An aerial photograph showing a wide, muddy river meandering through a vast, dense forest. The river is a prominent brownish-tan color, contrasting with the lush green of the surrounding trees. The forest appears to be a mix of deciduous and coniferous species. The river's path is highly irregular, with several sharp turns and oxbow-like curves. The overall scene is a natural, undisturbed landscape.

U.S. Fish & Wildlife Service

Big Muddy

*National Fish and Wildlife
Refuge*

Environmental Assessment and Draft Comprehensive Conservation Plan

U.S. Department of the Interior
Fish and Wildlife Service
Region 3 (Midwest Region)
Division of Conservation Planning;
Bloomington, MN

Cover Photograph: US Army Corps of Engineers



The mission of the U.S. Fish & Wildlife Service is working with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Comprehensive Conservation Plans provide long-term guidance for management decisions; set forth goals, objectives and strategies needed to accomplish refuge purposes; and, identify the Fish and Wildlife Service's best estimate of future needs. These plans detail program planning levels that are sometimes substantially above current budget allocations and, as such, are primarily for Service strategic planning and program prioritization purposes. The plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.



United States Department of the Interior



FISH AND WILDLIFE SERVICE

5600 American Boulevard West, Suite 990
Bloomington, Minnesota 55437-1458

IN REPLY REFER TO:

FWS-NWRS/CP

November 5, 2013

Dear Reviewer:

We are pleased to provide you with this Draft Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) for Big Muddy National Fish and Wildlife Refuge (NFWR).

Big Muddy NFWR is located in Missouri along the floodplain of the Missouri River and at present, is comprised of eleven units, totaling more than 17,600 acres. The 11 refuge units encompass river features, such as islands, chutes, bends, and tributary confluences.

The CCP will guide management of the Refuge for the next 15 years and will help the Refuge meet its purpose and contribute to the mission of the National Wildlife Refuge System. The CCP will provide both broad and specific guidance on various issues; describe a vision, goals, and measurable objectives; and list strategies for reaching the objectives.

We invite you to review and comment on the Draft CCP and EA. By sharing your thoughts, you can help ensure that the final CCP is both visionary and practical. We will host an open house where you will be able to ask questions, seek understanding, and voice concerns and suggestions. A meeting date and location will be announced through the media and other means.

Written comments are also welcome during the 30-day comment period and should be addressed to: U.S. Fish & Wildlife Service, Big Muddy NFWR, Attention: CCP Comment, 4200 New Haven Road, Columbia, MO 65201. You may also send comments to us through the following web address: <http://www.fws.gov/midwest/planning/bigmuddyccp/index.html>

To be considered in preparing the final CCP, comments must be received by Wednesday, November 20, 2013.

We look forward to continuing the dialogue on the future of the Refuge, and thank you for your continued interest in keeping this Refuge a special place for wildlife and people.

Sincerely,

Dean Granholm
Refuge Planner, Division of Conservation Planning

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NOTE: Appendix M was added to this document after it was released for public review on October 1, 2013 in response to public comment.

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Big Muddy

National Fish and Wildlife Refuge

Environmental Assessment and Draft Comprehensive Conservation

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Executive Summary

Introduction

This Environmental Assessment documents the National Environmental Policy Act (NEPA) process for developing a Comprehensive Conservation Plan (CCP) for managing Big Muddy National Fish and Wildlife Refuge (NFWR, refuge). In general, scoping reveals issues that drive alternative ways of managing the refuge. Implementation of each of those alternative management styles (including the No Action Alternative) may have different effects on the physical, biological, and socioeconomic environment. Analysis of these effects reveals the preferred alternative, which constitutes the CCP. The CCP includes goals, objectives, and strategies for the refuge to guide overall management for the next 15 years.

Big Muddy NFWR, located in Missouri along the floodplain of the Missouri River, is comprised of 11 units that total more than 17,600 acres. The 11 refuge units encompass river features, such as islands, chutes, bends, and tributary confluences. These features were once common but are now rare because of changes to the Missouri River and its floodplain initiated to promote navigation and minimize flooding. Some part of each unit still offers a glimpse of the former diversity of the Missouri River floodplain characterized by a shifting mosaic of river features driven by a wide range of seasonal and annual flows. Current refuge management focuses on reconnecting the Missouri River and its tributaries to their floodplains, restoring hydrology, returning native vegetation, reducing invasive species, and offering a variety of wildlife-dependent recreation opportunities. Restoring or mimicking the historic river dynamics fosters a range of bottom land and wetland vegetation and associated fish and wildlife including some, such as the pallid sturgeon, that are at risk of extinction.

Refuge Vision

In stretches between St. Louis and Kansas City, the Missouri river includes side channels, numerous sandbars, shifting depths and velocities, and adjacent wildlands much as it did when first seen by Lewis and Clark. A diverse abundance of native plants and animals confirm the heritage of this ever-changing system of river and floodplain. People come to enjoy and appreciate the recreation dependent on wildlife. They celebrate the river's heritage by supporting its restoration and conservation and the Big Muddy National Fish and Wildlife Refuge.

Refuge Goals

Habitat: Restore and maintain native habitat and natural processes sufficient to support species native to the Missouri River floodplain.

Wildlife: Promote biodiverse and abundant populations of endemic fish and wildlife within the Missouri River floodplain.

People: Refuge visitors enjoy wildlife-oriented recreation and understand refuge resources and efforts to maintain natural habitats and processes in the Missouri River floodplain.

Public Involvement

Initial conversations about comprehensive planning for Big Muddy NFWR began mid-year of 2007 to review policy, discuss the core team, tour the refuge, and gather background information. The initial phase of the planning process—scoping—officially began on May 16, 2007 when a Notice of Intent to prepare a CCP appeared in the *Federal Register*. Scoping, according to the Council on Environmental Quality Regulations for implementing NEPA, is “an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action.”

Issues

Planning is a means to address issues. Public scoping as well as scoping by U.S. Fish and Wildlife Service (FWS, Service) refuge and regional staff and other agencies took place, ultimately producing eight “driving issues,” which are consolidated into three groups. These groupings are the basis for planning alternatives and suggest a range of possible changes in management. They are:

Land and Water Conservation

- What types and intensities of habitat management should be used to help fulfill refuge purposes, the mission of the NWRS, and/or other conservation priorities?
- How should the refuge deal with invasive species?
- How does the refuge restore Missouri River floodplain dynamics in the face of social and political conflicts?
- How can we learn more about refuge ecosystems and assess the results of refuge management actions

Visitor Services and Refuge Administration

- How should the refuge address the demand for a range of recreation experiences, wildlife-dependent recreation opportunities, other public uses, and facilities?
- How and where should the refuge allocate its resources for administering land and water conservation, visitor services, maintenance, and monitoring?
- How should the refuge involve and coordinate the numerous communities, jurisdictions, authorities, governing bodies, and landowners that affect refuge management or are affected by refuge management?

Conservation Footprint

- How should the refuge determine the total number, individual size, and location of refuge units?

Alternatives

We developed three management alternatives: the No Action alternative, which would be continuation of current management direction, and two action alternatives including Alternative C, the preferred alternative. We did this through a process that included small group workshops and surveys. The three alternatives represent different approaches to the protection, restoration, and management of the refuge's fish, wildlife, plants, habitats, and other resources as well as to compatible wildlife-dependent recreation.

Within the planning area, the No Action Alternative would distribute refuge staff, funds, and efforts most broadly with no specific emphasis. The two action alternatives would vary management emphasis by river reach (figure ES-1). Alternative B would be more narrowly focused with an emphasis on the Columbia Reach. Alternative C would emphasize the Columbia and St. Louis Reaches, with a focus more narrow than Alternative A and more broad than Alternative B. In selecting a preferred alternative, we considered environmental, economic, and social factors and our ability to implement the actions necessary to accomplish the alternatives. We based our decision on how well each alternative met the goals of the refuge and the environmental consequences of each alternative.

The three alternatives describe different combinations of eight objectives for land and water management and visitor services and facilities across five reaches of the Missouri River floodplain (figure ES-1). The eight objectives fall into two distinct categories: standard objectives and supplemental objectives. Each of the two standard objectives describes a baseline condition—the specific actions associated with these objectives would occur on all refuge units regardless of their location within the planning area. In contrast, each of the six supplemental objectives describes an upper level of management or development. The specific action or actions listed for each supplemental objective are included to help describe the upper limit that could occur, but the inclusion and combination of supplemental objectives varies by river reach and by alternative. Table ES-1 summarizes the alternatives.

Figure ES-1: Big Muddy NFWR Planning Area River Reaches Delineated by River Miles

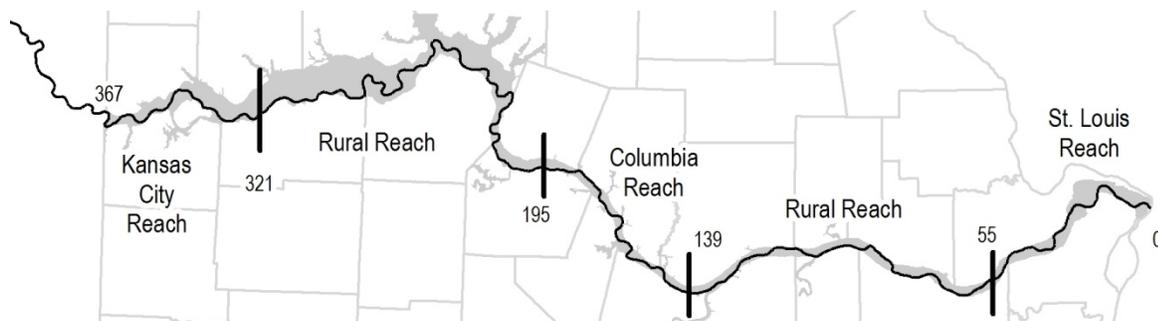


Table ES-1: Summary of Alternatives

	Alternative A (Current) no reach emphasized				Alternative B Columbia Reach emphasized				Alternative C (Preferred) Columbia and St. Louis Reaches emphasized			
	Reaches				Reaches				Reaches			
Objective	Rural	Columbia	St. Louis	Kansas City	Rural	Columbia	St. Louis	Kansas City	Rural	Columbia	St. Louis	Kansas City
Standard objectives. These <i>would</i> occur on all refuge units.												
Standard Land and Water Management includes: – Restore hydrology to Missouri River and its tributaries (where applicable) – Reconnect floodplain to the Missouri River and major tributaries – Maintain or return to natural cover types (primarily refers to conversion of cropland to cover types such as forest or grassland, mostly through ecological succession) – Manage invasive species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Standard Services and Facilities includes: – Reasonable car access* – Reasonable boat access* – Kiosks – Parking (in areas with vehicle access)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Supplemental objectives. Items listed under the objectives below <i>could</i> occur on one or more refuge units within the indicated reaches dependent on subsequent site-specific planning.												
Supplemental Land and Water Management <i>could</i> include: – Active management to achieve a particular cover type at a specific location to improve conditions for one or more species of fish and wildlife.	Y	Y	Y	Y	-	Y	-	-	-	-	-	-
Supplemental Services and Facilities <i>could</i> include: – Interpretive displays and other self-guided interpretation – Restrooms – Trails – Overlooks – Wildlife observation facilities – Maintenance center (shop)** – Environmental education site	Y	Y	Y	Y	-	Y	-	-	-	Y	Y	-
Administrative Center (Refuge Office): See appendix L for more details – Allows for the option of a structure located on refuge holdings to serve as the primary administrative center of the refuge. It would include offices and may also include a visitor contact station, an area of the structure dedicated to visitor services.	-	Y	-	-	-	Y	-	-	-	Y	-	-
Outreach and Collaboration – Collaboration (building relationships to deliver conservation) – Outreach (building public understanding and support)	-	-	-	-	-	Y	-	-	-	Y	Y	-
Programming: Allows for staff-led or volunteer-led programming – Environmental education programs – Interpretive programs and other guided interpretation	-	-	-	-	-	Y	-	-	-	Y	-	-
Study and Learning – Biological inventory – Monitoring – Research	-	-	-	-	-	Y	-	-	-	Y	Y	-
*Reasonable car access typically includes at least one maintained road that abuts or enters a refuge unit and developed parking for at least six vehicles. All current and future refuge units are located along the Missouri River and considered to have reasonable boat access. Some existing refuge units feature modest developed boat accesses but others are up to 15 river miles from a boat access point. This variation in boat access distance is expected to be similar on future refuge units.												
**Typically includes at least two service bays, a vehicle lift, and a third bay for storage with an office area and a storage area.												

Environmental Consequences

The environmental consequences of each impact topic were defined on the basis of type of effect, duration, intensity, and context for the following resources: Climate Change, Soil Resource, Water Resources, Air Quality, Vegetation, Ecosystems, Wildlife, Socioeconomics, and Visitor Services. The effects varied by resource across the river reaches and across alternatives, but not widely. Of the nine resources considered, adverse effects were identified for six resources under Alternative A, five resources under Alternative B, and three resources under Alternative C. Beneficial effects were identified for all resources under all alternatives with minor variation between alternatives.

Chapter 1: Purpose of and Need for the Proposed Action

In this chapter:

[Introduction](#)
[Proposed Action](#)
[Purpose of and Need for the Proposed Action](#)
[Decisions to be Made](#)

Introduction

This document presents an Environmental Assessment (EA) that evaluates alternatives for, and expected consequences of, managing Big Muddy National Fish and Wildlife Refuge (NFWR, refuge). Chapter 1 provides a summary of the planning process, briefly introduces the refuge, describes the proposed action, explains the purpose and need for the planning effort, and identifies the decisions to make as a course of the planning process. The remaining chapters provide more specific information on the planning process and existing laws and policies that guide refuge planning and management (chapter 2), management alternatives (chapter 3), and affected environment and environmental consequences associated with each of the alternatives (chapter 4).

The Process and the Plan

This EA documents the National Environmental Policy Act (NEPA) process for developing a Comprehensive Conservation Plan (CCP) for Big Muddy NFWR. The planning process to develop a CCP includes eight steps (FWS 2000c):

1. Preplanning: Planning the Plan
2. Initiate Public Involvement and Scoping
3. Review Vision Statement and Goals and Determine Significant Issues
4. Develop and Analyze Alternatives, Including the Proposed Action
5. Prepare Draft Plan and NEPA Document
6. Prepare and Adopt Final Plan
7. Implement Plan, Monitor, and Evaluate
8. Review and Revise Plan

In general, scoping reveals issues that drive alternative ways of managing the refuge. Implementation of each of those alternatives (including the no action alternative) may have different effects on the physical, biological, and socioeconomic environment. Analysis of these effects reveals the alternative that:

- Best achieves the refuge purposes, vision, and goals;
- Helps fulfill the National Wildlife Refuge System (NWRS, Refuge System) mission;

- Maintains and where appropriate restores ecological integrity of the refuge and the Refuge System (of which the refuge is a part);
- Addresses significant issues and mandates; and
- Is consistent with principles of sound fish and wildlife management.

This alternative is preferred and therefore constitutes the draft CCP. In this EA, Alternative C is the preferred alternative of the U.S. Fish and Wildlife Service (FWS, Service) and appears, along with additional supporting information, as the draft CCP in appendix A. When finalized, the CCP will serve as a working guide for management programs and actions over the next 15 years. Monitoring and evaluation of implementing the Plan provides a basis for eventual review and revision (as necessary). Public, partner, tribal and other stakeholder input throughout, guides the planning process and, in turn, the long-term management decisions of the refuge.

The Refuge



Welcome to Big Muddy NFWR; photo: USFWS

The refuge, at present, is comprised of 11 units, totaling more than 17,000 acres, located in Missouri along the floodplain of the Missouri River (figure 1-1). The 11 refuge units encompass river features, such as islands, chutes, bends, and tributary confluences. These features were once common but are now rare because of changes to the Missouri River and its floodplain initiated to promote navigation and minimize flooding. Surprisingly, some part of each unit still offers a glimpse of the former diversity of the Missouri River floodplain. This glimpse is from a time characterized by a shifting mosaic

of river features driven by a wide range of seasonal and annual flows. Therefore, current refuge management focuses on reconnecting the Missouri River and its tributaries to their floodplains, restoring hydrology, returning native vegetation, reducing invasive species, and offering a variety of wildlife-dependent recreation opportunities. Restoring or mimicking the historic river dynamics fosters a range of bottom land and wetland vegetation, and associated fish and wildlife including some, such as the pallid sturgeon, that are at risk of extinction.

Figure 1-1: Location of Big Muddy NFWR



Proposed Action

The Service proposes to prepare and implement a CCP for Big Muddy NFWR. The CCP would provide management direction for existing and future units of the refuge for the following 15 years.

Purpose of and Need for the Proposed Action

The purpose of the proposed action is to describe the desired future conditions of the refuge and to provide guidance and management direction for a 15-year period for the conservation of fish, wildlife, and plant resources and their related habitats, while providing opportunities for compatible wildlife-dependent recreational uses (FWS 2000c). The CCP should do the following:

- Achieve refuge purposes (see Refuge Purposes in chapter 2);
- Help fulfill the Refuge System mission (see National Wildlife Refuge System Mission, and Goals in chapter 2);
- Maintain and where appropriate, restore the ecological integrity of the refuge (see Ecological Integrity below);
- Help achieve the goals of the National Wilderness Preservation System (see Wilderness Review in chapter 2); and
- Meet other mandates including the U.S. Department of the Interior (DOI) Secretarial Orders 3289 and 3226, which direct all DOI agencies to consider and analyze potential climate change impacts as part of any long-range planning effort (see Legal and Policy Compliance in chapter 2).

There is a need for the proposed action because adequate, long-term management direction does not exist for the refuge. An Interim Comprehensive Management Plan completed in 1999 provides some management guidance but is now out of date and superseded by current Service policies. There is also a need for the proposed action to address management issues and opportunities as well as satisfy the legislative mandate of the National Wildlife Refuge System Improvement Act of 1997. This act requires the preparation of a CCP for each national wildlife refuge.

A planning team composed of representatives from various Service programs completed the EA and Draft CCP, which also incorporates input from the Missouri Department of Conservation (MDC), U.S. Army Corps of Engineers (USACE), and the public. Chapter 2 includes a description of the planning process and public involvement. Service policy guides preparation of CCPs and includes compliance with NEPA. This EA describes, compares, and analyzes the No Action alternative (which continues current management) and two action alternatives developed in response to three categories of planning issues: Conservation Footprint, Land and Water Conservation, and Visitor Services. Any of the three alternatives could be selected as the CCP that guides refuge management over the succeeding 15 years. Alternative C is the Service's preferred alternative, because it best meets the *Purpose of and Need for the Proposed Action* as described above and addresses the issues that drove the alternatives.

Decisions to be Made

The Regional Director for the Service's Midwest Region (Region 3) will make the following two decisions based on this EA:

- Select an alternative to serve as the CCP and provide long-term management direction for the refuge and
- Determine if the selected alternative is a major federal action significantly affecting the quality of the human environment, thus requiring preparation of an Environmental Impact Statement.

Chapter 2: Refuge Planning Context

In this chapter:

[Introduction](#)
[Refuge System Planning Guidance](#)
[Refuge Management Guidance](#)
[Relationship to Other Conservation Initiatives](#)
[The Planning Process](#)

Introduction

This chapter introduces the U.S. Fish and Wildlife Service (FWS, Service) and the National Wildlife Refuge System (NWRS, Refuge System) along with their missions and management guidance, existing laws and policies that guide refuge management, and other related conservation plans and initiatives. It concludes with an overview of the comprehensive conservation planning process including a description of public involvement and the planning issues.

Refuge System Planning Guidance

The U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service, the primary federal agency responsible for conserving, protecting, and enhancing the Nation's fish and wildlife populations and their habitats, administers Big Muddy National Fish and Wildlife Refuge (NFWR, refuge). The Service oversees the enforcement of federal wildlife laws, management and protection of migratory bird populations, restoration of nationally significant fisheries, administration of the Endangered Species Act, restoration of wildlife habitat such as wetlands, collaboration with international conservation efforts, and the distribution of conservation funding to States, territories, and tribes. Through its conservation work, the Service also provides a healthy environment in which Americans can engage in outdoor activities. Additionally, as one of three land managing agencies in the U.S. Department of the Interior (DOI), the U.S. Fish and Wildlife Service is responsible for the Nation's National Wildlife Refuge System.

FWS Mission

The mission of the Service is working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.

The National Wildlife Refuge System

The National Wildlife Refuge System was founded in 1903 when President Theodore Roosevelt designated a 3-acre island off the Florida coast, Pelican Island, as a sanctuary for colonial nesting birds. Today, the System has grown to a network of more than 560 national wildlife refuges (NWR, refuge), 37 wetland management districts, and 49 coordination areas covering approximately 150 million acres of public lands and waters. Most of these lands are contained within Alaska's 16 national wildlife refuges with the remainder distributed throughout the other

49 states and U.S. territories. Since 2006 Marine National Monuments have been added to the Refuge System, adding more than 50 million acres in the Pacific Ocean to the Refuge System.

The Refuge System is the world's largest collection of lands and waters specifically designated and managed for fish and wildlife. Overall, it provides habitat for more than 700 species of birds, 220 species of mammals, 250 reptile and amphibian species, 200 species of fish, and more than 280 threatened or endangered plants and animals. As a result of international treaties for migratory bird conservation and related legislation such as the Migratory Bird Conservation Act of 1929, many refuges have been established to protect migratory waterfowl and their migration flyways that extend from nesting grounds in the north to wintering areas in the south. Refuges also play a vital role in preserving threatened and endangered species. For example, Aransas NWR in Texas serves as the winter home of the Whooping Crane, the Florida Panther NWR protects its namesake, *Felis concolor coryi*, one of the Nation's most endangered mammals, while the Hawaiian Islands NWR is home to the Laysan Duck, Hawaiian monk seal, and many other unique species.

Refuges also provide important recreation and education opportunities for visitors. When public uses are deemed appropriate and compatible with wildlife and habitat conservation, they are places where people can enjoy hunting, fishing, wildlife observation, photography, environmental education, environmental interpretation, and other recreational activities. Many refuges have visitor centers, wildlife trails, automobile tours, and environmental education programs. Nationwide, more than 40 million people visit national wildlife refuges annually.

NWRS Mission

The mission of the Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

NWRS Goals

Revised goals for the Refuge System were adopted on July 26, 2006, and incorporated into Part 601, Chapter 1, of the Fish and Wildlife Service Manual (601 FW 1). The goals are:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered;
- Develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges;
- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts;
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation); and

- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

Legal and Policy Compliance

Laws, executive orders, and DOI and Service policies guide administration of refuges (including WMDs). A list of pertinent statutes and policy guidance are in appendix E.

Wilderness Review

Refuge planning policy mandates that wilderness reviews be conducted through the comprehensive conservation planning process (FWS 2000c). The wilderness review process consists of three phases: inventory, study, and recommendation. In the inventory phase we look at Service-owned lands and waters within the refuge that are not currently designated wilderness and identify those areas that meet the criteria for wilderness established by Congress. The criteria are size, naturalness, opportunities for solitude or primitive recreation, and supplemental values. Areas that meet the criteria are called Wilderness Study Areas (WSAs). In the study phase we develop and evaluate a range of management alternatives for the WSAs to determine if they are suitable for recommendation for inclusion in the National Wilderness Preservation System. In the recommendation phase we forward the suitable recommendations in a Wilderness Study Report that moves from the Director of the U.S. Fish and Wildlife Service through the Secretary of Interior and the President to Congress.

No lands within Big Muddy NFWR meet the criteria for wilderness established by Congress and described in Service policy (FWS 2008e). Big Muddy NFWR does not contain 5,000 contiguous acres of roadless, natural lands, nor does the refuge possess any units of sufficient size to make their preservation practicable as wilderness. Refuge lands and waters have been substantially altered by humans, especially by agriculture, dam construction, river channel modifications, and road building.

Refuge Management Guidance

General guidance for managing the refuge comes from several sources including refuge purposes (which drive establishment and acquisition), the Refuge System mission, Service policies, and other laws. The vision and goals developed during this planning process will also guide management of the refuge.

Brief History of Refuge Establishment and Acquisition

In the 1970s, the Service began discussions about the need for increased protection and rehabilitation of fish and wildlife resources on the Lower Missouri River (FWS 1999b). However, more formal consideration to create a national wildlife refuge did not begin until 1989. Then, in 1993, unprecedented flooding along the Lower Missouri River provided impetus for the idea. In 1994, the Service authorized the purchase of lands for the “development, advancement, management, conservation, and protection of Missouri River fish and wildlife resources...” [16 U.S.C. 742f(a)(4)] (FWS 1994). The authorized area consisted of seven units totaling 16,628 acres in eight counties. The Service officially established Big Muddy NFWR when the first parcel of land was purchased on April 3, 1995 (FWS 1995a and 1996b).

Meanwhile, in 1986, Congress passed the Water Resources Development Act that authorized the U.S. Army Corps of Engineers (USACE) Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project (Mitigation Project). The Mitigation Project is designed to compensate for fish and wildlife habitat losses that resulted from past channelization efforts on the Missouri River. The Project area extends from Sioux City, Iowa, to the mouth of the Missouri River near St. Louis, MO, a length of 735 river miles. As part of the Mitigation Project, the USACE has acquired over 16,500 acres of land from Kansas City, MO to St. Louis and completed habitat rehabilitation projects on a portion (table 2-1). Since the USACE is not a wildlife land management agency, it transfers management of the land to other such agencies (Missouri Department of Conservation [MDC] or the Service, as directed by the Fish and Wildlife Coordination Act of 1958 as amended) (appendix E).

To support and complement the USACE's Mitigation Project as well as MDC's 10-year fisheries strategic plan for the Missouri River, the Service proposed an expansion of the refuge in 1997. The expansion, for up to 60,000 acres, was to address a broader ecosystem approach to management of fish and wildlife habitats and provide for compatible public use. The proposed increase in size was intended to help the refuge attain goals for threatened and endangered species recovery, migratory bird and interjurisdictional fish conservation, biological diversity, and fish and wildlife-dependent public recreation.

In 1998, the refuge began managing land purchased by the USACE under terms of a Lease Agreement. This land, the 1,300-acre Overton Bottoms North Unit, complements adjacent fee title refuge land.

Finally, in 1999 to formalize the proposed expansion, the Service published a Record of Decision along with the Final Environmental Impact Statement (FEIS). These documents authorized acquisition of up to 60,000 acres within the Missouri River floodplain. The Service is currently authorized to acquire lands from willing sellers within approximately 820,000 acres of floodplain in the 367-mile stretch of the Missouri River between Kansas City and St. Louis. Land acquisitions may be located in 20 counties, from river mile 367.5 (near Kansas City) to river mile 0 (the Missouri River confluence with the Mississippi River near St. Louis), and the lower 10 miles of major tributaries. When fully implemented, the Service estimates the refuge will consist of 25–30 units, or “beads of habitat,” along the Lower Missouri River. The EIS identified and described the environmental impacts of the expansion and provides background for this document.

An Interim Comprehensive Management Plan was also prepared in 1999 for how to manage the expansion. The plan outlines the following goals:

- Restoration of natural floodplain conditions and associated native habitats including bottom-land forest, wetlands, and wet prairie and other grasslands;
- Restoration of natural riverine functions on public lands (connecting the river with the floodplain; allowing some natural meandering, widening of the channel, and creation of sandbars, chutes, sloughs, etc.);
- Restoration of habitat sufficient to protect federally-listed threatened and endangered species and candidate species within the project area;
- Conservation, management, and restoration of the biodiversity and abundance of native endemic fish and wildlife populations; and

- Provision of additional public areas for compatible fish- and wildlife-oriented recreation and increasing public understanding of Missouri River resources.

More recently, in 2010, under the authority of the Fish and Wildlife Coordination Act, the USACE and Service entered into a Federal Real Estate Use Agreement (appendix C). The Real Estate Use Agreement added Overton Bottoms South and Cora Island Units to the refuge and also included Overton Bottoms North. Other tracts may be added to the Agreement in the future. All Service policies and laws apply to the Mitigation Project lands to the extent of the authority granted to the Service in the agreement. The refuge currently includes 6,227 such acres and expects to add other tracts purchased by the USACE for the Mitigation Project in the future (table 2-1).

Table 2-1: Missouri River Recovery Program and Mitigation Project Land Acquisition

Site, County	River Miles	Fee Acreage	Public Fee/Easement Acreage	Date Acquired	Site Manager
Columbia Bottoms, St. Louis	0–5		4,108.15 110.65 7.19	24-Jun-02 17-Mar-03 17-Mar-03	MDC, (easement licensed to MDC)
Confluence Point, St. Charles	1–3	520.691	455	10-Apr-07 29-Dec-07	MO Department of Natural Resources (DNR)
Cora Island, St. Charles	3–8	1,265		25-Jun-08	Permitted to FWS
Berger Bend, Franklin	91–93	416.23 58.16		27-Sep-95 20-Nov-98	Proposed for FWS
Heckman Island, Montgomery	104–108	400 143		24-Jul-08 24-Jul-08	Proposed for FWS
Tate Island/Morrison Bend, Callaway County	110–113	403 19.41		13-Oct-94 24-Oct-94	Licensed to MDC
Providence Bend, Boone	162–168	579		22-Oct-07	Proposed for FWS
Eagle Bluffs CA, Boone	171–176		571 211	13-Nov-00 5-Dec-06	Licensed to MDC
Overton Bottoms, Cooper and Moniteau	178–188	4, 4,962 acres		1996	Permitted to FWS
Rocheport Cave, Boone	183		23	23-Apr-02	
Cambridge Bend, Chariton	227–234	168.1		13-June-06	Proposed for FWS
Grand River Bend, Saline	246–252	290		13-Oct-09	USACE
Grand Pass CA, Saline	268–271		0.37 4.19	16-Dec-91 16-Dec-91	Licensed to MDC
Tamerlane Bend, Carroll	271–281	390 484		30-Jun-08 10-Sep-09	Proposed for FWS
Bakers Bend, Saline	278–290	237		1-Dec-08	Proposed for FWS
Baltimore Bend, Lafayette	297–305	42 115.16		18-May-07 12-Jun-07	To be permitted to FWS
Bootlegger Bend, Lafayette	317-321	1,365		2011	Proposed for FWS

Total acres permitted for FWS = 6,227; Total Acres Proposed for FWS = 3,032.

Data current as of 10/1/2010 for the Big Muddy NFWR acquisition area. Data from USACE 2010. Excerpt from appendix C - Land acquisitions for the Missouri River recovery program/mitigation project.

Today, the Service is also actively seeking appropriate additions for the refuge from willing sellers within the acquisition area, and the number of units and acres continues to grow. As of April 2011, the refuge manages 11 units totaling 16,743 acres (table 2-2; figure 2-1).

Beginning in 2013, Big Muddy NFWR became part of a refuge complex that also includes Squaw Creek NWR and Swan Lake NWR. Each refuge retains separate management direction, but administration is shared and coordinated among the three refuges comprising the complex.

Table 2-2: Big Muddy NFWR Units

Unit	County	Acres	River Miles
Jackass Bend	Jackson Ray	498.0 227.8	337–339
Baltimore Bottom	Lafayette	1,626.0	296–302
Cranberry Bend	Lafayette Saline	85.0 522.0	278–291
Cambridge Bend	Chariton Saline	309	230-232
Lisbon Bottom	Howard	2,013.62	213–219
Jameson Island	Saline	1,870.9	210–216
Overton Bottoms North	Cooper	1,248.7 1,300.0*	185–193
Overton Bottoms South	Cooper Moniteau	3,662*	179–185
St. Aubert Island	Osage	1,126.0	119–126
Boone's Crossing	St. Louis	572.0	40–43
Cora Island	St. Charles	1,265*	2–7

Data current as of 2/2010

*acquired by USACE

Figure 2-1: Existing Units of Big Muddy NFWR



Refuge Purposes

Big Muddy NFWR is part of a national network of lands administered by the Service as the Refuge System. Each unit of the Refuge System has one or more purposes specified in or derived from the legal instrument that established, authorized, or expanded it. The first obligation is to fulfill and carry out the purposes of each refuge (FWS 2006c). Big Muddy NFWR

gets its purposes from two different legal authorities, the Fish and Wildlife Act of 1956, and the Emergency Wetlands Resources Act of 1986. Together they provide broad direction regarding conservation of fish and wildlife and their habitats with specific mention of wetlands and migratory birds. The specific purposes follow:

" . . . for the development, advancement, management, conservation, and protection of fish and wildlife resources . . . " 16 U.S.C. § 742f(a)(4) ". . . for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude . . . " 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" . . . the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions . . . " 16 U.S.C. § 3901(b), 100 Stat. 3583 (Emergency Wetlands Resources Act of 1986)

Refuge Vision Statement

The vision provides a concise statement of what the refuge is, or what it is desired to be, based primarily upon the Refuge System mission and specific refuge purposes, and other mandates. The Big Muddy NWFR vision is as follows:

In stretches between St. Louis and Kansas City, the Missouri river includes side channels, numerous sandbars, shifting depths and velocities, and adjacent wildlands much as it did when first seen by Lewis and Clark. A diverse abundance of native plants and animals confirm the heritage of this ever-changing system of river and floodplain. People come to enjoy and appreciate the recreation dependent on wildlife. They celebrate the river's heritage by supporting its restoration and conservation and the Big Muddy National Fish and Wildlife Refuge.

Refuge Goals

The goals are broad statements that describe the desired future conditions of the refuge.

Goal 1: Habitat

Restore and maintain native habitat and natural processes sufficient to support species native to the Missouri River floodplain.

Goal 2: Wildlife

Promote biodiverse and abundant populations of endemic fish and wildlife within the Missouri River floodplain.

Goal 3: People

Refuge visitors enjoy wildlife-oriented recreation and understand refuge resources and efforts to maintain natural habitats and processes in the Missouri River floodplain.

Relationship to Other Conservation Initiatives

Migratory Bird Conservation Initiatives

Several migratory bird conservation plans have been published over the last decade that can be used to help guide management decisions for the refuge. Bird conservation planning efforts have evolved from a largely local, site-based orientation to a regional, even inter-continental, landscape-oriented perspective. Several transnational migratory bird conservation initiatives have emerged to help guide the planning and implementation process. The regional plans most relevant to the majority of the refuge are:

- The Upper Mississippi River and Great Lakes Region Joint Venture (UMR/GLR JV) Waterfowl Habitat Conservation Strategy (<http://www.uppermissgreatlakesjv.org/>);
- The UMR/GLR JV Landbird Habitat Conservation Strategy;
- The UMR/GLR JV Shorebird Habitat Conservation Strategy;
- The UMR/GLR JV Waterbird Habitat Conservation Strategy; and
- The Central Hardwoods Joint Venture Concept Plan (http://www.chjv.org/CHJV_Strategic_Plan.html).

These plans are products of stepping-down and incorporating all other larger-scale (North American, United States, International, etc.) species and other management plans, in particular the North American Waterfowl Management Plan.

The UMR/GLR JV of the North American Waterfowl Management Plan is an effort to safeguard the waterfowl habitats of the Nation's only inland coastal area—the Great Lakes—plus interior wetlands, including the floodplains of four of the country's major river systems: the lower Missouri, upper Mississippi, the Illinois, and Ohio. More recently, this effort also includes protecting or increasing habitat for upland wildlife species that are associated with wetland habitats and that of declining non-waterfowl migratory birds, as long as the efforts were



Diversity of habitats; photo: Steve Hillebrand

consistent with waterfowl objectives. Therefore, the UMR/GLR JV is concerned with delivering a full spectrum of bird conservation (sustainable populations of all birds) through regionally based, biologically driven, landscape-oriented partnerships.

More specifically, the refuge spans across the Eastern Tallgrass Prairie and Central Hardwoods Bird Conservation Regions (BCR) 22 and 24. The Central Hardwoods BCR description probably best characterizes the refuge. The region includes some

of the most extensive forests in the middle of the continent, much of it oak-hickory deciduous forest in the uplands, which support forest interior bird species such as Cerulean Warbler,

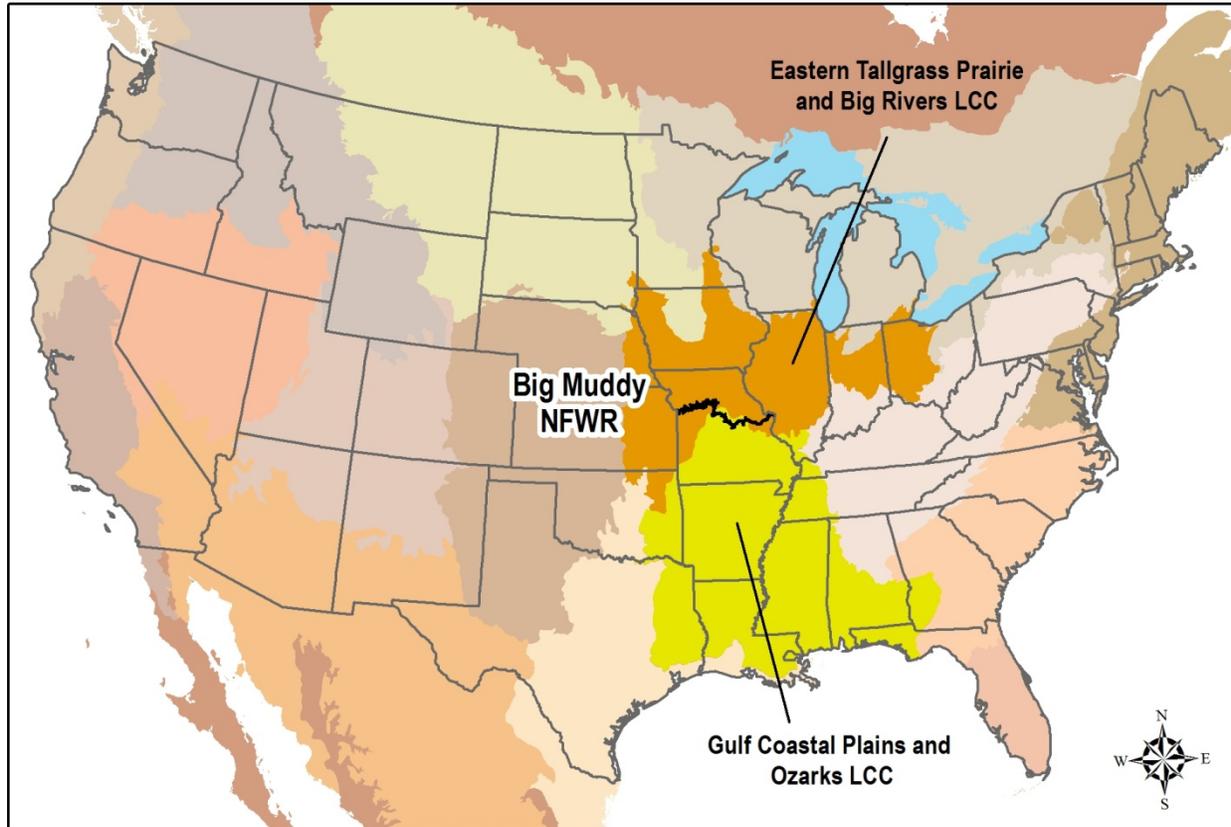
Worm-eating Warbler, and Louisiana Waterthrush. Although Wood Ducks are the primary breeding waterfowl, the region holds more significance for waterfowl as a migratory staging area. The floodplains of the river systems exhibit a diversity of habitats (e.g., floodplain forests, emergent wetlands, and submerged aquatic beds), all of which are utilized by migrating waterfowl. Large concentrations of waterfowl, including Mallard, Lesser Scaup, and Canvasback, are common during both spring and fall migration. Threats to the habitats of the region include agricultural conversion of floodplain habitats and urbanization.

BCRs 22 and 24 contain 47 bird species listed as “Of Conservation Concern” by the Service (FWS 2008b). This list identifies species, subspecies, and populations of all migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act. The overall goal of this report is to accurately identify the migratory and non-migratory bird species (beyond those already designated as federally threatened or endangered) that represent the Service’s highest conservation priorities. The Service based its 2008 list of Birds of Conservation Concern primarily on the landbird, shorebird, and waterbird status assessment scores. Some of the species on this list include: American Bittern (*Botaurus lentiginosus*), Bell’s Vireo (*Vireo bellii*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Cerulean Warbler (*Setophaga cerulea*), Horned Grebe (*Podiceps auritus*), Prothonotary Warbler (*Protonotaria citrea*), Short-billed Dowitcher (*Limnodromus griseus*), Short-eared Owl (*Asio flammeus*), Upland Sandpiper (*Bartramia longicauda*), Wood Thrush (*Hylocichla mustelina*), and Worm-eating Warbler (*Helmitheros vermivorum*).

Landscape Conservation Cooperatives

The Service, with support and cooperation from the U.S. Geological Survey, has developed a national geographic framework for “putting science in the right places” to conserve our Nation’s fish and wildlife resources. Just as flyways provided an effective spatial frame of reference to build capacity and partnerships for international, national, state, and local waterfowl conservation, the national geographic framework provides a continental platform upon which the Service can work with state and other partners to connect project- and site-specific efforts to larger biological goals and outcomes. By providing visual context for conservation at “landscape” scales—the entire range of a priority species or suite of species—the framework helps ensure that resource managers have the information and decision making tools they need to conserve fish, wildlife, plants and their habitats in the most efficient and effective way possible.

The Service is using the framework as a basis for locating Landscape Conservation Cooperatives (LCCs). Facilitated by DOI as part of its collaborative, science-based response to climate change, LCCs complement and build upon existing science and conservation efforts—such as fish habitat partnerships and migratory bird joint ventures as well as water resources, land, and cultural partnerships. Big Muddy NFWR planning area is split across the Eastern Tallgrass Prairie and Big Rivers LCC and the Gulf Coastal Plains and Ozarks LCC, just two of a network of partnerships working in unison to ensure the sustainability of America’s land, water, wildlife, and cultural resources (figure 2-2).

Figure 2-2: Relationship of Big Muddy NFWR to Landscape Conservation Cooperatives

Both LCCs conduct research, develop tools that improve natural resource management, and conduct outreach. Their goal is to focus coordinated action and eliminate duplication to support shared conservation priorities across large connected areas, or landscapes. The Eastern Tallgrass Prairie and Big Rivers LCC cuts a vast swath across the middle of America's heartland, covering the area more commonly referred to as the "corn belt." While the landscape is predominantly agricultural and in private ownership, the area also contains numerous state and federally managed tracts of land providing habitat for a wide variety of aquatic and terrestrial species of wildlife. This LCC contains portions of some of America's premier rivers including the Mississippi, Missouri, Illinois, Wisconsin, Ohio, and Wabash—each providing critical riverine corridor habitat for wildlife as well as a wide variety of natural lakes and reservoirs. The Gulf Coastal Plains and Ozarks LCC encompasses all of Arkansas and Mississippi and parts of 10 additional states, from Missouri to eastern Texas to the Florida panhandle.

Strategic Habitat Conservation

Strategic habitat conservation (SHC) is a science-based approach to conservation focused on providing landscapes capable of sustaining trust species populations at objective levels. This approach is founded on an adaptive, iterative process of biological planning, conservation design, conservation delivery, monitoring, and research. SHC is an application of the scientific method and adaptive management to conservation at multiple spatial scales. This strategic

conservation approach will include all Service programs and address both habitat and non-habitat factors limiting fish and wildlife populations

As a leader in fish and wildlife and habitat conservation and management, the Service is embracing a framework designed to maximize agency efficiency and increase on the ground conservation impacts. SHC enables the Service to:

- Respond to new environmental challenges;
- Advance opportunities with new and existing partners;
- Utilize science-based tools and resources to plan and evaluate our conservation efforts; and
- Continue to ensure conservation successes locally, while advancing landscape objectives.

The Service mission can be met at a landscape scale, especially in the face of climate change, by:

- Fully utilizing existing technology such as GIS;
- Becoming trained in better decision making through the structured decision making process;
- Reaching out to even more partners that have the necessary expertise to advance knowledge of the resource and its needs at multiple spatial and temporal scales; and
- Being diligent and transparent in planning and decision making processes.

SHC Guiding Principles

- Habitat conservation is simply a means to attain the Service's true goal—the conservation of populations and ecological functions that sustain them;
- Defining measurable population objectives is a key component of SHC, at any scale;
- Biological planning must use the best scientific information available, both as a body of knowledge and a method of learning. Service understanding of ecological conditions is never perfect. An essential element of SHC is managing uncertainty through an iterative cycle of planning, doing, and evaluating;
- Management actions, decisions, and recommendations must be defensible and explicit about the nature and magnitude of potential errors;
- Conservation strategies consist of dynamic suites of objectives, tactics, and tools that change as new information enters the SHC cycle; and
- Partnerships are essential, both for management and for developing conservation strategies.

Region 3 Fish and Wildlife Conservation Priorities

Every species is important; however, the number of species in need of attention exceeds the resources of the Service. To focus effort effectively, Region 3 of the Service compiled a list of Resource Conservation Priorities. The list includes:

- All federally listed threatened and endangered species and proposed and candidate species that occur in the Region;
- Migratory bird species derived from Service-wide and international conservation planning efforts; and
- Rare and declining terrestrial and aquatic plants and animals that represent an abbreviation of the Endangered Species program's preliminary draft "Species of Concern" list for the Region.

Climate Change Planning

U.S. Fish and Wildlife Service

The Service's *Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change* (FWS 2010b) establishes a basic framework within which the Service will work as part of the larger conservation community to help ensure the sustainability of fish, wildlife, plants, and habitats in the face of accelerating climate change. It was developed in an effort to rise up and respond to, as well as in recognition of, what is perhaps the 21st century's largest stressors on fish, wildlife, and plants: climate change. Part of the plan's primary purposes is to lay out a vision for accomplishing the Service mission to "work with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people" in the face of accelerating climate change. In this plan, a commitment to the Service's vision is expressed through strategic goals and objectives that must be accomplished to sustain fish and wildlife nationally and internationally. *A 5-Year Action Plan for Implementing the Climate Change Strategic Plan* identifies specific actions that will lead to the accomplishment of these goals and objectives. The goals and objectives most relevant to this planning effort include the following:

Goal 2: We will develop long-term capacity for biological planning and conservation design and apply it to drive conservation at broad, landscape scales:

- Objective 2.1: Access regional climate science and modeling expertise through regional climate science partnerships.
- Objective 2.2: Develop landscape conservation cooperatives to acquire biological planning and conservation design expertise.
- Objective 2.3: Develop expertise in and conduct adaptation planning for key species and habitats.
- Objective 2.4: Incorporate climate change in service activities and decisions.
- Objective 2.5: Provide requested support to state and tribal managers to address climate change issues that affect fish and wildlife service trust resources.

- Objective 2.6: Evaluate fish and wildlife service laws, regulations, and policies to identify barriers to and opportunities for successful implementation of climate change actions.

Goal 3: We will plan and deliver landscape conservation actions that support climate change adaptations by fish and wildlife of ecological and societal significance.

- Objective 3.1: Take conservation action for climate-vulnerable species.
- Objective 3.2: Promote habitat connectivity and integrity.
- Objective 3.3: Reduce non-climate change ecosystem stressors.
- Objective 3.4: Identify and fill priority freshwater needs.
- Objective 3.5: Conserve coastal and marine resources.
- Objective 3.6: Manage genetic resources.
- Objective 3.7: Reduce susceptibility to diseases, pathogens, and pests.
- Objective 3.8: Address fish and wildlife needs in renewable energy development.
- Objective 3.9: Foster international collaboration for landscape conservation.

The *Conserving the Future: Wildlife Refuges and the Next Generation* (2011) document is the Service's bold, new vision for the National Wildlife Refuge System. This 21st century strategic vision for the Refuge System acknowledges the broad social, political, and economic changes that have made habitat conservation more challenging since the agency last set comprehensive goals in 1999. In the intervening 12 years, the new vision states the Nation's population has grown "larger and more diverse . . . and the landscape for conservation has changed—there is less undeveloped land, more invasive species, and we are experiencing the impacts of a changing climate." The document includes 24 recommendations to guide the future of the National Wildlife Refuge System. The recommendation most relevant to this planning effort concerning climate change is:

- Recommendation 2: Develop a climate change implementation plan for the National Wildlife Refuge System that dovetails with other conservation partners' climate change action plans and specifically provides guidance for conducting vulnerability assessments of climate change impacts to refuge habitats and species as well as direction for innovation in the reduction of emissions and improved energy efficiency on federal lands.

State of Missouri

There is no climate change plan specific to Missouri available at this writing.

Missouri's Comprehensive Wildlife Strategy

Congress asked each state to develop a comprehensive wildlife strategy, later renamed wildlife action plan. These plans examine the health of wildlife and prescribe actions to conserve wildlife and vital habitat before they become rarer and more costly to protect. Using wildlife information gathered over the past 30 years, Missouri's comprehensive wildlife strategy promotes management that benefits all wildlife, rather than targeting single species. The strategy

identifies 33 Conservation Opportunity Areas in which management strategies will conserve both wildlife populations and the natural systems on which they depend. For each Conservation Opportunity Area, a team of partners developed a common vision of issues and actions. Six Conservation Opportunity Areas occur along the Missouri River: Upper Blue River, Wakenda Bottoms, Manitou Bluffs, Bonne Femme Karst, Missouri River Hills, and Missouri/Mississippi River Confluence.

Partners for Fish and Wildlife Program

At the heart of the Service's mission are the conservation and management of the Federal Trust Species: migratory birds; threatened and endangered species; inter-jurisdictional fish; certain marine mammals; and species of international concern. It is estimated that 73 percent of land in the United States and 93 percent of the land in Missouri is privately owned and that the majority of our fish and wildlife resources occur on those lands. Consequently, the conservation lands held by federal and state agencies and other conservation groups cannot completely provide for fish and wildlife needs. Because the habitat needs of all Trust Species cannot be met solely on public lands, public funds are also expended on private lands to accomplish habitat improvements through cooperative conservation programs such as the Partners for Fish and Wildlife Program (Partners Program).

The Partners Program provides technical and financial assistance to private landowners and tribes who are willing to work with the Service and other partners on a voluntary basis to help meet the habitat needs of the Service's Federal Trust Species. The Partners Program assists with projects in all habitat types, which conserve or restore native vegetation, hydrology, and soils associated with imperiled ecosystems. Locally based field biologists work one-on-one with private landowners and other partners to plan, implement, and monitor their projects. Partners Program field staff help landowners find other sources of funding and help them through the permitting process, as necessary. This level of personal attention and follow-through is a significant strength of the Partners Program that has led to national recognition and wide support.

The Partners Program is guided by a national policy (FWS 2003b) that identifies the following objectives:

- Promote and implement habitat improvement projects that benefit Federal Trust Species;
- Provide conservation leadership and promote partnerships;
- Encourage public understanding and participation; and
- Work with U.S. Department of Agriculture (USDA) to implement conservation programs.

The Big Muddy NFWR is engaged in a multi-partner cooperative conservation effort at the confluence of the Missouri and Mississippi Rivers. Partners include Audubon Missouri, The Nature Conservancy, The Trust for Public Land, the USACE – Riverlands Migratory Bird Sanctuary, Missouri Department of Conservation, Missouri Department of Natural Resources – State Parks Division, Great Rivers Habitat Alliance, Greenway Network, Ducks Unlimited, and numerous private waterfowl hunting clubs and citizens. The Service's Missouri Partners for Wildlife Office was instrumental in developing this partnership. This Public-Private partnership has leveraged funds and other resources to protect thousands of acres of land, develop

education and interpretation programs, and increase opportunities for wildlife oriented public use. Volunteers have planted thousands of trees and native prairie plants on public lands, including the Cora Island Unit of the Big Muddy NFWR, held invasive species eradication workdays, river cleanup events on public and private land, and held education events for the public. The confluence Partnership continues to have a positive influence in this important area.

Important Bird Areas

Important Bird Areas (IBAs) are sites that provide essential habitat for one or more species of bird. IBAs include sites for breeding, wintering, and/or migrating birds. IBAs may be a few acres or thousands of acres, but usually they are discrete sites that stand out from the surrounding landscape. IBAs may include public or private lands, or both, and they may be protected or unprotected.

To qualify as an IBA, a site must satisfy at least one of the following criteria. The site must support:

- Species of conservation concern (e.g., threatened and endangered species);
- Restricted-ranges species (species that are vulnerable because they are not widely distributed);
- Species that are vulnerable because their populations are concentrated in one general habitat type or biome; or
- Species, or groups of similar species (such as waterfowl or shorebirds), that are vulnerable because they occur at high densities due to their congregatory behavior.

Currently, three IBAs exist within or very close to the Missouri River floodplain between Kansas City and St. Louis. Some portions of these IBA's are part of the refuge.

Wetland Reserve Program

At one time, wetlands covered 4.8 million acres in Missouri. They began to decline in the late 1800s amid competing uses for the land. Today, 800,000 acres remain. The USDA's Wetlands Reserve Program (WRP), administered by the Natural Resources Conservation Service (NRCS), is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The goal of NRCS is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. Missouri was one of nine states to first enroll in the program and is one of the leading states in both number and area of easements enrolled. Currently, the State of Missouri has 994 wetlands easements covering 140,000 acres, much of which is concentrated in the Missouri River floodplain.

The Emergency Wetlands Reserve Program authorized in 1993 in response to major flooding throughout the Midwest provided payments to purchase easements and partial financial assistance to landowners who permanently restored wetlands at sites where restoration costs exceeded the land's fair market value. Land enrolled in this program is considered part of the WRP and accounts for the concentration of these lands along the Missouri River floodplain.

Conservation Reserve Program

The USDA's Conservation Reserve Program (CRP) protects millions of acres of United States' topsoil from erosion and is designed to safeguard the Nation's natural resources. By reducing water runoff and sedimentation, CRP protects ground water and helps improve the condition of lakes, rivers, ponds, and streams. Since an emphasis is placed on wetland and native prairie restoration as a condition of enrollment, the program has also become a major contributor to increased wildlife populations in many parts of the country. According to the USDA Farm Service Agency, the total acres enrolled in CRP within the 20 counties that contain the Missouri River floodplain in Missouri is just over 205,000. Carroll and Chariton Counties have the most CRPs currently enrolled, while St. Louis and Jackson Counties have the least.

Other Recreation and Conservation Lands in the Area

There are numerous tracts of public land managed by county, state and other federal agencies near the Big Muddy NFWR (figure 2-3). Several of the more prominent and representative areas are described below.

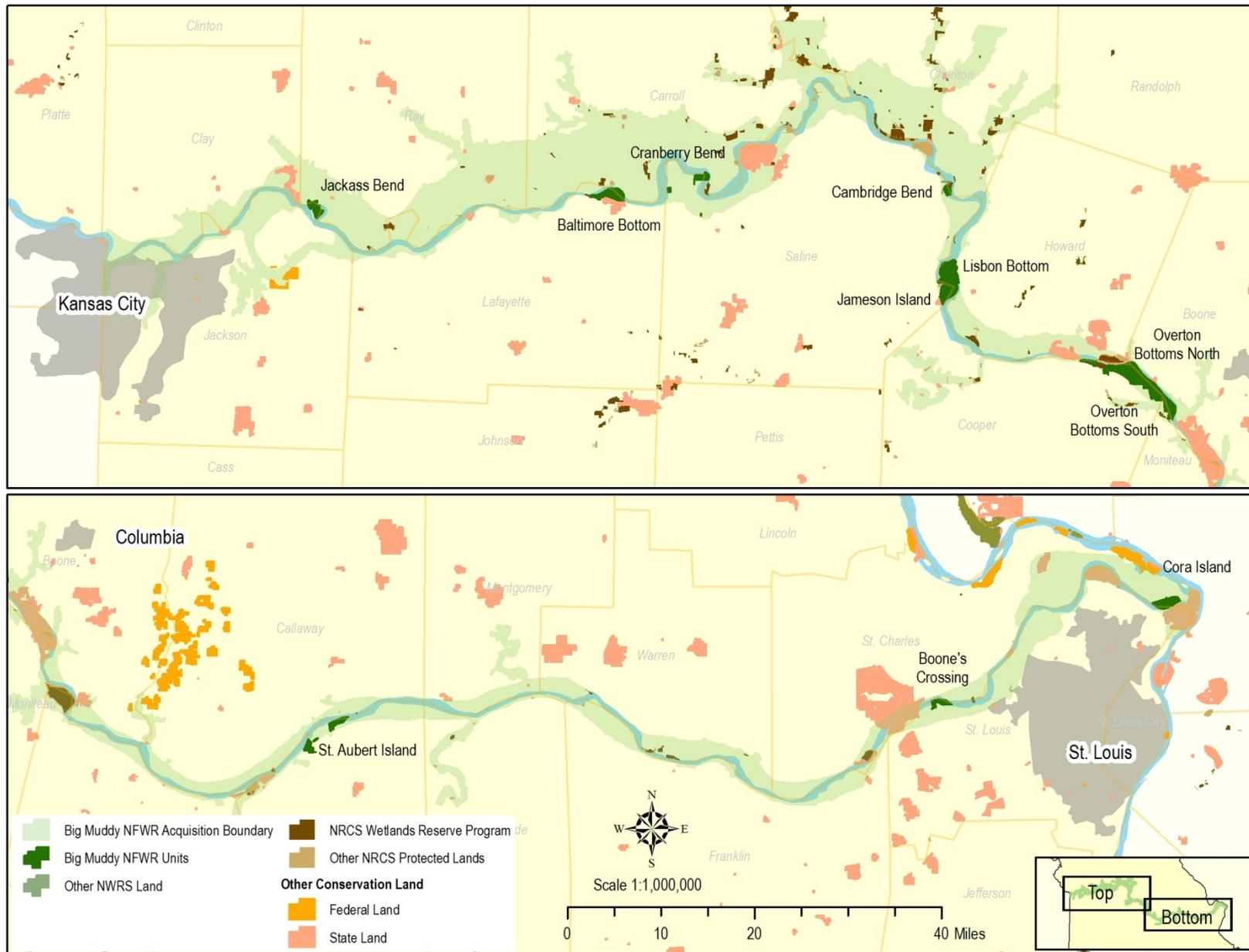
The Missouri Department of Conservation manages several large conservation areas in the Missouri River floodplain, including the Columbia Bottom Wildlife Area , 4,318 acres, on the south bank of the Missouri River at the confluence with the Mississippi. Columbia Bottom Wildlife Area boasts a visitor center, hiking trails, a boat ramp on the Missouri River, hunting programs and managed wetlands. The MDC also manages the Eagle Bluffs (4,269 acres) and Grand Pass (5,296 acres) Wildlife Areas in Boone and Saline Counties respectively. These two areas are intensively managed for waterfowl and waterfowl hunting. Other activities include fishing , hiking, wildlife observation and hunting species other than waterfowl. The Baltimore Bend Wildlife Area (1,192 acres) overlooks the Big Muddy NFWR Baltimore Bottom Unit. One of the refuge parking facilities and information kiosk is located on the MDC area.



Hunting at Overton; photo: Carol Weston

The Missouri Department of Natural Resources, State Parks Division, manages several large riverfront parks along the Missouri River. The Confluence State Park (1,100 acres) on the north bank of the Missouri River at the confluence with the Mississippi River is directly across the Missouri River from the MDC Columbia Bottom Wildlife Area and 1 mile downstream from the Big Muddy NFWR Cora Island Unit. The Katy Trail State Park runs along the Missouri River from near the confluence upstream to river mile 199, providing hiking and biking opportunities. The Arrow Rock State Park and Historic Site overlooks the Big Muddy NFWR Jameson Island Unit and is connected via a jointly managed interpretive hiking trail.

Figure 2-3: Other Recreation and Conservation Lands Near Big Muddy NFWR



The Planning Process

Public Involvement

Initial conversations about comprehensive planning for Big Muddy NFWR began mid-year of 2007 to review policy, discuss the core team, tour the refuge, and gather background information. The initial phase of the planning process—scoping—officially began on May 16, 2007 when a Notice of Intent to prepare a Comprehensive Conservation Plan (CCP) appeared in the Federal Register. Scoping, according to the Council on Environmental Quality Regulations for implementing National Environmental Policy Act (NEPA), is “*an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action.*”

In October 2007 Regional Office planners and refuge staff met to discuss likely planning issues, data needs, and to develop a draft version of the refuge vision and goals for public review. A planning team formed, made up of refuge staff, Regional Office planning staff, representatives from other programs within the Service, and representatives from MDC. Formal public scoping began in December 2007 with a series of public open houses held in seven communities along the Missouri River across the state. We announced the meetings via letters to those on the refuge mailing list, the Big Muddy NFWR planning web page, local media outlets, and email distribution lists. Collectively, more than 100 people attended the open house meetings and submitted dozens of comments. See table 2-3 for a summary of scoping and planning events.

Comments gathered during public scoping as well as comments from Service staff form the basis of a number of planning issues (see Planning Issues below). The planning team met with invited representatives from the Service, MDC, and USACE to discuss refuge management concerns and opportunities and develop a range of alternatives in response to the planning issues.

Table 2-3: Summary of Scoping and Planning Events

Date	Event
May 16, 2007	A Notice of Intent to prepare a CCP was published in the Federal Register marking the official start of the scoping process.
October 23, 2007	The planning team held a meeting with refuge staff to kick off the CCP process and collect comments on known issues and opportunities and develop a draft version of the refuge vision and goals.
December 3–6, 2007 December 12, 2007 January 14, 2008 January 15, 2008	A series of open house meetings occurred in the following Missouri communities: Columbia, Linn, Fayette, Arrow Rock, Chesterfield, Richmond, and Waverly.
February 5–7, 2008	A biological planning session that included representatives from the Service, Missouri Department of Natural Resources, Natural Resources Conservation Service, Missouri Department of Conservation, University of Missouri, and the U.S. Geological Service was held in Columbia, Missouri.
February 20, 2008	The planning team held a meeting in the Midwest Regional Office at Fort Snelling, Minnesota to collect additional comments from regional staff on issues and opportunities associated with the refuge.
September 13–15, 2011	The planning team, including representatives from the Service, MDC, and USACE met to develop alternatives.

Step-Down Management Plans

The CCP is a plan that provides general concepts and specific wildlife, habitat, and people-related objectives. Step-down management plans provide detail to managers and employees who will carry out the strategies described in the CCP. The refuge staff will develop the following step-down plans after completion of this CCP (table 2-4):

Table 2-4: Step-Down Management Plan Completion Time

Step-Down Management Plan	Amount of Time for Completion after CCP Approval
Habitat Management Plan(HMP)	2 years
Inventory and Monitoring Plan(IMP)	2 years
Visitor Services Plan (VSP)	1 year

Inventory, Monitoring, and Research

Following approval of the CCP and public notification of the decision, implementation will begin. Funding and staff time will be allocated to implementation of the CCP as appropriations and budgets allow. Development of a stepped down HMP and other plans (i.e., Visitor Services Plan) will begin and serve to guide habitat management, restoration and reconstruction priorities and public use. A companion IMP or additional chapters on inventory and monitoring appended to the HMP will be written to guide the refuge's priorities for monitoring. Information gained via inventories, monitoring or research activities will allow the station to evaluate its progress in achieving the planning unit purposes, vision, and goals. The associated step-down plans will address habitat and/or population objectives, and provide a means for evaluating the effects of management activities and public use. Through adaptive management, evaluation of monitoring and research results may indicate the need to modify refuge objectives or strategies.

Plan Review and Revision

The CCP provides guidance to the refuge manager and staff over the next 15 years. However, the CCP is also a dynamic and flexible document, and several of the strategies contained in this plan are subject to uncontrollable events of nature. Likewise, many of the strategies are dependent upon Service funding for staff and projects. For these reasons, the recommendations in the CCP will be reviewed annually and, if necessary, revised (FWS 2000c). The annual plan review process will include an evaluation of changing information and ecological conditions related to climate change. If significant changes are identified and comprise the refuge's purpose, vision, or goals, then the CCP will be revised. The CCP will be revised every 15 years, or sooner when significant new information becomes available, ecological conditions change, major refuge expansion occurs, or when determined necessary by the periodic review (FWS 2000c). All plan revisions will follow the Service's planning process and will be compliant with NEPA. Minor plan revisions that meet the criteria of a categorical exclusion will be handled in that manner; however, if the plan requires a major revision, then the CCP process starts anew at the preplanning step (FWS 2000c).

Planning Issues

Planning is a means to address issues. Issues associated with comprehensive conservation planning arise from both within and outside of the Service and are defined as any unsettled

matter, whether a problem or an opportunity, that requires a management decision. Public scoping as well as scoping of the Service's refuge and regional staff and other agencies took place and produced a wide range of individual comments. We grouped comments that were similar into 15 separate issues, each expressed below as a short statement or question along with a brief description or explanation.

We sorted the issues according to specific criteria. First, we evaluated each issue to see if it fit within the scope of the planning process and found three of the 15 were outside the scope. We identify those issues below along with an explanation of their exclusion. Next, we reviewed the remaining issues and sorted them into two categories: 1) driving issues: those that suggested a range of possible changes in management, and 2) non-driving issues: those that did not suggest a range of possible changes in management. This produced eight driving issues, which we consolidated into three groups: Land and Water Conservation, Visitor Services and Refuge Administration, and Conservation Footprint. These final three issue groupings are the basis for the planning alternatives. We considered the non-driving issues throughout the planning process, but addressed them the same way under each alternative.

Issues outside the Scope of the Planning Process

Issue

There are both support and opposition to further land acquisition by the refuge.

Explanation

This issue is beyond the scope of this planning process and not considered further, because a previous planning process that included public scoping and review determined the amount of land authorized for acquisition from willing sellers. A 1999 ROD for the Big Muddy NFWR FEIS approved expansion of the refuge for up to 60,000 acres for restoration and preservation efforts to reconnect the floodplain to the Missouri River.

Issue

Federal payments to states do not always fully offset loss of tax revenue resulting from federal ownership.

Explanation

This issue is beyond the scope of this planning process and not considered further because Congress, not the Service, ultimately determines federal payments to states. The Refuge Revenue Sharing Act is the law that governs federal payments to states to offset loss of tax revenue for lands acquired by the Service. The net income the Service receives from products or privileges—like timber sales, grazing fees, and right-of-way permit fees—from all acquired lands is deposited in the National Wildlife Refuge Fund for revenue sharing payments. If there is not enough money in the National Wildlife Refuge Fund to cover the payments, Congress is authorized to appropriate money to make up the difference. If the amount Congress appropriates is not enough, the units of local government receive a pro-rata share.

Issue

The annual flow regime of the Missouri River affects refuge resources and the ability to fulfill refuge purposes and other conservation priorities.

Explanation

This issue is beyond the scope of this planning process and not considered further, because the factors that affect Missouri River flow are not under refuge control. In the typical pre-

development Missouri River flow regime, a flood pulse resulted from rain and melting snow runoff, first in March from the Great Plains and then during late June from the Rocky Mountains. Flows declined through the summer and fall reaching their low point in late December. Native fish and wildlife evolved with this historical flow regime and depend on it to meet their different seasonal habitat and reproductive needs. Today a spring flood pulse is suppressed via reservoir storage, while dam releases provide higher river flows from July through November, eliminating summer/fall low-water flows. Seasonally inundated backwaters and wetlands historically provided food and habitat for native river fishes. The suppression of high spring flows has prevented recharging of these areas, reduced nutrient cycling and transport and accessibility to floodplain and nursery habitats for fishes. In relation to pre-development conditions, few high elevation sandbars form because of the suppression of high flows which are necessary to create them. Sandbars that do remain become covered with unwanted vegetation, because the scouring flows needed to clear them are unavailable. Native fish spawning cues once triggered by increasing water temperatures coupled with rising river stages have been lost within many river reaches.

Issues that Drive Alternatives

Driving issues are those that suggest a range of possible changes to refuge management and are the basis for alternative development. The driving issues appear under three headings:

- Land and Water Conservation
- Visitor Services and Refuge Administration
- Conservation Footprint

Land and Water Conservation

Issue

What types and intensities of habitat management should be used to help fulfill refuge purposes, the mission of the NWRS, and/or other conservation priorities?

Description

Historically, forested, grassland, and wetland habitats occurred along the Missouri River. Service policy supports maintaining and restoring native habitats, and there are opportunities to do so on the refuge. A number of comments supported passive management of refuge habitats, which require little or no direct human intervention. Such management requires less financial investment, but today the outcome of passive management is likely to be much different than what occurred before the floodplain was changed by river modifications, levees, and conversion of native habitats to agriculture. Another challenge is that natural disturbances such as fires and floods that played an important role in maintaining Missouri River habitats are now diminished or absent. Human intervention through active management, requires greater financial investment, but attempts to deliver a specific result. It includes actions such as tree cutting, prescribed fire, and plantings to restore native habitat as well as other actions such as moist soil management or growing crops. There were a number of comments that supported a variety of forms of active management. Any habitat management activity must help fulfill refuge purposes, the mission of the Refuge System, as well as other conservation priorities.

Issue

How should the refuge deal with invasive species?

Description

Invasive species are non-native species that if introduced into a system cause or are likely to cause environmental and economic harm or harm to human health. Invasive species often displace native species and alter ecosystem processes and the services they deliver. There are a number of invasive species already present on the refuge. Service policy supports maintaining and restoring where appropriate, biological integrity, diversity, and environmental health. An integrated approach to invasive species management will be utilized. This will include conducting inventory, use of a suite of control measures, establishing native species by seeding or planting, monitoring and follow up control and planting measures as determined using the best information available. Control measures could include mechanical methods, prescribed fire, chemical application, biological control, herbivores, altering hydrology or other methods. Adaptive management principles will be applied.

Issue

How does the refuge restore Missouri River floodplain dynamics in the face of social and political conflicts?

Description

Historically, a shifting, braided channel and abundant sandbars without vegetation characterized the Missouri River. The shifting channel provided a wide variety of hydraulic environments and a large quantity of connected and non-connected off-channel water bodies. Beginning in the early 1800s and continuing to the present, the channel of the lower Missouri River has been trained into a fast, deep, single-thread channel. Wing dikes now concentrate the flow, and revetments and levees keep the channel in place and disconnect it from the floodplain. While changes to the Missouri River have resulted in broad social and economic benefits, they have also been associated with degradation of river-corridor habitats and diminished populations of native fish and wildlife species. Much of the work on the refuge is directed at restoring river processes lost through the intensive management of the Missouri River for navigation and flood control. The refuge in conjunction with other Missouri River stakeholders continues to seek ways to restore some natural ecosystem benefits without compromising traditional economic uses of the river and floodplain. These river restoration activities are sometimes slowed by conflicts that are difficult to resolve.

Issue

How can we learn more about refuge ecosystems and assess the results of refuge management actions?

Description

Sustaining wildlife populations is central to the mission of the Refuge System, but in many cases information is sparse or absent for existing resources, fish and wildlife populations, and effects of management activities and public uses. This hampers managers' ability to adapt habitat management practices or modify public uses in ways that best sustain wildlife numbers. There is an opportunity to consider how to direct inventory, monitoring, and research activities to increase learning and help adapt subsequent management activities.

Visitor Services and Refuge Administration

Issue

How should the refuge address the demand for a range of recreation experiences, wildlife-dependent recreation opportunities, other public uses, and facilities?

Description

Service policy directs that where possible national wildlife refuges provide opportunities for six wildlife-dependent public uses: hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation. Zoning of these uses in both duration and extent helps avoid conflicts between user groups. A number of comments supported increasing the duration, available area, or amount of facilities for one or more of the existing uses. Others suggested allowing additional uses. Any use permitted on the refuge must be found compatible in accordance with Service policy.

Issue

How and where should the refuge allocate its resources for administering land and water conservation, visitor services, maintenance, and monitoring?

Description

Resource management opportunities and visitor demands vary along the length of the Missouri River where the refuge is authorized to acquire land. At present, resource management and visitor services are similar at each of the 11 existing refuge units. The number of units is likely to increase over the next 15 years and staff responsibilities along with it. There is an opportunity to consider the amount, intensity, and delivery of management, services, and related activities at current and future refuge units.

Issue

How should the refuge involve and coordinate the numerous communities, jurisdictions, authorities, governing bodies, and landowners that affect refuge management or are affected by refuge management?

Description

A wide range of stakeholders have interest in the refuge and the Missouri River floodplain. Some refuge activities are of widespread interest while others are more localized. Identifying the level of interest and ensuring communication and coordination among all relevant parties is an ongoing challenge.

Conservation Footprint

Issue

How should the refuge determine the total number, individual size, and location of refuge units?

Description

Presently, there are 11 refuge units: Jackass Bend, Baltimore Bottom, Cranberry Bend, Cambridge Bend, Jameson Island, Lisbon Bottom, Overton Bottoms North, Overton Bottoms South, St. Aubert Island, Boone's Crossing, and Cora Island. The 1999 FEIS for the expansion of the refuge estimates that the 60,000 acres approved for acquisition could be partitioned into 20 to 30 different sites. A number of criteria documented in the 1998 Interim Comprehensive Management Plan guide additions to the conservation footprint of the refuge.

Non-Driving Issues Considered

Non-driving issues are those that suggest a single course of action. These issues do not form the basis of alternatives but instead are addressed the same across all alternatives. It is important to note that this planning process covers the entire acquisition area, and these issues

did not drive alternatives at this scale. Any or all of the non-driving issues may become driving issues in subsequent smaller scale planning efforts.

Issue

How does the refuge fulfill its purposes, the Refuge System mission, and other conservation priorities in the face of the uncertainties associated with climate change?

Description

Climate change is an immense, serious, and sobering challenge—one that will continue to affect fish and wildlife profoundly. Despite tremendous advances in our understanding of climate change over the past decade, there remains considerable uncertainty about the magnitude, extent, and timing of climate changes that will occur in any given geographic area. Likewise, there remains considerable uncertainty as to how climate change will interact with non-climate factors to cause ecological changes at different scales. One of the major challenges inherent in addressing the effects of climate change on fish and wildlife will be identifying and accounting for this uncertainty as we design, implement and evaluate decisions, as well as management and monitoring programs.

Issue

How should the refuge administer and manage widely scattered easements?

Description

Refuge staff members are responsible for managing eight easements scattered across five Missouri counties. The easements were transferred to the Service from the Farm Services Administration. Present workforce capacity and long travel distances limit the amount of attention these properties currently receive.

Issue

Should rare or unique refuge habitats be nominated for designation as Missouri Natural Areas?

Description

Some refuge habitats are among the last remnants of natural communities within the state and may qualify as Missouri Natural Areas. Natural areas are defined as natural communities or geologic features that represent the natural character, diversity, and ecological processes of Missouri's native landscapes. Natural communities are groups of plants and animals and the landscapes, such as forests or prairies, that they inhabit—and that occur repeatedly throughout the state.

Issue

How should the refuge identify and protect cultural resources?

Description

There are known cultural resource sites, and likely many undiscovered sites, within the refuge and the acquisition area where future refuge lands may occur. The National Historic Preservation Act as well as other laws and regulations require the Service to avoid disturbing cultural resource sites and to work in coordination with the State Historic Preservation Officer.

Chapter 3: Management Alternatives

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[Selecting the Preferred Alternative](#)

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[Elements Common to All Alternatives](#)

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[Alternatives Considered but not Analyzed in Detail](#)

[Summary of Environmental Consequences](#)

Introduction

This chapter describes and compares three management alternatives for Big Muddy National Fish and Wildlife Refuge (NFWR, refuge): the No Action alternative, which is the continuation of the current management direction; and two action alternatives including Alternative C, the preferred alternative. Each of the three alternatives describes general management direction for the entire 820,000-acre planning area. The general direction contained in each alternative covers both existing and future units of the refuge. It is separate from site-specific direction, which is not part of this planning process, but which will occur in subsequent step-down management planning. The No Action alternative is the baseline for analysis. The descriptions of the action alternatives as well as their environmental consequences are relative to those of the No Action alternative. The preferred alternative is the one identified by the U.S. Fish and Wildlife Service (FWS, Service) as best meeting the purpose and need described in chapter 1.

This chapter also defines the differences between the alternatives including a summary of their environmental consequences (table 3-2, at the end of this chapter), which are covered in detail in chapter 4. Alternatives are different approaches or combinations of management objectives that achieve the refuge's purpose, fulfill the National Wildlife Refuge System (NWRS, Refuge System) mission, achieve the refuge vision and goals, maintain and restore ecological integrity, and meet other legal mandates. In addition to these requirements, alternatives address the planning issues identified by the Service and the public during scoping (see chapter 2). Each alternative is a potential Comprehensive Conservation Plan (CCP) that could be implemented if selected.

Development of the Management Alternatives

The planning team fully developed two alternatives in addition to the No Action alternative using the following process:

We invited representatives from Service programs, the U.S. Army Corps of Engineers (USACE), and the Missouri Department of Conservation (MDC) to participate in a workshop to develop management alternatives. Small groups worked independently to assess and respond to each of the three driving issues (Planning Issues in chapter 2). Each group received maps of the planning area, a summary of the planning issues, a summary of an earlier workshop on biological resources, and instructions to consider the entire planning area, which encompasses the 11 existing refuge units as well as potential future units. Following the workshop, members of the planning team compiled the results in the form of a survey and solicited responses from those invited to the workshop (see Appendix J: Alternatives Survey).

The survey responses in conjunction with information produced at the workshop formed the basis for the range of alternatives. The three alternatives represent different approaches to the protection, restoration, and management of the refuge's fish, wildlife, plants, habitats, and other resources as well as to compatible wildlife-dependent recreation. We considered one other alternative, but did not develop it in detail.

Selecting the Preferred Alternative

In selecting a preferred alternative, we considered environmental, economic, and social factors and our ability to implement the actions necessary to accomplish the alternatives. We based our decision on how well each alternative met the goals of the refuge and the environmental consequences of each alternative (see Chapter 4: Refuge Environment, Current Management, and Environmental Consequences). We selected Alternative C as our preferred alternative. Alternative C will fulfill our statutory mission and responsibilities, and we have adequate authority to implement it.

Summary of the Alternatives

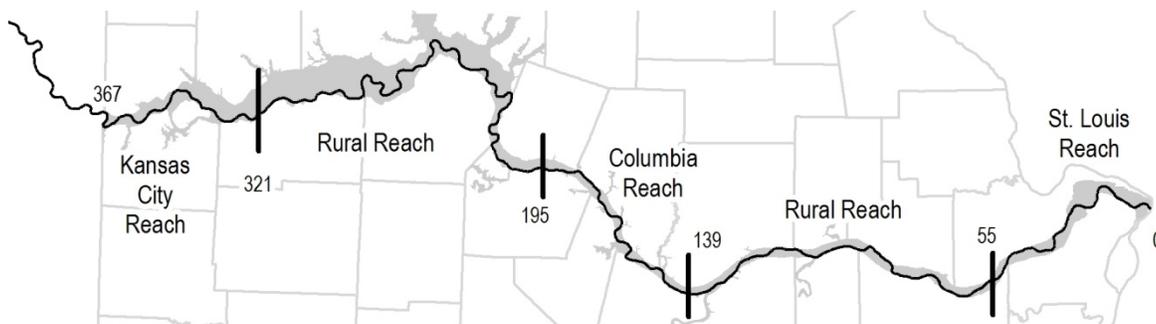
The three alternatives describe different combinations of eight objectives for land and water management and visitor services and facilities across five reaches of the Missouri River floodplain. The eight objectives fall into two distinct categories: standard objectives and supplemental objectives. Each of the two standard objectives describes a baseline condition—the specific actions associated with these objectives that would occur on all refuge units regardless of their location within the planning area. In contrast, each of the six supplemental objectives describes an upper level of management or development. The specific action or actions listed for each supplemental objective are included to help describe the upper limit that could occur, but the inclusion and combination of supplemental objectives varies by river reach and by alternative. Many of the actions listed as part of these objectives would require additional site level planning.

Table 3-1 displays the combination of objectives for each of the three alternatives considered in this Environmental Assessment.

Figure 3-1 displays the Big Muddy NFWR Planning Area river reaches.

Table 3-1: Summary of Alternatives

Objective	Alternative A (Current) no reach emphasized				Alternative B Columbia Reach emphasized				Alternative C (Preferred) Columbia and St. Louis Reaches emphasized			
	Reaches				Reaches				Reaches			
	Rural	Columbia	St. Louis	Kansas City	Rural	Columbia	St. Louis	Kansas City	Rural	Columbia	St. Louis	Kansas City
Standard objectives. These <i>would</i> occur on all refuge units.												
Standard Land and Water Management includes: - Restore hydrology to Missouri River and its tributaries (where applicable) - Reconnect floodplain to the Missouri River and major tributaries - Maintain or return to natural cover types (primarily refers to conversion of cropland to cover types such as forest or grassland, mostly through ecological succession) - Manage invasive species	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Standard Services and Facilities includes: - Reasonable car access* - Reasonable boat access* - Kiosks - Parking (in areas with vehicle access)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Supplemental objectives. Items listed under the objectives below <i>could</i> occur on one or more refuge units within the indicated reaches dependent on subsequent site-specific planning.												
Supplemental Land and Water Management <i>could</i> include: - Active management to achieve a particular cover type at a specific location to improve conditions for one or more species of fish and wildlife.	Y	Y	Y	Y	-	Y	-	-	-	-	-	-
Supplemental Services and Facilities <i>could</i> include: - Interpretive displays and other self-guided interpretation - Restrooms - Trails - Overlooks - Wildlife observation facilities - Maintenance center (shop)** - Environmental education site	Y	Y	Y	Y	-	Y	-	-	-	Y	Y	-
Administrative Center (Refuge Office): See appendix L for more details - Allows for the option of a structure located on refuge holdings to serve as the primary administrative center of the refuge. It would include offices and may also include a visitor contact station, an area of the structure dedicated to visitor services.	-	Y	-	-	-	Y	-	-	-	Y	-	-
Outreach and Collaboration - Collaboration (building relationships to deliver conservation) - Outreach (building public understanding and support)	-	-	-	-	-	Y	-	-	-	Y	Y	-
Programming: Allows for staff-led or volunteer-led programming - Environmental education programs - Interpretive programs and other guided interpretation	-	-	-	-	-	Y	-	-	-	Y	-	-
Study and Learning - Biological inventory - Monitoring - Research	-	-	-	-	-	Y	-	-	-	Y	Y	-
*Reasonable car access typically includes at least one maintained road that abuts or enters a refuge unit and developed parking for at least six vehicles. All current and future refuge units are located along the Missouri River and considered to have reasonable boat access. Some existing refuge units feature modest developed boat accesses but others are up to 15 river miles from a boat access point. This variation in boat access distance is expected to be similar on future refuge units.												
**Typically includes at least two service bays, a vehicle lift, and a third bay for storage with an office area and a storage area.												

Figure 3-1: Big Muddy NFWR Planning Area River Reaches Delineated by River Miles

Elements Common to All Alternatives

Some elements are common to all of the alternatives and are described separately for the driving issues and non-driving issues.

Driving Issues

Each alternative describes management direction associated with five reaches of the Missouri River floodplain. Delineation of the five river reaches is the same under all alternatives. Likewise, the practices and elements described for Standard Land and Water Management and Standard Services and Facilities would occur on all current and future refuge units regardless of river reach.

Conservation Footprint Issue

The response to the conservation footprint issue described in chapter 2 is the same under each alternative and does not vary by river reach. The three primary components of the issue are the size, location, and total number of refuge units. The size and number of refuge units are addressed in the 1999 Record of Decision (ROD) and Final Environmental Impact Statement (FEIS) for Big Muddy NFWR. It expanded the total area authorized for acquisition from 16,628 acres to 60,000 acres, indicating between 20 and 30 individual units of 800 acres or more, although smaller units are possible for biologically important sites or those that meet other resource needs. The FEIS includes a set of criteria to help evaluate individual tracts of land. Using the criteria along with input from participants of the CCP alternatives workshop, a computer model was built to help assess the relative value of available tracts. The model is more fully described in appendix K. The model and its output will change as the model evolves to accommodate additional inputs, revised data, and Service priorities.

The 1999 FEIS does not specify location or distribution of refuge units. This is because many more than 20 to 30 locations within the acquisition area are suitable, and because the refuge acquires land only from willing sellers. For the same reasons, this planning process does not identify the location and distribution of future refuge units. Nevertheless, there is one indicator of potential refuge units—USACE mitigation sites. USACE acquires lands along the Missouri River as mitigation for loss of fish and wildlife habitat from past channelization efforts. In many cases, after completing mitigation work, USACE turns over management of mitigation lands to other agencies, including the Service. A number of existing refuge units originated or expanded when the Service assumed management of mitigation sites through lease agreements with USACE. The Service often adds to these units with additional acquisitions from willing sellers. Although existing USACE mitigation lands (figure 3-2) are an indicator of future refuge units, not all mitigation lands within the refuge acquisition boundary will become refuge units. The refuge

may also establish units unrelated to USACE-acquired mitigation lands. Because the refuge manages lands acquired by USACE in addition to lands acquired as part of the Big Muddy NFWR, the total acres managed by the refuge could eventually exceed the total acres authorized for the refuge (60,000 acres).

Figure 3-2: USACE Mitigation Sites within Big Muddy NFWR Acquisition Boundary



USACE and Big Muddy NFWR

The 1999 ROD for the Big Muddy NFWR FEIS expanded the total area authorized for acquisition from 16,628 acres to 60,000 acres. This complemented similar land acquisition efforts by USACE and MDC with the collective goal of restoring as much as 20 percent of the 820,000-acre Missouri River floodplain between Kansas City and St. Louis, MO. In addition to the 60,000 acres for the Refuge, the USACE was to acquire 14,600 acres and MDC 20,000 acres. The MDC acreage goal remains at 20,000 acres, but the USACE acreage goal has changed.

The USACE land acquisition goal is part of a larger mitigation goal authorized by Congress for loss of fish and wildlife habitat from past channelization of the Missouri River. In 1986, Congress authorized the original mitigation goal at 48,100 acres apportioning it between existing public lands (18,200 acres) and lands USACE was to acquire (29,900 acres) within Missouri, Kansas, Iowa, and Nebraska. In a 1987 ROD accompanying the Missouri River Bank Stabilization and Navigation Feasibility Report and FEIS for the Fish and Wildlife Mitigation Plan USACE further allocated the land acquisition goal across the four states. Originally, the Missouri portion of the 29,900-acre land acquisition goal was 14,600 acres but later changed to 13,200 acres (USACE 1981; USACE 2002).

In 1999, Congress increased the total amount of mitigation required of USACE from 48,100 acres to 166,750 acres, which prompted a supplement to the original Environmental Impact Statement. The ROD for the supplemental Environmental Impact Statement allocates the additional 118,650 acres among the four states, but foregoes specifying separate targets for land acquisition and work on existing public lands, instead allowing accomplishment of the supplemental acres through any combination of the two methods (USACE 2003). The Missouri portion of the supplemental mitigation is 75,791 acres. Lands acquired and restored by USACE within Missouri may later be managed by the Refuge through an agreement with USACE.

Non-Driving Issues

Climate Change

The response to the climate change issue is the same across all alternatives. Each alternative is a potential CCP and as such provides overarching management direction for current and future refuge units but does not identify site-specific actions in response to climate change. Restoring nodes of fish and wildlife habitat along the Missouri River is the primary function of the refuge and does increase habitat connectivity and integrity, one of the objectives of the Service's strategic plan for addressing climate change. Specific measures to address climate change will occur through subsequent step-down planning.

Easement Management Issue

The Big Muddy NFWR is authorized to utilize easements as a land protection tool. Due primarily to a lack of interest by the public in selling easements, the Big Muddy NFWR has not acquired any easements for the refuge. The Big Muddy NFWR is responsible for administering approximately eight USDA–Farm Service Agency-acquired conservation easements. Region 3 of the Service recently completed the “Region 3 Easement Management and Enforcement Manual.” This manual provides guidance for management and enforcement issues of all types of easements administered by the Service in Region 3.

Missouri Natural Areas Issue

The Missouri Natural Areas Committee has discussed the highly altered big river environments in Missouri, including the Missouri River. The committee also visited several units of the Big Muddy NFWR. The consensus was that due to the highly altered condition of the river, no reaches of the Missouri River would currently qualify for serious consideration for inclusion in the Missouri Natural Areas System. As change occurs over time, habitats could evolve to the point where consideration for inclusion of a section of the Big Muddy NFWR would be revisited. Inclusion of a section of the Big Muddy NFWR into the Missouri Natural Areas System remains a possibility at a later date.

Cultural Resources Issue

The Service is charged with the responsibility, under Section 106 of the National Historic Preservation Act of 1966, of identifying historic properties (cultural resources that are potentially eligible for listing on the National Register of Historic Places) that may be affected by our actions. The Service is also required to coordinate these actions with the State Historic Preservation Office, Native American tribal governments, local governments, and other interested parties. See chapter 4 for additional discussion of cultural resource management.

Alternative A: Current Management (No Action)

Alternative A is the No Action alternative. The National Environmental Policy Act and Service planning policy each require consideration of a No Action alternative. Throughout this document, the term “no action” means the proposed action would not occur; that is, management of refuge habitats and visitor services would continue under current management direction without a CCP. Under Alternative A, current management direction would continue to apply to all existing refuge units, not river reaches,

although throughout this document we show river reaches for Alternative A to improve comparison with the other alternatives.

Under Alternative A, all present and future refuge units would receive the management described by the standard objectives for land and water management and visitor services. That is, where applicable, the Missouri River and its major tributaries would be reconnected to their floodplains and their hydrology restored. The sites would be returned to natural cover types and invasive species would be managed. Reasonable car and boat access, parking, and information kiosks would be available at all units. See table 3-1 and appendix A for a description of reasonable car and boat access.

Supplemental objectives that allow for additional land and water management and visitor services and facilities would also apply to all current and future units. Supplemental objectives describe an upper limit to management or development. Typical actions that could occur under supplemental objectives include self-guided interpretation facilities, restrooms, trails, overlooks, wildlife observation facilities, maintenance shop, or environmental education site. Not all actions would occur at every refuge unit and the location of these specific actions would occur opportunistically with no emphasis on any particular refuge unit or river reach.

Finally, the refuge would continue to have one administrative center (refuge office) located in Columbia, MO. Of the three alternatives, Alternative A would distribute refuge resources (staff and funds) most broadly within the planning area.

Alternative B

Alternative B is the first action alternative considered. Under Alternative B, the inclusion and combination of objectives varies by river reach with an emphasis on the Columbia Reach.

All River Reaches

Standard objectives for land and water management and visitor services and facilities would apply to all five river reaches. That is, where applicable, the Missouri River and its major tributaries would be reconnected to their floodplains and their hydrology restored. Each unit also would be returned to natural cover types and invasive species would be managed. Reasonable car and boat access, parking, and information kiosks would also be available at all units. See table 3-1 and appendix A for a description of reasonable car and boat access.

Columbia Reach

Within the Columbia Reach, all six supplemental objectives would also apply (table 3-1). Supplemental objectives describe an upper limit to management or development and allow for but do not ensure a range of additional actions. The following list, also shown in table 3-1, displays the potential actions that could occur within the Columbia Reach under the six supplemental objectives. These objectives would apply to all current and future refuge holdings within the Columbia Reach, but not all actions listed would occur at every refuge unit within the Columbia Reach.

This outlines the highest level of potential land and water management and visitor services for a single river reach of any of the three alternatives. Under this alternative, there would be less emphasis on existing and future refuge holdings within the St. Louis Reach, Kansas City Reach, and both Rural Reaches. No supplemental objectives would apply to these reaches.

Of the three alternatives, Alternative B would distribute refuge resources (staff and funds) most narrowly within the planning area.

Supplemental Land and Water Management *could* include:

- Active management to achieve a particular cover type at a specific location to improve conditions for one or more species of fish and wildlife

Supplemental Services and Facilities *could* include:

- Interpretive displays and other self-guided interpretation
- Restrooms
- Trails
- Overlooks
- Wildlife observation facilities
- Maintenance center (shop)—A typical Service facility includes at least two service bays, a vehicle lift, and a third bay for storage with an office area and a storage mezzanine
- Environmental education site

Administrative Center (Refuge Office):

- Allows for the option of a structure located on refuge holdings to serve as the primary administrative center of the refuge. It would include offices and may also include a visitor contact station, an area of the structure dedicated to visitor services. See appendix L for additional information.

Outreach and Collaboration:

- Collaboration (building relationships to deliver conservation)
- Outreach (building public understanding and support)

Programming:

- Allows for staff-led or volunteer-led programming
- Environmental education programs
- Interpretive programs and other guided interpretation

Study and Learning:

- Biological inventory
- Monitoring
- Research

Alternative C: Preferred Alternative

Alternative C is the second action alternative considered and is the preferred alternative. Under Alternative C, the inclusion and combination of objectives varies by river reach with an emphasis on both the Columbia Reach and the St. Louis Reach.

All River Reaches

Standard objectives for land and water management and visitor services and facilities would apply to all five river reaches. That is, where applicable, the Missouri River and its major tributaries would be reconnected to their floodplains and their hydrology restored. Each unit also would be returned to natural cover types and invasive species would be managed. Reasonable car and boat access, parking, and information kiosks would also be available at all units. See table 3-1 and appendix A for a description of reasonable car and boat access.

Under Alternative C, there would be no supplemental land and water management activities.

Columbia Reach and St. Louis Reach

Three of the six supplemental objectives would apply within both the Columbia and St. Louis Reaches (table 3-1). Again, supplemental objectives describe an upper limit to management or development and allow for but do not ensure a range of additional actions. The following list, also shown in table 3-1, displays the potential actions that could occur within the Columbia and St. Louis Reaches under the three supplemental objectives that would apply to both reaches (see additional information for Columbia Reach below). These objectives would apply to all current and future refuge holdings within the Columbia and St. Louis Reaches, but not all actions listed would occur at every refuge unit within each of the reaches.

Supplemental Services and Facilities *could* include:

- Interpretive displays and other self-guided interpretation
- Restrooms
- Trails
- Overlooks
- Wildlife observation facilities
- Maintenance center (shop)—A typical Service facility includes at least two service bays, a vehicle lift, and a third bay for storage with an office area and a storage mezzanine
- Environmental education site

Outreach and Collaboration:

- Collaboration (building relationships to deliver conservation)
- Outreach (building public understanding and support)

Study and Learning:

- Biological inventory
- Monitoring
- Research

Columbia Reach

Two supplemental objectives regarding the potential for a refuge office and programming shown below and in table 3-1, would apply only to the Columbia Reach.

Administrative Center (Refuge Office):

- Allows for the option of a structure located on refuge holdings to serve as the primary administrative center of the refuge. It would include offices and may also include a visitor contact station, an area of the structure dedicated to visitor services. See appendix L for additional information.

Programming:

- Allows for staff-led or volunteer-led programming
- Environmental education programs
- Interpretive programs and other guided interpretation

This alternative describes a mid-level of potential land and water management and visitor services, concentrated on two of the five river reaches rather than evenly distributed (Alternative A) or concentrated on a single river reach (Alternative B). There would be less emphasis on existing and future refuge holdings within the Kansas City Reach and both Rural Reaches. No supplemental objectives would apply to these reaches. Alternative C would distribute refuge resources (staff and funds) more narrowly than Alternative A but more widely than Alternative B.

Alternatives Considered but not Analyzed in Detail

We considered an additional alternative that emphasized all three urban reaches (Kansas City, Columbia, and St. Louis) of the Missouri River floodplain but did not fully develop the alternative because of the amount of resources required to implement the alternative. Emphasizing all three urban reaches would require staff and funding resources in excess of those presently available or anticipated to occur over the 15-year planning period.

Summary of Environmental Consequences

The following table compares and contrasts the various environmental effects that are expected to result from implementation of the three alternatives. The environmental consequences of each impact topic were defined on the basis of type of effect, duration, intensity, and context for the following resources: Climate Change, Soil Resource, Water Resources, Air Quality, Vegetation, Ecosystems, Wildlife,

Socioeconomics, Visitor Services, and Cultural Resources. Further description of the effects can be found under each resource in chapter 4.

Type refers to an effect being either *adverse* or *beneficial* for the topic being analyzed. Some resources may not be affected by a given activity; therefore, the type of effect is *none*. Effects also can be direct or indirect. Direct effects are caused by an action and occur at the same time and place as the action. Indirect effects are caused by the action and occur later or farther away, but they still are reasonably foreseeable.

Duration refers to how long an impact would last. The planning horizon for this plan is approximately 15 years. Unless otherwise specified, in this document the following terms are used to describe the duration of the impacts: *Short-term*: The effect would be temporary, lasting only while the management activity is occurring. *Medium-term*: The effect would be temporary, lasting less than the life of this plan. *Long-term*: The effect is expected to persist beyond the life of this plan.

Intensity refers to the degree or magnitude to which a resource would be positively or negatively affected. Each effect was identified as *negligible*, *minor*, *moderate*, or *major* in conformance with the criteria for the classifications established for each impact topic. Because this is a programmatic document, the intensity of each effect typically is expressed qualitatively. Further definitions and indicators for intensity by resource can be found in chapter 4. The planning team qualitatively evaluated the intensities of effects on all the resources.

Context refers to the setting within which an effect is analyzed, such as the affected region or locality. In this document most effects would be either *local* (site-level where the action is occurring) or *landscape* (planning area wide or larger)

Chapter 4: Refuge Environment, Current Management, and Environmental Consequences

In this chapter:

[Introduction](#)
[Physical Environment](#)
[Habitat](#)
[Wildlife](#)
[People](#)

Introduction

This chapter describes the existing physical, biological and social environment of the Big Muddy National Fish and Wildlife Refuge (NFWR, refuge) and its surroundings. Much of this environment will be affected, positively or negatively, by implementing any of the previously mentioned management alternatives. The consequences of those effects are also analyzed in this chapter.

Physical Environment

Geographic Setting

The Missouri River is the longest river in the United States (2,355 miles) and one of the Nation's most developed. Its basin extends across portions of ten states in the Midwest and Great Plains and covers roughly one-sixth of the continental United States (figure 4-1). Basin states include Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, and Missouri. Until the mid-twentieth century, the main stem Missouri River freely migrated back and forth across its wide floodplain. The shallow river assumed a braided pattern in some areas, with no single, distinct river channel. Before construction of river engineering structures in the 20th century, the Missouri was well known for its frequent floods, some of them severe.



The "Big Muddy"; photo: Steve Hillebrand

In its uppermost reaches, the river runs through canyons and rugged mountain terrain and is a clear mountain stream with a valley less than 780 feet wide (National Research Council [NRC] 2011). Downstream, the Missouri's tributaries flow through highly erodible soils, adding the heavy sediment loads to the river which played a major role in shaping its ecology and biological systems and led to it being called "The Big Muddy."

Figure 4-1: Missouri River Watershed

Local Context

The planning area is the same as the refuge acquisition boundary. It includes the Missouri River floodplain and lower 10 miles of major tributaries from river mile 367.5 at the confluence with the Kansas River to river mile 0 at the confluence with the Mississippi River. The river between Kansas City and Glasgow, MO meanders through a floodplain up to ten miles wide. From Glasgow to St. Louis the floodplain narrows to an average width of just two miles as bedrock bluffs bound the river.

Current Management

The geographic setting of the refuge and its surroundings cannot be managed.

Effects on Geographic Setting

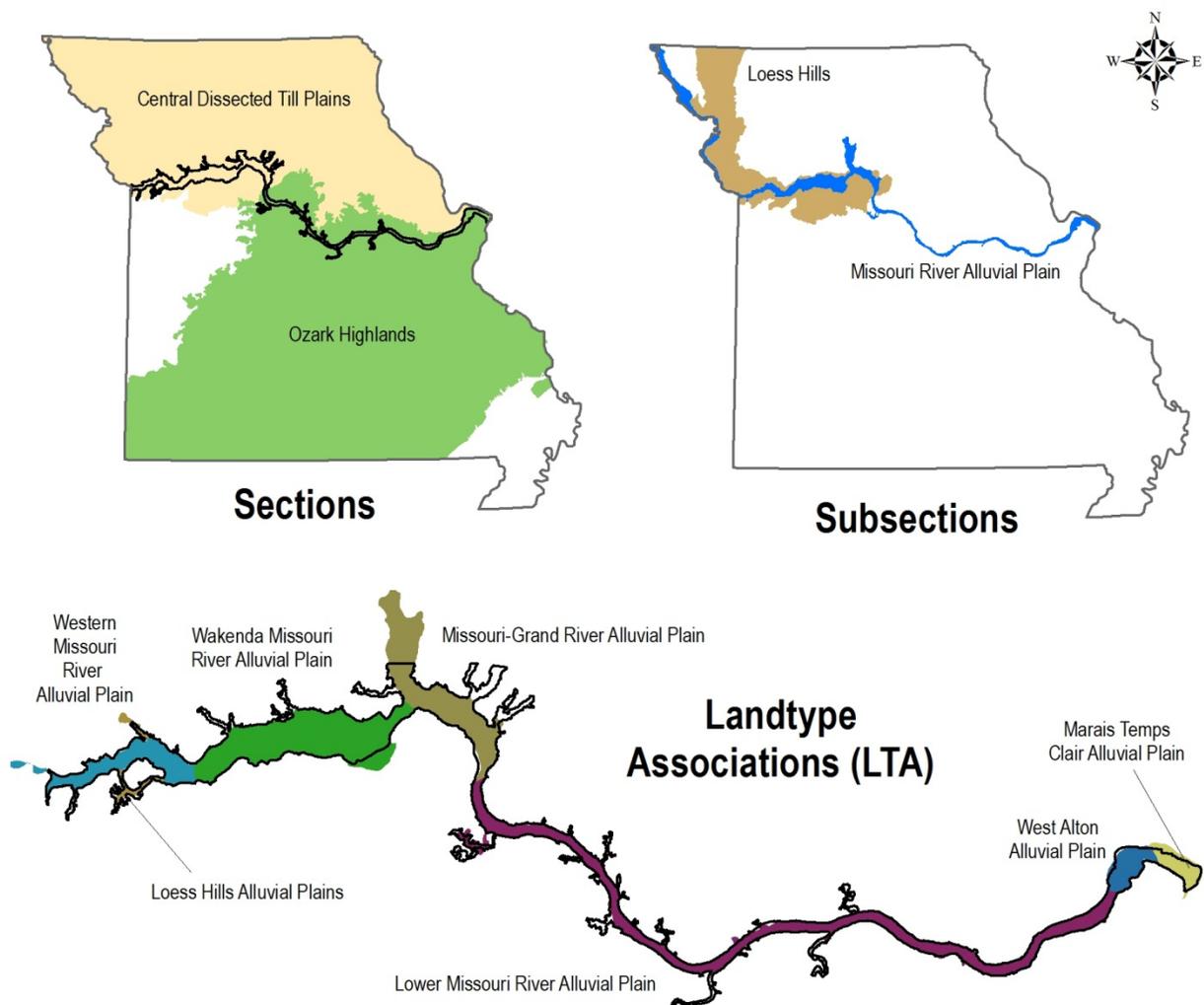
Direct, Indirect, and Cumulative

None of the actions included in any of the alternatives will have any effect on the geographic setting of the refuge or its surroundings.

Ecosystem Setting

The Missouri Ecological Classification Project, documented in the Atlas of Missouri Ecosystems (Nigh and Schroeder 2002), developed an ecological classification system (ECS) for Missouri that could be used for natural resources inventory, planning, and management. Attributes of climate, landforms, geology, hydrology, soils, and vegetation patterns were utilized at various scales to divide the state into progressively finer ecological units. The ECS Project places the Refuge Acquisition Area (RAA) in two ecoregion sections: Central Dissected Till Plains and Ozark Highlands. Each section is further divided into Landtype Associations (LTA) as described below and shown in figure 4-2. More detail can be found in the Atlas of Missouri Ecosystems.

Figure 4-2: Sections, Sub-sections, and Landtype Associations within the Big Muddy NFWR Planning Area



Central Dissected Till Plains

Missouri River Alluvial Plain Subsection

Western Missouri River Alluvial Plain LTA

This LTA occupies the narrow portion of the Missouri River alluvial plain from Mound City, MO in Holt County downstream past Kansas City to Camden in south-central Ray County. Its boundaries on both ends are where the plain broadens abruptly. It generally consists of a narrow alluvial plain (0-4 miles wide) with numerous oxbows and swales of former channel locations. An engineered cutoff of meander is at Sibley. This reach of the alluvial plain is distinguished for having small amounts of wet prairie historically and more extensive timberlands. Today, it is almost entirely cropland and extensive urban and industrial development at St. Joseph and Kansas City.

Wakenda Missouri River Alluvial Plain LTA

This LTA occupies a broad reach of Missouri River alluvial plain between Camden in south-central Ray County and the mouth of the Grand River. It generally consists of an exceptionally broad bottom enclosed by low bluffs mostly in Pennsylvanian shales. Wakenda Creek flows for 25 miles on the alluvial plain parallel to the channel of the Missouri River before joining it at Miami, MO. The plain has several prominent scour holes, or “blue holes,” created by the 1993 flood. The LTA includes the Tetesaw (Petits Osages) Flats, a large Pleistocene terrace below Malta Bend that drains away from the Missouri River. Unique fens and seeps occur on the Tetesaw Flats. Historically the whole LTA was dominated by wet prairie and marshland. Poorly drained soils on the northern side of the river formerly supported one of the most extensive bottom-land prairies on the Missouri River. Today the region is in productive, levee-protected cropland with a few publicly owned wetland conservation areas.

Missouri-Grand River Alluvial Plain LTA

This LTA occupies the alluvial plain of the lower Grand River below Locust Creek in extreme northwestern Chariton County and the alluvial plain of the Missouri River from the Grand River confluence downstream to south of Glasgow, MO. Boundaries are placed where the plains narrow abruptly. In general, the LTA consists of moderately broad alluvial plains with local relief of 10 to 20 feet that are subject to frequent and intense flooding at the confluence of the Grand and Missouri Rivers. The plain has numerous oxbows and other remnants of former channels. Several terraces, some with colluvial wash, stand out prominently. Historically, wet prairie dominated the Grand River plain and major portions of the Missouri River plain; the rest of the bottoms was bottom-land forest and marsh. Though cropland dominates today, there are substantial wetland acres associated with Fountain Grove Conservation Area, Swan Lake National Wildlife Refuge, and surrounding private lands in the Grand River sector.

Loess Hills Subsection

Loess Hills Alluvial Plains LTA

This LTA occupies broad alluvial plains on the Nodaway, One Hundred and Two, and Platte Rivers, mainly in Nodaway County. The LTA also includes a small area at the mouth of the Platte River in Platte County, a small area at the mouth of Fishing River in Clay County, a small area associated with the Little Blue River in Jackson County, and a small area along Davis Creek in Lafayette County. Boundaries encompass alluvial plains that are more than one mile wide. In general, these flat alluvial plains have little appreciable relief, except as associated with low terraces. Soils are mainly very deep and formed in alluvial materials of variable loamy, silty,

and clayey textures. Considerable upland loess has been redeposited onto the alluvial plains. Both moderately drained and poorly drained hydric soils are common. Streams are very low gradient and naturally intensely meandering, although channelization in the first decades of the 20th century has straightened most. Flooding is common, especially at the lower ends of channelized segments. The old, abandoned channel segments form wetlands. Historic vegetation was a mosaic of lowland prairie, marshes, and bottom-land forest. Today these landscapes are more than 95 percent cropland.

Ozark Highlands

Missouri River Alluvial Plain Subsection

Lower Missouri River Alluvial Plain LTA

This LTA occupies the Missouri River alluvial plain from north of Arrow Rock, MO to St. Charles. The western boundary is placed where the river narrows as it crosses the Burlington Escarpment into the Ozarks. The eastern boundary is placed where the alluvial plain widens and begins to merge with the Mississippi River alluvial plain. Conspicuous bluffs line the LTA on both sides. In general, the LTA consists of a river channel half of its former width and of a relatively narrow alluvial plain restricted by bluffs cut into Ozark bedrock materials, primarily dolomites and limestones. Bluff faces have been sharpened by quarrying and by railroad construction at their base. Considerable loess and other sediments have been washed down from the bluffs onto the alluvial plain. Soils are dominated by loamy, well-drained alluvium that was historically timbered. Today, this region is over 95 percent in row crops and levee-protected to varying heights. Industrial development, protected by the highest levees, is concentrated in the bottoms of St. Louis County. Many public acquisitions of flood-damaged land are in this reach of the river.

Marais Temps Clair Alluvial Plain LTA

This LTA occupies the broad plain of the lower reach of the Missouri River from St. Charles, MO downstream to Portage des Sioux. The southern boundary is the bluff in St. Louis County. The northern boundary is a prominent high terrace that separates the lower-lying Missouri River alluvial plain from sediments deposited by the Mississippi River. Missouri River flooding ordinarily does not extend north of the terrace. In general, this small LTA consists of the narrowed and stabilized Missouri River channel and a broad, alluvial plain created by the Missouri River. Historically the LTA was bottom-land prairie and long, sweeping marshes (Marais Temps Clair and Marais Croche) in partially filled oxbows that shared space with bottom-land forest. Today it is almost completely cropland with encroaching urban development. Its flood-prone nature so far has precluded industrial development.

West Alton Alluvial Plain LTA

This LTA occupies a moderately broad alluvial plain between the Missouri and Mississippi Rivers below Portage des Sioux, MO and a small portion south of the Missouri River (Columbia Bottoms). Boundaries are drawn to encompass the area of most recent alluvial construction by both rivers at their confluence. In general, this small but distinctive LTA is an alluvial plain at the confluence of the Missouri and Mississippi Rivers that receives frequent floodwaters and alluvium from both rivers but mainly from the Missouri. Soils are recent and immature. Historically the LTA consisted of bottom-land prairie and wetland complexes. Today it is in row crops and a major restored wetland with very limited residential and commercial development due to frequent flooding. Public lands are on both sides of the mouth of the Missouri River.

Current Management

The refuge manages the ecosystem setting through activities designed to restore hydrology, reconnect the river to its floodplain, reduce the spread of invasive species, and increase natural cover.

Effects on Ecosystems

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on ecosystems include the following:

- **Features:** Site-specific characteristics of a natural resource system (e.g., soil, ground cover, and hydrology) that establish its capacity to support various ecosystem functions.
- **Functions:** The biophysical processes that take place within an ecosystem typically characterized apart from any human context (e.g., fish and waterfowl habitat, cycling carbon, trapping nutrients). The level of a given function depends on the innate capacity of the ecosystem (local site characteristics) and its relationship to the larger landscape context (e.g., connectedness to other natural/human features, accessibility to wildlife).
- **Services:** The beneficial outcomes that result from ecosystem functions (e.g., better fishing and hunting, cleaner water, better views, reduced human health and risks). These require an appreciation by humans, and can be measured or expressed in physical terms (e.g., catch rates, water quality, and property damage avoided). Services depend on ecosystem functions and certain aspects of landscape context (e.g., proximity to floodwaters, people, and property; accessibility to hunters, birders, anglers).
- **Values:** Defined by Webster to be the quality of a thing according to which it is thought of as being more or less desirable, useful, estimable or important. Using this definition the values of an ecosystem might be defined in terms of its beauty, its uniqueness, its irreplaceability, its contribution to life support functions or commercial or recreational opportunities, or its role in supporting wildlife or reducing environmental or human health risks, or providing many other services that benefit humans.

The intensity categories for determining effects on ecosystems are defined as the following:

- **Negligible:** No measurable or detectable change.
- **Minor:** Slight effect; may be a detectable change.
- **Moderate:** Clearly detectable, appreciable change.
- **Major:** Substantial improvement or a severe decrease.

The effects on the ecosystem from implementing the various alternatives described above were determined to be the following:

Ecosystem Effects

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under all alternatives, restoring hydrology and reconnecting the Missouri River and its tributaries as well as maintaining or returning natural cover types would have a planning area wide and perhaps wider effect on ecosystem features, functions, services and values. Restored hydrology and increased perennial cover are features that would improve functions (i.e., habitat, nutrient cycling, etc.), which in turn would provide better services (i.e., hunting, fishing, cleaner water, etc.) and would increase the values of the refuge and Missouri River as a whole. The effects would be amplified if native cover types are used and invasive species management activities are completed.

Topography and Geology

Parts of the Missouri River basin formed at least 20 million years ago; however, the periodic glaciations that began just 2 million years ago forced the course of the river through the Great Plains southward to its present location. This current location of the Missouri River is considered the southern extent of glaciation in the state.

The RAA between Kansas City, MO and St. Louis consists of an alluvial floodplain that may be several miles wide at some points. Intermittent limestone or sandstone bluffs edge some of the floodplain, sometimes close to the river. Loess deposits, a windblown silty material ranging from 10 to 90 feet deep, overlays the limestone bedrock of hills and bluffs adjacent to the river. The floodplain soil is generally free of large rocks and boulders but contains extensive deposits of clay, sand, and gravel. Flood events, such as those that occurred in the summers of 1993 and 1995, distribute new sand in ways that can render formerly tillable land unsuitable for agriculture.

Current Management

The topography and geology of the refuge and its surroundings cannot be managed, although flood events can alter the local topography of the Missouri River floodplain within and beyond the refuge acquisition boundary.

Effects on Topography or Geology

Direct, Indirect, and Cumulative

None of the actions included in any of the alternatives will have any effect on the topography or geology of the refuge or its surroundings.

Climate

This section discusses the climate of Missouri as a whole, rather than just the RAA. The Acquisition Area stretches across the entire state from the Kansas City metropolitan area to the St. Louis metropolitan area, a distance of about 235 miles, and it experiences the range of climates that affect the whole state. Because Missouri lies in a geographic transitional position, it experiences “extremes” that in some years resemble areas to the east and south (e.g., wetter than average), and other years resemble areas to the west and north (e.g., drier than average) (University of Missouri’s Missouri Climate Center 2010).

Missouri has a continental type of climate marked by strong seasonality. In the winter, lack of topographic barriers allows dry, cold air masses to enter Missouri from the northern plains and Canada. If humid air already exists in the state when those air masses enter, precipitation results. During the summer, moist, warm air masses, also unblocked by topographic barriers, move north from the Gulf of Mexico and can produce large amounts of rain. Occasionally, high pressure stagnates over Missouri, creating extended periods of dry weather. The winter and summer weather patterns transition through spring and fall with abrupt changes in temperature and precipitation sometimes occurring.

Missouri normally experiences frequent changes in temperature. While winters are generally cold and summers generally hot, periods of unusually cold or hot weather typically do not last long. Occasional periods of above freezing temperatures occur almost every winter. Conversely, during the peak of the summer season, occasional dry, cool periods break up stretches of hot, humid weather.

Mean January minimum temperature ranges from a low of 12 °F in the northwest to a high of 24 °F in the southeast. However, mean July maximum temperature, 88 °F to 89 °F, shows little geographic variation. The Kansas City and St. Louis metropolitan areas exert a measurable effect on climate. Those metro areas have elevated temperatures of a few degrees, an effect known as the “urban heat island.”

Mean annual precipitation ranges from a low of 34 inches in the northwest to a high of 50 inches in the southeast. Seasonal climatic variations are more complex. Mean January precipitation ranges from a low of 0.8 inches in the northwest to a high of 3.6 inches in the southeast. However, mean July precipitation is greatest in northeastern Missouri (4.4 inches) and least in southwestern Missouri (3.2 inches). Though much less precipitation falls in northern Missouri in the winter than in the summer, it tends to be seasonally effective precipitation, since temperature and evaporation rates are much lower in winter.

Most snowfall occurs in December, January, and February, with the northern counties usually getting the most snow. North of the Missouri River the winter snowfall averages 18 to 24 inches. This average figure tapers off to 8 to 12 inches in the southernmost counties. It is unusual for snow to stay on the ground for more than a week or two before it melts. Winter precipitation usually is in the form of rain, or snow, or both, but conditions sometimes result in freezing drizzle or freezing rain.

Spring, summer, and early fall precipitation comes largely in the form of showers or thunderstorms. Measurable precipitation occurs on average about 100 days a year in Missouri, sometimes with thunderstorms and heavy rains.

Table 4-1 shows some point specific data for Kansas City, MO (western part of refuge), Columbia (mid-point of the refuge), and St. Louis (eastern part of refuge). The difference between Kansas City International Airport (KCI) and downtown Kansas City illustrates the “urban heat island” effect. The Columbia and St. Louis data are compiled from recording stations at Columbia Regional Airport and Lambert-St. Louis International Airport.

Table 4-1: Climate Normals for Selected Missouri Locations 1981 to 2010

		Kansas City International Airport ¹	Kansas City	Columbia	St. Louis
Mean Temperature, °F	January	28.8	31.0	29.7	31.8
	July	78.3	81.0	77.3	80.0
Mean Annual Precipitation, inches		38.86	39.06	42.62	40.96

In a semi-rural area about 15 miles north-northwest of downtown Kansas City.
 Data Source: <http://ggweather.com/normals/MO.html#S>

All of Missouri experiences extreme climate events, and such events must be considered part of the normal climate. Though infrequent in occurrence and often geographically restricted, these events produce environmental changes that may be relatively long lasting in their effects. Among these extreme climatic events are high-intensity rains, lengthy drought, heat and cold waves, ice storms, windstorms, and tornadoes. These climatic events, in turn, may lead to other environmental disturbances such as floods, fires, landslides, and abrupt changes in plant and animal populations and distributions. Since the refuge was established, periods of drought for several years, or several years with frequent flooding events, have markedly affected the succession of vegetation on refuge units.

Predicted Change

No climate predictions specific to Missouri were available at the time of this writing. The report *Global Climate Change Impacts in the United States* (Karl et al. 2009) prepared by the U.S. Global Change Research Group identifies predicted climate change for the Nation and associated impacts for various regions within the country. Missouri is included in the U.S. Fish and Wildlife Service’s (FWS, Service) Midwest Region. The amount and rate of climate change are closely tied to the amount of heat trapping gases in the atmosphere. Climate modeling projections for the end of the century based on higher emissions of heat trapping gases show an increase of 7 to 11 °F in the average U.S. temperature where models based on lower emissions show an increase of 4 to 6.5 °F. Following are some of the predicted impacts for the Midwest Region associated with the projected change in climate.

- During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and insect and waterborne diseases.
- In the winter, warming will have mixed impacts. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.
- While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects, and weeds will present increasing challenges to managing crops, livestock, and forests.

- Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.

Effects on Climate Change

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on climate change include the following:

- Carbon footprint: Both addition (emission) and removal (sequestration) of carbon from the atmosphere. Emission implies that the station is adding carbon to the atmosphere through outputs such as combustion and fossil energy use. Reduction implies that the refuge is trapping and storing carbon in biomass via sequestration.
- Awareness: The refuge’s relationship with the general public understanding of climate change. Components of this understanding include such things as education, research, monitoring, policy, outreach, capacity-building, and collaboration.
- System fortitude and resiliency: Changes in the ability of natural and human systems (habitat, wildlife, human populations, and ecological processes) to withstand or adapt to climate change due to characteristics such as susceptibility to threats, level of stress, system health, connectivity, size, diversity, and so forth.

The intensity categories for determining effects on climate change are defined as the following:

- Negligible: Management effect would be slight and undetectable; therefore, it would have no discernible effect on climate change.
- Minor: Management might result in a slightly detectable effect regarding climate change, but would result in little overall detracting or improvement.
- Moderate: A noticeable change in management impacts on climate change.
- Major: A substantial improvement or a severe decrease in management impacts on climate change.

The effects on climate change from implementing the various alternatives described above were determined to be the following:

Climate Change Effects 1

Context	Type	Duration	Intensity
<input type="checkbox"/> Local	<input checked="" type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input checked="" type="checkbox"/> Landscape	<input type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input type="checkbox"/> Minor
			<input checked="" type="checkbox"/> Negligible

Description

Under all alternatives, restoring hydrology and reconnecting the Missouri River and its tributaries as well as maintaining or returning natural cover types would have a planning area wide and perhaps wider effect on climate change in terms of reducing carbon footprint through sequestration and improving system fortitude and resiliency. A system that is closer to its

natural state (less altered) with more perennial cover sequesters more carbon and is more resilient to climate change.

Increased environmental education would reinforce how practices occurring on public land to address climate change would also be good on private land. It would generally increase awareness of climate change.

Climate Change Effects 2

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input checked="" type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input checked="" type="checkbox"/>	Negligible

Description

Under all alternatives, localized increase in emissions from operation of vehicles or heavy equipment associated with potential future facility construction or land and water management activities would increase the carbon footprint of the refuge.

The Soil Resource

Generally, floodplain alluvial soils in the seven counties west of Howard and Cooper Counties are of the Haynie-Leta-Waldron Association (Natural Resources Conservation Service 1993), a moderately well drained, to well drained loamy soil. These soils are well suited to cultivated crops, pasture, trees, and wildlife habitat and are used mostly for cultivated crops. In the other 13 counties of the refuge area, the dominant alluvial soil is of the Haynie-Waldron-Blake Association (Natural Resources Conservation Service 1993). This association is similar to the one described above; it may not drain quite as well due to the greater presence of the Waldron Series. Uses for the two associations are similar. Usually the presence of the Waldron Series is an indicator of prime farmland when drained and flood protected.

Current Management

The soil resource is currently managed indirectly through habitat and vegetation management, and conversion from agricultural row crops to natural cover. River and floodplain restoration activities also affect the soil resource.

Effects on Soil Resource

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on the soil resource include the following:

- Erosion: The removal of soil and/or rock from a surface (typically by wind or water) and the subsequent transport and deposition of these materials in another location.
- Structure: The arrangement of solid particles that compose a soil and the space between them. This indicator includes compaction and consolidation: pressure or stress applied to a soil surface causing densification as air (compaction) and water (consolidation) are displaced from the pores between the soil grains. Structure influences the movement of

air, water, and nutrients; erosion potential; as well as biological activity such as burrowing animals, soil organisms, root growth, and seedling success,

- Profile: The horizontal stratification of soil layers, which differ by physical characteristics such as particle type and texture.

The intensity categories for determining effects on the soil resource are defined as the following:

- Negligible: No measurable or detectable effect.
- Minor: Slight effect; may be a detectable change.
- Moderate: Clearly detectable effect, appreciable change, noticeable, and potential to remove small quantities of additional soil.
- Major: Permanent loss or alteration of soil, large change, strong likelihood to remove large quantities of additional soil.

The effects on the soil resource from implementing the various alternatives described above were determined to be the following:

Soils Effects 1

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under all alternatives, restoring hydrology and reconnecting the floodplain to the Missouri River and its tributaries would have an effect on soil erosion by allowing the river to spread out over its floodplain, slowing down the flow rate, and thereby causing less erosion. Reconnecting the floodplain will also allow for a more naturally meandering channel, which will in turn redistribute sediment throughout the refuge.

Under all alternatives, returning sites to natural vegetation cover types would have localized effect on soil erosion by stabilizing soils from both wind and water. Natural vegetation cover would also have localized effect on soil structure by adding to the organic layer over time as the vegetation naturally dies and decomposes. Soil with native perennial cover and managed invasive species may have greater stabilization and may gain a thicker organic layer as most native species (especially in grasslands) have deeper roots and some have greater above-soil biomass.

Soils Effects 2

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative B within the Rural Reaches, St. Louis Reach, and Kansas City Reach; and under Alternative C within the Rural Reaches and Kansas City Reach, trail construction may be

a source for erosion. This is a direct adverse effect on the soil resource as soil and/or rocky material is displaced. Any areas with increased visitor use would likely have increased compaction from foot traffic.

Soils Effects 3

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input checked="" type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A all river reaches, under Alternative B within the Columbia Reach, and under Alternative C within the Rural Reaches and Kansas City Reach, concentrated, additional trail construction may be a source for erosion. This is a direct adverse effect on the soil resource as soil and/or rocky material is displaced. More concentrated visitor use would likely have increased compaction from foot traffic.

Soils Effects 4

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input checked="" type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative B within the Columbia Reach, and under Alternative C within the Columbia and St. Louis Reaches, at sites where new facilities, roads, or parking lots are constructed there would be a very localized, but permanent change in soil structure and profile. There would also be an increase in erosion associated with these activities; however, the increase in erosion would likely be lessened or eliminated once the facility, road, or parking lot was constructed and the surrounding soil was re-vegetated.

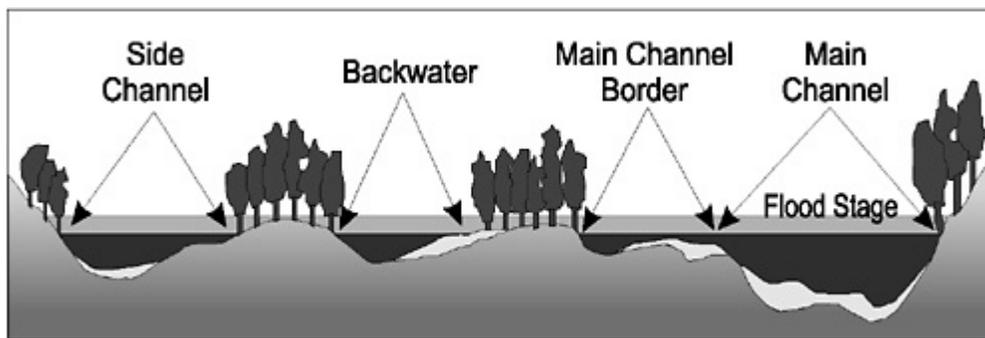
Water Resources

Historic Hydrology

The Missouri River basin encompasses 529,350 square miles or nearly one-sixth of the entire United States. The river is one of the largest in the world, and the reach between Gavin's Point Dam and its confluence with the Mississippi River remains the longest free-flowing river reach in the conterminous United States (Laustrup and LeValley 1998).

Historically, the shallow lower Missouri River represented one of North America's most diverse ecosystems whose braided channels continuously reshaped the lands and habitats within its meandering floodplain (figure 4-3). Large seasonal variations in flows helped provide the energy and hydrology for abundant braided channels, chutes, sloughs, islands, sandbars, backwater areas and floodplain wetlands. Major tributaries along the lower Missouri River not only influenced hydrologic conditions but also created unique habitats and aquatic corridors for species to travel into and out of the floodplain.

Figure 4-3: Typical Cross-Section of the Pre-Regulation Missouri River

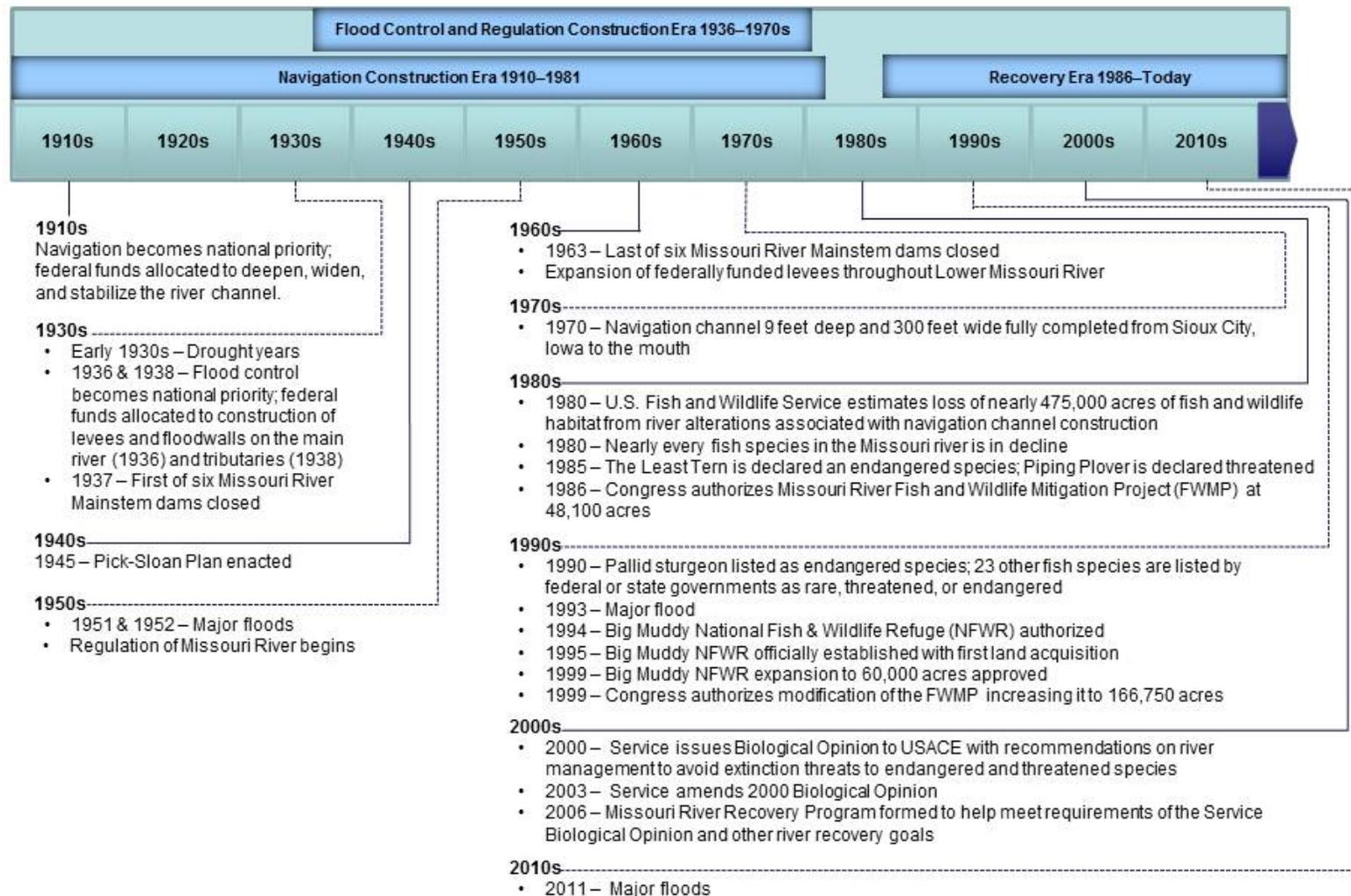


Source: NRC 2002

The historic hydrology of the River included two seasonal flood pulses. The first, or March/April "rise," was caused by snowmelt in the Great Plains and breakup of ice in the main channel and tributaries. The second, or June rise, was produced by runoff from Rocky Mountain snowmelt and rainfall in the Great Plains and lower basin. The spring March rise tended to be brief, lasting about one to two weeks, and was relatively localized. The summer June rise lasted longer and inundated larger portions of the floodplain (National Research Council [NRC] 2002). Late summer, fall, and winter were marked by declining streamflow and lower water levels, which exposed the shoreline and many sandbar-type habitats generated during the flood season.

The meandering nature of the Missouri River resulted in almost continual erosion and deposition of sediments, many times in extreme quantities. As an example, in 1879, it is estimated that 11 billion cubic feet of sediment were transported past St Charles, MO (Laustrup and LeValley 1998). The high sediment loads earned the River its nickname as the "Big Muddy" and were also a key component to the morphology and function of the River's ecosystems. Channels, which relocated over 2,000 feet in a single year and streambanks, which eroded over 200 feet during a single rise added to the sediment-rich water quality of the river (Laustrup and LeValley 1998). Downstream these same sediments were deposited in the form of sandbars, islands, or dynamic floodplain topography. See figure 4-4 for a timeline of major events and eras of Missouri River alteration and restoration.

Figure 4-4: Major Events and Eras of Missouri River Alteration and Restoration 1900–2013



River Alteration

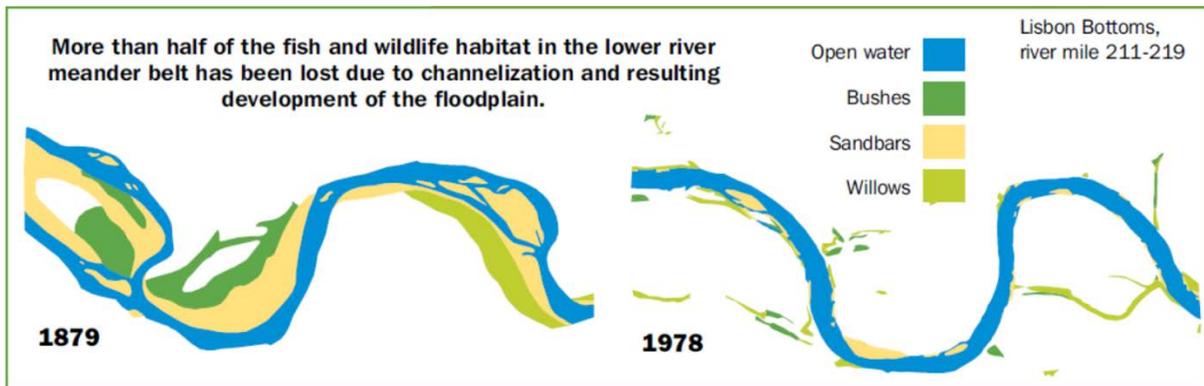
In order to moderate the adverse effects of flooding, as well as meet demands for water supplies for irrigation and cities, hydropower production, flood reduction, and a reliable navigation channel, Congress authorized a network of dams and bank stabilization projects, which were constructed on the Missouri River main stem and tributaries. The dams were built following the broad outlines of the “Pick-Sloan Plan,” a merger of already existing plans for the Missouri River basin developed by the U.S. Army Corps of Engineers (USACE) and the Bureau of Reclamation. The USACE constructed six main stem dams upon the upper Missouri River to promote flood control, commercial navigation, and other related purposes, while the Bureau of Reclamation assumed responsibility for water development along tributary streams and irrigation systems. In addition, private entities and the U.S. Department of Agriculture (USDA) built dams of different sizes on the tributaries, further affecting Missouri River waterflow and sediment transport (NRC 2011).

In the 1945 Rivers and Harbors Act, Congress authorized the Missouri River Bank Stabilization and Navigation Project (BSNP). This act completed channelization of most of the Missouri River below Sioux City, Iowa—a process that had begun in the nineteenth century—via a combination of dikes, revetments, and other engineering structures. Today, the dams and bank stabilization projects are maintained and operated by the USACE, Bureau of Reclamation, and other entities. The USACE manages the section of the Missouri River within the Refuge Acquisition Area.

Reservoir management objectives for the Missouri River basin system include flood control, hydropower generation, recreation, reliable municipal and irrigation water supplies, fish and wildlife, and maintenance of a commercial navigation channel. In the process of impounding and channelizing the Missouri River, the Pick-Sloan dams and the BSNP have provided numerous economic benefits. However, implementation of these projects also has had extensive and lasting implications for the river’s hydrologic, sedimentary, and ecological systems (figure 4-5) (NRC 2011).

In the section of the Missouri River between Kansas City and St. Louis, wing dikes and revetments stabilize the riverbanks and narrow and focus the thalweg (deepest portion of channel and fastest flow) to maintain a self-dredging navigation channel (Jacobson 2006). On adjacent alluvial land, extensive levee systems isolate the river from its floodplain.

Figure 4-5: Lisbon Bottom Fish and Wildlife Habitat 1879 and 1978

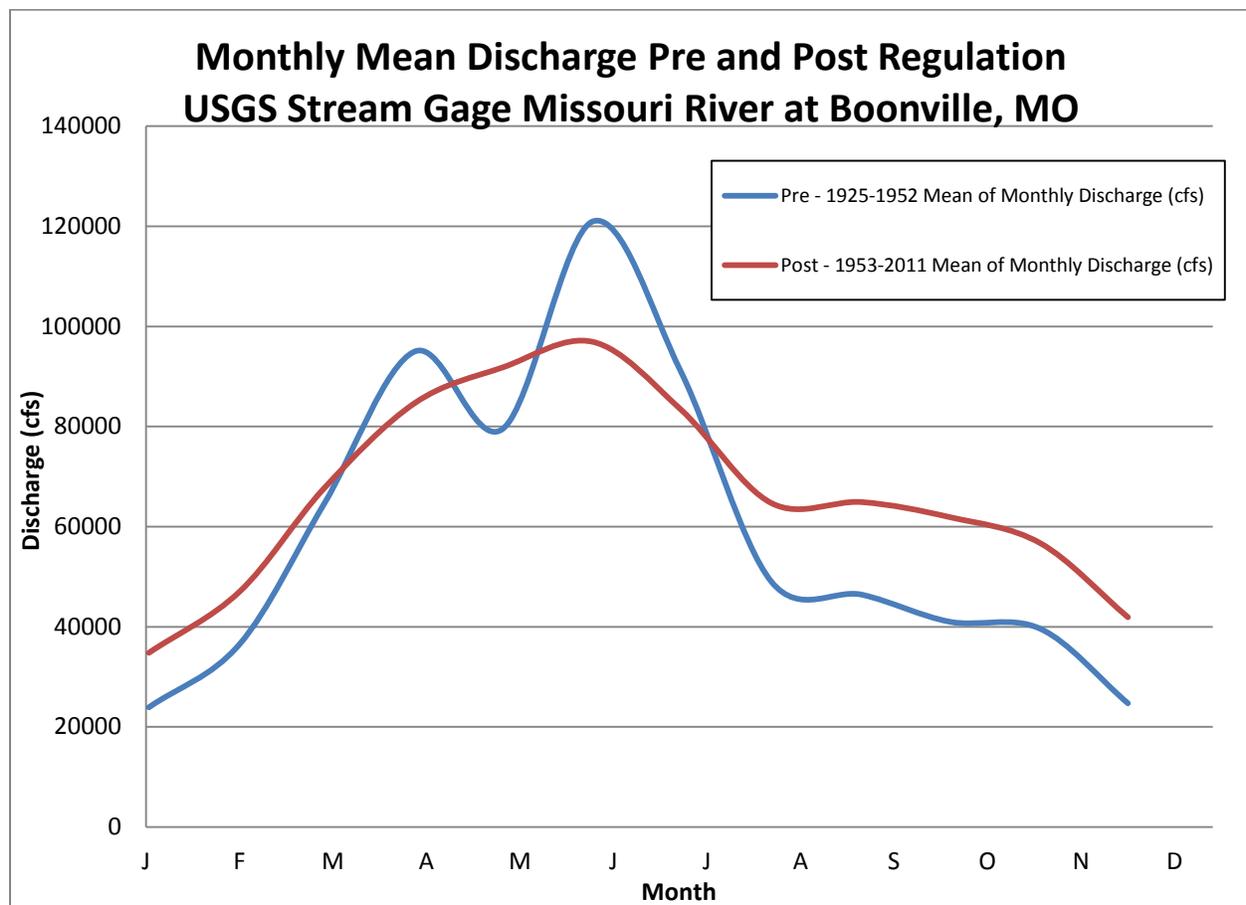


Source: Lastrup and LeValley 1998

The river engineering structures combined to create a narrow, swift, and deep channel from what was historically a shallow, shifting, braided river. The major changes of the river in Missouri resulted in an eight percent reduction in channel length, a 50 percent reduction in channel water surface area, a 98 percent reduction in island area, and an 89 percent reduction in the number of islands (Funk and Robinson 1974). In addition, regulation and management of the Missouri River to maintain sufficient channel depth (nine feet) for April-November navigation depresses the March and June flood pulses while augmenting late summer-autumn low flows.

Regulation of the Missouri River's flows also changed sediment transport and dynamics, greatly reducing the tons of sediment transported down river (figure 4-6). The channel downstream of dams has degraded (deepened), and the dam serves as a barrier to upstream sources capable of replacing the sediments removed by these flows. Channel degradation occurs from Sioux City to just above the Missouri's confluence with the sediment-laden Platte River. Other areas show localized degradation, most notably in the Kansas City area and immediately downstream. In other areas downstream, especially near the confluence of the Missouri and Mississippi Rivers, the channel bed is gradually aggrading (NRC 2002).

Figure 4-6: Monthly Mean Discharge Pre and Post Regulation USGS Stream Gage Missouri River Booneville, Missouri



Current Conditions

The alterations, infrastructure, and management of the Missouri River over the past century have profoundly changed the hydrology, function, and habitats of the lower river. The changes to the morphological and ecological processes that once sustained habitats and biotic communities along the river have resulted in a decline in species abundance, diversity, and distribution.

The construction and management of reservoirs within the upstream watershed have changed the previously dynamic flow regime of the river by suppressing the spring flood pulse and sustaining higher river flows throughout summer and fall, thus limiting the movement and resource availability for those species, which had adapted key phases of their lives to these types of hydrologic extremes. Floodplain wetlands and shallow water habitats typically inundated during annual flood events are now seldom recharged with water, nutrients, and connectivity to the river due to levees and channelization. Similarly, high elevation sandbar development, critical habitat for such species as the endangered Piping Plover and Least Tern, has been prevented by the lack of high flows necessary to create them, and those sandbars that do exist have become covered with vegetation due to the lack of natural disturbance processes, such as periodic scour and inundation. Channelization has removed or altered many other important riverine habitat features including chutes, backwater areas, and tributary confluence areas, which are key habitats of such species as the endangered pallid sturgeon.

Despite upstream flow regulation, some flooding does occur on the Missouri River especially along its lower reaches. The frequency of overbank flooding is somewhat reduced along many reaches by numerous agriculture levees constructed to hold back five-year and 10-year events. Other privately constructed levees offer even less protection (FWS 1999b). In fact, levees and channelization in some areas have constricted flood flows and thus magnified the elevation of flood peaks along sections of the river (Pinter and Heine 2005). Large unregulated tributaries along the lower Missouri River still offer some variability to flow regimes. In some areas, the river still reconnects with part or, in the case of the Great Midwest Flood of 1993, most of its floodplain on a periodic basis. However, most habitats within the meander belt of the lower Missouri River remain disconnected.

The changes in Missouri River sediment processes have greatly affected near-shore and riparian habitats important to some native species. As a result, three of these species—two birds (the Least Tern and Piping Plover) and one fish (the pallid sturgeon)—today are listed under the federal Endangered Species Act. Other water quality concerns include impaired waters and fish consumption advisories along the lower Missouri River and its tributaries. Many of these water quality impairments are associated with non-point source runoff from the vast amount of agricultural land within the drainage basin, as well as pollution from large population centers and industry.

Flooding

Flooding has been a major driver of ecosystems and human development along the Missouri River. The floods generated from this massive watershed have shaped the physical landscape both through the direct power of the floods themselves, as well as indirectly through human efforts to control flooding.

Historically, flood events provided the energy to move and redistribute sediments, inundate overbank areas, displace vegetation, and form new channels while abandoning others. Prior to

human intervention, flood pulses followed relatively predictable patterns, corresponding with spring melt in the lower Missouri River basin and followed by mountain snowmelt and rain-driven flooding in early summer. Over time, species adapted their lifecycles to the timing, disturbance, and water distribution provided by these flood events.

By the early 1800's people began to settle along the Missouri River. Annual flooding, including the massive 1844 flood, taught communities that transportation and development depended on controlling the river and its floodwaters. Before the turn of the 20th century work began to construct levees and channelize portions of the lower Missouri River for interests associated with development and navigation. These efforts handled lesser floodwaters but failed to contain catastrophic flood events, such as those of 1903, 1944, and 1951. The drive to control the river continued with the construction of dams and reservoirs, some of the largest in the world, along the upper portions of the Missouri River. Completion of the dams in the middle 20th century marked the start of flow regulation and further reduced the flood threat downstream (figure 4-7). Similar flood control and water supply projects proliferated along Missouri River tributaries throughout the following decades.

Today thousands of miles of infrastructure stretch across the entire Missouri River basin restraining the dynamism that once defined the river. Flood control, navigation, and water supply came at the expense of river processes that sustained some of the most abundant and diverse plant, animal, and fish communities in North America. With the processes all but gone, the diverse wild abundance soon followed.

After nearly 40 years without a major flood event, the summer of 1993 brought months of heavy rainfall across much of the Midwest culminating in an historic flood event along the lower Missouri River and most of its tributaries. The 1993 flood exceeded much of the flood control capacity within the basin, resulting in widespread inundation of the Missouri River corridor and major socioeconomic losses. Despite regulation of the river and the many flood storage reservoirs, the 1993 flood event was the largest ever recorded at Booneville, Missouri (figure 4-7). Although the aftermath of this flood event did spur the construction of additional flood control measures across the basin, it also helped bring about the recognition of the habitat, wildlife, and flood relief benefits associated with natural lands along the river and led to establishment of Big Muddy NFWR.

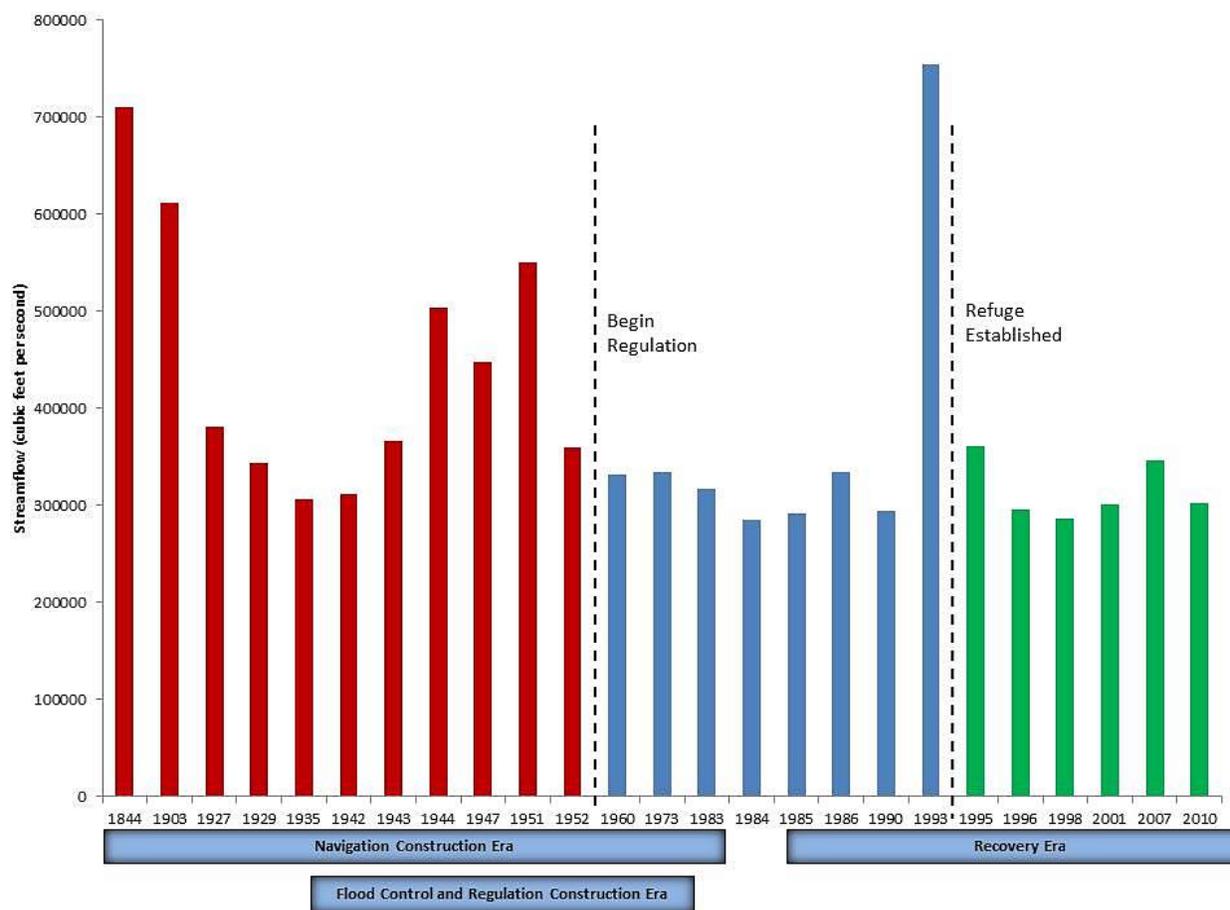
Flooding during the spring of 1995 came on the heels of the 1993 event and made a large impression on the communities and individuals that lived in or near the Missouri River floodplain, many of whom were still recovering from the 1993 event. This event reminded everyone, but especially those living and working in areas left exposed by the 1993 destruction, of the unpredictable nature and damage of flooding along the lower Missouri.

The Lisbon Bottom area received tremendous damage to human developments, infrastructure, and cropland as the result of the 1993 flood. Levees were breached, enormous scour holes were created in crop fields, and huge deposits of sand and debris were spread across much of the remaining crop fields. Landowners enrolled the Lisbon Bottom area into the USDA Natural Resource Conservation Service's "Emergency Wetland Reserve Program." Subsequently, landowners sold the remaining fee title interest in these tracts to The Nature Conservancy, a private conservation organization. The Nature Conservancy held title to these lands until the Service received appropriated funds and was able to purchase these tracts for the National Wildlife Refuge System (NWRS, Refuge System) as part of the Big Muddy NFWR in 1995. Subsequent flooding in 1995 and 1996 created the Lisbon Bottom side channel by connecting the huge scour holes created during the 1993 flood. In 2000 the USACE completed

construction of a revetment and associated rock water control structure to maintain the integrity of the navigation channel while still allowing a small portion of the Missouri River’s flow, approximately 7 percent, to enter the side channel for fish and wildlife benefits.

Flood events since 1993 have continued to shape the landscape, the human response to flooding, and presented challenges and learning opportunities for management of Big Muddy NFWR. Six of the 25 highest annual peaks recorded on the Missouri River at Booneville occurred since the refuge was established (figure 4-7).

Figure 4-7: USGS Recorded 25 Highest Annual Missouri River Flood Peaks at Booneville, MO



In 2011, heavy snowpack coupled with persistent spring rainfall set records for runoff volumes received in the upper Missouri River basin. The resulting flooding exceeded the management plans and capacity of the reservoir systems and resulted in high flows for much of the summer of 2011. Although the flood peak was moderate along the lower river, the sustained three-month duration of high flows being discharged from the reservoirs had significant impacts. Three months of inundation of habitats in low lying areas during the course of the growing season was reminiscent of the 1993 flood. The ecological impact was significant, even on the lower several hundred miles of river where infrastructure damages were relatively minor. Many trees and other plants died as a result of the growing season inundation, and refuge staff and other agencies continue to study the vegetative and wildlife response from this flood. For those that

live and work along the river, the sociological and political impact of this flood was enormous, as management of the river for flood control was openly disputed with navigation, recreation, and water supply interests. This latest chapter in the story of flooding along the Missouri River once again called into question the capacity and impacts of flooding and flood control along the Missouri River.

Restoration Efforts

Today many state and federal agencies have taken steps to address habitat loss along the Missouri River. Beginning with the BSNP Fish and Wildlife Mitigation Project authorized under the Water Resources Development Act of 1986, agencies began focusing efforts on restoring and recovering habitats along the Missouri River. The mitigation project is aimed at restoring lands and habitats downstream of Sioux City that were lost or damaged during channelization and bank stabilization activities. This project is authorized to purchase and restore up to 166,750 acres of land along the river for the benefit of fish and wildlife habitats. With the release of the Missouri River Biological Opinion in 2000 the Service identified USACE management actions by which to protect and recover endangered species on the river, including flow management, habitat restoration, rearing and stocking, and continued study in an adaptive management framework. Using recommendations from the Biological Opinion, the USACE initiated the multi-partner Missouri River Recovery Program (MRRP) aimed at achieving Missouri River ecosystem recovery goals.

MRRP efforts include projects designed to hasten or “direct” succession and diversity of floodplain habitats, several of which have occurred on refuge lands. A challenge of these efforts are the prevalence of private property adjacent to the river. Channel widening and chutes can only be accomplished where the USACE or a cooperating government agency [such as the Service] owns the adjacent property. Through the USACE’ Mitigation Project, side channels have been constructed at several refuge units to create shallow water habitat and reconnect the floodplain with the river. Some shallow water habitat work has been done within existing riverbanks to improve aquatic habitat next to several refuge units. The work to develop more shallow water habitat includes notching dikes, rock placement to create reverse dike chevrons, and some bank excavation to create “rootless” dikes. The restoration of Shallow Water Habitat (SWH) comes from one element of the reasonable and prudent alternative (RPA) outlined in the 2003 Biological Opinion, which requires the restoration of 20 percent of the SWH that existed prior to construction of the BSNP. A major component of the Missouri River Recovery Program is meeting this element of the RPA. Almost all of the required SWH acres will need to be created by channel widening and the restoration of chutes and side channels. The result is the creation of SWH acres within the current top-width of the river and the creation of SWH by the conversion of terrestrial acres into new aquatic habitat.

Floodplain Connection on Refuge Units

Since the establishment of the refuge in 1994, several changes have occurred on refuge units that allow some connection between the Missouri River and its floodplain. The following examples illustrate the dynamic condition of hydrology on refuge units, resulting from man-made and natural causes.

Lisbon Bottom

The Great Midwest Flood of 1993 left one large scour at the upstream margin of Lisbon Bottom and three smaller levee breaks and scours. Also the flow breached the cross-levee in numerous places, and at least five exit scours developed along the downstream margin. The unit flooded



Scour at Big Muddy NFWR; photo: USFWS

several times in 1995 and a flood event in June 1996 completed creation of Lisbon Chute, about two miles long and up to 200 feet wide. The chute, the first to be formed by the river in Missouri for many years, created a diversity of habitats that probably occurred on the river before channelization and flow regulation. Lisbon Bottom presents the opportunity to study ecosystem processes and dynamic geomorphology in a setting that more closely mimics the natural riverine system than any other site on the Lower Missouri River. Thus, the chute is of great interest to the public, river managers, and researchers.

At higher river stages Lisbon Chute initially passed as much as 20 percent of the river's flow (Jacobson and Lastrup 2001; copy in Ann Nar 2000). Over four wet years (1996–1999) the chute was allowed to evolve with minimal stabilization, resulting in a shallow, braided channel in the upper one half and a dynamically migrating, single-thread channel in the lower half. In 1999, to maintain the main stem navigation channel, the USACE (with design input from the Service and other federal and state agency representatives) added a grade-control structure across the chute about 1,500 feet upstream from the downstream end. In May 2000, the USACE completed a notched hydraulic control structure about 900 feet downstream of the revetment at the upstream end of the chute. They hoped the reduced velocities from the construction of the two structures would maintain the navigation channel but continue habitat benefits to the fish community in the chute. With the structures in place, considerable sedimentation occurred. Fisheries biologists from the Service's Columbia Fish and Wildlife Conservation Office (CFWCO) found declining fish diversity since 2000 when the control structures were completed. Asian carp species increased annually. In 2004 the USACE widened the notches in the structures controlling discharge through the chute to allow additional flow. After the notch in the inlet structure clogged with debris they lowered and widened it to increase the flow of water through the chute. The increased flow resulting from the 2004 modifications to the grade control structure and revetment structure helped alleviate some of the concern about sedimentation rates, but not all. Continued monitoring of fish population abundance and diversity did not show much improvement over premodification conditions. One area of specific concern is the apparent inability of larval fish to access the Lisbon side channel as they had prior to construction of the revetment and grade control structure. This is most likely due to structural exclusion of benthic flows. Additional study and discussion of potential fixes is continuing.

Overton Bottoms North

In 1998, as part of the Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Program, the USACE began design of a 15-foot wide pilot channel at Overton

Bottoms North. The construction was completed in 2000. They also lowered a section of the levee that ties back to the bluff at the southwestern corner of the unit to allow more overflow during flood events. Water first ran through the pilot channel in February 2001. By April the inlet and upper pilot channel were clogged with tons of large woody debris. A 10-year flood event in June 2001 lifted the large woody debris off of the inlet and upper chute. Most of it floated into the main channel Missouri River but some deposited at the lower end of the chute. To allow more water to enter the channel and flush out debris and sediment, the USACE widened the inlet structure and deepened the outlet. The chute was dry most of 2002, but a five-year flood event in May brought river water into the channel and again deposited large, packing, woody debris. In 2003 the USACE returned to construct a new inlet structure downstream of the old one and to deepen and widen the entire pilot channel, most of it to a bottom width of 70 feet. The adaptive management resulted in increased flows and reduced debris accumulation in the channel.

Jameson Island

The USACE began notching dikes in the Missouri River adjacent to Jameson Island in 1996 to create shallow water habitat. This resulted in a large field of sandbars at the northeast part of the unit. The USACE began a chute at Jameson Island in 2006 but halted construction of the project in 2007 when the Missouri Clean Water Commission raised objections to sediment added to the river. Frequent high water events between 2007 and 2011 naturally deepened and widened the developing Jameson chute, greatly increasing the diversity of channel habitats. CWFCO reported finding a record number of the endangered pallid sturgeon in one day at Jameson Island in an area smaller than a football field. Over the years of their sampling, the Lisbon-Jameson units of the refuge have produced the first evidence of wild spawning in over 50 years in this area and the most pallid sturgeon captures of any area on the Lower Missouri River (FWS 2008c).

Baltimore Bottom

In 2007, the USACE began construction of two small chutes to create two islands and four sandbars. They halted work due to wet weather and never resumed the project due to the controversy at Jameson Island. In May 2007, a 50-year flood event broke the old Hodge levee at Baltimore Bottom Unit in four places, greatly increasing river connectivity with the floodplain. In 2010, an old drainage pipe clogged with debris and sediment on Edwards Branch that backed up floodwaters on the western end of the unit, inundating the upstream tract for a long portion of the summer months.

Effects on Water Resources

Direct, Indirect, and Cumulative

Water resources refer to surface, ground, and atmospheric water. Indicators used for evaluating effects on water resources include the following:

- Water quantity: Water delivery (source, amount, rate, and distribution), water movement (pathways), and water storage (duration and frequency of inundation).
- Water quality: Sedimentation, turbidity, nutrients, and heavy metals.

The intensity categories for determining effects on water resources are defined as the following:

- Negligible: No measurable or detectable change.
- Minor: May be a detectable change.
- Moderate: Clearly detectable change.
- Major: Substantial and/or permanent change.

The effects on water resources from implementing the various alternatives described above were determined to be the following:

Water Resources Effects 1

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under all alternatives, restoring hydrology and reconnecting the floodplain to the Missouri River and its tributaries would have an effect primarily on water quantity but also water quality. If the system is restored and reconnected it can expand and contract more easily during flood and drought events. If the river can spread out over its floodplain, it will slow down, cause less erosion and carry away fewer nutrients. Water would more easily be stored within the system as well.

Returning natural cover types to the land would have both local and broad scale effects on water quantity by intercepting rain before it hits the soil, allowing water to infiltrate and slow down, therefore, minimizing runoff. Natural cover types, especially when adjacent to the water source, also stabilize the soil to better withstand a flood event and better protect against soil moisture loss during a drought event. It would also affect water quality by stabilizing the soil, thereby reducing erosion and sedimentation and retaining nutrients in the soil and vegetation. Natural cover types help maintain a natural hydrologic cycle by capturing water and nutrients in plants and slowing evapotranspiration. Sites with managed invasive aquatic species may have more water available with better flow as some invasive plants can interfere with the flow of water and withdraw water from deep in the soil and reduce the amount available for other uses.

Increased environmental education would reinforce how practices occurring on public land to protect/improve water quality and quantity would also be good on private land. It would also reinforce how important the Missouri River is as a source of water and would encourage the general public to treat it with respect.

Water Resources Effects 2

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input checked="" type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative B within the Rural Reaches, St. Louis Reach, and Kansas City Reach; and under Alternative C within the Rural Reaches and Kansas City Reach, localized decrease in water quality from increased runoff and erosion could lead to increased nutrient loading or sedimentation from potential future facility construction or land and water management activities.

Water Resources Effects 3

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input checked="" type="checkbox"/>	Moderate
				<input checked="" type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches; under Alternative B within the Columbia Reach; and under Alternative C within the Columbia Reach and Kansas City Reach, localized decrease in water quality from increased runoff and erosion could lead to increased nutrient loading or sedimentation from more concentrated potential future facility construction or land and water management activities.

Water Resources Effects 4

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input checked="" type="checkbox"/>	Negligible

Description

Under Alternative B within the Rural Reaches, St. Louis Reach, and Kansas City Reach; and under Alternative C within the Rural Reaches and Kansas City Reach, any new dirt trails may be a source for erosion, which would add to sedimentation. Any new impervious surfaces would increase runoff, which would add to sedimentation and turbidity as well as nutrient loading in the water.

Water Resources Effects 5

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input checked="" type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches; under Alternative B within the Columbia Reach; and under Alternative C within the Columbia Reach and St. Louis Reach, more concentrated new dirt trails may be a source for erosion, which would add to sedimentation. More concentrated impervious surfaces would increase runoff, which would add to sedimentation and turbidity as well as nutrient loading in the water. At sites where herbicides are utilized for invasive species management, there may be an increased chance for those chemicals to lessen the quality of water.

Air Quality

Existing air quality within the refuge is subject to air pollutants from internal combustion engines (e.g., vehicles, tractors, outboard motors, and chainsaws), agricultural sources (e.g., burning brush piles), and industrial sources (e.g., factory and other large industry output in larger cities).

Current Management

While several refuge management activities, such as those that require chainsaws and vehicles, release pollutants into the air, perhaps the activity of most concern regarding air quality is prescribed fire. Prescribed fire is one of the basic tools used to achieve a variety of management objectives within refuge ecosystems.

While prescribed fire affects air quality by releasing particulates and pollutant gases, it is only a sporadic and temporary source of air pollution. Since a specific burn plan is written, indicating, among other variables, particular wind requirements (direction and speed) for igniting any given fire, effects to air quality are short-lived. Wind typically dissipates smoke rapidly. Prescribed fire is used on approximately two to three refuge sites annually with each site typically under 100 acres.

Effects on Air Quality

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on air quality include the following:

- Air emissions: The introduction of solid particles, liquid droplets, or gasses (i.e., chemicals, particulate matter, biological materials) into the atmosphere from natural or anthropogenic sources.
- Visibility: The transparency of the air, or distance at which objects or light can be clearly discerned as a result of the absorption and scattering of light by particles and gases in the atmosphere.

The intensity categories for determining effects on air quality are defined as the following:

- Negligible: No measurable or detectable effect.
- Minor: Slight effect, causing a change.
- Moderate: Clearly detectable effect; appreciable change.
- Major: Substantial; highly noticeable change locally or regionally.

The effects on air quality from implementing the various alternatives described above were determined to be the following:

Air Quality Effects 1

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under all alternatives, returning sites to natural vegetation cover types would stabilize soils, reduce wind-blown particulate matter, and increase the amount of carbon dioxide absorbed from the atmosphere and stored as carbon in biomass and soils. (See [NRCS Air Quality site, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/alphabetical/plants/pub/?&cid=stelprdb1042920.](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/alphabetical/plants/pub/?&cid=stelprdb1042920))

Air Quality Effects 2

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input checked="" type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative B within the Rural Reaches, St. Louis Reach, and Kansas City Reach; and under Alternative C within the Rural Reaches and Kansas City Reach, localized increase in emissions from operation of vehicles or heavy equipment associated with potential future facility construction or land and water management activities.

Air Quality Effects 3

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input checked="" type="checkbox"/>	Moderate
				<input checked="" type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches; under Alternative B within the Columbia Reach; and under Alternative C within the Columbia Reach and St. Louis Reach, localized increase in emissions from operation of vehicles or heavy equipment associated with more concentrated potential future facility construction or land and water management activities.

Air Quality Effects 4

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input type="checkbox"/>	Long-term	<input checked="" type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input checked="" type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches, and under Alternative B within the Columbia Reach, if prescribed fire is used as a management tool it would cause localized, temporary increases in emissions from smoke.

Air Quality Effects 5

Context	Type	Duration	Intensity
<input checked="" type="checkbox"/> Local	<input type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input type="checkbox"/> Landscape	<input checked="" type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input type="checkbox"/> Minor
			<input checked="" type="checkbox"/> Negligible

Description

Under Alternative B within the Rural Reaches, St. Louis Reach, and Kansas City Reach; and under Alternative C within the Rural Reaches and Kansas City Reach, in areas where vehicle access is established and facilitated through road improvements or parking lots there would be a localized increase in emissions from vehicle traffic to and from each site.

Air Quality Effects 6

Context	Type	Duration	Intensity
<input checked="" type="checkbox"/> Local	<input type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input type="checkbox"/> Landscape	<input checked="" type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input checked="" type="checkbox"/> Minor
			<input type="checkbox"/> Negligible

Description

Under Alternative A within all reaches; under Alternative B within the Columbia Reach; and under Alternative C within the Columbia Reach and St. Louis Reach, in areas where more concentrated vehicle access is established and facilitated through road improvements or parking lots there would be a localized increase in emissions from vehicle traffic to and from each site.

Habitat

Historically, the Missouri River floodplain supported a diverse suite of forested communities, shrublands, prairies, swamps, and marshes (Nigh and Schroeder 2002). Flooding cycles typically included an early spring flood (due to upstream snowmelt), followed by an early summer flood (due to continued upstream snowmelt and rainfall), and concluded with a gradually diminished river flow during the summer and into the fall and winter (Galat and others 1998). This flooding cycle, like in most riparian systems, helped to produce a mosaic of

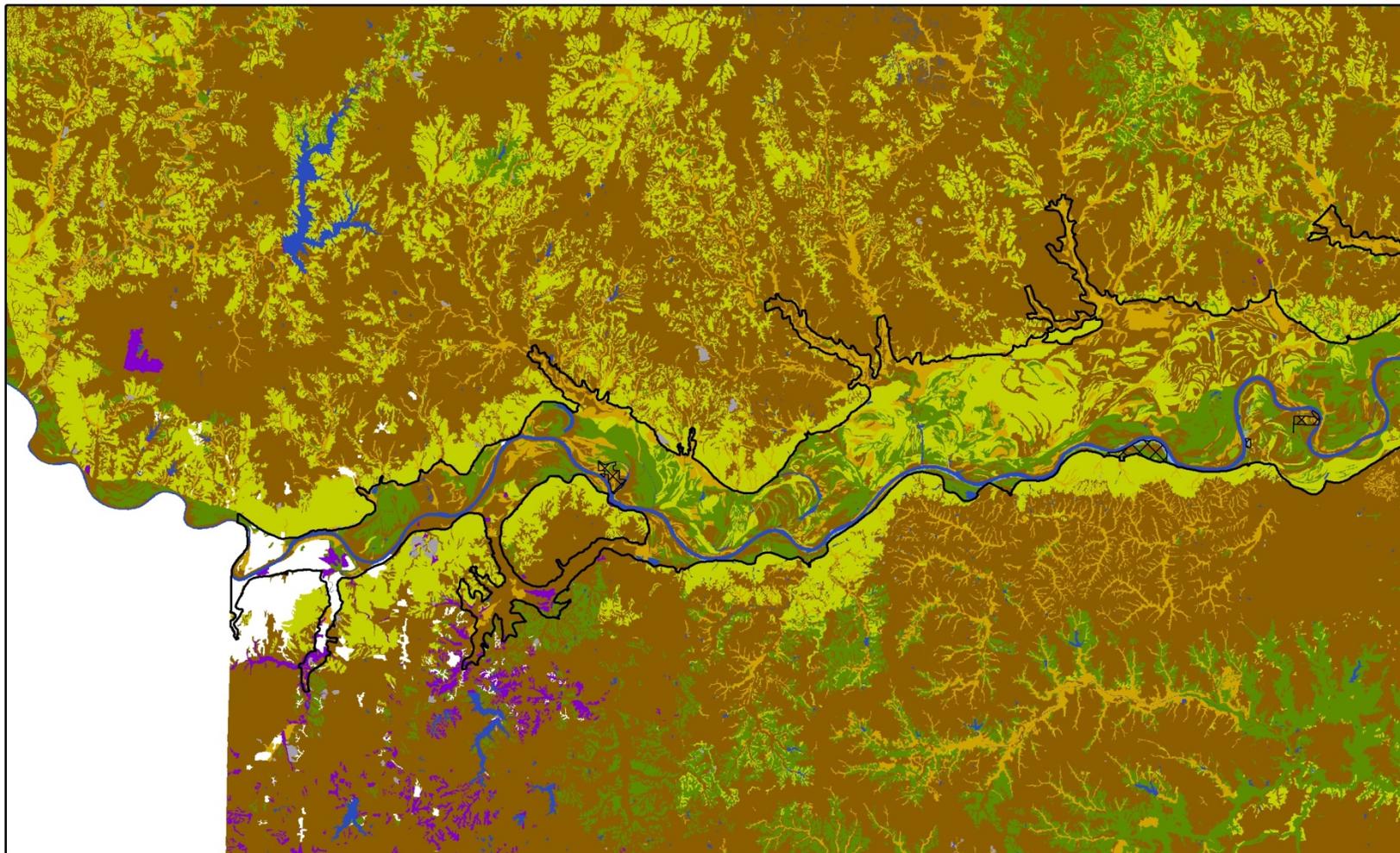


Floodplain forest; photo: USFWS

numerous terrestrial vegetation community types and wetlands ranging from open water to densely vegetated forests.

To contribute to the national commemoration of the Lewis and Clark Bicentennial (2003–2006), the Geographic Resources Center, Department of Geography, University of Missouri in partnership with the Missouri State Archives, Office of the Missouri Secretary of State, undertook the Lewis and Clark Landscape Project (Harlan 2002). The primary goals of the project were to geo-reference, digitize, and map all of the retrievable information from the Lewis and Clark journals and the 18th and 19th century Government Land Office land survey notes along the big river corridors of the State of Missouri. Based on witness trees and general descriptions provided during the survey effort, Harlan classified vegetation as either forest, woodland, open woodland, prairie, or barren (figure 4-8).

Figure 4-8: Historic Land Cover for Big Muddy NFWR Planning Area on Five Panels



- | | | |
|-------------------------------------|-------------------------|--------------------|
| NWR Approved Acquisition Boundary | Prairie With Some Trees | Water |
| Big Muddy Unit | Savanna | Water - Waste |
| Predicted Natural Vegetation | | |
| Forest | Marsh | Unknown/Not Mapped |
| Forest With Some Prairie Areas | Barren Land - Rocky | |
| Mixed Forest and Prairie | Alluvial Land | |



Scale 1:7,000,000
 0 5 10 Miles



Figure 4-8 (Continued)

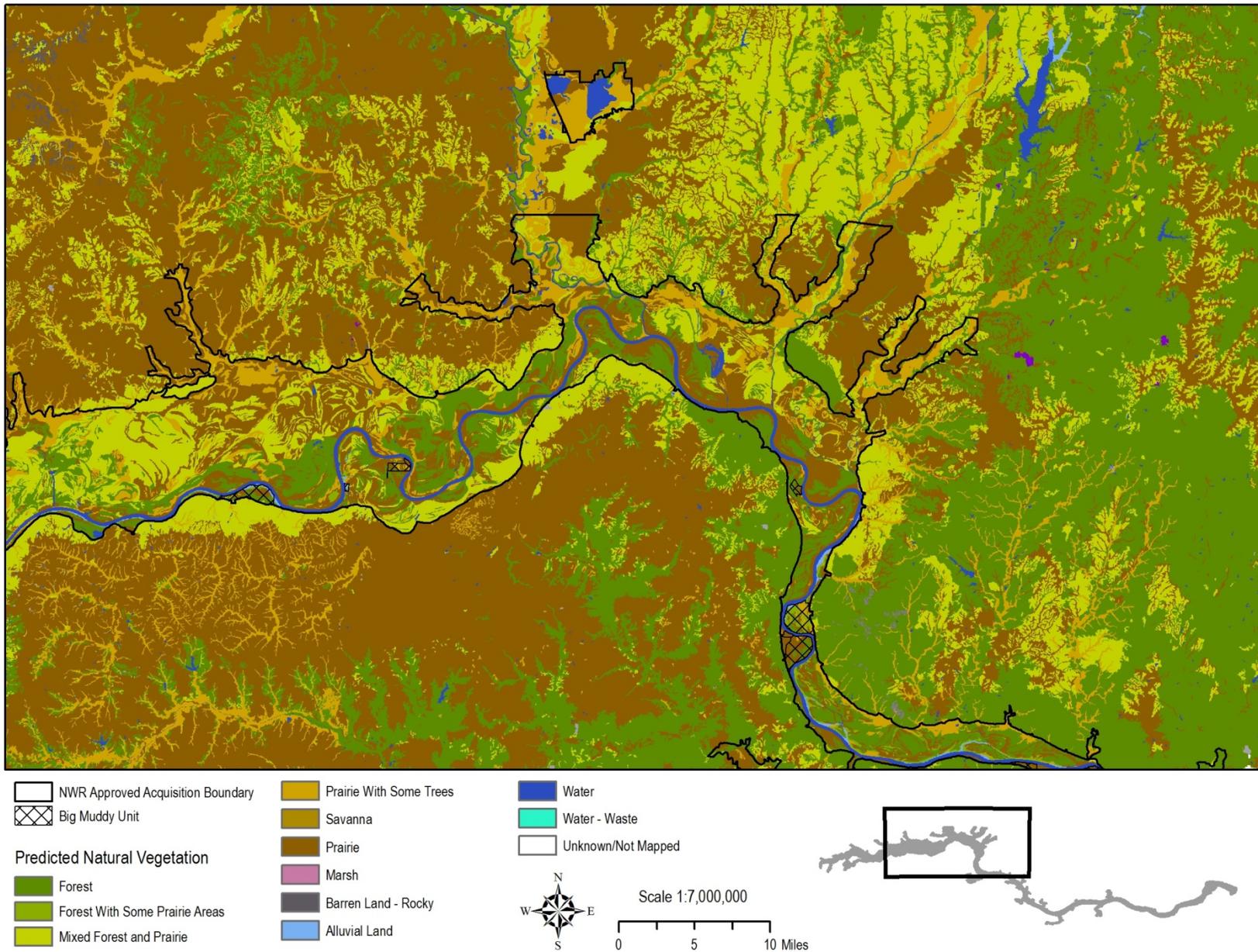
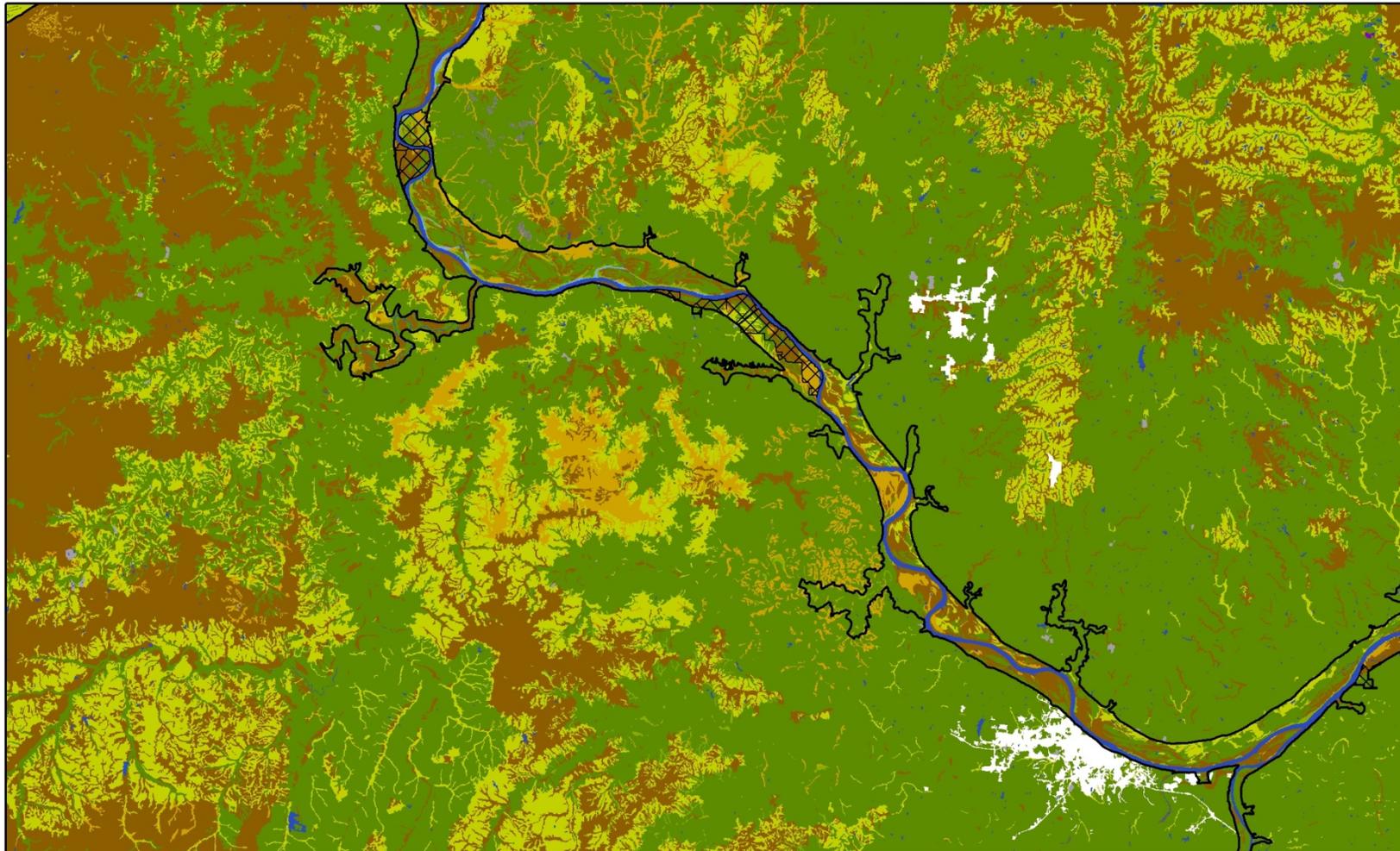


Figure 4-8 (Continued)



- | | | |
|-------------------------------------|-------------------------|--------------------|
| NWR Approved Acquisition Boundary | Prairie With Some Trees | Water |
| Big Muddy Unit | Savanna | Water - Waste |
| Predicted Natural Vegetation | | |
| Forest | Prairie | Unknown/Not Mapped |
| Forest With Some Prairie Areas | Marsh | |
| Mixed Forest and Prairie | Barren Land - Rocky | |
| | Alluvial Land | |

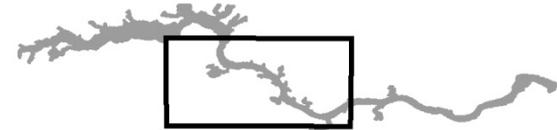
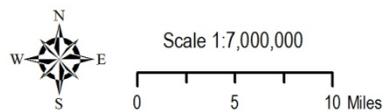


Figure 4-8 (Continued)

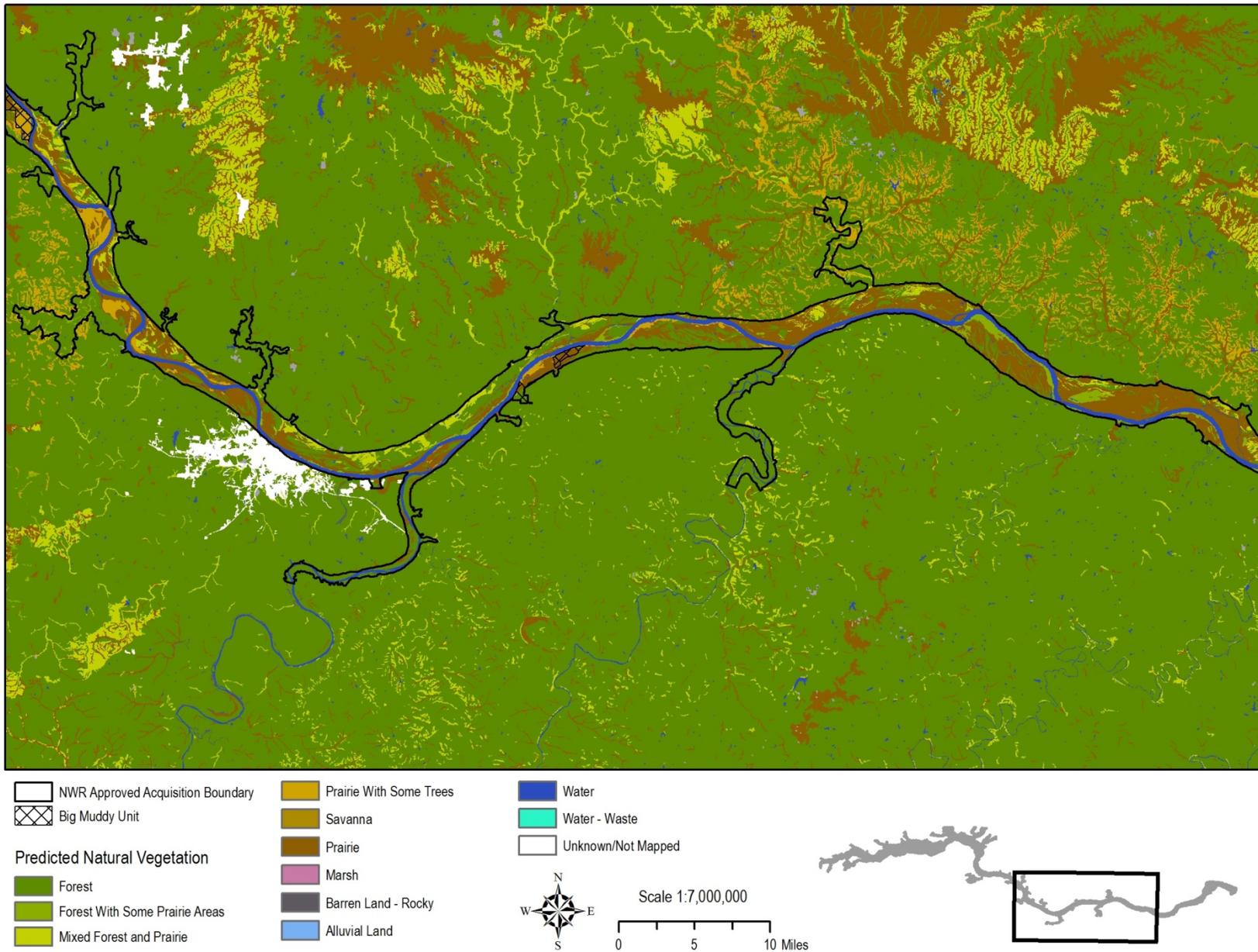


Figure 4-8 (Continued)



NWR Approved Acquisition Boundary	Prairie With Some Trees	Water
Big Muddy Unit	Savanna	Water - Waste
Predicted Natural Vegetation		
Forest	Marsh	Unknown/Not Mapped
Forest With Some Prairie Areas	Barren Land - Rocky	
Mixed Forest and Prairie	Alluvial Land	

Scale 1:7,000,000

0 5 10 Miles



Weaver's (1960) more complete descriptions of Missouri River riparian vegetation in western Missouri are summarized in Grabner and Struckhoff (2006). Weaver separated floodplains into two broad types: 1) low bottoms that occur near the river channel and are subject to occasional or frequent flooding, and 2) high bottoms that occur on wider and flatter parts of the floodplain, usually near bluffs. Low bottom forests contained cottonwood and willows while low bottom forest sites that were well drained included trees such as white ash, green ash, red elm, American elm, boxelder, hackberry, walnut, sycamore, sugar maple, honey locust, and Kentucky coffee tree. High bottom forest occupied a minor portion of the Missouri River bottoms, but species composition tended to resemble that found in forests on well-drained low bottom floodplains.

Swamps in the low bottoms contained a mix of bulrushes, cattails, reeds, arrowhead, and water plantain. Marshes contained a different suite of species including sedges, rushes, spike rushes, rice cutgrass, reed canary grass, and smartweeds. Prairies occurred on both the low and high bottoms. Low bottoms contained wet-prairies comprised of switchgrass, Canada wildrye, and prairie cord grass while the more well-drained soils on high bottoms contained big bluestem prairie. Low bottoms also contained abandoned river channels, lakes, ponds, sandbars, grasslands, and shrublands.

And finally, Nigh and Schroeder (2002) described presettlement vegetation along the river through the Ozark Highlands Section (Glasgow to St. Louis). The area was mostly bottom-land forests dominated by willow, cottonwood, sycamore, elm, silver maple, and hackberry. Mixed-hardwood forests that included oaks, sugar maple, walnut, and hickories occurred on high terraces.

Today the vegetation of the Missouri River floodplain is vastly different than the historic conditions described above. Agriculture is the predominate land use within the floodplain and the land cover is mostly cropland. The small amounts of forest, grasslands, and wetlands mostly occur within areas dedicated to conservation (figure 4-9).

Figure 4-9: Current Land Cover for Big Muddy NFWR Planning Area on Five Panels

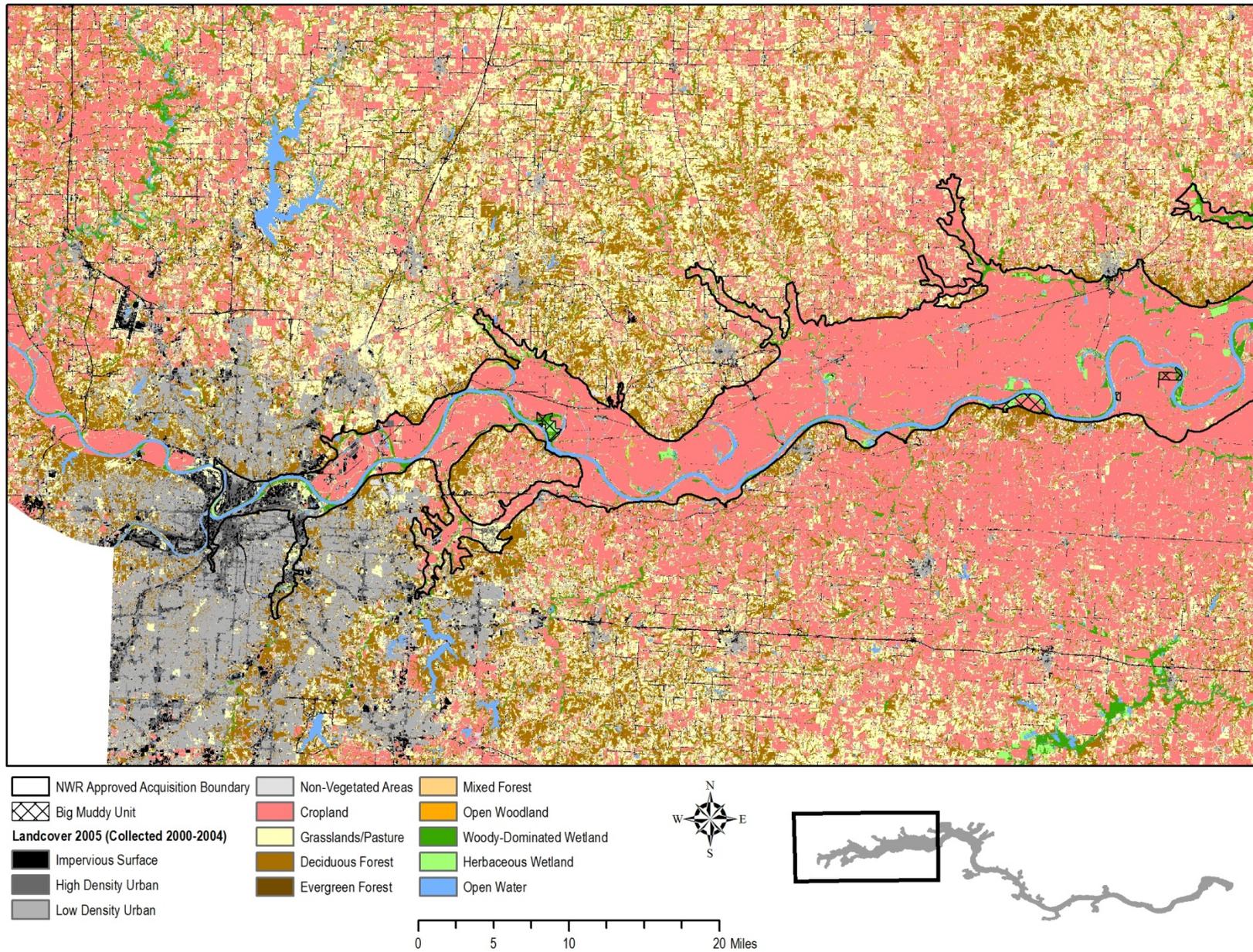


Figure 4-9 (Continued)

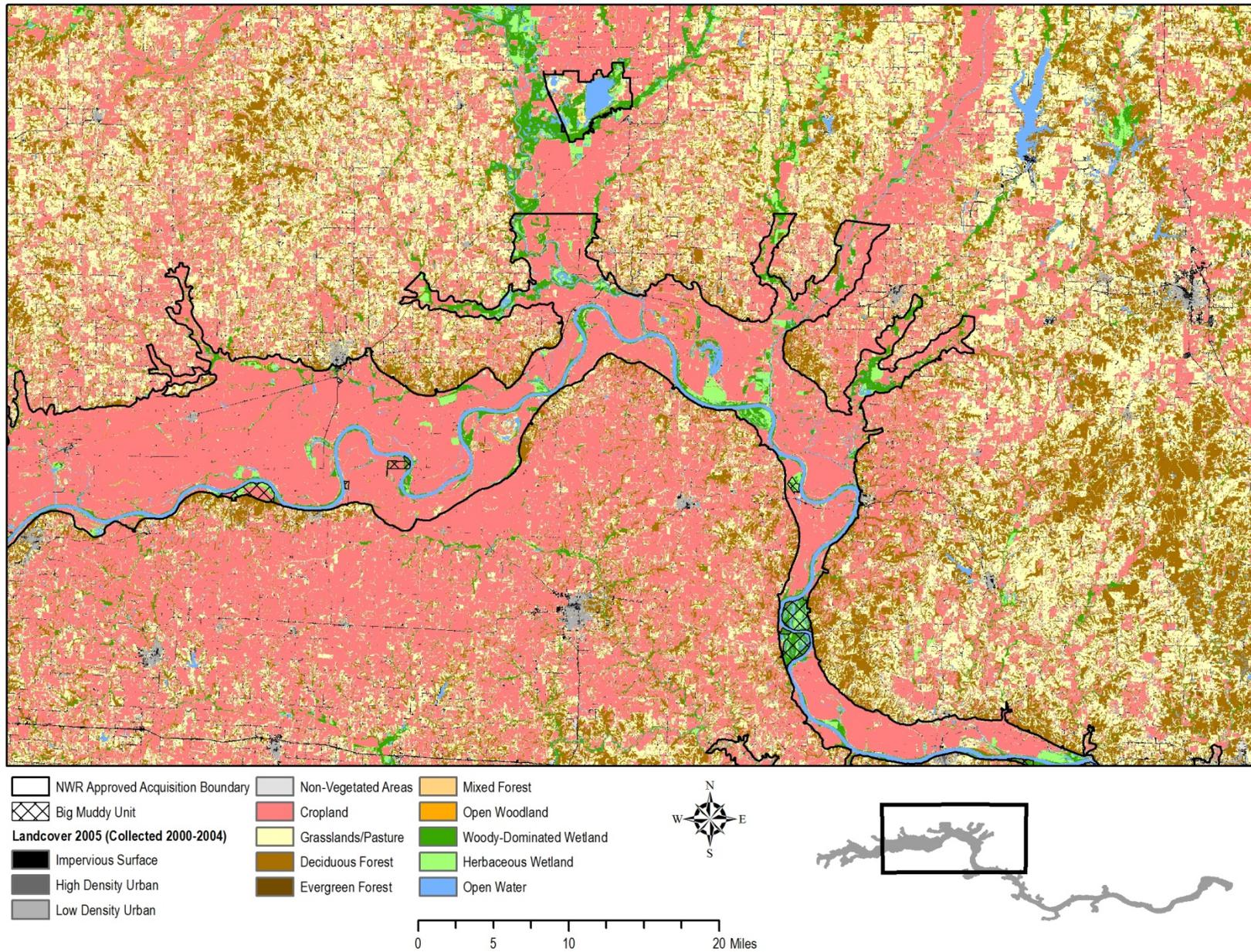


Figure 4-9 (Continued)

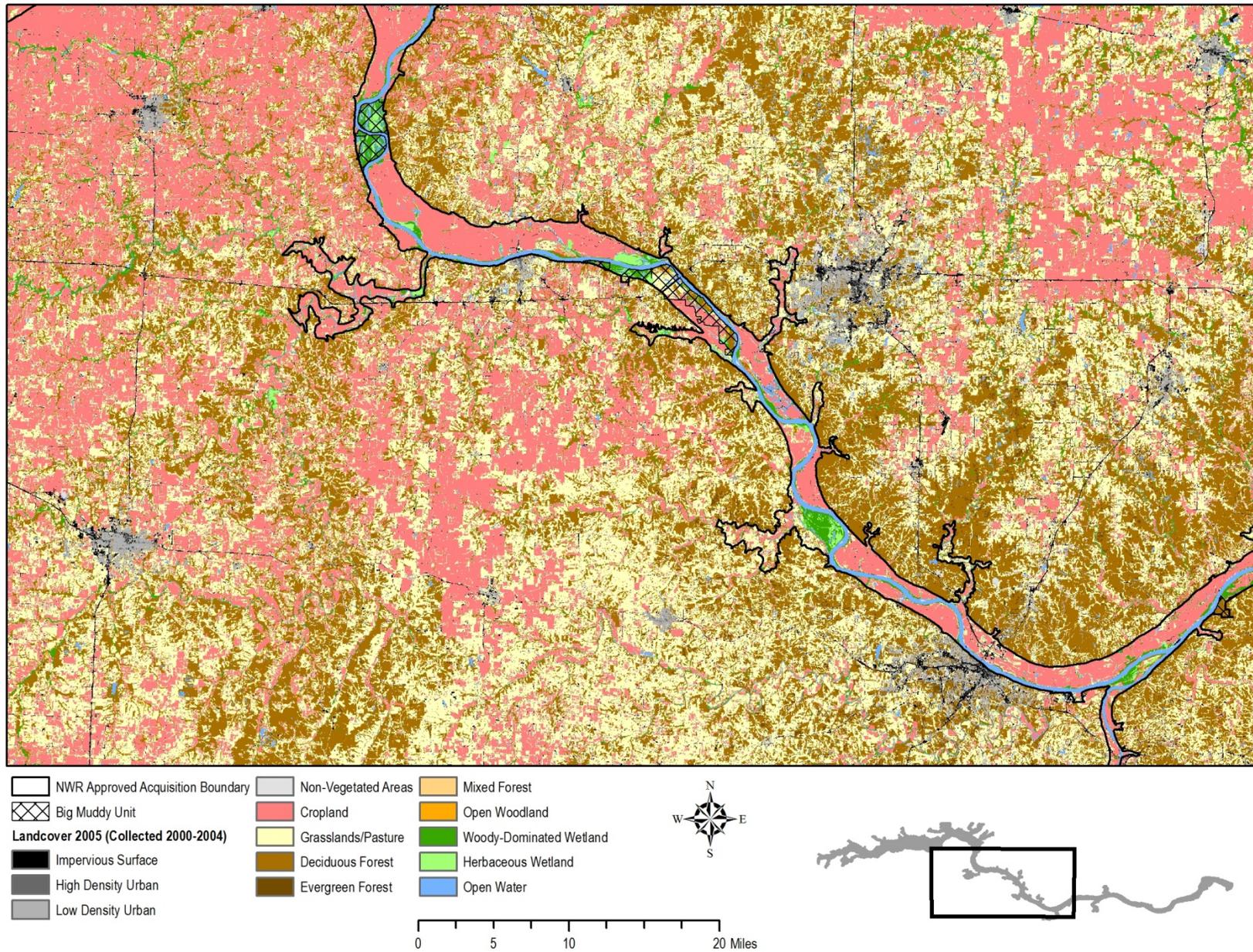


Figure 4-9 (Continued)

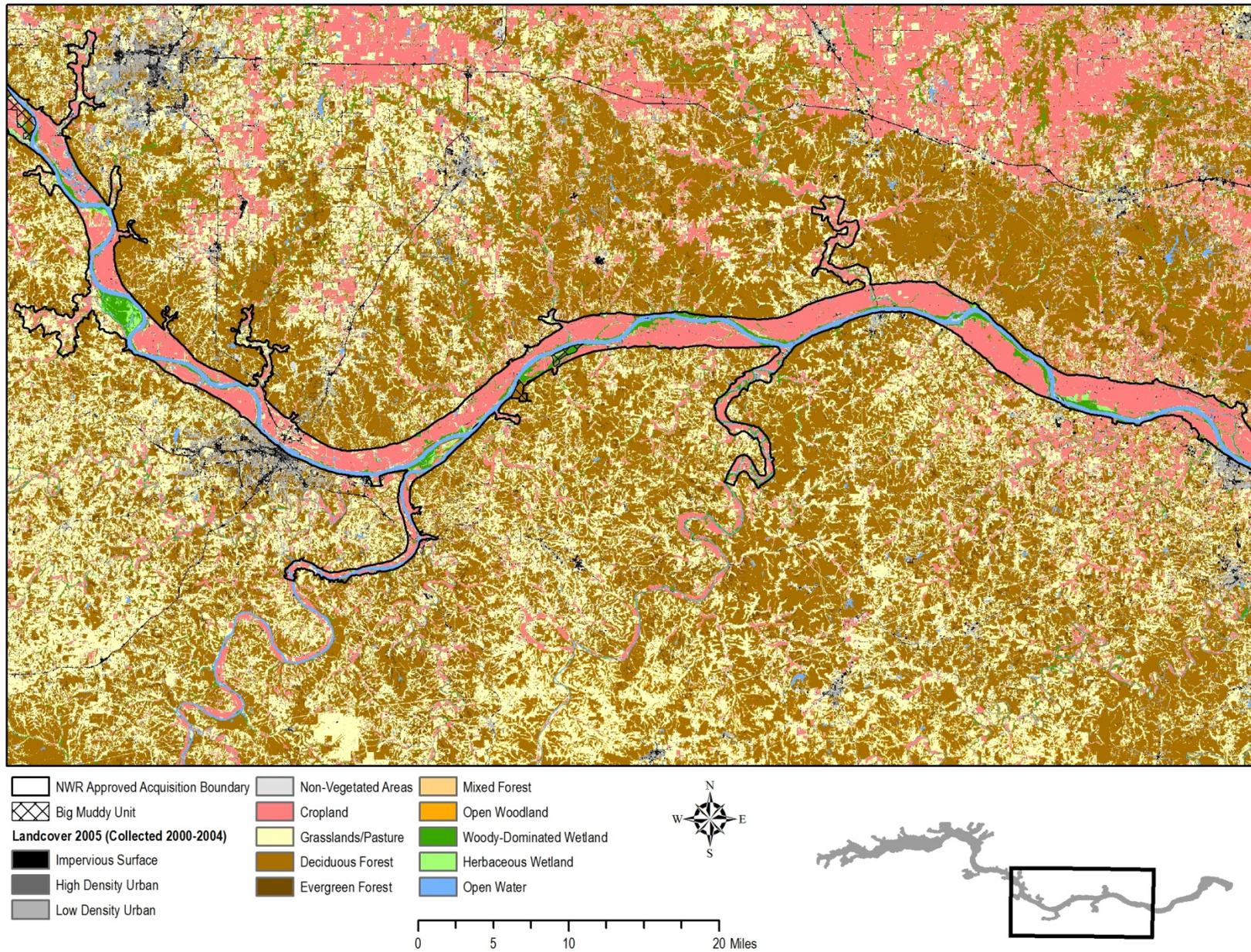
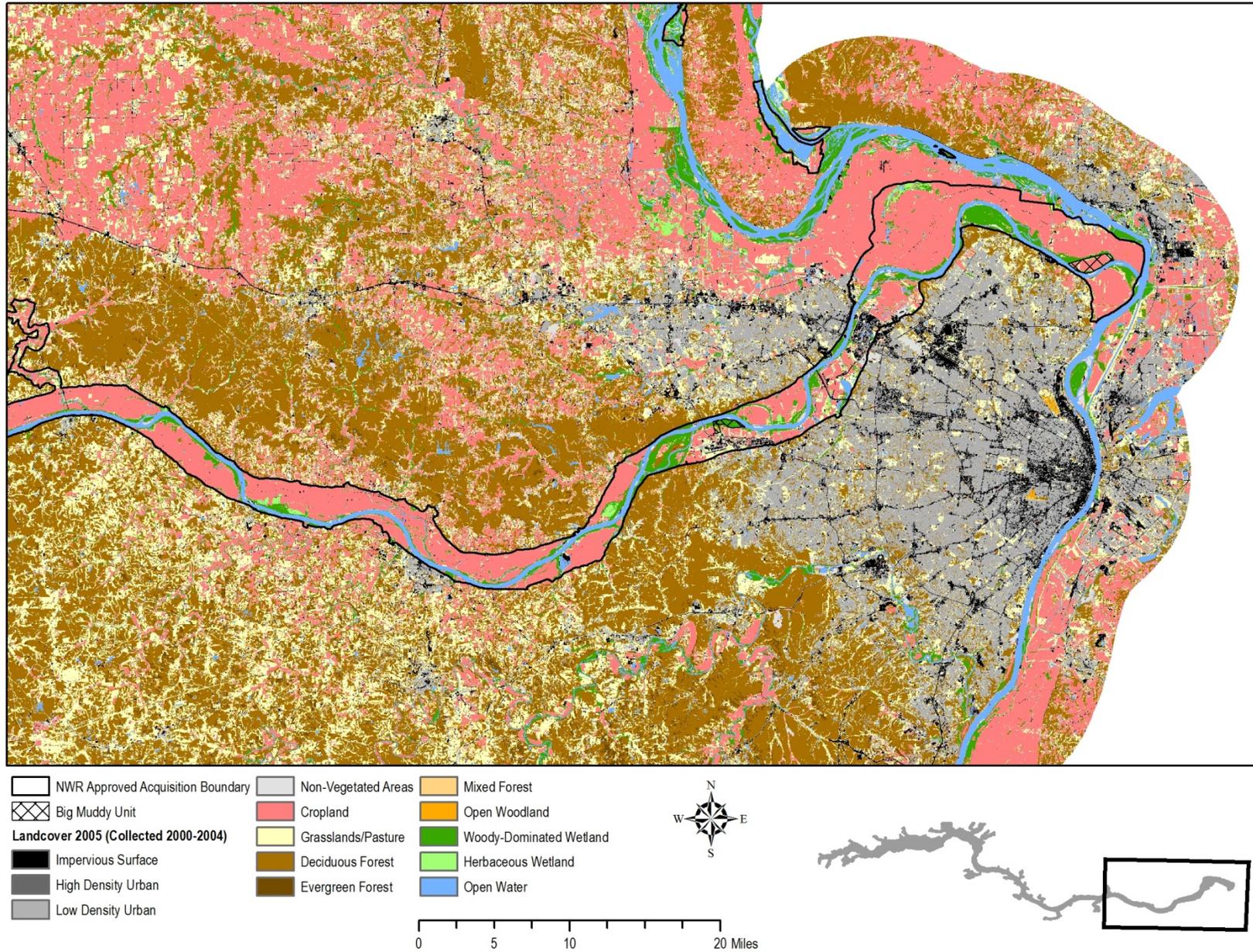


Figure 4-9 (Continued)



Refuge units, as well as other lands managed for wildlife along the Missouri River, provide an opportunity for historic vegetation to re-establish on the floodplain within the context of the existing regimen of river flows managed by the USACE and natural flooding. The following sections describe some of the habitats returning to the floodplain on refuge units.

A study of vegetation at five units of the refuge by USGS scientists (Struckhoff and others 2011) delineated and described 17 natural and semi-natural communities. They identified six upland forest communities, six temporarily flooded forest communities, one woodland, one shrubland, and three herbaceous communities (table 4-2).

Table 4-2: Vegetation Communities Encountered on Five Units of Big Muddy NWFR During Plot Sampling or Map Classification by USGS in 2011

U.S. National Vegetation Classification Standard Common Name	Total Area (acres) of Community Mapped on Five Units of Refuge*
Upland Forests	
White Oak-Red Oak-Sugar Maple Mesic Forest	37
White Oak/Dogwood Dry-Mesic Forest	52
Oak Dry-Mesic Alkaline Forest	
Midwest Post Oak-Blackjack Oak Forest	
Black Oak-White Oak-Hickory Forest	67
Ozark Red Cedar-Hardwood Forest	148
Temporarily Flooded Forests	
Cottonwood-Willow Forest	4,673
Black Willow Riparian Forest	
Silver Maple-American Elm Forest	193
Central Green Ash-Elm-Northern Hackberry Forest	
Ash-Oak-Sycamore Mesic Bottom-land Forest	12
Box Elder Forest	37
Woodland	
Cottonwood Floodplain Woodland	529
Shrubland	
Sandbar Willow Shrubland	363
Herbaceous	
Central Wet-Mesic Tallgrass Prairie	91
Midwest Ephemeral Pond	232
Sparse Herbaceous	
Riverine Sand Flats	264

*Communities with no area shown were encountered during map production but were mapped as other types. Units sampled included Jameson Island, Lisbon Bottom, Overton Bottoms, St. Aubert Island, and Boone's Crossing.

The scientists' review of literature concerning historic, current, and potential vegetation communities of the Missouri River floodplain identified 25 potential bottom-land vegetation associations that had a high likelihood of occurrence within the refuge (table 4-3). Many of these communities are now extremely rare within Missouri as a result of conversion to agriculture and river management. Primary among these are non-forested wetlands, wet-mesic prairies, and bottom-land oak woodlands and forests. Many of these were not found on the refuge during their study though they potentially exist within the Missouri River floodplain. Some may develop on refuge units with time.

Table 4-3: Potential Bottom-land Vegetation Associations not Encountered on Big Muddy NFWR Plot Sampling or Map Classification by USGS in 2011

U.S. National Vegetation Classification Standard	Common Name
Temporarily Flooded	
	Pin Oak Mixed Hardwood Forest
	Bur Oak-Swamp White Oak Mixed Bottom-land Forest
Woodland	
	Bur Oak Bottom-land Woodland
Shrubland	
	Northern Buttonbush Swamp
Herbaceous	
	Central Cordgrass Wet Prairie
	Bulrush-Cattail-Bur-Reed Shallow Marsh
	Midwest Cattail Deep Marsh
	Midwest Mixed Emergent Deep Marsh
	American Lotus Aquatic Wetland
	River Bulrush Marsh
	Central Midwest Sedge Meadow
	Eastern Great Plains Saline Marsh
	Great Plains Acidic Seep

Grasslands

True grasslands are rare on the refuge but occur where active management has hurried succession by adding native grass species to retired cropland. Old fields occur where crop fields have succeeded to aggressive weedy species.

Forest

In general, forests found on the refuge include narrow bands of large cottonwoods along the Missouri River and dense, young stands of riparian species such as cottonwood, willows, sycamore, box elder, ash, and silver maple in disturbed areas such as former cropland or recently flooded land. The most common forest types on the five units are Cottonwood-Willow Floodplain Forest and Silver Maple-American Elm Forest. Refuge staff and volunteers have planted small clusters of bottom-land hardwood species on the highest elevations of some units.

Many dense stands of trees established on former cropland after acquisition by the Service in the mid- to late-1990s. These “doghair” stands have entered the stem exclusion stage of forest development. Forests progress through four stages during development: stand initiation, stem exclusion, understory reinitiation, and old growth (Struckhoff and others 2011, citing Oliver and Larson 1990). In dense stands, stems compete for light, water, nutrients, and physical space, and less competitive stems die. Mortality is augmented by flooding, the effects of which tend to be patchily distributed within established stands due to variation in flood intensity (water depth, speed, duration) as determined by landscape characteristics.

Shallow Water Habitat

The transformation of the Missouri River into a shorter, swifter main channel reduced habitat diversity and increased water clarity. The new river has lost its dynamic nature and ability to carve the landscape. In 2000, and amended in 2003, the Service released a Biological Opinion to protect and recover the populations of three threatened and endangered species on the Missouri River. One element outlined in the 2003 Biological Opinion requires the restoration of 20 percent of the shallow water habitat that existed in the historical river.

Invasive Plants

Some exotic (also known as non-native or alien) plants greatly alter the plant communities of natural areas. Others more commonly affect already disturbed or agricultural areas. Invasive species are aggressive species that can be native or exotic. Left unchecked, noxious plant species can seriously degrade the productivity and wildlife value of invaded habitats.

Noxious Weeds

The following plants have been found on the refuge and are state-listed as noxious weeds (<http://plants.usda.gov>). In Missouri, the term “noxious” refers to the weed’s ability to cause economic harm to the State’s agriculture industry and to the high level of difficulty associated with controlling or eradicating the species (<http://mda.mo.gov/plants/forests>).

- Musk thistle (*Carduus nutans*), a biennial that develops annual tap root. Typically, seeds germinate in the spring or fall, forming large rosettes that bolt the following year. Seeds remain viable up to 10 years. Musk thistle spreads rapidly and forms extensive stands.
- Canada thistle (*Cirsium arvense*), an herbaceous perennial reaches two to five feet in height. Small, light purple flowers bloom from July to September. Seeds remain viable in soil for up to 20 years. Canada thistle can tolerate wide ranges of soil types and moisture levels. It quickly colonizes disturbed areas, and can replace native species by forming dense monotypic clones.
- Common and Cut-leaved teasels (*Dipsacus fullonum* and *D. laciniatus*), are herbaceous biennials, growing as a basal rosette of leaves for one year, then bolting, flowering and dying in the second year. Dispersal has been primarily along roadways.
- Purple loosestrife (*Lythrum salicaria*), an herbaceous perennial, featuring leaves that are opposite or three in a whorl without teeth, stems that have four angles and are semi-woody at its base, flowers that have five to seven purple petals in long spikes at the ends of branches, and blooms late June to late August. Grows in sunny wetlands, on stream banks, in ditches, and in other disturbed habitats. Reproduces prolifically by cuttings, offshoots, and seeds. A single plant can produce up to 300,000 seeds.
- Kudzu (*Pueraria lobata*), a perennial vine in the legume family. Each leaf has three dark green leaflets, with or without irregular, shallow lobes, and hairy beneath. Grows rampantly. Hairy vines trail, sprawl and twine from a large central root crown.
- Johnson grass (*Sorghum halepense*), a tall, coarse grass with rhizomes. Grows in dense clumps or nearly solid stands and can reach eight feet in height. Leaves are smooth with a white midvein. Panicles are large, loosely branched, purplish, and hairy.

Thrives in open, disturbed, rich bottom land, particularly cultivated fields. Quickly dominates the herbaceous flora and reduces plant diversity.

Invasive Non-Native Plants

Some of the most invasive non-native plant species found on the refuge include:

- Garlic mustard (*Alliaria petiolata*), a biennial herbaceous plant that grows as a basal rosette during the first year and flowers the second. Young leaves smell distinctly of garlic or onion. Prefers forest understory or along forested edges. Tolerates low light levels, and takes advantage of disturbed habitats such as trails, roadsides, and stream banks. Quickly out-competes other forest understory plants. Compounds in the plant found to depress growth of other forbs, grasses, and tree seedlings.
- Japanese hops (*Humulus japonicus*), a fast-growing, herbaceous annual vine. Seeds remain viable in the soil for three years, dispersed by wind and water along rivers and streams. Stems, covered with rough hairs that are irritating to bare skin, begin growth in May and by late summer can be up to 35 feet in length. They quickly climb and blanket native riverbank and floodplain vegetation.
- Bush honeysuckles, Morrow's and Amur (*Lonicera morrowii* and *L. maackii*), a deciduous shrubs, six to 20 feet tall, flower during May and June, with red fruit forming in the axils of the leaves. Often the source of the invasion comes from a landscaping planting, with seeds spread by birds. Thus refuge units near urban areas are at highest risk. Can tolerate moderate shade. Bush honeysuckle leaf out before many native species and hold their foliage until November, shading out the competition.
- Reed canarygrass (*Phalaris arundinacea*), a fast growing, cool season, perennial grass, three to seven feet tall, with rhizomes that forms a sod. Thrives in areas with frequent and extreme fluctuations of water levels, and is drought resistant.
- Common reed (*Phragmites australis*), a six to 15 foot tall grass that forms near monotypic stands, prefers low, wet areas and reproduces through wind dispersal of seeds and vigorous vegetative rhizomes. A purple-brown seed head with plumes appears by late July. The feathery plumes that form at the end of stalks can be up to 20 inches tall and eight inches wide.
- Sericea lespedeza (*Sericea lespedeza*), a shrubby, deciduous perennial about two to five feet tall. Coarse stems are single or clustered with numerous branches. Stems and branches densely leaved with trifoliate leaves about ¼ to 1 inch long. Each leaf has a conspicuous point at the tip, unlike native lespedezas. Small, yellowish-white with purple to pink marked flowers appear from mid-July to early October. A prolific seed producer, with seed that remains viable in the soil 20 years or longer. Establishes best where competing vegetation is short, such as heavily grazed or burned pastures.

Current Management: Habitat

Grasslands

Native grass species, such as prairie cordgrass, eastern gamagrass, and mixes of native grasses and forbs, have been planted on appropriate sites of retired cropland. Invasive species have been kept under some control through spot treatment efforts. For example, spraying with

glyphosate herbicide and mowing to control cedar invasion. Since Johnson grass, an aggressive invasive species of great concern in the floodplain, responds vigorously to burning, prescribed fire is not used as a tool to manage the grasslands where Johnson grass is present in stands large and dense enough to be of concern. In addition, a permittee cut hay annually at the Loesing tract, starting in 2002 and ending 2008. The mowing helped control woody and invasive species until native vegetation could be re-established. Seeding with a mix of native grasses and forbs was initiated at this site in 2008.

Forests

In 2001, small patches (two to 10 acres) of bottom-land hardwood tree species, such as bur oak, swamp white oak, pin oak, pecan, and shellbark hickory, were planted on higher elevations of retired cropland and when possible near existing forest (to increase forest block size). The tree seedlings planted were usually started by the root production method (RPM), shown to survive better and grow faster than bare root stock due to their larger size and dense, fibrous root systems. A cover crop, such as Virginia wildrye was usually planted and weed barrier mats and tree guards were usually placed around seedlings to reduce weedy competition and protect the tender bark from rodents and rabbits. The bottom-land hardwood trees add diversity to forests of more aggressive and abundant bottom-land species, such as cottonwood, sycamore, and willows, which often colonize within a few years sites. The planting of RPM trees and shrubs, usually mast bearing and always floodplain species, is used on a small percentage of refuge lands. Sites are chosen that are artifacts of manmade structures (remnant levees) or parcels that are levee protected and thus, in terms of flood frequency, at a much higher elevation than the measured mean sea level elevation. The RPM trees grow quickly, provide native vegetation and diversity. It is important to note these species did occur in historic times, but in small numbers and at scattered locations that provided environmental conditions necessary for survival and reproduction.

Shallow Water Habitat

Sometimes opportunities present themselves to hasten or “direct” succession and diversity of floodplain habitats. Through the USACE Mitigation Project, side channels have been constructed at several refuge units to create shallow water habitat and reconnect the floodplain with the river. Some shallow water habitat work has been done within existing riverbanks to improve aquatic habitat next to several refuge units. The work to develop more shallow water habitat includes notching dikes, rock placement to create reverse dike chevrons, and some bank excavation to create “rootless” dikes.

On a much smaller scale, two levee repair projects on private land adjacent to Jackass Bend Unit used soil from the refuge resulting in a shallow wetland area on the refuge. This project resulted in a seasonal wetland being created on refuge lands. In addition, a small wetland at Jameson Island was mechanically created to mitigate a wetland compromised by the side channel project at that unit.

Invasive Plants

In 2001, refuge staff initiated control of Johnson grass at Overton Bottoms North. The Johnson grass was sprayed with glyphosate herbicide and disked to expose roots to killing freezes. Then, the treated areas were planted with cover crops and native species such as eastern

gamagrass and a mix of prairie grasses. Some areas have shown success in reducing the vigor of Johnson grass while others have not.

The refuge began an inventory of noxious plant species in 2003 with three volunteers. Control of purple loosestrife began the next year. Also in 2004, the refuge began a program of invasive species inventory, mapping, and control during the summer months with Student Temporary Employment Program college students. The invasive weed inventory and mapping assists in reviewing and prioritizing control efforts in keeping with habitat management goals and objectives or to eradicate newly discovered invasives (early response) or reduce the spread of economically damaging species to neighboring properties/croplands. Since approximately 8,000 acres of the refuge have areas with invasive plants, the program continues today as funding allows.

During 2010, the refuge treated about 500 acres of invasive plants. The treatment concentrated on garlic mustard, Japanese hops, Johnson grass, common reed, purple loosestrife, sericea lespedeza, tree of heaven, bush honeysuckle, and a two-acre patch of kudzu found near the railroad at St. Aubert Island Unit.

Effects on Habitat

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on habitat include the following:

- Species Composition: The number and types of plant life present.
- Age Structure: The age-class diversity of plant life present (most relevant to forests).
- Spatial Distribution and Heterogeneity: The areal extent, location, and pattern of plant life.

The intensity categories for determining effects on habitat are defined as the following:

- Negligible: Changes to plant life would not be measurable or would be at the lowest level of detection.
- Minor: May be a detectable change, but the change would be slight and have a local effect on plant life.
- Moderate: Clearly detectable change or appreciable effect plant life.
- Major: Severe alteration of plant life, substantial and highly noticeable, could result in widespread change to plant life and could be permanent.

The effects on habitat from implementing the various alternatives described above were determined to be the following:

Habitat Effects 1

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under all alternatives, reconnecting the river to the floodplain would reintroduce riverine hydrology to formerly isolated habitats, which may shift vegetative communities across the landscape as the channel more naturally meanders.

Habitat Effects 2

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input checked="" type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under all alternatives, returning sites to natural vegetation cover types would have localized and broad scale effect on all vegetation indicators.

Habitat Effects 3

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input checked="" type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches, and under Alternative B within the Columbia Reach, disturbance (i.e., prescribed fire, harvest) and planting (i.e., trees, seeds) would likely increase species composition and could change the age structure, especially in grasslands and forests. In sites where invasive species are removed, native species composition would likely increase.

Habitat Effects 4

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input checked="" type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches; under Alternative B within the Columbia Reach; and under Alternative C within the Columbia Reach and St. Louis Reach, very localized change in all indicators of vegetation by removing it for potential future facility, road or parking lot construction.

Cooperative Farming

Current Management

Since the establishment of the refuge, some tracts have been actively farmed when acquired for the refuge. Usually, the previous owner managed and harvested that year's crops, and then over the next several years cropland was retired and allowed to revegetate with native species. Sometimes the residual seed bank or natural reforestation was supplemented by adding shrub and tree seedlings, grass plants, or seeds of native grasses and forbs. However, on some tracts, under a cooperative agreement, the farmer was allowed to continue planting and harvesting crops (with a portion of receipts returned to the government) to control invasive species until funds were available to revegetate the area. In one unusual situation, to reduce variability of habitat, cropping was allowed to continue at Cranberry Bend during a shorebird habitat study that started when it was added to the refuge.

In most cases cropland is retired within two years of land acquisition. Currently, all cropland on the refuge has been retired except those on the two most recently added units, Cora Island and Overton Bottoms South. Table 4-4 shows a summary of unit acquisition history, acres of crops permitted, and plantings to improve habitat diversity. For some tracts, especially those acquired during the 1990s, landowners had already retired cropland due to damage from floods (broken levees, sand splays, scour holes, etc.).

Table 4-4: Summary of Cooperative Farming and Habitat Improvement Plantings at Big Muddy NFWR

Unit	Acres	Year Added to Refuge	Plantings by Fiscal Year (Acres)				
			Year	Crops Permitted	Trees	Shrubs	Grasses/Forbs
Baltimore Bottom	1,490	2002	2003	760			
			2004	760			
			2005	760			
			2006	760			
			2007	700	7		2
			2008	210	25		175
			2009		9		4
			2010				
			2011				
	136	2005	2006	90			
			2007	90			5
2008			70			26	
2009			46	2		37	
2010			20				
Boone's Crossing	130	2002					
	442	2004					
Cora Island	1,265	2010 ^a	2010	700 ^b			
			2011	650			
			2012 ^d	420			5
Cranberry Bend	85	1996	2000 to 2006	7			
			2007	0	7	7	8
	468	2000	2000	283			
			2001	278			
			2002	278			
			2003	278			
			2004	278			
			2005	257			12
			2006	240	10		38
			2007	200	28	10	
			2008	115	12		12
			2009	78	15	8	28
		2010					
	2011						
54	2008						
Jackass Bend	468	1997	2001				50
	30	1998					
	39	1999					
	189	2002	2003	65			
			2004	65			
			2005	60			
			2006	60			12
			2007		10	2	32
	2008		32				
	2009						

			2010					
	117	2008						
Jameson Island	123	1995						
	212	1996						
	1,536	1998	2006			1		
Lisbon Bottom	1,126	1995						
	220	1996						
	668	1997						
Overton Bottoms North	92	1995						
	176	1996						
	281	1997						
	96	1998						
	1,300	1998 ^a	1999					21
			2000			21		154
			2001			12		172
			2002					1
			2003					
			2004			1		
			2005					
			2006					20
			2007					
			2008					
	2009			4		10		
2010								
2011								
103	2000	2003					35	
		2010					5	
		2011					5	
501	2006	2007			5			
		2008			3	2		
		2009						
Overton Bottoms South	2010 ^a	2010		554 ^b				
		2011		554 ^b			20	
		2012 ^d		483			20	
St. Aubert Island	657	1995						
	27	1996						
	442	2002 ^c						

^aAcquired for USACE Mitigation Project, licensed to refuge for management.

^bAgricultural lease managed by USACE.

^cAcquired by Farm Services Agency in 1993, transferred to refuge for management.

^dUnit with active cropland as of 2012.

Effects on Cooperative Farming

The effects on cooperative farming from implementing any of the various alternatives described above are included under the [Soil Resources](#), [Water Resources](#), and [Habitat](#) sections above. Since none of the actions in any of the alternatives include a change in the process for acquiring agricultural land and converting it to natural cover within two years, it was determined there would be no socioeconomic effects related to cooperative farming. No cooperative farmer or their financial situation would be affected by implementing any of the alternatives.

Wildlife

Studies of wildlife began shortly after establishment of the refuge, especially at Lisbon Bottom Unit, which has the first naturally formed chute on the lower Missouri River in many years. *Initial Biotic Survey of Lisbon Bottom, Big Muddy National Fish and Wildlife Refuge* (Humburg and Burke 2000) reports the findings of several studies done at Lisbon Bottom through collaboration among many researchers from agencies and universities to investigate the short-term effects of the Great Flood of 1993 and the diverse aspects of Lisbon Bottom Unit's physical setting and biota. The studies provide baseline information to judge the success of restoration efforts on other units of the refuge.

Plants

Plants occurring on the Big Muddy NFWR are representative of large floodplain communities. In many areas of the refuge former crop fields have been supplanted by dense floodplain forests dominated by cottonwood and willow. As these forests age species composition changes to include white mulberry, silver maple, box elder, sycamore and a few mast bearing hardwoods such as pin oak and bur oak. Areas not dominated by forest include species of aster, smartweed, sunflowers, goldenrod, Reed's canary grass, Johnson grass and other annual and perennial herbaceous plants typical of disturbed sites. Invasive species that are of concern include Johnson grass, Reed's canary grass, garlic mustard, Japanese hops, bush honeysuckle, kudzu and phragmites. This list seems to grow longer as time passes.

Mammals



Beaver; photo: USFWS

The refuge supports over 40 species of mammals, including white-tailed deer, coyote, red fox, striped skunk, bobcat, raccoon, and meadow vole (appendix B). In fact, six of the twenty counties in the RAA (Callaway, Boone, Chariton, Carroll, Osage, and Howard) are ranked in the top 25 deer harvest counties of Missouri. Principal aquatic mammals along the Missouri River include mink, river otter, beaver, and muskrat. Federally endangered gray and Indiana bats are reported to use lower Missouri River bluff caves for hibernation and the riparian corridor for foraging. Nine-banded armadillo

(*Dasypus novemcinctus*) are expanding their range northward and have been seen in every county along the southern shoreline of the Missouri River and a few counties on the northern side (Martensen 2007). Unfortunately, feral hogs have the potential to expand into habitat found on the refuge as well.

Fish and Mussels

The fish fauna of the Missouri River has undergone rapid change in response to the habitat modifications resulting from bank stabilization and creation of a navigation channel. By the 1970s the river was confined to a single, narrow, deep channel with virtual elimination of side channels and islands, and had less turbid water. The flathead chub and plains minnow, the two dominant forage fishes in the Missouri River in 1945, have nearly disappeared, largely replaced by the emerald shiner and other sight-feeding minnows. The pallid sturgeon has declined in abundance since the early part of the 20th century. Hybridization between this species and the shovelnose sturgeon probably is a response to changing habitat conditions in the Missouri River (Pflieger 1997).

The Missouri and Mississippi Rivers support a distinct assemblage of fishes that sets them apart as a separate faunal region (Pflieger 1997). Certain fishes found in these rivers occur nowhere else in Missouri. In all, 27 species of fishes are confined in the big rivers. The most abundant large fishes in the Missouri River are shortnose and longnose gar, gizzard shad, common carp, river carpsucker, buffalofishes (three species), channel catfish, flathead catfish, white bass, and freshwater drum. The largemouth bass, bluegill, and crappies (two species) are abundant in oxbows and backwaters. Other species especially characteristic of the Big River Region include chestnut lamprey, shovelnose and pallid sturgeons, paddlefish, skipjack herring, goldeye, blue sucker, and blue catfish. Minnows are the most abundant group of small fishes in the Big River Region. The speckled chub, sturgeon chub, sicklefin chub, silver chub, flathead chub, plains minnow, emerald shiner, river shiner, silverband shiner, and channel shiner are especially characteristic.

The CFWCO began fishery resources surveys on Lisbon Chute in 1997. Their first survey contained 36 species of over 100 fish species known to inhabit the lower Missouri River (FWS 1998). Sampling the next year collected 64 species in Lisbon Chute, and only 26 species in the adjacent Missouri River (FWS 1999a). In 1999 they documented reproduction of the endangered pallid sturgeon for the first time in the Lower Missouri River in 50 years with collection of a larval pallid sturgeon at the lower end of Lisbon Chute. They also collected four species of concern in the chute: sicklefin chub, sturgeon chub, plains minnow, and blue sucker. Later sampling by CFWCO fisheries biologists also found a greater relative abundance and species composition of fishes using side channels than fishes caught in the main channel (Mauldin 2004).

A study of Lisbon Bottom wetlands captured 40 species of fish (Chapman and others 2002). Relative abundance and species composition of fishes using the floodplain differed greatly from the fish communities associated with the Missouri River and Lisbon Chute.

These studies illustrate that a diversity of aquatic habitats supports a greater diversity of fish species. Fishes of Missouri (Pflieger 1997) lists over 130 species likely to occur in the RAA, including the lower 10 miles of major tributaries (appendix B).

Reptiles and Amphibians

Over 80 species of reptiles and amphibians likely occur on the refuge with some of the more common species including southern leopard frog, tiger salamander, American toad, and black rat snake (appendix B). The Service continued a mark/recapture study of aquatic turtles (begun in 1997 by a university student) at Overton Bottoms North Unit. The six species captured included spiny softshell, midland smooth softshell, western painted, false map, red-eared slider, and common snapping turtle.



Snapping turtle; photo: USFWS

Insects

A brief survey at three units of the refuge found 21 species of damselflies and dragonflies and four species of tiger beetles. The entomologist conducting the study felt that was only a fraction of the species likely to be found (Trial 2003).

Furthermore, a study of macroinvertebrates in the Lisbon Bottom wetlands found 167 species; 128 of these species were unique to the floodplain wetlands and not found in the main stem channel (Chapman and others 2002).

And finally, the refuge biologist worked with several volunteers from Missouri Master Naturalists to collect and identify pollinating insects on the refuge. To date they have found over 130 species of butterflies and moths and over 100 species of bees and wasps (appendix B).

Threatened and Endangered Species

Each year the Missouri Department of Conservation (MDC) issues a checklist of species of conservation concern. The January 2011 list includes 10 plants, 14 mollusks, two insects, 22 fishes, two amphibians, five reptiles, nine birds, and six mammals as state or federally threatened or endangered species.

Table 4-5 shows federally threatened, endangered, and candidate species that could occur in at least one of the 20 counties of the RAA (FWS 2010a). Five listed mussels and one proposed candidate mussel may occur in the lower 10 miles of Missouri River tributaries and therefore in the RAA. Four plants and two fishes are also included on the federal list for the 20 counties, but suitable habitat is not likely to occur within the RAA.

Table 4-5: Federally Threatened, Endangered, Proposed, and Candidate Species that Could Occur in Counties of the Big Muddy NFWR Acquisition Area

Common Name	Scientific Name	County	Status	Habitat
Least Tern (Interior Population)	<i>Sterna antillarum</i>	Chariton, St. Charles (breeding records) Migrant in all 20 RAA counties	Endangered	Large rivers. Nest on sandbars
Piping Plover	<i>Charadrius melodus</i>	Migrant in all 20 RAA counties	Endangered	Wide, flat, open, sandy beaches with very little grass or other vegetation
Gray bat	<i>Myotis grisescens</i>	Boone, Callaway, Cole, Franklin, Gasconade, Howard, Osage, St. Louis	Endangered	Caves
Indiana bat	<i>Myotis sodalis</i>	All 20 RAA counties	Endangered	Hibernacula=caves and mines; maternity and foraging habitat=small stream corridors with well-developed riparian woods; upland forests
Pallid sturgeon	<i>Scaphirhynchus albus</i>	All 20 counties	Endangered	Missouri and Mississippi Rivers
Decurrent false aster	<i>Boltonia decurrens</i>	St. Charles, St. Louis	Threatened	Disturbed alluvial soils
Running buffalo clover	<i>Trifolium stolonifereum</i>	Boone, Callaway, Cole, Cooper, Howard, Moniteau, Montgomery, St. Charles, St. Louis	Endangered	Disturbed bottom-land meadows
Suitable habitat not likely to occur in Missouri River but may in tributaries:				
Spectaclecase	<i>Cumberlandia monodonta</i>	Cole, Franklin, Osage, St. Louis	Candidate	Bourbeuse and Meramec Rivers
Snuffbox	<i>Epioblasma triquetra</i>	Franklin, Gasconade, St. Louis	Proposed Endangered	Small to medium-sized creeks with a swift current
Sheepnose	<i>Plethobasus cyphus</i>	Franklin, St. Louis	Candidate	Bourbeuse River
Scaleshell	<i>Leptodea leptodon</i>	Franklin, Gasconade, Osage, St. Louis	Endangered	Gasconade River, Osage River, Bourbeuse River, Meramec River
Pink mucket	<i>Lampsilis abrupt</i>	Cole, Franklin, Gasconade, Osage, St. Louis	Endangered	Rivers
Winged mapleleaf	<i>Quadrula fragosa</i>	Franklin	Endangered	Medium to large rivers in mud, sand, or gravel
Suitable habitat not likely to occur in the RAA for the following:				
Mead's milkweed	<i>Asclepias meadii</i>	St. Louis	Threatened	Virgin prairies
Western prairie fringed orchid	<i>(Platanthera praeclara)</i>	Jackson	Threatened	Wet prairies & sedge meadows
Niangua darter	<i>Etheostoma nianguae</i>	Osage	Threatened	Rivers
Topeka shiner	<i>Notropis topeka</i>	Boone, Callaway, Cole, Cooper, Moniteau, Ray	Endangered	Small prairie streams in pools of clear, clean water

In September 2010 the shovelnose sturgeon (*Scaphirhynchus platyrhynchus*) was designated Federal Status of Threatened/SA (threatened due to similarity of appearance) because of its similarity of appearance to the endangered pallid sturgeon. The two species are difficult to differentiate in the wild and inhabit overlapping portions of the Missouri and Mississippi River basins in Missouri.

Delisted in 2007, bald eagles no longer receive protection under the federal Endangered Species Act. However, the bald eagle remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Recent taxonomic studies indicate that massasauga rattlesnakes in Missouri are western, not the rare eastern massasauga that is a candidate for federal listing (Giles 2011). However, all massasauga species are rare and included on the State's list.

Migratory Birds

Sixty-nine species of special status birds have been observed on the refuge, including Bald Eagle, Piping Plover, Least Tern, and Peregrine Falcon (FWS 2008a) (appendix B). More than 200 species of neotropical migrant landbirds (mostly songbirds) spend most of their life in the tropic zones of North and South America. Each spring about 110 of these species migrate to breed and reproduce in the forests of Midwest regions of North America. Fragmentation of habitats by roads, urban and commercial developments, intensive farming, deforestation, and other factors has adversely affected many of these migrants.

Waterfowl have historically used the Missouri River and its floodplain for resting, feeding, and nesting. Their concentration numbers and locations vary from year to year due to shifts in climate and habitat conditions; however, numbers are greatest during the spring and fall migrations. Shorebirds and dabbling ducks rest on islands and sandbars and forage in mudflats (shorebirds), wetlands, and grain fields (waterfowl) during migration. Common waterbirds along the lower Missouri River are American White Pelican, American Coot, Snow Goose, Canada Goose, Blue-winged Teal, Green-winged Teal, Northern Shoveler, Gadwall, Mallard, Wood Duck, and Great Blue Heron. Killdeer, Lesser Yellowlegs, Pectoral, Baird's, Least, Spotted, and Semipalmated Sandpipers are common shorebird migrants.

Since its establishment, over 300 species of birds have been observed on the refuge. Appendix B contains a list of all birds that utilize the refuge.

Invasive Animal Species

Of the numerous non-native fishes introduced into Missouri around the turn of the 20th century, only the common carp was notably successful. By 1895 the common carp was well-established, and is now one of the most widespread and abundant large fishes in Missouri.

During the 1970s, bighead and silver carp were imported into the United States for use in aquaculture production of food fishes and biological control of plankton in aquaculture ponds and sewage treatment lagoons. Within ten years, bighead and silver carp escaped confinement and spread to the waters of the Mississippi River basin and other large rivers. They are often the most abundant larval fish collected (Galat and others 2005). Today, these carp live in 23 states; their population numbers are increasing exponentially, and in addition, they are close to entering the Great Lakes (CERC 2011). The carp compete directly with native aquatic species

for food and habitat. The bighead carp in particular, because of its success and food habits, may compete directly with paddlefish, bigmouth buffalo, and the young of many other species. Their rapid population increase disrupts the ecology and food web of the large rivers of the Midwest, including the Missouri River.

Current Management

Plants

Current management for plants consists of inventory, mapping and control of invasive species and noxious weeds. Control methods include mowing, herbicide application and use of prescribed fire. Supplemental plantings of native seed or seedlings are employed as resources allow. The refuge cooperative farming program is used primarily to control invasive species and prepare a seedbed for planting of native vegetation. Monitoring and evaluation of treated areas are conducted to determine success or failure and what subsequent management actions are needed.

Mammals

Management efforts for mammals consists of protecting and restoring habitat to native vegetation that support healthy populations of native species of mammals. Natural processes such as overbank flooding are encouraged where possible to assist in development of native habitats. Hunting is allowed under statewide regulation to provide recreation but also to prevent overpopulation of species prone to that, such as white-tail deer. Mammals are protected from illegal take by refuge law enforcement officers and cooperating agencies, principally the MDC and county sheriff's departments..

Fish and Mussels

Management of these aquatic species consists primarily of working with partners including the USACE, the MDC and the U.S. Geological Survey to construct, manage, monitor and assess shallow water habitat types that were largely lost as a result of human manipulation of the Missouri River and associated floodplain. Examples of important habitat types targeted for restoration include side channels, sand bars, oxbow lakes, marshes, and other shallow habitat features.

Reptiles and Amphibians

Management for reptiles and amphibians includes the habitat restoration measures described in the mammals and fish and mussels sections above.

Insects

The terrestrial and aquatic habitat restoration and monitoring efforts described in the sections covering mammals and fish and mussels have equal application for insects. In addition to these efforts, ongoing studies of pollinators including butterflies, moths, bees, and wasps are being conducted. As knowledge is gained regarding specific requirements for these important species, habitat management may be modified in future years to provide specific needs.

Threatened and Endangered Species

Management efforts to benefit endangered species consists of creation, restoration, and protection of rare aquatic habitats, especially shallow water habitats important to the pallid sturgeon, a federally listed endangered species. Many additional large river obligate species in serious decline benefit from these habitat management efforts, hopefully precluding the need to list them at some point in the future. Land acquisition to secure additional sites suitable for habitat restoration, including shallow water habitat, is ongoing.

Management is also directed towards restoring bottomland forests and riparian corridors suitable for Indiana bats and gray bats, two federally listed endangered species. Riparian corridors are important foraging areas for both species of bat. Large trees with loose or exfoliating bark, fissures, and other cavities are important maternity habitat for Indiana bats.

Migratory Birds

Habitat restoration efforts including establishment of large blocks of floodplain forest in various seral stages are important to migratory birds, especially neotropical migrants. Habitat restoration of shallow water habitats provide significant benefits to numerous species of migratory birds including wading birds, shorebirds, waterfowl, raptors and others.

Invasive Animals

Refuge staff continues to informally monitor for invasive animal species, such as feral hogs, on units. Refuge staff consult and work cooperatively with other Service divisions, other federal agencies, and state agencies to address invasive Asian carp and feral hog issues. No specific management actions have been taken on refuge lands to date.

Effects on Wildlife

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on wildlife include the following:

- **Abundance:** The relative representation, or number of individuals, of any given species in a geographic area.
- **Distribution:** The spatial arrangement of wildlife, and describes the dispersion or local densities of individuals within a geographical area over time.
- **Health/vitality:** The overall well-being of wildlife populations related to disturbance, stress, disease, environmental toxicity, mortality, reproductive success, and a multitude of behavioral factors.

The intensity categories for determining effects on wildlife are defined as the following:

- **Negligible:** May be a change in wildlife, but the change would not be measurable or would be at the lowest level of detection.
- **Minor:** May be a detectable change, but the change would be slight and have a local effect on a population, could include changes in the abundance or distribution of individuals in a local area, but not changes that would affect the viability of local populations.
- **Moderate:** Clearly detectable change in a population and could have an appreciable effect, could include changes in the abundance or distribution of local populations, but not changes that would affect the viability of regional populations.
- **Major:** Severely adverse or exceptionally beneficial to a population, substantial, and highly noticeable; could result in widespread change and be permanent, could include changes in the abundance or distribution of a local or regional population to the extent

that the population would not be likely to recover (adverse) or would return to a sustainable level (beneficial).

The effects on wildlife from implementing the various alternatives described above were determined to be the following:

Wildlife Effects 1

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches; under alternative B within the Rural Reaches, St. Louis Reach, and Columbia Reach; and under Alternative C within all reaches, restoring hydrology, reconnecting the floodplain, and returning natural cover to the landscape will create more natural and suitable habitat for a variety of wildlife.

Wildlife Effects 2

Context		Type		Duration		Intensity	
<input type="checkbox"/>	Local	<input checked="" type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input checked="" type="checkbox"/>	Landscape	<input type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input checked="" type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative B within the Columbia Reach, restoring hydrology, reconnecting the floodplain, and returning natural cover to the landscape will create more natural and suitable habitat for a variety of wildlife. The effects will be amplified in areas where improved or optimum habitat is restored and invasive species are managed.

Wildlife Effects 3

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input type="checkbox"/>	Minor
						<input checked="" type="checkbox"/>	Negligible

Description

Under Alternative A within all reaches; under Alternative B within the Rural Reaches, St. Louis Reach, and Kansas City Reach; and under Alternative C within the Rural Reaches and Kansas City Reach, development and visitors may reduce habitat and create more disturbance for a variety of wildlife, however, any adverse effects would be very localized and would be negligible across the planning area.

Wildlife Effects 4

Context		Type		Duration		Intensity	
<input checked="" type="checkbox"/>	Local	<input type="checkbox"/>	Beneficial	<input checked="" type="checkbox"/>	Long-term	<input type="checkbox"/>	Major
<input type="checkbox"/>	Landscape	<input checked="" type="checkbox"/>	Adverse	<input type="checkbox"/>	Medium-term	<input type="checkbox"/>	Moderate
				<input type="checkbox"/>	Short-term	<input checked="" type="checkbox"/>	Minor
						<input type="checkbox"/>	Negligible

Description

Under Alternative B within the Columbia Reach, and under Alternative C within the Columbia Reach and Kansas City Reach, more development and visitors may reduce habitat and create more disturbance for a variety of wildlife, however, any adverse effects would be very localized and would be negligible across the planning area.

People

Socioeconomic Setting

Current Situation

According to the 2010 U.S. Census Bureau figures (U.S. Census Bureau 2011), nearly 20 million people live within the Missouri River drainage area of the United States. States included in that drainage area (Montana, Wyoming, Colorado, North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, and Missouri) collectively showed an 8.6 percent increase in population since 2000. Land use in the northwestern one-half of the basin is primarily rangeland and shrubland; whereas, land use in the southeastern half of the basin consists primarily of pasture and row crops. Urban areas such as Denver, Omaha, and Kansas City comprise only a small part of the basin (Sprague and others 2007).

The State of Missouri lies near the center of the North American continent and represents a biological crossroads where the major biomes transition from the extensive deciduous forests east of the Mississippi River to the tallgrass prairie of the Great Plains. The Missouri River forms the northwest boundary of Missouri and then bisects the state from west to east between Kansas City and St. Louis, in general separating the fertile rolling hills of the north from the rocky limestone Ozarks of the south. Agricultural land dominates much of the northern half of the state as well as the southeastern Bootheel and the southwestern and west central plains. Two large urban centers, the Kansas City and St. Louis metropolitan areas, and a smaller urban region in the center of the state (Columbia and the state capital of Jefferson City) contain about half of the state's population of around 6 million people.

Table 4-6 summarizes some socioeconomic data for the 20 counties of the refuge acquisition area (RAA). This table has been divided into "urban" and "rural" counties, which show some differences. However, it should be noted that even the rural counties within the RAA lie along Interstate Highway 70 and thus have relatively easy access to the urban centers. The urban counties, excluding the city of St. Louis, have a somewhat higher income level and appear to be on average more highly educated than citizens of rural counties. As to be expected, more farms are found in rural counties; although, these numbers depend to a large degree on the sizes of the counties. Urban counties appear to be continuing to increase in population while populations of most rural counties remains steady or are declining somewhat.

Table 4-6: Summary of Socioeconomic Data for 20 Counties of the RAA and St. Louis City.¹

		Population ²				# of FT and PT jobs	Unemployment rate	Agriculture 2007	Income 2008	Education
		2000	2009	% Change	2015	2008	May 2010, %	# of Farms ³	Median Household, \$	% Citizens with College Degree ⁴
Urban Counties	Jackson	654,880	705,708	7.8	678,274	469,475	10.4	938	47,284	23.4
	Clay	184,006	228,358	24.1	241,150	125,624	8.4	752	58,803	24.9
	Boone	135,454	156,377	15.4	170,796	112,891	5.6	1,322	47,434	41.7
	Cole	71,397	75,018	12.3	76,979	66,838	6.0	1,103	55,684	27.4
	Franklin	93,807	101,263	7.9	106,652	52,870	10.4	2,004	49,064	12.8
	St. Charles	283,883	355,367	25.2	402,519	168,415	8.1	644	72,428	26.3
	St. Louis	1,016,315	992,408	-2.4	975,010	783,143	8.6	276	57,782	35.4
	St. Louis City	348,189	356,587	2.4	350,583	285,011	11.0	--	33,993	19.1
	SUB-TOTAL	2,133,051	2,265,378	6.2	2,323,689					
Rural Counties	Ray	23,354	23,358	0.0	23,787	10,391	10.6	1,321	42,929	10.8
	Lafayette	32,960	32,572	-1.2	32,785	14,664	10.3	1,299	46,394	13.8
	Carroll	10,285	9,535	-7.3	9,489	5,416	9.7	1,199	40,555	14.0
	Saline	23,756	22,821	-3.9	22,082	12,820	7.2	995	38,653	15.8
	Chariton	8,438	7,594	-10.0	7,178	4,748	9.0	1,173	38,455	11.4
	Howard	10,212	9,857	-3.5	9,933	4,596	7.7	867	40,527	17.9
	Cooper	16,670	17,298	3.8	18,760	9,751	8.2	942	42,929	13.7
	Moniteau	14,827	15,132	2.1	15,490	7,174	7.3	1,138	51,942	13.0
	Callaway	40,766	43,727	7.3	47,427	21,692	7.2	1,503	49,852	16.5
	Osage	13,062	13,561	3.8	13,379	6,717	5.9	1,181	47,420	10.4
	Montgomery	12,136	11,698	-3.6	11,803	6,026	9.9	859	39,365	9.9
	Gasconade	15,342	15,096	-1.6	15,743	8,618	9.2	867	38,468	10.4
	Warren	24,525	31,485	28.4	36,410	10,778	10.6	723	45,779	11.1
	SUB-TOTAL	222,979	230,376	3.3	240,479					
STATEWIDE TOTAL		5,595,211	5,987,580	7.0	6,184,390	3,672,794	8.7	107,825	46,847	21.6

¹ The independent city of St. Louis is included here for comparison. While not a part of the RAA, the city is entirely surrounded by St. Louis County, which is part of the RAA.

² As of this writing, official 2010 census data was not available; 2009 and 2015 figures are estimates and projected estimations.

³ For the purpose of the Census of Agriculture, a farm is any place from which \$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year.

⁴ Data from the year 2000.

Approximately two and a half million people live in counties within the RAA. Therefore, the refuge must deal with a diverse population as the acquisition area includes both major urban centers and rural agricultural areas, each of which has unique characteristics.

Urban Development



Interstate 70 bridge at Overton Bottoms; photo: USFWS

Jackass Bend Unit lies only ten miles east of the Kansas City metro area. Boone's Crossing Unit lies within the city limits of Chesterfield, and Cora Island lies across the river from the St. Louis metro area. Urban development brings special challenges to closer units, such as destruction of habitat, changes in the water cycle, increased numbers of visitors and related disturbances, and higher values for real estate. Opportunities presented by urban development close to refuge units include developing more awareness and appreciation of the refuge and the mission of the Service,

providing larger audiences for environmental education and more volunteers to help with refuge projects. The distance of Kansas City and St. Louis metro areas from the refuge headquarters, approximately 120 to 130 miles, increases complexity for all management activities.

Environmental Justice

Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" was signed by President Clinton on February 11, 1994. Its purpose was to focus the attention of federal agencies on the environmental and human health conditions of minority and low-income populations with the goal of achieving environmental protection for all communities. The order directed federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The order is also intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low-income communities' access to public information and participation in matters relating to human health or the environment.

None of the management alternatives for the Big Muddy NFWR described in this Environmental Assessment would disproportionately place any adverse environmental, economic, social, or health impacts on minority and low-income populations. Public use activities proposed for each alternative would be available to any visitor regardless of race, ethnicity, or income level.

Effects on Socioeconomics

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on socioeconomics include the following:

- **Social:** The change in the state or condition of an individual, group of individuals, community or society. This may include physiological, psychological, cultural, spiritual, or other forms of social change. Examples include physical health, mental health, education, incidence of crime or conflict, place attachment, stewardship, community pride, family cohesion, cultural understanding, spiritual health, and appreciation of nature.
- **Economic:** The change in a financial value, state, or condition of something to an individual, group, business, community, government, or society. Examples include direct fiscal impacts (e.g., sales, jobs, and income), perceived values, worker productivity, business success, and organizational wellness.

The intensity categories for determining effects on socioeconomics are defined as the following:

- **Negligible:** Very few individuals, families, social groups, businesses, communities, or government entities are impacted; impacts are barely detectable or detectable only through indirect means and with no discernible impact on regional social and/or economic conditions.
- **Minor:** A few individuals, families, social groups, businesses, communities, or government entities are impacted; impacts are small but detectable, limited to a small geographic area, comparable in scale to typical year-to-year or seasonal variations, and not expected to substantively alter social and/or economic conditions over the long term.
- **Moderate:** Many individuals, families, social groups, businesses, communities, or government entities are impacted; impacts are readily apparent and detectable across a wider geographic area and may have a noticeable effect on social and/or economic conditions over the long term.
- **Major:** A large number of individuals, families, social groups, businesses, communities, or government entities are impacted; impacts are readily detectable and observed, extend across much of the study area, and have a substantial influence on social and/or economic conditions over the long term.

The effects on socioeconomics from implementing the various alternatives described above were determined to be the following:

Socioeconomic Effects 1

Context	Type	Duration	Intensity
<input checked="" type="checkbox"/> Local	<input checked="" type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input type="checkbox"/> Landscape	<input type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input type="checkbox"/> Minor
			<input checked="" type="checkbox"/> Negligible

Description

The existence of the refuge adds to the social and financial situation of the surrounding area. Visitors who go to the refuge typically spend money on food, gas, and lodging at nearby businesses.

Socioeconomic Effects 2

Context	Type	Duration	Intensity
<input checked="" type="checkbox"/> Local	<input checked="" type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input type="checkbox"/> Landscape	<input type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input checked="" type="checkbox"/> Minor
			<input type="checkbox"/> Negligible

Description

Under Alternative B within the Columbia Reach, and under Alternative C within the Columbia Reach, if a new office, visitor center, and other supplemental services and facilities are realized, more visitors will go to the refuge and will therefore spend more money at local businesses for their amenities.

Visitor Services

Current Management

Hunting

All refuge units are open to compatible wildlife-dependent recreation, including hunting, under Missouri statewide regulations, except for refuge-specific restrictions for safety reasons at Overton Bottoms North and South, Boone’s Crossing, and Cora Island units (table 4-7). Refuge-specific regulations applicable on all units include:

- All blinds and decoys must be removed daily.
- Tree stands are allowed overnight during deer seasons but must be labeled with owner's name, address, and phone number and removed by February 1 each year.
- Baiting, salt blocks, and minerals are not allowed.
- Non-toxic shot is required in shotguns.

Table 4-7: Big Muddy NFWR-Specific Hunting Restrictions

Hunting Restriction	Refuge Unit
Only archery hunting allowed, all game species. No firearms allowed.	Section (130 acres) of Boone’s Crossing Unit adjacent to Chesterfield Athletic Complex on mainland
Only deer hunting by archery methods. Hunting other game restricted to shotgun, with shot no larger than a BB.	Johnson Island, (Boone’s Crossing Unit)
Only deer hunting by archery methods. Hunting other game restricted to shotgun, with shot no larger than a BB.	Cora Island Unit
No hunting or trespassing around buildings; closed areas posted.	Overton Bottoms North and South

Fishing

All refuge units are open to fishing, under Missouri statewide regulations. The I-70 Scour, created during the Great Flood of 1993 at Overton Bottoms North Unit, continues to provide opportunities for fishing Missouri River species. Smaller scour holes can be found scattered at Overton Bottoms as well as other units. These water bodies get an influx of river fish species each time they become reconnected with the Missouri River during a flood event. The Missouri River provides outstanding opportunities for catching large catfish. Anglers can hike to the river on the Lewis and Clark Trail of Discovery at Jameson Island Unit, hike to the MDC owned Taylor's Landing at Overton Bottoms North Unit, or fish from a boat. The MDC provides thirty-four boat ramps on the Missouri River from Kansas City to St. Louis (MDC 1995).

Wildlife Observation, and Photography

The refuge hosts opportunities for wildlife observation and photography along its roads and trails. Several vantage points off the refuge provide panoramic vistas of refuge units, such as the view from a restaurant in Rocheport, MO just across the river from Overton Bottoms North Unit. This unit has a lookout point on the Loesing parcel where a monument was erected to honor the cooperation of Ducks Unlimited, Inc., the National Wild Turkey Federation, and the Service to purchase the 500 acres in the view below. Arrow Rock State Historical Site in Arrow Rock, MO provides several observation points overlooking the Jameson Island Unit.

Interpretation

Interpretive signs are provided at each of the refuge kiosks to help visitors understand more about the Service as well as the refuge. The Jameson Island Unit has nine interpretive signs along the Lewis and Clark Trail of Discovery and the connecting Arrow Rock Landing Trail, located on the adjacent Arrow Rock State Historic Site. The trails lead to the Missouri River and provides information about the Lewis and Clark expedition's passage through the area. The kiosks at Overton Bottoms North and Lisbon Bottom Units display information about the Mitigation Project and our partnership with the USACE to improve wildlife habitat.

Environmental Education

Upon request, refuge staff coordinate with area schools and colleges to provide field trips and tours of the refuge. We also participate in environmental education events hosted by Friends of Big Muddy, Missouri River Relief, Living Lands & Waters, Audubon Missouri, MDC, and others. Overton Bottoms, due its close proximity to Columbia (with several public and private schools, two colleges, and the University of Missouri), receives the majority of the educational group visits.

The refuge hosts the annual Missouri Junior Duck Stamp Contest. The program promotes wetlands and waterfowl conservation, and young artists learn about the habitat and characteristics of their chosen subject. Several volunteers help prepare for and execute the event. Between 900 to 1,500 students from across the state enter their artwork. Several Best of Show pieces of art from the Missouri contest have gone on to place or win at the Federal Junior Duck Stamp Contest.

Non-Wildlife-dependent Recreation

Visitors may collect mushrooms, nuts, and berries on the refuge for personal consumption. Some of the moist bottom lands produce abundant opportunities to find mushrooms. Other visitors take advantage of patches of blackberries found on refuge uplands.

Facilities

Since the establishment of the refuge, its headquarters have been co-located with the U.S. Geological Survey-Columbia Environmental Research Center (CERC), in southeast Columbia, Missouri. CERC provides space for a nine-room, 2,128 square-foot Mobile Office Unit (trailer), employee parking, and a boat barn (2,700 square feet) including a heated shop (700 square feet). CERC also supplies staff for some computer and on-site maintenance support. In 2007, a 1,809 square foot residence was acquired on an upland tract at Overton Bottoms North Unit that was named the J.C. Bryant Cabin, in honor of the first refuge manager. The building functioned as a meeting place for a few years, and now serves as an employee residence.

When the refuge acquired management of Overton Bottoms South from the USACE in 2009, it also assumed possession of a 3,750 square foot, mostly unheated (72 square foot heated bathroom) pole barn/shop facility located at the northwest corner of the tract. This building is used to store heavy equipment and materials. The refuge has no formal visitor center; however, on rare occasions a visitor finds our office trailer at the back corner of the CERC campus.

After acquisition of each unit, refuge staff post ownership boundaries and construct user facilities such as parking lots and kiosks with maps, regulations, and site-specific information (figure 4-10). At some units, where opportunities allow due to lower flooding risks, refuge staff construct and maintain trails, such as the Lewis and Clark Trail of Discovery (levee top trail that terminates at the Missouri River, Jameson Island), Boone's Crossing Loop Trail, and Little Muddy Trail (Overton Bottoms North).

The refuge owns a 16-foot cargo trailer that has been modified to serve as a mobile outreach exhibit. The trailer contains refuge literature and a tabletop display of the Lisbon Bottom and Jameson Island Units. The tabletop display is capable of using flowing water in a relief model to demonstrate sediment transport. The trailer is used throughout the year at special events from Kansas City to St. Louis.

Figure 4-10: Big Muddy NFWR Visitor Services on Two Panels

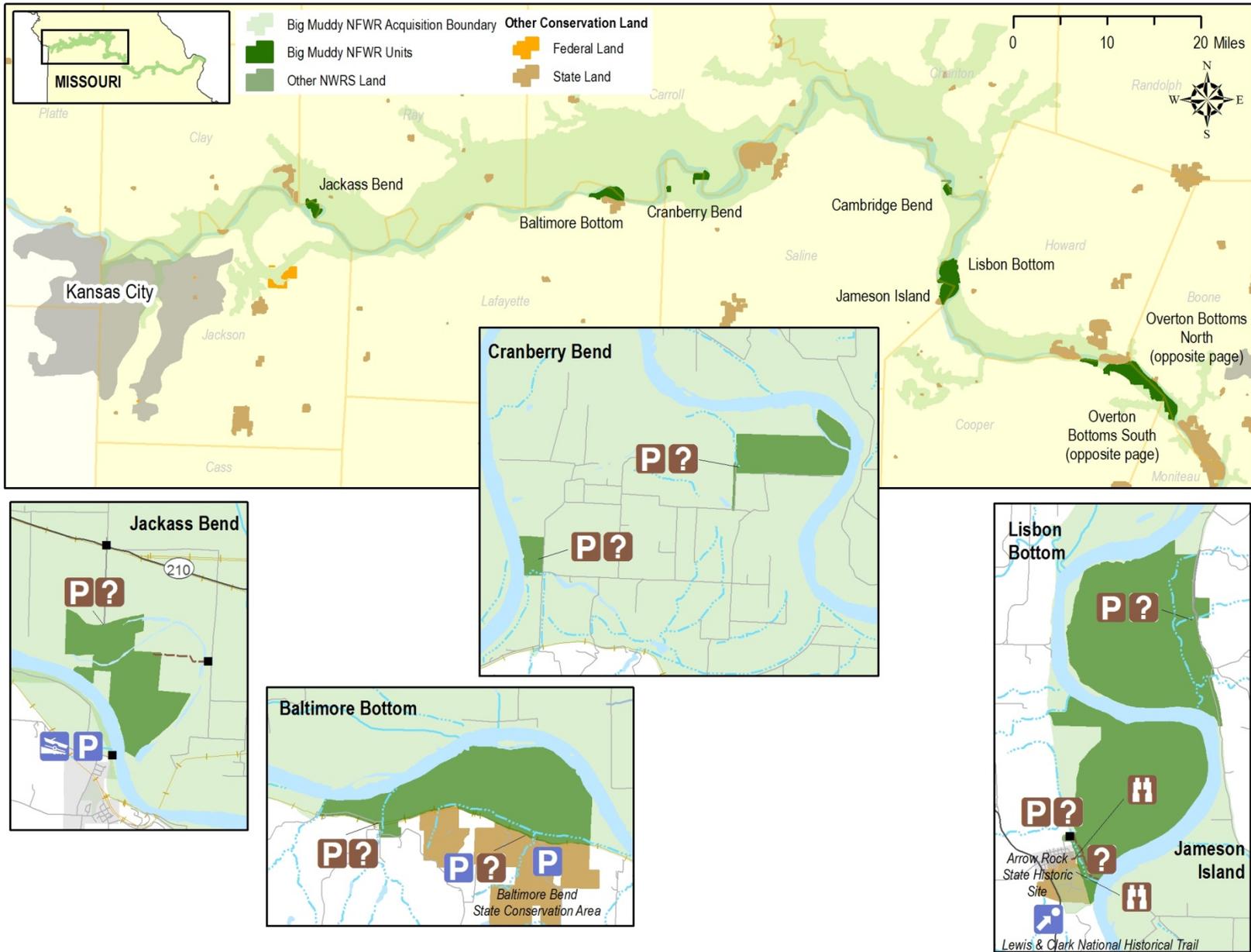
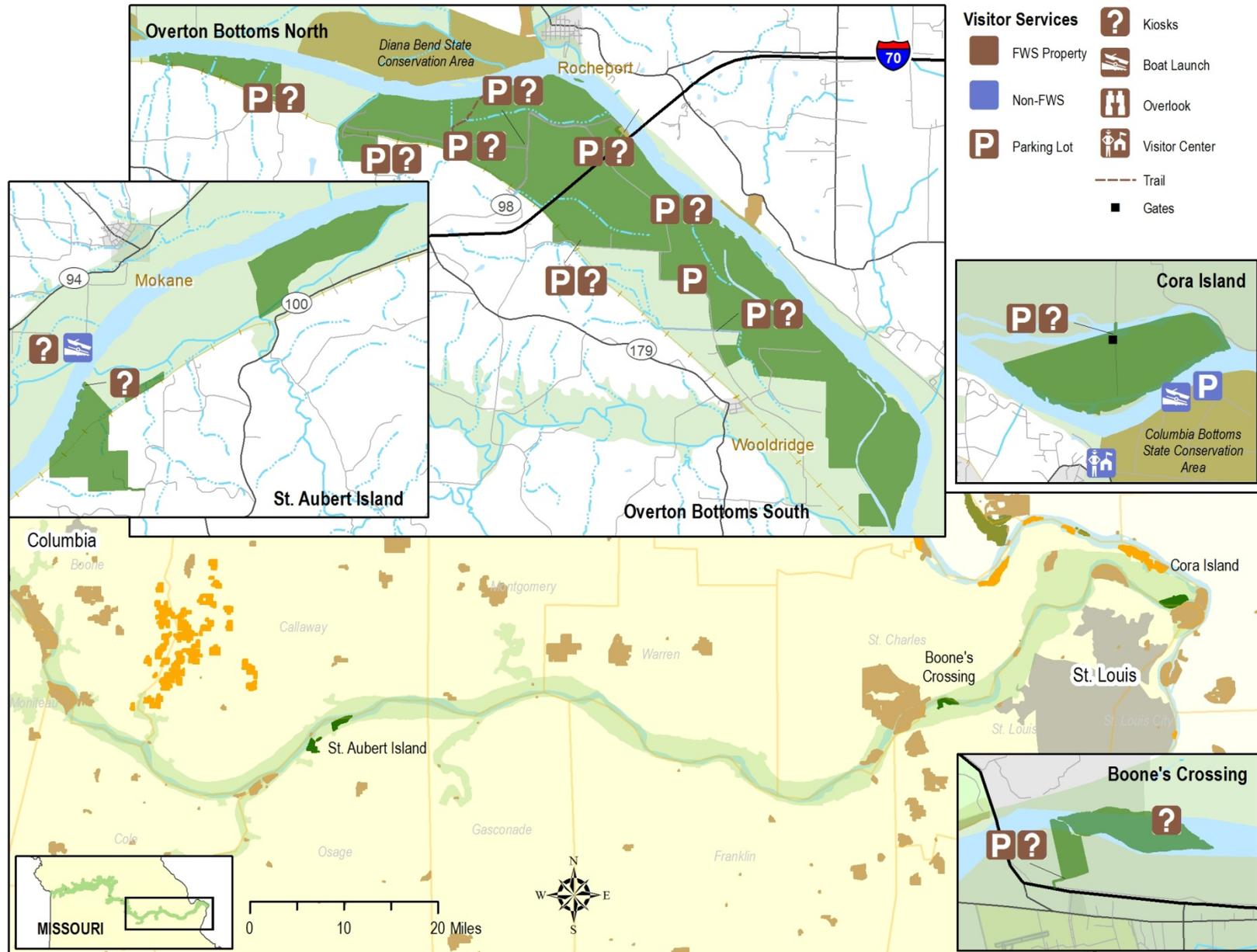


Figure 4-10 (Continued)



A pedestrian bridge was constructed over a steep ravine at Overton Bottoms North Unit to allow public access to the loop trail and about 500 acres. A smaller pedestrian bridge at Jameson Island provides access from the Arrow Rock Historic River Landing Trail on the Arrow Rock State Historical Site to the Lewis and Clark Trail of Discovery.

In 2002, MDC personnel reconstructed Taylor's Landing, which was damaged by the Great Flood of 1993. Subsequent flooding required extensive road repairs, sometimes multiple times in the same year. In 2011 the MDC decided to abandon efforts to maintain Taylor's Landing and permanently closed the popular boat ramp. The refuge is working with MDC, the USACE and the Overton–Wooldridge Levee and Drainage District Association to develop another boat landing and launch ramp at a nearby location on the refuge that will be less subject to damage from floodwaters. In 2002, a study of a possible site and design for a visitor center and office complex was completed. The study included a site analysis, space needs analysis, preliminary soils/geotechnical study, cultural resources survey, topography/landline survey, aerial photography, site master plan layouts for two locations, and cost estimates. The visitor center/office complex project will receive further study when funding becomes available.

Public Use

Each of the “Big Six” public uses emphasized in the National Wildlife Refuge System Improvement Act of 1997 (hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation, those uses traditionally supported and encouraged on the Refuge System) occurs at Big Muddy NFWR. It is estimated that about 34,000 people visited the refuge in 2012. Public use continues to grow as more boundary signs, kiosks, and parking facilities are installed and as the public becomes more aware of recreational opportunities.



Enjoying Big Muddy NFWR; photo: Steve Hillebrand

During 2012, 30 special events were hosted by the refuge with about 1,000 participants. Other use estimates include: 5,000 hunting visits, 5,000 wild edible gathering visits, 1,800 fishing visits, 2,500 wildlife observation visits, 600 photography visits, 700 environmental education participants, and 800 interpretive program participants.

Current refuge units adjoin the Missouri River shoreline (about 38.2 miles) and are therefore part of the Lewis and Clark National Historic Trail. The Santa Fe Trail crossed the Missouri River at what is now Jameson Island Unit, near Arrow Rock, MO.

A big picture look at Missouri River public use can be taken from a survey conducted by the MDC and the Nebraska Game and Parks Commission during 2004 and 2005 (Sheriff and others 2011). They estimated the number of recreational users of the Missouri River, fish and wildlife harvest from the river, and the economic value of the river to those users and described visitor activities and socio-characteristics. Clerks interviewed over 80,000 users at over 400 access

points along the river. They estimated there were slightly over two million recreational visits to public accesses and areas by more than 1.1 million parties and that users spent over 6.3 million hours on site. Overall river recreation provided between \$20 million and \$36 million in annual economic value to users. River recreation also resulted in over \$40 million of economic impacts, supported over 400 jobs, and yielded \$3 million in tax revenue.

River users at public accesses and areas reported being involved in 71 different activities, including: sightseeing (29 percent), fishing (23 percent), and boating (12 percent). See table 4-8 for information from three survey segments that include the RAA.

Table 4-8: Public Use Information from Three Segments of the Missouri River that Include the RAA

Activity	Survey Segment					
	Jefferson City, MO- Mouth		Miami, MO- Jefferson City, MO		Atchison, KS- Miami, MO	
	Individual Visits	Percent	Individual Visits	Percent	Individual Visits	Percent
Fishing	110,550	22	69,560	39	50,550	23
Hunting	10,160	2	4,970	3	6,050	3
Non-consumptive	389,840	78	107,150	61	164,690	74
Overall	500,290		176,550		221,560	

In 2010 and 2011 the Service partnered with the Policy Analysis and Science Assistance Branch of the U.S. Geological Survey’s Fort Collins Science Center to collect data on visitor experiences across the Refuge System as part of a National Visitor Survey. The survey was conducted to provide information both at a national level *and* at a field station level to more effectively manage visitor services and facilities across the Refuge System and to inform site-specific management and planning decisions such as Comprehensive Conservation Plans, Visitor Services step-down plans, and transportation plans. The results are based on two separate 15-day sampling periods at the Overton Bottoms Unit and Jameson Island Unit of the refuge. In all, 129 visitors completed surveys that formed the basis of a report describing visitor and trip characteristics, visitor spending in local communities, and visitor opinions about the refuge. The entire [report](#) is available online.

Effects on Visitor Services

Direct, Indirect, and Cumulative

Indicators used for evaluating effects on visitor services include the following:

- **Public Access:** The quantity of refuge land open and available to the public, seasonal variability in this access, and the universality of accessibility for refuge facilities and programs.
- **Availability of Information:** Visitors’ ability to find the refuge, on-site orientation, information interpreting refuge resources and describing recreation opportunities, and the presence of refuge staff.

- **Range of Activities:** The types and availability of wildlife-dependent recreation opportunities and programming associated with a refuge, including but not limited to the “Big Six” uses: hunting, fishing, wildlife observation, photography, environmental education, and interpretation.
- **Level of Developed Infrastructure:** The perceived quantity of facilities and quantity of the environment altered from its natural condition to accommodate refuge recreation and management.
- **Safety:** A refuge environment that protects visitors from danger, risk, or injury; or otherwise reduces recognized hazards.
- **Visitation:** The volumes and patterns of visitation on a station over a period of time as indicated by the number, timing, location, and duration of visits. These visitation factors have implications on station activities, services, infrastructure, law enforcement, and user interaction.

The intensity categories for determining effects on visitor services are defined as the following:

- **Negligible:** Effect not detectable by visitors or barely perceptible to most visitors; therefore, not discernible.
- **Minor:** May be a slightly detectable effect that would result in little detracting or improvement in the quality of the visitor experience.
- **Moderate:** Change in the experiences of a large number of visitors, resulting in a noticeable decrease or improvement in the quality of the experience.
- **Major:** Substantial improvement or a severe decrease in the quality of many visitors experience would result from a clearly detectable action that dramatically alters the availability of important aspects of the visitor experience such as the addition or elimination of a recreation opportunity or a permanent change in access to a popular area.

The effects on visitor services from implementing the various alternatives described above were determined to be the following:

Visitor Services Effects 1

Context	Type	Duration	Intensity
<input type="checkbox"/> Local	<input checked="" type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input checked="" type="checkbox"/> Landscape	<input type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input checked="" type="checkbox"/> Minor
			<input type="checkbox"/> Negligible

Description

Under all alternatives, providing reasonable car and boat access, kiosks, and parking may increase public access, range of activities, availability of information, safety, and amount of visitation.

Visitor Services Effects 2

Context	Type	Duration	Intensity
<input type="checkbox"/> Local	<input checked="" type="checkbox"/> Beneficial	<input checked="" type="checkbox"/> Long-term	<input type="checkbox"/> Major
<input checked="" type="checkbox"/> Landscape	<input type="checkbox"/> Adverse	<input type="checkbox"/> Medium-term	<input checked="" type="checkbox"/> Moderate
		<input type="checkbox"/> Short-term	<input type="checkbox"/> Minor
			<input type="checkbox"/> Negligible

Description

Under Alternative B within the Columbia Reach, and under Alternative C within the Columbia Reach, any supplemental activities that occur including constructing a refuge office, visitor center, restrooms, overlooks, trails, interpretive displays, etc.; as well as the development of environmental education and interpretive programs that would increase access, range of activities, availability of information, level of developed infrastructure, safety and amount of visitation. In general the more visitor services activities that occur, the greater the benefit to the visitor. However, a point of saturation may be reached where an area becomes too crowded or developed for a visitor to have a quality, nature-based experience.

Historic and Cultural Resources

Native American History and Early Settlement

In prehistoric times, the Missouri River probably served as a major route for the movement of people. It also served this function for Spanish explorers, the first Europeans to enter the Missouri basin, and British and French fur traders. Many early settlements of Europeans became established along the river in Missouri (Missouri State University 2010).

Occupation of Missouri by Native Americans began more than 10,000 years ago. Clovis and Folsom fluted points, believed to be the oldest Native American points, have been found at Mastodon State Historic Site just south of St. Louis. Many styles of stone implements and pottery, dating from 1,000 to 10,000 years B.C.E., have been found at sites along the Missouri River, as well as burial mounds and evidence of Native American villages. In Cooper County, a study of cultural resources on a refuge unit ridge overlooking the Missouri River found remnants of a Late Archaic to Early Woodland occupation, as well as Late Woodland pottery (Lantham 2003).

By the time Europeans began exploring the Missouri territory in the late 17th and early 18th centuries, Native Americans of the area were organized into several distinct tribes. The Missouriia tribe, which gives the river and state their name, are believed to have migrated into Missouri from north of the Great Lakes, settling near the confluence of the Grand River with the Missouri River in Carroll and Chariton Counties. Six years before the Lewis and Clark expedition passed by that point, an attack by Sauk and Fox tribes from the northeast devastated the Missouriia, and the survivors moved to south of the Platte River in what is now Nebraska.

Native American human remains and cultural objects found on refuge lands are subject to repatriation to descendants and culturally affiliated tribes. At this time, culturally affiliated tribes include the Missouriia, Osage, and Kansas tribes (FWS 1999b). Other artifacts, including any Native American human remains and cultural objects not repatriated, will be preserved in approved repositories. The main repository for Service land in Missouri is the University of Missouri at Columbia. A small portion of cultural materials collected at Jameson Island are held at Arrow Rock State Historic Site.

As of Nov. 15, 2010, the National Register of Historic Places listed more than 900 qualifying sites in the 20 counties of the RAA (MO DNR 2010). This number is skewed some by the urban counties within the Area (Jackson County had 297 listed sites, St. Louis County, 178), but many rural sites, including archaeological sites, were also listed. Sites that could be found on units of the refuge include farmsteads and homesteads, bridges, mills, a battlefield, and a section of the Santa Fe Trail. The Missouri River served as the route for the Lewis and Clark Corps of Discovery (1804–1806); 43 campsites for that Corps occur in counties within the RAA. There may also be historic riverboat landings and other historic sites related to the Santa Fe, Oregon, and California Trails. It remains unlikely that constructed properties would be found in the river's floodplain.

Cultural Resource Management

Cultural resources (archaeological sites, historic structures, and Native American traditional cultural properties) are important parts of the Nation's heritage. The Service strives to preserve evidence of these human occupations, which can provide valuable information regarding not only human interactions with each other, but also with the natural environment. Protection of cultural resources is accomplished in conjunction with the Service's mandate to protect fish, wildlife, and plant resources.

The Service is charged with the responsibility, under Section 106 of the National Historic Preservation Act of 1966, of identifying historic properties (cultural resources that are potentially eligible for listing on the National Register of Historic Places) that may be affected by our actions. The Service is also required to coordinate these actions with the State Historic Preservation Office, Native American tribal governments, local governments, and other interested parties. Cultural resource management in the Service is the responsibility of the regional director and is not delegated for the Section 106 process when historic properties could be affected by Service undertakings, for issuing archaeological permits, and for Indian tribal involvement.

The Archaeological Resources Protection Act of 1979 (ARPA) Section 14 requires plans to survey lands and a schedule for surveying lands with "the most scientifically valuable archaeological resources." This act also affords protection to all archeological and historic sites more than 100 years old (not just sites meeting the criteria for the National Register) on Federal land, and requires archeological investigations on Federal land be performed in the public interest by qualified persons.

The Regional Historic Preservation Officer (RHPO) advises the regional director about procedures, compliance, and implementation of these and other cultural resource laws. The actual determinations relating to cultural resources are to be made by the RHPO for undertakings on Service fee title lands and for undertakings funded in whole or in part under the direct or indirect jurisdiction of the Service including those carried out by or on behalf of the Service, those carried out with federal financial assistance, and those requiring a federal permit, license, or approval.

The responsibility of the refuge manager is to identify undertakings that could affect cultural resources and coordinate the subsequent review process as early as possible with the RHPO and state, tribal, and local officials. Also, the refuge manager assists the RHPO by protecting archeological sites and historic properties on Service-managed and administered lands, by

monitoring archaeological investigations by contractors and permittees and by reporting ARPA violations.

There are no specific activities included in any of the alternatives to directly benefit cultural resources. A variety of laws prohibit any adverse effect on cultural resources as a result of management activities on public land. Additional review and approval of specific site-level projects will be completed if and when those projects are planned. Any effects to cultural resources will be determined at that time.

Refuge Administration

Current Situation

The refuge has two law enforcement officers, one full-time officer, and one collateral duty officer, who make visitor contacts, enforce laws on the refuge, and coordinate with other law enforcement personnel in the state, such as MDC agents, county sheriffs, and deputies that work within the RAA. Regulations are posted on each unit's kiosk(s), the general refuge brochure, each unit's fact sheet, and the refuge website. Past violations include off-road vehicle use, poaching wildlife, fishing without a license, trespass of the public onto private lands, and traffic violations. Vandalism and littering occur, but violators are not often caught.

Farm Service Agency Conservation Easements

In the mid-1980s, Farmers Home Administration, now Farm Services Agency (FSA), made loans to farmers temporarily unable to obtain credit from commercial lending institutions. FSA foreclosed on some farm loans due to delinquent payments. One of the provisions in the 1985 Farm Bill required FSA to protect wetland and floodplain resources on the default property prior to resale to the public. The Service assisted the FSA in identifying wetlands and important floodplain resources on these properties. Once identified, the FSA assigned a perpetual conservation easement on the property and transferred management responsibility to the Service as part of the Refuge System. The refuge administers about 550 acres in eight conservation easements through the Service's Partners for Fish and Wildlife Program (figure 4-11). Some conservation easements are up to a three-hour drive from the office, making inspections and management challenging (table 4-9).

Figure 4-11: Big Muddy NFWR FSA Easements

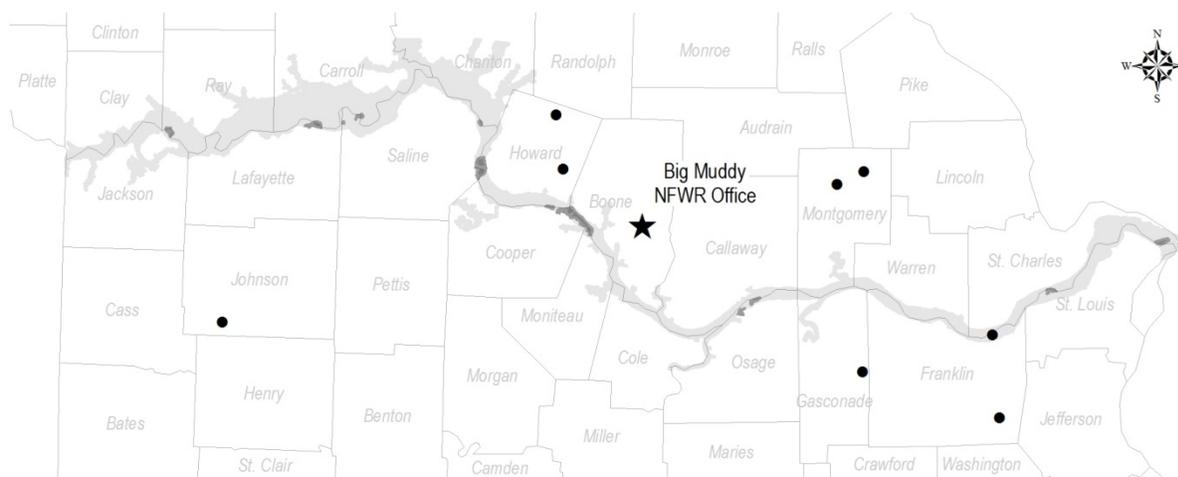


Table 4-9: Conservation Easements Managed by the Refuge

County	Acres	Easement Habitat
Franklin	32	Woods, lies between slough and Missouri River
Franklin	8	Woods, along creek
Gasconade	16	Mostly wooded, along creek
Howard	309	Mostly wooded, Moniteau Creek Conservation Area*
Howard	31	Native grasses and woods, along creek
Johnson	94.5	Native grasses and woods
Montgomery	32	Woods and old field regenerating to trees, along creek
Montgomery	25	Mostly woods, along creek

*Land formerly owned by Farmers Home Administration, with fee title transferred to the State of Missouri, Department of Conservation, in 1996. The Service has administrative oversight responsibility for the restrictive covenants contained in the property deed. The deed requires the easement area be managed for wildlife.

Staff and Budget

Current permanent staff includes a refuge manager, wildlife refuge specialist (assistant manager and collateral-duty law enforcement officer), wildlife biologist, park ranger (outreach specialist), park ranger (law enforcement officer), maintenance worker, and administrative officer. The refuge also has a temporary (four-year term) wildlife refuge specialist. Each summer, as funding allows, student employees are hired to help with invasive species control, user facility maintenance, and biological monitoring. Occasionally the refuge hosts conservation interns. The base budget for the refuge in fiscal year 2010 totaled \$1,013,330. The USACE, through the Mitigation Project annual management plan process, provides funding for wildlife habitat work and operation of Mitigation Project tracts at Overton Bottoms North and South and Cora Island. In 2010, they provided \$111,968 for activities and items that included noxious weed control, parking lot construction, kiosks, signs, and posting boundaries.

Refuge Support

Current Situation

The refuge staff works with many agencies and organizations to accomplish refuge goals. Some of these include the following:

- USACE: The refuge coordinates habitat projects constructed by the USACE on overlay Mitigation Project tracts, such as those at Overton Bottoms North and South, Jameson Island, and Baltimore Bottom Units.
- USGS-CERC: Provide the refuge space for an office trailer, parking, and boat barn/shop; frequently provide input on habitat plans and monitoring; have completed several studies on the refuge and provided valuable information.
- MDC: Researchers and managers from MDC have participated in several studies, habitat planning projects, and monitoring on the refuge. MDC provides strong law enforcement support and coordination on refuge lands.
- MO DNR: The refuge has an on-going educational and interpretive program with Arrow Rock State Historic Site and Friends of Arrow Rock. A trail connects the Historic Site and Jameson Island Unit.
- University of Missouri (MU). Several students from MU have conducted research projects on the refuge. Staff at the MU Entomology Museum assisted refuge staff and volunteers with identification of pollinators (such as butterflies, moths, bees, wasps) collected on the refuge. Students and faculty from the Civil & Environmental Engineering Department assisted the refuge with design and construction of structures to stem erosion threatening the pedestrian bridge at Jameson Island Unit.
- Missouri River Realty Partners: Staff from the USACE, MDC, MO DNR, U.S. Department of Agriculture-Natural Resources Conservation Service, and the refuge meet regularly to coordinate land acquisition and management strategies along the Missouri River.
- Agency Coordination Team (ACT): Coordinated by the USACE, the ACT meets bimonthly to hear updates and discuss issues pertinent to the various Missouri River recovery programs. The team includes the USACE, Service, Environmental Protection Agency, USGS, state agencies from Nebraska, Kansas, Iowa, and Missouri; and several industry and agriculture stakeholders.
- Friends of Big Muddy: Formed in 1998, Friends of Big Muddy is an organization that supports the refuge. Members have provided several thousands of hours volunteering on refuge projects such as posting boundaries, planting grasses and trees, helping with the Junior Duck Stamp Contest, and staffing refuge information booths at environmental festivals in towns across the RAA. During 2010, volunteers donated over 1,300 hours to the refuge.
- Missouri River Relief (MRR): MRR is a grassroots, volunteer and equipment-based organization dedicated to reconnecting people to the Missouri River through hands-on river clean-ups and education events. Refuge staff participate and supply/operate a boat for events held near refuge units. MRR staff have also helped with grass and tree plantings on the refuge, advertised events, and supplied materials.
- Missouri Master Naturalists (MMN): The Master Naturalist program, through University of Missouri Extension, provides training for individuals interested in natural resources. The

training includes a 40-hour of hands-on service project, with a focus on natural resources. Many Master Naturalists have participated in butterfly, moth, bee, and wasp surveys on the refuge working alongside the refuge biologist. Assist with visitor surveys, trail maintenance, information kiosks maintenance and stocking, and with the Junior Duck Stamp Contest.

- National Audubon Society (NAS): The Columbia, MO Chapter of NAS adopted the refuge in 1997. The partnership between the refuge and NAS benefits conservation of the Service's trust species, fish and wildlife habitats, and ecosystems with emphasis on public awareness and participation. The St. Louis Chapter of NAS has been supportive of the refuge receiving funds for land acquisition from the Land and Water Conservation Fund.
- Audubon Missouri is a partner in the Confluence Partnership and assists with outreach programs in the confluence area of the Missouri and Mississippi Rivers,
- Greenway Network is an important partner in the St. Louis metro area. Greenway Network leads the organization of national Public Lands Day activities, assists with river cleanups in the St. Charles and St. Louis Counties portion of the Missouri River, and is the organizing force behind expanding the Big Muddy Speaker Series into the St. Louis Metro Area. Greenway Network is also one of the founders of the annual River Soundings Symposium held in St. Louis each fall.
- Big Muddy Speaker Series: The refuge, Missouri River Relief, Friends of Big Muddy, and the Services CFWCO host monthly presentations and discussions on the history, science, ecology, and culture of the Missouri River Valley. People gather the second Tuesday of each month to learn about the River at a restaurant in Rocheport, MO that overlooks the Missouri River. In recent years the Big Muddy Speaker Series has been expanded to venues in the Kansas City and St. Louis metro regions. There are now three speakers events each month.
- Saint Louis Artworks: The refuge park ranger and biologist worked with students to develop an awareness of invasive plant species as well as the important role of pollinators on the landscape. Students produced interpretive panels to inform refuge visitors about these topics.

Appendix A: Implementation of the Preferred Alternative

In this appendix:

Objectives and Strategies

The purpose of this appendix is to make it easier for the reader to understand the preferred alternative and what would be required to implement it. U.S. Fish and Wildlife Service (FWS, Service) policy directs that certain elements be included in a Comprehensive Conservation Plan (CCP). Most of those elements are included in the Draft Comprehensive Conservation Plan/Environmental Assessment (CCP/EA). Elements dealing with the implementation of the plan, not included in the Draft CCP/EA, are included in this appendix. Following public review and comment of the Draft CCP/EA, we will produce a stand-alone CCP that draws on much of the information in the EA.

Objectives and Strategies

Objective 1-1: All River Reaches Standard Land and Water Management

Over the life of the plan, on Big Muddy National Fish and Wildlife Refuge (NFWR, refuge) units across all five river reaches, restore the hydrology of the Missouri River and its tributaries (where applicable), reconnect the Missouri River and major tributaries to their floodplains, and maintain or return natural cover types.



Rationale

This objective addresses the planning issues associated with land and water management (see chapter 2). It applies to all river reaches, because it helps meet the purposes of the refuge as well as other legal and policy obligations. The purposes of the refuge, drawn from the Fish and Wildlife Act of 1956 and Emergency Wetlands Act of 1986, are to conserve fish and wildlife and their habitats, particularly migratory birds and wetlands. Further, Service policy calls for maintaining or restoring refuge habitats to historic conditions if doing so is feasible and does not conflict with refuge purposes (FWS 2001). In addition to habitat, this includes restoring environmental structure, function, and composition of abiotic components such as hydrology. Finally, the decisions to establish and expand the refuge (FWS 1994, 1995a, 1996b, and 1999c) call for restoring refuge lands to a natural floodplain condition, and improving and restoring wetland values.

Strategy

Develop a Habitat Management Plan to address specific aspects of land and water management on individual refuge units.

Objective 1-2: Columbia Reach and St. Louis Reach Study and Learning

Over the life of the plan, within each refuge unit along the Columbia and St. Louis Reaches, emphasize and encourage biological inventory, monitoring, and research.



Rationale

This objective addresses the land and water management issue regarding learning about refuge ecosystems and management (see chapter 2). Conserving a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered, is one of the goals of the National Wildlife Refuge System (NWRS, Refuge System). To evaluate whether management actions are having the predicted consequences, we need to inventory existing biological resources and monitor actual outcomes, most often using a representative sample of sites to ensure that, on average, the effects of a particular type of treatment match expectations. Information gained through monitoring that is clearly linked to our management actions helps us learn and adapt, increasing our effectiveness in meeting conservation objectives. This objective applies to the Columbia and St. Louis Reaches because of proximity of refuge staff or proximity to potential partnership opportunities. Monitoring, inventory, and research typically require routine visits for data collection or maintenance of equipment. The proximity of data collectors to data collection sites is an important factor in developing a sound program for inventory, monitoring, and research.

Strategy

Develop an Inventory and Monitoring Plan based on a Habitat Management Plan that identifies specific actions for individual refuge units.

Objective 2-1: All River Reaches Standard Visitor Services and Facilities

Over the life of the plan, on each refuge unit across all five river reaches, create or maintain a recreational and management setting that includes all of the following: reasonable car access, reasonable boat access, information kiosks, and parking (in areas with vehicle access).



Rationale

This objective addresses planning issues associated with visitor services and refuge administration (see chapter 2). It applies to each refuge unit within all river reaches, because providing reasonable access and information facilitates wildlife-dependent recreation and helps fulfill legal and policy obligations. The National Wildlife Refuge System Improvement Act of 1997 recognizes wildlife-dependent recreation as a legitimate and appropriate general public use of the Refuge System. Also, Service policy on wildlife-dependent recreation has the overarching goal of enhancing wildlife-dependent recreation opportunities and access to quality visitor experiences on refuges while managing refuges to conserve fish, wildlife, plants, and their habitats (FWS 2006b).

Finally, the decisions to establish and expand the refuge (FWS 1994, 1995a, 1996b, and 1999c) call for providing wildlife-dependent recreation. Reasonable car access typically includes at least one maintained road that abuts or enters a refuge unit and developed parking for at least six vehicles. Examples of reasonable car access occur on all refuge units with the exception of Cambridge Bend and St. Aubert Island Units. Refuge staff is exploring possibilities to provide car access to Cambridge Bend and St. Aubert Units in the future. Legal and logistical hurdles remain as of this writing. All refuge units are accessible by boat, with a couple of locations featuring modest, developed boat accesses. Developed boat accesses are difficult to maintain as river conditions can and do vary widely depending on flow. MDC and some municipalities provide boat ramp access to the Missouri River, but these may be located up to 15 river miles from the nearest refuge unit. While limited access such as described is inconvenient, it does offer the advantage of increasing the opportunity to experience solitude and a truly wild character on some remote refuge units. This is becoming a rarer and often sought after recreation experience in modern society.

Strategy

Develop a Visitor Services Plan to address specific aspects of visitor services on individual refuge units.

Objective 2-2: Columbia Reach and St. Louis Reach Supplemental Visitor Services and Facilities

Over the life of the plan, within each refuge unit along the Columbia Reach and St. Louis Reach, create or maintain a recreational and management setting characterized by the presence of one or more of the following: interpretive displays and other self-guided interpretation, restrooms, trails, overlooks, wildlife observation facilities, maintenance center, and environmental education site.



Rationale

This objective addresses planning issues associated with visitor services and refuge administration (see chapter 2). The legal and policy basis of this objective is the same as that described for Objective 2-1. This objective applies to the Columbia Reach, because the reach encompasses an urban area with many potential visitors, includes other conservation lands that offer complementary opportunities, includes existing well-developed partnerships, is centrally located within the refuge acquisition boundary, and encompasses the existing refuge headquarters. It applies to the St. Louis Reach, because the reach encompasses a large urban area with many potential visitors, includes existing refuge units, and includes other public and private conservation lands and associated partnership opportunities.

Strategy

Develop a Visitor Services Plan to address specific aspects of visitor services on individual refuge units.

Objective 2-3: Columbia Reach Administrative Center (Refuge Office)

Over the life of the plan, within the Columbia Reach, allow for the option of a structure located on refuge holdings to serve as the primary administrative center of the refuge. It would include offices and may also include a visitor contact station, an area of the structure dedicated to visitor services.



Rationale

This objective addresses planning issues associated with visitor services and refuge administration (see chapter 2). The legal and policy basis of this objective is the same as that

described for Objective 2-1. This objective applies to the Columbia Reach because the reach encompasses an urban area with many potential visitors, includes other conservation lands that offer complementary opportunities, includes existing well-developed partnerships, is centrally located within the refuge acquisition boundary, and encompasses the existing refuge headquarters.

Objective 2-4: Columbia Reach and St. Louis Reach Outreach and Collaboration

Over the life of the plan, within the Columbia Reach and St. Louis Reach, emphasize collaboration (building relationships for conservation delivery) as well as outreach (building public understanding and support for conservation).



Rationale

This objective addresses planning issues associated with visitor services and refuge administration (see chapter 2). The legal and policy basis of this objective is the same as that described for Objective 2-1. This objective applies to the Columbia Reach, because the reach encompasses an urban area with many potential visitors, includes other conservation lands that offer complementary opportunities, includes existing well-developed partnerships, is centrally located within the refuge acquisition boundary, and encompasses the existing refuge headquarters. It applies to the St. Louis Reach, because the reach encompasses a large urban area with many potential visitors, includes existing refuge units, and includes other public and private conservation lands and associated partnership opportunities.

Objective 2-5: Columbia Reach Programming

Over the life of the plan, within the Columbia Reach, allow for staff-led or volunteer-led programming associated with environmental education and interpretation.



Rationale

This objective addresses planning issues associated with visitor services and refuge administration (see chapter 2). The legal and policy basis of this objective is the same as that described for Objective 2-1. This objective applies to the Columbia Reach, because the reach encompasses an urban area with many potential visitors, includes other conservation lands that offer complementary opportunities, includes existing well-developed partnerships, is centrally located within the refuge acquisition boundary, and encompasses the existing refuge headquarters.

Objective 3-1: All Reaches Conservation Footprint

Over the life of the plan, across all five river reaches, continue to pursue conservation of up to 30 individual refuge units evaluating tracts available from willing sellers based on the following criteria. Note that the listed criteria are not presented in priority order.

- Proximity to existing refuge units
- Connectivity to existing public lands
- Potential for river feature restoration
- Quality of existing habitat
- Amount of river frontage
- Proximity to populations centers
- Land value and cost
- Size and spatial connectedness or contiguity



Rationale

The refuge includes less than the 60,000 acres authorized to meet the purpose and need of the expansion approved in a 1999 Record of Decision and documented in the *Big Muddy National Fish and Wildlife Refuge Final Environmental Impact Statement (1999b)*. Land acquisition is not emphasized by river reach, but is instead guided by the availability of willing sellers and the evaluation of individual tracts based on criteria that reflect Service priorities.

Strategies

- Use the adaptive decision support model (see appendix K) to assist in evaluating available tracts.
- Continue to use all available conservation options including land acquisition, easements, cooperative agreements, and partnerships.
- Continue to work with the U.S. Army Corps of Engineers (USACE) to assume management of USACE Missouri River mitigation sites within the refuge acquisition boundary.

Appendix B: Species Lists

In this appendix:

[Plants](#)

[Mammals](#)

[Birds](#)

[Pollinators](#)

[Fish and Mussels](#)

[Reptiles and Amphibians](#)

Plants

Scientific Name	Common Name
<i>Abutilon theophrasti</i>	velvetleaf
<i>Acalypha ostryifolia</i>	pineland threeseed mercury
<i>Acalypha rhomboidea</i>	common threeseed mercury
<i>Acalypha virginica</i>	Virginia threeseed mercury
<i>Alliaria petiolata</i>	garlic mustard
<i>Amaranthus tamariscinus</i>	tall amaranth
<i>Ambrosia artemisifolia</i>	annual ragweed
<i>Ambrosia trifida</i>	great ragweed
<i>Ammannia coccinea</i>	valley redstem
<i>Amorpha brachycarpa</i>	leadplant
<i>Ampelopsis cordata</i>	heartleaf peppervine
<i>Amphicarpaea bracteata</i> var. <i>comosa</i>	American hogpeanut
<i>Amsonia illustris</i>	Ozark bluestar
<i>Anemone canadensis</i>	Canadian anemone
<i>Apocynum cannabinum</i>	Indian hemp
<i>Aristolochia tomentosa</i>	Woolly dutchman's pipe
<i>Artemisia annua</i>	sweet sagewort
<i>Asarum canadense</i>	Canadian wildginger
<i>Asclepias incarnata</i>	swamp milkweed
<i>Asclepias purpurascens</i>	purple milkweed
<i>Asclepias syriaca</i>	common milkweed
<i>Asclepias verticillata</i>	whorled milkweed
<i>Aster lateriflorus</i>	calico aster
<i>Aster pilosus</i>	hairy white oldfield aster
<i>Aster subulatus</i>	eastern annual saltmarsh aster
<i>Bergia texana</i>	Texas bergia
<i>Bidens cernua</i>	nodding beggerstick
<i>Bidens connata</i>	purplestem beggarticks
<i>Boehmeria cylindrica</i>	smallspike false nettle
<i>Callitriche terrestris</i>	terrestrial water-starwort
<i>Calystegia sepium</i>	hedge false bindweed
<i>Campsis radicans</i>	trumpet creeper
<i>Cardamine hirsuta</i>	hairy bittercress
<i>Carex crus-corvi</i>	ravenfoot sedge
<i>Carex hyalinolepis</i>	shoreline sedge, thinscale sedge
<i>Carex molesta</i>	troublesome sedge
<i>Cassia fasciculata</i>	partridge pea

<i>Castilleja coccinea</i>	scarlet Indian paintbrush
<i>Cenchrus longispinus</i>	mat sandbur
<i>Chasmanthium latifolium</i>	Indian woodoats
<i>Chenopodium album</i>	lambsquarters
<i>Cicuta maculata</i>	spotted water hemlock
<i>Cirsium altissimum</i>	tall thistle
<i>Conohea multifida</i>	narrowleaf paleseed
<i>Conyza canadensis</i>	Canadian horseweed
<i>Corydalis flavula</i>	yellow fumewort
<i>Croton glandulosus</i>	vente conmigo
<i>Croton monanthogynus</i>	prairie tea
<i>Cynanchum laeve</i>	honeysuckle
<i>Cyperus erythrorhizos</i>	redroot flatsedge
<i>Cyperus odoratus</i>	fragrant flatsedge
<i>Cyperus squarrosus</i>	bearded flatsedge
<i>Cyperus strigosus</i>	strawcolored flatsedge
<i>Descurainia sophia</i>	herb sophia
<i>Desmanthus illinoensis</i>	Illinois budleflower
<i>Desmodium glabellum</i>	Dillenius' tricktrefoil
<i>Desmodium paniculatum</i>	panickedleaf ticktrefoil
<i>Diodia teres</i>	poorjoe
<i>Echinodorus berteroi</i>	upright burhead
<i>Eclipta prostrata</i>	false daisy
<i>Eleocharis ovata</i>	ovate spikerush
<i>Elephantopus carolinianus</i>	Carolina elephantsfoot
<i>Elymus virginicus</i>	Virginia wildrye
<i>Equisetum arvense</i>	field horsetail
<i>Equisetum hyemale</i>	scouringrush horsetail
<i>Erechtites hieracifolia</i>	American burnweed
<i>Erigeron annuus</i>	eastern daisy fleabane
<i>Erigeron strigosus</i>	prairie fleabane
<i>Euonymus fortunei</i>	winter creeper
<i>Eupatorium capillifolium</i>	dogfennel
<i>Eupatorium perfoliatum</i>	common boneset
<i>Eupatorium rugosum</i>	white snakeroot
<i>Eupatorium serotinum</i>	lateflowering thoroughwort
<i>Euphorbia dentata</i>	toothed spurge
<i>Euphorbia maculata</i>	nodding spurge
<i>Euphorbia supina</i>	spotted sandmat
<i>Festuca obtusa</i>	nodding fescue
<i>Galium</i>	bedstraw
<i>Galium triflorum</i>	fragrant bedstraw
<i>Geum vernum</i>	spring avens
<i>Glechoma hederacea</i>	ground ivy
<i>Grindelia squarrosa</i>	curlycup gumweed
<i>Helianthus annuus</i>	common sunflower
<i>Hibiscus laevis</i>	halberdleaf rosemallow
<i>Humulus japonicus</i>	Japanese hops
<i>Impatiens capensis</i>	jewelweed
<i>Impatiens pallida</i>	pale touch-me-not
<i>Ipomoea hederacea</i>	ivyleaf morning-glory
<i>Ipomoea lacunosa</i>	whitestar
<i>Ipomoea pandurata</i>	man of the earth

<i>Iva annua</i>	annual marsh elder
<i>Krigia biflora</i>	twoflower dwarfdandelion
<i>Lactuca canadensis</i>	Canada lettuce
<i>Lactuca floridana</i>	woodland lettuce
<i>Lamium purpureum</i>	purple deadnettle
<i>Lathyrus latifolius</i>	perennial pea
<i>Lepidium virginicum</i>	Virginia pepperweed
<i>Lindernia dubia</i> var. <i>anagallidea</i>	yellowseed false pimpernel
<i>Lippia lanceolata</i>	lanceleaf frogfruit
<i>Lithospermum canescens</i>	hoary puccoon
<i>Lobelia siphilitica</i>	great blue lobelia
<i>Ludwigia alternifolia</i>	seedbox
<i>Lycopus americanus</i>	American water horehound
<i>Lycopus virginicus</i>	Virginia water horehound
<i>Lysimachia nummularia</i>	creeping jenny
<i>Lythrum salicaria</i>	purple loosestrife
<i>Melilotus</i>	sweetclover
<i>Menispermum canadense</i>	common moonseed
<i>Mentha arvensis</i>	wild mint
<i>Mimulus alatus</i>	sharpwing monkeyflower
<i>Mollugo verticillata</i>	green carpetweed
<i>Monarda bradburiana</i>	eastern beebalm
<i>Muhlenbergia sobolifera</i>	rock muhly
<i>Oenothera biennis</i>	common evening primrose
<i>Oenothera laciniata</i>	cutleaf evening primrose
<i>Oxalis stricta</i>	common yellow oxalis
<i>Oxalis violacea</i>	violet woodsorel
<i>Parietaria pensylvanica</i>	Pennsylvania pellitory
<i>Paspalum laeve</i>	field paspalum
<i>Pedicularis canadensis</i>	Canadian lousewort
<i>Penstemon digitalis</i>	foxglove beardtongue
<i>Penthorum sedoides</i>	ditch stonecrop
<i>Perilla frutescens</i>	beefsteakplant
<i>Phalaris arundinacea</i>	reed canarygrass
<i>Phyla lanceolata</i>	lanceleaf fogfruit
<i>Physalis heterophylla</i>	clammy groundcherry
<i>Physalis missouriensis</i>	Missouri groundcherry
<i>Physalis virginiana</i>	Virginia groundcherry
<i>Phytolacca americana</i>	American pokeweed
<i>Pilea pumila</i>	Canadian clearweed
<i>Podophyllum peltatum</i>	mayapple
<i>Polygonum amphibium</i> var. <i>emersum</i>	longroot smartweed
<i>Polygonum hydropiperoides</i>	swamp smartweed
<i>Polygonum pensylvanicum</i>	Pennsylvania smartweed
<i>Portulaca oleracea</i>	little hogweed
<i>Potentilla recta</i>	sulphur cinquefoil
<i>Potentilla simplex</i>	common cinquefoil
<i>Pueraria lobata</i>	kudzu
<i>Pyrrhopappus carolinianus</i>	Carolina desert-chicory
<i>Ricciocarpus natans</i>	purple-fringed riccia
<i>Rorippa sessiliflora</i>	stalkless yellowcress
<i>Rorippa sylvestris</i>	creeping yellowcress
<i>Rotala ramosior</i>	lowland rotala

<i>Rudbeckia laciniata</i>	cutleaf coneflower
<i>Rumex crispus</i>	curly dock
<i>Scirpus fluviatilis</i>	river bulrush
<i>Scrophularia marilandica</i>	carpenter's square
<i>Senecio glabellus</i>	butterweed
<i>Sicyos angulatus</i>	oneseed bur cucumber
<i>Sida spinosa</i>	prickly fanpetals
<i>Solanum carolinense</i>	Carolina horsenettle
<i>Solidago altissima</i>	Canada goldenrod
<i>Solidago gigantea</i>	giant goldenrod
<i>Sonchus asper</i>	spiny sowthistle
<i>Spermacoce glabra</i>	smooth false buttonweed
<i>Sporobolus cryptandrus</i>	sand dropseed
<i>Stachys tenuifolia</i>	smooth hedgenettle
<i>Stellaria media</i>	common chickweed
<i>Strophostyles helvola</i>	amberique-bean
<i>Stylophorum diphyllum</i>	celandine poppy
<i>Symphoricarpos orbiculatus</i>	corralberry
<i>Teucrium canadense</i>	Canada germander
<i>Thlaspi arvense</i>	field pennycress
<i>Torilis japonica</i>	erect hedgeparsley
<i>Tridens flavus</i>	purpletop tridens
<i>Trifolium campestre</i>	field clover
<i>Trillium sessile</i>	toadshade
<i>Urtica dioica</i>	stinging nettle
<i>Verbena urticifolia</i>	white vervain
<i>Vernonia baldwinii</i>	Baldwin's ironweed
<i>Viola papilionacea</i>	meadow violet
<i>Viola sororia</i>	common blue violet
<i>Viola tricolor</i>	johnny jumpup
<i>Xanthium strumarium</i>	rough cocklebur
Grasses	
<i>Agrostis alba</i>	redtop
<i>Andropogon gerardii</i>	big bluestem
<i>Andropogon scoparius</i>	sittle bluestem
<i>Digitaria cognata</i>	Carolina crabgrass
<i>Digitaria ischaemum</i>	smooth crabgrass
<i>Echinochloa crus-galli</i>	barnyardgrass
<i>Eragrostis cilianensis</i>	stinkgrass
<i>Eragrostis pectinacea</i>	tufted lovegrass
<i>Leersia virginica</i>	whitegrass
<i>Leptochloa panicea</i>	mucronate sprangletop
<i>Panicum capillare</i>	witchgrass
<i>Panicum sphaerocarpon</i>	roundseed panicgrass
<i>Panicum virgatum</i>	switchgrass
<i>Phragmites australis</i>	common reed
<i>Setaria viridis</i>	green bristlegrass
<i>Sorghastrum nutans</i>	Indiangrass
<i>Sorghum bicolor</i>	sorghum
<i>Sorghum halepense</i>	Johnsongrass
<i>Spartina pectinata</i>	prairie cordgrass
<i>Triplasis purpurea</i>	purple sandgrass
<i>Tripsacum dactyloides</i>	eastern gamagrass

Shrubs/Vines	
<i>Asimina triloba</i>	pawpaw
<i>Campsis radicans</i>	trumpet creeper
<i>Cephalanthus occidentalis</i>	common buttonbush
<i>Cornus drummondii</i>	roughleaf dogwood
<i>Cuscuta pentagona</i>	fiveangled dodder
<i>Euonymus fortunei</i>	winter creeper
<i>Lonicera maackii</i>	Amur honeysuckle
<i>Parthenocissus quinquefolia</i>	Virginia creeper
<i>Rhus glabra</i>	smooth sumac
<i>Rubus pensilvanicus</i>	Pennsylvania blackberry
<i>Smilax tamnoides</i>	bristly greenbriar
<i>Symphoricarpos orbiculatus</i>	coralberry
<i>Toxicodendron radicans</i>	eastern poison ivy
<i>Vitis aestivalis</i>	summer grape
<i>Vitis rupestris</i>	sand grape
<i>Vitis vulpina</i>	frost grape
Trees	
<i>Acer negundo</i>	boxelder
<i>Acer saccharinum</i>	silver maple
<i>Ailanthus altissima</i>	tree of heaven
<i>Betula nigra</i>	river birch
<i>Carya illinoensis</i>	pecan
<i>Celtis laevigata</i>	sugarberry
<i>Celtis occidentalis</i>	common hackberry
<i>Cercus canadensis</i>	eastern redbud
<i>Diospyros virginiana</i>	common persimmon
<i>Fraxinus pennsylvanica</i>	green ash
<i>Gleditsia triacanthos</i>	honeylocust
<i>Gymnocladus dioica</i>	Kentucky coffeetree
<i>Juglans nigra</i>	black walnut
<i>Juniperus virginiana</i>	eastern redcedar
<i>Maclura pomifera</i>	osage orange
<i>Morus rubra</i>	red mulberry
<i>Nyssa sylvatica</i>	blackgum
<i>Platanus occidentalis</i>	American sycamore
<i>Populus deltoides</i>	eastern cottonwood
<i>Prunus americana</i>	American plum
<i>Pyrus calleryana</i>	Callery (Bradford) Pear
<i>Quercus bicolor</i>	swamp white oak
<i>Quercus imbricaria</i>	shingle oak
<i>Quercus macrocarpa</i>	bur oak
<i>Quercus palustris</i>	pin oak
<i>Quercus velutina</i>	black oak
<i>Salix caroliniana</i>	coastal plain willow
<i>Salix exigua</i>	sandbar willow
<i>Salix nigra</i>	black willow
<i>Sassafras albidum</i>	sassafras
<i>Taxodium distichum</i>	bald cypress
<i>Tilia americana</i>	American basswood
<i>Ulmus americana</i>	American elm
<i>Ulmus rubra</i>	slippery elm

Mammals

Scientific Name	Common Name
<i>Blarina hylophaga</i>	Elliot's short-tailed shrew
<i>Canis familiaris</i>	domestic dog
<i>Canis latrans</i>	coyote
<i>Castor canadensis</i>	American beaver
<i>Cryptotis parva</i>	least shrew
<i>Dasypus novemcinctus</i>	nine-banded armadillo
<i>Didelphis virginiana</i>	Virginia opossum
<i>Eptesicus fuscus</i>	big brown bat
<i>Geomys bursarius</i>	plains pocket gopher
<i>Glaucomys volans</i>	southern flying squirrel
<i>Lasionycteris noctivagans</i>	silver-haired bat
<i>Lasiurus borealis</i>	eastern red bat
<i>Lasiurus cinereus</i>	hoary bat
<i>Lontra canadensis</i>	North American river otter
<i>Lynx rufus</i>	bobcat
<i>Marmota monax</i>	groundhog, woodchuck
<i>Mephitis mephitis</i>	striped skunk
<i>Microtus ochrogaster</i>	prairie vole
<i>Microtus pinetorum</i>	woodland vole
<i>Mus musculus</i>	house mouse
<i>Mustela frenata</i>	long-tailed weasel
<i>Mustela vison</i>	American mink
<i>Myotis grisescens</i>	gray bat
<i>Myotis lucifugus</i>	little brown bat
<i>Myotis septentrionalis</i>	northern long-eared bat
<i>Myotis sodalis</i>	Indiana bat
<i>Neotoma floridana</i>	eastern woodrat
<i>Nycticeius humeralis</i>	evening bat
<i>Ochrotomys nuttalli</i>	golden mouse
<i>Odocoileus virginianus</i>	white-tailed deer
<i>Ondatra zibethicus</i>	muskrat
<i>Peromyscus leucopus</i>	white-footed mouse
<i>Peromyscus maniculatus</i>	deer mouse
<i>Pipistrellus subflavus</i>	eastern pipistrelle
<i>Poliocitellus franklinii</i>	Franklin's ground squirrel
<i>Puma concolor</i>	cougar
<i>Procyon lotor</i>	raccoon
<i>Reithrodontomys megalotis</i>	western harvest mouse
<i>Scalopus aquaticus</i>	eastern mole
<i>Sciurus carolinensis</i>	eastern gray squirrel
<i>Sciurus niger</i>	fox squirrel
<i>Sigmodon hispidus</i>	hispid cotton rat
<i>Sorex longirostris</i>	southeastern shrew
<i>Spilogale putorius</i>	eastern spotted skunk
<i>Sylvilagus floridanus</i>	eastern cottontail rabbit
<i>Synaptomys cooperi</i>	southern bog lemming
<i>Tamias striatus</i>	eastern chipmunk
<i>Taxidea taxus</i>	American badger
<i>Urocyon cinereoargenteus</i>	gray fox

<i>Vulpes vulpes</i>	red fox
<i>Zapus hudsonius</i>	meadow jumping mouse

Birds

Scientific Name	Common Name
Ducks, Geese, Swans	
<i>Aix sponsa</i>	Wood Duck
<i>Anas americana</i>	American Wigeon
<i>Anas discors</i>	Blue-winged Teal
<i>Anas platyrhynchos</i>	Mallard
<i>Anas rubripes</i>	American Black Duck
<i>Anas strepera</i>	Gadwall
<i>Anser albifrons</i>	Greater White-fronted Goose
<i>Anser caerulescens</i>	Snow Goose
<i>Anser rossii</i>	Ross's Goose
<i>Aythya affinis</i>	Lesser Scaup
<i>Aythya americana</i>	Redhead
<i>Aythya collaris</i>	Ring-necked Duck
<i>Aythya marila</i>	Greater Scaup
<i>Aythya valisineria</i>	Canvasback
<i>Branta canadensis</i>	Canada Goose (resident)
<i>Branta canadensis</i>	Canada Goose (migrant)
<i>Branta hutchinsii</i>	Cackling Goose
<i>Bucephala albeola</i>	Bufflehead
<i>Bucephala clangula</i>	Common Goldeneye
<i>Clangula hyemalis</i>	Long-tailed Duck
<i>Cygnus buccinator</i>	Trumpeter Swan
<i>Cygnus columbianus</i>	Tundra Swan
<i>Lophodytes cucullatus</i>	Hooded Merganser
<i>Melanitta americana</i>	Black Scoter
<i>Melanitta deglandi</i>	White-winged Scoter
<i>Melanitta perspicillata</i>	Surf Scoter
<i>Mergus merganser</i>	Common Merganser
<i>Mergus serrator</i>	Red-breasted Merganser
<i>Oxyura jamaicensis</i>	Ruddy Duck
Quail	
<i>Colinus virginianus</i>	Northern Bobwhite
Grouse & Turkey	
<i>Bonasa umbellus</i>	Ruffed Grouse
<i>Meleagris gallopavo</i>	Wild Turkey
<i>Phasianus colchicus</i>	Ring-necked Pheasant
Loons	
<i>Gavia immer</i>	Common Loon
Grebes	
<i>Aechmophorus occidentalis</i>	Western Grebe
<i>Podiceps auritus</i>	Horned Grebe
<i>Podiceps nigricollis</i>	Eared Grebe
<i>Podilymbus podiceps</i>	Pied-billed Grebe
Cormorants	
<i>Phalacrocorax auritus</i>	Double-crested Cormorant

Pelicans	
<i>Pelecanus erythrorhynchos</i>	American White Pelican
Hérons & Bitterns	
<i>Ardea alba</i>	Great Egret
<i>Ardea herodias</i>	Great Blue Heron
<i>Botaurus lentiginosus</i>	American Bittern
<i>Bubulcus ibis</i>	Cattle Egret
<i>Butorides virescens</i>	Green Heron
<i>Egretta caerulea</i>	Little Blue Heron
<i>Egretta thula</i>	Snowy Egret
<i>Ixobrychus exilis</i>	Least Bittern
<i>Nycticorax nycticorax</i>	Black-crowned Night-Heron
<i>Nyctanassa violacea</i>	Yellow-crowned Night-Heron
Ibises	
<i>Plegadis chihi</i>	White-faced Ibis
<i>Plegadis falcinellus</i>	Glossy Ibis
Vultures	
<i>Cathartes aura</i>	Turkey Vulture
<i>Coragyps atratus</i>	Black Vulture
Hawks & Eagles	
<i>Accipiter cooperii</i>	Cooper's Hawk
<i>Accipiter gentilis</i>	Northern Goshawk
<i>Accipiter striatus</i>	Sharp-shinned Hawk
<i>Aquila chrysaetos</i>	Golden Eagle
<i>Buteo jamaicensis</i>	Red-tailed Hawk
<i>Buteo lagopus</i>	Rough-legged Hawk
<i>Buteo lineatus</i>	Red-shouldered Hawk
<i>Buteo platypterus</i>	Broad-winged Hawk
<i>Buteo swainsoni</i>	Swainson's Hawk
<i>Circus cyaneus</i>	Northern Harrier
<i>Haliaeetus leucocephalus</i>	Bald Eagle
<i>Ictinia mississippiensis</i>	Mississippi Kite
<i>Pandion haliaetus</i>	Osprey
Falcons	
<i>Falco columbarius</i>	Merlin
<i>Falco mexicanus</i>	Prairie Falcon
<i>Falco peregrinus</i>	Peregrine Falcon
<i>Falco sparverius</i>	American Kestrel
Rails & Coots	
<i>Coturnicops noveboracensis</i>	Yellow Rail
<i>Rallus elegans</i>	King Rail
<i>Rallus limicola</i>	Virginia Rail
Sora	
<i>Fulica americana</i>	American Coot
<i>Gallinula chloropus</i>	Common Moorhen
<i>Porphyrio martinicus</i>	Purple Gallinule
<i>Porzana carolina</i>	Sora
Cranes	
<i>Grus canadensis</i>	Sandhill Crane
Plovers	
<i>Charadrius melodus</i>	Piping Plover (Great Plains)
<i>Charadrius nivosus</i>	Snowy Plover
<i>Charadrius semipalmatus</i>	Semipalmated Plover
<i>Charadrius vociferus</i>	Killdeer

<i>Pluvialis dominica</i>	American Golden-Plover
<i>Pluvialis squatarola</i>	Black-bellied Plover
Avocets & Stilts	
<i>Himantopus mexicanus</i>	Black-necked Stilt
<i>Recurvirostra americana</i>	American Avocet
Sandpipers	
<i>Actitis macularius</i>	Spotted Sandpiper
<i>Arenaria interpres</i>	Ruddy Turnstone
<i>Bartramia longicauda</i>	Upland Sandpiper
<i>Calidris alba</i>	Sanderling
<i>Calidris alpina</i>	Dunlin
<i>Calidris bairdii</i>	Baird's Sandpiper
<i>Calidris fuscicollis</i>	White-rumped Sandpiper
<i>Calidris himantopus</i>	Stilt Sandpiper
<i>Calidris mauri</i>	Western Sandpiper
<i>Calidris melanotos</i>	Pectoral Sandpiper
<i>Calidris minutilla</i>	Least Sandpiper
<i>Calidris pusilla</i>	Semipalmated Sandpiper
<i>Gallinago delicata</i>	Wilson's Snipe
<i>Limnodromus griseus</i>	Short-billed Dowitcher
<i>Limnodromus scolopaceus</i>	Long-billed Dowitcher
<i>Limosa fedoa</i>	Marbled Godwit
<i>Limosa haemastica</i>	Hudsonian Godwit
<i>Numenius phaeopus</i>	Whimbrel
<i>Phalaropus lobatus</i>	Red-necked Phalarope
<i>Phalaropus tricolor</i>	Wilson's Phalarope
<i>Scolopax minor</i>	American Woodcock
<i>Tringa flavipes</i>	Lesser Yellowlegs
<i>Tringa melanoleuca</i>	Greater Yellowlegs
<i>Tringa semipalmata</i>	Willet
<i>Tringa solitaria</i>	Solitary Sandpiper
<i>Tryngites subruficollis</i>	Buff-breasted Sandpiper
Gulls & Terns	
<i>Chlidonias niger</i>	Black Tern
<i>Chroicocephalus philadelphia</i>	Bonaparte's Gull
<i>Hydroprogne caspia</i>	Caspian Tern
<i>Larus argentatus</i>	Herring Gull
<i>Larus delawarensis</i>	Ring-billed Gull
<i>Larus fuscus</i>	Lesser Black-backed Gull
<i>Larus hyperboreus</i>	Glaucous Gull
<i>Larus thayeri</i>	Thayer's Gull
<i>Leucophaeus atricilla</i>	Laughing Gull
<i>Leucophaeus pipixcan</i>	Franklin's Gull
<i>Sterna forsteri</i>	Forster's Tern
<i>Sterna hirundo</i>	Common Tern
<i>Sternula antillarum</i>	Least Tern (Interior)
<i>Xema sabini</i>	Sabine's Gull
Pigeon's & Doves	
<i>Columba livia</i>	Rock Pigeon
<i>Streptopelia decaocto</i>	Eurasian Collared-Dove
<i>Zenaida macroura</i>	Mourning Dove
Cuckoos	
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo
<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo

Barn Owls	
<i>Tyto alba</i>	Barn Owl
Owls	
<i>Aegolius acadicus</i>	Northern Saw-whet Owl
<i>Asio flammeus</i>	Short-eared Owl
<i>Asio otus</i>	Long-eared Owl
<i>Bubo scandiacus</i>	Snowy Owl
<i>Bubo virginianus</i>	Great Horned Owl
<i>Megascops asio</i>	Eastern Screech-Owl
<i>Strix varia</i>	Barred Owl
Nightjars	
<i>Antrostomus carolinensis</i>	Chuck-will's-widow
<i>Antrostomus vociferus</i>	Whip-poor-will
<i>Chordeiles minor</i>	Common Nighthawk
Swifts	
<i>Chaetura pelagica</i>	Chimney Swift
Hummingbirds	
<i>Archilochus colubris</i>	Ruby-throated Hummingbird
<i>Selasphorus rufus</i>	Rufous Hummingbird
Kingfishers	
<i>Ceryle alcyon</i>	Belted Kingfisher
Woodpeckers	
<i>Colaptes auratus</i>	Northern Flicker
<i>Dryocopus pileatus</i>	Pileated Woodpecker
<i>Melanerpes erythrocephalus</i>	Red-headed Woodpecker
<i>Melanerpes carolinus</i>	Red-bellied Woodpecker
<i>Picoides pubescens</i>	Downy Woodpecker
<i>Picoides villosus</i>	Hairy Woodpecker
<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker
Flycatchers	
<i>Contopus cooperi</i>	Olive-sided Flycatcher
<i>Contopus virens</i>	Eastern Wood-Pewee
<i>Empidonax alnorum</i>	Alder Flycatcher
<i>Empidonax flaviventris</i>	Yellow-bellied Flycatcher
<i>Empidonax minimus</i>	Least Flycatcher
<i>Empidonax traillii</i>	Willow Flycatcher
<i>Empidonax virescens</i>	Acadian Flycatcher
<i>Myiarchus crinitus</i>	Great Crested Flycatcher
<i>Sayornis phoebe</i>	Eastern Phoebe
<i>Tyrannus forficatus</i>	Scissor-tailed Flycatcher
<i>Tyrannus tyrannus</i>	Eastern Kingbird
<i>Tyrannus verticalis</i>	Western Kingbird
Shrikes	
<i>Lanius ludovicianus</i>	Loggerhead Shrike
Vireos	
<i>Vireo bellii</i>	Bell's Vireo
<i>Vireo flavifrons</i>	Yellow-throated Vireo
<i>Vireo gilvus</i>	Warbling Vireo
<i>Vireo griseus</i>	White-eyed Vireo
<i>Vireo olivaceus</i>	Red-eyed Vireo
<i>Vireo philadelphicus</i>	Philadelphia Vireo
<i>Vireo solitarius</i>	Blue-headed Vireo
Crows & Jays	
<i>Corvus brachyrhynchos</i>	American Crow
<i>Corvus ossifragus</i>	Fish Crow

<i>Cyanocitta cristata</i>	Blue Jay
Larks	
<i>Eremophila alpestris</i>	Horned Lark
Swallows	
<i>Hirundo rustica</i>	Barn Swallow
<i>Petrochelidon pyrrhonota</i>	Cliff Swallow
<i>Progne subis</i>	Purple Martin
<i>Riparia riparia</i>	Bank Swallow
<i>Stelgidopteryx serripennis</i>	Northern Rough-winged Swallow
<i>Tachycineta bicolor</i>	Tree Swallow
Chickadees & Titmice	
<i>Baeolophus bicolor</i>	Tufted Titmouse
<i>Poecile atricapillus</i>	Black-capped Chickadee
<i>Poecile carolinensis</i>	Carolina Chickadee
Nuthatches	
<i>Sitta canadensis</i>	Red-breasted Nuthatch
<i>Sitta carolinensis</i>	White-breasted Nuthatch
Creepers	
<i>Certhia americana</i>	Brown Creeper
Wrens	
<i>Cistothorus palustris</i>	Marsh Wren
<i>Cistothorus platensis</i>	Sedge Wren
<i>Thryomanes bewickii</i>	Bewick's Wren
<i>Thryothorus ludovicianus</i>	Carolina Wren
<i>Troglodytes aedon</i>	House Wren
<i>Troglodytes hiemalis</i>	Winter Wren
Gnatcatchers	
<i>Poliophtila caerulea</i>	Blue-gray Gnatcatcher
Kinglets	
<i>Regulus calendula</i>	Ruby-crowned Kinglet
<i>Regulus satrapa</i>	Golden-crowned Kinglet
Thrushes	
<i>Catharus fuscescens</i>	Veery
<i>Catharus guttatus</i>	Hermit Thrush
<i>Catharus minimus</i>	Gray-cheeked Thrush
<i>Catharus ustulatus</i>	Swainson's Thrush
<i>Hylocichla mustelina</i>	Wood Thrush
<i>Sialia sialis</i>	Eastern Bluebird
<i>Turdus migratorius</i>	American Robin
Mockingbirds & Thrashers	
<i>Dumetella carolinensis</i>	Gray Catbird
<i>Mimus polyglottos</i>	Northern Mockingbird
<i>Toxostoma rufum</i>	Brown Thrasher
Starlings	
<i>Sturnus vulgaris</i>	European Starling
Pipits	
<i>Anthus rubescens</i>	American Pipit
<i>Anthus spragueii</i>	Sprague's Pipit
Waxwings	
<i>Bombycilla cedrorum</i>	Cedar Waxwing
Warblers	
<i>Cardellina canadensis</i>	Canada Warbler
<i>Cardellina pusilla</i>	Wilson's Warbler
<i>Geothlypis formosa</i>	Kentucky Warbler
<i>Geothlypis philadelphia</i>	Mourning Warbler

<i>Geothlypis trichas</i>	Common Yellowthroat
<i>Helmitheros vermivorum</i>	Worm-eating Warbler
<i>Icteria virens</i>	Yellow-breasted Chat
<i>Limnothlypis swainsonii</i>	Swainson's Warbler
<i>Mniotilta varia</i>	Black-and-white Warbler
<i>Oporornis agilis</i>	Connecticut Warbler
<i>Oreothlypis celata</i>	Orange-crowned Warbler
<i>Oreothlypis peregrina</i>	Tennessee Warbler
<i>Oreothlypis ruficapilla</i>	Nashville Warbler
<i>Parkesia motacilla</i>	Louisiana Waterthrush
<i>Parkesia noveboracensis</i>	Northern Waterthrush
<i>Protonotaria citrea</i>	Prothonotary Warbler
<i>Seiurus aurocapilla</i>	Ovenbird
<i>Setophaga americana</i>	Northern Parula
<i>Setophaga castanea</i>	Bay-breasted Warbler
<i>Setophaga cerulea</i>	Cerulean Warbler
<i>Setophaga citrina</i>	Hooded Warbler
<i>Setophaga discolor</i>	Prairie Warbler
<i>Setophaga dominica</i>	Yellow-throated Warbler
<i>Setophaga fusca</i>	Blackburnian Warbler
<i>Setophaga magnolia</i>	Magnolia Warbler
<i>Setophaga palmarum</i>	Palm Warbler
<i>Setophaga pensylvanica</i>	Chestnut-sided Warbler
<i>Setophaga petechia</i>	Yellow Warbler
<i>Setophaga pinus</i>	Pine Warbler
<i>Setophaga ruticilla</i>	American Redstart
<i>Setophaga striata</i>	Blackpoll Warbler
<i>Setophaga tigrina</i>	Cape May Warbler
<i>Setophaga virens</i>	Black-throated Green Warbler
<i>Vermivora cyanoptera</i>	Blue-winged Warbler
<i>Vermivora chrysoptera</i>	Golden-winged Warbler
Sparrows	
<i>Ammodramus henslowii</i>	Henslow's Sparrow
<i>Ammodramus leconteii</i>	Le Conte's Sparrow
<i>Ammodramus nelsoni</i>	Nelson's Sparrow
<i>Ammodramus savannarum</i>	Grasshopper Sparrow
<i>Calcarius lapponicus</i>	Lapland Longspur
<i>Calcarius pictus</i>	Smith's Longspur
<i>Chondestes grammacus</i>	Lark Sparrow
<i>Junco hyemalis</i>	Dark-eyed Junco
<i>Melospiza georgiana</i>	Swamp Sparrow
<i>Melospiza lincolnii</i>	Lincoln's Sparrow
<i>Melospiza melodia</i>	Song Sparrow
<i>Passerculus sandwichensis</i>	Savannah Sparrow
<i>Passerella iliaca</i>	Fox Sparrow
<i>Peucaea aestivalis</i>	Bachman's Sparrow
<i>Pipilo maculatus</i>	Spotted Towhee
<i>Pipilo erythrophthalmus</i>	Eastern Towhee
<i>Plectrophenax nivalis</i>	Snow Bunting
<i>Poocetes gramineus</i>	Vesper Sparrow
<i>Spizella arborea</i>	American Tree Sparrow
<i>Spizella pallida</i>	Clay-colored Sparrow
<i>Spizella passerina</i>	Chipping Sparrow
<i>Spizella pusilla</i>	Field Sparrow

<i>Zonotrichia albicollis</i>	White-throated Sparrow
<i>Zonotrichia leucophrys</i>	White-crowned Sparrow
<i>Zonotrichia querula</i>	Harris's Sparrow
Tanagers & Buntings	
<i>Cardinalis cardinalis</i>	Northern Cardinal
<i>Passerina caerulea</i>	Blue Grosbeak
<i>Passerina ciris</i>	Painted Bunting
<i>Passerina cyanea</i>	Indigo Bunting
<i>Pheucticus ludovicianus</i>	Rose-breasted Grosbeak
<i>Piranga olivacea</i>	Scarlet Tanager
<i>Piranga rubra</i>	Summer Tanager
<i>Spiza americana</i>	Dickcissel
Blackbirds & Orioles	
<i>Agelaius phoeniceus</i>	Red-winged Blackbird
<i>Dolichonyx oryzivorus</i>	Bobolink
<i>Euphagus carolinus</i>	Rusty Blackbird
<i>Euphagus cyanocephalus</i>	Brewer's Blackbird
<i>Icterus galbula</i>	Baltimore Oriole
<i>Icterus spurius</i>	Orchard Oriole
<i>Molothrus ater</i>	Brown-headed Cowbird
<i>Quiscalus mexicanus</i>	Great-tailed Grackle
<i>Quiscalus quiscula</i>	Common Grackle
<i>Sturnella magna</i>	Eastern Meadowlark
<i>Sturnella neglecta</i>	Western Meadowlark
<i>Xanthocephalus xanthocephalus</i>	Yellow-headed Blackbird
Finches	
<i>Acanthis flammea</i>	Common Redpoll
<i>Carpodacus mexicanus</i>	House Finch
<i>Carpodacus purpureus</i>	Purple Finch
<i>Coccothraustes vespertinus</i>	Evening Grosbeak
<i>Loxia curvirostra</i>	Red Crossbill
<i>Spinus pinus</i>	Pine Siskin
<i>Spinus tristis</i>	American Goldfinch
Old World Sparrows	
<i>Passer domesticus</i>	House Sparrow

Pollinators

Scientific Name	Common Name
MOTHS and BUTTERFLIES	
Swallowtails	
<i>Eurytides marcellus</i> (Cramer)	zebra swallowtail
<i>Papilio cresphontes</i> (Cramer)	giant swallowtail
<i>Papilio polyxenes asterius</i> (Stoll)	black swallowtail
<i>Pterourus glaucus glaucus</i> (Linnaeus)	eastern tiger swallowtail
<i>Pterourus troilus troilus</i> (Linnaeus)	spicebush swallowtail
Whites And Sulphurs	
<i>Abaeis nicippe</i> (Cramer)	sleepy orange
<i>Artogeia rapae</i> (Linnaeus)	europaean cabbage butterfly
<i>Colias eurytheme</i> (Boisduval)	alfalfa butterfly, orange sulphur
<i>Colias philodice philodice</i> (Godart)	clouded sulphur
<i>Falcapica midea</i> (Hübner)	falcate orangetip

<i>Nathalis iole</i> (Boisduval)	dainty sulphur
<i>Phoebis sennae eubule</i> (Linnaeus)	cloudless sulphur
<i>Pieris rapae</i>	small cabbage white
<i>Pontia protodice</i> (Boisduval & Leconte)	checkered white
<i>Pyrisitia lisa lisa</i> (Boisduval & Leconte)	little sulphur, little yellow
Gossamer-Wing Butterflies	
<i>Everes comyntas comyntas</i> (Godart)	eastern-tailed blue
<i>Hylolycaena hyllus</i> (Cramer)	bronze copper
<i>Strymon melinus</i> (Hübner)	gray hairstreak
Brushfooted Butterflies	
<i>Anaea andria</i> (Scudder)	goatweed leafwing
<i>Asterocampa celtis celtis</i> (Boisduval & Leconte)	hackberry emperor
<i>Asterocampa clyton clyton</i> (Boisduval & Leconte)	tawny emperor
<i>Cercyonis pegala</i> (Fabricius)	common wood-nymph
<i>Danaus plexippus</i> (Linnaeus)	monarch
<i>Euptoieta claudia</i> (Cramer)	variegated fritillary
<i>Junonia coenia</i> (Hubner)	common buckeye
<i>Libytheana carinenta</i> (Cramer)	American snout
<i>Limenitis archippus archippus</i> (Cramer)	viceroys
<i>Limenitis arthemis astyanax</i> (Fabricius)	red-spotted purple
<i>Megisto cymela cymela</i> (Cramer)	little wood satyr
<i>Phyciodes tharos tharos</i> (Drury)	pearl crescent
<i>Polygonia comma</i> (Harris)	comma, hop merchant
<i>Polygonia interrogationis</i> (Fabricius)	question mark, violet tip
<i>Speyeria cybele cybele</i> (Fabricius)	great spangled fritillary
<i>Speyeria idalia</i> (Drury)	regal fritillary
<i>Vanessa atalanta rubria</i> (Fruhstorfer)	red admiral
<i>Vanessa cardui</i> (Linnaeus)	painted lady
Skippers	
<i>Atrytone logan logan</i> (W.H. Edwards)	Delaware skipper
<i>Epargyreus clarus clarus</i> (Cramer)	silver-spotted skipper
<i>Pholisora catullus</i> (Fabricius)	common sootywing
<i>Poanes hobomok</i> (Harris)	hobomok skipper
<i>Poanes taxiles</i> (W.H. Edwards)	taxiles skipper
<i>Pyrgus communis</i> (Grote)	common checkered-skipper
<i>Staphylus hayhurstii</i> (W.H. Edwards)	Hayhurst's scallopedwing
<i>Thorybes bathyllus</i> (J.E. Smith)	southern cloudywing
Pyralid Snout Moths	
<i>Agriphila vulgivaagella</i> (Clemens)	vagabond crambus
<i>Crambus trisectus</i> (Walker)	sod webworm
<i>Desmia funeralis</i> (Hübner)	grape leafroller moth
<i>Diastictis argyralis</i> (Hübner)	white-spotted orange moth
<i>Hymenia perspectalis</i> (Hübner)	spotted beet Webworm moth
<i>Nephopteryx basilaris</i> (Zeller)	nephopteryx moth
<i>Nomophila nearctica</i> (Munroe)	American celery webworm moth
<i>Ostrinia nubilalis</i> (Hübner)	European corn borer moth
<i>Pyrausta inaequalis</i> (Guenée)	pyralid moth
<i>Saucrobotys futilalis</i> (Lederer)	dogbane saucrobotys moth
<i>Urola nivalis</i> (Drury)	snowy urola moth
Inchworms	
<i>Anavitrinella pampinaria</i> (Guenée)	cranberry spanworm, common gray
<i>Apicia confusaria</i>	
<i>Calothysanis amaturaria</i> (Walker)	cross-lined wave

<i>Digrammia subminiata</i> (Packard)	dark-waved angle
<i>Eusarca confusaria</i> (Hübner)	confused eusarca
<i>Eutrapela clemataria</i> (J.E. Smith)	curve-toothed geometer
<i>Haematopsis grataria</i> (Fabricius)	chickweed geometer
<i>Mellilla xanthometata</i> (Walker)	orange wing
<i>Metanema inatomaria</i> (Guenée)	pale metanema
<i>Nemoria lixaria</i> (Guenée)	red-bordered emerald
<i>Prochoerodes transversata</i> (Drury)	large maple spanworm moth
<i>Scopula inductata</i> (Guenée)	soft-lined wave
<i>Synchlora aerata</i> (Fabricius)	wavy-lined emerald
<i>Tornos scolopacinarius</i> (Guenée)	dimorphic gray
<i>Xanthotype sospeta</i> (Drury)	crocus geometer
<i>Xanthotype urticaria</i> (Swett)	false crocus geometer, buttercup moth
Sphinx Moths	
<i>Ceratonia catalpae</i> (Boisduval)	catalpa sphinx
<i>Ceratonia hageni</i> (Grote)	osage orange sphinx, Hagen's sphinx
<i>Ceratonia undulosa</i> (Walker)	waved sphinx
<i>Darapsa myron</i> (Cramer)	Virginia creeper sphinx
<i>Hemaris diffinis</i> (Boisduval)	snowberry clearwing
<i>Hyles lineata</i> (Fabricius)	white-lined sphinx
<i>Laothoe juglandis</i> (J.E. Smith)	walnut sphinx
<i>Pachysphinx modesta</i> (Harris)	poplar sphinx, modest sphinx
<i>Paratreia plebeja</i> (Fabricius)	plebeian sphinx
<i>Smerinthus jamaicensis</i> (Drury)	twin-spotted sphinx
Giant Silkworm Moths / Emperors	
<i>Antheraea polyphemus</i> (Cramer)	polyphemus
<i>Sphingicampa bicolor</i> (Harris)	honey locust moth
Leaf Roller Moths	
<i>Choristoneura rosaceana</i> (Harris)	oblique-banded leafroller moth
<i>Sparganothis sulfureana</i> (Clemens)	sparganothis fruitworm moth
Prominents	
<i>Datana perspicua</i> (Grote & Robinson)	spotted datana
<i>Nadata gibbosa</i> (J.E. Smith)	rough prominent
<i>Pheosia rimosa</i> (Packard)	black-rimmed prominent
Owlet Moths	
<i>Acontia aprica</i> (Hübner)	exposed bird-dropping moth
<i>Alypia octomaculata</i> (Fabricius)	eight-spotted forester
<i>Agrotis ipsilon</i> (Hufnagel)	ipsilon dart, black cutworm
<i>Argyrostromis quadrifilaris</i>	four-lined chocolate
<i>Anagrapha falcifera</i> (Kirby)	celery looper
<i>Caenurgina erechtea</i> (Cramer)	forage looper, common grass moth
<i>Catocala cara</i> (Guenée)	darling underwing
<i>Cirrhophanus triangulifer</i> (Grote)	goldenrod stowaway
<i>Eudryas grata</i> (Fabricius)	beautiful wood nymph
<i>Felita jaculifera</i> (Guenée)	dingy cutworm or clay-backed cutworm
<i>Helicoverpa zea</i> (Boddie)	corn earworm
<i>Orgyia leucostigma</i> (J.E. Smith)	white-marked tussock moth
<i>Proxenus miranda</i> (Grote)	miranda moth
<i>Pseudaletia unipuncta</i> (Haworth)	army worm moth
<i>Psychomorpha epimenis</i> (Drury)	grapevine epimenis
<i>Schinia arcigera</i> (Guenée)	arcigera flower moth
<i>Schinia Lynx</i>	lynx flower moth
<i>Simyra henrici</i> (Grote)	cattail caterpillar

<i>Spaelotis clandestina</i> (Harris)	W-marked cutworm moth
<i>Spodoptera ornithogalli</i> (Guenée)	yellowstriped armyworm
<i>Thioptera nigrofimbria</i> (Guenée)	black-bordered lemon moth
<i>Zale lunata</i> (Drury)	lunate zale
Tiger Moths	
<i>Apantesis nais</i> (Drury)	banded tiger moth
<i>Apantesis nais</i>	nais tiger moth
<i>Cisseps fulvicollis</i> (Hübner)	yellow-collared scape moth
<i>Cisthene plumbea</i> (Stretch)	lead-colored lichen moth
<i>Clemensia albata</i> (Packard)	little white lichen moth
<i>Cycnia oregonensis</i> (Stretch)	Oregon cycnia
<i>Cycnia tenera</i> (Hübner)	orange-margined dogbane tiger moth
<i>Ecpantheria scribonia</i>	giant leopard moth
<i>Estigmene acrea</i> (Drury)	acrea moth
<i>Euchaetes egle</i> (Drury)	milkweed tussock moth
<i>Grammia oithona</i> (Strecker)	Oithona tiger, straight-lined tiger moth
<i>Grammia virgo</i> (Linnaeus)	virgin tiger moth
<i>Halysidota tessellaris</i> (J.E. Smith)	banded tussock moth
<i>Haploa colona</i> (Hübner)	colona moth
<i>Haploa reversa</i> (Stretch)	reversed haploa moth
<i>Holomelina aurantiaca</i> (Hübner)	orange holomelina
<i>Hyphantria cunea</i> (Drury)	fall webworm moth
<i>Spilosoma virginica</i>	yellow bear
BEES and WASPS	
Bumble Bees	
<i>Bombus auricomus</i> (Robertson)	
<i>Bombus bimaculatus</i> (Cresson)	
<i>Bombus griseocollis</i> (DeGeer)	
<i>Bombus impatiens</i> (Cresson)	
<i>Bombus pensylvanicus</i> (DeGeer)	
Long-horned Bees	
<i>Eucera hamata</i> (Bradley)	
<i>Eucera rosae</i> (Robertson)	
<i>Melissodes agilis</i>	
<i>Melissodes bimaculata</i> (Lepeletier)	
<i>Melissodes communis</i>	
<i>Melissodes comptoides</i> (Robertson)	
<i>Melissodes denticulata</i>	
<i>Melissodes desponsa</i> (Smith)	
<i>Melissodes subillata</i>	
<i>Melissodes trinodis</i> (Robertson)	
<i>Peponapis pruinosa</i>	
<i>Svastra stripes</i> (Cresson)	
Carpenter Bees	
<i>Xylocopa latreille</i>	
<i>Xylocopa virginica</i> (Cresson)	
Small Carpenter Bees	
<i>Ceratina calcarata</i> (Robertson)	
<i>Ceratina dupla</i> (Provancher)	
<i>Ceratina strenua</i> (Smith)	
Cuckoo Bees	
<i>Nomada affabilis</i>	
<i>Nomada bidentate</i>	

<i>Nomada gracilis</i>	
<i>Nomada near armatella</i>	
<i>Nomada pygmaea</i>	
<i>Nomada superba</i>	
<i>Triepeolus Sp#1</i>	
<i>Xeromelecta californica</i>	
Honey Bees	
<i>Apis mellifera</i> (Linnaeus)	
Digger Bees	
<i>Florilegus condignus</i> (Cresson)	
<i>Ptilothrix bombiformis</i> (Cresson)	
Sand Bees, Mining Bees	
<i>Andrena andrenoides</i> (Cresson) red form	
<i>Andrena erythrogaster</i> (Ashmead)	
<i>Andrena carlini</i> (Cockerell)	
<i>Andrena commoda</i> (Robertson)	
<i>Andrena cressonii</i> (Cockerell)	
<i>Andrena erigeniae</i>	
<i>Andrena hippotes</i>	
<i>Andrena imatatrix</i>	
<i>Andrena miserabilis</i> (Smith)	
<i>Andrena nasonii</i> (Viereck)	
<i>Andrena nuda</i>	
<i>Andrena perplexa</i>	
<i>Andrena personata</i>	
<i>Andrena rudbeckia</i> (Robertson)	
<i>Andrena violae</i> (Robertson)	
<i>Anthophora abrupta</i> (Smith)	
<i>Calliopsis andreniformis</i> (Smith)	
<i>Perdita halictoides</i> (Cockerell)	
<i>Perdita octomaculata</i> (Say)	
<i>Pseudopanurgus albitarsis</i> (Cresson)	
Plasterer Bees	
<i>Colletes inequalis</i> (Cresson)	
<i>Colletes latitarsus</i> (Robertson)	
<i>Hylaeus mesillae</i> (Cockerell)	
<i>Hylaeus modestus</i>	
Sweat Bees	
<i>Agapostemon sericeus</i> (Förster)	
<i>Agapostemon texanus</i> (Cresson)	
<i>Agapostemon virescens</i> (Fabricius)	
<i>Augochlora pura</i> (Say)	
<i>Augochlorella persimilis</i> (Viereck)	
<i>Augochlorella aurata</i> (Smith)	
<i>Augochloropsis metallica</i> (Fabricius)	
<i>Dieunomia heteropoda</i> (Say)	
<i>Halictus confusus</i> (Smith)	
<i>Halictus ligatus</i> (Cresson)	
<i>Halictus parallelus</i> (Say)	
<i>Halictus rubicundus</i> (Christ)	
<i>Halictus tripartitus</i>	
<i>Lasioglossum bruneri</i> (Crawford)	
<i>Lasioglossum callidum</i>	

<i>Lasioglossum cattallae</i>	
<i>Lasioglossum coreopsis</i> (Robertson)	
<i>Lasioglossum coriaceum</i>	
<i>Lasioglossum cressonii</i> (Robertson)	
<i>Lasioglossum disparila</i>	
<i>Lasioglossum forbesii</i>	
<i>Lasioglossum fuscipenne</i>	
<i>Lasioglossum hartii</i> (Robertson)	
<i>Lasioglossum imitatum</i> (Smith)	
<i>Lasioglossum lustrans</i>	
<i>Lasioglossum mitchelli</i>	
<i>Lasioglossum nelumbonis</i>	
<i>Lasioglossum nymphaeorum</i>	
<i>Lasioglossum obscurum</i> (Robertson)	
<i>Lasioglossum oceanicum</i> (Cockerell)	
<i>Lasioglossum pectorale</i> (Smith)	
<i>Lasioglossum pictum</i> (Crawford)	
<i>Lasioglossum pilosum</i> (Smith)	
<i>Lasioglossum platyparium</i>	
<i>Lasioglossum tegulare</i> (Robertson)	
<i>Lasioglossum testaceum</i>	
<i>Lasioglossum truncatum</i> (Robertson)	
<i>Lasioglossum versatum</i> (Robertson)	
<i>Lasioglossum weemsi</i>	
<i>Lasioglossum zephyrum</i> (Smith)	
<i>Sphecodes dichrous</i> (Smith)	
Leafcutting Bees	
<i>Hoplitis pilosifrons</i> (Cresson)	
<i>Hoplitis producta</i> (Cresson)	
<i>Megachile brevis</i> (Say)	
<i>Megachile exilis</i>	
<i>Megachile inimical</i>	
<i>Megachile mendica</i>	
<i>Megachile montivaga</i> (Cresson)	
<i>Megachile petulans</i>	
<i>Megachile texana</i>	
<i>Megachile xylocopoides</i> (Smith)	
Mason Bees	
<i>Osmia atriventris</i>	
<i>Osmia collinsiae</i> (Robertson)	
<i>Osmia conjuncta</i> (Cresson)	
<i>Osmia georgica</i> (Cresson)	
<i>Osmia lignaria</i>	
<i>Osmia pumila</i> (Cresson)	
<i>Osmia texana</i>	
Wasps	
<i>Ammophila</i>	
<i>Astata</i>	
<i>Dolichovespula maculata</i>	
<i>Myzinum berlyi berlyi</i>	
<i>Myzinum obscurum</i>	
<i>Myzinum quinquecinctum</i>	
<i>Oxybelus</i>	

<i>Polistes fuscatus</i>	
<i>Polistes exclamans</i>	
<i>Polistes metricus</i>	
<i>Polistes metriens</i>	
<i>Sceliphron caementarium</i>	
<i>Sphecius speciosus</i>	
<i>Thyredon aticolor</i>	

Fish and Mussels

Scientific Name	Common Name
<i>Acipenser fulvescens</i>	lake sturgeon
<i>Alosa alabamae</i>	Alabama shad
<i>Alosa chrysochloris</i>	skipjack shad
<i>Ambloplites rupestris</i>	rock bass
<i>Ameiurus melas</i>	black bullhead
<i>Ameiurus natalis</i>	yellow bullhead
<i>Anguilla rostrata</i>	American eel
<i>Aplodinotus grunniens</i>	freshwater drum
<i>Campostoma oligolepis</i>	largescale stoneroller
<i>Campostoma pullum</i>	central stoneroller
<i>Carassius auratus</i>	goldfish
<i>Carpoides carpio</i>	river carpsucker
<i>Carpoides cyprinus</i>	quillback
<i>Carpoides velifer</i>	highfin carpsucker
<i>Catostomus commersonii</i>	white sucker
<i>Cottus bairdi</i>	mottled sculpin
<i>Cottus carolinae</i>	banded sculpin
<i>Crystal asprella</i>	crystal darter
<i>Ctenopharyngodon idella</i>	grass carp
<i>Cycleptus elongatus</i>	blue sucker
<i>Cyprinella spiloptera</i>	spotfin shiner
<i>Cyprinus carpio</i>	common carp
<i>Dorosoma cepedianum</i>	American gizzard shad
<i>Dorosoma petenense</i>	threadfin shad
<i>Erimystax x-punctatus</i>	gravel chub
<i>Esox lucius</i>	northern pike
<i>Etheostoma blenniodes</i>	greenside darter
<i>Etheostoma caeruleum</i>	rainbow darter
<i>Etheostoma flabellare (Rafinesque)</i>	fantail darter
<i>Etheostoma nigrum (Rafinesque)</i>	johnny darter
<i>Etheostoma punctulatum</i>	stippled darter
<i>Etheostoma spectabile</i>	orangethroat darter
<i>Etheostoma tetrazonum</i>	Missouri saddled darter
<i>Fundulus catenatus</i>	northern studfish
<i>Fundulus notatus</i>	blackstripe topminnow
<i>Fundulus olivaceus</i>	blackspotted topminnow
<i>Fundulus sciadicus</i>	plains topminnow
<i>Fundulus zebrinus</i>	plains killifish
<i>Gambusia affinis</i>	western mosquitofish
<i>Hiodon alosoides</i>	goldeye

<i>Hiodon tergisus</i>	mooneye
<i>Hybognathus argyritis</i>	western silvery minnow
<i>Hybognathus placitus</i>	plains minnow
<i>Hyognanthus hankinsoni</i>	brassy minnow
<i>Hypentelium nigricans</i>	northern hogsucker
<i>Hypophthalmichthys molitrix</i>	silver carp
<i>Hypophthalmichthys nobilis</i>	bighead carp
<i>Ichthyomyzon castaneus</i>	chestnut lamprey
<i>Ictalurus furcatus</i>	blue catfish
<i>Ictalurus punctatus</i>	channel catfish
<i>Ictiobus bubalus</i>	smallmouth buffalo
<i>Ictiobus cyprinellus</i>	bigmouth buffalo
<i>Ictiobus niger</i>	black buffalo
<i>Labidesthes sicculus</i>	brook silverside
<i>Lepisosteus osseus</i>	longnose gar
<i>Lepisosteus platostomus</i>	shortnose gar
<i>Lepomis cyanellus</i>	green sunfish
<i>Lepomis gulosus</i>	warmouth
<i>Lepomis humilis</i>	orangespotted sunfish
<i>Lepomis macrochirus</i>	bluegill
<i>Lepomis megalotis</i>	longear sunfish
<i>Lepomis microlophus</i>	redeer sunfish
<i>Lota lota</i>	burbot
<i>Luxilus chrysocephalus</i>	striped shiner
<i>Luxilus cornutus</i>	common shiner
<i>Luxilus zonatus</i>	bleeding shiner
<i>Lythrurus umbratilis</i>	redfin shiner
<i>Macrhybopsis aestivalis</i>	speckled chub
<i>Macrhybopsis gelida</i>	sturgeon chub
<i>Macrhybopsis meeki</i>	sicklefin chub
<i>Macrhybopsis storeriana</i>	silver chub
<i>Micropterus dolomieu</i>	smallmouth bass
<i>Micropterus punctulatus</i>	spotted bass
<i>Micropterus salmoides</i>	largemouth bass
<i>Minytrema melanops</i>	spotted sucker
<i>Morone chrysops</i>	white bass
<i>Morone saxatilis</i>	striped bass
<i>Moxostoma carinatum</i>	river redhorse
<i>Moxostoma duquesnei</i>	black redhorse
<i>Moxostoma erythrurum</i>	golden redhorse
<i>Moxostoma macrolepidotum</i>	shorthead redhorse
<i>Nocomis biguttatus</i>	hornyhead chub
<i>Notemigonus crysoleucas</i>	golden shiner
<i>Notropis atherinoides</i>	emerald shiner
<i>Notropis blennioides</i>	river shiner
<i>Notropis boops</i>	bigeye shiner
<i>Notropis burchanani</i>	ghost shiner
<i>Notropis dorsalis</i>	bigmouth shiner
<i>Notropis ludibundus</i>	sand shiner
<i>Notropis nubilus</i>	Ozark minnow
<i>Notropis rubellus</i>	rosyface shiner
<i>Notropis shumardi</i>	silverband shiner
<i>Notropis topeka</i>	Topeka shiner

<i>Notropis wickliffi</i>	channel shiner
<i>Noturus exilis</i>	slender madtom
<i>Noturus flavus</i>	stonecat
<i>Noturus gyrinus</i>	tadpole madtom
<i>Osmerus mordax</i>	rainbow smelt
<i>Perca flavescens</i>	yellow perch
<i>Percina caprodes</i>	logperch
<i>Percina evides (Jordan)</i>	gilt darter
<i>Percina maculata (Girard)</i>	blackside darter
<i>Percina phoxocephala</i>	slenderhead darter
<i>Percopsis omiscomaycus</i>	trout-perch
<i>Phenacobius mirabilis</i>	suckermouth minnow
<i>Phoxinus erythrogaster</i>	southern redbelly dace
<i>Pimephales notatus</i>	bluntnose minnow
<i>Pimephales promelas</i>	fathead minnow
<i>Platygobio gracilis</i>	flathead chub
<i>Polyodon spathula</i>	American paddelfish
<i>Pomoxis annularis</i>	white crappie
<i>Pomoxis nigromaculatus</i>	black crappie
<i>Pylodictis olivaris</i>	flathead catfish
<i>Scaphirhynchus albus</i>	pallid sturgeon
<i>Scaphirhynchus platyrhynchus</i>	shovelnose sturgeon
<i>Semotilus atromaculatus</i>	creek chub
<i>Stizostedion canadense</i>	sauger
<i>Stizostedion vitreum</i>	walleye

Reptiles and Amphibians

Scientific Name	Common Name
Amphibians- Salamanders, Toads and Frogs	
<i>Acris crepitans blanchardi</i>	Blanchard's cricket frog
<i>Ambystoma annulatum</i>	ringed salamanders
<i>Ambystoma maculatum</i>	spotted salamander
<i>Ambystoma opacum</i>	marbled salamander
<i>Ambystoma texanum</i>	small-mouthed salamander
<i>Ambystoma tigrinum tigrinum</i>	eastern tiger salamander
<i>Bufo americanus americanus</i>	eastern American toad
<i>Bufo cognatus</i>	great plains toad
<i>Bufo fowleri (Hinckley)</i>	Fowler's toad
<i>Bufo woodhousii woodhousii</i>	Woodhouse's toad
<i>Cryptobranchus alleganiensis</i>	hellbender
<i>Eurycea longicauda</i>	long-tailed salamander
<i>Eurycea lucifuga</i>	cave salamander
<i>Gastrophryne carolinensis</i>	eastern narrow-mouthed toad
<i>Gastrophryne olivacea</i>	great plains narrow-mouthed toad
<i>Hemidactylium scutatum</i>	four-toed salamander
<i>Hyla chrysoscelis-Hyla versicolor</i>	gray treefrog
<i>Necturus maculosus maculosus</i>	common mudpuppy
<i>Notophthalmus viridescens louisianensis</i>	central newt
<i>Plethodon albagula (Grobman)</i>	western slimy salamander
<i>Plethodon serratus (Grobman)</i>	southern red-backed salamander

<i>Pseudacris crucifer crucifer</i>	northern spring peeper
<i>Pseudacris triseriata triseriata</i>	western chorus frog
<i>Rana areolata</i>	northern crawfish frog
<i>Rana blairi</i>	plains leopard frog
<i>Rana catesbeiana (Shaw)</i>	bullfrog
<i>Rana clamitans melanota</i>	green frog
<i>Rana palustris</i>	pickerel frog
<i>Rana sphenocephala</i>	southern leopard frog
<i>Rana sylvatica</i>	wood frog
<i>Siren intermedia nettingi</i>	western lesser siren
<i>Scaphiopus holbrookii holbrookii</i>	eastern spadefoot
<i>Spea bombifrons</i>	plains spadefoot toad
Reptiles- Crocodilians, Turtles, Lizards and Snakes	
<i>Agkistrodon contortrix phaeogaster</i>	Osage copperhead
<i>Apalone mutica mutica</i>	midland smooth softshell
<i>Apalone spinifera spinifera</i>	eastern spiny softshell
<i>Carphophis vermis</i>	western wormsnake
<i>Chelydra serpentina serpentina</i>	common snapping turtle
<i>Chysemys picta bellii</i>	western painted turtle
<i>Cnemidophorus sexlineatus sexlineatus</i>	six-lined racerunner
<i>Columber constictor flaviventris</i>	eastern yellow-bellied racer
<i>Crotalus horridus</i>	timber rattlesnake
<i>Crotaphytus collaris collaris</i>	eastern collared lizard
<i>Diadophis punctatus armyi</i>	prairie ring-necked snake
<i>Emydoidea blandingii</i>	Blanding's turtle
<i>Elpaha guttata emoryi</i>	great plains ratsnake
<i>Elaphe obsoleta obsoleta</i>	black ratsnake
<i>Elaphe vulpina vulpina</i>	western foxsnake
<i>Eumeces anthracinus pluvialis</i>	southern coal skink
<i>Eumeces fasciatus</i>	five-lined skink
<i>Eumeces laticeps</i>	broad-headed skink
<i>Eumeces obsoletus</i>	great plains skink
<i>Eumeces septentrionalis septentrionalis</i>	northern prairie skink
<i>Graptemys geographica</i>	common map turtle
<i>Graptemys pseudogeographica</i>	false map turtle
<i>Heterodon platirhinos</i>	eastern hog-nosed snake
<i>Kinosternon flavescens</i>	yellow mud turtle
<i>Lampropeltis calligaster calligaster</i>	prairie kingsnake
<i>Lampropeltis getula holbrookii</i>	speckled kingsnake
<i>Lampropeltis triangulum sypila</i>	red milksnake
<i>Macrochelys temminckii</i>	alligator snapping turtle
<i>Masticophis flagellum flagellum</i>	eastern coachwhip
<i>Nerodia erythrogaster flavigaster</i>	yellow-bellied watersnake
<i>Nerodia rhombifer rhombifer</i>	diamond-backed watersnake
<i>Nerodia sipedon sipedon</i>	northern watersnake
<i>Opheodrys aestivus aestivus</i>	rough greensnake
<i>Ophisaurus attenuatus attenuatus</i>	western slender glass lizard
<i>Pituophis catenifer sayi</i>	bullsnake
<i>Pseudemys concinna concinna</i>	river cooter
<i>Regina grahamii</i>	Graham's crayfish snake
<i>Sceloporus undulatus hyacinthinus</i>	northern fence lizard
<i>Scincella lateralis</i>	ground skink
<i>Sistrurus catenatus catenatus</i>	eastern massasauga rattlesnake

<i>Sternotherus odoratus</i>	common musk turtle
<i>Storeria dekayi wrightorum</i>	midland brownsnake
<i>Storeria occipitomaculata occipitomaculata</i>	northern red-bellied snake
<i>Tantilla gracilis</i>	flat-headed snake
<i>Terrapene carolina triunguis</i>	three-toed box turtle
<i>Terrapene ornata ornata</i>	ornate box turtle
<i>Thamnophis proximus proximus</i>	western ribbonsnake
<i>Thamnophis radix radix</i>	plains gartersnake
<i>Thamnophis sirtalis sirtalis</i>	eastern gartersnake
<i>Trachemys scripta elegans</i>	red-eared slider
<i>Tropidoclonian lineatum</i>	lined snake
<i>Virginia striatula</i>	rough earthsnake
<i>Virginia valeriae elegans</i>	western earthsnake

Appendix C: Federal Real Estate Use Agreement for Overton Bottoms South and Cora Island Units

ORIGINAL

Agreement No. DACW41-4-09-0013

**DEPARTMENT OF THE ARMY
FEDERAL REAL ESTATE USE AGREEMENT
TO OTHER FEDERAL GOVERNMENT DEPARTMENT OR AGENCY
TO USE PROPERTY LOCATED ON
MISSOURI RIVER BANK STABILIZATION AND NAVIGATION
FISH AND WILDLIFE MITIGATION PROJECT
MISSOURI**

THE SECRETARY OF THE ARMY, hereinafter referred to as the Secretary hereby grants to **U.S. FISH AND WILDLIFE SERVICE**, hereinafter referred to as the Grantee, a Federal Real Estate Use Agreement for Fish and Wildlife activities, over, across in and upon the lands identified in **EXHIBIT "A"**, attached hereto and made a part hereof, hereinafter referred to as the premises.

The Secretary and the Grantee enter this Real Estate Use Agreement under the authority of Fish and Wildlife Coordination Act, Public Law 85-624.

THIS FEDERAL REAL ESTATE USE AGREEMENT is granted subject to the following conditions.

1. This Federal Real Estate Use Agreement is hereby granted for a term of twenty-five years beginning **September 30, 2009** and ending **September 29, 2034** but revocable at will by the Secretary. It is understood by the parties that other tracts may be added to this Real Estate Use Agreement by appending documents to this Real Estate Use Agreement. Notwithstanding the date a tract is added to the Real Estate Use Agreement, the term for all tracts shall end on September 29, 2034.
2. The consideration for this Federal Real Estate Use Agreement is the operation and maintenance of the premises by the Grantee for the benefit of the United States and the general public in accordance with the conditions herein set forth.
3. All correspondence and notices to be given pursuant to this Federal Real Estate Use Agreement shall be addressed, if to the Grantee to the **Refuge Manager; Big Muddy NFWR, U.S. Fish and Wildlife Service, 4200 New Haven Road, Columbia, Missouri 65201** and if to the **Secretary, to the District Engineer, Attention: Chief, Real Estate Division, Kansas City District, 601 East 12th Street, Kansas City, Missouri 64106-2896**; or as may from time to time otherwise be directed by the parties. Notice shall be deemed to have been duly given if and when enclosed in a properly sealed envelope or wrapper addressed as aforesaid, and deposited, postage prepaid, in a post office regularly maintained by the United States Postal Service.
4. The use and occupancy of the premises shall be without cost or expense to the Department of the Army and under the general supervision and subject to the approval of the District Engineer, Kansas City District, or his duly authorized representative, hereinafter referred to as said officer and to such rules and regulations as may be prescribed from time to time by said officer.
5. The Grantee acknowledges that it has inspected the premises, knows its condition, and understands that the same is granted without any representations or warranties whatsoever and without any obligation on the part of the Department of the Army.

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6. The Grantee shall, at its own expense and without cost or expense to the Department of the Army maintain and keep the premises in good repair and condition. This term does not limit or restrict the Secretary's ability to reimburse Grantee for the Grantee's costs of operating, maintaining, repairing and rehabilitating the premises during the term of this Federal Real Estate Use Agreement in accordance with Paragraph 17 of this agreement.

7. Any interference with the use of or damage to property under control of the Department of the Army incident to the exercise of the privileges herein granted shall be promptly corrected by the Grantee to the satisfaction of said officer.

8. The Grantee shall pay the cost, as determined by the officer having immediate jurisdiction over the premises, of producing or supplying any utilities and/or other services furnished by or through the Department of the Army for the use of the Grantee.

9. No additions to or alterations of the premises shall be made without the prior written approval of the District Engineer or said officer.

10. On or before the expiration of this Federal Real Estate Use Agreement or its relinquishment by the Grantee, the Grantee shall vacate the premises and remove its property therefrom. If, however, this Federal Real Estate Use Agreement is revoked by the Secretary, the Grantee shall vacate the premises and remove its property therefrom within such time as the District Engineer may designate.

11. The Grantee shall comply with all applicable laws and regulations wherein the premises are located, to the extent doing so is consistent with the sovereign immunity of the United States.

12. A Preliminary Assessment Screening (PAS) documenting the known history of each tract with regard to the storage, release or disposal of hazardous substances thereon is/are attached hereto and made a part hereof as **EXHIBIT "B"**. The Grantee has the right to enter the premises and inspect the premises, and to attach the Grantee's findings as to each tract covered in this Real Estate Use Agreement as **EXHIBIT "C"** which is/are incorporated herein. Upon expiration, revocation or relinquishment of this Federal Real Estate Use Agreement another PAS shall be prepared which will document the environmental condition of the tracts at that time.

13. The Secretary will retain the exclusive authority, responsibility and liability for all environmental compliance, response, or remediation of contamination resulting from past, present or future Secretary activities. The Secretary will not be responsible for any environmental compliance or remediation requirements that occur as a result of new contamination generated or pre-existing contamination released by the Grantee or any activities of Grantee's contractors, agents or visitors. The Grantee shall not have any authority, responsibility or liability for any environmental response actions or remediation for releases resulting from the Secretary's past, present or future activities in relation to the premises or for any matters identified on **Exhibit "B"**. The Grantee will be responsible for all environmental compliance and remediation requirements resulting from new contamination generated by Grantee or pre-existing contamination released by the Grantee's activities during the term of this agreement.

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14. The Secretary reserves the right to remove and properly dispose of the existing substances which are identified in the PAS as potential sources of contamination, as required to carry out the Department of the Army environmental programs.

15. It is understood that the requirements of the Federal Real Estate Use Agreement pertaining to maintenance, repair, protection, and restoration of the premises and reimbursement for utilities and other services, shall be effective only insofar as they do not conflict with the Annual Management Plan pertaining to such matters made between the Secretary or said officer and Grantee in accordance with existing regulations, and are consistent with applicable laws.

16. The Grantee must obtain approval in writing from said officer before any pesticides or herbicides are applied to the premises. The Grantee shall report any planned pesticide or herbicide usage to the said officer by the 1st of October of each year.

17. The Secretary is authorized to pay and the Grantee is authorized to receive reimbursement of Grantee's direct expenses for planning and development of optimum wildlife habitat including documenting and controlling invasive exotic species, establishing native vegetation and habitat, reconnecting the floodplain with the Missouri River, and protection of endangered or threatened species. Reimbursement for the cost of Grantee's employees who are directly engaged in such activities on the premises is also authorized. The Grantee, however, will not use the proceeds to pay for general administrative expenses. In order for the Secretary to pay said reimbursement, each year the Grantee shall submit its Annual Management Plan detailing specific expenses. The Secretary or said officer shall review the subject of the expense and the amount of the expense and shall authorize such payment or return to Grantee for revision. The Annual Management Plan can be revised within each yearly term as well by mutual agreement of the parties.

18. Within the limits of their respective legal powers, the parties to this Federal Real Estate Use Agreement shall protect the premises against pollution of its air, ground and water. The Grantee shall comply with any laws, regulations, conditions or instructions affecting the activity hereby authorized if and when issued by the Environmental Protection Agency, or any Federal, state, interstate or local governmental agency having jurisdiction and authority over the United States to abate or prevent pollution. The Grantee will use all reasonable means available to protect the environment and natural resources and where damage nonetheless occurs from the Grantee's activities, the Grantee shall be liable to restore the damaged resources in accordance with applicable federal law. Nothing in this term is intended to waive the Grantee's sovereign immunity or to subject the Grantee to regulation or liability beyond existing federal laws.

19. The Grantee shall not remove or disturb, or cause to be removed or disturbed, any historical, archeological, architectural or other cultural artifacts, relics, remains or objects of antiquity. In the event such items are discovered on the premises, the Grantee shall immediately notify said officer and protect the site and the material from further disturbance until said officer gives written clearance to proceed. Furthermore, any future earth disturbing activities or structure removals will require coordination with the Kansas City District archeologist and my require State Historic Preservation Office (SHPO) coordination as well.

Agreement No. DACW41-4-09-0013

20. This Federal Real Estate Use Agreement is subject to all existing easements, easements subsequently granted, and established access routes for roadways and utilities located, or to be located, on the premises, provided that the proposed grant of any new easement or route will be coordinated with the Grantee, and easements will not be granted which will, in the opinion of the District Engineer, interfere with developments, present or proposed by the Grantee. The Grantee will not close any established access routes without written permission of the District Engineer.

21. The parties to this agreement are federal agencies constrained by federal laws and subject to Congressional appropriations. As such, it is mutually understood that all obligations in this agreement are made subject to the availability of funds.

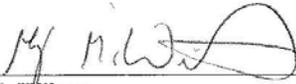
22. The Grantee will be responsible for accepting and processing any tort claims for incidents arising out of its activities on the premises. The Secretary will cooperate in providing information relating to any such tort claim. Any liability between the Secretary and the Grantee will be determined in accordance with the Federal Tort Claims Act and other applicable laws.

23. In the event this Federal Real Estate Use Agreement is renewed by a similar instrument, then numbered Condition 10 hereof will not be applicable.

24. Permit No. DACW41-4-97-211 is hereby revoked upon execution of this Real Estate Use Agreement.

THIS FEDERAL REAL ESTATE USE AGREEMENT is not subject to Title 10, United States Code, Section 2662, as amended.

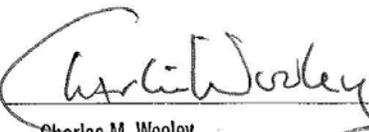
IN WITNESS WHEREOF, I have hereunto set my hand by authority of the Secretary of the Army, this 2 day of February, 2010.



Greg G. Wilson
Chief, Real Estate Division

THIS FEDERAL REAL ESTATE USE AGREEMENT is also executed by the Grantee this 25 day of January, 2010.

U.S. Fish and Wildlife Service

BY: 

TITLE: **Charles M. Wooley**
Acting Regional Director

Appendix D: Abbreviations and Glossary

Abbreviations

The following is a list of the most frequently used abbreviations in this document. More detail for some of the abbreviations is included in the Glossary.

NOTE: “Abbreviations” is used generically to refer to abbreviations (shortened version of a term or series of words), acronyms (word formed from letters or parts of a series of words), and initialisms (initial letters pronounced separately).

BCA:	Bird Conservation Areas
BCC:	Birds of Conservation Concern
BCR:	Bird Conservation Region
CCP:	Comprehensive Conservation Plan
CD:	Compatibility Determination
CFR:	Code of Federal Regulations
CRP:	U.S. Department of Agriculture’s Conservation Reserve Program
DNR:	Department of Natural Resources (often preceded by state abbreviation)
DOI:	U.S. Department of the Interior
DU:	Ducks Unlimited
EA:	Environmental Assessment
EAS:	Environmental Action Statement
EE:	Environmental Education
EIS:	Environmental Impact Statement
EO:	Executive Order
EPA:	U.S. Environmental Protection Agency
ESA:	Endangered Species Act
FONSI:	Finding of No Significant Impact
FR:	Federal Register
FTE:	Full-time Equivalent
FWS:	U.S. Fish and Wildlife Service (also USFWS and Service)
FY:	Fiscal Year
GAP:	Gap Analysis Program
GIS:	Geographic Information System
HAPET:	U.S. Fish and Wildlife Service’s Habitat and Population Evaluation Team
IBA:	Audubon Society’s Important Bird Area
IPCC:	Intergovernmental Panel on Climate Change
LCC:	Landscape Conservation Cooperative
LCD:	Landscape Conservation Design
MOA:	Memorandum of Agreement
MOU:	Memorandum of Understanding
NABCI:	North American Bird Conservation Initiative
NAI:	Natural Areas Inventory
NEPA:	National Environmental Policy Act
NRHP:	National Register of Historic Places
NWR:	National Wildlife Refuge (also Refuge)
NWRS:	National Wildlife Refuge System (also Refuge System)
PFT:	Permanent Full-time
PPJV:	Prairie Pothole Joint Venture

PPR:	Prairie Pothole Region
R3:	Region 3 (Midwest) of the U.S. Fish and Wildlife Service (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin)
ROD:	Record of Decision
SGCN:	Species of Greatest Conservation Need
SHC:	Strategic Habitat Conservation
TFT:	Temporary Full-time
UMR/GLR JV:	Upper Mississippi River & Great Lakes Region Joint Venture
USC:	United States Code
USDA:	U.S. Department of Agriculture
USGS:	U.S. Geologic Survey
WMA:	Wildlife Management Area
WMD:	Wetland Management District (also District)
WPA:	Waterfowl Production Area
WRP:	U.S. Department of Agriculture's Wetland Reserve Program
WSA:	Wilderness Study Areas

Glossary

Adaptation: Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Adaptive Management: The rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities. A process that uses feedback from refuge research and monitoring and evaluation of management actions to support or modify objectives and strategies at all planning levels (FWS, 602 FW 1.6(A)).

Alternatives: Different sets of objectives and strategies or means of achieving refuge purposes and goals, helping fulfill the National Wildlife Refuge System mission, and resolving issues (FWS, 602 FW 1.6(B)).

Appropriate Use: A proposed or existing use on a refuge that meets at least one of the following four conditions (FWS, 603 FW 1.6):

- The use is a wildlife-dependent recreational use as identified in the Fish and Wildlife Improvement Act of 1978.
- The use contributes to fulfilling the refuge purpose(s), the National Wildlife Refuge System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the National Wildlife Refuge System Improvement Act of 1997 was signed into law.
- The use involves the take of fish and wildlife under state regulations.
- The use has been found to be appropriate as specified in section 1.11.

Approved Acquisition Boundary: A project boundary that the Director of the U.S. Fish and Wildlife Service approves upon completion of the planning and environmental compliance process. An approved acquisition boundary only designates those lands that the Service has authority to acquire and/or manage through various agreements. Approval of an acquisition boundary does not grant the Service jurisdiction or control over lands within the boundary, and it does not make lands within the refuge boundary part of the National Wildlife Refuge System. Lands do not become part of the Refuge System until they are purchased or are placed under an agreement that provides for management as part of the Refuge System.

Biological Control: The use of organisms or viruses to control weeds or other pests.

Biological Diversity: The variety of life, including the variety of living organisms, the genetic differences among them, and the communities in which they occur (FWS, 602 FW 1.6(C)).

Biological Integrity: Biotic composition, structure, and functioning at the genetic, organism, and community levels consistent with natural conditions, including the natural biological processes that shape genomes, organisms, and communities (FWS, 602 FW 1.6(D)).

Candidate Species: Plants and animals for which the U.S. Fish and Wildlife Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act of 1973, but for which development of a proposed listing regulation is precluded by other higher priority listing activities.

Carbon Sequestration: The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen, and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned.

Climate Change: Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from (1) natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun; (2) natural processes within the climate system (e.g., changes in ocean circulation); (3) human activities that change the atmosphere's composition (e.g., through burning fossil fuels) and the land surface (e.g., deforestation, reforestation, urbanization, desertification, etc.).

Code of Federal Regulations (CFR): The codification of the general and permanent rules published in the *Federal Register* by the departments and agencies of the federal government. It is divided into 50 titles that represent broad areas subject to federal regulation. The 50 subject matter titles contain one or more individual volumes, which are updated once each calendar year, on a staggered basis.

Council on Environmental Quality (CEQ): An executive office of the president whose members are appointed by the president. CEQ recommends national policies to promote the improvement of the quality of the environment.

Compatible Use: A proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge (FWS, 603 FW 2.6(B)).

Compatibility Determination (CD): A written determination signed and dated by the refuge manager and the U.S. Fish and Wildlife Service regional chief signifying that a proposed or existing use of a national wildlife refuge is a compatible use or is not a compatible use. The director of the Service makes this delegation through the regional director (FWS, 603 FW 2.6(A)).

Comprehensive Conservation Plan (CCP): A document that describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purposes of the refuge; helps fulfill the mission of the Refuge System; maintains and, where appropriate, restores the ecological integrity of each refuge and the National Wildlife Refuge System; helps achieve the goals of the National Wilderness Preservation System; and meets other mandates (FWS, 602 FW 1.6(E)).

Consumptive Use: Use of a refuge resource that removes the resource from the refuge (e.g., killing an animal to eat, catching and keeping fish, harvesting berries or plants, or removal of mineral or other specimens).

Cultural Resource Inventory: A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register of Historic Places follows the criteria found in 36 CFR 60.4.

Cultural Resources: “Those parts of the physical environment—natural and built—that have cultural value to some kind of sociocultural group . . . [and] those non-material human social institutions” Cultural resources include historic sites, archeological sites and associated artifacts, sacred sites, traditional cultural properties, cultural items (human remains, funerary objects, sacred objects, and objects of cultural patrimony), and buildings and structures.

Easement: A privilege or right that is held by one person or other entity in land owned by another.

Ecological Integrity: The integration of biological integrity, natural biological diversity, and environmental health; the replication of natural conditions (FWS, 602 FW 1.6(G)).

Ecosystem: A biological community together with its environment, functioning as a unit. For administrative purposes, 53 ecosystems covering the United States and its possessions have been designated. These ecosystems generally correspond with watershed boundaries, and their sizes and ecological complexity vary (FWS, 602 FW 1.6(H)).

Effects (Impacts): Effects include:

- Direct effects, which are caused by the action and occur at the same time and place.
- Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

- Cumulative effects, which result from past, present, and reasonably foreseeable future actions that, collectively, become significant over time.

Effects and impacts as used in these regulations are synonymous. Effects includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (40 CFR 1508.8).

Endangered Species: Any species of plant or animal defined through the Endangered Species Act of 1973 as being in danger of extinction throughout all or a significant portion of its range and published in the *Federal Register*.

Endangered Species Act (ESA): Through federal action and by encouraging the establishment of state programs, the Endangered Species Act of 1973 provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. The act authorizes the determination and listing of species as endangered and threatened; prohibits unauthorized taking, possession, sale, and transport of endangered species; provides authority to acquire land for the conservation of listed species, using land and water conservation funds; authorizes establishment of cooperative agreements and grants-in-aid to states that establish and maintain active and adequate programs for endangered and threatened wildlife and plants; authorizes the assessment of civil and criminal penalties for violating the act or regulations; and authorizes the payment of rewards to anyone furnishing information leading to arrest and conviction for any violation of the act or any regulation issued thereunder.

Section 7 of the Endangered Species Act of 1973 requires federal agencies to insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

Environmental Action Statement (EAS): The decision document for an environmental assessment for the U.S. Fish and Wildlife Service. The EAS will consist of a one-page document indicating the proposal, the Service decision, references to supporting documents (if any), and a signature block. The purposes of the EAS are to establish a process for internal review of National Environmental Policy Act-related decision documents and to provide an appropriate administrative record of NEPA-related decisions at all management levels of the Service (FWS, 550 FW 3.3 (C)).

Environmental Analysis: The process associated with preparing documents such as environmental assessments and environmental impact statements and the decision whether to prepare an environmental impact statement. It is an analysis of alternative actions and their predictable short-term and long-term effects, which include physical, biological, economic, and social factors and their interactions.

Environmental Assessment (EA): A systematic analysis to determine if proposed actions would result in a significant effect on the quality of the environment.

Environmental Consequences: The scientific and analytic basis for the comparison of alternatives. The environmental impacts of the alternatives including the proposed action, any

adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources that would be involved in the proposal should it be implemented (40 CFR 1502.16).

Environmental Health: Abiotic composition, structure, and functioning of the environment consistent with natural conditions, including the natural abiotic processes that shape the environment (FWS, 602 FW 1.6(I)).

Environmental Impact Statement (EIS): A detailed written statement, required by section 102(2)(C) of the National Environmental Policy Act, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.11).

Environmental Justice: The fair treatment and meaningful involvement of all people in the development, implementation, and enforcement of environmental laws regardless of race, color, national origin, or income.

Extirpation: The local extinction of a species that is no longer found in a locality or country but exists elsewhere in the world.

Finding of No Significant Impact (FONSI): A document prepared in compliance with the National Environmental Policy Act and supported by an environmental assessment that briefly presents why a federal action will have no significant effects on the human environment and for which an Environmental Impact Statement will not be prepared (40 CFR 1508.13).

Global Warming: Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

Goal: A descriptive, open-ended, and often broad statement of desired future conditions that conveys purposes but does not define measurable units (FWS, 602 FW 1.6(J)).

Greenhouse Gas (GHG): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O₃), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

Habitat: The physical and biological resources required by an organism for its survival and reproduction; these requirements are species-specific. Food and cover are major components of habitat and must extend beyond the requirements of the individual to include a sufficient area capable of supporting a viable population.

Incompatible: Any use (recreational or nonrecreational) of a refuge that, in the sound professional judgment of the Director of the U.S. Fish and Wildlife Service, will materially

interfere with or detract from the fulfillment of the mission of the National Wildlife Refuge System or the purposes of the refuge. Incompatible uses are not allowed to occur on Service areas.

Indicator: In effects analysis, a way for measuring effects from management alternatives on a particular resource or issue.

Interjurisdictional Fish: Fish that occur in waters under the jurisdiction of one or more states, for which there is an interstate fishery management plan or which migrates between the waters under the jurisdiction of two or more states bordering on the Great Lakes.

Invasive Species: Invasive species are organisms that are introduced into a non-native ecosystem and that cause, or are likely to cause, harm to the economy, environment, or human health.

Inventory: Accepted biological methods to determine the presence, relative abundance, and/or distribution of species (FWS, 701 FW 2.6(A)).

Issue: Any unsettled matter that requires a management decision—that is, a U.S. Fish and Wildlife Service initiative, opportunity, resource management problem, a threat to the resources of the unit, conflict in uses, public concern, or the presence of an undesirable resource condition (FWS, 602 FW 1.6(K)).

Landscape Conservation Cooperative: A national network of public-private partnerships that provide shared science to ensure the sustainability of America's land, water, wildlife, and cultural resources.

Landscape Conservation Design: A partnership-driven activity that results in an assessment of current and anticipated future resource patterns and processes, and a spatially explicit depiction of a desired future condition. These products guide partners' identification of broad management, restoration, and protection strategies that could be implemented on the ground to address identified resource concerns, attain desired future conditions, sustain ecosystem function, and achieve the missions, mandates, and goals of partner agencies, organizations, and tribes.

Major Federal Action: Includes action with effects that may be major and that are potentially subject to federal control and responsibility. "Major" reinforces but does not have a meaning independent of significantly. "Actions" include new and continuing activities. Federal actions include adoption of official policy, formal plans, programs, and approval of specific projects (40 CFR 1508.18).

Memorandum of Understanding or Agreement (MOU or MOA): A legal document outlining the terms and details of an agreement between parties (often U.S. Fish and Wildlife Service and a state natural resource agency), including each party's requirements and responsibilities. It sets forth the basic principles and guidelines under which the parties will work together to accomplish their goals. A memorandum of understanding or agreement are generally recognized as binding, even if no legal claim could be based on the rights and obligations laid down in them.

Migratory Birds: Birds that follow a seasonal movement from their breeding grounds to their wintering grounds. Waterfowl, shorebirds, raptors, and songbirds are all migratory birds.

Monitoring: Accepted biological methods to determine the status and/or demographics of species over time (FWS, 701 FW 2.6(B)).

National Environmental Policy Act (NEPA): This act, promulgated in 1969, requires all federal agencies to disclose the environmental effects of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA with other planning requirements and must prepare appropriate NEPA documents to facilitate better environmental decision making (40 CFR 1500). The law also established the Council on Environmental Quality to implement the law and to monitor compliance with the law.

National Wilderness Preservation System: A network of federally owned areas designated by Congress as wilderness and managed by one of four federal agencies: the U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, or the U.S. Forest Service. Includes over 600 areas and more than 105 million acres. The National Wildlife Refuge System includes over 20 million acres of wilderness in more than 60 refuges (FWS, 610 FW 1.9).

National Wildlife Refuge (NWR, refuge): A designated area of land, water, or an interest in land or water within the National Wildlife Refuge System, but does not include Coordination Areas. A complete listing of all units of the Refuge System is located in the current Report of Lands Under Control of the U.S. Fish and Wildlife Service (FWS, 602 FW 1.6(L)).

National Wildlife Refuge System (NWRS, Refuge System): All lands, waters, and interests therein administered by the U.S. Fish and Wildlife Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas for the protection and conservation of fish, wildlife, and plant resources.

National Wildlife Refuge System Improvement Act of 1997 (improvement act): Sets the mission and administrative policy for all refuges in the National Wildlife Refuge System. Clearly defines a unifying mission for the Refuge System; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation); establishes a formal process for determining compatibility; establishes the responsibilities of the Secretary of the Interior for managing and protecting the Refuge System; and requires a Comprehensive Conservation Plan for each refuge by the year 2012. This act amended portions of the Refuge Recreation Act and National Wildlife Refuge System Administration Act of 1966.

Native Species: A species, subspecies, or distinct population that occurs within its natural range or natural zone of potential dispersal (i.e., the geographic area the species occupies naturally or would occupy in the absence of direct or indirect human activity or an environmental catastrophe).

No Action Alternative: In the context of a Comprehensive Conservation Plan, this refers to the current management direction. With this alternative, no change from the current CCP would be implemented.

Non-consumptive Uses: Recreational activities (e.g., hiking, photography, and wildlife observation) that do not involve the taking or catching of fish, wildlife, or other natural resources.

Non-native Species: A species, subspecies, or distinct population that has been introduced by humans (intentionally or unintentionally) outside its natural range or natural zone of potential dispersal.

Objective: A concise statement of what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for the work. Objectives derive from goals and provide the basis for determining strategies, monitoring refuge accomplishments, and evaluating the success of strategies. Objectives are to be attainable, time-specific, and measurable (FWS, 602 FW 1.6(N)).

Ozone (O3): Ozone, the triatomic form of oxygen (O₃), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (photochemical smog). In high concentrations, tropospheric ozone can be harmful to a wide range of living organisms. Tropospheric ozone acts as a greenhouse gas. In the stratosphere, ozone is created by the interaction between solar ultraviolet radiation and molecular oxygen (O₂). Stratospheric ozone plays a decisive role in the stratospheric radiative balance. Depletion of stratospheric ozone, due to chemical reactions that may be enhanced by climate change, results in an increased ground-level flux of ultraviolet (UV) B radiation.

Planning Area: The area upon which the planning effort will focus. A planning area may include lands outside existing planning unit boundaries currently studied for inclusion in the National Wildlife Refuge System and/or partnership planning efforts. It also may include watersheds or ecosystems outside of our jurisdiction that affect the planning unit. At a minimum, the planning area includes all lands within the authorized boundary of the refuge (FWS, 602 FW 1.6(O)).

Planning Team: A planning team is interdisciplinary in membership and function. A team generally consist of a planning team leader, refuge manager, staff biologists, a state natural resource agency representative, and other appropriate program specialists (e.g., social scientist, ecologist, recreation specialist). Other federal and tribal natural resource agencies may also be asked to provide team members, as appropriate. The planning team prepares the Comprehensive Conservation Plan and appropriate National Environmental Policy Act documentation (FWS, 602 FW 1.6(P)).

Prescribed Burning: Controlled application of fire to the landscape that allows the fire to be confined to a predetermined area while producing the intensity of heat and rate of spread required to achieve planned management objectives.

Preferred Alternative: A proposed action in the National Environmental Policy Act document for the Comprehensive Conservation Plan identifying the alternative that the U.S. Fish and Wildlife Service believes best achieves planning unit purposes, vision, and goals; helps fulfill the National Wildlife Refuge System mission; maintains and, where appropriate, restores the ecological integrity of each refuge and the Refuge System; addresses the significant issues and mandates; and is consistent with principles of sound fish and wildlife management.

Priority Public Uses: Six uses authorized by the National Wildlife Refuge System Improvement Act of 1997 to have priority and are found to be compatible with the refuge purposes. This includes hunting, fishing, wildlife observation and photography, and environmental education and interpretation.

Proposed Action: In the context of a Comprehensive Conservation Plan, this is the same as the Preferred Alternative.

Public Involvement: A process that offers affected and interested individuals and organizations opportunities to become informed about, and to express their opinions on, U.S. Fish and Wildlife Service actions and policies. In the process, these public views are studied thoroughly and are thoughtfully considered in shaping decisions for refuge management.

Purposes of the Refuge: The purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. For refuges that encompass congressionally designated wilderness, the purposes of the Wilderness Act are additional purposes of the refuge (FWS, 602 FW 1.6(S)).

Record of Decision (ROD): A concise public record of a decision prepared by the federal agency, pursuant to National Environmental Policy Act, that contains a statement of the decision, identification of all alternatives considered, identification of the environmentally preferable alternative, a statement whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).

Resident Species: A nonmigratory species inhabiting a given locality throughout the year. Examples include white-tailed deer, muskrat, raccoon, mink, and fox.

Scoping: A process for determining the scope of issues to be addressed by a Comprehensive Conservation Plan and for identifying the significant issues. Involved in the scoping process are federal, state, and local agencies; private organizations; and individuals.

Shorebird: Long-legged birds, also known as waders, belonging to the order Charadriiformes that use shallow wetlands and mud flats for foraging and nesting.

Significant Issue: A significant issue is typically: within Service jurisdiction, suggests different actions or alternatives, and will influence the decision (FWS, 602 FW 3.4 (3)(b)).

Species: A distinctive kind of plant or animal having distinguishable characteristics, and that can interbreed and produce young. A category of biological classification.

Sound Professional Judgment: A finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of the National Wildlife Refuge System Administration Act of 1966 and other applicable laws.

Stakeholder: A person or group who has an interest in activities within the Planning Area.

Step-down Management Plan: A plan that provides specific guidance on management subjects (e.g., habitat, public use, fire, safety) or groups of related subjects. It describes strategies and implementation schedules for meeting Comprehensive Conservation Plan goals and objectives (FWS, 602 FW 1.6(U)).

Strategic Habitat Conservation (SHC): A structured, science-driven approach for making efficient, transparent decisions about where and how to expend Service resources for species, or groups of species, that are limited by the amount or quality of habitat. It is an adaptive management framework integrating planning, design, delivery, and evaluation.

Strategy: A specific action, tool or technique, or combination of actions, tools, and techniques used to meet unit objectives (FWS, 602 FW 1.6(V)).

Surrogate Species: Species that are used to represent other species or aspects of the environment.

Threatened Species: Those plant or animal species likely to become endangered species throughout all of or a significant portion of their range within the foreseeable future. A plant or animal identified and defined in accordance with the Endangered Species Act of 1973 and published in the *Federal Register*.

Vision Statement: A concise statement of what the planning unit should be or hope to do, based primarily upon the National Wildlife Refuge System mission, specific refuge purposes, and other mandates. The vision statement for the refuge should be tied to the mission of the Refuge System; the purpose(s) of the refuge; the maintenance or restoration of the ecological integrity of each refuge and the Refuge System; and other mandates (FWS, 602 FW 1.6(Z)).

Waterfowl: A group of birds that include ducks, geese, and swans (belonging to the order Anseriformes).

Waterfowl Production Area (WPA): Prairie wetlands with associated uplands managed to provide nesting areas for waterfowl and owned in fee title by the U.S. Fish and Wildlife Service. These lands are purchased from willing sellers with funds from federal Duck Stamp sales. They are open to public hunting, fishing, and trapping according to state and federal regulations.

Watershed: The entire land area that collects and drains water into a river/stream or river/stream system.

Wetland: A wetland is land transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purposes of this classification a wetland must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al. 1979).

Wetland Management District (WMD): An area covering several counties that acquires (with federal Duck Stamp funds), restores, and manages prairie wetland habitat critical to waterfowl and other wetland birds.

Wildlife-Dependent Recreational Use: A use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation. These are the six priority public uses of the National Wildlife Refuge System as established in the National Wildlife Refuge System Administration Act of 1966, as amended. Wildlife-dependent recreational uses, other than the six priority public uses, are those that depend on the presence of wildlife. These

other uses will also be considered in the preparation of refuge Comprehensive Conservation Plans; however, the six priority public uses always will take precedence (FWS, 602 FW 1.6(Y)).

Wildlife Diversity: A measure of the number of wildlife species in an area and their relative abundance.

Water Birds: This general category includes all birds that inhabit lakes, marshes, streams and other wetlands at some point during the year. The group includes all waterfowl such as ducks, geese, and swans and other birds such as loons, rails, cranes, herons, egrets, ibis, cormorants, pelicans, shorebirds, and passerines that nest and rely on wetland vegetation.

Appendix E: Legal and Policy Guidance

Administrative Procedures Act of 1946

Outlines administrative procedures to be followed by federal agencies with respect to identification of information to be made public; publication of material in the *Federal Register*; maintenance of records; attendance and notification requirements for specific meetings and hearings; issuance of licenses; and review of agency actions.

American Indian Religious Freedom Act of 1978

Establishes as policy of the United States the protection and preservation for American Indians of their inherent right to freedom to believe, express, and practice their traditional religions. The act directs federal agencies to evaluate their policies and procedures, in consultation with native traditional religious leaders, in order to determine changes required to protect and preserve Native American religious cultural rights and practices.

Americans with Disabilities Act of 1990, as amended by the ADA Amendments Act of 2008

Prohibits discrimination of individuals based on disability. It requires that public transportation services be accessible to individuals with disabilities and prohibits discrimination in employment of qualified individuals with disabilities. It requires the Equal Employment Opportunity Commission to issue regulations relating to discrimination of disabled individuals, and requires the National Council on Disability to conduct a study of areas designated as wilderness to determine the effect of the designation on the ability of individuals to enjoy such areas. The ADA Amendments Act of 2008 restored the intent and protections of the original act.

Antiquities Act of 1906

Authorizes the president to designate as National Monuments objects or areas of historic or scientific interest on lands owned or controlled by the United States. The act requires that a permit be obtained for examination of ruins, excavation of archaeological sites, and the gathering of objects of antiquity on lands under the jurisdiction of the Secretaries of Interior, Agriculture, and Army; and provides penalties for violations.

Archaeological Resources Protection Act of 1979

Largely supplanted the resource protection provisions of the Antiquities Act for archaeological items. This act established detailed requirements for issuance of permits for any excavation for or removal of archaeological resources from federal or Indian lands. It also established civil and criminal penalties for the unauthorized excavation, removal, or damage of any such resources; for any trafficking in such resources removed from federal or Indian land in violation of any provision of federal law; and for interstate and foreign commerce in such resources acquired, transported or received in violation of any state or local law. This act also required the land managing agencies to establish public awareness programs regarding the value of archaeological resources to the Nation.

Archeological and Historic Preservation Act of 1960, as amended

This act carries out the policy established by the Historic Sites, Buildings and Antiquities Act of 1935 (known as the Historic Sites Act). It directs federal agencies to notify the Secretary of the Interior whenever they find a federal or federally assisted, licensed, or permitted project may cause loss or destruction of significant scientific, prehistoric, or archaeological data. The act authorizes use of appropriated, donated, and/or transferred funds for the recovery, protection, and preservation of such data.

Archeological and Historic Preservation Act of 1974

Directs the preservation of historic and archaeological data in federal construction projects.

Architectural Barriers Act of 1969

Ensures that certain buildings financed or leased by federal agencies are constructed (or renovated) so that they will be accessible to the physically handicapped.

Bald and Golden Eagle Protection Act of 1940, as amended

Prohibits the possession, sale, or transport of any bald or golden eagle, alive or dead, or part, nest, or egg except as permitted by the Secretary of the Interior for scientific or exhibition purposes or for the religious purposes of Indians.

Bankhead-Jones Farm Tenant Act of 1937

Directs the Secretary of Agriculture to develop a program of land conservation and utilization in order to correct maladjustments in land use and thus assist in such things as control of soil erosion, reforestation, preservation of natural resources, and protection of fish and wildlife. Some early refuges and hatcheries were established under authority of this act.

Clean Air Act of 1970

Regulates air emissions from area, stationary, and mobile sources. The act and its amendments charge federal land managers with direct responsibility to protect the "air quality and related values" of land under their control. These values include fish, wildlife, and their habitats.

Emergency Wetlands Resources Act of 1986

Authorized the purchase of wetlands from Land and Water Conservation Fund moneys, removing a prior prohibition on such acquisitions. Requires the Secretary of the Interior to establish a National Wetlands Priority Conservation Plan, requires the states to include wetlands in their comprehensive outdoor recreation plans, and transfers to the Migratory Bird Conservation Fund amounts equal to import duties on arms and ammunition. It established entrance fees at national wildlife refuges. It also extended the Wetlands Loan Act authorization through 1988 and required the Secretary to report to Congress on wetlands loss. In addition, it directed the Secretary, through the U.S. Fish and Wildlife Service, to continue the National Wetlands Inventory; to complete mapping of the contiguous United States; and to produce at ten-year intervals reports to update and improve in the September 1982 "Status and Trends of Wetlands and Deepwater Habitat in the Conterminous United States, 1950s to 1970s." This act also increased the price of Duck Stamps.

Endangered Species Act of 1973, as amended

Directs federal agencies to take actions that would further the purposes of the act and to ensure that actions they carry out, authorize, or fund do not jeopardize endangered species or their critical habitat. The act also provides authority for land acquisition. Conservation of threatened and endangered species has become a major objective of both land acquisition and refuge management programs.

Endangered Species Conservation Act of 1969

This act expanded the provisions of the Endangered Species Preservation Act of 1966 to include the listing of species in danger world-wide and added mollusks and crustaceans to the animals that could be listed.

Endangered Species Preservation Act of 1966

This act was the predecessor to the Endangered Species Act of 1973 and directed the Secretary of the Interior to produce a list of native U.S. vertebrate species in danger of extinction for the limited protection of those animals.

Environmental Education Act of 1990

Established the Office of Environmental Education within the Environmental Protection Agency to develop and administer a federal environmental education program in consultation with other federal natural resource management agencies, including the U.S. Fish and Wildlife Service.

Executive Order 11593: Protection and Enhancement of the Cultural Environment (1971)

States that if the U.S. Fish and Wildlife Service proposes any development activities that may affect the archaeological or historic sites, the Service will consult with federal and state Historic Preservation Officers to comply with section 106 of the National Historic Preservation Act of 1966, as amended.

Executive Order 11644: Use of Off-road Vehicles on the Public Lands (1972)

Established policies and procedures to ensure that the use of off-road vehicles on public lands will be controlled and directed to protect the resources of those lands, to promote the safety of all users of those lands, and minimize conflicts among the various uses of those lands. EO 11989 (1977) amends section 2 of EO 11644 and directs agencies to close areas negatively impacted by off-road vehicles.

Executive Order 11988: Floodplain Management (1977)

Prevents federal agencies from contributing to the “adverse impacts associated with occupancy and modification of floodplains” and the “direct or indirect support of floodplain development.” In the course of fulfilling their respective authorities, federal agencies “shall take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values served by floodplains.

Executive Order 11990: Protection of Wetlands (1977)

Directs federal agencies to: (1) minimize destruction, loss, or degradation of wetlands; and (2) preserve and enhance the natural and beneficial values of wetlands when a practical alternative exists.

Executive Order 12372: Intergovernmental Review of Federal Programs (1982)

Seeks to foster intergovernmental partnerships by requiring federal agencies to use the state process to determine and address concerns of state and local elected officials with proposed federal assistance and development programs.

Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (1994)

Mandates that each federal agency shall make achieving environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. This order also creates an Interagency Working Group on Environmental Justice to provide guidance to federal agencies in overcoming these issues.

Executive Order 12906: Coordinating Geographical Data Acquisition and Access: The National Spatial Data Infrastructure (1994), as amended by Executive Order 13286: Amendment of Executive Orders, and Other Actions, in Connection With the Transfer of Certain Functions to the Secretary of Homeland Security (2003)

Recommended that the executive branch develop, in cooperation with state, local, and tribal governments, and the private sector, a coordinated National Spatial Data Infrastructure to support public and private sector applications of geospatial data. Of particular importance to Comprehensive Conservation Plans is the National Vegetation Classification System (NVCS), which is the adopted standard for vegetation mapping. Using NVCS facilitates the compilation of regional and national summaries, which, in turn, can provide an ecosystem context for individual refuges.

Executive Order 12962: Recreational Fisheries (1995)

Directs federal agencies to improve the quantity, function, sustainable productivity, and distribution of United States aquatic resources for increased recreational fishing opportunities in cooperation with states and tribes.

Executive Order 12996: Management and General Public Use of the National Wildlife Refuge System (1996)

Defines a conservation mission for the National Wildlife Refuge System, six compatible wildlife-dependent recreational activities, and four guiding principles for management of the Refuge System. Directs the Secretary of the Interior to undertake several actions in support of management and public use and to ensure the maintenance of the biological integrity and environmental health of the Refuge System. It also provides for the identification of existing wildlife-dependent uses that will continue to occur as lands are added to the Refuge System.

Executive Order 13007: Indian Sacred Sites (1996)

Directs federal land management agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, avoid adversely affecting the physical integrity of such sacred sites, and where appropriate, maintain the confidentiality of sacred sites.

Executive Order 13061: Federal Support of Community Efforts Along American Heritage Rivers (1997)

Established the American Heritage Rivers initiative for the purpose of natural resource and environmental protection, economic revitalization, and historic and cultural preservation. The act directs federal agencies to preserve, protect, and restore rivers and their associated resources important to our history, culture, and natural heritage.

Executive Order 13084: Consultation and Coordination With Indian Tribal Governments (2000)

Provides a mechanism for establishing regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications.

Executive Order 13112: Invasive Species (1999)

Directs federal agencies to prevent the introduction of invasive species, detect and respond rapidly to and control populations of such species in a cost effective and environmentally sound manner, accurately monitor invasive species, provide for restoration of native species and habitat conditions, conduct research to prevent introductions, to control invasive species, and to promote public education on invasive species and the means to address them. This EO replaces and rescinds EO 11987: Exotic Organisms (1977).

Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds (2001)

Instructs federal agencies to conserve migratory birds by several means, including the incorporation of strategies and recommendations found in Partners in Flight Bird Conservation plans, the North American Waterfowl Plan, the North American Waterbird Conservation Plan, and the United States Shorebird Conservation Plan, into agency management plans and guidance documents.

Executive Order 13443: Facilitation of Hunting Heritage and Wildlife Conservation (2007)

Directs federal agencies that have programs and activities that have a measurable effect on public land management, outdoor recreation, and wildlife management, including the Department of the Interior and the Department of Agriculture, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat.

Farmland Protection Policy Act of 1981, as amended

Minimizes the extent to which federal programs contribute to the unnecessary conversion of farmland to nonagricultural uses. Federal programs include construction projects and the management of federal lands.

Federal Advisory Committee Act of 1972, as amended

Governs the establishment of and procedures for committees that provide advice to the federal government. Advisory committees may be established only if they will serve a necessary, nonduplicative function. Committees must be strictly advisory unless otherwise specified and meetings must be open to the public.

Federal-Aid Highways Act of 1968

Establishes requirements for approval of federal highways through wildlife refuges and other designated areas to preserve the natural beauty of such areas. The Secretary of Transportation is directed to consult with the Secretary of the Interior and other federal agencies before approving any program or project requiring the use of land under their jurisdiction.

Federal Aid in Sport Fish Restoration Act (Dingell-Johnson Act) of 1950

Authorizes the Secretary of the Interior to provide financial assistance for state fish restoration and management plans and projects. It is financed by excise taxes paid by manufacturers of rods, reels, and other fishing tackle.

Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act) of 1937

Taxes the purchase of ammunition and firearms and earmarks the proceeds to be distributed to the states for wildlife restoration.

Federal Cave Resources Protection Act of 1988

Established requirements for the management and protection of caves and their resources on federal lands, including allowing the land managing agencies to withhold the location of caves from the public and requiring permits for any removal or collecting activities in caves on federal lands.

Federal Lands Recreation Enhancement Act (REA) of 2004

Allows the government to charge a fee for recreational use of public lands managed by the U.S. Fish and Wildlife Service and other agencies. The recreation fee program is a program by which fees paid by visitors to certain federal recreation sites are retained by the collecting site and used to improve the quality of the visitor experiences at those sites.

Federal Noxious Weed Act of 1975, as amended

The Secretary of Agriculture was given the authority to designate plants as noxious weeds and to cooperate with other federal, state, and local agencies; farmers associations, and private individuals in measures to control, eradicate, prevent, or retard the spread of such weeds. The act requires each federal land-managing agency, including the U.S. Fish and Wildlife Service, to designate an office or person to coordinate a program to control such plants on the agency's land and implement cooperative agreements with the states, including integrated management systems to control undesirable plants.

Federal Records Act of 1950

Directs the preservation of evidence of the government's organization, functions, policies, decisions, operations, and activities, as well as basic historical and other information.

Federal Water Pollution Control Act of 1948, as frequently amended particularly by the Clean Water Act of 1977

This act and its amendments have as their objectives the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters and, therefore, regulates the discharge of pollutants into waters of the United States. The act protects fish and wildlife, establishes operation permits for all major sources of water pollution, limits the discharge of pollutants or toxins into water, and makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit is obtained under the Clean Water Act. Section 404 charges the U.S. Army Corps of Engineers with regulating discharge of dredge or fill materials into waters of the United States, including wetlands. The "Clean Water Act" became the common name with amendments in 1977.

Federal Water Project Recreation Act of 1965, as amended

Declares the intent of Congress that recreation and fish and wildlife enhancement be given full consideration as purposes of federal water development projects. The act also authorizes the use of federal water project funds for land acquisition in order to establish refuges for migratory waterfowl when recommended by the Secretary of the Interior, and authorizes the Secretary to provide facilities for outdoor recreation and fish and wildlife at all reservoirs under his control, except those within national wildlife refuges.

Fish and Wildlife Act of 1956, as frequently amended

Establishes a comprehensive national fish, shellfish, and wildlife resources policy with emphasis on the commercial fishing industry but also with a direction to administer the act with regard to the inherent right of every citizen and resident to fish for pleasure, enjoyment, and betterment and to maintain and increase public opportunities for recreational use of fish and wildlife resources. The 1998 amendments to the act modified the powers of the Secretary of the Interior in regard to volunteer service, community partnerships, and education programs.

Fish and Wildlife Conservation Act of 1980, as amended

Requires the Service to monitor non-gamebird species, identify species of management concern, and implement conservation measures to preclude the need for listing under the Endangered Species Act of 1973.

Fish and Wildlife Coordination Act of 1934

Promotes equal consideration and coordination of wildlife conservation with other water resource development programs by requiring consultation with the U.S. Fish and Wildlife Service and the state fish and wildlife agencies where the "waters of a stream or other body of

water are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified” by any agency under federal permit or license. This act also authorized use of surplus federal property for wildlife conservation purposes and authorized the Secretary of the Interior to provide public fishing areas and accept donations of lands and funds.

Fish and Wildlife Improvement Act of 1978

Improves the administration of fish and wildlife programs and amends several earlier laws including the Refuge Recreation Act, the National Wildlife Refuge System Administration Act of 1966, and the Fish and Wildlife Act of 1956. It authorizes the Secretary of the Interior to accept gifts and bequests of real and personal property on behalf of the United States. It also authorizes the use of volunteers on Service projects and appropriations to carry out a volunteer program.

Food Security Act of 1985 (Farm Bill), as amended

Known as the Farm Bill, this act contains several provisions that contribute to wetland conservation. The Swampbuster provisions state that farmers who convert wetlands for the purpose of planting after enactment of the law are ineligible for most farm program subsidies. The act also established the Wetlands Reserve Program to restore and protect wetlands through easements and restoration of the functions and values of wetlands on such easement areas.

Freedom of Information Act of 1966

Requires all federal agencies to make available to the public for inspection and copying administrative staff manuals and staff instructions; official, published and unpublished policy statements; final orders deciding case adjudication; and other documents. Special exemptions have been reserved for nine categories of privileged material. The act requires the party seeking the information to pay reasonable search and duplication costs.

Geothermal Steam Act of 1970, as amended

Authorizes and governs the lease of geothermal steam and related resources on public lands. Section 15(c) of the act prohibits issuing geothermal leases on virtually all U.S. Fish and Wildlife Service-administered lands.

Historic Sites, Buildings and Antiquities Act of 1935

Popularly known as the Historic Sites Act, as amended in 1965, declared it a national policy to preserve historic sites and objects of national significance, including those located on refuges. It provided procedures for designation, acquisition, administration, and protection of such sites. Among other things, National Historic and Natural Landmarks are designated under authority of this act.

Lacey Act of 1900, as amended

Originally designed to help states protect their native game animals and to safeguard U.S. crop production from harmful foreign species. The act prohibits interstate and international transport and commerce of fish, wildlife, or plants taken in violation of domestic or foreign laws. It regulates the introduction to the United States of foreign species into new locations.

Land and Water Conservation Fund Act of 1965

Provides funding through receipts from the sale of surplus federal land, appropriations from oil and gas receipts from the outer continental shelf, and other sources for land acquisition under several authorities. Appropriations from the fund may be used for matching grants to states for

outdoor recreation projects and for land acquisition by various federal agencies including the Fish and Wildlife Service.

Migratory Bird Conservation Act of 1929

Establishes a Migratory Bird Conservation Commission to approve areas recommended by the Secretary of the Interior for acquisition with Migratory Bird Conservation Funds. Authorizes the Secretary of the Interior to cooperate with local authorities in wildlife conservation and to conduct investigations, to publish documents related to North American birds, and to maintain and develop refuges. The act provides for cooperation with states in enforcement. It establishes procedures for acquisition by purchase, rental, or gift of areas approved by the Commission for migratory birds. This act includes acquisition authority for purchase or rental of a partial interest in land or waters and requires the Secretary of the Interior to consult with the appropriate units of local government and with the governor of the state concerned, or the appropriate state agency, before recommending an area for purchase or rental. This provision was subsequently amended in 1983, 1984, and 1986 to require that either the governor or the state agency approve each proposed acquisition. The role of the Commission was expanded by the North American Wetland Conservation Act to include approving wetlands acquisition, restoration, and enhancement proposals recommended by the North American Wetlands Conservation Council.

Migratory Bird Hunting and Conservation Stamp Act (Duck Stamp Act) of 1934

Known as the Duck Stamp Act, this act requires every waterfowl hunter 16 years of age or older to carry a stamp, and earmarks proceeds of Duck Stamps to buy or lease waterfowl habitat. A 1958 amendment authorizes the acquisition of small wetland and pothole areas to be designated as “Waterfowl Production Areas,” which may be acquired without the limitations and requirements of the Migratory Bird Conservation Act.

Migratory Bird Treaty Act of 1918

Implements various treaties and conventions between the United States and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Except as allowed by special regulations, the act makes it unlawful to pursue, hunt, kill, capture, possess, buy, sell, purchase, barter, export, or import any migratory bird, part, nest, egg, or product.

Mineral Leasing Act for Acquired Lands of 1947, as amended

Authorizes and governs mineral leasing on acquired public lands.

Minerals Leasing Act of 1920, as amended

Authorizes and governs leasing of public lands for development of deposits of coal, oil, gas, and other hydrocarbons, sulphur, phosphate, potassium, and sodium. Section 185 of this act contains provisions relating to granting rights-of-way over federal lands for pipelines.

Mining Act of 1872, as amended

Authorizes and governs prospecting and mining for the so-called “hardrock” minerals (such as gold and silver) on public lands.

National and Community Service Act of 1990

Authorizes several programs to engage citizens of the United States in full and/or part-time projects designed to combat illiteracy and poverty, provide job skills, enhance educational skills, and fulfill environmental needs. Among other things, this law established the American Conservation and Youth Service Corps to engage young adults in approved human and natural resource projects, which will benefit the public or are carried out on federal or tribal lands.

National Environmental Policy Act of 1969 (NEPA), as amended

This act and the implementing regulations developed by the Council on Environmental Quality (40 CFR 1500–1508) require federal agencies to integrate the National Environmental Policy Act (NEPA) process with other planning at the earliest possible time to provide a systematic interdisciplinary approach to decision making; to identify and analyze the environmental effects of their actions; to describe appropriate alternatives to the proposed actions; and to involve the affected state and federal agencies, tribal governments, and public in the planning and decision making process. This act requires the disclosure of the environmental impacts of any major federal action significantly affecting the quality of the human environment.

National Historic Preservation Act of 1966

Repeatedly amended, the act provides for preservation of significant historical features (buildings, objects, and sites) through a grant-in-aid program to the states. It established a National Register of Historic Places and a program of matching grants under the existing National Trust for Historic Preservation (16 U.S.C. 468–468d). The act established an Advisory Council on Historic Preservation, which was made a permanent independent agency in 1976 (90 Stat. 1319). That act also created the Historic Preservation Fund. Federal agencies are directed to take into account the effects of their actions on items or sites listed or eligible for listing in the National Register and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. Section 110 requires federal agencies to manage historic properties, e.g., to document historic properties prior to destruction or damage; section 101 requires federal agencies consider Indian tribal values in historic preservation programs and requires each federal agency to establish a program leading to inventory of all historic properties on its land.

National Trails System Act of 1968

Established the National Trails System to protect the recreational, scenic, and historic values of some important trails. National Recreation Trails may be established by the Secretaries of the Interior or Agriculture on land wholly or partly within their jurisdiction, with the consent of the involved state(s) and other land managing agencies, if any. National scenic and national historic trails may only be designated by an act of Congress. Several national trails cross units of the National Wildlife Refuge System.

National Wildlife Refuge System Administration Act of 1966 (amended by the National Wildlife Refuge System Improvement Act of 1997)

This act consolidates the authorities relating to the various categories of lands for the conservation of fish and wildlife administered by the Secretary of the Interior through the U.S. Fish and Wildlife Service by designating all such areas part of a single National Wildlife Refuge System. Areas include wildlife refuges, areas for the protection and conservation of fish and wildlife threatened with extinction, wildlife ranges, game ranges, wildlife management areas, and waterfowl production areas. The law also prohibits knowingly disturbing any area within the system or the take of Refuge System wildlife without a permit. The act addresses the growing need for recreational opportunities by providing a decision framework for allowing appropriate and compatible uses of the Refuge System.

National Wildlife Refuge System Centennial Act of 2000

Establishes a commission to promote awareness by the public to develop a long-term plan to meet priority needs of the National Wildlife Refuge System, require an annual report on the needs, and improve public use programs and facilities.

National Wildlife Refuge System Improvement Act of 1997

This act, which amends the National Wildlife Refuge System Administration Act of 1966, serves as the "organic act" for the National Wildlife Refuge System. The act states first and foremost that the mission of the National Wildlife Refuge System is focused singularly on wildlife conservation. It establishes a unifying mission for the Refuge System, reinforces the importance of refuge purposes to guide management direction, articulates a process for determining compatible uses of refuges, identifies six priority wildlife-dependent recreation uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation), and adds a requirement for preparing comprehensive conservation plans through a public planning process. The act requires the Secretary of the Interior to maintain the biological integrity, diversity, and environmental health of the Refuge System.

National Wildlife Refuge System Volunteer and Community Partnership Enhancement Act of 1998

Amends the Fish and Wildlife Act of 1956 to encourage the use of volunteers to help in the management of refuges within the National Wildlife Refuge System; facilitates partnerships between the Refuge System and nonfederal entities to promote public awareness of the resources of the Refuge System and public participation in the conservation of the resources; and encourages donations and other contributions.

National Wildlife Refuge Volunteer Improvement Act of 2010

Maintains the current funding authorization level for the U.S. Fish and Wildlife Service's volunteer and community partnerships programs that are vital to national wildlife refuges but makes a number of important amendments. The law amends the National Wildlife Refuge Volunteer and Community Partnership Enhancement Act of 1998 to direct the Service to carry out a National Volunteer Coordination Program within the National Wildlife Refuge System. It also requires the Director of the Service to publish a national strategy for the coordination and utilization of volunteers within the Refuge System and provide at least one regional volunteer coordinator for each Service region to implement the strategy.

Native American Graves Protection and Repatriation Act (NAGPRA) of 1990

Requires federal agencies and museums to inventory, determine ownership of, and repatriate cultural items under their control or possession. This act imposes serious delays on a project when human remains or other cultural items are encountered in the absence of a plan.

Neotropical Migratory Bird Conservation Act of 2000

Establishes a matching grants program to fund projects that promote the conservation of neotropical migratory birds in the United States, Latin America, and the Caribbean.

North American Wetlands Conservation Act of 1989

Provides funding and administrative direction for implementation of the North American Waterfowl Management Plan and the Tripartite Agreement on wetlands between the United States, Canada, and Mexico. North American Wetlands Conservation Council is created to recommend projects to be funded under the act to the Migratory Bird Conservation Commission. Available funds may be expended for up to 50 percent of the United States' share cost of wetlands conservation projects in Canada, Mexico, or the United States (or 100 percent of the cost of projects on federal lands).

Partnerships for Wildlife Act of 1992

Established a Wildlife Conservation and Appreciation Fund to receive appropriated funds and donations from the National Fish and Wildlife Foundation and other private sources to assist the

state fish and game agencies in carrying out their responsibilities for conservation of non-game species. The funding formula is no more than 1/3 federal funds, at least 1/3 foundation funds, and at least 1/3 state funds.

Refuge Recreation Act of 1962, as amended

Requires that any recreational use on areas of the National Wildlife Refuge System be "compatible" with the primary purpose(s) for which the area was acquired or established. This act also requires that sufficient funding be available for the development, operation and maintenance of recreational uses that are not directly related to the area's primary purpose(s).

Refuge Revenue Sharing Act of 1935

Provides for payments to counties in lieu of taxes, using revenues derived from the sale of products from refuges. A major revision in 1964 requires all revenues received from refuge products be distributed to counties for public schools and roads (this stipulation later removed). Another revision in 1974 requires that any remaining funds be transferred to the Migratory Bird Conservation Fund for land acquisition. A 1978 amendment stated payments to counties were established as:

- on acquired land, the greatest amount calculated on the basis of 75 cents per acre, three-fourths of one percent of the appraised value, or 25 percent of the net receipts produced from the land, and
- on land withdrawn from the public domain, 25 percent of net receipts and basic payments.

This amendment also required counties to pass payments along to other units of local government within the county that suffer losses in revenues due to the establishment of U.S. Fish and Wildlife Service areas.

Rehabilitation Act of 1973, as amended

Prohibits discrimination on the basis of disability under any program or activity receiving federal financial assistance.

Rivers and Harbors Appropriations Act of 1899, as amended

Requires the authorization by the Chief of Engineers prior to any work in, on, over, or under navigable waters of the United States. The Fish and Wildlife Coordination Act provides authority for the U.S. Fish and Wildlife Service to review and comment on the effects on fish and wildlife activities proposed to be undertaken or permitted by the COE. Service concerns include contaminated sediments associated with dredge or fill projects in navigable waters.

Secretarial Order 3289 Amendment 1: Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources (2010)

Secretarial Order 3285, issued in March 2009, made production and transmission of renewable energy on public lands a priority for the Department of the Interior. This Secretarial Order, 3289A1, issued in February 2010 establishes a Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural resources that the Department manages.

Sikes Act of 1960, as amended

Provides for the cooperation by the U.S. Departments of the Interior and Defense with state agencies in planning, development, and maintenance of fish and wildlife resources and outdoor

recreation facilities on military reservations throughout the United States. It requires the Secretary of each military department to use trained professionals to manage the wildlife and fishery resource under his jurisdiction and requires federal and state fish and wildlife agencies be given priority in management of fish and wildlife activities on military reservations.

Surface Mining Control and Reclamation Act of 1977

Regulates surface mining activities and reclamation of coal-mined lands. Further regulates the coal industry by designating certain areas as unsuitable for coal mining operations.

Transfer of Certain Real Property for Wildlife Conservation Purposes Act of 1948

Provides that upon a determination by the Administrator of the General Services Administration, real property no longer needed by a federal agency can be transferred without reimbursement to the Secretary of the Interior if the land has particular value for migratory birds or to a state agency for other wildlife conservation purposes.

Transportation Equity Act for the 21st Century of 1998

Established the Refuge Roads Program, requires transportation planning that includes public involvement, and provides funding for approved public use roads and trails and associated parking lots, comfort stations, and bicycle/pedestrian facilities.

Treasury and General Government Appropriations Act of 2000

In December 2002, Congress required federal agencies to publish their own guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information that they disseminate to the public (44 U.S.C. 3502). The amended language is included in section 515(a). The Office of Budget and Management directed agencies to develop their own guidelines to address the requirements of the law. The Department of the Interior instructed bureaus to prepare separate guidelines on how they would apply the act. The U.S. Fish and Wildlife Service has developed "Information Quality Guidelines" to address the law.

Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970

Provides for uniform and equitable treatment of persons who sell their homes, businesses, or farms to the U.S. Fish and Wildlife Service. The act requires that any purchase offer be no less than the fair market value of the property.

Water Resources Planning Act of 1965

Established the Water Resources Council to be composed of Cabinet representatives, including the Secretary of the Interior. The Council reviews river basin plans with respect to agricultural, urban, energy, industrial, recreational, and fish and wildlife needs. The act also established a grant program to assist states in participating in the development of related comprehensive water and land use plans.

Wild and Scenic Rivers Act of 1968

Established a National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers may be identified and added to the system. Section 5(d)(1) requires that in all planning by federal agencies for the use and development of water and related land resources, consideration be given to potential wild, scenic, and recreation rivers. Rivers are added to the national system based on their free-flowing character and their outstandingly remarkable scenic, recreation, geologic, fish and wildlife, historic, cultural, ecological, or other values. Rivers in the system are managed to maintain and protect these outstandingly remarkable values for present and future generations.

Wilderness Act of 1964

Defined the Wilderness resource and established the National Wilderness Preservation System. It directed the Secretary of the Interior, within 10 years, to review every roadless area of 5,000 or more acres and every roadless island (regardless of size) within National Wildlife Refuge and National Park Systems and to recommend to the president the suitability of each such area or island for inclusion in the National Wilderness Preservation System, with final decisions made by Congress. The Secretary of Agriculture was directed to study and recommend suitable areas in the National Forest System. This act also prescribes the management of new inclusions as wilderness.

Youth Conservation Corps Act of 1970

Established a permanent Youth Conservation Corps program within the Departments of the Interior and Agriculture. Within the U.S. Fish and Wildlife Service, YCC participants perform many tasks on refuges, fish hatcheries, and research stations.

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Appendix G: Draft Compatibility Determinations

In this appendix:

[Introduction](#)

[Gathering Wild Edibles \(mushrooms, berries, and nuts\) for Personal Use](#)

[Recreational Fishing](#)

[Wildlife Observation, Wildlife Photography, Environmental Education, and Interpretation](#)

Introduction

Compatibility determinations are documents written, signed, and dated by the refuge manager and the regional chief of refuges that signify whether proposed or existing uses of the National Fish and Wildlife Refuge (NFWR, refuge) are compatible with its establishing purposes and the mission of the National Wildlife Refuge System (NWRS, Refuge System). This appendix provides copies of the compatibility determinations for Big Muddy NFWR.

Before undertaking a compatibility review of a use, the refuge manager must first determine that the use is appropriate. A compatible use is any proposed or existing wildlife-dependent recreational use or other use of a refuge by the public or entity other than the U.S. Fish and Wildlife Service (FWS, Service) that, based on sound professional judgment, will not materially interfere with or detract from fulfilling the mission of the Refuge System or the purposes of the refuge. The final policy and regulations required by the National Wildlife Refuge System Improvement Act of 1997 provide guidance for determining compatibility.

If a proposed use is not appropriate, the use will not be allowed, and a compatibility determination will not be prepared.

A compatibility determination is required for activities on a refuge (district) by the public or entity other than the Service including:

- all refuge recreational and educational programs;
- construction or expansion of recreational and educational facilities such as boardwalks and boat ramps;
- management activities performed by private parties in return for a market commodity, such as cooperative farming to provide food for wildlife; and
- granting or modifying rights-of-way through refuges for pipelines, roads, or electrical transmission lines.

Activities when a compatible determination is NOT required include:

- refuge management activities such as prescribed burning, managing water levels, and controlling invasive species;
- routine scientific monitoring, studies, surveys, and censuses;
- conducting historic preservation;
- law enforcement activities; and

- maintaining <refuge or district> facilities, structures, or improvements.

Although a refuge use may be both appropriate and compatible, the refuge manager retains the authority to not allow the use or modify the use.

COMPATIBILITY DETERMINATION

Use: Gathering Wild Edibles (mushrooms, berries, and nuts) for Personal Use

Refuge Name: Big Muddy National Fish and Wildlife Refuge

Establishing and Acquisition Authorities:

Fish and Wildlife Act of 1956 (16 U.S.C. § 742(a)(4)) and (16 U.S.C. § 742(b)(1))
Consolidated Farm and Rural Development Act (7 U.S.C. 2002) - FMHA fee title transfer property

Date Established:

September 9, 1994, [(16 U.S.C. 742f(a)(4)]

“ . . . for the development, advancement, management, conservation and protection of fish and wildlife resources . . . “

Refuge Purposes:

As designated by 16 U.S.C. 742f(a)(4):

The primary purpose of Big Muddy NFWR is for “the development, advancement, management, conservation, and protection of fish and wildlife resources...”. It is intended to fill a public need to preserve and restore natural river floodplain, manage fish and wildlife habitats, and provide for compatible public use.

National Wildlife Refuge System Mission:

The Mission is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use:

What is the use?

The use is the gathering of wild edibles (specifically mushrooms, berries and nuts) for personal use. The National Wildlife Refuge System Improvement Act of 1997 did not identify gathering wild edibles as one of the six, priority, wildlife-dependent recreational uses to be facilitated in the Refuge System. There is however a long-standing tradition of gathering mushrooms, nuts and berries from private and public land in Missouri and throughout the Midwest.

Where would the use be conducted?

Gathering of wild edibles, for personal use, would be allowed on all refuge units (existing and future acquisitions) unless specifically closed by the refuge manager. Current refuge units include Jackass Bend in Ray and Jackson Counties. Baltimore Bottom in Lafayette County, Cranberry Bend in Saline and Lafayette Counties, Cambridge Bend in Chariton and Saline

Counties, Lisbon Bottom in Howard County, Jameson Island in Saline County, Overton Bottom in Cooper and Moniteau Counties, St. Aubert Island in Osage County, Boone's Crossing in St. Louis County, and Cora Island in St. Charles County.

When would the use be conducted?

Refuge units will be open 24 hours per day during any time of the year, unless specifically closed by the refuge manager.

How would the use be conducted?

Gathering of wild edibles will be authorized and regulated according to provisions in 50 CFR, Subchapter C, Part 33 and consistent with State regulations. Allowable means of access within refuge units include driving motorized vehicles on designated roads, hiking, canoeing, and no-wake motorized boating. Law enforcement patrols and compliance checks by refuge officers will be used to enforce the provisions of 50 CFR, Subchapter C, as applicable.

Why is the use being proposed?

Gathering wild edibles for personal use is not a priority public use on National Wildlife Refuge System lands as identified in the Refuge Improvement Act of 1997. However gathering morel mushrooms in the spring is currently our largest public use on the refuge. Gathering wild edibles will be conducted to provide compatible recreational opportunities for visitors to enjoy the resource and to gain understanding and appreciation for fish and wildlife.

Availability of Resources:

Resources are available to administer this use. These refuge lands have been open to public use since they were acquired. Thus, the Fish and Wildlife Service has provided parking lots, kiosks and signs. We will provide other facilities as plans are completed and funds are available. We will work with partners, including communities, non-government organizations, and other agencies, to develop a high quality wildlife-dependent recreational program on the refuge. The annual cost of refuge activities to administer this use is an estimated \$20,000 out of an overall refuge operating budget of about \$1,124,000. These costs include staff (20 days, \$10,000) and operating expenses (\$10,000) for refuge law enforcement, visitor services and maintenance of facilities.

Anticipated Impacts of the Use:

Allowing the gathering of wild edibles for personal use would pose minimal impacts on the purposes for which Big Muddy NFWR was established. It is intended to fill a public need to preserve and restore natural river floodplain, manage fish and wildlife habitats, *and provide for compatible public use.*

Access to the refuge would be by motorized vehicle on public roads and parking lots, and on foot beyond the roads and parking lots. Access to popular locations for gathering wild edibles is generally on foot. Damage to habitat by walking is minimal and temporary. There is some temporary disturbance to wildlife due to human activity on the land. One impact to the refuge purpose could be disruption of breeding and rearing activities during spring and early summer, but the expected sporadic and limited use by the public should not create unreasonable

impacts. Any unreasonable harassment of wildlife would be grounds for the refuge manager to close the area to these uses or restrict the uses to minimize harm.

Litter is sometimes a problem around public use areas including areas where people congregate. Littering is not limited to this use, however, and refuge staff would be monitoring refuge roads, parking areas, etc... for litter, and cleaning up those areas regardless of the source of the litter. The added staff time to clean these areas is minimal.

The concern therefore is whether or not these disturbances are sufficient to adversely affect the subject purposes for which the refuge was established. Since gathering wild edibles for personal use is limited by access, weather, infestation of insects, and shallow water which limits the use of water craft, the major evaluation criteria will be the frequency of human presence.

Refuge-wide, gathering opportunities are limited to those areas that can be driven to or boated to and require limited walking. Most recreational gathering of wild edibles for personal use on Big Muddy NFWR occurs at Overton Bottoms North and South units within 1,000 feet of a gravel road. Access from the Missouri River, by boat for gathering wild edibles does occur, but it is not significant at this time.

We estimate that 1,500 refuge visitors would spend time gathering wild edibles for personal use on the Big Muddy NFWR, which is an average of 4 people per day over the entire refuge. Since most people gather wild edibles on two refuge units that are also used by other refuge users, we consider the potential impact from gathering wild edibles for personal use on the refuge to be negligible.

There would be no cultural or historical resource impacts expected.

Public Review and Comment:

Action taken due to comments:

Determination:

Use is Not Compatible

Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

All fires are prohibited.

Justification:

Signature: <Refuge or District> Manager /<name>/ or actual signature mm/dd/yyyy
(Signature and Date)

Concurrence: Regional Chief /<name>/ or actual signature mm/dd/yyyy
(Signature and Date)

Mandatory 15-year Reevaluation Date for Wildlife-dependent Recreation Uses: **May 2027**

COMPATIBILITY DETERMINATION

Use: Recreational Fishing

Refuge Name: Big Muddy National Fish and Wildlife Refuge

Establishing and Acquisition Authorities:

Fish and Wildlife Act of 1956 (16 U.S.C. § 742(a)(4)) and (16 U.S.C. § 742(b)(1))
Consolidated Farm and Rural Development Act (7 U.S.C. 2002) - FMHA fee title transfer property

Date Established:

September 9, 1994, [(16 U.S.C. 742f(a)(4)]

“ . . . for the development, advancement, management, conservation and protection of fish and wildlife resources . . . “

Refuge Purposes:

As designated by 16 U.S.C. 742f(a)(4):

The primary purpose of Big Muddy NFWR is for “the development, advancement, management, conservation, and protection of fish and wildlife resources...”. It is intended to fill a public need to preserve and restore natural river floodplain, manage fish and wildlife habitats, and provide for compatible public use.

National Wildlife Refuge System Mission: The Mission is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use:

What is the use?

The use is fishing. The National Wildlife Refuge System Improvement Act of 1997 identified fishing as one of the six, priority, wildlife-dependent recreational uses to be facilitated in the Refuge System, and the act encouraged the Service to provide opportunities for these uses

Where would the use be conducted?

Fishing would be allowed on all refuge units (existing and future acquisitions) with fishable waters unless specifically closed by the refuge manager. In addition, fishing on the Missouri River is regulated by the State of Missouri, however, shoreline access to the river would be regulated by the Service. Current refuge units include Jackass Bend in Ray and Jackson Counties, Baltimore Bottom in Lafayette County, Cranberry Bend in Saline and Lafayette Counties, Cambridge Bend in Chariton and Saline Counties, Lisbon Bottom in Howard County, Jameson Island in Saline County, Overton Bottom in Cooper and Moniteau Counties, St. Aubert

Island in Osage County, Boone's Crossing in St. Louis County, and Cora Island in St. Charles County.

When would the use be conducted?

Refuge units will be open 24 hours per day during any time of the year, unless specifically closed by the refuge manager.

How would the use be conducted?

Fishing will be authorized and regulated according to provisions in 50 CFR, Subchapter C, Part 33 and consistent with State regulations. Allowable means of access within refuge units (including scour holes not connected to the river) include driving motorized vehicles on designated roads, hiking, canoeing, and no-wake motorized boating. Law enforcement patrols and compliance checks by refuge officers will be used to enforce the provisions of 50 CFR, Subchapter C, Parts 26, 27, and 33, as applicable.

Why is the use being proposed?

Recreational fishing is a priority public use on National Wildlife Refuge System lands as identified in the Refuge Improvement Act of 1997. Fishing will be conducted to provide compatible recreational opportunities for visitors to enjoy the resource and to gain understanding and appreciation for fish and wildlife.

Availability of Resources:

Resources are available to administer this use. These refuge lands have been open to public use since they were acquired. Thus, the Fish and Wildlife Service has provided parking lots, kiosks and signs. We will provide other facilities as plans are completed and funds are available. We will work with partners, including communities, non-government organizations, and other agencies, to develop a high quality wildlife-dependent recreational program on the refuge. The annual cost of refuge activities to administer this use is an estimated \$40,000 out of an overall refuge operating budget of about \$1,124,000. These costs include staff (40 days, \$20,000) and operating expenses (\$20,000) for refuge law enforcement, visitor services and maintenance of facilities.

Anticipated Impacts of the Use:

The 1999 *Environmental Impact Statement for the Proposed Expansion of the Big Muddy National Fish and Wildlife Refuge* addresses the impacts of fishing.

Allowing recreational fishing would pose minimal impacts on the purposes for which Big Muddy NFWR was established. It is intended to fill a public need to preserve and restore natural river floodplain, manage fish and wildlife habitats, and provide for compatible public use.

Access to small lakes and ponds on the refuge would be by motorized vehicle on public roads and parking lots, and on foot beyond the roads and parking lots. Access to popular fishing lakes and ponds is generally on established trails covered in mulch, gravel, or vegetation to stabilize the soil and minimize soil erosion or damage to vegetation. Damage to habitat by walking is minimal and temporary. There is some temporary disturbance to wildlife due to human activity on the land. One impact to the refuge purpose could be disruption of breeding and rearing

activities during spring and early summer, but the expected sporadic and limited use by the public should not create unreasonable impacts. Any unreasonable harassment of wildlife would be grounds for the refuge manager to close the area to these uses or restrict the uses to minimize harm.

Litter is also a problem around public use areas including areas where fisherman congregate. Fishing can also potentially cause death or serious injury to migratory birds by using lead sinkers that can become ingested, or by discarding hooks, monofilament line, or other litter that can trap or entangle birds and other wildlife. Littering is not limited to fisherman, however, and refuge staff would be monitoring refuge roads, parking areas, etc... for litter, and cleaning up those areas regardless of if fishing were allowed. The added staff time to clean these areas is minimal.

The concern therefore is whether or not these disturbances are sufficient to adversely affect the subject purposes for which the refuge was established. Since fishing is limited by access, weather, infestation of insects, and shallow water which limits the use of water craft, the major evaluation criteria will be the frequency of human presence.

Refuge-wide, fishing opportunities are limited to those areas that can be driven to and require no walk or a very short walk. Most recreational fishing on Big Muddy NFWR occurs at Overton Bottoms North at the I-70 Scour hole and the Diana Scour. Bank fishing on the Missouri River rarely occurs because of the absence of river access points on the refuge. Other refuge units have no lakes or ponds that would draw fisherman to the refuge solely for fishing.

We estimate that 1,800 fisherman would use Big Muddy NFWR for fishing, which is an average of 5 people per day over the entire refuge. Since most people fish at two lakes on one unit that were located near public parking areas that were also used by other refuge users, we consider the potential impact from fisherman on the refuge to be negligible.

There would be no cultural or historical resource impacts expected.

Public Review and Comment:

Action taken due to comments:

Determination:

Use is Not Compatible

Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

All fires are prohibited.

Justification:

Signature: <Refuge or District> Manager /<name>/ or actual signature mm/dd/yyyy
(Signature and Date)

COMPATIBILITY DETERMINATION

Use: Wildlife Observation, Wildlife Photography, Environmental Education, and Interpretation

Refuge Name: Big Muddy National Fish and Wildlife Refuge

Establishing and Acquisition Authorities:

Fish and Wildlife Act of 1956 (16 U.S.C. § 742(a)(4)) and (16 U.S.C. § 742(b)(1))
Consolidated Farm and Rural Development Act (7 U.S.C. 2002) - FMHA fee title transfer property

Date Established:

September 9, 1994, [(16 U.S.C. 742f(a)(4)]

“ . . . for the development, advancement, management, conservation and protection of fish and wildlife resources . . . “

Refuge Purposes:

As designated by 16 U.S.C. 742f(a)(4):

The primary purpose of Big Muddy NFWR is for “the development, advancement, management, conservation, and protection of fish and wildlife resources...”. It is intended to fill a public need to preserve and restore natural river floodplain, manage fish and wildlife habitats, and provide for compatible public use.

National Wildlife Refuge System Mission:

The Mission is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Description of Use:

What is the use?

Allow wildlife observation, wildlife photography, environmental education, and interpretation by the general public at refuge units.

Where would the use be conducted?

All refuge units (existing and future acquisitions) will be open to the public for these four uses unless specifically closed by the refuge manager. Current refuge units include Jackass Bend in Ray and Jackson Counties, Baltimore Bottom in Lafayette County, Cranberry Bend in Saline and Lafayette Counties, Cambridge Bend in Chariton and Saline Counties, Lisbon Bottom in Howard County, Jameson Island in Saline County, Overton Bottom in Cooper and Moniteau

Counties, St. Aubert Island in Osage County, Boone's Crossing in St. Louis County, and Cora Island in St. Charles County.

When would the use be conducted?

Refuge units will be open 24 hours per day during any time of the year, unless specifically closed by the refuge manager.

How would the use be conducted?

Allowable means of access within refuge units (including scour holes not connected to the river) include driving motorized vehicles on designated roads, hiking, canoeing, and no-wake motorized boating.

Prohibited acts that apply to the refuge under 50 CFR 26 & 27 include:

- Motorized vehicles and bicycles off of public roads or parking lots.
- Camping.
- Collecting artifacts or objects of antiquity.
- Harassment of wildlife.
- Excessive damage to vegetation.
- Dogs off of a leash.
- Horseback riding.

State regulations apply to the navigable waters of the refuge and therefore are not subject to compatibility determination. Sandbars below ordinary high water line are not part of the refuge and therefore are not subject to compatibility determination.

Why is the use being proposed?

Wildlife observation, wildlife photography, environmental education, and interpretation are priority public uses on National Wildlife Refuge System lands as identified in the Refuge Improvement Act of 1997. The refuge lands have been open to public use since they were acquired.

Entry on all or portions of individual areas may be temporarily suspended by posting upon occasions of unusual or critical conditions affecting land, water, vegetation, wildlife populations, or public safety.

Facilities needed to support these uses include parking areas, kiosks with informational and interpretive signs, and in some cases, trails. Facilities currently exist on most units. Additional facilities will be provided as units are added a funding allows.

Availability of Resources:

Resources are available to administer these uses. These refuge lands have been open to public use since they were acquired. Thus, the Fish and Wildlife Service has provided parking

lots, kiosks and signs. We will provide other facilities as plans are completed and funds are available. We will work with partners, including communities, non-government organizations, and other agencies, to develop a high quality wildlife-dependent recreational program on the refuge. The annual costs of refuge activities to administer these uses is an estimated \$150,000 out of an overall refuge operating budget of about \$1,124,000. These costs include staff (190 days, \$78,000) and operating expenses (\$50,000) for refuge law enforcement, visitor services and maintenance of facilities. This estimate also includes refuge staff time associated with evaluating new public use opportunities.

Some areas of units are accessible only from the Missouri River. We will continue to strive to provide land-based access to refuge units through acquisition of easements and/or fee title properties from willing sellers.

Anticipated Impacts of the Use:

The 1999 *Environmental Impact Statement for the Proposed Expansion of the Big Muddy National Fish and Wildlife Refuge* addresses the impacts of wildlife observation, wildlife photography, environmental education, and interpretation.

The four uses pose minimal impacts on the purposes for which Big Muddy NFWR was established. Access for observation, photography and interpretation is typically by individuals or small groups on foot. Access for environmental education will be scout groups, school classes, etc. that will be in larger groups on foot. Damage to habitat by walking is minimal and temporary. There is some temporary disturbance to wildlife due to human activity on the land. One impact to the refuge purpose could be disruption of breeding and rearing activities during spring and early summer, but the expected sporadic and limited use by the public should not create unreasonable impacts. Any unreasonable harassment of wildlife would be grounds for the refuge manager to close the area to these uses or restrict the uses to minimize harm.

Access by motorized vehicles is limited to public roads and parking lots. Hiking trails would have established vegetative cover or chat. Parking lots and hiking trails have minimal impacts because of their small size and generally have gravel or vegetation on them to stabilize the soil.

Public Review and Comment:

Action taken due to comments:

Determination:

_____ Use is Not Compatible

_____ Use is Compatible with the Following Stipulations

Stipulations Necessary to Ensure Compatibility:

No photo or viewing blinds may be left over night.
All fires are prohibited.

Justification:

Signature: <Refuge or District> Manager /<name>/ or actual signature mm/dd/yyyy
(Signature and Date)

Concurrence: Regional Chief /<name>/ or actual signature mm/dd/yyyy
(Signature and Date)

Mandatory 15-year Reevaluation Date for Wildlife-dependent Recreation Uses: **May 2027**

Appendix H: List of Preparers and Contributors

Preparers

The following individuals were members of the core planning team, instrumental in the development of this document, and/or made major contributions throughout the planning process.

Station Staff

- Refuge Manager, Thomas G. Bell
- Assistant Refuge Manager, Dean C. Bossert
- Assistant Refuge Manager, Barbara V.G. Moran (Retired)
- Refuge Biologist, Wedge W. Watkins
- Park Ranger, Timothy A. Haller
- Wildlife Refuge Specialist, Jestin C. Clark
- Administrative Officer, Molly A. Comstock
- Others

Midwest Regional Office

USFWS Branch of Conservation Planning Staff, Region 3

- Dean Granholm, Wildlife Biologist
- Jared Bowman, Wildlife Biologist
- Connie Rose, Fish and Wildlife Biologist
- Gabe DeAlessio, GIS Specialist
- Mark Hogeboom Writer/Editor

USFWS Regional Office Staff, Region 3

- Josh Eash, Regional Hydrologist
- Patricia Heglund, Regional Biologist
- James Myster, Regional Archaeologist
- Maggie O'Connell, Chief Visitor Services Branch

State Partners

- Missouri Department of Conservation

Contributors

Guidance, contributions, and support to the CCP were also made by the following individuals:

- U.S. Army Corps of Engineers
- Missouri Department of Conservation
- Missouri Department of Natural Resources
- U.S. Geological Service

Appendix I: Mailing List

In this appendix:

- Elected Federal Officials
- Elected State Officials
- Federal Agencies
- Native American Tribes
- State Agencies and Boards
- Cities
- Counties
- Organizations
- River Associations and Committees
- Media
- Citizens

Numerous individuals (some included below) as well as many organizations were contacted during various stages of public involvement for this project.

Elected Federal Officials

U.S. Senators	U.S. Representatives, Districts 1, 2, 3, 4, 5, and 6		
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Elected State Officials

Missouri Senators, Districts 1, 2, 4, 5, 6, 7, 8, 10, 11, 13, 14, 15, 16, 17, 19, 21, 22, 23, 24, 26			
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Federal Agencies

National Park Service (multiple offices)	USDA North Central Exp. Station	U.S. Forest Service - Mark Twain National Forest- Headquarters Office	USGS Upper Midwest Environmental Sciences Center
U.S. Army Corps of Engineers (multiple offices)	U.S. EPA	USGS-CERC	USGS - Water Resources Division
USDA-Natural Resources Conservation Service			

Native American Tribes

Absentee-Shawnee Tribe of Oklahoma	Iowa Tribe of Kansas and Nebraska	Omaha Tribe of Nebraska	Sac & Fox Tribe of the Mississippi in Iowa - Tama Settlement
Absentee-Shawnee Tribe of Oklahoma Cultural Preservation Department	Iowa Tribe of Oklahoma	Osage Nation of Oklahoma	Shawnee Tribe (Loyal Shawnee Tribe)
Chickasaw Nation	Kickapoo Traditional Tribe of Texas	Peoria Indian Tribe of Oklahoma	Chickamauga Cherokee Nation
Choctaw Nation of Oklahoma	Kickapoo Tribe of Kansas	Prairie Band Potawatomi Nation	Eastern Shawnee Tribe of Oklahoma
Delaware Nation of Oklahoma	Kickapoo Tribe of Oklahoma	Sac & Fox Nation of Missouri in Kansas and Nebraska	Northern Cherokee Nation of the Old Louisiana Territory
Delaware Tribe of Indians	Miami Tribe of Oklahoma	Sac & Fox Nation of Oklahoma	The Osage Nation

State Agencies and Boards

Missouri Department of Conservation (multiple offices)	Missouri Department of Natural Resources (multiple offices)	Missouri Department of Natural Resources, Clean Water Commission	Missouri Department of Transportation
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Cities

Alma	Corder	Keytesville	Russellville
Armstrong	Creve Coeur	Lawson	Salisbury
Ashland	Ellisville	Lee's Summit	Slater
Ballwin	Eureka	Levasy	Smithville
Belle	Fayette	Lexington	St. Ann
Berger	Fenton	Liberty	St. Charles
Black Jack	Florissant	Linn	St. Clair
Blackburn	Foristell	Manchester	St. Louis
Bland	Fulton	Maryland Heights	St. Paul
Blue Springs	Gerald	Missouri City	St. Peters
Chesterfield	Gladstone	Montgomery City	Sturgeon
Augusta	Glasgow	Mosby	Sullivan
Auxvasse	Grain Valley	New Florence	Sweet Springs

Avondale	Grandview	New Franklin	Tipton
Boonville	Greenwood	New Haven	Truesdale
Bridgeton	Hall of Waters	Norborne	Union
Brunswick	Hallsville	North Kansas City	Warrenton
Buckner	Hardin	Odessa	Washington
California	Hartsburg	O'Fallon	Wellington
Carrollton	Hazelwood	Orrick	Wellsville
Centralia	Higginsville	Otterville	Wentzville
Chamois	Holt	Owensville	Wood Heights
Chesterfield	Holts Summit	Pacific	Wright City
Hermann	Independence	Pilot Grove	Marthasville
Kearney	Jamestown	Portage Des Sioux	Chesterfield
Lake Saint Louis	Jefferson City	Raytown	St. Peters
Columbia	Jonesburg	Richmond	St. Charles
Concordia	Kansas City	Rocheport	

Counties

Boone	Cole	Jackson	Ray
Callaway	Cooper	Lafayette	Saline
Carroll	Franklin	Moniteau	St. Charles
Chariton	Gasconade	Montgomery	St. Louis
Clay	Howard	Osage	Warren

Organizations

American Rivers	Missouri Farm Bureau	Ozark Regional Land Trust	The Trust for Public Land
American Land Conservancy	Missouri Forest Products Association	Pheasants Forever	Conservation Organizations and Clubs (47)
Ducks Unlimited	Missouri River Levee & Drainage Assoc.	Quail Forever	Businesses (24)
Environmental Defense Fund	National Fish and Wildlife Foundation	Rails-to-Trails Conservancy	Libraries (14)
Friends of Big Muddy	National Wild Turkey Federation	Sierra Club	Schools/Universities (6)
Greenway Network	National Wildlife Federation	The Nature Conservancy	Fire Protection Organizations (7)

Missouri Corn Growers Association	National Wildlife Refuge Association		
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River Associations and Committees

Great Rivers Habitat Alliance	Missouri River Communities Network	Missouri River Initiative	Missouri River Relief
Great Rivers Land Pres. Assoc.			

Media

Newspapers (60)	Radio (6)	TV (6)	Magazines (2)
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Citizens (355)

Appendix J: Alternatives Survey

Alternatives Survey

Comprehensive Conservation Planning
Big Muddy National Fish and Wildlife Refuge

The information included in this survey is a distillation of ideas and conversations that occurred at a workshop held in September 2011. The workshop was one step in the ongoing conservation planning for the Big Muddy National Fish and Wildlife Refuge. This survey is a follow up to the workshop. We will use the results of this survey to guide development of a range of alternatives that ultimately will be presented for public review and comment as a Draft Comprehensive Conservation Plan and Environmental Assessment. Much of the survey is self-explanatory, but instructions for each section are provided below.

A. Visitor Services and Facilities Instructions

- ▶ The list of items in this section of the survey describes a range of visitor services and facilities. Choose the items you suggest be available within each of the three urban zones (see map) as well as what would be available within the rural zones. (choose all that apply)
- ▶ Consider the time frame. The planning horizon for the Comprehensive Conservation Plan is 15 years. Indicate if the item would occur in the next 15 years (left side) or if it would occur, but beyond 15 years from today (right side).

B. Land and Water Conservation: Refuge-wide Standard Management

This section of the survey asks you to consider what type of management actions would be carried out for all refuge holdings regardless of their location. (choose all that apply)

C. Land and Water Conservation: Recurring Management

This section of the survey asks you to consider what model should direct recurring management activities. Recurring management are management actions that would occur in addition to those described under section B above.

D. Zones of Opportunity: Conservation Footprint and Land and Water Conservation

This section includes a list of criteria or opportunities that would guide future expansion of the refuge's conservation footprint and any associated land and water management. Rank each criterion and suggest others not on the list.

Visitor Services and Facilities (Check all that apply. Consider typical management constraints such as funding and staff)

		Would occur within next 15 years		Would occur, but beyond 15 years
		Rural Zone Columbia Zone St. Louis Zone Kansas City Zone		
Management Intensity/presence	Low	<input type="checkbox"/>	Infrastructure is flood-resistant (if present)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Infrastructure is low to no maintenance (if present)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Refuge boundaries marked	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Open to hunting, fishing, and mushroom gathering	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Reasonable car and/or boat access	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Kiosks	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Parking lot (in areas with vehicle access)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Collaboration (building relationships to deliver conservation)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Outreach (building public understanding and support)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Environmental education programs	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Interpretive programs and other guided interpretation	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Interpretive displays and other self-guided interpretation	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Refuge land base is, or will be, established	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Staff at the location	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Infrastructure beyond that described for rural zone (e.g. restrooms, trails, boat ramps, wildlife observation facilities, etc.)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Environmental education site (includes a shelter and is located in proximity to multiple potential recreational experiences)	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	Refuge office	<input type="checkbox"/>
	High	<input type="checkbox"/>	Visitor center	<input type="checkbox"/>
	<input type="checkbox"/>	Other: _____	<input type="checkbox"/>	



Choose the items to include as the default land and water management that would occur on all Refuge holdings regardless of the location of the holdings within the acquisition boundary. Assume the listed actions are possible and/or feasible. (check all that apply)

- Restore hydrology
- Reconnect floodplain to the Missouri River and major tributaries
- Control, and/or eradicate invasive species of vegetation
- Restore native flora and fauna
- Protect and manage for federal and state listed threatened and endangered species
- Survey boundaries
- Mark boundaries
- Other: _____

C. Land and Water Conservation: Recurring Management

Recurring management includes those activities that occur on a routine basis (maintenance, monitoring, research, etc.) and are in addition to the standard management described above. Choose which model should guide Refuge recurring management for the succeeding 15 years (check one).

- Option 1: Recurring land and water management activities would be directed based on proximity to the existing base(s) of operations (work centers). Refuge holdings closer to the base(s) of operations (work centers) would receive a greater level of management attention and resources.
- Option 2: Recurring land and water management activities would be directed to zones of greatest opportunity (as defined by the criteria in item D below) regardless of proximity to existing Refuge base(s) of operations (work centers).
- Option 3: Recurring land and water management activities would be directed to zones of greatest opportunity and the clusters of these zones would guide future placement of one or more base of operations (work centers).

D. Zones of Opportunity: Conservation Footprint and Land and Water Conservation

The criteria listed below would define zones of opportunity. Zones with higher concentrations of opportunities are higher priorities for expanding the Conservation Footprint and, subsequently, Land and Water Management. (indicate ranking for each criterion)

Ranking			Criterion
Low	Med	High	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Adjacency/proximity to existing Refuge units
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Connectivity to existing public lands
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Potential for river feature restoration (e.g. islands, chutes, side channels, bends, tributary confluences)
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Significant bird migration sites
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Ability to set back levees
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Large (800 acres or more) contiguous tract(s)
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	River frontage
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Quality of existing habitat (high quality= natural cover types; medium quality= non-developed cover types [e.g. agricultural land]; low quality= developed lands)
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Fish hotspots
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Proximity to population centers (closer is better because it allows greater public access)
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Partnership potential
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Land value/cost
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Other: _____

Appendix K: Land Acquisition Decision Support Model

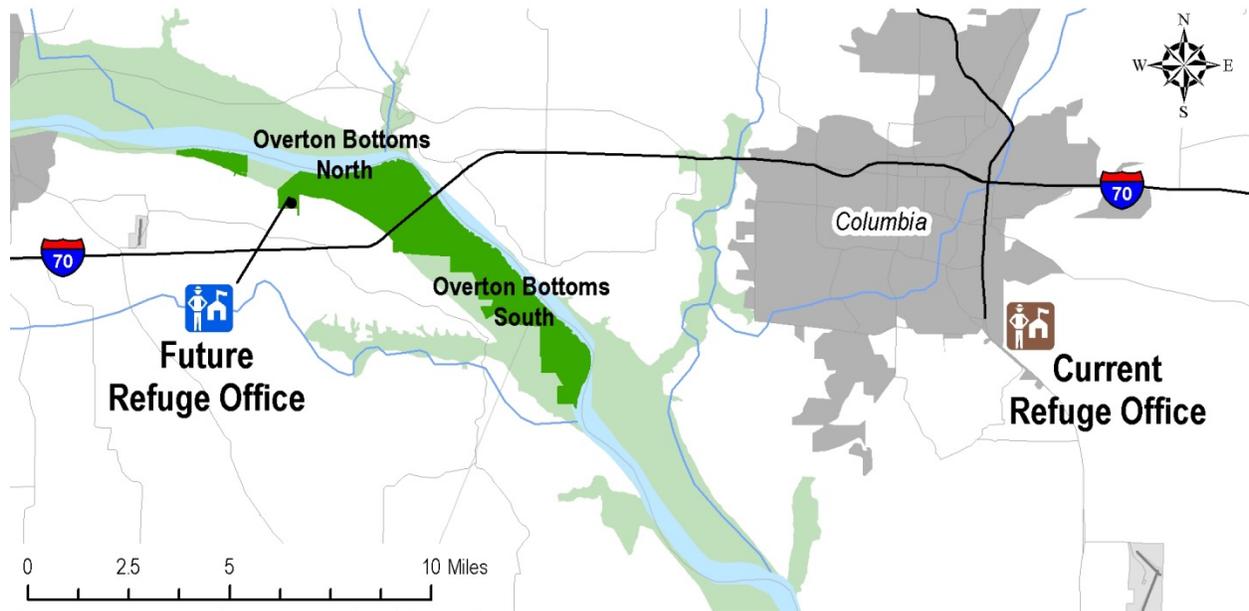
The purpose of the GIS derived model is to give any proposed tract a weighted value based on the acquisition criteria set forth in the 1999 Big Muddy Final Environmental Impact Statement and in appendix A. The model is broken into multiple sub-models. First, a proposed tract is merged with existing conservation lands (U.S. Fish and Wildlife Service and other ownership). The whole area is overlaid with distinct river features (bottoms, islands, etc.). Tracts that acquire large percentages of river features (or complete conservation on river features) are given higher weighting. This is because management of river features is much easier when adjacent private landowners are not affected by actions (levee removals, reconnecting backchannels and sloughs, etc.).

Finally, the model evaluates distance to the river itself. When other factors are more or less equal, it is generally more desirable to acquire land directly along the river itself. The use of this model is to give a quick ranking of proposed acquisitions at any one time. Other factors may influence actual acquisition. For example, this model would not weight acquisition of a previously unprotected river feature high (unless the tract to be acquired is a large portion of said feature). The model is meant to be used as a tool and not the end-all decision maker when considering tracts for acquisition.

Appendix L: Proposed Refuge Office Location and Description

The US Fish and Wildlife Service has of a variety of office designs to meet administration and staffing needs at various locations. The office facility for Big Muddy National Fish and Wildlife Refuge would be located outside of Columbia, Missouri (see figure below) with the following specifications:

- Encompass approximately 5,000 square feet
- Contain office space facilities to accommodate up to 8 full time employees, volunteers, and 250,000 visitors annually.
- Meet Department of Interior energy and sustainability guidelines



Appendix M: Errata

In this appendix:

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The following errata sheets add information to the Big Muddy National Fish and Wildlife Refuge (NFWR) Environmental Assessment and Draft Comprehensive Conservation Plan (EA and Draft CCP), released for public review on October 1, 2013 regarding the farming program and refuge-specific effects from the use of genetically-modified organisms and pesticides. The addition largely contains background information and an explanation that supports the conclusion that no refuge-specific effects are anticipated. Although multiple pages in length, the information does not change the alternatives or identify any effects not already disclosed in the EA and Draft CCP or disclosed in documents it references. This EA and Draft CCP, along with these errata sheets, represent the complete environmental analysis for this project. The use of errata sheets for this purpose is supported in a March 6, 2012 memorandum from the Council of Environmental Quality to heads of federal departments and agencies regarding improving the process for preparing efficient and timely environmental reviews under the National Environmental Policy Act of 1969 (NEPA) (CEQ, 2012).

Description of the Farming Program for the Big Muddy NFWR

The use of farming as a land management tool supports the biological purposes and management strategies of the Big Muddy NFWR presented in the EA and Draft CCP and will adhere to all regional and national policies and guidance, such as; Region 3 Pesticide Use Policy (appendix O of the Big Muddy NFWR Final CCP), Region 3 Farm Program Guidance (appendix P of the Big Muddy NFWR Final CCP) and the U.S. Fish and Wildlife Service (FWS, Service)'s Midwest Region Environmental Assessment (EA) for row crop farming and the use of genetically-modified, glyphosate-tolerant (GMGT) corn and soybeans on refuge/district land (FWS, 2011c).

Farming on Big Muddy NFWR is accomplished through the issuance of a Special Use Permit (SUP) to private individuals (cooperative farmers). The SUP provides direction to the cooperative farmer on: types of crops to be planted, crop shares or cash payments for farming privileges, use of pesticides, use of best management practices, and other special conditions to ensure the farming program is conducted in an appropriate manner and within state, regional, and national Service guidance. The SUP is completed, issued, and signed by the Big Muddy NFWR project leader. These annual agreements are typically written to work with the same cooperator farming the unit for multiple years.

Farming on Big Muddy NFWR typically occurs only on recently acquired land, and only on previously disturbed areas, such as previously farmed land. These lands are farmed to prepare them for restoration to native grasslands or forestlands. Crops planted on Big Muddy NFWR currently include corn and soybeans. Table M-1 provides farm crop and acreage information for the 2011–2013 farming seasons.

Cooperative farmers utilize conventional farming practices including the use of tractors, plows, disks, planters, spray equipment, and combines. Each site is tilled prior to spring planting, once

ground conditions permit the use of heavy equipment without damage to the soil (i.e., rutting). Some sites may also be treated with a pre-emergent herbicide prior to planting. Crops such as corn and soybeans are planted. Typically, planting is completed in six days or less on any individual site, and planting on all sites typically begins as early as mid-April and is completed as late as early June depending on soil conditions and type of crop planted. Cooperating farmers will be subject to Service policy and regulation regarding use of chemicals and treated seeds. Chemical use is restricted by type and to the minimum necessary amount applied.

Harvest techniques are the same for both no-till and traditional farming practices. Harvest begins in the fall using a self-propelled harvesting implement such as a combine. It usually takes about six days per site and is completed on all sites by late October or early November.

All use of genetically-modified crops on Big Muddy NFWR will occur under the guidance of the Service's Midwest Region EA for row crop farming and the use of GMGT corn and soybeans on refuge land (FWS, 2011c). The use of genetically-modified crops will be limited to GMGT corn and soybeans, will be allowed only for the purpose of habitat restoration, and will under regional policy be limited to five years for any individual tract in preparation for habitat restoration.

The Big Muddy NFWR project leader is required to demonstrate that the proposed use of GMGT crops is essential for habitat restoration. If the use of GMGT crops is proposed, the project leader must complete a Standard Eligibility Questionnaire for Genetically Modified Crops on National Wildlife Refuge System Lands (appendix N of the Big Muddy NFWR Final CCP). The Regional Chief of Refuges will review all requests for authorization to use GMGT crops and will approve or deny requests based on the questionnaire. A current farming compatibility determination that addresses the use of GMGT crops for habitat restoration is also required (appendix H of the Big Muddy NFWR Final CCP). The use of GMGT corn and soybeans for restoration purposes has been authorized on Big Muddy NFWR and has been implemented since the 2011 farming season. The use of GMGT crops is not allowed for any other farming purposes, including habitat management, supplemental food, and attracting wildlife for viewing and photography.

For the past several years, the Service has been reducing the number of acres farmed on National Wildlife Refuge System (NWRS, Refuge System) land as well as the number of acres planted to GMGT crops within the region. However, Big Muddy NFWR has been acquiring land that has existing farming operations and uses farming as a land management tool to prepare the land for restoration as indicated in Table M-1. Generally, three to five years of farming is necessary to prepare the soil for planting of native grass/forb seed or native bottomland hardwood trees. Big Muddy NFWR has a goal of gradually phasing out farming on each newly acquired tract of land over five years and restoring native habitat.

The use of treated crop seeds, particularly those treated with chemicals referred to as neonicotinoids, have been a growing environmental concern due to potential effects on pollinator species. Neonicotinoids are a class of insecticides chemically similar to nicotine. They are marketed and distributed in various forms including sprays, powders, and seed treatments. Trade names containing neonicotinoids may include (but are not limited to) Acceleron®, Acetamiprid®, Actara®, Adage®, Adjust®, Admire®, Advantage®, Alpine®, Arena®, Assail®, Belay®, Calypso®, Celero®, Centric®, Clutch®, Confidor®, Cruiser®, Dinotefuran®, Encore®, Flagship®, Gaucho®, Helix®, Inside®, Intruder®, Ledgend®, Merit®, Meridian®, Nipsit®, Platinum®, Poncho®, Pravado®, Premise®, Regent®, Safari®, Scorpion®, Titan®, Touchstone®, Tristar®, and Venom®. Active ingredients include: acetamiprid, clothianidin, dinotefuran, imidacloprid, nithiazine, sulfoxaflor, thiacloprid, and thiamethoxam. Due to this

concern, Big Muddy NFWR will implement the following Region 3 guidance on the use of neonicotinoid treated seeds (a refuge manager can always be more restrictive than these more general regional guidelines):

- Refuge managers will exhaust all alternatives before allowing the use of neonicotinoid treated seeds on Refuge System land in 2014 and 2015.
- Refuge managers need to eliminate the use of neonicotinoid treated seed on Refuge System land in Region 3. The strategy is to start the transition in calendar year 2014 and be "neonicotinoid seed free" in calendar year 2016. In 2014 and 2015 there will be some flexibility for the transition and take in to account the availability of non-treated seed. During the two transition years, refuge managers need to have an approved Pesticide Use Proposal (PUP) before allowing the planting of neonicotinoid treated seed on Refuge System land under their management. Special attention will be given to the "justification" section of the PUP. The PUP will become part of the official record and should clearly state the need to use treated seed during this transition period. Refuge managers must provide justification to the area supervisor and receive written concurrence prior to initiating a PUP for the use of neonicotinoid treated seeds.
- All crop seeds treated with neonicotinoid chemicals must be planted (incorporated) beneath the soil surface due to their high toxicity to birds. No residue seeds can be left above ground. Any treated seeds that are spilled and/or left above ground at the time of planting must be picked-up and removed or replanted underground immediately. The refuge/district must conduct random field spot checks at the time the treated seeds are planted to ensure they are incorporated beneath the soil surface. To accommodate this process, any Region 3 field station that uses neonicotinoid treated seed must complete a Region 3 Treated Seed Incorporation Monitoring Statement. This Statement will document that all treated seed has been incorporated beneath the soil surface, thus adhering to Service policy. This guidance also applies to fungicide treated seed as indicated in the Region 3 Pesticide Use Policy.
- Seeds treated with neonicotinoid chemicals are listed as toxic to aquatic invertebrates. Therefore, field stations using neonicotinoid treated seeds must develop specific Best Management Practice guidelines to be included in the submitted PUP and implemented in the special use conditions of the SUP.
- Seed treatment chemicals cannot be mixed or applied to the crop seeds on refuge/district land, they must be treated off-site.

Farming, to accomplish habitat restoration objectives, is implemented either to prepare a quality seed bed for the establishment of native prairie grasses and forbs, or to eliminate competition for bottomland hardwood seedlings. Farming may be utilized for up to five years to reduce unacceptable levels of undesirable chemical residue, noxious weeds, or non-native plant species. Newly acquired properties for Big Muddy NFWR are often land that is currently being farmed. Past restoration efforts, without utilizing farming, have resulted in unacceptable levels of invasive vegetation competition, thereby limiting the success of the restoration effort. Furthermore many of the tracts acquired by Big Muddy NFWR have been extensively farmed for a long period of time reducing the possibility that simply idling the land will produce a desirable outcome. SUPS will be utilized to extend the farming program to keep the land free of weeds until funds are available for habitat restoration, generally within five years. Under the SUP the last year of farming typically requires the cooperative farmer to plant soybeans, as soybean stubble is a preferred substrate in which to plant native grasslands or tree seedlings. If native

prairie is going to be restored, native plant seeds are broadcast on top of the ground or drilled into the soybean stubble depending on local planting strategies.

The decision to use cooperative farming for habitat restoration and habitat management would occur as part of strategies developed under specific program or unit habitat management planning. The use of farming provides a management tool that allows the Refuge staff to meet the habitat goals and objectives. As practiced at the Big Muddy NFWR, farming contributes to the achievement of Refuge purposes and the Refuge System mission because it helps enhance and restore native habitat for migratory birds and resident wildlife.

Table M-1: Acres Farmed on Refuge System Land and Acres Planted to GMGT Crops on Big Muddy NFWR

Planted by:	2013 (acres)	2012 (acres)	2011 (acres)
Cooperators/contractors to genetically-modified organism (GMO) corn.	340	460	149
Cooperators/contractors to GMO soybeans.	560	440	93
Cooperators/contractors to non-GMO corn.	0	0	0
Cooperators/contractors to non-GMO soybeans.	0	0	0
Cooperators/contractors to other crops as part of a farming rotation.	0	0	0
Total Acres Farmed by Cooperators/Contractors	900	900	242

Site-Specific Effects Analysis for the Farming Program on Big Muddy NFWR

No site-specific effects on the environment, other than what have already been disclosed in other NEPA documents completed by other federal agencies, are expected from the farming program in the district because of the following:

1. *The Animal and Plant Health Inspection Service (APHIS) regulates the cultivation of genetically engineered organisms, not the U.S. Fish and Wildlife Service.*

APHIS regulates the introduction (importation, interstate movement, or release into the environment) of certain genetically engineered organisms and products that may pose a risk to plant or animal health. APHIS exercises its regulatory authority through a system that includes both permits and notifications. A permit is granted for a field trial when APHIS has determined that the conduct of the field trial, under the conditions specified by the applicant or stipulated by APHIS, does not pose a plant pest risk. A researcher or developer may also request that APHIS no longer regulate an organism by submitting a petition for nonregulated status.

Such field trials have been completed for both glyphosate-tolerant soybeans and corn. For soybeans, nine field tests took place between 1991 and 1994 at approximately 54 sites in 19 states (including Missouri). "Field trial reports from these tests show no deleterious effects on plants, nontarget organisms, or the environment as a result of these releases," (U.S.

Department of Agriculture [USDA]-APHIS, 1994). For corn, field tests occurred between 1993 and 1996 in the major corn growing regions of the United States (20 states, assumed to include Missouri). “This line [MON 802] has been evaluated extensively to confirm that it exhibits the desired agronomic characteristics and does not pose a plant pest risk,” (USDA-APHIS, 1997a).

Given the field trial results, petitions for nonregulated status were also submitted for both soybeans and corn. In 1994 (USDA-APHIS), APHIS completed an environmental assessment and reached a finding of no significant impact on the environment “from the unconfined, agricultural use of glyphosate-tolerant soybean line 40-3-2 and its progeny.” In 1997 (USDA-APHIS, 1997a), a similar environmental assessment was completed with a finding that “MON 802 corn will not have a significant adverse impact on organisms beneficial to plants or agriculture, or other nontarget organisms, and will not affect threatened or endangered species.” APHIS concluded, “There will be no significant impact on the human environment if MON 802 corn and its progeny were no longer considered a regulated article,” (USDA-APHIS, 1997a).

Similar field trials, assessment, and finding were completed later in 1997 for glyphosate-tolerant GA21 corn (USDA-APHIS, 1997b). Other extensions of these original petitions have been submitted in more recent years, and similar trials, assessments, and findings have been completed or are underway for other glyphosate-tolerant corn and soybean crop lines. This documentation, which includes analyses of the effects on humans and the environment from growing genetically engineered crops, can be found at the following website: http://www.aphis.usda.gov/biotechnology/petitions_table_pending.shtml.

Since another federal agency, APHIS, regulates the cultivation of genetically engineered organisms and that agency has completed NEPA documentation including effects analyses of this activity, the Service relies on the findings from that agency when determining the effects of the same activity on refuge system land. APHIS has both the regulatory authority and the necessary technical expertise to assess effects of genetically engineered crops on the environment, while the Service has no regulatory jurisdiction over that activity. Therefore, no other site-specific effects other than what have already been disclosed by APHIS are expected from cultivation of genetically engineered crops by the Service.

2. The U.S. Environmental Protection Agency (EPA) regulates the use of pesticide chemicals, including herbicides, in the environment.

The EPA regulates the use of pesticide chemicals, including herbicides, in the environment. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA has the authority to regulate the testing, sale, distribution, use, storage, and disposal of pesticides. Before a pesticide may be sold, distributed, or used in the United States, it must be registered under FIFRA.

For example, the EPA first issued a registration standard for glyphosate in June of 1986. Because of advances in scientific knowledge, pesticides that were first registered years ago are required by law to be reregistered to make sure that they meet today’s more stringent standards. In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. Glyphosate was reregistered in 1993 as it was found to “not pose unreasonable risks or adverse effects to humans or the environment.” Furthermore, “EPA determined that the effects of glyphosate on birds, mammals, fish and invertebrates are

minimal,” (EPA, 1993). In 1997, permanent tolerances for residues of glyphosate were established in or on raw agricultural commodities including field corn varieties genetically-modified to be tolerant of glyphosate (EPA, 1997).

The herbicide 2,4-D has been used since the 1940s as a pre-plant or post-emergent herbicide to control broadleaf weeds on a broad range of crop and non-crop sites, including cornfields. The EPA first issued a registration standard for 2,4-D in 1988, and the herbicide was reregistered in 2005. In summary, the EPA stated, “Some ecological risks are of concern on some sites for some species,” (EPA, 2005). They provide mitigation measures “expected to lessen, but not eliminate, the risk of 2,4-D to wildlife and plants,” (EPA, 2005). Currently, 2,4-D is approved for pre-plant and post-emergent application on corn and pre-plant application on soybeans.

Dicamba is widely used in agricultural, industrial, and residential settings for the post emergent control of certain broadleaf weeds and woody plants. It was first registered by the EPA in 1967 and was reregistered in 2006 with amendments in 2008 (EPA, 2009). During the reregistration, the EPA determines whether the pesticide meets the “no unreasonable adverse effects” criteria of FIFRA. As a result of the reregistration review, the EPA “determined that all products containing the active ingredient dicamba are eligible for reregistration provided that the risk mitigation measures indicated in the document are adopted,” (EPA, 2009).

APHIS is currently considering the deregulation of new genetically engineered corn, soybean, and cotton plants resistant to the herbicides known as 2,4-D and dicamba. However, the use of GMO crops on Big Muddy NFWR is limited to glyphosate-tolerant corn and soybeans (FWS 2011c).

Since another federal agency, the EPA, regulates the use of pesticides, and that agency has completed NEPA documentation including effects analyses of this activity, the Service relies on the findings from that agency when determining the effects of the same activity on refuge system land. The EPA has both the regulatory authority and the necessary technical expertise to assess effects of pesticide use on the environment while the Service has no regulatory jurisdiction over that activity. Therefore, no other site-specific effects other than what have already been disclosed by the EPA are expected from pesticide use by the Service.

3. *The farming program on the refuge will follow the Service’s Midwest Region Environmental Assessment (EA) for row crop farming and the use of genetically-modified glyphosate tolerant (GMGT) corn and soybeans on refuge/district land.*

In 2011, the Service’s Midwest Region completed an EA for row crop farming and the use of GMGT corn and soybeans on refuge/district land (FWS, 2011c). Under the selected alternative, beginning in calendar year 2012, the use of GMGT corn and soybeans on Refuge System land in the Midwest Region would continue only for the purpose of habitat restoration. According to the EA, the use of GMGT corn and soybeans would be limited to five years on any individual tract being prepared for habitat restoration. Farming could continue to be used as a management tool for achieving multiple objectives; however, it would be limited to non-GMGT crops for objectives other than habitat restoration. Multiple objectives include but are not limited to the following:

- Habitat restoration

- Habitat management
- Supplemental food for wildlife
- Attracting wildlife for viewing and photography

Similarly, the Service's ecological integrity policy specifies that GMGT crops cannot be used on Refuge System land unless they are "essential to accomplishing refuge [district] purposes." Habitat restoration is a core objective of most refuges in achieving their purpose and in some circumstances, the use of GMGT crops could be essential. However, habitat management, supplemental food, and wildlife viewing objectives can more readily be accomplished without the use of GMGT seeds, and thus, their use is not likely essential.

Furthermore, refuge and district managers are required to demonstrate that their proposed use of GMGT crops is essential for habitat restoration. The Service has established an approval process for the use of GMGT corn and soybeans that includes completion of a Standard Eligibility Questionnaire for Genetically Modified Crops on National Wildlife Refuge System Lands (appendix N of the Big Muddy NFWR Final CCP). When managers propose to use GMGT corn and soybeans, they are required to complete this questionnaire as part of the approval process. There will be strict adherence to the regional programmatic EA regarding the use of GMGT corn and soybeans on Big Muddy NFWR.

4. The farming program on the Refuge will adhere to all national, Department of Interior, Service, and Region 3 policies regarding pest management and treatments.

Pest management activities on Service land and facilities must conform to all EPA regulations, chemical labels, Material Safety Sheets, and Service and Department of the Interior policies and directives including:

- 517 DM 1 (<http://www.nature.nps.gov/biology/ipm/Documents/DOI517DM1.pdf>),
- 569 FW 1 (<http://www.fws.gov/policy/569fw1.html>), and
- 242 FW 7 (<http://www.fws.gov/policy/242fw7.html>).

These policies state that pests will be managed using an integrated sustainable approach when the pest is detrimental to site management goals and objectives and the planned pest management actions will not interfere with achieving site management goals and objectives.

Service employees use their best professional judgment and available scientific information to select the lowest risk, most effective integrated pest management method, or combination of methods that is feasible for each pest management project.

If chemical treatment is considered, a Pesticide Use Proposal (PUP) must be prepared and approved by an appropriate level supervisor prior to the chemical application.

PUPS are extensive, detailed documents that require specific information about the planned treatment (pest target, threshold for treatment, active ingredient, application rate, application method) as well as a descriptions of the treatment site(s) (soil type, slope, organic content, nearest water, depth to ground water).

The PUPs are valid for only one year and provide a timely, site-specific evaluation of the current conditions. Reports regarding the efficacy of the treatments are required in February

of each year so Service staff can evaluate past management actions, and refine and improve subsequent control measures.

5. *Best Management Practices (BMPs) are currently being used for the farming program on the refuge, and a more thorough list of BMPs will be developed for the farming program to follow in the future.*

In general, the Refuge System is reducing the amount of farming on national wildlife refuges (NWRs, refuges) including the use of genetically-modified crops and pesticides. Farming with genetically-modified crops within refuges is restricted to a very specific purpose (i.e., habitat restoration). Due to the many policies (e.g., Pesticide Use Policy, appendix O of the Big Muddy NFWR Final CCP); the regional programmatic EA regarding the use of GMGT corn and soybeans, etc.; the approval processes (e.g., Pesticide Use Proposals, Special Use Permits, Habitat Management Agreements, Memorandums of Understanding, etc.); and guidelines (e.g., Best Management Practices, Regional Direction regarding cooperative farming, etc.) in place governing farming practices on Refuge System land, farming on Big Muddy NFWR is not expected to have the potentially significant adverse effects to the environment as surrounding farming practices on private land.

Farming is used on Big Muddy NFWR to accomplish habitat and wildlife goals and purposes. When farming is used to prepare the seed bed of a newly acquired property (typically in row crop agriculture), the refuge uses farming cooperators and Special Use Permits. In the Special Use Permit the Service articulates through stipulations the best management practices that will be used on refuge property. Examples of stipulations include the following:

Note: These stipulations may change over time to reflect new information.

- Use of chemicals must be approved through a Pesticide Use Proposal.
- Fall tillage is prohibited.
- Glyphosate tolerant corn and soybean seed may only be used for habitat restoration purposes.
- No insecticides may be used.

Chemical application provides the most effective means for site preparation prior to habitat restoration. Chemical site preparation reduces potential future applications by reducing weed seeds prior to restoration. The following Best Management Practices will be followed to lessen any potential effects from pesticide application on Big Muddy NFWR:

- Allow pesticide application buffers around sensitive areas,
- Follow pesticide labels,
- Spray only when winds are 12 mph or less (but not inversions),
- Control drift through use of low pressure and nozzles that create larger droplets,
- Monitor current and predicted winds,
- Monitor predicted rainfall,
- Be cautious around shallow groundwater, and

- Maintain a buffer around water and wetlands.

6. *The land in the farming program within the refuge has been privately farmed for over 50 years, more recently with the use of GMGT crops and pesticides.*

Landowners in the floodplain of the Missouri River began farming the floodplain in earnest after about 1945 when the U.S. Corps of Engineers began building flood control levees along the river. Over time, most of the floodplain was protected from annual flooding and more and more land was cleared for farming. The number of farms tended to decrease over time, but the size of farms steadily increased. Scientific advances in biotechnology (crop genetics, broadcast treatment of weeds, etc.) as well as general technology (larger and more aggressive tillage equipment, more accurate planting and harvesting equipment, etc.) continue to change and influence farming today as it did in the past. Farming on Big Muddy NFWR will occur on only previously disturbed areas such as previously farmed or currently farmed land. The farming program is simply used as a tool to prepare the seedbed for restoration of natural habitat.

In summary, no significant effects are expected from any of the proposed activities, based on the effects analysis completed in the EA for Big Muddy NFWR Draft CCP as well as the various effects analyses completed and cited above by APHIS regarding genetically engineered crops and the EPA regarding pesticide regulation. These analyses together constitute a “hard look” at the potential effects on the environment from the farming program on Big Muddy NFWR. Furthermore, various Section 7 consultations with the Ecological Services branch of the Service in concurrence, have been completed for pesticide use on Big Muddy NFWR regarding threatened and endangered species.

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U.S. Fish and Wildlife Service

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