

Big Muddy

National Fish and Wildlife Refuge

Headquartered in Columbia, Missouri

Fiscal Year 2008 - Annual Narrative Report



Troy Gordon, Chair of Friends of Big Muddy, died tragically in April 2008. We estimate he volunteered over 7,500 hours for Big Muddy National Fish & Wildlife Refuge before and after its establishment in 1994.

Thomas L. Bell, March 23, 2009
Refuge Manager Date

Matt Sprenger 3/27/09
Refuge Supervisor Date

Nita M. Furr 3.30.2009
Regional Chief, NWRS Date

Table of Contents

Introduction.....	1
Fiscal Year 2008 Highlights.....	3
River Heights During Fiscal Year 2008.....	4
Big Muddy NFWR Staff during FY 2008.....	7
1. Monitoring and Studies.....	8
1a. Surveys and Censuses.....	8
1b. Studies and Investigations.....	11
2. Habitat Restoration.....	14
2a. Wetland Restoration.....	14
2b. Upland Restoration.....	24
2c. Deepwater/Riverine Restoration.....	24
3. Habitat Management.....	25
3a. Water Level Management.....	25
3b. Moist Soil Management.....	25
3c. Graze/mow/hay.....	25
3d. Farming.....	25
3e. Forest Management.....	26
3f. Fire Management.....	27
3g. Pest Plant Control.....	27
4. Fish and Wildlife Management.	29
4a. Bird Banding.....	29
4b. Disease Monitoring and Treatment.....	29
4c. Reintroductions.....	29
4d. Nest Structures.....	29
4e. Pest, Predator, & Exotic Animal Control.....	29
5. Coordination Activities.....	30
5a. Interagency Coordination.....	30
5b. Tribal Coordination.....	34
5c. Private Land Activities (excluding restoration).....	34
5d. Cooperative/Friends organizations.....	34
5e. Intra-agency Coordination.....	39

6. Resource Protection.....	40
6a. Law Enforcement.....	40
6b. Permits & Economic Use Management.....	43
6c. Contaminant Investigation.....	44
6d. Contaminant Cleanup.....	44
6e. Water Rights Management.....	45
6f. Cultural Resource Management.....	45
6g. Land Ownership Support.....	45
7. Public Education and Recreation.....	47
7a. Visitor Services.....	47
7b. Outreach.....	54
8. Planning and Administration.....	62
8a. Comprehensive Management Planning.....	62
8b. General Administration.....	65

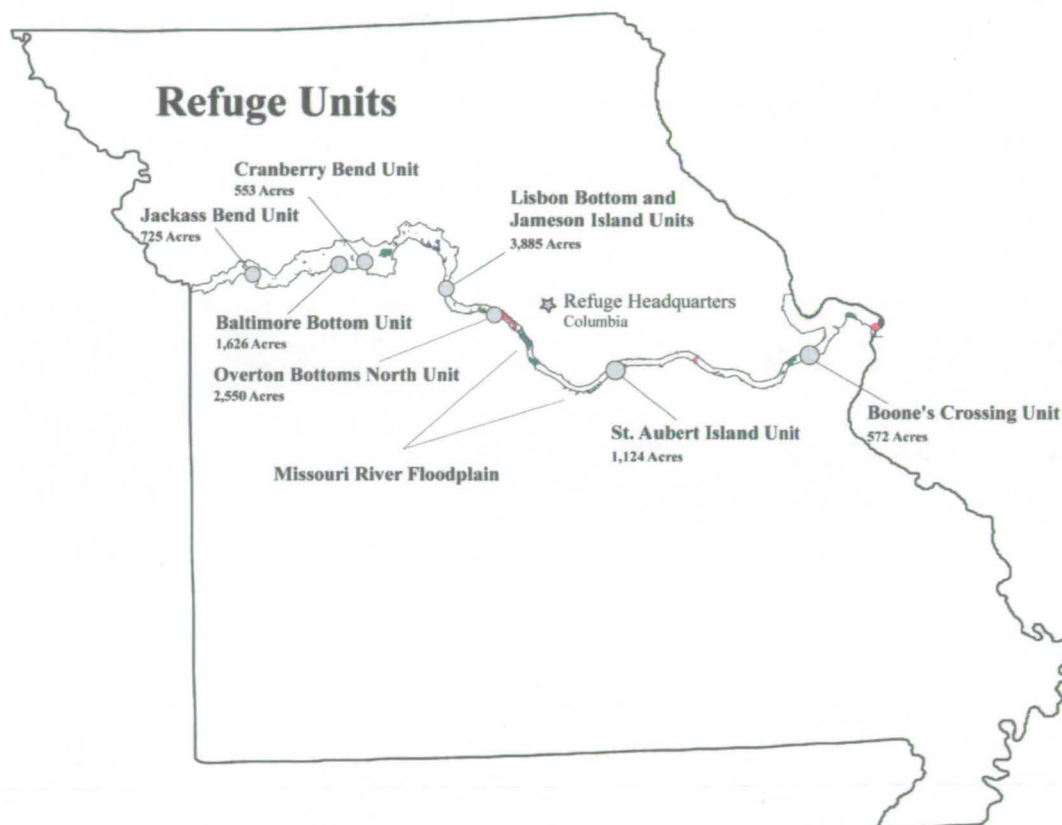
Appendices

- A. *Fish, Reptile and Amphibian Survey of Various Wetlands, Ponds and Scour Holes at Three Units of Big Muddy National Fish and Wildlife Refuge, August 2008, Lorena Varkonyi, 15 pages.*
- B. *Butterfly and Moth Checklist, Big Muddy National Fish and Wildlife Refuge, USFWS, 2 pages.*
- C. *Big Muddy National Fish and Wildlife Refuge Two Year Traffic Counter Report, February 2008, Tim Haller, 15 pages.*
- D. *Establishment and Sampling of Permanent Vegetation Monitoring Plots at Big Muddy National Fish and Wildlife Refuge, December 2007, Matthew Struckhoff, USGS, 18 pages.*
- E. *Executive Summary from Evaluation of Fish Use of the Side-Channel Chutes at Lisbon Bottom, North Overton Bottoms, Tadpole Island, and Tate Island, 2007 Annual Report, Missouri River Mitigation Project, March 2008, Nick Utrup, Zac Beussink, Joseph McMullen, Jeff Finley, and Tracy Hill, 146 pages.*
- F. *Site Photos taken at Baltimore Bottoms on 01 February 2008. Report from Chance Bitner, US Army Corps of Engineers, of shallow water habitat work initiated at Baltimore Bottom Unit. 6 pages.*
- G. *Current and Historic Vegetation at Big Muddy National Fish & Wildlife Refuge. Prepared for the Biological Review, Wedge Watkins.*

INTRODUCTION

The US Fish & Wildlife Service (FWS) established the Big Muddy National Fish and Wildlife Refuge in 1994 "...for the development, advancement, management, conservation, and protection of Missouri River fish and wildlife resources." The FWS purchased the first parcel of land the next year. The *Record of Decision and Environmental Impact Statement* completed in 1999 authorized acquisition of up to 60,000 acres in the 367-mile stretch of the Missouri River floodplain from Kansas City to St. Louis.

To date, the refuge encompasses 11,207 acres in eight different units along a 300-mile reach of the Missouri River from Jackass Bend Unit just east of Kansas City to Boone's Crossing Unit just west of St. Louis.



Map of Missouri showing the unit locations of the Big Muddy National Fish and Wildlife Refuge.

As outlined in the *Interim Comprehensive Management Plan, Big Muddy National Fish and Wildlife Refuge, Missouri, 1999*, our goals include:

- Restoration of natural floodplain conditions and associated native habitats including bottomland 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
- Providing additional public areas for compatible fish- and wildlife-oriented recreation and increasing public understanding of Missouri River resources

Most of the refuge is located in the river floodplain that can vary in width from 2 to 10 miles. Low river benches, terraces, and the remains of former river channels are common. Record flooding in 1993 and 1995 produced dramatic scouring and extensive sand deposits. Other terrain on the refuge includes steeply sloping hillsides or bluffs that connect uplands to the river's floodplain.

Historically, large seasonal variations in flow characterized the Missouri River. These dynamic conditions resulted in a diversity of riverine and floodplain habitat, including sloughs, chutes, oxbow lakes, sandbars, deep pools, marshes, seasonally-flooded bottomland forests, and wet prairies. Presently an extensive levee system isolates the river from its floodplain during seasonal flooding events, along with a dike and revetment system that attempts to constrain the river in its main channel. Blankets of quarried rock stabilize the banks. The refuge works with partners, especially the Army Corps of Engineers (COE), to reconnect the river to its floodplain.



*Evening Swim by Rebekah Nastav -Hooded Merganser
2008 Missouri Best of Show Winner and 3rd Place National Winner*

FISCAL YEAR 2008 HIGHLIGHTS

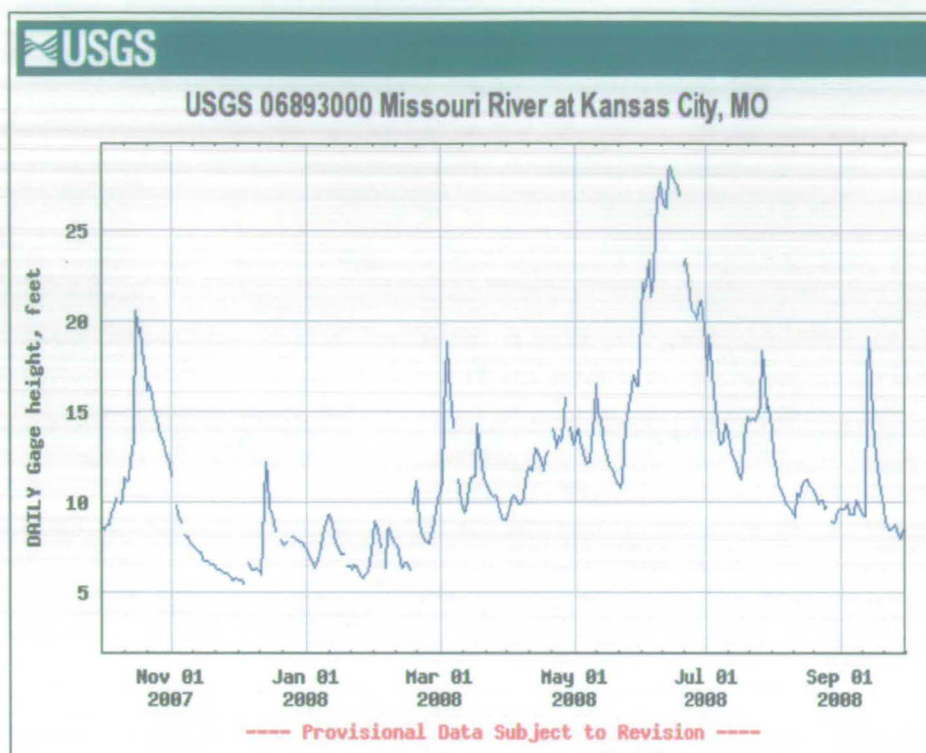
October 1, 2007-September 30, 2008

- We acquired two new tracts for the refuge: 117 acres at Jackass Bend Unit (Shropshire tract) and 54.4 acres at Cranberry Bend Unit (Thorp tract), increasing the refuge to 11,207 acres.
- A long anticipated land exchange occurred between the Refuge and two sets of neighbors at Jameson Island Unit, resolving a long-standing boundary dispute.
- Contractors and refuge staff worked on boundary posting. About 80 percent of the refuge now has boundary posted consistent with US Fish & Wildlife Service standards.
- We continued the Comprehensive Conservation Plan (CCP) process and hosted open houses for the public to discuss the CCP steps and collect issues and concerns from participants.
- We held a Biological Review in February. The guidance in that document will help us formulate the CCP and future habitat management plans.
- The refuge hosted the Missouri Junior Duck Stamp Program and over 800 students from across the state prepared artwork for the contest. Rebekah Nastav, age 17, took the state's Best of Show with *Evening Swim*, a depiction of a hooded merganser. Her artwork placed third at the national competition. We displayed the 100 Missouri winners at the Missouri State Capitol and 14 other public venues across the state.
- For the second year in a row, higher than usual spring rains fell on tributaries of the Missouri River. Water levels rose above flood stage and peaked on all refuge units during June. Some refuge units also flooded during heavy rain events in July and September.

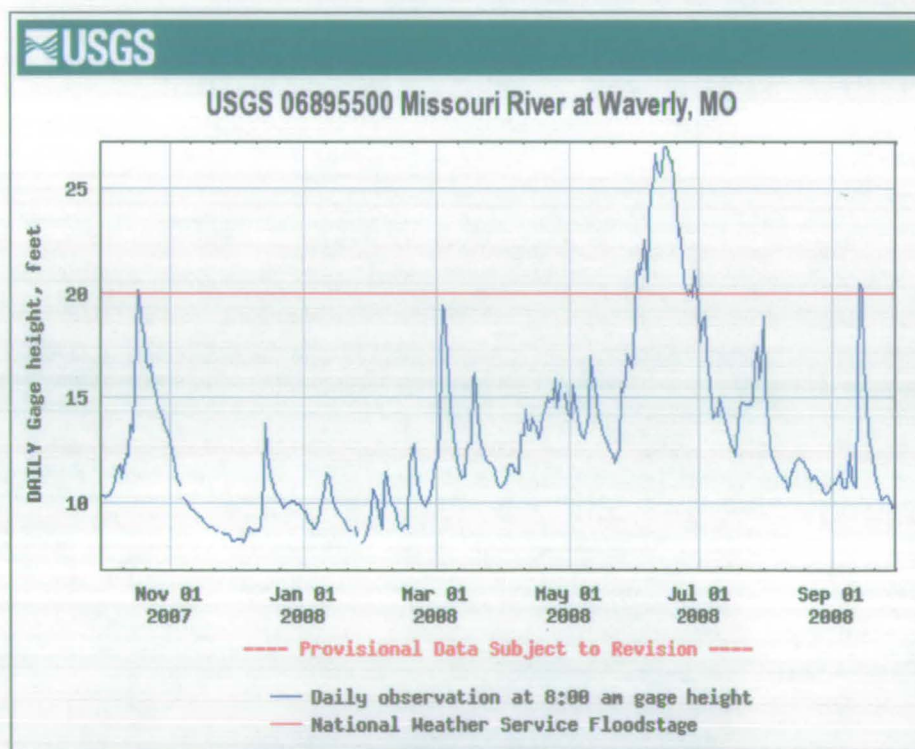


Kiosk on Arrow Rock Historic Landing Trail during June 2008 flood.

River Heights During Fiscal Year 2008 Recorded at Gages near Refuge Units



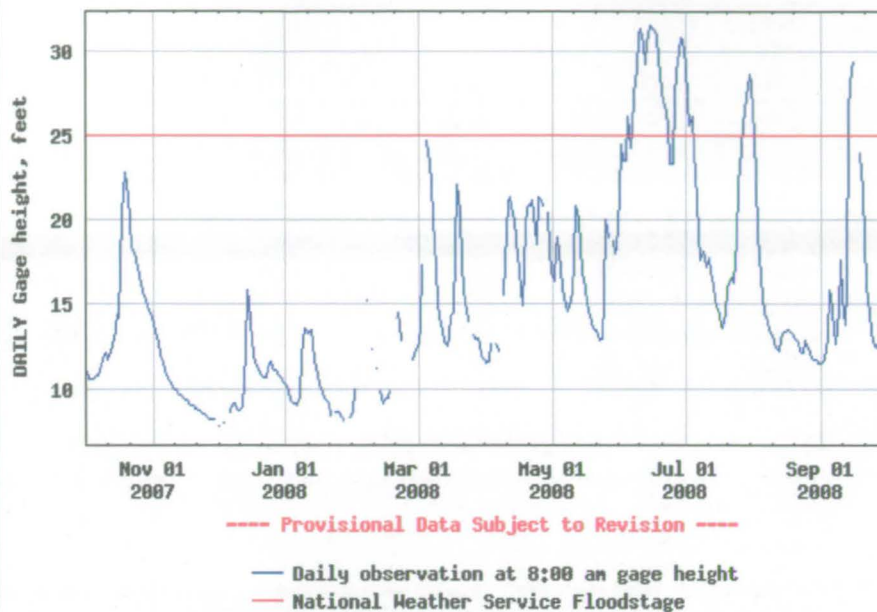
Gage Upstream of Jackass Bend Unit
 Note: Floodstage is 32 feet at Kansas City gage.



Gage closest to Baltimore Bottom and Cranberry Bend



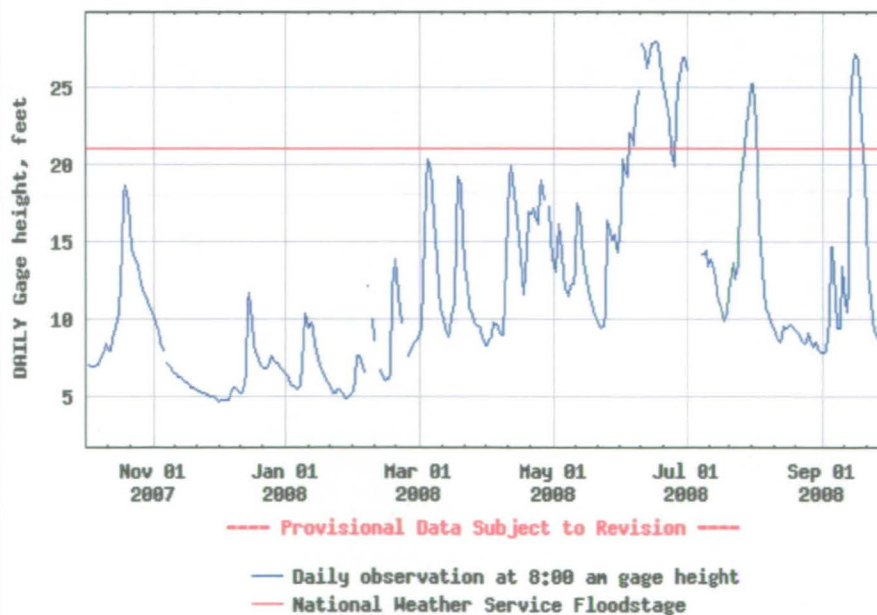
USGS 06906500 Missouri River at Glasgow, MO



Gage Upstream of Lisbon Bottom and Jameson Island Units



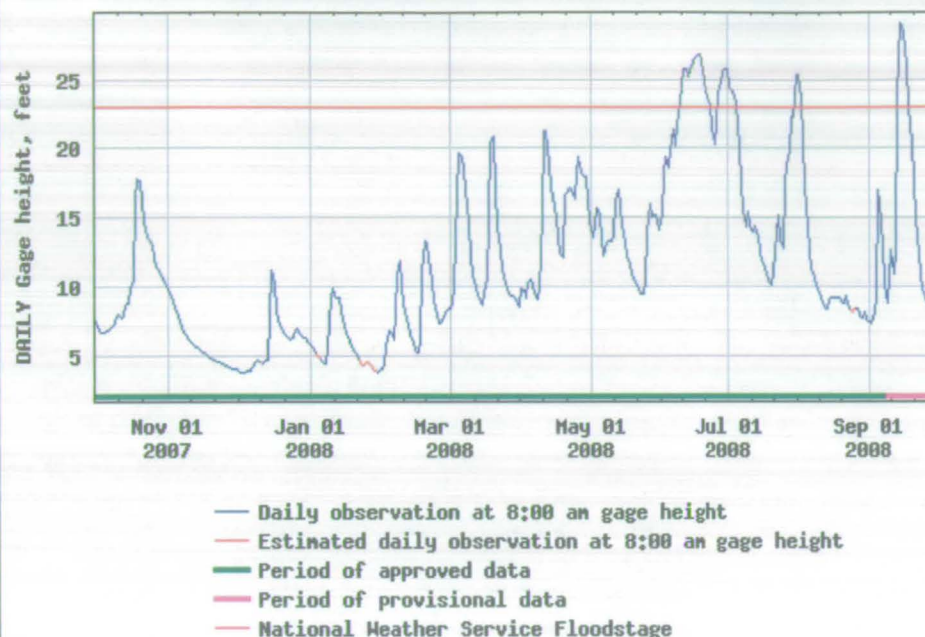
USGS 06909000 Missouri River at Boonville, MO



Gage Upstream of Overton Bottoms North Unit



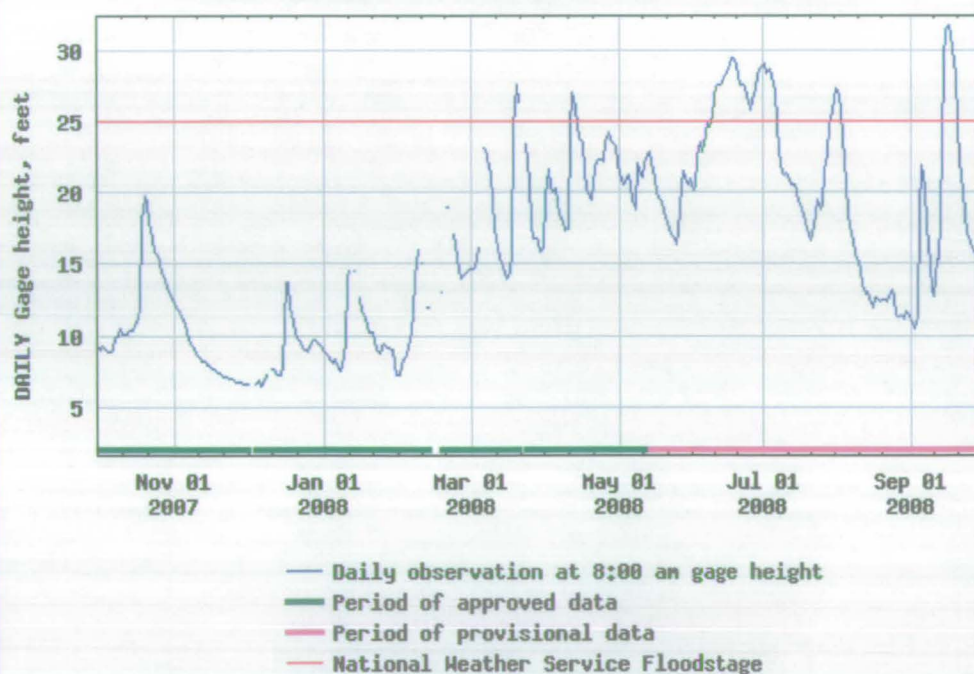
USGS 06910450 Missouri River at Jefferson City, MO



Closest Gage Upstream of St. Auberts Island Unit



USGS 06935965 Missouri River at St. Charles, MO



Closest Gage to Boone's Crossing Unit

FY2008 Big Muddy NFWR Staff:

Name	Job Position	Series-Grade	Status	Entered on Duty	Time Ended at Big Muddy
Thomas G. Bell	Wildlife Refuge Manager	GS-0485-13	PFT	6/1999	
Barbara V.G. Moran	Wildlife Refuge Specialist	GS-0485-12	PFT	11/1999	
Timothy A. Haller	Park Ranger	GS-0025-11	PFT	8/2001	
Molly A. Comstock	Administrative Tech Administrative Officer	GS-0303-07 GS-0303-09	PFT	12/2001 3/1/2008	
Randy L. Stenberg	Maintenance Worker	WG-4749-6	PFT	8/2005	
Wedge W. Watkins	Wildlife Biologist	GS-0486-12	PFT	9/2005	
Michael W. Blessington	Park Ranger (LE)	GS-0025-9	PFT	7/2006	8/2008
Dale E. Waites	Bio Science Aide (WL)	GS-404-03	STEP	5/2007	1/2009
Chad Collard	Bio Science Aide (WL)	GS-404-03	STEP	5/2008	

In mid-October 2007 we borrowed intermittent Columbia National Fish and Wildlife Conservation Office (CNFWCO) employees Zach Beussink, Emily Kunz, Adam McDaniel, and Craig Williamson after that office had to lay them off. Craig left for another job after one pay period. The others worked on projects with us through mid-February 2008.

Lorena (Lori) Varkonyi started her Conservation Internship Program with us on June 9. She returned to El Paso TX in September.

In the interest of brevity for this document, persons mentioned above will be identified with first name only. The document frequently uses the following acronyms:

CNFWCO = Columbia National Fisheries and Wildlife Conservation Office

COE = United States Army Corps of Engineers

FWS = United States Fish and Wildlife Service

MDC = Missouri Department of Conservation

MO DNR = Missouri Department of Natural Resources

MU = Missouri University

USGS - CERC = United States Geological Survey, Columbia Environmental Research Center

1. MONITORING AND STUDIES

1a. Surveys and Censuses

Survey of Fish, Reptiles and Amphibians. Lori summarized the biological survey work done during the summer in "Fish, Reptile and Amphibian Survey of Various Wetlands, Ponds and Scour Holes at Three Units of Big Muddy National Fish and Wildlife Refuge," which can be found as Appendix A. From the abstract:

"A survey was conducted of ten previously unsampled wetlands, ponds, and scour holes within the Big Muddy NFWR in the summer of 2008. The purpose of the survey was to determine the presence of fish, reptiles, and amphibians using a variety of traps and nets. A bag seine was used, when possible, along with baited hoop nets, mini-fyke nets, and minnow traps. At each location, GPS waypoints were taken and the traps were deployed in water less than four feet deep. Traps were deployed in a variety of habitats including open water, emergent vegetation, along shallow banks, and near trees and shrubs. Specimens were collected the following morning and inspected to determine their size and species. Total counts were estimated when more than 100 individuals were caught. Over 20 different species of fish, 7 species of amphibians, and 4 species of reptiles common to the region were observed during the survey."



(Left to right) Lori, Chad, and Dale sampled at several wetlands, ponds, and scours during the summer.



Some of the species sampled during the summer survey, July 2008.

Butterfly and Moth Survey. The butterfly and moth survey partnership with the Boone's Lick Chapter of the Missouri Master Naturalists and the University of Missouri completed the third and final field season in 2008. Four flood events (June, July, August and September) interrupted sampling. These floods not only made the logistics of sampling a challenge, but also affected plant phenology (delayed flowering). A total of eight days were spent sampling, but four of these outings were limited to the upland/old field site. Both night sampling efforts were limited to the upland site. A total of 116 hours of volunteer time and 34 hours of staff time were devoted to this project

Ten new species were documented in 2008 (see Table 1). Some work remains in order to complete final identification of pinned specimens. To date we have identified 133 species of moths and butterflies using the floodplain and upland/ bluff top habitats on the Overton Bottoms North Unit of the refuge. In addition, 12 species of dragonflies and damselflies were identified during this survey. An updated Butterflies and Moths Checklist for the refuge can be found as Appendix B.

Table 1. Ten new species documented on the refuge during 2008.

Waved Sphinx	<i>Ceratomia undulosa</i> (Walker)
Polyphemus	<i>Antheraea polyphemus</i> (Cramer)
Four-lined Chocolate	<i>Argyrostroma quadrifilaris</i>
Giant Leopard Moth	<i>Ecparytheria scribonia</i>
Spotted Straw Moth	<i>Heliothus turbatus</i>
Roadside Skipper	<i>Amblyscirtes vialis</i> (W.H. Edwards)
Juvenal's Dusky Wing	<i>Erynnis juvenalis juvenalis</i> (Fabricius)
Basswood Leaf Roller Moth	<i>Pantographa limata</i>
Yellow-fringed Dolichomia	<i>Dolichomia olinalis</i>
Glossy Black Idia Moth	<i>Idia lubricalis</i>



CIP Lori Varkonyi (top) captures a butterfly on a Hibiscus plant. She and several Master Naturalist candidates sampled butterflies and moths on the refuge during the summer of 2008.

Visitor Use. Tim summarized data from traffic counters placed on the refuge. His February 2008 report can be found as Appendix C, "Big Muddy National Fish & Wildlife Refuge Two-Year Traffic Counter Report." Recommendations to improve collection and interpretation of data are included in the report. From the summary section:

"The average counts of 1,200 visitors a month at Overton supported the refuge belief that this was our highest visited unit. Also the 600-800 visitors a month put the Jameson Unit at half the visitors of Overton. Looking at vehicles, Overton is receiving an average of 20 vehicles per day and Jameson 12 vehicles per day.

The traffic counters at Boone's Crossing and Lisbon reflected visitors going specifically to the refuge parking areas. The lower numbers of 95 visitors a month at Lisbon and 186 visitors at Boone's Crossing indicated that the parking areas are visited much less frequently but are still receiving an average of 1 to 2 vehicles per day."

Fisheries Sampling. During October 2007, CNFWCO sampled the three scours at Overton Bottoms North Unit. Crew Leader Cliff Wilson provided the following information: The crew collected fish to determine species richness, diversity, abundance, and condition using night electrofishing, large trap nets, and mini-fyke nets. They caught 1,691 fish from 32 species. Bluegill and gizzard shad comprised the majority of the fish sampled. Continued sampling in future years will allow them to observe the effects of the recent bass stockings (1,200 largemouth bass averaging five inches in length were stocked in two of the scours in September 2007) and reconnections to the river.

1b. Studies and Investigations (Field Work, Data Analysis, Publications)

Permanent Vegetation Monitoring Plots. Matthew Struckhoff, Plant Ecologist with US Geological Survey (USGS), provided a copy of *Administrative Report - Establishment and Sampling of Permanent Vegetation Monitoring Plots at Big Muddy National Fish and Wildlife Refuge in December 2007*. From the report's (Appendix D) abstract:

"Vegetation sampling points originally sampled in 2002 and 2003 were revisited in late summer 2007 to establish permanent plots and to collect baseline data for long-term ecological monitoring at Big Muddy National Fish and Wildlife Refuge. Plot design followed the Beyond NAWMA Circle plot design recommended by the National Institute of Invasive Species Science. Sixty-seven plots were installed at the approximate location of sample points within communities that had been designated as "wet prairie" for sampling during 2002 and 2003. The location of each sample point was recorded using handheld GPS receivers, and permanent markers were installed at the plot centers to allow future resampling. Sampling documented 166 species on the refuge. Approximately 130 voucher specimens were collected and dried to serve as documentation for many of the species encountered."

Due to flooding during the 2008 growing season, the researchers were unable to complete the field work required for the year. They requested and received a one year extension from the funding source.



USGS Plant Ecologists Matt Struckhoff (left) and Keith Grabner (right) at permanent vegetation plots.

Fisheries Use of Side-Channel Chutes. In March 2008, Columbia National Fish and Wildlife Conservation Office (CNFWCO) staff provided us a copy of the 2007 Annual Report, *Evaluation of Fish Use of the Side-Channel Chutes at Lisbon Bottom, Overton Bottoms North, Tadpole Island, and Tate Island* and the Executive Summary can be found as Appendix E. In brief, the complexity of habitats present, as well as the overall geomorphology, contributes to how different life stages of river fish species use these chutes. In the study area, Lisbon and Tate are considered conditioned chutes because they are naturally formed or have been subject to natural processes for many years and have features such as scour pools, backwaters, and tie channels that are formed by years of flood pulses, erosion, and deposition. Overton and Tadpole chutes are unconditioned because they were recently constructed. Overton, despite being over five years old, has not yet experienced a flood event capable of altering its geomorphology resulting in relatively homogeneous habitat.

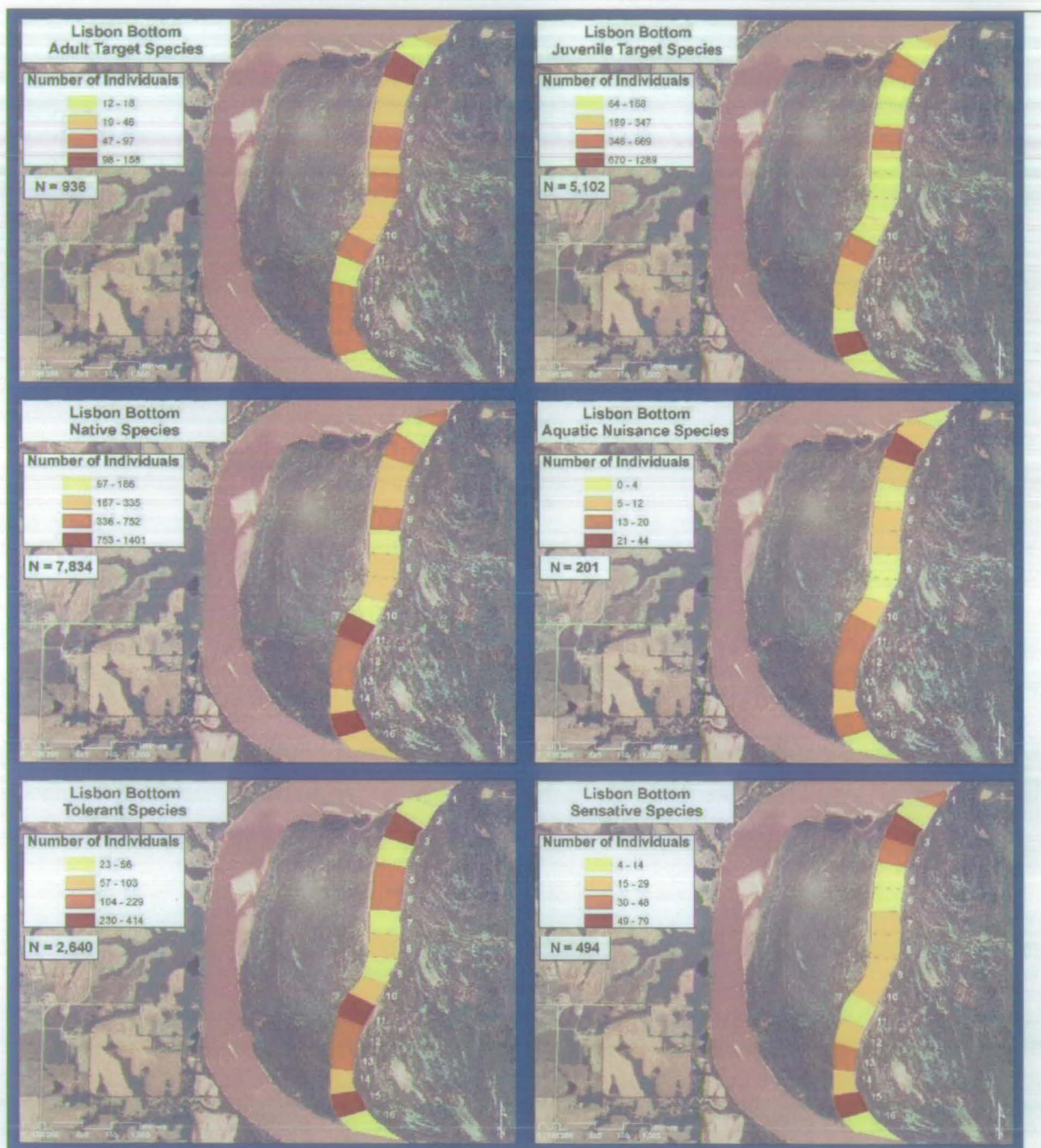


Figure 61. GIS overlays showing abundances of fish based on functional groups. Abundance data is calculated relative to cells within Lisbon chute. Functional groups are displayed in Tables 26 – 35.

Figure from CNFWCO annual report on fish use of side-channel chutes, March 2008.

River Corridor Habitat Dynamics Project Research in the Big Muddy National Fish and Wildlife Refuge – 2008. Robert Jacobson, Research Hydrologist, US Geological Survey, CERC, provided the following summary:

“The US Geological Survey River Corridor Habitat Dynamics Project (RCHDP) addresses spatial and temporal variability of aquatic and flood-plain habitats, with

emphasis on the Lower Missouri River. Units within the Big Muddy National Fish and Wildlife Refuge have provided opportunities for applied habitat dynamics research since inception of the Refuge in 1994. During 2008, RCHDP activities were mainly related to monitoring and assessing side-channel chute habitat dynamics at Lisbon Bottom and Overton Bottoms North units. Channel changes were updated using recent aerial photography and ground surveys, allowing for calculation of sediment delivery through channel migration. Boat hydroacoustic surveys in March and August were used to update stage-discharge relations and to calculate percentage of the main-channel flow that was being accommodated in the chutes.

“Although funding has not been identified for continuation of chute monitoring, aquatic habitat data are being analyzed and will be published in collaboration with US Fish and Wildlife Service fisheries studies during 2009. Also, through September 2008, an automated camera was operated to monitor large-woody debris loading in the Overton North Chute, and to monitor geomorphic and vegetation changes in a sandbar complex adjacent to the Overton Bottoms North Unit. In addition, RCHDP scientists participated in several meetings and field visits with Refuge personnel to discuss ongoing geomorphic changes at Overton Bottoms North and Jameson Island units.”



Questionmark butterfly on blackberry leaf, October 2007.

2. HABITAT RESTORATION

2a. Wetland Restoration

Above average rains fell during June, July, and September 2008. The Missouri River rose above flood levels and reconnected portions of the floodplain to the river. Flood waters inundated some portions of refuge units for several weeks and created many ephemeral wetland areas.

During November 2007 Wedge, Zach, and Adam planted blue flag iris seeds at Baltimore Bottom, Cranberry Bend, Jameson Island, and Overton Bottoms North units.



The green spouts of blue flag iris appeared at Jameson Island, September 2008.

The farmers at Cranberry Bend and Baltimore Bottom units completed the seeding of native grasses and forbs as a part of our agreement; see aerial photographs and maps below.

Baltimore Bottom Unit

The construction of a large chute designed by US Army Corps of Engineers (COE) staff for shallow water development at Baltimore Bend Unit remains on hold pending an Independent Science Review of sediment placement related to chute construction methods.

Contractors with Mid-River Restoration Company planted 6 acres of prairie cordgrass plugs on November 10, 2007, at a retired cropfield at Baltimore Bottom Unit. The plants thrived during the summer 2008 flood events.



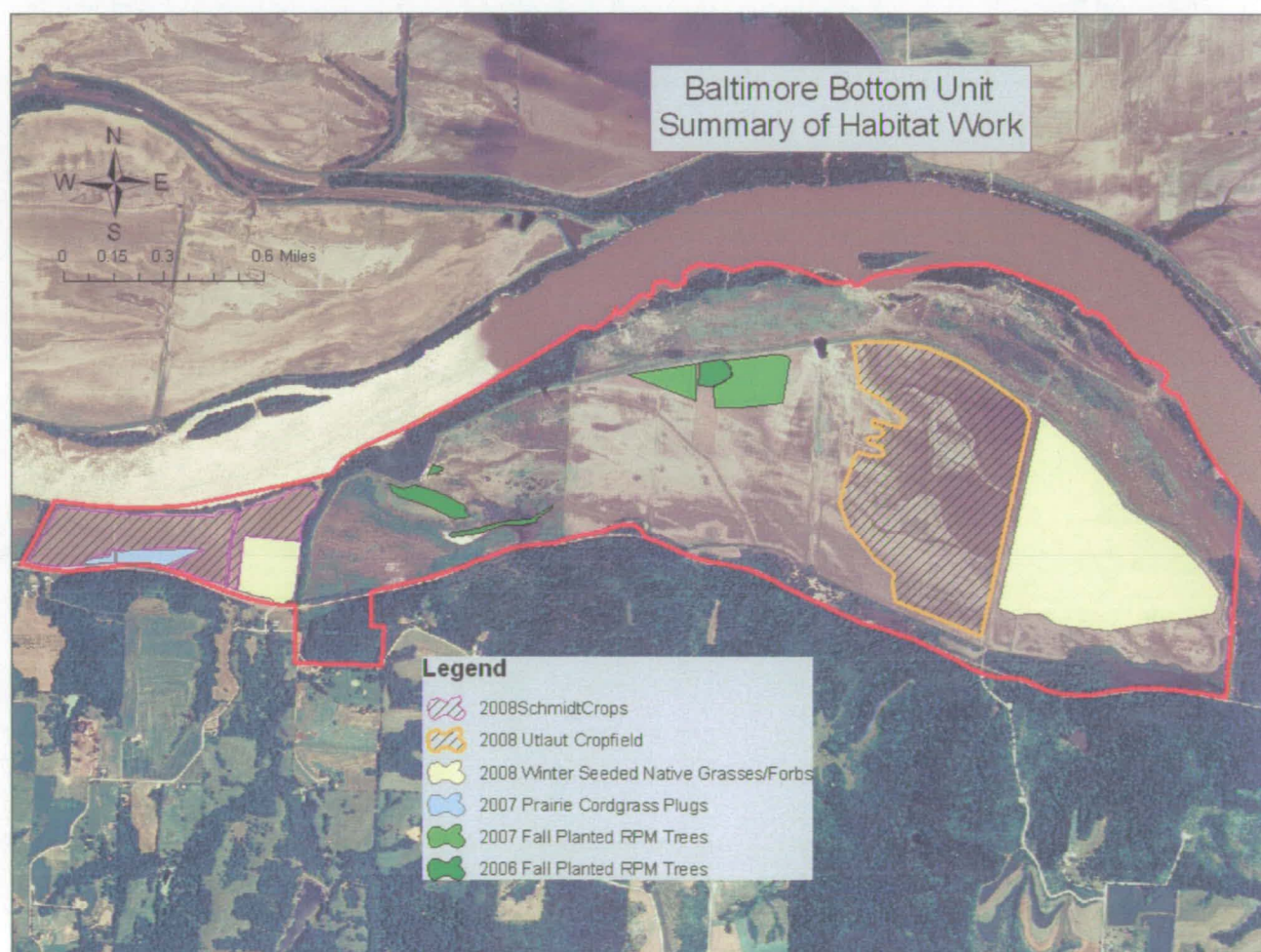
Prairie cordgrass plugs planted in November 2007 on Peters Tract, Baltimore Bottom Unit, July 2008.

Chance Bitner, COE Hydrology Engineer, provided photographs taken February 1, 2008, and a report of the shallow water habitat project on which work stopped about May 2007 at Baltimore Bottom Unit (see Appendix F). The project includes a completed 1720-ft long revetment chute near RM 300.6 and a 50% completed bank notch at RM 300.4.

In September Tim and Barbara met with Steve Dowler, WalMart Market 3 Volunteer Coordinator, at Baltimore Bottom Unit to begin plans for a prairie cordgrass and bottomland hardwood trees planting event in October 2008.

As part of their agreement, the cooperative farmers on the east end of Baltimore Bottom Unit planted 25 acres of root production method (RPM) bottomland hardwood trees during November 2007. In early February 2008 they broadcast a mix of native grasses and forbs on about 175 acres. More RPM trees will be planted during November 2008. This is the last year for cropping on this part of the refuge.

The cooperative farmers on the west end of Baltimore Bottom Unit planted about 20 acres with a mix of native grasses and forbs. The following figure shows the locations of habitat work done during the past few years.



Summary of habitat work completed at Baltimore Bottom Unit.

Cranberry Bend Unit

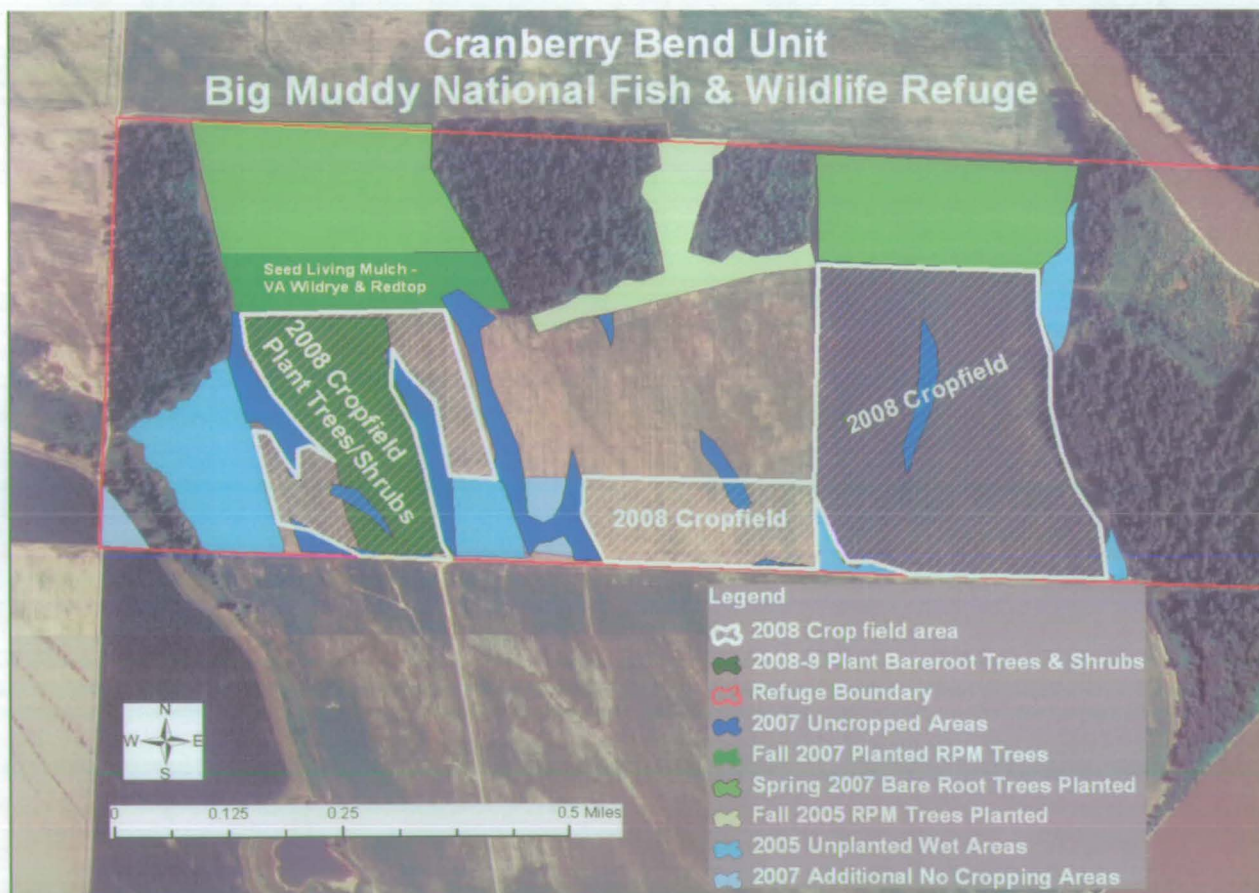
In January 2008 Randy mowed about 5 acres of overstory weed jungle at a bareroot tree and shrub planting at Cranberry Bend Unit. The early successional plant response following the levee break and floods of 2007, two months after the trees and shrubs were planted, was impressive. The mowing provided an opportunity for the seedlings to resprout and get some sunlight to compete with the weeds during the 2008 growing season.



Gray-headed coneflower and Virginia wildrye at Cranberry Bend Unit, July 2008.

The levee association at Cranberry Bend Unit got a small amount of soil to raise the agricultural levee on the east side of the unit and reseeded the levee top.

A contractor hired by the cooperative farmer at Cranberry Bend Unit planted RPM bottomland hardwood trees on 12 acres of retired cropfield in November 2007. The farmer overseeded the area with a cover crop of Virginia wildrye and redtop the following April. After harvest of soybeans in the fall of 2008, the farmer will seed a cover crop at the area that will be planted with bareroot trees and shrubs in spring 2009 as shown on the following figure.



Summary of habitat work completed and planned at Cranberry Bend Unit.

Jackass Bend Unit.

Tri-County Levee District requested soil from the refuge to repair a levee break on the neighbor's land to the west of Jackass Bend Unit that occurred during floods in May-June 2007. We issued a special use permit to the District to obtain soil from the refuge to repair the levee and to create a wetland on the refuge. The Tri-County Levee District Engineer worked with the refuge to design the desired shallow area.



Borrow pit area at Jackass Bend Unit.

Soil removed from the refuge was used to repair the Tri-County Levee to the west, November 2007.

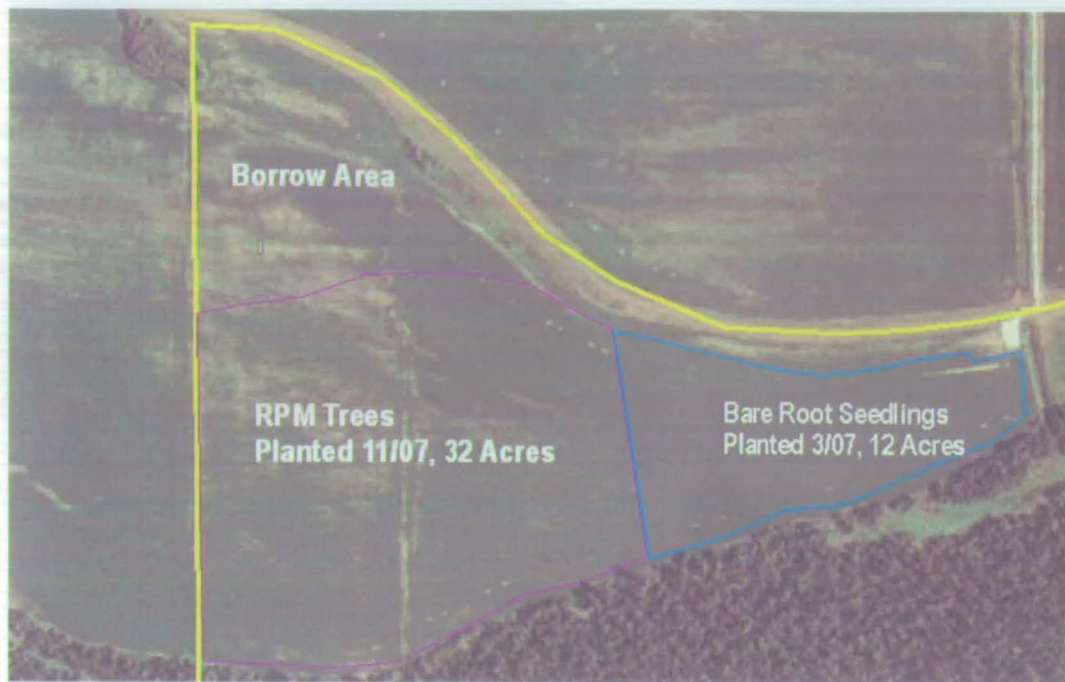


Jackass Bend Unit, wetland developing at borrow area, July 2008.

We had a contractor plant 32 acres of RPM bottomland hardwood trees south of the new wetland. The contractors returned in April to place mats on most of the trees. Barbara and Wedge worked with Girl and Boy Scouts from Orrick MO to finish the job reserved for the scouts.



Wedge (left) talks to scouts from Orrick MO before they pin weed barrier mats at Jackass Bend Unit, April 2008.



Locations of borrow area (developing wetland) and RPM trees planted November 2007 and bare root seedling planted March 2007.

Jameson Island Unit.

The construction of a chute at Jameson Island Unit started in 2006 and became controversial. Neighbors in Howard County objected to the alignment of the chute outlet structure and the Missouri Clean Water Commission voiced objections to the introduction of sediment and nutrients in the river. During fall 2007 issues elevated to include FWS Deputy Regional Director Charlie Wooley, COE Colonel Roger Wilson, Environmental Protection Agency Regional Director John Askew, and the Missouri Governor's Office. COE initiated a National Academy of Sciences National Research Council review of sediment in the Missouri River. In November 2007, COE terminated the contract for construction of the Jameson Island Chute "for the convenience of the government." The contractor removed all equipment by the end of December 2007.



Dredge brought in by contractor that they never used, October 2007.

Discussions and meetings about side-casting and how and if to modify the design of the project continued throughout fiscal year 2008. Tom attended a National Academy of Sciences committee meeting held in Clayton MO on October 2, 2008. The committee received comments on issues regarding sediment in the Missouri River. No decision about the chute is expected until the study of sediment management in the Lower Missouri River is released in about 1 year.



Condition of the access road to Jameson Island Chute in October, 2007 (left), and July 2008 (right).
The road became a stream channel during the flooding in July.

cedar tree



cedar tree



Looking upstream at the Jameson Island Chute (left October 2007). The photo on the right (July 2008) of the same area shows large woody debris brought in by floodwaters. Note also the evolution of chute habitat.

Tom met with Deputy Regional Director Charlie Wooley in January 2008 to brief him prior to a VIP meeting held about the Missouri River in Jefferson City. Tom also met with COE and Columbia Ecological Services Field Office staff in April 2008 to discuss possible alternatives at Jameson Island, but no decisions were reached.

The *April 2008 Columbia NFWCO Update* included the following: “*Controversial habitat restoration site produces record number of endangered pallid sturgeon.* While scouring the Big Muddy for potential brood fish, a record number of the endangered pallid sturgeon were captured in one day at Jameson Island in an area smaller than a football field...Over the years of our sampling, the Lisbon-Jameson units of the Big Muddy NFWR has produced the first evidence of wild spawning [in over 60 years] and the most pallid captures of any area on the Lower Missouri River.”



Oblique aerial photograph of Lisbon Bottom (top) and Jameson Island units, taken by COE staff in late July 2008.

In August, Wedge and Robb Jacobson, USGS Hydrologist, toured the Jameson Island Chute to look at the effects of summer 2008 flooding.



Robb Jacobson studies the evolving Jameson Island chute, July 2008.

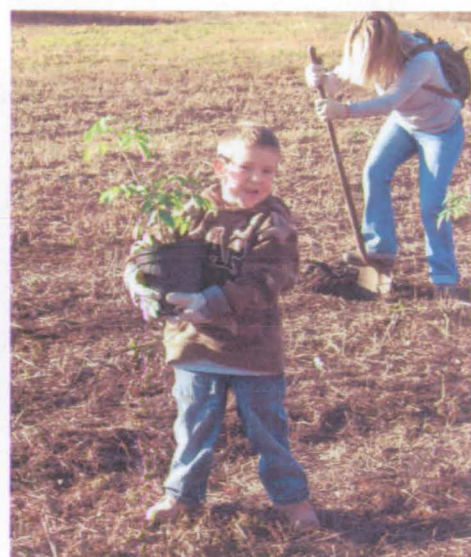
Robb wrote the following in an e-mail to COE, and copied to Tom on 10/03/2008: "I think Jameson Island deserves special attention. The design was unique; Chance Bitner used historical side channels as the template, and he placed the chute in sandier sediments in order to accelerate the rate of widening. Since work stopped, substantial headcutting (100 meters or more) appears to have occurred during large floods. Although the channel has not connected from the headcut to the upstream entrance, there are several areas of scour that may coalesce to accomplish connection at some time in the future."



Flood waters eroded the sides of the Jameson Island Chute, July 2008. The flooding greatly increased the diversity of channel habitats at the chute construction.

Overton Bottoms North.

Missouri River Relief and Friends of Big Muddy coordinated an event to plant 150 RPM bottomland hardwood trees and 100 native shrubs at the Alexander tract November 2007. Living Lands and Waters and Forrest Keeling Nursery donated the hardwood trees. The native bottomland shrubs were purchased at more than 50 percent discount from Missouri Wildflower Nursery. Barbara selected the site and species and Randy mowed the area. About 35 volunteers from Kansas City, Orrick, Columbia, Rocheport, Lupus and Boonville worked with Barbara and Mike to plant the trees. A reporter and photographer from the Columbia Daily Tribune came to the event and an article about the planting appeared on the front page of the following Sunday's paper.



Volunteers, including Mike Blessington's family (right), help plant native trees and shrubs at Overton Bottoms North Unit, November 2007.

The following excerpt from one of our partners, the Missouri River Relief, at their blog on the internet (<http://www.riverrelief.org>), highlights the issues and discussion we've had with interested persons about planting bottomland hardwood tree species on the refuge:

Overton Bottoms Tree Planting

November 3, 2007

Big Muddy National Fish and Wildlife Refuge

text by Steve Schnarr, photo by Melanie Cheney,

both with Missouri River Relief

These tree plantings are often called restorations, but that is probably the wrong word for what's happening. If you want trees to grow in most places of these bottoms, you just stop mowing. You'll get trees – you don't have to plant them. These hardwood plantings are actually a real artificial attempt to bring something back to the area that nature rarely, but importantly, provided before historic times.

The situation on the ground now is that a majority of land on the refuge is undergoing a rapid natural succession cycle. There are patches of older forest, but most of the visible bottomland is cottonwood, willow, silver maple and sycamore grown up since the 95 flood. It's a race for sunlight, and these fast growing trees are tall and slender. Only the oldest trees have branches that stretch out into the forest.

Those trees that get crowded out die and fall to the ground. The forest floor is criss-crossed with logs, branches and fallen vines – slow-release fertilizer for the future. In this scramble for the sky, slower growing trees like oaks don't have a chance. When the river ran free across the bottoms, accumulating patches of disturbance, varied soils and topography, trees like oaks and hickories found places where they could get a foothold. In this new situation, where suddenly thousands of acres of land are being taken out of cultivation and allowed to grow up in trees, where are these footholds?



So humans make decisions, based on a lot of ecologically irrelevant reasons (like property boundaries, previous land uses and available funds), to artificially bring a little diversity to the equation. History and old survey lines show that there were rare pockets of oaks throughout the Missouri River bottomlands, attracting their own mix of wildlife. Most of these were logged for firewood, to fuel steamboats and as railroad ties. Occasional pockets of pecans were found in the Missouri River bottoms. Some speculate that these were all planted by Native Americans who saw how useful and flood tolerant they were.

So, once again, nature and human intention are mixing. It's yet another time of rapid change in the Missouri River bottoms, and once again, people and the many forces of nature are in a push-pull effort. We just hope that this time, our efforts will help and not harm."

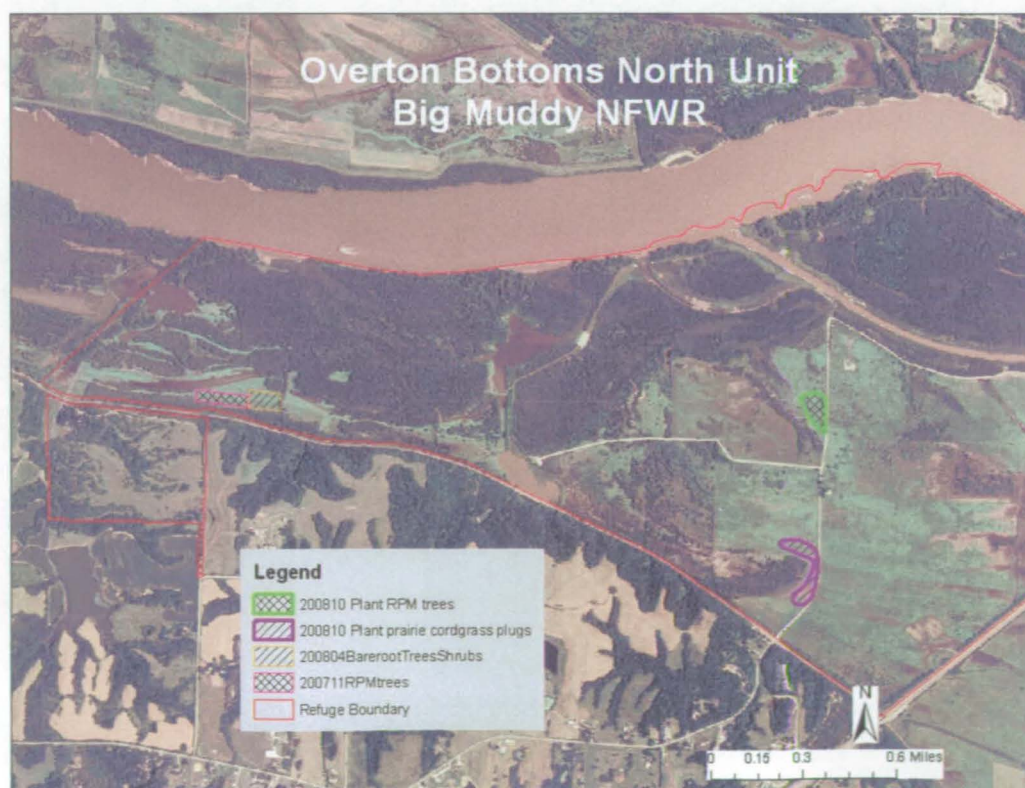
After we completed the planting, the group hiked the levee out to the Missouri River and on the return pulled out large amounts of blue plastic found on the refuge.



Volunteers work to remove piles of blue plastic from the refuge after planting trees, November 2007.

On a Saturday in April 2008 Barbara and 22 volunteers from Missouri River Relief and Friends of Big Muddy planted bare root native shrubs and trees on the Alexander tract of Overton Bottoms North Unit. They also placed mats on the RPM trees planted at the site last November.

In July we began discussions with Living Lands & Waters (LL&W) and the 3M Company in Columbia regarding a volunteer project planned for October 2008 to plant prairie cordgrass plugs and RPM trees. LL&W organized purchase of plants, equipment, and 3M is encouraging employees and their families to come plant. Barbara prepared planting site maps and arranged for a contractor to mow and later spray herbicide on Johnson grass regrowth at the planting sites for the 800 prairie cordgrass plugs and 200 RPM trees. The 3M Company hopes to have over 100 volunteers participate. [Note: Tim and Wedge planted trees with about 75 volunteers from 3M and LLW on October 18, 2008.]



Habitat work at Overton Bottoms North Unit, including planting completed in October 2008 (technically FY09).

2b. Upland Restoration No activity.

2c. Deepwater/Riverine Restoration

On February 1, 2008, Dereck Wansing, Kansas City COE, took photos of the shallow water habitat constructed at the Baltimore Bottom Unit during fiscal year 2007 to document status of the project since work stopped in late April 2007. The project consists of a completed 1720-ft long revetment chute near river mile (RM) 300.6 and a 50% completed bank notch at RM 300.4. The Waverly, Missouri gage height was approximately 10.7-feet on February 1st. Flow is expected to enter the revetment chute at a Waverly gage reading of approximately 6.1 feet. Chance Bittner, Kansas City COE, provided the complete report that can be found as Appendix F.

The Overton Bottoms North Chute continued to widen (2-6 meters) and the banks continued to slough as a result of the summer high water events. Hydrologist Robb Jacobson still considers the chute poorly conditioned, in early evolution, and contributing substantial amounts of sediment (e-mail communication 10/3/2008).



The Overton Bottoms North chute has widened and deepened, but shows little variety of habitat, even after several high water events in 2007 and 2008.

3. HABITAT MANAGEMENT

3a. Water Level Management - none

3b. Moist Soil Management - none

3c. Graze/mow/hay

Under special use permit, a neighbor cut about 25 acres of orchard grass/smooth brome on July 21, 2008, and baled it for hay at the Loesing tract. The site yielded 91 large round bales this year. Molly sent the \$182 check for our 1/3 share to the Refuge Revenue Sharing Fund.

3d. Farming

In November 2007 our coop farmers harvested a bumper crop of soybeans. Molly sent 10% (\$31,568) to the Refuge Revenue Sharing Fund. Our remaining share, \$73,570 (23%), was available for habitat work on retired cropfields. As described in Section 2.a., Wetland Restoration, we continue to restore cropland to native vegetation as funding from crop receipts allows.

Barbara received the farmers' 2007 herbicide use reports and provided that information, through the electronic Pesticide Use Proposal system, to the regional office in January 2008. She drafted the cooperative agreements and habitat restoration plans for a portion of each of the crop fields on the refuge. At two units farmers lost corn crops planted in May 2008 during the June floods. The units upstream of Jefferson City had two times the average rainfall during June and July. All coop farmers planted soybeans in July when ground conditions finally became suitable. As a result, harvest came in mid-November, later than usual. The following table summarizes the cooperative farming on the refuge during 2008.

Areas Planted under Cooperative Farming Permits During FY2008

Refuge Unit	Acres Planted
Baltimore Bottom East	210*
Baltimore Bottom West	70
Cranberry Bend East	115

TOTAL: 395 Acres

*About 180 of the planned 390 acres of cropfield never dried enough to plant.

Barbara discovered that the farmer at Baltimore Bottom West planted soybeans in an area seeded to native grass and forb species last winter. Because of the flooding the farmer assumed that the native seed washed away, and he used up the beans in the hopper and planted soybeans on part of the native area. Upon inspection, very few natives had sprouted except for scattered partridge pea. Barbara explained that the area was still not available for crops. The farmer did not spray the area to control weeds or harvest soybeans at this large, donated food plot.



Area planted to native species (left) and soybeans added (right).

3e. Forest Management

In July, flooding current and saturated soils caused some RPM trees planted in November 2007 to lean heavily, and the root wads of some plants even heaved out of the soil. As soon as we had access, Chad and Dale replanted and straightened trees at Jackass Bend Unit and Barbara replanted and straightened those at Alexander tract, Overton Bottoms North Unit.

Barbara checked the survival of some of the bare root trees and shrubs at Overton Bottoms North and Cranberry Bend units. The floods took their toll on seedlings planted in April 2008, with few surviving. Plants at Cranberry Bend (planted spring 2007) fared better.

Baltimore Bottom Unit. In November 2007, a contractor for the cooperative farmers planted 25 acres of RPM bottomland hardwood trees adjacent to RPM trees planted in November 2006. He returned in April 2008 to place the weed barrier mats around each seedling.

Cranberry Bend Unit. In November 2007 a contractor for the cooperative farmer planted RPM bottomland hardwood trees and attached the weed barrier mats at each seedling on 12 acres of retired cropfield. Volunteers Troy and Janine Gordon straightened the mats during February 2008.

Jackass Bend Unit. We hired a contractor to plant 32 acres of RPM trees in November 2007. He later placed the weed mats on 29 acres and Girl and Boy Scouts from Orrick MO placed mats around each seedling on the remaining 3 acres in April and May 2008.



A contractor planted a mix of bottomland hardwood species of root production method (RPM) trees at Jackass Bend Unit, November 2007.

Overton Bottoms North Unit.

Volunteers from Missouri River Relief and Friends of Big Muddy planted 3 acres of RPM trees on the Alexander tract in November 2007. They returned in April 2008 to place the weed barrier mats around the trees and to plant 4 additional acres with bareroot trees and shrubs. Randy, at Janine Gordon's request, planted about 100 bareroot tree seedlings left by her recently deceased husband, Troy, at the Overton Bottoms Unit.



Kids help at Overton Bottoms planting, November 2007.

3f. Fire Management

Tim updated eight cooperative fire agreements with the rural fire departments that protect refuge units; the regional office reviewed and executed them. Tim helped four of the departments (Cooper County, Arrow Rock, Waverly, and Howard County) submit requests for assistance grants. Molly processed grant payments to Arrow Rock and Howard County rural fire departments.

Tim distributed information to the fire departments about the University of Missouri Fire Training Institute and Midwest Wildfire Academy course offerings so fire fighters would be aware of training opportunities.

Emily and Tim took the Wildland Fire Refresher course and passed the Pack Test. Tim went on a two-week wildfire assignment as Helicopter Manager on the Soda Creek Complex Fire on the Mendicino National Forest in northern California.

3g. Pest Plant Control

Wedge discovered two populations of Japanese hops at Overton Bottoms North Unit. In April, Dale sprayed Japanese hops at Overton Bottoms North, Baltimore Bottom, and Jameson Island units. He also sprayed garlic mustard at Overton Bottoms North Unit.



Japanese honeysuckle found near Edwards Branch, Baltimore Bottom Unit, March 2009.

In March, Randy mowed patches of Johnson grass at the Alexander tract of Overton Bottoms North Unit and spot sprayed the sites during the summer.

During April, Wedge and Volunteer Troy Gordon pulled garlic mustard plants at Overton Bottoms North. Wedge returned with Dale and pulled more garlic mustard, resulting in about 14 garbage bags full of plants removed from the refuge.

Barbara prepared a list of priorities for invasive weed spraying. After Chad had completed his pesticide training in June, he and Dale continued the battle against Japanese hops and Johnson grass on the levees and upland sites and in the bottoms as they became accessible in July when flood waters receded. Even the invasive species were set back by the flooding.

In August, Barbara met with the Missouri Department of Agriculture inspector to report on our applicator licenses and use of pesticides (all glyphosate).

Barbara arranged for a contractor to spot spray Johnson grass scattered on 25 acres of hay field at the Loesing tract, Overton Bottoms North Unit.

Chad and Dale spot treated invasive plants on about 175 acres during the year.



The boundary surveyor sent these photographs of kudzu he took at St. Aubert Island Unit in August 2008.

4. FISH AND WILDLIFE MANAGEMENT

4a. **Bird Banding** No activity.

4b. **Disease Monitoring and Treatment** No activity.

4c. **Reintroductions.** No activity.

4d. **Nest Structures** No activity.

4e. **Pest, Predator, and Exotic Animal Control** No activity.



Jewel weed found at Baltimore Bottom Unit, September 2008.

5. COORDINATION ACTIVITIES

5a. Interagency Coordination

We work with many other agencies to accomplish refuge goals. The following listing illustrates some of our coordination activities:

US Army Corps of Engineers (COE). We worked closely with COE to plan habitat improvement on refuge units. We kept a close eye on the chute at Jameson Island Unit and provided comments on the design of the Baltimore Bottom chute project.

We annually discuss Overton Bottoms North Unit projects with COE. COE purchased 1,300 acres of this unit as a mitigation site. We manage that acreage as an “overlay” unit of the refuge. Barbara prepared the Annual Management Plan and COE provided funding for operations and management through a reimbursable agreement.

Tom represented Big Muddy NFWR at the kickoff meeting to discuss herp monitoring in the Lower Missouri River floodplain at mitigation sites. Partners included COE, USGS, Nebraska Fish, Game & Parks, Iowa Dept. of Natural Resources, Benedictine College, and MDC. Wedge proposed monitoring sites on the refuge and joined the partners in April to talk more about herp monitoring on mitigation sites.

Tom toured sites in the Missouri River floodplain the COE had either acquired or would likely acquire soon. Some details need to be addressed before the refuge will request management authority for the sites as part of the Big Muddy NFWR.

In July 2008 Tom had several telephone conversations and conference calls with various COE officials from the Kansas City District regarding land acquisition projects and land management issues. The COE agreed to meet with refuge staff and Columbia Ecological Services Field Office (CESFO) Supervisor Charlie Scott to discuss how the COE Missouri River Recovery Program can be better meshed with the refuge to meet the goals and objectives of both agencies. Tom, Barbara, Charlie, and CESFO Biologist Jane Ledwin met with COE Kansas City District personnel on two days in August to discuss Overton Bottoms South Unit and other Bank Stabilization & Navigation Project (BSNP) Mitigation Program issues. We made progress on several fronts. Several COE employees assumed new roles this year and this contributed greatly to improved coordination and communication. One result is that the refuge will add several new units using BSNP Mitigation Program Realty funds. We discussed the addition of approximately 7,000 acres in six units to Big Muddy NFWR in the near future.

Tom and Charlie met again with COE personnel from St. Louis, Kansas City, and Omaha District Offices, and Missouri DNR in September to discuss management of Cora Island and the BSNP Mitigation Program. Discussion revolved around procedures spelled out in the Fish & Wildlife Coordination Act. COE plans to transfer management of Cora Island to FWS soon. [Note: Transfer still not completed.]

US Geological Survey (USGS), Columbia Environmental Research Center (CERC). The USGS Biological Resources Division (BRD)-CERC provides space for the refuge’s mobile office unit (trailer) and shop/boat barn as well as computer and maintenance support.

Wedge coordinated with USGS plant ecologists on the year-end report for the permanent vegetation plots established on the refuge in 2007. He also worked with Matt Struckhoff, USGS, to develop a Science Support proposal for vegetation response modeling.

University of Missouri (MU). Several students from MU have conducted research projects on the refuge. Tom met with staff from MU, USGS, MDC, NPS, and FWS to discuss implementation of a new Cooperative Education Studies Unit (CESU).



Giant swallowtail on wild bergamot, St. Aubert Unit, July 2008.

Wedge and Missouri Master Naturalists candidates visited the MU Entomological Museum to use the collection's specimens to identify butterflies and moths captured on the refuge.

Tim worked with a faculty member and 4 students from MU Department of Civil and Environmental Engineering on an erosion control design to minimize further damage at the bridge and trail at Jameson Island Unit.

Missouri Department of Conservation (MDC). MDC manages Taylor's Landing, a boat launch facility located on a 9-acre in-holding owned by MDC at the Overton Bottoms North Unit. MDC maintains the road and the signs directing the public to the landing.

Tim obtained approval from MDC to install a kiosk at their Mokane River Access.

Six MDC Visitor Centers exhibited the Missouri Junior Duck Stamp winning artwork during the year, thanks to coordination by Tim.

In May Wedge attended a spring Wetland Review hosted by MDC at the Fountain Grove Conservation Area. NRCS participated, as well as several MDC staff.

In June Wedge, Dale, Chad, and Lori met with two biologists from MDC to learn amphibian sampling techniques.



STEPS Dale Waites and Chad Collard and Refuge Biologist Wedge Watkins learn amphibian sampling technique from MDC biologists Shawna Marquardt and Doreen Mengel at the pond by Bryant Cabin. CIP Lori Varkonyi, behind the camera, also participated. June 2008.

Missouri Department of Natural Resources (MO DNR). We continue to work with Arrow Rock State Historic Site Administrator Michael Dickey to increase public awareness of the refuge, our programs, and river resources. One can view the Jameson Island Unit of the refuge from the state park overlooks. Many park visitors use the refuge's Lewis & Clark Trail of Discovery and the Arrow Rock Historic Landing Trail to access the Missouri River.

In September 2008 Wedge met with Michael to discuss invasive tree of heaven on the state park near the refuge boundary, and possible ways to work together to control it.

Counties. The Refuge coordinates with governments in eight Missouri counties: Jackson, Ray, Lafayette, Saline, Howard, Cooper, Osage, and St. Louis.

Cities. The City of Arrow Rock collaborated with the refuge on several projects. Tim requested approval from City of Chesterfield to add refuge information to a city directional sign near Boone's Crossing Unit.

Levee Districts. Several levee districts have interests near and within the Refuge. We developed a wetland at Jackass Bend Unit in cooperation with the Tri-County Levee District.

International Cooperation. Wedge and Lori met with Jinwon Seo, Senior Research Scientist for KWATER (Korea Water Resources Corporation) and a representative from Korea Institute of Water and Environment. They spent the day touring the refuge and discussing restoration techniques and strategies that may apply to a watershed in Korea.

The following section includes projects we worked with that involve multiple agencies:

Agency Coordination Team. Tom attended the bimonthly Agency Coordination Team (ACT) meetings held during the year. Representatives from COE (Omaha and Kansas City Districts); Nebraska, Kansas, Iowa, and Missouri state agencies; FWS; Environmental Protection Agency; USGS; and several industry and agricultural stakeholders attend the meetings to hear updates and discuss issues pertinent to the various Missouri River recovery programs.

Big Muddy NFWR Biological Review. In November Wedge contacted biologists from Natural Resources Conservation Service (NRCS), Missouri Department of Conservation (MDC), USGS (US Geological Survey), and FWS (Ecological Services, Fisheries, Refuges) to serve on the Comprehensive Conservation Plan (CCP) Biological Review Team. We held the review in February. See Section 8.a. for more details.

Lower Missouri River Corridor Modeling Group. Wedge had several conference calls with the Lower Missouri River Corridor Modeling Group concerning hydraulic modeling of the Missouri River from Boonville to Jefferson City. Partners include The Nature Conservancy, COE, USGS, MU, and MDC. Wedge and Robb Jacobson (USGS) hosted the group at CERC for a meeting on July 1 and a tour on July 2 at Overton Bottoms North Unit.

Missouri River Environmental Recovery Plan (MRERP) Team. MRERP is responsible for designing and writing the long term Missouri River Recovery Plan and the environmental impact document for the COE. Tom provided the MRERP team a presentation and a tour of the Overton Bottoms North Unit in March 2008. Refuge staff joined MRERP leaders and staff from CNWFCO and USGS for a 2-hour brown bag seminar with the team leaders.

Missouri Bird Conservation Initiative. Wedge represented the refuge at the annual MOBCI meeting in August 2008.

Missouri River Natural Resources Committee. Tom attended the Missouri River Natural Resources Committee meeting in Nebraska City NE in February. He presented a power point program (developed with assistance from Tim) entitled *Big Muddy NFWR – A Work in Progress*. Tom also served on a panel to discuss the challenges of *Dynamic Floodplain Management in a Non-dynamic System*.

Tom attended the group's fall meeting at Desoto NWR in September. FWS Regions 3 and 6 representatives included personnel from Refuges, Fisheries, and Ecological Services field and Regional Offices. Other attendees included COE, EPA, USGS, NPS, The Nature Conservancy (TNC), Missouri River Association of States and Tribes (MORAST) and state agency representatives from Montana, North Dakota, South Dakota, Nebraska, Kansas, Iowa and Missouri. All attendees (except MO DNR) gave updates on habitat and realty projects. The new Mississippi Interstate Cooperative Resources Agreement (MICRA) coordinator, Greg Conover, also attended and had the opportunity to meet this dynamic group.

Missouri River Realty Partners. Staff from COE, NRCS, MDC, MO DNR, and Tom met periodically throughout the year to coordinate land acquisition and management strategies along the Missouri River.

Partners in Amphibian and Reptile Conservation (PARC). In September 2008 Wedge attended the Midwest Working Group of Partners in Amphibian and Reptile Conservation (PARC), in Blue Grass IA. PARC members from South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Ohio, Indiana, and Michigan attended the meeting. Representatives of state agencies, universities, and non-profit organizations, as well as federal agencies, private business, and members of the public were all represented at the meeting. Wedge participated in the field bio-blitz for herptiles on the Port Louisa NWR, TNC, Iowa DNR, and NRCS Wetland Reserve Program properties during cool temperatures and steady rain. He also listened to research papers and viewed poster presentations. Within the next year

PARC will be producing a number of products including an update of the Midwest Habitat Management Guidelines and a guide for Inventory and Monitoring.

Teaming with Wildlife. Teaming with Wildlife is a national coalition of more than 5,500 conservation organizations and businesses working together to prevent wildlife from becoming endangered. The coalition supports dedicated funding for fish, forest, and wildlife conservation, education and outdoor recreation. Tom participated in a Teaming with Wildlife Symposium held in June 2008 at MU. The symposium featured presentations from a diverse group of federal, state, and local government employees as well as representatives of private conservation organizations involved in various cooperative conservation efforts. The Comprehensive Wildlife Strategies concept was the most prominent program discussed. The symposium provided an excellent opportunity to network with conservation partners from all over Missouri.

5b. Tribal Coordination No activity.

5c. Private Land Activities (excluding restoration)

Wedge and Mike visited the conservation easement in Franklin County during October. In December Wedge talked with Brent Vandelueck, MDC Private Lands Division, about developing a quail management plan for the Wilson FMHA Easement in Howard County.

In May, Wedge started work on a right-of-way for a pipeline proposed to cross the conservation easement in Montgomery County. In June, we sent a draft letter (through FWS channels) addressing the request from Keystone Pipeline Company to build a petroleum pipeline across the easement to Regional Director Thorson for consideration and signature. The letter responding to the request was developed by Wedge and Tom with input from Region 3 Realty Division and the Refuge Supervisor's office.

5d. Cooperative/Friends Organizations

Friends of Big Muddy and other volunteer individuals and groups helped us accomplish refuge goals during FY2008. Activities, listed by month, follow:

October 2007. Friends of Big Muddy and Girl Scouts from Chesterfield MO helped Mike and Volunteer Marissa Daniel (former STEP) post Johnson Island, Boone's Crossing Unit. Friends of Big Muddy and Friends of Arrow Rock guided 3 hikes on the Lewis & Clark Trail of Discovery, Jameson Island Unit, with 25 participants.

November 2007. Tom and Tim met with Troy Gordon, Chair of Friends of Big Muddy, to discuss the future of the Friends and his stepping down from leadership. Friends of Big Muddy staffed hunter information booths on opening day of firearms deer season at Baltimore Bottom and Overton Bottoms North units.

Tom met with Ducks Unlimited to begin planning for 2008 activities and to brief DU chapter and state officers on Big Muddy NFWR land acquisition efforts, CCP process, and other refuge activities.

December 2007. Tim and Emily met with Mike and Mary Duncan of the Lewis and Clark National Trail Foundation, Manitou Bluffs Chapter, regarding the Fish and Wildlife Foundation

Preserve America Grant. Mike and Mary's group received funds for interpretive signs for the Arrow Rock Landing Trail at Arrow Rock State Historic Site and Jameson Island Unit.

January 2008. Friends of Big Muddy and Missouri River Relief hosted a presentation by Duane Chapman, USGS Research Fisheries Biology, about Asian carp in the Missouri River. They met at the JC Bryant Cabin.



Troy Gordon (top right), Duane Chapman (lower left), and Tom Bell (lower right) spoke at the January Speaker's Forum held at the Bryant Cabin, January 2008.

Friends of Big Muddy held a Christmas Bird Count at Boone's Crossing Unit. Tim and Troy participated in the Regional Friends conference call. Wedge met with Troy to discuss the refuge bird list and to plan a presentation of the butterfly and moth survey data from Overton Bottoms North Unit.

February 2008. Tom and Tim attended the Friends of Big Muddy/Missouri River Relief meeting held at the Bryant Cabin. This month's program featured Jim Denny, a historian with MODNR. Denny spoke to the crowd of 32 about Lewis & Clark's trip on the Missouri River. The organizers also had on display woodcarvings by Fred Oerly who was born in the town of Overton where his parents ran the post office, the general store, a movie theater, and the rail ticket office.

Thirteen people from the Friends of Big Muddy and Missouri River Relief picked up 18 bags of trash and 113 tires at Lisbon Bottom Unit! Troy arranged for a tire recycling company to pick up the tires from the parking lot.

Tim began working with a representative of WalMart that wants a group from the area stores to pick up trash, tires, appliances, etc. at Baltimore Bottom Unit. About 80 volunteers are expected.

Joanne Grady, FWS Fisheries Biologist, referred a volunteer photographer to Tim, and Tim signed her up. Her first task was to take photos at the Junior Duck Stamp contest in April.

March 2008. The Friends/Missouri River Relief seminar series at the Bryant Cabin continued. Attendance remains high (30-35). Dr. Robb Jacobson presented this month's seminar and addressed Missouri River sediment issues. Tom, Tim, and Troy gave updates of refuge and Friends activities.

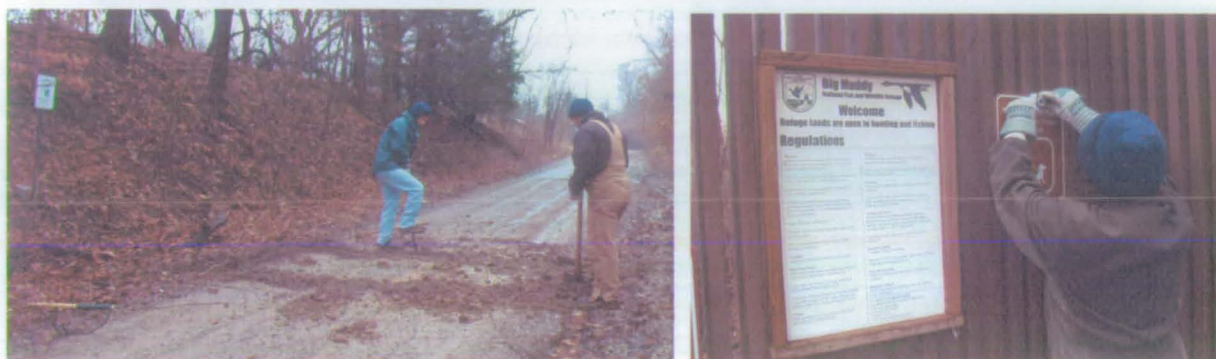


*Robb Jacobson (left,) USGS Research Hydrologist, spoke at the March 2008 Speaker's Forum.
Tom Bell (right photo in blue shirt) answered questions about the refuge.*

Troy and Tim participated in the regional Friends conference call on 3/31.

Tom met with Ducks Unlimited to discuss fund raising and conservation efforts in 2008.

The Friends held a clean up at Jameson Island and fixed traffic counters, repaired trails, and cleaned signs and benches.



Friends of Big Muddy worked on several projects at the Jameson Island Unit on a workday in March 2008.

Tim and Troy scouted at the Baltimore Bottom Unit for trash that can be gathered during an April clean up by WalMart associates.



Some of the debris the river brought to the refuge discovered in March 2008.

April 2008. Tim recruited four new volunteers (other than Friends) to help with the Junior Duck Stamp Contest, including two from Missouri Master Naturalists.

Troy and his family spent a day re-pinning mats on RPM trees at Cranberry Bend Unit. Friends of Arrow Rock and Troy led tours of the Lewis & Clark Trail of Discovery at Jameson Island. Inclement weather resulted in a low turnout, with only six people taking the hike at one of the three offered times.

About 75 Kansas City area WalMart associates volunteered at Baltimore Bottom Unit to pick up 8 tons of debris. Anything that could be recycled was put onto a WalMart trailer and hauled to a recycling center where they recycled about ½ ton of material. The idea to get involved came from Steve Dowler, a Market Technical Specialist for WalMart based in the Lee Summit store and his desire to fulfill a company-wide initiative to find ways to help the environment in local communities.



Volunteers from WalMart helped clean up trash and old appliances from Baltimore Bottom Unit, April 2008.

As mentioned in Section 2.a., Girl and Boy Scouts from Orrick MO volunteered to pin mats around RPM trees at Jackass Bend Unit. A volunteer from France working for CNWFCO, Marie Delacort, wanted some refuge experience and joined us on one of the work days.

Marie Delacort (left, a volunteer from France,) and a Girl Scout from Orrick MO helped pin weed barrier mats around RPM trees at Jackass Bend Unit, May 2008.



Tom met with the Friends group at the Bryant Cabin. He also met with DU three times, and assisted with the DU Fund Raiser *Ladies Wine-Tasting* event.

Troy Gordon, Chair of Friends of Big Muddy for many years, died tragically April 25.

May 2008. A memorial service for Troy Gordon was held at Arrow Rock Historic Site overlooking the Jameson Island Unit of Big Muddy NFWR.

Friends of Big Muddy and Missouri River Relief hosted another seminar at the JC Bryant Cabin. Jim Harlan, doctoral candidate at MU, spoke about historic vegetation records from Government Land Office records in the Missouri River bottoms. Wedge, Tim, and Mike attended, as well as 35 others.



Jim Harlan gave a presentation about historic vegetation in the Missouri River bottoms during May 2008.

Tim helped organize and met with members of Friends of Big Muddy, Missouri River Communities Network, Friends of Arrow Rock, and Lewis & Clark National Historic Trail Foundation to develop a Nature of Learning grant proposal for environmental education on the refuge at Arrow Rock. [The National Fish & Wildlife Foundation did not select the proposal for funding.]

Tom continued coordination activities with Ducks Unlimited. The new fund raising event, *Sportsman's Night Out*, raised net proceeds in excess of \$10,000.

June 2008. Wedge and Lori worked with Missouri Master Naturalists and Friends of Big Muddy to conduct a butterfly sampling/collection as part of National Pollinators Week.

July 2008. Tim participated in the Friends of Big Muddy and Missouri River Relief Missouri River Speaker's Forum at the JC Bryant Cabin. About 20 people heard Danny Garrett, MU fisheries doctoral candidate, speak about catfish migration on the Missouri River.

August 2008. Tom met with DU twice to continue coordination for the fall banquet. They have averaged almost \$60,000 per year just from this one event for the past 4 years.

September 2008. Tom met with DU to continue planning for the Columbia Fall Banquet and fund raiser.

New volunteer and neighbor, Rich Lawson, adopted the parking lot at Jameson Island Unit and reported about 4 hours per week spent mowing during the growing season.

5e. Intra-agency Coordination

Tom participated in monthly FWS Regions 3 and 6 Missouri River conference calls. These calls keep our far-flung employees and offices from two Regions and several programs informed and effectively engaged.

As the Region 3 Pollinator Coordinator, Wedge joined in national conference calls regarding pollinators.

During October 2007, Tom traveled to Memphis TN to testify in an Equal Employment Opportunity Complaint hearing.

Wedge, Tim, and Randy worked with CNFWCO on the Missouri River in search of pallid sturgeon broodstock for the hatchery program in April 2008. The coordinated effort by many staff and volunteers covering over 800 miles of river resulted in the record collection of over 40 wild adults in one week's time. During Wedge's trip on the river, they caught 1 gravid female (1992 hatchery fish) that was turned over to USGS crew and implanted with a transmitter.



Refuge Biologist Wedge Watkins holds pallid sturgeon captured on the Missouri River, April 2008.

Tom attended the USFWS Missouri River Summit held in Yankton SD in June. He reported on the Missouri Clean Water Commission controversy regarding sediment disposal in conjunction with COE side channel construction projects, recent realty activities, and other Big Muddy NFWR management activities. The relaxed atmosphere, lack of distractions and absence of any external partners contributed to an excellent information exchange and team building.

In July 2008 Tom participated in a conference call with other Missouri national wildlife refuge managers and R3 NWRs Chief Nita Fuller to discuss the growing problem with feral hogs in Missouri. The Missouri Governor has created a task force to address this serious issue. State staff drafted an MOU encompassing almost every state and federal land managing agency in Missouri to address the feral hog problem.

Tom and Wedge participated in a conference call held in July with the other members of the Big River Biological Network to discuss how best to build an accessible data base for refuge field station data that is currently residing in file cabinets.

Randy spent a week at Port Louisa NWR working on flood-damaged areas.

6. RESOURCE PROTECTION

6a. Law Enforcement

Law enforcement activities for October 2007 through July 2008 were summarized from the monthly activity reports supplied by Refuge Officer Blessington. Mike transferred in August 2008, so the 2008 data lacks information from August and September. Data from 2007 is included for comparison.

		<u>2007</u>	<u>2008</u>
Total Number of Contacts:	Public Use	268	145
	Fishing	207	122
	Hunting	<u>433</u>	<u>243</u>
	TOTAL	908	510
Total Number of Violation Notices		28	22
Total Number of Warnings		96	45
Incident Reports		19	10
Total Miles Traveled		25,378	21,907

Number of Warnings Issued, Listed by Code of Federal Regulation (CFR) Violated:

<u>2008</u>		
5	16 USC 668dd 50 CFR 26.21(b)	(f)(2) Permit unconfined domestic animal to enter a NWR
1	16 USC 668dd 50 CFR 26.22 (a)	(f)(2) Fail to comply with special regulations (unlabeled deer stand)
3	16 USC 668dd 50 CFR 26.22 (a)	(f)(2) Fail to comply with special regulations (camping)
3	16 USC 668dd 50 CFR 26.22 (a)	(f)(2) Fail to comply with special regulations (campfire)
2	16 USC 668dd 50 CFR 27.26 (a)	(f)(2) Trespass on National Wildlife Refuge – enter area closed due to flooding
5	16 USC 668dd 50 CFR 27.31 (a)	(f)(2) Operate a vehicle in Violation of State Law
6	16 USC 668dd 50 CFR 27.31 (d)	(f)(2) Exceed posted speed limit (21-30 mph over)
2	16 USC 668dd 50 CFR 27.81 (d)	(f)(3) Operate a vehicle without license plate/registration
1	16 USC 668dd 50 CFR 27.31 (g)	(f)(2) Operate a vehicle without a driver's license
4	16 USC 668dd 50 CFR 27.31 (l)	(f)(2) Operate a vehicle without proper headlights, taillights, or brake lights
14	16 USC 668dd 50 CFR 32.2(d)	(f)(2) Hunting in violation of state law
3	16 USC 668dd 50 CFR 32.5 (a)	(f)(2) Fishing without a state license

6. RESOURCE PROTECTION

6a. Law Enforcement

Law enforcement activities for October 2007 through July 2008 were summarized from the monthly activity reports supplied by Refuge Officer Blessington. Mike transferred in August 2008, so the 2008 data lacks information from August and September. Data from 2007 is included for comparison.

		<u>2007</u>	<u>2008</u>
Total Number of Contacts:	Public Use	268	145
	Fishing	207	122
	Hunting	<u>433</u>	<u>243</u>
	TOTAL	908	510
Total Number of Violation Notices		28	22
Total Number of Warnings		96	45
Incident Reports		19	10
Total Miles Traveled		25,378	21,907

Number of Warnings Issued, Listed by Code of Federal Regulation (CFR) Violated:

<u>2008</u>		
5	16 USC 668dd 50 CFR 26.21(b)	(f)(2) Permit unconfined domestic animal to enter a NWR
1	16 USC 668dd 50 CFR 26.22 (a)	(f)(2) Fail to comply with special regulations (unlabeled deer stand)
3	16 USC 668dd 50 CFR 26.22 (a)	(f)(2) Fail to comply with special regulations (camping)
3	16 USC 668dd 50 CFR 26.22 (a)	(f)(2) Fail to comply with special regulations (campfire)
2	16 USC 668dd 50 CFR 27.26 (a)	(f)(2) Trespass on National Wildlife Refuge – enter area closed due to flooding
5	16 USC 668dd 50 CFR 27.31 (a)	(f)(2) Operate a vehicle in Violation of State Law
6	16 USC 668dd 50 CFR 27.31 (d)	(f)(2) Exceed posted speed limit (21-30 mph over)
2	16 USC 668dd 50 CFR 27.81 (d)	(f)(3) Operate a vehicle without license plate/registration
1	16 USC 668dd 50 CFR 27.31 (g)	(f)(2) Operate a vehicle without a driver's license
4	16 USC 668dd 50 CFR 27.31 (l)	(f)(2) Operate a vehicle without proper headlights, taillights, or brake lights
14	16 USC 668dd 50 CFR 32.2(d)	(f)(2) Hunting in violation of state law
3	16 USC 668dd 50 CFR 32.5 (a)	(f)(2) Fishing without a state license

Number of "Notice of Violation" Issued, Listed by CFR Violated:

- 1 16 USC 668dd 50 CFR 27.31(g)
 Operate vehicle on NWR without a driver's license
- 3 16 USC 668dd 50 CFR 27.32 (a) (f)(2)
 Operate boat in violation of Coast Guard law (No PFD)
- 2 16 USC 668dd 50 CFR 27.41
 Carry, possess or discharge fireworks
- 1 16 USC 668dd 50 CFR 27.51 (f)(2)
 Disturb, injure, damage plant on National Wildlife Refuge
- 4 16 USC 668dd 50 CFR 32.2 (d) (f)(2)
 Hunt in violation of state law
- 1 16 USC 668dd 50 CFR 32.2 (f) (f)(2)
 Failure to comply with refuge specific regulations (campfire)
- 1 16 USC 668dd 50 CFR 32.2 (f) (f)(2)
 Failure to comply with refuge specific regulations (camping)
- 1 16 USC 668dd 50 CFR 32.5 (a) (f)(2)
 Fishing without a state license
- 3 16 USC 703
 Attempt to take migratory birds with lead shot (minors)

In November 2007 Mike turned four individuals over to the Cooper County Sheriff for trespass on Union Pacific rail line and cutting trees along the rail line and refuge boundary. He issued Notice of Violation for not having deer hunting license and seized the rifle. He also seized a deer cart left on the refuge for more than 7 days. Mike seized one unlabeled deer stand in January and one in February from Boone's Crossing Unit.

Mike found a 55-gallon drum with a small amount of waste oil dumped on the Lisbon Bottom Unit. He reported the issue to Missouri Department of Natural Resources. Staff from MODNR checked the drum for toxic waste and removed the drum from the refuge.

In March Mike found four dead calves dumped at Lisbon Bottom Unit. He also received report of 13 snow geese dumped on the side of a road near Eagle Bluffs Conservation Area. He met the complainant, documented the snow geese, collected the snow geese, and reported the issue to MDC officers.

Mike met Zone Officer Gavin Gensmer at the Atlanta Conservation Area and requalified with all issued weapons. He attended the annual Law Enforcement In-Service at NCTC in April and attended Field Training Evaluation Program Review in Georgia at the Federal Law Enforcement Training Center in May.

Mike found three shot signs on the Cranberry Bend Unit – west parcel.

In January, Mike worked the deer hunt on Clarence Cannon NWR. He went on a detail to Flint Hills NWR in June to help decrease the number of individuals operating motor vehicles off road in violation of refuge specific regulations. Also in June he assisted Refuge Officer Rodney Hansen at Desoto National Wildlife Refuge for an overnight fishing event. They issued numerous Notices of Violation during the detail.

During much of June and July refuge lands and all state boat ramps on the lower Missouri River were under water due to flooding conditions.

In June, Barbara sent a letter to our neighbor at Jameson Island Unit requesting that he remove the ornamental plants and rockwork that he added to the parking lot. The neighbor complied and had everything on the refuge removed by June 30.



The landowner next to Jameson Island parking lot has made several improvements to what is considered the Missouri River crossing for the Santa Fe Trail in the Arrow Rock area.

Also in June, Tom met with a neighbor at the Lisbon Bottom Unit to discuss the boundary survey and posting. The neighbor was upset with what he perceived to be a "taking" of his property. Two site visits and two telephone calls resulted in the re-establishment of our former good relations. R3 Surveyor Rob Nicolli and Refuge Officer Mike Blessington helped maintain cordial relations with their professional and polite demeanor.

Tom worked with the Missouri Water Patrol to identify the ownership and history of an aluminum bass boat that Wedge and Robb Jacobson found during a site visit in August at Jameson Island chute.

In September Tom and Barbara met with refuge neighbors to discuss an ongoing dispute at Overton Bottoms North Unit. Surveys don't always make neighbors happy!

Tom met with Desoto NWR Manager Larry Klimek and Iowa/Missouri Zone Officer Gavin Gensmer in September to discuss law enforcement coverage in Missouri and Iowa for the upcoming busy fall hunting seasons. They also discussed other LE items of mutual concern and interest.

6b. Permits and Economic Use Management

Permits:

We issued four special use permits during FY2008:

1. 33590-08001 Dennis Dieckhoff

Period of use 2/8/2008-6/30/2008

To cut and move large woody debris blocking a drainage.

Large woody debris brought in by the May 2007 flood blocked one of the ditches on the refuge, causing water to back up onto the neighbor's crop fields and over the field access road.



We issued a special use permit to a neighbor to remove woody debris blocking the drainage of his field: before (left) in February 2008 and after (right) June 2008.

2. 33590-08002* Gerald and Dorothy Oswald

Period of use 6/20/2008-6/30/2009

To allow motorized access at the west side of the Loesing tract.

*This permit was not signed and is therefore not in effect. The neighbors are disputing the location of the boundary line following a survey.

3. 33590-08003 Ted McGuire

Period of use 7/1/2008-9/30/2008

To cut and bale hay at Loesing Tract, Overton Bottoms North Unit

4. 33590-08004 Kansas Biological Survey, Univ. of Kansas-Lawrence

Period of use 7/15/2008-7/15/2009

To conduct wetland sampling at Jameson Island Unit.

A professor and 3 graduate students will sample soils and vegetation for 3 years in wetlands along the Missouri River floodplain. They used the National Wetland Inventory to find sampling points and one of their points fell on the refuge.

The following previously issued permits were in effect during FY 2008:

1. 33590-06001 Troy Gordon

Period of use 11/1/2005-12/31/2007

To sample water quality and macroinvertebrates at Overton Bottoms North Unit.

2. 33590-06007 US Army Corps of Engineers
Period of use 9/1/2006-9/30/2008
To construct a chute at Jameson Island Unit.

Economic Use:



We notified the COE about a fiber optics cable that became exposed at the Overton Bottoms chute with bank sloughing and channel deepening, August 2008. The COE contacted the utility company responsible for the cable.

6c. Contaminant Investigation

Wedge and Barbara worked with Dave Mosely and John Weber, FWS Contaminants specialists, to provide background information for the refuge Contaminants Assessment Plan. John provided the completed plan to the refuge in February 2008.

6d. Contaminant Cleanup

In December 2007 Randy, Adam, and Zach hauled off trash and recycled old appliances, etc. from the Alexander house site and old barn.



Mike looking outside and inside the barn at the Alexander tract prior to cleanup, November 2007.

Joe Schlueter, Missouri DNR Well Protection Division, went with Barbara to measure abandoned wells on the refuge at Baltimore Bottom, Overton Bottoms North, and Lisbon Bottom units. Joe later submitted recommendations to fill and permanently cap the wells. Barbara submitted bid packages to potential bidders to plug the wells and received no bids. She continued to work to find contractors to cap the wells, and in July provided a tour of the

Baltimore Bottom sites. She sent another bid package out in August to several contractors, and again received no bids.



Joe Schlueter, MO DNR, estimates the depth of wells at Lisbon Bottom (left) and at Baltimore Bottom units, March 2008.

6e. Water Rights Management No activity.

6f. Cultural Resources Management No activity.

6g. Land Ownership Support

Tom attended bimonthly Missouri River Realty Partners meetings with staff from Corps of Engineers, Missouri Department of Conservation, Natural Resources Conservation Service, and Missouri Department of Natural Resources. These valuable meetings help coordinate and address some of the complexities of acquisition on the Missouri River. John Saxhaug and Steve Muyskens (RO Realty) attended the May meeting held at Arrow Rock State Historic Site and Tom gave them a tour of refuge units the following day.

Tom looked at several tracts of land for sale during the year. In February he met with Bob Rinacke to discuss the potential purchase of 22 acres at Jackass Bend Unit. He inspected a potential acquisition site in St. Louis County in March. In April he visited land and met with a realtor in Montgomery County regarding land COE may purchase. In August he inspected three additional new COE land purchases for possible addition to the refuge. We continue to coordinate with COE and MDC to determine management strategies, including which agency would be best suited to manage these new Missouri River floodplain properties.

In May Tom and Barbara met with Gerald and Dorothy Oswald to discuss several issues regarding our shared boundary (recently surveyed and posted) at Overton Bottoms North Unit.

In January 2008 FWS Surveyor Rob Nicolli started the survey of the Thorp portion of Cranberry Island to address the title company's concerns. We closed on the acquisition of this 54.4 acre tract on June 20, 2008. The refuge now manages the entire island. Federal ownership of the island and the adjoining mainland provides protection and management potential for the natural side channel located there.

We acquired the Shropshire tract at Jackass Bend Unit on February 22, 2008. The 117.0 acre tract of mature bottomland forest links two existing FWS parcels and consolidates ownership.

In May we closed on the three-party exchange done to resolve a trespass at the Jameson Island Unit. The neighbor's porch now resides on private land. Shirley Karman, RO Realty, came for the closing and Wedge gave her a tour of some refuge units.

COE acquired Cora Island on June 22, 2008, and in July, informed the refuge of the acquisition pursuant to the Fish and Wildlife Coordination Act as mitigation for the Bank Stabilization and Navigation Mitigation Project. In August, Tom and Columbia Ecological Services Field Office Supervisor Charlie Scott briefed Regional Director Thorson, R3 NFRS Chief Nita Fuller, and Ecological Services ARD Lynn Lewis on the on-going issues of who should manage Cora Island. Missouri Department of Natural Resources, not a fish and wildlife management agency, expressed to the COE their interest in managing the island as part of state parks. In September, Tom replied to COE that FWS was pleased to accept Cora Island as a unit of Big Muddy NFWR and asked that they initiate the paperwork necessary for the transfer of management.

Boundary Posting. To date, the FWS has awarded the survey company Ruble, Riggs & Shotts task orders totaling \$121,390. Task orders with Midland Surveying totaled \$78,420. Shotts continues to work on the survey and posting at St. Aubert Island Unit.

Randy helped Rob Nicolli with the survey of boundary behind the town of Lisbon. Flood waters slowed down progress, but they finished the location of the line and Randy began construction of a fence to reduce boundary issues with the neighbors.

Mike posted 28 refuge signs with refuge staff at Overton Bottoms North and Boone's Crossing-Johnson Island units.

COE continues to survey lands they acquired at Overton. Barbara provided copies of maps and deeds of nearby lands acquired by FWS to assist their record search.

Revenue Sharing.

The Refuge Revenue Sharing Act provides for annual payments (in lieu of taxes) to local counties for lands under the administration of the US Fish and Wildlife Service. These payments are funded from the economic use of FWS lands plus a supplemental Congressional appropriation. For FY2007 (paid by electronic fund transfer in May 2008), revenues and the supplemental Congressional appropriation are sufficient to provide for a nationwide payment of 41.9 percent of the full entitlement amount. The amounts shown below are the payments for the lands in each county managed by Big Muddy NFWR. The payments to counties totaled \$29,440.

County	Cooper	Howard	Jackson	Lafayette	Osage	Ray	Saline	St. Louis
Acres	1,249	2,014	498	1,575	1,124	228	2,339	572
Amount	\$4,380	\$3,124	\$859	\$6,574	\$3,515	\$437	\$4374	\$6,177

7. PUBLIC EDUCATION AND RECREATION

7a. Visitor Services

Use. Currently all refuge lands are open to compatible wildlife-dependent recreation, including hunting and fishing under Missouri statewide regulations. Exceptions include the refuge-specific regulation of "Archery Hunting Only" for safety reasons at Jameson Island (due to chute construction) and the non-island portion of Boone's Crossing (due to location adjacent to athletic fields and busy highway US 40).

An estimated 27,500 people visited the refuge this year. Public use continues to grow as we install more boundary signs, kiosks, and parking facilities, and as the public becomes aware of recreational opportunities.

We hosted 14 special events on the refuge, with about 400 participants. Other use estimates include: 3,600 hunting visits, 1,200 fishing visits, 2,075 wildlife observation visits, 500 photography visits, 2,500 environmental education participants, and 1,870 interpretive program participants.

Area Closure at Cabin. Mike and Barbara scouted a safety zone perimeter around the JC Bryant (formerly Alexander) Cabin, then Randy, Zach, and Adam cleared the route and built a 3-strand smooth wire fence to delineate an area closed to public use. They also posted the closure signs. The closed area includes the railroad crossing below the cabin. Emily, Adam, and Zach refurbished and painted 2 gates for the closed area.

User Facilities.

Trails. During spring through fall we removed trees and limbs and regularly mowed the Lewis & Clark Trail of Discovery (Jameson Island Unit), the Missouri River Levee Trail that goes from the Diana Scour to the Missouri River (Overton Bottoms North Unit), and Boone's Crossing Loop Trail (Boone's Crossing Unit).

In October 2007 Randy, Tim, Zach, Emily, and Adam cleared a new foot trail and future bridge crossing site near Diana Scour at Overton Bottoms North Unit.



Future sites of Diana Scour Pedestrian Bridge, Overton Bottoms North Unit, October 2007 (left), and Edwards Branch Bridge, Baltimore Bottom Unit, November 2007.

During November 2007 Barbara worked with a representative of Union Pacific Railroad to determine the right-of-way width at the Baltimore Bottom Unit. Randy, Zach, and Adam cleared a path for the proposed pedestrian bridge crossing over Edwards Branch just north of the railroad ROW.

Also in November, Tim, Randy, Adam, and Zach cleared small trees and brush and mowed on the levee at Lisbon Bottom Unit to provide a trail to the Missouri River. Randy returned the next summer to remove more trees and stumps using the forestry tool on our new Bobcat.



During December 2007 and January 2008 Tim, Zach, and Adam cleared a foot trail to Cottonwood Scour at Overton Bottoms North Unit. The trail provides a side loop from the Missouri River Levee Trail down to the scour. An Eagle Scout candidate worked with Tim to plan two sets of steps for the levee. Tim, Randy, Dale, and Chad helped the Scout and many of his troop members and leaders construct the steps for the side loop during several work days.

Trail cleared to Cottonwood Scour, November 2007.

With all the heavy rain events in 2007 and 2008 the bridge at the Arrow Rock Landing Trail started to show erosion problems around the concrete piers. In September 2008 Tim met with Dr. John Bowder, an engineer on faculty at MU, regarding plans for repairs at the bridge and met again later in the month with Bowder and some of his engineering students. They plan to design a solution as a student project and provide volunteers and some supplies to accomplish the repairs.



The center piers of the bridge for the Arrow Rock Historic Landing Trail started to erode as shown in pictures from July 2007 (left), March 2008 (center), and September 2008 (right).

Roads, Parking Lots, Gates, and Kiosks.

In October 2007 with the help of Randy Smith and a dozer, both from Port Louisa NWR, Randy Stenberg constructed a parking lot and installed bollards and concrete bumpers at the Loesing tract of Overton Bottoms North Unit. Zach, Adam, Emily, and Randy later installed a

kiosk, temporary signs, and a gate. In September 2008 Randy installed a culvert and added ditch rock (following the design contributed by volunteer engineer Marty Comstock) to improve the drainage at the parking lot entrance.



New parking lot under construction at Loesing tract, October 2007.

In November 2007 Randy repaired, and then he and Emily rehung, gates at Baltimore Bottom east.

Barbara met with the Cooper County Road Supervisor regarding road work at Overton Bottoms North Unit. The county will clear the county road right-of-way at the entrance to the Loesing parking lot to improve the sight distance, and make improvements to the county road at the Merna parking lot.

In December 2007 Randy and Adam made two kiosks in our shop. In early July, while the river was too high for fish sampling, we borrowed three fisheries employees (Zach Beussink, Brandon Spratt, and Adam McDaniel) to help Chad and Dale build three more kiosks.



We replaced the map and regulations at the St. Aubert Island kiosk in January 2008.

In January 2008 Zach and Adam built part of the Merna (Overton Bottoms North) parking lot fence, put up boundary signs, and installed kiosk metal braces. In February we installed the Merna kiosk, brochure box, and temporary signs.

Tim, Zach, and Adam also installed a kiosk and signs at the MDC Mokane River Access during January. Tim and Randy returned in March to repair the kiosk damaged by vandalism. They returned again in May to repair more damage to the kiosk.



Kiosk and fence installed at Merna (left) and kiosk at Mokane Access (right), January 2008.



*Kiosk at Mokane Access after vandalism (left) and during repair (center), March 2008.
MDC later added large rocks in front of signs at the parking lot, September 2008.*

After flood waters receded, we checked for damage from the June-July high water events. It was an unusually wet early summer, and many areas of the refuge held water that in previous years have been dry in July. No major damage was detected to facilities. Some sediment dropped on roads and parking lots, and water damaged some traffic counters.

Railroad Crossings.

During FY 2007, Terry Penaz, Region 3 Engineer, completed a design for the railroad crossing at Jackass Bend Unit to improve the site distance and grade. To deal with the poor sight distance at the crossing (MODOT requires a 500' sight distance), Barbara solicited bids for cutting several large cottonwoods at the Jackass Bend railroad crossing. A professional sawyer (retired Forest Service employee) won the bid and cut the largest trees. Randy assisted with cutting smaller trees and bucking up fallen material.

A contract went out from the regional office and bids for the crossing improvements were due 12/27/07. Wet weather and flooding delayed the start of construction. In June 2008 Wedge and Molly participated in the pre-construction conference call and the contractors finally started work. In July Harold Aebly (Regional Office Engineering) met Barbara at the Jackass Bend Unit to inspect the railroad crossing improvement project. The contractor has installed the culvert and started hauling fill to raise the ramp. In August Barbara inspected the work of the contractors and sent photos to the Regional Office. Randy extended the front gate, put up new signs at the kiosk, received delivery of road rock and bladed the worst sections of the access road south of the tracks. The public finally has vehicular access to Jackass Bend Unit.



Harold Aebly (Region 3) and Kenny White (Norfolk Southern Railroad) pose at the improved railroad crossing at Jackass Bend Unit, September 2008.

In May 2008 Molly coordinated with a representative from Union Pacific Railroad to complete a Private Crossing Lease agreement for Alexander Tract/OBN Crossing (Wooldridge) and the Baltimore Bottom (East) Crossing.

Website.

Tim learned the Dreamweaver software and worked with Regional Webmaster Larry Dean to update our website to the new standards. Tim made quarterly updates to the website as necessary.

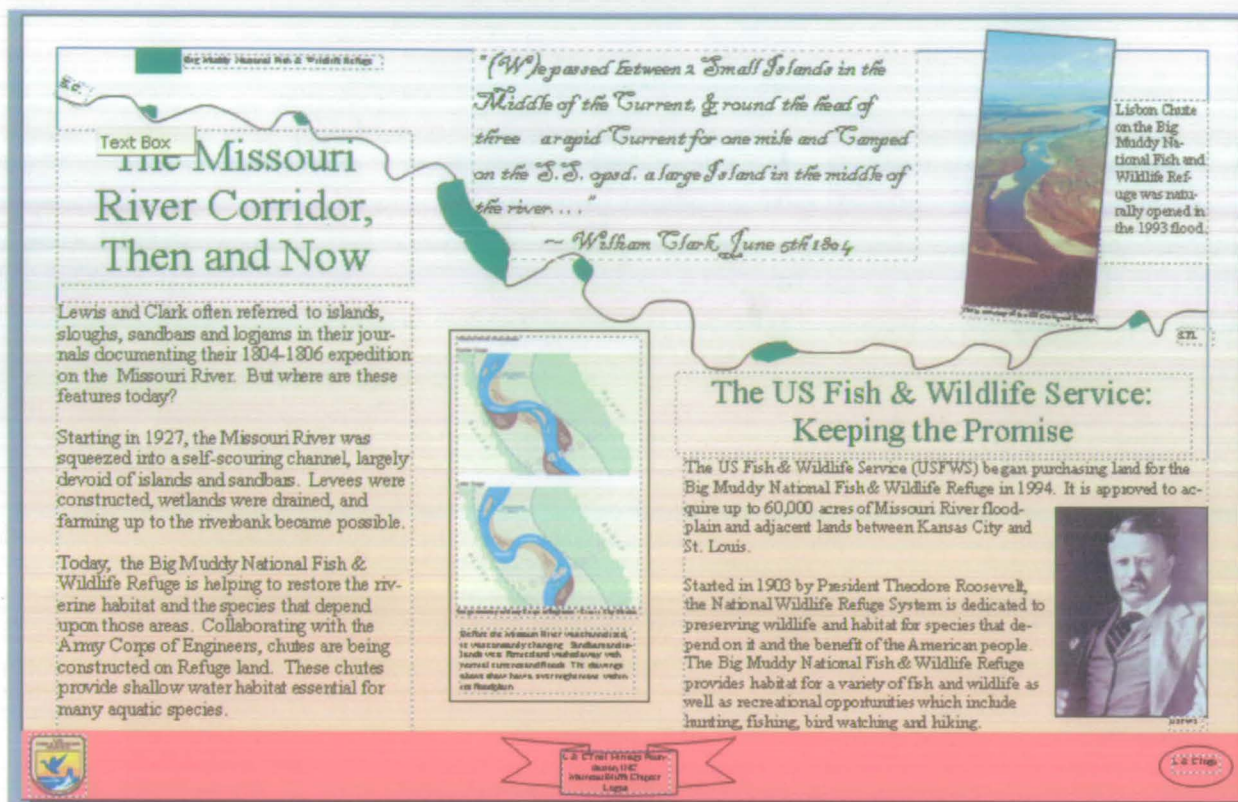
Signs.

In April 2007 the Lewis & Clark Trail Heritage Foundation received a grant from the Fish & Wildlife Foundation to develop five interpretive signs for the Arrow Rock Historic Landing Trail at Jameson Island Unit and adjacent Arrow Rock State Historic Site. Emily worked with Tim to develop

interpretive panels for the three signs that would be placed on the refuge portion of the Arrow Rock Landing Trail. Tim provided edits for the interpretive panels during development and later when prepared by the contractor, GS Images. In May 2008, two volunteers from the Foundation and Tim, Chad, and Dale installed the five interpretive signs along the trail.



Interpretive text explains invasive species at a sign placed along the Arrow Rock Historic Landing Trail.

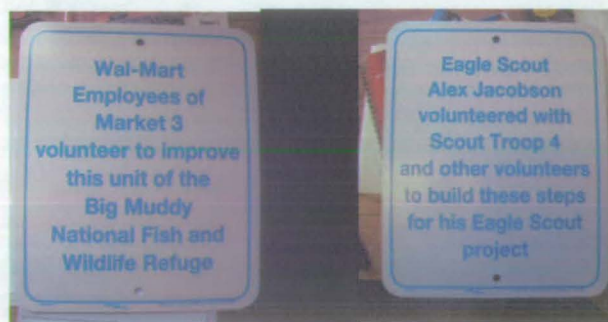


Zach, Adam, and Randy built frames and installed standard entrance signs during November 2007 at Baltimore Bottom (East) and Boone's Crossing units.



Standard entrance sign at Baltimore Bottom Unit (left) and Boone's Crossing (right), November 2007.

In April 2008 Tim started development of 14 signs for kiosks with the regional sign coordinator. The sign company contracted by the regional office will make 94 signs (some are duplicates). Tim also developed signs that acknowledge volunteers who helped with refuge projects (WalMart clean up and two Boy Scout step construction projects).



Signs to recognize volunteer projects.

While we wait for the more permanent signs from the contractor, Tim made updates to the temporary (laminated paper) signs and maps, and refuge staff installed them at the various unit kiosks.

In May 2008 Tim installed flat fiberglass posts (Carsonite) with informational decals at problem areas on Jameson Island and Lisbon Bottom units that direct people to the river, or that depict restrictions, such as no ATVs, no bicycles, dogs on leash, etc.

Carsonite sign placed by steps at Trail of Discovery, Jameson Island Unit.



The following table shows a summary of our sign progress.

Status of Signs and Orientation for Public at Big Muddy NFWR - RAPP* Goals

Refuge Unit	Adequate directional sign in place to find unit	Adequate directional & safety signs on unit	Standard Entrance Sign in Place	Adequate Orientation Points/Kiosks/Parking in Place	Permanent Signs Developed and Installed
Jackass Bend		At kiosk		1 kiosk 1 parking lot	In development
Baltimore Bottom		At kiosk	At east parking lot	1 kiosk 1 parking lot (with MDC)	In development
Cranberry Bend		At kiosk	At east parcel	1 kiosk 1 parking lot	In development
Lisbon Bottom	"to regulations" sign on county road	At kiosk	North and south ends	1 kiosk 1 parking lot	Yes
Jameson Island		At kiosk		2 kiosks 1 parking lot	Yes
Overton Bottoms North	2 directional signs on Hwy 98 "To regs" sign on county road	At kiosks	1 at largest tract	Main – 3 parking lots, 1 kiosk Loesing – 1 parking lot, 1 kiosk Merna – 1 parking lot, 1 kiosk	Yes
St. Aubert Island		At kiosk		1 kiosk on island 1 kiosk at MDC Mokane River Access	In development
Boone's Crossing		At kiosks	At parking lot	1 parking lot 1 kiosk on island 1 kiosk on mainland	In development

*Refuge Annual Performance Plan

Boundary Posting.

We continue to make progress and have about 80 percent of our boundaries posted consistently with the FWS Sign Manual standards. The contract survey of boundary at St. Auberts Island Unit is incomplete and we still lack some signs for some railroad track and river boundary.



In October 2007, Tim, Zach, Emily, and Adam posted river boundary along Jameson Island Unit. The contract surveyor (Craig Ruble) continued boundary survey work at the Overton Bottoms North Unit. Rob Nicolli, Surveyor, worked on locating the access road to Merna at Overton Bottoms North Unit. Staff put up boundary signs and started plans for the parking lot.

Zach and Emily post boundary and "No Firearms" signs along the river at Jameson Island Unit, October 2007.

In December 2007, Dale prepared the boundary signs for St. Auberts Island Unit by etching them with the date "2007" so we can easily determine which old signs (placed on approximate locations) to remove after the survey of the landline which was started later that month by Bob Shotts of Ruble, Riggs, and Shotts Surveyors is completed.

Randy assisted Surveyor Rob Nicolli in February 2008 and operated a boat so that they could access the tract on the island at Cranberry Bend owned by the Thorps. The survey resolved the description issues raised by the title company and we acquired the tract in June.

In July 2008, Randy, Lori, Chad, and Dale helped Rob relocate the boundary line and post signs adjacent to the town of Lisbon. Randy and Chad added a locked gate across the access easement into Lisbon Bottom Unit. Randy began construction of a smooth wire fence on the refuge boundary behind the town in September.

Rob Nicolli started the boundary survey at the east end of Baltimore Bottom Unit in August. After experiencing almost impenetrable brush and poor visibility, he made plans to return to the site after leaf fall.

7b. Outreach

Outreach efforts during FY2008 included:

October 2007:

Wedge spent a half day with a photographer from the *Columbia Missourian* newspaper at Jameson Island Unit in preparation for an upcoming feature article.

Tim, assisted by Emily, consolidated the contact list for the Missouri Junior Duck Stamp Program.

Tim worked with DJ Case & Associates, Missouri River Communities Network, and Les Bourgeois Vineyards on development of a National Fish & Wildlife Foundation (NFWF)

Preserve America grant application for a spotting scope for the winery and interpretive panels along a proposed Overton driving tour. Unfortunately, the NFWF did not select the project for funding.

November 2007:

Wedge worked with Journalism major students from MU on a feature article for the *Columbia Missourian*.

Tom attended the Dedication Ceremony and Open House at the new educational facility at Fort Osage which overlooks the Jackass Bend Unit of the refuge.

Barbara gave a presentation about habitat restoration and the refuge to about 30 volunteers at the tree and shrub planting event at Alexander tract.

We received and responded to numerous telephone calls and e-mails regarding hunting opportunities on Big Muddy NFWR.

December 2007:

Tom gave radio interviews to stations in Marshall, Sedalia, and St. Louis. The primary topic was the Comprehensive Conservation Plan process and meetings.

Tom met with Cooper County Commissioners in Boonville to discuss CCP, land acquisition, road maintenance, law enforcement, and other items of mutual interest.

At our Chesterfield CCP scoping meeting, a den of cub scouts arrived with several parents. Tom provided an impromptu talk about the refuge.

January 2008:

Tim continued preparations for the Junior Duck Stamp contest in early April. He sent letters to the 5 judges and confirmed funding support from Bass Pro Shops in the amount of \$1,050.

Tim made a presentation about the refuge at the 1/8/08 Friends meeting.

February 2008:

We continued to receive numerous questions about the Junior Duck Stamp Contest from teachers, students, and parents. Tim responded, and also contacted entrants who did not submit proper paperwork.

Robb Jacobson, USGS, made a presentation about sediment in the Missouri River and specifically about side channel restoration work on Big Muddy NFWR to the School of Natural Resources at University of Missouri. Tom, Wedge, and Barbara attended.

March 2008:

Big Muddy NFWR, MU, and Columbia MO School District received notice that our grant application for a joint education project was chosen for funding by the National Fish & Wildlife Foundation. We look forward to working closely with challenged youth and local educators using the refuge as an outdoor classroom and laboratory to learn about man's relationship with nature, both currently and historically in Lewis & Clark's time.

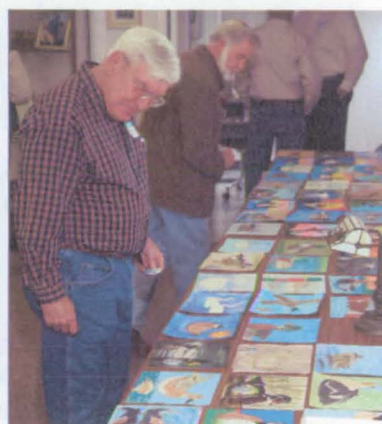
Tim organized the onslaught of 800 pieces of Junior Duck Stamp artwork received by our office. He responded to parents and teachers wanting information about the contest.

April 2008:

We held the Missouri Junior Duck Contest on April 3. Several staff and volunteers helped with the event. We received over 800 entries. We matted and labeled the artwork and sent it to Squaw Creek NWR to start the year-long tour for the display. Tim sent information about the winners with the artwork returned to the teachers, distributed a news release about the Best of Show, and started the updates of the JDS information on our website.



Volunteers at the Junior Duck Stamp contest included (left photo) photographer Sonja Crozier, Alice Havard, Troy Gordon, and Caroline Doyle. At right, Judges Ken Gerardy, Doug Ross, Carl Korschgen, Glenn Chambers, and Jeff Nichols score artwork, April 2008.



Melissa Blessington and Christie Thompson lay out artwork for judging (left). At right, Judges Ken Gerardy and Doug Ross study artwork.



Volunteers Troy, Alice, and Carolyn spread out artwork and Alice and Barbara record winners.



Tim, Mike, and Wedge help conduct the Junior Duck Stamp contest.

On Earth Day, about 30 students from Eldon High School took a tour of Overton Bottoms North for an outdoor education day. The advanced biology class and biology club students broke up into groups and rotated between speakers. Tim discussed ecology of turtles and other animals that make the refuge their home; Wedge gave a presentation on butterflies and moths and other insects found on the refuge; Andy Starostka, CNFWCO, talked about large river systems, specifically the Missouri River; and staff from Missouri River Relief discussed aquatic invertebrates and upcoming Missouri River clean up projects.

Tim, Wedge, and Troy Gordon hosted about 24 candidate Missouri Master Naturalists at Overton Bottoms North Unit. The day focused on mitigation projects and included a boat tour.

Tom and Barbara met with neighbors Mr. & Mrs. Gerald Oswald to discuss boundary issues at Overton Bottoms North Unit.

Tim contacted all the first place winners to obtain information needed so that Bass Pro could award them cash prizes. Dale scanned (for our website) and framed (for physical display) the artwork. Tim arranged for the display of the 2008 Missouri Junior Duck Stamp contest winners' original artwork at the following locations during the year:

Original Artwork Displayed:

May 2008	Squaw Creek National Wildlife Refuge	Mound City
June 2008	Runge Conservation Nature Center	Jefferson City
July 2008	Springfield Conservation Nature Center	Springfield
August 2008	Bass Pro Outdoor World	Springfield
September 2008	Burr Oak Woods Conservation Nature Center	Blue Springs
October 2008	Discovery Center Urban Conservation Campus	Kansas City
November 2008	Powder Valley Conservation Nature Center	Kirkwood
December 2008	Conservation Campus Nature Center	Cape Girardeau
January 2009	Mingo National Wildlife Refuge	Puxico
February 2009	Camden County Library	Camdenton
March 2009	Morgan County Library	Versailles

Copy of Artwork Displayed:

October 5-6, 2007	Missouri Art Education Conference	Knob Noster SP
November 2007	Missouri Wildlife Art Festival	St. Charles
Jan. – mid-Feb, 2008	Daniel Boone Library	Columbia
June 27, 2008	Bass Pro Store	Columbia

September 2-24, 2008
September 30 – Oct.

Truman State Office Building, Second Floor
Columbia Bottoms Conservation Area

Jefferson City
near St. Louis



Missouri Junior Duck Stamp display at the Missouri Wildlife Art Festival in St. Charles MO, November 2007.



Display at the Truman State Office Building, September 2008.



*Display at Daniel Boone Public Library in Columbia MO, February (left),
and Runge Nature Center, Jefferson City MO, June 2008 (right).*

May 2008:

Tim worked with Bass Pro Shop and MDC to arrange our participation in Free Fishing Day in June, and designed a button for the day.

June 2008:

Tim and Wedge assisted with Reel Time for Kids, sponsored by MDC and held at Bass Pro Shop in Columbia on June 9.

Wedge gave a presentation about butterflies and moths for the Monthly Speaker's Forum held at the Bryant Cabin on June 10.

Wedge met with Bryan Danford, graduate student from MU, to do some preliminary planning for an educational partnership with Douglas High School. Wedge provided background information on FWS, Big Muddy NFWR, and Overton Bottoms North, and a reading list on the Missouri River.

July 2008:

On July 10 Tim conducted a tour of the Missouri River for the Missouri Master Naturalists Boones Lick Chapter, with help from Tracy Hill and Cliff Wilson of the Columbia Wildlife and Fisheries Conservation Office.

Wedge met with Bryan Danford, MU graduate student, in July and August to coordinate field days on the refuge for the MU and Douglas High School Partnership.

August 2008:

Tom attended the quarterly meeting of the Presidents Advisory Council on Historic Preservation in St. Louis on 8/14-15 to accept an award on behalf of the USFWS. The award was an Agency Companion Certificate to an Award given to DOI for preservation and education work on the National Historic Trails System. The Lewis and Clark National Historic Trail and Santa Fe National Historic Trail are both located in part on the Big Muddy NFWR. Similar Companion Certificates were awarded to Bureau of Land Management, National Park Service, and the USDA Forest Service. Dignitaries in attendance at the banquet on 8/14 and the ceremony on 8/15 included Governor Matt Blunt, DOI Deputy Secretary Lynn Scarlett and Department of Agriculture Under Secretary Mark Rey.



Tom accepted an award on behalf of the USFWS at a President's Advisory Council on Historic Preservation meeting held in St. Louis in August 2008.

Tim developed a design for a Missouri Junior Duck Stamp calendar highlighting the twelve first place winners (three from each age group) on a 2009 calendar. He coordinated with Kinkos on design specifications of the calendar. CIP Lori scanned the artwork and made digital files for the project.

September 2008:

We sent general refuge brochure text to Tom Kelley in the regional office. Now we're in search of good photos.

Wedge attended the "Virtual Career Fair for Natural Resources, Agriculture and the Environment" at Lincoln University. Over 30 vendors/agencies attended and over 200 students took advantage of the information available.

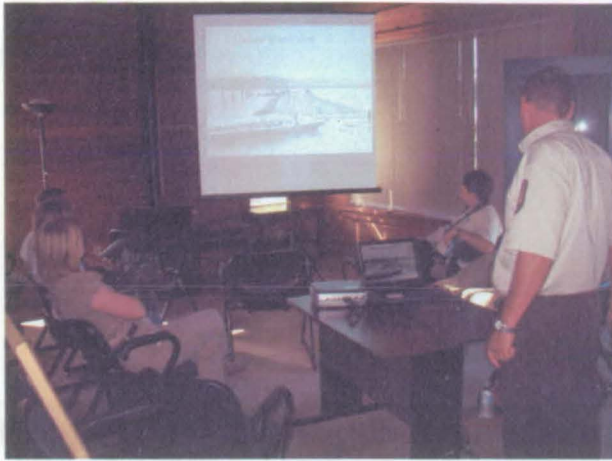
An article printed Sept. 16, 2008, in the *St. Louis Post Dispatch* described how fire department crews used a boat to rescue a deer hunter from a tree near the Missouri River (Boone's Crossing Unit) near Chesterfield after he was trapped there by rising floodwaters. The man was hunting with a friend when water overflowed the agricultural levee.

Tim set up a learning center about aquatic turtles at the Watershed Learning Festival held at Columbia Bottoms Conservation Area near St. Louis on 9/12.



Tim talked about turtles at the Watershed Festival held near St. Louis in September 2008.

Tim, Wedge, and fisheries biologists from Columbia NWFCO provided a field tour about wetland communities at Overton Bottoms North Unit for the Missouri Interpretive Association. About 25 interpreters attended the tour.



Participants at the Missouri Interpretive Association learned about the refuge and turtles during a tour and presentation by Tim Haller at the Bryant Cabin, September 2008.

Tim had a booth at the Arrow Rock 13th Children's Craft Fair. Friends of Arrow Rock members reported that the festival had well over 100 volunteers and 46 school groups attend from as far away as Independence and Fulton. They estimated that 1,705 students and 370 adults participated.



Tim had several furs to touch at the Arrow Rock Children's Craft Fair, September 2008.

PLANNING AND ADMINISTRATION

8a. Comprehensive Management Planning

We began our Comprehensive Conservation Plan (CCP) that will guide management of Big Muddy National Fish & Wildlife Refuge for the next 15 years. Planning ensures that the refuge is managed in a way that fulfills its own purposes and fulfills the mission and purpose of the National Wildlife Refuge System. The Division of Conservation Planning in our regional office created a website at <http://www.fws.gov/midwest/planning/bigmuddyccp> that outlines the process.

We started with pre-planning meetings and field tours held October 22-25, 2007. Jon Kauffeld, Tom Larson, and Dean Granholm from our regional office joined refuge staff as we “planned the plan” and drafted a communication plan to guide our public involvement efforts.



We held field tours with Regional Office staff in October 2007.



And we held pre-planning CCP meetings, October 2007.

During November Tim coordinated meeting spaces for seven scoping meetings for the CCP, and visited each site to check suitability. He and Emily prepared a PowerPoint presentation about the refuge units to exhibit at upcoming scoping meetings. Emily worked on the list of CCP contacts, starting with our draft communication plan and the old EIS mailing list. We mailed about 1,300 invitations to the open houses scheduled for early December. Regional staff prepared several items for our CCP scoping meetings: maps (Gabe DeAlessio), newsletter (Jane Hodgins), logistics and other (Dean Granholm).



Refuge staff spoke with many interested persons during the public scoping meetings held at seven locations in December 2007 and January 2008.

We held open house/public scoping meetings to gather concerns and issues about refuge management in Columbia (12/3), Linn (12/4), Fayette (12/5), Arrow Rock (12/6), and Chesterfield (12/12). Emily updated the CCP mailing lists, and we prepared and sent a second mailing for the rescheduled meetings at Richmond (1/14) and Waverly (1/15) that had been postponed due to wintry weather and icy roads in December.

All of the meetings had interested people engaged in stimulating discussions about the Missouri River and refuge issues. In total, 56 people signed in at the public scoping meetings. We received several written comments at meetings and in e-mails.

We held our Biological Review in early February. Attendees included Pat Heglund (Regional Biologist), Dean Granholm (Regional Planning staff), Jared Bowman (Regional Office SCEP), Wyatt Doyle (CNWFCO), Jeff Finley (CNWFCO), Jane Ledwin (Columbia ES), David Galat (University of Missouri), Carl Korschgen (USGS), Doug Helmers (NRCS), Neal Young (MDC), Keith Grabner (USGS), Rochelle Renken (MDC), Frank Durbian (Squaw Creek NWR), Tom, Barbara, and Wedge (Organizer). Wedge prepared notebooks of information to facilitate discussions. The current and historic vegetation of each unit can be found as Appendix G. Gabe prepared large unit maps on aerial photographs. In August, Wedge finished edits on the draft report of the review written by Regional Biologist Pat Heglund.



Biological Review participants discussed refuge and Missouri River issues, February 2008.

Tom traveled to the Regional Office on 2/19-2/20 to hold an internal scoping meeting for the CCP.

In May we met three days with Dean Granholm and Gabe DeAlessio (RO Planning Shop), Cheryl Groom (Neal Smith NWR), and Doyle Brown (MDC Planning) for three days to formulate plan alternatives.

8b. General Administration

Funding - Fiscal Year 2008

Wildlife and Habitat Management (includes \$10,000 for Challenge Cost Share - Native Veg Restoraion at OBN)	1261	\$ 421,754
Maintenance	1262	\$ 127,106
Additional Funds to acquire Bobcat and Trailblazer	1262	\$ 89,984
Visitor Services (includes \$1,500 for Volunteers and \$19,000 for 3 Challenge Cost Share projects)*	1263	\$ 175,536
Refuge Law Enforcement	1264	\$ 118,402
Conservation Planning	1265	\$ 34,913
Junior Duck Stamp Additional Funding	4524	\$ 1,883
Overton Bottoms Management - Funds from COE for Operations and Maintenance	1971 - 0326	\$ 75,710
Carryover - Visitor Services Facilities Construction – Jackass Bend Access Improvement (RR crossing) Project	2821-E355	\$ 28,992
Carryover - Lewis & Clark Floodplain Heritage Partnership II (MO) NAWCA funds, used in acquisition of Shropshire tract	3720-0431	\$ 89,354
Total Funding to Refuge (including carryover)		\$1,163,634

*The refuge received funding for 3 Challenge Cost Share projects in Visitor Services (1263):

Junior Duck Stamp Program
Environmental Education Projects
Improved Access to Cottonwood Scour

In January Tom was interviewed by Government Accounting Office (GAO) regarding the National Wildlife Refuges budget and staffing.



Smartweed in bloom at Baltimore Bottom Unit, September 2008.

Personnel - Permanent Staff at Big Muddy NFWR during FY2008



Big Muddy NFWR Staff

Left to right around the table: Wildlife Refuge Specialist Barbara Moran, Maintenance Worker Randy Stenberg, Refuge Officer Mike Blessington, Wildlife Refuge Manager Tom Bell, Refuge Biologist Wedge Watkins, Administrative Officer Molly Comstock, and Park Ranger Tim Haller

In March, Molly became the Administrative Officer for Big Muddy NFWR and Swan Lake NWR.

In August, Refuge Officer Mike Blessington left Big Muddy NFWR to assume law enforcement duties at the Madison Wetland District in South Dakota. Mike and his family will be missed.

Tom initiated a replacement for Mike, and the Office of Personnel Management, through the USAJobs internet site, released the vacancy announcement on 8/14. Tom finished interviewing candidates and references for the position and forwarded his tentative selection to the Regional Office for review in September. [New Refuge Officer Radford Dew reported to work on 11/23/08.]



Bluff above Diana Scour. Photo by Jon Kauffeld, October, 2007.

Personnel - Temporary Employees at Big Muddy NFWR During FY2008



Dales Waites started as a STEP in May 2007, and worked during the summer on invasive species inventory and control, visitor facilities maintenance, and "other duties as assigned." He continued part-time when school resumed in August. He returned full-time in May 2008 and was able to hit the ground running.

Dale Waites, STEP

Chad Collard joined our staff in mid-May as a STEP and worked with Dale on many refuge projects. Due to class schedules, he was unable to work at the refuge after school started in fall 2008. Chad is a senior at MU majoring in fisheries & wildlife management.



Chad Collard, STEP



(Left to right) Emily Kunz, Craig Williamson, Adam McDaniel, and Zach Beussink, intermittent employees from the Fisheries office, helped us out with several projects.

Intermittent NWFCO employees Zach Beussink, Emily Kunz, Adam McDaniel, and Craig Williamson (for one pay period) helped us with several labor intensive projects. Emily also helped with the CCP process and developing interpretive signs.

On June 9, Loreнна (Lori) Varkonyi, came to us as a refuge volunteer paid by the Conservation Internship Program. She lived at the Bryant Cabin, and worked on many different refuge projects and spent time at ES. She drove 2 days to get here from University of Texas-El Paso, where she is majoring in biology. After working on many biological sampling and other refuge projects, she returned to El Paso in September.

Lori Varkonyi, Conservation Internship Program employee.



Facilities



The USGS Columbia Environmental Research Center (CERC) in Columbia, Missouri, provides space for our Mobile Office Unit (trailer), parking, and storage building, as well as computer support and facilities maintenance for on-site buildings.



JC Bryant Cabin. Tim designed and had a sign made for the Bryant Cabin. Barbara, Mike, and Molly conducted a safety check at the cabin and compiled a list of items needed to bring it into compliance to be a residence. Barbara solicited bids for the electrical work needed to meet safety standards. Molly did the paperwork to get the successful bidder onto the Central Contractor Register (CCR) and awarded the work. Mike sent in water quality samples and results showed high iron and sulfur content of the well water. We had a water filtering system installed, and placed a drinking water bottle and stand at the cabin. The cabin was ready for habitation when the CIP volunteer came in early June.



Randy maintained the grounds over the growing season, and he and the STEPS removed several locust trees from the Bryant Cabin yard. To reduce the trips to a tire repair shop, we also foam filled the John Deere mower tires.

Equipment

The refuge added a 2008 Chevy Trail Blazer (\$14,131) to the fleet that the refuge manager uses. Molly transferred the 2001 Ford Expedition to Necedah National Wildlife Refuge in Wisconsin.



We replaced the law enforcement vehicle with a 2008 Ford F150 and Mike outfitted it with necessary gear. Molly transferred the old Chevy pick up to Lacreek Wetland Management District in South Dakota.

In March 2008 Benny Ayres from Lacreek Wetland Management District came to get our old law enforcement vehicle.

We acquired a Bobcat Skid Steer and Brush Cutter (\$75,853).



Randy operates the new Bobcat with a forestry tool attachment to grind up locust stumps, August 2008.

Training, Work Details, and Meetings

We all completed the required training for ethics, IT, etc. as well as training on the DOI Learning intranet site: Privacy Act, Records Management, Federal Information System Security Awareness, and Cardholder Training.

In January 2008 Molly went to the Washington Office on a detail to help distribute 2007 year-end funds. We really missed her while she was gone. Barbara got to do the first Quicktime (new electronic payroll system) entries.

In June we participated in safety training, including CPR, First Aid, and Blood Borne Pathogens. Paul Heine, CERC Safety Officer, provided Fire Extinguisher training. Chad completed ATV safety training/certification and pesticide applicator training. Chad and Randy went to the Federal Occupational Health facility in Rolla MO for their pesticide applicator (and for Randy, also his Commercial Driver's License) medical surveillance physicals.

Through the year Molly completed several courses to update her warrant qualifications: CON 110 – Mission Support Planning, CON 111 - Mission Strategy Execution, CON 112 - Mission Performance Assessment, and CON 120 – Mission-focused Contracting. In June she started the application process for Federal Acquisition Certification in Contracting and received her certificate in September. [She submitted all necessary paperwork and received her updated warrant, Contracting Officer Certificate of Appointment, in January 2009.]

Molly went on a detail to work at the Division of Management Authority, the Office of Program Support and the Assistant Director's Office, Arlington Office for two weeks in late July. She participated in conference calls on TAVS (new travel authorization and voucher system) and hosted training for approximately 30 FWS employees at the CERC Conference Building in July. Molly also participated in several Administration Workgroup conference calls. She completed Ideas – Annual Recertification and completed the "pay.gov" training.

Mike attended and helped instruct the Motorboat Operator Certification Course (MOCC) annual training in Wausau WI in February. Tim took MOCC refresher on-line and passed the field test with Instructor Mike Blessington.

Tom, Barbara, and Wedge attended the Missouri Natural Resources Conference in late January. Barbara and Wedge spoke to many potential STEP participants at the Wednesday night Job Fair. Tim, Mike, and Molly attended on the first day of the conference to hear the plenary speakers, including Richard Louv who wrote *Last Child in the Woods*.

In February, Wedge attended the R-3 Biologist Conference in Milan IL that he helped plan. In March he went to the regional office for Pre-Retirement Training.

Randy took online pre-class training courses and attended heavy equipment training held at Savannah IL, Upper Mississippi NWR June 10-13. He completed requirements necessary to operate a motor grader and excavator. He also traveled to Neal Smith NWR to pick up surplus tables and chairs that he placed at the Bryant Cabin for meetings and presentations.

Lori attended the Region 3 Workshop for Conservation Interns and STEPS held at the Regional Office in July. She learned about career options with FWS, further education and training opportunities, and the benefits of working for a federal agency. She also talked with accomplished veteran employees about their FWS experiences. The group of 29 toured Minnesota Valley NWR and saw their Visitor Center.



Lori (top row, third from the left) attended the Region 3 Interns Workshop held in the Twin Cities, July 2008.

Barbara, with spouse Jeff, attended the Pre-Retirement Training at the RO in March. In September she went to the Large River Conference held in Missoula MT. She toured several national wildlife refuges in western Montana and spoke with employees she encountered about their management issues.

Reports

Molly did many reports during the year, including: monthly reports with the Budget Tracking System (BTS), Annual Energy Report, Semi-annual Vehicle Mileage Report, FTS 2001 Services and Cellular Devices/Services, FY2007 Resource Conservation and Recovery Act (RCRA) reporting on Implementation of Executive Order 13423, and year-end reports for Big Muddy and Swan Lake refuges.

Barbara also did many reports, including the Refuge Annual Performance Plan (RAPP), Pesticide Use, Archeological Report, Annual Narrative, Deferred Maintenance Plan, Real Property Inventory Annual Certification, and Service Asset Maintenance Management System (SAMMS) with help from Randy.

Tom and Molly sent the final NAWCA report for the Lewis and Clark Floodplain Initiative to the Washington Office.

Tim filed accomplishment reports to the Accomplishment Reporting System (ARS) database for: *BMNFWR Hosts Missouri Master Naturalists, Friends of Big Muddy and Missouri River Relief co-sponsor presentations at BMNFWR, and BMNFWR participates in Children's Festival.*

Plans and Proposals. Barbara prepared and submitted the Annual Management Plan for Overton Bottoms North Mitigation Area to COE for their review and funding. Tim and Barbara each submitted two Challenge Cost Share proposals to the Regional Office for consideration and funding.

Other. On August 28, 2008, the refuge mobile office unit (trailer) had a lightning strike. Several items were fried, including the internet hub, internet cables, phones, radio, label maker, computer network cards, one printer, the fax, etc. We were lucky the trailer didn't catch fire from the looks of the hub. We have made good progress repairing and replacing all our systems except the radio.

Molly assisted staff in setting up their govtrip.com profiles. She sent 3 security ID files to FW3 Compusec. She coordinated with RO IT and Swan Lake staff for needed equipment to install internet accessibility in the maintenance shop at Swan Lake. She also assisted Swan Lake's new maintenance mechanic in getting set up in Quicktime, FFS, Uniform database, etc.

In the personnel realm, Molly reviewed and submitted paperwork for our new STEP, Chad Collard. She transferred Mike's government credit card, uniform database, badge and firearms, Lotus Notes, and Vendor Information to his new duty station. She also completed action to extend our two STEPS for another semester.

Randy and Barbara met with COE and MDC staff at Overton Bottoms South to turn in keys to the COE maintenance shed (that formerly housed some of our equipment). MDC has removed all of their equipment and signs, and will no longer manage Overton Bottoms South for COE.

Barbara flew with Regional Pilot Brian Lubinski during a high water event in September and took many photos of refuge units.

Photograph of the Jameson Island chute taken on September 10, 2008.



Other Other.

Personnel Fleet:



Big Muddy NFWR employees pride themselves on being green.

Personnel Lifetime's Longest Hair:



Tom Bell, 1979



Mike Blessington, 1998



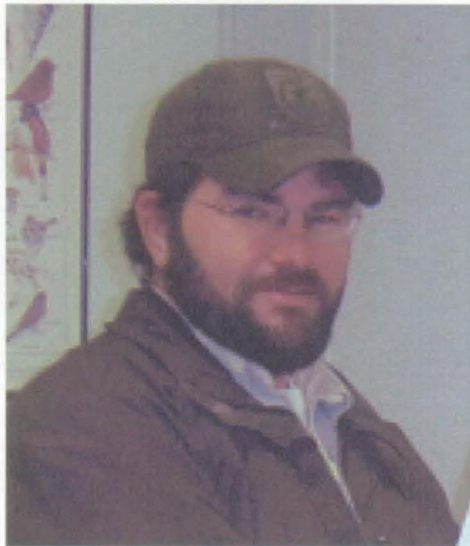
Molly Comstock, 1996



Tim Haller, 1987



Barbara Moran, 1974



Randy Stenberg, 2006



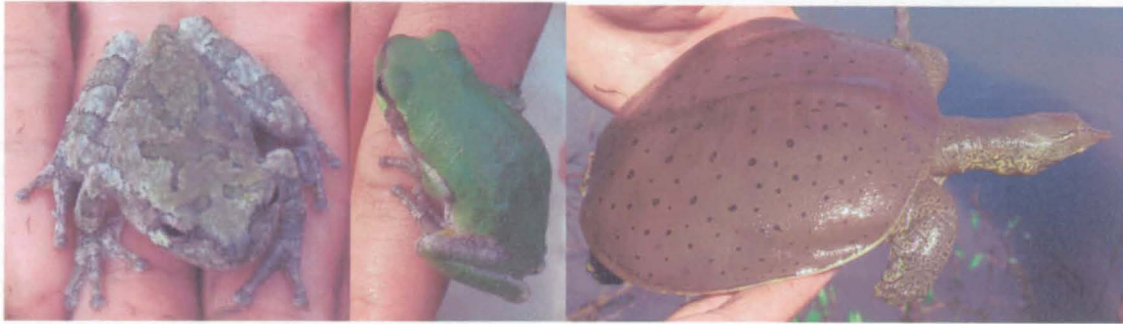
Wedge Watkins, 1975

Appendices

- A. *Fish, Reptile and Amphibian Survey of Various Wetlands, Ponds and Scour Holes at Three Units of Big Muddy National Fish and Wildlife Refuge*, August 2008, Loreenna Varkonyi, 15 pages.
- B. *Butterfly and Moth Checklist, Big Muddy National Fish and Wildlife Refuge*, USFWS, 2 pages.
- C. *Big Muddy National Fish and Wildlife Refuge Two Year Traffic Counter Report*, February 2008, Tim Haller, 15 pages.
- D. *Establishment and Sampling of Permanent Vegetation Monitoring Plots at Big Muddy National Fish and Wildlife Refuge*, December 2007, Matthew Struckhoff, USGS, 18 pages.
- E. *Executive Summary from Evaluation of Fish Use of the Side-Channel Chutes at Lisbon Bottom, North Overton Bottoms, Tadpole Island, and Tate Island, 2007 Annual Report, Missouri River Mitigation Project*, March 2008, Nick Utrup, Zac Beussink, Joseph McMullen, Jeff Finley, and Tracy Hill, 146 pages.
- F. *Site Photos taken at Baltimore Bottoms on 01 February 2008*. Report from Chance Bitner, US Army Corps of Engineers, of shallow water habitat work initiated at Baltimore Bottom Unit. 6 pages.
- G. *Current and Historic Vegetation at Big Muddy National Fish & Wildlife Refuge*. Prepared for the Biological Review, Wedge Watkins.

Appendix A.

**Fish, Reptile and Amphibian Survey of Various Wetlands,
Ponds and Scour Holes at Three Units of
Big Muddy National Fish and Wildlife Refuge**



by

Lorenn Varkonyi

August, 2008

U.S. Fish and Wildlife Service
Big Muddy National Fish and Wildlife Refuge
Columbia, Missouri

Abstract

A survey was conducted of ten previously unsampled wetlands, ponds and scour holes within the Big Muddy NFWR in the summer of 2008. The purpose of the survey is to determine the presence of fish, reptiles and amphibians using a variety of traps and nets. A bag seine was used, when possible, along with baited hoop nets, mini-fyke nets and minnow traps. At each location, GPS waypoints were taken and the traps were deployed in water less than four feet deep. Traps were deployed in a variety of habitats including open water, emergent vegetation, along shallow banks and near trees and shrubs. Specimens were collected the following morning and inspected to determine their size and species. Total counts were estimated when more than 100 individuals were caught. Over 20 different species of fish, 7 species of amphibians, and 4 species of reptiles, common to the region, were observed during the survey.

Introduction

In the summer of 2008, the Big Muddy National Fish and Wildlife Refuge (BMNFWR) was comprised of more than 11,000 acres (eight discrete units) of land along the Missouri River between Kansas City and St. Louis, Missouri. The Refuge consists of several units that are located on floodplains and adjacent lands of the lower Missouri River, and was created in 1994 “for the development, advancement, management, conservation and protection of fish and wildlife resources” (FWS).

One of the main objectives for the Big Muddy NFWR is to restore habitat within the flood plain along the Missouri River that have been greatly altered through extensive human activity. Where feasible, this restoration can be accomplished by allowing the river to access its floodplain during minor flood events by creating side channels, cutting down levees, and allowing the native vegetation to return.

During flood events, many temporary and permanent bodies of water are formed and intermittently connected to the river. These periods of connection, provide access to critical habitats for fish and other wildlife. For example, many fish species, utilize these flooded environments for feeding, spawning and rearing. (Lubinski et al. 2008). In addition, river-floodplain connectivity provides an opportunity for the exchange of energy and nutrients essential in maintaining ecosystem biodiversity and productivity (Lubinski et al. 2008).

A brief survey of various small wetlands, ponds and scour holes was conducted at three units of Big Muddy NFWR to determine the presence of fish, amphibians and reptiles. This inquiry is for the purpose of documenting the presence and variety of wildlife utilizing these habitats. The habitats surveyed included two ponds found in an upland old field, a new pond located on a terrace/bench above the flood plain, two ephemeral wetlands and five small scour holes.

Study Area

Overton Bottoms

Overton Bottoms is located in eastern Cooper County approximately 15 miles west of Columbia, Missouri. The area is divided into north and south units (mitigation sites for ACOE). Overton Bottoms North is managed by the Big Muddy NFWR and is an area consisting of large open fields with a mix of grasses and forbs. Additionally, there are large areas of dense young forests (<20 years) consisting primarily of cottonwood, silver maple, willow, sycamore and box elder, and a narrow strip of mature cottonwood trees also exists on a levee along the river.

A total of 5 bodies of water including three small ponds, two existing scour holes and a temporary wetland were sampled at this unit. The Bryant, Frog and Tadpole Ponds are located in an upland/old field on the Loesing and Alexander tracts on the southwestern portion of the Overton North unit. Bryant Pond is located south of Bryant cabin. Further

east on the Loesing tract is Tadpole Pond and adjacent to it is Frog Pond. These vernal ponds are further from the river and therefore did not have river connectivity, however because Bryant Pond has been stocked in the past it is known to contain fish.

North from Bryant Pond and closer to the river are the Willow and Lone Tree Scours (Fig. 1). Willow Scour is close to the railroad tracks. It is bordered on the east side by a road and on the north and northwest by tree stands. The perimeter is shallow (< 4 ft.), but quickly gives way to water greater than 6 feet deep.

Continuing north from Willow Scour along the road is the Lone Tree Scour, a large and deep scour basin. During the time of our study the scour was flooded, covering a wide expanse largely surrounded by bottomland forests and a few sedges including smart weed.

At the southern end of the Overton Bottoms unit along I-70 and just southwest from the I-70 Scour is the Ring Levee Wetland. This ephemeral wetland ranged in size from 10-400 acres during the summer of 2008. It is surrounded by trumpet creeper, sedges, grasses, forbs and scattered trees. Due to heavy rainfall, water has persisted in this shallow wetland throughout the duration of the study.



Figure 1. Overton Bottoms Unit of BMNFWR

Jameson Island

Jameson Island lies in eastern Saline County near Arrow Rock, Missouri. The unit occupies a large bend of the Missouri River floodplain and is mostly bottom land forest, primarily consisting of cottonwood, willow, box elder, and sycamore.

On the southwestern border of the unit is a parking area leading to the Lewis and Clark Trail of Discovery. Traveling east along the trail is Wedge's Wetland, approximately 150 yards from the entrance. The wetland was inundated during the flood events of 2007 and 2008. At the time of sampling the wetland was less than 2 feet deep and draining. The wetland is bordered by the levee on the west and by tree stands on all other sides.



Bag Seine at Wedge's Wetland



Mini-fyke net at Wedge's Wetland

Figure 2. Jameson Island unit of BMNFWR

Baltimore Bottom

Baltimore Bottom lies in Lafayette County, west of Waverly, Missouri. The unit, which is over 1,150 acres, lies almost entirely within the Missouri River floodplain. It consists of a mixture of cropland, old fields and floodplain forests of sycamore cottonwoods, willows, and silver maples.

Four bodies of water were sampled at this refuge unit. The Wood Duck Scour is furthest West, and was formed when the levee breached in 2007. The perimeter was shallow, however the north half along the steep side was more than 6 feet deep. The north side was also lined with trees while the rest was a dense stand of smart weed and sedges.

Along the levee and further northeast is Windy Scour. This scour hole is similar to the Wood Duck Scour in that it is deep (>5ft.) and steep-sided, and was also formed where the levee was breached in 2007. The scour is characterized by little to no surrounding vegetation and an extremely silty bottom.

The Owl Wetland is on the southeast corner of the unit, adjacent to the interior of the levee. This wetland is shallow and broad, and encompassed by grasses, forbs and sedges. A small patch of willows lines a portion of the east between the wetland and levee. Further north, and east of the levee is the Duckweed Scour, named so because it is covered by *Lemna minor*. The scour hole is very deep (>6 ft.) and entirely surrounded by young willows and sedges.

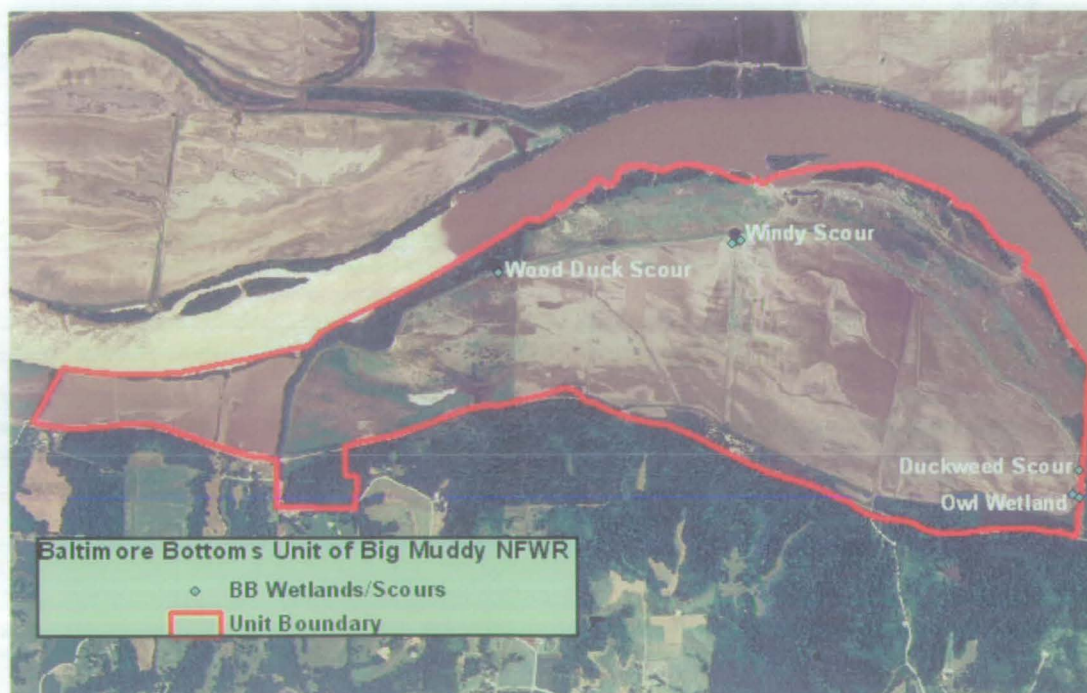


Figure 3. Baltimore Bottoms Unit

Methods

A combination of gear was used to sample these water bodies. This gear included a bag seine, mini-fyke nets, baited hoop nets, dip nets and minnow traps. A bag seine was employed in water bodies having enough surface area with minimal vegetation and debris, and water shallow enough to navigate. 3 out of 11 sites were sampled with the bag seine. All sites were sampled with a mini-fyke net and baited hoop nets. Minnow traps were used at all but one site.

At each site GPS waypoints were taken. All sampling was done in water less than four feet deep. Traps were deployed once at each site in a variety of habitats including open water, emergent vegetation, along shallow banks and near trees and shrubs. Specimens were collected the following morning and inspected to determine their size and species. Photographs and or preserved specimens were taken of unidentifiable species that could not be identified in the field. Total counts were estimated when more than 100 individuals were caught.

	Bag Seine	Minnow Trap	Hoop Net	Mini-fyke
Bryant Pond	✓	6	1	2
Frog Pond		5	1	1
Tadpole Pond		6	1	1
Ring Levee Wetland		5	2	1
Lone Tree Scour		6	2	1
Willow Scour		5	2	1
Wedge's Wetland	✓	6	2	1
Wood Duck Scour		0	2	1
Owl Wetland	✓	6	2	1
Windy Scour		6	2	1
Duckweed Scour		5	1	1

Table 1. Number and types of traps for each site.

Fish less than 8 cm in length were grouped according to size categories listed below (Table 2), otherwise they were individually measured. Tadpoles were also grouped according to size categories. The length and width of the carapace was measured for all turtles.

	Fish Size Categories	Tadpole Size Categories
S	≤ 2.5 cm	≤ 2 cm
M	2.6 – 5 cm	2.1 – 5 cm
L	5.1 – 8 cm	> 5 cm
XL	> 8 cm	

Table 2. Fish and tadpole size categories

Results

Overton Bottoms

Bryant Pond

All traps and nets were used to sample this pond including a bag seine, one hoop net and two mini-fyke nets. This was the only pond sampled with 2 mini-fyke nets. A total of 133 fish were captured with the bag seine and mini-fyke nets. Only two species of fish were captured at this previously stocked pond, white crappie and green sunfish. Three red-eared slider turtles were captured with the mini-fyke and hoop nets. Cricket frogs were observed in the shallow areas of the pond, as well as a few cricket frog larvae captured by the bag seine.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	white crappie	M	1
	white crappie	136-188 mm	100
	white crappie	251-293 mm	3
	green sunfish	99-150 mm	29
			133 Fish total
Reptiles	red-eared slider	125x110 mm	1
	red-eared slider	165x113 mm	1
	red-eared slider	216x178 mm	1
			3 Reptiles total
Amphibians	cricket frog	larvae	10
	4 species		146 total

Table 3. Results for Bryant Pond

Frog Pond

The bag seine was not employed at this pond, however all other gear was, with the exception that only hoop net was employed. This pond was absent of fish and turtles, and abundant in amphibians. Adult and juvenile frogs were both heard and observed in large numbers. 5 species of frogs were captured with the mini-fyke net.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Amphibians	bullfrog	larvae	2
	bullfrog	metamorphs	3
	southern leopard frog	larvae	3
	southern leopard frog	metamorphs	5
	green frog	larvae	1
	green frog	metamorphs	1
	green frog	adult	3
	gray tree frog	larvae	30
	gray tree frog	adult	5
	cricket frog	adult	2
	5 species		55 total

Table 4. Results for Frog Pond

Tadpole Pond

A bag seine was not employed at this pond and only one hoop net was used. Amphibians and turtles were present and fish were absent. Frog larvae were observed in abundance. Several different frog/toad mating calls were heard as well.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Reptiles	painted turtle	152x112 mm	1
	painted turtle	160x120 mm	1
			2 Reptiles total
Amphibians	cricket frog	larvae	19
	cricket frog	adults	7
	southern leopard frog	larvae	27
	gray tree frog	larvae	37
			90 Amphibians total
4 species			92 total

Table 5. Results for Tadpole Pond

Willow Scour

The bag seine was not employed, however all other gear was, including two baited hoop nets. Very few fish and only one bullfrog larvae were captured at this small scour where wood ducks and great blue heron were observed. 4 species of turtles were captured including three very large specimens, an eastern spiny softshell and two snapping turtles.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	white crappie	L	5
	shortnose gar	XL	3
			8 Fish total
Reptiles	eastern spiny softshell	380x315 mm	1
	painted turtle	165x140 mm	1
	painted turtle	70x70 mm	1
	painted turtle	70x80 mm	1
	red-eared slider	200x180 mm	1
	snapping turtle	260x270 mm	1
	snapping turtle	280x290 mm	1
			7 Reptiles total
Amphibians	bullfrog	larvae	1
7 species			16 total

Table 6. Results for Willow Scour

Lone Tree Scour

Though a bag seine was not used, the 2 hoop nets and mini-fyke net yielded an abundance of fish and turtles. Twelve different species of fish and 3 species of turtles were captured. Six small specimens of fish were unidentified. Many southern leopard frogs were observed along the shallow perimeter, as well as a few small unidentified toadlets.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	bighead carp	S	1
	bighead carp	M	1
	bighead carp	L	4
	bigmouth buffalo	450 mm	1
	bluegill	165 mm	1
	common carp	S	3
	common carp	M	14
	freshwater drum	M	1
	longear sunfish	L	1
	longnose gar	L	7
	longnose gar	XL	3
	shortnose gar	XL	1
	shortnose gar	480-640 mm	4
	silver carp	S	7
	silver carp	L	1
	silver carp	570 mm	1
	skipjack herring	M	1
	smallmouth buffalo	S	2
	smallmouth buffalo	433 mm	1
	white crappie	M	3
	white crappie	L	14
	white crappie	260-270 mm	2
			74 Fish total
Reptiles	midland smooth softshell	160x140 mm	1
	false map turtle	250x200 – 80x70 mm	6
	red-eared slider	290x180 – 130x110 mm	10
			17 Reptiles total
15 species			91 total

Table 7. Results for Lone Tree Scour

Ring Levee Wetland

All traps with the exception of a bag seine were employed at this wetland. The number of fish captures was low, as well as the number of turtles. Only one amphibians was captured, however many southern leopard frogs were observed in addition to several large frogs that were either green frogs or bullfrogs. A large snapping turtle was also observed.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	bluegill	M	1
	common carp	S	1
	common carp	M	3
	common carp	L	5
	green sunfish	XL	1
	gizzard shad	M	2
	gizzard shad	L	1
	gizzard shad	XL	1
	silver carp	S	1
			16 Fish total
Reptiles	false map turtle	85x80, 95x90 mm	2
	red-eared slider	100x100 mm	1
			3 Reptiles total
Amphibians	green frog	adult	1
8 species			20 total

Table 8. Results for Ring Levee Wetland

Jameson Island
Wedge's Wetland

All traps and nets including a bag seine were employed at this wetland. Amphibians and turtles were not captured, however southern leopard frogs and unidentified small toads were observed along the levee. Northern crayfish were captured as well.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	bighead carp	M	3
	bluegill	M	2
	carpsucker	S	2
	freshwater drum	S	5
	gizzard shad	S	3
	largemouth bass	M	1
	logperch	S	1
	mosquitofish	S	1
	silver carp	S	3
	silver carp	M	8
	silver carp	L	3
	silver carp	XL	2
	white crappie	S	1
			35 Fish total
	northern crayfish	M	6
	northern crayfish	L	3
11 species			44 total

Table 9. Results for Wedge's Wetland

Baltimore Bottoms

Wood Duck Scour

The only nets employed in this pond were a mini-fyke net and two hoop nets. Fish, turtles and blue and red northern crayfish were captured, however amphibians were not captured or observed. Wood ducks were observed as well as a snapping turtle. The overwhelming majority of captures were longnose gar of similar size.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	largemouth bass	M	1
	longnose gar	190 – 260 mm	~100
	white crappie	S	3
	white crappie	M	7
			111 Fish total
	northern crayfish (blue)	XL	4
	northern crayfish (red)	XL	3
Reptiles	red-eared slider	51x50 mm	1
	false map turtle	190x170	2
			3 Reptiles total
6 species			121 total

Table 10. Result for Wood Duck Scour

Windy Scour

All traps and nets were employed including two hoop nets, however a bag seine was not. The highest abundance of turtles (28 total) were captured at this scour hole including two very large snapping turtles. Freshwater shrimp were also captured. Amphibians were neither captured, heard, nor observed.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	bighead carp	M	6
	common carp	M	2
	common carp	L	1
	gizzard shad	S	1
	gizzard shad	M	32
	gizzard shad	L	2
	grass carp	M	2
	largemouth bass	M	1
	largemouth bass	XL	1
	mooneye	S	3
	mooneye	M	3
	mooneye	L	1
	quillback	M	1
	sauger	L	3
	sauger	XL	1
	silver carp	S	1
	silver carp	M	5

	silver carp	L	1
			67 Fish total
	freshwater shrimp	S	3
Reptiles	false map turtle	60x55 – 105x85 mm	21
	red-eared slider	60x50 – 125x105 mm	3
	snapping turtle	110x100 – 140x140 mm	2
	snapping turtle	200x250, 230x160 mm	2
			28 Reptiles total
	13 species		98 total

Table 11. Results for Windy Scour

Owl Wetland

All traps including a bag seine were used at this wetland. Fish were captured in abundance, however turtles and amphibians were not. Many bullfrogs were heard and observed, and their larvae captured. A previously unseen frog was captured as well. Freshwater shrimp were captured also.

<i>Group</i>	<i>Species</i>	<i>Size</i>	<i>Total</i>
Fish	bighead carp	S	10
	bigmouth buffalo	S	2
	bluegill	S	3
	common carp	S	156
	common carp	M	10
	common carp	L	1
	common carp	290, 535	2
	freshwater drum	M	1
	gizzard shad	M	202
	gizzard shad	L	75
	gizzard shad	XL	38
	grass carp	S	3
	green sunfish	M	4
	green sunfish	L	1
	longnose gar	XL	4
	mooneye	M	20
	mosquito fish	S	8
	quillback	S	20
	quillback	M	35
	redfin shiner	S	32
	silver carp	S	120
	silver carp	M	133
	silver carp	L	1
	white crappie	S	1
	white crappie	L	1
			883 Fish total
	freshwater shrimp	S	11

Amphibians	bullfrog	larvae	4
	bullfrog	adult	1
	plains leopard frog	adult	1
			6 Reptiles total
18 species			900 total

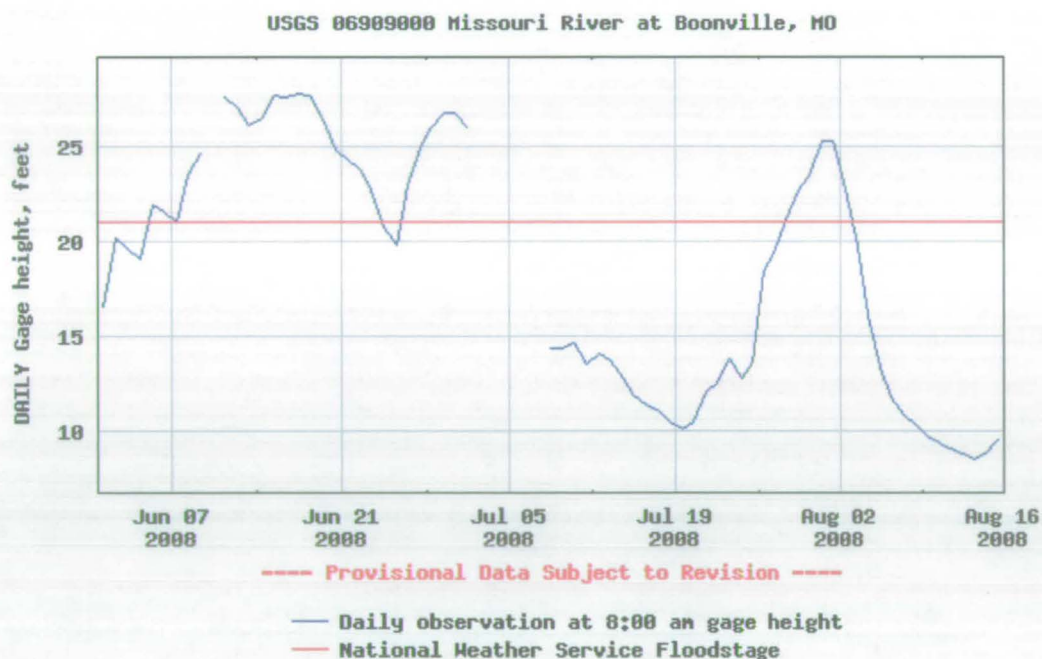
Table 12. Results for Owl Wetland

Duckweed Scour

The bag seine was not employed at this deep scour, and only one hoop net and 4 minnow traps were deployed. Thirteen longnose gar were captured at this site. No turtles or amphibians were captured, however bullfrogs were present at this site (seen and heard).

Discussion and Recommendations

An important consideration in monitoring efforts of fish communities in a river floodplain are the flooding events allowing river-floodplain connectivity (Lubinski et al., 2008). Between January and August of 2008, gage heights at the Boonville Station, as reported by the USGS, have reached flood stage or above on three separate occasions, each lasting several days to weeks. A total of 36 days had levels allowing river-floodplain connectivity, and June had almost 30 consecutive days (Fig.4).



4. Daily Gage Heights for Missouri River at Boonville Station

In future studies the sampling methods should be modified to capture a greater diversity of amphibians. The baited hoop nets and mini-fyke nets were successful in capturing our target species; however, the minnow traps were not successful in capturing amphibian adults or larvae, even in ponds with an abundance of both. A modified box-trap and kick

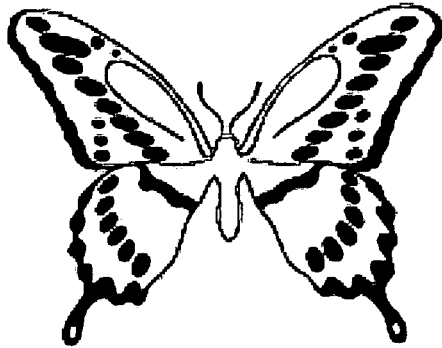
net have been used in amphibian monitoring studies by MDC and have resulted in higher abundance and density for all amphibians including salamanders. In addition, for amphibians in particular, seasonal considerations should be made to increase sampling diversity.

This survey provides a baseline for presence/absence of fish, amphibians and reptiles. It would be interesting to resample these areas in the future, particularly in the spring or during a period of drought.

Appendix B.

Butterfly and Moth Preliminary Checklist

Overton Bottoms North
Unit
Big Muddy National Fish
and Wildlife Refuge



Butterflies and moths are an integral part of the wildlife of the Big Muddy National Fish and Wildlife Refuge. This preliminary checklist has been prepared by refuge staff, with assistance from members of the Boone's Lick Chapter of the Missouri Master Naturalist Program and the Friends of Big Muddy. Note that it is not a complete list of all butterflies and moths that occur on this refuge unit. Instead, it is a preliminary checklist of species that have been documented as occurring on this refuge unit during 2006, 2007 and 2008. This list will be expanded as additional species are identified and documented.

Please provide information on sightings of additional species to the refuge at Wedge_Watkins@fws.gov or by writing the refuge address on the back of this brochure. Assistance in collecting and identifying species was provided by members of the Boone's Lick Chapter of the Missouri Master Naturalist Program:

**Missouri Master Naturalist Program
c/o Boone County Extension
1012 N. Highway UU
Columbia, MO 65203
(573) 445-9792
<http://extension.missouri.edu/masternaturalist/>**

Additional assistance and printing provided by:
**Friends of Big Muddy
4200 New Haven Road
Columbia, MO 65201**

**<http://www.friendsofbigmuddy.org/>
friends@friendsofbigmuddy.org**

December 2008

BUTTERFLIES

SKIPPERS

Silver-spotted Skipper *Epargyreus clarus clarus* (Cramer)
Southern Cloudy Wing *Thorybes bathyllus* (J.E. Smith)
Hayhurst's Scallopwing *Staphylus hayhurstii* (W.H. Edwards)
Checkered Skipper *Pyrgus communis* (Grote)
Common Sooty Wing *Pholisora catullus* (Fabricius)
Delaware Skipper *Atrytone logan logan* (W.H. Edwards)
Hobomok Skipper *Poanes hobomok* (Harris)
Taxiles Skipper *Poanes taxiles* (W.H. Edwards)
Roadside Skipper *Amblyscirtes vialis* (W.H. Edwards)
Juvenal's Dusky Wing *Erynnis juvenalis juvenalis* (Fabricius)

SWALLOWTAILS

Zebra Swallowtail *Eurytides marcellus* (Cramer)
Black Swallowtail *Papilio polyxenes asterius* Stoll
Giant Swallowtail *Papilio cresphontes* (Cramer)
Tiger Swallowtail *Pterourus glaucus glaucus* (Linnaeus)
Spicebush Swallowtail *Pterourus troilus troilus* (Linnaeus)

WHITES AND SULPHURS

Checkered White *Ponita protodice* (Boisduval & Leconte)
Cabbage White *Pieris rapae*
European Cabbage Butterfly *Artogeia rapae* (Linnaeus)
Falcate Orange Tip *Falcapica midea* (Hübner)
Clouded Sulphur *Colias philodice philodice* Godart
Alfalfa Butterfly *Colias eurytheme* Boisduval
Cloudless Sulphur *Phoebis sennae eubule* (Linnaeus)
Little Sulphur *Pyrisitia lisa lisa* (Boisduval & Leconte)
Sleepy Orange *Abaeis nicippe* (Cramer)
Dainty Sulphur *Nathalis iole* Boisduval

GLOSSAMER-WING BUTTERFLIES

Bronze Copper *Hylolycaena hyllus* (Cramer)
Gray Hairstreak *Strymon melinus* Hübner
Eastern-tailed Blue *Everes comyntas comyntas* (Godart)

BRUSHFOOTED BUTTERFLIES

American Snout *Libytheana carinenta* (Cramer)
Variegated Fritillary *Euptoieta claudia* (Cramer)
Great Spangled Fritillary *Speyeria cybele cybele* (Fabricius)
Regal Fritillary *Speyeria idalia* (Drury)
Pearl Crescent *Phyciodes tharos tharos* (Drury)

Question Mark or Violet Tip *Polygonia interrogationis* (Fabricius)
Comma or Hop Merchant *Polygonia comma* (Harris)
Painted Lady *Vanessa cardui* (Linnaeus)
Red Admiral *Vanessa atalanta rubria* (Fruhstorfer)
Common Buckeye *Junonia coenia* Hubner
Viceroy *Limenitis archippus archippus* (Cramer)
Red-spotted Purple *Limenitis arthemis astyanax* (Fabricius)
Goatweed Leafwing *Anaea andria* Scudder
Hackberry Emperor *Asterocampa celtis* (Boisduval & Leconte)
Tawny Emperor *Asterocampa clyton clyton* (Boisduval & Leconte)
Little Wood Satyr *Megisto cymela cymela* (Cramer)
Wood Nymph *Cercyonis pegala* (Fabricius)
Monarch *Danaus plexippus* (Linnaeus)

MOTHS

LEAF ROLLER MOTHS

Oblique-banded Leafroller Moth *Choristoneura rosaceana* (Harris)
Sparganothis Fruitworm Moth *Sparganothis sulfureana* (Clemens)
Basswood Leaf Roller Moth *Pantographa limata*

PYRALID/ SNOUT MOTHS

Dogbane Saucrobotys Moth *Saucrobotys futilalis* (Lederer)
European Corn Borer Moth *Ostrinia nubilalis* (Hübner)
Pyralid Moth *Pyrausta inaequalis* (Guenée)
Celery Webworm Moth *Nomophila nearctica* Munroe
Grape Leaf Folder Moth *Desmia funeralis* (Hübner)
Spotted Beet Webworm Moth *Hymenia perspectalis* (Hübner)
White-spotted Orange Moth *Diastictis argyralis* (Hübner)
Vagabond Crambus *Agriphila vulgivagella* (Clemens)
Sod Webworm *Pediasia trisectus* Walker
Snowy Urola Moth *Urola nivalis* (Drury)
Nephopterix Moth *Nephopterix basilaris* (Zeller)
Yellow-fringed Dolichomia *dolichomia olinalis*

INCHWORMS

Orange Wing *Mellilla xanthometata* (Walker)
Dark-waved Angle *Semiothisa snoviata* (Packard)
Dimorphic Gray *Tomos scolopacinaris*
Cranberry Spanworm *Anavitrinella pampinaria* (Buttercup Moth *Xanthotype urticaria* Swett)
Crocus Geometer *Xanthotype sospeta* (Drury)
Pale Metanema *Metanema inatomaria* Guenée
Confused Eusarca *Eusarca confusaria* (Hübner)

Yellow-shouldered slug *Lithacodes fsciola*
 Curve-Toothed Geometer *Eutrapela clemataria* (J.E. Smith)
 Large Maple Spanworm Moth *Prochoerodes transversata* (Drury)
 Red-bordered Emerald *Nemoria lixaria* (Guenée)
 Wavy-lined Emerald *Synchlora aerata* (Fabricius)
 Chickweed Geometer *Haematopsis grataria* (Fabricius)
 Cross-lined Wave *Calothysanis amaturaria* (Walker)
 Soft-lined Wave *Scopula inductata* (Guenée)

GIANT SILKWORM MOTHS / EMPERORS

Honey Locust Moth *Sphingicampa bicolor* (Harris)
 Polyphemus *Antheraea polyphemus* (Cramer)

SPHINX MOTHS

Catalpa Sphinx *Ceratomia catalpae* (Boisduval)
 Osage Orange Sphinx *Ceratomia hageni* Grote
 Plebian Sphinx *Paratreia plebeja* (Fabricius)
 Twin Spotted Sphinx *Smerinthus jamaicensis* (Drury)
 Walnut Sphinx *Laotloe juglandis* (J.E. Smith)
 Big Poplar Sphinx or Modest Sphinx *Pachysphinx modesta* (Harris)
 Snowberry Clearwing *Hemaris diffinis* (Boisduval)
 Grape-vine Sphinx or Hog Sphinx *Darapsa myron* (Cramer)
 White-lined Sphinx *Hyles lineata* (Fabricius)
 Waved Sphinx *Ceratomia undulosa* (Walker)

PROMINENTS

Spotted Datana *Datana perspicua* Grote & Robinson
 Rough Prominent *Nadata gibbosa* (J.E. Smith)
 Black-rimmed Prominent *Pheosia rimosa* Packard

TIGER MOTHS

Lead-Colored Lichen Moth *Cisthene plumbea* Stretch
 Little White Lichen Moth *Clemensia albata* (Packard)
 Painted Lichen Moth *Hypoprepia fucosa*
 Leconte's Haploa *Haploa lecontei*
 Colona Moth *Haploa colona* (Hübner)
 Reversed Haploa Moth *Haploa reversa* (Stretch)
 Orange Holomelina *Holomelina aurantiaca* (Hübner)
 Acrea Moth *Estigmene acrea* (Drury)
 Fall Webworm Moth *Hyphantria cunea* (Drury)
 Isabella Tiger Moth *Pyrrharctia isabella*
 Banded Tiger Moth *Apantesis nais* (Drury)
 Straight-lined Tiger Moth *Grammia oithona* (Strecker)
 Virgin Tiger Moth *Grammia virgo* (Linnaeus)
 Banded Tussock Moth *Halysidota tessellaris* (J.E. Smith)
 Orange-margined Dogbane Moth *Cycnia tenera* Hübner
 Oregon Cycnia *Cycnia oregonensis* (Stretch)
 Milkweed Tussock Moth *Euchaetes egle* (Drury)
 Giant Leopard Moth *Epantheria scribonia*
 Yellow-collared Scape Moth *Cisseps fulvicollis* (Hübner)

OWLET MOTHS

White-marked Tussock Moth *Orgyia leucostigma* (J.E. Smith)
 Lunate Zale *Zale lunata* (Drury)
 Forage Looper or Clover Looper *Caenurgina erechtea* (Cramer)
 Four-lined Chocolate *Argyrostromis quadrifilaris*
 Darling Underwing *Catocala cara* Guenée
 Celery Looper *Anagrapha falcifera* (Kirby)
 Black-Bordered Lemon Moth *Thioptera nigrofimbria* (Guenée)
 Exposed Bird-dropping Moth *Acontia aprica* (Hübner)
 Cattail Catapillar *Simyra henrici* (Grote)
 Beautiful Wood-nymph *Eudryas grata* (Fabricius)
 Grapevine Epimenis *Psychomorpha epimenis* (Drury)
 Eight-spotted Forester *Alypia octomaculata* (Fabricius)
 Miranda Moth *Proxenus miranda* (Grote)
 Yellow-striped Army Worm *Spodoptera ornithogalli* (Guenée)
 Goldenrod Stowaway *Cirrhophanus triangulifer* Grote
 Army Worm Moth *Pseudaletia unipuncta* (Haworth)
 Ipsilon Dart or Black Cutworm *Agrotis ipsilon* (Hufnagel)
 Dingy Cutworm or Clay-backed Cutworm *Feltia jaculifera* (Guenée)
 Well-Marked Cutworm Moth *Spaelotis clandestina* (Harris)
 Corn Earworm *Helicoverpa zea* (Boddie)
 Arc-lined Flower Moth *Schinia arcigera* (Guenée)
 Glossy Black Idia Moth *Idia lubricalis*

The U.S. Fish and Wildlife Service created the Big Muddy National Fish and Wildlife Refuge in September of 1994 to provide wildlife habitat along the Missouri River. The refuge is divided up into several individual units. These units are open to the public including hunting and fishing following state regulations.

For more information about the Big Muddy National Fish and Wildlife Refuge, contact:

Big Muddy National Fish and Wildlife Refuge
4200 New Haven Road
Columbia, MO 65201
1-800-611-1826
<http://www.fws.gov/midwest/bigmuddy/>
BigMuddy@fws.gov

Appendix C

Big Muddy National Fish and Wildlife Two Year Traffic Counter Report

In the fall of 2005 the Big Muddy National Fish and Wildlife Refuge purchased 5 traffic counters to establish an estimation of visitation on the refuge. Four inductive loop counters called the Traffic Tally 41 and one infrared trail counter TTC-4420 were purchased from Diamond Traffic Products out of Oakridge, Oregon.



Inductive loop counters count vehicles by a buried inductive loop (wire) under a road bed. The loop gives off a slight magnetic signal and when a large metal vehicle passes over that loop the counter counts. The system has proven successful and will operate for over a year on a set of batteries.

Infrared trail counters use an invisible infrared beam passed across a trail between the counter and a reflector. When ever the beam is broken the counter counts. The counters beam is placed at waist height approximately 4 feet. This system is the most widely used trail counter system.

Counter Location Justification

The Big Muddy National Fish and Wildlife Refuge currently has eight units. These eight units do not have equal public access and visitation to each unit varies greatly. The refuge choose four sites to install the inductive loop counters that represented a range from highly accessible, close to a major thoroughfare and larger communities to more remote away from communities and a distance from major thoroughfare.

The trail counter was placed on a trail completed in 2004 with the highest probability of diverse hikers spurred from trails and experiences on adjacent Arrow Rock State Historical Site and campground.

Description of Locations

Overton Bottoms North Unit

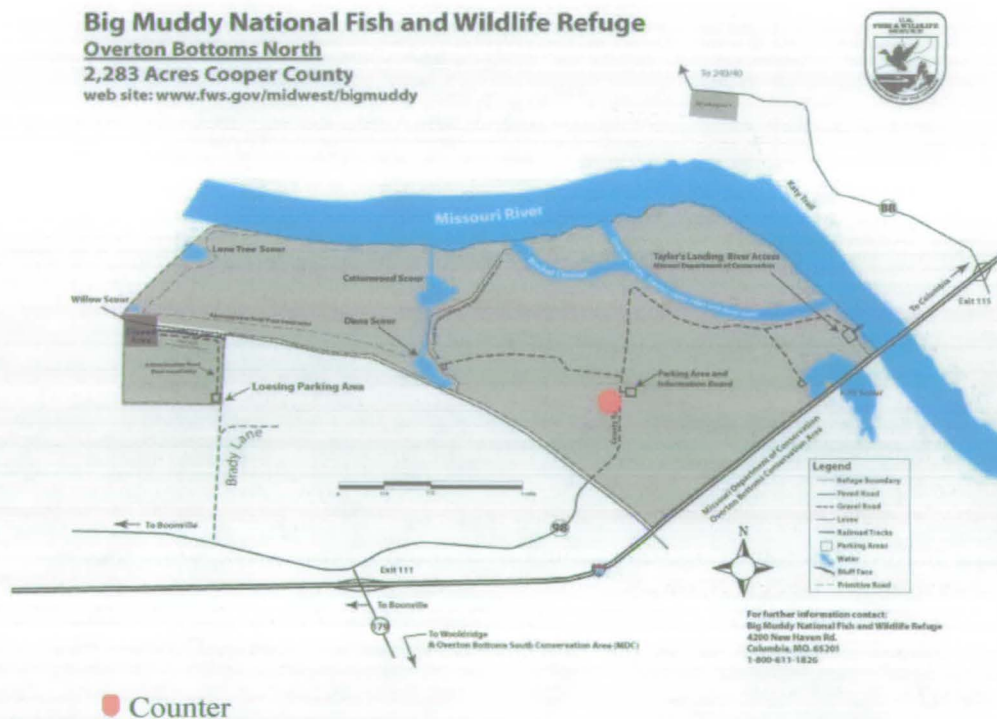
An inductive loop counter was placed under a county road that passes through this unit. This is the refuge's most accessible unit with almost 4 miles of road passing through it. The roads dead end at two parking areas and a boat ramp so visitors must pass over the counter twice.

The boat ramp is owned and maintained by the Missouri Department of Conservation. The counter can not differentiate between a vehicle pulling a trailer and one that did not. The counter was placed about a half mile into the entrance of the refuge.

At the entrance is a train track and there was a concern that if the counter was too close to the tracks vehicles may park over the counter while waiting for the train. Or the train vibrations could possibly trigger additional counts.

Counter was placed under a lone tree in order for it to be easily located as heavy vegetation could easily conceal it.

The counter was installed on December 22, 2005. This unit is in close proximity to interstate 70 and the communities of Boonville and Columbia. See map for reference.

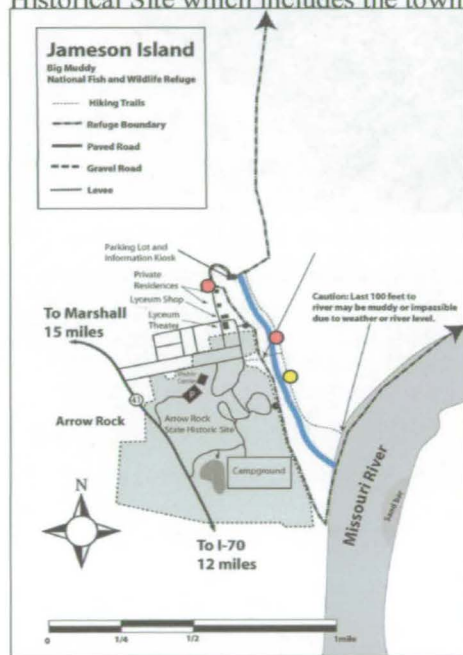


Jameson Island Unit

An inductive loop counter was placed under a county road leading to a parking area of this unit of the refuge. There are no interior roads in this unit so all vehicles traveling to this road must return. Installed 12/21/2006

In addition to the inductive loop counter, an inferred trail counter was placed along the Lewis and Clark Trail of discovery. Installed 12/19/2005, removed 10/06 reinstalled on 1/18/08.

The Jameson Island Unit has a unique location situated next to Arrow Rock State Historical Site which includes the town of Arrow Rock. The State Historical site and attractions in the town of Arrow Rock receive almost 250,000 visitors a year. (Friends of Arrow Rock Website) The State Historic Site includes a visitor center-museum, campground and hiking trails. The town also has the Lyceum Theater, Missouri's oldest regional operating theater.



Starting in October 2006 the Jameson Island Chute project began which dramatically impacted the traffic on the road monitored by the inductive loop. Heavy equipment was transported down this road. Contractors conducting the work traveled up and down the road daily.

Circles represent traffic counter locations:

Lisbon Bottoms Unit

The traffic counter for the Lisbon Bottom Unit was placed on the access road to the parking lot. This parking lot is located off graveled Howard County road 317. The counter was not placed on the county road as the road is used for quarry operations moving rock from the quarry just down the road from the parking lot. Installed 1/3/2006.

This unit represents a more isolated situation for a refuge visitor. This survey area represents approximately 50 percent of our refuges public accessibility to refuge units. Several of our units are in isolated areas, and would represent a destination for the informed visitor. Occasionally a casual visitor would stumble across these locations.

Casual visitors traveling along the county road would possibly be enticed to pull off the county road to the parking lot as the information kiosk visible from the county road and signs directing visitors to it would spark visitors to pull into the area for more information. (See photo below of county road and access road to parking area.)

This counter proved to be the most consistent overall with counts that reflected overall use of the area.

The area receives considerable hunting during the Missouri firearms deer season. This information comes from direct observations from refuge Law Enforcement officer who patrols the area frequently during the season. All users do not use the parking lot as the county road provides access to numerous locations.



Big Muddy National Fish and Wildlife Refuge
Lisbon and Jameson Island Units
 Saline and Howard Counties 3,885 Acres
 website: www.fws.gov/midwest/bigmuddy



The map demonstrates how the county road serves as a hunting access along the east side of the property boundary in the Lisbon Unit. Many of the hunters who use the unit do not visit the parking lot as the desired hunting area may be closer to the county road. Several blocked roads into the unit provide enough room to park a vehicle. The shoulder of the county road provides areas to park as well

and hunters and other refuge users are likely to utilize these locations other than the parking area because it provides easier access to areas they want to utilize on the refuge. Direct observations on the amount of users that utilize the parking area verses the other access areas was difficult to obtain. A professional judgment of the use is approximately

25% of the refuge users in the area visit the parking lot to park or gather information from the kiosk.

Boone's Crossing Unit

The traffic counter at the Boone's Crossing unit is also located under the road into the parking area for the unit. Unlike the Lisbon unit this is more likely the only area hunters and other refuge specific users utilize to access the area. First installed 1/13/2006.

A large parking lot adjacent to the refuge lot was built by the city of Chesterfield to provide access for people to utilize ball playing fields built next to this refuge unit. The refuge receives occasional visitors that walk from that parking lot into the refuge, and thus are not counted. To offset that count it is assumed that some users of the ball fields may utilize the refuge parking lot because trees adjacent to the refuge parking lot provide shade for vehicles that the city parking lot does not. This is typical of the summer months when refuge use is at its lowest and ball field use is at its highest.



A new multipurpose paved trail built by the city of Chesterfield in 2007-08 on top of the levee adjacent to this unit will increase the use of the refuge by foot. A short refuge trail was built on the refuge with help from a local Girl Scout troop and a future trail counter would help to estimate use of the trail, which will likely increase as the new trail gets utilized and more users discover the refuge.



On this aerial photo and refuge outline in yellow the thickest red line represents Interstate 64. The medium red line represents the new multipurpose trail and the small red line represent a mulched trail on refuge and adjacent city property. Johnson Island of this unit is totally separated by a permanent side channel of the Missouri River. The island is getting used by hunters but seldom by other visitors. Mosely's landing provides a visitors information kiosk and access steps up the bank. The majority of the use in this unit of the refuge is on the 131 acre mainland parcel.

This unit is located in St. Louis County and within the city limits of Chesterfield. Chesterfield is a suburb of St. Louis and the area has seen dramatic growth in the last 10 years. The use of this unit is expected to grown as more people discover its location and use increases of the new multi-purpose paved trail.

Traffic Counter Success

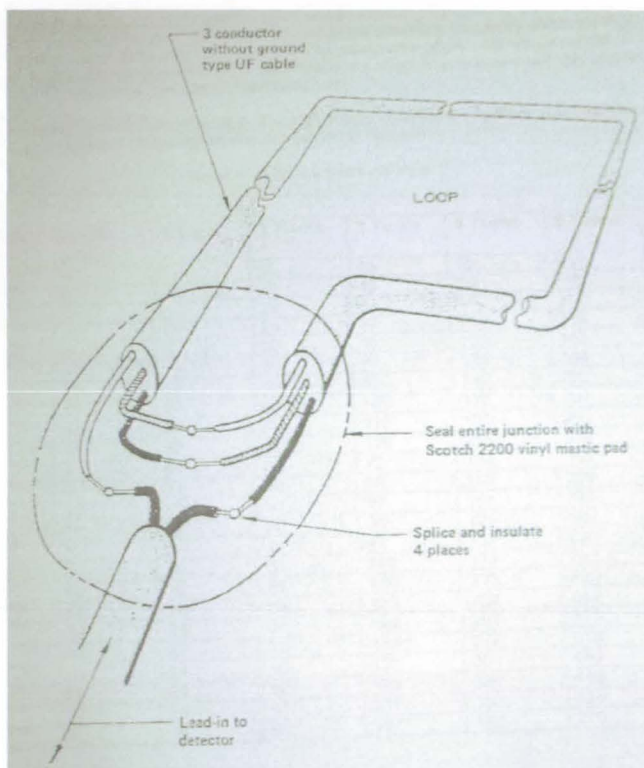
Over the two years that these counters have been installed there were wide variations in counts. Two inductive loop counters were damaged by water getting into the circuitry. The trail counter was also damaged by water that got into the circuitry by a whole chewed into the counters plastic case covering. Either a squirrel or mouse was the vandal in this situation.

Another problem encountered were the cables of the inductive loop counters would get wet where they were spliced together under the road bed. This would cause the counters to quit counting, or over count. All of the loops were dug up and re-spliced and sealed with and epoxy to make sure that water did not get into the spliced wire. The counts we more productive after the splices were sealed.



Diamond Traffic Products recommended tar to seal the splice. JB Weld Quickset epoxy or similar flexible epoxy was used to seal the splice. It provided a cleaner and quicker method than tar. After the two parts of the epoxy were mixed you had approximately 5 minutes to seal the splice before the epoxy set. The photo shows the sealed splice for the counter at Lisbon. Wire nuts were used in this case but butt splices were more effective and easier to tape after

the epoxy set. Epoxy was used to cover the entire splice and any exposed wire. After the epoxy set the entire splice was wrapped in electrical tape.



This diagram shows the formation of the inductive loop. This loop was typically buried under the gravel road at least 6 inches. The loop averaged 12 feet long by 6 feet wide. To complete the entire loop and lead into the counter required approximately 50 feet of wire. The wire was 14 AWG (American Wire Gauge). The wire is required to be in three strands insulated impervious to water, sunlight, and other destructive residues.

The wire is available at most retail home improvement centers and at the time of this writing was available for approximately .66 cents a linear foot.

Each counter will be described in detail and a summation of the counts will be formulated to the best professional judgment on the amount of use in the particular area of the traffic counter.

Overton Bottoms North Counter

The Overton Bottoms North counter was installed on December 22, 2005. The counter appeared to work steadily through June 2006. On June 19th, the inductive loop wire was dug up to the splice and filled with epoxy to keep water out of the connection under the road. After the splice was completed the traffic counter worked well after several crossing attempts.

On June 21st I checked the counter in the peak time of day. It was extremely hot 90 plus and the counter was not counting. I adjusted the delay without success. On June 27th I checked the counter again on a cooler part of the day and the counter counted my vehicle at each crossing. This lead me to the conclusion that there may be a problem with the counter under extreme conditions. I called the company and they informed me there may be a problem with the circuitry in the unit.

I was unable to test the unit until September 26th-27th To conduct the test I switched the Lisbon unit with the Overton Unit. The Lisbon counter was counting steadily but I concluded that the Overton count would be more beneficial so I switched the two. I got no improvement at Overton so I concluded that it had to be a problem with the inductive loop. I dug up the cable again and re-spliced the connection. This corrected the problem and the traffic counter continued with steady counts until May 8th 2007. In the meantime I replaced the batteries on this unit on April 14, 2007.

On May 8th I found that the traffic counter at Overton had been flooded with rainwater. My plan was to remove it due to the predicted flood crest on May 11th. The heavy rain events had saturated the ground enough to flood the counter before the flood waters of the river reached the counter. It was removed for replacement

The flood on May 11th reached the location of the counter at Overton. The wooden box that protected the counter floated out of the ground and was tethered by the inductive loop cable. If not it would have floated away. On May 17th Wedge Watkins and myself while inspecting the flood at Overton moved the box to a more secure location under a tree. The cable was disconnected from the box and dropped into the flood waters. The rest of the cable was still buried under the road and 2 feet of floodwater.

On May 21st I reconnected the Boone's Crossing counter to the Overton site. I removed the Boone's Crossing unit because of flood threat there as well. I found the cable and cleaned it and connected it to the counter on May 21st. The counter worked, the cable and splice had held after being under flood waters for over a week. The counter worked steadily through August 23rd. At some point between this date and August 4th the Cooper county road crew graded up the gravel road and ripped out the inductive loop cable in the

road. Fortunately the counter was not damaged. I scoured the road looking for the cable and finally found it in several pieces in the graded gravel along the side of the road.

The cable was reburied on September 22nd with help from scout troop 707. The digging was difficult but the scouts prevailed and the new cable was buried approximately 8 inches deep. Splices were sealed with epoxy. Sand was used to cushion the cable from the sharp rocks in the road around the cable in the ditch.

The traffic counter is currently counting to the date of this report.

Summary of Counts at Overton

Dates	Counts
12/22/05-8/21/06 8 months	8,802 = 1,100 visitors a month
9/27/06-4/19/07 7 months	7,144 = 893 visitors a month
5/21/07-8/23/07 3 months summer	4,327 = 1,442 visitors a month
9/22/07-1/9/08 4 months fall-winter	3,564 = 891 visitors a month

The traffic counter at Overton considers each count of the counter as a visitor even though the traffic counter counts each vehicle twice. Due to observations most vehicles contain at least two individuals. The peak of use at Overton is during the summer when days are longer and more traffic is visiting especially Taylors Landing boat ramp.

There is a slight rise during the hunting seasons between October through December of the average of 900 visitors a month but it is not significant. The low typically occurs between December and March where certain counts have dropped below 200 visitors per month.

The Missouri Department of Conservation (MDC) conducted a Missouri River Recreation survey from January 2004 to January 2005. In this survey, individuals were stationed at various Missouri River access points to establish some finite statistics on the recreational use of the Missouri River. One of the access points surveyed was Taylor's Landing. This landing is the access point in the Overton Bottoms North Unit of the refuge. In speaking with Steve Sheriff of MDC he informed refuge staff that he would probably have good estimates of use from Taylors Landing from March 2004 to January 2005. He would share that information when the entire project becomes finalized.

Jameson Island Unit

The Jameson Island unit traffic inductive loop counter was installed on December 21, 2005. The counter experienced some technical difficulty in the first few months of operation it would occasionally miss a count on checks. On June 12th 2006 the inductive loop wire was dug up and the connection was re-spliced and sealed with epoxy. The counter was reset to 0. The counter seemed to work correctly from that time on. It had

previously counted when the unit was bumped. The re-splicing also seemed to correct the problem.

In October of 2006 the Jameson Island Chute construction project started. This project slightly impacted the count on the road as the contractor used the access road exclusively to transport equipment and workers to the construction site.

On April 19th 2007 batteries of the unit were replaced, and the counter was reset to zero. The access road had apparent damage due to construction equipment traveling on the road.

Due to the construction project, and the malfunctions in the unit in the first months of operation, the best estimate on true traffic counts occurred between June and October of 2006.

Summary of Counts at Jameson Island Unit

Dates	Counts
12/21/05-6/12/06 6 months	4,389 = 732 visitors a month
6/12/06-12/12/06 6 months	4057 = 676 visitors a month
12/12/06-4/19/07 5 months, construction	6,530 = 1306 visitors a month
4/19/07-10/16/07 6 months construction	5,617 = 936 visitors a month
10/16/07-1/18/08 3 months (worst counts)	28,623 = 9541 visitors a month (invalid?)
6/12/06-10/23/06 4 months (best counts)	2,576 = 644 visitors a month

The extremely high count between October 2007 and January 2008 were possibly because of the movement of equipment from the construction project. The contractor was required to move all equipment off the site. A large earth mover parked and idling over the counter could have attributed to the extremely high counts?

Lewis and Clark Trail of Discovery

The infrared trail counter installed on the Lewis and Clark Trail of discovery has not produced any effective counts. The counter was damaged by a rodent, which allowed water to get into the unit. The reflector was continually moved and got in the way of mowing the trail. The counter was completely removed on September 20th 2006.

The counter was reinstalled on December 13th 2007, it was checked on January 18, 2008 and showed 429 counts. This is a possible number and needs to be correlated with more connections with people counts to deer counts. A trail camera could be placed at this location to get an idea of the amount of trail use by people vs. deer. It is possible that more counts will indicate more accurate use of the trail.

Lisbon Bottoms Counter

The Lisbon Bottoms Counter was installed on January 3rd 2006. Because of the remote location and requirement for the visitor to travel off the county road to the parking area the counts were expected to be low the other units. The first two months indicated that with approximately 240 visitors a month.

The next traffic counts showed extreme spike in counts for no apparent reason. The best count that was more indicative to the area was 130 in between May 18, 2006 to June 27 2006.

On March 3rd 2007 the cable at Lisbon was pulled and sealed. The counter was thoroughly checked after the flood on May 11th 2007 and was unaffected by the floodwaters. The counts after the cable was sealed seemed to reflect the more typical counts expected at this units parking area.

Summary of Counts at Lisbon Bottom Unit

Dates	Counts
1/3/2006-5/18/2006	7981 = 1596 visitors a month
5/18/06-6/27/06	130 = 130 visitors for month
6/27/06-12/13/06	6110 = 1018 visitors a month
12/13/06-03/07/07	9880 = 3293 visitors a month
03/07/07-5/21/07	367 = 183 visitors a month
5/21/07-11/28/07	721 = 120 visitors a month
11/28/07-1/18/08	140 = 70 visitors a month

The counts after the inductive loop was sealed appear to be more accurate than the high counts prior. The productive count during the May-June period in 2006 may have occurred during a period of favorable weather where the oxidation of the unsealed splice may have not been a concern.

After the inductive loop was sealed the higher counts in the spring were possibly attributed to the spring turkey hunting and the greater occurrences of casual drivers that tend to travel back roads in the spring to get out after the winter.

The total for a 10 month count came out to 116 visitors a month. The can also be interpreted to 58 vehicles a month utilizing the parking area over a 10 month period from March until January. As with the other two locations each vehicle is estimated to contain two visitors. The peak of visitation at this unit was probably during the firearms deer season. Direct observations from the refuge law enforcement officer counted up to 8 vehicles in the parking area at one time.

Boone's Crossing Counter

The Boone's Crossing counter was installed on January 13, 2006. This counter experienced numerous problems for the first year. Someone tampered with it and reset it within the first six months of its installation. On July 10th 2006 a wooden box was constructed and buried to conceal the counter from the public. Previously it had been hidden behind a large rock adjacent to the parking area. To check the counter from this point on required a ¼ hex head bit and drill to remove the board from the top of the box to check the counter.

This counter was not checked again until February 5, 2007. On that date a high recording of 15,282 was on the counter and it did not record any additional counts after several attempts. The counter was checked again on 3/14/07 and it had the same number as February. The counter was pulled from the box and was full of water. The electronics were in need of full replacement.

The constructed wooden box at one time had filled with rainwater and could not drain because of the high clay content in the soil. On 4/17/07 a repaired counter was reinstalled. A French drain was constructed under the box with a one inch pipe to allow draining of rain water from the box. The splice on the inductive loop wire was also sealed at this time. On 5/9/07 the counter had to be removed because of threat of the area to flooding. This counter was put at Overton after the flood waters receded. The repaired Overton counter was installed at Boone's Crossing on 6/12/07. The best counts on this counter were between April and May 07 and June through October 07. The additional counts will not be considered.

The last count taken at Boone's crossing was on 1/24/08. Another extremely high count had occurred which leads to concern that the counter has experienced another set back in counting.

Summary of Counts at Boone's Crossing Unit

Dates	Counts
4/17/07-5/9/07	860 = 860 visitors a month
6/12/07-10/14/07	746 = 186 visitors a month

The 186 visitors a month is the most probable count that can be considered for this counter. A short count between June 12 2007 and July 2 was taken showing 108 counts. The 860 count between April and June is probable as that covered Spring Turkey hunting and numerous counts during the final trail mulching project in which trucks crossed the counter numerous times on April 29th.

Summary

Traffic counters create challenges in interpreting the data collected. Numerous conditions can affect the count. They cannot inform you of the intended use of the visitor but they can give you an idea of visits.

The assumed successful counts taken from the inductive loop counters on the refuge will give the refuge a number of visitors to help understand impact to refuge resources, such as roads and parking areas. The average counts of 1200 visitors a month at Overton supported the refuge belief that this was our highest visited unit. Also the 600-800 visitors a month put the Jameson unit at half the visitors of Overton. Looking at vehicles, Overton is receiving an average of 20 vehicles per day and Jameson 12 vehicles per day.

The traffic counter at Boone's Crossing and Lisbon reflected visitors going specifically to the refuge parking area. The lower numbers of 95 visitors a month at Lisbon and 186 visitors at Boone's Crossing indicated that the parking areas are visited much less frequently but are still receiving an average of 1 to 2 vehicles per day.

To improve the future of the data it is recommended to gather information from the counters at least twice a month. This would help monitor monthly use and possibly show spikes in use that may correspond with hunting seasons, considered one of the highest uses of the refuge. A weekly count before and after weekends would help in monitoring possible increase use on the weekend.

Further collection of the data with existing counters will produce better statistics and help in monitoring problems that arise with the counters. Use of activity ratios to estimate visits for recreational or educational activities that are not monitored by traffic counters or direct head-count, including hunting, fishing, wildlife observation, photography, and other compatible uses. Acceptable sources of information for calculating activity ratios: Visitor Satisfaction Survey results, Surveys conducted by other agencies, visitor registers, law enforcement reports, especially for hunting and fishing. (Introduction to Visitation Estimation on National Wildlife Refuges and Wetland Management Districts) Dr. John B. Davis University at Albany, State University of New York.

The survey conducted by the Missouri Department of Conservation on the recreational use of the river will provide an excellent source to establish a visitor ratio at the Overton Bottoms Unit of the refuge.

Other methods considered in (Introduction to Visitation Estimation on National Wildlife Refuges and Wetland Management Districts) Dr. John B. Davis University at Albany, State University of New York.

Direct Observation

Direct observation means that the visitor is monitored visually or by video camera. One very common method of direct observation is to have a receptionist, volunteer, or staff member use a hand-held counter to tally each visitor who enters a visitor center or contact station. Direct observation is also used to calibrate traffic counters, determine activity ratios, and count the number of participants in programs. Obviously, direct observation can provide highly accurate counts, but can also be time-consuming. Direct observation in the field is indispensable when it is incorporated as a periodic supplement to other counting methods in order to obtain estimates of critical multipliers (such as the number of persons per vehicle) or activity ratios.

Patrols

In the patrol method, a refuge employee or volunteer walks, drives, or takes a boat to specific locations where visitors participate in recreational or educational activities. Typical locations for patrols include boat ramps, parking lots, and fishing areas. Patrols are the recommended method for use on wetland management districts. The purpose of a patrol is to observe a sample of visitors, vehicles, or boats at visitor use areas and extrapolate an estimate of the total number of visitors using those areas. Patrols can be specifically scheduled for this purpose, or they may be collateral to other duties, such as law enforcement patrols during hunting season. The greatest drawback to the patrol method is that it is time-consuming, but for refuges that have too many areas to monitor with traffic counters, patrols may be the best solution.

Self-Registration

Applications of this method include: guest books at visitor centers, trail registers, and voluntary permits for hunters or anglers. The respondent may be asked to indicate the number of persons in the party, the types of activities selected, and the length of his or her stay. Information about the types of activities selected is particularly helpful because it can be used to estimate activity ratios. Self-registration tools are inexpensive and may be the only feasible methods at remote trailheads or parking areas. However, accuracy of the counts is always limited by uncertainty about the degree of compliance. Many visitors do not bother to register. Repeat visitors and local residents are highly unlikely to register each time they visit.

Entrance Fee Stations and Permits

Entrance fees may be collected at a staffed entrance station, a visitor center, or a self-pay station such as an "iron ranger." Examples of user permits, both with and without fees, include campground registration, permits for river access, and hunting permits (such as

those assigned by lottery for specific areas). User permits can be very accurate sources of information for particular activities, such as boating or hunting, especially if the refuge devotes sufficient time to permit checks and enforcement. Entrance fees are also a valuable source of data regarding trends in the number of visitors, but they do not provide complete information about the number of visitors unless there is a staffed fee booth where all visitors must stop before entering the refuge. The entrance fees collected at a self-pay station usually can not be used to estimate the total number of visitors to a refuge.

Surveys

Surveys include mail-back questionnaires placed on windshields; traffic-stop surveys conducted by volunteers, contractors or staff; contracted telephone or mail surveys; and hunter reports at check-in stations. Surveys are very accurate if properly conducted. They can provide a wealth of information about the number of persons per vehicle, the type of activity in which each party participates, and even marketing data, such as demographics and activity preferences. However, surveys performed by contractors are expensive. One additional complication is that visitor surveys must be approved through a formal procedure requiring significant advance notice.

Indirect Estimation Based on Professional Judgment

This method includes two types of estimation: (1) extrapolating the total number of visitors to the refuge or the number participating in a specific activity, using a very small sample of visitors and (2) estimating visitor numbers based on an assumption about the visitors' behavior. This is the least accurate method of visitation estimation, but there are cases where no other method is practical, especially for remote and roadless refuges. The manager who uses these methods should strive to make the most reasonable estimates possible and document the logical reasons for the estimates

Appendix D



Establishment and Sampling of Permanent Vegetation Monitoring Plots at Big Muddy National Fish and Wildlife Refuge

By Matthew Struckhoff

Administrative Report

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
Dirk Kempthorne, Secretary

U.S. Geological Survey
Mark Meyers, Director

U.S. Geological Survey, Reston, Virginia 2007

For product and ordering information:
World Wide Web: <http://www.usgs.gov/pubprod>
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth,
its natural and living resources, natural hazards, and the environment:
World Wide Web: <http://www.usgs.gov>
Telephone: 1-888-ASK-USGS

Suggested citation:

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this report is in the public domain, permission must be secured from the individual copyright owners to reproduce any copyrighted material contained within this report.

Contents

Contents	iii
Acknowledgements:.....	iv
Abstract	1
Introduction	1
Methods	3
Data Collection	3
Data Summary	4
Results.....	4
General.....	4
Diversity Measures	5
Products/Deliverables	5
Discussion	5
Future Sampling Modifications.....	5
Potential Modifications to Plot Markers.....	6
Future Sampling Effort.....	6
Identification Uncertainty	7
References Cited	7
Appendix A	A

Figures

Figure 1. Location of management units and number of plots sampled at each for Big Muddy National Fish and Wildlife Refuge, Missouri, USA.	8
Figure 2. Plot center monumentation.	8
Figure 3. Beyond NAWMA Plot design.	9

Tables

Table 1. Distribution of plots at Big Muddy National Fish and Wildlife Refuge.	9
Table 2. Plot locations at Big Muddy National Fish and Wildlife Refuge.	10
Table 3. Alphabetical species list with number of occurrences overall and by site.....	12
Table 4. 20 species most frequently in top five in cover within a plot and mean cover.....	16
Table 5. Additional species collected at Big Muddy National Fish and Wildlife Refuge.....	16
Table 6. Mean species richness by site and combined.	17
Table 7. Mean Shannon Diversity by site and combined.....	17

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
yard (yd)	0.9144	meter (m)
Area		
acre	4,047	square meter (m ²)
acre	0.4047	hectare (ha)
square foot (ft ²)	0.09290	square meter (m ²)

SI to Inch/Pound

Multiply	By	To obtain
Length		
centimeter (cm)	0.3937	inch (in.)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)
Area		
square meter (m ²)	0.0002471	acre
hectare (ha)	2.471	acre
square meter (m ²)	10.76	square foot (ft ²)

Acknowledgements:

The author would like to express his gratitude to Keith Grabner, who provided advice on data collection methods and assisted with field work. Also, I would like to thank Michael Mac, Director of the Columbia Environmental Research Center, who agreed to fund this research effort.

Establishment and Sampling of Permanent Vegetation Monitoring Plots in Herbaceous Communities at Big Muddy National Fish and Wildlife Refuge

By Matthew Struckhoff¹

Abstract

Vegetation sampling points originally sampled in 2002 and 2003 were revisited in late summer 2007, to establish permanent plots and to collect baseline data for long-term ecological monitoring at Big Muddy National Fish and Wildlife Refuge. Plot design followed the Beyond NAWMA Circle plot design recommended by the National Institute of Invasive Species Science. Sixty-seven plots were installed at the approximate location of sample points within communities that had been designated as “wet prairie” for sampling during 2002 and 2003. The location of each sample point was recorded using handheld GPS receivers, and permanent markers were installed at plot center to allow future resampling. Sampling documented 166 species on the refuge. Approximately 130 voucher specimens were collected and dried to serve as documentation for many of the species encountered. Additional summary data are provided in this document.

Introduction

In 2002 and 2003, as part of an effort to characterize bird habitat, vegetation at Big Muddy National Fish and Wildlife Refuge (Big Muddy) was sampled in three very coarse vegetation types. “Early successional forests” included all forests with high stem densities of early successional tree species such as cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), and silver maple (*Acer saccharinum*). This classification as applied at Big Muddy also included communities dominated by shrubs and trees from the genus *Salix* (willow). “Mature forests” included many of the same species, though with more mature trees, with taller canopies, lower stem densities and larger stem diameters. These were typically limited to low lying swales and floodplain margins that had not been cleared for agricultural purposes, as well as levees. “Wet prairies” included all herbaceous communities that lacked a significant amount of woody vegetation (little or no tree canopy). Areas designated as wet prairies were dominated by former agricultural fields. Prior to sampling in 2002 and 2003, these three types were delineated using aerial photos of the management units of Big Muddy. It should be noted, however, that the resolution of this remote sensing effort was coarse, such that areas delineated as one type of community often included

¹ U.S. Geological Survey—Columbia Environmental Research Center, 4200 New Haven Rd, Columbia, MO 65201
Phone: 573-441-2781; Fax: 573-876-1896; E-mail: mstruckhoff@usgs.gov

examples of one or both of the other community types. Sample points were then distributed at regular intervals throughout each of the delineated areas.

Areas designated as wet prairie in 2002 were sampled at that time using methods that were intended to provide information on the structure of vegetation, rather than on the particular species present or the amount of diversity within plots or particular communities. Accordingly, estimates of cover were provided only for the following coarse vegetation groups; sedges, grasses, forbs, woody plants, litter and bare soil. Litter depth measurements and measures of visual obscuration were also taken. Other than two species of interest—cattail (*Typha* spp.) and reed canary grass (*Phalaris arundinacea*)—no data on individual species were collected. Collection methods used in 2002 and 2003 are described in Appendix A.

In 2007, limited funds were made available by the USGS-Columbia Environmental Research Center (USGS) to establish and collect data at permanent vegetation monitoring plots at Big Muddy. USGS staff, in consultation with Big Muddy biologists, identified a number of objectives for this effort:

1. Establish permanent vegetation monitoring plots
2. Adopt a sampling method that could easily be used by temporary staff with a minimal amount of training
3. Collect baseline data on newly established plots
4. Allow detection of changes in exotic species abundance
5. Compare data from 2002-2003 to current vegetation data
6. Provide species-level data for analysis of communities using ordination techniques

The final provision was included in order to provide data that would inform an ongoing vegetation mapping project on the refuge.

We determined that using the methods employed in 2002 and 2003, though appropriate for comparing vegetation between 2002-2003 and now, would not provide data sufficient to meet the current needs of refuge management. Further, it was determined that additional sampling within the various subtypes of herbaceous communities present on the refuge would be desirable. Therefore, we decided that installation of additional plots not associated with previous sampling locations would be appropriate. It was also determined that some comparison of vegetation data between 2002-2003 and present would be appropriate, and that resampling at the approximate location of previous sampling would allow for that type of comparison, despite the changes in methodology and the low likelihood of sampling in the exact locations that sampling had been conducted previously. Finally, it was determined that while data would be collected in a manner that would allow comparisons between vegetation in 2002-2003 and now, insufficient funds were then available to perform the necessary data analysis.

In order to meet the above objectives, we adopted the Beyond NAWMA Circle plot design, one of many endorsed by the National Institute on Invasive Species Science (NIISS; 2007) (<http://www.niiss.org/cwis438/websites/niiss/Home.php?WebSiteID=1>). The plot design—see methods section below—is simple to set-up, can be easily modified to account for data collectors less-skilled in plant identification, and provides enough data to allow for the detection of changes in exotic species abundance. Furthermore, it is similar enough to the methods used in 2002-2003 to allow for coarse comparisons between vegetation then and now. Finally, the plot design selected

provides enough species-level data to allow for ordination analysis for the ongoing vegetation mapping project.

Methods

Data Collection

Five management units were sampled (Figure 1); Jameson Island, Lisbon Bottoms, Overton Bottom, St. Aubert Island and Boone's Crossing. Sampling was limited to those communities that had been designated as wet prairie in 2002 and 2003, except at Boone's Crossing, where sampling was conducted in herbaceous communities identified using 2006 USDA National Agricultural Imagery Program data obtained from the Missouri Spatial Data Information Service (MSDIS, 2007). Data collection was initiated during July, 2007, with the bulk of the sampling occurring between August 22 and October 12. Typically, vegetation sampling would have occurred earlier in Missouri, but flooding of the Missouri River during June of 2007 prevented access to many of the sites and delayed plant development. As a result, plants had not developed enough to allow for adequate identification in the field until approximately August 1.

We used GIS data and handheld global positioning system (GPS) receivers to find the approximate locations of plots sampled in 2002 and 2003. We used Magellan (Thales) ProMark 3 GPS receivers with an external NAP100 antenna (Magellan, San Dimas, CA). This system achieves sub-meter, post-processed accuracy, well within the needs of current management goals and the goals of this research. The location of the new plot center was also recorded by noting the height of the antenna above the ground and taking GPS reading for the duration of plot vegetation sampling.

Plot center was permanently marked (Figure 2). A 10 foot section of UV-resistant, PVC electrical conduit was cut approximately 0.6 m (2 ft) from the flared end. A 15 cm piece of 3/8 in rebar was placed through a hole drilled just below the flared end. A piece of corrosion resistant wire was used to secure the rebar and to attach a corrosion resistant tag engraved with the plot name. This item was then driven into the ground until the rebar was flush with the ground, with the flared end of conduit sticking up. The remaining segment of conduit (approximately 2.4 m in length) was then nested in the exposed, flared end of the buried conduit to enable rapid relocation of plot center. The rebar is included to allow for relocation of the plot center using a metal detector, should the more visible portions of the monument become lost or obscured (for example, as a result of flooding).

The Beyond NAWMA Plot (Figure 3) used in this study is a 7.32 meter, fixed radius plot, with a total sample area of 168 m². Three transect lines are located on the 30°, 150°, and 270° azimuths from plot center, radiating out to the plot edge. Transects are temporarily flagged at the outer terminus to delineate the perimeter of the plot. Vegetation quadrats (1 m²) are located on the clockwise side of each transect with two of their corners at 4.57 m and 5.57 m (15 ft and 18.3 ft) along the transects. These corners are permanently marked using survey flags with metal pins.

Within each quadrat, we identified all species present and estimated the percent cover of each species to the nearest 1 percent. We also estimated to the nearest 1 percent the cover for each of the following microhabitat variables: dead wood, dung, fungus, lichen, litter/duff, live tree bole and visible roots, mineral soil/sediment, moss, road, rock, standing/flooded water, stream and trash/junk. Within the 7.32 m radius plot, we recorded as present all identified species that were not previously recorded in the quadrats. We also identified to species and recorded the diameter at breast height (dbh) of all woody stems that have a dbh. We estimated total canopy cover for the

plot, and recorded the following environmental data for the plot: slope, aspect, elevation, distance to water, distance to road, and distance to crops. We also noted any human or other animal disturbance. Finally, we collected photographs from plot center oriented along each of the three transects. Each photo includes an indication of the plot and the transect. Plant nomenclature followed the USDA-PLANTS database (USDA, NRCS 2007)

Data collected departed from the Beyond NAWMA Circle plot design only in the fact that we did not record the azimuth and distance to individual woody stems with a dbh. Collection of such information greatly increased the time needed for field data collection and provided information that was not believed to be important for either the current management needs of the refuge or for the objectives of this research effort.

Data were collected using the EcoNab data collection tool (available free from the NIISS website) on handheld PDAs with the Palm™ operating system. This program includes numerous features designed to ensure data quality, including required-entry data fields, a subprogram to aid in the management and identification of unknown species, and regionally customizable look-up tables for species. Data were downloaded to and managed within the VegSurvey Database (.mdb format), also available free from the NIISS website.

Data Summary

We calculated species richness (the number of species detected) and Shannon Diversity (H') for each plot:

$$H' = \sum_{i=1}^S \left(\frac{n_i}{N} \ln \left(\frac{n_i}{N} \right) \right)$$

where S is the total number of plant species, n_i is the cover of the i th plant species, and N is the combined cover of all plant species. Mean species richness and mean Shannon Diversity were calculated for each site.

Results

General

Sixty-seven plots were installed and sampled on five units of the Big Muddy National Fish and Wildlife Refuge (Figure 1; Table 1). Nineteen new plots were installed at locations not associated with sampling in 2002 and 2003. Most plots (34) were located at the Overton Bottoms unit (OVN), where the largest expanses of herbaceous communities are to be found. All sites included at least a few plots that were located in communities dominated by woody vegetation (trees and shrubs), despite the fact that all plots were characterized as being within herbaceous communities, either in 2002-2003 or based upon photo-interpretation prior to the current sampling effort.

GPS data were collected at all plots (Table 2). The duration of GPS sampling ranged from 2.6 to 64.7 minutes, with a mean value of 24.9 minutes. GPS data from all but 13 plots were post-processed using Continually Operating Reference Station (CORS) differential correction data downloaded from the NOAA National Geodetic Survey website (2007; <http://www.ngs.noaa.gov/CORS/Data.html>). Data from the Lathrop, MO station (LTHM) were used to differentially correct data from the Lisbon Bottoms, Overton Bottoms, and Jameson Island units, while St. Aubert Island and Boone's Crossing data were corrected against CORS data from the Bloomfield, MO station (BLLM). Estimated horizontal error for corrected data ranged from

0.241 m to 2.54 m (mean = 0.5496 m). Estimated vertical error ranged from 0.219 m to 2.072 m (mean = 0.6149 m). Positional Degree of Precision (PDOP) estimates ranges from 1.27 to 3.15, with a mean value of 1.8 (no units).

Diversity Measures

One hundred fifty four species were recorded in plots during sampling in 2007. An additional eleven specimens collected during sampling remain to be identified to species, as of December, 2007. Table 3 lists the recorded species and indicates the number of plots where each was recorded, both for the entire sampling effort and by individual sites. Table 4 lists the twenty species that most frequently were recorded as within the top five species by vegetative cover within plots. Fifteen additional species were collected outside of plots at various locations within the refuge (Table 5). These specimens were collected as voucher specimens for a collection of plants from the refuge.

Mean species richness values ranged from 16.88 species per plot at Boone's Crossing to 28.80 species per plot at Jameson Island (Table 6). Overall mean species richness was 21.21. Mean Shannon Diversity measures ranged from 1.49 at Lisbon Bottoms to 1.99 at Jameson Island (Table 7). Overall mean Shannon Diversity was 1.59.

Products/Deliverables

In addition to this report, the research has yielded a number of products that were delivered in electronic format on compact disc to the Big Muddy refuge before the start of calendar year 2008:

- ☐ C2CBM Veg Data.mdb-A project specific version of the NIISS VegSurvey database (NIISS, 2007)
- ☐ Help files for the above database
- ☐ Plot photos (.jpg)
- ☐ C2CBM Plots.shp-A shapefile indicating the location of plots

The first item includes numerous pre-defined queries, forms and report generating tools that will enable simple comparisons between data collected for this project on the one hand, and either previously collected data or data from future sampling on the other. The summary data and diversity measures presented in this report were generated using these tools in the database. The second item provides a photographic record of the appearance of plots during this sampling effort, and will enable photo-based descriptions of coarse changes in vegetation following future sampling. The final product listed above will enable easy relocation of plots using GPS receivers.

Discussion

Future Sampling Modifications

The Beyond NAWMA Plot design used in this study can be modified in a variety of ways. In particular, the amount of data collected during each sampling event can be altered to allow data collection by persons with varying abilities in identifying vegetation. Future sampling may be directed toward species-level identification (as during this sampling effort), or it can be modified to record information on broad categories of vegetation (such as those used in 2002 and 2003).

Another option would be to focus efforts on the detection of target species (invasive, non-native species or species of concern).

Future data analysis would benefit from the acquisition of additional environmental data sets. First, it is commonly held that, within floodplains of the Missouri River, a change in elevation of as little as 15 cm can have a profound impact on vegetation communities. Therefore, high resolution elevation data, particularly at plot locations, would benefit future analysis. Second, data relating to surface and subsurface soil types would also be valuable. The Access database (C2CBM Veg Data.mdb) allows for collecting additional data beyond those collected during this sampling effort. Help files associated with the database and other information from the NIISS website (NIISS, 2007) provide information on how to modify the database to facilitate field entry of additional data.

Nevertheless, with the transfer of products from USGS to Big Muddy, refuge staff will have a very useful tool in the C2CBM Veg Data database. It includes regional species lists that can be easily updated by manually entering new species or by visiting the NIISS website (NIISS, 2007) and downloading relevant state species lists. Further, the database contains many pre-structured queries, forms and reports to facilitate data analysis and reporting of results. (Many of the tables in this report were modified from the products of these tools.) Blank VegSurvey.mdb databases (upon which the C2CBM Veg Data.mdb database is based) can be downloaded from the NIISS website (NIISS, 2007).

Potential Modifications to Plot Markers

Other modifications that may be made include the use of metallic, rather than PVC conduit to permanently mark plots. Our choice of PVC pipe in conjunction with steel rebar was based on 1) the fact that this offered the simplest, least expensive option for marking plots and 2) our perception that this arrangement would allow future researchers to locate plot center using a metal detector, should the upper portion of the monument become lost or obscured (for example, due to flooding). Regarding the first point, connecting pieces of aluminum conduit required the purchase and use of additional fasteners, increasing both effort and cost. Regarding the second point, we were not sure that aluminum conduit would create a detectable signal on a metal detector, and the option of drilling through aluminum conduit to insert a rebar was more difficult than doing the same on PVC. Additionally, the upright PVC poles of the current marking system have two advantages over aluminum. First, their flexibility increases the likelihood that markers will survive flood events and high winds, the most likely disturbance events on the floodplains. Second, the posts are not permanently attached to the base, which both enables their simple removal to perform management actions such as mowing, and decreases the likelihood that the entire monument would be removed in a disturbance event (due to the higher likelihood of the top separating from the base). However, it is not known how this marking system will prevail in the face of changing management practices on the refuge. In particular, prescribed and natural fires might reasonably be expected to damage plot markers.

Future Sampling Effort

This study has provided the baseline data necessary to begin tracking long-term ecological change on the refuge. As such, continued sampling of herbaceous communities is important. However, the plots established at Big Muddy are located primarily in herbaceous communities. Therefore, future sampling may wish to focus on wooded communities and poorly sampled herbaceous communities, in order to compliment the current sampling effort and to provide

baseline information on a broader array of community types. Subsequent to the establishment of plots in all community types of interest, the next logical step would be to establish a rotating sampling scheme within which a subset of plots within each community type are sampled at a regular basis (for example, annually), and all plots get sampled at least once every five to ten years.

Identification Uncertainty

Uncertainty remains regarding the identification of plants within a few genera and families. Among these are included members of the genus *Symphyotrichum* (*S. lateriflorus*, *S. pilosus*, and *S. subulatus*, all formerly in the genus *Aster*), as well as plants belonging to the family Convolvulaceae (*Ipomoea lucunosa*, *I. pandurata* and *Calystegia sepium*, the latter of which was documented during the study, but not within plots). The *Symphyotrichum* genus proved exceptionally difficult to identify to species, even when flowers were present. Plants from the Convolvulaceae were not difficult to identify to species when flowers were present, but it frequently was necessary to apply a species identification based solely on vegetative characteristics. The plants identified as *Morus rubra* and *Muhlenbergia sobolifera* are placeholders that serve to indicate the presence of species from each genus. Without flowers, identification to species is suspect, though the most likely species has been indicated. Initially we had used the place holder *Cirsium vulgare* to indicate the presence of species from that genus. However, later identification in the lab, based solely upon remnant flower heads from the previous growing season, indicated that the only species that is likely extant in the study area is *C. altissimum*. However, given the poor condition of these flower heads, the species classification is suspect. Furthermore, the fact that they flower heads were found only at a few plots, it is possible that other species from the genus *Cirsium* may be extant in the study area. All species' identifications for which uncertainty remains should be confirmed in plots were they have been documented during future sampling efforts.

References Cited

USDA, NRCS. 2007. The PLANTS Database (<http://plants.usda.gov>, 5 December 2007). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

National Institute on Invasive Species Science (NIISS) website. 2007.

<http://www.niiss.org/cwis438/websites/niiss/Home.php?WebSiteID=1>). USGS Fort Collins Science Center, Fort Collins, Colorado.

NOAA National Geodetic Survey website. 2007. (<http://www.ngs.noaa.gov/CORS/Data.html>).

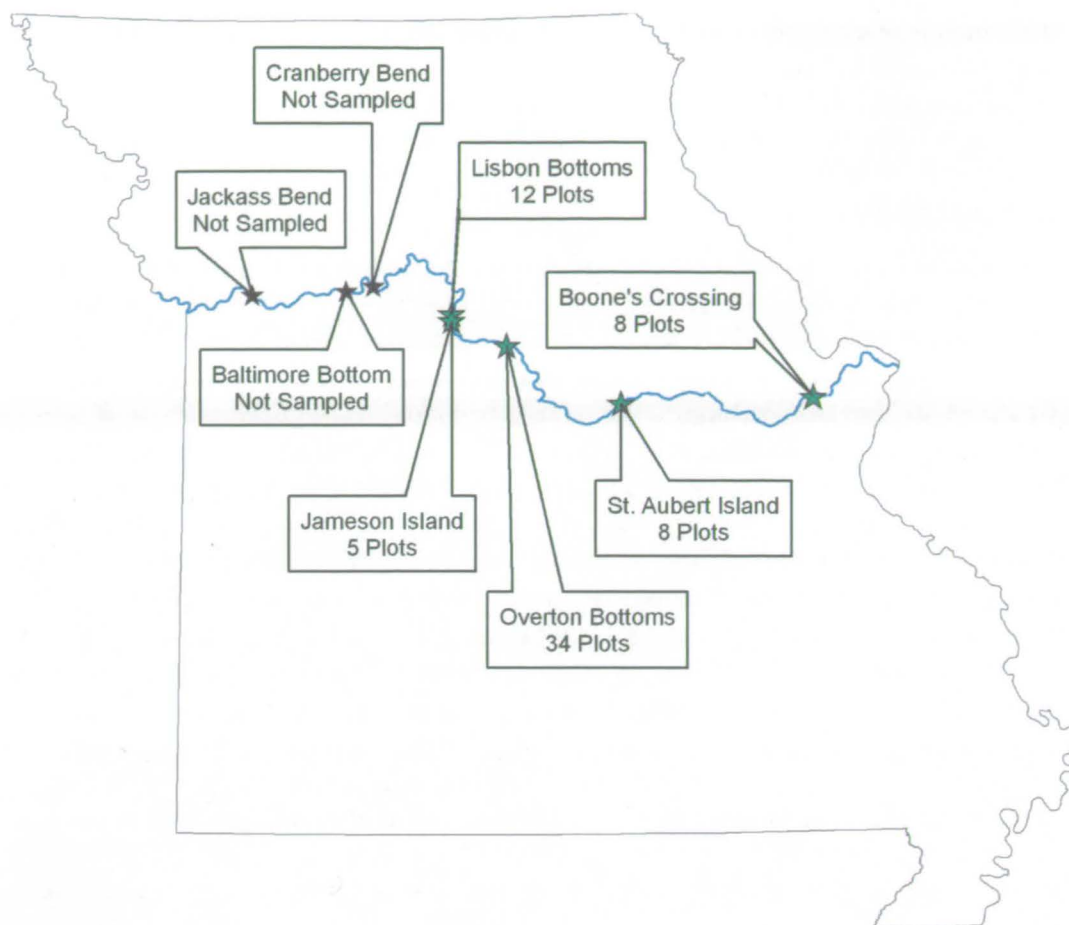


Figure 1. Location of management units and number of plots sampled at each for Big Muddy National Fish and Wildlife Refuge, Missouri, USA.

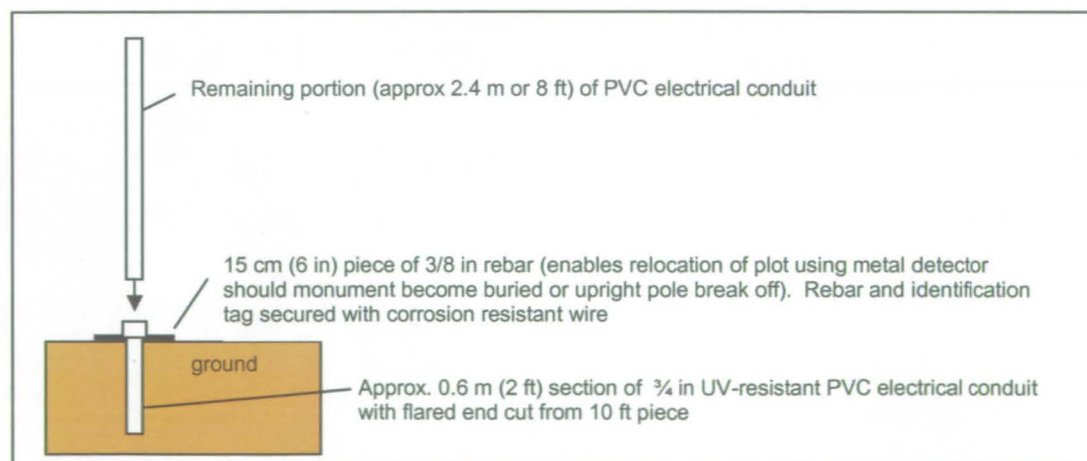


Figure 2. Plot center monumentation.

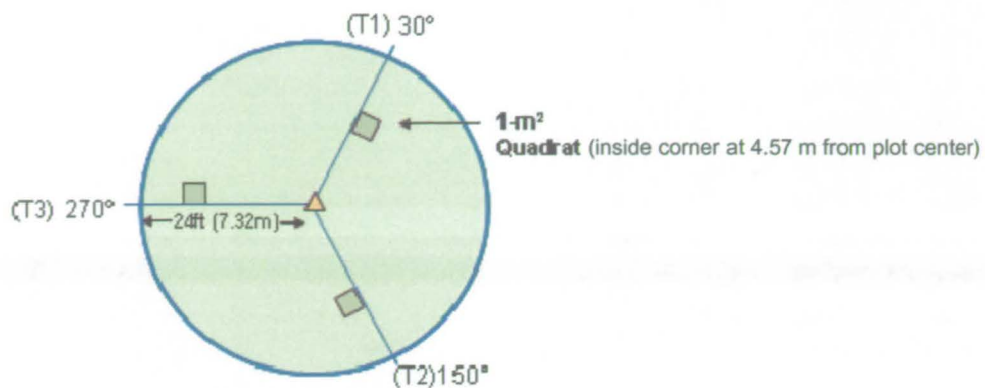


Figure 3. Beyond NAWMA Plot design.

Table 1. Distribution of plots at Big Muddy National Fish and Wildlife Refuge.

Site ¹	Total Plots	New Plots	Plots in woody dominated communities	Plots in herbaceous communities	CORS data correction station
Overton Bottoms	34	7	5	29	Lathrop, MO (LTHM)
Lisbon Bottoms	12	0	4	8	LTHM
Jameson Island	5	0	4	1	LTHM
St. Aubert Island	8	4	4	4	Bloomfield, MO (BLMM)
Boone's Crossing	8	8	2	6	BLMM

¹ Cranberry Bend, Jackass Bend and Baltimore Bottom were not sampled.

Table 2. Plot locations at Big Muddy National Fish and Wildlife Refuge.

All spatial measurements are in meters. Universal Transverse Mercator, Zone 15N, WGS 84.

Plot	Site	Easting	Northing	Hor. Error	Altitude	Vert. Error	PDOP	Duration
BC1	Boone's Crossing	704797.41	4284170.68	0.60	122.75	0.61	1.85	00:21:39
BC2	Boone's Crossing	704708.56	4284118.29	0.63	122.19	0.72	1.63	00:14:11
BC3	Boone's Crossing	704696.06	4283998.48	0.77	125.15	0.86	2.10	00:25:50
BC4	Boone's Crossing	705026.42	4284174.06	0.56	124.10	0.65	1.93	00:22:09
BC5	Boone's Crossing	705001.60	4283918.51	0.64	123.36	0.62	1.87	00:10:27
BC6	Boone's Crossing	704860.56	4283903.51	0.61	123.96	0.65	1.56	00:21:01
BC7	Boone's Crossing	704702.21	4283779.74	0.88	125.12	1.18	2.08	00:10:15
BC8	Boone's Crossing	704765.88	4283653.95	0.67	124.98	0.80	1.70	00:20:05
JAM55	Jameson Island	505668.65	4326228.33	0.00	150.79	0.00	1.75	00:36:54
JAM56	Jameson Island	505441.62	4324980.08	0.00	151.06	0.00	1.50	00:46:46
JAM57	Jameson Island	505497.68	4325976.50	0.00	150.18	0.00	1.27	00:46:43
JAM58	Jameson Island	505416.40	4325538.98	0.00	154.43	0.00	1.77	00:52:39
JAM59	Jameson Island	505421.98	4325262.88	0.00	158.43	0.00	1.56	00:42:01
LIS17	Lisbon Bottoms	506704.89	4329816.88	0.36	171.10	0.30	3.06	00:10:57
LIS18	Lisbon Bottoms	506968.78	4329726.95	0.24	171.04	0.22	2.03	00:38:00
LIS26	Lisbon Bottoms	506850.98	4329454.85	0.67	173.23	0.63	1.55	00:05:18
LIS43	Lisbon Bottoms	506817.49	4328061.22	0.38	170.20	0.28	1.27	00:31:41
LIS47	Lisbon Bottoms	506562.92	4327995.55	0.33	170.41	0.34	2.08	00:34:42
LIS49	Lisbon Bottoms	506343.80	4329156.43	0.33	171.76	0.29	1.40	00:43:44
LIS50	Lisbon Bottoms	506509.98	4329485.65	0.45	171.80	0.47	1.86	00:24:21
LIS51	Lisbon Bottoms	506038.61	4328422.45	0.46	171.71	0.50	1.84	00:31:02
LIS52	Lisbon Bottoms	506456.63	4328298.44	0.63	171.76	0.93	1.75	00:37:48
LIS54	Lisbon Bottoms	506328.03	4328085.13	0.44	170.93	0.50	1.80	00:15:11
LIS55	Lisbon Bottoms	506494.23	4328636.80	0.30	170.91	0.28	1.94	00:28:56
LIS56	Lisbon Bottoms	506279.65	4328511.12	0.36	172.92	0.32	1.39	00:21:56
OVN001	Overton Bottoms	537488.31	4311047.81	0.35	162.61	0.38	1.92	00:23:18
OVN002	Overton Bottoms	538394.28	4312038.09	0.00	145.66	0.00	3.15	00:24:48
OVN004A	Overton Bottoms	537568.87	4312470.61	1.39	164.49	2.07	1.71	00:46:10
OVN007A	Overton Bottoms	537472.71	4312049.36	0.75	158.50	0.91	2.00	00:11:16
OVN009	Overton Bottoms	538099.25	4311978.77	0.00	143.46	0.00	2.16	00:32:41
OVN009A	Overton Bottoms	537646.65	4311567.59	0.61	160.38	0.57	2.20	00:47:44
OVN010	Overton Bottoms	537775.77	4312111.98	0.33	162.62	0.29	1.55	00:39:59
OVN011	Overton Bottoms	537098.21	4311187.80	0.59	158.17	0.66	2.29	00:19:35
OVN013A	Overton Bottoms	537331.39	4312576.14	0.78	159.48	0.96	2.03	00:13:24
OVN014	Overton Bottoms	537417.79	4311390.62	0.72	158.12	1.02	3.08	00:13:08
OVN014A	Overton Bottoms	537292.86	4312304.68	0.32	163.32	0.27	1.33	00:42:01
OVN016	Overton Bottoms	537773.06	4311704.55	0.61	159.94	0.68	2.04	00:21:36
OVN016A	Overton Bottoms	537990.74	4311546.00	0.72	160.17	1.03	2.64	00:17:00
OVN018	Overton Bottoms	536441.29	4311931.63	0.00	142.97	0.00	2.16	00:30:02

Plot	Site	Easting	Northing	Hor. Error	Altitude	Vert. Error	PDOP	Duration
OVN018A	Overton Bottoms	538342.52	4311804.94	2.54	161.06	0.76	1.86	00:42:42
OVN019	Overton Bottoms	536579.92	4311492.42	0.35	162.86	0.30	1.59	00:44:40
OVN039	Overton Bottoms	539032.47	4312318.11	0.00	145.27	0.00	1.46	00:47:39
OVN073A	Overton Bottoms	538636.55	4311970.65	0.59	159.28	0.64	1.70	01:04:47
OVN086	Overton Bottoms	537256.77	4311969.72	0.66	158.10	0.93	2.40	00:15:03
OVN091	Overton Bottoms	537320.91	4310942.43	0.39	163.18	0.32	1.52	00:23:59
OVN200	Overton Bottoms	536347.55	4311598.57	0.40	162.90	0.36	1.63	00:10:57
OVN201	Overton Bottoms	536379.41	4311977.37	0.40	164.68	0.35	1.38	00:21:56
OVN203	Overton Bottoms	536681.23	4311598.34	0.38	163.93	0.44	2.31	00:20:45
OVN206	Overton Bottoms	537736.40	4311242.81	1.12	158.85	1.17	2.16	00:20:53
OVN208	Overton Bottoms	537374.33	4311725.63	0.29	162.84	0.28	2.03	00:34:21
OVN211	Overton Bottoms	536180.61	4311865.66	0.36	164.28	0.33	1.50	01:03:03
OVN212	Overton Bottoms	535917.77	4311958.03	0.38	163.62	0.43	2.07	00:15:04
OVNHERB031	Overton Bottoms	536176.49	4312252.94	0.30	163.56	0.30	2.07	00:30:54
OVNHERB033	Overton Bottoms	536428.79	4312534.39	0.00	142.86	0.00	1.50	00:28:56
OVNHERB034	Overton Bottoms	536386.10	4312217.61	0.36	164.54	0.33	1.91	00:17:35
OVNHERB035	Overton Bottoms	536593.79	4312457.68	0.00	142.87	0.00	1.87	00:18:06
OVNHERB040	Overton Bottoms	536846.91	4312180.86	0.00	143.57	0.00	1.57	00:38:31
OVNHERB073	Overton Bottoms	538133.76	4312431.84	0.35	163.04	0.30	1.49	00:17:59
OVNHERB078	Overton Bottoms	537870.99	4312420.25	0.79	159.82	0.89	1.91	00:12:09
STA13	St. Aubert Island	601874.67	4281200.30	0.64	145.70	0.59	1.38	00:11:27
STA14	St. Aubert Island	600730.00	4280547.00	0.00	128.00	0.00	0.00	
STA15	St. Aubert Island	602315.34	4281419.97	1.07	150.08	1.62	1.95	00:02:37
STA16	St. Aubert Island	601446.79	4280919.19	0.44	146.32	0.45	1.90	00:21:02
STAHERB1	St. Aubert Island	602111.49	4281288.55	0.61	146.00	0.73	2.06	00:06:56
STAHERB2	St. Aubert Island	601962.07	4281133.47	0.57	146.18	0.53	1.61	00:35:21
STAHERB3	St. Aubert Island	601603.36	4280909.03	0.62	147.52	0.67	1.70	00:12:14
STAHERB4	St Aubert Island	601460.47	4280841.78	0.60	146.25	0.68	1.99	00:14:49

Table 3. Alphabetical species list with number of occurrences overall and by site.

Non-native species are shown in bold.

USDA Code	Scientific Name	Common Name	Voucher?	Species Occurrences by Site ¹ (n)					
				All Sites (67)	BC (8)	JAM (5)	LIS (12)	OVN (34)	STA (8)
abth	<i>Abutilon theophrasti</i>	velvetleaf	Y	6	0	0	0	6	0
acrh	<i>Acalypha rhomboidea</i>	common threeseed mercury	Y	15	1	2	2	4	6
acne2	<i>Acer negundo</i>	boxelder	N	23	5	2	4	7	5
acsa2	<i>Acer saccharinum</i>	silver maple	N	13	1	4	0	5	3
amta3	<i>Amaranthus tamariscinus</i>	tall amaranth	Y	33	6	0	0	25	2
amar2	<i>Ambrosia artemisiifolia</i>	annual ragweed	N	7	0	0	3	2	2
amtr	<i>Ambrosia trifida</i>	great ragweed	N	16	1	1	2	8	4
amco	<i>Ammannia coccinea</i>	valley redstem	Y	4	2	0	0	2	0
ambr6	<i>Amorpha brachycarpa</i>	leadplant	Y	3	0	0	0	2	1
amco2	<i>Ampelopsis cordata</i>	heartleaf peppervine	Y	2	1	0	0	0	1
ange	<i>Andropogon gerardii</i>	big bluestem	Y	6	0	0	0	6	0
ansc10	<i>Andropogon scoparius</i>	little bluestem	Y	6	1	0	0	5	0
apca	<i>Apocynum cannabinum</i>	indianhemp	Y	26	0	2	3	19	2
arto3	<i>Aristolochia tomentosa</i>	woolly dutchman's pipe	N	1	0	1	0	0	0
aran3	<i>Artemisia annua</i>	sweet sage	Y	2	0	1	1	0	0
asin	<i>Asclepias incarnata</i>	swamp milkweed	Y	2	1	0	0	1	0
assy	<i>Asclepias syriaca</i>	common milkweed	Y	10	0	0	1	9	0
bete	<i>Bergia texana</i>	Texas bergia	Y	3	2	0	0	1	0
bice	<i>Bidens cernua</i>	nodding beggartick	Y	1	0	0	1	0	0
bico5	<i>Bidens connata</i>	purplestem beggarticks	Y	13	2	2	3	2	4
bocy	<i>Boehmeria cylindrica</i>	smallspike false nettle	Y	13	0	5	4	0	4
cate19	<i>Callitriche terrestris</i>	terrestrial water-starwort	N	1	0	0	0	0	1
cara2	<i>Campsis radicans</i>	trumpet creeper	N	31	0	4	3	18	6
cahy3	<i>Carex hyalinolepis</i>	shoreline sedge	Y	3	0	1	1	1	0
cail2	<i>Carya illinoensis</i>	pecan	N	5	0	3	0	1	1
cafa	<i>Cassia fasciculata</i>	sleepingplant	Y	6	0	0	1	5	0
cela	<i>Celtis laevigata</i>	sugarberry	N	19	0	2	4	13	0
celo3	<i>Cenchrus longispinus</i>	mat sandbur	Y	3	0	0	3	0	0
chla5	<i>Chasmanthium latifolium</i>	indian woodoats	N	1	0	0	1	0	0
chal7	<i>Chenopodium album</i>	lambsquarters	Y	2	0	0	0	2	0
cial2	<i>Cirsium altissimum</i>	tall thistle	Y	13	0	0	0	13	0
comu4	<i>Conoclea multifida</i>	narrowleaf paleseed	Y	10	3	1	0	5	1
coca5	<i>Conyza canadensis</i>	Canadian horseweed	N	7	0	3	0	3	1
codr	<i>Cornus drummondii</i>	roughleaf dogwood	N	3	0	0	2	1	0
crgl2	<i>Croton glandulosus</i>	vente conmigo	Y	1	0	0	0	1	0
crmo6	<i>Croton monanthogynus</i>	prairie tea	Y	3	0	0	0	3	0
cyla	<i>Cynanchum laeve</i>	honeysuckle	N	44	1	1	5	30	7
cyer2	<i>Cyperus erythrorhizos</i>	redroot flatsedge	Y	20	6	2	4	7	1

USDA Code	Scientific Name	Common Name	Voucher?	Species Occurrences by Site ¹ (n)					
				All Sites (67)	BC (8)	JAM (5)	LIS (12)	OVN (34)	STA (8)
cyod	<i>Cyperus odoratus</i>	fragrant flatsedge	Y	27	4	0	1	21	1
cysq	<i>Cyperus squarrosus</i>	bearded flatsedge	Y	1	1	0	0	0	0
cyst	<i>Cyperus strigosus</i>	strawcolored flatsedge	Y	5	1	1	1	2	0
deil	<i>Desmanthus illinoensis</i>	prairie bundleflower	Y	3	0	0	0	3	0
dedi2	<i>Desmodium dillenii</i>	dillenius' ticktrefoil	Y	14	2	0	6	6	0
depa6	<i>Desmodium paniculatum</i>	panickedleaf ticktrefoil	N	53	6	5	12	25	5
dico6	<i>Digitaria cognata</i>	carolina crabgrass	Y	2	0	0	0	0	2
diis	<i>Digitaria ischaemum</i>	smooth crabgrass	Y	14	1	0	8	1	4
dite2	<i>Diodia teres</i>	poorjoe	Y	2	0	0	0	2	0
divi5	<i>Diospyros virginiana</i>	common persimmon	N	5	0	0	3	2	0
eccr	<i>Echinochloa crus-galli</i>	barnyardgrass	Y	15	4	0	1	9	1
ecbe2	<i>Echinodorus berteroi</i>	upright burrhead	Y	3	1	0	0	2	0
ecpr	<i>Eclipta prostrata</i>	false daisy	Y	9	2	2	4	1	0
elov	<i>Eleocharis ovata</i>	ovate spikerush	Y	1	1	0	0	0	0
elca3	<i>Elephantopus carolinianus</i>	Carolina elephantsfoot	Y	1	0	1	0	0	0
elvi3	<i>Elymus virginicus</i>	virginia wildrye	N	3	0	1	0	2	0
eqar	<i>Equisetum arvense</i>	field horsetail	Y	2	1	0	1	0	0
erci	<i>Eragrostis cilianensis</i>	stinkgrass	Y	3	1	0	0	2	0
erhi2	<i>Erechtites hieraciifolia</i>	American burnweed	N	7	0	0	0	4	3
eran	<i>Erigeron annuus</i>	Eastern daisy fleabane	N	9	1	0	5	0	3
erst3	<i>Erigeron strigosus</i>	prairie fleabane	N	1	0	0	1	0	0
euru6	<i>Eupatorium rugosum</i>	white snakeroot	N	3	0	1	2	0	0
euse2	<i>Eupatorium serotinum</i>	lateflowering thoroughwort	Y	36	0	3	10	18	5
eude4	<i>Euphorbia dentata</i>	toothed spurge	Y	3	0	0	3	0	0
euma7	<i>Euphorbia maculata</i>	spotted sandmat	Y	13	0	0	0	8	5
eusu	<i>Euphorbia supina</i>	spotted sandmat	Y	5	2	0	1	0	2
feob	<i>Festuca obtusa</i>	nodding fescue	N	2	0	0	1	1	0
frpe	<i>Fraxinus pennsylvanica</i>	green ash	N	8	1	0	1	4	2
gatr3	<i>Galium triflorum</i>	fragrant bedstraw	N	1	0	0	0	0	1
glhe2	<i>Glechoma hederacea</i>	ground ivy	N	1	0	0	0	1	0
gltr	<i>Gleditsia triacanthos</i>	honeylocust	N	1	0	0	1	0	0
hean3	<i>Gelianthus annuus</i>	common sunflower	Y	12	0	0	3	8	1
himi2	<i>Gibiscus militaris</i>	halberdleaf rosemallow	Y	1	0	0	0	0	1
huja	<i>Humulus japonicus</i>	Japanese hop	Y	1	0	0	0	0	1
ipla	<i>Ipomoea lacunosa</i>	whitestar	Y	26	2	0	2	14	8
ippa	<i>Ipomoea pandurata</i>	man of the earth	Y	11	0	0	0	10	1
ivci2	<i>Iva ciliate</i>	annual marshelder	Y	1	0	1	0	0	0
juvi	<i>Juniperus virginiana</i>	Eastern redcedar	N	3	0	0	0	3	0
laca	<i>Lactuca canadensis</i>	Canada lettuce	Y	2	0	0	0	2	0
lafl	<i>Lactuca floridana</i>	woodland lettuce	N	2	0	0	0	2	0
levi2	<i>Leersia virginica</i>	whitegrass	Y	6	0	4	2	0	0
lepa6	<i>Leptochloa panicea</i>	mucronate sprangletop	Y	11	2	0	0	8	1
lila10	<i>Lippia lanceolata</i>	lanceleaf fogfruit	Y	16	7	3	1	4	1

USDA Code	Scientific Name	Common Name	Voucher?	Species Occurrences by Site ¹ (n)					
				All Sites (67)	BC (8)	JAM (5)	LIS (12)	OVN (34)	STA (8)
lyvi4	<i>Lycopus virginicus</i>	Virginia water horehound	Y	12	1	4	3	3	1
mapo	<i>Maclura pomifera</i>	osage orange	N	1	0	0	0	1	0
meal2	<i>Melilotus albus</i>	yellow sweetclover	N	3	3	0	0	0	0
move	<i>Mollugo verticillata</i>	green carpetweed	Y	2	0	0	0	2	0
moru2	<i>Morus rubra</i>	red mulberry	N	20	0	5	3	6	6
muso	<i>Muhlenbergia sobolifera</i>	rock muhly	N	7	0	3	4	0	0
nysy	<i>Nyssa sylvatica</i>	blackgum	N	1	0	0	0	0	1
oebi	<i>Oenothera biennis</i>	common evening-primrose	Y	11	0	2	2	6	1
oela	<i>Oenothera laciniata</i>	cutleaf evening-primrose	Y	1	0	0	1	0	0
oxdi2	<i>Oxalis dillenii</i>	common yellow oxalis	N	4	0	0	0	1	3
paca6	<i>Panicum capillare</i>	witchgrass	Y	19	5	1	6	5	2
pavi2	<i>Panicum virgatum</i>	switchgrass	N	1	0	0	0	1	0
paqu2	<i>Parthenocissus quinquefolia</i>	Virginia creeper	Y	9	0	3	1	4	1
pala10	<i>Paspalum laeve</i>	field paspalum	Y	4	1	1	0	2	0
pese6	<i>Penthorum sedoides</i>	ditch stonecrop	Y	2	0	1	1	0	0
phhe5	<i>Physalis heterophylla</i>	clammy groundcherry	Y	3	1	0	0	2	0
phmi5	<i>Physalis missouriensis</i>	Missouri groundcherry	Y	1	0	0	0	1	0
phvi5	<i>Physalis virginiana</i>	Virginia groundcherry	Y	39	3	4	5	19	8
pham4	<i>Phytolacca americana</i>	American pokeweed	N	12	0	4	0	5	3
pipu2	<i>Pilea pumila</i>	Canadian clearweed	Y	2	0	0	1	0	1
ploc	<i>Platanus occidentalis</i>	American sycamore	N	9	1	1	3	3	1
poco8	<i>Polygonum coccineum</i>	longroot smartweed	Y	23	0	4	3	11	5
pope2	<i>Polygonum pensylvanicum</i>	Pennsylvania smartweed	Y	21	5	0	0	12	4
pode3	<i>Populus deltoides</i>	Eastern cottonwood	N	33	3	5	9	10	6
pool	<i>Portulaca oleracea</i>	little hogweed	Y	2	0	0	0	2	0
pram	<i>Prunus americana</i>	American plum	Y	2	0	0	0	2	0
pyca2	<i>Pyrrhopappus carolinianus</i>	Carolina desert-chicory	Y	2	2	0	0	0	0
quim	<i>Quercus imbricaria</i>	shingle oak	N	5	0	0	2	1	2
quma2	<i>Quercus macrocarpa</i>	bur oak	N	1	0	0	0	1	0
rose	<i>Rorippa sessiliflora</i>	stalkless yellowcress	Y	1	0	0	0	1	0
rora	<i>Rotala ramosior</i>	lowland rotala	Y	1	0	0	1	0	0
rula3	<i>Rudbeckia laciniata</i>	cutleaf coneflower	N	1	0	1	0	0	0
rucr	<i>Rumex crispus</i>	curly dock	N	6	1	1	1	3	0
saca5	<i>Salix caroliniana</i>	coastal plain willow	N	1	0	1	0	0	0
sain3	<i>Salix interior</i>	sandbar willow	Y	26	6	5	7	7	1
sani	<i>Salix nigra</i>	black willow	N	5	0	2	0	3	0
saal5	<i>Sassafras albidum</i>	sassafras	N	1	0	0	1	0	0
scma2	<i>Scrophularia marilandica</i>	carpenter's square	Y	1	0	0	0	1	0
sevi4	<i>Setaria viridis</i>	green bristlegrass	Y	38	1	0	8	23	6
sian	<i>Sicyos angulatus</i>	oneseed burr cucumber	Y	3	0	1	0	0	2
sisp	<i>Sida spinosa</i>	prickly fanpetals	Y	12	1	0	0	6	5
smta2	<i>Smilax tamnoides</i>	bristly greenbrier	N	2	0	0	1	1	0
soca3	<i>Solanum carolinense</i>	Carolina horsenettle	Y	26	1	0	1	18	6

USDA Code	Scientific Name	Common Name	Voucher?	Species Occurrences by Site ¹ (n)					
				All Sites (67)	BC (8)	JAM (5)	LIS (12)	OVN (34)	STA (8)
soal6	<i>Solidago altissima</i>	Canada goldenrod	Y	13	5	0	0	8	0
sogi	<i>Solidago gigantea</i>	giant goldenrod	Y	9	0	1	7	1	0
soas	<i>Sonchus asper</i>	spiny sowthistle	Y	1	0	0	0	1	0
sonu2	<i>Sorghastrum nutans</i>	indiangrass	Y	8	0	1	0	7	0
soha	<i>Sorghum halepense</i>	johnsongrass	N	32	0	1	5	21	5
spgl2	<i>Spermacoce glabra</i>	smooth false buttonweed	Y	3	0	0	0	0	3
spr	<i>Sporobolus cryptandrus</i>	sand dropseed	Y	1	0	0	1	0	0
stte	<i>Stachys tenuifolia</i>	smooth hedgenettle	Y	1	0	1	0	0	0
stme2	<i>Stellaria media</i>	common chickweed		1	0	0	1	0	0
sthe4	<i>Strophostyles helvula</i>	trailing fuzzybean	Y	2	0	0	1	1	0
syor	<i>Symphoricarpos orbiculatus</i>	coralberry	N	1	0	0	1	0	0
	<i>Symphyotrichum</i>								
sylal7	<i>lateriflorum</i> var. <i>lateriflorum</i>	calico aster	Y	13	1	5	5	0	2
	<i>Symphyotrichum pilosum</i>								
sypip3	var. <i>pilosum</i>	hairy white oldfield aster	Y	11	0	0	1	10	0
sysu5	<i>Symphyotrichum subulatum</i>	Eastern annual saltmarsh aster	Y	1	0	0	1	0	0
teca3	<i>Teucrium canadense</i>	Canada germander	Y	4	0	1	1	1	1
tora2	<i>Toxicodendron radicans</i>	Eastern poison ivy	N	22	0	4	5	9	4
trfl2	<i>Tridens flavus</i>	purpletop tridens	Y	1	0	0	0	1	0
trca5	<i>Trifolium campestre</i>	field clover	Y	2	0	0	0	2	0
trpu4	<i>Triplasis purpurea</i>	purple sandgrass	Y	3	0	0	1	2	0
trda3	<i>Tripsacum dactyloides</i>	Eastern gamagrass	Y	8	0	0	0	8	0
ulam	<i>Ulmus americana</i>	american elm	N	13	1	0	3	4	5
ulru	<i>Ulmus rubra</i>	slippery elm	N	8	0	0	0	8	0
urdi	<i>Urtica dioica</i>	stinging nettle	Y	4	0	3	1	0	0
veur	<i>Verbena urticifolia</i>	white vervain	Y	12	2	2	4	3	1
veba	<i>Vernonia baldwinii</i>	baldwin's ironweed	Y	4	0	0	0	4	0
viso	<i>Viola sororia</i>	common blue violet	N	6	0	4	1	0	1
viae	<i>Vitis aestivalis</i>	summer grape	N	21	0	1	4	12	4
viru2	<i>Vitis rupestris</i>	sand grape	N	3	0	0	0	3	0
vivu	<i>Vitis vulpina</i>	frost grape	Y	35	3	5	7	13	7
xast	<i>Xanthium strumarium</i>	rough cocklebur	N	55	8	5	12	24	6

¹BC=Boone's Crossing, JAM=Jameson Island, LIS=Lisbon Bottoms, OVN=Overton Bottoms, STA=St. Aubert Island

Table 4. 20 species most frequently in top five in cover within a plot and mean cover.

Non-native species are shown in bold.

USDA Code	Scientific Name	Common Name	#of plots in top 5 in cover (n = 67)	Mean % Cover
depa6	<i>Desmodium paniculatum</i>	panickedleaf ticktrefoil	23	19.7
xast	<i>Xanthium strumarium</i>	rough cocklebur	23	15.3
pode3	<i>Populus deltoides</i>	eastern cottonwood	22	17.3
cara2	<i>Campsis radicans</i>	trumpet creeper	18	15.4
sevi4	<i>Setaria viridis</i>	green bristlegrass	16	15.4
cyla	<i>Cynanchum laeve</i>	honeyvine	12	25.3
ipla	<i>Ipomoea lacunosa</i>	whitestar	12	13.1
soha	<i>Sorghum halepense</i>	johnsongrass	12	10.9
cyod	<i>Cyperus odoratus</i>	fragrant flatsedge	10	29.1
diis	<i>Digitaria ischaemum</i>	smooth crabgrass	10	7.8
sain3	<i>Salix interior</i>	sandbar willow	9	12.7
apca	<i>Apocynum cannabinum</i>	indianhemp	8	23.6
lila10	<i>Lippia lanceolata</i>	lanceleaf fogfruit	8	20.9
poco8	<i>Polygonum coccineum</i>	longroot smartweed	8	10.0
vivu	<i>Vitis vulpina</i>	frost grape	8	6.9
acrh	<i>Acalypha rhomboidea</i>	common threeseed mercury	6	7.5
sonu2	<i>Sorghastrum nutans</i>	indiangrass	6	2.9
acne2	<i>Acer negundo</i>	boxelder	5	22.6
asla6	<i>Aster lateriflorus</i>	calico aster	5	9.2
cyer2	<i>Cyperus erythrorhizos</i>	redroot flatsedge	5	4.8

Table 5. Additional species collected at Big Muddy National Fish and Wildlife Refuge.

Non-native species are shown in bold.

USDA Code	Scientific Name	Common Name
acvi	<i>Acalypha virginiana</i>	Virginia three-seeded mercury
alpe4	<i>Alliaria petiolata</i>	garlic mustard
cacr8	<i>Carex crus-corvi</i>	raven-foot sedge
camo11	<i>Carex molesta</i>	troublesome sedge
case	<i>Calystegia sepium</i>	hedge field bindweed
cima2	<i>Cicuta maculata</i>	spotted water hemlock
erpe	<i>Eragrostis pectinacea</i>	tufted lovgrass
iphe	<i>Ipomoea hederacea</i>	ivy leaf morning-glory
lidu	<i>Lindernia dubia</i>	yellowseed false pimpernel
lyam	<i>Lycopus americana</i>	American water horehound
lynu	<i>Lysimachia nummularia</i>	creeping jenny
pape5	<i>Parietaria pensylvanica</i>	Pennsylvania pellitory
phar3	<i>Phalaris arundinacea</i>	reed canary grass
rosy	<i>Rorippa sylvestris</i>	creeping yellowcress
sppe	<i>Spartina pectinacea</i>	prairie cordgrass

Table 6. Mean species richness by site and combined.

	Overton Bottoms	Jameson Island	Lisbon Bottoms	Boone's Crossing	St. Aubert Island	All Sites
Mean Richness	20.088	28.800	20.750	16.875	26.250	21.209
Standard Error	1.173	3.397	3.177	2.240	2.282	0.994
Standard Deviation	6.842	7.596	11.005	6.334	6.453	8.134
Sample Variance	46.810	57.700	121.114	40.125	41.643	66.168
Range	30	21	32	18	18	33
Minimum	9	19	8	7	15	7
Maximum	39	40	40	25	33	40
n	34	5	12	8	8	67
Upper 95 % Confidence Limit	2.387	9.432	6.992	5.296	5.395	1.984

Table 7. Mean Shannon Diversity by site and combined.

	Overton Bottoms	Jameson Island	Lisbon Bottoms	Boone's Crossing	St. Aubert Island	All Sites
Mean Shannon Diversity (H')	1.561	1.985	1.493	1.664	1.554	1.592
Standard Error	0.077	0.052	0.127	0.160	0.194	0.055
Standard Deviation	0.448	0.116	0.440	0.453	0.550	0.449
Sample Variance	0.201	0.013	0.194	0.205	0.302	0.202
Range	2.025	0.270	1.427	1.201	1.685	2.025
Minimum	0.589	1.846	0.910	1.085	0.853	0.589
Maximum	2.614	2.117	2.337	2.286	2.538	2.614
n	34	5	12	8	8	67
Upper 95% Confidence Limit	0.156	0.143	0.280	0.379	0.459	0.110

Appendix A

STANDARDIZED COLLECTION OF PRAIRIE VEGETATION

Reproduced by permission from Big Muddy National Fish and Wildlife Refuge

Habitat assessment methods for wet prairie habitats are from Paul Konrad and Silka Finkbeiner of Northern Prairie Wildlife Research Center, USGS, in Jamestown, North Dakota. 3 samples will be taken at each prairie point. They will be taken at the following bearings and distances:

- 1) 8 meters @ 45 degrees
- 2) 41 meters @ 180 degrees
- 3) 25 meters @ 315 degrees

Prairie vegetation is not to be sampled when the vegetation is wet, e.g., do not measure vegetation during the early morning hours and within 1 hour after a rain. At each sample point, place the Daubenmire frame such the surrounding vegetation is not pushed down. If the random point is trampled, then place the Daubenmire frame in the nearest untrampled location. The Daubenmire frame is your reference point for all measurements. Use the following sequence of measurements so as not to disturb the vegetation:

- a) estimate vegetation cover
- b) count the number of woody stems
- c) measure vegetation height and litter depth at each of the four corners of the Daubenmire frame
- d) take Robel pole readings

Estimate the percent vegetation cover within the Daubenmire frame to the nearest 5%, separately for sedges, grasses, forbs, woody plants, litter (lying: $<45^\circ$, and standing: $45-90^\circ$), and bare soil: 1 measurement per one sample. For stem density, count the number of woody stems within each Daubenmire frame. Differentiate between small stems (< 30 cm tall) and high stems (≥ 30 cm tall). Determine the height (cm) of the highest plant touching the meter stick about 3 cm off each of the 4 corners of the Daubenmire frame; 4 measurements /sample point. If the vegetation is higher than the meter stick, then put a hand at the end of the stick, and measure the distance from the hand to the highest plant. Other measurements include:

Litter depth (mm): Estimate the height at which the meter stick is totally covered by horizontally lying dead plant material if you were looking horizontally. Use a dry grass stem to help estimate litter depth by poking it horizontally through the vegetation. Take measurements about 3 cm off each of the 4 corners of the Daubenmire frame: 4 measurements /sample point.

Robel pole (dm): It measures the height and density (visual obstruction reading [VOR]) of vegetation. Determine the highest half dm interval (1 dm = 10 cm) that is NOT totally covered by vegetation. Measurements are taken at a distance of 4 m at a height of about 1m, in each cardinal direction from the pole: 4 measurements/sample point. The Robel pole is marked off in red, underlined, 1-dm intervals. The observer is looking for any portion of the lowest line that is not covered by vegetation. You then record the 0.5 dm BELOW the line that you can see. For example, if you can see the red line underneath the number 4, you record 3.5. If you can see the 4.5 line and most of the number 4, but you cannot see the red line below the 4, you still record 4.

Appendix E

2007 Annual Report Excerpt

Missouri River Mitigation Project

Evaluation of Fish Use of the Side-Channel Chutes at Lisbon Bottom,

North Overton Bottoms, Tadpole Island, and Tate Island



Prepared for the U.S. Army Corps of Engineers

By:

Nick Utrup, Zac Beussink, Joseph McMullen, Jeff Finley, and Tracy Hill

U.S. Fish and Wildlife Service

Columbia National Fish and Wildlife Conservation Office

101 Park DeVill Drive, Suite A

Columbia, MO 65203

March 2008

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers is mitigating for aquatic habitat losses resulting from the multiple activities and projects along the Missouri River. These activities were primarily driven by the Missouri River Bank Stabilization Act and Navigation Project. The result of altering the river for navigation was reduced channel width, deepening of the channel, armoring the banks, building of artificial structures, and the closing off of side channels and chutes which once frequently occurred on the Lower Missouri River. As a method of mitigation, side-channel chute habitat is being created, restored, and maintained throughout the lower Missouri River. State and federal agencies are in the process of conducting a three year evaluation of the fish use of these side-channel chutes.

The scope of this report is to evaluate fish use of four chutes in the Lower Missouri River, including: Lisbon Bottom Chute, North Overton Bottoms Chute, Tadpole Island Chute, and Tate Island Chute. Results from the 2006 sampling season show that all four chutes act as nursery habitat for juvenile river species. Results from the 2007 sampling season show similar fish response. It is clear, however, that life stages of certain river fish species favor some chutes over others. The complexity of habitats present, as well as the overall geomorphology, contributes to how different life stages of river fish species use these chutes. When comparing the chutes based on their complexity of habitat, or degree of "conditioning", some basic differences exist. Chutes that are "conditioned" have natural habitat features (i.e., scour pools, backwaters, and tie channels) that are formed by many years of flood pulses, erosion, and deposition. Chutes that are "unconditioned" are man-made structures with relatively homogeneous geomorphology that have been recently constructed and lack the complex natural habitats that generally form as a result of flood events. In the study area, Lisbon and Tate are considered "conditioned" chutes because they are naturally formed or have been subject to natural processes for many years, whereas Overton and Tadpole Chutes are considered "unconditioned" because they were recently constructed. Overton, despite being over five years old, is still considered "unconditioned" because it has not yet experienced a flood event capable of altering its geomorphology.

Though each chute is different, they all serve a role as nursery habitat for native river fishes. By virtue of their design and development, these chutes act as a connection to the river floodplain and thus fulfill many functions necessary for the health of the river ecosystem. Continued monitoring of these chutes is necessary to better understand how they operate within the flood-pulse paradigm and will provide an opportunity to observe and document how fish use these mitigated habitats. Use of hydraulic modeling to predict useable fish habitat relative to flow and the application of a biologic response variable, such as the widely used Index of Biotic Integrity (IBI), would give biologists better tools to evaluate the progress of these chutes over time.

Appendix F

CENWK EC-HR (1110-2-1150a2)

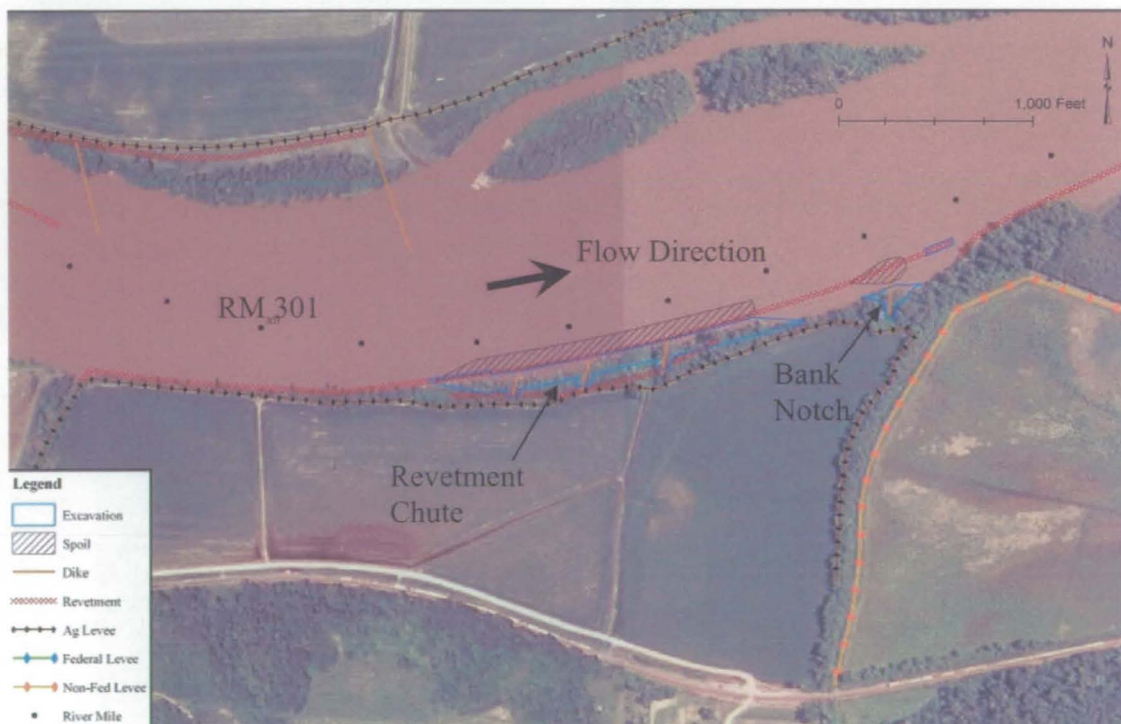
05 FEB 2008

MEMORANDUM TO FILE

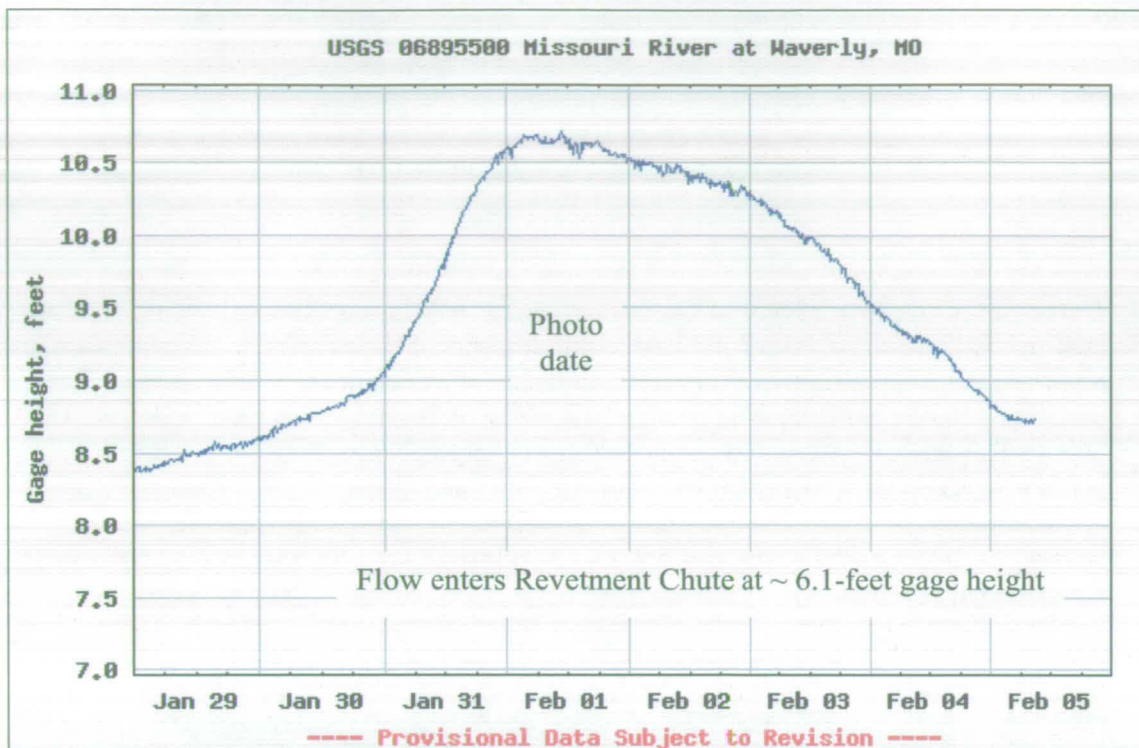
SUBJECT: Site photos taken at Baltimore Bottoms on 01 FEB 2008

OVERVIEW:

1. Dereck Wansing took photos of the shallow water habitat constructed at the Baltimore Bottoms Refuge on 01 FEB 2008 to document status of the project since work stopped on or around 27 APR 2007. The project consists of a completed 1720-ft long revetment chute near river mile (RM) 300.6 and a 50% completed bank notch at RM 300.4. The Waverly, Missouri gage height was approximately 10.7-feet on February 1st. Flow is expected to enter the revetment chute at a Waverly gage reading of approximately 6.1-feet. The site plan, Waverly gage hydrograph, and site pictures starting upstream of the revetment chute and continuing downstream to the bank notch are provided below.



Baltimore Bottoms SWH site plan



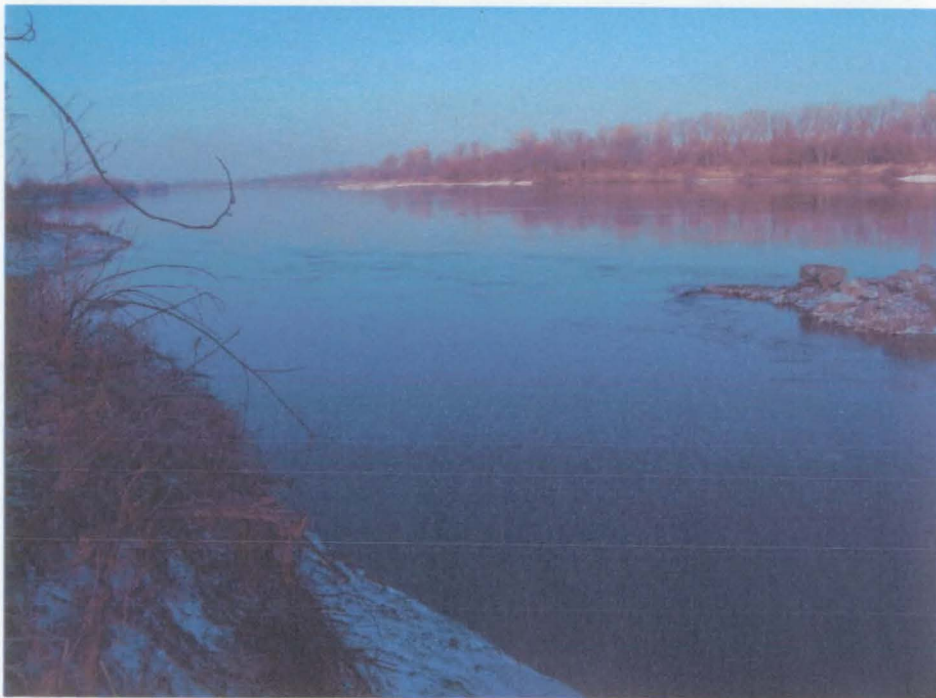
Waverly gage hydrograph 29 JAN to 05 FEB 2008



Looking Downstream at the Revetment Chute Entrance from RM 300.9



View of the revetment (island tip) at the revetment chute entrance notch RM 300.8



Looking upstream at the revetment chute entrance at RM 300.8



Looking downstream from the revetment chute entrance at RM 300.8



Looking upstream from the revetment chute midpoint near RM 300.6



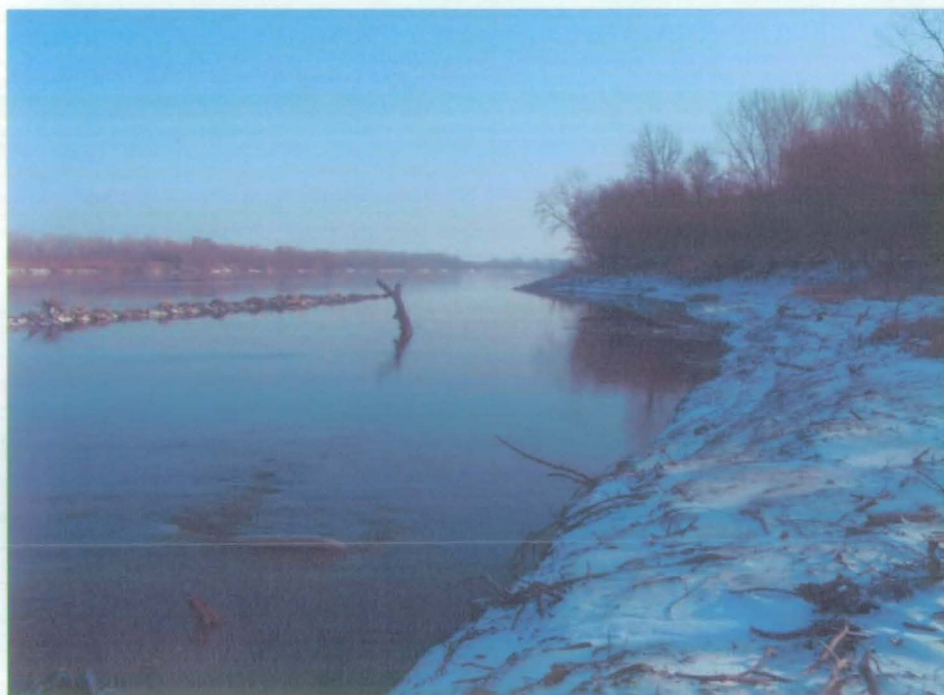
Looking downstream from the revetment chute midpoint near RM 300.6



Looking upstream from partially complete bank notch at RM 300.4



Partially complete bank notch at RM 300.4



Looking downstream from partially completed bank notch at RM 300.4

Appendix G.

Current and historic vegetation of refuge units.

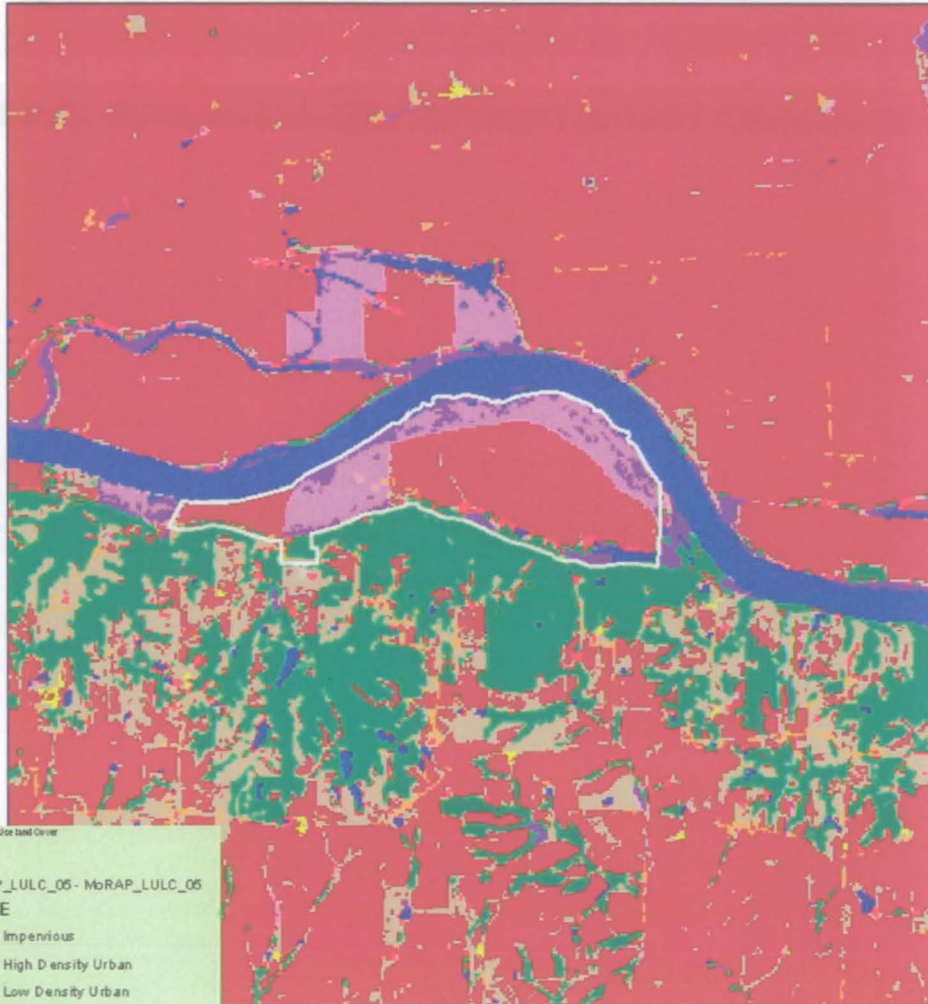
(arranged alphabetically)



U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Baltimore Bottom



2001 Land Use and Cover

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0 0.25 0.5 1 Miles

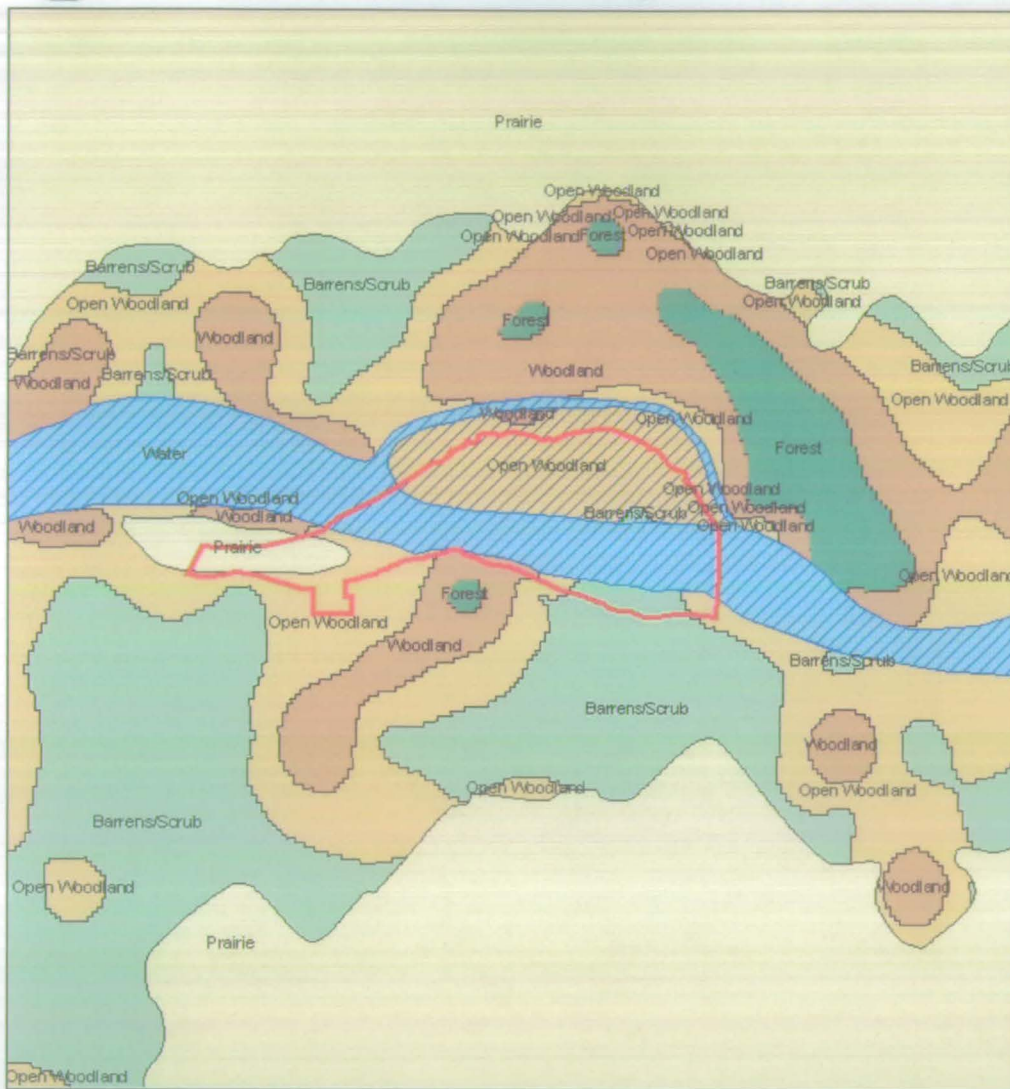




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Baltimore Bottom



Historic Land Cover 1980s

- Refuge Ownership
- Historic_Missouri_River
- Historic_Land_Cover
- <all other values>

TYPE

- Barrens/Scrub
- Forest
- Open Woodland
- Prairie
- Water
- Woodland

0 0.2 0.4 0.8 Miles

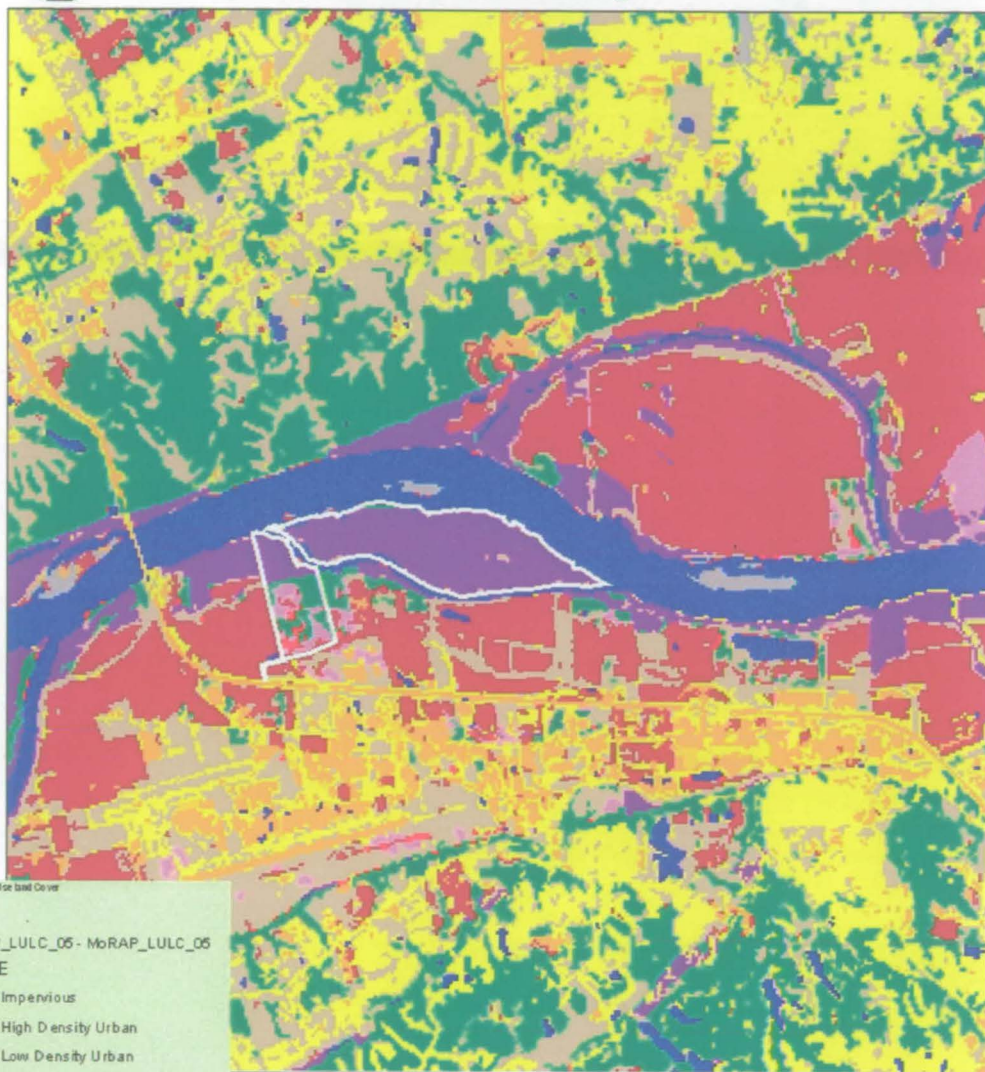




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Boone's Crossing



2001 Land Use Cover

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0 0.2 0.4 0.8 Miles

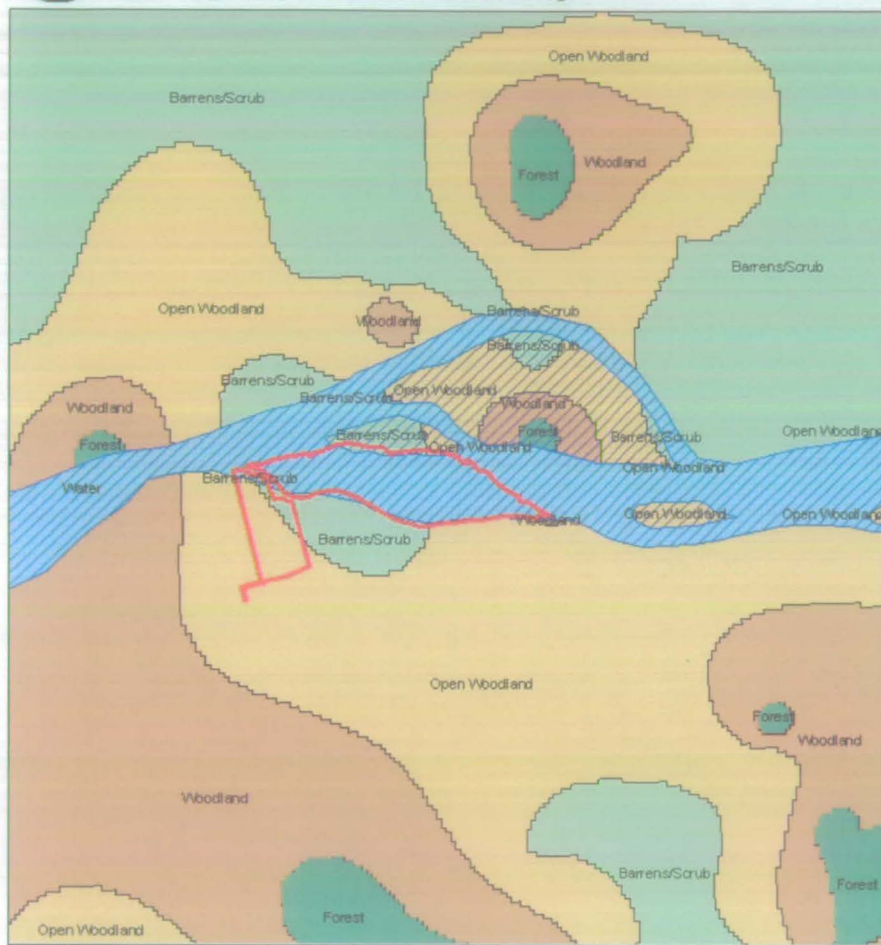




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Boone's Crossing



Historic Land Cover 1800s

- Refuge Ownership
- Historic_Missouri_River
- Historic_Land_Cover
- <all other values>

TYPE

- Barrens/Scrub
- Forest
- Open Woodland
- Prairie
- Water
- Woodland

0 0.2 0.4 0.8 Miles





U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Cranberry Bend



2000 Land Use Data Center

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0 0.3 0.6 1.2 Miles





U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Cranberry Bend



Historic Land Cover 1880s

- Refuge Ownership
- Historic_Missouri_River
- Historic_Land_Cover
- <all other values>

TYPE

- Barrens/Scrub
- Forest
- Open Woodland
- Prairie
- Water
- Woodland

0 0.35 0.7 1.4 Miles

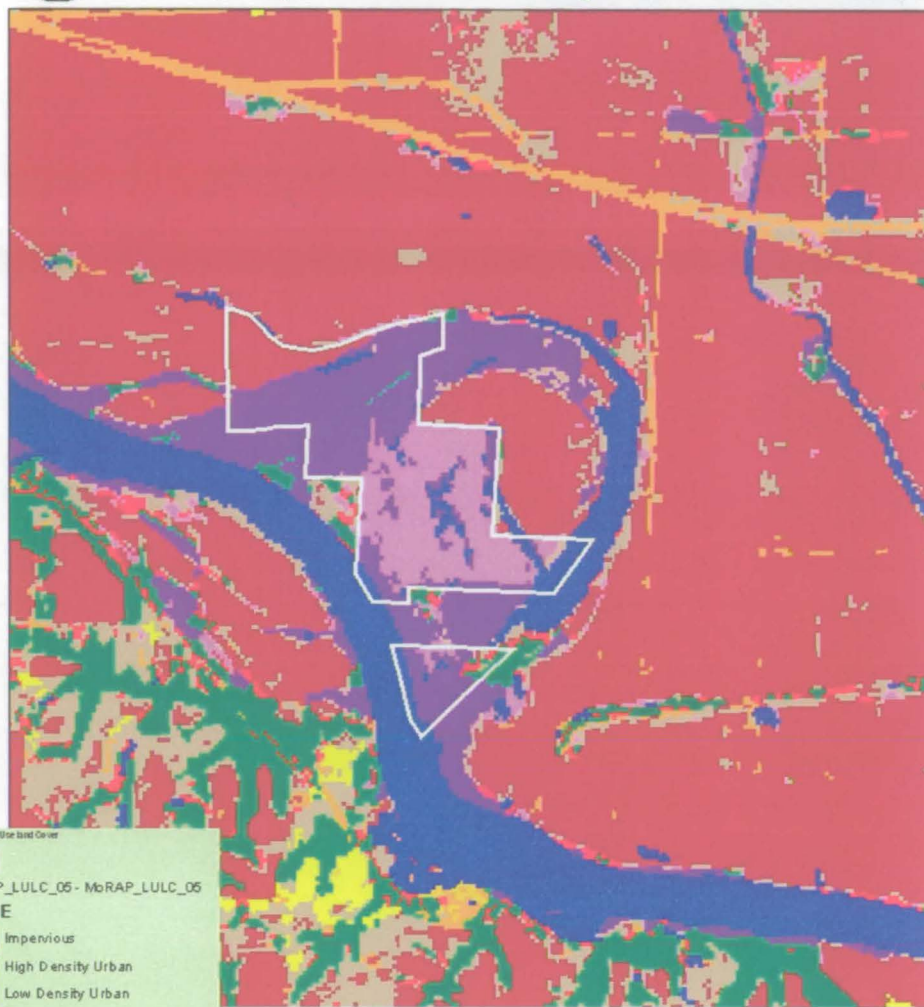




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Jackass Bend



2000 Land Use Data Cover

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0.125 0.25 0.5 Miles





U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Jackass Bend



Historic Land Cover 1890s

- Refuge Ownership
- Historic_Missouri_River
- Historic_Land_Cover
- <all other values>

TYPE

- Barrens/Scrub
- Forest
- Open Woodland
- Prairie
- Water
- Woodland

0 0.15 0.3 0.6 Miles

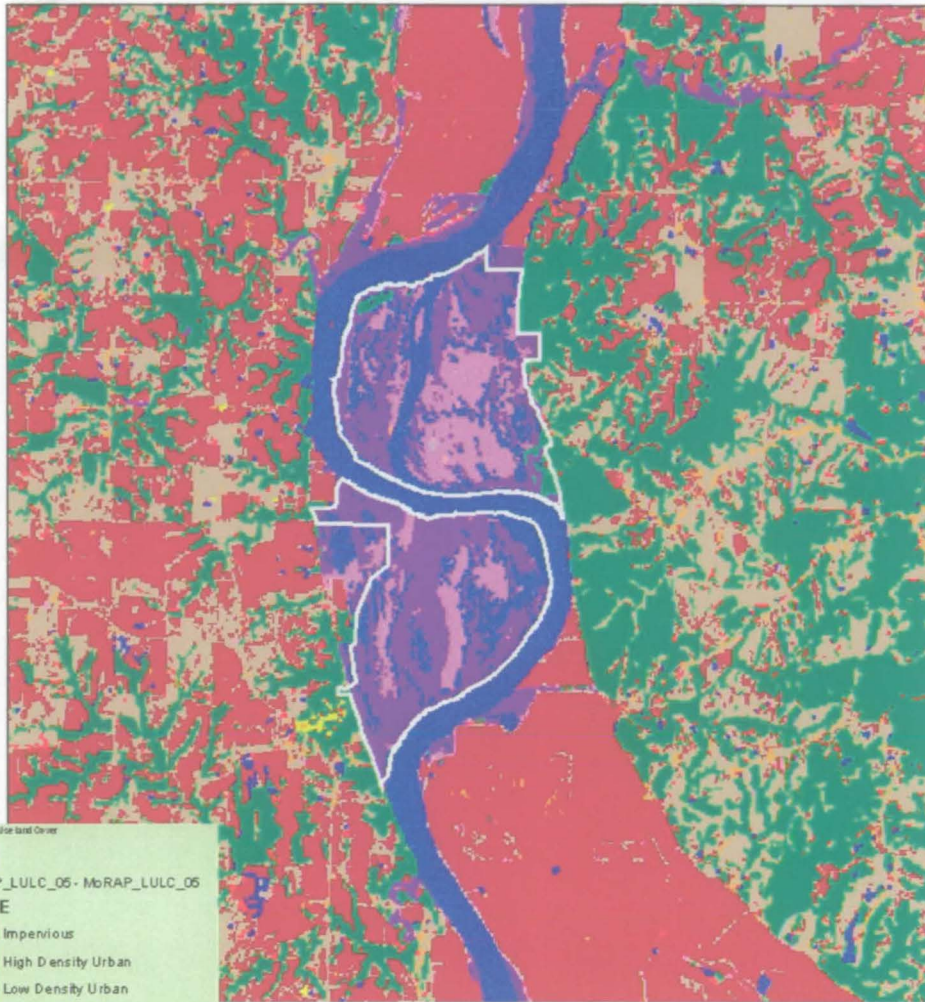




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Lisbon Bottom/Jameson Island



2006 Land Use Data Overlay

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0 0.250.5 1 Miles

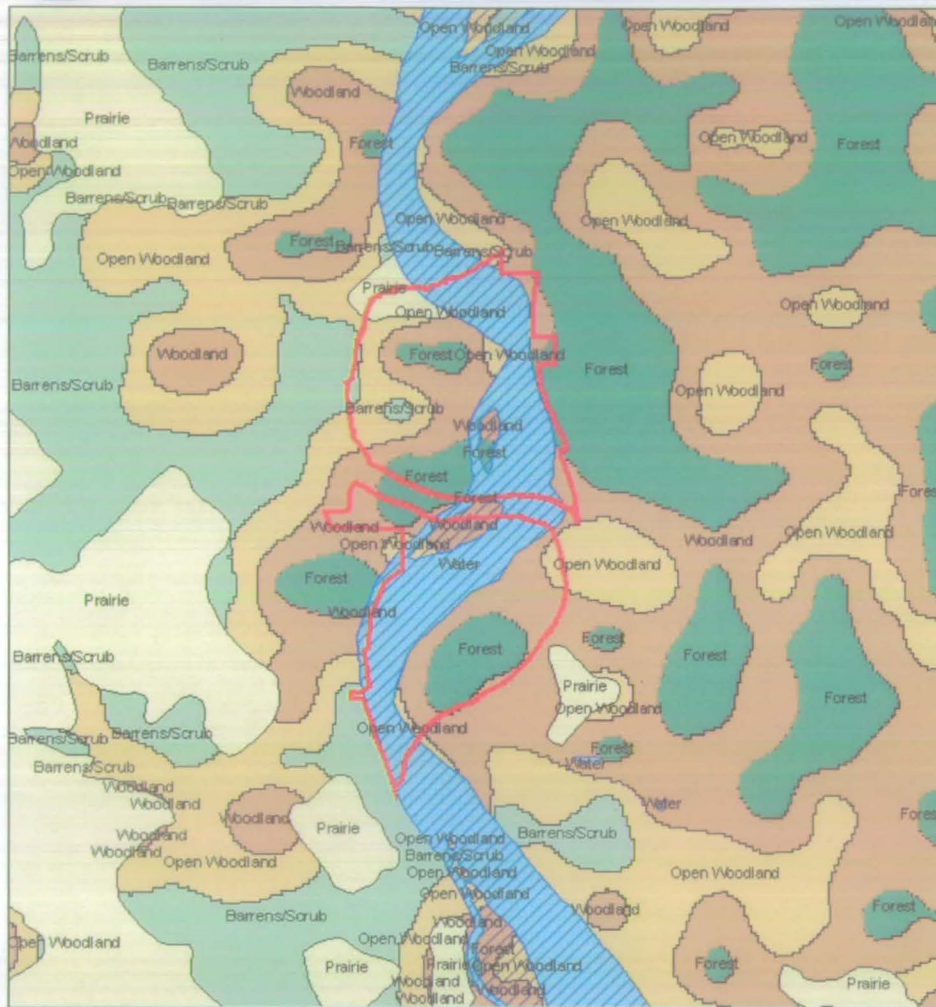




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Lisbon Bottom/Jameson Island



Historic Land Cover 1880s

- Refuge Ownership
- Historic_Missouri_River
- Historic_Land_Cover
- <all other values>

TYPE

- Barrens/Scrub
- Forest
- Open Woodland
- Prairie
- Water
- Woodland

0 0.3 0.6 1.2 Miles

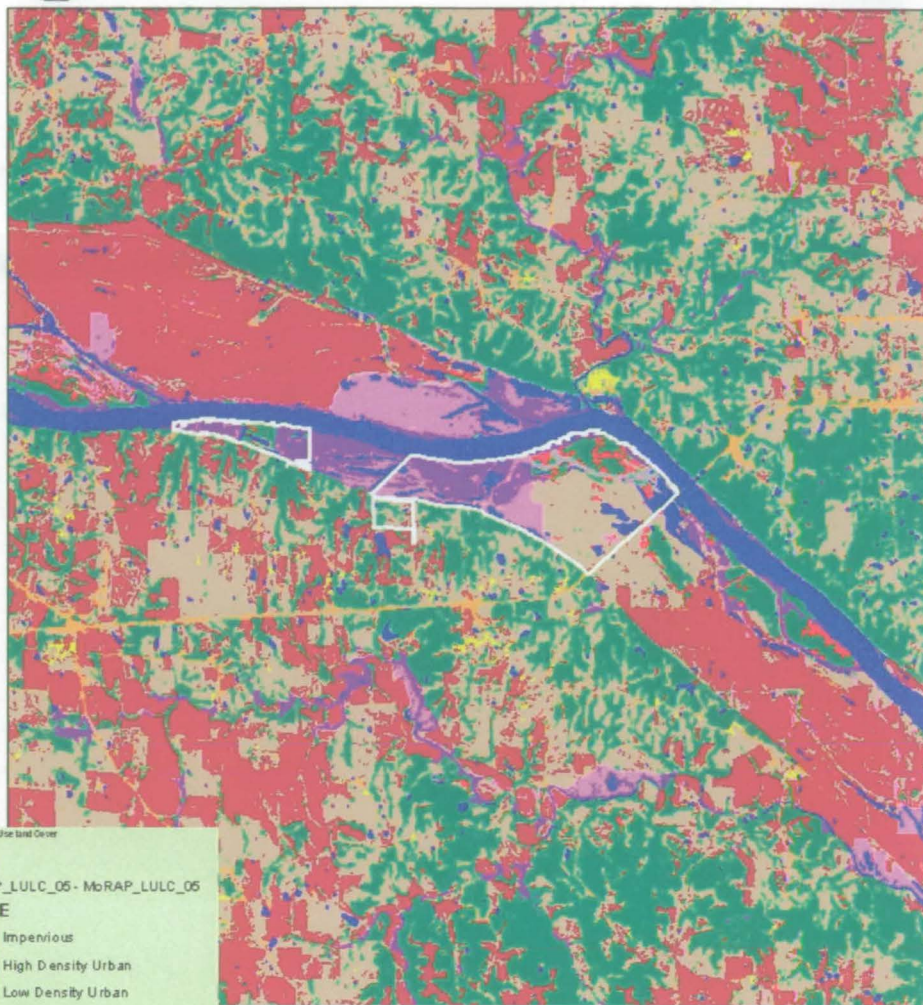




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Overton Bottoms North



2001 Land Use and Cover

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0 0.45 0.9 1.8 Miles

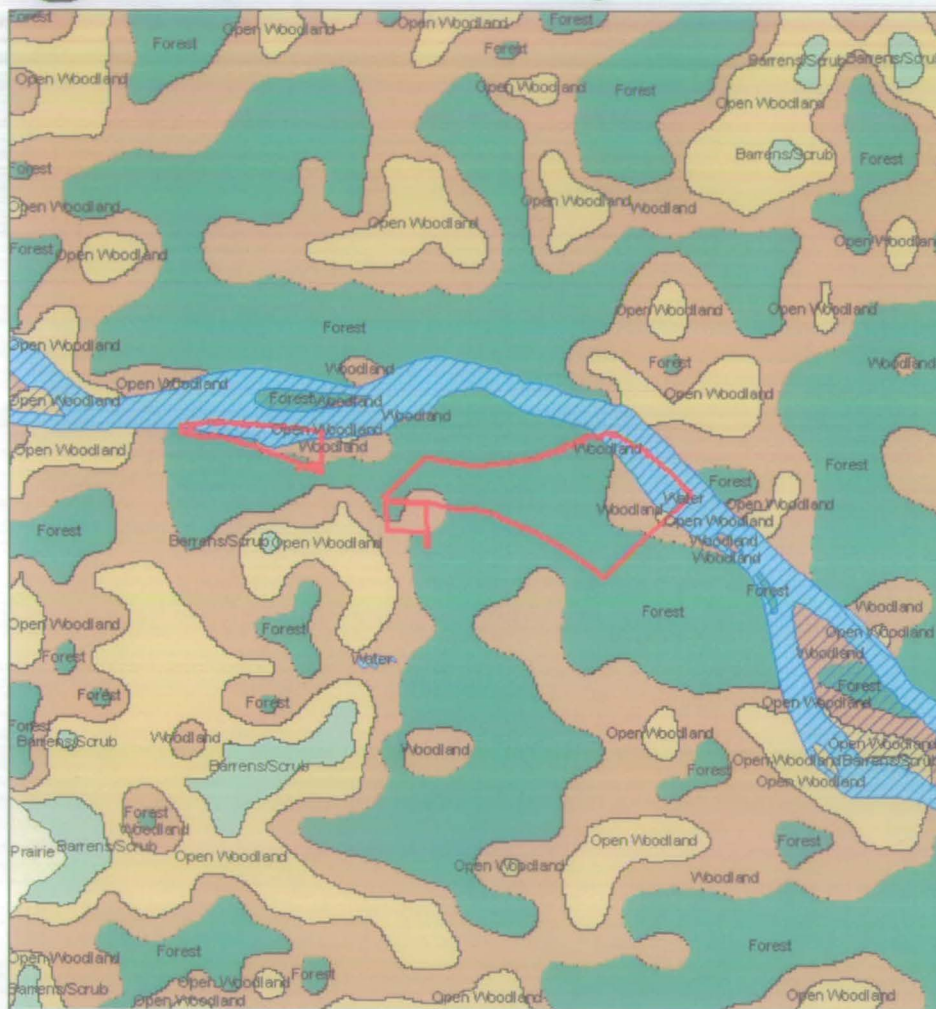




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

Overton Bottoms North



- Historic Land Cover 1990s
- Refuge Ownership
 - Historic_Missouri_River
 - Historic_Land_Cover
 - <all other values>
- TYPE
- Barrens/Scrub
 - Forest
 - Open Woodland
 - Prairie
 - Water
 - Woodland

0 0.4 0.8 1.6 Miles

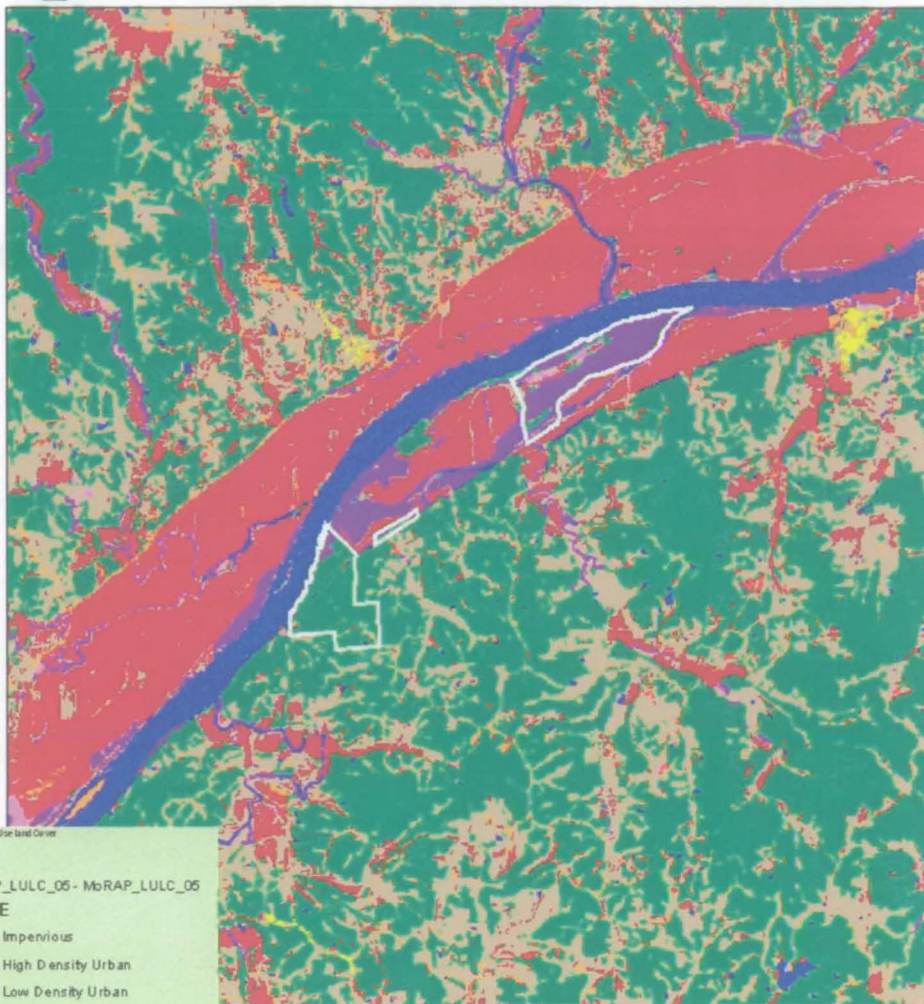




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

St. Aubert Island



2006 Land Use Cover

MoRAP_LULC_05 - MoRAP_LULC_05

VALUE

- Impervious
- High Density Urban
- Low Density Urban
- Barren or Sparsely Vegetated
- Cropland
- Grassland
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Deciduous Woody/Herbaceous
- Evergreen Woody/Herbaceous
- Woody-Dominated Wetland
- Herbaceous-Dominated Wetland
- Open Water

0 0.30.6 1.2 Miles

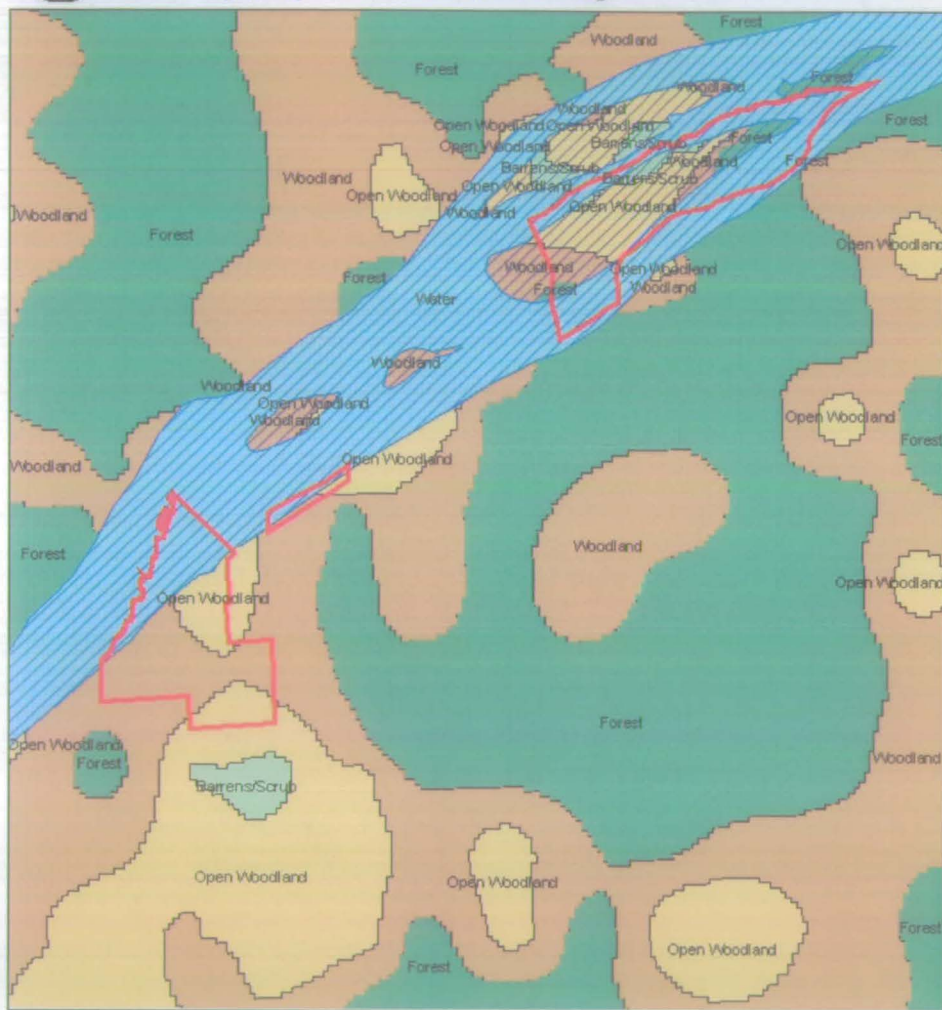




U.S. Fish & Wildlife Service

Big Muddy National Fish & Wildlife Refuge

St. Aubert Island



Wetlands Land Cover 1990s

- Refuge Ownership
- Historic_Missouri_River
- Historic_Land_Cover
- <all other values>
- TYPE**
- Barrens/Scrub
- Forest
- Open Woodland
- Prairie
- Water
- Woodland

0 0.2 0.4 0.8 Miles

