated, the flow can be used to only increase diversity. In general, the larger the notch and the closer the notch is located to the bank, the more the adjacent bank will erode and the more diversity will increase in the general area. Based on analysis of past and current bank notching efforts, it is estimated that one bank notch will create between 4 and 6 acres of diverse shallow water habitat. As of 2009, 219 bank notches have been completed which have provided between 507 and 822 acres of SWH (Jalili and Pridal, 2010).

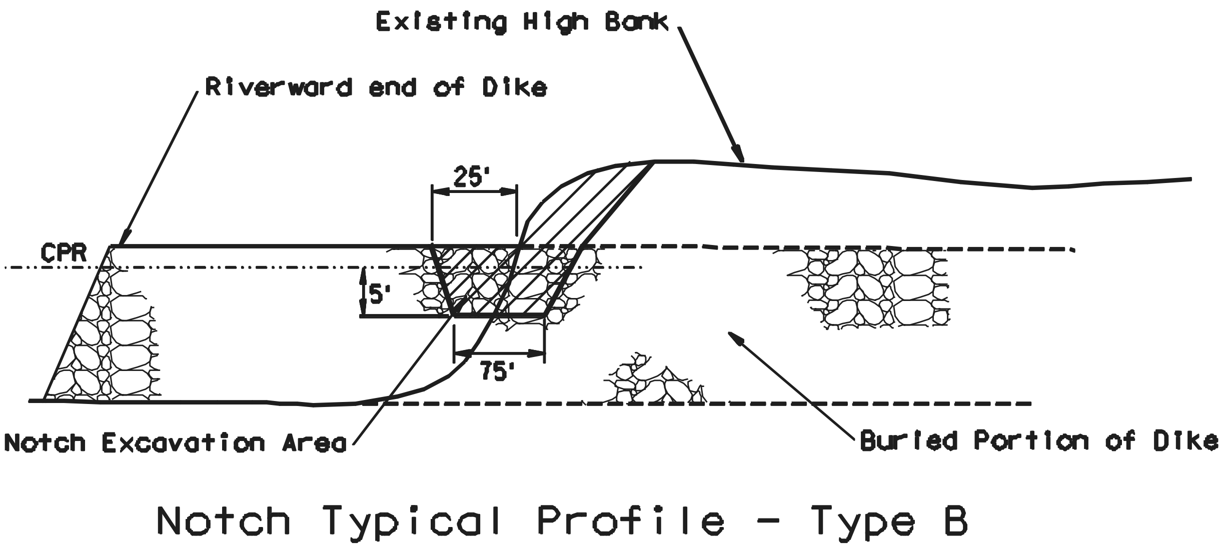
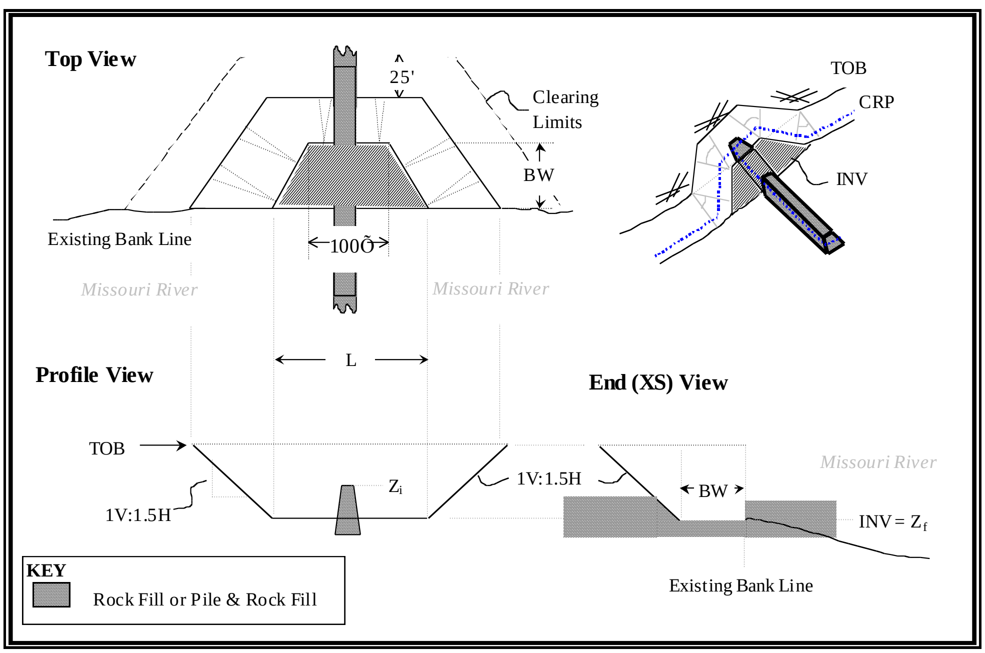


Figure C: Profile view of a typical dike notch



*CRP = Construction Reference Plane = Elevation Representing Flow Exceeded 75% of the time

Figure D: Top view of a typical bank notch (note: TOB refers to "Top of Bank.")

3.1.1.2 Dike Notches

A Dike Notch consists of excavating a 50' to 100' wide section of a dike to an elevation either 4' or 5' below CRP. Dike Notches are placed entirely riverward of the high bank, but not further than the halfway point between the high-bank and riverward end of a dike. Dike notches are most often constructed using water-based equipment, but may also be constructed using land-based equipment.

Physical changes expected from dike notch construction include the diversion of flow from the main channel through the notch, and then back to the main channel. Flow diversion creates a side channel formed by sand bars on each side, often to the elevation of the un-altered portion of the dike. A scour pool forms downstream of a notch due to increased turbulence from flow plunging over the notch. Localized bank erosion is expected downstream of dike notches constructed in close proximity to the bank. Based on USACE analysis of dike notching, it is estimated that a 50' dike notch will produce one acre of shallow water habitat and a 100' notch will produce two acres of shallow water habitat (USACE 2004). As of 2009, approximately 950 dikes have been notched resulting in an estimate of between 700 and 3,800 acres of SWH.

Figure E: Dike Notches, Lower Little Sioux Bend

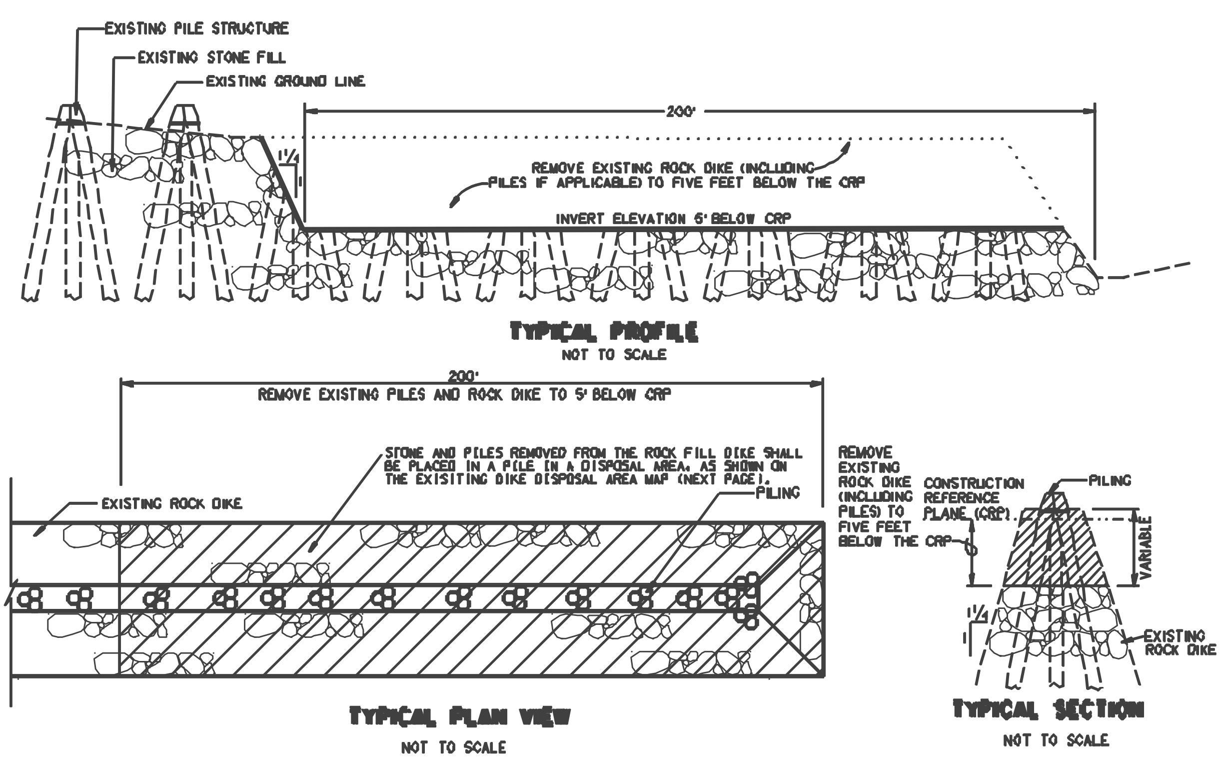


Figure F: Profile view of a typical dike notch

3.1.1.3 Revetment notches and lowering

Revetments were constructed as part of the Bank Stabilization and Navigation Project (BSNP) to induce channelization of the Missouri River and prevent bank erosion. A Revetment Notch consists of excavating a 50' to 100' wide section of a stone-fill revetment to an elevation 5' below CRP using water- or land-based equipment. Without notches in the revetment, these aquatic areas are poorly connected to the main channel at normal summer flows, and therefore have little to no flow, no velocity diversity, and no fish access. Revetment notches are placed at locations where a slack water pool is separated from the main channel by a stone fill revetment, or along a L-head revetment. In most cases notches are cut at the upstream and downstream end of the pool to maximize the effects of the notches.

Physical changes expected from a revetment notch include a scour pool on the landward side of a notch. Scour pools are created due to increased turbulence from flow being diverted from the main channel and plunging over the revetment. Accordingly, as compared to the previous, disconnected condition, greater diversity in velocity and depth is expected on the landward side of a revetment after notch construction. The size of a revetment notch controls the amount of water flowing into the adjacent pool, causing larger notches to have greater influence to the aquatic habitat environment. It is estimated that a 50' revetment notch will produce one acre of shallow water habitat and a 100' revetment notch will produce two acres of shallow water habitat (USACE 2004).

Revetment lowering consists of excavating an entire section of revetment 50' to 100' feet into the bank in order to allow the Missouri River to widen its top-width and form SWH. As of 2009, there were approximately 194 revetment notches and resulting in an estimate of between 160 and 570 acres of SWH and 2.1 miles of revetment was lowered resulting in an estimate of between 17 and 51 acres of SWH.

Figure G: Aerial view of a revetment lowering.

Figure H: Revetment lowering at low water, Lower Decatur Bend.

3.1.2 New structures

In addition to modifying existing structures, new structures could be placed in the Missouri River to encourage formation of SWH. Following is a list of potential new structures that could be placed to create SWH.

3.1.2.1 Chevron

A chevron is a “U” or “V” shaped rock structure that points upstream and is intended to induce deposition of substrate to form SWH as well as widening of the adjacent bank. Chevrons can be either closed or opened and may be modified to include wings or rootless dike-like structures. Chevrons may be grouped and placed in different configurations in order to use local conditions to achieve the desired objectives. As of 2009, 11 chevron's had been constructed in the target segments which formed between 3 and 7 acres of SWH. Chevrons are anticipated to cost between $5,000 and $50,000 per structure and are anticipated to produce approximately 0.5 acres of SWH per structure.

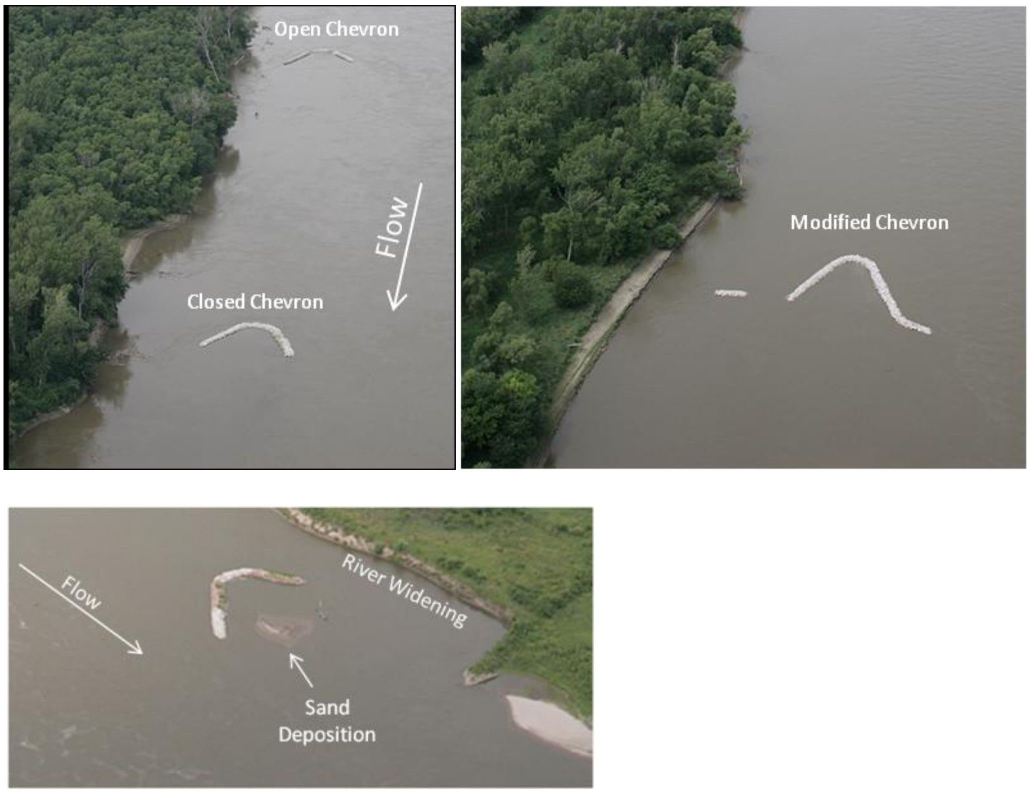


Figure I: Aerial view of chevrons.

3.1.2.2 Rootless Dikes and Reverse Sills

A rootless dike is a stone structure perpendicular to the flow of the river that is completely detached from the bank, typically placed between two existing dikes. These structures increase the amount of SWH by causing river widening on the landward side of the dike and deposition of sand downstream of the dike. Reverse sills are similar structures to rootless dikes except that they are placed atop an existing dike and so are attached to the bank via a lower elevation dike. Rootless dikes and reverse sills are anticipated to provide approximately 1 acre of SWH each. As of 2009, 48 rootless dikes and reverse sills had been constructed, with an additional 19 reverse sills added to modified dike notches. These structures are estimated to have formed between 49 and 77 acres of SWH. Rootless dikes and reverse sills are anticipated to cost between $20,000 and $80,000 dollars per structure and are anticipated to produce approximately 1 acre of habitat.

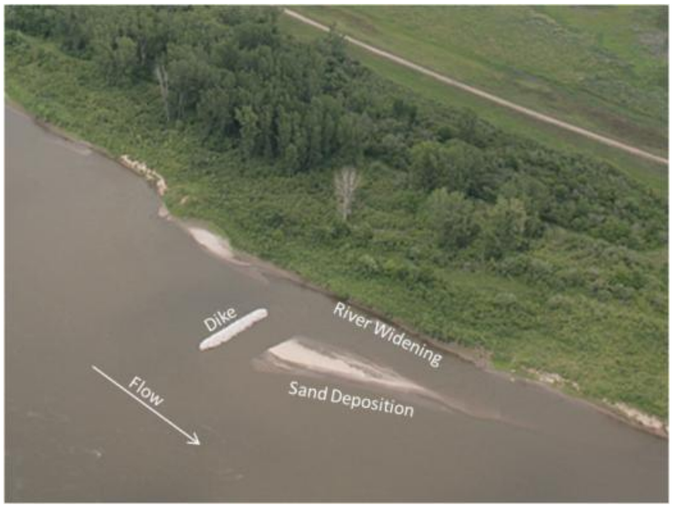


Figure J: Aerial view of a rootless dike.

Figure K: Reverse sills at Sandy Point Bend

3.1.2.3 Major dike modifications

Major dike modifications consist of lowering a large portion (approximately 200 feet) of the riverward end of a series of dikes and construction of chevron structures between each pair of lowered dikes. As of 2009, 207 major dike modification structures had been constructed which are estimated to have formed between 145 and 275 acres of SWH. Major dike modifications are anticipated to produce between 8 and 15 acres of SWH per mile.

3.1.3 Off-Channel Habitat

The primary methods used to restore off-channel habitat include creation of chutes and backwaters, widening the main channel, and altering existing levees. Habitat is constructed using mechanical equipment, hydraulic dredges, or a combination of both to excavate material from the floodplain. The major difference between backwaters and chutes is that chutes are connected to rivers on both ends, contain flowing water, and are intended to develop over time through dynamic processes where backwaters are only connected at the downstream end, contain slack-water, and are constructed to the ultimate desired condition. For all habitat types, additional transient benefits to water quality and sediment availability may be achieved through deposition of excavated material in the channel and through restoring natural erosion processes.

3.1.3.1 Chutes

A chute is a side-channel of a river which diverts flow from the main channel through the chute, and back into the main channel, thus creating an island. Chutes are typically constructed as a pilot channel which consists of a trapezoidal-shaped dredge cut 50' to 75' wide at the invert, excavated from the floodplain a depth of between two to five feet. While chutes could be constructed wider, this would be more expensive and result in fewer projects. Chutes have typically been constructed with minimal meandering. Increased initial meandering and chute length has benefits of increasing initial habitat area, but typically costs more and could result in slower development. However increased sinuosity may provide better habitat quality and complexity; therefore, this cost-benefit analysis should occur.

Construction can be accomplished through the use of hydraulic dredges or use of excavators to remove material. Physical changes expected at chutes include bed and bank erosion of the chute, accelerated after construction, then following natural meander migration as the chute matures. Chutes are intended to have an ultimate width of between 125 and 300+ feet and a diversity of depths and water velocities. Chutes are the only SWH management actions that have the potential to produce some of the extensive lateral migration (alluvial cut and fill dynamics) that characterized the pre-engineered Missouri River. Other physical changes include sediment deposition downstream of the chute, eroding banks in the chute, and introduction of large woody debris into the river. If the entirety of a chute that was 1000' x 125'met the physical characteristics of SWH, it would provide three acres of SWH (USACE 2004). The biological expectations would vary with time as the chute develops. Reduced velocities in the chutes should contribute to deposition of fines and organics that contribute to establishment of vegetation as well as invertebrate production (secondary productivity). Vegetation contributes to increased deposition of fines through lateral diffusion of fines and organics into the vegetation. Vegetation provides escape cover for small and juvenile fish. Species typically found in chutes include benthic riverine species such as blue sucker, shovelnose sturgeon, and chub species.

In naturally-functioning chutes and sidechannels, the entrances receive deposition first and this process proceeds in a downstream fashion. The "plugged" entrance contributes to reduced velocities and deposition within the chute. As this process proceeds the chutes change in depth, morphology, and velocity. It's likely that the summation of the variety of ecological stages within an area contributes to the areas overall value (i.e. habitat diversity). While this dynamic nature may contribute too many of the Objectives of the SWH AM Strategy, the energy within chutes also has the potential to cause excessive depths within chutes and higher velocities than desired which could require post-construction modifications such as inlet and grade control structures to achieve the desired benefits. As of 2009, there were 38 sites in the target segments where either single chutes or complexes of chutes were constructed totaling approximately 900 acres of SWH. The anticipated cost for chute construction is between $50,000 and $200,000 per acre for construction.


Figure L: Side-channel chute at Kansas Bend.

3.1.3.2 Backwaters

A backwater is a floodplain feature which is connected to the river on the downstream end but disconnected at the upstream end under normal flow conditions. Because of this, backwaters have still water. Backwaters are constructed in a similar manner to chutes, however, they are not expected to have similar cut-and-fill dynamics. As such, backwaters are constructed to the desired ultimate depth, width, and slope configurations. Backwaters typically have higher water temperatures than chutes and can have high primary productivity; potentially high enough that algal bloom die-offs could reduce dissolved oxygen levels enough to impact aquatic organisms. Backwaters may be highly productive foraging areas. Fish communities in backwaters differ from those in chutes. Backwaters may contain higher numbers of sunfishes (centrarchids); shads (clupeids); temperate basses, walleye and sauger (perciformes). Slow, deep backwater habitats are also selected foraging habitat for invasive Asian carps; therefore these habitats will need to be monitored to assure that they do not enhance these populations. Backwater entrances have the potential to fill in over time due to sedimentation and may require periodic dredging. The backwater itself will tend to fill in over time so designs which reduce this rate will be preferred. As of 2009, 15 backwaters have been constructed in the target segment totaling approximately 413 acres of SWH. The anticipated cost for backwater construction is between $50,000 and $150,000 per acre for construction.

Figure M: Backwater at Ponca State Park, Nebraska.

3.1.3.3 Channel Widening
Channel widening projects involve using mechanical equipment to lower the adjacent floodplain and bank of the Missouri River and create an adjacent "bench" of SWH. While some structure modification projects are intended to cause channel widening through erosion, this process can take many years and numerous structure modifications to complete. Channel widening projects seek to accomplish this in a shorter timeframe. Only one project has been planned using this methodology so far. These projects are expected to achieve the physical habitat complexity and project-scale biological benefits much sooner following construction, however they are also expected to be more expensive. The anticipated cost for channel widening is between $120,000 and $200,000 per acre.

3.1.3.4 Levee Alterations
Existing levees in the floodplain can be altered through notching or by setting back levees farther away from the channel to provide additional SWH under high-water conditions. This allows access of high-waters to additional floodplain areas and are likely to be most appropriate in areas where existing levees are close to the existing channel (> 0.5 mile). It should be noted, however, that these actions would not meet the current quantitative definition of SWH under low water conditions. The anticipated cost for notching levees $100,000 to 200,000 per unit and the anticipated cost for levee setback construction is $1 to 2 M per mile.

3.2 **Potential Adjustments**
The following sections discuss potential adjustments that may be taken to alter previously created SWH sites to ensure that they better achieve the stated objectives.

3.2.1 Modifications to chute inlet
In cases where a chute is accepting either too much or not enough water from the main channel, an inlet structure may be either added or modified. Modification of a chute inlet typically costs between $500,000 and $1,000,000 and is expected to alter the maturation of a chute to reach the desired physical conditions described under Objective 3. In cases where too little water is coming into the chute, modifying the inlet structure would prevent the chute inlet from closing due to sedimentation, preserving the desired habitat type. Increasing flow through the chute may

also be necessary if the chute is not developing as desired. In cases where too much water is entering the chute (possibly creating problems with maintaining the navigation channel), the size of the chute entrance may be modified to reduce the amount of water entering the chute. Because high flows through the chute are critical for initial chute development but reducing flow at some point may also have habitat benefits, planning control structures with a staged approach may have benefits. Chute inlet design may also impact fish access and/or bedload movement and modifications may be necessary when a problem is detected. These inlet structures can be modified in a variety of different ways to address physical conditions (flow and sediment load) at the inlet as well as biological factors such as fish access. The width, depth and shape of the inlet structure may need to be altered to achieve the right balance of flow and sediment load. Potential options for inlet structures include trapezoidal designs, v-shaped designs, and bottomless structures in which the width of the inlet is controlled but the depth is allowed to be altered by erosion and deposition processes.

Figure N: Inlet structure, Plattsmouth Chute

3.2.2 Modifications to Backwater connection

Backwaters are designed in a manner so that they maintain their connection to the river through a channel. In some cases, these channels may fill in faster than anticipated or be unable to maintain this connection. In these instances, these connections may be modified to include structures such as kicker dikes that divert flow and sediment to prevent deposition and maintain river connection. The anticipated cost for these modifications is approximately $50,000 to 100,000 per unit.

3.2.3 Grade Control Structure

Grade control structures are used to limit downcutting within chutes and maintain the desired amount of flow in the chute. They may be placed as part of the original chute design or could be added later due to changing chute conditions. Grade control structures may degrade over time and need replacement or repair. Grade control design may also impact fish movement or access. A typical grade control structure costs between $500,000 and $1,5000,000.

Figure O: Grade Control Structure Repair

3.2.4 River tie-back channel

In addition to providing increased acreage of shallow water habitat, the inclusion of river tie-back channels (secondary entrance or exit) as project features are intended to provide increased habitat quality by providing a high diversity of depths and velocities in the complex, particularly at the intersection of the chutes and the tie-back channels. It is believed that these "edge" habitats are frequently used by sturgeon and other native fish species. These features could be added to introduce additional flow and depth diversity into existing or new chutes. Tie-back channels also provide additional avenues for fish access. The typical cost for a river tie-back channel is $100,000 to 200,000 per acre.

Figure P: River tie-back channel during low water

3.2.5 Modifications to initial chute design (pre-construction)

Chutes are typically constructed with a consistent channel width along the entirety of the chute. However, this design may not facilitate development of meanders and variable widths as well as alternative design options. One alternative design option is to vary the widths of the constructed chute. For example, instead of digging a channel of uniform width at 70 feet, some sections could be dug at 90 feet and some at 50 feet in a way that would not alter the volume of sediment moved. The benefit would be nearly immediate bathymetric diversity. If the wider portions were created at the bend apexes, then a more shallowly-sloped point bar could form. The result would be greater initial abundance of shallow and slow water across all flow stages in the main stem

Missouri and potentially increase the rate of chute development. However, this design option has the potential to increase construction costs and there is uncertainty as to whether it would be effective at reducing chute development timeframes. This design option could potentially be evaluated further under the AM process to reduce these uncertainties.

3.2.6 Dredging of backwaters

As backwaters age, there is the potential they may fill with sediment and require periodic dredging of either the inlet structure, the backwater itself, or both. If backwaters are too shallow or lose their connection to the river, they may cease to attain the desired biological or physical objectives. The cost for maintenance dredging of a backwater is approximately $50,000 to 100,000 per acre

3.2.7 Removal of additional rock from structures controlling ultimate width at bank notches and chutes

In order to construct chutes or widen the Missouri River, structures (revetted banks and dikes) used to channelize the river under the Bank Stabilization and Navigation Project are typically altered either by lowering them or removing a section of them. When natural development of chutes or river top-width widening projects is being restricted by these structures, they may be further altered to permit achievement of Objective 3. The cost to alter these structures is anticipated to be approximately$10,000 to $30,000 per structure.

3.2.8 Lessen slopes on banks of chutes and backwaters to provide additional access to floodplain

Part of Objective 3 includes increasing the lateral connection of created habitat to the floodplain. While backwater projects are typically constructed to the ultimate desired configuration (including size, shape and side slopes), chutes are often constructed as “pilot” channels with the intention of using natural processes to erode banks and establish the desired side slopes. If a chute is not developing as desired and has steep cut banks in some areas, side slopes may be lessened on the banks to allow access to the floodplain. The cost to alter these side slopes in anticipated to be approximately $400 to $600 per foot of bankline.

3.2.9 Add structures to encourage chute meandering, scour hole creation, erosion and deposition

Under Objective 3, chutes are intended to develop over time and meander through natural cut and fill processes. In instances where a chute is not developing as desired, structures may be added to a chute to direct the flow to encourage these processes. The cost for these structures is anticipated to be approximately $100,000 to $500,000 per structure.

3.3 Potential Future Management Actions

The following sections describe management actions that are not currently proposed for implementation due to a variety of circumstances, but may be available for implementation in the future or warrant further investigation of potential costs and benefits.

3.3.1 Habitat projects constructed to final width

Although a few chutes have been constructed to their desired final width, many chute projects and river top-width widening efforts seek to use the river’s energy to develop the projects over time. If we are seeing significant delays in the response time for development of these projects, future projects may look at the cost of constructing projects to their ultimate width and configuration.

3.3.2 Restoration of confluence areas

Confluence areas are important habitat areas for many fish species as they represent dynamic areas where a combination of physical and biological gradients occur. Many of the Missouri River tributary confluence areas are currently altered or engineered in some way. Although such a project has not yet been undertaken, in the future, these confluence areas may be restored through the removal of control structures or some other means to improve these areas.

3.3.3 Flow Modifications through Missouri River Operations

Currently, flow modifications to either create or modify SWH that are outside of the current Master Manual preferred alternative are not proposed. However, one ongoing study, the Missouri River Ecosystem Restoration Plan, may explore opportunities to adjust the operation of the Missouri River in ways that could aid in meeting the SWH objectives.

3.3.4 Actions on tributaries

While the USACE does not currently have authority to undertake actions on tributaries to the target segments of the Missouri River, the Missouri River Ecosystem Restoration Plan is authorized to look at the prospect of expanding management actions to tributaries as part of that study.

4 Monitoring and Assessment

Several sources of information will be used to evaluate SWH performance in achieving stated objectives. The primary information sources will be the Habitat Assessment and Monitoring Program (HAMP), the PSPAP, and focused investigations. For each objective, the strategy for monitoring and assessment is described for each type of habitat project (i.e. chutes, backwaters, main channel structure modifications). This section includes general descriptions of the monitoring required to assess progress towards objectives. Development of detailed monitoring strategies and sampling designs will be initiated once the draft AM Strategy has undergone reviews. These plans will be included as appendices to this document once they are developed. The objectives and performance metrics previously provided in Section 2 are restated below for ease of reference.

4.1 System-wide responses of wild pallid sturgeon and other target fishes

Population responses of pallid sturgeon and other native fishes, excluding larval fishes, will be tracked on a larger scale over a long time period as part of the PSPAP. If SWH projects are addressing population bottlenecks and benefitting young and small-bodied native fishes, then populations of these fishes are expected to show a response over time which will be seen in the PSPAP. It is important to note that trends detected in the PSPAP are unlikely to provide information on cause and effect at a scale relevant to adaptive management of SWH. Therefore, more detailed monitoring, assessment, and focused investigations of SWH functions are needed. The PSPAP can provide trend data for catch rates and length frequency distributions of target fishes. Power analyses indicate that PSPAP data could detect population changes in the long-term time frames relevant to SWH creation actions at the segment scale (Wildhaber et al. 2011).

The PSPAP is not designed to detect short-term changes or determine cause-effect relationships. Population estimates for pallid sturgeon are currently underway for the lower Missouri River and will be available in late 2012. Additional monitoring efforts/focused investigations will be necessary to evaluate larval/YOY fish abundance over time.

4.2 Shallow water habitat creation and distribution

Several methods for enumerating SWH acres were evaluated during the 2010 SWH accounting effort (Jalili and Pridal 2010), however, a single and consistent method of quantifying SWH still needs to be developed. In general, acres of created habitat are calculated using numerous data sources including limited extent surveys extrapolated to all projects and GIS measurements using the best available aerial photos at each site. Accounting has been based on the general depth (<5 feet) criteria specified in the BiOp with velocities modeled at a subset of bends and extrapolated to the rest of the Missouri River. Three numbers were calculated for created SWH. “Minimum” acres represent the amount of SWH present initially following construction. “Current” acres are used in tracking progress toward BiOp targets and represent the amount of SWH currently present (minimum plus acres that have developed as a result of management actions), and “anticipated future acres” represent the maximum acreage expected once habitat development has fully progressed (for example, once a chute has reached maximum design width or once a bank notch has widened the Missouri River to the maximum extent allowed). All three numbers are reported at median-August flow levels (median August flows over a period of record) consistent with the direction in the BiOp. Tracking these three numbers will aid in evaluation of habitat development, forecasting anticipated future acres, and eventually assessing validity of these projections.

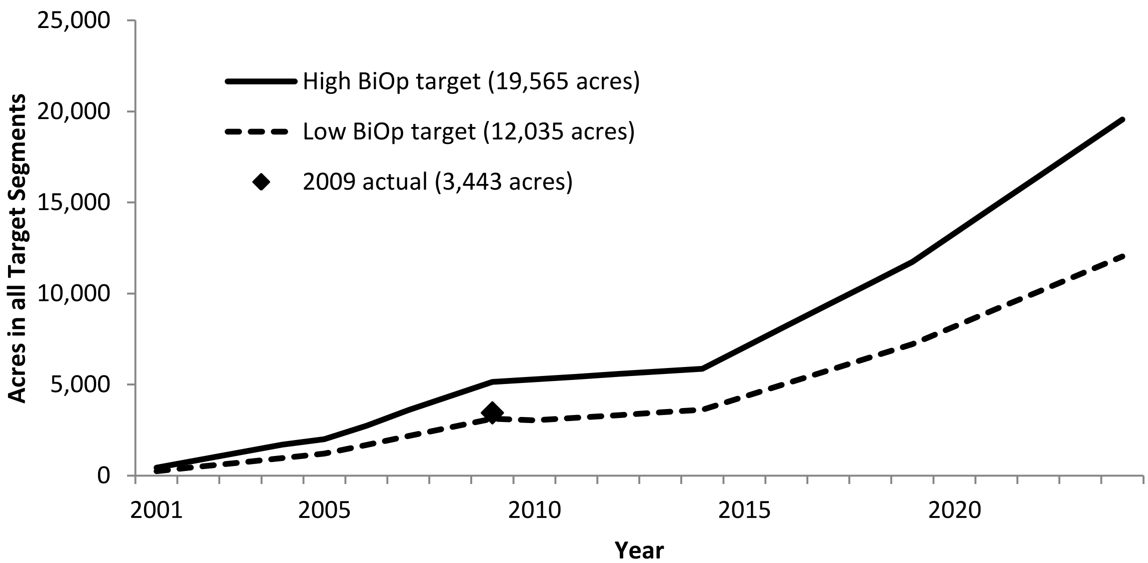
In the future, SWH accounting criteria and targets may be refined based on increased knowledge of habitat needs to address limiting factors for pallid sturgeon and other native fishes as well as increased knowledge gained by evaluating hypotheses related to the CEM (Appendix A). In addition, future accounting efforts in Kansas City and Omaha Districts will utilize the same methodology to aid in the compilation and interpretation of results (see page 2 of Jalili and Pridal, 2010 for a description of current methods).

Table 2. Acres of constructed shallow water habitat reported in the 2010 accounting effort.

	Current	Minimum	Anticipated future acres
Omaha District			
Chutes and revetment chutes	572	348	659
Backwaters	413	367	481
Main-channel modifications	312	421	840
Kansas City District			
Chutes and revetment chutes	331	171	450
Main-channel modifications	1815	1202	4799
Total	3443	2509	7229

There are two key questions related to Objective 2.1. Where are habitat creation efforts in relation to BiOp targets? Are created SWH acres sufficient to produce the desired biological response? The first question will be tracked annually by comparing estimates of created acres ("created acres currently present") to the BiOp timeline (Figure Q). The second question will become increasingly relevant as the BiOp target is approached in 2024. It may take at least this long to determine if the BiOp target acreage is appropriate to achieve biological objectives, especially related to pallid sturgeon and other native fishes (see Objective 1).

Figure Q: Estimated SWH acres created (minimum, current, expected future) in relation to BiOp targets (note: data for the lines in the below graph are based on the BiOp targets of 10% of BiOp acreage goals met by 2005, 30% by 2014, and 100% by 2024).



How is success determined? Success for this objective will be determined by tracking the current acreage and its progress towards the acreage target. However, issues regarding the projected future acreages, the timeframe for achievement, the acreage target itself, and the incorporation of qualitative metrics will require additional discussions amongst the USACE and FWS. Also, as more information becomes available on biological responses, including pallid sturgeon recruitment, target acreages may need to be reevaluated.

Objective 2.2 addresses how SWH projects are distributed amongst target segments on the Missouri River. Assessing this requires estimates of both the amount and location of different types of SWH. As part of the 2010 SWH accounting effort (Jalili and Pridal 2010), two methods were used to refine those estimates - an extrapolation of past HAMP data and an evaluation using GIS. Both methods resulted in similar counts (Table 2). These counts may provide a more accurate estimate of the current distribution of SWH as it was developed from a combination of physical measurements and 2-D hydraulic models and did not extrapolate broadly across segments.

Specific biological justifications for project prioritization will be incorporated as information becomes available from focused investigations. For example, if it is determined that SWH near confluences of large tributaries is important to pallid sturgeon then those areas would receive higher priority. While some inferences may be gained from monitoring efforts, addressing these uncertainties will require focused investigations.

Table 3: Estimates of shallow water habitat acreages currently present as determined by two methods and compared to base acres listed in the BiOp.

River segment	Acres/mile (HAMP)	Acres/mile (GIS)	Acres/mile (BiOp est.)	BiOp Restoration Target @ 20 Acres/mile	BiOp Restoration Target @ 30 Acres/mile
12 – Sioux City to Platte River	4.8	5.6	1.8	18	28
13 – Platte to Kansas River	6.3	9.4	4.6	15.4	25.4
14 – Kansas to Osage River	17.8	17.1	4.6	15.4	25.4
15 – Osage River to mouth	20.8	18.4	4.6	15.4	25.4

How is success determined? Currently, success is based on how well distribution of projects mirrors the SWH targets for each segment. There are many constraints, however, which also influence project location. Land availability and funding are often overriding factors when prioritizing projects. Again, this approach may be altered as information becomes available regarding the biological implications of SWH distribution, in particular relative to pallid sturgeon needs.

4.3 Physical characteristics of created shallow water habitat

Objectives 3.1 – 3.4 address changes in physical habitat which occur as a result of SWH projects. Expected changes to physical habitat vary somewhat depending on project type and, therefore, will need to be evaluated differently for chutes, backwater, and main-channel projects. Measures of success will be determined by a combination of the following depending on project type: comparisons of constructed habitats to best-achievable habitats and/or historic conditions; comparisons of constructed habitats to main stem river habitats; and comparisons among constructed habitats of different designs, ages, and locations.

In comparing physical metrics between best-achievable sites/historic conditions and created sites, success will be based on degree of similarity (i.e. how well do the constructed sites emulate best-achievable/historic sites). Best-achievable sites used for comparison will represent the best examples of SWH available based on fish use and professional input. Historic comparisons will be attempted similar to Latka et al. 1993. Although it is true that the best SWH examples on today's Missouri River are different than historic habitats, they do represent a reasonable target that can also be evaluated. Comparisons to historic conditions, when possible, will also be important to understand how well management actions are restoring conditions under which the fish evolved and to better understand the degree of dissimilarity between best-achievable and historic conditions. In addition to comparisons with best-achievable sites/historic conditions, created sites will be compared to the main stem to determine whether they are providing habitats with the desired diversity and contrast to conditions already present. Because the age and design of habitat projects vary, comparisons among similar projects of varying ages and designs will help better understand habitat development rates and which design factors are most beneficial.

4.3.1 Chutes (including revetment chutes)

Evaluation of chutes will focus on comparing physical metrics between constructed chutes and best-achievable chutes to determine if constructed chutes increasingly emulate their natural counterparts over time. Comparison of many constructed chutes of varying ages over time will allow for better evaluation of whether habitat progression is occurring as desired and at what rate. Comparisons will also be made between constructed chutes and the main channel to further determine whether constructed habitats are providing physical attributes that are currently rare. The primary physical metrics used to evaluate chutes will be depth and velocity distributions, wetted area/stage relationships, substrate diversity, and abundance of large woody debris. Because habitat change can occur slowly, information on each of the physical metrics will be collected on a three year rotation for all constructed chutes and selected best-achievable chutes. Extreme water events or modifications to projects may result in additional sampling.
A key component of evaluating chute development will be comparisons of constructed chutes to best-achievable chutes. Selection of best-achievable chutes will be based on habitat complexity metrics, fish use data, and professional input (Table 4). The intent is to use best-achievable chutes as guides to assess the development of constructed chutes not to duplicate a particular chute or to suggest that all chutes need to look the same.

Table 4: List of potential reference chutes between Sioux City and St. Louis.

Chute	Length	River miles
Lisbon	2.25 miles	218-215
Cranberry Bend	1 mile	282-280.5
Little’s Island	2 chutes – 1 mile and 3 miles	11-8.5
Pelican Island	3.5 miles	16-10.5

Frequency distributions similar to that shown in Figure R will be used to evaluate depth, velocity, substrate, and lateral connectivity. These distributions can then be used to compare habitats (e.g. similarity indices) and evaluate changes over time (Figure S) to determine if chutes are progressing in the desired direction or suggest modifications to projects to further direct chute development. Not only will individual chutes be monitored over time to track change, many chutes of differing ages will be compared to make an assessment now of how physical metrics are changing over time.

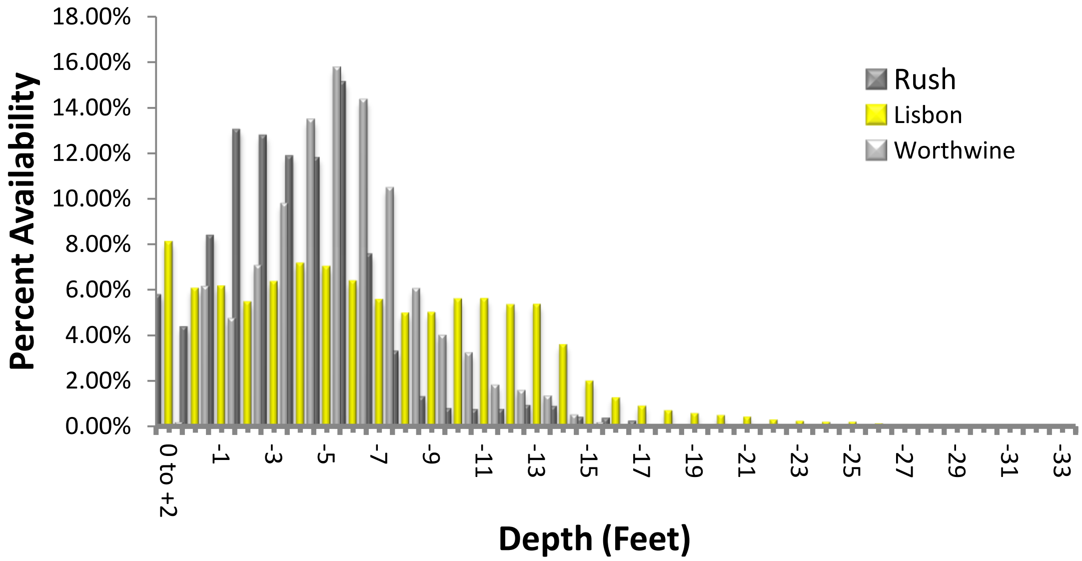


Figure R: An example of depth distributions of constructed and best-achievable chutes. Similar frequency distributions will be used for other metrics as well. Note: depths are relative to median August flow stage. Similar data is available for some chutes in the upper portion of the channelized reach.

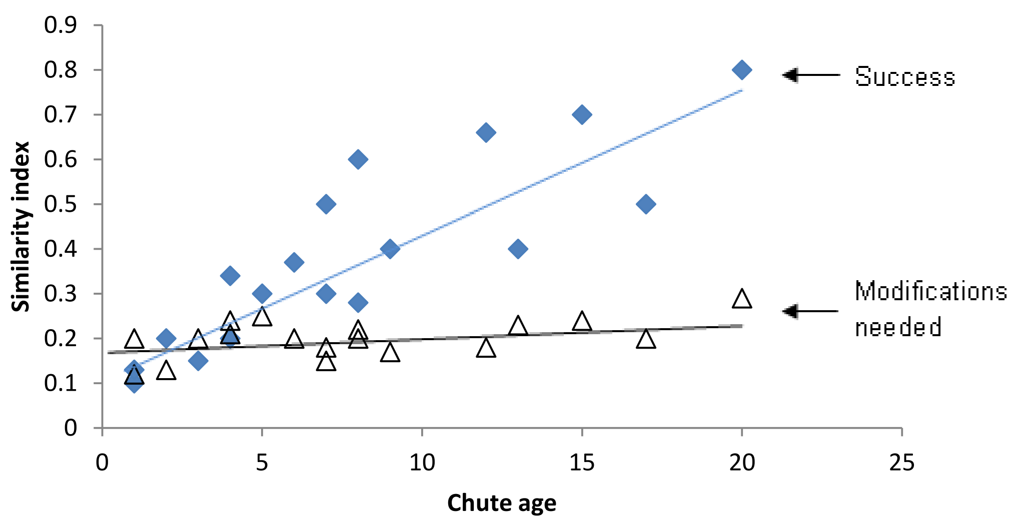


Figure S: Hypothetical similarity indices between best-achievable chutes and created chutes of different ages (index of 1 indicates identical characteristics and index of 0 indicates no similarity). This is a hypothetical graph and could pertain to any of the performance metrics. A similar analysis can be used to track development of an individual chute over time. Where possible, similarity to historic conditions should also be determined as context for the relative condition of best-achievable habitats.

Proportional Similarity Indices (PSI) can be calculated to compare similarity between frequency distributions as follows:

$$PSI = 1 - 0.5 \sum_{i} |p_i - q_i|$$

where p_i and q_i are the relative frequencies for constructed and best-achievable habitats in class i; the Sum function sums over all classes. The result is a value between 0 (no similarity) and 1 (identical distributions).

How is success determined? As chutes age and are modified through natural processes, they are expected to increasingly emulate best-achievable chutes (i.e. older chutes should look more like best-achievable chutes than do younger chutes). A comparison of similarity between constructed chutes and best-achievable chutes should therefore show a positive relationship with chute age. This information will also provide an average rate of progression which can be used to compare performance of individual chutes. It should also be noted that younger chutes may "age" more quickly when they are subjected to extreme events such as the flows experienced in 2011.

Depth and velocity distributions (Objective 3.1) - Distribution data similar to that shown in Figure R can be used to describe depth and velocity data and evaluate changes over time (Figure S) to determine if chutes are progressing in the desired direction or suggest modifications to projects to further direct chute development. Bathymetric data will be collected on all constructed chutes and selected best-achievable chutes once every three years. Additional data collection may occur due to high water events, planned modifications, etc. Bathymetric information will be evaluated based on the 50% exceedance August flow duration (either measured at this time or calculated based on index flows). Data collection needs to occur at flows high enough to allow boat access to all SWH. Velocity data will be collected at selected constructed and best-achievable chutes. Velocity data will be collected along transects with an Acoustic Doppler Current Profiler (ADCP).

Lateral connectivity (Objective 3.4)

When chutes are constructed, the banks are often vertical and high as a result of construction methods and elevation of surrounding lands. These conditions are similar to what is currently found in the mainchannel. As a result, SWH acreage changes little, and may even decrease, as river stage increases within the range of median August flows to the ordinary high water mark. This is opposite of what occurred historically when SWH acreage increased as river stage increased. Best-achievable chutes and historic side-channels typically have/had sloped banks and a variety of surrounding elevations which create increasing areas of inundated land as river stage increases (Figures T and U). These conditions are created over time by natural erosion and deposition processes. Allowing these processes to act in created chutes is necessary to create this lateral connectivity. Chute design, construction methods, and site selection can all play a role in promoting these natural processes. To evaluate whether constructed chutes are developing lateral connectivity, elevation profiles of adjacent lands will be compared between constructed and best-achievable chutes over time. Elevation data will be collected with LiDAR during low water periods. Bathymetry data collected during high water events may also be used.

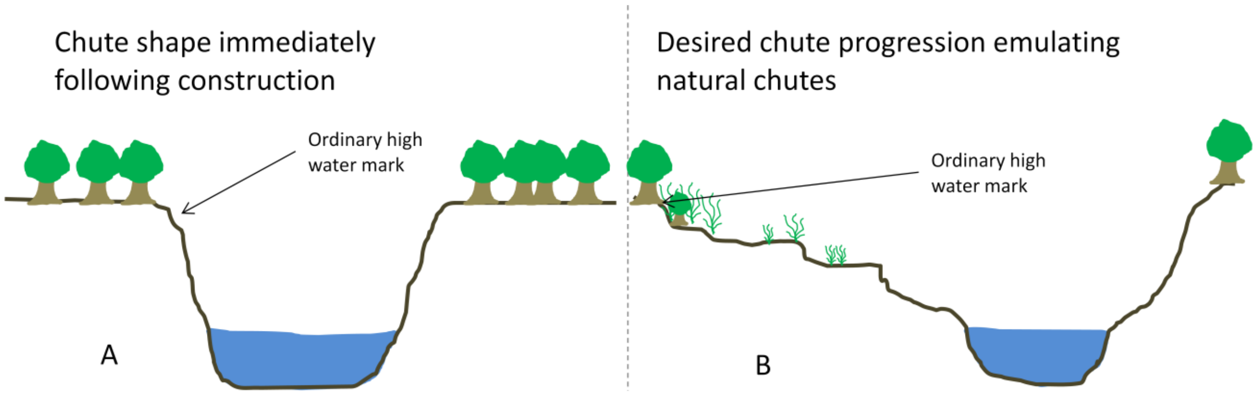


Figure T: Diagram showing the lack of lateral connectivity in newly-created chutes and the main channel (A) and the increased lateral connectivity seen in best-achievable chutes and expected to develop over time in created chutes (B).

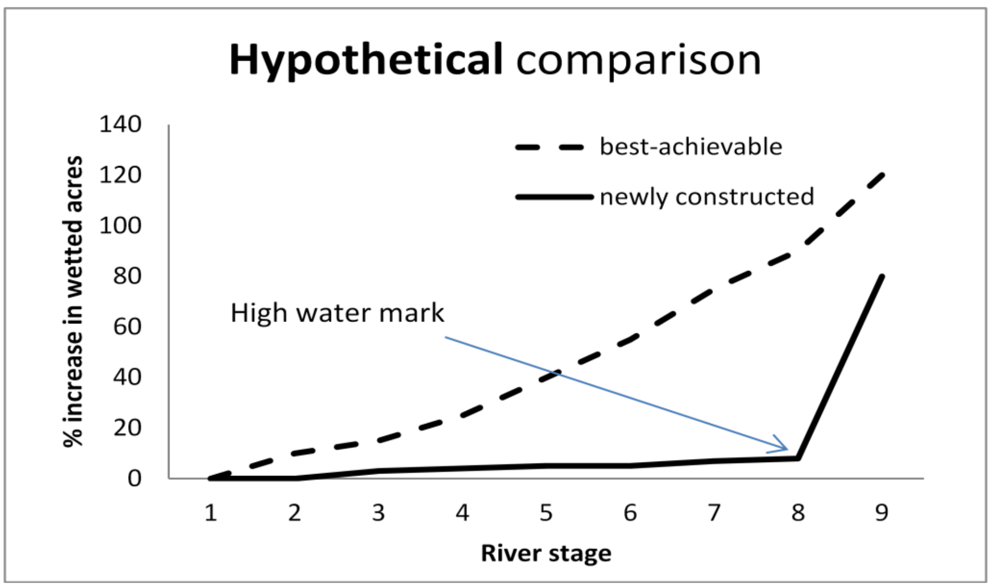


Figure U: A hypothetical comparison of lateral connectivity (wetted area/river stage) between best-achievable and constructed chutes.

How is success determined? Similarity in normalized lateral connectivity (elevation profiles, area/stage relationships) between created, best-achievable, and historic chutes will be evaluated over time. In order to compare amongst chutes of varying sizes, chutes will be normalized for surface area at the median August flow. If similarity increases over time (see Figure S), the desired progression is occurring. If progression is occurring very slowly or not at all, modifications may be necessary to further promote desired hydrologic processes.

Substrate size distribution (Objective 3.2)

As a result of diverse water velocities and erosional and depositional processes, chutes are expected to contain a diversity of substrates including an increased prevalence of fine substrates resulting from increased prevalence of slow water. Substrate size distributions can be affected by the chute entrance as well as hydrogeomorphic processes within the chute. Substrate size is an important determinant of habitat use by many benthic fishes, can be used as a surrogate for water velocities, and is useful in interpreting benthic invertebrate data. Substrate size distribution will be compared between constructed and best-achievable chutes to determine degree of similarity.

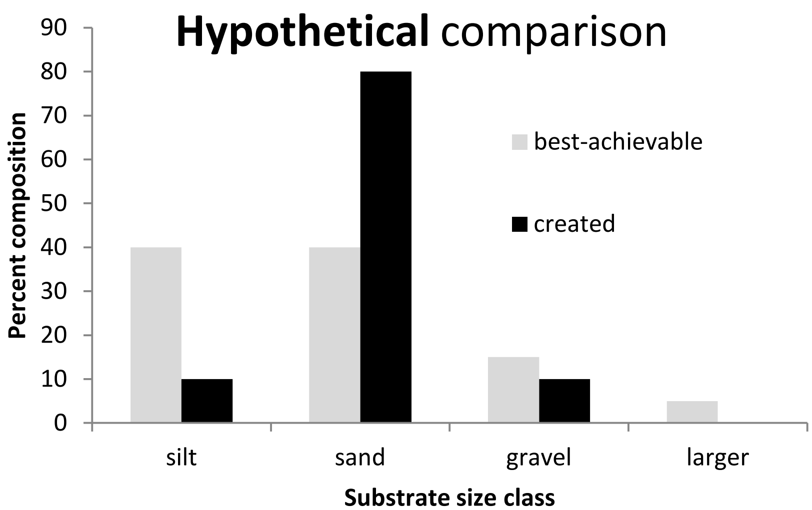


Figure V: A hypothetical comparison of substrate sizes between best-achievable and constructed chutes.

How is success determined? Similarity in substrate size distribution will be compared between constructed and best-achievable chutes over time. If they become more similar, the desired progression is occurring. If progression is occurring very slowly or not at all, modifications may be necessary to further promote the desired changes in substrate size distributions.

Abundance of large woody debris (Objective 3.3)

Increasing abundance of woody debris in created habitats will depend on inputs of wood form shoreline vegetation and creating the depths and velocities necessary to allow entrainment and retention of woody debris.

How is success determined? Initially, constructed chutes may not retain large woody debris because of steep banks, fast water, and lack of shallow water. Over time, the chute’s ability to retain large woody debris should increase and the abundance of woody debris should become more similar to abundance of woody debris in best-achievable chutes and historic conditions (Figure W).

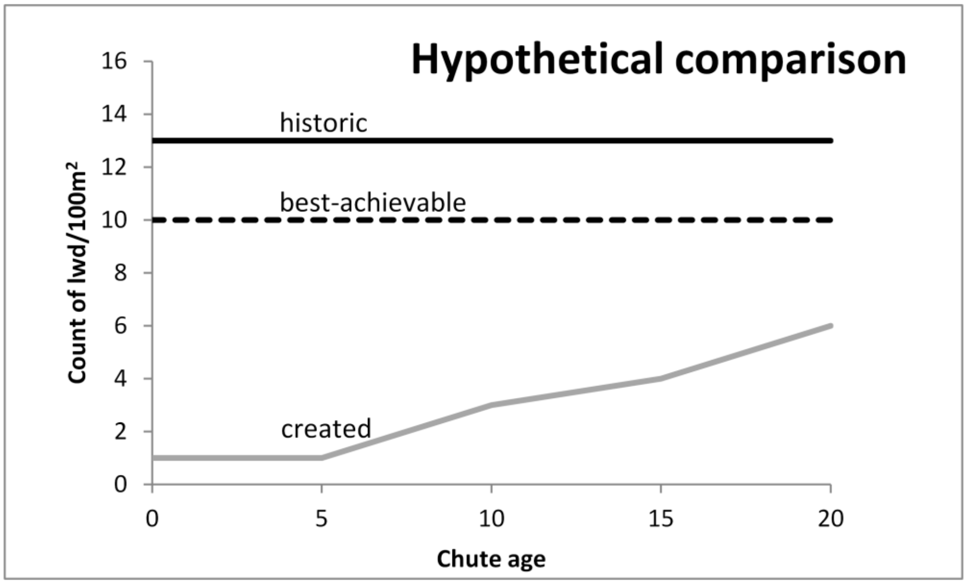


Figure W: Hypothetical graph showing abundance of large woody debris in a constructed chute over time compared to historic abundance and abundance in best-achievable chutes. This graph depicts the desired progression (i.e. abundance of woody debris becomes more similar to abundances found in best-achievable chutes and in the historic Missouri River.

4.3.2 Backwaters

Backwaters are expected to provide areas of little or no water velocity and predominantly shallow depths. Most created backwaters will also be expected to maintain connection to the river at low flows to provide access to young fish during critical rearing periods from mid summer through winter. It is important that the design minimize the need for dredging to maintain the backwater and its connection to the river. Key physical characteristics include degree of connectivity to the river (or chute), depth distributions, size, and lateral connectivity. These physical characteristics are important for tracking rate of siltation and they will affect productivity, dissolved oxygen levels, potential for fish kills, and accessibility/suitability for native fishes. Because so few natural backwaters currently exist which maintain connectivity to the river, the primary methods of evaluation will be comparing backwaters of different designs to determine which design options maintain connectivity with lowest maintenance costs.

Depth and velocity distributions (Objective 3.1)

Monitoring of water depth will focus on rate of siltation, maintenance of connectivity to the river, and depth distributions. Backwaters may become shallower over time due to siltation but the rate at which this occurs is important for cost projection and adaptive management. Based on projected O&M costs, over time it is expected that some backwaters will be allowed to go through a successional process to become more-shallow and potentially become shallow lakes and wetlands. The rate of siltation needs to be documented over time for individual backwaters and compared among backwaters of different designs. Routine creation of bathymetric maps of each backwater will be the primary monitoring approach. Bathymetric maps will be created for each backwater on a three year rotation. Bathymetry data should be collected during high water to ensure access to as much of the backwater as possible. Water velocity is generally not an

important metric for evaluating backwaters – water velocities will be at or near zero. Water velocities may be important for evaluating performance of the connection to the river.
How is success determined? Comparisons among constructed backwaters will help determine designs which minimize rates of siltation and maintenance costs. Information collected to evaluate biological response objectives will help determine how backwater depths and connectivity to the river affect productivity and fish communities. This information will be used to design future projects and propose improvement to current projects.

Lateral connectivity (Objective 3.4)
Surrounding elevations of constructed backwaters are important since they determine lateral connectivity and extent of inundated vegetation as river stage rises. Maximizing inundated acres as river stage between the median August flow and the ordinary high water mark increases is important and will be a measure of backwater quality. Surrounding elevations can be determined from LiDAR or bathymetric mapping during high water.
How is success determined? Unlike constructed chutes which are expected to develop over time, constructed backwaters must be constructed to near desired condition and over time will fill in. The degree of lateral connectivity which can be achieved at a proposed site along with the related cost will be an important design consideration. Understanding the relationship among lateral connectivity, flows, and biological objectives will be important in designing backwaters in the future.

Substrate diversity (Objective 3.2)
Substrate diversity is not an important metric for evaluating backwaters. Because there is little or no current in backwaters, substrates will be predominantly silt.

Abundance of large, woody debris (Objective 3.3)
Retainment of large woody debris into backwaters will depend on high flow events which introduce woody debris or on input from surrounding land.
How is success determined? Woody debris will be counted initially following backwater construction or as soon as possible. Woody debris abundance will then be tracked over time to determine if retainment is occurring. The expectation is that woody debris abundance will increase in years following construction.

4.3.3 Main channel habitats (bank notches and dike notches)
Initial assessments of monitoring data have indicated that notching of dikes has resulted in little detectable change in fish use (Schapaugh et al. 2010; Schloesser 1991) or has potentially had negative impacts to some species (Ridenour 2008). These studies have looked at the effect of dike notches at the bend level and have not attempted to differentiate among notch types. These analyses also indicated that additional information on physical and biological characteristics of these habitats, including degree of habitat change resulting from notching, are needed to interpret these results. For example, a 2006 study found that, when comparing notched dikes with unnotched dikes, "a difference in the areas that meet the SWH criteria for both velocity and depth is not pronounced" (Papanicolaou and Elhakeem, 2006)." This study also concluded that the addition of structures and modifications may have resulted in a net loss of SWH. However, these results were based on measurements and models of a single 1.5 km segment of the river and additional monitoring and analyses of actual changes over time is warranted. Evaluation of physical habitat changes would focus on determining which notch sizes, notch elevations, and

notch locations most emulate the physical conditions present within the highest quality reaches currently found on the Missouri River. Future dike modifications should be performed on treated HAMP bends while maintaining control bends as is. This will permit continued use of the HAMP before-after control-impact (BACI) design to evaluate responses to dike notching and theoretically should continue to increase the treatment effect by additional modifications to treatment bends. Information should also be collected in treated bends prior to additional modifications to allow evaluation of the resulting changes. There may be significant differences in the benefits of notching in upstream reaches compared to downstream as the length of dikes and river width increases downstream. Evaluation of main-channel modifications should be stratified by location (for example: upstream of the Kansas River compared to downstream).

Depth and velocity distributions (Objective 3.1)
Dike notches are intended to emulate braided flow and in some cases increase river top-width. Future dike modifications will seek to emulate the depth and velocity distributions of reaches with increased habitat complexity and increased abundance of target fishes and size classes. Depth and velocity distributions will be taken at selected dikes and bank notches at median August flows.

How is success determined? One measure of success will be the similarity between depth and velocity distributions between best-achievable sites and treated HAMP bends. Where possible, comparisons to historic depth distributions will be made to evaluate relative quality of best-achievable sites. In the case of bank notches, a measure of success will be the extent that the river top-width increases (e.g. towards the design width).

Lateral connectivity (Objective 3.4)
Bank and dike notches should increase lateral connectivity by eroding banks and creating increased elevation diversity of banks and sand bars.
How is success determined? One measure of success will be the similarity in bank slopes and sand bar elevations compared to best-achievable reaches as well as historic conditions.

Substrate size distribution (Objective 3.2)
Substrate size influences habitat use by benthic fishes and could be an important factor in preferential use of some river reaches by target fishes.
How is success determined? Substrate size distributions will be compared between modified reaches and best-achievable reaches. Success will depend on whether dike modifications result in increased similarity of substrate sizes between modified reaches and best-achievable sites.

Table 5: Physical metrics and periodicity of sampling for evaluating chutes, backwaters, and main channel structure modifications. Specific periods will be determined as part of detailed sampling design.

	Chute	Backwater	Main channel Structure mods
Depth	All constructed chutes (periodic)	All constructed backwaters (periodic)	HAMP bends (periodic)
Velocity	20% of chutes (periodic)	N/A	HAMP bends (periodic)
Lateral Connectivity	All constructed chutes (periodic)	All constructed backwaters (periodic)	N/A
Substrate size	All constructed chutes (periodic)	N/A	HAMP bends (periodic)
Large woody debris	All constructed chutes (periodic)	All constructed backwaters (periodic)	Bank notches (periodic)

4.4 Project-scale biophysical and biological responses

4.4.1 Chutes (including revetment chutes)

Abundance and species diversity of native larval, YOY, and small-bodied fishes (Objective 4.1)

Evaluation of chutes will focus on determining whether they are developing areas within them which are retaining larval, YOY, and small bodied fishes.

How is success determined? Comparing catch rates of target species and size classes between constructed chutes and best-achievable chutes will determine whether constructed chutes emulate their more natural counterparts or at least progressing in that direction. Comparisons will also be made between constructed chutes and the main channel to further determine whether created habitats are providing areas which increase retention of young fishes. Comparisons with best-achievable habitats will provide an initial meaningful comparison. Evaluations of hypotheses associated with the CEM (Appendix A) will allow for assessment of whether SWH creation alone can achieve desired biological responses.

Provide appropriate feeding/nursery areas for larval/YOY, and small-bodied fishes (Objective 4.2)

Chutes are expected to provide areas of quality nursery habitat for larval, YOY, and small bodied fishes. For example, areas within a chute should provide increased organic retention and secondary productivity. These areas, which should also be retaining young fishes, should be providing the food resources those young fishes need at the right time.

How is success determined? One measure of success will be whether project-level biological responses (e.g. increased organic retention, increased invertebrate abundance) are occurring within created chutes and are similar to those found in best-achievable chutes (i.e. those which have highest abundance of target fishes). It is expected that as chutes develop, biological responses will increasingly emulate best-achievable chutes. Another measure of success will be whether created chutes are providing higher quality nursery areas than already present in the adjacent Missouri River. Further, success will be determined by whether areas within a chute are providing the desired nursery habitat conditions at the proper times and locations based on presence of target species and life stages. Achieving the desired project-level biological responses will be highly dependent on the interaction of the created habitat with flows. Evaluations of these project-level metrics across a range of flows will allow for assessment of whether current flow regimes will allow SWH creation to achieve desired biological responses. Water quality parameters, including water temperature, turbidity, and DO will be monitored as covariates, at little cost, to help interpret primary and secondary productivity metrics.

4.4.2 Backwaters

Abundance and species diversity of native larval, YOY, and small-bodied fishes (Objective 4.1)

Evaluation of backwaters will focus on determining whether they are utilized by larval, YOY, and small bodied fishes.

How is success determined? Comparing catch rates of target species and size classes between constructed backwaters and main channel habitats will help determine whether backwaters are accessible at the right times and whether they are being utilized by target species and size classes. Evaluations of hypotheses associated with the CEM (Appendix A) will allow for assessment of whether SWH creation alone can achieve desired biological responses.

Provide appropriate feeding/nursery areas for larval/YOY, and small-bodied fishes (Objective 4.2)

Backwaters are expected to provide areas of quality nursery habitat for larval, YOY, and small bodied fishes. Backwaters should be providing the food resources young fishes need at the right time.

How is success determined? One measure of success will be whether the desired project-level biological responses (e.g. increased organic retention, increased invertebrate abundance) are occurring within created backwaters and therefore providing higher quality nursery areas than already present in the adjacent Missouri River. Comparisons of growth, condition, and relative abundance of target fishes collected in backwaters compared to other habitats will help determine whether backwaters are providing higher quality nursery habitats. Achieving the desired project-level biological responses will be highly dependent on the interaction of the created habitat with flows. Evaluations of these project-level metrics across a range of flows will allow for assessment of whether current flow regimes will allow SWH creation to achieve desired biological responses. Water quality parameters, including water temperature, turbidity, and DO will be monitored as covariates, at little cost.

4.4.3 Main channel habitats (bank notches and dike notches)

Abundance and species diversity of native larval, YOY, and small-bodied fishes (Objective 4.1)

Evaluation of created main channel habitats will focus on determining whether they are developing areas within them which are retaining larval, YOY, and small bodied fishes.

How is success determined? Comparing catch rates and diversity of target species and size classes between created habitats and best-achievable habitats will determine whether created habitats emulate their more natural counterparts or at least progressing in that direction. Catches of larval/YOY fish will be compared at the bend level between notched dikes and un-notched dikes to determine whether main channel modifications are producing habitats more suitable to target species and age classes. Comparisons will continue using HAMP bends (control and treated) and will occur once every three years. In addition, similar sampling will occur in river reaches believed to represent the best habitat available to verify that these locations are preferentially used by target species and to use as a comparison and guide for main channel modifications. It will be important to compare both total catch, catch rates, and level of effort because an increase in quality habitat could result in more habitat to sample (and more fish) but no change in catch rates. Although comparisons with best-achievable habitats will provide a meaningful comparison, even the best-achievable habitats may not achieve the level of retention needed to recover target species. Evaluations of hypotheses associated with the CEM (Appendix A) will allow for assessment of whether SWH creation alone can achieve desired biological responses.

Provide appropriate feeding/nursery areas for larval/YOY, and small-bodied fishes (Objective 4.2)
Created habitats within the main channel are expected to provide quality nursery areas for larval, YOY, and small bodied fishes. These areas, which should be retaining young fishes, should also be providing the food resources those young fishes need at the right time.
How is success determined? One measure of success will be whether project-level biological responses (e.g. increased organic retention, increased invertebrate abundance) are occurring within created habitats and are similar to those found in best-achievable habitats (i.e. those which have highest abundance of target fishes). It is expected that as habitats develop, biological responses will increasingly emulate best-achievable habitats. Another measure of success will be whether created habitats are providing higher quality nursery areas than already present in control habitats (those where habitat creation actions have not occurred). Further, success will be determined by whether created habitats are providing the desired nursery habitat conditions at the proper times and locations based on presence of target species and life stages. Achieving the desired project-level biological responses will be highly dependent on the interaction of the created habitat with flows. Evaluations of these project-level metrics across a range of flows will allow for some assessment of whether current flow practices will allow SWH creation to achieve desired biological responses. Water quality parameters, including water temperature, turbidity, and DO will be monitored as covariates, at little cost.

4.5 Priorities

Priorities for monitoring efforts are listed below. These priorities were derived from both the linkages in the conceptual ecological model and input of the SWH PDT and reflect the most crucial pieces of information for decision-making related to the SWH AM Strategy. Costs are rough approximations based on past efforts and projected levels of efforts required.

1. Local abundance of larval and YOY pallid sturgeon and other native fish species

As SWH is hypothesized to benefit larval and YOY pallid sturgeon by providing areas for them to settle out and grow, one of the highest priorities is to determine if this is occurring to a greater degree than in habitats already available. Sampling will determine habitat suitability based on catch rates of larval and YOY pallid sturgeon in all habitats including SWH sites and best-achievable reference sites. During this collection effort, other native fish species would be collected as well. The anticipated cost for this effort is $500,000 per year.

2. Abundance and size-structure of pallid sturgeon and other native fish populations

The ultimate measure of success for this management action along with other MRRP management actions related to pallid sturgeon will be in terms of population growth rate of nonhatchery-raised fish. In order to determine population trends, a long-term monitoring program of pallid sturgeon was established in 2003 (PSAP). As part of this collection effort, other native fish species will be monitored as well. The anticipated cost for this effort in the target segments is approximately $2,200,000 per year.

3. Abundance and distribution of SWH

Accounting progress towards SWH goals is an important piece of information for decision-making in order to determine the amount of creation needed to meet long-term SWH goals. This effort would likely pull from other data sources but involves processing and potentially some collection of new data such as updated aerial photography. The anticipated cost for this effort is approximately $50,000 and would be conducted every three to five years.

4. Depth distributions

Data on depth distributions is needed to assess changes in physical habitat complexity of both created SWH sites and best-achievable sites for comparison against targets. Depth distributions are one of the highest priority pieces of physical information needed to inform decision-making. The anticipated cost for this effort is approximately $400,000 and would be conducted every three to five years.

5. Lateral Connectivity

Lateral connectivity is hypothesized to have many connections between SWH creation and biophysical responses in the conceptual model. Elevation data would be collected from areas adjacent to SWH creation sites and best-achievable sites. The anticipated cost for this effort is approximately $700,000, however, this effort may only need to conducted every 10 years or after a large flow event on the system.

6. Velocity distributions

Velocity within SWH are anticipated to be closely related to depth of water and flow, however, velocity distributions will likely be collected at a smaller number of sites than depth distributions and other physical data in order to better understand these relationships and to facilitate the development of 2D hydraulic models used in accounting efforts. The anticipated cost for collection and processing of velocity distributions is $500,000 per year.

7. Local abundance of organic matter and benthic macroinvertebrates

Local abundance of organic matter and/or benthic macroinvertebrates are two of the primary hypothesized connections between habitat complexity and growth of larval and YOY pallid sturgeon in the CEM. This data would be collected at a representative sample of created SWH sites and best-achievable sites. The anticipated cost for collection and processing of this data is $100,000 per year.

8. Abundance of large woody debris

Abundance of LWD is important for fish habitat structure, proliferation of benthic macroinvertebrates, and is an important source of organic input. It is also one of the predictors of both depths and velocities. LWD debris counts would be made at SWH sites while other monitoring is conducted. The anticipated cost for assessing the abundance of LWD is $50,000 per year.

9. Substrate diversity

Substrate diversity is an important variable related to biological metrics such as the abundance of benthic macroinvertebrates, as well as physical metrics such as water velocity. Data would be gathered using either grab samples or scanning technology and is anticipated to cost approximately $50,000 per year.

10. Terrestrial vegetation cover

Extent of establishment of terrestrial vegetation below the ordinary high water would be gathered using visual estimates of percent cover and is anticipated to cost approximately $50,000 per year.

11. Water quality

Many of the water quality parameters (such as dissolved oxygen, turbidity, temperature, etc.) are covariates needed to interpret other monitoring data as well as assess habitat suitability. This information will be collected at very little cost and at the same time as other monitoring efforts. As there is no cost associated with these efforts, priority for funding is low.

Table 6. Summary of Monitoring Priorities and cost estimates

Priority	Monitoring	Frequency of Collection	Anticipated Annual Cost
1	Larval & YOY fish	Annually	$500,000
2	Pallid sturgeon and native fish	Annually	$2,200,000
3	Abundance of SWH	Every 3-5 years	$50,000
4	Depth Distributions	Every 3-5 years	$400,000
5	Lateral Connectivity	Every 10 years	$500,000
6	Velocity Distributions	Every 3-5 years	$500,000
7	Organic matter / Benthic macroinvertebrates	Every 3-5 years	$100,000
8	Abundance of LWD	Every 3-5 years	$50,000
9	Substrate Diversity	Every 3-5 years	$50,000
10	Terrestrial Vegetation Cover	Every 3-5 years	$50,000
11	Water Quality	Every 3-5 years	N/A

4.6 Data Storage and Quality Assurance/ Quality Control

Data entry, quality control, and storage standards are currently in place for ongoing monitoring of pallid sturgeon and native fish species populations under the PSPAP. PSPAP data is collected using standardized two-page data sheets designed for recording all information (e.g., sample site, habitat characteristic, and fish data) which use standardized codes to ensure consistency in the database. A field crew leader is responsible for reviewing the data sheets promptly following field data collection efforts to ensure that all codes are complete, accurate, and legible. After all data sheets have been reviewed by the field crew supervisor, the original is submitted for data entry, and a copy of each data sheet will be maintained at the field station. All data is entered into a database via double-blind entry to identify any mistakes that may occur during the process of data entry. Distribution of this data is made via an approved request.

HAMP data will follow a different protocol. Individual partners involved in sampling efforts will compile their data, will be responsible for the QA/QC of the data, and will use the appropriate methods insure data quality. Upon completion, the data and reports will be delivered to the USACE. This information may be utilized by the USACE through consultation with the providing partner. Outside requests for use of this data will be submitted to the HAMP lead and in consultation with the data providing partner, the data may distributed in order to encourage open analysis and learning from the data. Partners who collected the data will have proprietary publishing rights to the data for one year following submission of the final report to USACE.

Assessments will be conducted on an annual basis and captured in an Annual AM Report. Every five years, additional analyses may be conducted on an as-needed basis (see section 6.2).

5 Investigations

The following sections describe prioritized focused investigations that will aid in addressing uncertainties associated with the management actions that cannot be fully addressed through the proposed monitoring efforts. These investigations are intended to be shorter term than monitoring efforts and have defined end-dates. Rough order of magnitudes estimates of cost and timeframe for each investigation are included. Investigations are listed in order of priority.

1. Determine the locations of larval pallid sturgeon

This investigation would be a target effort to determine locations of larval pallid sturgeon in the Missouri River, and potentially the Mississippi River, to determine the types of habitat that are being occupied, the qualities these habitats exhibit, and the spatial distribution of larval pallid sturgeon. Also determine spawning locations and expected locations of larvae based on those locations. This investigation would assist in addressing uncertainties related to the habitat needs of larval pallid sturgeon and their distribution and abundance in the Missouri River. This investigation is anticipated to cost approximately $1,500,000 over 4 years.

2. Develop a set of reference conditions for comparison of created sites to best-achievable habitats and historic conditions

Many of the analyses and assessments described in this AM strategy rely on the use of reference conditions for comparing the development of SWH projects to determine progress towards restoration objectives. This investigation would focus on developing these reference conditions from existing sites on the Missouri River using existing data and from historic data. This effort is anticipated to cost approximately $300,000 and be completed in one year.

3. Investigate fluid interactions around SWH to determine whether larval pallid sturgeon can enter SWH sites and be retained

This investigation would involve the collection of physical data and development of either two- or three-dimensional hydraulic models for a subset of SWH sites (approximately four) to determine if designs of inlet structures and structure modifications including dike notches are providing the proper conditions to allow drifting larval sturgeon to settle out in SWH at the right time of year. This investigation would assist in answering uncertainties related to the potential for SWH creation sites to retain larval pallid sturgeon and identify the most suitable types of designs. For the two-dimensional modeling, this investigation is anticipated to cost approximately $250,000 over 2 years. For the three-dimensional modeling, the anticipated cost would be $750,000 over 3 years.

4. Interaction between flows and the availability and functionality of SWH

The benefits of restoring some natural form to the Missouri River through SWH creation are not only dependent on changes to channel form but also the interaction with flows. This investigation would seek a more detailed understanding of these interactions needed to achieve biological objectives including changes in availability of SWH at different flow levels, timing and duration of flows and their affects on biological metrics. This would involve the development of a flow-stage relationship for a subset of SWH and best-achievable sites. This investigation is anticipated to cost approximately $300,000 over 2 years.

5. Investigate differences amongst large, clustered, and small SWH sites to address uncertainties regarding the best scale for SWH creation sites

This investigation would involve the collection of additional data from selected large, small and clustered SWH sites, with the potential to pair this investigation with one or more pilot projects, as well as additional data analysis of past data in order to determine if there are differences in biological responses due to the scale of SWH. This investigation would assist in addressing uncertainties related to design characteristics and placement of SWH creation sites. This investigation is anticipated to cost approximately $1,000,000 over 5 years.

6. Investigate potential drift distances for pallid sturgeon produced downstream of Gavins Point Dam

This investigation would involve studies to determine the potential drift distances for pallid sturgeon spawned downstream of Gavins Point Dam and would test and potentially validate assumed drift distances developed from studies in the upper Missouri River. This investigation would assist in addressing uncertainties related to the potential for SWH sites in different locations to retain larval pallid sturgeon. This investigation is anticipated to cost approximately $300,000 over 2 years.

7. Determine the relative benefits of different types of SWH sites

This investigation would primarily use existing data to compare the relative benefits amongst different types of SWH sites such as chutes, backwaters, various types of structure modifications, and new structures. The investigation would include analyses related to the rates of habitat development, physical habitat characteristics, and biological responses. This investigation would assist in addressing uncertainties related to the creation of SWH and the potential benefits to be gained from different types of sites. The anticipated cost for this investigation is approximately $100,000 over 1 year.

8. Investigate the implications of different distributions of SWH amongst target segments

This investigation would use historical data, emerging understanding of pallid sturgeon genetic population structure, drift dynamics, and additional information on the native fish community to improve understanding of optimal distribution of SWH downstream of Gavins Point Dam. The analysis will consider uniform distribution, distribution scaled to channel size, historical distribution, and distributions designed to optimize ecological functions within the engineered system. This investigation would assist in addressing uncertainties related to the distribution of SWH creation sites amongst the target segments. The anticipated cost for this investigation is approximately $250,000 over 2 years.

9. Investigate growth rates and feeding requirements of larval and YOY pallid sturgeon.

This investigation would involve lab and field studies to determine optimal and existing growth rates for larval and juvenile pallid sturgeon, compare differences amongst growth rates in lab and field settings and determine the viability and feasibility of using sturgeon growth rates as a potential metric for the SWH AM Strategy. It would also address the food requirements for pallid sturgeon and whether those foods are available in SWH creation and best-achievable habitats. This investigation would help to address the potential benefits of created SWH sites. The anticipated cost for this investigation is approximately $500,000 over 3 years. There is an ongoing multi-year research project with South Dakota State University titled: *Determinants of Growth and Survival of Larval Pallid Sturgeon; a combined laboratory and field approach* (Graeb, Chipps, and Klumb) that would provide much of this information.

10. Determine the amount of SWH that can be restored without impacting the navigation channel

This investigation would address uncertainties related to the amount of habitat that can be restored before too much water is diverted from the main channel and navigation on the system is impacted or no longer possible. This effort would involve development of a model to determine the amount of water under different flow scenarios that could be diverted into SWH sites without negatively impacting flows in the navigation channel using existing data. This anticipated cost for this investigation is approximately $300,000 over 2 years.

11. Investigate the amount of time required for SWH to develop though erosion and deposition processes

There can be a significant lag time (many years, even decades) between the management action of constructing SWH and the desired condition of the habitat. The amount of time needed for development of different types of SWH projects due to hydrogeomorphic processes is somewhat uncertain and depends on flows, project type and design, and location. While this data will be derived from successive years of monitoring SWH creation sites, this investigation would involve a modeling effort in the near-term to determine rates of development under different flow scenarios and for different types of SWH creation sites. This would involve the development of an appropriate hydraulic model derived from empirical data of bank erosion and deposition for a subset of SWH sites (approximately four) that incorporates sediment transport and channel morphology. This investigation is anticipated to cost approximately $750,000 over 3 years.

12. Develop a revised quantitative definition of SWH

The clarified definition of SWH adds many qualitative characteristics to the quantitative definition of less than five feet deep and less than two feet per second velocity. This investigation would use existing data to develop quantifiable indices. Existing depth and velocity datasets may be mined to develop quantitative metrics and to compare with existing biological data and expert opinion. The anticipated cost for this investigation is approximately $250,000 over 2 years.

13. Conduct a study to determine important food resources for chub species

Chub species are hypothesized to be an important food resource for pisciverous pallid sturgeon. However, populations of many native chub species have declined on the Missouri River. This investigation would involve laboratory and field work to determine diet requirements and important food resources for chub species. A follow on analysis would be conducted using monitoring data from the SWH and best achievable sites to determine if these food resources are available or if there are measurable differences amongst different types of SWH sites. The anticipated cost for this investigation is approximately $375,000 over 3 years.

14. Investigate the potential impacts of contaminants in the Missouri River on pallid sturgeon

This investigation would involve determining levels of contaminants in the Missouri River (with either passive or active sampling methodologies) as well as laboratory studies to determine the potential impacts of these contaminants in various concentrations on different life stages of pallid sturgeon. The anticipated cost for this investigation is approximately $100,000 over 2 years.

15. Investigate the potential impacts of SWH sites on invasive species

This investigation would look at the potential for different types of SWH to benefit non-native aquatic species such as Asian carp. Existing data would be used to determine potential trade-offs associated with SWH types and designs regarding undesirable species. The anticipated cost for this investigation is approximately $100,000 over 1 year.

Other potential investigations:

In addition to the prioritized list of investigations above, a number of other potential investigations were identified. These investigations may be added to the list of priorities as the SWH AM Strategy transitions into the implementation phase.

- Investigate system energy inputs (in the form of carbon inputs) in the navigation channel of the Missouri River compared with SWH creation sites and sample sites from other, more natural segments of rivers, such as the Gavins Point segment of the Missouri River and the Yellowstone river.
- Investigate the energetic requirements for larval pallid sturgeon and compare with available resources in different types of SWH.
- Investigate interspecific interactions between shovelnose & pallid sturgeon to determine the potential effects of competition and hybridization and any implications on meeting the SWH AM Strategy's stated objectives. This investigation may also explore the differences between shovelnose sturgeon and pallid sturgeon that allow shovelnose to successfully recruit at early life stages where the pallid sturgeon bottleneck is believed to occur.
- Investigate the long term effects of SWH on the stabilization of the Missouri River channel and banks.

Table 7. Priorities for potential investigations

Priority	Investigation	Duration (years)	Anticipated Cost
1	Location of larval pallid sturgeon	4	$1,500,000
2	Develop reference conditions	1	$300,000
3	Fluid interactions around SWH	2-3	$250,000 - $750,000
4	Flows and availability of SWH	2	$300,000
5	Scale of SWH sites	5	$1,000,000
6	Drift distances of larval sturgeon	2	$300,000
7	Benefits of different types of SWH	1	$100,000
8	Distributions of SWH	2	$250,000
9	Growth rates & food of larval pallid sturgeon	3	$500,000
10	Amount of SWH w/out impacting navigation	2	$300,000
11	Amount of time for SWH development	3	$750,000
12	Revised quantitative definition	2	$250,000
13	Food resources for chub species	3	$375,000
14	Potential impacts of contaminants	2	$100,000
15	Potential impacts on invasive species	1	$100,000

6 Implementation and Decision-making

6.1 Strategy(s)

The SWH program, and specifically the Habitat Assessment and Monitoring Program (HAMP), will take information gained from creation efforts and monitoring of physical and biological responses and analyze these data on an annual basis to help inform implementation and decision making. Due to the geographic scope of this program, AM principles will be applied at numerous scales including the overall amount of habitat to be restored, the distribution of restored habitat throughout the target segments, changes to design and creation techniques, and site-specific adjustments. Included below are example decision matrices that may be used to determine decision points in annual and periodic reviews to determine when modifications are warranted. Additional decision points are included in Appendix A related to the CEM.

6.1.1 Amount of Habitat to be Created

The BiOp calls for the creation of 12,035-19,565 acres of SWH to meet an overall goal of 20-30 acres per river mile (15,060-22,590 total acres). SWH creation also addresses the provisions of the BSNP Fish and Wildlife Mitigation Program which calls for 7,000-20,000 acres of habitat of this type. Inventories of the amount of SWH are complicated by two sets of criteria (the original definition and the qualitative clarified definition), multiple methods being used to delineate habitat, and an imprecise goal (20-30 acres per mile).

It remains uncertain how much of this habitat is needed in order to achieve the population objectives. Currently, about 3,443 acres have been restored with the potential of those projects to produce twice that amount in the future as habitat develops. There are approximately 9,400 acres of SWH currently present between Ponca, Nebraska and St. Louis, Missouri. As additional habitat is restored and uncertainties are clarified regarding the rate of habitat development, implementation plans (including the amount of habitat restored on an annual basis) may be altered in order to achieve acreage targets within the desired timeframes. Additionally, a combination of physical and biological responses will be used to determine whether sufficient habitat has been restored. As progress towards the SWH acreage target is made, assessments will be made to determine whether efforts should be focused on improving quality of the created habitat, whether additional habitat should be created, or whether all objectives have been met and efforts should focus on maintaining habitat quantity and quality.

There are three proposed times established in the BiOp for assessing progress towards the SWH acreage goals:

2014 – Establish 30% of the target SWH acreage (3,611-5,780 acres)
2019 – Establish 60% of the target SWH acreage (7,221-11,739 acres)
2024* – Establish 100% of the target SWH acreage (12,035-19,565 acres)

* As resources are being used for construction of the Intake Diversion Dam Project, the USFWS extended the previous check-in point of 2020 in a letter dated October 23, 2009 by a period of not-to-exceed 4 years.

In addition, annual and periodic (5-year) assessments will be made during the implementation phase of the AM process to determine if any adjustments to the program are warranted.

The following decision matrix relates SWH acreage and abundance of pallid sturgeon and other native fishes. The matrix assumes that project-scale assessments have already indicated that habitat complexity is developing as expected and project scale biological metrics are responding. That is, hypotheses about the relationships between shallow water habitat complexity and larval fishes are supported by monitoring data. Accordingly, "current SWH acres" are those that have achieved success at the project-scale, implying that project-scale biological and physical metrics are on track as well. In this matrix, dark green squares indicate the desired end states, light green squares indicate that progress is occurring, orange squares indicate situations where there may be a reversal in trends, red squares indicate situations where corrective adjustments may be warranted, and blue squares indicate situations in which fundamental hypotheses may be in question.

		Objective 1: System Wide responses of pallid sturgeon and other native fishes	
Objective 2.1: Abundance of SWH		Abundance of pallid sturgeon and native fishes **steady or decreasing**	Abundance of pallid sturgeon and native fishes **increasing**
	Current SWH acres **at or above target**	*Status:* Habitat developed but insufficient *Action:* Create more habitat, revise targets*	*Status:* Habitat developed and sufficient *Action:* Maintain if necessary
	Current SWH acres **below target**, anticipated acres **at target**	*Status:* Habitat insufficient and developing *Action:* Wait and monitor	*Status:* Habitat developing, and already sufficient *Action:* Maintain if necessary, consider revising metrics or targets
	Current and anticipated SWH acres **below target**	*Status:* Habitat insufficient *Action:* Create more habitat	*Status:* Habitat sufficient *Action:* Revise metrics or targets
	SWH acres **decreasing**	*Status:* Habitat insufficient and declining *Action:* Create more habitat or improve existing habitat	*Status:* Habitat currently sufficient but declining *Action:* Monitor to determine need for habitat modifications

Figure X: Decision matrix for amount of SWH to be created

*This outcome could also indicate the hypothesized relationships between SWH and pallid sturgeon are at least partly incorrect, especially if some native fish populations are steady or increasing but pallid populations are not.

Under this matrix, decisions as to whether to increase the amount of habitat would be based on both the amount of habitat currently in place that is meeting both physical and biological objectives and the trajectory of populations of pallid sturgeon and other native fish species. It should be noted that the amount of hatchery-raised pallid sturgeon must be taken into account when calculating the pallid sturgeon population growth rate to interpret these results.

6.1.2 Distribution of Restored Habitat

While the initial target for distributing SWH is to construct in target segments proportional to the size of each segment, investigations and analysis of collected data will be undertaken to determine whether there are biological benefits to other distributions of habitat or whether different types of SWH (backwaters, chutes, topwidth widening, etc.) have greater benefits in different locations. This information will be used to develop a long-term plan for distribution of different types of SWH within the target segments. This distribution will be tracked as part of the AM implementation phase and will be used to measure progress towards Objective 2. The current distribution of habitat was presented earlier in Table 1. An experimental approach and series of focused investigations should be used for project placement in order to increase understanding and adaptively manage project distribution.

6.1.3 Design and Construction Techniques

Data on physical habitat changes and biological responses will be used to help determine the effectiveness and potential benefits of various types of SWH (chutes, backwaters, structure modifications, etc.) as well as project features such as river tie-back channels, inlet structures, placement of LWD, and other features. This information will be used on an annual basis to influence design and construction techniques as well as alternative analysis at potential restoration sites.

6.1.4 Site Adjustments

Data from physical and biological responses at SWH creation sites will be used to determine whether or not site-specific adjustments are needed to achieve the desired habitat quality. Sites will be compared with best-achievable sites as described in the Monitoring and Assessment section. Progress towards biological and physical targets, as well as comparison amongst restored habitats, will be used to determine if a specific site requires additional work in order to achieve the stated objectives.

The following matrices reflect project-scale adjustments that may be warranted for both sites that are anticipated to develop and sites that are constructed to the desired condition. In these matrices, dark green squares indicate the desired end states, light green squares indicate that progress is occurring, orange squares indicate situations where there may be a reversal in trends, red squares indicate situations where corrective adjustments may be warranted, and blue squares indicate situations in which fundamental hypotheses may be in question.

In the proceeding matrix, trends in physical habitat complexity would be compared with trends in biological responses to determine whether or not a change is warranted at sites that are not built to their final condition – these are sites that are meant to develop through erosion and deposition processes and where biological responses are questionable. The matrix on the next page relates to the construction of sites that are built to their desired final condition and where physical complexity is not anticipated to improve over time (namely backwaters). At these sites, there is little uncertainty regarding biological responses of phytoplankton, zooplankton, and benthic invertebrates. Monitoring is instead focused on physical aspects of the habitat and ensuring they have been constructed properly and are not degrading over time.

Objective 3: Physical characteristics of SWH \ Objective 4.1: Abundance of larval, YOY and juvenile native fishes	Native larval fishes absent or decreasing	Native larval fishes abundant or increasing
Similar to best-achievable, at equilibrium	*Status:* Habitat developed but insufficient to support biotic community *Action:* Assess other potential limiting factors	*Status:* Habitat developed and sufficient *Action:* Maintain if necessary
Improving, becoming more-similar to best-achievable, **not at equilibrium**	*Status:* Habitat not yet sufficient but on development trajectory *Action:* Wait and continue to monitor	*Status:* Habitat developing, already sufficient *Action:* Monitor to ensure trends do not reverse
Stagnant, no significant increase or decrease, dissimilar to best-achievable, **not at equilibrium**	*Status:* Habitat complexity insufficient and not developing *Action:* Modify habitat or wait for a significant flow event (if lacking)	*Status:* Habitat not developing, but sufficient *Action:* Consider revising metrics or targets
Physical habitat complexity decreasing	*Status:* Habitat insufficient and declining *Action:* Modify habitat or wait for significant flow events if they have not occurred	*Status:* Habitat currently sufficient but declining in complexity *Action:* Monitor to determine need for habitat modifications

Figure Y: Decision matrix for site-specific adjustments to SWH projects intended to develop over time

Objective 3: Emulate depth distributions of best-achievable habitats / Objective 3: Increase lateral connection of created habitat	Lateral connectivity of habitat dissimilar from best-achievable habitat	Lateral connectivity of habitat similar to best-achievable habitat
Depths similar to best-achievable habitat, no signs of significant sedimentation or degradation	*Status:* Habitat stable but constructed with insufficient lateral connectivity *Action:* Re-slope banks to establish lateral connectivity	*Status:* Habitat stable and constructed with adequate physical complexity *Action:* Maintain if necessary
Depths dissimilar from best-achievable habitat, no signs of significant sedimentation or degradation	*Status:* Habitat stable but constructed with insufficient physical complexity and lateral connectivity *Action:* Re-slope banks to establish lateral connectivity, consider dredging to improve depth distributions	*Status:* Habitat stable but constructed with insufficient physical complexity *Action:* Consider dredging to improve depth distributions
Depths dissimilar from best-achievable habitat, signs of significant sedimentation or degradation	*Status:* Habitat actively filling in and constructed with insufficient physical complexity and lateral connectivity *Action:* Abandon habitat or re-slope banks to establish lateral connectivity, dredge to improve depth distributions and preserve connection to river	*Status:* Habitat actively filling in and constructed with insufficient physical complexity but with adequate lateral connectivity *Action:* Dredge to improve depth distributions and preserve connection to river

Figure Z: Decision matrix for site-specific adjustments to SWH projects constructed to desired end state

6.1.5 Adjustments to Objectives, Metrics, and Targets

During the implementation of the SWH AM Strategy, it may be necessary to adjust elements of the strategy to respond to new information garnered from ongoing monitoring and investigations. For example, the physical definition of SWH specifies average depths of less than 5 feet and average flows of less than 2 feet per second. However, some literature indicates that water velocities critical for survival of larval fishes may be much lower - closer to 0.1 feet per second. If data collected through monitoring and investigations indicates that depth and velocity criteria, or other objectives, metrics and targets, need to be revised, they will be updated in the AM Strategy and may have implications for accounting methods, sampling designs or other aspects of the AM Strategy.

6.2 Implementation cycle

On an annual basis, data will be compiled and analyzed to assess progress towards the stated objectives and to report information gained from monitoring and investigations. This annual report will include recommendations related to all or some of the following decisions:

1. **Level of construction effort:** Continue with current, increase level of effort, or decrease level of effort. If a change to the level of effort is proposed, a cost estimate will be included along with a list of potential implications if the change is not adopted.

2. **Pilot projects:** Recommendations for new construction pilot projects, or new project features to be included, and associated costs and expected benefits. This will include performance metrics, monitoring needs, and timeframe for monitoring to determine success.
3. **Site Adjustments:** Recommended actions to be taken at existing created SWH sites in order to improve these sites. Include methods, cost estimate, anticipated benefits and any additional monitoring necessary.
4. **Incorporation of new methodologies:** If previous pilot projects indicate that new methodologies will be successful, the team will recommend how these methodologies should be incorporated into the program and estimate changes in cost and expected benefits.
5. **Investigations:** Includes any new or additional investigations to be undertaken to address uncertainties associated with the program.

Every five years, additional analyses will be conducted in order to assess whether the elements of the SWH AM Strategy (including Objectives, Metrics, Targets, Monitoring, etc.) should be altered. If a decision is made to update the AM Strategy, a scope, schedule and plan of action will be developed to update the AM Strategy.

6.3 Responsible Parties

Three primary parties will be responsible for implementing this AM Strategy (including documentation). The SWH implementation PMs will be responsible for setting up and leading a series of calls and meetings that will occur between them, the SWH Product Delivery Team (PDT) and the MRRP AM Work Group (AMWG). The USACE, through the SWH PDT, will be responsible for gathering the data and conducting the primary data analyses. This group will also form recommendations for implementation of the SWH sub-program based on the results of the data. The AMWG will provide an outline of the Annual AM Report, assist USACE in completing the annual report, and assist in facilitating the meetings, conducting analyses and documenting the annual review process. The AMWG will also assist in internal and external status updates and distribution of the annual and five-year AM reports.

6.4 Decision-making Process

Once the SWH AM Strategy is developed and finalized, the next step is to implement it. The SWH Implementation PM, in coordination with the SWH PDT, will develop a set of site specific management actions and monitoring and investigations needed associated with the SWH AM Strategy on an annual basis which will feed into the development of the MRRP Annual Work Plan. In addition to the primary management action of SWH creation, the Annual Work Plan may also include pilot projects to test new methodologies and adjustments to previously constructed projects.

The USACE Executive Steering Committee (ESC) will use the input from the Implementation PMs and the PDTs to establish MRRP priorities and create the MRRP Annual Work Plan. The Annual Work Plan includes real estate actions, habitat creation actions, monitoring of physical and biological responses to actions, and research activities. This Annual Work Plan is then used by PDTs to implement the management actions that make it into the final Annual Work Plan. As projects are constructed and operated, the Integrated Science Program (ISP) is responsible for monitoring the results of these management actions to track progress towards the objectives and metrics identified in the AM Strategy. In addition, the ISP conducts necessary investigations to reduce uncertainty associated with the management actions.

The data from the monitoring efforts and investigations are provided to the PDTs and the AMWG for analysis and comparison to metrics from the AM Strategy. Following data analysis, the PDTs and the AMWG meet to discuss the results and any implications for the MRRP Annual Work Plan, including an assessment regarding whether the management actions are meeting the objectives or whether adjustments are needed in order to ensure success over time. The analysis and assessment, along with recommendations, are coordinated through the ISP and captured in an Annual AM Report. ISP coordination involves both review of the draft document as well as ongoing discussion at ISP Management Team meetings and discussions for inclusion in the ISP work plan. The Annual AM Report includes: 1) analysis of data collected; 2) evaluation of the effectiveness of actions towards achieving program objectives; 3) recommended Sub-Program or project adjustments; and 4) data needs and recommended research activities to improve predictive capabilities. As the Annual AM Reports are developed, independent review will be incorporated into the process as appropriate.

The draft report is then provided to the PDTs, CORE Team, the ESC, the appropriate MRRIC work group, the MRRIC, and other groups as appropriate. This provides an opportunity for these groups to gain an understanding of the MRRP at a key time in the annual cycle – occurring after information is compiled on the previous year's efforts, and before development of the next Annual Work Plan.

Feedback from these entities is provided to the PMs and PDTs through interaction with the AMWG and may result in changes to the multi-year action strategy or the development of the next Annual Work Plan. The cycle then repeats.

Periodically (every 5 years), the AM implementation phase will also involve a critical review of elements of the individual AM Strategies to see if adjustments to the AM Strategies are needed. If a recommendation is made to update an AM Strategy and major changes are warranted, the AM Strategy Development phase may be reinitiated in full or in part. This recommendation would come from the AMWG and the PDT and the decision to reinitiate the Strategy Development Phase would be made by either the CORE or the ESC, as appropriate. Otherwise, general updates would be made and coordinated through the external and internal teams described above under AM Strategy Development.

Additionally, MRRIC and other groups may choose to provide comments or recommended adjustments to AM Strategies at any time during the implementation phase. This could include changes to objectives, incorporation of additional management actions, input on anticipated benefits and tradeoffs, and other pertinent elements of AM Strategies. As these comments are received, they will be considered by the agencies, PDTs and AMWG and the AM Strategies will be updated as appropriate. For additional information on the implementation process for AM strategies, please refer to the MRRP AM Process Framework.

6.5 Reporting

The most recent SWH AM Strategy, annual AM reports, periodic (five-year) AM reports, reports on focused investigations, and other related reports will be made available to the public on www.moriverrecovery.org.

7 References

Aarts, B.W., Van Den Brink, F.B., and P.H. Nienhuis. 2004. Habitat loss as the main cause of the slow recovery of fish faunas of regulated rivers in Europe: the transversal floodplain gradient. River Research and Applications 20:3-23.

Archer, M.W., 2010. Retention, Movement, and the Biotic Response To Large Woody Debris in the Channelized Missouri River. Master's Thesis. University of Nebraska School of Natural Resources, Lincoln, NE.

Anderson, R.V., Day, D.M., 1986. Predictive Quality of Macroinvertebrate-Habitat Associations in Lower Navigation Pools of the Mississippi River. *Hydrobiologia* 136: 101-112.

Beck, L., Iwanowicz, L., Iwanowicz, D., and D. Palic. 2008. ""Fishing"" for Cytokines and Immune Molecules to Better Understand Pallid Sturgeon Health. Report to USACE. 11 p.

Beckett, D.C., Pennington, C.H. Water Quality, Macroinvertebrates, Larval Fishes, and Fishes of the Lower Mississippi River – a Synthesis. Technical Report. E-86-12, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

Bergman, H.L., Boelter, A.M., Parady, K., Fleming, C., Keevin, T., Latka, D.C., Korschgen, C., Galat, D.L., Hill, T., Jordan, G., Krentz, S., Nelson-Stastny, W., Olson, M., Mestl, G.E., Rouse, K., and Berkley, J., 2008. Research Needs and Management Strategies for Pallid Sturgeon Recovery, *in* Proceedings of a Workshop held July 31-August 2, 2007, St. Louis, Mo., William D. Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, Laramie, p. 37.

Berry, C. R. and B. A. Young. 2001. Introduction to the benthic fishes study. Volume 1 of Population structure and habitat use of benthic fishes along the Missouri and lower Yellowstone rivers. U. S. Geological Survey, Cooperative Research Units, South Dakota State University, Box 2140b, Brookings, South Dakota 57007.

Berry, C.R., Wildhaber, M.L., and D.L. Galat. 2004. Fish distribution and abundance, vol. 3. Population structure and habitat use of benthic fishes along the Missouri and lower Yellowstone Rivers. U.S. Geological Survey, Cooperative Research Units, South Dakota State University, Brookings.

Blevins, D. and J. Fairchild. 2001, Applicability of NASQAN data for ecosystem assessments on the Missouri River: Hydrological Processes, v. 15, no. 7, p. 1347-1362. http://dx.doi.org/10.1002/hyp.215

Bovee, K.D., Newcomb, T.J., and T.G. Coon. 1994. Relations between habitat variability and population dynamics of bass in the Huron River, Michigan. U.S. National Biological Survey Biological Report 21.

Bowan, Z.H., Freeman, M.C., and K.D. Bovee. 1998. Evaluation of generalized habitat criteria for assessing impacts of altered flow regimes on warmwater fishes. Transactions of the American Fisheries Society 127:455-468.

CDM Federal Programs Corporation, 2007, Miscellaneous Military and Civil Hazardous Waste Investigation Projects for the U. S. Army Corps of Engineers Kansas City District: unpub. file reports.: Kansas City, Mo.

Copp, G.H. 1992. Comparative microhabitat use of cyprinid larvae and juveniles in a lotic floodplain channel. Environmental Biology of Fishes 33:181-193.

DeLonay, A.J., Jacobson, R.B., Papoulias, D.M., Wildhaber M.L., Chojnacki, K.A., Pherigo, E.K., Bergthold, C.L., and G.E. Mestl. 2009. Ecological requirements for pallid sturgeon reproduction and recruitment in the Lower Missouri River: Annual report 2009: U.S. Geological Survey Open-File Report 2010-1215, 64 p.

DeLonay et al. 2007. Use of behavioral and physiological indicators to evaluate Scaphirhynchus sturgeon spawning success. Journal of Applied Ichthyology 23(4), p. 428-435.

Dryer, M. P., and A. J. Sandvol. 1993. Pallid sturgeon recovery plan. United States Fish and Wildlife Service, Bismarck, North Dakota.

Echols, K.R., Brumbaugh, W.G., Orazio, C.E., May, T.W., Poulton, B.C., and P.H. Peterman. 2008. Distribution of pesticides, PAHs, PCBs and bioavailable metals in depositional sediments of the Lower Missouri River, USA: Archives of Environmental Contamination and Toxicology, v. 55, p. 161-172.

Freeman, M.C., Bowen, Z.H., Bovee, K.D., and E.R. Irwin. 2001. Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes. Ecological Applications 11:179-190.

French, W. E. 2010. Predation vulnerability and trophic interactions of pallid sturgeon Scaphirhynchus albus. Master’s thesis. South Dakota State University, Brookings.

Funk, J.L. and J.W. Robinson. 1974. Changes in the Channel of the Lower Missouri River and Effects on Fish and Wildlife: Jefferson City, MO.\, Missouri Department of Conservation, 52 p.

Gehrke, P.C., Brown, P., Schiller, C.B., Moffatt, D.B., and A.M. Bruce. 1995. River regulation and fish communities in the Murray-Darling River system, Australia. Regulation Rivers: Research and Management 11:363-375

Gerrity, P.C., Guy, C.S. and W.M. Garnder. 2006. Juvenile Pallid Sturgeon are Piscivorous: A Call for Conserving Native Cyprinids. Transactions of the American Fisheries Society 135:604-609.

Gozlan, R.E., Mastrorillo, S., Dauba, F., Tourenq, J., and G.H. Copp. 1998. Multi-scale analysis of habitat use during late summer for 0+ fishes in the River Garonne (France). Aquatic Sciences 60:99-117.

Graeb, B.D.S., Chipps, S.R., Klumb, R.A. 2009. Determinants of Growth and Survival of Larval Pallid Sturgeon; a combined laboratory and field approach. South Dakota State University.

Grohs, K. L., R. A. Klumb, S. R. Chipps. And G. A. Wanner. 2009. Ontogenetic patterns in prey use by pallid sturgeon in the Missouri River, South Dakota and Nebraska. Journal of Applied Ichthyology. 25 (Supplement 2):48-53.

Hall, J. R. and S. J. Sampson. 2009. Pallid Sturgeon Habitat Assessment and Monitoring Program 2008 Annual Report. Nebraska Game and Parks Commission. Lincoln, NE.

Hendrick, R.P., T. Kurobe, T.S. McDowell, S.C.Yun, and E. MacConnel. 2009. Development of Management Tools for the Pallid Sturgeon Iridovirus. Final Report to U.S. Army Corps of Engineers, Gavins Point Project, Omaha District, Omaha, Nebraska. 20pp.

Humphries, P. and P.S. Lake. 2000. Fish larvae and the management of regulated rivers. Regulated Rivers: Research and Management 16:421-432.

Jacobson, R.B., Johnson, H.E., Laustrup, M.S., D'Urso, G.J., and J.M. Reuter. 2004. Physical habitat dynamics in four side-channel chutes, Lower Missouri River. U.S. Geological Survey Open-File Report 2004-1071.

Jacobson, R.B., and Galat, D.L., 2006. Flow and form in rehabilitation of large-river ecosystems: An example from the Lower Missouri River: Geomorphology, v. 77, no. 3-4, p. 249-269 http://137.227.231.90/pubs/center/pdfDocs/flow-and-form-rehab.pdf.

Jacobson, R.B., D.W. Blevins, and C.J Bitner. 2009. Sediment regime constraints on river restoration – An example from the Lower Missouri River, in James, L.A., Rathburn, S.L., and Whittecar, G.R., eds., Management and restoration of fluvial systems with broad historical changes and human impacts: Denver, Colo., Geological Society of America Special Paper 451, p. 1-22.

Jalili, Shahrzad and Dan Pridal. 2010. Missouri River Shallow Water Habitat Accounting Report – 2010. U.S. Army Corps of Engineers.

Jurajda, P. 1995. Effect of channelization and regulation on fish recruitment in a floodplain river. Regulated Rivers: Research and Management 10:207-215.

Knowlton, M.F., and J.R. Jones. 2000. Seston, light, nutrients and chlorophyll in the Lower Missouri River, 1994-1998. Journal of Freshwater Ecology 15:283-297.

Kwak, T.J. 1988. Lateram movement and use of floodplain habitat by fishes of the Kankakee River, Illinois. American Midland Naturalist 120:241-249.

Latka, D.C., Nesteler, J., and L.W. Hesse. 1993. Restoring physical habitat in the Missouri River: a historical perspective. In: Hesse, L.W., Stalnaker, C.B., Benson, N.G., Zuboy, J.R. (Eds.). Proceedings of the Symposium on Restoration Planning for the Rivers of the Mississippi River Ecosystem. National Biological Survey Report, vol. 19, pp 350-359.

Missouri Department of Health and Senior Services, 2011, 2011 Fish Advisory: Jefferson City, Missouri, Missouri Department of Health and Senior Services, 22 p.

Morris, L.A., Langemeier, R.N., Russell, T.R., and A. Witt. 1968. Effects of main stem impoundments and channelization upon the limnology of the Missouri River, NE. Transactions of the American Fisheries Society 97:380-388.

National Research Council. 2002. Restoration of Aquatic Ecosystems. National Academy Press, Washington, DC.

National Research Council, 2011, Missouri River Planning -- Recognizing and Incorporating Sediment Management: Washington, D.C., National Academy Press, 152 p.

O'Neill, B.J. and J.H. Thorp. 2011. Flow refugia for the zoobenthos of a sand-bed river: the role of physical-habitat complexity. Journal of the North American Benthological Society 30:546-558.

Papanicolaou, A.N. and M. Elhakeem. 2006. Evaluation of the Existing Shallow Water Habitat Areas in the Upper Missouri River. University of Iowa. Iowa City, IA.

Pflieger, W.L. and T.B. Grace. 1987. Changes in the fish fauna of the lower Missouri River, 1940-1983. In: Matthews, W.J., heins, D.C. (Eds.). Community and Evolutionary Ecology of North American Stream Fishes, Univ. Oklahoma Press, Norman, pp. 166-177.

Poulton, B.C., Wildhaber, M.L., Charbonneau, C.S., Fairchild, J.F., Mueller, B.G., and Schmitt, C.J., 2003, A longitudinal assessment of the aquatic macroinvertebrate community in the channelized Lower Missouri River: Environmental Monitoring and Assessment, v. 85, no. 1, p. 23-53.

Poulton, B.C., and Allert, A.L., 2011, An evaluation of the relative quality of dike pools for benthic macroinvertebrates in the Lower Missouri River, USA: River Research and Applications, p. 1-22. 10.1002/rra.1558

Quist, M.C., Boelter, A.M., Lovato, J.M., Korfanta, N.M., Bergman, H.L., Latka, D.C., Korschgen, C., Galat, D.L., Krentz, S., Oetker, M., Olson, M., Scott, C.M., and Berkley, J., 2004, Research and assessment needs for pallid sturgeon Recovery in the Missouri River--Final report to the U.S. Geological Survey, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and U.S. Environmental Protection Agency: Laramie, Wyo., William D. Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, 82 p.

Robinson, A.T., Clarkson, R.W., and R.E. Forrest. 1998. Dispersal of larval fishes in a regulated river tributary. Transactions of the American Fisheries Society 127:772-786.

Schalk, G.K., Holmes, R.R., and Johnson, G.P., 1997, Physical and chemical data on sediments deposited in the Missouri and Mississippi River flood plains during the July through August 1993 flood: U.S. Geological Survey Circular 1120-L, 62 p.

Schapaugh, Adam, Tim L. Hiller, Andrew J. Tyre. 2010. The Pallid Sturgeon Habitat Assessment and Monitoring Program 2007-2009. University of Nebraska Lincoln School of Natural Resources.

Scheidegger, K.J. and M.B. Bain. 1995. Larval fish distribution and microhabitat use in free-flowing and regulated rivers. Copeia 1995:125-135.

Schiemer, F., Hubert, K., and E. Kamler. 2003. The early life history stages of riverine fish: ecophysiological and environmental bottlenecks. Comparative Biochemistry and Physiology Part A 133:439-449.

Schiemer, F., H. Keckeis, W. Reckendorfer and G. Winkler. 2001. The "inshore retention concept" and its significance for large rivers. Large Rivers Vol. 12, No.2-4. Arch. Hydrobiol. Suppl. 135/2-4, p. 509-516.

Schlosser, T.J. 1991. Stream fish ecology: a landscape perspective. BioScience 41:704-712.

Stansbury, John, Istvan Bogardi, and Jennifer Gitt. 2009. Multi-criteria Assessment of Habitat Restoration for the Missouri River: Final Report to the U.S. Army Corps of Engineers, the U.S. Geological Survey, and the Nebraska Cooperative Fish and Wildlife Research Unit. University of Nebraska-Lincoln.

Sterner et al., 2009. Missouri River Fish and Wildlife Mitigation Program Fish Community Monitoring and Habitat Assessment of Off-Channel Mitigation Sites. 1338 pp.

Tibbs, J.E. and D.E. Galat. 1997. Larval, juvenile, and adult small fish use of scour basins connected to the lower Missouri River. Cooperative Fish and Wildlife Research Unit, University of Missouri, Columbia.

Turner, R.E., and Rabalais, N.N., 2003, Linking Landscape and Water Quality in the Mississippi River Basin for 200 Years: Bioscience, v. 53, no. 6, p. 563-572.

U.S. Army Corps of Engineers. 2003. Final Supplemental Environmental Impact Statement for the Missouri River Fish and Wildlife Mitigation Project located on the Missouri River from Sioux City, Iowa to the mouth near St. Louis, Missouri in the States of Iowa, Nebraska, Kansas and Missouri.U.S. Army Corps of Engineers. 2004. Missouri River shallow water habitat report. 404pp.

U.S. Army Corps of Engineers, 2005, Ordinary high water mark definition: U.S. Army Corps of Engineers, Regulatory Guidance Letter 05-05, 4 p.

U.S. Army Corps of Engineers. 2009. Memorandum for Commanders, Major Subordinate Commands: Implementation Guidance for Section 2036(a) of the Water Resources Development Act of 2007 (WRDA 07) – Mitigation for Fish and Wildlife and Wetlands Losses. 10 pp.

U.S. Army Corps of Engineers. 2010. Program Management Plan for the US Army Corps of Engineers MRRP Water Quality Program.

U.S. Fish and Wildlife Service (USFWS). 2000. Biological opinion on the operation of the Missouri River main stem Reservoir system, operation and maintenance of the Missouri River bank stabilization and navigation project, and operation of the Kansas River reservoir system: U.S. Fish and Wildlife Service, 286 p.

U.S. Fish and Wildlife Service (USFWS). 2003. Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System, U.S. Fish and Wildlife Service.

U.S. Fish and Wildlife Service (USFWS). 2007. Pallid sturgeon (Scaphirhynchus albus) 5-year review: summary and evaluation. USFWS, Billings, Montana.

Volesky, D.F. 1963. A comparison of the macrobenthos from selected habitats in cattail marshes of the Missouri River. Masters Thesis, Dickinson State College, 44 pages.

Ward, J.V. and J.A. Sanford. 1995. The serial discontinuity concept: extending the model to floodplain rivers. Regulated Rivers 10:159-168.

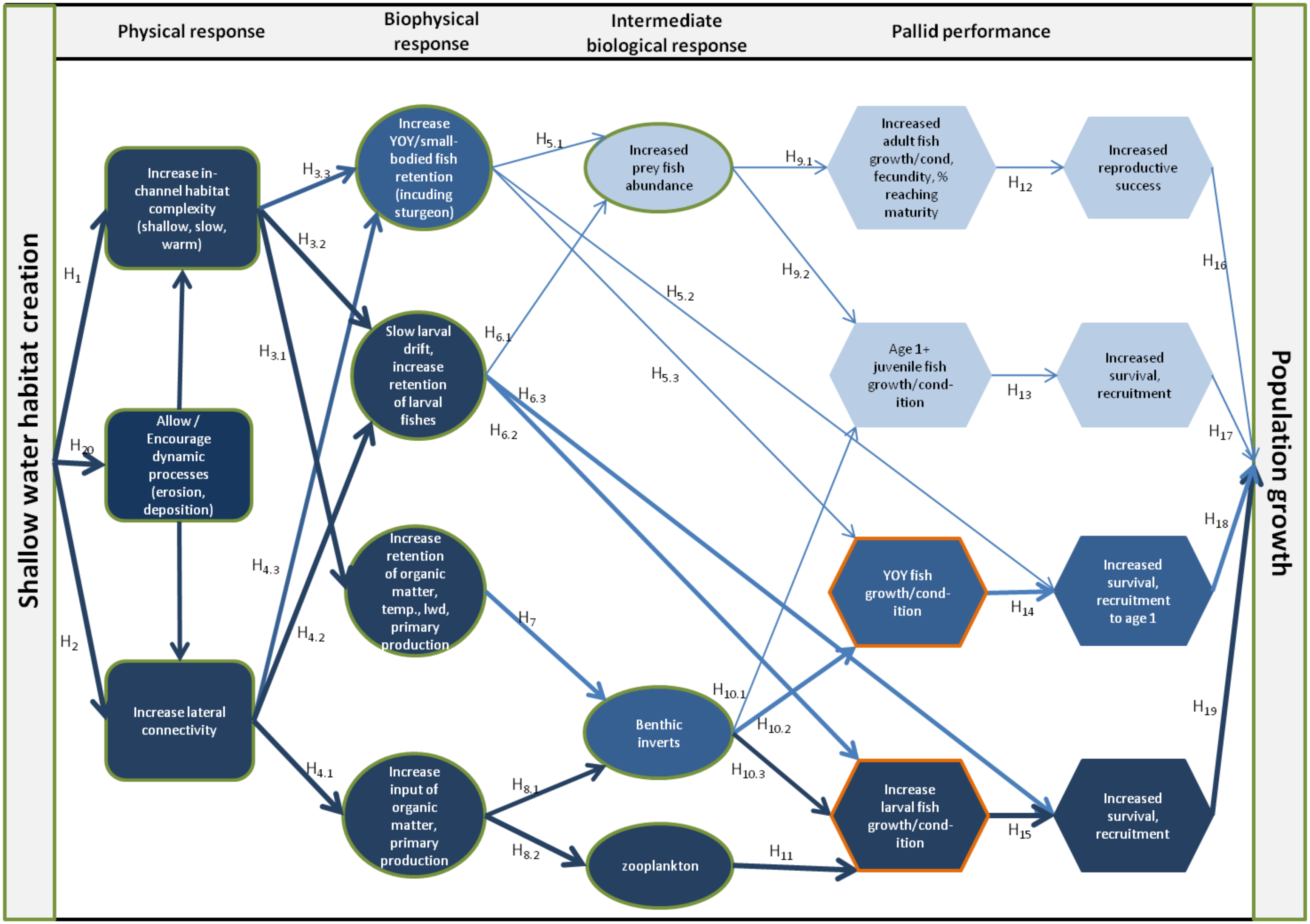
Welcomme, R.L. 1979. Fisheries ecology of floodplain rivers. Longman Group Limited. New York.

Welker, T.L., and M.R. Drobish (editors), 2010. Pallid Sturgeon Population Assessment Project, Volume 1.5. U.S. Army Corps of Engineers, Omaha District, Yankton, SD.

Wildhaber, M.L., DeLonay, A.J., Papoulias, D.M., Galat, D.L., Jacobson, R.B., Simpkins, D.G., Braaten, P.J., Korschgen, C.E., and Mac, M.J., 2007, A conceptual life-history model for pallid and shovelnose sturgeon: U.S. Geological Survey Circular 1315, 18 p. http://pubs.usgs.gov/circ/2007/1315/.

Wildhaber, M.L., DeLonay, A.J., Papoulias, D.M., Galat, D.L., Jacobson, R.B., Simpkins, D.G., Braaten, P.J., Korschgen, C.E., and Mac, M.J., 2011, Identifying structural elements needed for development of a predictive life-history model for pallid and shovelnose sturgeons, Journal of Applied Ichthyology, 27(2): 462-469, (91798)

Appendix A
Conceptual Ecological Model and List of Hypotheses



Shallow water habitat creation
Physical response
Biophysical response
Intermediate biological response
Pallid performance
Population growth
Increase in-channel habitat complexity (shallow, slow, warm)
Allow / Encourage dynamic processes (erosion, deposition)
Increase lateral connectivity
Increase YOY/small-bodied fish retention (incuding sturgeon)
Slow larval drift, increase retention of larval fishes
Increase retention of organic matter, temp., lwd, primary production
Increase input of organic matter, primary production
Increased prey fish abundance
Benthic inverts
zooplankton
Increased adult fish growth/cond, fecundity, % reaching maturity
Age 1+ juvenile fish growth/cond-ition
YOY fish growth/cond-ition
Increase larval fish growth/cond-ition
Increased reproductive success
Increased survival, recruitment
Increased survival, recruitment to age 1
Increased survival, recruitment
H1
H2
H20
H3.1
H3.2
H3.3
H4.1
H4.2
H4.3
H5.1
H5.2
H5.3
H6.1
H6.2
H6.3
H7
H8.1
H8.2
H9.1
H9.2
H10.1
H10.2
H10.3
H11
H12
H13
H14
H15
H16
H17
H18
H19

SWH Conceptual Ecological Model Description

The above Conceptual Ecological Model (CEM) for SWH portrays the hypothesized linkages between the SWH management actions and the ultimate objectives related to pallid sturgeon. This CEM is organized by categories of responses:

Physical Response: Changes to physical characteristics of habitat (e.g. depth, velocity) arising from management actions and dynamic processes that alter those habitats following construction

Biophysical Response: Biological changes directly affected by the physical characteristics of habitat such as retention times

Intermediate Biological Response: Biological responses stemming from the Biophysical Responses and related to food sources for multiple life stages of pallid sturgeon

Pallid Performance: Indicators that relate biophysical responses and intermediate biological responses to pallid sturgeon life history, ultimately related to pallid sturgeon population growth

The CEM displays the likelihood of certain linkages being bottlenecks to population growth with heavier arrows and darker colored boxes. Boxes that are highlighted in green represent linkages that are proposed to be monitored in the SWH AM Strategy where boxes that are highlighted in orange represent linkages that are proposed to be addressed through focused investigations. Beside each arrow is an alphanumeric code relating to a hypothesis describing the connection between the two boxes which are described in the following section.

Hypotheses related to SWH Conceptual Ecological Model

The following list of hypotheses describes the relationships in the SWH Conceptual Ecological Model in a step-wise fashion and describes a framework for addressing successive hypotheses based on monitoring and investigations described in the SWH AM Strategy.

H_{1a}: SWH projects increase channel/habitat complexity by increasing the prevalence of shallow, slow water, increasing the abundance of LWD, and increasing temperature variability by providing areas which warm more quickly during warm periods
H_{1b}: SWH projects do not increase channel/habitat complexity.
IF H1b THEN modify the SWH projects so they better create the desired channel/habitat complexity.

IF H1a THEN H3.1a, H3.2a, H3.3a:
$H_{3.1a}$: SWH projects increase organic matter retention due to increased habitat complexity including increased prevalence of shallow, slow water. Shallower, slower water also results in increased water temperatures and increased area where light penetrates to the bottom. As a result, primary productivity increases in these locations.
$H_{3.1b}$: SWH projects do not increase organic matter retention and primary productivity.
IF H3.1b THEN modify the SWH projects so they better retain organic matter. Evaluate whether density and/or size of projects is sufficient when uniformly distributed longitudinally to achieve desired increases in retention. Evaluate whether flow regime hinders habitats ability to retain organic matter.

IF H3.1a THEN:
H7a: Increased organic retention in SWHs results in increased abundance of benthic invertebrates at those locations.
H7b: Increased organic retention in SWHs does not result in increased abundance of benthic invertebrates at those locations.
IF H7b THEN determine what other factors may limit invertebrate abundance (e.g. water quality, predation, timing of flows, etc), evaluate whether density and/or size of projects is sufficient when uniformly distributed longitudinally to achieve desired benefits.
IF H7a: THEN:
H10.1a: Increased production of benthic invertebrates in SWH results in increased age 1+ fish growth/condition.
H10.1b: Increased production of benthic invertebrates in SWH does not result in increased age 1+ fish growth/condition.
IF H10.1b THEN conclude that invertebrate abundance is not limiting growth, investigate whether increased invertebrate abundance is occurring at the proper location and/or time
IF H10.1a: THEN
H13a: Increased growth/condition of age 1+ fishes results in increased survival and recruitment to adult
H13b: Increased growth/condition of age 1+ fishes does not result in increased survival and recruitment to adult
IF H13b THEN determine what other factors may be limiting recruitment to adult (e.g. predation)
IF H13a THEN:
H17a: Increased survival and recruitment to adult results in population growth
H17b: Increased survival and recruitment to adult does not result in population growth
IF H17b THEN determine what other factors may limit recruitment to adult (e.g. illegal harvest)
IF 17a THEN success, continue

H3.2a: SWH slows drift and increases retention of larval pallid sturgeon and other native larval fishes
H3.2b: SWH does not slow drift or increase retention of larval pallid sturgeon and other native larval fishes
IF H3.2b THEN modify SWH projects to increase retention times and better retain larval pallid sturgeon and other larval fishes and/or modify projects to better permit access by drifting larval fishes. Consider related hypotheses, for example:

The distribution of SWH sites affects retention and dispersal of larval pallid sturgeon
Increased size or clustering of SWH projects results in enhanced biological response
SWH has greater benefits in areas downstream of spawning areas
An even distribution of SWH (20-30 acres/mile) will result in greater larval survival
Locating SWH near the mouths of major tributaries will increase benefits associated with the site.
Flows reduce ability of habitats to retain fishes

IF H3.2a THEN H6.1, H6.2, H6.3
H6.1a: Increased retention of larval prey fishes results in increased abundance of juvenile and adult prey fishes
H6.1b: Increased retention of larval prey fishes does not result in increased abundance of juvenile and adult prey fishes
IF H6.1b THEN determine what other factors may limit abundance of prey fishes
IF H6.1a THEN H9.1, H9.2
H9.1a: Increased prey fish abundance results in increased growth/condition, fecundity, and/or % adults reaching sexual maturity
H9.1b: Increased prey fish abundance does not result in increased growth/condition, fecundity, and/or % adults reaching sexual maturity
IF H9.1b THEN conclude that prey fish abundance is not limiting for adult sturgeon, some data indicate condition may not be limiting for adults thus this pathway is not highlighted in the model
IF H9.1a THEN
H12a: Increased growth/condition, fecundity, and/or % adults reaching sexual maturity results in increased reproductive success
H12b: Increased growth/condition, fecundity, and/or % adults reaching sexual maturity does not result in increased reproductive success
IF H12b THEN determine what other factors may be limiting reproductive success
IF H12a THEN
H16a: Increased reproductive success results in population growth
H16b: Increased reproductive success does not result in population growth
IF H16b THEN determine what other factors may be limiting population growth
IF H16a THEN success, continue

H3.3a: SWH increases the retention of YOY pallid sturgeon and other native YOY and small-bodied fishes
H3.3b: SWH does not increase the retention of YOY pallid sturgeon and other native YOY and small-bodied fishes

IF H3.3b THEN determine if modifications to SWH projects could better retain YOY fishes
IF H3.3a THEN H5.1, H5.2, H5.3
H5.1a: Increased retention of YOY and small-bodied native fishes (key prey species) results in increased abundance of those fishes
H5.1b: Increased retention of YOY and small-bodied native fishes (key prey species) does not result in increased abundance of those fishes
IF H5.1b THEN determine what other factors may limit abundance of key prey fishes
IF H5.1a THEN H9.1, H9.2
H9.1a: Goto…
H9.2a: Increased prey fish abundance results in increased growth/condition of juvenile (age 1+) pallid sturgeon.
H9.2b: Increased prey fish abundance does not result in increased growth/condition of juvenile (age 1+) pallid sturgeon.
IF H9.2b THEN conclude that abundance of these prey fishes is not limiting
IF H9.2a THEN
H13a: Increased growth/condition of age 1+ fishes results in increased survival and recruitment to adult
H13b: Increased growth/condition of age 1+ fishes does not result in increased survival and recruitment to adult
IF H13b THEN determine what other factors may be limiting recruitment to adult
IF H13a THEN:
H17a: Increased survival and recruitment to adult results in population growth
H17b: Increased survival and recruitment to adult does not result in population growth
IF H17b THEN determine what other factors may limit recruitment to adult (e.g. illegal harvest)
IF 17a THEN success, continue

H2a: SWH projects increase lateral connectivity
H2b: SWH projects do not increase lateral connectivity
IF H2b THEN modify projects so they better develop lateral connectivity
IF H2a THEN H4.1, H4.2, H4.3
H4.1a: Increased lateral connectivity results in areas of inundated vegetation, increased organic matter input, and in some cases areas of increased primary productivity
H4.1b: Increased lateral connectivity does not result in areas of inundated vegetation or increased organic matter input
IF 4.1b THEN evaluate the inundation timing, frequency, duration, and extent to determine what factors are preventing the desired seasonal inundation of vegetation
IF 4.1a THEN H8.1, H8.2
H8.1a: Seasonal inundation of terrestrial vegetation and increased input of organic matter increases abundance of benthic invertebrates.
H8.1b: Seasonal inundation of terrestrial vegetation and increased input of organic matter does not increase abundance of benthic invertebrates.
IF H8.1b THEN determine what other factors may limit abundance of benthic invertebrates (e.g. water quality)
IF H8.1a THEN H10.1, H10.2, H10.3
H10.1a: Go to H13

H10.2a: Increased production of benthic invertebrates in SWH results in increased YOY fish growth/condition.
H10.2b: Increased production of benthic invertebrates in SWH does not result in increased YOY fish growth/condition.
IF H10.2b THEN conclude abundance of benthic invertebrates does not limit growth/condition of YOY fishes or increased abundance of invertebrates is not occurring in the proper locations
IF H10.2a THEN
H14a: Increased YOY fish growth/condition results in increased survival and recruitment to age 1
H14b: Increased YOY fish growth/condition does not result in increased survival and recruitment to age 1
If H14b THEN determine what other factors may limit survival and recruitment to age 1
IF H14a THEN H18
H18a: Increased survival and recruitment to age 1 results in population growth
H18b: Increased survival and recruitment to age 1 does not result in population growth
IF H18b THEN determine what other factors may be limiting population growth
IF H18a THEN success, continue

H10.3a: Increased production of benthic invertebrates in SWH results in increased larval fish growth/condition.
H10.3b: Increased production of benthic invertebrates in SWH does not result in increased larval fish growth/condition.
IF 10.3b THEN determine what other factors may limit larval condition, conclude benthic invertebrate abundance does not limit larval condition, other conditions prevent larval fishes from benefitting from increased invertebrate abundance
IF 10.3a THEN
H15a: Increased growth/condition of larval fishes results in increased recruitment to post-larval stages
H15b: Increased growth/condition of larval fishes does not result in increased recruitment to post-larval stages
IF H15b THEN determine what other factors may limit recruitment to post-larval stages
IF H15a THEN
H19a: Increased larval survival and recruitment to post-larval stages results in population growth
H19b: Increased larval survival and recruitment to post-larval stages does not result in population growth
IF H19b THEN determine what other factors limit population growth
IF H19a THEN success, continue

H4.2a: SWH and associated laterally connected habitats slow drift and increase retention of larval pallid sturgeon and other native larval fishes
H4.2b: SWH and associated laterally connected habitats do not slow drift or increase retention of larval pallid sturgeon and other native larval fishes

IF H4.2b THEN modify SWH projects so they more effectively increase retention times and slow larval drift, evaluate whether other factors such as flow regime are preventing these laterally connected habitats from functioning as desired
IF H4.2a THEN H6.1, H6.2
H6.1 go to H9.1, H9.2

H6.2a: Increased retention of larval fishes results in increased growth/condition
H6.2b: Increased retention of larval fishes does not result in increased growth/condition
IF 6.2b THEN evaluate whether other factors are limiting growth such as lack of proper food at the right time
IF 6.2a THEN H15 (go to H19)

H4.3a: SWH and associated laterally-connected habitats increase the retention of YOY pallid sturgeon and other native YOY and small-bodied fishes
H4.3b: SWH and associated laterally-connected habitats does not increase the retention of YOY pallid sturgeon and other native YOY and small-bodied fishes
IF H4.3b THEN modify SWH projects so they more effectively increase retention and increase habitat suitability for these small fishes, evaluate whether other factors such as flow regime are preventing these laterally connected habitats from functioning as desired
IF H4.3a THEN H5.1, H5.2, H5.3
H5.1a go to H9.1, H9.2
H5.2a: Increased retention of YOY sturgeon results in increased survival and recruitment to age 1
H5.2b: Increased retention of YOY sturgeon does not result in increased survival and recruitment to age 1
IF 5.2b THEN determine what other factors may be limiting recruitment to age 1
IF 5.2a THEN go to H18

H5.3a: Increased retention of YOY/small-bodied fishes results in increased growth/condition
H5.3b: Increased retention of YOY/small-bodied fishes does not result in increased growth/condition
IF H5.3b THEN determine what other factors may limit growth/condition
IF H5.3a THEN go to H14

H8.2a: Seasonally inundated habitats created by development of lateral connectivity produce increased abundance of zooplankton
H8.2b: Seasonally inundated habitats created by development of lateral connectivity do not produce increased abundance of zooplankton
IF H8.2b THEN modify SWH projects to increase retention times to promote increased zooplankton abundance, evaluate whether flow regime is preventing created habitats from producing desired benefits
IF H8.2a THEN
H11a: Increased zooplankton abundance results in increased growth/condition of larval fishes
H11b: Increased zooplankton abundance does not result in increased growth/condition of larval fishes

increased zooplankton abundance coincides with larval fish presence
IF H11a THEN go to H15

H6.3a: Increased retention of larval fishes results in increased survival and recruitment to post-larval stages.
H6.3b: Increased retention of larval fishes does not result in increased survival and recruitment to post-larval stages.
IF H6.3b THEN evaluate other factors which may be limiting survival and recruitment of larval fishes
IF H6.3a THEN go to H19

Pallid Sturgeon Hypotheses not directly related to SWH

There are also numerous other hypotheses related to pallid sturgeon that are not directly related to the abundance, distribution and quality of SWH that may help explain causal linkages between management actions and population responses. These hypotheses may need to be addressed through other investigations or monitoring efforts to completely understand the response of the pallid sturgeon population. (not listed in priority order)

- Pallid sturgeon population growth is being limited due to hybridization between pallid sturgeon and shovelnose sturgeon.
- Higher than historic rates of predation on early life stages are limiting pallid sturgeon population growth.
- Long drift distances are causing pallid sturgeon larvae to be carried from the Missouri River downstream to the Mississippi River.
- Habitat segmentation due to the placement of dams on the Missouri River has limited the potential migratory path length of pallid sturgeon.
- Water quality, particularly the presence of endocrine disrupters, is causing incidences of hermaphrodism and lowering rates of reproductive success.
- Declines in the overall pallid sturgeon population size have led to a low number of reproductively-ready adults which has limited the potential for population growth.
- Decreases in turbidity levels in the Missouri River have resulted in higher than historic rates of predation of larval and juvenile pallid sturgeon and/or decreased the ability of pallid sturgeon to compete for resources
- Introduction of predator species has increased rates of pallid sturgeon predation.
- A combination of reduced flow peaks and incised channel morphology has reduced floodplain connectivity which has lowered the productivity of the overall system during key rearing stages for larval and juvenile pallid sturgeon
- Changes in the channel morphology coupled with a lack of relatively low summer flows has decreased the availability of habitat for larval and juvenile pallid sturgeon.
- Introduction of non-native species (such as carp species) in the Missouri River has increased competition for food resources and negatively affected pallid sturgeon recruitment and/or growth rates.
- Condition of reproductively-ready pallid sturgeon is reduced due to lack of resources, faster than historic channel velocities, or some combination of these and other factors

Decision Tree Related to the SWH CEM

The following decision tree addresses potential decisions that may be made based on the results of monitoring to address hypotheses related to the SWH CEM. Solid lines indicate "Yes" responses or where hypotheses have been supported by monitoring data. Dashed lines represent "No" responses or where the desired response is not occurring and a corrective action is warranted. Dashed lines mayalso indicate where a hypothesis is not being supported by monitoring data and some additional investigation may be warranted.

Relationship of the SWH CEM to the draft Pallid Sturgeon Functional Model

As part of the development of the Missouri River Ecosystem Restoration Plan and Environmental Impact Statement, numerous functional models of the Missouri River ecosystem have been developed which are currently in draft form. One of these functional models relates to pallid sturgeon life history and the "Key Ecological Attributes" that affect it. This preliminary draft model is provided below to frame the SWH CEM in a broader context. Also included is draft text that describes the elements of the functional model and a graphic that depicts the relationship between elements of the SWH CEM and the pallid sturgeon functional model. The following text is from the draft MRERP Focal Natural Resources Provisional Baseline Assessment Document and describes the pallid sturgeon functional model and its components:
The purpose of this functional model is to describe the life cycle of pallid sturgeon by identifying life history states, transitions between these states, and their relation to KEA critical to the persistence of pallid sturgeon in the Missouri River ecosystem (Figure D-15). This model is based on the pallid sturgeon life history model developed by Wildhaber et al. (2007) and modified to emphasize relationships between the various states, transitions, and KEAs. The following KEAs are important to some but not all states or transitions within the Pallid Sturgeon FNR.

River Flows

This "master variable" KEA has a major effect on a large number of KEAs. River flows are responsible for moving sediment (NRC 2002), and so this KEA is related to River Sediment. The flows also affect River Water Chemistry and River Water Temperature by affecting the chemical and thermal dynamics of the river (Junk et al. 1989; Hesse et al. 1989; Hesse and Sheets 1993). River flows drive connectivity (Tockner and Stanford 2002) and affect habitat generation (Bayley 1995), so this KEA is linked to River–Floodplain Connectivity and River–Floodplain Habitat Turnover. River flows affect biota, as they are responsible for moving organic matter and nutrients vital to the persistence of living creatures in the river system (River Food Web; Junk et al. 1989); they affect Native River and Floodplain Vegetation (Johnson 1992); and play a role in the life cycles of various creatures living in the river channel (Native River Wildlife; Hesse et al. 1993).

River Water Temperature

This KEA is affected by River Flows. The continuous movement of water, and the seasonal and extreme flows, bring in warm or cold waters and/or aid in the formation of ice cover. The volume of water is directly related to its thermal inertia. This KEA affects River Flows, River Water Chemistry, River–Floodplain Habitat Turnover, River Food Web, Native River Wildlife, and Native River and Floodplain Vegetation. River water temperature, in conjunction with river flows, affects the growth and development rates of numerous organisms (Diana 1995; McCullough 1999), and triggers life history events such as spawning and hatching (Lehmkuhl 1972; Galat et al. 1996; Phelps et al. 2010). Water temperature influences dissolved oxygen concentration in the water, and strongly affects the physiologic state of numerous aquatic organisms. Extreme temperatures and extremely low dissolved oxygen levels can kill organisms (Sargent and Galat 2002; SDDENR 2008) or trigger transitions to dormant states. Temperature influences the River Food Web at all trophic levels. Water temperature affects primary production due to the temperature optima of phytoplankton, periphyton, and macrophytes. The rate of primary production influences the amount of oxygen produced by photosynthesis and the amount in the water. This also influences the higher trophic levels of the River Food Web, because temperature can affect the capture efficiency of predators (Herzog 2004; Wuellner et al. 2010). Temperature changes affect not only Native River Wildlife and Native River and Floodplain Vegetation, but also the River Food Web due to the interrelationship between fauna and flora. The river temperature and hydrologic regimes jointly determine the dynamics of ice formation, breakup, and transport, which influences geomorphology and habitat in the river and on the floodplain.

River Water Chemistry

This KEA affects the River Food Web, Native River Wildlife, and Native River and Floodplain Vegetation KEAs. If a system is nutrient-limited, increases or decreases in nutrient availability can shift primary productivity, thereby altering the base of the food web (Chapman et al. 2003). Fish and benthic macroinvertebrates can be indirectly affected by nutrients through effects on algal food resources and the resulting hypoxic or anoxic conditions (Sargent and Galat 2002), and studies have shown that some forms of nitrogen (ammonia and nitrite) have toxic effects on juvenile mussels (Myers-Kinzie 1998) and fish (Randall and Tsui 2002). Water pH levels affect the availability and uptake of metals, nutrients, and carbon dioxide in water and sediment, having an effect on various aquatic organisms. High levels of turbidity limit light penetration and can interrupt primary productivity in the forms of phytoplankton and submergent macrophytes in the river and within wetlands. The bioaccumulation of contaminants and metals in aquatic fauna has an impact on organismal health, at all levels of the food chain, from zooplankton to macroinvertebrates to fishes to fish predators (Lemly 1993; Schmitt 2004). The sensitivity of aquatic fauna and flora to levels and forms of nutrients, pH, dissolved oxygen, turbidity, and pollutants in the sediment and water could alter the diversity, abundance, growth, and/or productivity of these species, and lead to mortality of sensitive species and/or increased diversity and abundance of tolerant and nonnative species (Mauk and Brown 2001). This affects not only Native River Wildlife and Native River and Floodplain Vegetation, but also the River Food Web, due to the interrelationship between fauna and flora.

Native River Wildlife

The health and composition of the fish and macroinvertebrate assemblages could affect the food web of the river as well as the native floodplain wildlife. These fauna are links within the food web; they are consumers of energy as well as food resources for higher trophic levels. If the species diversity or richness of the native assemblages is altered, then the various interrelationships in the food web could experience unnatural shifts, disruptions, or disconnections. In addition, many fauna play a role in the decomposition of matter crucial to the stability of the food web (Delong et al. 2001; Thorp et al. 2006).

This KEA is affected by River Flows, River Water Chemistry, River Water Temperature, River Food Web, Native Floodplain Wildlife, River–Floodplain Connectivity, and River Habitat Connectivity. Dynamic and seasonal river flows and river–floodplain connectivity allow for crucial exchange of nutrients, biota, and energy up and down the main channel as well as between the river and floodplain (Bayley 1995). This connectivity aids in the reproduction, growth, and movement of native river wildlife (Delong et al. 2001). The River Food Web connects Native River Wildlife and Native Floodplain Wildlife. Variations in River Water Chemistry and River Water Temperature provide dynamic conditions throughout the riverine habitats and how native river wildlife respond depends on their individual sensitivities or tolerance to particular conditions.

River-Floodplain Habitat Turnover

River Flows and River Sediment are the driving forces behind this KEA (Junk et al. 1989; NRC 2002; Sluis and Tandarich 2004). River flows move and redeposit sediment to generate new habitat (River Habitat Quality and Floodplain Habitat Quality). River–Floodplain Connectivity also interrelates with this KEA, as connectivity between the river and its floodplain facilitates habitat turnover (Bayley 1995; NRC 2002; Whitledge et al. 2005).

Pallid Organismal Condition

Pallid Sturgeon Organismal Condition has interrelationships with River Habitat Quality and River Food Web, which support the animals upon which pallid sturgeon prey (Gerrity et al. 2006; Wanner et al. 2007) and the physical environment in which they live.

Pallid Growth

As with Pallid Sturgeon Organismal Condition, Pallid Sturgeon Growth has interrelationships with River Habitat Quality and River Food Web, which support the animals that pallid sturgeon require for food (Gerrity et al. 2006; Wanner et al. 2007) and the physical environment in which they live. Without food and suitable foraging habitat, the development of new tissues is impossible, and growth stops.

Pallid Early Juvenile Food Availability

This KEA has interrelationships with Pallid Sturgeon Organismal Condition and Pallid Sturgeon Growth where these KEAs apply to pallid sturgeon in the early juvenile life stage. The availability of suitable food for early juvenile pallid sturgeon supports their growth and condition. This KEA also has interrelationships with River Habitat Quality, River Food Web, and Native River Wildlife, all important ecological components that produce the organisms upon which early juvenile pallid sturgeon feed.

River Sediment

River sediment is responsible for turbidity in the river system (Blevins 2006), linking this KEA to River Water Chemistry. As a building material contributing to river and floodplain macrohabitat complexity (NRC 2002; Sluis and Tandarich 2004), this KEA has a strong link to River–Floodplain Habitat Turnover, River Habitat Quality, and Floodplain Habitat Quality. Also, river sediment plays a role in the life cycle of various organisms living in the river, and so this KEA is linked to the River Food Web and to Native River Wildlife.

River Habitat Quality

River–Floodplain Habitat Turnover, in combination with River Flows and River Sediment, creates and maintains a diversity of channel forms (Funk and Robinson 1974; Junk et al. 1989; NRC 2002). River Habitat Quality, in turn, affects River–Floodplain Habitat Turnover by directing and absorbing the energy with which floodwaters move along different paths from the channel to the floodplain. Interrelationships also exist among this KEA and the biotic KEAs River Food Web, Native River Wildlife, Native Floodplain Wildlife, and Native River and Floodplain Vegetation), because the type, availability, and quality of river habitats determine whether organisms can successfully feed, reproduce and raise young. Floodplain Habitat Size and Connectivity interrelates with this KEA as well, due to the import of large wood from the floodplain during high-flow events and their effects on habitat.

River Habitat Connectivity

This KEA affects River Sediment because sediment can move longitudinally through the river channel only to the degree at which there is longitudinal connectivity. This KEA also affects the biotic KEAs (River Food Web, Native River Wildlife, Native Floodplain Wildlife, and Native River and Floodplain Vegetation) to the degree to which the particular organisms concerned require longitudinal connectivity for successful completion of their life cycles, or to make them available as prey for other organisms.

Pallid Reproductive Success

Pallid Sturgeon Reproductive Success has interrelationships with River Flows and River Water Temperature, both of which are factors in determining the suitability of the river environment for larval fish survival. It also interrelates with River Habitat Size and Connectivity, which affects the ability of the pallid sturgeon to migrate upstream to mate, and the ability of the larva to drift downstream after hatching (Braaten et al. 2008).

Pallid Population Size

Pallid Sturgeon Population Size interrelates with River Habitat Quality. This KEA supports the particular type of physical environment necessary to support the existence of a stable population of pallid sturgeon.

The model depicts the pallid sturgeon life cycle using seven distinct life states. States are represented as boxes with black bold borders in the conceptual model. Arrows show the sequential progression of one state to the next in the life cycle, representing transitions between states. Transitions appear as ovals. States and transitions are numbered sequentially (Table D-10 and Figure D-15). The spatial element of the model is depicted by a river graphic and states and transitions are arranged around the river to illustrate the spatial movement of life stages either upstream (migration) or downstream (drift). Arrows are color coordinated to depict when these movements are taking place in the state/transition cycle. Black boxes represent KEAs, as determined through coordination with the aquatic technical team.

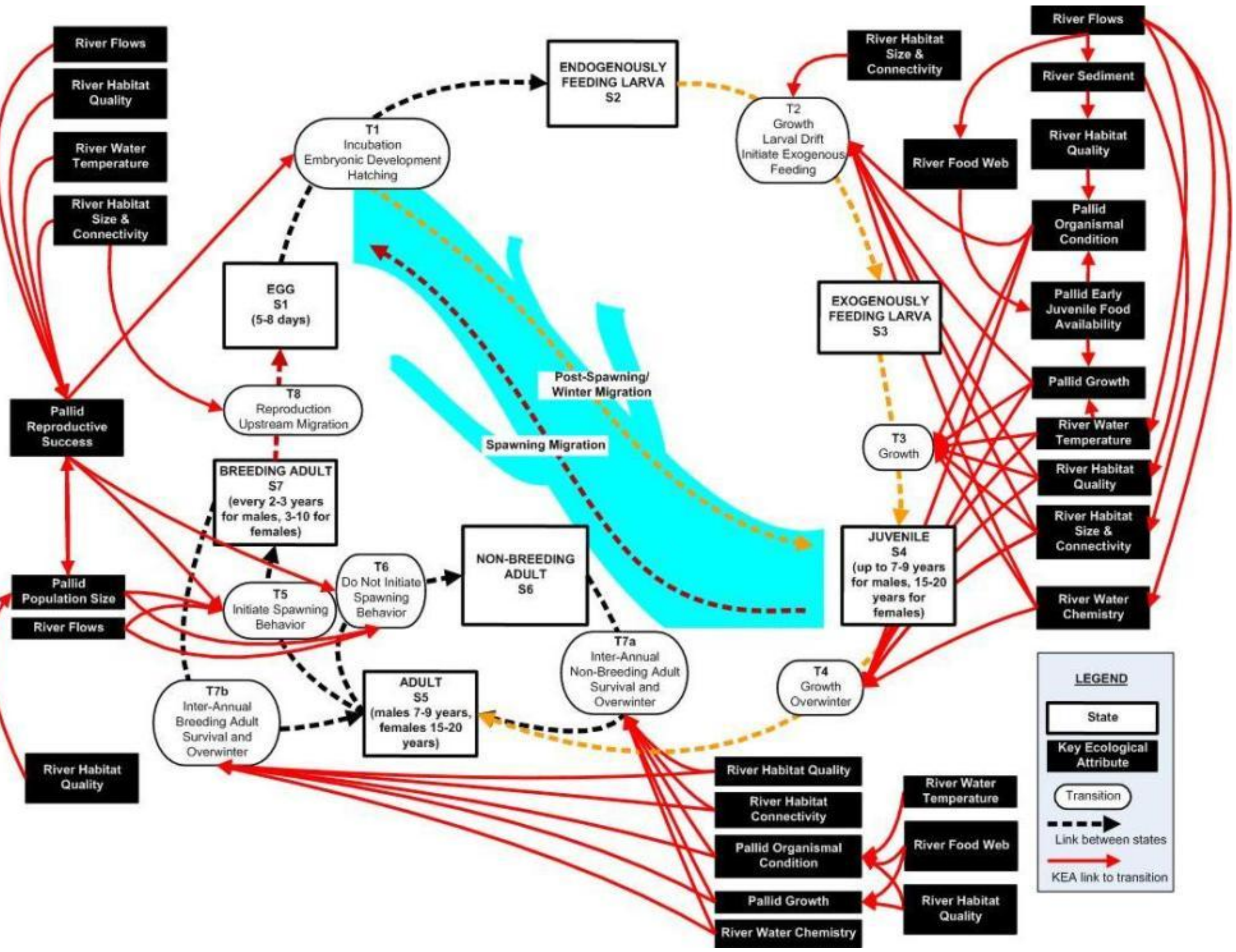


TABLE D-10: PALLID STURGEON STATES AND TRANSITIONS (LIFE HISTORY)

Description
S1. Egg **T1. Incubation/Embryo Development/Hatching**
The egg is the initial life state of the pallid sturgeon. The egg becomes adhesive soon after release and attaches to the substrate until hatch. Pallid sturgeon eggs are spawned over coarse substrate in or adjacent to the main river channel. Once deposited, the egg incubates and the embryo develops until it hatches, typically within 5-8 days. It is important that eggs are not covered by silt during this time, as this may prevent them from receiving oxygen. Egg oxygen requirements generally increase with development, being greatest at hatch (Wildhaber et al. 2007).
S2. Endogenously Feeding Larva **T2. Larval Drift/Initiate Exogenous Feeding**
After hatching, larvae obtain energy from their own internal yolk sac (endogenous feeding). The transition between endogenously and exogenously feeding larvae is the initiation of ingestion of external foods (T2). Drift is the passive dispersal of the larvae carried by the flow of river water from the site of hatching to comparatively more stationary rearing habitats. Laboratory studies have shown larval pallid sturgeon drifting freely for up to 13 days (Kynard et al. 2002). Once larval pallid sturgeon stop drifting and consume the entire reserve of their internal yolk sac, they begin feeding on other organisms (Braaten et al. 2008).
S3. Exogenously Feeding Larva **T3. Growth**
Exogenous larvae have fully digested their own yolk sac and must begin feeding on other organisms. Food habits of exogenous larval pallid sturgeon are poorly understood (Wanner et al. 2007; Grohs et al. 2009);

Description
however, they likely feed on small invertebrates and plankton at this life cycle state (Wanner et al. 2007; Wildhaber et al. 2007; Grohs et al. 2009). They begin to occupy benthic habitats to feed (Wildhaber et al. 2007). Habitats occupied appear to be adjacent to (or readily accessible from) the thalweg (i.e., source of drifting sturgeon) with relatively fast velocity (0.5-0.7 m/s) over sand dominated substrate and in moderate depth (1.7-3.0 m) (Ridenour et al. In Press). The transition from Exogenous Larvae (S3) to a Juvenile (S4) is generally characterized by continued growth as a result of a net gain between energy intake and energy output. The transition from Exogenous Larvae (S3) to a Juvenile (S4) is generally characterized by continued growth as a result of feeding net gain between energy intake and energy output.
S4. Juvenile **T4. Growth/Overwinter**
Juvenile pallid sturgeon have matured enough to be able to consume larger prey items such as fishes, but are not yet sexually mature. Fish prey, especially chubs, constitute an important part of the pallid sturgeon's diet at this state (Gerrity et al. 2006), although they also feed on macroinvertebrates (Grohs et al. 2009). They must be able to seek refuge as necessary from drought, floods, and high temperature. The transition from juvenile to adult pallid sturgeon is generally characterized by continued growth and over-wintering survival.
S5. Adult **T5. Initiate Spawning Behavior** **T6. Do not initiate spawning behavior**
The Adult state (S5) refers to pallid sturgeon that are fully sexually mature and capable of breeding. Male pallid sturgeon are sexually mature at 7-9 years of age, and females at 15-20 years of age (Keenlyne and Jenkins 1993). Breeding occurs every 2-3 years for males and every 3-10 years for females (Keenlyne and Jenkins 1993). Food habits and refuge needs are similar to those of the Juvenile state (S4), yet adults consume larger prey items. Initiation of spawning behavior (T5) is characterized by hormonal changes, gonad maturation, and pre-spawning movements (migration), while spawning behavior itself is characterized by aggregation, courtship, and reproduction. Photoperiodic and hydrologic cues likely play a role in initiating spawning behaviors (Bramblett 1996). Available evidence suggests that pallid sturgeon spawn in the spring or early summer, and release their eggs at intervals (USFWS 2000). An adult pallid sturgeon in a nonbreeding year would not initiate spawning behavior (T6).
S6. Nonbreeding Adult **T7a. Interannual nonbreeding adult survival and overwinter**
The Interannual Nonbreeding Adult Survival transition (T7a) is linked in a circular fashion to the Adult state (S5), showing that nonbreeding adults must survive the nonbreeding years in order to be capable of breeding successfully (potentially transitioning to the Breeding Adult [S7] state) the next year or future years.
S7. Breeding Adult **T7b. Interannual breeding adult survival and overwinter** **T8. Reproduction/Spawning migration (upstream)**
Reproductive pallid sturgeon engage in spring spawning runs that may traverse many miles, necessitating unimpeded longitudinal connectivity (Bramblett 1996; Bramblett and White 2001; DeLonay and Little 2002; Sheehan et al. 2002). Populations of breeding adults must be of a size sufficient to facilitate encounters between individuals and initiation of successful spawning behavior. Successful spawning results in fertilized eggs being deposited over gravel/cobble substrate (S1). Breeding adults (S7) return to the Adult state (S5), after breeding successfully, if they overwinter and survive through the following year (T7b). They will then be Nonbreeding Adults (S6) until they are able to breed again.

The following table shows the relationship between KEAs in the pallid sturgeon functional model and components of the SWH CEM.

Pallid Sturgeon Functional Model Key Ecological Attribute	Shallow Water Habitat Conceptual Ecological Model Component	Relationship
River Habitat Size and Connectivity	Shallow Water Habitat Creation	Both address the quantity of habitat in the river
River-Floodplain Connectivity	Increase lateral connectivity	Lateral connectivity addresses a subset of overall river-floodplain connectivity
River Habitat Quality	Increase in-channel habitat complexity	Both address channel form, depth diversity, habitat diversity, and abundance of LWD
River-Floodplain Habitat Turnover	Allow / encourage dynamic processes	Both address the amount of habitat re-worked by dynamic processes
River Food Web	Increase retention of organic matter, temp, primary production	The four CEM components address various indicators of the River Food Web KEA including phyotplankton and periphyton, chlorophyll-a, cyprinids, zooplankton, particulate organic matter, and fish length and biomass.
	Increase input of organic matter, primary production	
	Increased prey fish abundance	
	Zooplankton	
Pallid Early Juvenile Food Availability	Benthic inverts	Both address the abundance of benthic macroinvertebrates
Pallid Growth	Increased adult growth/condition	The two pallid KEAs and the four CEM components all address the growth and condition of multiple life stages of pallid sturgeon
Pallid Organismal Condition	Age 1+ juvenile growth/condition	
	YOY fish growth/condition	
	Larval fish growth/condition	
Pallid Sturgeon Reproductive Success	Increased reproductive success	Both address the reproductive success, survival, and recruitment of multiple life stages
	Increased survival, recruitment	
Pallid Population Size	Population growth	Both address the size and trends of the population

References for Appendix A

Bayley, P. 1995. Understanding Large River Floodplain Ecosystems. *BioScience* 45(3): 153-158.

Braaten, P.J., D.B. Fuller, L.D. Holte, R.D. Lott, W. Viste, T.F. Brandt, and R.G. Legare. 2008. Drift dynamics of larval pallid sturgeon and shovelnose sturgeon in natural habitats of the upper Missouri River. *North American Journal of Fisheries Management* 28: pp. 808-826.

Bramblett, R.G. 1996. Habitats and movements of pallid and shovelnose sturgeon in the Yellowstone and Missouri Rivers, Montana and North Dakota. Doctoral dissertation. Bozeman, MT: Montana State University. 210 pp.

Bramblett, R.G., and R.G. White. 2001. Habitat use and movements of pallid and shovelnose sturgeon in the Yellowstone and Missouri Rivers in Montana and North Dakota. *Transactions of the American Fisheries Society* 130: pp. 1006-1025.

DeLonay, A.J., and E.E. Little. 2002. Development of Methods to Monitor Pallid Sturgeon (*Scaphirhynchus albus*) Movement and Habitat Use in the Lower Missouri River. Project Summary Report dated October 1, 2002. U.S. Geological Survey, Columbia Environmental Research Center, Columbia, Missouri. Diana, J.S. 1995. Temperature Effects on Fishes. Pages 29-39 in Diana, J.S., Biology and Ecology of Fishes, Biological Sciences Press, Carmel, Indiana.

Funk, J. L. and J. W. Robinson. 1974. Changes in the channel of the lower Missouri River and effects on fish and wildlife. Missouri Department of Conservation Aquatic Series No. 11. Jefferson City. 52 pp.

Galat, D. L., J.W. Robinson, L.W. Hesse. 1996. Restoring aquatic resources to the lower Missouri River: issues and Initiatives. In Galat, D. L. and Frazier, A. G., eds., Overview of river-floodplain ecology in the Upper Mississippi River Basin, f. 3 of Kelmelis, J.A., ed., Science for floodplain management into the 21st century: Washington, D.C., U.S. Government Printing Office, pp. 49-71.

Gerrity, P.C., C.S. Guy, and W.M. Gardner. 2006. Juvenile Pallid Sturgeon are Piscivorous: A Call for Conserving Native Cyprinids. *Transactions of the American Fisheries Society* 135: pp. 604-609.

Grohs, K.L., R.A. Klumb, S.R. Chipps, and G.A. Wanner. 2009. Ontogenetic patterns in prey use by pallid sturgeon in the Missouri River, South Dakota and Nebraska. *Journal of Applied Ichthyology* 25(2): 48-53.

Herzog, D.P. 2004. Capture efficiency and habitat use of sturgeon chub (*Macrhybopsis gelida*) and sicklefin chub (*Macrhybopsis meeki*) in the Mississippi River. Master’s thesis. Southeast Missouri State University, Cape Girardeau, Missouri.

Hesse, L. W., J.C. Schmulbach, J.M. Carr, K.D. Keenlyne, D.G. Unkenholz, J.W. Robinson and G.E. Mestl. 1989. Missouri River fishery resources in relation to past, present and future stresses. Pages 352-371. In D. P. Dodge [ed.]. Proceedings on the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Hesse, L.W. and W. Sheets. 1993. The Missouri River hydrosystem. Fisheries 18: pp. 5-14.

Johnson, W. C. 1992. Dams and riparian forests: case study from the upper Missouri River. *Rivers* 3(4): pp. 229–242.

Junk, W.J., P.B. Bayley, and R.E. Sparks. 1989. The Flood Pulse Concept in River-Floodplain Systems. *Canadian Special Publication of Fisheries and Aquatic Sciences* 106: pp. 110-127.

Keenlyne, K.D., and L.G. Jenkins. 1993. Age at sexual maturity of the pallid sturgeon. *Transactions of the American Fisheries Society* 122: pp. 393-396.

Kynard, B., E. Henyey, M. Horgan M. 2002. Ontogenetic behavior, migration, and social behavior of pallid sturgeon, *Scaphirhynchus albus*, and shovelnose sturgeon, S. platorynchus, with notes on the adaptive significance of body color. *Environmental Biology of Fishes* 63: pp. 389-403.

Lehmkuhl, D.M. 1972. Change in Thermal Regime as a Cause of Reduction of Benthic Fauna Downstream of a Reservoir. Journal of the Fisheries Research Board of Canada 29:1329-1332

Lemly, A.D. 1993. Guidelines for evaluating selenium data from aquatic monitoring and assessment studies. Environmental Monitoring and Assessment 28:83-100.

Mauk, Robert J., and Michael L. Brown. 2001. Performance of Walleye Progeny from Missouri River Tributaries in South Dakota. North American Journal of Aquaculture 63:167-170.

McCullough, D.A. 1999. A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. U.S. Environmental Protection Agency, Region 10, Seattle, WA. EPA910-R-99-010.

Myers-Kinzie, M. L. 1998. Factors affecting survival and recruitment of unionid mussels in small Midwestern streams. Doctoral dissertation. Purdue University, West Lafayette, Indiana.

National Research Council (NRC). 2002. The Missouri River Ecosystem: Exploring the Prospects for Recovery. Committee on Missouri River Ecosystem Science. National Academy Press, Washington, D.C.

Phelps, Q.E., S.J. Tripp, W.D. Hintz, J.E. Garvey, D.P. Herzog, D.E. Ostendorf, J.W. Ridings, J.W. Crites, and R.A. Hrabik. 2010. Water Temperature and River Stage Influence Mortality and Abundance of Naturally Occurring Mississippi River Scaphirhynchus Sturgeon. *North American Journal of Fisheries Management* 30:767-775.

Randall, D.J., and T.K.N. Tsui. 2002. Ammonia Toxicity in Fish. Marine Pollution Bulletin 45:17-23.

Sargent, J., and D. Galat. 2002. Fish mortality and physicochemistry in a managed floodplain wetland. *Wetlands Ecology and Management* 10: pp. 115-121.

Schmitt, C. 2004. Concentrations of Arsenic, Cadmium, Copper, Lead, Selenium, and Zinc in Fish From the Mississippi River Basin, 1995. Environmental Monitoring and Assessment 90: 289-321.

Sheehan, R.J., R.C. Heidinger, P. Wills, N. Jackson, R. Columbo, and A. Miller. 2002. Middle Mississippi River Pallid Sturgeon Habitat Use Project. Year 6 Annual Progress Report. Fisheries Research Laboratory and Department of Zoology, Southern Illinois University at Carbondale.

Sluis, W., and J. Tandarich. 2004. Siltation and hydrologic regime determine species composition in herbaceous floodplain communities. *Plant Ecology* 173: 115-124.

South Dakota Department of Environment and Natural Resources (SDDENR). 2008. South Dakota Water Quality Water Years 2002-2007 (streams) and Water Years 2000-2007 (lakes). The 2008 South Dakota Integrated Report Surface Water Quality Assessment by the State of South Dakota Pursuant to Sections 305(b), 303(d), and 314 of the Federal Water Pollution Control Act. South Dakota Department of Environment and Natural Resources. 269 pp.

Sterner et al., 2009. Missouri River Fish and Wildlife Mitigation Program Fish Community Monitoring and Habitat Assessment of Off-Channel Mitigation Sites. 1338 pp.

Thorp, J.H., J.E. Flotemersch, M.D. Delong, A.F. Casper, M.C. Thoms, F. Ballantyne, B.S. Williams, B.J. O'Neill, and C.S. Haase. 2010. Linking Ecosystem Services, Rehabilitation, and River Hydrogeomorphology. *Bioscience* 60(1): 67-74.

Tockner, K.F., and J.A. Stanford. 2002. Riverine Flood Plains: Present State and Future Trends. *Environmental Conservation* 29(3): 308-330.

U.S. Fish and Wildlife Service (USFWS). 2000. USFWS 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System.

U.S. Fish and Wildlife Service (USFWS). 2007. Pallid sturgeon (Scaphirhynchus albus) 5-year review: summary and evaluation. USFWS, Billings, Montana.

Wanner, G.A., D.A. Shuman, and D.W. Willis. 2007. Food habits of juvenile pallid sturgeon and adult shovelnose sturgeon in the Missouri River downstream of Fort Randall Dam, South Dakota. *Journal of Freshwater Ecology* 22(1): 81-92.

Whitledge, G.W., D.L. Galat and G.T. Gelwicks. 2005. Habitat use by fishes in periodically and continuously connected lower Missouri River floodplain water bodies. Final Report to Missouri Department of Conservation, Resource Science Center, Columbia, Missouri.

Wildhaber, M.L., A.J. DeLonay, D.M. Papoulias, D.L. Galat, R.B. Jacobson, D.G. Simpkins, P.J. Braaten, C.E. Korschgen, and M.J. Mac. 2007. A conceptual life-history model for pallid and shovelnose sturgeon: U.S. Geological Survey Circular 1315, 18 pp.

Wuellner, M.R., Chipps, S.R., Willis, D.W., 2010. Interactions between Walleyes and Smallmouth Bass in a Missouri River Reservoir with Consideration of the Influence of Temperature and Prey. North American Journal of Fisheries Management 30:445–463.

Appendix B: Project Delivery Team Members

Role	Role / Uncertainty to be addressed	Area of Expertise Required	PDT Members
Team Lead	Ensure information improves design and is implementable	River Engineering	Zach White (USACE)
AM Process Managers	How the AM process will integrate with USACE guidelines and the MRRP	USACE AM Guidelines, USFWS AM Guidelines, ESA	Tim Fleeger (USACE) / Carol Hale (USFWS)
Quantity of SWH	Amount of SWH needed to support pallid sturgeon; amount of existing SWH; impacts to authorized purposes; aquatic habitat monitoring & design priorities	Fish Biology, USACE authorized purposes, flood control features, surveys, hydrology	Joe Bonneau (USACE) / Mike Chapman (USACE) / Dan Pridal (USACE)
Quality of Created SWH	Timeline for development of created habitats, relative benefits of SWH - river control structure modifications, side channels, backwaters, tie-back channels, inlet/outlet structures, chute designs, etc.	Fluvial Geomorphology, SWH design, statistics, Fish Biology	Robb Jacobson (USGS) / Chris Larson (IDNR) / Wyatt Doyle (USFWS) / Vince Travnichek (MDC)
Quality of Created SWH	Effects of habitat creation on metrics identified in SWH definition (primary and secondary productivity, temperature, fish community composition, habitat diversity, etc.).	Aquatic Ecology, invertebrates, fish biology	Mark Boone (MDC) / Schuyler Sampson (NGPC)
Quality of Created SWH	Water quality associated with SWH	Water Quality	Larry Shepard (EPA)
Distribution of Created SWH	Proximity to other features (major tributaries, wetland complexes), lustered vs. evenly-spaced, etc.	Mitigation habitat, natural resource management	Wedge Watkins (USFWS)
Distribution of Created SWH	Upstream vs. downstream, effect on drift distances; usage during different life stages	Pallid sturgeon life history, ecological models	Rob Klumb (USFWS) / Aaron DeLonay (USGS),