Appendix C
Biological Resources

TABLE OF CONTENTS
APPENDIX C

APPENDIX C:

BIOLOGICAL RESOURCES

C.1 Introduction

This appendix includes additional information concerning biological resources located in the MKARNS system and associated properties. Biological resources as discussed previously in this document, includes threatened and endangered species, other protected species, wetlands, aquatic resources, and terrestrial resources. The documents included in this section and their authors are as follows:

- USFWS Planning Aid and CAR, USFWS;
- Biological Assessment, Tulsa District USACE;
- USFWS Draft Biological Opinion, USFWS;
- Terrestrial Habitat Evaluation Procedures, Parsons in coordination with ERDC-EL;
- Aquatic Habitat Evaluation Procedures, ERDC-EL;
- Aquatic Mitigation Summary, USACE
- Aquatic Monitoring and Adaptive Management, USACE
- Aquatic Mitigation Cost Effective and Incremental Cost Analysis, USACE
- Mussel Survey, Ecological Specialists Inc.;
- Geomorphic Assessment, ERDC-EL; and
- Prime Farmland Coordination, Parsons and NRCS.

C.2

USFWS Planning Aid and CAR

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
222 S. Houston, Suite A
Tulsa, Oklahoma 74127

April 2, 2001

Thomas A. Holden, Jr.
U.S. Army Corps of Engineers
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

#2-14-01-I-0385

Dear Colonel Holden:

This transmits initial planning information for the Arkansas River Navigation Study, Arkansas and Oklahoma. The purpose of the study is to develop and evaluate various solutions for the economic problems resulting from sustained high flows on the McClellan-Kerr Arkansas River Navigation System (MKARNS). The MKARNS experiences sustained high flows from the upper reaches of the Arkansas River watershed that result in decreased navigation traffic, losses to recreational use, flooding, and other adverse effects. The area for this feasibility study consists of the entire MKARNS in Arkansas and Oklahoma, and the study will be conducted in two phases.

The first phase is expected to take three years to complete, and will investigate various alternatives to reduce impacts of high flows, such as operational changes to existing reservoirs on the MKARNS, additional storage in the existing reservoirs, and construction of additional lakes and levees. If funding is continued, the second phase will overlap with the third year of the first phase, and take an additional two years to complete. This phase will investigate the feasibility of deepening the entire length of the MKARNS and adding passing lanes on the Verdigris River in Oklahoma. The enclosed Planning Aid Report provides preliminary information on existing fish and wildlife resources present.

This planning assistance report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act.

We appreciate the opportunity to participate in this study during the preliminary planning phase, and look forward to further coordination should additional planning be initiated. If you have any questions, please contact Richard Stark at 918-581-7458, extension 240.

Sincerely,

Jerry J. Brabander
Field Supervisor

Enclosure

This page reproduces the text from the April 2, 2001 letter from the USFWS on the preceding page as the scanned document is difficult to read.

April 2, 2001

Thomas A. Holden, Jr. #2-14-01-I-0385
U.S. Army Corps of Engineers
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

Dear Colonel Holden:

This transmits initial planning information for the Arkansas River Navigation Study, Arkansas and Oklahoma. The purpose of the study is to develop and evaluate various solutions for the economic problems resulting from the sustained high flows on the McClellan-Kerr Arkansas River Navigation System (MKARNS). The MKARNS experiences sustained high flows from the upper reaches of the Arkansas River watershed that result in decreased navigation traffic, losses to recreational use, flooding, and other adverse effects. The area for this feasibility study consists of the entire MKARNS in Arkansas and Oklahoma, and the study will be conducted in two phases.

The first phase is expected to take three years to complete, and will investigate various alternatives to reduce impacts of high flows, such as operational changes to existing reservoirs on the MKARNS, additional storage in the existing reservoirs, and construction of additional lakes and levees. If funding is continued, the second phase will overlap with the third year of the first phase, and take an additional two years to complete. This phase will investigate the feasibility of deepening the entire length of the MKARNS and adding passing lanes on the Verdigris River in Oklahoma. The enclosed Planning Aid Report provides preliminary information on existing fish and wildlife resources present.

This planning assistance report is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act.

We appreciate the opportunity to participate in this study during the preliminary planning phase, and look forward to further coordination should additional planning be initiated. If you have any questions, please contact Richard Stark at 918-581-7458, extension 240.

Sincerely,

Jerry J. Brabander
Field Supervisor

cc: Director, Oklahoma Department of Wildlife Conservation, Oklahoma City, OK
(Attn: Natural Resources Section)
Director, Oklahoma Department of Environmental Quality, Oklahoma City, OK
(Attn: Wayne Craney, Water Quality Programs Division 0207)
Regional Administrator, Environmental Protection Agency, Dallas, TX
(Attn: 6WQ-EM)
Director, Arkansas Game and Fish Commission, Little Rock, AR
(Attn: Craig Uyeda)
Director, Arkansas Waterways Commission, Little Rock , AR
Director, The Department of Arkansas Heritage, Little Rock, AR
Field Supervisor, U. S. Fish and Wildlife Service, Conway, AR
(Attn: Marge Harney)
Manager, Sequoyah National Wildlife Refuge, Vian, OK
Manager, White River National Wildlife Refuge, DeWitt, AR
Manager, Holla Bend National Wildlife Refuge, Dardanelle, AR

PLANNING AID REPORT

ARKANSAS RIVER NAVIGATION STUDY, ARKANSAS AND OKLAHOMA

Little Rock District

U.S. Army Corps of Engineers

Prepared by Richard C. Stark

Oklahoma Ecological Services

U.S. Fish and Wildlife Service

Tulsa, Oklahoma

March 2001

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

This report provides information on fish and wildlife resources associated with the McClellan-Kerr Arkansas River Navigation System (MKARNS) for use during the preliminary planning phase of the Arkansas River Navigation Study, Arkansas and Oklahoma (ARNS). Specifically, this report is intended to provide an overview of the existing fish and wildlife resources associated with the MKARNS, address possible impacts to fish and wildlife resources, discuss unmet mitigation needs associated with the initial development of the MKARNS, and provide preliminary recommendations for fish and wildlife habitat restoration projects. This report is based largely on past Fish and Wildlife Service (Service) reports concerning resources in the project area (Arkansas River/MKARNS) in Oklahoma and Arkansas. Concerns and recommendations listed here are preliminary and subject to change upon receipt of more detailed project descriptions.

The purpose of the Study is to develop and evaluate various operational changes to the MKARNS that will serve as solutions to the problems resulting from sustained high flows on the MKARNS that originate from the upper reaches of the Arkansas River watershed. These problems include decreased navigation traffic, flooding, and losses to recreational use. Alternatives currently are being developed to address these problems.

This report has been coordinated with the Oklahoma Department of Wildlife Conservation (ODWC) and the Arkansas Game and Fish Commission (AGFC) and is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended, 16 U.S.C. 661 et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act. A formal Fish and Wildlife Coordination Act report from the Service will be prepared after the Corps develops formal project alternatives.

PROJECT AREA

The following description of the project area is based largely on the ecoregions (i.e., large geographic divisions based on natural communities, geology, and land use) as mapped by Omernik (1995), and on the recent conservation assessments of the terrestrial and freshwater ecoregions of North America undertaken by the World Wildlife Fund (Abell et al., 2000; Ricketts et al., 1999). These assessments divide the continent into coarse terrestrial and freshwater ecoregions similar to other classification schemes such as Kuchler (1975), Bailey (1994) and Omernik (1995), and describe the biodiversity of each area.as well as the threats that each ecoregion currently faces.

The area for this study consists of the entire 445–mile–long MKARNS in Arkansas and Oklahoma (Figure 1) (except for the ten mile White River entrance channel), and the 11 upstream multi-purpose reservoirs in Oklahoma that act as the MKARNS's primary flow modifiers: Copan, Hulah, Oologah, Kaw, Keystone, Pensacola (Grand), Hudson (Markham Ferry), Fort Gibson, Tenkiller Ferry, Eufaula, and Wister (Table 1). The MKARNS has a minimum depth of nine feet, a minimum width of 250 feet, and a normal current velocity range between two and four miles per hour. The upstream reservoirs can store about 7.6 million acre-feet of water for flood control, and each project has a specific purpose as authorized by Congress (Table 1). Although the Corps has broad authority to modify the operations of the reservoirs to benefit navigation, navigation is an authorized purpose for only 3 reservoirs (Oologah, Keystone, and Eufaula), and operational plans of the reservoirs cannot be changed in a way that is detrimental to their authorized purpose.

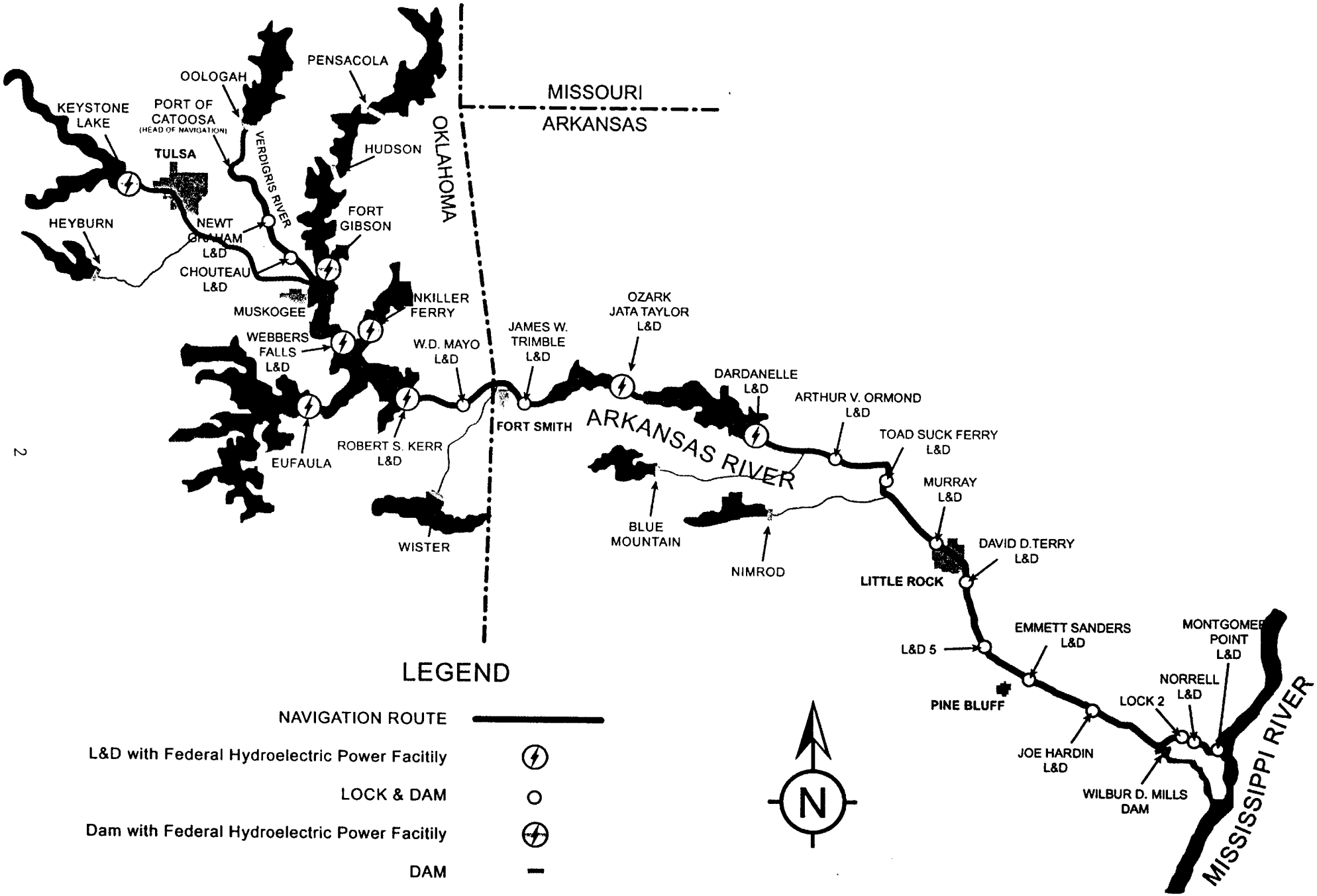


Figure 1. Location of the McClellan-Kerr Arkansas River Navigation System.

Table 1. Information on the Eleven upstream reservoirs in Oklahoma (US Fish and Wildlife Service, 1985; Oklahoma Water Resources Board, 1990).

Reservoir	Agency	Counties	River/Stream and Purpose of reservoir	Ecoregion (Ricketts et al., 1999)	Normal pool(acres)/ elevation (NGVD)	Flood pool(acres)/ elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Copan	Corps	Washington	Little Caney River; flood control, water supply, water quality control, recreation, fish and wildlife	Central Forest/ Grassland Transition Zone	4, 850/710.0	13, 380/732.0	505	30
Hulah	Corps	Osage	Caney River; flood control, water supply, low-flow regulation, conservation	Flint Hills Tall Grasslands/ Central Forest Grassland Transition Zone	3, 570/733.0	13, 000/765.0	732	62
Oologah	Corps	Nowata, Rogers	Verdigris River; flood control, water supply, and navigation	Central Forest/Grassland Transition Zone	29, 460/638.0	56, 800/661.0	4, 339	180
Kaw	Corps	Kay, Osage	Arkansas River; flood control, water supply, water quality, recreation, fish and wildlife	Central and Souther Mixed Grasslands/Flint Hills Tall Grasslands	17, 040/1, 010.0	38, 020/1, 044.5	46, 530	168
Keystone	Corps	Osage, Creek, Pawnee, Tulsa	Arkansas and Cimarron River; flood control, water supply, hydroelectric power, navigation, fish and wildlife	Central Forest/ Grassland Transition Zone	23, 610/723.0	54, 320/754.0	74, 506	330
Grand	GRDA[1]	Ottawa, Delaware, Mayes	Neosho and Spring River; flood control, hydroelectric power	Central U.S. Hardwood Forests and Central Forest /Grassland Transition Zone	46, 500/745.0	59, 200/755.0	10, 298	1, 300

Table 1
continued

Reservoir	Agency	Counties	River/Stream and Purpose of reservoir	Ecoregion (Ricketts et al., 1999)	Normal pool(acres)/ elevation (NGVD)	Flood pool(acres)/ elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Hudson (Markham Ferry)	GRDA[1]	Mayes	Neosho River; flood control, hydroelectric power	Ozark Mountain Forests	250/756	NA	NA	8
Fort Gibson	Corps	Mayes, Wagoner, Cherokee	Neosho River; flood control, hydroelectric power	Ozark Mountain Forests	19, 900/554.0	51, 000/582.0	12, 492	225
Tenkiller	Corps	Cherokee, Sequoyah	Illinois River; flood control, hydroelectric power	Ozark Mountain Forests	12, 900/632.0	20, 800/667.0	1, 610	130
Eufaula	Corps	McIntosh, Pittsburg	North Canadian, South Canadian, and Deep Fork; flood control, water supply, hydroelectric power, navigation	Central Forest/ Grassland Transition Zone	105, 000/585.0	143, 000/597.0	47, 522	600
Wister	Corps	LeFlore	Poteau River and Fourche Maline Creek; flood control, water supply, low flow augmentation, water conservation and sedimentation	Ozark Mountain Forests	7, 333/478.0	23, 070/502.5	993	115

1 Grand River Dam Authority

Although the Arkansas River constitutes a large portion of the MKARNS, the Arkansas River and the reservoirs on or associated with the river are not one in the same with the MKARNS. The MKARNS consists of four distinct segments: fifty miles of the Verdigris River in Oklahoma (RM 445 - 394), 375 miles of the Arkansas River proper in Oklahoma and Arkansas (RM 394 - 19), the manmade Arkansas Post Canal (RM 19 -10), and the White River entrance channel in Arkansas (RM 10 -0). The MKARNS was constructed to enable large vessels to overcome the steep slope of the Arkansas River Valley due to the 420-foot difference in elevation from the Mississippi River to the head of the MKARNS near Catoosa, Oklahoma.

There are 17 existing locks and dams on the MKARNS (all 110 feet wide by 600 feet long) with 5 in Oklahoma and 12 in Arkansas; and one currently is under construction on the White River entrance channel. Although the series of locks, dams, and reservoirs associated with the MKARNS can be considered beneficial because they allow inland navigation and provide flood control, hydroelectric power, water supply, and recreational activities such as boating, camping, fishing, hunting, and hiking, they have also resulted in negative ecological impacts. These include inundation of vast areas of numerous natural habitat types including forests, grasslands, palustrine and riverine wetlands, tributary streams, and oxbow lakes; additional ecological impacts have occurred as a result of secondary development such as dredging and vegetation removal.

The head of the MKARNS is at the Port of Catoosa in Rogers County in northeast Oklahoma near Tulsa (navigation mile 444.8). From this port, the MKARNS follows the Verdigris River for 50 miles southeasterly through the Newt Graham Lock and Dam (# 18 at NM 421.4) and the Chouteau Lock and Dam (# 17 at NM 401.4) in Wagoner County. This area of Oklahoma is in the Central Forest/Grassland Transition Zone terrestrial ecoregion (CTZ) (Ricketts et al. 1999) and the Central Prairie freshwater ecoregion (Abell et al. 2000). The area is a combination of Omernik's (1995) Central Irregular Plains and Central Oklahoma/Texas Plains. The Arkansas, Grand, Verdigris, Cimarron, and Canadian Rivers each drain portions of this area of Oklahoma.

Oologah, Keystone, Copan, Fort Gibson, Hudson, and Eufaula Reservoirs are located in this portion of the study area, which consists primarily of a mixture of prairie, savannah, and woodlands on low rolling hills, and broad floodplain forests of elm, oak, hackberry, cottonwood, and sycamore created by slow-moving and muddy tributaries. The grasslands occur on relatively deep and fertile soils as opposed to the thin layer of soil over limestone that occurs in the Flint Hills Tall Grasslands (Ricketts et al., 1999) to the northwest (location of Hulah Reservoir). The CTZ is distinguished from the Central and Southern Mixed Grasslands (Ricketts et al., 1999) of central and western Oklahoma (location of Kaw Reservoir) by its increased average annual precipitation resulting in a higher density of trees and shrubs.

Typical grasses of the CZT include big bluestem (Andropogon gerardi), little bluestem (Schizachyrium scoparium), Indian grass (Sorghastrum nutans), switchgrass (Panicum virgatum), and grama grasses (Bouteloua spp.) Upland forests dominated by oak (Quercus spp.) and hickory (Carya spp.) occur in the more mesic draws and ravines. The "crosstimbers" (wide belt of timber on the prairie encountered by explorers as they crossed the plains) also occur in this area on light colored sandy soils with reddish clay subsoils, and consist of hickory trees scattered among short post oak (Q. stellata) and blackjack oaks (Q. marilandica). Considered one of the richest places for biodiversity in North America because of its large size and proximity to both the great plains and eastern deciduous forests, this area is within the top 10 ecoregions for bird, reptile, and tree species (Ricketts et al. 1999). Much of the fauna is shared with the adjacent grassland ecoregions (prairie species can be found in the woodland understory layer).

The major aquatic habitat types are temperate headwaters and lakes. Endemism for aquatic

species is relatively low (Abell et al. 2000). The biological distinctiveness of the area (i.e., the

biological importance of an ecoregion based on species richness and endemism, and rarity of ecological phenomena and habitat types within the ecoregion) is considered regionally outstanding (high regional biodiversity). Only 1 percent of the area is thought to be intact as a result of intensive farming for crops such as corn and soybeans, and the degree of fragmentation is ranked as extremely high (Ricketts et al., 1999).

The MKARNS joins the Arkansas River northeast of Muskogee in Muskogee County, Oklahoma (NM 395.0), and then extends southeasterly through Oklahoma toward Arkansas through Webbers Falls Lock and Dam (# 16 at NM 366.6) creating the 34.5 mile-long Webbers Falls Reservoir in portions of Muskogee, Wagoner, and Cherokee counties. Webbers Falls impounds 28 miles of the Arkansas River to the mouth of the Verdigris River and then 6.5 miles up the Verdigris to Chouteau Lock and Dam (U. S. Fish and Wildlife Service, 1983).

From Webbers Falls Lock and Dam, the channel forms a portion of the county line between Sequoyah and Muskogee and Sequoyah and Haskell counties near the Sequoyah National Wildlife Refuge (NWR) (described below), and then extends through Robert S. Kerr Lock and Dam (# 15 at NM 336.2) creating Robert S. Kerr Reservoir. Kerr Reservoir forms many irregular arms and peninsulas and extends about 32.7 navigation miles upstream to Webbers Falls Lock and Dam. From Kerr Reservoir, it continues along the Sequoyah/LeFlore County line through W. D. Mayo Lock and Dam (# 14 at NM 319.6), as it leaves Oklahoma and enters Arkansas, where it flows through the James W. Trimble Lock and Dam (#13 at NM 292.8) along the Crawford/Sebastian County line, and through the Ozark – Jeta Taylor Lock and Dam (# 12 at NM 256.8) in Franklin County creating Ozark Lake. Continuing southeasterly along the Johnson/Logan County line, the MKARNS forms Lake Dardanelle at Dardanelle Lock and Dam (#10 at NM 205.5), and then flows along the Yell/Pope County lines, forming the northern border of Holla Bend NWR (described below) in Pope County. From there, it flows through Arthur V. Ormond Lock and Dam (#9 at NM 176.9) in Conway County and along the Conway/Perry and Faulkner/Perry County lines where it extends through Toad Suck Ferry Lock and Dam (# 8 at NM 155.9). The MKARNS continues along the Faulkner/Pulaski County lines, and through the Murray Lock and Dam (# 7 at NM 125.4) in Paluski County near Little Rock.

This area of Oklahoma and Arkansas is within the Ozark Mountain Forests terrestrial ecoregion as defined by Ricketts et al. (1999) and the Central Prairie freshwater ecoregion from around Muskogee, Oklahoma, to the Oklahoma/Arkansas state line where the project area enters the Ozark Highlands freshwater ecoregion as defined by Abell et al. (2000). These ecoregions combine Omernik's (1995) Ouachita Mountains (location of Wister Reservoir), Ozark Mountains (location of Grand and Tenkiller Reservoirs), and Arkansas Valley ecoregions, with the Arkansas Valley occurring between the others. The Arkansas River floodplain is confined to the Arkansas Valley ecoregion.

Other major rivers in this broad area include the Grand, Illinois, and Poteau Rivers in Oklahoma and the Petit Jean, Fourche Lafave, and Ouachita Rivers in Arkansas.

The natural communities of the area include bottomland hardwood forests along rivers and streams, oak – hickory forests in upland sites, shortleaf pine savannas and mixed pine – hardwood forests on ridge tops, and scattered tallgrass prairie communities in the valley between the dry upland forests and bottomland hardwood forests. The limestone formation (karst geology) in the northern portion of the area (Ozarks) has dissolved in many places, forming caves. Many of the natural communities of the project area have been greatly altered by timber harvesting, cultivated agriculture, and development of the MKARNS. Riparian habitat along the

Arkansas River is considered severely degraded, and only about 3 percent of the pre-settlement habitat is intact as a result of agriculture, logging, fire suppression, and grazing (Ricketts et al., 1999). Several near-endemic herpetofauna species are found in this area including Strecker's chorus frog (Pseudacris streckeri), the ringed salamander (Ambystoma annulatum) (Abell et al., 2000) and the many-ribbed salamander (Eurycea multiplicata) (Conant and Collins, 1991).

From Little Rock, the Arkansas River/MKARNS continues southeasterly through the David D. Terry Lock and Dam (# 6 at NM 108.1) in Paluski County and through Lock and Dam # 5 (at NM 86.3) in Jefferson County. It then flows through Emmet Sanders Lock and Dam (#4 at NM 66.0) northeast of Pine Bluff. From there, it continues through Joe Hardin Lock and Dam (# 3 at NM 50.2) along the Jefferson/Lincoln County Line, and along the Arkansas/Lincoln and Arkansas/Desha county lines. It extends then through Lock # 2 (at NM 13.3) and Norrell Lock and Dam # 1 (at NM 10.3) as it follows the nine mile manmade Arkansas Post Canal in Arkansas County that connects the White and Arkansas Rivers. Finally, ten miles of the White River in eastern Arkansas (mile 599 on the Mississippi River) make up the MKARNS's entrance channel.

This portion of the MKARNS is within the Mississippi Embayment freshwater ecoregion (Abell et al., 2000) and the Mississippi Lowland Forest terrestrial ecoregion (Ricketts et al., 1999). In Arkansas, this is identical to Omernik's (1995) Mississippi Alluvial Plain. Other major rivers in the area are the White and Mississippi rivers. Wetland areas, oak-hickory-pine forests, and bottomland hardwoods once dominated the landscape; however, these habitats have been extensively altered resulting in the loss of most (91–95%) of the original riparian and bottomland forest systems. Much of the remaining floodplain forests include river swamp forests, forests of backwater and flats, and upland transitional forests. Much of the remaining habitat is restricted to wet areas that are difficult or not feasible to exploit economically through cultivation or other means (Ricketts et al., 1999). The biological distinctiveness of the Mississippi Embayment is considered globally outstanding (i.e., the biological diversity of the area is equaled or surpassed in few other places worldwide) (Abell et al., 2000).

The geology of the entire project area varies from recent alluvium and terrace deposits of the Mississippi Alluvial Plain in eastern Arkansas and the Mississippian and Pennsylvanian Ozark and Ouachita Highlands in central/western Arkansas and eastern Oklahoma, to the more recent Quaternarian sand dunes and silts of major drainages in the west. The area contains a variety of siltstones, sandstones, clays, sedimentary limestones, and shales formed during the Pennsylvanian and Permian periods (U. S. Fish and Wildlife Service, 1990).

The climate is primarily influenced by movement of moist air from the Gulf of Mexico, hot and dry air from the desert southwest, and cold air from the Arctic. The region undergoes seasonal variations in temperature and precipitation and typically experiences long, humid summers and short, mild winters. Mean annual precipitation increases from west to east and ranges from 36 inches near Keystone Reservoir west of Tulsa, Oklahoma, to 54 inches in eastern Arkansas at the Arkansas River's confluence with the Mississippi River. Average annual temperatures range from about 60–62° Fahrenheit, and the growing season varies from 209 days in the grasslands and crosstimbers of Oklahoma to about 220 days in the Mississippi Alluvial plain of eastern Arkansas.

PROJECT DESCRIPTION

The Study will be conducted in two phases. The first phase is expected to take three years, and will investigate possible operational changes that might improve the MKARNS's ability to evacuate high water from the eleven upstream reservoirs in Oklahoma and reduce impacts of

sustained high flows. The potential alternatives include altering the reservoir regulation plan through operational changes to the MKARNS in Oklahoma which might include changes in flow rates and durations, reallocating storage from one reservoir to another, or adding storage in the reservoirs. Other possible changes include constructing additional reservoirs, additional high flow relief structures (i.e., spillways), and additional levees along the MKARNS, as well as adjustments/increases in flowage easements, removal of channel restrictions, in-stream modification of existing navigation structures, and restoration/enhancement of aquatic and riparian habitat along the MKARNS. If funding is continued, the second phase will overlap with the third year of the first phase, and take an additional two years to complete. This phase would investigate the feasibility of deepening the entire length of the MKARNS from 9 to 12 feet to allow for deeper tow drafts, and adding passing lanes on the Verdigris River in Oklahoma for increased tow safety. Formal project alternatives have not been developed to date.

FISH AND WILDLIFE RESOURCES WITHOUT THE PROJECT

The Corps has not supplied formal project alternatives that will serve as potential solutions for the problems resulting from the sustained high flows on the MKARNS. Accordingly, this section will provide general information on the fish and wildlife resources in the vicinity of the project area. Specifically, this section includes general information on the terrestrial and aquatic fish and wildlife resources associated with the MKARNS, the eleven Oklahoma reservoirs and their associated rivers/streams, wildlife management areas, and national wildlife refuges. This section also covers information on the federally-listed proposed, threatened, endangered and species of concern, as well as state-listed and rare species that occur within the vicinity of the project area. Detailed descriptions of the aquatic and terrestrial resources of the individual reservoirs and associated streams/rivers have been described in previous reports on various individual projects (lock and dams, hydropower, etc.) and will not be repeated here. More detailed and quantitative information can be provided when specific project alternatives are available.

Arkansas River and Eleven Oklahoma Reservoirs: Aquatic Resources

A variety of fish species occur in the eleven reservoirs in Oklahoma that act as the MKARNS's primary flow modifier, in the Arkansas River/MKARNS in Oklahoma and Arkansas, and in other streams/rivers associated with the upstream reservoirs. Prior to construction of the locks, dams, and reservoirs on the MKARNS, the fish fauna in the various rivers/streams were diverse and unique. However, construction of the MKARNS has resulted in increased occurrence of minimum flows, stabilized channel conditions, and the creation of reservoirs that provide habitat for lake fishes, but limit habitat for native riverine species. The result of the changes is an overall more homogenous aquatic environment within the MKARNS that benefits particular fish fauna at the expense of others. Thus, the fishery resources are generally similar except in areas where trout are stocked below cold water discharges, such as in the lower Illinois below Tenkiller Ferry. A list of fish species common to the eleven upstream reservoirs in Oklahoma is provided in Table 2. Table 3 lists fish species found in the MKARNS in Oklahoma and Arkansas.

Management of the fishery resources in the project area is a cooperative effort between the Corps and the respective state wildlife agencies, and involves monitoring studies and stocking programs. Management programs recognize all species, but concentrate on those most popular with fishermen, such as largemouth bass, crappie, walleye, blue catfish, flathead catfish, white bass, and striped bass. More detailed information on fish species and required habitats can be provided when specific project details are available.

Other fishery resources of significance include oxbow lakes adjacent the MKARNS, tributaries

Table 2. Common fish species found in the eleven Oklahoma reservoirs.

	Copan	Hulah	Oologah	Kaw	Keystone	Grand	Hudson	Fort Gibson	Tenkiller	Eufaula	Wister
Species											
largemouth bass	x	x	x	x	x	x	x	x	x	x	
spotted bass						x	x	x	x		
smallmouth bass			x			x	x		x	x	
white crappie	x	x	x	x	x	x	x	x	x	x	
black crappie			x		x		x		x		
white bass		x	x		x	x	x	x	x	x	x
striped bass	x/hybid		x/hybrid	x	x	x/hybrid	x		x		
channel catfish	x	x	x	x	x	x		x	x	x	
bluegill	x	x	x	x	x	x	x	x	x	x	x
longear sunfish	x	x	x		x	x	x	x	x	x	
carp		x	x		x	x	x	x	x	x	x
freshwater drum		x	x		x	x	x	x	x	x	
smallmouth buffalo		x			x	x	x	x	x	x	x
bigmouth buffalo		x	x				x	x	x	x	x
river carpsucker		x	x		x	x		x	x	x	
black bullhead								x	x		
spotted sucker									x		
golden redhorse									x	x	
river redhorse									x	x	
shorthead redhorse									x	x	
flathead catfish	x	x	x	x	x	x	x	x	x	x	x
xlongnose gar		x							x	x	
spotted gar		x							x	x	
gizzard shad		x	x	x	x	x	x	x	x	x	
walleye			x				x	x	x	x	
paddlefish			x	x		x	x	x			
black bullhead		x			x						
green sunfish		x	x		x	x	x	x	x	x	
warmouth			x		x	x	x	x	x	x	x
orange spotted		x	x		x		x	x			x
redear sunfish		x	x	x	x	x	x	x	x	x	x

Table 3. Fish species known to occur (not inclusive) in the MKARNS and tributaries in Oklahoma and Arkansas (Buchanan, 1976; Jimmie Pigg, unpublished data).

Common Name	Scientific Name
chestnut lamprey	*Ichthyomyzon castaneus*
bowfin	*Amia calva*
American eel	*Anguilla rostrata*
blue catfish	*Ictalurus furcatus*
channel catfish	*Ictalurus punctatus*
flathead catfish	*Pylodictus olivaris*
yellow bullhead	*Ictalurus natalis*
black bullhead	*Ictalurus melas*
tadpole madtom	*Notorus gyrinus*
brindled madtom	*Notorus miurus*
white bass	*Morone chrysoos*
striped bass	*Morone saxitalis*
largemouth bass	*Micropterus salmoides*
spotted bass	*Micropterus punctulatus*
black crappie	*Pomoxis nigromaculatus*
white crappie	*Pomoxis annularis*
walleye	*Stizostedion vitreum*
sauger	*Stizostedion canadense*
warmouth	*Lepomis gulosus*
green sunfish	*Lepomis cyanellus*
longear sunfish	*Lepomis megalotis*
bluegill	*Lepomis macrochirus*
orangespotted sunfish	*Lepomis humilis*
longnose gar	*Lepisosteus osseus*
spotted gar	*Lepisosteus oculatus*
shortnose gar	*Lepisosteus platostomus*

Table 3 continued

Common Name	Scientific Name
skipjack herring	*Alosa chrysochloris*
shovelnose sturgeon	*Scphirhynchus platorynchus*
paddlefish	*Polyodon spathula*
blue sucker	*Cycleptus elongatus*
largemouth buffalo	*Ictiobus cyrpinellus*
smallmouth buffalo	*Ictiobus bubalus*
river carpsucker	*Carpiodes carpio*
golden redhorse	*Moxostoma erythrurum*
carp	*Cyprinus carpio*
drum	*Aplodinotus grunniens*
gizzard shad	*Dorosoma pentenense*
threadfin shad	*Dorosoma pentenense*
golden shiner	*Notemigonus crysoleucas*
pallid shiner	*Hybopsis amnis*
redfin shiner	*Lythrurus umbratilis*
emerald shiner	*Notropis atherinoides*
ghost shiner	*Notropis buchanani*
mimic shiner	*Notropis volucellus*
central stoneroller	*Campostoma anomalum*
blackstripe topminnow	*Fundulus notatus*
blackspotted topminnow	*Fundulus olivaceous*
bullhead minnow	*Pimephales vigilax*
suckermouth minnow	*Phenacobius mirabilis*
silver chub	*Macrhybopsis storeriana*
Mosquito fish	*Gambusia affinis*
brook silversides	*Labidesthes sicculus*

Table 3 continued

Common Name	Scientific Name
logperch	*Percina caprodes*
greenside darter	*Etheostoma blennioides*
bluntnose dater	*Etheostoma chlorosomum*
fantail darter	*Etheostoma flabellare*
slough darter	*Etheostoma gracile*
cypress darter	*Etheostoma proeliare*
banded darter	*Etheostoma zonale*
dusky darter	*Percina sciera*
redfin darter	*Etheostoma whipplei*

Table 4. Major Tributaries of the Arkansas River in Arkansas (U. S. Fish and Wildlife Service, 1988).

Mountain Steams	Delta Streams
Little Maumelle River	Big Bayou Meto
Maumelle River	Little Bayou Meto
Palarm River	Plum Bayou
East Fork Cadron River	Pennington Bayou
Point Remove Creek	
Illinois Bayou	
Big Piney Creek	
Lee Creek	
Petit Jean River	
Fourche Lafave River	
Big Mulberry Creek	

of the MKARNS in Arkansas such as mountain streams west of Little Rock and delta streams east of Little Rock (Table 4), and four Corps lakes in Arkansas that total 51, 360 surface acres: Blue Mountain Lake on the upper reach of the Petit Jean River, Lake Dardanelle and Ozark Lake on the MKARNS, and Nimrod Lake on the upper reach of the Fourche Lafave River. Prominent game species inhabiting the oxbow lakes include largemouth bass, catfish spp., bluegill, carp, and crappie spp. The fisheries of the mountain streams in Arkansas are considered excellent including smallmouth bass, largemouth bass, spotted bass, bluegill, walleye, sauger, and numerous minnow and sucker species. The principal fish species in the delta streams include crappie spp., catfish spp., bluegill, largemouth bass, carp, and buffalo. Common game and commercial fish species occurring in the four Corps lakes in Arkansas include largemouth bass, bluegill, crappie spp., and striped bass (U. S. Fish and Wildlife Service, 1988).

Arkansas River Basin (AR and OK), and Eleven Oklahoma Reservoirs: Terrestrial Resources

Numerous important habitats that support a wide variety of wildlife occur within the project area in Oklahoma and Arkansas. A tentative list of habitat types include: post oak – blackjack oak forest, oak – hickory forest, oak – hickory – pine forests, tallgrass prairie, midgrass prairie, caves, cropland, introduced grassland, riparian forest, bottomland forest, river swamp forests, lower hardwood swamp forests, lacustrine and palustrine wetlands, lentic aquatic habitat, and lotic aquatic habitat (U. S. Fish and Wildlife Service, 1985; U. S. Fish and Wildlife Service, 1988). These habitat types support numerous game and nongame wildlife within the project area; a list of indicator flora and fauna for the habitat types is presented in Table 5. The list is not inclusive of all species typically found in a particular type, since the exact species that occur in each habitat type can vary from location to location.

The habitat types are subjectively ranked according to their overall value to fish and wildlife. The ratings can vary within habitat types, and site specific evaluations would be appropriate when project alternatives are developed and studied in more detail. The following description of the habitat types that may occur within the project area is drawn largely from the Service's reports for a similar study by the Corps on the Arkansas River Basin where proposals were reviewed for storage, conservation, treatment, and conveyance of water in the Arkansas River and tributaries in Arkansas and Oklahoma for industrial and municipal uses (U. S. Fish and Wildlife Service, 1985; U. S. Fish and Wildlife Service, 1988).

The post oak – blackjack oak forest (crosstimbers) occurs on thin soils prone to erosion if disturbed. Plant species diversity is relatively low; however, the juxtaposition of this forest type with native grasslands greatly increase its value to wildlife.

The oak – hickory forest covers a large portion of the Ozark Plateau in Eastern Oklahoma and Western Arkansas. This forest type tends to have higher species diversity than the crosstimbers resulting in a potentially greater number of ecological niches for fauna. Tracts adjacent to bottomland hardwood forests and/or riparian forests are especially valuable and provide high quality habitat for many wildlife species.

Tallgrass prairie occurs in deep, fertile soil on the eastern and western borders of the crosstimbers and in the flint hills. Bison were abundant in the prairies during pre-settlement times, and contributed to the major disturbance regimes which were grazing, drought, and fire (Ricketts et al., 1999). Because of highly fertile soils, much of tallgrass prairie has been converted to cultivated agriculture and introduced grassland pasture (except in the flint hills due to limestone beneath the soil). The remaining tracts of tall grass prairie provide valuable wildlife habitat (Table 5).

Table 5. Cover types, indicator species, and cover type value – index. Indices range from 1 (low habitat potential) to 5 (high habitat potential) (U. S. Fish and Wildlife, 1985).

Habitat Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Post oak – blackjack oak forest	post oak, blackjack oak, dogwood, red cedar, sumacs, buckbrush	white-tailed deer, fox squirrel, bobwhite, carolina chickadee, black and white warbler, armadillo, garter snake, ground skink	3
Oak-hickory forest	post oak, black hickory, mockernut hickory, bitternut hickory, white oak, sugar maple, winged elm	white-tailed deer, fox squirrel, gray squirrel, eastern woodrat, cottontail rabbit, eastern chipmunk, downy woodpecker, white-breasted nuthatch, fence lizard, black rat snake, American toad	4
Oak-hickory-pine forest	post oak, white oak, northern red oak, mockernut hickory, bitternut hickory, black hickory, shagbark hickory, shortleaf pine, loblolly pine, sweetgum	white-tailed deer, fox squirrel, pileated and hairy woodpeckers, gray fox, three-toed box turtle	4
Tallgrass prairie	big and little bluestem, switch grass, Indian grass, goldenrods, side oats grama	coyote, red-tailed hawk, bobwhite, eastern meadowlark, grasshopper sparrow, dickcissel, ornate box turtle, ribbon snake, great plains rat snake	3
Midgrass prairie	little and big bluestem, purple cone flower, gramas, buffalo grass	thirteen-lined ground squirrel, eastern cottontail, jackrabbit, bobwhite, ornate box turtle, Texas horned lizard, prairie kingsnake, prairie skink, Woodhouse's toad	3

Table 5 continued

Habitat Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Caves	–	Bats (Myotis and Pipistrellus spp.), Ozark cavefish, grotto salamander, cave salamander	5
Cropland	wheat, alfalfa, soybeans, sorghums, etc	white-footed mouse, eastern cottontail, mourning dove, eastern meadowlark	2
Introduced grassland	Bermuda grass, fescue, rye, buffalo bur, nightshade, ragweeds	cotton rat, eastern meadowlark	1
Riparian forest	cottonwood, willow, green ash, hackberry, elm, sycamore, dogwood, river birch	white-tailed deer, raccoon, river otter, beaver, red-bellied woodpecker, belted kingfisher, eastern phoebe, fox squirrel, wood duck, herons, cricket frog, green frog	5
Bottomland forest	oaks, sycamore, elms, pecan, boxelder, greenbriar	white-tailed deer, gray squirrel, pileated woodpecker, wood duck, red-shouldered hawks, spring peeper	5
River swamp forests	bald cypress, black willow, water tupelo, water elm, button bush	white-tailed deer, beaver, ducks, warblers, herons, egrets, squirrel, barred owl, swamp rabbit, chorus frogs, aquatic snakes	5

Table 5 continued

Habitat Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Mud flats	devoid of vegetation when inundated; barnyard grass, rushes spp., sedges spp.	raccoon, lesser yellowlegs, common snipe, great blue heron	2 – 5
Lower hardwood swamp forests	red maple, water hickory, green ash, river birch, hackberry, American holly, sweetgum, willow oak, laurel oak	white-tailed deer, beaver, ducks, warblers, herons, egrets, prothonotary warbler, squirrel, swamp rabbit, spotted salamander, chorus frogs, aquatic snakes	5
Lacustrine wetland	cattails, rushes, smartweeds, muskgrass, sedges	bullfrog, cricket frog, carp, water snakes, belted kingfisher, great blue heron, ducks	4
Palustrine wetland	willows, cottonwood, cattails, rushes, pondweed, sedges, buttonbush	beaver, great blue heron, egrets, American bittern, waterfowl, snipe, marsh hawk, marsh wren, red-winged blackbird, grebes, leopard frog, eastern newt, water snakes	5
Lentic aquatic habitat	algae, coontail, bladderwort	largemouth bass, bluegill, catfish, crappie, carp	4
Lotic aquatic habitat	algae, other periphyton	minnows, striped bass, channel catfish	3 – 5*

* mountain streams = 5; Arkansas River/System and associated tributaries and delta streams = 3.

Midgrass prairie occurs in scattered tracts in central and western Oklahoma. Much of the midgrass prairie has been altered by grazing and agricultural practices; however, the prairie that remains supports numerous wildlife species (Table 5).

Caves generally occur in areas with karst topography (areas of carbonate rock, especially limestone, where sinkholes, springs, and caves have formed as a result of the dissolution of the rock by chemical action). They provide a stable environment and habitat for many animals such as frogs, salamanders, reptiles, bats, snails, isopods, amphipods, crayfish, fish, spiders, and crickets. Although caves are underground habitats, they face many potential threats from activities above ground because they typically are connected to the surface through many openings.

Cropland and introduced grassland have increased greatly since settlement and continue to increase at the expense of natural terrestrial habitats with high value for fish and wildlife. Cropland adjacent or in close proximity to other habitats, such as forests, wetlands, or grasslands, provides beneficial habitat to some wildlife species. However, monotypic introduced grasses tend to provide few requisites for wildlife.

Bottomland hardwood forests occur in floodplains throughout the study area. Few undisturbed tracts remain. In Oklahoma, over 85 percent of the bottomland hardwood forests have been lost, and only a portion of the remaining forest is undisturbed (Oklahoma Water Resources Board, 1990). At one time, about 8 million acres of bottomland hardwood forests occurred in Arkansas. Today, only about 850, 000 acres remain, with almost 160, 000 of these acres in a contiguous block in the White River NWR. Due to the presence of productive soils, favorable water regimes, and juxtaposition with other habitats, the bottomland forests are one of the most productive habitats in the U. S. (Clark et al., 1981), and may be the most important wildlife habitat in the project area.

Riparian forests occur in frequently flooded areas adjacent to streams that have saturated soils and high water tables. They generally occur along tributary streams that lack a well-defined flood plain. The juxtaposition of riparian forest with other habitat types enhances the value of the forest for many species.

Numerous palustrine and lacustrine wetlands (Cowardin et al., 1979) occur in association with the MKARNS, its tributaries, and the 15 aforementioned reservoirs in Oklahoma and Arkansas. Wetlands are one of the most important areas in the U. S. due to their numerous valuable functions which include providing crucial habitat for numerous fish and wildlife species, as well as functions that benefit people such as water quality improvement, flood control and prevention, groundwater recharge and discharge, erosion control, and education, recreation, and aesthetics. About 221 million acres of wetlands are estimated to have occurred in the U. S. at the time of settlement; however, less than half of this amount (105.5 million acres) is thought to exist today. Between 1950 and 1970, it is estimated that the annual loss of wetlands was about 458, 000 acres. Data gathered between 1986 and 1997 indicate the annual loss during this period was 58, 500 acres, which represents an 80 percent reduction in the average annual wetland loss. Factors involved in this decline include implementation and enforcement of wetland protection measures and wetland restoration and creation actions (Dahl, 2000).

Lacustrine wetlands (Cowardin et al., 1979) include permanently flooded lakes and reservoirs, impounded lakes, and intermittent lakes such as playa lakes (depressions on the plains that seasonally pond during events of high rainfall and vary from a few hundred feet to several miles in diameter). Lacustrine wetlands tend to be areas of deep water with extensive wave action that are bounded by upland or wetland vegetation such as trees, shrubs, emergents, mosses, or

lichens. Lacustrine wetlands exceed 20 acres, occur in topographic depressions or on a dammed river, lack extensive areal vegetative cover (<30%), and provide valuable habitat for numerous species that require standing water environments (Table 5).

Palustrine wetlands (Cowardin et al., 1979) include swamps, marshes, bogs, mudflats, fens, and ponds. They can be isolated or occur shoreward of lakes and river channels, on river floodplains, on slopes, or within a lacustrine or riverine system (wetlands within a channel except those dominated by vegetation) as islands. They typically are smaller than 20 acres, less than 2 meters deep, and lack significant wave action. Palustrine wetlands provide habitat for many game, non-game, and fur-bearing species.

Lentic aquatic habitats include the aquatic areas in oxbow lakes (old river and stream channels that have been cut off from the main channel), reservoirs, and ponds. Although not as valuable as the pre-impoundment conditions for many species, impoundments have increased the availability of niches for species that require large bodies of standing water, such as warm water lake fish species.

Lotic aquatic habitat is represented by the streams in the project area. Many of these streams have diminished value to fish and wildlife due to impoundment, and as a result of water quality degradation from municipal, industrial, and agricultural effluents. However, because many of the mountain streams in Arkansas are relatively unaltered, many of the fisheries there are still considered to be of excellent condition.

Wildlife Management Areas and National Wildlife Refuges

McClellan – Kerr Wildlife Management Areas (WMAs) managed specifically for wildlife by the ODWC and Corps occur along the MKARNS near Chouteau Lock and Dam in Wagoner County, Webbers Falls Reservoir in Muskogee County, and Robert S. Kerr Reservoir in Haskell and Sequoyah Counties. Nine of the eleven Oklahoma Reservoirs that serve as the MKARNS's primary flow modifier also have WMAs (Table 6). Wildlife management areas in the project area in Arkansas (managed by the Arkansas Game and Fish Commission) include Dardanelle, Bayou Meto, Trusten Holder, and Galla Creek (Table 6). The WMAs in both states provide habitat for species such as white-tailed deer, rabbit, squirrel, migratory birds, quail, turkey, songbirds, and many species of reptiles and amphibians. The areas provide a total of 276, 058 acres of public lands available to sportsmen.

Three national wildlife refuges (NWR) occur along or near the MKARNS. The refuges are the Sequoyah NWR in eastern Oklahoma, and the Holla Bend NWR and White River NWR in Arkansas.

The Sequoyah NWR occurs in Haskell, Muskogee, and Sequoyah Counties near the confluence of the Arkansas and Canadian Rivers in Oklahoma. The refuge was established by cooperative agreement between the Service and the Corps in 1970 to provide habitat for waterfowl and other migratory birds. The refuge covers about 29, 000 acres and annually hosts the largest concentration of wintering snow geese in Oklahoma. Bottomland hardwood habitat found at the refuge provides habitat for numerous wildlife species such as songbirds, raptors, quail, rabbit, muskrat, deer, bobcat, and squirrels, as well as many species of reptiles and amphibians including green tree frogs, cottonmouths, red-eared sliders, diamond back water snakes, and bullfrogs.

The refuge also appears to be one of the last strongholds in Oklahoma for the alligator snapping turtle, a state species of special concern in Oklahoma. Sequoyah NWR offers the public

Table 6. Wildlife Management Areas near the MKARNS in Oklahoma and Arkansas.

Wildlife Management Areas		Acres
Copan (OK)		7,500
Hulah (OK)		16,141
Oologah (OK)		14,155
Kaw (OK)		16,254
Keystone (OK)		16,537
Fort Gibson (OK)		21,798
Tenkiller (OK)		1,950
Eufaula (OK)		48,469
Wister (OK)		35,550
McClellan Kerr (OK)		7,875
	Subtotal (OK)	186,229
Dardanelle (AR)		42,500
Bayou Meto (AR)		34,000
Trusten Holder (AR)		10,000
Galla Creek (AR)		3,329
	Subtotal (AR)	89, 829
	Total	276,058

opportunities for hiking, wildlife photography, bird watching, and freshwater fishing. Public hunting is allowed for waterfowl, deer, and small game (rabbit, grey squirrel, fox squirrel, coot, snipe, mourning dove, woodcock, and bobwhite quail).

The Holla Bend NWR in west-central Arkansas was established in 1957 and covers 7, 057 acres of bottomland hardwoods and wetlands. The refuge lies along the Arkansas River in Pope County, and is bounded by an oxbow lake created when the Corps cut a channel through the bend in the river to improve the MKARNS for navigation and flood control. Wildlife at the refuge includes wintering waterfowl, the golden eagle, the federally-listed threatened bald eagle, migratory songbirds, as well as many species of mammals, reptiles, and amphibians. The refuge receives about 40,000 visitors annually and offers the public opportunities for hiking, wildlife photography, hunting, bird watching, and freshwater fishing.

The White River NWR in Desha, Monroe, and Phillips Counties in eastern Arkansas is located near the confluence of the Arkansas and White Rivers. The refuge occupies 90 of the lower 100 miles of the White River in Arkansas as well as three miles of the MKARNS's Arkansas Post Canal. Established in 1935, the refuge consists of about 160, 000 acres including about 154, 000 acres of forest, 1, 000 acres of grassland, 900 acres of cropland, and 4, 000 acres of natural and manmade lakes. The area provides habitat for wading birds, shorebirds, waterfowl, raptors, a variety of reptiles, amphibians, and mammals, including a healthy population of black bears. The refuge also has four active nests of the federally-listed threatened bald eagle, and hosts the largest concentration of wintering mallard ducks in the Mississippi Flyway. White River NWR is visited by about 150,000 people annually and offers opportunities for hunting, boating, fishing, wildlife observation and photography, and hiking.

Threatened and Endangered Species

The Endangered Species Act (87 Stat. 884 as amended; 16 U. S. C. 1531 et seq.) requires consultation with the Service regarding endangered and threatened species. Thirteen federally-listed endangered and threatened species, one species proposed for federal listing, and one candidate for federal listing occur within the vicinity of the project area. A species by county list for Oklahoma and Arkansas is enclosed as Appendix A and B, respectfully. Endangered species include the interior least tern (Sterna antillarum athalassos), gray bat (Myotis grisescens), Indiana bat (M. sodalis), Ozark big-eared bat (Corynorhinus tonsendii), pink mucket pearlymussel (Lampsilis abrupta), Harperella (Ptilimium nodosum), and the American burying beetle (Nicrophorus americanus). Threatened species include the bald eagle (Haliaeetus leucocephalus), piping plover (Charadrius melodus), Arkansas River shiner (Notropis girardi), Geocarpon minimum (no common name), and the western prairie fringed orchid (Platanthera praeclara). The scaleshell mussel (Leptodea leptodon) is proposed for federal listing as endangered and occurs within the vicinity of the study area, as does the Arkansas darter (Etheostoma cragini), which is a federal candidate species.

The endangered interior least tern is a piscivorous bird (McDaniel and McDaniel, 1963) that nests on sandbars and sandy islands of major rivers and sandy shorelines of reservoirs in the interior United States. Reasons for the decline include anthropomorphic causes (U. S. Fish and Wildlife Service, 1990) such as impoundments and irrigation, overgrowth of vegetation, the recreational use of sandbars by humans, and flooding of nesting areas caused by unpredictable water discharge patterns below reservoir dams (U.S. Fish and Wildlife Service, 1993). Within the project area, interior least terns forage and nest along the Arkansas River in Oklahoma and Arkansas from April through late August and early September. Interior least terns nest in small colonies and prepare nests by making small scrapes in the sand where two or three eggs are usually laid. Both parents feed the young, which are fairly mobile upon hatching. Terns tend to

forage in shallow water habitats on small surface schooling fish (2.0 to 9.0 cm long for adults and 1.5 to 4.0 cm long for chicks) (Atwood and Minsky, 1983; Schweitzer and Leslie, Jr., 1996; Wilson et al., 1993). They are considered "surface plungers" (Erickson, 1985) because they hunt for prey while hovering five to ten meters over water bodies, and plunge into the water to capture the fish. Distance to water bodies with available food highly influences reproductive success. Density of surface schooling fish and aquatic vegetation, and water transparency affect the suitability of an area for this species (Schweitzer and Leslie, Jr., 1996). The Nature Conservancy manages about 1, 175 acres along the Arkansas River in Tulsa, Oklahoma, as the Arkansas River Least Tern Preserve.

Three endangered bat species occur within the project area. Gray bats are medium sized grayish-brown bats with a wing span of ten to eleven inches. They occur in Oklahoma and Arkansas, and migrate each year from summer caves that are typically located near lakes and rivers to winter caves, where mating occurs (U.S. Fish and Wildlife Service, 1993). Gray bats feed on insects almost exclusively over water along reservoir edges and rivers, and use associated forest canopy as a travel corridor and escape route between caves and feeding sites (U.S. Fish and Wildlife Service, 1982). Indiana bats occur in the Midwest and the eastern United States where the western edge of the Ozark region in Oklahoma marks the western limit of their range. They mate in caves during fall and begin hibernation in October in limestone caves. During summer, females and juveniles roost in small colonies under tree bark usually near streams, and forage in riparian woodlands and floodplains. Males tend to forage over floodplain ridges and hillside forests (U.S. Fish and Wildlife Service, 1993). Hence, rivers may provide important summer habitat (U.S Fish and Wildlife, 1985). Ozark big-eared bats are medium sized bats with distinctively long ears and facial glands on either side of the face. They primarily dwell in caves. In Arkansas, the bats are known to occur only in Marion and Washington Counties, outside of the project area. Caves in Adair County, Oklahoma, support some of the largest maternity colonies and hibernacula for both Ozark big-eared bats and gray bats. However, except for a small portion of Spavinaw Creek, these caves do not include any major water areas in the project area.

The pink mucket pearlymussel is an endangered mussel that occurs in Arkansas in the Lower Mississippi River and its larger tributaries. The largest populations occur in the Spring and White Rivers. Smaller populations occur in the Ouachita and Little River systems. The pink mucket pearlymussel prefers sand and gravel. The shell is thick, round to elliptical and smooth with a tan, yellow, or yellowish green color and either faint green rays or no rays. Misidentification by commercial harvesters may be a leading factor in its decline.

Populations of the endangered American burying beetle are known to occur within Arkansas and Oklahoma. Current information suggests that this species is a habitat generalist that occurs in both grasslands and forests. American burying beetles feed on carrion about the size of chipmunks, and carrion availability and the availability of enough humus and top soil for carrion burial may be one of most important factors determining where this species can survive (U. S. Department of the Interior, 1989). The beetle is active only on warm nights (> about 60^0F). The most effective method known for surveying for American burying beetles is the use of small baited pitfall traps (24 oz. plastic cups) (Creighton et al., 1993, unpublished data); however, baiting pitfall trips may bring beetles into an otherwise unoccupied area.

Harperella is an endangered annual herb that is known to occur in only 12 extant populations, including populations in Yell and Scott Counties, Arkansas. Habitat includes palustrine and riverine wetlands. It typically occurs in rocky/gravel shoals of swift, clear streams, and edges of intermittent pine land ponds. This species requires moderately intensive spring floods. Causes for decline include alterations of water regime from impoundments, water withdrawal, draining

or deepening of ponds, and shoreline development.

The threatened bald eagle breeds and winters in Oklahoma and Arkansas where it is known to occur along the Arkansas River/MKARNS and near large reservoirs where it utilizes large trees for perching and roosting. Trees used for diurnal perches and feeding are typically different than those used for roosting at night. Trees used for diurnal perching are usually tall, with large diameters and stout branches. Trees used for communal night roosts are usually more secluded but are usually located near their feeding areas. The eagles along the MKARNS and reservoirs probably feed mainly on fish, but may also eat waterfowl and carrion. Several of the eleven upstream Oklahoma reservoirs support sizeable concentrations of wintering bald eagles: Keystone, Eufaula, Wister, Grand, Fort Gibson, and Kaw. Additionally, bald eagles are known to nest at numerous locations within the project area, especially along the mainstem of the Arkansas River.

The Arkansas River shiner is a threatened species that is native to wide, sandy streams in the Arkansas River drainage in Arkansas, Kansas, New Mexico, Texas, and Oklahoma. However, the shiner is currently limited to the Canadian River in Oklahoma, Texas, and New Mexico, and to the Cimarron River in Kansas and Oklahoma. Threats to the shiner include habitat destruction and modification resulting from the construction of impoundments, stream water depletion due to groundwater pumping and diversion of surface water, and water quality degradation (U. S. Fish and Wildlife Service, 1998). Proposed critical habitat for the shiner includes the Canadian River in Oklahoma. Eufaula reservoir is located on the Canadian River at river mile 27.0.

The threatened western prairie fringed orchid once occurred in the vicinity of the project area. This species was found in moist areas in tallgrass prairie or sedge meadows throughout the tallgrass regions of North America. The orchid has, however, experienced a drastic decline, and currently, extant populations are found only in Iowa, Kansas, Minnesota, Missouri, Nebraska, and North Dakota (U.S. Fish and Wildlife Service, 1993).

The threatened piping plover is a migratory bird that breeds from southern Canada to the northeastern and central United States. It winters along the southern Atlantic and Gulf Coasts. Piping plovers use sand-bottom rivers, reservoir beaches and mudflats in their migration corridor. They migrate through Oklahoma every year, and are known to use the Winganon Flats at Oologah reservoir (U.S. Fish and Wildlife Service, 1993).

Geocarpin minimum (no common name) is a small succulent annual plant that is federally-listed as threatened. It is known to only occur in 14 sites in Missouri and 4 sites in Arkansas, including a small population in Franklin County. This species typically occurs on sandy-clay prairies which may represent Pleistocene lake beds. Threats include habitat modification, trampling and grazing by livestock, and off-road vehicle use.

The only species proposed for federal listing that may occur within the vicinity of the project area is the scaleshell. The scaleshell is a relatively small mussel that possesses a thin shell with faint green rays. It occurs in medium to large rivers with stable channels and sand and gravel bottoms, where it partially buries itself and siphons the water for food, improving water quality. Over the last fifty years this species has declined due to pollution, increased sedimentation (suffocates the mussels and makes feeding difficult), and dams (act as barriers to host fish, isolate populations, and destroy habitat), and it is currently proposed for federal listing as endangered. There are only 13 known scattered populations in the Mississippi River basin in Missouri, Oklahoma, and Arkansas.

The Arkansas darter is a federal candidate species that occurs in the Arkansas River drainage in

Missouri, Colorado, Kansas, Arkansas, and Oklahoma. It is a small, strongly bicolored fish (upper half dark brown, lower half white to orange). Within the vicinity of the study area, it occurs in northeastern Oklahoma and northwestern Arkansas in spring fed vegetated creeks and headwaters typically over mud. Although not afforded protection under the Endangered Species Act (only listed and proposed species are protected pursuant to the Act), the Service provides this information to encourage efforts to avoid adverse impacts to this species.

More specific project information is required to determine impacts on federally-listed threatened and endangered species. As solutions for problems resulting from the sustained high flows on the MKARNS are determined, it will be incumbent upon the Corps to determine if the selected solutions will adversely affect federally-listed or proposed species, or their designated critical habitat. If a project is determined to adversely affect these resources, then formal consultation under Section 7 of the Endangered Species Act will be required.

Other species that also should be considered during project planning include state-listed and rare species, species with restricted ranges, and species of concern such as paddlefish (Polydon spatula) that may occur within the project area (Tables 7 and 8; It is important to note that rare/declining, state-listed threatened or endangered species, and species of concern are not afforded protection under the Act, unless proposed for federal listing, but protection of these species now will help prevent the need to list them in the future.). Paddlefish are smooth-skinned fish with an elongated snout that occupy the calmer, open waters of large rivers. They prefer slow moving water behind islands and sandbars because of the abundance of zooplankton, their primary food source. They were once common in big rivers in the Mississippi basin such as the Arkansas River. However, excessive commercial harvest for roe (mass of eggs in the female fish) that is processed and sold as caviar, and water development projects that greatly altered their natural habitat have drastically reduced this species in the Arkansas River. For example, rising water levels in spring trigger upstream spawning migrations. However, in many cases, migrations are blocked by dams. Restoration attempts through a joint effort of the Tishomingo National Fish Hatchery, Oklahoma Fisheries Resource Office, Oklahoma Ecological Services, and the ODWC have resulted in a self-sustaining population above Kaw Reservoir in Oklahoma, and the stocking of about 80, 000 paddlefish in the Arkansas and Verdigris Rivers in northern Oklahoma. Currently, Service fisheries biologists are conducting surveys on the brood stock.

IMPACT EVALUATION AND PRELIMINARY CONCERNS

The Service's overall goal is to protect and/or enhance important fish and wildlife resources. A brief discussion of the general impacts that may be associated with the potential measures that might serve as solutions to the problems resulting from sustained high flows of the MKARNS are discussed below followed by some preliminary concerns. Because formal project alternatives have not been developed to date, a detailed evaluation of all potential impacts is not possible. As more in-depth project alternative descriptions become available, site-specific determinations of impacts can be provided. In general, a diverse water project that may include the construction of new reservoirs and flood control levees, changes to flow rates on the MKARNS, reallocating or adding storage in the eleven upstream Oklahoma reservoirs, raising of levees, removal of channel impediments, deepening the entire MKARNS, and adding passing lanes on the Verdigris River portion of the MKARNS will cause various physical changes leading to numerous impacts, both positive and negative, on fish and wildlife resources.

Due to the nature of the various solutions being investigated, it is likely that wetlands will be impacted by the project. The Service's Mitigation Policy (Federal Register 46(15):7644-7663) provides guidance for formulating measures to eliminate, reduce and offset environmental

Table 7. State-listed rare and endangered/threatened species that occur or may occur within the project area in Oklahoma.

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Animals		
Gray bat (Myotis grisescens)	E	northeastern OK; limestone caves, forests near rivers/lakes
Indiana bat (Myotis sodalis)	E	eastern OK; caves, forests
Ozark big-eared bat (Plecotus townsendii ingens)	E	northeastern OK; caves (karst areas) in oak-hickory forests
Marsh rice rat (Oryzomys palustris)	SS2	eastern OK; near wetlands, grasslands
Golden mouse (Ochrotomys nuttali)	SS2	east-central OK; greenbriar thickets, swamps
Long-tailed weasel (Mustela frenata)	SS2	variety of habitats statewide
Mountain lion (Felis concolor)	SS2	rare in eastern OK
Rafinesque's big-eared bat (Plecotus rafinesqui)	SS2	east-central Oklahoma; forests with dense foliage
River otter (Lutra canadensis)	SS2	eastern OK, Wister WMA; aquatic
Woodchuck (Marmota monax)	SS2	east-central & northeastern OK; open woodlands
Piping plover (Charadrius melodus)	T	migrates through central and eastern OK; known to use Winganon Flats at Oologah Reservoir
Bald eagle (Haliaeetus leucocephalus)	E	major rivers and reservoirs
Interior least tern (Sterna antillarum)	E	Arkansas and Canadian Rivers
Prairie falcon (Falco mexicanus)	SS1	dry plains and prairies
Swainson's hawk (Buteo swainsoni)	SS2	grasslands

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Loggerhead shrike (Lanius ludovicianus migrans)	SS2	open areas with high perches
Barn owl (Tyto alba)	SS2	woodlands, savannas, farmlands, suburbs
Bell's Vireo (Vireo bellii)	SS2	deciduous thickets along streams, ravines, forest edges
Arkansas darter (Etheostoma cragini)	SS2	northeastern Oklahoma; spring feed vegetated creeks and headwaters typically over mud
Arkansas River shiner (Notropis girardi)	T	Canadian River above Eufaula Reservoir
Ozark cavefish (Amblyopsis rosae)	T	streams in nutrient rich caves in northeastern OK/Ozark highlands
Blackside darter (Percina maculata)	T	eastern OK in pools of creeks of small-medium rivers
Longnose darter (Percina nasuta)	E	east-central OK in gravel runs of small-medium rivers
Alabama shad (Alosa alabame)	SS2	east-central and northeast OK in open water of medium - large rivers
Alligator gar (Lepisosteus spatula)	SS2	eastern OK except northeast in pools and backwaters of rivers, lakes, swamps
Arkansas River speckled chub (Macrhybopsis aestivalis tetranemus)	SS2	gravel runs of major rivers and tributaries
Blue sucker (Cycleptus elongatus)	SS2	Grand lake and tailwaters
Black buffalo (Ictiobus niger)	SS2	eastern and central OK in rivers and lakes
Bluntface shiner (Notropis camurus)	SS2	northeastern OK in small clear streams

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Harlequin darter (Etheostoma histrio)	SS2	mostly Saline, Spavinaw, and Spring Creeks
Kiamichi shiner (Notropis ortenburgeri)	SS2	Poteau River and streams in Ouachita Mountains
Pallid shiner (Notropis amnis)	SS2	Poteau River
Plains topminnow (Fundulus sciadicus)	SS2	Grand River drainage
Ribbon shiner (Lythrurus fumeus)	SS2	Illinois and Poteau Rivers
River Darter (Percina shumardi)	SS2	Grand and Illinois Rivers
Shorthead redhorse (Moxostoma macrolepidotum)	SS2	northeastern OK in clear gravel-bottom streams/rivers
Shovelnose sturgeon (Scaphirhyncus platorynchus)	SS2	Arkansas River and tributaries
Southern brook lamprey (Ichthyomyzon gagei)	SS2	clear streams of Ouachitas and Ozarks
Spotfin shiner (Notropis spilopterus)	SS2	Illinois River
Spotted bass (Micropterus punctulatus)	SS2	eastern OK in clear, spring- fed streams
Stonecat (Notorus flavus)	SS2	northeatern OK in clear bottom, gravel streams
Northern scarlet snake (Cemophora coccinea)	SS2	eastern OK in sandy/loamy areas
Alligator snapping turtle (Macroclemys temminckii)	SS2	Eastern OK in lakes, rivers, oxbows, and sloughs; known to occur at Seqouyah NWR and near Eufaula Reservoir
Map turtle (Graptemys geographica)	SS2	Delaware County; large bodies of water

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Texas horned lizard (Phrynosoma cornutum)	SS2	grasslands with areas of sparse vegetation
Rich Mountain salamander (Plethodon ouachitae)	SS2	north facing talus slopes of Ouachtia Mountains
Grotto salamander (Typhlotriton spelaeus)	SS2	northeastern OK in limestone caves with springs
Oklahoma salamander (Eurycea tynerensis)	SS2	northeast OK in spring-fed creeks with gravel bottoms
Ouachita dusky salamander (Desmognathus brimleyorum)	SS2	southeastern OK in springs, streams
Ringed salamander (Ambystoma annulatum)	SS2	eastern OK in moist wooded areas
Scaleshell (Leptodea leptodon)	SS2	scattered populations in Arkansas River Basin
Neosho mucket (Arkansia wheeleri)	E	Illinois River above Lake Tenkiller
Western fanshell (Cyprogenia aberti)	SS2	historically occurred in Verdigris and Caney Rivers ; may be extirpated from Oklahoma
Spectacle-case shell (Quadrula cylindrica)	SS2	Illinois River in Cherokee County
Rich Mountain Slitmouth (Stenotrema pilsbryi)	SS1	talus slope in Ouachita Mountains
American Burying Beetle (Nicrophorus americanus)	E	habitat generalist; grasslands, forests
Prairie mole cricket (Gryllotalpa major)	SS2	prairies
Plants		
Ozark chinquapin oak (Castenea pumela var. ozarkensis	R	eastern OK in oak-pine and oak-hickory forests

Table 7 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Waterfall's sedge (Carex latebracteata)	R	mesic slopes in southeastern OK
Hammock sedge (Carex fissa)	R	northeastern OK along edges of ponds/lakes
Ozark wake-robin (Trillium pusillum var. ozarkanum)	R	Oak-hickory and Oak-pine woodlands in LeFlore County
Ozark spiderwort (Tradescantia ozarkana)	R	eastern OK in deciduous forests in ravines and steep rocky hillsides
Skinner's false foxglove (Agalinis skinneriana)	R	Delaware County in prairies and open areas of oak-hickory forests but may be extirpated from OK
Earleaf false-foxglove (Agalinis auriculata)	R	currently only known from prairie hay meadows bordered by upland woods in Choctaw County
Dwarf pipewort (Eriocaulon kornickianum)	R	sandy hillsides in Atoka, Muskogee, and Pushmataha Counties
Southern Lady's slipper (Cyprepedium kentuckiense)	R	southeastern OK in floodplain forests and mesic ravines
Ouachita indigo bush (Amorpha ouachitensis)	R	Leflore, McCurtain, and Pushmataha Counties along rocky creeks, streambanks, and floodplains
Western prairie fringed orchid (Platanthera praeclara)	T	northeastern Oklahoma in moist grasslands; may be extirpated from Oklahoma

1 E = Endangered

T = Threatened

SS1 = Species of Special Concern where current evidence indicates species is vulnerable because of limited range, low population, or other factors

SS2 = Species of Special Concern that is possibly threatened or vulnerable but with little evidence to document current population levels and range.

R = Rare

Table 8. Arkansas state-listed rare species that occur or may occur within the project area. All state listed threatened/endangered can be found in the federal list in Appendix B (list of species and their state rank provided by the Arkansas Natural Heritage Commission).

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Animals		
Rafinesque's big-eared bat (Corynorhinus rafinesquii)	S2	statewide except Ozark Mountains; occupies buildings, barns, caves, forests
Brazilian free-tailed bat (Tadarida brasiliensis)	S3	central and southern Arkansas; occupies buildings, forests
Gray myotis (Myotis grisescens)	S2	forests and caves near rivers, lakes
Florida panther (Puma concolor coryi)	SH	–
Swainson's warbler (Limnothlypis swainsonii)	S3B	possibly statewide; swamp forests, bottomland hardwood forests, riparian forests
Interior least tern (Sterna antillarum athalassos)	S2B	sand bars on Arkansas and White Rivers
Bald eagle (Haliaeetus leucocephalus)	S2B, S4N	statewide; rivers, reservoirs/lakes
Strecker's chorus frog (Pseudacris streckeri streckeri)	S2	eastern and central Arkansas; moist woods, rocky ravines, riparian forests, lagoons, swamp forests, croplands
Plains spadefoot (Scaphiopus bombifrons)	S1	isolated population in north-central/northwest Arkansas; grasslands
Arkansas River shiner (Notropis girardi)	SX	–
Shorthead redhorse (Moxostoma macrolepidotum)	S2	northern half of Arkansas; rocky pools and riffles of small and large rivers, lakes
Slenderhead darter (Percina phoxocephala)	S2	western Arkansas; gravel runs and riffles of small creeks to medium rivers

Table 8 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Suckermouth minnow (Phenacobius mirabilis)	S1	west-central Arkansas; gravel/rubble riffles and runs of creeks, and in small to large rivers
Flathead chub (Platygobio gracilis)	S1?	eastern Arkansas; sandy runs of rivers
Paddlefish (Polydon spathula)	S2?	statewide; slow flowing, deep water of large rivers
Swamp darter (Etheostoma fusiforme)	S2?	south and eastern Arkansas; standing of slow-moving water over sand or mud
Goldeye (Hiodon alosoides)	S2B, S4N	statewide; occurs in deep open pools, channels, lowland rivers, lakes.
Plains minnow (Hybognathus placitus)	SX	west-central Arkansas; shallow sandy runs, pools of creeks, and small to large rivers
Lake sturgeon (Acipenser fulvescens)	S1	eastern Arkansas; bottom of lakes and large rivers
Lake chubsucker (Erimyzon sucetta)	S2?	southern, east-central, and eastern Arkansas; lakes, ponds, and swamps over silt, sand, or debris
Plants		
San Antonio false-foxglove (Agalinis homalantha)	S1	statewide; oak woodlands
Texas bergia (Bergia texana)	S2	Johnson , Perry, ansd Desha Coutnies; swamps, mud flats, muddy pond shores
Tissue sedge (Carex hyalina)	S3	statewide inventory needed; margins of forested wetlands and swamps
Scratch-daisy (Croptilon hookerianum var. validum)	S2	limited to the Arkansas Valley and Mississippi Alluvial Plain

Table 8 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Lax hornpod (Cynoctonum mitreola)	S3	wetlands
Six-angle spurge (Euphorbia hexagona)	S2	known to occur in Franklin and Pope Counties; sandy shores and bottoms
Showy prairie-gentian (Eustoma russellienum)	S2	Clark County and Arkansas River Valley
Soapwart gentian (Gentiana saponaria)	S3	western and central Arkansas; swamps, bogs
Hairy water-fern (Marsilea vestita)	S3	Arkansas River Valley and in Bradley, Chicot, Washington and Polk Counties; wetlands
California bullrush (Scirpus californicus)	S1S2	known to occur in Hempstead, Johnson, and Conway Counties; wetlands
Riddell's spike moss (Selaginella arenicola)	S3	known from the Ozark Plateau; dry rocks and packed sand
Twistflower (Streptanthus obtusfolius)	S3	restricted to Ouachita Mountains

1 S1 = Extremely rare. Typically 5 or fewer estimated occurrences in the state, or only a few remaining individuals, may be especially vulnerable to extirpation.

S2 = Very rare. Typically between 5 and 20 estimated occurrences or with many individuals in fewer occurrences, often susceptible to becoming extirpated.

S3 = Rare to uncommon. Typically between 20 and 100 estimated occurrences, may have fewer occurrences but with many large number of individuals in some populations, may be susceptible to immediate threats.

S4 = Common, apparently secure under present conditions. Typically 100 or more estimated occurrences but with large number of individuals in some populations, may be restricted to only a portion of the state.

? = Indecision regarding rank assignment

B = Breeding status

N = Non-breeding status

impacts. These guidelines follow the sequenced approach to mitigation presented in the Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations (40 CFR 1508.20). The mitigation definition found in the NEPA regulations consists of five sequential steps: 1) avoiding the impact altogether by not taking a certain action or parts of an action; 2) minimizing impacts by limiting the degree or magnitude of the action; 3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and 5) compensating for the unavoidable impacts by replacing or providing substitute resources or environments. The primary focus of the Mitigation Policy is mitigation of losses of habitat value, with the degree of mitigation corresponding to the value and scarcity of habitat for selected evaluation species to be impacted by a proposed project. The Service's mitigation policy for wetlands is No Net Loss.

Construction of new reservoirs

The effects of constructing a new dam are various and so complex that all possible impacts will not be discussed here. Actual impacts will ultimately depend on the project location, design and operation.

Creation of a new reservoir through the impoundment of a river will have the obvious effect of dramatically changing a running river and associated terrestrial ecosystem that once provided habitat to a wide variety of fish and wildlife species into a large standing aquatic ecosystem providing habitat for a manmade warm water fishery and wildlife associated with large standing bodies of water. If not cleared, the terrestrial habitats in the area to be flooded will experience continuous inundation and decomposition of inundated vegetation may result in high rates of deoxygenation leading to a reduction in the original fish population. New habitat types along the edge of the reservoir may be created. The species that occurred in the area prior to inundation will experience increased stress due to the necessity of migrating to new suitable habitat or dying (non-mobile species will experience local die-offs), and from the increase in competition from other animals already occupying niches in the new habitat area. Factors involved in determining the significance of the change include the amount of area that will be flooded, the habitat types in the area, and the wildlife inhabiting these habitats.

By storing water and releasing it at a later date, the physical and biological characteristics of the area downstream become controlled and unnatural. Flow patterns will change depending on the purpose of the reservoir, and the type of flow modification that occurs will determine the extent of the impacts.

A wide variety of physical and biological changes can occur as a result of a new impoundment. Other impacts associated with dam construction include downstream changes in water quality and temperature (Churchill, 1965), increased erosion (Hagan and Roberts, 1972), changes in river morphology (Kupier, 1965), and changes in the habitat types that occur along the river (Hagan and Roberts, 1972).

Reallocating or adding storage in the eleven upstream Oklahoma reservoirs

Increasing storage in an existing reservoir may result in flooding terrestrial habitat types resulting in habitat loss for many species. For example, the federally-listed threatened piping plover is known to use the Winganon Flats area at Oologah Reservoir. An increase in water storage that caused continuous inundation of this area would represent habitat loss for this species. As mentioned above, continuous inundation of areas with terrestrial vegetation can increase the rates of deoxygenation through the decomposition of vegetation which can be detrimental to aquatic

organisms. Increasing storage in the reservoirs also may result in changes in the physical characteristics of the river downstream of the dam such as depth, velocity, temperature, and turbidity which, in turn, affect the biology of the area. For example, holding water in a reservoir upstream of a breeding colony of endangered interior least terns could cause sandy islands used by the terns for nesting to become connected to the shore, thereby increasing predation on this species. Releasing large amounts of water during the breeding season, by contrast, may result in the loss of nests and chicks to flooding (Leslie et al., 2000).

Drawdowns in reservoirs can result in a loss of habitat for various fish species that inhabit littoral zones and impact fish spawning. Aquatic vegetation in littoral zones provides cover for many spawning fish and their eggs. A loss of this habitat type could force the fish into open water habitat where spawning is less successful, and predation rates may increase.

Adjustments/increases to flowage easements and changes in flow rates and duration

The upstream reservoirs in Oklahoma have multiple purposes; however, only three reservoirs are authorized for navigation (Table 1). Although the Corp has broad authority to modify the operations of the reservoirs to benefit navigation, the operational plans cannot be changed in a way that is detrimental to any authorized purpose of a reservoir. For example, slowing the flow rate from reservoirs after flood events that are authorized for flood control so that navigation can resume earlier may be detrimental to the flood control function of the reservoirs (U. S. GAO, 1988). Likewise, the Corps does not have the authority to make adjustments in flow rates from reservoirs with the authorized purpose of fish and wildlife, if the changes will have negative impacts to fish and wildlife. For example, Keystone Reservoir is authorized for flood control, navigation, and fish and wildlife. It is reasonable to assume that the Corps cannot legally change the operational plan of the MKARNS if the change will directly or indirectly cause flooding of endangered interior least tern nests below Keystone or result in land bridging of islands and, thereby, increasing predation pressure on the terns, because such operational changes would be detrimental to the fish and wildlife function of habitat directly influenced by the reservoir, as well as a negative impact to a federally-listed species. It is our understanding that, by law, the Corps must make adjustments on the MKARNS that are compatible with all reservoir functions unless the Corps can obtain legislative approval to remove an approved function of a reservoir.

Constructing new flood control levees

New levees usually contain potential overbank flooding, that could produce negative impacts on adjacent wetlands. New levees may also allow the adjacent lands to be converted to agricultural or industrial use that could likely increase the amount of nutrients, pesticides, and other pollutants entering the MKARNS that are harmful to aquatic organisms. Additionally, borrow areas used for the levees could result in the loss of valuable habitat, and levees placed adjacent to the channel could cause a loss of riparian vegetation that serves as wildlife habitat and as a buffer zone between the waterway and potential pollution sources.

Removal of channel restrictions

Removal of flow obstructions may result in a loss in habitat diversity in areas along the MKARNS. Large logs and islands in rivers provide valuable wildlife habitat. For example, pools created by turbulence from water flowing around or over obstructions such as logs increase habitat diversity in uniform systems such as navigation channels. The pools would be lost when the obstruction is removed. Removal of channel restrictions also may negatively affect adjacent wetlands by decreasing the amount of water for over bank flooding due to improved water conveyance efficiency in the MKARNS, and water quality likely would be affected by a short

term increase in suspended solids, nutrients, and pesticides as bottom sediments are disturbed.

Constructing additional spillways

The area of the floodplain subject to periodic inundation downstream of the spillway is likely to be reduced. Wetlands associated with these flood events may be negatively impacted. Depending on the capacity of the structure, a spillway can cause reduced flows and pooling that decreases the ability of the waterway to dilute or assimilate pollutants, which then may concentrate in an area and negatively affect the aquatic organisms.

Deepening the entire MKARNS from 9 to 12 feet

Deepening the entire MKARNS will allow it to carry more water during flood periods which also may result in several negative ecological impacts. More water in the MKARNS results in less water for floodplain overflow, thereby negatively affecting the ecology of the floodplain. Adjacent wetlands may be drained by the deeper channel, especially during dry periods. The flood waters may move quickly through the enlarged waterway, but the water will likely concentrate somewhere downstream of the MKARNS. Increasing the depth of the entire channel from 9 to 12 feet will require dredge material disposal sites. Disposal of the material adjacent to the MKARNS will reduce floodplain area subject to periodic flooding, and riparian vegetation is often lost because it is either removed or suffocates beneath the deposits. Construction activities also may decrease water quality by releasing substances such as metals, nutrients, and pesticides otherwise bound to bottom sediments.

Adding passing lanes on the Verdigris River portion of the MKARNS in Oklahoma

Adding passing lanes will eliminate existing riparian and wetland habitat along the Verdigris River valuable to many species of mammals, amphibians, reptiles, and birds, and may increase water temperatures due to the loss of shade provided by the vegetation. Clearing the riverside vegetation also may reduce the stability of the stream banks resulting in increased erosion and suspended solids in the water columns. Due to construction activities, there may be an additional increase in suspended solids resulting in greater sediment deposition in the floodplain or downstream sites. However, widening also could result in a decrease in bed load and cause deposition near the project area because the larger cross-sectional area of the waterway may decrease its ability to transport sediments. Widening also will allow the MKARNS to carry more water during flood events, thereby negatively impacting adjacent wetlands by reducing the amount of water for floodplain overflow. The addition of passing lanes also would require spoil deposition areas that may result in the reduction of the floodplain area subject to periodic flooding and the loss of fish and wildlife habitat.

Restoration/enhancement of aquatic and riparian habitat

The Service recommends making every possible effort to operate the MKARNS in a manner that promotes the health and diversity of the various ecosystems associated and impacted by the MKARNS. Today, there are innovative river structures and concepts that can be used to improve navigation while still providing positive benefits to the environmental resources of a highly altered area such as the MKARNS. These innovative concepts have been used successfully by other Corps districts such as the St. Louis District on the Mississippi River and include: 1) notched dikes that allow the river to move in and out between notches resulting in sediment build up that can create valuable habitat in the form of small islands between the dikes, 2) stepped up dikes that tend to counteract sediment deposition, 3) off bank line revetments that do not require the loss of terrestrial habitat, and create habitat diversity and fishing opportunities between the

revetment and the shore, 4) placement of dredge material behind chevron dikes to form valuable habitat in the form of small islands, and 5) notches in closure structures so that flow is allowed to re-enter side channels, thereby increasing habitat diversity. The Service also recommends restoring and enhancing habitat by acquiring land through fee title interests, conservation easements, or management agreements in habitat types that are known to have high habitat values, including lands adjacent to the MKARNS that are susceptible to flooding but currently being farmed. The property could be deeded to the state fish and wildlife agencies as additions to their wildlife management areas, to the Service as additions to the Nation's refuge system, or other appropriate environmental agencies or organizations to conserve the environmental resources of the area and be used by the general public. Trips along the MKARNS in Arkansas and Oklahoma will allow Corps engineers and biologists, state and federal agency biologists, and local hunters and anglers to identify potential enhancement and restoration sites.

Preliminary concerns

1) *Loss of fish and wildlife habitat* – Habitat loss would result from construction, excavation, inundation, and drainage and dredging activities.

2) *Loss or deterioration of highly productive, valuable, or scarce habitats* – Construction of a new reservoir(s), changes in the operating pools of existing reservoirs, excavation of borrow areas for new levees, and disposal of dredge material could result in the loss of already scarce habitat types such as bottomland hardwood forests, palustrine wetlands, and unaltered stream habitats.

3) *Deleterious impacts to rare, threatened and endangered species and their habitats* – The Endangered Species Act (87 Stat. 884 as amended; 16 U. S. C. 1531 et seq.) requires consultation with the Service regarding endangered and threatened species and designated critcal habitat. Identification of habitat for federally-listed species, as well as any potential impacts to these species, should be an integral part of the study.

4) *Changes in water level fluctuations of existing reservoirs* – Alteration of water levels would impact the littoral zone that provides spawning and nursery habitat for many fish species, and may alter valuable aquatic and terrestrial habitat.

5) *Impairment of operating efficiency of existing public parks and/or fish and wildlife installations* – National wildlife refuges, wildlife management areas, public hunting areas, state parks, and natural heritage areas could be negatively impacted. The Service is concerned about potential loss of land and valuable habitat at these areas due to construction and/or inundation.

6) *Possible degradation of water quality* – Increased turbidity, sedimentation, and resuspension of contaminants in the MKARNS, streams and existing reservoirs during construction of new levees, spillways, dams, etc., and from dredging and subsequent development can cause degradation of the water quality.

7) *Impacts on in-stream flows* – Fish and wildlife resources dependent on flowing waters in streams should be protected by establishing recommended in-stream flow regimes to meet seasonal needs.

8) *Loss of free flowing mountain stream* – Numerous miles of free flowing mountain streams have been lost to the construction of reservoirs in the past such as at Nimrod and Blue Mountain Lakes in Arkansas. Preserving these stream types should be a high priority considering the excellent quality and increasing rarity of these fisheries and associated aquatic ecosystems.

9) *Mitigation of important habitat values that may be unavoidably lost due to project construction or operation* – The Service has preliminarily categorized fish and wildlife resources in the study area in accordance with the Service's mitigation policy. These categorizations are in the following section (Preliminary Categorization of Habitat Types). Our objective is to avoid or minimize habitat value losses, and where appropriate to mitigate/compensate for lost resources.

10) *Loss of backwater areas adjacent to the MKARNS* – The shallow water areas adjacent to the MKARNS, such as sloughs and side channels, serve as important spawning and nursery areas for many fish species. These shallow water areas are being negatively impacted or lost due to dikes and other structures blocking side channels and sloughs, and from deposition of dredged material adjacent to the channel resulting in increased siltation.

11) *Declining productivity of the oxbow lakes* – Productivity in oxbow lakes declines when flood waters deposit sediment that fills in aquatic habitat, increases turbidity levels, and smother fish eggs and benthic organisms. Flood waters also cause channel cutting in the lower end of the lake that lowers the lake's average water depth.

12) *Increased barge traffic may impact fish and wildlife populations* – Through increased noise levels, increased potential for the accidental release of pollutants, and changes in water quality due to various factors, fish and wildlife populations may be adversely impacted.

13) *Unmet mitigation needs* – As discussed in greater detail below in the Discussion and Preliminary Recommendations section, the full extent of impacts caused by the original development of the MKARNS were not known during the initial project planning process, or were not adequately mitigated at the time of implementation. Thus, it was not possible to consider all actual impacts during the development of the project mitigation plan, and appropriate mitigation measures could not have been incorporated into the initial project development. The area impacted by the operation of the MKARNS greatly exceeds the MKARNS's flowage easements. This study provides an opportunity for the Corps to address these unmet mitigation needs. The Service will place emphasis on this issue in the course of these invetsigations.

PRELIMINARY CATEGORIZATION OF HABITAT TYPES

Because it is the objective of the Service to minimize or avoid the loss of habitat values in planning water development projects, we have categorized fish and wildlife resources in accordance with the Service's Mitigation Policy (U. S. Fish and Wildlife Service, 1981) to facilitate ongoing project investigations.

Category 2 resources, as defined in the policy, includes high quality habitats that are scarce or becoming scarce in the ecoregion or nationwide. The mitigation goal for this category is no net loss of in-kind habitat value. Included in category 2 for the project area are high quality native prairie, caves, streams (mountain), oxbow lakes, bottomland hardwood forests, riparian forests, and other high quality palustrine and lacustrine wetlands such as river swamp forests. Areas of somewhat lesser quality bottomland forests, riparian forests, upland forests, prairies, the Arkansas River proper and its associated tributaries and delta streams, man-made wetlands and reservoirs are assigned to category 3. Category 3 includes high to medium value habitat that is abundant on a national basis. The preferred mitigation goal for category 3 habitat is no net loss of habitat value while minimizing loss of in-kind habitat value. Mitigation in-kind for category 3 resources is preferred, but out-of-kind mitigation with no net loss is acceptable.

EVALUATION DATA NEEDS AND FUTURE FISH AND WILDLIFE COORDINATION ACTIVITIES

The Corps has not supplied formal project alternatives that will serve as potential solutions for the problems resulting from the sustained high flows on the MKARNS. To determine impacts to existing fish and wildlife resources associated with the MKARNS, upstream reservoirs and intervening aquatic, wetland, and terrestrial habitats, the Service requests the following information be provided by the Corps:

1) Specific solutions with alternatives to the problem of sustained high flows on the MKARNS. The alternatives should contain detailed quantitative descriptions of all the possible operational changes to the MKARNS, including but not limited to, information regarding: a) reallocating storage from one project purpose to another, b) changes in flow rates and durations, and, c) adjustments/ increases in flowage easements. Adequate assessment of impacts to fish and wildlife resources also will require detailed and quantitative information, including specific locations, on any possible changes such as: a) new levees, b) additional reservoir (s), c) all possible in-stream modification of existing navigation structures, d) all channel restrictions that might be removed, and, e) any new high flow relief structures (spillways) that may be constructed.

2) Possible changes in quantity of habitat types (quantitative gain or loss) associated with the MKARNS in Oklahoma and Arkansas and the eleven upstream reservoirs in Oklahoma, including habitat types in the wildlife management areas and national wildlife refuges, and all other areas with ecological/fish and wildlife value such as, but not limited to, the habitat types listed in this report.

3) Locations and sizes of all potential dredge material disposal sites, and quantitative information regarding the existing habitat types at these sites.

4) Locations and sizes of all potential borrow areas that may be excavated for construction of new levees, and quantitative information regarding the existing habitat types at these sites.

5) Detailed and quantitative information regarding the addition of passing lanes on the Verdigris River portion of the MKARNS in Oklahoma.

6) Amount, location, and type of wetlands along either side of the Verdigris River portion of the MKARNS in Oklahoma that might be impacted by adding passing lanes to this portion of the MKARNS, as well as potential wetland, bottomland forest and riparian forest restoration sites.

7) As discussed below in the Recommendations section of this report, the full extent of impacts caused by the original development of the MKARNS were not known during the initial project planning process. Thus, it was not possible to consider all actual impacts during the development of the project mitigation plan, and appropriate mitigation measures could not have been incorporated into the initial project development. This study provides an opportunity for the Corps to address these unmet mitigation needs. The Service requests that the Tulsa and Little Rock Districts quantify project impacts attributable to construction and operation of the MKARNS on fish and wildlife resources for the entire navigation system (including upstream reservoirs and intervening aquatic, wetland, and terrestrial habitats) and initiate planning to address these impacts. The Service requests the mitigation plan be developed through interagency coordination.

8) Local anglers, hunters, Corps engineers, and wildlife and fisheries biologists participated on trips on the MKARNS from the Arkansas/Oklahoma state line to Lock # 2 in eastern Arkansas during Fall 2000 to locate areas with the potential for fish and wildlife enhancement projects. As a result of the trips, 256 possible fish and wildlife enhancement projects were identified for further evaluation. The Service commends the Corp's effort, and looks forward to additional opportunities for enhancement/restoration projects for fish and wildlife resources. The projects identified on the Arkansas trip have been included below as part of our recommendations. The Service is aware that a similar trip along the Oklahoma portion of the MKARNS is being planned for Spring 2001 that will involve local anglers and hunters, Corps engineers, Service biologists, and state fish and wildlife biologists. Again, we appreciate this effort and look forward to the possibilities.

Future fish and wildlife coordination activities include: 1) attending meetings pertaining to this study; 2) investigating potential sites for fish and wildlife enhancement/restoration projects; 3) gathering data as necessary to investigate potential project impacts to fish and wildlife resources as more details on the alternatives are developed; and 4) providing the Corps with evaluation data needs not mentioned in this report if required by new developments/details on project alternatives that have not been provided to the Service as of the date of this report. The Service also will provide the Corps with a draft FWCA report about 60 days after receiving formal project alternatives and the requested information needed to adequately assess impacts to fish and wildlife resources (evaluation data needs).

DISCUSSION AND PRELIMINARY RECOMMENDATIONS

The project study area contains a variety of high quality fish and wildlife resources on public and private lands. These include several rivers, numerous lakes and wildlife management areas, three national wildlife refuges, numerous state parks, and many natural heritage areas. The Service's overall goal is the protection and enhancement of important fish and wildlife resources, with special emphasis on those discussed above. We recommend that the Corps make fish and wildlife conservation an integral part of the project and seek full Congressional funding for these efforts.

The Corps should avoid negative impacts to all federally-listed species. Examples of potential concerns include alterations to interior least tern habitat on the Arkansas River due to changes in the operational plans of Keystone Reservoir. The Corps currently often changes the flow rates from Keystone Reservoir at the request of Southwestern Power Administration, an agency of the Department of Energy located in Tulsa, Oklahoma, that markets the hydroelectric power produced at numerous Corps dams in Oklahoma, Texas, Arkansas, and Missouri. Operational plans that flood nesting habitat or cause land-bridging of islands used during the breeding season may result in increased predation and human access pressure on the terns and should be avoided. If the Corps and Southwestern Power Administration determine that negative impacts to terns cannot be avoided, formal consultation with the Service should be initiated.

Similarly, the Corps should avoid impacts to bald eagles and their nests along the MKARNS and lakes and streams in the project area. Surveys for bald eagle nests and winter roosts should be conducted prior to removal of any large trees. Changes in operational plans that may reduce potential piping plover habitat at Oologah Reservoir also should be avoided. If the Corps (and Southwestern Power Administration) determines that negative impacts to any federally – listed species within the project area as discussed above cannot be avoided, formal consultation with the Service should be initiated.

Three of the eleven upstream Oklahoma Reservoirs have fish and wildlife conservation as a project purpose. The Services requests that any new operational plans developed by the Corps not be detrimental to the fish and wildlife conservation function of these reservoirs or downstream and upstream habitat associated with these reservoirs. Further, the Service recommends ensuring that shallow water habitat that provides spawning and nursery habitat is available by making every reasonable effort at holding reservoir pool levels relatively stable during the fish spawning season.

Adverse impacts to the three national wildlife refuges should be avoided. The National Wildlife Refuge System Improvement Act of 1997 that amends the National Wildlife Refuge System Administration Act of 1966 clearly states that the primary mission of the nation's refuges is wildlife conservation; however, the legislation does not preclude the Service from allowing other uses if they area determined to be compatible with the Refuge System mission and the purposes of individual refuges (65 FR 62457). If refuge lands are impacted by navigation or required for project right-of-way, mitigation for adverse impacts will be required since navigation is not consistent with the purpose for each refuge (Table 9).

As discussed above, the White River NWR consists of about 160, 000 acres including about 154, 000 acres of bottomland hardwood forests. Although historically about 8 million acres of bottomland hardwood forests occurred in Arkansas, today only about 850, 000 acres remain. Almost 160, 000 of these acres occur in a contiguous block of forest in the White River NWR, representing nearly 20 percent of the state's remaining bottomland hardwood forest acreage. As the host of the largest concentration of wintering mallard ducks in the Mississippi Flyway the refuge helps bring about 2.5 million dollars per day to the area during the sixty day duck hunting season, and thus is already a major economic asset to the area. The refuge also brings additional economic activity to the area through eco-tourism. People visit the refuge not only for the chance to witness the largest concentration of wintering mallard ducks in the Mississippi Flyway, but also because the refuge provides habitat for thousands of neo-tropical migratory songbirds, about 325 black bears, and contains cypress trees nearly 1, 000 years old; the refuge also has 350 lakes suitable for fishing and contains one of the best warm water fisheries in the Mississippi Basin. The number of people visiting the area annually is likely to increase in the future. A thorough investigation of the refuge will be necessary to ensure its health and preservation.

The White River NWR occupies about three miles of the MKARNS's Arkansas Post Canal and also houses the dredge disposal sites needed when this portion of the Arkansas Post Canal (mile marker 8 – 10) is dredged for maintenance purposes. These spoil areas are not consistent with the Refuge System mission or the purposes of White River NWR, although attempts are being made to pass legislation that will allow the continued use of the spoil areas. Mitigation for the spoil areas is required since navigation is not consistent with the purpose of the refuge. Appropriate mitigation measures currently are being investigated.

Opportunities for fish and wildlife habitat/restoration enhancement projects also exist at Sequoyah and Holla Bend NWRs. Coordination with the individual refuges during project planning to explore these possibilities is essential. Also, each refuge is currently developing a Comprehensive Conservation Plan (CCP) that will guide management activities for the next 15 years. The Service requests that the Corps incorporate the CCPs of the refuges, as they become available, as part of the operational plan of the MKARNS to help ensure adverse impacts to the fish and wildlife resources associated with the refuges do not occur as a result of navigation operations.

During Fall 2000, local anglers, hunters, Corps engineers, and wildlife and fisheries biologists participated on trips on the MKARNS from the Arkansas/Oklahoma state line to Lock # 2 in

Table 9. Purpose of White River, Holla Bend, and Sequoyah National Wildlife Refuges (http://refuges.fws.gov/databases/purposes.taf?function=form).

National Wildlife Refuge	Purpose
White River	Breeding ground and inviolate sanctuary for migratory birds and other wildlife; conservation, maintenance, and management of wildlife resources/habitat; fish and wildlife oriented recreational development; conservation of endangered and threatened species.
Holla Bend	Inviolate sanctuary for migratory birds; management of migratory birds; development, advancement, management, conservation, and protection of fish and wildlife resources; fish and wildlife oriented recreational development; conservation of threatened and endangered species.
Sequoyah	Conservation, maintenance, and management of wildlife resources/habitat.

eastern Arkansas to locate areas with the potential for fish and wildlife enhancement projects. As a result of the trips, about 255 possible fish and wildlife enhancement projects were identified for further evaluation. The projects include: 1) notching dikes to create backwater areas for spawning fish, 2) notching revetments for fish, angler, and hunter access, 3) development of moist soil management areas for waterfowl, 4) island construction for interior least tern and other shorebird habitat, 5) construction of nursery ponds for fish production, and 6) establishment of water level management plans for fish spawning season.

The Service recommends incorporating these fish and wildlife enhancement opportunities into the project, as well as potential restoration/enhancement projects that might be identified during a similar trip along the Oklahoma portion of the MKARNS scheduled for Spring 2001. These projects should include enhancement/restoration of habitat used by popular sport fish and game species, non-game species, and rare/declining species. Because several federally-listed species occur in the project area, the projects also offer the Corps an opportunity to carry out Section 7 (a) 1 responsibilities, as mandated by the Endangered Species Act. Section 7 (a) 1 of the Act requires that all federal agencies use their authorities to carry out programs for the specific purpose of conserving threatened and endangered species. Island construction for interior least terns could represent one such opportunity.

In previous Service reports and letters to the Corps regarding the MKARNS, dated May 5, 1989, October 20, 1989, October 6, 1992, and January 4, 1994, the Service noted that the areas impacted by occasional or permanent flooding were underestimated during the original project planning process. The initial real estate interests purchased prior to construction and development of the MKARNS were based on a flat pool elevation at normal navigation pool levels. However, the water levels of the pools are sloping rather than flat. The effects of the MKARNS greatly exceed the original flowage easements. The impacted areas include important fish and wildlife habitat.

For example, the inundation of the Arkansas River channel and tributary streams has resulted in the loss of stream fishery habitat. Additionally, vast tracts of valuable wildlife habitat, such as bottomland hardwood forests, have been negatively impacted by continuous inundation. Because the full extent of impacts caused by the development of the MKARNS were not known during the initial project planning process, all impacts could not have possibly been considered during the development of the project mitigation plan, and appropriate mitigation measures could not have been incorporated into the initial project development. Section 906 (b) of the Water Resources Development Act of 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife resources resulting from any water resource project under his jurisdiction, whether completed, under construction, or to be constructed. This study provides an opportunity for the Corps to address the unmet mitigation needs of the original project, and the Service applauds the Corps for listing fish and wildlife habitat restoration and enhancement projects as a part of this study. In light of this exciting opportunity, the Service requests the following:

1) The Tulsa and Little Rock Districts quantify project impacts attributable to construction and operation of the MKARNS to fish and wildlife resources for the entire navigation system (including upstream reservoirs and intervening aquatic, wetland, and terrestrial habitats) and initiate planning to address these impacts.

2) The Corps should acquire fee title interests or conservation easements in lands that are impacted by the project and known to have high habitat values, including lands adjacent to the MKARNS that are susceptible to flooding but currently being farmed, and deed the property to the state fish and wildlife agencies as additions to their wildlife management areas, to the Service as additions to the National Wildlife Refuge System, or other appropriate environmental agencies

for fish and wildlife management purposes.

Due to the nature of the various solutions being investigated, such as adding passing lanes along the Verdigris River portion of the MKARNS in Oklahoma and reallocating or adding storage to existing reservoirs, it is likely that wetlands will be adversely impacted by the project. The Service is aware that the mitigation plan for the resource losses likely will be extensive after the Corps quantifies both the potential impacts from the possible changes to the MKARNS now being considered and the unanticipated impacts on fish and wildlife resources for the entire navigation system as a result of the original project. Again, the Service applauds the Corps for listing potential fish and wildlife habitat restoration and enhancement projects as a part of the study. We believe this will provide a significant opportunity for habitat restoration, and request that a mitigation plan for future potential impacts and unmet mitigation needs be developed through interagency coordination. The plan should include: 1) actions discussed in this report such as habitat restoration, enhancement, and creation projects within the project area for habitats used by federally-listed species, rare/declining species, and species popular with local anglers and hunters; 2) mitigation for impacts to refuges; and 3) acquisition of ecologically valuable habitats that are scarce in the ecoregion and/or provide quality hunting and fishing opportunities for addition to the Nation's refuge system, as potential additions to the states' wildlife management areas, or to be deeded to other appropriate environmental agencies so the areas could be conserved and used by the general public. The Service recommends that the Corps seek full Congressional funding for these efforts.

The Service appreciates the opportunity to provide preliminary comments and recommendations. We emphasize that this report is based on a very general and large-scale project description. Comments, concerns, and recommendations included in this report are subject to revision as more information is developed on project alternatives and impacts. We look forward to working with the Corps as the study progresses and more details are provided.

LITERATURE CITED

Abell, R. A., D. M. Olson, E. Dinerstein, and P. T. Hurley. 2000. Freshwater ecoregions of North America: a conservation assessment. Island Press. Washington D.C. 319 pp.

Atwood, J. L., and D. E. Minsky. 1983. Least tern foraging ecology at three major California breeding colonies. Western Birds 14:57-72.

Bailey, R. G. 1994. Ecoregions of the United States, USDA Forest Service (scale 1:7,500,000, revised 1994).

Buchanan, T. M. 1976. An evaluation of the effects of dredging within the Arkansas River Navigation System. Volume V: The effects upon the fish populations. Westark Community College. Fort Smith, Arkansas. 277 pp.

Churchill, M. A. 1965. Control of temperature through streamflow regulation in Symposium on Streamflow Regulation for water quality control. U. S. Department of Health, Education, and Welfare, Public Health Service Pub. No. 999-Wp-30, Taft Sanitary Engineering Center, Cincinnati, Ohio.

Clark, J. R. and J. Benfardo, eds. 1981 Wetlands of bottomland hardwood forests. Elsever Science Publication Co., New York. 402 pp.

Conant, R., and J. T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. 3rd Edition. New York: Houghton Mifflin Company. 616 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. Laroe. 1979. Classification of wetlands and deepwater habitats of the United States. U. S. Department of the Interior. Fish and Wildlife Service. Washington, D. C. 131 pp.

Creighton, J. C., M. V. Lomolino, and G. Schnell. 1993. Unpublished report. Survey methods for the American burying beetle (Nicrophorus americana) in Oklahoma and Arkansas. Oklahoma Biological Survey. Norman, OK.

Dahl, T. E. 2000. Status and trends of wetlands in the conterminous United States 1986 to 1997. U. S. Department of the Interior, Fish and Wildlife Service. Washington, D.C. 82 pp.

Erickson. M. O. G. 1985. Prey detectability for fish-eating birds in relation to fish density and water transparency. Ornis Scandinavica 16: 1 – 7.

Hagan, R. M. and E. B. Roberts. 1972. Ecological impacts of water projects in California. Journal of the Irrigation and Drainage Division. 98:25-48.

Kupier, E. 1965. Water Resources Development. Butterworth, London.

Kuchler, A. W. 1975. Vegetation maps of North America.

Leslie, D. M. , Jr., G. K. Wood, and T S. Carter. 2000. Productivity of endangered least terns *(Sterna antillarum)* below a hydropower and flood-control facility on the Arkansas River. The Southwestern Naturalist 45:483 – 489.

Oklahoma Water Resources Board. 1990. Oklahoma Water Atlas. University of Oklahoma Printing Services. Norman, Oklahoma. 360 pp.

McDaniel, B., and S. McDaniel. 1963. Feeding of least terns over land. Auk 80:544-545.

Omernick J. M. 1995. Level III ecoregions of the continent. Washington, DC: National Health and Environment Effects Research Laboratory, U. S. Environmental Protection Agency.

Ricketts, T. H., E. Dinerstein, D. M. Olson, and C. J. Loucks. 1999. Terrestrial ecoregions of North America: a conservation assessment. Island Press. Washington D.C. 485 pp.

Schweitzer, S. H. and D. M. Leslie, Jr. 1996. Foraging patterns of the least tern (*Sterna antillarum*) in north-central Oklahoma. Southwestern Naturalist 41:307-314.

U. S. Army Corps of Engineers. 1985. Reconnaissance Report on the Arkansas River Basin, Arkansas and Oklahoma (Oklahoma Portion). Tulsa District. Tulsa, OK. 12 pp.

U. S. Department of the Interior. 1989. Fish and Wildlife Service. 50 CFR Part 17. Endangered and threatened wildlife and plants; determination of endangered status for the American burying beetle. Final Rule. Federal Register Vol. 54 No. 133.

U. S. Fish and Wildlife Service. 1981. U. S. Fish and Wildlife Service Mitigation Policy. Federal Register, Vol. 46(15):7644-7663.

U. S. Fish and Wildlife Service. 1982. Gray bat recovery plan. Denver, CO. 91 pp.

U. S. Fish and Wildlife Service. 1983. Fish and Wildlife Coordination Act Report on Fish and Wildlife Resources of the Arkansas River and Tributaries: Hydropower and other purposes, Oklahoma and Arkansas (Webbers Falls Lock and Dam 16). Oklahoma Ecological Services. Tulsa, OK. 42 pp.

U. S. Fish and Wildlife Service. 1985. Planning Aid Report on the Corp's Arkansas River Basin Study, Arkansas and Oklahoma (Oklahoma Portion). Oklahoma Ecological Services. Tulsa, OK. 25 pp.

U. S. Fish and Wildlife Service. 1988. Planning Aid Report on the Corp's Arkansas River Basin Study, Arkansas and Oklahoma (Arkansas Portion). Vicksburg, MS. 20 pp.

U. S. Fish and Wildlife Service. 1990. Fish and Wildlife Coordination Act Report on the Arkansas River Basin, Arkansas and Oklahoma. Tulsa, OK. 31 pp.

U. S. Fish and Wildlife Service. 1993. Endangered and threatened species of Oklahoma. Tulsa, OK.

U. S. Fish and Wildlife Service. 1998. Fish and Wildlife Service. 50 CFR Part 17. Endangered and threatened wildlife and plants; Final rule to list the Arkansas River basin population of the Arkansas River shiner (Notropis girardi) as threatened. Final Rule. Federal Register Vol. 63 No. 225.

U. S. General Accounting Office. 1988. Issues concerning the Arkansas River Basin Operation Plan. Washington D. C.

Wilson, E. C., W. A. Hubert, and S. H. Anderson. 1993. Nesting and foraging of least terns on sand pits in central Nebraska. Southwestern Naturalist 38:9-14.

APPENDIX A

OKLAHOMA COUNTY DISTRIBUTIONS OF FEDERALLY LISTED SPECIES

FEDERALLY LISTED THREATENED OR ENDANGERED SPECIES, PROPOSED SPECIES, AND CANDIDATE SPECIES OKLAHOMA COUNTY DISTRIBUTIONS MARCH 2001

COUNTY	SPECIES	CLASSIFICATION
Cherokee	American burying beetle	Endangered
	gray bat	Endangered
	Ozark big-eared bat	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Creek	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Delaware	gray bat	Endangered
	Indiana bat	Endangered
	Ozark big-eared bat	Endangered
	bald eagle	Threatened
	Ozark cavefish	Threatened
	piping plover	Threatened
	Arkansas darter	Candidate
Haskell	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Kay	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	black-tailed prairie dog	Candidate
LeFlore	American burying beetle	Endangered
	Indiana bat	Endangered
	interior least tern	Endangered
	Ouachita rock-pocketbook	Endangered
	bald eagle	Threatened
	leopard darter	Threatened
	leopard darter critical habitat	
	piping plover	Threatened
	scaleshell	Proposed Endangered
Mayes	bald eagle	Threatened
	Ozark cavefish	Threatened
	piping plover	Threatened
	Arkansas darter	Candidate

COUNTY	SPECIES	CLASSIFICATION
McIntosh	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	Arkansas River shiner	Threatened
	Arkansas River shiner critical habitat	Proposed
Muskogee	American burying beetle	Endangered
	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Nowata	bald eagle	Threatened
	piping plover	Threatened
Osage	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	mountain plover	Proposed Threatened
Ottawa	gray bat	Endangered
	Ozark big-eared bat	Endangered
	winged mapleleaf	Endangered
	bald eagle	Threatened
	Neosho madtom	Threatened
	piping plover	Threatened
	Arkansas darter	Candidate
Pawnee	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Pittsburg	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	Arkansas River shiner	Threatened
	Arkansas River shiner critical habitat	Proposed
Rogers	interior least tern	Endangered
	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	western prairie fringed orchid	Threatened
	Arkansas darter	Candidate

COUNTY	SPECIES	CLASSIFICATION
Sequoyah	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Tulsa	American burying beetle	Endangered
	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Wagoner	interior least tern	Endangered
	bald eagle	Threatened
	piping plover	Threatened
Washington	whooping crane	Endangered
	bald eagle	Threatened
	piping plover	Threatened
	mountain plover	Proposed Threatened

APPENDIX B

ARKANSAS COUNTY DISTRIBUTIONS OF FEDERALLY LISTED SPECIES

FEDERALLY LISTED THREATENED OR ENDANGERED SPECIES, PROPOSED SPECIES, AND CANDIDATE SPECIES ARKANSAS COUNTY DISTRIBUTIONS MARCH 2001

COUNTY	SPECIES	CLASSIFICATION
Arkansas	bald eagle	Threatened
	pink mucket	Endangered
Conway	Florida panther	Endangered
	interior least tern	Endangered
Crawford	scaleshell	Proposed Endangered
	interior least tern	Endangered
Desha	bald eagle	Threatened
	interior least tern	Endangered
Faulkner	interior least tern	Endangered
Franklin	Geocarpin minimum	Threatened
Jefferson	Florida panther	Endangered
	bald eagle	Threatened
Johnson	Florida panther	Endangered
	interior least tern	Endangered
Lincoln	bald eagle	Threatened
Logan	bald eagle	Threatened
	Magazine Mountain shagrine	Threatened
	American burying beetle	Endangered
	Arkansas River shiner	Threatened
	interior least tern	Endangered
Perry	scaleshell	Proposed Endangered
	red-cockaded woodpecker	Endangered
	interior least tern	Endangered
Pope	gray bat	Endangered
	interior least tern	Endangered
Sebastian	bald eagle	Threatened
	American burying beetle	Endangered
	interior least tern	Endangered

COUNTY	SPECIES	CLASSIFICATION
Yell	Florida panther	Endangered
	harperella	Endangered
	interior least tern	Endangered

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
222 South Houston, Suite A
Tulsa, Oklahoma 74127
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/
ARNS

June 23, 2005

Colonel Wally Walters
U.S. Army Corps of Engineers
Little Rock District
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

Dear Colonel Walters:

Enclosed is the U. S. Fish and Wildlife Service's (Service) final report on the fish and wildlife resources likely to be impacted by proposed actions related to the Arkansas River Navigation Study, Arkansas and Oklahoma. This report fulfills the reporting requirements set forth in Section 2 (b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*) (FWCA) and is intended to accompany the U. S. Army Corps of Engineers' (Corps) feasibility report on this project.

The Corps, Service, Oklahoma Department of Wildlife Conservation, and Arkansas Game and Fish Commission have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening feature would have on fish and wildlife resources. As of the date of this report, a full assessment of adverse impacts and a complete mitigation plan have been developed for impacts due to disposal of dredged material at terrestrial sites within the floodplain of the navigation system in Oklahoma. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report. The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. This report provides additional compensatory mitigation recommendations for aquatic resource impacts for Corps consideration during development of the final mitigation plan for aquatic resource impacts in Appendix G. We believe that incorporating these additional mitigation features into the mitigation plan should serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable provided that it was demonstrated through a Habitat Evaluation Procedures or similar analysis to completely offset losses in habitat value over the project life. A final aquatic mitigation plan could be provided in a supplemental FWCA report.

The Service appreciates the cooperation of your staff in development of this report. If you have any questions, please contact Richard Stark of this office at 918-581-7458, extension 240.

Sincerely,

Jerry J. Brabander
Field Supervisor

Enclosure

cc: Chief, Planning and Environmental, U.S. Army Corps of Engineers, Tulsa, OK
Regional Director (ARD-ES), FWS, Albuquerque, NM
(Attn:: Dean Watkins)
Regional Director (ARD-ES), FWS, Atlanta, GA,
(Attn:: Jeff Weller)
Director, Arkansas Game and Fish Commission, Little Rock, AR
(Attn:: Craig Uyeda)
Director, Oklahoma Department of Wildlife Conservation, Oklahoma City, OK
(Attn:: Fisheries and Natural Resources Section)
Oklahoma Department of Wildlife Conservation, Northeast Regional Office,
Porter, OK (Attn:: Mike Plunkett, Randy Hyler, and Gary Peterson)
Director, Oklahoma Department of Environmental Quality, Oklahoma City, OK
(Attn:: Water Quality Programs Division 0207)
Regional Administrator, Environmental Protection Agency, Dallas, TX
(Attn: 6WQ-EM)
Director, Department of Arkansas Heritage, Little Rock, AR
Field Supervisor, U. S. Fish and Wildlife Service, Conway, AR
(Attn: Marge Harney)
Manager, Sequoyah National Wildlife Refuge, Vian, OK
Manager, White River National Wildlife Refuge, DeWitt, AR
Manager, Holla Bend National Wildlife Refuge, Dardanelle, AR
Natural Resources Library, U.S. Department of the Interior, Washington, DC

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

FINAL COORDINATION ACT REPORT
ARKANSAS RIVER NAVIGATION STUDY, ARKANSAS AND OKLAHOMA

Prepared by

Richard Stark and Lindsey Lewis
Oklahoma and Arkansas Ecological Services

June 2005

TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF APPENDICES

EXECUTIVE SUMMARY

This summarizes the U. S. Fish and Wildlife Service's (Service) final report on the fish and wildlife resources likely to be impacted by proposed actions related to the Arkansas River Navigation Study, Arkansas and Oklahoma. This report will accompany the U. S. Army Corps of Engineers' (Corps) feasibility report on this project.

The Little Rock and Tulsa Districts of the Corps are charged with the operation and maintenance of the McClellan-Kerr Arkansas River Navigation System (MKARNS) for commercial navigation. The proposed action is to improve and maintain the MKARNS through three features: 1) River Flow Management, 2) Navigation Channel Deepening, and 3) Navigation Channel Depth Maintenance.

This final report 1) identifies the effects of actions proposed to maintain and improve navigation on the MKARNS on fish and wildlife resources within the project area, 2) discusses measures to appropriately identify, avoid, and minimize environmental impacts, and 3) provides recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources and to maintain the value of the fish and wildlife resources associated with the navigation system.

The project area consists of the entire 445–mile–long MKARNS in Arkansas and Oklahoma, and 11 upstream multi-purpose reservoirs in Oklahoma that act as the MKARNS's primary flow modifiers. The extensive project area contains a diversity of high quality fish and wildlife resources.

Important fish and wildlife resources are associated with the 11 upstream reservoirs used to regulate flow on the system. These include state wildlife management areas (WMAs) located on the project lands surrounding the reservoirs and managed by the Oklahoma Department of Wildlife Conservation (ODWC), WMAs managed by the Arkansas Game and Fish Commission (AGFC), river oxbows, dike fields, floodplain habitat, bottomland hardwood forest, wetlands, national wildlife refuges, the Arkansas and Verdigris rivers and their tributaries, and numerous federally-listed species.

RIVER FLOW MANAGEMENT

The purpose of the River Flow Management feature of the study is to improve the safety and efficiency of commercial navigation operations, and to reduce flood damages by managing the MKARNS to limit periods of sustained high flows that originate from the upper reaches of the Arkansas River watershed. The effects of modifying the current operating plan were evaluated using the Corps "Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System," also known as the SUPER Model. For this evaluation, reservoir elevations and river stages were modeled using a 61 year (January 1940 – December 2000) period of record.

The River Flow Management feature would consist of maintaining the existing operating plan (*i.e.*, operating Van Buren at 150,000 cubic feet per second (cfs)), but replacing the current 75,000 cfs bench with a 60,000 cfs bench beginning at 3 percent lower system storage, except from June 15 – October 1. Fluctuations of reservoir water levels under the selected plan are expected to change only slightly from current operations. Based on average annual lake levels and stream flows, impacts to fish and wildlife resources at the reservoirs would appear not to differ significantly from current conditions. The Service believes, however, that it is important to also consider all conditions that would occur in extreme high and low years in order to adequately evaluate potential effects to fish and wildlife resources. Anticipated impacts could include altering the littoral zone, eliminating vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migratory birds.

Implementation of the selected plan also would reduce the duration of flooding in the floodplain downstream of the 11 reservoirs. Because the hydrology of wetlands in the floodplain would be altered, important wetland habitats may be adversely impacted. In order to adequately assess impacts to these wetlands and compensate for unavoidable losses, we recommend that the Corps identify the specific lands that would receive flood protection benefits, determine the quantity (acres) and quality (habitat type and value) of wetlands that the selected operating plan would alter, and determine the quantity (acres) and quality (habitat type and value) of wetlands that would be acquired and/or managed to compensate for wetland losses.

NAVIGATION CHANNEL DEEPENING

The purpose of the proposed Navigation Channel Deepening feature is to remove the disparity between the navigation channel depths of the MKARNS (9 feet) and the Lower Mississippi (12 feet), and thereby increase the volume and efficiency of commercial navigation operations. The proposed action is anticipated to have substantial direct and indirect effects to important fish and wildlife resources. Impacts would include the loss of terrestrial habitat due to the disposal of dredged material in upland sites; the loss of aquatic habitat due to disposal of dredged material in aquatic sites and the construction and raising of river training structures; the removal and alteration of gravel bars, which support a variety of aquatic species, due to dredging activity; and adverse effects on freshwater mussel patches and beds (*i.e.,* mussel concentrations) due to dredging activity and the disposal of dredged material.

Early in the evaluation process, a Multi-agency Ecosystem Evaluation Team was established to evaluate impacts of the proposed Navigation Channel Deepening feature on terrestrial and aquatic habitats and ecological benefits resulting from proposed mitigation measures. The multidisciplinary team included biologists with technical expertise from the Corps, Little Rock and Tulsa Districts, the Service, the Corp's Engineer Research and Design Center, ODWC, AGFC, and Parsons, a private consulting firm. The team evaluated the environmental impacts of proposed dredging and disposal of dredged material using Habitat Evaluation Procedures (HEP).

The HEP were used to conduct assessments at the terrestrial dredged material disposal sites and at selected mitigation sites. The disposal of dredged material at terrestrial sites would result in the loss of about 750 acres of important habitat in Oklahoma, for which compensatory mitigation

is being recommended. Terrestrial dredge disposal sites in Arkansas would occur in cropland sites along the Post Canal, which were selected to avoid impacts to important fish and wildlife habitat. Habitat conditions were projected over the 50-year life of the project. A mitigation plan to offset anticipated impacts was developed through interagency cooperation of biologists with the Corps, Service, and the ODWC. The compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that are currently agricultural fields.

The entire aquatic impacts analysis has not been completed as of the date of this report due largely to the expedited study schedule and missing information. Certain variables used in the analysis are currently being fine-tuned. Aquatic mitigation features considered to date would result in a net gain of habitat units in Oklahoma, but a deficit in Arkansas. The Corps, Service, and the AGFC have recently developed additional and modified mitigation features for the Arkansas portion of the project. This report provides these additional compensatory mitigation recommendations for aquatic resource impacts for consideration by the Corps during development of a complete mitigation plan. We believe incorporation of these recommendations into the final mitigation plan would serve to completely offset losses in habitat value (see Appendix G).

NAVIGATION CHANNEL MAINTENANCE

The purpose of the proposed Maintenance Dredging and Disposal feature is maintenance of the navigation channel through the continued use of a series of river training structures, as well as maintenance dredging at locations where the channel is less than desired depth due to sediment accumulation. This feature would consist of disposal of dredged material at new sites not included in the original Operation and Maintenance Plan, once existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. This component also includes new river training structures. Impacts anticipated as a result of the Navigation Channel Maintenance feature are being assessed using the same HEP methodology as described above for the Navigation Channel Deepening element.

FEDERALLY-LISTED SPECIES

Several federally-listed species occur in the project area. Formal consultation under section 7 of the Endangered Species Act (ESA) currently is in progress for the following four species: the interior least tern, American burying beetle, bald eagle, and pallid sturgeon.

The study offers the Corps an opportunity to carry out both section 7 (a) 1 and 7 (a) 2 responsibilities, as mandated by the ESA. Section 7 (a) 1 of the ESA requires that all federal agencies use their authorities to carry out programs for the specific purpose of conserving threatened and endangered species. Island construction for interior least terns using dredged material could represent one such opportunity. Section 7 (a) 2 responsibilities are addressed in the Service's biological opinion.

MITIGATION AND SERVICE POSITION

Environmental Management Program

The effects of the development, operation, improvement, and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, wetlands, backwater areas, and in the main stem of the navigation channel) will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. The Service believes the Corps should seek Congressional authorization and funding for an Environmental Management Program in order to perform long-term monitoring and resource studies to assess the true magnitude of the development, operation, and maintenance of the MKARNS. The Service also recommends that a mitigation fund be established that would be utilized to address mitigation needs identified through the long-term monitoring program. The cost of the long-term monitoring program and the mitigation fund should be considered in the Corp's benefit:cost analysis for the Arkansas River Navigation Study. Benefits to local economies attributable to expenditures by outdoor recreation enthusiasts, such as wildlife observers, hunters, and anglers, are likely to increase as the quality of habitat supporting fish and wildlife species increases. These benefits to local/regional economies also should be considered.

Unmet Mitigation Needs

The MKARNS is a large and complex system that impacts rivers, tributaries, oxbows, reservoirs, wetlands, and other important natural resources. The original construction of the navigation project destroyed a considerable amount of highly valuable fish and wildlife habitat along the Verdigris and Arkansas rivers. Losses of fish and wildlife habitat as a result of original construction, operation and maintenance of the MKARNS were not evaluated using habitat value as a basis for determining compensation needs. About 28,200 acres of project lands, including the Sequoyah National Wildlife Refuge and McClellan-Kerr WMA units, were allocated for wildlife management after construction of the MKARNS. The Service believes it is reasonably certain that the total combined habitat value lost within the impacted areas far exceeds the habitat value gained from project lands and water licensed and designated for fish and wildlife resource management.

Furthermore, since the initial navigation project was completed, many acres of impacts have been identified that were not accounted for originally. Impacts to these areas were never fully assessed or mitigated during initial navigation project planning or implementation. In addition, the proposed project likely will increase the impacts to these areas. The full extent of unmitigated impacts associated with the original project, and the current proposed project impacts, should be considered within this project assessment and mitigated appropriately.

The Service recommends that the Corps seek Congressional authorization and funding to initiate a study to address any unmet mitigation needs of the original project and implement conservation

measures previously recommended by the Service. This study could constitute an initiation of the Environmental Management Program.

Service Position

Fish and wildlife resources and wildlife-associated recreational activities are an important aspect of American culture. In 2001, U. S. residents spent more than $108 billion dollars while pursuing fish and wildlife related activities. In Oklahoma alone, wildlife observers, hunters, and anglers spent $193,248,000, $248,071,000, and $476,019,000, respectively during 2001 (USDOI and USDOC, 2001). In 2002, over 35 million people visited national wildlife refuges. Their expenditures (*e.g.*, lodging, food, equipment) generated over $809 million in regional economies (USFWS, 2003).

The Service's overall mitigation goal is to conserve important fish and wildlife resources for the benefit of the American people, while facilitating balanced development. This goal is supported by language in the Fish and Wildlife Coordination Act (FWCA) and other authorities. The FWCA establishes fish and wildlife conservation as a coequal purpose of water resource development projects and states that fish and wildlife resources shall receive equal consideration with other features of water resources development programs.

The action alternatives for deepening and maintaining the navigation channel would have significant adverse impacts on both terrestrial and aquatic fish and wildlife resources. As of the date of this report, a full assessment of adverse impacts and a complete mitigation plan have been developed for impacts due to disposal of dredged material at terrestrial sites within the floodplain of the navigation system in Oklahoma.

The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report. The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. This report provides additional compensatory mitigation recommendations for Corps consideration during development of the final mitigation plan for aquatic resource impacts in Appendix G. We believe that incorporating the additional mitigation features into the mitigation plan should serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

The Service believes that in order to ensure that fish and wildlife resources receive equal consideration, as mandated by the FWCA, the Corps should:

- Develop a final mitigation plan through interagency coordination that would minimize, avoid, and compensate for all project impacts;

- Utilize the authorities provided under section 906(b) Water Resources Development Act (WRDA) 1986 and section 306 WRDA 1990 to seek full Congressional authorization and funding for an Environmental Management Program in order to perform the long-term studies and monitoring of the fish and wildlife resources associated with the navigation system; and

- Establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program.

INTRODUCTION

This Fish and Wildlife Coordination Act Report (CAR) provides information on fish and wildlife resources associated with the McClellan-Kerr Arkansas River Navigation System (MKARNS) for use during the Arkansas River Navigation Study, Arkansas and Oklahoma (ARNS). This study is being conducted by the U. S. Army Corps of Engineers (Corps) to investigate maintenance and improvement of commercial navigation on the MKARNS.

The development of the Arkansas River and its tributaries for the purposes of navigation, flood control, hydropower, water supply, recreation, and fish and wildlife habitat was initially authorized by the Rivers and Harbors Act of July 24, 1946. Public Law 91-649 stated the project would be known as the McClellan – Kerr Arkansas River Navigation System. Development of and construction on the MKARNS began in 1957 and was completed in 1971.

The current study results from an March 11, 1982, Resolution by the Committee on Public Works and Transportation of the U. S. House of Representatives dated March 11, 1982, known as the Arkansas River Basin Study Authority. This resolution authorized the Corps to examine proposals for storage, conservation, treatment, and conveyance of water in the Arkansas River and Tributaries in Arkansas and Oklahoma for municipal and industrial uses. The resultant reconnaissance study that began in 1984 recommended that more detailed feasibility level studies be conducted to solve navigation, flood control, recreation, water supply, and fish and wildlife resource problems in the Arkansas River Basin in Arkansas and Oklahoma. Funds were provided in the Energy and Water Development Appropriations Act of 1999 to perform a reconnaissance study of the flooding problems in the vicinity of Fort Smith, Arkansas. As a result of the reconnaissance study, a section 905(b) analysis in accordance with the Water Resources and Development Act (WRDA) of 1986 was prepared by the Southwest Division Corps. The report recommended the current feasibility study with two phases, and was approved by the Corps Headquarters on January 4, 2000.

The Corps completed a draft Feasibility Report and Environmental Impact Statement for Phase 1 in August 2003. The purpose of Phase 1 was to investigate possible operational changes that might improve the MKARNS's ability to evacuate high water through the system and reduce impacts of sustained high flows. The purpose of Phase 2 was to investigate the feasibility of deepening the entire length of the MKARNS from 9 to 12 feet where necessary to allow for deeper tow drafts. Phase 2 also would have been used to investigate adding passing lanes on the Verdigris River in Oklahoma for increased tow safety. However, the Corps decided to combine the two phases into a single comprehensive study based on comments received during the National Environmental Policy Act scoping process for Phase 1 and Phase 2 (Notice of Intent published in the July 16, 2004, issue of the 136 FR 42549).

The purpose of the comprehensive ARNS was to identify and evaluate environmental and socioeconomic aspects of viable alternatives to improve the productivity of commercial navigation on the MKARNS while maintaining the other project purposes of flood control, recreation, hydropower, water supply, and fish and wildlife. The alternatives evaluated in detail

are associated with three major elements related to the maintenance and improvement of the MKARNS, and, therefore, influence navigation on the system. The three elements considered in this study are: 1) River Flow Management, 2) Navigation Channel Deepening and 3) Navigation Channel Maintenance.

The purpose of the River Flow Management element is to develop and evaluate various modifications to the MKARNS that would resolve specific socioeconomic problems resulting from sustained high flows that originate from the middle reaches of the Arkansas River watershed. These problems include flood damages along the river, decreased navigation traffic, and losses to recreational use.

The study team initially examined eight structural alternatives and 23 non-structural alternatives, including altering the current reservoir regulation plan, to facilitate operational changes to the MKARNS in Oklahoma. These alternatives examined measures such as modification of reservoir releases to enable changes in flow rates and durations, reallocating storage from one reservoir to another, or adding storage in the reservoirs. Other alternatives included constructing additional reservoirs, additional high flow relief structures (i.e., spillways), and additional levees along the MKARNS, as well as adjustments/increases in flowage easements, removal of channel restrictions, in-stream modification of existing navigation structures, and restoration/ enhancement of aquatic and riparian habitat along the MKARNS. The study team determined that structural alternatives would be too expensive relative to the associated benefits and would not adequately meet the study objective. From the 23 non-structural alternatives evaluated, four operational alternatives were examined in detail. The detailed analysis for each of the four operational alternatives included a hydraulics study, hydrologic modeling of the river system, and an economics study for each proposed alternative.

The purpose of the Navigation Channel Deepening feature was to determine the feasibility of deepening the MKARNS to improve efficiency and productivity of commercial navigation. The existing 9-foot draft channel limits towboat loads when compared with loads supported by the 12-foot draft channel of the Lower Mississippi River. The disparity between the channel depths of the two systems is believed to result in less efficient operations than could be achieved with a consistent 12-foot navigation channel depth throughout the two systems. Channel deepening has been proposed to occur in six river segments: 1) mouth to Pine Bluff, 2) Pine Bluff to Little Rock, 3) Little Rock to Dardanelle, 4) Dardanelle to Ft. Smith, 5) Fort Smith to Muskogee, and 6) Muskogee to Catoosa. Alternatives considered include a 10-, 11-, and 12-foot channel depth. However, only the 12-foot channel depth would address the channel disparity between the Mississippi River and the MKARNS.

The purpose of the Navigation Channel Maintenance feature is to maintain the desired navigation channel depth (currently 9-feet) through the continued use of a series of river training structures and maintenance dredging. Dredging would be required to continue ongoing operation of the existing 9-foot navigation channel. Ongoing channel maintenance activities since completion of the MKARNS in 1971 have resulted in previously authorized dredged material disposal sites reaching capacity. Six new disposal sites will be required to accommodate continued channel maintenance activities.

This report provides the U. S. Fish and Wildlife Service's (Service), in cooperation with the Oklahoma Department of Wildlife Conservation (ODWC) and Arkansas Game and Fish Commission (AGFC), evaluation of likely impacts to fish and wildlife resources as a result of possible structural and operational changes to the MKARNS in Oklahoma and Arkansas. Specifically, this report is intended to 1) identify the effects of river flow management, channel deepening, and navigation channel depth maintenance alternatives on fish and wildlife resources within the project area; 2) discuss measures to avoid and minimize environmental impacts; and 3) provide recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources.

This CAR has been prepared under the authority of and in accordance with the Fish and Wildlife Coordination Act (FWCA; 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and fulfills the reporting requirement set forth in section 2(b) of the FWCA. The CAR is intended to accompany the Corps report on the feasibility of adopting one of four river flow and channel deepening alternatives for the MKARNS that are intended to improve commercial navigation. This report has been coordinated with the ODWC and the AGFC, and has their support as indicated in Appendix A.

The Service (Oklahoma and Arkansas field offices) previously provided an evaluation of resources likely to be affected by proposed improvements to the MKARNS in planning aid reports (PAR) dated September 24, 1985, May 13, 1986, June 23, 1988, February 23, 1989, and a CAR dated December 21, 1989. We provided an overview of the existing fish and wildlife resources associated with the MKARNS, addressed possible impacts to fish and wildlife resources, discussed unmet mitigation needs associated with the initial development of the MKARNS, and provided preliminary recommendations for fish and wildlife habitat restoration projects for the present feasibility study in a planning aid report dated April 2, 2001. Planning assistance letters dated September 29, 2003 (pertaining to anticipated project impacts and assessments); March 1, 2004 (pertaining to our concerns regarding the expedited schedule for impact analysis, EIS completion, and implementation); May 5, 2004 (pertaining to aquatic habitat assessment methodology); June 15, 2004 (pertaining to dredging, dredge disposal sites, and mitigation for dredge disposal impacts); and April 29, 2005 and May 11, 2005 (both pertaining to freshwater mussel impacts and mitigation) also have been provided. A preliminary draft CAR dated February 25, 2005, also was provided.

PROJECT AREA

The following description of the project area is derived largely from the ecoregions (*i.e.*, large geographic divisions based on natural communities, geology, and land use) as mapped by Omernik (1995), and on the recent conservation assessments of the terrestrial and freshwater ecoregions of North America undertaken by the World Wildlife Fund (Abell *et al.*, 2000; Ricketts *et al.*, 1999). These assessments divide the continent into coarse terrestrial and freshwater ecoregions similar to other classification schemes such as Kuchler (1975), and Bailey (1994), and describe the biodiversity of each area as well as the threats that each ecoregion currently faces.

The project area for this study encompasses the entire 445–mile–long MKARNS in Arkansas and Oklahoma (Figure 1), and the 11 upstream multi-purpose reservoirs in Oklahoma that act as the MKARNS's primary flow modifiers (Table 1). The series of locks, dams, and reservoirs associated with the MKARNS facilitate inland navigation and provides flood control, hydroelectric power, water supply, and recreational activities such as boating, camping, fishing, hunting, and hiking. The 11 upstream reservoirs can store about 7.7 million acre-feet of water for flood control. Each reservoir has specific purposes as authorized by Congress (Table 1). Although the Corps has broad authority to modify the operations of the reservoirs to benefit navigation, operational plans of the reservoirs cannot be changed in a way that is detrimental to their authorized purpose. Navigation is an authorized purpose for only three reservoirs (Oologah, Keystone, and Eufaula). Runoff from a 7,500 square mile drainage area below the 11 reservoirs and above Van Buren, Arkansas, is uncontrolled.

FOUR SEGMENTS OF THE MKARNS

The MKARNS consists of four distinct segments: 1) 50 miles of the Verdigris River in Oklahoma (RM 445 - 394), 2) 375 miles of the Arkansas River proper in Oklahoma and Arkansas (RM 394 - 19), 3) the manmade Arkansas Post Canal (RM 19 -10), and 4) the White River entrance channel (RM 10 - 0) at the confluence of the White and Mississippi Rivers in Desha County, Arkansas.

The head of the MKARNS is the Port of Catoosa in Rogers County, Oklahoma near Tulsa (navigation mile (NM) 444.8). From this port, the MKARNS follows the Verdigris River for 50 miles southeasterly through the Newt Graham Lock and Dam (# 18 at NM 421.4) and the Chouteau Lock and Dam (# 17 at NM 401.4) in Wagoner County. This area of Oklahoma is in the Central Forest/Grassland Transition Zone terrestrial ecoregion (CTZ) (Ricketts *et al.* 1999) and the Central Prairie freshwater ecoregion (Abell *et al.* 2000). The area is includes portions of Omernik's (1995) Central Irregular Plains and Central Oklahoma/Texas Plains. The Arkansas, Grand, Verdigris, Cimarron, and Canadian Rivers each drain portions of this area of Oklahoma.

Oologah, Keystone, Copan, Fort Gibson, Hudson, and Eufaula Reservoirs are all located in this portion of the project area, which consists primarily of a mixture of prairie, savannah, and woodlands on low rolling hills, and broad floodplain forests of elm *Ulmus* spp., oak *Quercus* spp., hackberry *Celtis occidentalis*, cottonwood *Populus deltoides*, and sycamore *Platanus occidentalis* created by slow-moving and muddy tributaries. The CTZ grasslands predominantly occur on relatively deep and fertile soils with the exception of those occurring on the thin layer of soil over limestone that occurs in the Flint Hills Tall Grasslands (Ricketts *et al.*, 1999) to the northwest (location of Hulah Reservoir). A greater average annual precipitation in the CTZ results in higher densities

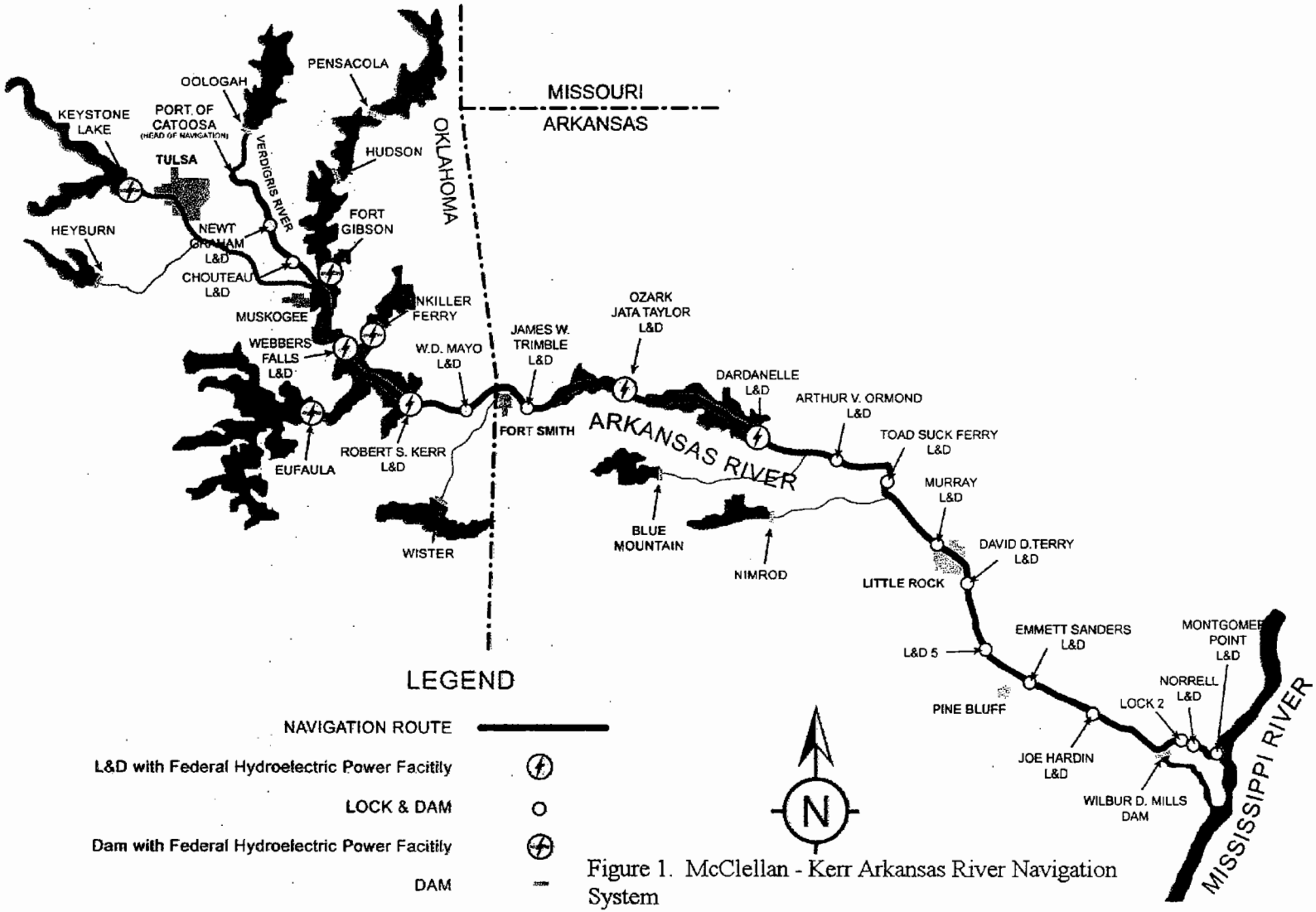


Figure 1. McClellan - Kerr Arkansas River Navigation System

Table 1. Information on the 11 upstream reservoirs in Oklahoma (U.S. Fish and Wildlife Service, 1985; Oklahoma Water Resources Board; 1990).

Reservoir	Agency	Counties	River/Stream and Purpose of Reservoir	Flood Storage (acre-feet)	Conservation pool(acres)/ elevation (NGVD)	Flood pool(acres)/ Elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Copan	Corps	Washington	Little Caney River; flood control, water supply, water quality control, recreation, fish and wildlife	184,300	4,850/710.0	13,380/732.0	505	30
Hulah	Corps	Osage	Caney River; flood control, water supply, low-flow regulation, conservation	257,900	3,570/733.0	13,000/765.0	732	62
Oologah	Corps	Nowata, Rogers	Verdigris River; flood control, water supply, navigation, fish and wildlife	965,600	29,460/638.0	56,800/661.0	4,339	180
Kaw	Corps	Kay, Osage	Arkansas River; flood control, water supply, water quality, recreation, fish and wildlife	919,400	17,040/1, 010.0	38,020/1, 044.5	46,530	168
Keystone	Corps	Osage, Creek, Pawnee, Tulsa	Arkansas and Cimarron River; flood control, water supply, hydroelectric power, navigation, fish and wildlife	1,180,000	23,610/723.0	54,320/754.0	74,506	330
Grand	Corps/ GRDA	Ottawa, Delaware, Mayes	Neosho and Spring River; flood control, hydroelectric power	525,000	46,500/745.0	59,200/755.0	10,298	1,300
Hudson (Markham Ferry)	Corps/ GRDA	Mayes	Neosho River; flood control, hydroelectric power	244,210	10,900/619	18,800/636	11,533	200

Table 1 Continued

Reservoir	Agency	Counties	River/Stream and Purpose of reservoir	Flood Storage (acre-feet)	Conservation pool(acres)/ elevation (NGVD)	Flood pool(acres)/ Elevation (NGVD)	Drainage area (sq. miles)	Shoreline length (miles)
Fort Gibson	Corps	Mayes, Wagoner; Cherokee	Neosho River; flood control, hydroelectric power	919,200	19,900/554.0	51,000/582.0	12,492	225
Tenkiller	Corps	Cherokee, Sequoyah	Illinois River; flood control, hydroelectric power	576,700	12,900/632.0	20,800/667.0	1,610	130
Eufaula	Corps	McIntosh, Pittsburg	North Canadian, South Canadian, and Deep Fork; flood control, water supply, hydroelectric power, navigation, fish and wildlife	1,510,800	105,000/585.0	143,000/597.0	47,522	600
Wister	Corps	LeFlore	Poteau River and Fourche Maline Creek; flood control, water supply, low flow augmentation, water conservation, sedimentation	386,800	7,333/478.0	23,070/502.5	993	115

of trees and shrubs relative to the Central and Southern Mixed Grasslands (Ricketts *et al.*, 1999) of central and western Oklahoma (location of Kaw Reservoir).

Typical grasses of the CZT include big bluestem *Andropogon gerardii*, little bluestem *Schizachyrium scoparium*, Indian grass *Sorghastrum nutans*, switchgrass *Panicum virgatum*, and grama grasses *Bouteloua spp.* Upland forests dominated by oak *Quercus spp.* and hickory *Carya spp.* occur in the more mesic draws and ravines. The "crosstimbers" (wide belt of timber on the prairie encountered by explorers as they crossed the plains) also occur in this area on light colored sandy soils with reddish clay subsoils, and consist of hickory trees scattered among short post oak *Q. stellata* and blackjack oaks *Q. marilandica*. Considered one of the most biologically diverse areas in North America because of its large size and proximity to both the great plains and eastern deciduous forests, this region is within the top 10 ecoregions nationally for bird, reptile, and tree species diversity (Ricketts *et al.*, 1999). Much of the fauna is shared with the adjacent grassland ecoregions (prairie species can be found in the woodland understory layer).

The major aquatic habitat types are temperate headwaters and lakes. Endemism for aquatic species is relatively low (Abell *et al.*, 2000).

Only 1 percent of the area is thought to be intact as a result of intensive farming for crops such as corn and soybeans. The degree of terrestrial habitat fragmentation is ranked as extremely high (Ricketts *et al.*, 1999).

The MKARNS joins the Arkansas River northeast of Muskogee in Muskogee County, Oklahoma (NM 395.0). The MKARNS then extends southeasterly through Oklahoma toward Arkansas through Webbers Falls Lock and Dam (# 16 at NM 366.6) creating the 34.5 mile-long Webbers Falls Reservoir in portions of Muskogee, Wagoner, and Cherokee Counties. Webbers Falls impounds 28 miles of the Arkansas River to the mouth of the Verdigris River and then 6.5 miles up the Verdigris to Chouteau Lock and Dam (USFWS, 1983).

From Webbers Falls Lock and Dam, the river channel forms a portion of the county line between Sequoyah/Muskogee and Sequoyah/Haskell Counties near the Sequoyah NWR (described below), and then extends through Robert S. Kerr Lock and Dam (# 15 at NM 336.2) creating Robert S. Kerr Reservoir. Kerr Reservoir forms many irregular arms and peninsulas and extends about 32.7 navigation miles upstream to Webbers Falls Lock and Dam. From Kerr Reservoir, the river continues along the Sequoyah/LeFlore County line through W. D. Mayo Lock and Dam (# 14 at NM 319.6), where it leaves Oklahoma and enters Arkansas. The MKARNS then flows through the James W. Trimble Lock and Dam (# 13 at NM 292.8) along the Crawford/Sebastian County line, and through the Ozark – Jeta Taylor Lock and Dam (# 12 at NM 256.8) in Franklin County, creating Ozark Lake. Continuing southeasterly along the Johnson/Logan County line, the MKARNS forms Lake Dardanelle at Dardanelle Lock and Dam (# 10 at NM 205.5), and then flows along the Yell/Pope County lines, abutting the northern border of Holla Bend NWR (described below). From there, the river flows through Arthur V. Ormond Lock and Dam (# 9 at NM 176.9) in Conway County and along the Conway/Perry and Faulkner/Perry County lines where it extends through Toad Suck Ferry Lock and Dam (# 8 at NM 155.9). The MKARNS

continues along the Faulkner/Pulaski County lines, and through the Murray Lock and Dam (# 7 at NM 125.4) in Pulaski County near Little Rock.

This area of Oklahoma and Arkansas lies within the Ozark Mountain Forests terrestrial ecoregion as defined by Ricketts *et al.* (1999) and the Central Prairie freshwater ecoregion near Muskogee, Oklahoma, to the Oklahoma/Arkansas state line, where the project area enters the Ozark Highlands freshwater ecoregion as defined by Abell *et al.* (2000). These ecoregions are a combination of Omernik's (1995) Ouachita Mountains (location of Wister Reservoir), Ozark Mountains (location of Grand and Tenkiller Reservoirs), and Arkansas Valley ecoregions (with the Arkansas Valley occurring between the others). The Arkansas River floodplain is confined to the Arkansas Valley ecoregion. Other major rivers in this broad area include the Grand (Neosho), Illinois and Poteau Rivers in Oklahoma and the Petit Jean, Fourche Lafave, Mulberry, and Ouachita Rivers in Arkansas.

The natural communities of the area include bottomland hardwood forests along rivers and streams, oak – hickory forests in upland sites, shortleaf pine savannas and mixed pine – hardwood forests on ridge tops, and scattered tallgrass prairie communities in the valley between the dry upland forests and more mesic bottomland hardwood forests. The limestone formation (karst geology) in the northern portion of the area (Ozarks) has dissolved in many places, forming caves.

Many of the natural communities of the project area have been greatly altered by timber harvesting, cultivated agriculture, and development of the MKARNS. Riparian habitat along the Arkansas River is considered severely degraded, and only about 3 percent of the pre-settlement habitat is intact as a result of agriculture, logging, fire suppression, and grazing (Ricketts *et al.*, 1999). Several near-endemic herpetofauna species are found in this area including Strecker's chorus frog *Pseudacris streckeri*, the ringed salamander *Ambystoma annulatum* (Abell *et al.*, 2000) and the many-ribbed salamander *Eurycea multiplicata* (Conant and Collins, 1991).

From Little Rock, the MKARNS continues southeasterly through the David D. Terry Lock and Dam (# 6 at NM 108.1) in Pulaski County and through Lock and Dam (# 5 at NM 86.3) in Jefferson County. The MKARNS then flows through Emmet Sanders Lock and Dam (#4 at NM 66.0) northeast of Pine Bluff. From there, the MKARNS continues through Joe Hardin Lock and Dam (# 3 at NM 50.2) along the Jefferson/Lincoln County Line, and along the Arkansas/Lincoln and Arkansas/Desha County lines. The channel then extends through Lock (# 2 at NM 13.3) and Norrell Lock and Dam (# 1 at NM 10.3) as it follows the nine mile manmade Arkansas Post Canal in Arkansas County that connects the White and Arkansas Rivers. Finally, ten miles of the White River in eastern Arkansas (mile 599 on the Mississippi River) make up the MKARNS's entrance channel from the Mississippi.

This lower reach of the MKARNS is within the Mississippi Embayment freshwater ecoregion (Abell *et al.*, 2000) and the Mississippi Lowland Forest terrestrial ecoregion (Ricketts *et al.*, 1999). In Arkansas, this is identical to Omernik's (1995) Mississippi Alluvial Plain. Other major rivers in the area are the White and Mississippi Rivers. Wetland areas, oak-hickory-pine forests, and bottomland hardwoods once dominated the landscape; however, these habitats have

been extensively altered resulting in the loss of most (91–95 percent) of the original riparian and bottomland forest systems. Much of the remaining floodplain forests include river swamp forests, forests of backwater areas and flats, and upland transitional forests. Most of the remaining habitat is restricted to wet areas that are difficult or not feasible to exploit economically through cultivation or other means (Ricketts *et al.*, 1999). The biological distinctiveness of the Mississippi Embayment is considered globally outstanding (*i.e.*, the biological diversity of the area is equaled or surpassed in only a few other places worldwide) (Abell *et al.*, 2000).

ELEVEN OKLAHOMA RESERVOIRS

Water flow and storage on the MKARNS is influenced primarily by the following 11 Oklahoma reservoirs: Copan, Hulah, Oologah, Kaw, Keystone, Pensacola (Grand), Hudson (Markham Ferry), Fort Gibson, Tenkiller Ferry, Eufaula, and Wister (Table 1). Collectively, storage by these reservoirs represents more than 70 percent of total flood control storage in the basin. The reservoirs modify flow within the system through controlled water releases through spillways and power generating units (for those reservoirs with hydropower capabilities). Water releases depend on numerous complex factors such as weather conditions, water storage capacity, inflow rates, river flow rates downstream, power requirements, and navigation water requirements. Brief information specific to each reservoir is provided below. A summary of reservoir characteristics (*e.g.*, reservoir purpose, drainage area, storage capacity, etc.) was previously provided in Table 1.

Copan Lake: This reservoir is located in Washington County on the Little Caney River, a tributary of the Caney River, at river mile 7.4 in the Verdigris River watershed. Copan Lake was authorized by the Flood Control Act approved October 23, 1962. Construction began in 1972 and the project was in full operation in 1983. The reservoir is located in the CTZ among gently rolling hills forested with oak, hickory, and other small hardwood trees, tall grass prairie habitat, and bottomland hardwoods. Copan Lake was constructed by the Corps for flood control, water supply, water quality control, recreation, and fish and wildlife. The normal pool area is 4,850 acres. The drainage area is about 505 square miles (Oklahoma Water Resources Board, 1990).

Hulah Lake: Located in the Verdigris watershed at river mile 96.2 on the Caney River in Osage County, this lake was constructed by the Corps under the authority of the Flood Control Act approved June 22, 1936, for flood control, water supply, low-flow regulation, and conservation. Construction began in 1946 and the project was completed in 1951. The normal pool is 3,570 acres. The total drainage area is 732 square miles (Oklahoma Resources Board, 1990). The reservoir is located in the Flint Hills Tall Grasslands ecoregion (Ricketts *et al.*, 1999). The area surrounding the reservoir is characterized by rolling hills with a habitat mixture of oak woodlands, prairie, and bottomland hardwoods.

Oologah Lake: Oologah Lake is located on the Verdigris River within the CTZ. The lake was authorized by the Flood Control Act approved June 28, 1938. Construction began in 1950. The project was in full operation in 1974. The Corps constructed the project for flood control, water

supply, and navigation. Oologah Lake is considered a key unit in the flood control plan for the Arkansas River Basin. The normal pool area is 56,800 acres. The drainage area consists of 4,339 square miles (Oklahoma Water Resources Board, 1990).

Kaw Lake: Kaw Lake was authorized by the Flood Control Act approved October 23, 1962. Construction began in 1966. The project was in full operation in 1976. The reservoir is located in the Flint Hills Tall Grasslands ecoregion (Ricketts *et al.*, 1999). The lake was constructed by the Corps for flood control, water supply, water quality, recreation, and fish and wildlife. The normal pool is about 17,000 acres. The drainage area is 46,530 square miles (Oklahoma Water Resources Board, 1990).

Keystone Lake: Keystone Lake was constructed by the Corps on the Arkansas River in Osage, Pawnee, Creek, and Tulsa Counties, near the confluence with the Cimarron River, for flood control, water supply, hydroelectric power, navigation, and fish and wildlife. Keystone Lake was authorized by the Flood Control Act approved May 17, 1950. Construction began in 1957. The project was completed in 1964. The drainage area is 74,506 square miles and the normal pool is 23,610 acres (Oklahoma Water Resources Board, 1990).

Grand Lake: Grand Lake was authorized by the Grand River Dam Authority Enabling Act of 1935 which created the Grand River Dam Authority (GRDA). The GRDA is responsible for construction and operation of dams on the Grand River for the purpose of flood control and hydroelectric power production. The project was initiated in 1936 and was completed in 1940. The reservoir begins at the Pensacola Dam on the Grand (Neosho) River in Mayes County and extends northeast into Delaware and Ottawa Counties in the far western portion of the Central Hardwoods Forest (Rickets *et al.*, 1999). Grand Lake was constructed by the GRDA for flood control and hydroelectric power. The Flood Control Act of 1944 mandated that the Corps minimize downstream flooding. As a result, the reservoir is jointly operated by the GRDA and the Corps. The Corps controls all releases when the reservoir water levels is above the conservation pool elevation (745 msl). The total drainage area of the lake is 10,298 square miles. The normal pool is 46,500 acres.

Hudson Lake: The reservoir (also known as Markham Ferry) was authorized by the Flood Control Act approved August 18, 1941. The GRDA initiated construction of the project in 1954. Hudson Lake was constructed on the Grand River near Locust Grove in Mayes County, Oklahoma, by the GRDA for flood control and hydroelectric power. Construction was completed in 1964. As with Grand Lake, the project is jointly operated by the GRDA and the Corps, with the Corps controlling all releases when the reservoir water surface level is above the conservation pool elevation. The normal pool for the lake is 10,900 acres. The drainage area is 11,533 square miles (Oklahoma Water Resources Board, 1990).

Fort Gibson Lake: This reservoir was authorized by the Flood Control Act approved August 18, 1941. Construction began in 1942 but was suspended due to World War II until 1946. The project was completed in 1953. Fort Gibson Lake is located on the Grand River in Mayes, Wagoner, and Cherokee Counties, about 7.7 miles above the confluence of the Grand and Arkansas Rivers. The reservoir extends upriver to Lake Hudson, and has a drainage of about

12,500 square miles. The conservation pool covers 19,900 acres (Oklahoma Water Resources Board, 1990).

Tenkiller Ferry: Tenkiller Ferry Lake was authorized by the Flood Control Act approved June 28, 1938. Construction began in 1947 and was completed in 1953. The project is located in the Ozark Mountain Forest ecoregion (Ricketts *et al.*, 1999) on the Illinois River in Cherokee and Sequoyah Counties. The reservoir was constructed for flood control and hydroelectric power. The lake drains a 1,610-square mile drainage area. The surface area at the top of the conservation pool is 12,900 acres (Oklahoma Water Resources Board, 1990).

Eufaula Lake: The reservoir was authorized by the River and Harbors Act approved July 24, 1946. Authorized project purposes are flood control, water supply, hydroelectric power, and navigation. Construction began in 1956. The project was in full operation in 1964. The dam is located on the Canadian River in McIntosh County. The reservoir occurs in portions of McIntosh, Pittsburg, Okmulgee, and Haskell Counties. The North Canadian, Canadian, and Deep Fork Rivers converge near the center of the reservoir. The reservoir drains a 47,522-square mile area. The surface area for the conservation pool is about 105,000 acres (Oklahoma Water Resources Board, 1990). Eufaula Lake is the largest reservoir in Oklahoma.

Wister Lake: Wister Lake was authorized by the Flood Control Act approved June 28, 1938. Wister Lake was constructed for flood control, water supply, low flow augmentation, water conservation, and sedimentation. Construction began in 1946. The project was in full operation in 1949. The dam is located on the Poteau River about two miles south of Wister in LeFlore County. The reservoir is located in LeFlore and Latimer Counties, and drains a 993-square mile area (Oklahoma Water Resources Board, 1990). The basic topography of the area is rough, varying from low rounded ridges on the north and northeast to high mountainous ridges in the south, southwest, and central portions of the watershed. The surface area for the conservation pool is about 7,400 acres.

GEOLOGY, SOILS, AND CLIMATE

The geology of the project area is quite variable. Quaternary sand, silt, clay, and gravel occur in the floodplains and terrace deposits of the major rivers (*i.e.*, Arkansas, Verdigris, and White Rivers). Mississippian and Devonian-Silurian marine limestone, sandstone, and shale occur in the Ozark region where karst features such as caves, sinkholes, and underground streams are common. Thick, complexly folded conglomerates of shale, sandstone, limestone and coal characterize the geology of the Ouachita Mountains (Arkansas Geological Commission, 1997; Miser, 1954).

Soil types found in the project area also are quite variable as a result of subsoil variations and climatic differences. Soils vary from rich prairie loams to heavy clay to thin soils overlying bedrock. Alluvial soils are located throughout the project area along the major drainages. Soils in the Ozarks in northeastern Oklahoma and northwestern Arkansas range from sandy loams to heavy clays to rock outcrops. In the southeastern portion of the study area in Arkansas, soil

types range from loamy soils along bayou ridge tops to predominantly clay in lower elevations. A more detailed description of soils within the project area can be found in the Natural Resources Conservation Service's Soil Survey publications for the various Counties.

The climate is primarily influenced by movement of moist air from the Gulf of Mexico, hot and dry air from the desert southwest, and cold air from the Arctic. The region undergoes seasonal variations in temperature and precipitation and typically experiences long, humid summers and short, mild winters. Mean annual precipitation increases from west to east and ranges from 36 inches near Keystone Reservoir west of Tulsa, Oklahoma, to 54 inches in eastern Arkansas at the Arkansas River's confluence with the Mississippi River. Average annual temperatures range from about 60–62° Fahrenheit, and the growing season varies from 209 days in the grasslands and crosstimbers of Oklahoma to about 220 days in the Mississippi Alluvial plain of eastern Arkansas.

PROJECT DESCRIPTION

The purpose of the current operating plan for the navigation system is to optimize benefits for navigation, flood control, water supply, fish and wildlife, hydropower, and recreation while minimizing adverse impacts to the environment, farmland, and fish and wildlife resources. The proposed action is to maintain and improve the MKARNS to benefit commercial navigation on the system while maintaining the other project purposes. The alternatives evaluated in detail are associated with three major project features that influence navigation on the system: 1) River Flow Management, 2) Navigation Channel Deepening, and 3) Navigation Channel Maintenance.

RIVER FLOW MANAGEMENT FEATURE

Flows on the MKARNS are modified primarily by Corps operation of the 11 reservoirs in Oklahoma. Each reservoir is linked through their releases to the main stem of the Arkansas River. Each reservoir is not only operated for local conditions but also must be operated as part of the larger system in conjunction with the other controlling reservoirs. The reservoirs are collectively operated to maintain flow targets at the Van Buren, Arkansas, gage because all the regulated flow releases pass this gage. Channel capacity at Van Buren is 137,000 cubic feet per second (cfs) and is the primary control point for the Lower Arkansas River Basin.

For their analysis, the Corps designated flow rates as optimum, moderate, high, or very high based on the flow rate's effect on commercial navigation and farming operations:

- Optimum: River flows less than 61,000 cfs, which correlates to optimum conditions for commercial navigation.

- Moderate: River flows between 61,000 and 100,000 cfs. Under this flow rate, flooding of some cultivated fields along the main stem of the Arkansas River in western Arkansas begins. Agricultural damages have historically occurred in the Van Buren area when

river flows exceed 61,000 cfs. Warnings are issued to operators of small, recreational water crafts when flows exceed 70,000 cfs.

- High: Flow rates between 100,000 and 175,000 cfs. Any flow above 100,000 cfs renders the system non-navigable for commercial barge traffic, and commercial barge traffic is suspended until flows decrease. The 137,000 cfs flow rate represents bank full discharge at Van Buren.

- Very High: Flow rates greater than 175,000 cfs.

OPERATIONAL HISTORY AND SPECIFIC PROBLEMS

The Arkansas River basin encompasses a drainage area of about 138,000 square miles. Forty-eight Federal and two State (Oklahoma) water resource development projects have been constructed on the Arkansas River from the 1940's to the 1980's. The projects have a variety of purposes such as hydropower, water supply, sediment control, navigation, recreation, fish and wildlife, and flood control.

Water storage in the 11 Oklahoma reservoirs represents more than 70 percent of the total flood control storage in the basin. Runoff from about 7,500 square miles of land below the 11 Oklahoma reservoirs and above Van Buren, Arkansas, is uncontrolled.

Construction of the navigation system itself began in 1957. The MKARNS was constructed to enable large vessels to overcome the steep slope of the Arkansas River Valley due to the 420-foot difference in elevation from the Mississippi River to the head of the MKARNS near Catoosa, Oklahoma. The Corps currently maintains a minimum channel depth of nine feet on the system, a minimum width of 250 feet, and a normal current velocity range between two and four miles per hour. There are 18 existing locks and dams on the MKARNS (all 110 feet wide by 600 feet long). Five occur in Oklahoma and 13 occur in Arkansas. The navigation system was completed in 1970 with the development of the Port of Catoosa, Oklahoma. Since that time, the Corps has modified the operating plan of the system to improve the flow regime for navigation.

Flows on the MKARNS are highly influenced by the storage and release of water in the 11 Oklahoma reservoirs. Initially, the existing reservoirs on the system were operated to achieve a target flow of 150,000 cfs at the Van Buren gage. Under this operating plan, shoaling would occur in the river after a flooding event due to rapid recession of flow. The shoaling would restrict navigation until maintenance dredging could occur. A tapered operation that required water to be retained in the flood control pools for longer periods of time was needed to more gradually reduce flows after a flooding event.

Flows at Van Buren depend on the season of the year and percent of flood control storage being utilized. Seasonal guide curves were developed to aid the Corps in regulating flows at Van Buren. The guide curves related flows at Van Buren with the percent of flood control storage

being utilized plus three days of forecasted inflow into the 11 controlling reservoirs. To meet the intended objective, a delay in evacuation of the lower portion of the flood control storage would occur. The amount of delay depends on the time of year, hydrologic conditions in the basin, and the amount of flood control storage in the 11 controlling reservoirs. Four release zones were used: 1) 150,000 cfs, 2) 150,000 to 105,000 cfs, 3) 105,000 to 40,000 cfs, and 4) 40,000 to 20,000 cfs. The system was operated under this "Van Buren Guide Curve Plan" from 1979 to 1986.

Successive high flow events in the early 1980s resulted in the flooding of additional agricultural lands near the river and increased costs and delays for navigation interests. In June 1986, the "Fine Tuning Plan" was implemented to address difficulties experienced by navigation interests and farmers as a result of high flows on the system. The objective of the revised operating plan was to provide a different transition from flood releases and increase the number of days where flow was below 80,000 cfs. The new plan included a 75,000 cfs flow bench (*i.e.*, period of time where the flow is held at or below a certain cfs) for 7 to 14 days following flood events. However, problems with sedimentation continue to occur at the 75,000 cfs bench rate, influencing maintenance dredging of the channel.

The 75,000 cfs bench impacts maintenance dredging activities in the lower reaches of the Arkansas River. Dredging is difficult when flows exceed 70,000 cfs and uncontrolled flows during flood events can increase flows to between 85,000 and 90,000 cfs. Therefore, additional delays in the evacuation of the lower portion of the flood control storage are implemented when the system flood storage remaining reaches less than 18 percent. The degree of the delay is dependent on hydrologic conditions, season of the year, and the distribution of the flood control storage within the system.

The "Fine-Tuning Plan" involves five release zones: 1) 150,000 cfs, 2) 150,000 to 135,000 cfs, 3) 75,000 cfs (*i.e.*, the bench), 4) 75,000 to 40,000 cfs, and 5) finally, gradually reducing the target flow at Van Buren from 40,000 cfs to 20,000 cfs when the flood storage in the 11 controlling reservoirs in Oklahoma reaches from 3 percent in the spring to 11 percent in the summer. This plan continued to utilize a 75,000 cfs bench to allow for sediment flush out and to increase the number of days where the flow is held at or below 75,000 cfs to allow dredges to remove flood-induced sedimentation.

CURRENT STUDY AND SPECIFIC PROBLEMS

The purpose of the River Flow Management aspect of the current study is to address various problems, such as flooding, decreased navigation traffic, reduction in hydropower generation, and losses to recreational use along the Arkansas River, influenced by sustained high flows. The study is based upon revisions to the operational flows of the river, as measured at the Van Buren gage. Operational modification of river flows would be accomplished by altering the water storage in the eleven regulating reservoirs.

The objective of the current study is to investigate flow management on the MKARNS to develop solutions that would evacuate high flows through the system at the fastest rate feasible to reduce flood damages, and improve the safety and efficiency of commercial navigation operations while maintaining other project purposes such as recreation, fish and wildlife, water supply, and hydropower. This objective would be achieved by reducing the number of days when river flows exceed 61,000 cfs at the Van Buren gage.

NAVIGATION CHANNEL DEEPENING FEATURE

The proposed Navigation Channel Deepening action would consist of deepening the navigation channel to allow deeper draft tows to operate on the MKARNS. The existing 9-foot navigation channel depth is believed to limit the efficiency and volume of commercial navigation operations on the MKARNS compared to the Lower Mississippi River's authorized 12-foot draft channel. Deepening the channel would remove the disparity between the navigation channel depths of the MKARNS and the Lower Mississippi.

NAVIGATION CHANNEL MAINTENANCE FEATURE

Operation and maintenance of the MKARNS at the existing 9-foot draft channel depth requires periodic dredging at some locations within the navigation system. Some existing authorized dredged material disposal sites have reached capacity and new disposal sites would be required to support continued operation of the existing MKARNS for the 9-foot channel.

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

The Service's overall planning objective is to conserve important fish and wildlife resources for the benefit of the American people, while facilitating balanced development. This goal is supported by language in the FWCA and other authorities. The FWCA establishes fish and wildlife conservation as a coequal purpose of water resource development projects, and states that fish and wildlife resources shall receive equal consideration with other features of water resource development programs.

Deepening the navigation channel to allow deeper draft tows to operate on the MKARNS and maintaining this navigation channel depth would have significant adverse impacts on both terrestrial and aquatic fish and wildlife resources. In general, these impacts would include the loss of terrestrial habitat due to the disposal of dredged material in upland sites; the loss of aquatic habitat due to disposal of dredged material in aquatic sites and the construction and raising of river training structures; the removal and alteration of gravel bars, which support a variety of aquatic species, due to dredging activity; and adverse effects on freshwater mussel patches and beds (*i.e.,* mussel concentration areas) due to dredging activity and the disposal of dredged material.

The Service has been actively involved with the ARNS over the last several years through participation in numerous site visits, meetings and conference calls pertaining to planning efforts designed to avoid and minimize unnecessary impacts, as well as meetings pertaining to impact assessment analysis and development of appropriate mitigation measures. The Service believes that a complete and thorough analysis for unavoidable project impacts on fish and wildlife resources is necessary to ensure that all losses are adequately and appropriately offset over the project life. Specifically, we believe that a mitigation plan addressing both aquatic and terrestrial resource impacts, developed through interagency coordination, will be necessary to minimize, avoid, and fully compensate for project related impacts.

The Service and our state resource partners have expressed our concern, through the various stages of the study, that the project had been placed on an extremely expedited time schedule, and that, due to the expedited schedule, an adequate assessment of the proposed project's environmental impacts not be possible within the time frame allotted. A more traditional schedule would allow a more thorough evaluation of the project so that full evaluation of all direct, indirect, and cumulative impacts could occur.

Due to the expedited time schedule for the project, the aquatic field studies conducted to describe baseline conditions and evaluate impacts of channel deepening on riverine habitats and associated fish communities throughout the entire 445-mile navigation system was limited to the summer of 2004. Similarly, the study to assess impacts to freshwater mussels was limited in time and scope such that all potential dredging and dredged material disposal areas were not surveyed. While considerable effort has been expended to estimate the overall impact of project implementation, an accurate assessment was impossible due to a lack of detailed baseline information.

The Service alerted the Corps early in project planning stages that the effects of the proposed modifications combined with the continued operation and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, dike fields, oxbows, and other backwater areas, and the main stem of the navigation channel), likely will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. We believe that a long-term adaptive monitoring program developed and implemented through interagency coordination is necessary to fully assess the true magnitude of the cumulative impacts from the proposed modifications, ongoing project maintenance and continued system operation. The program also should identify and address any unmet mitigation needs not anticipated due to the expedited study schedule and lack of detailed information.

EVALUATION METHODS

RIVER FLOW MANAGEMENT FEATURE

The effects of the River Flow Management Action components were evaluated using the Corps "Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System," also known as the SUPER Model. The model consists of linked programs designed to "perform" and analyze a period of record for a specific system of reservoirs operated under various plans of regulation. For this study, reservoir elevations and river stages were modeled using 61 years (January 1940 – December 2000) of flow data. This period was considered a good representation of what may be expected in the Arkansas River Basin, because it contains floods with large volumes and high peak flow periods (1943, 1957, 1986, 1990, 1994, and 1995) and drought years (1950's and 1970's).

The following components were examined in detail:

1) No Action Plan (to establish a baseline condition for comparison with the other simulations),

2) the 175,000 cfs Plan: increasing the operating target at Van Buren to 175,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3 percent (*i.e.*, from 18 to 15 percent system full) except from June 15– October 1.

3) the 200,000 cfs Plan: operating Van Buren at 200,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3 percent except from June 15 – October 1.

4) the Operations Only Plan: maintaining the existing operating plan (*i.e.*, operating Van Buren at 150,000 cfs), but replacing the current 75,000 cfs bench with a 60,000 cfs bench beginning at 3 percent lower system storage except from June 15 – October 1.

Information obtained from the SUPER Model for each non-structural alternative included 1) average annual river flow and condition, 2) average annual reservoir stages and duration, and 3) operational damages within the system. This analysis was based on average reservoir elevations and river flows over the above period of record.

We determined, using data obtained through the SUPER Model analysis, possible impacts to fish and wildlife resources resulting from the four non-structural operating alternatives selected by the Corps for detailed analysis. For our analysis, we compared future habitat conditions without the project to future habitat conditions with the project conditions for each alternative. Detailed information associated with the SUPER Model screening runs can be found in Appendix A, Hydrology and Hydraulics Report, of the Corp's draft Integrated Feasibility Report (USACE, 2005b).

The Operations Only plan was selected by the Corps as the component of the River Flow Management feature. We then compared daily reservoir elevations under with and without project conditions over the period of record for the Operations Only component at four of the 11 modifying reservoirs on the navigation system: Oologah, Tenkiller, Eufaula, and Keystone. These reservoirs exhibited the greatest change in the number of days they would be expected to be above conservation pool compared to existing conditions, as indicated by the average reservoir pool elevation over the period of record. This analysis allowed us to conservatively evaluate the effects of flow management operations on reservoir elevations under extreme conditions. These extreme conditions, in any given year or during successive years, potentially would have the most significant effect on fish and wildlife resources. Such effects likely would not be apparent from an analysis that examined only averages of reservoir elevations and river flows over the 60-year period of record.

NAVIGATION CHANNEL DEEPENING FEATURE

Early in the evaluation process, a Multi-agency Ecosystem Evaluation Team was established to evaluate impacts of the proposed Navigation Channel Deepening feature on terrestrial and aquatic habitats and ecological benefits resulting from proposed mitigation measures. The multidisciplinary team included biologists with technical expertise from the Little Rock and Tulsa District Corps, the Service, the Corps Engineer Research and Design Center-Environmental Laboratory (ERDC-EL), ODWC, AGFC, and Parsons, a private consulting firm (Table 2). The team evaluated the environmental impacts of proposed dredging and disposal of dredged material using the Habitat Evaluation Procedures (HEP).

Table 2. Interagency Evaluation Team.

Name	**Agency/Company**
Johnny McLean	Corps, Little Rock District
Tony Hill	Corps, Little Rock District
Sandra Stiles	Corps, Tulsa District
Wesley Fowler	Corps, Tulsa District
Charles Schrodt	Corps, Tulsa District
Antisa Webb	ERDC-EL
Kelly Burks	ERDC-EL
Jack Killgore	ERDC-EL
Catherine Murphy	ERDC-EL
Richard Stark	USFWS, Oklahoma Ecological Services
Kevin Stubbs	USFWS, Oklahoma Ecological Services
Lindsey Lewis	USFWS, Arkansas Ecological Services
Marge Harney	USFWS, Arkansas Ecological Services
Gary Peterson	ODWC
Mike Plunkett	ODWC
Randy Hyler	ODWC
Jeff Quinn	AGFC
Stephen Webber	ODEQ
Richard Hall	Parsons

Table 2 Continued

Table 2 Continued

Name	Agency/Company
Randy Norris	Parsons
Virginia Flynn	Parsons
Enid McNutt	Parsons
Luke Eggering	Parsons

Terrestrial Impacts From Dredged Material Disposal

A modified version of the Service's HEP was used to assess impacts at terrestrial dredged material disposal sites and to determine appropriate mitigation measures. Experienced biologists and staff from ERDC, both Corps Districts, the Service's Oklahoma Field Office, and the ODWC jointly developed three wildlife community based models encompassing the major cover types present at proposed dredged material disposal sites in Oklahoma and at proposed mitigation sites. Major cover types consisted of grassland (open field and old field), forest (bottomland hardwood and floodplain forest), and marsh.

Data used in the analysis were collected at representative dredged material disposal sites and at reference sites for each cover type. Data collected from the field investigations at the reference sites also were used to adjust optimum habitat values for each variable within the three models. Data collected at representative dredged material disposal sites were extrapolated to all other disposal sites so that impacts could be predicted. The team of biologists used best professional judgment to project natural succession at selected target years for the dredge disposal sites.

The ERDC-EL used the HEP models and data provided by the interagency team to evaluate impacts from dredged material disposal and determine mitigation needs. The analysis provided a measure of the habitat value of the proposed impact sites and mitigation sites over the 50-year life of the project using a software package developed by the ERDC Environmental Laboratory known as EXHEP *(i.e.,* EXpert Habitat Evaluation Procedure). Impacts were quantified in non-monetary terms using HEP, and provided a basis for determining the measures needed to mitigate for terrestrial dredged material disposal impacts along the system in Oklahoma.

The evaluation rated the quality of each cover type in the project area on a scale of 0.0 to 1.0. The rating (Habitat Suitability Index – HSI) is based on the habitat's capability to support and sustain a community of wildlife, as determined through the evaluation models and the professional judgment of experienced biologists. Cover types with the highest HSI value have the best capability to sustain associated fish and wildlife populations and communities. Multiplying the HSI (quality) by the extent (*e.g.,* acres) of each cover type provides a measure of the Habitat Units (HUs), the combined quality and quantity of habitat.

The average number of HUs expected to be lost or gained annually for each cover type over the 50 year project life provides the average annualized habitat units (AAHUs). The AAHUs were determined for the with and without project conditions to compare future habitat conditions without the project to future habitat conditions with the project. The AAHUs also were determined for proposed mitigation sites. Preliminary discussion, including locations of

mitigation sites, developed in cooperation with the ODWC, was provided in a planning assistance letter from the Service dated June 15, 2004.

The net loss or gain in AAHUs with the project was determined by calculating the difference between annualized loss or gain for the with and without project conditions. The AAHUs at the proposed terrestrial dredged material disposal sites and at the potential mitigation sites were then used to develop a mitigation plan that would completely offset losses of habitat value.

Trade-off rules were developed to ensure appropriate in- and out-of kind mitigation would occur for unavoidable impacts at terrestrial dredged material disposal sites (Table 3). Baseline habitat value (HSI) for agricultural fields managed as food plots for wildlife was assumed to be 0.24 due to the low value provided to evaluation species.

Table 3. Trade-off rules for compensatory mitigation of unavoidable impacts of terrestrial dredge disposal.

Impacted Habitat	**Replacement Habitat**				
	Bottomland Hardwood	**Floodplain Forest**	**Old Field**	**Open Field**	**Marsh Wetland**
Bottomland Hardwood	Yes	No	No	No	No
Flood Plain Forest	Yes	No	No	No	No
Old Field	Yes	No	No	No	Yes
Open Field	Yes	No	No	No	Yes

The following assumptions were made:

- All terrestrial disposal areas would be continuously disturbed and have no fish and wildlife value;
- Under the without project scenario, all mitigation sites remain the same cover type and quality over time;
- Proposed bottomland hardwood and marsh wetland mitigation sites would have restored hydrology and would be maintained over the project life to facilitate attainment of ecological function;
- Bottomland hardwood mitigation sites were considered newly created marsh habitat from the time they were flooded until bottomland hardwood forest would be expected to develop (at project year 11);
- Agricultural land used as food plots would have a low HSI value of 0.24 throughout the 50-year project life;

- Agricultural land not used as food plots were selected for terrestrial disposal sites as a measure to avoid areas that provide quality habitat. These areas were assumed to have no habitat value; and

- All sites selected for compensatory mitigation would currently be agricultural cropland not used as food plots;

Complete details pertaining to the HEP analysis used in this study, including methodology, techniques, graphs and descriptions of the variables assessed for each cover type, cover type acres, HUs, HSI values, and AAHUs, etc., can be found in Appendix C of the Corp's draft Environmental Impact Statement for ARNS (USACOE, 2005a).

Aquatic Impacts: Riverine Habitats And Associated Fish Community

An aquatic field study was conducted by experienced ERDC aquatic biologists to describe baseline conditions and evaluate impacts of channel deepening on riverine habitats and associated fish communities. Due to the expedited time schedule for the project, field data collection was limited to the summer of 2004.

The interagency evaluation team provided input on evaluation procedures through several interagency meetings. The objective of the aquatic evaluation was to provide the greatest amount of information to describe baseline conditions, predict potential impacts, and develop mitigation requirements, all within the allotted time period. Specifically, the objectives of the evaluation were to 1) describe and quantify fish communities and aquatic habitat of representative pools in the MKARNS; 2) quantify amount and location of gravel bars (gravel bars provide spawning habitat for inter-jurisdictional fishes such as paddlefish and shovelnose sturgeon and habitat for many species of aquatic insects, snails, crustaceans, and freshwater mussels) that could be impacted by dredging; 3) quantify relative fishery habitat value of dike fields and other aquatic sites proposed to be used as dredged material disposal sites; and 4) determine appropriate mitigation measures to offset losses in habitat value (Killgore *et al.*, 2005).

The representative pools selected for fish and habitat sampling were: 1) pool 2 and the old channel (representing the lower Delta reaches within the Gulf Coastal Plain); 2) pools 5, 6, and 7 (representing the Ouachita Mountains reaches); 3) pools 9, 10, 11, and 12 (representing the Arkansas River Valley reaches between the Ozark and Ouachita Mountains); and 4) pools 16 and 17 (representing the uppermost reaches of the navigation system).

Sampling occurred during April and May 2004. A minimum of three sections was sampled in most pools in order to collect data from the upper, middle, and lower reaches of each pool. Several sites within each section were sampled to incorporate major habitat features (*e.g.*, tributary mouths, main channel, and backwater habitats), areas frequently dredged for maintenance purposes, and dredged material disposal sites (Table 4).

Table 4. Fish Sampling Sites in Summer 2004 for the Arkansas River Navigation Project (from Killgore *et al.*, 2005)

Site #	Location/Pool	Station	River Mile	Seine	Shock	Trawl
1	Chouteau	Below Newt Graham L&D 18	420.8	v	v	v
2	Chouteau	Channel near Afton Landing	411.0			v
2.5	Chouteau - bw	Afton Landing backwater	BW	v	v	
3	Chouteau	Above Chouteau L&D 17	402			v
4	Chouteau - bw	Backwater at RM 403.2	BW	v		
5	Pool 16	Below Chouteau L&D 17	401.2		v	v
6	Pool 16 - bw	Falls Park Backwater at RM 398	BW		v	
7	Pool 16	Confluence of AR and Verdigris R.	394.5	v	v	v
7.5	Pool 16 - bw	Sandbar Pool at Confluence	394.5	v		
8	Pool 16	Channel at Coody Creek mouth	389.5	v	v	v
8.5	Pool 16 - bw	Backwater at 389.5 (inside sandbar)	BW	v		
9	Pool 16 - trib	Mouth of Coody Creek	389.5		v	
10	Pool 16 - trib	Mouth of Maynard Bayou	387		v	
11	Neosho	Neosho (Grand) River 4 mi. upst. of AR R.	--			v
12	Pool 13	Island above Trimble L&D 13	293.3	v	v	v
13	Pool 13	Right bank upst. of Trimble L&D 13	293.3	v	v	
14	Ozark	Below Trimble L&D 13	289.5	v	v	v
15	Ozark	Channel at mouth of Mulberry River	272	v	v	v
15.5	Ozark	Channel upst. of Mulberry River mouth	277			v
16	Ozark - trib	Lower mouth of Mulberry River	272		v	v
17	Dardanelle	Below Ozark-Jeta L&D 12	256.5	v	v	v
18	Dardanelle	Rock weir at Rogers Cabin	231.5		v	v
19	Dardanelle	Across from Spadra Park	229.8	v	v	v
20	Dardanelle	Mouth of Cabin Creek at ramp nr. old RR bridge	--		v	
21	Pool 9	Below Dardanelle L&D 10	205	v	v	v
22	Pool 7	Below Toad Suck L&D 8 – pool	155.3	v	v	
22.5	Pool 7	Below Toad Suck L&D 8 – channel	155.3	v	v	v
23	Pool 7	Mouth of Fouche La Fave	146.8	v	v	
24	Pool 7	AR @ Fouche La Fave mouth – rt. bank	146.8	v		v
24.5	Pool 7	AR @ Fouche La Fave mouth – lft. bank	146.8	v		
25	Pool 7	2° Channel at Beaver Dam Island	141.5	v	v	v
26	Terry Lake	Below Murray L&D 7 – main channel	124.3	v	v	v
26.5	Terry Lake	Below Murray L&D 7 – side channel	124.3	v		
27	Terry Lake	AR @ downtown Little Rock	120	v	v	
28	Terry Lake - bw	Willow Bend Cutoff nr. Terry L&D 6	108.4		v	
29	Terry Lake	Above David D. Terry L&D 6	109.8	v	v	v
30	Pool 5	Below David D. Terry L&D 6	107.6	v	v	v
31	Pool 2	Below Joe Hardin L&D 3	49.6	v	v	v
32	Pool 2	AR @ Mud Lake entrance	44.6	v		v
32.5	Pool 2 - bw	Inside Mud Lake entrance	44.4	v	v	
33	Pool 2	Upst. of mouth of Big Bayou Meto	31.7	v	v	v
34	Pool 2 - bw	AR @ mouth of Big Bayou Meto	31.2	v	v	
35	Pool 2	Post Canal at Merrisach Lake	14.4	v	v	
36	Pool 2	Above L&D 2	13.4		v	v
37	Wild AR R.	1 mile dnst. of Wilbur D. Mills Dam – channel	--	v	v	v
37.5	Wild AR R.	1 mile dnst. Of Wilbur D. Mills Dam – bw	--	v		
38	Wild AR R.	Below Wilbur D. Mills Dam	--		v	

Multiple sampling gear types were used to collect fishery data from three different aquatic fishery habitats. Seining was employed to collect littoral/shoreline fishes. Electrochocking was used to collect pelagic/slack water fishes. Benthic trawls were used for demersal and main channel fishes (Table 4).

Physical parameters were measured concurrently with fish sampling efforts. Physical parameters recorded include stream width, substrate composition, percent instream cover, water temperature, pH, conductivity, dissolved oxygen, and turbidity. Occurrences of major backwaters adjacent to sampling sites also were recorded.

Multiple regression analysis on seining and electrofishing data was used to identify the influence of project impacts on fish communities. Fish were classified as either pool dwelling/backwater species or gravel associated species. Total number of fish collected at each site was used as the dependent variable. Water depth and amount of gravel were used as the independent variables.

The regression analysis of seining data indicated a positive relationship between fish abundance and the depth of the dike pools and the amount of gravel available. This relationship implies that reducing water depth in a dike field pool and reducing the amount of gravel in the channel would adversely impact pool dwelling and gravel associated fish. Analysis of electrofishing data for pool-dwelling fishes did not provide a significant model. This is likely attributable to the prevalence of pool like habitat throughout the navigation system and the lack of physical habitat variation at the sites sampled needed for the identification of predictive relationships.

An aquatic HEP was developed by the ERDC with input from biologists from the Service, ODWC, AGFC, and the Corps Tulsa and Little Rock Districts (interagency evaluation team). The aquatic HEP was used to assess impacts from the disposal of dredged material and to assess overall potential impacts of the proposed project on aquatic resources. The aquatic HEP also was used to provide a basis for determining the mitigation measures needed to compensate for aquatic impacts. Future with and without the project conditions were predicted to determine habitat value at impact sites and potential mitigation sites over the 50-year life of the project.

The interagency evaluation team evaluated the impacts and benefits that would occur at 185 disposal/mitigation sites in Arkansas and 39 sites in Oklahoma. Existing HSI values at disposal and mitigation sites were determined using best professional judgment of the interagency evaluation team, while examining Red Hen (aerial) video of the navigation system (recorded from August 9 – 13, 2004), from maps, and existing local expertise. HSI values for the with and without out project condition also were predicted for target years 11, 31, and 51. These HSI values for the with and without project conditions then were adjusted downward using an estimated filling coefficient, as explained below.

Dredged material would be placed in dike fields in Arkansas. A filling rate for Arkansas dike field disposal sites was estimated in order to determine the remaining life of the dike fields. The filling rate was calculated based on dredging records from Pools 2, 7, and 12, and averaged over the length of the project.

Corps engineers estimated that complete filling of the dike fields to be used as disposal areas would occur in 117, 79, and 66 years for the 9-, 11-, and 12-foot alternatives, respectively. For example, for the 12-foot alternative, dike fields would be 75 percent full on average at the end of the project life (50/66 = 0.75). Because filling of the dike pools is anticipated to negatively affect habitat quality, as indicated by multiple regression analysis, the estimated annual filling rate was used to reduce the HSI of dike field disposal sites over the life of the project. The value at 25 years was derived from a linear relationship and was used to obtain AAHUs. Sediment accretion in a dike field is extremely variable, but the rate of change was assumed to be linear to simplify the analysis. The adjusted filling rate is called the filling coefficient (Table 5). The without project AAHUs were determined using the filling coefficient for the existing 9-foot channel since maintenance activity would be necessary to maintain the 9-foot channel depth.

Table 5. Conversion of estimated fill rates of dike fields to filling coefficients used to annualize Habitat Suitability Index values over the life of each project alternative (from Killgore *et al.*, 2005).

	Maintain 9-ft channel	Dredge 11-ft channel	Dredge 12-ft channel
Fill rate (percent per year)	0.86 percent	1.35 percent	1.63 percent
Time until 100 percent full	117 years	79 years	66 years
Percent full at 50 years	43 percent	63 percent	76 percent
Percent full at 50 years (notched dikes/revetments)	21.5 percent	31.5 percent	38 percent
Percent full at 25 years	**21.5 percent**	**31.5 percent**	**38 percent**
Percent full at 25 years (notched dikes/revetments)	**10.75 percent**	**15.75 percent**	**19 percent**

The interagency evaluation team proposed dike notching as a mitigation measure that would serve to minimize impacts of the channel deepening component at dike fields that would be used as disposal sites, and at those that would not receive dredged material (*e.g.*, dike fields in Oklahoma). Notches in dikes would facilitate scouring in the dike pools behind the notch, and thereby increase habitat complexity. Therefore, we assumed that the HSI values of dike fields with notched dikes would decline 50 percent less than that of an un-notched dike field (Table 5).

Three broad types of mitigation measures were proposed by the interagency evaluation team to offset project impacts: 1) Avoid, 2) Minimize, and 3) Compensate. Avoidance measures would consist of avoiding disposal of dredged material at a site estimated to have high habitat quality by relocating the disposal site to a location of lesser habitat value, as determined by best professional judgment of the evaluation team. Minimization projects consisted of features assumed by the team to minimize the impacts of the project. Notching a dike is assumed to minimize impacts to dike field habitat. Compensatory mitigation features consisted of projects that would restore, enhance, or create habitat. Figure 2 provides a flow model describing how benefits were determined under each type of mitigation measure.

Several sources were utilized to preliminarily determine the extent of gravel bars: 1) existing GIS layers of gravel deposits, 2) Red Hen video footage of the navigation system recorded August 9 – 13, 2004, 3) locations of current and historical gravel mining operations, and 4) observations recorded by field crews during fish sampling.

Field observations of gravel bars were conducted when a channel trawl yielded gravel in the sample and during velocity transect measurements. A 16-foot otter trawl with 1-inch mesh was used to sample benthic fishes. Trawls were dragged along the river bottom at 2 – 5 miles per hour for 10 – 20 minute intervals. All occurrences of gravel in the trawl sample were recorded.

Velocity transect measurements were taken at representative cross sections of the channel. A metal weight carrying a velocity meter was lowered to the bottom of the channel. The operator determined the substrate based on the vibration produced by the metal as it hit the river bottom. Substrate was recorded as mud, sand, gravel, bedrock, rip rap, or detritus/woody debris.

GPS coordinates for all potential gravel bar locations were recorded. Potential gravel bed locations were incorporated as a layer in a GIS database. GIS maps were used to examine potential gravel sites for features that influence substrate composition. The features examined were channel width, channel morphology, channel depth, scour, adjacent bars, dike fields, and size of nearby tributaries. The potential proportion of gravel substrate at a site was estimated based on the width of the channel. The potential proportion of gravel for each site was then multiplied by the site area to obtain an estimate of the amount of gravel.

Potential gravel bed locations were compared to the GIS layer of proposed dredging locations to obtain an estimate of project impacts on gravel beds. The potential locations of gravel bars that could be impacted were visited by a hydrographic survey crew from the Corps Memphis District to further examine and map locations of the gravel substrates. The crew used a sounding chain to identify the predominant substrates at the potential gravel bar locations as sand, sand/gravel mix, or pure gravel. The survey boat moved slowly down longitudinal transects within the GIS dredge polygon (*i.e.*, area proposed to be dredged) while dragging the sounding chain along the river bottom. Each substrate type was digitally recorded. The maps were incorporated into the project GIS to determine the estimated acres by pool of sand/gravel mix and pure gravel.

The interagency evaluation team agreed that the goal of mitigation for impacts to pure gravel bars should be no-net-loss when possible. This habitat is a finite resource in the navigation system and is of great importance as a habitat feature for a variety of sensitive fishes such as paddlefish and sturgeon.

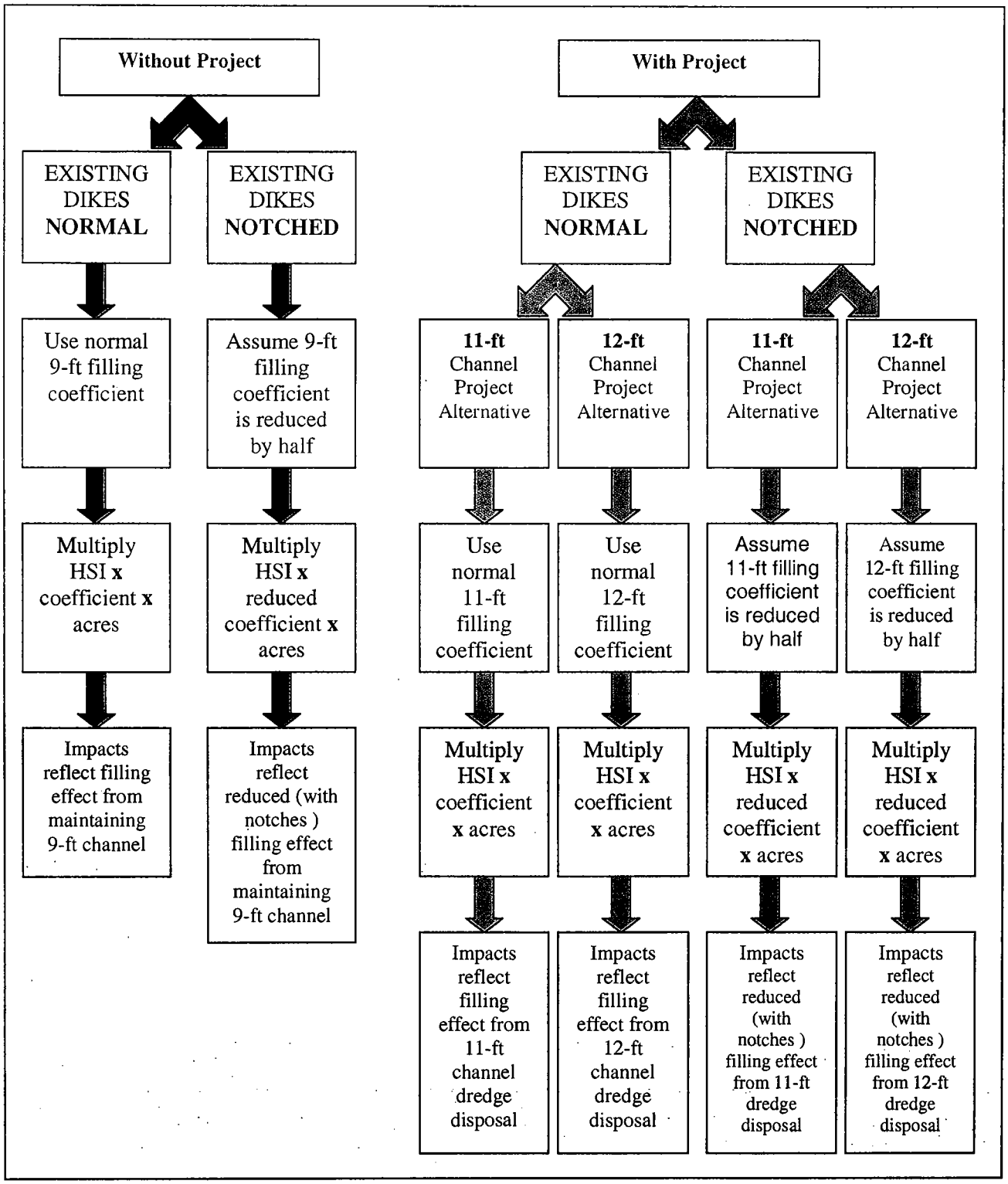


Figure 2. Conceptual model used to calculate project impacts by alternative (from Killgore *et al.*, 2005).

Aquatic Impacts: Freshwater Mussels

A freshwater mussel (unionid) distribution study from the Port of Catoosa, Oklahoma, to the navigation system's confluence with the Mississippi River in Arkansas was conducted during the summer and fall of 2004 by Ecological Specialists, Inc. This study provides unionid species composition and distribution data throughout the MKARNS (Ecological Specialists, 2005). The study was used to assess potential impacts to freshwater unionids and develop mitigation measures to avoid and minimize adverse impacts. Sampling efforts focused on areas proposed to be dredged and on open water dredged material disposal sites. Sampling sites were selected during an interagency meeting among the Corps, Service, and the AGFC.

Sediment Quality Analysis

A screening level analysis of MKARNS sediment quality was performed during September 2004 for both future maintenance dredging needs for the 9-foot channel and for impact assessment for the proposed channel deepening component. The analysis was necessary to determine the types and locations of expected contaminants in dredged sediment, and to develop disposal measures necessary to minimize the environmental impact of disposal of contaminated sediments, if necessary. Detailed information regarding sampling site selection, sampling methods, analytical parameters, threshold values for data interpretation, constituents selected for analysis, and the chemical methods employed can be found in Appendix E of the DEIS for ARNS (USACOE, 2005a).

NAVIGATION CHANNEL MAINTENANCE FEATURE

Impacts anticipated as a result of the Navigation Channel Maintenance feature were assessed using the same methodology as described above for the Navigation Channel Deepening feature.

FISH AND WILDLIFE RESOURCES: EXISTING

This section provides information on the terrestrial and aquatic fish and wildlife resources associated with the MKARNS, the 11 Oklahoma reservoirs and their associated rivers/streams, wildlife management areas, and national wildlife refuges. This section also provides information on federally-listed threatened and endangered species as well as species proposed for listing, species of concern, and state-listed and rare species that occur within the vicinity of the project area. Detailed descriptions of the existing aquatic and terrestrial resources of the individual reservoirs and associated streams/rivers have been provided in previous reports on various individual projects (lock and dams, hydropower, etc.) and will not be repeated here.

ARKANSAS/VERDIGRIS RIVERS AND 11 OKLAHOMA RESERVOIRS: AQUATIC AND WETLAND RESOURCES

Aquatic cover types in the project include lentic habitats (reservoirs and ponds), lotic habitats (rivers and streams) and wetlands. These habitat types support numerous game and nongame fish and wildlife species. A list of indicator flora and fauna for both aquatic and terrestrial habitat types is presented in Table 6.

Fishery Resource

A variety of fish species occur in the project area. Prior to construction of the locks, dams, and reservoirs on the MKARNS, the fish fauna in the various rivers/streams were diverse and unique. However, construction and operation of the MKARNS has altered the magnitude and frequency of flow events, stabilized channel conditions, and created reservoirs that provide habitat for lake fishes, but limit habitat for native riverine species. The overall result is a more homogenous aquatic environment within the MKARNS that benefits particular fish fauna to the detriment of others (Buchanan, 1976). Thus, fishery resources are generally uniform throughout the MKARNS, except in areas where trout are stocked downstream of reservoirs with cold water discharges, such as in the lower Illinois River below Tenkiller Ferry.

Eighty-six fish species are known to occur in the navigation system in Oklahoma. About 108 species are reported from the system in Arkansas (Buchanan, 1976; Limbird, 1993). A list of fish species common to the 11 upstream reservoirs in Oklahoma is provided in Table 7. Table 8 lists fish species known to occur in the MKARNS in Oklahoma and Arkansas.

Killgore *et al.* (2005) collected 65 fish species during the fish sampling effort conducted for this study. This drop in species diversity as compared to previous studies (*e.g.*, Buchanan, 1976) is likely attributable to the relatively limited survey effort conducted by Killgore *et al.* (2005). The limited survey effort was due to time limitations caused by the expedited project schedule. The previous surveys were conducted over a greater period of time (*e.g.*, 7-month period in Buchanan (1976) versus a 2-month period in 2004), consisted of a greater number of collections (75 seine samples in 1976 vs 33 seine samples in 2004), used disparate techniques (rotenone in 1976, trawling in 2004), and included habitats outside the current project area (clear tributaries). Most of the 45 species reported in 1976, but not collected in 2004, were rare (represented by 5 or fewer specimens). Gizzard and threadfin shad were the most abundant species in both the 1976 and 2004 surveys.

Table 6. Cover types, indicator species, and cover type value – index. Indices range from 1 (low habitat potential) to 5 (high habitat potential) (modified from U. S. Fish and Wildlife Service, 1985).

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Post oak-blackjack oak forest	post oak, blackjack oak, dogwood, red cedar, sumacs, buckbrush	white-tailed deer, fox squirrel, bobwhite, carolina chickadee, black and white warbler, armadillo, garter snake, ground skink	3
Oak-hickory forest	post oak, black hickory, mockernut hickory, bitternut hickory, white oak, sugar maple, winged elm	white-tailed deer, fox squirrel, gray squirrel, eastern woodrat, cottontail rabbit, eastern chipmunk, downy woodpecker, white-breasted nuthatch, fence lizard, black rat snake, American toad	4
Oak-hickory-pine forest	post oak, white oak, northern red oak, mockernut hickory, bitternut hickory, black hickory, shagbark hickory, shortleaf pine, loblolly pine, sweetgum	white-tailed deer, fox squirrel, pileated and hairy woodpeckers, gray fox, three-toed box turtle	4
Tallgrass prairie	big and little bluestem, switch grass, Indian grass, goldenrods, side oats grama	coyote, red-tailed hawk, bobwhite, eastern meadowlark, grasshopper sparrow, dickcissel, ornate box turtle, ribbon snake, great plains rat snake	3

Table 6 continued

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Mixed-grass prairie	little and big bluestem, purple cone flower, gramas, buffalo grass	thirteen-lined ground squirrel, eastern cottontail, jackrabbit, bobwhite, ornate box turtle, Texas horned lizard, prairie kingsnake, prairie skink, Woodhouse's toad	3
Caves	-	Bats (*Myotis* and *Pipistrellus* spp.), Ozark cavefish, grotto salamander, cave salamander	5
Cropland	wheat, alfalfa, soybeans, sorghums, etc	white-footed mouse, eastern cottontail, mourning dove, eastern meadowlark	2
Introduced grassland	Bermuda grass, fescue, rye, buffalo bur, nightshade, ragweeds	cotton rat, eastern meadowlark	1
Riparian forest	cottonwood, willow, green ash, hackberry, elm, sycamore, dogwood, river birch	white-tailed deer, raccoon, river otter, beaver, red-bellied woodpecker, belted kingfisher, eastern phoebe, fox squirrel, wood duck, herons, cricket frog, green frog	5

Table 6 continued

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Bottomland forest	oaks, sycamore, elms, pecan, boxelder, greenbriar	white-tailed deer, gray squirrel, pileated woodpecker, wood duck, red-shouldered hawks, spring peeper	5
Mud flats	devoid of vegetation when inundated; barnyard grass, rushes, sedges.	raccoon, lesser yellowlegs, common snipe, great blue heron	2 – 5
Lower hardwood swamp forests	red maple, water hickory, green ash, river birch, hackberry, American holly, sweetgum, willow oak, laurel oak	white-tailed deer, beaver, ducks, warblers, herons, egrets, prothonotary warbler, squirrel, swamp rabbit, spotted salamander, chorus frogs, aquatic snakes	5
Lacustrine fringe wetland	cattails, rushes, smartweeds, muskgrass, sedges	bullfrog, cricket frog, carp, water snakes, belted kingfisher, great blue heron, ducks	4
Palustrine pond wetland	willows, cottonwood, cattails, rushes, pondweed, sedges, buttonbush	beaver, great blue heron, egrets, American bittern, waterfowl, snipe, marsh hawk, marsh wren, red-winged blackbird, grebes, leopard frog, eastern newt	5

Table 6 continued

Cover Type	Indicator Flora	Indicator Fauna	Cover Type Value-Index
Lentic aquatic habitat	algae, coontail, bladderwort	largemouth bass, bluegill, catfish, crappie, carp	4
Lotic aquatic habitat	algae, other periphyton	minnows, sauger, bass, channel catfish, sturgeon	3 – 5*

* mountain streams = 5; Arkansas River/System and associated tributaries and delta streams = 3.

Table 7. Common fish species found in the 11 Oklahoma reservoirs.

	Copan	Hulah	Oologah	Kaw	Keystone	Grand	Hudson	Fort Gibson	Tenkiller	Eufaula	Wister
Species											
largemouth bass	X	X	X	X	X	X	X	X	X	X	X
spotted bass						X	X	X	X		
smallmouth bass			X			X	X		X	X	
white crappie	X	X	X	X	X	X	X	X	X	X	
black crappie			X		X		X		X		
white bass		X	X		X	X	X	X	X	X	X
striped bass	X/hybid		X/hybrid	X	X	X/hybrid	X		X		
channel catfish	X	X	X	X	X	X		X	X	X	
bluegill	X	X	X	X	X	X	X	X	X	X	X
longear sunfish	X	X	x		X	X	X	X	X	X	
carp		X	X		X	X	X	X	X	X	X
freshwater drum		X	X		X	X	X	X	X	X	
smallmouth buffalo		X			X	X	X	X	X	X	X
bigmouth buffalo		X	X				X	X	X	X	X
river carpsucker		X	X		X	X		X	X	X	
black bullhead								X	X		
spotted sucker									X		
golden redhorse									X	X	

Table 7 continued

	Copan	Hulah	Oologah	Kaw	Keystone	Grand	Hudson	Fort Gibson	Tenkiller	Eufaula	Wister
river redhorse									X	X	
shorthead redhorse									X	X	
flathead catfish	X	X	X	X	X	X	X	X	X	X	X
longnose gar		X							X	X	
spotted gar		X							X	X	
gizzard shad		X	X	X	X	X	X	X	X	X	
walleye			X				X	X	X	X	
paddlefish			X	X		X	X	X			
black bullhead		X			X						
green sunfish		X	X		X	X	X	X	X	X	
warmouth			X		X	X	X	X	X	X	X
orange spotted sunfish		X	X		X		X	X			X
redear sunfish		X	X	X	X	X	X	X	X	X	X

Table 8. Partial listing of fish species known to occur in the MCKARNS and tributaries in Oklahoma and Arkansas (Buchanan, 1976; Jimmie Pigg, unpublished data).

Common Name	Scientific Name
Chestnut lamprey	*Ichthyomyzon castaneus*
Bowfin	*Amia calva*
American eel	*Anguilla rostrata*
blue catfish	*Ictalurus furcatus*
channel catfish	*Ictalurus punctatus*
Flathead catfish	*Pylodictus olivaris*
yellow bullhead	*Ictalurus natalis*
black bullhead	*Ictalurus melas*
tadpole madtom	*Notorus gyrinus*
brindled madtom	*Notorus miurus*
White bass	*Morone chrysops*
striped bass	*Morone saxatilis*
largemouth bass	*Micropterus salmoides*
spotted bass	*Micropterus punctulatus*
black crappie	*Pomoxis nigromaculatus*
white crappie	*Pomoxis annularis*
walleye	*Stizostedion vitreum*
sauger	*Stizostedion canadense*
warmouth	*Lepomis gulosus*
green sunfish	*Lepomis cyanellus*
longear sunfish	*Lepomis megalotis*
luegill	*Lepomis macrochirus*
orangespotted sunfish	*Lepomis humilis*
longnose gar	*Lepisosteus osseus*
spotted gar	*Lepisosteus oculatus*
shortnose gar	*Lepisosteus platostomus*

Table 8 continued

Common Name	Scientific Name
skipjack herring	*Alosa chrysochloris*
shovelnose sturgeon	*Scaphirhynchus platorynchus*
paddlefish	*Polyodon spathula*
blue sucker	*Cycleptus elongatus*
largemouth buffalo	*Ictiobus cyrpinellus*
smallmouth buffalo	*Ictiobus bubalus*
river carpsucker	*Carpiodes carpio*
golden redhorse	*Moxostoma erythrurum*
common carp	*Cyprinus carpio*
freshwater drum	*Aplodinotus grunniens*
gizzard shad	*Dorosoma cepedianum*
threadfin shad	*Dorosoma pentenense*
golden shiner	*Notemigonus crysoleucas*
pallid shiner	*Hybopsis amnis*
redfin shiner	*Lythrurus umbratilis*
emerald shiner	*Notropis atherinoides*
ghost shiner	*Notropis buchanani*
mimic shiner	*Notropis volucellus*
central stoneroller	*Campostoma anomalum*
blackstripe topminnow	*Fundulus notatus*
blackspotted topminnow	*Fundulus olivaceous*
bullhead minnow	*Pimephales vigilax*
suckermouth minnow	*Phenacobius mirabilis*
silver chub	*Macrhybopsis storeriana*
mosquito fish	*Gambusia affinis*
brook silversides	*Labidesthes sicculus*
logperch	*Percina caprodes*
greenside darter	*Etheostoma blennioides*
bluntnose dater	*Etheostoma chlorosomum*
fantail darter	*Etheostoma flabellare*
slough darter	*Etheostoma gracile*
cypress darter	*Etheostoma proeliare*
banded darter	*Etheostoma zonale*
dusky darter	*Percina sciera*
redfin darter	*Etheostoma whipplei*

Electrofishing was conducted in numerous habitats, and allowed for fish species diversity comparisons among the different habitats. Killgore *et al.* (2005) found that dike fields, armored banks, sand bars, and wooded banks yielded high species diversity (> 30 spp.). Fish species diversity was found to be moderate in impoundments, aquatic vegetation, and rock outcroppings (20 - 26 spp.). Sampling in the main channel and along eroded banks yielded the lowest species diversity (< 10 spp.).

However, sampling effort was variable among habitats. The number of observed species collected from each habitat, therefore, could not be directly compared or used to assess the ecological value of the habitat. Killgore *et al.* (2005) used rarefaction (*i.e.,* a statistical method used to compare the number of taxa from samples of different size; Ludwig and Reynolds, 1988; Holland, 2003) to compensate for the uneven sampling efforts. Rarefaction was used to estimate the number of species expected to occur in a sample of 25 randomly drawn individuals from a single habitat. This analysis indicated that dike fields and sand bars are the most species rich habitats (>11 spp./25). Impoundments, rock outcroppings, wooded or armored banks also were identified as species rich (about 10 spp./25). The main channel and along eroded banks were identified as the lowest in species diversity (5 – 7 spp./25). The rarefaction analysis yielded similar species diversity as the electrofishing results.

Management of the fishery resources in the project area is a cooperative effort between the Corps and the respective state wildlife agencies, and involves monitoring studies and stocking programs. Management programs influence all species, but concentrate on those most popular with anglers, such as largemouth bass, crappie, walleye, blue catfish, flathead catfish, white bass, and striped bass.

Commercial fishing within the MKARNS is limited to Arkansas, where commercial fishing has occurred since 1971. Commercial fish include catfish, smallmouth buffalo, drum, carp, gar, carpsucker, bowfin, and paddlefish.

Paddlefish, considered imperiled in both Oklahoma (Natural Heritage S1S2 ranking) and Arkansas (S2), were once common in big rivers in the Mississippi Basin, such as the Arkansas River. Excessive commercial harvest for roe (mass of eggs in the female fish) that is processed and sold as caviar, and water development projects that greatly altered their natural habitat have drastically reduced paddlefish populations in the Arkansas River.

Paddlefish are smooth-skinned fish with an elongated snout that occupy the calmer, open waters of large rivers. They prefer slow moving water behind islands and sandbars because of the abundance of zooplankton, their primary food source. Spawning occurs in mid channel currents over gravel substrates where adhesive eggs stick until hatching. Rising water levels in spring trigger upstream spawning migrations. However, in many cases, migrations are blocked by dams. In addition, dredging, flow alterations, and channelization have reduced the available habitat for spawning.

Restoration attempts through a joint effort of the Tishomingo National Fish Hatchery, Oklahoma Fisheries Resource Office, Oklahoma Ecological Services, and the ODWC have resulted in a

self-sustaining population above Kaw Reservoir in Oklahoma, and the stocking of about 80,000 paddlefish in the Arkansas and Verdigris rivers in northeastern Oklahoma. The population in the Verdigris River also is considered stable and self-sustaining. Currently, Service fisheries biologists are conducting surveys on the brood stock in the Arkansas and Verdigris rivers.

Other aquatic resources of significance include oxbow lakes (old river and stream channels that have been cut off from the main channel) adjacent the MKARNS, tributaries of the MKARNS in Arkansas (mountain streams west of Little Rock and delta streams east of Little Rock (Table 9)). Prominent game species inhabiting the oxbow lakes include largemouth bass, catfish, bluegill, and crappie. The fisheries of the mountain streams in Arkansas are considered excellent for smallmouth bass, largemouth bass, spotted bass, bluegill, and sauger. The principal fish species in the delta streams include crappie, catfish, bluegill, largemouth bass, carp, and buffalo.

Four Corps lakes in Arkansas that total 51,360 surface acres (Blue Mountain Lake on the upper reach of the Petit Jean River, Lake Dardanelle and Ozark Lake on the MKARNS, and Nimrod Lake on the upper reach of the Fourche Lafave River) also provide habitat for some fish species. Common game and commercial fish species occurring in the four Corps lakes in Arkansas include largemouth bass, bluegill, crappie spp., and striped bass (U. S. Fish and Wildlife Service, 1988).

Table 9. Major Tributaries of the Arkansas River in Arkansas (U. S. Fish and Wildlife Service, 1988).

Mountain Steams	Delta Streams
Little Maumelle River	Big Bayou Meto
Maumelle River	Little Bayou Meto
Palarm Creek	Plum Bayou
Cadron Creek	Pennington Bayou
Point Remove Creek	
Illinois Bayou	
Spadra Creek	
Big Piney Creek	
Lee Creek	
Petit Jean River	
Fourche Lafave River	
Mulberry River	

Mussel Fauna

Fifty-five species of unionids have been reported to historically occur in the Arkansas River. Thirty-seven of these species were reported from Arkansas, while 49 were reported from Oklahoma (Table 10; Ecological Specialists, 2005). Thirty species were common to both states.

Information on freshwater mussel species (unionids) composition and distribution for the main stem of the MKARNS is limited to a few studies (Isley, 1925 for the Verdigris River; Davison, 1997 for work in Dardanelle and Ozark pools; and Harris, 1992 for a study in Dardanelle pool). Due to limited existing information, a study was conducted during 2004 by Ecological Specialists, Inc. (O'Fallon, Missouri) to determine 1) unionid distribution and composition in the MKARNS, and 2) how the navigation channel deepening component of the proposed project would affect unionids. Sampling areas focused on proposed dredge and dredged material disposal sites (Ecological Specialists, 2005).

Table 10. Mussel species historically recorded from the Arkansas River drainage (from Ecological Specialists, 2005).

Species[1]	AR[2]	OK[3]
Actinonaias ligamentina	x	x
Alasmidonta marginata	x	x
Amblema plicata	x	x
Anodonta suborbiculata	x	-
Arcidens confragosus	x	x
Cyprogenia aberti (OK II)	x	x
Ellipsaria lineolata	x	x
Elliptio complanata	-	x
Elliptio dilatata	x	x
Fusconaia ebena	x	-
Fusconaia flava	x	x
Lampsilis abrupta (FE)	x	-
Lampsilis cardium	x	x
Lampsilis hydiana	x	x
Lampsilis powelli (FE)	-	x
Lampsilis rafinesqueana (FC)	-	x
Lampsilis satura	-	-
Lampsilis siliquoidea	x	x
Lampsilis teres	x	x
Lasmigona complanata	x	x
Lasmigona costata	x	x
Leptodea fragilis	x	x
Ligumia recta	x	x
Ligumia subrostrata	-	x
Megalonaias nervosa	x	x
Obliquaria reflexa	x	x
Obovaria jacksoniana	x	x
Obovaria olivaria	x	-
Plectomerus dombeyanus	x	-
Pleurobema cordatum	x	x
Pleurobema rubrum	-	x
Pleurobema sintoxia	-	x

Table 10 continued.

Species[1]	AR[2]	OK[3]
Potamilus alatus	-	x
Potamilus capax (FE)	-	?
Potamilus ohiensis	x	x
Potamilus purpuratus	x	x
Ptychobranchus occidentalis	-	x
Pyganodon grandis	x	x
Quadrula cylindrica (OK II)	x	x
Quadrula nobilis (aspera)	-	x
Quadrula metanevra	x	x
Quadrula nodulata	x	x
Quadrula p. pustulosa	x	x
Quadrula quadrula	x	x
Strophitus undulates	-	x
Toxolasma lividus	-	x
Toxolasma parvus	-	x
Tritigonia verrucosa	x	x
Truncilla donaciformis	-	x
Truncilla truncate	x	x
Uniomerus tetralasmus	x	x
Utterbackia imbecillis	x	x
Villosa arkansasensis	-	x
Villosa iris	-	x
Villosa lienosa	-	x
Total No. species	37	49

[1]Nomenclature follows Turgeon *et al.* (1998); except *Q. aspera (=nobilis)* follows Watters (OSU, pers. comm. 2004)
FE=federally endangered, FC=federal candidate, OK II=Oklahoma category II
[2]Arkansas (Gordon, 1984-White River site below Newport included; Harris and Gordon, 1986)
[3]Oklahoma (Branson, 1982, 1983, 1984; Shepard and Covich, 1982; Vaughan and Spooner, 1994)

Twenty-seven species were collected during the survey effort (Table 11). No federally-listed threatened or endangered species were found. The largest concentration of mussels was found to occur in the Arkansas Post Canal, where as many as 2,000,000 mussels may occur.

Table 11. Number of unionid species and individuals collected within each MKARNS Reach, 2004 (from Ecological Specialists, 2005).

	Reach 1		Reach 2		Reach 3		Reach 4		Reach 5		Reach 6		Total	
Species	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Amblema plicata	541	17.7	-	-	6	0.6	2	0.5	21	2.3	3	1.69	573	10.5
Anodonta suborbiculata	1	0.0	-	-	10	1.1	1	0.3	9	1.0	-	-	21	0.4
Arcidens confragosus	11	0.4	-	-	-	-	5	1.3	4	0.4	-	-	20	0.4
Fusconaia ebena	8	0.3	-	-	-	-	-	-	2	0.2	-	-	10	0.2
Fusconaia flava	1	0.0	-	-	-	-	-	-	8	0.9	-	-	9	0.2
Lampsilis cardium	2	0.1	-	-	-	-	-	-	-	-	-	-	2	0.0
Lampsilis siliquoidea	1	0.0	-	-	-	-	-	-	-	-	-	-	1	0.0
Lampsilis teres	117	3.8	-	-	7	0.8	-	-	1	0.1	1	0.56	126	2.3
Lasmigona c. complanata	2	0.1	-	-	-	-	-	-	WD	-	-	-	2	0.0
Leptodea fragilis	17	0.6	1	5.0	34	3.7	4	1.0	25	2.8	17	9.6	98	1.8
Megalonaias nervosa	119	3.9	-	-	31	3.3	1	0.3	9	1.0	WD	-	160	2.9
Obliquaria reflexa	250	8.2	4	20.0	207	22.3	84	21.6	213	23.6	88	49.7	846	15.5
Obovaria olivaria	5	0.2	-	-	-	-	-	-	-	-	-	-	5	0.1
Plectomerus dombeyanus	909	29.8	-	-	238	25.7	132	34.0	1	0.1	-	-	1280	23.4
Pleurobema cordatum	-	-	-	-	-	-	-	-	-	-	WD	-	WD	-
Potamilus ohiensis	2	0.1	FD	-	29	3.1	2	0.5	37	4.1	9	5.08	79	1.4
Potamilus purpuratus	204	6.7	WD	-	27	2.9	-	-	7	0.8	12	6.78	250	4.6
Pyganodon grandis	50	1.6	1	5.0	50	5.4	19	4.9	31	3.4	WD	-	151	2.8
Quadrula aspera	122	4.0	-	-	28	3.0	15	3.9	26	2.9	-	-	191	3.5
Quadrula nodulata	27	0.9	-	-	-	-	-	-	-	-	8	4.52	35	0.6
Quadrula p. pustulosa	13	0.4	-	-	1	0.1	-	-	12	1.3	15	8.47	41	0.7
Quadrula quadrula	636	20.8	14	70.0	248	26.8	117	30.2	482	53.4	10	5.65	1507	27.6
Strophitus undulates	-	-	-	-	-	-	-	-	1	0.1	-	-	1	0.0
Toxolasma parvus	-	-	-	-	-	-	-	-	1	0.1	-	-	1	0.0
Toxolasma sp.	WD	WD	-	-	-	-	-	-	-	-	-	-	WD	-
Tritogonia verrucosa	*8*	*0.3*	-	-	-	-	-	-	*8*	*0.9*	*14*	*7.91*	*30*	*0.5*
Truncilla donaciformis	1	0.0	-	-	2	0.2	3	0.8	2	0.2	-	-	8	0.1
Truncilla truncate	1	0.0	-	-	1	0.1	1	0.3	-	-	-	-	3	0.1
Utterbackia imbecillis	5	0.2	-	-	8	0.9	2	0.5	2	0.2	-	-	17	0.3
Total	3053		20		927		388		902		177		5467	
No. live species	25		4		16		14		21		10		27	
Total no. species	26		6		16		14		22		13		29	

Note: FD=freshly dead shell, WD=weathered dead shell. Reach 1 = confluence of Mississippi River to Bunge Corporation dock near Pine Bluff, AR (NM 0 – 75.2); Reach 2 = Bunge Corporation Dock to Union pacific railroad Crossing in Little Rock, AR (NM 75.2 – 119.5); Reach 3 = Union Pacific railroad crossing to near Shoal Creek (NM 199.5 – 220.3); Reach 4 = Shoal Creek to near mouth of Poteau River (Nm 220.3 – 308.7); Reach 5 = from near the Oklahoma/Arkansas border to the Verdigris River (NM 308.7 – 394.0); Reach 6 = junction of Grand and Arkansas Rivers to the head of navigation at the Port of Catoosa (NM 394 -445).

42

Based on their sampling efforts, Ecological Specialists (2005) concluded that 1) the MKARNS provides limited habitat for mussels, 2) the navigation system does not support a significant unionid community, and 3) that the species that occurred in the river were common. The mussel study report provides details on methodology, sampling sites, and results, and can be found in Appendix C of the DEIS for the Arkansas River Navigation Study (USACOE, 2005a).

Commercial harvesting of freshwater mussels also occurs on the navigation system, primarily from the Arkansas River in Arkansas. Ft. Gibson Reservoir on the Grand River undergoes most of the relatively limited shelling that occurs in Oklahoma (Limbird, 1993).

Wetlands

Numerous wetlands occur within the study area. Wetlands are transitional lands between uplands and aquatic systems where water is present at least periodically during the growing season each year and for which the flora and fauna and the nature of soil development are primarily influenced by the presence of water or soil saturated with water. Wetlands perform many valuable functions, such as providing crucial habitat for numerous fish and wildlife species, as well as functions such as water quality improvement, flood control and prevention, groundwater recharge and discharge, erosion control, and education, recreation, and aesthetics that benefit people.

Wetlands occur in association with the MKARNS, its tributaries, and the 15 aforementioned reservoirs in Oklahoma and Arkansas. Wetland types include palustrine, riverine and lacustrine wetlands (Cowardin *et al.*, 1979).

Palustrine wetlands include swamps, marshes, forested wetlands (*e.g.*, bottomland hardwoods), bogs, mudflats, fens, and ponds. They can be isolated or occur shoreward of lakes and river channels, on river floodplains, on slopes, or as islands within a lacustrine or riverine system (wetlands within a channel except those dominated by vegetation). They typically are smaller than 20 acres, less than 2 meters deep, and lack significant wave action (Cowardin *et al.*, 1979). Palustrine wetlands provide habitat for a wide variety of game, non-game, and fur-bearing species (Table 2).

Riverine wetlands are confined within a channel in which water usually flows. They are typically bounded by upland, a palustrine forested wetland that occurs within the boundaries of a channel, or a forested floodplain (Cowardin *et al.*, 1979). Riverine wetlands provide valuable habitat for numerous wildlife species (Table 2). Some of the streams and rivers in the study area, however, have diminished value to fish and wildlife due to impoundment, channelization, and water quality degradation from municipal, industrial, and agricultural effluents. Others, including many of the Ozark streams in Arkansas and Oklahoma, are relatively unaltered. The fisheries in most of these unaltered streams are still considered to be in excellent condition. Lacustrine wetlands include permanently flooded lakes, impounded lakes, oxbow lakes, and intermittent lakes, such as playa lakes (depressions on the plains that seasonally pond during events of high rainfall and vary from a few hundred feet to several miles in diameter). Lacustrine wetlands tend to be large areas of deep water with extensive wave action. They are

bounded by upland or wetland vegetation such as trees, shrubs, emergents, mosses, or lichens. Lacustrine wetlands typically exceed 20 acres in size, occur in topographic depressions or on a dammed river, lack extensive areal vegetative cover (<30 percent) (Cowardin *et al.*, 1979), and provide valuable habitat for numerous species that require standing water environments (Table 2). Although not as valuable as the pre-impoundment conditions for many species, impoundments have increased the availability of niches for species that utilize large bodies of standing water, such as warm water lake fish species.

ARKANSAS/VERDIGRIS RIVERS AND 11 OKLAHOMA RESERVOIRS: TERRESTRIAL RESOURCES

Numerous important habitats that support a wide variety of wildlife occur within the project area in Oklahoma and Arkansas. A tentative list of habitat types and associated indicator flora and fauna are presented in Table 2 (USFWS, 1985; USFWS, 1988). These habitat types support numerous game and nongame wildlife within the project area. The list is not inclusive of all species typically found in a particular type, considering the exact species that occur in each habitat type can vary from location to location. The habitat types are subjectively ranked (see Table 2) according to their overall value to fish and wildlife resources. The ratings can vary within habitat types. The following description of the habitat types that may occur within the project area is drawn largely from the Service's reports for a similar study by the Corps on the Arkansas River Basin (USFWS, 1985; USFWS, 1988).

The post oak – blackjack oak forest (crosstimbers) occurs on thin soils prone to erosion if disturbed. Plant species diversity is relatively low; however, the juxtaposition of this forest type with native grasslands greatly increases its value to wildlife.

The oak – hickory forest covers a large portion of the Ozark Plateau in Eastern Oklahoma and Western Arkansas. This forest type tends to have higher species diversity than the crosstimbers, resulting in a potentially greater number of ecological niches for fauna. Tracts adjacent to bottomland hardwood forests and/or riparian forests are especially valuable and provide high quality habitat for many wildlife species.

Native grasslands in the project area consist of tallgrass prairie and mixed-grass prairie. Tallgrass prairie occurs in deep, fertile soil on the eastern and western borders of the crosstimbers and in the Flint Hills. Because of highly fertile soils, much of the tallgrass prairie has been converted to cultivated agriculture and introduced grassland pasture (except in the Flint Hills due to extensive limestone sub-surface). The remaining tracts of tall grass prairie provide valuable wildlife habitat (Table 2). Mixed-grass prairie occurs in scattered tracts in central and western Oklahoma. Much of the mixed-grass prairie has been altered by grazing and agricultural practices; however, the prairie that remains supports numerous wildlife species (Table 2).

Grassland habitats in the project area can be divided into two broad categories determined by the amount of woody cover present. Open field describes grasslands for which less than 25 percent of the area is comprised of woody cover, such as trees and shrubs in early succession stages. Old

field describes grasslands for which more than 25 percent of the area is comprised of woody cover.

Caves generally occur in areas with karst topography (areas of carbonate rock, especially limestone, where sinkholes, springs, and caves have formed as a result of the dissolution of the rock by chemical action). They provide a stable environment and habitat for many animals such as frogs, salamanders, reptiles, bats, snails, isopods, amphipods, crayfish, fish, spiders, and crickets. Although caves are underground habitats, they face many potential threats from activities above ground because they typically are connected to the surface through many openings.

The areal extent of cropland and introduced grassland has increased greatly since settlement and continue to increase often at the expense of natural terrestrial habitats with higher value for fish and wildlife resources. Cropland adjacent or in close proximity to natural habitats can serve as a food source for wildlife species. However, pastures or rangeland with monotypic introduced grasses tend to provide few life requisites for wildlife.

Bottomland hardwood forests occur in floodplains throughout the study area, although few undisturbed tracts remain. In Oklahoma, over 85 percent of the bottomland hardwood forests have been lost, and only a portion of the remaining forest is undisturbed (Oklahoma Water Resources Board, 1990). At one time, about 8 million acres of bottomland hardwood forests occurred in Arkansas. Today, only about 850,000 acres remain, with almost 160,000 of these acres in a contiguous block in the White River NWR. Due to the presence of productive soils, favorable water regimes, and juxtaposition with other habitats, the bottomland forests are one of the most productive habitats in the U. S. (Clark and Clark, 1981), and may be the most important wildlife habitat in the project area.

Riparian forests occur in frequently flooded areas adjacent to streams that have saturated soils and high water tables. They generally occur along tributary streams that lack a well-defined floodplain. The juxtaposition of riparian forest with other habitat types enhances the value of the forest for many species.

DREDGED MATERIAL DISPOSAL SITES

Navigation channel deepening and navigation channel maintenance would require the disposal of dredged material at approved sites along the navigation system. The Corps, ODWC, and the Service have worked cooperatively to minimize the use of environmentally sensitive sites, such as bottomland hardwoods, other wetlands, and important upland forests, as disposal sites. Habitat types at the selected dredged material disposal sites include open field, old field, pasture, cropland, upland floodplain forest (riparian forest), open water, and a small amount of bottomland forest (Table 12). These habitat types are described in more detail in the previous section on aquatic and terrestrial resources.

Wildlife Management Areas

Wildlife management areas (WMAs) managed specifically for wildlife by the ODWC and Corps occur along the MKARNS in the vicinity of Chouteau Lock and Dam in Wagoner County, Webbers Falls Reservoir in Muskogee County, and Robert S. Kerr Reservoir in Haskell and Sequoyah Counties. Nine of the 11 Oklahoma reservoirs that serve as the MKARNS's primary flow modifiers also have WMAs (Table 13). Wildlife management areas in the project area in Arkansas (managed by the AGFC) include Dardanelle, Bayou Meto, Trusten Holder, and Galla Creek (Table 13). The WMAs in both states provide habitat for species such as white-tailed deer, rabbit, squirrel, migratory birds, bobwhite quail, turkey, songbirds, and many species of reptiles and amphibians. These WMAs provide 276,058 acres of public lands available to sportsmen and other outdoor enthusiasts. Agricultural leases also occur within the WMAs that provide important annual revenue to the wildlife departments. Revenue from these leases partially funds the operation and maintenance of the WMAs. A brief description of each WMA is provided below. Detailed information (including some maps) for each WMA is provided on the ODWC and AGFC websites:

- ODWC : http://www.wildlifedepartment.com/wmas2.htm
- AGFC: http://www.agfc.state.ar.us/wma_lakes/wma_all.html.

Copan WMA: The Copan WMA encompasses about 7,500 acres of cross timbers, bottomland hardwood, and tallgrass prairie habitat around the upper end of Copan Reservoir in Washington County, Oklahoma. Aquatic habitats include the reservoir, numerous wetlands, the Little Caney River and its tributaries. Ongoing management practices include developing about 1,000 acres of food plots as well as controlled grazing, and prescribed burning. Six wetland units consisting of about 460 acres have been developed to provide habitat for migratory birds. The water levels in these units are manipulated annually to provide moist soil habitat. The wetland units are used annually by thousands of migratory birds. Game species of interest include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, bobwhite quail, fox and gray squirrel, and waterfowl. The bald eagle and greater prairie chicken *Tympanuchus cupido* also occur on the WMA.

Table 12. Dredged material disposal sites for the navigation channel deepening and navigation channel maintenance elements. Cover type acres were not provided for sites OK 393.1 L-DI and OK 336.3 L-DI. Cover type acres was not fully provided for site OK-318.3 R-DI. For Dredge Disposal Site names: OK = Oklahoma; 398.2 = river mile; R = right bank; L= Left Bank; DI = Direct Impact; PT = Poteau River; SBC = Sans Bois Creek. For Cover Types: OLF = old field; OF = open field; FF = floodplain forest; BLH = bottomland hardwood forest; OW = Open Water; AG = Cropland; BS = barren sand; P = pond.

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK PR L-DI	X	X		9							9	9	
OK 436.1 L-DI	X			13							13		
OK 422.9 L-DI	X	X		7							7	7	
OK 421.3 R-DI	X			13							13		
OK 312.5 R-DI		X		19								19	
OK 335.9 L-DI	X			22							22		
OK 338.0 R-DI	X			28							28		
OK 443.7 L-DI	X			27							27		
OK 382.0 L-DI	X			23							23		
OK 441.1 L-DI	X			12							12		
OK 401.6 R-DI	X	X		39							39	39	
OK 394.4 L-DI	X							27			27		
OK 393.3 L-DI		X						50				50	
OK 418.5 R-DI	X							33			33		

Table 12 continued

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK 318.6 L-DI	X								40		40		
OK 375.2 L-DI	X							31			31		
OK 351.9 R-DI	X							14			14		
OK 365.9 R-DI	X							6			6		
OK 396.6 L-DI	X							12			12		
OK 414.2 R-DI (2nd priority)	X							9			9		
OK 429.3 R-DI	X							10			10		
OK 429.4 R-DI	X							14			14		
OK 393.8 L-DI	X							45			45		
OK 391.8 R-DI		X								16		16	
OK 379.1 L-DI	X							31			31		Create wetland
OK 348.3 L-DI (2nd priority)	X	X					20				20	20	Create interior least tern island
OK 389.7 L-DI	X			37							37		
OK 355.0 R-DI		X					31					31	Create interior least tern island
OK 349.4 L-DI		X					20					20	Create interior least tern island
OK 393.1 L-DI		X											Create wetland

Table 12 continued

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK 336.3 L-DI	X												Beach nourishment
OK 367.2 L-DI	X						32						Marsh creation
OK-SBC 0.4 L-DI	X						100						Marsh creation
OK-SBC 4.8 L-DI	X						94						Marsh creation
OK 336.4 R-DI	X						11						Marsh creation
OK-SBC 6.6 L-DI	X	X					10				10	10	Marsh creation
OK-SBC 6.9 L-DI	X	X					10				10	10	Marsh creation
OK 354 L-DI	X	X					18				18	18	Bank stabilization
OK 345.3 L-DI	X									21	21		Reclaim strip pit
OK 337.2 R-DI	X				28						28		
OK 444.6 R-DI		X			9							9	
OK 444.6 L-DI		X	15									15	
OK 416.4 L-DI	X		14								14		
OK 414.9 R-DI	X		8								8		
OK 366.5 L-DI	X		6								6		
OK 400.0 L-DI		X	23									23	
OK 395.2 L-DI		X	18									18	

Table 12 continued

Disposal Sites	12-ft	9-ft.	Cover Type Acres								Total 12-ft.	Total 9-ft.	Beneficial Use of Dredged Material
			OLF	OF	FF	BLH	OW	AG	BS	P			
OK 394.0 R-DI		X	48									48	
OK 400.7 R-DI	X	X	31								31	31	
OK 434.3 R-DI	X		10								10		
OK 335.8 R-DI	X			14		8					22		
OK-SBC 8.7 L-DI		X	8			2						10	
OK-SBC 9.7 R-DI		X			5	5						10	
OK 383.9 R-DI	X		27	13	2						42		
OK 315.4 R-DI	X	X	28		8						36	36	
OK 318.3 R-DI		X			20							80	
OK-SBC 10.0 R-DI		X	2		16							18	
OK 342.3 L-DI	X		15		14						29		
OK 407.6 R-DI	X		8		2						10		
OK 309.1 R-DI	X	X		23	5						28	28	
OK 420.8 L-DI		X		43	10							63	
OK 398.2 R-DI	X		10	34							44		
Total Acres											**889**	**638**	

Table 13. Wildlife Management Areas associated with the MKARNS in Oklahoma and Arkansas.

Wildlife Management Areas	Acres
Oklahoma	186,229
Copan	7,500
Hulah	16,141
Oologah	14,155
Kaw	16,254
Keystone	16,537
Fort Gibson	21,798
Tenkiller	1,950
Eufaula	48,469
Wister	35,550
McClellan Kerr	7,875
Arkansas	89, 829
Dardanelle	42,500
Bayou Meto	34,000
Trusten Holder	10,000
Galla Creek	3,329
Total	276,058

Hulah WMA: The Hulah WMA consists of about 16,000 acres of bottomland hardwood forest, tallgrass prairie, and post oak/blackjack oak forest in Osage County, Oklahoma.

Aquatic habitats include the reservoir, numerous small ponds, the Caney River and its tributary streams. Ongoing management practices include controlled grazing, agricultural plantings on about 2,200 acres, and prescribed burning. Two wetlands units have been developed that require water level manipulations to provide about 260 acres of moist soil habitat for migratory birds. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, and waterfowl. Other species of interest that occur on the WMA include the bald eagle and greater prairie chicken.

Oologah WMA: The WMA consists of about 13,000 acres around Oologah Lake in Rogers and Nowata Counties, Oklahoma. The area primarily provides bottomland hardwood habitat for native wildlife species. Pecan, oak, and willow are the dominant tree species in the bottomlands. Old field and native prairie habitat also occur on the area. Aquatic habitats include emergent wetlands, ponds, and the Verdigris River and its tributaries. Management efforts are directed at maintaining native plant species. About 1,000 acres of food plots and agricultural leases also are utilized to provide additional wildlife food sources. The Overcup Bottoms and Upper Verdigris Units consist of wetland development areas managed for waterfowl. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle occurs in the area during the winter.

Kaw WMA: The WMA is located along the upper 2/3 of Kaw Reservoir including the Arkansas River, Beaver Creek, Little Beaver Creek, and Bear Creek in Kay County, Oklahoma. The area consists of about 16,000 acres of cropland, upland oak forest, bottomland hardwoods, old fields, and tallgrass prairie. Native bluestem grasses predominate on the prairie sites. Post oak, blackjack oak and sand plum are the most common tree species in the upland forested areas. Predominant trees in the bottomlands are hackberry, burr oak, and sycamore. Aquatic habitats include the Arkansas River, Beaver Creek, Little Beaver Creek, Bear Creek and their tributaries, and wetlands. Management practices include: 1) leasing about 4,000 acres to be planted in milo, corn, wheat, and soy beans, 2) planting about 1,000 acres of mud flats in Japanese millet that are inundated when the plants mature (to increase waterfowl habitat), and 3) planting trees and shrubs to enhance upland habitat. Popular game species include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, pheasant, and waterfowl. The bald eagle occurs at the reservoir/WMA in large numbers during the winter, and also is known to nest in the area. Other species of interest include the greater prairie chicken, osprey *Pandion haliaetus*, upland sandpiper *Bartramia longicauda*, and the Texas horned lizard *Phrynosoma cornutum*.

Keystone WMA: The WMA encompasses about 16,500 acres located along the Arkansas and Cimarron Rivers above Keystone Reservoir in Creek, Osage and Pawnee Counties. Fish and Wildlife habitat include the wide, shallow rivers, their tributaries and sandbars, riparian areas adjacent to the rivers (dominated by cottonwood and willow), wetlands, sloughs, mudflats,

bottomland hardwoods, crop fields, fallow crop fields, and some post oak-blackjack oak uplands. Management practices include enhancing/maintaining native vegetation, food plot plantings, agricultural leases, and prescribed burns. Popular game species include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, Rio Grande turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle nests and winters in the area.

Fort Gibson WMA: The area consists of a mixture of tallgrass prairie, farm fields, post oak-blackjack oak woods, and bottomlands on about 21,800 acres in Wagoner and Cherokee Counties, Oklahoma. Prescribed burning and row crops enhance upland habitats. A waterfowl refuge with nine wetland units occurs on about 3,500 acres. Popular game species include white-tailed deer, fox squirrel, cottontail rabbit, raccoon, coyote, bobcat, beaver, mourning dove, bobwhite quail, and waterfowl. The bald eagle winters in the area.

Tenkiller WMA: The WMA contains about 2,590 acres of oak/hickory upland and riparian habitat adjacent to Tenkiller reservoir in Cherokee and Sequoyah Counties, Oklahoma. Riparian species primarily are elm, willow, river birch, hackberry, and sycamore. Management practices include planting food plots and thinning upland wooded areas. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, gray fox, bobcat, beaver, turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle winters and nests in the area.

Eufaula WMA: The WMA occurs on about 48,615 acres in Latimer, McIntosh, Pittsburg, and Cherokee Counties, Oklahoma. The area consists primarily of floodplain and bottomland hardwoods supporting of a variety of tree species such as pin oak, willow, and sycamore. Numerous natural wetlands and sloughs occur on the WMA. About 780 acres have been developed into wetland units managed for waterfowl. Mixed upland hardwoods, prairie, and old fields also occur on the area. About 1,500 acres are farmed through lease agreements to provide additional food sources for wildlife. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, gray fox, bobcat, beaver, turkey, mourning dove, bobwhite quail, and waterfowl. The bald eagle winters and nests in the area.

Wister WMA: The WMA contains about 35,500 acres of bottomland hardwoods along the Poteau and Fourche Maline Rivers, with prairie and oak/hickory/pine forest in the uplands. The WMA is located in LeFlore and Latimer Counties, Oklahoma. Ongoing management focuses on maintaining openings and controlling woody vegetation. Practices include prescribed burning, strip discing, brush hogging, and planting food plots. Controlled grazing is allowed on about 14,000 acres. Popular game species include white-tailed deer, fox and gray squirrel, cottontail rabbit, raccoon, coyote, gray fox, bobcat, beaver, turkey, mourning dove, bobwhite quail, and waterfowl. Black bear are present in low numbers. The bald eagle winters and nests in the area. The golden eagle also winters in the area.

Dardanelle WMA: The area consists of about 45,000 acres of uplands and wetlands in Pope, Yell, Johnson, and Logan Counties, Arkansas. Popular game species include white-tailed deer, coyote, cottontail and swamp rabbit, bobwhite quail, mourning dove, American woodcock, and waterfowl.

Bayou Meto: The WMA consists of about 31,830 acres in Jefferson and Arkansas Counties, Arkansas. The area provides both upland and wetland habitats including six lakes totaling 1,080 acres. Numerous water control structures are used to manipulate water on the area to benefit waterfowl. About 13,000 acres are flooded each fall to provide habitat for migrating waterfowl. Other management practices include controlled burning, brush hogging, strip discing, and planting food plots. Popular game species include whitetail deer, raccoon, cottontail rabbit, fox squirrel, turkey, and waterfowl. The American alligator also occurs on the WMA.

Trusten Holder: The WMA contains about 4,400 acres of overflow bottomland hardwoods adjacent to the White River in Desha and Arkansas Counties, Arkansas. Typical tree species include overcup and nuttal oak, hackberry, ash, and persimmon. Management practices include selective timber harvest, controlled burns, and planting food plots. Popular game species include whitetail deer, squirrel, cottontail and swamp rabbit, bobwhite quail, mourning dove, and waterfowl.

Galla Creek: The WMA contains about 3,330 acres in two tracts located north of Holla Bend NWR and the Arkansas River in Pope and Yell Counties, Arkansas. The area contains both upland forests, wetlands, and a lake on Galla Creek. Popular game species include whitetail deer, fox and gray squirrel, raccoon, cottontail and swamp rabbit, mourning dove, American woodcock, bobwhite quail, and waterfowl.

National Wildlife Refuges

Three NWRs occur along or near the MKARNS. The refuges are the Sequoyah NWR in eastern Oklahoma, and the Holla Bend and White River NWRs in Arkansas.

Sequoyah NWR: The refuge occurs in Haskell, Muskogee, and Sequoyah Counties near the confluence of the Arkansas and Canadian Rivers in Oklahoma. The refuge was established by cooperative agreement between the Service and the Corps in 1970 to provide habitat for waterfowl and other migratory birds. The refuge covers about 20,800 acres and annually hosts the largest concentration of wintering snow geese in Oklahoma. Bottomland hardwood habitat found at the refuge provides habitat for numerous wildlife species such as songbirds, raptors, quail, rabbit, muskrat, deer, bobcat, and squirrels, as well as many species of reptiles and amphibians including the green tree frog, cottonmouth, red-eared slider, diamondback water snake, and bullfrog. The bald eagle is common at the refuge during the fall and winter. The refuge also appears to be one of the last strongholds in Oklahoma for the alligator snapping turtle, a state species of special concern in Oklahoma.

Sequoyah NWR offers the public opportunities for hiking, wildlife photography, bird watching, and freshwater fishing. Public hunting is allowed for waterfowl, deer, and small game (rabbit, grey squirrel, fox squirrel, American coot, snipe, mourning dove, woodcock, and bobwhite quail).

Holla Bend NWR: The refuge is located in west-central Arkansas along the Arkansas River in Pope County. This refuge was established in 1957 and encompasses 7,057 acres of bottomland

hardwoods and wetlands. The refuge is bounded to the north by an oxbow lake created when the Corps excavated a channel through the bend in the river to improve the MKARNS for navigation and flood control. Wildlife resources at the refuge include several species of wintering waterfowl, the golden eagle, the federally-listed threatened bald eagle, migratory songbirds, as well as many species of mammals, reptiles, and amphibians. The refuge receives about 40,000 visitors annually and offers the public opportunities for hiking, wildlife photography, hunting, bird watching, and freshwater fishing.

White River NWR: The refuge occurs in Desha, Monroe, and Phillips Counties in eastern Arkansas and lies in the floodplain of the lower White River near the confluence of the Arkansas and Mississippi Rivers. The refuge encompasses 90 of the lower 100 miles of the White River in Arkansas as well as three miles of the Arkansas Post Canal. Established in 1935, the refuge is about 160,000 acres in size, including about 154,000 acres of bottomland hardwood forests forest, 1,000 acres of grassland, 900 acres of cropland, and 4,000 acres of natural and manmade lakes. Although historically about 8 million acres of bottomland hardwood forests occurred in Arkansas, today only about 850,000 acres remain. The bottomland hardwood forest within the refuge represents nearly 20 percent of the state's remaining bottomland hardwood forest acreage. The refuge is one of the largest remaining contiguous bottomland hardwood forests in the lower Mississippi River Valley.

The refuge has been designated as a Wetland of International Importance and is on the American Bird Conservancy list of globally important bird areas. As the host of the largest concentration of wintering mallard ducks in the Mississippi Flyway, the refuge helps bring about 2.5 million dollars per day to the area during the sixty day waterfowl hunting season. Thus, the refuge is a major economic asset to the area. The area provides habitat for wading birds, shorebirds, waterfowl, raptors, a variety of reptiles, amphibians, and mammals, including a healthy population of black bears. The refuge also has four active nests of the federally-listed threatened bald eagle. White River NWR is visited by about 150,000 people annually and offers opportunities for hunting, boating, fishing, wildlife observation and photography, and hiking.

THREATENED AND ENDANGERED SPECIES

Section 7(a)(2) of the Endangered Species Act (ESA) requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any federally-listed threatened or endangered species or result in adverse modification or destruction of designated critical habitat. When the federal action agency, in this case the Corps, determines that its action "may affect" a federally-listed threatened or endangered species or designated critical habitat, the agency is required to enter into formal consultation with the Service. The federal agency or their designated non-federal representative would prepare a biological assessment that addresses possible impacts to the federally-listed species that occur within the project area.

Seventeen federally-listed endangered and threatened species and two candidates for federal listing occur within the vicinity of the project area. Specific information relative to these species is included in Appendix B.

Formal consultation under section 7 of the ESA is nearing completion for the following four species: 1) the interior least tern, 2) the American burying beetle, 3) the bald eagle, and 4) the pallid sturgeon. The Service has recommended that the Corps (and the Federal Energy Regulatory Commission) also formally consult with the Service on the operation of Grand Lake to address incidental take related to the operation of this reservoir. This consultation will be conducted separate from the ongoing consultation pertaining to ARNS.

STATE LISTED AND OTHER RARE/DECLINING SPECIES

Other species that also should be considered during project planning include state-listed and rare species, species with restricted ranges, and species of conservation concern that may occur within the project area (Tables 14 and 15). Rare/declining, state-listed threatened or endangered species, and species of concern are not afforded protection under the ESA, unless proposed for federal listing. However, protection of these species now may help prevent the need to list them in the future.

ZEBRA MUSSELS

The zebra mussel *Dreissena polymorpha* is a small (thumbnail size) mussel with alternating light and dark stripes native to the Caspian Sea Region of Asia. This species, native to the Caspian Sea Region of Asia, has spread throughout the eastern United States since its unintentional introduction in the Great Lakes around 1986 in the ballast water of ships and on the hulls of barges. They are now found in at least 20 states, including Oklahoma and Arkansas.

Zebra mussels adversely impact infested aquatic habitats (D'Itri, 1997). They occur in large, dense clusters of up to 30,000 individuals in one square meter (O'Neill and MacNeill, 1991). Zebra mussels are known to smother native mussel fauna. They also can alter the natural food chain by consuming food otherwise available to native species, alter habitat substrates, and impact water quality.

Table 14. State-listed rare and endangered/threatened species that occur or may occur within the project area in Oklahoma.

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Animals		
Gray bat (*Myotis grisescens*)	E	northeastern OK; limestone caves, forests near rivers/lakes
Indiana bat (*Myotis sodalis*)	E	eastern OK; caves, forests
Ozark big-eared bat (*Plecotus townsendii ingens*)	E	northeastern OK; caves (karst areas) in oak-hickory forests
Marsh rice rat (*Oryzomys palustris*)	SS2	eastern OK; near wetlands, grasslands
Golden mouse (*Ochrotomys nuttali*)	SS2	east-central OK; greenbriar thickets, swamps
Long-tailed weasel (*Mustela frenata*)	SS2	variety of habitats statewide
Mountain lion (*Felis concolor*)	SS2	rare in eastern OK
Rafinesque's big-eared bat (*Plecotus rafinesqui*)	SS2	east-central Oklahoma; forests with dense foliage
River otter (*Lutra canadensis*)	SS2	eastern OK, Wister WMA; aquatic
Woodchuck (*Marmota monax*)	SS2	east-central & northeastern OK; open woodlands
Piping plover (*Charadrius melodus*)	T	migrates through central and eastern OK; known to use Winganon Flats at Oologah Reservoir
Bald eagle (*Haliaeetus leucocephalus*)	E	major rivers and reservoirs
Interior least tern (*Sterna antillarum athalassos*)	E	Arkansas and Canadian Rivers
Prairie falcon (*Falco mexicanus*)	SS1	dry plains and prairies
Swainson's hawk (*Buteo swainsoni*)	SS2	grasslands
Migrant loggerhead shrike (*Lanius ludovicianus migrans*)	SS2	open areas with high perches

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Barn owl (*Tyto alba*)	SS2	woodlands, savannas, farmlands, suburbs
Bell's Vireo (*Vireo bellii*)	SS2	deciduous thickets along streams, ravines, forest edges
Arkansas darter (*Etheostoma cragini*)	SS2	northeastern Oklahoma; northwestern Arkansas; spring feed vegetated creeks and headwaters typically over mud
Arkansas River shiner (*Notropis girardi*)	T	Canadian River above Eufaula Reservoir
Ozark cavefish (*Amblyopsis rosae*)	T	streams in nutrient rich caves in northeastern OK/Ozark highlands
Blackside darter (*Percina maculata*)	T	eastern OK in pools of creeks of small-medium rivers
Longnose darter (*Percina nasuta*)	E	east-central OK in gravel runs of small-medium rivers
Alabama shad (*Alosa alabame*)	SS2	east-central and northeast OK in open water of medium - large rivers
Alligator gar (*Atractosteus spatula*)	SS2	eastern OK except northeast in pools and backwaters of rivers, lakes, swamps
Peppered chub (*Macrhybopsis tetranema*)	SS2	gravel runs of major rivers and tributaries
Blue sucker (*Cycleptus elongates*)	SS2	Grand lake and tailwaters
Black buffalo (*Ictiobus niger*)	SS2	eastern and central OK in rivers and lakes
Bluntface shiner (*Cyprinella camura*)	SS2	northeastern OK in small clear streams

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Harlequin darter (*Etheostoma histrio*)	SS2	mostly Saline, Spavinaw, and Spring Creeks
Kiamichi shiner (*Notropis ortenburgeri*)	SS2	Poteau River and streams in Ouachita Mountains
Pallid shiner (*Hybopsis amnis*)	SS2	Poteau River
Plains topminnow (*Fundulus sciadicus*)	SS2	Grand River drainage
Ribbon shiner (*Lythrurus fumeus)*	SS2	Illinois and Poteau Rivers
River Darter (*Percina shumardi*)	SS2	Grand and Illinois Rivers
Shorthead redhorse (*Moxostoma macrolepidotum*)	SS2	northeastern OK in clear gravel-bottom streams/rivers
Shovelnose sturgeon (*Scaphirhyncus platorynchus*)	SS2	Arkansas River and tributaries
Southern brook lamprey (*Ichthyomyzon gagei*)	SS2	clear streams of Ouachitas and Ozarks
Spotfin shiner (*Notropis spilopterus*)	SS2	Illinois River
Spotted bass (*Micropterus punctulatus)*	SS2	eastern OK in clear, spring- fed streams
Stonecat (*Notorus flavus*)	SS2	northeatern OK in clear bottom, gravel streams
Northern scarlet snake (*Cemophora coccinea*)	SS2	eastern OK in sandy/loamy areas
Alligator snapping turtle (*Macroclemys temminckii*)	SS2	Eastern OK in lakes, rivers, oxbows, and sloughs; known to occur at Seqouyah NWR and near Eufaula Reservoir
Map turtle (*Graptemys geographica*)	SS2	Delaware County; large bodies of water

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Texas horned lizard (*Phrynosoma cornutum*)	SS2	grasslands with areas of sparse vegetation
Rich Mountain salamander (*Plethodon ouachitae*)	SS2	north facing talus slopes of Ouachtia Mountains
Grotto salamander (*Typhlotriton spelaeus)*	SS2	northeastern OK in limestone caves with springs
Oklahoma salamander (*Eurycea tynerensis*)	SS2	northeast OK in spring-fed creeks with gravel bottoms
Ouachita dusky salamander (*Desmognathus brimleyorum*)	SS2	southeastern OK in springs, streams
Ringed salamander (*Ambystoma annulatum*)	SS2	eastern OK in moist wooded areas
Scaleshell (*Leptodea leptodon*)	SS2	scattered populations in Arkansas River Basin
Neosho mucket (*Lampsilis rafinesqueana*)	E	Illinois River above Lake Tenkiller
Western fanshell (*Cyprogenia aberti*)	SS2	historically occurred in Verdigris and Caney Rivers ; may be extirpated from Oklahoma
Spectacle-case shell (*Quadrula cylindrica*)	SS2	Illinois River in Cherokee County
Rich Mountain slitmouth (*Stenotrema pilsbryi*)	SS1	talus slope in Ouachita Mountains
American Burying Beetle (*Nicrophorus americanus*)	E	habitat generalist; grasslands, forests
Prairie mole cricket (*Gryllotalpa major*)	SS2	prairies
Plants		
Ozark chinquapin oak (*Castenea pumela* var. *ozarkensis*	R	eastern OK in oak-pine and oak-hickory forests

Table 14 continued

Species	State Status[1]	Distribution and/or typical habitat in Study Area
Waterfall's sedge (Carex latebracteata)	R	mesic slopes in southeastern OK
Hammock sedge (Carex fissa)	R	northeastern OK along edges of ponds/lakes
Ozark wake-robin (Trillium pusillum var. ozarkanum)	R	oak-hickory and oak-pine woodlands in LeFlore County
Ozark spiderwort (Tradescantia ozarkana)	R	eastern OK in deciduous forests in ravines and steep rocky hillsides
Skinner's false foxglove (Agalinis skinneriana)	R	Delaware County in prairies and open areas of oak-hickory forests but may be extirpated from OK
Earleaf false-foxglove (Agalinis auriculata)	R	currently only known from prairie hay meadows bordered by upland woods in Choctaw County
Dwarf pipewort (Eriocaulon kornickianum)	R	sandy hillsides in Atoka, Muskogee, and Pushmataha Counties
Southern Lady's slipper (Cyprepedium kentuckiense)	R	southeastern OK in floodplain forests and mesic ravines
Ouachita indigo bush (Amorpha ouachitensis)	R	Leflore, McCurtain, and Pushmataha Counties along rocky creeks, streambanks, and floodplains
Western prairie fringed orchid (Platanthera praeclara)	T	northeastern Oklahoma in moist grasslands; may be extirpated from Oklahoma

E = Endangered
T = Threatened
SS1 = Species of Special Concern where current evidence indicates species is vulnerable because of limited range, low population, or other factors
SS2 = Species of Special Concern that is possibly threatened or vulnerable but with little evidence to document current population levels and range.
R = Rare

Table 15. Arkansas state-listed rare species that occur or may occur within the project area (list of species and their state rank provided by the Arkansas Natural Heritage Commission).

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Animals		
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	S2	statewide except Ozark Mountains; occupies buildings, barns, caves, forests
Brazilian free-tailed bat (*Tadarida brasiliensis*)	S3	central and southern Arkansas; occupies buildings, forests
Gray myotis (*Myotis grisescens*)	S2	forests and caves near rivers, lakes
Florida panther (*Puma concolor coryi*)	SH	–
Swainson's warbler (*Limnothlypis swainsonii*)	S3B	possibly statewide; swamp forests, bottomland hardwood forests, riparian forests
Interior least tern (*Sterna antillarum athalassos*)	S2B	sand bars on Arkansas and White Rivers
Bald eagle (*Haliaeetus leucocephalus*)	S2B, S4N	statewide; rivers, reservoirs/lakes
Strecker's chorus frog (*Pseudacris streckeri streckeri*)	S2	eastern and central Arkansas; moist woods, rocky ravines, riparian forests, lagoons, swamp forests, croplands
Plains spadefoot (*Scaphiopus bombifrons*)	S1	isolated population in north-central/northwest Arkansas; grasslands
Arkansas River shiner (*Notropis girardi*)	SX	–
Shorthead redhorse (*Moxostoma macrolepidotum*)	S2	northern half of Arkansas; rocky pools and riffles of small and large rivers, lakes
Slenderhead darter (*Percina phoxocephala*)	S2	western Arkansas; gravel runs and riffles of small creeks to medium rivers

Table 15 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Suckermouth minnow (*Phenacobius mirabilis*)	S1	west-central Arkansas; gravel/rubble riffles and runs of creeks, and in small to large rivers
Flathead chub (*Platygobio gracilis*)	S1?	eastern Arkansas; sandy runs of rivers
Paddlefish (*Polyodon spathula*)	S2?	statewide; slow flowing, deep water of large rivers
Swamp darter (*Etheostoma fusiforme*)	S2?	south and eastern Arkansas; standing of slow-moving water over sand or mud
Goldeye (*Hiodon alosoides*)	S2B, S4N	statewide; occurs in deep open pools, channels, lowland rivers, lakes.
Plains minnow (*Hybognathus placitus*)	SX	west-central Arkansas; shallow sandy runs, pools of creeks, and small to large rivers
Lake sturgeon (*Acipenser fulvescens*)	S1	eastern Arkansas; bottom of lakes and large rivers
Lake chubsucker (*Erimyzon sucetta)*	S2?	southern, east-central, and eastern Arkansas; lakes, ponds, and swamps over silt, sand, or debris
Plants		
San Antonio false-foxglove (*Agalinis homalantha*)	S1	statewide; oak woodlands
Texas bergia (*Bergia texana*)	S2	Johnson , Perry, ansd Desha Coutnies; swamps, mud flats, muddy pond shores
Tissue sedge (*Carex hyalina*)	S3	statewide inventory needed; margins of forested wetlands and swamps
Scratch-daisy (*Croptilon hookerianum* var. *validum*)	S2	limited to the Arkansas Valley and Mississippi Alluvial Plain

Table 15 continued

Species	State Rank[1]	Distribution in Arkansas and/or typical habitat
Lax hornpod (*Cynoctonum mitreola*)	S3	wetlands
Six-angle spurge (*Euphorbia hexagona*)	S2	known to occur in Franklin and Pope Counties; sandy shores and bottoms
Showy prairie-gentian (*Eustoma russellienum*)	S2	Clark County and Arkansas River Valley
Soapwart gentian (*Gentiana saponaria*)	S3	western and central Arkansas; swamps, bogs
Hairy water-fern (*Marsilea vestita*)	S3	Arkansas River Valley and in Bradley, Chicot, Washington and Polk Counties; wetlands
California bullrush (*Scirpus californicus*)	S1S2	known to occur in Hempstead, Johnson, and Conway Counties; wetlands
Riddell's spike moss (*Selaginella arenicola*)	S3	known from the Ozark Plateau; dry rocks and packed sand
Twistflower (*Streptanthus obtusfolius*)	S3	restricted to Ouachita Mountains

S1 = Extremely rare. Typically 5 or fewer estimated occurrences in the state, or only a few remaining individuals, may be especially vulnerable to extirpation.
S2 = Very rare. Typically between 5 and 20 estimated occurrences or with many individuals in fewer occurrences, often susceptible to becoming extirpated.
S3 = Rare to uncommon. Typically between 20 and 100 estimated occurrences, may have fewer occurrences but with many large number of individuals in some populations, may be susceptible to immediate threats.
S4 = Common, apparently secure under present conditions. Typically 100 or more estimated occurrences but with large number of individuals in some populations, may be restricted to only a portion of the state.
SH = Historical occurrence but may be extirpated
SX = Believed to be extirpated.
? = Indecision regarding rank assignment
B = Breeding status
N = Non-breeding status

Zebra mussels spread primarily by attaching to boats used in infested waters that are then launched on lakes they have not been invaded. The mussels and their veligers can be carried in bilges, minnow buckets, live wells, and engine cooling systems. They populate a new body of water quickly due to their high reproductive rate (*e.g.*, a female can release up to one million eggs each season) and their few natural predators (*e.g.*, diving ducks, blue catfish, red ear sunfish, and freshwater drum).

Eliminating established populations is impossible. Washing and scrubbing boats and equipment that have been used in infested waters currently is the best method to prevent further spread of this species.

Zebra mussels are known to occur throughout the project area with concentrations established at the following locations: 1) lock and dam # 10 (Dardanelle) on the Arkansas River, 2) Arkansas Nuclear One intake canal and effluent bay (Lake Dardanelle), 3) lock and dam # 14 (W. D. Mayo) on the Arkansas River; 4) lock and dam # 15 (Robert S. Kerr) on the Arkansas River; 5) lock and dam # 16 (Webbers Falls) on the Arkansas River; 6) lock and dam # 17 (Choteau) on the Verdigris River; 7) lock and dam # 18 (Newt Graham) on the Verdigris River; 7) at Oologah Lake on the Verdigris River, and 8) Kaw Reservoir.

FISH AND WILDLIFE RESOURCES: FUTURE WITHOUT THE PROJECT

The future conditions for fish and wildlife resources are difficult to accurately predict due to the large areal extent of the project area and complex nature of the project. Habitat improvements along the system, such as riparian restoration and dike notching, are likely to continue through various available means such as section 1135 (Project Modifications for the Improvement of the Environment) of Water Resources Development Act (WRDA) of 1986, Section 206 (Aquatic Ecosystem Restoration) of WRDA 1996, landowner incentive measures of the Farm Bill, and the Service's Partners for Fish and Wildlife Program.

Sixty-two fish species were identified within the navigation system from the aquatic impact assessment conducted during Summer 2004. Although Buchanan's (1976) assessment identified 106 fish species within the navigation system, his study also included tributaries and the White River. The 2004 assessment restricted sampling primarily to tail waters, which largely accounts for the disparity in the number of fish species reported from these sources.

Construction and ongoing operation of the MKARNS has resulted in stabilized channel conditions, and the creation of reservoirs that provide habitat for lake species, but limit habitat for native riverine species. The overall result is a more homogenous aquatic environment within the MKARNS that benefits particular fish and mussel fauna at the expense of others (Buchanan, 1976). The Corps likely would continue to maintain commercial navigation on the MKARNS at the current 9-foot navigation depth if the proposed project were not implemented. Thus, the navigation system and reservoirs would continue to provide a relatively homogenous aquatic environment. The overall fish and mussel fauna would be expected to be similar to existing conditions without the proposed project.

Changes to aquatic resources in the reservoirs on the system would occur as the reservoirs continue to age. The upper ends of the reservoirs will continue to become more shallow and convert to marsh habitat as they fill in with sediments deposited by the incoming watercourse. The natural process of eutrophication also would continue, especially in the shallow reservoir headwaters.

Other changes may occur as newly developed or modified lake level management plans are implemented or stocking/restoration efforts are pursued. Management of biotic resources would continue and are likely to be beneficial to fish and wildlife species.

Wildlife Management Areas and NWRs along the MKARNS in both states and at the Oklahoma reservoirs that serve as the MKARNS's primary flow modifiers are expected to continue to be managed specifically for fish and wildlife resources by the ODWC, AGFC, Corps and the Service. Changes may occur as a result of natural succession and modified management plans, but are anticipated to be beneficial due to continued management practices. Natural species succession also would be expected to occur in most of the terrestrial cover types described previously.

Federally-listed species are afforded protection under the ESA, as amended. The ESA provides a framework for the federal government, states, private industry and individuals to work cooperatively to conserve listed species. Conservation and protection of listed species is anticipated to continue through federal, state, and private recovery actions, future research studies and monitoring efforts, interagency consultations, and the implementation of conservation measures on private land.

Rare/declining, state-listed threatened and endangered species, and other species of concern are not afforded protection under the ESA. Continued population declines may occur, warranting listing and subsequent federal recovery efforts. Protection of these species now will help prevent the need to list them in the future. Various federal initiatives, for example, the State Wildlife Grants program authorized by the Department of the Interior and Related Agencies Appropriations Act, 2004, provide millions of dollars in wildlife conservation grants to the states, tribes, and private organizations. These grants will be used to benefit wildlife and their habitat, including rare/declining, state-listed threatened or endangered species, and other species of concern.

The population of paddlefish within the navigation system likely would remain stable or increase. Existing gravel bars should continue to support spawning habitat for the paddlefish. Also, restoration attempts and surveys on the brood stock of paddlefish in the Arkansas and Verdigris rivers in northeastern Oklahoma are expected to be on-going without the project.

A task force to address the spread of zebra mussels, known as the 100th Meridian Initiative, has been formed with representatives from federal and state agencies, private industry, and user groups. Eliminating an established population of zebra mussels is difficult to impossible. Zebra mussels possess a high reproductive rate and have limited natural predators within the project area. For these reasons, zebra mussels can rapidly populate a new body of water. Further spread

of this species within the project area may occur, for example, should a boat from infested waters be moved to non-infested waters.

SUMMARY OF PLAN SELECTION PROCESS AND IDENTIFICATION OF EVALUATED ALTERNATIVES

The proposed action for the study objectives consists of three features that influence navigation: 1) River Flow Management, 2) Navigation Channel Deepening, and 3) Navigation Channel Maintenance. Within each feature, numerous project components were examined as part of the study. Project Alternatives (combinations of components from the three features) were then developed to address the attainment of the study purpose. We briefly describe the components of each feature and the alternatives that were analyzed here. The Corps draft Environmental Impact Statement (USACOE, 2005a) and Feasibility Report (USACOE, 2005b) provides a more detailed description of the components and alternatives evaluated, and the selected plan.

The project can initially be divided into two major elements, the No Project element and the Action element. The "No Project" element would only occur if none of the components within each feature were selected. We do not anticipate this element would be selected due to the lack of existing dredged material containment/disposal areas for anticipated ongoing maintenance activities with the existing nine-foot channel (see discussion under Navigation Channel Maintenance feature).

RIVER FLOW MANAGEMENT FEATURE

The study team initially examined nine structural components and three non-structural components. The structural components were:

- Construction of an extensive levee system in the Oklahoma portion of the study area;
- Evacuation of water from the upper MKARNS;
- Construction of one or more new reservoirs;
- Pre-release of water from the Oklahoma reservoirs based upon short-term weather forecasts;
- Removal of channel restrictions such as training dikes;
- Modification of existing in-stream navigation structures;
- Removal of locks and dams throughout the MKARNS;
- Construction of high flow relief structures; and

- Restoration/enhancement of aquatic and riparian habitats along the MKARNS;

The non-structural project components considered included:

- Modification of flow rates and durations, primarily associated with the operation of the 11 Oklahoma reservoirs;

- Reallocation of reservoir storage from one project purpose to another; and

- Adjustments/increases in flowage easements.

The study team determined that only the non-structural components met the project objectives established for the study and that structural components would be too expensive relative to the associated benefits. A total of twenty-three specific non-structural components were evaluated and compared using the Corps Southwest Division SUPER Model. Detailed information associated with the SUPER Model screening runs can be found in Appendix A, Hydrology and Hydraulics Report, of the draft Feasibility Report (USACOE, 2005b). Four operational components, including a No Action component, were selected from this evaluation and examined in detail.

The "No Action" Component consists of maintaining the current operating plan that includes five release zones: 1) 150,000 cfs, 2) 150,000 to 105,000 cfs, 3) 75,000 cfs, 4) 75,000 to 40,000 cfs, and 5) 40,000 to 20,000 cfs. The No Action Alternative includes a 75,000 cfs bench (*i.e.*, period of time where the flow is held at or below 75,000 cfs.) The bench is adjusted seasonally to minimize flood impacts and maximize benefits to farmland. No changes to the existing rivers or reservoirs would be made.

The detailed analysis of the three action components involved a major hydraulics study, modeling runs of the river system, and an economics study for each proposed alternative (USACOE, 2005a and b). Each action component would change the number of days that river flows would exceed certain flow conditions at Van Buren, Arkansas (Table 16). The components are briefly described below.

Table 16. The difference in the number of days that river flows would exceed certain flow conditions at Van Buren, Arkansas, under the Action Components.

River Flow at Van Buren	Component 2: 175,000 cfs Plan	Component 3: 200,000 cfs plan	Component 4: Operations Only Plan
Difference in days above 60,000 cfs	-9	-9	-14
Difference in Dyas above 100,000 cfs	-16	-17	+2
Difference in days above 137,000 cfs	-4	-5	0
Difference in days above 175,000 cfs	+4.3	+7.1	0

Component 2 consists of increasing the target operating flows at Van Buren to 175,000 cfs with a 60,000 cfs bench (replacing the existing 75,000 cfs bench) lowered 3 percent (*i.e.*, from 18 to 15 percent system full) except from June 15– October 1.

Component 3 consists of operating Van Buren at 200,000 cfs with a 60,000 cfs bench replacing the 75,000 cfs bench lowered 3 percent except from June 15 – October 1.

Component 4 is the operations only plan. This component consists of maintaining the existing operating plan (*i.e.*, operating Van Buren at 150,000 cfs), but replacing the current 75,000 cfs bench with a 60,000 cfs bench beginning at 3 percent lower system storage except from June 15 – October 1.

Component 4 is the Corps recommended component for the River Flow Management feature, and was selected based on three primary differences from the existing plan (*i.e.*, the No Action component): 1) a reduction of 14 days below 61,000 cfs (a key level for farming interests in Arkansas and navigation interests), 2) an increase in days between 40,000 cfs and 60,000 cfs (key to scouring flows in the navigation system), and 3) accelerated evacuation of the storage projects when the system exceeds 75 percent full. This component was carried forward for inclusion in the development of project alternatives.

NAVIGATION CHANNEL DEEPENING FEATURE

The screening process included the evaluation of four major components:

- Navigation Channel Deepening via Dredging;
- Navigation Channel Deepening via Pool Raising;
- Navigation Channel Deepening via a combination of Dredging and Pool Raising; and
- Verdigris River Navigation Channel Widening.

Only the Navigation Channel Deepening via dredging component was determined to generate enough benefits, in light of the environmental and economic costs, to merit further evaluation. Four navigation channel dredging components, including a No Action component, were selected for detailed analysis.

Under the No Action component, no segments of the existing nine-foot navigation channel would be deepened. Dredging and new river training structures would not be required.

The three action components consist of deepening the existing navigation channel from 9 feet to 10, 11, or 12-feet, respectively. The MKARNS was divided into six river segments extending from the mouth near the Mississippi River to the Port of Catoosa in Oklahoma to assess the options of deepening the entire system or only specific segments. Each of the four components was considered for each river segment.

Additional dredging and river training structures (dikes and revetments) would be employed to achieve navigation depths between 10 and 12 feet. New dredged material disposal sites would be required to accommodate dredged material for each of the three action components.

Incremental deepening of only certain segments of the navigation system, such as only the lower segments, was determined not to be financially justified. Deepening the navigation channel to a depth of 10-feet also was not financially justified. The Corps' analysis indicated that the 11 and 12-foot components would achieve a positive cost:benefit ratio. These two channel deepening components were moved forward for development of project alternatives.

NAVIGATION CHANNEL MAINTENANCE FEATURE

The screening process included the evaluation of the four following components:

- Cessation of Maintenance Dredging;
- Maintenance Dredged Material Disposal via Transportation to Selected Approved Sites (*i.e.*, areas with high quality habitat would be avoided) in the Original Operation and Maintenance Plan;
- Maintenance Dredged Material Disposal at Approved Sites in the Original Operation and Maintenance Plan; and
- Maintenance Dredged Material Disposal at New Disposal Sites.

Cessation of maintenance dredging was not considered viable due to the inability to maintain a nine-foot navigation channel without maintenance dredging. Dredged material disposal via transportation to selected approved sites would involve movement of dredged material by barge or truck from places on the navigation system where disposal capacity has been reached to areas of low habitat quality where capacity remains. This component was not considered viable due to the lack of perceived benefits in light of the predicted economic costs.

The Maintenance Dredging and Disposal in Approved Areas component would involve movement of dredged material by barge or truck from places on the navigation system where disposal capacity has been reached to areas where capacity remains, regardless of the quality of habitat at the site. This component also would involve new river training structures, and was evaluated in more detail.

The Maintenance Dredging and Disposal at New Disposal Sites component would consist of disposal of dredged material at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. This component also includes new river training structures, and was evaluated in more detail.

The two action components examined in detail were determined to be very similar financially. However, the Maintenance Dredging and Disposal at New Disposal Sites was the least environmentally damaging component. Only this component of the Navigation Channel Maintenance feature was retained for the development of project alternatives.

DEVELOPMENT OF ALTERNATIVES

Five project alternatives that consist of a combination of components from the three features were developed for further consideration and analysis.

- Alternative A – No Action: The existing flow management plan, navigation channel depth, and maintenance activities would remain unchanged.

- Alternative B – Navigation Channel Maintenance Only: The existing flow management plan and navigation channel depth would remain unchanged. Disposal of dredged material would occur at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable.

- Alternative C – Navigation Channel Maintenance and Operations Only Flow Management: The existing navigation channel depth would remain unchanged. Disposal of dredged material would occur at new sites not included in the original Operation and

Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. The existing flow management plan would be replaced with the Operations Only Flow Management Plan.

- Alternative D – Navigation Channel Maintenance, Operations Only Flow Management, and 11-Foot Navigation Channel: Disposal of dredged material would occur at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. The existing flow management plan would be replaced with the Operations Only Flow Management Plan. The current 9-foot navigation channel would be deepened to an 11-foot navigation channel throughout the entire length of the MKARNS.

- Alternative E – Navigation Channel Maintenance, Operations Only Flow Management, and 12-Foot Navigation Channel: Disposal of dredged material would occur at new sites not included in the original Operation and Maintenance Plan after existing disposal sites reach holding capacity. New disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided where practicable. The existing flow management plan would be replaced with the Operations Only Flow Management Plan. The current 9-foot navigation channel would be deepened to a 12-foot navigation channel throughout the entire length of the MKARNS.

DESCRIPTION OF THE ALTERNATIVES EVALUATED AND A FEATURE DEVELOPED BY THE SERVICE

The plan recommended by the Corps is Alternative E. According to the analysis conducted by the Corps, this alternative maximizes national economic development (NED) benefits (has the greatest excess benefits over cost) according to the federal objective, and was therefore identified as the NED Plan.

The selected plan and a feature developed by the Service is briefly described here. The Corps draft Environmental Impact Statement (USACOE, 2005a) and Feasibility Report (USACOE, 2005b) provides a more detailed description of the selected plan.

A brief discussion of anticipated impacts for each project alternative is provided in the following section with emphasis on evaluation of Alternative E. Because Alternative E maximizes NED benefits consistent with the federal objective, the Corps has indicated Alternative E will be selected for implementation unless there are compelling reasons not to do so. Furthermore, Alternative E encompasses the features and components of all other alternatives (river flow management changes, channel deepening, and channel maintenance) and would have the most

significant impacts on the environment. A discussion of impacts anticipated to occur as a result of Alternative E, therefore, also would cover impacts anticipated to occur under the other alternatives.

ALTERNATIVE E: – NAVIGATION CHANNEL MAINTENANCE, OPERATIONS ONLY FLOW MANAGEMENT, AND 12-FOOT NAVIGATION CHANNEL

The Navigation Channel Deepening component of Alternative E would consist of deepening the current 9-foot navigation channel to a 12-foot navigation channel throughout the length of the MKARNS. The River Flow Management component would entail operating under the current plan with a modified 60,000 cfs bench in place of the 75,000 cfs bench beginning at 3 percent lower system storage, except from June 15 through October 1. The Navigation Channel Maintenance component would consist of maintaining the navigation channel through dredging and river training structures; dredging sediment from the navigation channel in volumes consistent with current annual rates; disposal of dredged material associated with navigation channel maintenance in existing and new disposal sites not included in the original Operation and Maintenance Plan, after existing disposal sites reach holding capacity (new disposal sites would be selected based on the quality of the habitat type so that unnecessary impacts to forests, wetlands, and native grasslands could be avoided, where practicable); and the construction of river training structures and revetments. Alternative E would include the construction of 68 new dredged material disposal sites; 91 new and 142 modified river training structures; and 7 new and 13 modified revetments. A summation of the aspects of Alternative E that will cause impacts to fish and wildlife resources is provided in Tables 17 - 21.

The Corps conducted a hydrographic survey to locate areas along the channel that would require deepening. Pipe line dredges with cutter head equipment would be used to deepen the channel.

Construction of the terrestrial disposal sites would consist of excavating a pit and utilizing the excavated material to form a dike around the pit. The pits would include a discharge pit to return dredge water to the channel after settling. Submersible pumps would be used at pits where gravity or overland flow is not possible. The pits are designed to store twice as much as the initial channel dredging volume to allow for future operation and maintenance dredging. The design of terrestrial disposal sites can be found in the Dredge Disposal Site Sketches in Appendix C of the draft Feasibility Report (USACOE, 2005b).

Table 17. The difference in the number of days that river flows would exceed certain flow conditions at Van Buren, Arkansas, under Alternative E compared to existing conditions.

River Flow Management (change in days)		
At or above 60,000	At or above 100,000	At or above 137,000
-13.6	+1.7	0

Aquatic disposal areas would be created by installing a floating silt curtain around the disposal area to control the release of silt. Some open water disposal pits would be designed to provide

Table 18. Dredged material volumes by river segment and for Alternative E and the 11-foot channel depth for comparison.

	River Segment						
Navigation Channel Depth	Mouth to Pine Bluff (N. M. 0.0 –75.2)	Pine Bluff to Little Rock (N.M. 75.2-119.5)	Little Rock to Dardenelle (N.M.119.5-220.3)	Dardenelle to Ft. Smith (N.M.220.3-308.7)	Ft. Smith to Muskogee (N.M. 308.7-394.0)	Muskogee to Catoosa (N.M. 394.0-445.2)	**Total (cubic yards)**
No Action	0	0	0	0	0	0	0
11-foot depth	1,299,276	225,517	387,227	643,500	2,255,323	2,026,333	6,837,176
12-foot depth (Alternative E)	2,066,876	445,995	925,439	1,226,500	3,256,749	3,063,790	10,985,349

Table 19. Projected volume of dredged material and acres of both new and existing aquatic and terrestrial disposal sites for the Navigation Channel Deepening and Maintenance Features of Alternative E.

Dredge Volume (Cubic yards 000s)			**Dredge Area (Surface Acres)**			**Terrestrial Disposal Sites (Acres)**			**Aquatic Disposal Sites (Surface Acres)**		
Maint	**Deep**	**Total**	**Maint**	**Deep**	**Total**	**Maint Exist New**	**Deep (New Only)**	**Total New Grand Total**	**Maint Exist New**	**Deep Exist New**	**Total New Grand Total**
37,704	10,985	48,689	1,429	5,645	7,074	3,840	1,065	1,602	3,020	3,329	385
						537		5,442	148	237	6,734

Note: The Corps predicts that the same number and acres of aquatic and terrestrial disposal sites would be needed to deepen and maintain both an 11- and 12–foot navigation channel. The rate of fill, however, would differ due to the projected volume of dredged material required to obtain and maintain the two depths.

Table 20. New and modified river training dikes proposed to facilitate maintenance of the deeper navigation depth by river segment.

	River Segment					
	Mouth to Pine Bluff (N. M. 0.0 -75.2)	Pine Bluff to Little Rock (N.M. 75.2-119.5)	Little Rock to Dardenelle (N.M.119.5-220.3)	Dardenelle to Ft. Smith (N.M.220.3-308.7)	Ft. Smith to Muskogee (N.M. 308.7-394.0)	Muskogee to Catoosa (N.M. 394.0-445.2)
Existing Structures	278	201	392	236	195	12
New Structures Needed	4	30	5	6	44	0
Length of New Structures (ft.)	2,040	9,700	2,050	1,850	48,729	0
Number of raised or extended structures	36	4	31	24	0	0

Note: Structures required for the 11-foot channel component would be about 2/3 the length of those required for the 12-foot channel component.

Table 21. New and modified river training structures and revetments required for the Navigation Channel Deepening and Maintenance Features of Alternative E.

New River Training Structures			Modified River Training Structures			New Revetments			Modified Revetments		
Maint	Deep	Total	Maint	Deep	Total	Maint	Deep	Total	Maint	Deep	Total
2	89	91	50	92	142	2	5	7	4	9	13

Note: The same number of structures would be required for the 11-foot channel component. The structures would be about 2/3 the length of those required for the 12-foot channel component.

marsh habitat for fish and wildlife species. These open water disposal sites also would contain riprap breakwater dikes to protect the habitat created. The design of aquatic disposal sites can be found in the Dredge Disposal Site Sketches in Appendix C of the Corps draft Feasibility report (2005b).

ALTERNATIVE F: FISH AND WILDLIFE CONSERVATION INITIATIVE

The Service recommends that the Corps investigate the feasibility of adding a Fish and Wildlife Conservation feature to their existing alternatives. (We are not advocating the deepening of the navigation channel to a particular depth under this alternative.) We have provided a description of a conceptual Fish and Wildlife Conservation feature in the concept paper, " Arkansas River Navigation Project Mitigation Proposal and the Arkansas River Conservation Initiative." This concept paper is provided in Appendix C.

When implemented, calculation of the benefit-to-cost ratio should include the annual federal cost of implementing the initiative and the annual net benefits associated with the fish and wildlife and other outdoor-related recreational activities that are likely to increase in the project area (*e.g.,* hunting, fishing, photography, camping, hiking, etc.). We believe this alternative would serve to conserve important fish and wildlife resources for the benefit of the American people, while facilitating balanced development.

Table 22. Impacts Matrix.

	Features of Proposed Navigation Project				
Impact	**Terrestrial Disposal of Dredged Material**	**Aquatic Disposal of Dredged Material**	**Dredging**	**Training Structure Modification/ Addition**	**Flow Management**
Negative effects to protected and sensitive species	X	X	X	X	X
Reduction in invertebrate biomass and diversity	X	X	X	X	X
Reduction of fisheries biomass and diversity		X	X	X	X
Loss of upland hardwoods and grasslands	X				
Loss of bottomland hardwoods	X				
Loss of wetlands	X	X		X	X
Reduction of gravel habitat			X		
Reduction of backwater habitat		X		X	X
Alteration of river hydrology and morphology		X	X	X	X
Reduction in water quality		X	X	X	X
Increased sedimentation and accretion		X	X	X	X
Increased flooding of riparian habitat		X			X
Resuspension/Exposure of contaminants from sediment	X	X	X		
Loss of large woody debris, aquatic vegetation, and shallows habitats		X	X	X	
Benefits to non-native and invasive species			X	X	X

DESCRIPTION OF IMPACTS OF THE SELECTED PLAN

The selected alternative would result in significant impacts to important terrestrial and aquatic fish and wildlife resources. An impact matrix is provided in Table 22 to summarize the major impact types and demonstrate the relationship between the features of the selected plan and the anticipated impacts. We also provide a written description of anticipated impacts, by feature, below.

RIVER FLOW MANAGEMENT FEATURE

Based on an analysis of average annual pool levels and river flows, reservoir pool levels are expected to deviate only slightly from those observed under current operations.

Duration of storage between 0 and 10 feet above conservation pool changes slightly at all operational reservoirs with the exception of Copan, Kaw, and Hulah (Table 23). The greatest change, for example, is expected to occur at Tenkiller, Keystone, and Oologah reservoirs. At Lake Tenkiller, the reservoir pool elevation is expected to be two feet above the conservation pool elevation for four additional days per year as compared to existing conditions. At Keystone and Oologah, the conservation pool would be four feet above the current conservation pool elevation three additional days per year.

Table 23. Annual change in the number of days reservoirs are expected to be above conservation pool compared to existing conditions (No Action Alternative).

Alternative 4: Operations Only	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Copan	0	0	0	0	0	0	0
Eufaula	1	0	0	0	0	0	0
Gibson	0	0	1	1	1	-2	-2
Grand	1	1	0	0	-1	0	0
Hudson	0	1	0	0	0	0	0
Hulah	0	0	0	0	0	0	0
Kaw	0	0	0	0	0	0	0
Keystone	1	2	3	2	2	0	0
Oologah	2	1	3	2	0	0	0

Table 23 Continued

Alternative 4: Operations Only	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Tenkiller	2	4	2	1	1	0	0
Wister	1	1	0	0	0	0	0

Prolonged higher water levels during the growing season could adversely affect vegetation in portions of the conservation and flood control pools by drowning or weakening established plants not adapted for those hydrological conditions. Impacts would occur to both aquatic and terrestrial habitats. Although most bottomland hardwood trees are tolerant of flooding during the dormant season, intermittent inundation during the growing season may injure or kill trees (Black, 1980; Bell and Johnson, 1974; Hall and Smith, 1955). See Appendix D for data on reservoir pool elevations under existing conditions and with the recommended plan during the growing season, April – September.

Although average annual impacts at these reservoirs are expected to be minimal, it is important to note that the occurrence extreme conditions in even a single or a few consecutive years could significantly affect fish and wildlife resources. These effects are not likely to be evident from an analysis based on average annual reservoir levels and river flows. The effects would be dependent upon the time of the year in which inundation occurs, duration of inundation, and the elevation, soil characteristics, existing vegetation, and topography of the areas experiencing inundation. Impacts could include altering the littoral zone, altering or eliminating vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migrating birds, such as waterfowl.

Increased frequency and duration of flooding of agricultural lease lands on the WMAs also would decrease the value of the lease to farmers/lessees. The revenue gained from these lands, which is vital for continued operation and maintenance of the WMAs, would, in turn, decline. Farmers also likely would be less willing to plant wildlife food crops due to increased financial risks from flooding of crops.

Analysis of conditions that would occur in extreme high and low water years (rather than only on average annual lake levels and river flows) is more appropriate for considering potential effects to fish and wildlife resources. However, because water releases from each reservoir depend on numerous complex factors, such as weather conditions, water storage capacity, inflow rates, river flow rates downstream, power requirements, and navigation water requirements, accurately predicting the effects of the operating plan on fish and wildlife resources associated with the system reservoirs would be especially difficult. Predicting variables, such as weather patterns and power requirements, with complete accuracy, for example, is impossible. Long-term monitoring, consequently, would be necessary to accurately assess the impacts of changes in river flows and reservoir pool levels, as explained below in the section titled Discussion, Mitigation, and Recommendations.

The frequency of annual out-of-bank flows (*i.e.*, flows of 137,000 cfs or greater as measured at Van Buren) would not change from existing conditions. There would not be an increase in erosion potential or impacts to lower elevation wetlands and backwater areas over impacts currently occurring. River flow days above 175,000 cfs would, on average, increase only one day per year. Impacts to higher elevation wetland habitats also would not differ significantly from current conditions.

This alternative would, however, decrease the number of days per year for which flows would be greater than 61,000 cfs by 14 days. This would reduce the duration of flooding in the floodplain. Because the hydrology of wetlands in the floodplain would be altered, important wetland habitats may be adversely impacted.

River Flow Management: Summary Of Anticipated Impacts

Impacts anticipated from project implementation include:

- Increased inundation of portions of the flood control pools at the 11 controlling reservoirs in Oklahoma which may kill or injure vegetated areas adjacent to the reservoirs, alter the littoral zone, adversely impact fish spawning and recruitment, and reduce available habitat for migrating birds such as waterfowl;

- Increased frequency of flooding of agricultural lease lands which would decrease the value of the leases and their long-term revenue;

- Changes in the depth, temperature, turbidity, and velocity of the river downstream of each reservoir;

- Conversion of wetlands along the navigation system to agricultural production as a result of increased flood protection; and

- Increased potential for the accidental release of pollutants as a result of increased barge traffic.

NAVIGATION CHANNEL DEEPENING FEATURE

Under the proposed action, the entire 445 mile navigation channel would be maintained for a navigation depth of 12 feet. This would require dredging and/or construction or modification of channel training structures to deepen areas currently shallower than 12 feet. To achieve the desired navigation depth, many existing shoals would require in excess of 3 feet of substrate removal. Disposal of dredged material in Oklahoma would occur in both open water and terrestrial out of bank containment areas. In Arkansas, most of the disposal will occur in open water areas behind dike fields and revetments.

Early in the evaluation process, a multidisciplinary Multi-agency Ecosystem Evaluation Team was established to evaluate impacts of the proposed Navigation Channel Deepening feature on terrestrial habitats and ecological benefits resulting from proposed mitigation measures. The multidisciplinary team included various interests and technical expertise from the Little Rock and Tulsa Corps Districts, the Service, ERDC-EL, and Parsons, a private consulting firm. The team evaluated the environmental impacts of proposed dredging and disposal of dredged material using HEP analysis.

Terrestrial Resources

Dredging to achieve the 12-foot navigation depth would require numerous disposal areas along the navigation system in Arkansas and Oklahoma. The Service and ODWC worked closely with the Corps during the selection of new dredged material disposal sites to minimize and avoid impacts to high quality habitat such as bottomland hardwoods, native grasslands, and wetlands. The majority of the areas being impacted by dredged material disposal would be previously degraded habitats, such as agricultural lands and old field, thus minimizing direct impacts to higher quality terrestrial habitats. Wetlands and high quality bottomland hardwoods were avoided where possible.

Dredged material disposal would occur at 43 new terrestrial sites located within the floodplain of the Verdigris and Arkansas rivers. The existing terrestrial habitat would be lost due to the conversion of the site to a dredge spoil containment area (a pit surrounded by an earthen dike). Vegetation eventually would become established within the disposal pits. Willows, river birch, cottonwood, and a few species of sedges and grasses are likely to be early colonizers of the disposal pits (Allen and Hardy, 1980). However, the new community will generally be less diverse and have lower value to the terrestrial wildlife due to loss of terrestrial habitat, low plant species diversity and slow colonization by native plants (McMahon and Eckbald, 1975; Ziegler and Sohmer, 1977) and frequent disturbance over the project life due to disposal of dredged material.

The disposal of dredged material in terrestrial sites is expected to result in the conversion of about 1,602 acres along the MKARNS. The terrestrial dredge disposal sites in Arkansas would occur in cropland along the Arkansas Post Canal, which should reduce impacts to fish and wildlife habitat. Over the 50-year life of the project, the disposal of dredged material at terrestrial sites would result in the loss of about 15 acres of bottomland hardwood forest, 121 acres of upland forest, 300 acres of open field habitat, 315 acres of old field habitat, 790 acres of agricultural land, and 61 acres of barren/sand habitat.

Wetlands

National Wetland Inventory (NWI) maps were used to identify and help avoid wetland areas when choosing dredged material disposal sites. No impacts to wetlands are expected to occur. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be deposited in new disposal sites designated in the 2003 20-year Dredge Material Management Plan. Areas with high quality habitat, such as forest, wetlands, and high quality grassland, would be avoided for dredged material disposal wherever practical. This alternative would maintain the existing conditions, including the hydrology and species composition of wetlands.

The Service and our state partners were concerned during early planning stages of the study that channel incision could further eliminate floodplain hydrology causing loss of wetlands and seepage of water from adjacent oxbows. However, ERDC-EL evaluated sediment transport and flow models to assess the potential for channel incision and found no indication that this would result from channel deepening associated with this project (USACOE, 2005a).

Aquatic Resources

The navigation channel deepening feature would adversely affect important aquatic habitats and species. Backwaters, such as oxbows and dike fields, would be impacted as a result of dredged material disposal, construction and modification of river training structures, and sediment deposition. Gravel shoals would be removed by dredging. Freshwater mussels and fish would be impacted by dredging and disposal of dredged material.

Backwaters are essential to numerous species that are both ecologically and economically important to the system. Degradation and loss of backwater habitats would adversely impact numerous wildlife species. Some waterfowl (*e.g.*, mallard, wood duck) utilize backwater areas for roosting and feeding. Backwater areas also provide important feeding, breeding, and nursery habitat for reptiles (*e.g.*, river cooter, common snapping turtle), amphibians (*e.g.*, leopard, chorus, cricket, and tree frogs), and invertebrates (*e.g.*, freshwater unionids).

Degradation and loss of backwater habitats also would adversely impact numerous species of fish. Species such as largemouth bass, crappie, catfish, and gar depend on backwater areas for foraging habitat and as nurseries (Buchanan, 1976). Loss of this habitat due to dredge spoil disposal, sedimentation, and revetments could substantially affect densities of these species and fish community structure. Largemouth bass are important predators within fish communities and are highly valued recreationally. Reductions in densities of largemouth bass would alter fish community structure and negatively affect the local economies related to recreational tourism.

In addition, many fish species once common to large river systems have experienced sharp population declines following impoundment and channelization (Gilbert 1992; Herkert 1992; Etnier and Starnes 1993; Pflieger 1997). For example, the alligator gar is now very rare in the Arkansas River (Buchanan, 1974 and 1976; Robinson and Buchanan, 1988). Many of these adversely impacted species relied on large backwater floodplains, floods, and uninhibited rivers.

Further loss of backwater habitat could adversely impact the alligator gar and other species dependent on backwater habitats.

Gravel substrates support a diverse array of fishes, many of which are obligate riverine species and sensitive to habitat degradation (Buchanan, 1976). Gravel bars provide important habitat for sturgeon, suckers, benthic minnows, madtoms, darters, and other species. For example, paddlefish, a species of concern in Oklahoma and Arkansas, migrate upstream to spawn over gravel bars in spring (Purkett, 1961; Wallus, 1986).

Loss of these habitats in similar navigation projects has demonstrated their importance to fish species and communities. Species such as paddlefish, shovelnose sturgeon, and numerous darters may be impacted by the loss of gravel substrates associated with dredging. Paddlefish are an ecologically important plankton foraging species and their roe has a high commercial value (Graham, 1997). This species is of particular concern due to the cumulative affects of dams inhibiting fish passage, loss of habitat from channelization, and commercial harvesting. Further loss of habitat could have dire consequences to this species within the Arkansas River system.

Additional sediment accretion and loss of surface waters will result from construction and modification of channel training structures, increased filling rates, and increased dredged material disposal. This will increase the rate of habitat loss and add to the cumulative loss of fisheries backwater habitat, side channels, and islands due to land bridging that has occurred since the initial project completion.

The effects of the deepening feature on the hydrologic and geomorphic characteristics of the Arkansas River ecosystem have not been fully assessed. ERDC-EL conducted a geomorphic assessment to evaluate potential project impacts (USACOE, 2005a). However, as indicate in the Corps report, the results should be considered preliminary due to data limitations of the model. The long-term impacts could be substantial, and would require further study to more accurately ascertain the impacts. For example, over the project life, unanticipated deepening and scouring of the channel during high flow periods could eliminate remaining gravel shoals, an essential habitat component for numerous aquatic species, as discussed above.

Increases in dredging and barge traffic could have additional deleterious effects, including entrainment of aquatic species in the dredge cutter head (Reine and Clark., 1998), increased fish passage through dams, and increased zebra mussel and other invasive species immigration. Fish and mussel entrainment currently occurs with existing maintenance dredging; however, this project would require substantially more initial dredging in addition to long-term maintenance dredging, that will in turn increase the amount of entrainment. While increasing the passage of fish through dams is usually encouraged, in some circumstances increasing passage of non-native or invasive species can have serious consequences. Paddlefish, freshwater eels, alligator gar, sturgeon, and numerous other species likely would benefit from increased passage through locks. However, increased lockage also would allow further introduction and/or immigration of non-native and invasive species, such as zebra mussels, big head carp, and yellow bass. The additional lockage would increase the likelihood of non-native introductions upstream of locks and dams and enhance the ability for species like zebra mussels to maintain high densities.

Waves created by the wakes of more numerous and deeper draft barges could increase the volume and rate of bank failure and subsequent erosion along the river. Currently, waves caused by barges, recreational boats, and wind blowing across wide pools contribute to bank failures and erosion. Increasing the volume and frequency of waves due to barge traffic could exacerbate the extent and rate of bank failure and erosion, further contributing to cumulative losses of riparian and aquatic habitat within the system.

Aquatic Disposal Sites

The multidisciplinary team collectively evaluated the environmental impacts of the proposed dredging and disposal on the MKARNS through HEP analysis. The HEP analysis was used to determine impacts on aquatic habitats and ecological benefits resulting from the proposed mitigation. According to GIS data compiled by the Corps, dredged material would be deposited on approximately 3,020 acres of existing aquatic maintenance dredged disposal sites in Arkansas during continued operation of the navigation system. Under the channel deepening feature of Alternative E, aquatic disposal would occur on an additional 148 acres of aquatic habitat for maintenance dredging, 3,329 acres of shallow water dike field habitat in Arkansas and 237 acres of aquatic habitat in Oklahoma for a total of 6,734 acres. Approximately 5,645 acres and 10,985,340 cy of navigation channel substrate would be dredged for deepening along the MKARNS. In addition, approximately 1,429 acres and 37,704,000 cy of substrate would be dredged for maintenance along the MKARNS for this alternative for a total of 6,238 acres and 44,541,000 cy. Additionally, construction of 92 new and modification of 89 existing river training structures, and the additional 5 new and modification of 9 existing revetments is proposed for this project (USACOE, 2005a).

Because the main channel of the MKARNS currently has numerous training structures and has been previously degraded through establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to maintaining and deepening the channel to 12 feet, and from adding and modifying river training structures, would be quantitatively less than if the river were in a natural state. However, the cumulative loss of habitat from this system only increases the qualitative value of the remaining habitat.

Gravel Bars

Estimates of the total available acres of gravel substrate along the project length were 6,984 acres. Gravel surveys found 165 acres of gravel and 620 acres of sand/gravel mix substrate in proposed dredging areas that would be impacted by the project (Table 24).

Freshwater Mussels

A freshwater mussel survey was conducted by Ecological Specialists, Inc., (ESI) during September, October and December 2004. The new surveys by ESI found no federally-listed or proposed threatened or endangered species within the MKARNS, but did find productive, diverse (29 species total) mussel communities within most reaches of the system.

Table 24. Location and area of gravel and sand/gravel mix substrates in the Arkansas River Navigation Project. All locations coincide with proposed dredging sites for the 11 and 12-ft channel.

Pool	River Mile	Gravel (acres)	Total per pool	Mix sand/gravel (acres)	Total per pool
	108	1.6		7.47	
Pool 5			1.6		7.47
	140	0.11		4.94	
	146	3.42		36.45	
Pool 7	150	17.44		36.88	
	150.5	20.43		1.4	
			41.4		79.67
	186	23.36		144.25	
Pool 9	205	27.8		6.77	
			51.16		151.02
Pool	229	0.61		54.15	
10			0.61		54.15
Pool	361	36.7		154.15	
15					154.15
	374	1.23		55.81	
Pool	393	0.83		41.06	
16	395	3.54		32.93	
			5.6		129.8
	402	7.24		32.14	
Pool	421	20.69		11.82	
17			27.93		43.96
Total		**165**		**620.22**	

The proposed project would impact mussels and mussel habitats, most directly by dredging and disposal of dredged materials in conjunction with constructing a minimum 12-foot channel depth. The potential exists not only for direct removal and burial of mussels, but also for effects on nearby mussels from dispersion of temporarily suspended sediments and destabilization of substrates adjacent to the excavated channel. In addition, the expected operation of larger barges in the MKARNS would increase re-suspension of sediments and other turbulence-related effects in the system (Sparks *et al.*, 1980).

The largest impact to freshwater mussels would occur as a result of dredging impacts to beds found in the Arkansas Post Canal. Recent survey efforts indicate about 2 million mussels may occur in the canal (Ecological Specialists, 2005). The estimate is based on qualitative sampling (41 five minute samples) and there may be considerable variability in the number of mussels present (Ecological Specialists, 2005). Additional mussel concentrations would be impacted by the project. Ecological Specialists (2005) provided specific information on other mussel concentrations that would be affected by proposed dredging and disposal activity. This report can be found in the draft Environmental Impact Statement for the Arkansas River Navigation Study (USACOE, 2005a).

Water Quality and Sediment Analysis

Deepening the channel, constructing or modifying training structures, and increasing the channel volume could concentrate flows and increase the instability of channel substrates. This could result in increased turbidity, oxygen reduction, channel incision, bank failure, headcutting, and backwater sediment deposition. Increased turbidity would affect reproduction of some fish and mussel species, reduce primary productivity, impact foraging, and alter water quality. The construction and modification of new river training structures would have a short-term minor adverse impact on surface water as sediment suspension may increase during construction.

Channel incision, bank failure, and head cutting would contribute to additional habitat loss, suspension of sediments, and sediment accretion in dike fields. Channel incision further eliminates floodplain hydrology causing loss of wetlands and seepage of water from adjacent oxbows. Hydrologic and morphologic modeling of flows and substrates suggest that velocities and water elevations should not cause long-term channel instability that would result in incision or tributary headcutting (USACOE, 2005a). However, these results should be considered preliminary due to the data limitations of the model and lack of prototype information (DEIS Appendix C.8 Geomorphic Assessment). Long-term monitoring should be performed to validate the predictive capability of these models.

Dredging conducted to achieve a 12-foot channel would require the removal of approximately 10,985,340 cy above the volume of material removed by maintenance dredging, which could negatively affect water quality within the MKARNS if any contaminants occur within riverbed sediments. Release and resuspension of contaminants into the water that have been accumulating in sediments for many years could have toxic effects to both aquatic and terrestrial species along the Arkansas River. Additionally, contaminants could be introduced into backwater or adjacent terrestrial habitats through dredge disposal sites.

The Corps conducted a limited sediment analysis along the MKARNS during September 2004 and February 2005. The results of the sediment sampling can be found in Appendix E of the DEIS (USACOE, 2005a). Results of the sediment sampling suggest that the composition and extent of contaminants currently trapped in sediments from Arkansas and Oklahoma are insufficient to cause concern. An Inland Testing Manual Tier I evaluation would be performed along watercourses before dredging is conducted. The Service's comment and recommendation letter regarding the Oklahoma portion of the sediment analysis is provided in Appendix E of this report.

The ODWC has specific concerns regarding dredging activities and sediment analysis within the vicinity of the Sequoyah Fuels Corporation Industrial site located in Gore, Oklahoma. Their comments and recommendations can be found in their concurrence letter in Appendix A.

Increased dredging and barge traffic likely would lead to increased turbidity and sediment deposition (Sparks *et al.*, 1980). These impacts would further contribute to the poor water quality that currently is observed during late summer and fall in the lower ends of pools and in tailwater releases. Low dissolved oxygen concentrations and high nutrient levels often exceed current state water quality standards. Increasing the volume and rate of deposition,

sedimentation, and nutrient transport will contribute to further water quality degradation and impacts to aquatic communities.

NAVIGATION CHANNEL DEEPENING: SUMMARY OF ANTICIPATED IMPACTS

Accurately identifying the nature and magnitude of anticipated impacts is difficult to impossible given the limited amount of data available. Further study prior to project implementation and initiation of long-term monitoring studies would be required to more precisely describe the various impacts that would occur due to deepening the navigation channel. Potential impacts anticipated as a result of this project are provided in Table 22 and summarized below.

- Numerous protected and sensitive species may be affected by this project; however, through long-term monitoring, adaptive management, mitigation, and conservation these species can be protected and preserved;
- Many freshwater mussels and beds throughout the system will be affected either directly by dredging and dredged material disposal or indirectly by increased turbidity and sedimentation;
- Numerous species of fish and associated fish community structure could be affected by additional loss of gravel and backwater habitats associated with dredging and dredges material disposal;
- Various types of terrestrial habitats would be impacted by dredged material disposal;
- Wetlands would be impacted by dredge spoil disposal, sediment deposition, and hydrologic alteration;
- Reduction of gravel and sand shoal habitats would impact important habitat for fish spawning, foraging, and reproduction;
- Loss of backwater and adjacent terrestrial habitat would occur with dredged material disposal;
- Changes in water depth, temperature, turbidity, and velocity of the river downstream of each reservoir would occur;
- An increase in the sediment deposition rate in backwaters, shallows, side channels, and dike fields;
- A reduction in the habitat value of backwater areas, such as oxbow lakes and sloughs, that provide important waterfowl and fish spawning habitat for a variety of species;
- Large woody debris, aquatic vegetation, and vegetated shallows may be further lost to sediment deposition in back waters and side channels; however, these habitats may be conserved or restored through project design and mitigation;

- Impacts to additional lands and habitats will continue and increase;
- Increased potential for the accidental release of pollutants as a result of increased barge traffic.
- Geomorphological changes, such as channel incision, bank failure, headcutting, and scouring are not likely to occur, but should be monitored;
- Increased habitat loss and erosion from bank failures caused by increased barge wake frequency and magnitude;
- Water quality degradation in lower pools and tailwaters from increased sedimentation, turbidity, and deposition, resulting in increased nutrient loading and dissolved oxygen depletion;
- Increased fish entrainment during dredging; and
- Increased non-native and invasive species passage through locks and dams.

Navigation Channel Maintenance Feature

Although smaller volumes of material would be removed more frequently, impacts anticipated from recurring maintenance of the navigation channel depth would generally be the same as those anticipated from the proposed navigation channel deepening feature described in the preceding section. Adverse impacts would occur due to the loss of both terrestrial and aquatic habitats as a result of dredging activities, construction of river training structures, and disposal of dredged material.

DISCUSSION, MITIGATION, AND RECOMMENDATIONS

The Service's overall mitigation goal is to protect and/or enhance important fish and wildlife resources while facilitating balanced development. The Service's Mitigation Policy (*Federal Register* 46(15):7644-7663) provides guidance for formulating measures to avoid, reduce and offset environmental impacts. These guidelines follow the sequenced approach to mitigation presented in the Council on Environmental Quality's National Environmental Policy Act (NEPA) regulations (40 CFR 1508.20). The mitigation definition found in the NEPA regulations consists of five sequential steps: 1) avoiding the impact altogether by not taking a certain action or parts of an action; 2) minimizing impacts by limiting the degree or magnitude of the action; 3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; 4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and 5) compensating for the unavoidable impacts by replacing or providing substitute resources or environments. The primary focus of the Service's Mitigation Policy is mitigation of losses in habitat value, with the degree of mitigation corresponding to the value and scarcity of impacted habitats.

CATEGORIZATION OF FISH AND WILDLIFE HABITATS

Fish and wildlife resources have been categorized in accordance with the Service's Mitigation Policy. Category 2 resources, as defined in the policy, include high quality habitats that are scarce or becoming scarce in the ecoregion or nationwide. Habitats considered category 2 resources within the project area are high quality native prairies, caves, streams (mountain), submerged gravel bars, oxbow lakes and river cuttoffs, bottomland hardwood forests, riparian forests, and other high quality palustrine and lacustrine wetlands, such as river swamp forests. The mitigation goal for this category is no net loss of in-kind habitat value. Section 906(d) of WRDA 1986 also requires that mitigation for impacts to bottomland hardwood forests be in-kind, to the extent possible.

Areas of somewhat lesser quality riparian forests, upland forests, prairies, the Arkansas River proper and its associated tributaries and delta streams, man-made wetlands and reservoirs are assigned to category 3. Category 3 resources include habitat of high to medium value that is abundant on a national basis. The preferred mitigation goal for category 3 habitat is no net loss of habitat value while minimizing loss of in-kind habitat value. Mitigation in-kind for category 3 resources is preferred, but out-of-kind mitigation with no net loss of habitat value is acceptable. The Service's Mitigation Policy is used as a basis for both our impact analyses and in development of conservation recommendations and measures.

FISH AND WILDLIFE MITIGATION MEASURES

River Flow Management Feature

Based on average annual lake levels and river flows, reservoir level fluctuations are expected to change only slightly from current operations. The biological change resulting from implementation of the selected alternative at the controlling reservoirs, as indicated by average water level conditions, would not constitute a significant adverse impact for which mitigation would be required.

The Service believes, however, that in order to fully address potential impacts to fish and wildlife resources at the 11 Oklahoma reservoirs, extreme conditions that could occur during high and low water years also must be considered. As discussed previously, the conditions that occur during extreme high and low years could significantly affect fish and wildlife resources. These effects are not likely to be evident from an analysis based on average annual reservoir levels and stream flows. The effects of changes to the resulting reservoir pool levels would be dependent upon the time of the year in which they occur, duration of inundation, and the elevation, soil characteristics, existing vegetation, and topography of the areas experiencing inundation. Impacts could include altering the littoral zone, killing or injuring vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migratory birds.

Water releases from each reservoir depend on numerous, complex factors such as weather conditions, water storage capacity, inflow rates, river flow rates downstream, hydropower

generation requirements, and navigation water demands. Accurately predicting the effects of the proposed operating plan on the fish and wildlife resources downstream of the reservoirs on the system would be especially difficult. For example, weather patterns which ultimately influence fluctuations in river flow and reservoir pool elevations cannot be predicted with complete accuracy. However, operational changes superimposed upon hydrologic data from a period of record can provide meaningful insight into potential impacts to natural resources.

Uncertainty is an unavoidable component of managing and maintaining the natural resources associated with the system. Unexpected detrimental events are likely to occur. These events will alter fish and wildlife resource values associated with this large and dynamic system.

We believe that the mitigation goal for the fish and wildlife resources associated with the 11 primary flow modifying reservoirs in Oklahoma likely could be met through pro-active conservation actions and monitoring. Therefore, to avoid and minimize potential adverse effects as a result of the Corps recommended River Flow Management feature, and to provide appropriate compensation, the Service recommends that the Corps:

- Incorporate minimum instream flow releases for each reservoir into the selected plan (Orth and Maughan, 1981);
- Conduct angler surveys for a minimum period of five years after the plan has been implemented to assess economic impacts;
- Implement a monitoring program to assess realized impacts to the littoral zones and vegetated areas adjacent to the reservoirs, including the WMAs and agricultural leases managed by the ODWC, at each of the 11 controlling reservoirs in Oklahoma;
- Assess the impacts of the plan on dissolved oxygen concentrations and stream morphology in the rivers below the dams; and
- Develop and implement lake level management plans for the 11 Oklahoma reservoirs, where feasible, to enhance the fishery resources and the migratory bird habitat of these areas.

The lake level management plans should be designed to ensure that unnecessary negative impacts to aquatic fish and wildlife habitat due to seasonal fluctuations in conservation pools are avoided and/or minimized to the greatest extent practicable. We recommend determining, in cooperation with the Service and the ODWC, the most appropriate rule curve management for each reservoir to enhance fish and waterfowl populations. Shallow water habitat that provides spawning and nursery habitat for fish should be made available by making every reasonable effort at holding reservoir pool levels relatively stable during the fish spawning season. Slight seasonal draw downs in summer and early fall would provide areas to seed waterfowl food plants, such as millet or sorghum, on suitable exposed mudflats around the reservoirs and would facilitate the natural establishment of wetland vegetation. Flooding these areas during late fall then would provide foraging habitat for wintering waterfowl. The Service's Waterfowl Management Handbook (USFWS, Fish and Wildlife Leaflet 13) provides a single source of information regarding the management of waterfowl and their habitat. This handbook is

available as a series of chapters and can be accessed at the following website: <http://www.nwrc.usgs.gov/wdb/pub/wmh/preface.html>.

Implementation of the selected plan would reduce the duration of flooding in the floodplain. Because the hydrology of floodplain wetlands would be altered, important wetland habitats may be adversely impacted. Unfortunately, sufficient information to determine the extent of those impacts is lacking. In order to adequately assess impacts to these wetlands and to compensate for any unavoidable losses, we recommend that the Corps:

- Identify the specific lands that would receive flood protection benefits;
- Determine the quantity (acres) and quality (habitat type and value) of wetlands that the selected operating plan would alter;
- Obtain conservation easements in floodplain areas that would be protected from flooding to deter floodplain development;
- Determine the quantity (acres) and quality (habitat type and value) of wetlands that should be acquired and/or managed to compensate for wetland losses; and
- Provide compensatory mitigation for any unavoidable wetland impacts.

Navigation Channel Deepening and Maintenance Features

Dredging and disposal of sediments would be necessary to achieve and maintain a 12-foot navigation channel. These actions would have substantial direct and indirect effects to both the aquatic and terrestrial sites in which they would occur. Impacts anticipated from deepening and maintaining the proposed navigation channel depth would occur as a result of losses to both aquatic habitat, due to dredging and construction of river training structures, and to terrestrial habitat due to disposal of dredged material. Because the impacts of maintaining the navigation channel depth generally would be similar in nature as those anticipated from the proposed navigation deepening feature, we discuss mitigation recommendations for these project features together.

Presently the interagency evaluation team has completed the impact assessment for the terrestrial disposal sites in Oklahoma. Unfortunately, the team does not have complete assessments for in-stream dredged material disposal sites in Oklahoma or Arkansas. There is great potential for this action to substantially and continually impact the habitat and species along and within the Arkansas River ecosystem. We anticipate substantial direct and indirect effects to both the aquatic and terrestrial sites in which they will occur.

The Service, Corps, and ODWC worked cooperatively during the planning process to avoid unnecessary impacts to high quality fish and wildlife habitat. Potential disposal sites were either relocated or reconfigured during project planning stages in order to avoid impacts to bottomland hardwoods, wetlands, and high quality floodplain forest.

For example, four of the 43 originally proposed dredged material disposal sites in Oklahoma were proposed to be located on lands licensed to the State for fish and wildlife management. Disposal of dredged material on these sites would have directly impacted about 109 acres of land in the Choteau and Webbers Falls units of the McClellan-Kerr WMA, which largely consist of bottomland habitat along the channel and scattered agricultural fields.

The HEP models and data provided by the interagency team were used by ERDC-EL to evaluate impacts from dredged material disposal and determine mitigation needs. Out of bank disposal of dredged material in Oklahoma is expected to result in the loss of 220 acres of old field grassland and 170 acres of open field grassland over the 50-year project life. Fifteen acres of bottomland hardwood forest and 287 acres of floodplain forest also are anticipated to be lost with the proposed project over the 50-year project life. Most of the forested acres expected to be lost is an artifact of the natural succession of many old field sites along the navigation system to early forest stages over the project life.

A plan for mitigating unavoidable terrestrial disposal impacts in Oklahoma was developed through interagency cooperation by biologists with the Corps, Service, and the ODWC. The proposed mitigation plan was developed in accordance with the Service's Mitigation Policy with the primary focus on concerns for potential habitat value losses. The plan was developed to ensure that losses, as measured in habitat value, rather than in acres, would be offset over the 50-year project life.

The compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that currently are agricultural fields: OK 405.0 and OK 408.9 (Figure 3). The proposed mitigation plan would consist of a total of 248 acres of marsh creation and 130 acres of bottomland hardwood restoration. Recommended compensatory mitigation at the site near river mile 405.0 would consist of 157 acres of marsh creation and 61 acres of bottomland hardwood restoration. Recommended compensatory mitigation measures at the site near river mile 408.9 would consist of about 91 acres of marsh creation and about 69 acres of bottomland hardwood restoration. The restored bottomland hardwood forests and marsh wetlands would compensate for impacts associated with disposal of dredged material on terrestrial sites. Although the number of acres restored would be less than the acres impacted, the quality of habitat anticipated to be gained through this mitigation plan (HSI range 0.7 – 0.75) is much higher than that lost through disposal of dredged material (HSI range 0.28 – 0.50). This plan should completely offset losses of habitat

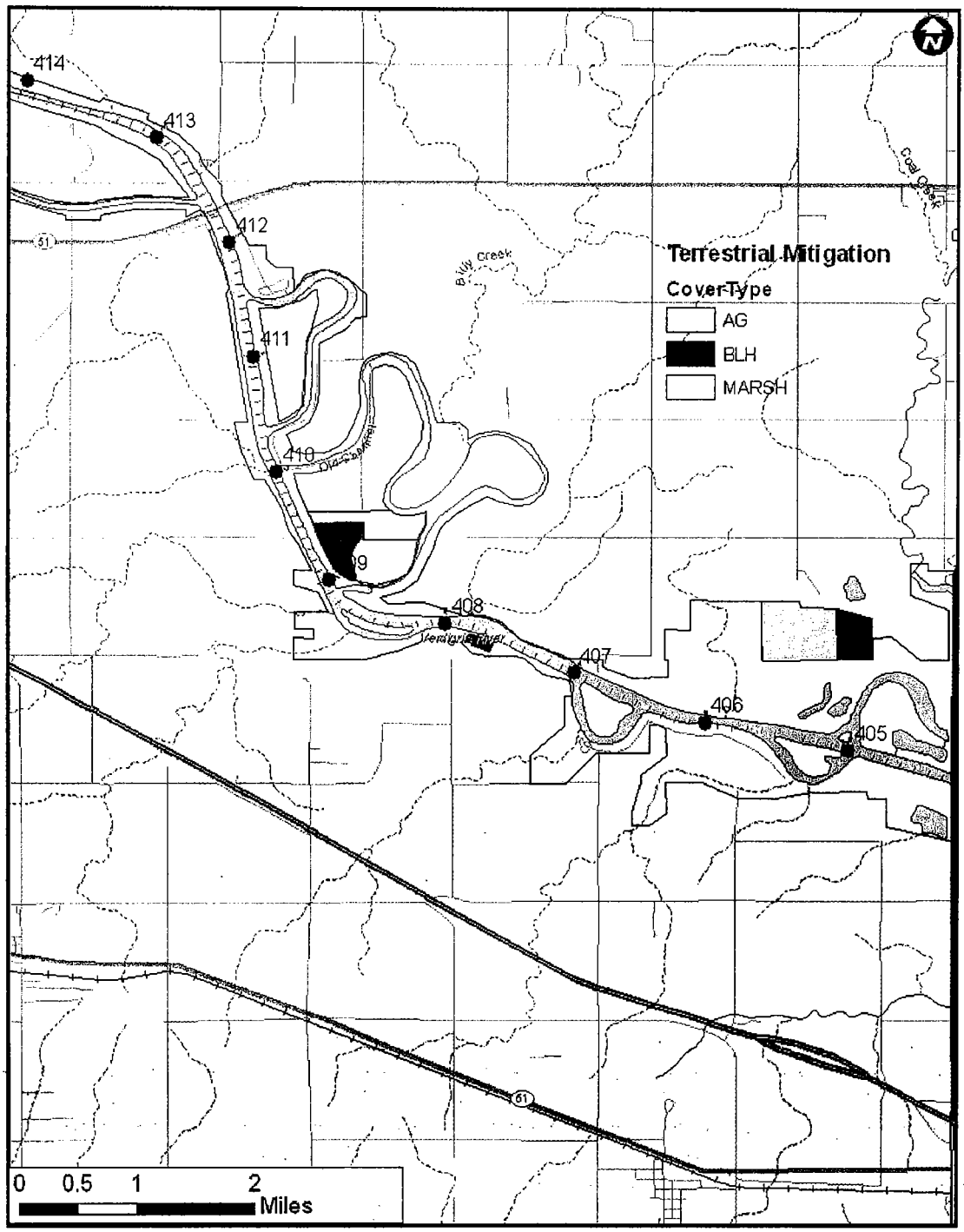


Figure 3. The terrestrial compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that currently are agricultural fields.

value over the 50-year project life that would occur as a result of terrestrial disposal of dredged material in Oklahoma (Tables 25, 26, and 27).

Appendix F provides additional preliminary recommendations pertaining to tree plantings, monitoring, and remedial actions for bottomland hardwood restoration. We recommend developing detailed restoration, monitoring, and contingency plans through interagency coordination for both the bottomland hardwood and marsh wetlandrestoration sites. The resource agencies should be afforded the opportunity to review the final mitigation plan prior to implementation.

Dredged material disposal sites OK 379.1 L-DI and OK 389.7 L-DI occur on land allocated to the ODWC for fish and wildlife resource management. These lands are currently in agricultural leases. The ODWC utilizes revenue gained from agricultural leases to support management activities on WMA lands. Construction of dredged material disposal pits at these locations would result in the loss of 80 acres of WMA lands currently in agricultural leases and the important revenue gained from these leases. Because agricultural land used as food plots is assumed to have a constant HSI value of 0.24 throughout the project life, recommended compensatory mitigation for this impact is to replace this land at a 1:1 acre ratio with agricultural land adjacent to the recommended mitigation sites (Figure 2).

Table 25. Summary of terrestrial acres and AAHUs anticipated to be lost as a result of the selected plan.

	Bottomland Hardwoods	**Upland Forest**	**Forest Total**	**Old Field**	**Open Field**	**Grassland Total**
Sum of Acres Lost	-15	-287	-302	-220	-170	-390
Sum of AAHUs Lost	-7.3	-76.4	-83.7	-123.8	-71.0	-194.0
Average Annual HSI Value			0.28			0.50

Table 26. Summary of terrestrial habitat acres and AAHUs anticipated to be gained as a result of the recommended mitigation plan for unavoidable impacts to terrestrial resources.

Mitigation Site	**Bottomland Hardwoods**			**Marsh**		
	Acres gained	**Net AAHUs Gained**	**HSI Value of Mitigation Sites**	**Acres Gained**	**Net AAHUs Gained**	**HSI Value of Mitigation Sites**
408.9	69	48.3		91	66.6	
405.0	61	42.7		157	131.3	
Total	130	91.0	0.7	248	197.9	0.75

Table 27. Summary of the Net Loss and Gain of AAHUs anticipated as a result of the selected alternative and the recommended terrestrial mitigation plan.

Compensatory Mitigation for Forest Impacts Anticipated to be Realized through Bottomland Hardwood Restoration		**Compensatory Mitigation for Grassland Impacts Anticipated to be Realized through Marsh Restoration**		**Compensatory Mitigation for Grassland Impacts Anticipated to be Realized through Bottomland Hardwood Restoration**	
Bottomland and Upland Forest AAHUs loss	-83.7	**Grassland AAHUs Loss**	-194.0	**Carry over AAHUs from BLH gain**	+7.3
Bottomlnad Hardwood AAHUs Gain	+91.0	**Marsh AAHUs Gain**	+187.0	**Deficit AAHUs for Grassland Impacts after Marsh Benefits Applied**	-7.0
Net Gain or Loss	+7.3	**Net AAHUs Gain or Loss**	-7.0	**Surplus of AAHUs after Net Bonus BLH AAHUs Applied**	+0.3

Eight additional sites were selected by the interagency team for which appropriate mitigation measures likely could be developed to improve habitat value and offset losses, such as river cutoffs and oxbows along the Verdigris River (Table 28). The Service has repeatedly sought conservation for the oxbows because they represented some of the most valuable habitat remaining after the original construction of the navigation system. Additional potential mitigation features and sites also were identified in the Service's planning assistance letter dated June 15, 2004. More information pertaining to additional mitigation sites, including locations and potential AAHUs, also can be found in the HEP Appendix of the Corp's draft Environmental Impact Statement for ARNS. Alternative mitigation plans would be acceptable to the Service and ODWC provided that the plan was 1) developed through interagency coordination, and 2) demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

Table 28. Potential mitigation sites for unavoidable impacts to terrestrial resources as a result of disposal of dredged material in the floodplain.

Potential Mitigation Area by River Mile	River Bank	Bottomland Hardwood Restoration (acres)	Marsh Wetland Restoration/Creation (acres)
406.0	Left	162	38
408.9	Left	69	91
405.0	Left	61	157
410.4	Left	124	46
412.4	Right	570	224
415.2	Right	626	500
410.11	Left	106	38
419.5	Left	1,074	176
420.5	Left	140	44
422.8	Right	332	70
379.1	Left	40	0
379.1 Alternative	Left	0	40
389.7	Left	40	0
389.7 Alternative	Left	0	40

Maintaining the habitat value of compensatory mitigation lands likely would require on-going maintenance and management efforts. Without these efforts, the habitat value of the lands is likely to decrease and fail to meet mitigation projection goals. Losses in habitat value as a result of the project, therefore, would not be offset by appropriate mitigation without ongoing maintenance and management. In accordance with section 2 (d) of the FWCA, costs to carry out fish and wildlife conservation measures are to be considered project costs. Furthermore, section 906 (c) WRDA 1986 states that the costs of fish and wildlife mitigation are to be cost-shared at the same rate as the project purpose causing the impact. Navigation projects are fully federally-funded. The Corps should seek full congressional funding for Operation and Maintenance (O and M) needs. These funds should be provided to the managing entity on an annual basis. An O

and M budget should be developed in cooperation with the managing entity prior to project implementation.

Aquatic Resources

Deepening the navigation channel would have significant adverse impacts on aquatic fish and wildlife resources. The primary impacts would include the loss of back water and side channel aquatic habitat due to dredging, dredged material disposal in aquatic sites and the construction and raising of river training structures; the removal and alteration of gravel bars through dredging; and direct adverse effects on freshwater mussel patches and beds *(i.e.,* mussel concentrations) due to dredging activity and the disposal of dredged material.

Additional impacts to important aquatic fish and wildlife resources are certain to occur as a result of the proposed plan, including impacts to water quality, re-suspension of contaminants in dredged areas, impacts to mussel concentrations near dredging and disposal areas, and incision and headcutting in tributary streams. However, an adequate assessment of these types of impacts cannot presently be conducted and will require long-term monitoring. Our recommendations for long-term monitoring can be found in the "Environmental Management Program" section below.

The impacts to aquatic fish and wildlife resources anticipated as a result of disposal of dredged material in dike fields and backwater areas, and the construction/modification of river training structures, are being evaluated using HEP. The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. The ERDC-EL is using HEP to determine aquatic impacts and necessary mitigation features using data provided by the interagency team. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report.

The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. The Service is willing to continue coordination with the Corps and our State partners to assist in the analysis and development of an appropriate aquatic resource mitigation plan that would ensure aquatic resource impacts would be offset. The following sections discuss the need for fish and wildlife mitigation measures, discuss the current status of the impacts analysis, and recommend measures that would avoid, minimize, and compensate for anticipated project impacts.

Aquatic Resources: Aquatic Disposal Sites and River Training Structures

Disposal of dredged material in backwater habitats will have significant adverse impacts to aquatic fish and wildlife resources. The rate and extent of loss of backwater areas will increase as a result of increased sedimentation from dredged material disposal and deposition associated with this project. Results from the aquatic habitat impacts analysis illustrate a positive relationship between fish abundance and the depth of dike pools. This implies that reducing water depth in a dike field through dredged material disposal and new training structure

construction and modifications would have a major adverse impact to fishes. However, high quality habitat could be avoided, thereby minimizing the impact of this action.

There has been an ongoing effort to restore and maintain many backwater areas in Arkansas through dike notching to facilitate removal of accreted sediments. Additional dredged material disposal in these areas would contribute to the cumulative loss of habitat and the overall degradation of fish and wildlife resources within the MKARNS.

Careful planning prior to open water disposal, however, could provide opportunities to enhance and/or create important fish and wildlife habitat. Areas that already provide high quality habitat, such as backwater channels and oxbows, should not be considered for the disposal of dredged material. Dredged material also could be used to create, rebuild, or enhance island and/or marsh habitat in existing areas of low habitat quality.

Island creation or enhancement generally requires the disposal of suitable dredged material on existing islands or in shallow water areas. Although substrate preferences vary by target species, coarse material generally should be used in island creation or enhancement due to its greater stability. The elevation of created islands should be high enough to minimize flooding of nesting areas, but low enough to minimize excessive wind erosion. Generally, islands that provide the highest benefits for wildlife have similar characteristics. These islands tend to: 1) be separated from the mainland a sufficient distance or with a surrounding water depth of about 1.5 - 2 feet to provide relatively predator-free nest sites, 2) have a high ratio of water edge to land mass, and 3) be in close proximity to loafing sites and food sources.

Marsh habitat development would consist of utilizing the dredged material to change a deep water area into a shallow water wetland. Achieving the desired elevation requires detailed management of the quantity and configuration of dredged material disposed at the site.

The guidelines and criteria followed for a particular habitat development/creation project ultimately should be based on the target species for which the habitat is being created. For example, islands created specifically for interior least tern nesting habitat should be separated from the mainland to reduce access by predators. The portion of the island above the water surface should be capped with a sandy substrate. A vegetation management program designed to control vegetation would be necessary to ensure appropriate nesting requirements are met over the project life.

The Service's "Resource Publication 149: Mitigation and Enhancement Techniques for the Upper Mississippi River System and Other Large River Systems" (Schnick *et al.*, 1982) provides valuable information on the use of dredged material to develop high quality island and marsh habitat. This information includes guidelines, disposal techniques, required equipment and materials, and references to many other important scientific papers and reports concerning the use of dredged material to enhance or create habitat.

Additionally, the Sandtown Bottoms area along the Arkansas River and within the Sequoyah NWR has experienced heavy shoreline erosion due to wind-driven wave action, river current

erosion, and boat/barge traffic. The Service recommends that the Corps investigate the feasibility of using dredged material and structures, such as geo-tubes, in order to: a) provide long-term erosion control, b) provide a substrate for riparian vegetation establishment, and c) increase the aesthetic value of the area. The use of such structures would restore wildlife habitat value to the area by facilitating the development of riparian vegetation and, thereby, contributing to the environmental quality of the refuge's natural resources. We believe that dredged material could be used as fill for the tubes. The use of dredged material as bank stabilization material would sufficiently minimize shoreline erosion due to ongoing and future operations of the MKARNS.

Numerous dike fields currently occur along the navigation system and many new dikes would be constructed or modified as part of the proposed project. These structures will be used to guide the river and maintain the navigation channel. Adding notches to rock dikes would increase the habitat quality and diversity of dike fields and allow the dikes to continue to provide their navigation function. The river would be allowed to move in and out between the notches, while sediment build up would likely result in small islands between dikes.

Traditionally, side channels and oxbows were closed with rock structures to divert flow into the main channel. Re-opening side channels and oxbows would serve to minimize and rectify project impacts by reestablishing fish access to important habitats used for foraging, breeding, and refuge.

Aquatic Resources: Status of the HEP Analysis and Recommended Mitigation for Disposal Sites and River Training Structures

The interagency evaluation team has developed a mitigation plan based on the following avoidance, minimization, and compensatory features:

- Relocate disposal areas to alternate sites that avoid valuable aquatic habitat;
- Notch dikes and revetments to reduce fill rates and create side channel habitat;
- Re-open connections to oxbows/backwaters and side channels;
- Create islands for aquatic diversity and tern habitat;
- Create marsh habitat at aquatic disposal sites to offset disposal impacts;

The following assumptions were made in developing the plan:

- Alternative disposal sites would be feasible provided they were within one mile of the proposed dredge area;
- Raising dikes and revetments would accelerate filling by 50 percent;
- Notching dikes and revetments would reduce the rate of fill by 50 percent;

- Notches would be one per structure, in the middle third of the structure, 20 feet wide, and to a depth of 3-feet below the normal pool elevation;

- Backwater areas could be reconnected after addressing landowner and section 404/401 Clean Water Act issues;

- Island and marsh habitat could be created where adequate volumes of dredged material allowed; and

- Due to the uncertainty of the success of mitigation features, the Corps and ERDC would develop a long-term monitoring plan and adaptive management strategies through interagency coordination.

Habitat Suitability Index values were determined for the aquatic mitigation sites based on best professional judgment of the biologists on the interagency team. Red Hen flight video footage, local expertise, and familiarity with the areas were used to assist in the selection of HSI values. Acreages for the sites were digitized by the Corps. The results of this interagency effort resulted in a detailed database containing quantitative and qualitative data on impact and mitigation sites.

Dike field impacts would result in an overall loss of 1021.6 AAHU along the entire length of the project. Benefits from approved and partially approved mitigation projects resulted in a gain of 636.8 AAHU. However, the mitigation and avoidance/minimization efforts of the project fail to fully compensate for anticipated project impacts to aquatic resources. The existing HEP analysis indicates a net deficit of 429.4 AAHU (Table 29).

The filling rate coefficient (*i.e.,* rate of fill anticipated to occur in dike fields; see evaluation methods section for more information) used for the current analysis was initially based on dredging maintenance records over the last eight years from Arkansas pools only. The interagency team concluded that filling rates should be derived from dredging maintenance records over the last 24 years for representative pools in Arkansas and Oklahoma to more accurately reflect future conditions. The filling rate coefficients are currently being modified.

Aquatic mitigation features considered to date would result in a net gain of habitat units in Oklahoma, but a deficit in Arkansas. The Little Rock District, Service staff from Arkansas, and the AGFC have recently developed additional and modified mitigation features for the Arkansas portion of the project. Future HEP analysis of impacts and mitigation features should incorporate the new filling rate and the additional mitigation features for the Arkansas portion of the project. Additional and modified compensatory mitigation recommendations for aquatic resource impacts for the Corps consideration during development of the complete mitigation plan is provided in Appendix G. Incorporating these mitigation features into the mitigation plan would serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

Table 29. Aquatic impacts and benefits by project alternative for the Arkansas and Oklahoma portions of the Arkansas River Navigation Project.

	Arkansas	Oklahoma	Total
WITHOUT PROJECT	**5797.8 AAHU**	**782.9 AAHU**	**6580.7 AAHU**
IMPACTS[1]			
11-ft Channel	**- 583.7 AAHU**	**- 35.4 AAHU**	**- 619.2 AAHU**
12-ft Channel	**- 963.1 AAHU**	**- 58.5 AAHU**	**- 1021.6 AAHU**
BENEFITS[2]			
Approved Mitigation			
11-ft Channel	**+ 459.1 AAHU**	**+ 199.0 AAHU**	**+ 658.2 AAHU**
12-ft Channel	**+ 439.4 AAHU**	**+ 197.3 AAHU**	**+ 636.8 AAHU**
Avoid/Minimize			
11-ft Channel	**+ 299.3 AAHU**	**+ 22.8 AAHU**	**+ 322.1 AAHU**
12-ft Channel	**- 43.3 AAHU**	**- 1.3 AAHU**	**- 44.6 AAHU**
NET GAIN/LOSS[3]			
11-ft Channel	**+ 174.7 AAHU**	**+ 186.3 AAHU**	**+ 361.1 AAHU**
12-ft Channel	**- 566.9 AAHU**	**+ 137.5 AAHU**	**- 429.4 AAHU**

[1] With Project AAHU – Without Project AAHU = Impacts AAHU

[2] Mitigation AAHU – Without Project AAHU = Benefits AAHU

[3] Benefit AAHU - Impact AAHU = Deficit/Gain AAHU

Aquatic Resources: Gravel

Gravel bar surveys in proposed dredging locations indicated that 165 acres of gravel substrate potentially could be impacted. Gravel is a finite resource and limited in distribution and abundance within the system. Any impacts from dredging would be a primary concern because of the inherent habitat value of gravel bars. Gravel substrate has been documented as important spawning habitat for numerous species of fish, such as paddlefish, darters, and shovelnose sturgeon. Results from the aquatic habitat impacts analysis illustrates a positive relationship between fish abundance and the amount of gravel and sand/gravel mixture available. It implies that reducing the amount of gravel substrate in the channel through dredging and construction or modification of training structures would have a major adverse impact to fishes.

Conservation of imperiled species and the overall loss of gravel substrates from anthropogenic disturbances fully justify creation or relocation of gravel bars as a mitigation feature. The mitigation goal should be no net loss of pure gravel bars. Appropriate mitigation should involve either relocating gravel that is dredged to a nearby, suitable area or establishing gravel bars by transporting dredged gravel to other more distant but suitable sites within the project area. Through project design modifications and mitigation, important gravel habitats can be conserved and possibly even restored to many locations along the river. Relocation efforts should be followed with long-term monitoring and adaptive management to ensure mitigation features can provide both conservation and restoration of these habitats within this system. Specific recommendations are provided in Appendix G to minimize and rectify impacts to gravel bars over the project life.

Aquatic Resources: Mussels

Dredging and disposal of sediments would directly affect freshwater mussels inhabiting this system. Indirectly, mussels are likely to be impacted by changes in water quality, sediment destabilization, host fish impacts, and increased invasive species introductions. A mussel survey of the MKARNS was conducted in 2004 by Ecological Specialists (Ecological Specialists, 2005). Service comments on the study and recommendations to avoid, minimize, and compensate for freshwater mussel impacts were provided in planning aid letters dated April 29 and May 11, 2005, respectively. These letters can be found in Appendix H.

Many of the anticipated aquatic resources impacts from navigation channel maintenance would be similar in nature to those anticipated from the proposed navigation deepening feature. Potential impacts would include reduction of gravel bar habitat, loss of terrestrial and backwater habitat due to dredged material disposal, changes in water quality, adverse impacts to fish spawning and recruitment, a change in the habitat value of backwater areas (*e.g.*, oxbow lakes and sloughs that provide important waterfowl and fish spawning habitat), morphological changes (*e.g.*, channel incision, bank failure, head cutting, and scouring), potential for contaminant re-suspension and relocation within the water column and adjacent habitats that could affect organisms, and continued water quality degradation in lower pools and tailwaters from increased sedimentation, turbidity, and deposition resulting in increased nutrient loading and dissolved oxygen depletion.

Sediment Analysis

The fish and wildlife agencies strongly recommend further analysis of dredged material for contaminants prior to disposal. Specific disposal measures to minimize the environmental impact of disturbance, transport, and disposal of contaminated sediments should be developed and utilized where necessary. The resource agencies should be afforded the opportunity to review and comment on these measures. This issue is not only relevant from the standpoint of impacts to fish and wildlife resources, but also is a public health concern.

The ODWC has specific concerns regarding dredging activities and sediment analysis within the vicinity of the Sequoyah Fuels Corporation Industrial site. Their comments and recommendations can be found in their concurrence letter in Appendix A.

In summary, a complete mitigation plan for terrestrial impacts at disposal sites in Oklahoma has been proposed. Aquatic mitigation features considered to date would result in a net gain of habitat units in Oklahoma, but a deficit in Arkansas. Additional and modified compensatory mitigation recommendations for aquatic resource impacts for the Corps consideration during development of the complete mitigation plan is provided in Appendix G. Incorporating these mitigation features into the mitigation plan would serve to adequately offset aquatic resource impacts.

Many of the effects of this project cannot be mitigated in-kind due to the nature of the project and its impacts. Compensation for impacts occurring from the filling of terrestrial and aquatic disposal areas can and should be achieved by restoring and maintaining habitats that are lost. Loss of main channel gravel shoals may not be adequately mitigated and restored in-kind because these habitats must be dredged and continuously maintained at a 12-foot navigation channel depth. Side channel or out-of-channel gravel substrate and shoals may not naturally be sustained or remain suitable as habitat for some aquatic species. Therefore, out-of-kind mitigation may be necessary to maintain these species within the system.

There are many indirect effects to habitats and species that cannot be quantified or qualified due to time constraints, data limitations, and our lack of knowledge regarding the functions of large river ecosystems and the effects of navigation projects. Initiation of long-term analysis and ecosystem monitoring is necessary to adequately assess potential impacts to fish and wildlife resources (see Environmental Management Program below). Only in time can the necessary data be collected and assessed to fully comprehend and establish correlations indicating the extent of project impacts to habitat, water quality, fish communities, productivity, and individual species.

Should further analysis indicate that adverse impacts to fish and wildlife resources along the river likely would occur, we believe that the mitigation goal for Category 3 resources likely could be met through enhancement and conservation actions throughout the river such as:

- creation and seeding of shallows and backwater areas to restore and enhance habitat lost for migrating waterfowl and fisheries;

- providing ODWC and AGFC funds for the construction and/or enhancement and management of islands, floodplains, green tree reservoirs, marshes, and/or other fisheries and waterfowl resources affected by the project in a coordinated and comprehensive conservation program;

- providing funds for monitoring studies by ODWC, AGFC, and/or ERDC in a coordinated and comprehensive monitoring program to assess impacts, identify correlations, and develop future adaptive management and mitigation options;

- providing funds for fish management, stocking, and habitat mitigation based on future impact assessments and recommendations for maintaining species viability;

- providing funds to ODWC and AGFC or assisting in the restoration and maintenance of in-stream habitat and improvement of habitat diversity by notching dikes, constructing hardpoints, and restoring connections with oxbows and side channels where possible; and

- creating, restoring, and maintaining vegetation free islands at suitable elevations for the least tern along the entire length of the MCKARNS to aid species recovery and guarantee species viability.

In order to adequately assess impacts and to compensate for unavoidable losses, we recommend that the Corps:

- Continue to work with the interagency evaluation team to finalize the aquatic impact assessment. The assessment should determine the quantity (acres) and quality (habitat type and value) of resources that would be impacted and that would require mitigation; and determine the quantity and quality of habitats that would be acquired and/or managed to compensate for habitat losses;

- Implement mitigation for identified and quantifiable impacts by restoring, enhancing, and/or creating substitute habitats within the project area; and develop a long-term coordinated and comprehensive environmental monitoring and assessment program to collect baseline data, identify additional impacts, develop recommendations, and propose future adaptive management and mitigation measures. A conceptual environmental monitoring and assessment program is discussed in more detail below in the section titled Environmental Management Program. We also provide a paper on a conceptual program in Appendix C.

ENVIRONMENTAL MANAGEMENT PROGRAM

The effects of the development, operation and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, wetlands, backwater areas, and in the main stem of the navigation channel) likely would have long-term consequences that cannot be adequately identified, predicted , or appropriately assessed without long-term studies and extensive

monitoring efforts. Due to the large project area and complex variables that can influence the navigation system, uncertainty is an unavoidable component of managing and maintaining the natural resources associated with this large river ecosystem. For example, predicting weather patterns which ultimately influence fluctuations in river flow and reservoir pool elevations is not possible with complete accuracy. Furthermore, unpredictable potential impacts to the aquatic environment could result from a number of factors: 1) an increase in commercial shipping would increase the risk of potential spills of pollutants (*e.g.*, oil, fertilizers, chemicals, etc.) into the aquatic environment; 2) an increase in municipal and industrial development along the system would increase the number of discharges (point and non-point) into the system and cause direct loss of habitat; 3) dredging and aquatic dredged material disposal would modify the amount and type of fish and wildlife habitat available in impacted areas. These events would alter fish and wildlife resource values associated with this large and dynamic system.

Due to the potential for future impacts to the natural resources associated with the navigation system, sustained, long-term monitoring efforts appear to be warranted (Buchanan, 1976). Section 306 WRDA 1990 made environmental restoration one of the primary missions of the Corps, permitting the Corps to undertake studies and implement projects that restore habitat. Section 906 (b) of WRDA 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife resources resulting from any water resource project under Corps jurisdiction, whether completed, under construction, or proposed to be constructed. The long-term studies and monitoring program could serve as an adaptive strategy to: 1) facilitate the development of appropriate conservation measures that would restore and maintain the habitat value of the fish and wildlife resources associated with the navigation system over the project life, 2) assess the true magnitude of the cumulative impacts from the development, maintenance, and continued operation of the system, and 3) identify and address any unanticipated mitigation needs. Assessing unforeseen beneficial and adverse impacts to fish and wildlife resources may be the only guaranteed means to ensure that the important fish and wildlife resource values associated with the system, as discussed throughout this report, are restored and maintained.

Therefore, to maintain and restore the habitat value of the fish and wildlife resources affected by the MKARNS, we recommend that the Corps utilize the authority provided under section 906 (b), WRDA 1986 and section 306, WRDA 1990 to:

1) (a) Seek full Congressional authorization and funding for a Cooperative and Comprehensive Environmental Management Program. The program would be based on long-term monitoring and relevant environmental studies that would occur before, during and following project implementation and extending until such time as sufficient data have been collected to clearly accurately determine the full extent of environmental impacts, establish any needed post project mitigation measures, and develop a coordinated and comprehensive management plan encompassing the life of the proposed project. (Table 30 provides a preliminary example of needed long-term monitoring studies developed by the interagency team to date). The purpose of the program would be to monitor Arkansas River resources to assess project impacts and develop proposed recommendations for adaptive management and mitigation measures. Cooperation and partnerships are essential to effectively assess, comprehend and manage the complexities of this large river ecosystem. The establishment of a coordinated

monitoring program that combines the efforts and resources of local, state, federal, and private natural resource agencies would be ideal. The waters, islands, and floodplain riparian corridor owned by the Corps, along with the NWRs, state wildlife management areas, state parks, and/or non-governmental organization conservation lands comprise an extensive complex of important fish and wildlife resources in the Arkansas River Valley. Coordinated, comprehensive management of these important lands and waters would provide benefits for habitat diversity, species viability, and corridor connectivity that likely could not be achieved by independent management efforts alone.

1) (b) Establish multiple resource monitoring stations along the navigation system as an effective means of meeting the objectives of a monitoring program. Monitoring stations would facilitate the following:

    - Identification and quantification of project impacts to fish and wildlife resources that are attributable to construction and operation of the MKARNS for the entire navigation system (including the upstream reservoirs, rivers, and wetland and terrestrial habitats);

    - Planning to address these impacts and the development of an interagency mitigation plan for any unmet mitigation needs. The mitigation plan should include: a) actions discussed in this report, such as habitat restoration, enhancement, and creation projects within the project area for habitats used by federally-listed species, rare/declining species, and species popular with local anglers and hunters; and b) acquisition of ecologically valuable habitats that are scarce in the ecoregion and/or provide quality fish and wildlife resource-associated recreational opportunities. These lands should be considered for addition to the national wildlife refuge system, state wildlife management areas, or other appropriate natural resource agencies' holdings for fish and wildlife resource management purposes; and

    - Identification of undesirable, on-going or future impacts and trends, unexpected adverse effects, and the necessary remedial actions to compensate for impacts, restore habitat, or reverse undesirable trends.

2) Establish an interagency McClellan-Kerr Arkansas River Navigation System Conservation Committee to coordinate efforts and oversee the Environmental Management Program. The committee would serve to formulate and assist in implementation of plans, studies, and necessary conservation measures designed to enhance, restore, compensate for losses, and maintain the fish and wildlife habitat value associated with the navigation system. A coordinated and comprehensive approach is necessary to effectively manage a large river ecosystem and maintain the corridors and species viability within the system. The committee should be made up of biologists from the ODWC, AGFC, Corps, the Service (refuge and ecological services staff), and experts from local and regional universities. The committee would evaluate reports from the Corps, ODWC, AGFC, and the Service regarding impacts to fish and wildlife resources associated with the system as identified through the Environmental Management Program. Examples include adverse impacts to terrestrial

and/or aquatic resources managed by the ODWC during extreme high and low water years, backwater areas, and gravel shoals. The reports also would include the conservation measures needed to adequately compensate for the loss of fish and wildlife habitat value and to assure continued effectiveness of mitigation features.

3) Establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program.

The cost of any long-term monitoring program and the recommended mitigation fund should be considered in the Corps benefit:cost analysis for ARNS. A long-term monitoring program and associated mitigation fund is necessary to ensure adequate compensation for impacts to fish and wildlife resources and to maintain the quality of fish and wildlife resources. Significant benefits to local, state, and regional economies likely could be realized as a result of the Environmental Management Program through an increase in fish and wildlife resource-associated recreational activities within the project area. Outdoor recreation continues to be popular with a large segment of the American people. For example, in 2001, U.S. residents nationwide spent more than $108 billion dollars while pursuing fish and wildlife related activities. In Oklahoma alone, wildlife observers, hunters, and anglers spent over $193, $248, and $476, million dollars, respectively (USDOI and USDOC, 2001). In 2002, over 35 million people visited national wildlife refuges throughout the country. Their expenditures (*e.g.*, lodging, food, equipment, etc.) generated over $809 million in regional economies (USFWS, 2003). An increase in outdoor recreation activities is likely to occur within the project area should the objectives of the Environmental Management Program be realized. Increases in the quality of habitat supporting fish and wildlife populations would lead to more opportunities for outdoor enthusiasts over the 50-year project life.

FISH AND WILDLIFE ENHANCEMENT MEASURES

The Service recommends making every possible effort to operate the MKARNS in a manner that promotes the health and diversity of the various ecosystems associated with and impacted by the MKARNS. Today, there are innovative river structures and concepts that can be used to improve navigation, while still providing positive benefits to the environmental resources of a highly altered area, such as the MKARNS (USFWS, 1982). For example, backwater areas adjacent to the MKARNS, such as sloughs, oxbows, river cutoffs, dike fields, and side channels, that serve as important spawning and nursery areas for many fish species are being negatively impacted or lost due to enclosed dikes, revetments, and accreted sediments blocking connection to the channel. Notching the dikes and revetments allows flow behind the structure to scour out areas that have silted in, and allows fish access to important spawning, nursery, foraging, and flow refugia areas. In addition, geotubes and chevrons could aid in creating braided side channels and diversifying bottom contours and substrates. Creating sand islands on or downstream of these structures could restore least tern habitat in areas where sand islands have been lost due to wave action, reductions in flows, and/or vegetative encroachment.

Table 30. Preliminary list of monitoring needs for the Arkansas River Navigation Project.

Task/Activity	Annual Cost (x1000)[1]
1 – Sediment dynamics in dike fields and backwaters • Bathymetry • Substrate sampling • Lidar, GIS	220
2 – Relationships between fish diversity and physicochemical characteristics of dike fields and backwaters • Seasonal sampling in trend pools • Comparison of notched and un-notch dikes • Comparison of mitigation and reference sites	190
3 - Potamological characteristics of impacted and mitigated gravel bars • Substrate borings and classification • Substrate profiling	110
4 - Seasonal use of gravel bars as fish spawning, feeding, and resting areas • Comparison of natural and mitigated bars • Limited invertebrate sampling	145
5 - Head-cutting of important tributaries • Six tributaries • Establish gages and cross sections	110
6 - Habitat characteristics and fish communities in tributary mouths of the Arkansas River	40
7 – Success of freshwater mussel relocation efforts	undetermined

[1] Costs are based on rates provided by EDRC-EL, and include labor to manage the project, analyze data, and prepare reports.

Efforts to identify potential fish and wildlife habitat enhancement projects in Arkansas began in the fall of 2000 with staff from the AGFC, representatives of Ducks Unlimited, and local anglers. Dike notching to allow water to flow behind the dikes and re-open fish spawning areas in Arkansas began in July 2001. In Oklahoma, potential enhancement and restoration sites have been identified in meetings with representatives from the Service, Corps, and the ODWC. The Service commends the Corps for your participation in these efforts. However, there is still much that could be accomplished. Dike notching in Arkansas has currently ceased due to legal

complications and budget restraints. Additional funding and assistance is needed to continue restoring backwater areas and to improve fisheries, wildlife, and recreational management of this resource. Dredged material disposal can be used to create islands, shallows, and vegetated substrates that improve waterfowl and fisheries habitat. Backwater habitats also can be restored using dredged material and notching dikes. Created islands could serve many purposes, such as habitat for least tern colonies, aquatic vegetation substrates to increase available forage and cover, and as recreation sites for camping and swimming. Some islands could be managed as wildlife habitat to provide forage and cover for many mammals, reptiles, amphibians, and birds, in addition to increasing the available acreage for hunting, bird watching or hiking. We also recommend the Corps continue these enhancement efforts by scheduling a trip on the Verdigris River to conduct a preliminary investigation of potential restoration and enhancement projects for river cutoffs and oxbows.

As a result of the ARNS investigation, an opportunity exists to initiate and develop a coordinated and comprehensive management plan to enhance important wildlife habitat, to improve and restore fisheries habitat, protect riparian buffers, and protect and restore wetlands throughout the entire 445 mile MCKARNS corridor. The management of this system could be improved substantially through a cooperative and coordinated effort among the many state, federal, and private resource agencies and organizations responsible for, or having a stake in, the conservation of the Arkansas River ecosystem. The Corps could initiate this effort as part of the design or mitigation efforts associated with this project to promote the improvement of recreation, management, conservation, and protection of fish and wildlife resources, including five federally-listed threatened and endangered species. Personnel from the Corps, along with the NWRs, state WMAs, state parks, and/or non-governmental organization conservation areas could coordinate their management efforts under one plan for habitat diversity, species viability, and corridor connectivity. This cooperatively managed corridor would 1) be the longest conservation complex in the lower 48 states, 2) manage most of the Arkansas River Valley ecoregion, 3) cross two states, and 4) join two Service regions.

In addition to focusing funds and efforts, this partnership could assist with bio-monitoring of the river; fish, wildlife, habitat, and recreational research and management throughout the system; and provide improved management and habitat conservation for federally-listed threatened and endangered species, other rare species, the sport fishery, migratory birds, and other game and non-game fish and wildlife resources. This complex also would improve recreational opportunities and accessibility along the shorelines of the river by cooperatively maintaining and improving parks, access areas, and adding multi-use facilities. In the end, this partnership could provide the long term coordinated biological assessment the Arkansas River Navigation Project needs, while preserving and enhancing the fish and wildlife resource, accessibility, tourism, economic, and educational opportunities along the Arkansas River. Additional funding may be necessary to make this plan a reality, but having a plan in place that reflects stakeholder needs could assist in achieving the necessary support. A conceptual paper on this type of plan is provided in Appendix C.

The Service, ODWC, and AGFC are excited about the opportunity to enhance fish and wildlife habitat along the navigation system. The Service has published a guide that identifies and

describes numerous enhancement and mitigation techniques that could be used to offset and reduce impacts of the development and maintenance of a navigation channel on large riverine systems (Schnick *et al.*, 1982). We recommend utilizing this valuable resource as potential environmental enhancement projects and ideas continue to be developed.

The Service also recommends that the Corps consider restoring and enhancing habitat by acquiring land through fee title interests, conservation easements, flowage easements, or management agreements in habitats that are known to have high values, including lands adjacent to the MKARNS that are susceptible to flooding, but currently being farmed. These properties could be added to state wildlife management areas, to the national wildlife refuge system, or other appropriate land holdings to conserve the environmental resources of the area and be used by the general public.

Enhancement of Recreational Opportunities

Although the Service does not recommend measures to increase recreational values as a means of compensating for losses of habitat value, losses to recreational use that would not be offset through habitat mitigation measures should be addressed through other distinct measures. We provide the following potential measures that could be used to offset project-related human use losses of fish and wildlife resources.

The Service recommends that the Corps consider enhancing recreational opportunities at the NWRs along the navigation system. We provide some current needs at the Sequoyah NWR below. Projects at Holla Bend and White River NWRs also should be investigated in coordination with refuge staff.

a) Fishing/Observation Piers: Permanent piers at the Sandtown Woods parking lot and at Fisherman's Point would provide refuge visitors additional opportunities for fishing, wildlife observation, and photography. The piers should be constructed adjacent to the shoreline and would be about 30 – 40 feet long. The estimated cost of the project is $75,000.

b) Vian Ramp Courtesy Dock and Fishing Pier: The existing courtesy dock at the Vian Public Use area has deteriorated. A new floating or permanently anchored courtesy dock would enhance recreational opportunities for boaters and anglers on the NWR and in Robert S. Kerr Reservoir. The estimated cost of the project is about $75,000.

THREATENED AND ENDANGERED SPECIES

The Corps has determined that proposed changes to the MKARNS as a result of the current study may affect federally-listed threatened and endangered species. The project's potential effects on federally-listed species and measures to avoid and minimize any adverse effects are being addressed separately as part of a formal consultation pursuant to section 7 of the ESA for the following four species: 1) the interior least tern, 2) the American burying beetle, 3) the bald eagle, and 4) the pallid sturgeon.

Because several federally-listed species occur in the project area, the project also offers the Corps an opportunity to carry out section 7 (a) 1 responsibilities, as mandated by the ESA. Section 7 (a) 1 of the ESA requires that all federal agencies use their authorities to carry out programs for the specific purpose of conserving threatened and endangered species. Island construction for interior least terns represents one such opportunity.

UNMET MITIGATION NEEDS

The MKARNS is a large and complex system that impacts rivers, tributaries, oxbows, reservoirs, wetlands, and other important natural resources. The original construction of the navigation project destroyed a considerable amount of highly valuable fish and wildlife habitat along the Verdigris and Arkansas rivers. About 28,200 acres of project lands (Sequoyah NWR, McClellan-Kerr WMA units) were allocated for fish and wildlife management after construction of the MKARNS. These lands are still owned by the Corps, but managed either by the Service, AGFC, or ODWC under license agreement. No Corps funding is provided for ongoing management of these properties.

Losses of fish and wildlife habitat as a result of construction, operation and maintenance of the MKARNS were not evaluated using habitat value as a basis for determining compensation needs. The Service believes it is likely that the total combined habitat value of the impacted areas far exceeds the value obtained from lands established through cooperative agreement to compensate for lost fish and wildlife habitat due to the MKARNS (*i.e.*, the 28,200 acres discussed above).

In addition to lands licensed to the Service, ODWC, and AGFC, some MKARNS lands were classified as "Recreation-Low Density Use" and as "Natural Areas," with the Corps retaining responsibility for management. Decreasing budgets over the past decade have not allowed the Corps to manage these lands effectively, or at a level anticipated during original MKARNS planning efforts. As a result, the expected fish and wildlife resource benefits have not materialized.

Furthermore, since the initial navigation project was completed, many acres of additional impacted lands and waters have been identified. Impacts to these areas were never fully assessed or mitigated for by the initial navigation project. In addition, the proposed project likely would increase the impacts to these areas. The full extent of unmitigated impacts associated with the original project and the current proposed project impacts should be considered within this project assessment and mitigated for appropriately at this time.

Section 906 (b) WRDA 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife resources resulting from any water resource development project under Corps jurisdiction, whether completed, under construction, or to be constructed. The Service recommends that the Corps seek Congressional authorization and funding to initiate a study to address unmet fish and wildlife mitigation needs of the original MKARNS project and implement conservation measures previously recommended by the Service. The study should assess the impacts of the original construction and subsequent operation and maintenance of the MKARNS to determine whether existing mitigation is adequate to compensate for losses of fish

and wildlife habitat. Fish and wildlife resource based recreational use and needs should be an integral part of this investigation. Application of HEP and geographic information system databases could be used to assess value of the impacted habitat and that of the existing areas allocated for wildlife management (*e.g.*, Sequoyah NWR, McClellan-Kerr WMAs).

Section 3 (a) of the FWCA provides for the use of project lands for fish and wildlife conservation purposes. The Service recommends the re-allocation of high quality project lands along the navigation system in Oklahoma and Arkansas to fish and wildlife management as potential compensatory mitigation. The Corps cumulatively owns large areas of project lands that provide important fish and wildlife habitat, but currently are not protected from potential adverse impacts, such as disposal as surplus Federal property or future development. These lands include such high value habitats as oxbows, islands, wetlands, and riparian areas. The remaining 23 oxbows and cutoffs along the Verdigris River, for example, comprise the last portions of the river in its natural state. These areas have become some of the most highly productive and essential habitats along the river for many species of fish, waterfowl, and other native fauna. The oxbows and cutoffs provide resting areas for waterfowl and important spawning areas for fish. The bottomland hardwood and riparian forests adjacent to and surrounding these oxbows and cutoffs also provided high quality habitat no longer found along much of the river as a result of the MKARNS project.

Many of the oxbows and cutoffs, however, were not afforded protection from future development at the time of project construction. The Service sought protection for all of these areas because they represented the most valuable remaining habitat along the Verdigris River. During the spring of 1980, Verdigris area industrial interests, including the Arkansas Basin Development Association, requested that the Corps leave all oxbows and cutoffs along the Verdigris River portion of the navigation system open for industrial development. The Corps identified seven oxbows and cutoffs for re-allocation to preclude their industrial development. Ultimately, only four oxbows and cutoffs were re-allocated and provided protection from future development, far short of the habitat conservation level envisioned during MKARNS planning efforts.

The Service and ODWC also recommend that the Corps consider as mitigation lands the thousands of acres of floodplain habitat adjacent to the Verdigris River portion of the navigation system between U. S. Route 412 and State Highway 51 in Oklahoma that have been altered by the development of the navigation system, drained, and converted to agricultural use. These properties represent excellent opportunities for wetland and bottomland hardwood restoration efforts, especially the large contiguous tract of agricultural lands in the Big, Goodhope, and Guinn Bottoms. Section 906 (a) WRDA 1986 and section 3 (c) of the FWCA authorizes the Corps to purchase lands for mitigation purposes. We recommend investigating the feasibility of acquiring fee title interests to lands in this area. The lands could then be licensed or deeded to the ODWC as additions to their wildlife management areas or to the Service as additions to the national wildlife refuge system.

The ARNS presents the Corps the opportunity to provide the needed protection, restoration and enhancement of project lands with high fish and wildlife habitat value and potential, such as the river cutoffs and oxbows along the Verdigris River in Oklahoma and altered floodplain habitat.

LIST OF RECOMMENDATIONS

Section 906 (d) WRDA 1986 requires that all post-1986 Corps projects submitted to Congress have either 1) a specific mitigation plan or 2) a determination that the project will have negligible impacts to fish and wildlife resources. Such mitigation plans should be implemented prior to or concurrent with project construction, as mandated by section 906(a) WRDA 1986. This report has demonstrated that the proposed project would result in substantial impacts to important fish and wildlife resources. These impacts would constitute a significant biological change for which mitigation would be required to offset losses. In view of the information provided, the Service provides the following list of recommendations for the purposes of mitigating adverse impacts to fish and wildlife resources attributable to the ARNS selected alternatives:

1) Minimum Instream Flow Releases: Incorporate minimum instream flow releases (based on Orth and Maughan, 1981) for all system reservoirs into the plan selected for implementation. Minimum flow releases should be conducted in a manner that maintains water quality standards as set by the Oklahoma Water Resources Board.

2) Lake Level Management Plans: Develop and implement lake level management plans for the 11 primary flow modifying reservoirs on the MKARNS in Oklahoma in coordination with the Service and ODWC.

3) Impacts to Floodplain Habitat: Identify the specific lands that would receive flood protection benefits, determine the quantity (acres) and quality (habitat type and value) of wetlands that the selected operating plan would alter, determine the quantity (acres) and quality (habitat type and value) of wetlands that would be necessary to compensate for wetland losses, and obtain conservation easements in floodplain areas that would be protected from flooding to deter floodplain development and compensate for losses of wetland habitat.

4) Contaminant Analysis: Conduct additional analyses of dredged material for contaminants prior to disposal. The ODWC has specific concerns regarding dredging activities and sediment analysis within the vicinity of the Sequoyah Fuels Corporation Industrial site, which can be found in their concurrence letter in Appendix A. Disposal measures to minimize the environmental impact of disturbance, transport, and disposal of contaminated sediments should be developed and utilized where necessary. This issue is not only relevant from the standpoint of impacts to fish and wildlife resources, but also is a public health concern.

5) Beneficial Use of Dredged Material and Disposal Sites: Use dredged material to create, rebuild, or enhance island and/or marsh habitats in areas that currently have low habitat quality. As an example, the Sandtown Bottoms area (secs. 6, 7, and 18, T. 11 N., R. 22

E.) within the Sequoyah NWR along the Arkansas River has experienced severe erosion from wind-driven wave action, river current erosion, and wakes from boat/barge traffic. The Service recommends that the Corps investigate the feasibility of using dredged material and structures such as geo-tubes that would provide long-term erosion control and increase the aesthetic and wildlife habitat value of the area by providing a substrate that would facilitate the growth of riparian vegetation.

6) Unavoidable Terrestrial Impacts: Implement the mitigation plan for unavoidable terrestrial disposal impacts in Oklahoma that was developed through interagency cooperation by biologists with the Corps, Service, and the ODWC. The plan was developed to ensure that losses in habitat value, rather than in acres, would be offset over the 50-year project life. The compensatory mitigation plan currently endorsed by the Service and ODWC consists of bottomland hardwood restoration and marsh creation at two sites along the Verdigris River that are currently agricultural fields. This plan or an acceptable alternative should be implemented prior to, or concurrent with, project construction as mandated by section 906 (a) WRDA 1986. Alternative mitigation plans would be acceptable to the Service and ODWC, provided that the plan 1) was developed through interagency coordination, and 2) demonstrated that losses in habitat value were fully offset over the project life through a HEP or similar analysis. Specific details for bottomland hardwood and marsh restoration/creation, such as tree plantings and exact measures to restore hydrology, should be finalized through interagency coordination with the Service and ODWC.

7) Impacts of Aquatic Dredged Material Disposal and the Construction/Modification of River Training Structures in Oklahoma and Arkansas: The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening would have on aquatic fish and wildlife resources. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report. The Corps should continue to work with the interagency evaluation team to assess the impacts of the project on aquatic fish and wildlife resources.

8) Mitigation Plan for Aquatic Impacts: The Corps should continue to work with the interagency evaluation team to develop a complete compensatory mitigation plan that would offset losses to habitat value over the 50-year project life caused by dredging, river training structures, and disposal of dredged material in aquatic sites in Oklahoma and Arkansas. This report provides additional and modified mitigation recommendations for the Corp's consideration during development of the final mitigation plan (Appendix G). We believe incorporating these recommendations into the final plan would help ensure that losses of aquatic habitat value would be adequately offset. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

9) Impacts to Freshwater Mussel Communities: Implement mitigation measures to avoid and minimize impacts to freshwater mussel concentrations. The Service's Arkansas and

Oklahoma Ecological Services field offices provided recommended mitigation measures for freshwater mussels in planning aid letters dated April 29 and May 11, 2005, respectively.

10) General Plans for Terrestrial Mitigations Sites: In accordance with section 3 and 4 of the FWCA, the Service requests that the Corps begin coordination with the Service and the ODWC on the development of a General Plan (*i.e.*, agreements that make project lands available to the Service or State for fish and wildlife management purposes) for the terrestrial mitigation sites.

11) Operation and Maintenance Funds for Compensatory Mitigation Lands: Maintaining the habitat value of compensatory mitigation lands likely will require on-going maintenance and management efforts. Without these efforts, the habitat value of the lands is likely to decrease and fail to meet mitigation goals. Losses in habitat value as a result of the project, therefore, would not be adequately offset by intended mitigation. In accordance with section 2 (d) of the FWCA, costs to carry out fish and wildlife conservation measures are to be considered project costs. Furthermore, section 906 (c) WRDA 1986 states that the costs of fish and wildlife mitigation are to be cost-shared at the same rate as the project purpose causing the impact. Navigation projects are fully federally-funded. The Corps should seek full Congressional authorization and funding for Operation and Maintenance (O and M) needs. These funds should be provided to the managing entity on an annual basis. An O and M budget should be developed in cooperation with the managing entity prior to project implementation.

12) Environmental Management Program, Conservation Committee, and Mitigation Fund: Seek full Congressional authorization and funding for an Environmental Management Program. The effects of the modifications to river flow management and channel depths, and the continued operation and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, downstream segments of the rivers, wetlands, backwater areas, and the main stem of the navigation channel), likely will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. The Service believes the Corps should utilize the authorities provided under section 906(b) WRDA 1986 and section 306 WRDA 1990 to seek full Congressional authorization and funding for an Environmental Management Program. This would enable the Corps to perform long-term studies and monitor fish and wildlife resources associated with the navigation system that would occur before, during and following project implementation and extending until sufficient data have been collected to clearly and accurately determine the full extent of environmental impacts. The long-term monitoring program would serve to 1) facilitate the development of appropriate conservation measures that would maintain and restore the habitat value of the fish and wildlife resources associated with the navigation system, 2) assess the ultimate magnitude of the cumulative impacts from the proposed modifications to channel depths and river flow management, and from maintenance and continued operation of the system, 3) identify and address any unmet mitigation needs not identified as a result of the expedited

study schedule, 4) coordinate and comprehensively manage and improve recreation, fisheries, wildlife, and natural resource conservation throughout the system, and 5) improve the efficiency and maximize resource potential through cooperative operation and management of the system. The Service believes that it would be necessary to establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program. Due to the necessity of the long-term monitoring program and mitigation fund to ensure adequate compensation is provided for impacts to fish and wildlife resources and to maintain and restore habitat value, the cost of the long-term monitoring program and the mitigation fund should be considered in the Corp's benefit:cost analysis for ARNS. Benefits to local, state, and regional economies as a result of the likely increase in expenditures for outdoor recreational pursuits (*e.g.*, wildlife photographers/observers, hunters, and anglers) also should be considered in the analysis. A paper on a conceptual Environmental Management Program is provided in Appendix C.

13) Invasive Species: The Corps should continue public awareness efforts to increase knowledge and concern about the spread of the zebra mussel and other invasive species by distributing outreach materials that summarize the life history of these species, the adverse environmental consequences caused by their establishment, and recommended measures to help prevent the further spread of these species. This material should be available at project offices and boat ramps throughout the navigation system. The Service also recommends that the Corps consider installing washing and scrubbing stations that provide appropriate water solution and temperature (*e.g.*, a 10 percent water and chlorine solution and water temperatures of 140° F) for removal of zebra mussels at appropriate locations on all reservoirs that support the navigation system to help prevent further spread of zebra mussels.

14) Unmet Mitigation Needs: The Corps should seek full Congressional authorization and funding to initiate a study to identify and address any unmet mitigation needs of the original project. The study should assess the impacts of the original construction and subsequent operation and maintenance of the MKARNS to determine whether existing mitigation is adequate to compensate for losses of fish and wildlife resources.

15) Enhancement/Restoration of Fish and Wildlife Habitat: The Service recommends that the Corps continue efforts to identify and implement potential fish and wildlife habitat enhancement projects in Arkansas and Oklahoma, such as bottomland hardwood restoration and dike notching projects.

16) Endangered Species: Implement projects under authority of section 7 (a) 1, as mandated by the ESA, to help conserve threatened and endangered species, such as island creation and management for interior least terns.

SUMMARY AND POSITION OF THE SERVICE

The project area contains a variety of high quality fish and wildlife resources. These resources include wetlands, bottomland hardwoods, floodplain forest, backwater areas such as oxbows, several streams and rivers, numerous reservoirs, wildlife management areas, and national wildlife refuges. The effects of modifying the current operating plan were evaluated using the Corps "Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System," also known as the SUPER Model. For this study, reservoir elevations and river stages were modeled using 61 years (January 1940 – December 2000) of stream flow data. Information obtained from the SUPER Model for each non-structural alternative included 1) average annual river flow and condition, and 2) average annual reservoir stages and duration.

Reservoir level fluctuations are expected to change only slightly from current operations under the selected plan. Impacts to fish and wildlife resources at the reservoirs would not likely differ significantly from current conditions based on average annual lake levels and stream flows. The Service believes, however, that conditions that would occur during extreme high and low years (rather than only on average annual lake levels and river flows) also should be considered in order to appropriately consider potential effects to fish and wildlife resources. These effects are not likely to be evident from an analysis based on average annual reservoir levels and stream flows. Conditions that occur during these extreme years could significantly affect fish and wildlife resources.

Impacts could include altering the littoral zone, eliminating or reducing vegetated areas adjacent to the reservoirs, adversely impacting fish spawning and recruitment, and reducing available habitat for migratory birds. We believe that the mitigation goal for the fish and wildlife resources associated with the 11 primary flow modifying reservoirs in Oklahoma could be met through pro-active conservation actions and adaptive management. Examples are lake level management plans, minimum in-stream flow releases, and monitoring to identify any needed management alterations.

The selected River Flow Management alternative would reduce the duration of over bank flooding in the floodplain. Because the hydrology of floodplain wetlands would be altered, important wetland habitats may be adversely impacted. Therefore, the Service recommends that the Corps identify the specific lands that would receive flood protection benefits, assess adverse impacts to habitat value, and provide compensatory mitigation for unavoidable wetland-related impacts.

Deepening and maintaining the navigation channel would have significant adverse impacts on important fish and wildlife resources. Potential impacts are diverse but primarily would include the direct loss and degradation of terrestrial and aquatic habitat through dredging and dredged material disposal, and degradation of backwater habitats. An assessment of adverse impacts and a complete mitigation plan have been developed for impacts due to disposal of dredged material at terrestrial sites in Oklahoma. The Corps, Service, ODWC, and AGFC have been in constant and frequent coordination regarding the assessment of impacts the navigation channel deepening

would have on aquatic fish and wildlife resources. Unfortunately, due to the extremely expedited schedule for this study, the aquatic impacts analysis has not been completed as of the date of this report.

The Service understands that the Corps intends to fully mitigate for aquatic resource impacts. The Service provides additional and modified compensatory mitigation recommendations for aquatic resource impacts for the Corps consideration during development of the complete mitigation plan in Appendix G. We believe that incorporating these mitigation features into the mitigation plan would serve to adequately offset aquatic resource impacts. The final mitigation plan for aquatic resource impacts would be acceptable to the Service, ODWC, and AGFC provided that it was demonstrated through a HEP or similar analysis to completely offset losses in habitat value over the project life.

The effects of the development, operation, improvement, and maintenance of the navigation system on the fish and wildlife resources in the study area (including the reservoirs, wildlife management areas, the downstream segments of the rivers, wetlands, backwater areas, and the main stem of the navigation channel) will have long-term consequences that cannot be adequately identified or appropriately assessed without long-term studies and extensive monitoring efforts. The Service believes the Corps should perform long-term studies to assess the true magnitude of the development, operation, and maintenance of the MKARNS on important fish and wildlife resources. These further studies also would help identify and address any unfulfilled or unanticipated mitigation needs.

Fish and wildlife resources and associated recreational activities are an important aspect of American culture. In 2001, for example, U. S. residents spent more than $108 billion dollars while pursuing fish and wildlife related recreational activities. In Oklahoma alone, wildlife observers, hunters, and anglers spent $193,248, 000, $248,071,000, and $476,019,000, respectively (USDOI and USDOC, 2001). The Service's overall goal is to conserve these important fish and wildlife resources for the benefit of the American people, while facilitating balanced development. This goal is supported by language in the FWCA. The FWCA establishes fish and wildlife conservation as a coequal purpose of water resource development projects and states that fish and wildlife resources shall receive equal consideration with other features of water resources development programs.

Section 906 (d) of WRDA 1986 requires that all post-1986 Corps projects submitted to Congress must have either 1) a specific mitigation plan or 2) a determination that the project will have negligible impacts to fish and wildlife resources. This mitigation plan should be implemented prior to, or concurrent with, project construction as mandated by section 906(a) WRDA 1986. We have demonstrated in this report that the proposed project would result in substantial impacts to important fish and wildlife resources. These impacts would constitute a significant biological change for which mitigation would be required to offset losses.

Therefore, the Service believes that in order to ensure that fish and wildlife resources receive equal consideration, as mandated by the FWCA, the Corps should:

- Continue to work with the interagency team to fully assess potential impacts to terrestrial and aquatic fish and wildlife resources, and develop a specific mitigation plan through interagency coordination that would avoid, minimize and compensate for project impacts;

- Utilize the authorities provided under section 906(b) WRDA 1986 and section 306 WRDA 1990 to seek full Congressional authorization and funding for an Environmental Management Program in order to perform the long-term studies and monitoring of the fish and wildlife resources associated with the navigation system. The long-term monitoring program would serve to 1) facilitate the development of appropriate conservation measures that would maintain and restore the habitat value of the fish and wildlife resources associated with the navigation system, 2) assess the true magnitude of the cumulative impacts from the proposed modifications to channel depths and river flow management, and from maintenance and continued operation of the system, 3) identify and address any unfulfilled or unanticipated mitigation needs not identified due to the expedited study schedule, 4) coordinate and comprehensively manage and improve recreation, fisheries, wildlife, and natural resource conservation throughout the system, and 5) improve the efficiency and maximize resource potential through cooperative operation and management of the system; and

- Establish a mitigation fund that would be utilized to address mitigation needs identified through the long-term monitoring program. Due to the necessity of the long-term monitoring program and mitigation fund to ensure adequate compensation for impacts to fish and wildlife resources, the Service strongly believes that the cost of the long-term monitoring program and the mitigation fund should be considered in the Corps benefit:cost analysis for ARNS. Benefits to local economies attributable to expenditures for outdoor recreational pursuits, such as wildlife observation, hunting, and fishing, also should be considered.

The Service could support the recommended change to river flow management and deepening of the navigation system up to a 12-foot navigation depth, provided that appropriate mitigation measures that would serve to offset losses in aquatic and terrestrial habitat value, such as those developed by the interagency team and recommended in this report, are implemented. We further believe that an Environmental Management Program and Mitigation Fund should be established to ensure that adverse effects continue to be rectified over time and that unidentified mitigation needs could be met. The cooperation of the Corps during our investigation of the proposed action is greatly appreciated.

LITERATURE CITED

Abell, R. A., D. M. Olson, E. Dinerstein, and P. T. Hurley. 2000. Freshwater ecoregions of North America: a conservation assessment. Island Press. Washington D.C. 319 pp.

Allen, K. O., and J. W. Hardy. 1980. Impacts of navigational dredging on fish and wildlife: a literature review. U. S. Fish and Wildlife Service, National Coastal Ecosystems Team, Slidell, Louisiana. FWS/OBS-80/07. 81 pp.

Arkansas Geological Commission. 1997. Bulletin 24: Mineral, fossil fuel and water resources of Arkansas.

Bailey, R. G. 1994. Ecoregions of the United States, USDA Forest Service (scale 1:7,500,000, revised 1994).

Bell, D. T., and F. L. Johnson. 1974. Flood-caused tree mortality around Illinois reservoirs. Transactions of the Illinois Academy of Science 67:28-37.

Black, R. A. 1980. The effects of flooding on pin oaks in southeastern Missouri. Unpublished report.

Branson, B. A. 1982. The mussels (Unionacea:Bivalvia) of Oklahoma –Part 1: Ambleminae. Proceedings of the Oklahoma Academy of Sciences 62:38-45.

Branson, B. A. 1983. The mussels (Unionacea:Bivalvia) of Oklahoma –Part 2: The Unioninae, Pleurobemini and Anodontini. Proceedings of the Oklahoma Academy of Sciences 63:49-59.

Branson, B. A. 1984. The mussels (Unionacea:Bivalvia) of Oklahoma –Part 1: Lampsilini. Proceedings of the Oklahoma Academy of Sciences 64:20-36.

Buchanan, T. M. 1974. Threatened native fishes of Arkansas. In Arkansas Natural Area Plan. William M. Shepard (ed.). Arkansas Department of Planning, Little Rock.

Buchanan, T. M. 1976. An evaluation of the effects of dredging within the Arkansas River Navigation System. Volume V: The effects upon the fish populations. Westark Community College. Fort Smith, Arkansas. 277 pp.

Clark, J. H. and J. R. Clark, eds. 1981. Wetlands of bottomland hardwood forests. Elsevier Science Publication Co., New York. 401 pp.

Conant, R., and J. T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America. 3rd Edition. New York: Houghton Mifflin Company. 616 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. Laroe. 1979. Classification of wetlands and deepwater habitats of the United States. U. S. Department of the Interior. Fish and Wildlife Service. Washington, D. C. 131 pp.

Davidson, C. L. 1997. Analysis of mussel beds in the Little Missuori and Saline Rivers, Blue Mountain, Ozark, and Dardenelle Lakes, Arkansas. Unpublished M. S. Thesis, Arkansas State University, 56 pp.

D'Itri, F. 1997. Zebra mussels and aquatic nuisance species. Ann Arbor Press, Chelsea, Michigan. 650 pp.

Ecological Specialists. 2005. McClellan – Kerr Arkansas River Navigation Study: Freshwater Mussel (Unionid) Survey. Prepared for the Tulsa and Little Rock Districts, U. S. Army Corps of Engineers, ESI no. 04-027. 40+pp.

Etnier, David A. and Wayne C. Starnes. 1993. The Fishes of Tennessee. University of Tennessee Press, Knoxville. 681 pp.

Gilbert, C. R. 1992. Alligator gar *Atractosteus spatula*. Pages 128-132 in C. R. Carter, editor. Rare and endangered biota of Florida. Volume II. Fishes. University Press of Florida, Gainesville, Florida.

Gordon, M. E. 1984. First record for *Anodonta suborbiculata* Say (Unionidae:Anodontinae) in Oklahoma. The Southwestern Naturalist 29:233-234.

Graham, K. 1997. Contemporary status of the North American paddlefish, *Polyodon spatula*. Environmental Biology of Fishes 48: 279-289.

Hall, T. F., and G. E. Smith. 1955. Effects of flooding on woody plants, West Sandy dewatering project, Kentucky Reservoir. Journal of Forestry 53:281-285.

Harris, J. L. 1992. A mussel survey of Lake Dardanelle in the vicinity of the proposed River Mountain Pumped Storage Project. Report submitted to JDJ Energy Company. 20pp.

Harris, J. L., and M. E. Gordon. 1986. Arkansas Mussels, Arkansas Game and Fish Commission, Little Rock, Arkansas. 32pp.

Herkert, J. R., editor. 1992. Endangered and threatened species of Illinois: status and distribution. Vol. 2: Animals. Illinois Endangered Species Protection Board. iv + 142 pp.

Holland, S. 2003. Analytic rarefaction 1.3. University of Georgia, Athens. Software available at: http:www.uga.edu/~strata/software/

Isley, F. B. 1925. The freshwater mussel fauna of eastern Oklahoma. Proceedings of the Oklahoma Academy of Science. 4:43-118.

Killgore, J., J. Hoover, and C. Murphy. 2005. Arkansas River Navigation Project: Aquatic Evaluation. Department of the Army, Engineer Research and Development Center Waterways Experiment Station. 29 pp.

Kuchler, A. W. 1975. Potential natural vegetation of the conterminous United States. Map. American Geology Society, Special Pub. 36, New York, NY.

Limbird, R. The Arkansas River – a changing river. 1993. Arkansas Game and Fish Commission Biological Report 19: 282-294.

Ludwig, J. A., and J. F. Reynolds. 1988. Statistical Ecology. John Wiley and Sons, New York. 337 pp.

McMahon, G., and J. W. Eckbald. 1975. The impact of dredge spoil placement on the upper Mississippi River. Fish and Wildlife Work Group, Great River Environmental Action Team, St. Paul Minnesota.

Miser, H. D. 1954. Geological Map of Oklahoma. U. S. Geological Survey. Scale 1: 500,000.

Oklahoma Water Resources Board. 1990. Oklahoma Water Atlas. University of Oklahoma Printing Services. Norman, Oklahoma. 360 pp.

Omernick J. M. 1995. Level III ecoregions of the continent. Washington, DC: National Health and Environment Effects Research Laboratory, U. S. Environmental Protection Agency.

O'Neill, C. R. Jr. and D. B. MacNeill 1991. The Zebra Mussel *Dreissena polymorpha,* An Unwelcome North American Invader. New York Sea Grant, Brockport, NY, 12 pp.

Orth, D. J., and O. E. Maughan. 1981. Evaluation of the "Montana method for recommending instream flows in Oklahoma streams. Proc. Okla. Acad. Sci. 61:62-66.

Pflieger, W. L. 1997. The fishes of Missouri. Revised edition. Missouri Department of Conservation, Jefferson City. vi + 372 pp.

Purkett, C. A. 1961. Reproduction and early development of the paddlefish. Trans. Amer. Fish Society. 97:252-259.

Reine, K. and Clark, D. 1998. Entrainment by hydraulic dredges – a review of potential impacts. Technical Note DOER-E1. U. S. Army Corps of Engineers Research and Development Center, Vicksburg, MS.

Ricketts, T. H., E. Dinerstein, D. M. Olson, and C. J. Loucks. 1999. Terrestrial ecoregions of North America: a conservation assessment. Island Press. Washington D.C. 485 pp.

Robison, H. W., and T. M. Buchanan. 1988. Fishes of Arkansas. University of Arkansas Press, Fayetteville, Arkansas. 536 pp.

Schnick, R. A., J. M. Morton, J. C. Mochalski, and J. T. Beall. 1982. Mitigation and Enhancement Techniques for the Upper Mississippi River System and Other Large River Systems. U. S. Fish and Wildlife Service. Resource Publication 149. Washington, D. C. 714 pp.

Shepard, W. D., and A. P. Covich. 1982. The unionid fauna of Ft. Gibson Reservoir and the Grand (Neosho) River in Oklahoma: comments on a proposed increase in water level. Southwestern Naturalist 27:359-361.

Sparks, R. E., R. C. Thomas, and D. J. Schaeffer. 1980. The effects of barge traffic on suspended sediment and turbidity in the Illinios River. Illinois Natural History Survey and Environmental Protection Agency. 68 pp.

Turgeon, D. D., A. E. Bogan, E. V. Coan, F. G. Hochberg, W. G. Lyons, P. M. Mikkelsen, R. J. Neves, C. F. E. Roper, G. Rosenberg, B. Roth, A Scheltema, F. G. Thompson, , M. Vecchione, and J. D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks, 2nd Edition. American Fisheries Society Special Publication 26. 526 pp.

USACOE (U. S. Army Corps of Engineers). 2005a. Draft Environmental Impact Statement for the Arkansas River Navigation Study, Arkansas and Oklahoma McClellan-Kerr Arkansas River Navigation System , Little Rock and Tulsa Districts.

USACOE (U. S. Army Corps of Engineers). 2005b. Draft Feasibility Report for the Arkansas River Navigation Study, Arkansas and Oklahoma McClellan-Kerr Arkansas River Navigation System , Little Rock and Tulsa Districts.

USDOI and USDOC (U. S. Department of the Interior, Fish and Wildlife Service and U. S. Department of Commerce, U.S. Census Bureau). 2001. 2001 National Survey Of Fishing, Hunting, And Wildlife-Associated Recreation.

USFWS (U. S. Fish and Wildlife Service). 1981. U. S. Fish and Wildlife Service Mitigation Policy. Federal Register, Vol. 46(15):7644-7663.

USFWS (U.S. Fish and Wildlife Service). 1982. Mitigation and Enhancement Techniques for the Upper Mississippi River System and Other Large River Systems. 714 pp.

USFWS (U. S. Fish and Wildlife Service). 1983. Fish and Wildlife Coordination Act Report on Fish and Wildlife Resources of the Arkansas River and Tributaries: Hydropower and other

purposes, Oklahoma and Arkansas (Webbers Falls Lock and Dam 16). Oklahoma Ecological Services. Tulsa, OK. 42 pp.

USFWS (U. S. Fish and Wildlife Service). 1985. Planning Aid Report on the Corp's Arkansas River Basin Study, Arkansas and Oklahoma (Oklahoma Portion). Oklahoma Ecological Services. Tulsa, OK. 25 pp.

USFWS (U. S. Fish and Wildlife Service). 1988. Planning Aid Report on the Corp's Arkansas River Basin Study, Arkansas and Oklahoma (Arkansas Portion). Vicksburg, MS. 20 pp.

USFWS (U. S. Fish and Wildlife Service). 1990. Fish and Wildlife Coordination Act Report on the Arkansas River Basin, Arkansas and Oklahoma. Tulsa, OK. 31 pp.

USFWS (U. S. Fish and Wildlife Service). 2003. Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. Washington D.C. 124 pp.

Vaughn, C.C. and D.E. Spooner. 2004. Status of the mussel fauna of the Poteau River and implications for commercial harvest. Amer. Midl. Nat. 152(2):336-346.

Wallus, R. 1986. Paddlefish reproduction in the Cumberlandand Tennessee river systems. Trans. Am. Fish. Soc. 115:424-428.

Ziegler, S. R., and S. H. Sohmer. 1977. The flora of dredged material disposal sites in navigation pool 8 of the Upper Mississippi River. Univ Wisconsin-LaCrosse. U. S. Army Waterways Experiment Station, Vicksburg, Mississippi. Tech Rep D-77-31.

APPENDIX A

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Concurrence Letters

Arkansas Game & Fish Commission

2 Natural Resources Drive Little Rock, Arkansas 72205

David Goad
Deputy Director

Loren Hitchcock
Deputy Director

Scott Henderson
Director

June 23, 2005

Richard Stark
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Oklahoma Ecological Service
Tulsa Field Office
222South Houston Avenue
Tulsa OK 74127

Dear Mr. Stark:

Our agency has reviewed your Fish and Wildlife Coordination Act Report that evaluates the Arkansas River Navigation Study, Arkansas and Oklahoma. We appreciate the efforts of the dedicated U.S. Fish and Wildlife Service biologists that completed this report under an expedited project schedule.

Biologists from our agency have reviewed this report and concur with the recommendations. Our agency will have further comments regarding the aquatic impact assessment and mitigation plan (Appendix G). We believe that the Corps should seek ideas for proposed mitigation features from user groups (e.g., BASS, Arkansas Bass Association, Arkansas Bass Federation, Arkansas Wildlife Federation). Our agency would like to see experts from the U.S. Geological Survey and universities be contracted to perform some of the monitoring projects.

We appreciate the opportunity to review this Coordination Act Report.

Sincerely,

Robert K. Leonard

Robert K. Leonard, Biologist
River Basins Division

Cc: Doyle Shook
Mike Gibson

Phone: 501-223-6300 Fax: 501 223-6448 Website: www.agfc.com

APPENDIX B

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Federally-listed Species

Endangered species that occur within the project area include the fat pocketbook mussel, *Potamilus capax*, pink mucket pearly mussel *Lampsilis abrupta*, scaleshell mussel *Leptodea leptodon,* American burying beetle *Nicrophorus americanus*, pallid sturgeon *Scaphirhynchus albus,* interior least tern *Sterna antillarum athalassos*, whooping crane *Grus americana*, Indiana bat *M. sodalis*, gray bat *Myotis grisescens*, Ozark big-eared bat *Corynorhinus townsendii ingens*, and the Harperella *Ptilimnium nodosum*. The endangered ivory-billed woodpecker *Campephilus principalis*, recently rediscovered at the Cache River National Wildlife Refuge in Arkansas, also occurs in the study area. Threatened species include the Neosho madtom *Noturus placidus*, Arkansas River shiner *Notropis girardi*, Ozark cavefish *Amblyopsis rosae*, bald eagle *Haliaeetus leucocephalus*, piping plover *Charadrius melodus*, *Geocarpon minimum* (no common name), and the western prairie fringed orchid *Platanthera praeclara*. The Neosho mucket *Lampsilis rafinesquana* and the Arkansas darter *Etheostoma cragini*, federal candidate species, also occur within the vicinity of the study area.

We provide a description of all listed and candidate species known to occur in the vicinity of the project below.

Invertebrates: Mussels

Fat pocketbook

The fat pocketbook is an endangered mussel that historically occurred in approximately 200 miles of the St. Francis River system, including the Floodway and associated drainage ditches; the lower Wabash River, Indiana; the mouth of the Cumberland River, Kentucky; and the Mississippi River, Missouri. Over 2,000 individuals were transplanted from the St. Francis Floodway to the Mississippi River by the Missouri Department of Conservation in 1989 to augment that population in an effort to enhance viability. Fresh dead shells have been collected from the Ohio River in Kentucky. The historic records of this species from the Green River, Kentucky, are questionable. The only known viable population of the fat pocketbook is in the St. Francis Floodway, Arkansas.

The greatest impact on the habitat of the fat pocketbook throughout its historic range has been from activities related to navigation and flood control. Channel maintenance dredging has been particularly destructive. Impacts include the loss of stable sandbars and other suitable habitat, increased siltation, and reduced numbers of fish hosts. The upper Mississippi River has been impounded for navigation and is dredged routinely to maintain a 9-foot navigation channel. The fat pocketbook, once widespread in this river, has disappeared in recent years even from areas where other species (including the endangered species *Lampsilis hicioinsi*) continue to exist. The largest populations occur in the St. Francis River and associated ditches. Smaller populations occur in the Ouachita and Little River systems. Within the vicinity of the project, it has been collected near river mile 12 on the White River and downstream on the Mississippi River.

Pink mucket pearly mussel

The pink mucket pearly mussel is an endangered mussel that historically occurred in 25 river systems in 13 states in the eastern United States. The shell of this mussel is thick and smooth with a tan, yellow, or yellowish-brown color. Shells of males are circular in shape while female shells may be nearly square. Faint broad, green rays may cover the shell, but rays are frequently absent from adult shells (Oesch, 1995). This species occurs in medium to large rivers having a medium to strong current over a gravel or sand substrate.

The pink mucket has declined as a result of habitat modification (*e.g.*, dam construction and dredging), water quality degradation, and overharvest by the commercial mussel industry. By 1990, it was known to occur in only 16 river systems, including rivers in Arkansas (Mathews and Moseley, 1990). The largest populations occur in the Spring and White Rivers. Smaller populations occur in the Ouachita and Little River systems. Within the vicinity of the project, it has been collected primarily from the middle and upper portions of the White River (Harris *et al.*, 1997.).

Scaleshell

The endangered scaleshell is a relatively small mussel that possesses a thin, oblong olive-colored shell with faint green wavy rays. The scaleshell occurs in small to medium rivers with stable channels and high water quality. The scaleshell occurs in riffle areas that have a substrate of sand and gravel, where it partially buries itself and siphons the water for food (Oesch, 1995).

This species was historically known from 55 streams in 13 states in the eastern United States. Over the last fifty years the species has declined due to pollution, increased sedimentation (suffocates the mussels and makes feeding difficult), and dams (act as barriers to host fish, isolate populations, and destroy habitat). There are only 13 known scattered populations in the Mississippi River basin in Missouri, Oklahoma, and Arkansas. In Oklahoma, the scaleshell is known from the Kiamichi, Mountain Fork, and Little River systems in the southeastern corner of the state. A single specimen was located in the Poteau River, a tributary to the MKARNS, in Leflore County, but it is unlikely that the species persists in the Poteau River due to habitat modification. Within the study area in Arkansas, the scaleshell is known to occur in two tributaries to the MKARNS: the Fourche LaFaye River and Frog Bayou. Living specimens have not been collected at the confluence of the Mississippi with the Arkansas River (Gordon, 1980). Its occurrence within the project area is unlikely.

Neosho mucket

The Neosho mucket, a candidate for federal listing and a state-listed endangered species in Oklahoma, is an endemic freshwater mussel species known to inhabit both large and small river channels in the upper Arkansas River system in southeast Kansas, southwest Missouri, northwest Arkansas, and northeast Oklahoma. Recent status surveys indicate that this species has experienced a drastic decline, possibly as a result of reservoir construction and siltation.

In Oklahoma, the Neosho mucket is currently believed to only occur in the Illinois River, a tributary to the MKARNS, above Lake Tenkiller. Larger concentrations were observed in silty, backwater areas (Mather, 1990; NatureServe, 2003). It has not been located below the reservoir, and is unlikely to occur within the project area.

Invertebrates: Snails

Magazine Mountain Shagreen

The brown to buff-colored threatened snail is known only from one slope in the Ozark National Forest in Arkansas (Natureserve, 2003). The snail requires a cool, moist climate, and is known to move deeper into rock crevices during dry weather. This extremely limited range makes the species particularly vulnerable to extirpation.

Invertebrates: Insects

American burying beetle

The endangered American Burying Beetle (ABB) is a habitat generalist and has been found in a variety of habitat types including grasslands, grazed pasture, bottomland forest, riparian zones, and oak-hickory forest (Creighton et al., 1993; Lomolino and Creighton, 1996; Lomolino et al., 1995; NatureServe Explorer, 2003; U. S. Fish and Wildlife Service, 1991). Populations of the endangered American burying beetle are known to occur within Arkansas and Oklahoma. Suitable habitat for the ABB exists within the project area.

American burying beetles are nocturnal (active only at night) and have a life span of about one year. American burying beetles enter an inactive period underground when the nighttime low temperatures are 60°F or below. This typically occurs from mid-September through late-May in Oklahoma. Once the nighttime low temperatures are consistently (at least 5 consecutive days) above 60°F, ABBs become active. Consequently, the timing of project implementation is crucial to the selection of conservation measures and influences how effectively those measures achieve project goals and compliance with the ESA.

Vertebrates: Fish

Pallid sturgeon

The endangered pallid sturgeon is a large primitive fish with a cartilaginous skeleton and several easily recognizable characteristics: a shovel-like snout, large skutes on the head and along the back, and four large fleshy barbells near the ventrally located mouth. The species is restricted to the deep, large channels of the Mississippi-Missouri River system and is considered very rare throughout its range (NatureServe, 2003). Sturgeon inhabit turbid main channels with a strong current over firm sand or gravel. The pallid sturgeon

feeds on insects, crustaceans, mollusks, annelids, other fish, and fish eggs. The pallid sturgeon has drastically declined due to habitat degradation caused by impoundments, channelization, and modified flow regimes. This species also has been adversely affected by over harvesting for their meat and eggs (caviar).

The pallid sturgeon is not currently known to occur in the MKARNS or the White River in Arkansas. Collection records from the Corps Waterways Experiment Station show that this species has been collected from the Mississippi near the confluences of the Arkansas and White Rivers (U. S. Army Corps of Engineers, 2003).

Neosho madtom

The threatened Neosho madtom is a small, short-lived catfish with a mottled appearance and characteristics typical of other catfish (*i.e.,* scaleless skin, a wide head, and barbells). The madtom occurs in large streams with a moderate to strong current. Adults prefer shallow riffles over loosely-packed gravel and pebbles. Young are found in deeper pools (Bulger and Edds, 2001; Natureserve, 2003; Wenke et al., 1992).

Historically, this species occurred in the Neosho, Cottonwood, Spring, and Illinois rivers in Kansas, Missouri, and Oklahoma. The Neosho madtom has been adversely impacted by dredging of gravel, water pollution, an increase in water demand, and by habitat degradation caused by the construction of dams. Impoundments on the Illinois and Grand Rivers in Oklahoma have eliminated about one-third of the former range of this species. Although the Neosho madtom historically occurred in the Illinois River in Oklahoma, it has not been collected from that stream since the construction of Tenkiller Reservoir. The species no longer occurs downstream of reservoirs in the project area that generate hydropower (Grand Lake, lake Hudson, Fort Gibson Reservoir, and Tenkiller Reservoir).

Today, this species is divided into three distinct populations separated by reservoirs: 1) the Cottonwood and Neosho River population above John Redmond Reservoir in Kansas, 2) the Spring River population in Kansas and Missouri, and 3) the Neosho River population below John Redmond Reservoir downstream to the headwaters of Grand Lake in Oklahoma. Thus, within the vicinity of the project, the Neosho madtom persists in the Neosho River above Grand Lake in Ottawa County, Oklahoma (Luttrell, 1991; NatureServe, 2003). Under current operations, portions of the known range are periodically inundated by Grand Lake's flood pool. The more frequently that Grand Lake is in the flood pool, the greater the potential to adversely impact this population of the Neosho madtom (U. S. Fish and Wildlife Service, 1992).

Arkansas River shiner

The Arkansas River shiner is a threatened species native to wide, sandy streams in the Arkansas River drainage in Arkansas, Kansas, New Mexico, Texas, and Oklahoma. Historically, this species would have occurred in the project area. However, the fish has disappeared from over 80% of its former range. The shiner currently is limited to about

500 miles in the Canadian River in Oklahoma, Texas, and New Mexico, and to the Cimarron River in Kansas and Oklahoma.

Threats to the shiner include habitat destruction and modification resulting from the construction of impoundments, stream water depletion due to groundwater pumping and diversion of surface water, and water quality degradation (U. S. Fish and Wildlife Service, 1998). Proposed critical habitat for the shiner includes portions of the Canadian and Cimarron Rivers in Oklahoma (69FR 59859). Eufaula Reservoir is located on the Canadian River at river mile 27.0 downstream of proposed critical habitat.

Ozark cavefish

The threatened Ozark cavefish is one of the most cave adapted vertebrates known. It is a small, blind fish with rudimentary eyes, but no optic nerve. The Ozark cavefish occurs in the waters of limestone solution caves in the Springfield Plateau of the Ozarks in Arkansas, Missouri and Oklahoma.

The Ozark cavefish is extremely sensitive to ground water quality deterioration caused by pesticides and other contaminants within cave recharge areas. Collection by scientists and curiosity seekers also has impacted this species (Willis and Brown, 1985).

The cavefish historically occurred in 24 caves in 9 counties in Oklahoma, Missouri and Arkansas (Brown and Todd, 1987; U. S. Fish and Wildlife Service, 1989). Recent estimates indicate that it is found in 14 caves in 6 counties in the White, Neosho, and Osage River drainage (Willis and Brown, 1985; U. S. Fish and Wildlife Service, 1989). Within the immediate project area, the cavefish occurs in Twin Cave located in Delaware County, Oklahoma near Grand Lake. Water levels in Twin Cave are affected by water levels in Grand Lake, but these fluctuations are not believed to adversely impact the Ozark cavefish (Benham-Holway, 1988; U. S. Fish and Wildlife Service, 1992).

Arkansas darter

The Arkansas darter is a federal candidate species that occurs in the Arkansas River drainage in Missouri, Colorado, Kansas, Arkansas, and Oklahoma. This darter is a small, strongly bi-colored fish (upper half dark brown, lower half white to orange). Within the vicinity of the project, it occurs in northeastern Oklahoma and northwestern Arkansas. This fish inhabits spring-fed creeks and headwaters with abundant herbaceous aquatic vegetation such as watercress *Nasturtium officinale.*

Vertebrates: Birds

Interior Least Tern

The endangered interior least tern inhabits major river systems in the interior United States. Reasons for the decline of this species include anthropomorphic causes (U. S. Fish and Wildlife Service, 1990) such as impoundments and irrigation, overgrowth of

vegetation, the recreational use of sandbars by humans, and flooding of nesting areas caused by unpredictable water discharge patterns below reservoirs (U.S. Fish and Wildlife Service, 1993). Low river flows that result in a land bridge between river islands and the streambank also can adversely impact terns by facilitating predator and human access to nesting sites.

The interior least tern nests on sandbars and sandy islands of major rivers and sandy shorelines of reservoirs. Within the project area, interior least terns forage and nest along the Arkansas River in Oklahoma and Arkansas from April through late August to early September. Terns nest in small colonies and prepare nests by making small scrapes in the sand where two or three eggs are usually laid. Both parents feed the young, which are fairly mobile upon hatching.

Terns prey on small fish, crustaceans, and insects. They prefer to forage in shallow water habitats on small surface schooling fish (2.0 to 9.0 cm long for adults and 1.5 to 4.0 cm long for chicks) (Atwood and Minsky, 1983; Schweitzer and Leslie, Jr., 1996; Wilson et al., 1993). They are considered "surface plungers" (Erickson, 1985) because they hunt for prey while hovering five to ten meters over water bodies, and plunge into the water to capture the fish. Distance to water bodies with available food highly influences reproductive success. Density of surface schooling fish and aquatic vegetation, and water transparency affect the suitability of an area for this species (Schweitzer and Leslie, Jr., 1996).

Interior least terns nest within three main areas in the Oklahoma portion of the study area: 1) the Arkansas River between Kaw Dam and Keystone Lake, 2) the Arkansas River between Keystone Dam and Muskogee, Oklahoma, and 3) the Canadian River between Eufaula Dam and the upper end of Robert S. Kerr Lake. Nesting populations are monitored annually by the Corps, Tulsa District, in accordance with the Service's Biological Opinion on the effects of the operation of Keystone and Kaw Reservoirs on this species. The Corps, Tulsa District, and the Service update specific management practices and guidelines on a continual basis to account for annual variations in nesting patterns and water management needs.

In Arkansas, nesting locations vary between years depending upon river conditions. Nesting areas observed in 2004 were at river miles 32, 35, 38, 42, 100, 105,106, 147, 151, 161, 170, 175, 188, 189, 232, 239, and 282. Management practices in Arkansas include restrictions on dredging near nesting areas, notching dikes, and building new islands using dredged material.

Whooping crane

The whooping crane is a tall, mostly white migratory bird with red facial skin. This species utilizes freshwater marshes, wet prairies, shallow lakes, lagoons, salt flats, and grain fields during the summer and during their spring and fall migration period. Whooping cranes occur in coastal marshes, salt flats, and along barrier islands during the winter. They feed on insects, crustaceans, and berries during the summer. During the

winter, their diet consists of grains, insects, crustaceans, mollusks, fish, reptiles, and marine worms (U.S. Fish and Wildlife Service, 1986).

The whooping crane was once widespread over North America. However, it has declined drastically primarily due to 1) the loss of nesting and wintering habitat to agriculture, 2) human disturbance of nesting areas, and 3) uncontrolled hunting. Other causes for their decline include disease, natural events such as storms, and collision with power lines (U. S. Fish and Wildlife Service, 1986; NatureServe, 2003).

Currently, the only self-sustaining population consists of about 200 individuals. This population breeds in one small area in Canada and winters primarily along the Texas coast. These cranes migrate each spring and fall between their breeding and summer grounds primarily through the Great Plains area of the central United States. Their migration route includes western Oklahoma. Salt Plains NWR is a very important stopover area for this population of migrating whooping cranes and is designated critical habitat. The whooping crane is considered a migrant through the study area in the following five Oklahoma counties: Osage, Rogers, Tulsa, Muskogee, and Wagoner.

Bald eagle

The bald eagle was once declining due to pesticide-induced reproductive failure, loss of habitat, and human disturbances such as shooting, poisoning, and trapping, and was originally listed as endangered in 1967. Nationwide, populations have increased due to habitat protection, a reduction in the use of organochlorine pesticides (*e.g.*, use of DDT was banned by the EPA in 1972), and conservation programs. Accordingly, the bald eagle was reclassified as threatened in all 48 conterminous states in 1995. The Service has proposed to remove the bald eagle from the list of Endangered and Threatened Wildlife in the lower 48 states of the United States.

The bald eagle breeds and winters in Oklahoma and Arkansas. Eagles utilize large, mature trees, such as cottonwoods, near rivers and reservoirs for perching and roosting. Trees used for diurnal perching are usually tall, with large diameters and stout branches. Trees used for communal night roosts are usually secluded, and provide protection from adverse weather conditions and human disturbance. Roosting areas are often located near their feeding areas. The eagles along the MKARNS and reservoirs feed mainly on fish, but also may eat waterfowl and carrion.

The MKARNS and associated reservoirs provide suitable habitat for the bald eagle. Eagles are known to occur at each of the 11 Oklahoma reservoirs (and the associated WMAs) that modify flow on the MKARNS. Several of these upstream reservoirs support sizeable concentrations of wintering bald eagles: Keystone, Eufaula, Wister, Grand, Fort Gibson, and Kaw. Bald eagles have used a protected area at Keystone Lake as a communal roost during the winter and spring for over 20 years (U. S. Army Corps of Engineers, 2003). Bald eagles also are known to occur at Sequoyah and Holla Bend NWRs, along the Arkansas River/MKARNS, and at large reservoirs in Arkansas. More

than 1,000 bald eagles are counted in Arkansas each winter. Large numbers occur at Lake Dardanelle and the White River National Wildlife Refuge.

Bald eagles are known to nest at numerous locations within the project area, especially along the main stem of the Arkansas River. Bald eagles have occupied over 30 known nests within the study area in Oklahoma during recent years including below Kaw and Keystone dams and along the Canadian River below Eufaula Reservoir. Numerous nests also are documented from the Arkansas River Valley in Arkansas.

Piping Plover

The piping plover is a small migratory shorebird with a tan back and white belly. The plover has bright yellow legs that distinguish it from similar species. The piping plover breeds from southern Canada to the northeastern and central United States along the Atlantic Coast, on the Northern Great Plains, and around the Great Lakes. Breeding habitat consists of sparsely vegetated, sandy shores of lakes, ponds, and rivers. The plover winters along the southern Atlantic and Gulf coasts, and in the Bahamas and West Indies. Non-breeding habitats include ocean beaches and sand, mud, and algal flats (NatureServe, 2003). Piping plovers use sandy rivers, reservoir beaches and mudflats during migration. Some birds may fly nonstop between breeding and wintering grounds.

Threats to this species are primarily human induced. Drastic declines have occurred due to loss of beach habitat resulting from recreational and commercial development, unfavorable water management, and the modification of riverine habitat through channelization and the construction of dams. The Great Lakes population is endangered. Populations in the northern Great Plains, along the Atlantic and Gulf coasts, in the Bahamas, and west Indies are considered threatened.

The threatened northern Great Plains population migrates through the study area in Oklahoma each spring and fall. They are known to use the Winganon Flats, a shallow water mudflat area at Oologah Reservoir, during their migration (U.S. Fish and Wildlife Service, 1993).

Ivory-billed woodpecker

The ivory-billed woodpecker was recently rediscovered in the Cache River NWR in Arkansas after being presumed extinct for more than 60 years. Following credible sight reports from the NWR, an intensive year long survey for the species resulted in the rediscovery, including feeding marks, and audio and video recordings.

The ivory-billed woodpecker historically occurred in mature, bottomland hardwood forests in the southeastern United States and Cuba. The woodpecker primarily feeds on beetle larvae found beneath the bark of recently dead trees. The usual feeding method consists of the bird using its bill to strip away pieces of bark to locate beetle larvae and tree boring insects (Jackson, 2002).

The ivory-billed woodpecker nests in a cavity in a dead or partly dead tree. No data exists pertaining to the incubation period, but it may be similar to other woodpeckers, which generally have a short incubation period of about 10 – 15 days (Jackson, 2002).

The Department of the Interior has created the "Corridor of Hope Conservation Plan" to save the ivory-billed woodpecker. The "Corridor of Hope" refers to the Big Woods of Arkansas, an area about 120 miles long and up to 20 miles wide in eastern Arkansas where the Ivory-billed woodpecker has been sighted.

The Interior Department, along with the Department of Agriculture, has proposed that more than $10 million in federal funds be committed to conserve the bird. This amount would supplement $10 million already committed to research and habitat protection efforts by private sector groups and citizens, an amount expected to grow once news of the rediscovery spreads. Federal funds will be used for research and monitoring, recovery planning and public education. In addition, the funds will be used to enhance law enforcement and conserve habitat through conservation easements, safe-harbor agreements and conservation reserve agreements.

Vertebrates: Mammals

Indiana Bat

The endangered Indiana bat is a grayish-brown migratory bat with blackish brown wing membranes and ears. This bat occurs in the Midwest and the eastern United States. The western edge of the Ozark region in Oklahoma marks the western limit of their range. Indiana bats migrate between winter and summer areas. They hibernate in caves during the winter and occur in wooded areas near streams during the summer. They mate during fall before they enter hibernation while swarming around cave entrances.

Indiana bats require specific temperature and humidity conditions within caves for hibernation. Consequently, the entire species concentrates in only those caves that provide the appropriate conditions for hibernation. While hibernating, they congregate into tight clusters of hundreds or thousands of individuals. Most bats leave their hibernation caves in March and April.

Rivers and streams and their associated vegetated riparian zones and floodplains provide important summer foraging habitat (Humphrey et al., 1977; U. S. Fish and Wildlife Service, 1985). Indiana bats prey on flying insects such as moths, beetles and flies (Humphrey et al., 1977; Black and LaVal, 1985). During summer, maternity colonies roost under tree bark or in hollow trees usually near streams. Males tend to forage over floodplain ridges and hillside forests. They roost in caves (Humphrey et al., 1977; Humphrey, 1978; U.S. Fish and Wildlife Service, 1993).

The Indiana bat has declined primarily due to human disturbances. These disturbances include commercialization of roosting caves, destruction of caves by vandals, disturbance to hibernating bats and pregnant females (disturbances can result in death of hibernating

adults in winter and abortion of young in the summer), and possibly insecticide poisoning. About 87% of the species hibernates in only seven caves. Therefore, the Indiana bat is especially vulnerable to human disturbance during winter (U. S. Fish and Wildlife Service, 1983). Another probable factor in Indiana bat decline is loss of summer habitat such as native forest along waterways (NatureServe, 2003).

The Indiana bat is a migrant through the project area and may occur in riparian and floodplain habitats in the project area during the summer. This species utilizes limestone caves in northern Arkansas and sandstone talus caves south of Lake Wister in the Winding Stair Mountain National Recreation and Wilderness Area, Leflore County, Oklahoma, during the winter hibernation period (Saugey et al., 1990). Summer caves are not known to occur in the project area.

Gray bat

The endangered gray bat is a medium sized bat that occupies a limited geographic range in limestone karst regions of the southeastern United States. Populations are found mainly in Alabama, northern Arkansas, Kentucky, Missouri, and Tennessee. Gray bats also occur in Florida, western Georgia, southeastern Kansas, southern Indiana, southern Illinois, northeastern Mississippi, western Virginia, and northeastern Oklahoma (Barbour and Davis, 1969; Tuttle, 1979).

Gray bats utilize caves year round (Tuttle, 1976). They migrate seasonally between maternity and hibernacula, where mating occurs (U.S. Fish and Wildlife Service, 1993). Only a small percent of the caves within the bat's range provide needed conditions for hibernation (Tuttle, 1979). Consequently, about 95% of the known gray bat population hibernates in only nine caves each winter with more than half utilizing a single cave. Gray bats enter hibernation some time between September and November and emerge in late March or April to migrate to summer caves. Summer caves are typically located within 1 km of lakes and rivers. Undisturbed colonies contain from 5,000 to 250,000 or more bats, while most colonies number between 10,000 and 50,000 bats (Tuttle, 1979).

Gray bats feed on insects almost exclusively over water along reservoir edges and rivers and, to some extent, in adjoining riparian forest canopy during spring and summer. They also use associated forest canopy as a travel corridor and escape route between caves and feeding sites. This behavior provides protection from predators such as owls (U.S. Fish and Wildlife Service, 1982).

The major reasons for the gray bat's decline are human disturbance and habitat or environmental disturbance such as introduction of pesticides, impoundment of waterways, cave commercialization, improper gating, and natural calamities such as cave-ins (Tuttle, 1979). Due to the gray bat's preference for caves near rivers, flooding of caves as a result of man-made impoundments also can be problematic. For example, in summer bats often will move deeper into caves and select areas over water to avoid human disturbance. These areas are more likely to be affected by rising water levels (Tuttle, 1979).

The total gray bat population is estimated at 1,575,000 individuals. Due to conservation measures such as the acquisition of priority caves, many populations are now stable or increasing.

In Oklahoma, gray bats occur in five summer maternity caves in Delaware, Adair, Ottawa, and Cherokee counties. These caves support about 60,000 to 70,000 bats. Known maternity caves are located in close proximity to Tenkiller, Grand, and Fort Gibson reservoirs. Gray bats utilizing these caves likely forage along the reservoir margins, the Illinois and Neosho rivers, and associated streams. These bats migrate to southern Missouri and northern Arkansas to hibernate during the winter.

Ozark big-eared bat

The endangered Ozark big-eared bat is a medium sized, cave dwelling bat with distinctively long ears and facial glands on either side of the face. The bat is endemic to the Ozark region where it inhabits limestone and sandstone caves in oak–hickory Ozark forest (Clark, 1991; U. S. Fish and Wildlife Service, 1995). Ozark big-eared bats often forage in edge habitat between forested and open areas (Clark et al., 1993; Wethington et al., 1996) Their diet consists primarily of moths and other flying insects such as flies and beetles (Clark, 1991).

Caves used by the Ozark big-eared bat occur in a variety of surroundings, ranging from large tracts of contiguous forest to smaller forested tracts adjacent to open areas. Ozark big-eared bats do not migrate. They generally return to the same maternity caves and hibernacula each year. Maternity colonies begin to form in late April to early June (Clark, 1991). Ozark big-eared bats hibernate in locations with high humidity and cold temperatures in areas of total darkness deep within a cave, but they also have been known to occasionally hibernate in twilight areas near the entrance (Clark, 1991; Clark et al., 2002). They usually hibernate in clusters of up to 100 individuals, but also will hibernate in small groups or even singly (Clark et al., 1996).

The vulnerability of the geographically isolated Ozark big-eared bat to extinction is high because of its susceptibility to disturbance. Fragmentation and loss of habitat, vandalism, and increased human activity in maternity roosts and hibernacula have caused population declines (U. S. Fish and Wildlife Service, 1995). Recent counts indicate a population of roughly 1,800 individuals in eastern Oklahoma and about 500 in western Arkansas.

The Ozark big-eared bat was historically found throughout the Ozarks in southern Missouri, Arkansas, and northeastern Oklahoma. However, today this species is found only in Arkansas and Oklahoma (Elliot et al., 1999; U. S. Fish and Wildlife Service, 1995). In Arkansas, the bats are known to primarily occur in Marion, Crawford, and Washington counties. They also occur in Franklin County, and potentially may occur in Benton, Searcy, Logan, Newton, Johnson, and Madison counties. In Oklahoma, Ozark big-eared bats occur in Adair, Delaware, Cherokee, Ottawa, and Sequoyah counties. Caves in Adair County support some of the largest maternity colonies and numbers of

hibernating Ozark big-eared bats. Except for a small portion of Spavinaw Creek, in Delaware County, Oklahoma, Ozark big-eared bat caves are not associated with any major water bodies in the project area.

Plants

Harperella

Harperella is an endangered, annual herb with slender stems, small white flowers, and hollow, quill like leaves. It is known to occur in two habitat types: 1) rocky/gravel shoals of swift, clear streams, and 2) the edges of intermittent pine-land ponds. This species is dependent on a narrow range of hydrologic conditions. Causes for its decline include alterations of water regime from use changes and impoundments, water withdrawal, upstream development, and the draining or deepening of ponds. Harperella is currently known to occur in only 13 extant populations, including populations in Yell and Scott counties, Arkansas (NatureServe, 2003). However, this species is not likely to occur along the MKARNS due to numerous impoundments and the highly modified water regime.

Geocarpon minimum

Geocarpon minimum (no common name) is a small succulent annual plant that is known to only occur at 53 sites in Missouri, Louisiana and Arkansas, including a small population in Franklin County, Arkansas. This threatened species typically occurs on sandstone glades and saline prairies. Typical sites are high in sodium and magnesium and are low in species diversity. This plant completes its entire life cycle within a four week period during spring. Threats include habitat modification, trampling and grazing by livestock, and off-road vehicle use. The species is vulnerable to extirpation due to its limited range and limited available habitat (NatureServe, 2003). Although the species occurs within the project area, it is not likely to be found along the MKARNS.

Western prairie fringed orchid

The threatened western prairie fringed orchid is a perennial herb that produces a tall white inflorescence. It occurs in moist areas in tallgrass prairie or sedge meadows in western portions of the tallgrass region of North America. The orchid once occurred in the vicinity of the project area. However, it has experienced a drastic decline due to conversion of habitat to cropland and pasture, and overgrazing. Currently, extant populations are found from 172 known locations in Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and Manitoba, Canada (NatureServe, 2003; U.S. Fish and Wildlife Service, 1993).

Literature Cited

Atwood, J. L., and D. E. Minsky. 1983. Least tern foraging ecology at three major California breeding colonies. Western Birds 14:57-72.

Barbour, R. W., and W. H. Davis. 1969. Bats of America. Univ. Kentucky Press, Lexington. 286 pp.

Benham-Holway Power Group. 1988. Supplemental Information to New License Application Major Project – Existing Dam, Pensacola Hydropower Project. FERC No. 1494-002. State of Oklahoma, Grand River Dam Authority, Vinita, OK.

Black, V., and R. K. LaVal. 1985. Food habitst of the Indiana bat in Missouri. Journal of Mammalogy 66(2):308-315.

Brown, A. V., and C. S. Todd. 1987. Status review of the threatened Ozark cavefish (*Amblyopsis rosae*). Proc. Arkansas Acad. Sci. 41:99-100.

Bulger, A. G., and D. R. Edds. 2001. Population structure and habitat use in the Neosho madtom (*Notorus placidus*). The Southwestern Naturalist 46:8-15.

Clark, B. S. 1991. Activity patterns, habitat use, and prey selection by the Ozark big-eared bat (*Corynorhinus townsendii ingens*) PhD Dissertation. Oklahoma State University, Stillwater, OK. 80 pp.

Clark, B. S., B. Clark, and D. M. Leslie, Jr. 2002. Seasonal variation in activity patterns of the endangered Ozark big-eared bat (*Corynorhinus townsendii ingens*). Journal of Mammalogy 83 (2):590-598.

Clark, B. S., D. M. Leslie, Jr., and T. S. Carter. 1993. Foraging activity of adult female Ozark big-eared bats in summer. Journal of Mammalogy 74:422-427.

Clark, B. K., B. S. Clark, D. M. Leslie, Jr., and M. S. Gregory. 1996. Characteristics of caves used by the endangered Ozark big-eared bat. Wildlife Society Bulletin 24:8-14.

Creighton, J. C., M. V. Lomolino, and G. Schnell. 1993. Unpublished report. Survey methods for the American burying beetle (*Nicrophorus americanus*) in Oklahoma and Arkansas. Oklahoma Biological Survey. Norman, OK.

Elliot, W. R., K. B. Lister, and M. A. Shiver. 1999. A Survey for Ozark big-eared bats, *Corynorhinus townsendii ingens*, and a cave crayfish, *Cambarus aculabrum*, in Southern Missouri.

Erickson. M. O. G. 1985. Prey detectability for fish-eating birds in relation to fish density and water transparency. Ornis Scandinavica 16: 1-7.

Gordon, M. E. 1980. Freshwater Molluska of the Elk River, White River abover Beaver Reservoir, and Frog Bayou of the souther Ozarks. MS Thesis, University of Arkansas, Fayetteville. 366 pp.

Harris, J. L., P. J. Rust, A. C. Christian, W. R. Posey II, C. L. Davidson, and G. L. Harp. 1997. Revised status of rare and endangered Un ionacea (Mollusca: Margaritiferidae, Unionidae) in Arkansas. Journal of the Arkansas Academy of Sceince 51: 66-89.

Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotyis sodalis*. Journal of Mammalogy 58:334-346.

Humphrey, S. R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*. Florida Scientist 41(2):65-76.

Jackson, J. A. (2002). Ivory-billed Woodpecker (*Campephilus principalis*). The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North American Online database: http://bna.birds.cornell.edu/BNA/account/Ivory-billed_Woodpecker/

Lomolino, M., and C. Creighton. 1996. Habitat selection, breeding success and conservation of the endangered American burying beetle (*Nicrophorus americanus*). Biological Conservation 77:235-241.

Lomolino, M.V., J.C. Creighton, G.D. Schnell, and D.L. Certain. 1995. Ecology and conservation of the endangered American burying beetle (*Nicrophorus americanus*). Conservation Biology 9:605-614.

Luttrell, G. R. 1991. Status of threatened and endangered fishes in Oklahoma, Status of the Neosho madtom in Oklahoma. Final Report, Sec. 6. Endangered Species Act; Federal Aid Project E-8, Job 2. Oklahoma Department of Wildlife Conservation, Oklahoma City, OK. 22 pp.

Mather, C. 1990. Status survey of the western fanshell and the Neosho mucket in Oklahoma. Final Report to the Oklahoma Deptartment of Wildlife Conservation. #E7.

Mathews, J. R., and C. J. Mosely. 1990. The official world wildlife guide to endangered species of America. Volume 2. Reptiles, amphibians, fishes, mussels, crustaceans, snails, insects, and arachnids. Xiii+ pp 561 – 1180.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: November 6, 2003).

Oesch, R. D. 1995. Missouri Naiadse: A guide to the mussels of Missouri. Missouri Department of Conservation, Jefferson City. 270 pp.

Saugey, D. A., G. A. Heidt, D. R. heath, and V. R. McDaniel. 1990. Hibernating Indiana bats (*Myotis sodalis*) from the Ouachita Mountains of southeastern Oklahoma. The Southwestern Naturalist 35: 341-342.

Schweitzer, S. H. and D. M. Leslie, Jr. 1996. Foraging patterns of the least tern (*Sterna antillarum*) in north-central Oklahoma. Southwestern Naturalist 41:307-314.

Tuttle, M. D. 1976. Population ecology of the gray bat (*Myotis grisescens*): philopatry, timing, and patterns of movement, weight loss during migration, and seasonal adaptive strategies. Univ. Kansas. Occ. Paper. Mus. Nat. Hist. 54:1-38.

Tuttle, M. D. 1979. Status, causes of decline, and management of endangered gray bats. Journal of Wildlife Management 43(1):1-17.

U. S. Army Corps of Engineers. 2003. Draft Integrated Feasibility Report and Environmental Impact Statement for the Arkansas River Navigation Study, Arkansas and Oklahoma. Little Rock and Tulsa Districts.

U. S. Fish and Wildlife Service. 1982. Gray bat recovery plan. Denver, Colorado. 91 pp.

U. S. Fish and Wildlife Service. 1983. Indiana bat recovery plan. Twin Cities, Minnesota. 82 pp.

U. S. Fish and Wildlife Service. 1985. Planning Aid Report on the Corp's Arkansas River Basin Study, Arkansas and Oklahoma (Oklahoma Portion). Oklahoma Ecological Services. Tulsa, OK. 25 pp.

U. S. Fish and Wildlife Service. 1986. Whooping crane recovery plan. Albuquerque, New Mexico. 283 pp.

U. S. Fish and Wildlife Service. 1989. Ozark cavefish recovery plan. U. S. Fish and Wildlife Service. Atlanta, Georgia. 42 pp.

U. S. Fish and Wildlife Service. 1990. Fish and Wildlife Coordination Act Report on the Arkansas River Basin, Arkansas and Oklahoma. Tulsa, OK. 31 pp.

U.S. Fish and Wildlife Service. 1991. American Burying Beetle (*Nicrophorus americanus*) Recovery Plan. Newton Corner, Massachusetts. 80 pp.

U.S. Fish and Wildlife Service. 1992. Biological opinion of the U. S. Fish and Wildlife Service on the Pensacola Hydropower Project, FERC Project No. 1494-002. 16 pp.

U. S. Fish and Wildlife Service. 1993. Endangered and threatened species of Oklahoma. Tulsa, OK. Oklahoma Ecological Services Field Office, Tulsa, Oklahoma.

U. S. Fish and Wildlife Service. 1995. Ozark big-eared bat revised recovery plan. Tulsa, OK. 51 pp.

U. S. Fish and Wildlife Service. 1998. Fish and Wildlife Service. 50 CFR Part 17. Endangered and threatened wildlife and plants; Final rule to list the Arkansas River basin population of the Arkansas River shiner (*Notropis girardi*) as threatened. Final Rule. Federal Register Vol. 63 No. 225.

Wenke, T.L., M.E. Eberle, G.W. Ernsting., and W.J. Stark. 1992. Winter collections of the Neosho madtom (*Notorus placidus*). The Southwestern Naturalist 37:330 -333.

Wethington, T. A., D. M. Leslie, Jr., M. S. Gregory., and M. K. Wethington. 1996. Pre-hibernation habitat use and foraging activity by endangered Ozark big-eared bats. American Midland Naturalist 135:218-230.

Willis, L. D., and A. V. Brown. 1985. Distribution and habitat requirements of the Ozark cavefish, *Amblyopsis rosae*. The American Midland Naturalist 114:311-317.

Wilson, E. C., W. A. Hubert, and S. H. Anderson. 1993. Nesting and foraging of least terns on sand pits in central Nebraska. Southwestern Naturalist 38:9-14.

APPENDIX C

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Concept Paper: Fish and Wildlife Conservation Feature

Concept Paper

May 27, 2005

Arkansas River Navigation Project Mitigation Proposal and the Arkansas River Conservation Initiative

Monitoring Arkansas River Resources Stations (MARRS) & Arkansas River Valley Resource Complex (ARVRC)

Background : The Arkansas River Navigation Study (Impacts and Assessment)

The U.S. Army Corps of Engineers is in the process of finalizing the Arkansas River Navigation study to consider deepening the navigation channel for the entire length of the McClellan-Kerr Arkansas River Navigation System (MKARNS) in Arkansas and Oklahoma. If authorized, the project will increase the depth of the navigation system from 9 feet to 12 feet for approximately 445 miles from the confluence with the Mississippi River to the Port of Catoosa on the Verdigris River near Tulsa, Oklahoma.

Achieving a 12-foot channel will require additional removal of approximately 10,985,340 cubic yards of dredge material at 140 locations along the MKARNS and disposal into 68 new aquatic and terrestrial dredged material disposal sites encompassing 10,189 acres. Gravel bar surveys indicate that 165 acres of gravel could potentially be lost. This represents the removal of the last remaining shoal habitat within the main channel of the lower Arkansas River and additional loss of backwater habitats. The project would remove shoaling areas to increase the navigation channel depth, however, the inadvertent consequence of this project will be the removal of most of the main channel shoals and the further cumulative loss of backwaters along the entire length of the navigation system.

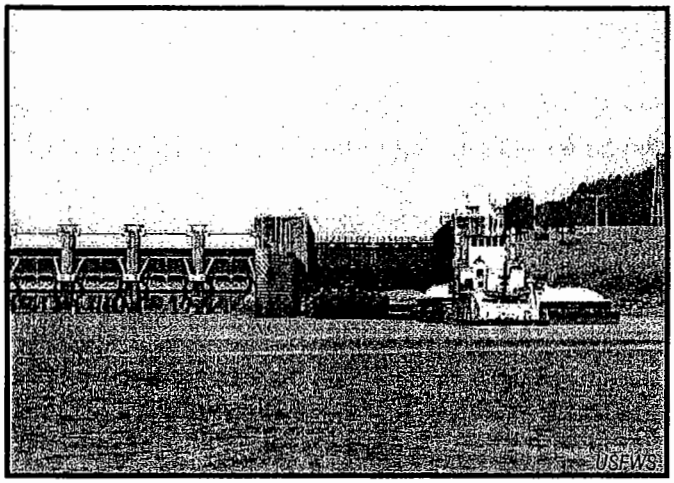
Shoals on the Arkansas River are typically composed of gravel and sand substrates which are important habitat for numerous fish species. In addition, they play an important role in the water quality, hydrology, and morphology of the river. What effect the removal of most of the existing main channel shoal habitat will have on fish species, communities, and ecosystems is uncertain. Gravel is a finite resource, and any impacts from dredging should be a primary concern because of the inherent habitat value of gravel to water quality and aquatic species. Conservation of these species and the cumulative loss of gravel substrates due to dredging and channelization fully justify creation or relocation of gravel as a mitigation technique. The goal of the mitigation should be to have no net loss of gravel by relocating gravel that is dredged to a suitable site within the project area.

Disposal of dredged material in backwater habitats will have significant impacts. Results from the aquatic habitat impacts analysis illustrates a positive relationship between fish abundance and the depth of dike pools. Reducing water depth in a dike field through dredged material disposal and new training structure construction and modifications would have major adverse impact to fishes. Additional loss of backwater habitats could have substantial impacts on fish abundance and diversity.

In total impacts will result in the loss of 1066.2 average annual habitat units (AAHU) and mitigation benefits will yield 636.8 AAHU. Therefore, a net mitigation deficit of 429.4 AAHU remains following exhaustive efforts to avoid, minimize, and mitigate in-kind.

Most of the data and mitigation planning required for impacts from dredging, aquatic and terrestrial dredge

The Arkansas River winding through rural Arkansas downstream of Ozark. Corps owned riparian buffers maintain a 445 mile corridor of habitat and wildlife along America's sixth longest river in Arkansas and Oklahoma.



A grain barge enters the Dardanelle Lock headed up river. By deepening the channel barges will be able to operate more efficiently , saving energy and money. However, environmental costs must be fully mitigated.

disposal, loss of fresh water mussels, and affects to threatened and endangered species has been completed. However, the mitigation deficit for aquatic impacts, the need for long term monitoring, and the ability to adaptively mitigate and manage the system based on results of the monitoring is essential to this project. Many unforeseen impacts may be identified through monitoring and some assessments may have been under- or over-estimated, thus requiring more or less mitigation in the future. In addition, mitigation techniques and sites may require modification to ensure success. There is little precedence for relocating or creating habitats and maintaining mitigation sites on a large river ecosystem of this magnitude. Maintenance of the mitigation features is essential to compensate for the perpetual losses resulting from maintenance of dikes, dredging, and disposal necessary to sustain a 12ft channel.

The consequences of large scale and long term changes to an entire river ecosystem are difficult, if not impossible, to completely predict. The extent of the impact may be predicted and quantified in acres and cubic yards of sediment to be removed and disposed, however, assessing and quantifying the direct, indirect, short, and long term impacts of habitat alteration and loss to an entire ecosystem is a practical impossibility. Further replacement of these habitats through one time in-kind mitigation may not be an option, as available habitat for restoration is limited. Mitigating out-of-kind will not benefit or restore the habitats or the fish and wildlife resources affected, therefore, fully assessing and quantifying the effects of the project and providing applicable mitigation to fisheries will require innovative and long term monitoring and subsequent mitigation and adaptive resource management to fully compensate for project impacts and to restore the Arkansas River ecosystem.

The Service believes that a long term monitoring plan is essential to addressing these uncertainties and evaluating the success of the proposed mitigation. Completion of the navigation project will likely take 4-6 years and for many years following the project will require extensive maintenance adjustments. Likewise, effective and viable mitigation will require additional maintenance to ensure success.

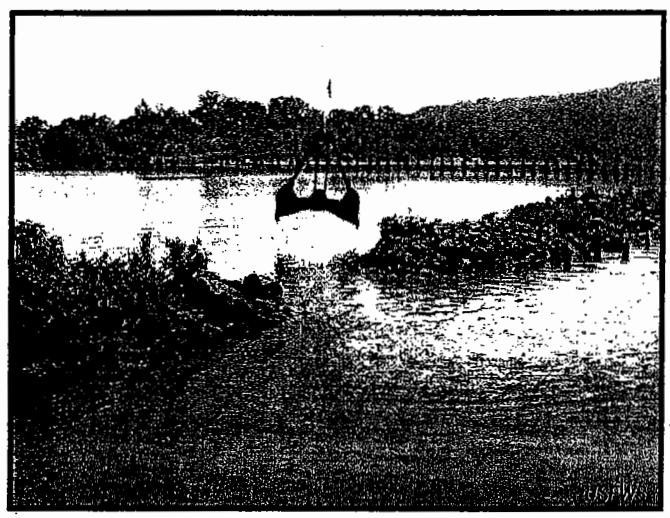
Feasibility

Currently the feasibility of the project based on cost:benefit assessment is uncertain. However, combining wildlife conservation with navigation as coequal project goals would allow for inclusion of economic benefits resulting from recreation and tourism dollars to be included in the feasibility calculations.

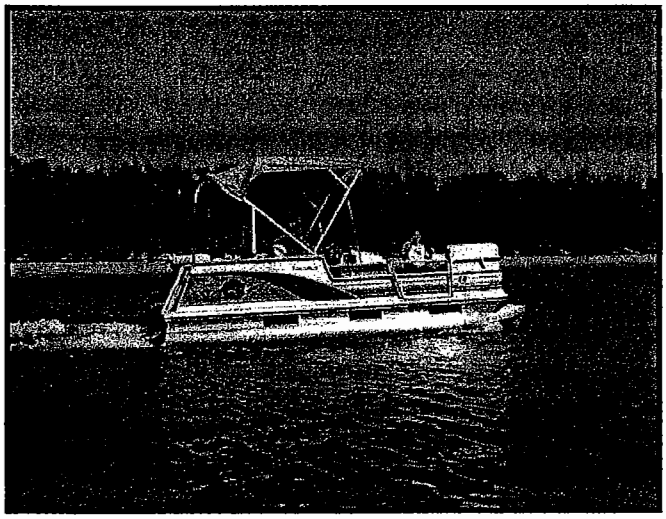
The Corps has the ability to seek full Congressional authorization and funding for an "Environmental Management Program" in order to include ecosystem restoration under section 906(b) of WRDA 1986 and section 306 of WRDA 1990. Furthermore, this goal is supported by the Fish and Wildlife Coordination Act and other authorities that have established fish and wildlife conservation as a coequal purpose of water resource development projects by stating "wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs".

Alternative Models

The Upper Mississippi River National Wildlife and Fish Refuge and the Long Term Resource Monitoring Program are perfect examples of monitoring, mitigating,



Backwater habitat restoration through dike notching is already happening along the river and the mitigation plan calls for more to be done. However, the number of dikes available for notching as mitigation and the ability to maintain these important fisheries habitats into the future is uncertain.



Recreational fishing and boating is popular with many locals and fishing tourists, however, recreational businesses, shoreline accessibility, river viewing, and other recreational and educational opportunities are lacking.

restoring, and managing natural resources on a large river ecosystem. The Upper Mississippi River NWFR is the longest refuge in the lower 48 states, extending 261 miles along the Mississippi River. It was established in 1924 to protect bottomland habitat for migratory birds and fish.

The Upper Mississippi River NWFR provides essential habitat for a wide variety of plants, fish, migratory birds, and other animals. Over 3 million people visit the refuge and contribute an estimated $1 billion in recreational benefits to the region. Its attractiveness to recreationalists is directly related to its rich fish and wildlife populations and natural scenic beauty.

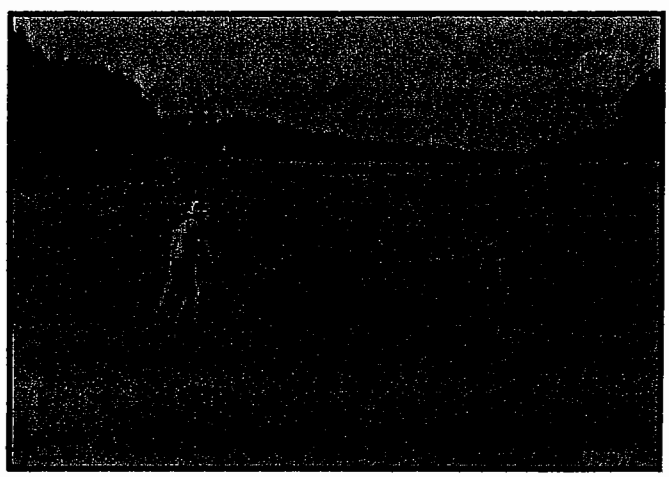
An integral part of maintaining and monitoring this system and the effects of the navigation project is the Long Term Resource Monitoring Program. The program was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The program is implemented by the U.S. Geological Survey (USGS) in cooperation with the five Upper Mississippi River System states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), with guidance and overall program responsibility provided by the U.S. Army Corps of Engineers. A directive outlining the mode of operation and the respective roles of the agencies is embodied in a 1988 Memorandum of Agreement (MOA).

In the 1986 WRDA, Congress recognized the Upper Mississippi River System as nationally significant both ecologically and economically and furthermore appropriated funding for this program. The mission of the program is to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The long term goals of the program are to understand the system, determine resource trends and impacts, develop management alternatives, manage information, and develop useful products.

The Arkansas River Opportunity

The Corps of Engineers presently owns over 5,000 acres of closed, closing, and/or undeveloped parks at 49 locations along the length of the navigation system in Arkansas and Oklahoma. Many of these parks have existing roads and infrastructure such as trails, benches, boat ramps, and toilets, while others are entirely forested or in pasture. These parks range in size from a few acres to over 100 acres with most averaging around 20 acres. The Corps does not manage these areas for fish and wildlife, nor are they open to public access accept by boat or foot. Most of these areas provide limited or no recreational, educational, or management opportunities under the Corps' ownership.

The Corps also owns over 50,000 acres of islands and floodplain lands, which are important riparian habitats and serve as an invaluable buffer along the river. As with the park lands, neither the islands, riparian floodplains, the associated habitats, nor the wildlife within them are managed for recreation, education, enhancement, protection, or restoration. Generally, budget restrictions have prevented the Corps from more detailed management of these sites. The Corps could use the authorities provided under the 1986 and 1990 WRDAs to seek authorization and funding for an "Environmental Monitoring and Management Program".



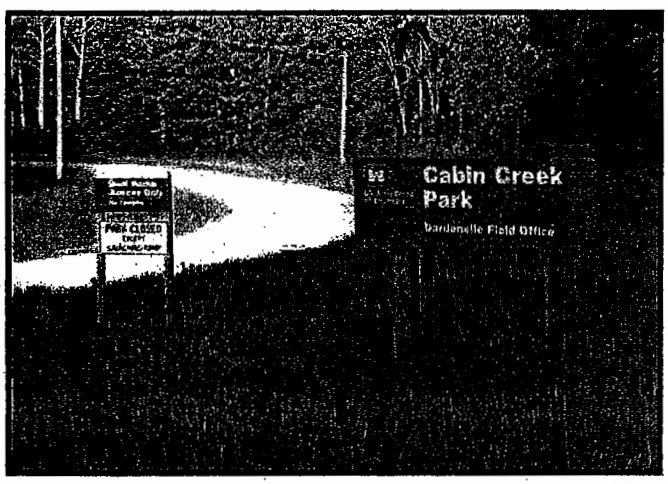
Coordinating research and management of backwater waterfowl habitat, fisheries, and nurseries will prevent species extirpation and enhance non-game and game waterfowl and fisheries conservation.

The MARRS Concept

The Arkansas River Navigation Study will have numerous impacts on both terrestrial and aquatic ecosystems, with limited opportunity for in-kind mitigation. One option would be to follow the model of the Upper Mississippi River and mitigate for these impacts through the creation of the Monitoring Arkansas River Resources Stations (MARRS), which would identify aquatic resource mitigation and management needs through long term monitoring for application of future adaptive management and mitigation based on coordinated and cooperative research among resource agencies.

With proper funding management of closed and/or undeveloped parks could be transferred to state or federal natural resource agencies as part of the mitigation package to establish a series of biological monitoring stations through property transfer or MOA. The MARRS stations could be constructed incrementally along the river to provide a comprehensive and coordinated monitoring system. With cooperation of the Arkansas and Oklahoma state wildlife resource agencies and the state university systems these sites could be operated and maintained by the state universities. Research and monitoring for the entire length of the navigation system can then be coordinated and administered by the state and federal resource agencies to provide a comprehensive assessment of the project impacts over time and to expand our knowledge and understanding of the Arkansas River and large river ecosystems.

The Universities of Arkansas (UA) at Monticello, UA at Pine Bluff, UA at Little Rock, University of Central Arkansas (Conway), Arkansas Tech University (Russellville), UA at Fort Smith, Oklahoma State



One of the many parks closed due to budget restraints. An all too familiar site for local users and tourists. Closing parks affects local economies and parks are often the only tourist attraction and public recreational resource for small rural communities. Conservation is directly related to use.

Education, tourism, and visitor's centers are few a far between along the nation's 4th longest river. Interstate 40 provides the access and the river is the attraction, what people need is a way to experience it and learn.

University at Okmulgee, Tulsa University, and the University of Oklahoma at Tulsa are ideally located to provide the necessary students, staff, and expertise. Many of these universities have established programs capable and willing to perform this function, but currently lack the coordination, funding, and facilities to conduct such monitoring and research.

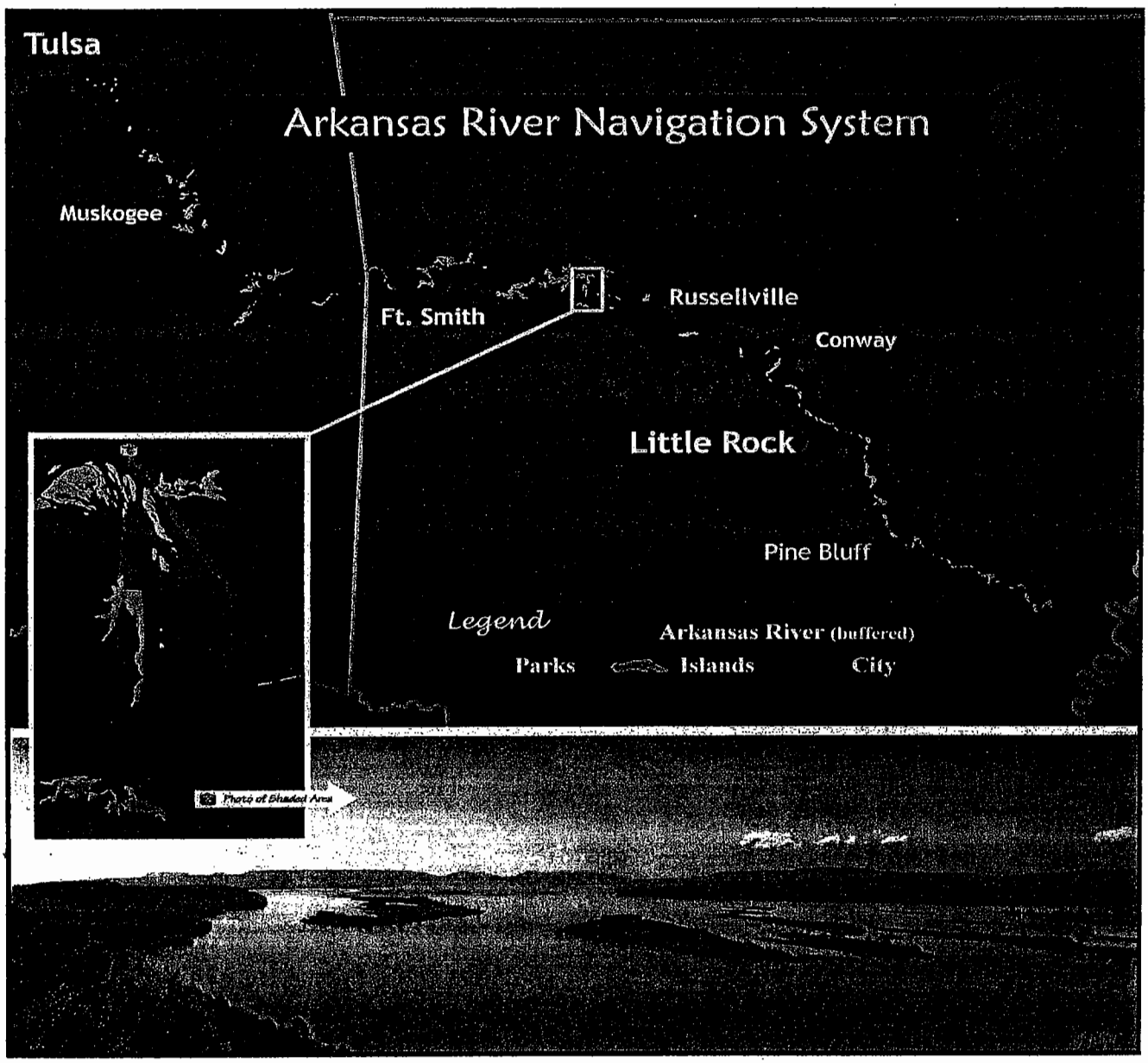
Facilities for these stations could be constructed as part of the out-of-kind mitigation for aquatic impacts to provide the necessary laboratories and housing for staff and students to provide long term monitoring, implement reasonable and prudent measures, and to produce the data to support recommendations for future adaptive management and mitigation.

The ARVRC Concept

In addition to the park areas there are over 50,000 acres of additional lands and islands within the Corps owned floodplains along the Arkansas River Navigation System that are potentially available for transfer to conservation organizations, state, and/or federal resource agencies in either ownership, easement, and/or management through an MOA. These areas are important wildlife habitat, riparian buffers, and wetlands that could be managed as mitigation for this project or independently as a measure to simply improve management, conservation, and protection of fish and wildlife resources, including five threatened and endangered species.

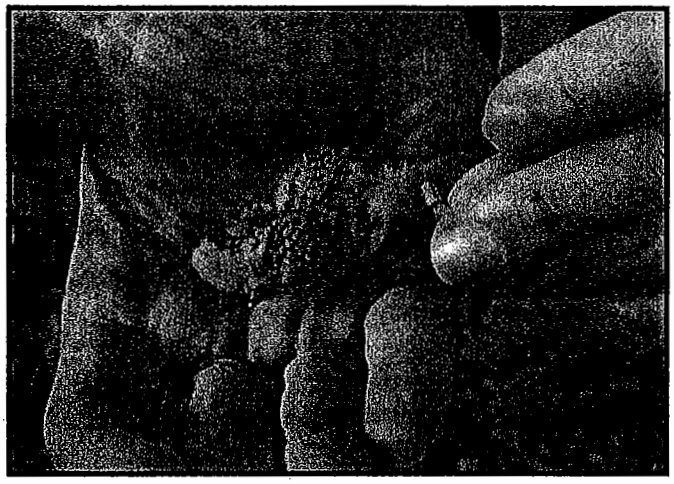
These islands and the floodplain riparian corridor stretching over 445 miles and encompassing a significant amount of habitat within the Arkansas River Valley could either become part of the National Wildlife Refuge (NWR) system, National Park System, state wildlife

The blue area indicates the Arkansas River Navigation System from the Arkansas/White River confluence with the Mississippi River to the Port of Catoosa on the Verdigris River near Tulsa, Oklahoma; red areas indicate closed or undeveloped Corps parks; and yellow areas indicate islands and large floodplain Corps lands. Magnification of the Lake Dardanelle project area within the inset provides greater detail of Corps parks and lands. The photo inset illustrates the Corps owned islands within the area known as the Spadra Straits on Lake Dardanelle, Arkansas River, Arkansas.



management areas, state parks, and/or a non-governmental organization conservation areas. Another option would be to coordinate and manage these lands in cooperation with the over 489,000 acres of existing state conservation areas, wildlife management areas, Department of Defense lands, and White River, Sequoya, and Holla Bend NWRs as the Arkansas River Valley Resource Complex (ARVRC). The ARVRC would be the longest conservation complex in the lower 48 states, manage most of the Arkansas River Valley ecoregion, and cross two states.

The MARRS stations, in addition to biomonitoring the river, could assist with the wildlife, habitat, and recreational research and management of these areas, and serve as public education/visitor centers along the Arkansas River corridor in Arkansas and Oklahoma. The ARVRC could provide improved management and habitat conservation for game, T&E species, and migratory birds. In addition, this complex will promote tourism through improved recreational opportunities and accessibility along the shorelines of the river. In the end this complex could provide the long term coordinated biological assessment, mitigation, and balance the Arkansas River Navigation Project needs, while improving the fish and wildlife resources, accessibility, tourism, economics, and educational opportunities along the Arkansas River.



Riparian habitat research and least tern tagging by Arkansas Tech University students are a few examples of how the MARRS stations, in addition to biological monitoring, will provide the universities and the resource agencies with research and conservation centers to expand our knowledge and ability to conserve ecosystems and species.

Monitoring, Mitigating, and Adaptive Management

The Service believes that a long term monitoring program is necessary to address the uncertainties in predicting impacts and success of proposed mitigation projects. Completion of the navigation project will take 4-6 years and for many years following the project will require extensive maintenance adjustments.

A monitoring program has been recommended that includes both biological and engineering studies. These studies address sediment dynamics in dike fields and backwaters, developing a better understanding of biological responses of fish and other aquatic organisms to dike modifications such as notching, field surveys of gravel bar characteristics and fish utilization, potential of headcutting and associated impacts to fish in tributaries, water quality monitoring, and habitat assessments to determine if the impact predictions were accurate, if mitigation worked, and make recommendations for further mitigation needs if necessary. Furthermore, a more detailed monitoring program should be developed in cooperation with state and federal agencies to insure that each of these issues is addressed in detail.

Monitoring and assessing the gravel habitat relocations for sustainability and viability is essential to insuring successful mitigation. Dike notching and island creation may succeed initially in restoring backwaters and a braided channel to the river, but there are no guarantees that these areas will remain and function as designed. Unlike the navigation channel there are no funds currently planned for adaptive management, mitigation, or maintenance. Understanding how the river functions and which mitigation measures work will require observation and the ability to adapt techniques and strategies.

The Service believes that at least 10 years of monitoring is necessary to fully assess all aspects of the project and mitigation. Some components will not require monitoring in consecutive years and may be broken up into incremental assessments as warranted. Pre-construction baselines and post-construction assessments are essential. A partial baseline assessment has been completed, however, completion of the project will take many years allowing for time to complete baseline and seasonal studies. In addition, it is essential that the details of the monitoring plan be coordinated with the resource agencies to insure consensus and a comprehensive assessment.

In general, the monitoring plan should include:

1 - Sediment dynamics in dike fields and backwaters
- Bathymetry
- Substrate sampling
- Lidar, GIS
- Headcutting assessment

2 – Relationships between fish diversity and physicochemical characteristics of dike fields and backwaters
- Seasonal sampling in trend pools
- Water quality sampling
- Comparison of notched and un-notch dikes
- Comparison of mitigation and reference sites

3 - Potamological characteristics of impacted and mitigated gravel bars
- Substrate borings and classification (1-year only)
- Substrate profiling (3-years)

4 - Seasonal use of gravel bars as fish spawning, feeding, and resting areas
- Comparison of natural and mitigated bars
- Limited invertebrate sampling

5 - Habitat characteristics and fish communities in tributary mouths of the Arkansas River

6 - Mussel assessment and relocation monitoring

A net mitigation deficit of 429.4 AAHU remains following exhaustive efforts to avoid, minimize, and identify up front in-kind on-site mitigation. The Service in cooperation with the Corps, state agencies, and private consultants have identified numerous alternative mitigation sites along the river. These sites include restoring and maintaining fish access to backwaters, notching dikes and revetments, and creating aquatic habitat. Selection of these sites for mitigation should correspond proportionally to impacts by navigation pool and coordinated with the resource agencies. The final mitigation plan should include a description of all of these features.

Considering the expediency of the environmental impact study, the absence of precedence, and a project and innovative mitigation plan of this magnitude it is unlikely that we will achieve "no net loss" of habitat with our initial efforts. It is reasonable to assume that gravel relocation will likely fail in some locations and require additional and costly relocation. It is also reasonable to assume that some dike notches will fail, will require modification, or will require filling to maintain dike integrity. Because of these likely failures adaptive management and continuing implementation of additional mitigation measures is essential.

Ecosystem Restoration

There has been insufficient time to complete an appropriate impact assessment, develop a complete mitigation plan, and include mitigation costs in the feasibility assessment. With monitoring, time, and money a complete assessment can be completed and adequate mitigation can be achieved, however, the feasibility of this project to meet economic and mitigation requirements is currently in question.

Control burns on islands and in riparian areas could improve habitat diversity for migratory birds, reduce dense ground vegetation to restore bottomland hardwood species, enhance game management, and enable access. Oxbows, wetlands, and island ponds could be used for fishing and managed as nurseries with increased accessibility.

Hundreds of miles of bottomland hardwood corridor could be restored to islands and in riparian areas currently fragmented by old fields and early successional habitat dominated by cattail, willows, sycamore, and cottonwoods. Many game species and migratory birds, such as the Ivory-billed Woodpecker, could benefit from reconnecting these fragmented habitats.

There are multiple options for resolving these issues. One option is to extend the EIS to resolve these issues with a complete and comprehensive assessment and mitigation plan as previously discussed prior to finalization of the EIS. Another option is to add ecosystem restoration as part of the project plan. Through ecosystem restoration this project would extend its goal of modifying the river for navigation to include restoring many of the ecological functions that have been lost or are in decline as a result of channelization and impoundments, thereby erasing and surpassing the mitigation deficits with positive environmental benefits. Additionally, ecosystem restoration would benefit recreation and tourism, economies of local communities, and could be included as a project benefit when calculating project feasibility.

In summary, the Arkansas River Navigation Project along with an Ecosystem Restoration Project would benefit energy conservation; national, state, and local economies; education; recreation; and conservation. This is a rare opportunity to recognize the full potential of the Arkansas River as a national resource.

For more information, please contact:

Lindsey Lewis
U.S. Fish & Wildlife Service
1500 Museum Rd., Suite 105
Conway, Arkansas 72032

E-mail: Lindsey_Lewis@fws.gov
Voice: (501) 513-4489

APPENDIX D

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Reservoir Elevations

Copan Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	28.89	30.94	30.24	16.90	5.74	2.26
714.0	17.95	22.23	22.18	13.37	4.56	1.30
716.0	11.94	15.24	15.45	10.87	3.08	1.00
720.0	5.50	7.93	8.63	6.20	0.80	0.17
725.0	0.64	2.98	4.68	1.74	0.00	0.00
730.0	0.00	0.76	1.57	0.09	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	8.7	9.6	9.1	5.2	1.8	0.7
714.0	5.4	6.9	6.7	4.1	1.4	0.4
716.0	3.6	4.7	4.6	3.4	1.0	0.3
720.0	1.7	2.5	2.6	1.9	0.2	0.1
725.0	0.2	0.9	1.4	0.5	0.0	0.0
730.0	0.0	0.2	0.5	0.0	0.0	0.0

Copan Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	29.01	30.95	30.43	17.03	5.75	2.28
714.0	18.07	22.30	22.20	13.28	4.65	1.30
716.0	11.96	15.45	15.47	10.78	3.08	1.00
720.0	5.41	8.02	8.51	6.14	0.80	0.17
725.0	0.03	2.92	4.72	1.67	0.00	0.00
730.0	0.00	0.76	1.58	0.09	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
712.0	8.7	9.6	9.1	5.3	1.8	0.7
714.0	5.4	6.9	6.7	4.1	1.4	0.4
716.0	3.6	4.8	4.6	3.3	1.0	0.3
720.0	1.6	2.5	2.6	1.9	0.2	0.1
725.0	0.0	0.9	1.4	0.5	0.0	0.0
730.0	0.0	0.2	0.5	0.0	0.0	0.0

Hulah Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	46.09	51.47	46.08	26.92	10.03	9.73
736.0	37.30	40.17	36.83	19.08	7.55	6.01
738.0	30.16	32.62	29.01	15.23	5.81	4.41
740.0	23.74	26.14	23.68	12.93	4.69	3.17
750.0	2.08	4.91	6.49	3.25	0.67	0.39
760.0	0.00	0.00	0.90	0.10	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	13.8	16.0	13.8	8.3	3.1	2.9
736.0	11.2	12.5	11.0	5.9	2.3	1.8
738.0	9.0	10.1	8.7	4.7	1.8	1.3
740.0	7.1	8.1	7.1	4.0	1.5	1.0
750.0	0.6	1.5	1.9	1.0	0.2	0.1
760.0	0.0	0.0	0.3	0.0	0.0	0.0

Hulah Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	46.09	51.37	46.18	27.12	10.23	9.84
736.0	37.23	40.07	36.90	19.33	7.83	6.04
738.0	30.16	32.41	29.11	15.33	6.01	4.46
740.0	23.67	26.16	23.68	13.03	4.96	3.17
750.0	2.01	4.91	6.48	3.25	0.67	0.39
760.0	0.00	0.00	0.90	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
734.0	13.8	15.9	13.9	8.4	3.2	3.0
736.0	11.2	12.4	11.1	6.0	2.4	1.8
738.0	9.0	10.0	8.7	4.8	1.9	1.3
740.0	7.1	8.1	7.1	4.0	1.5	1.0
750.0	0.6	1.5	1.9	1.0	0.2	0.1
760.0	0.0	0.0	0.3	0.0	0.0	0.0

Oologah Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	18.57	24.32	48.77	48.53	16.71	13.62
642.0	10.72	16.42	33.66	32.39	10.44	4.14
644.0	6.04	12.92	16.92	9.41	1.46	0.00
645.0	4.64	11.35	10.55	5.54	0.35	0.00
650.0	2.45	5.81	4.95	2.30	0.00	0.00
660.0	0.00	0.50	1.46	0.28	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	5.6	7.5	14.6	15.0	5.2	4.1
642.0	3.2	5.1	10.1	10.0	3.2	1.2
644.0	1.8	4.0	5.1	2.9	0.5	0.0
645.0	1.4	3.5	3.2	1.7	0.1	0.0
650.0	0.7	1.8	1.5	0.7	0.0	0.0
660.0	0.0	0.2	0.4	0.1	0.0	0.0

Oologah Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	17.27	22.27	46.24	48.76	18.95	14.56
642.0	10.51	16.22	32.87	35.86	13.42	5.15
644.0	5.95	13.02	19.94	12.90	2.70	0.28
645.0	4.66	11.39	11.36	5.86	0.36	0.08
650.0	2.40	5.81	4.95	2.35	0.00	0.00
660.0	0.00	0.50	1.45	0.28	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
640.0	5.2	6.9	13.9	15.1	5.9	4.4
642.0	3.2	5.0	9.9	11.1	4.2	1.5
644.0	1.8	4.0	6.0	4.0	0.8	0.1
645.0	1.4	3.5	3.4	1.8	0.1	0.0
650.0	0.7	1.8	1.5	0.7	0.0	0.0
660.0	0.0	0.2	0.4	0.1	0.0	0.0

Kaw Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	45.13	64.48	62.10	51.46	10.68	11.00
1012.0	13.01	20.23	21.93	19.45	6.34	5.13
1014.0	8.72	11.67	15.72	13.97	4.10	1.90
1020.0	3.95	6.75	7.86	5.55	2.00	0.08
1030.0	0.94	2.50	2.83	2.19	0.03	0.00
1040.0	0.00	0.58	0.82	0.38	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	13.5	20.0	18.6	16.0	3.3	3.3
1012.0	3.9	6.3	6.6	6.0	2.0	1.5
1014.0	2.6	3.6	4.7	4.3	1.3	0.6
1020.0	1.2	2.1	2.4	1.7	0.6	0.0
1030.0	0.3	0.8	0.8	0.7	0.0	0.0
1040.0	0.0	0.2	0.2	0.1	0.0	0.0

Kaw Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	44.75	63.83	61.98	52.51	10.50	10.88
1012.0	12.75	19.92	21.47	19.26	6.41	5.26
1014.0	8.42	11.56	15.25	13.87	4.32	2.16
1020.0	3.65	6.75	7.41	5.57	2.08	0.00
1030.0	0.75	2.35	2.85	2.45	0.00	0.00
1040.0	0.00	0.60	0.82	0.31	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
1010.0	13.4	19.8	18.6	16.3	3.3	3.3
1012.0	3.8	6.2	6.4	6.0	2.0	1.6
1014.0	2.5	3.6	4.6	4.3	1.3	0.6
1020.0	1.1	2.1	2.2	1.7	0.6	0.0
1030.0	0.2	0.7	0.9	0.8	0.0	0.0
1040.0	0.0	0.2	0.2	0.1	0.0	0.0

Keystone Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	32.50	50.71	62.99	59.39	28.60	24.54
726.0	13.17	24.93	49.35	49.01	20.65	14.95
728.0	9.56	18.36	37.09	30.98	12.14	6.21
730.0	7.33	15.83	23.53	16.14	4.94	2.18
740.0	2.70	6.32	5.10	2.21	0.00	0.00
750.0	0.36	2.03	2,90	0.43	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	9.7	15.7	18.9	18.4	8.9	7.4
726.0	3.9	7.7	14.8	15.2	6.4	4.5
728.0	2.9	5.7	11.1	9.6	3.8	1.9
730.0	2.2	4.9	7.1	5.0	1.5	0.7
740.0	0.8	2.0	1.5	0.7	0.0	0.0
750.0	0.1	0.6	0.9	0.1	0.0	0.0

Keystone Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	32.44	50.65	63.77	59.97	29.46	24.72
726.0	12.50	24.07	48.53	49.91	21.01	15.83
728.0	10.03	17.86	37.93	33.86	14.07	7.41
730.0	7.66	15.83	26.17	20.79	7.00	2.58
740.0	2.60	6.51	5.10	2.40	0.00	0.00
750.0	0.23	2.03	2.90	0.43	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
724.0	9.7	15.7	19.1	18.6	9.1	7.4
726.0	3.8	7.5	14.6	15.5	6.5	4.7
728.0	3.0	5.5	11.4	10.5	4.4	2.2
730.0	2.3	4.9	7.9	6.4	2.2	0.8
740.0	0.8	2.0	1.5	0.7	0.0	0.0
750.0	0.1	0.6	0.9	0.1	0.0	0.0

Pensacola (Grand) Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	26.79	31.76	85.97	34.88	8.33	5.27
748.0	5.35	10.90	8.28	4.32	0.21	0.50
749.0	4.16	8.15	6.66	2.77	0.00	0.40
750.0	3.20	6.37	5.44	1.67	0.00	0.20
751.0	2.34	4.63	4.24	0.89	0.00	0.20
752.0	1.65	3.37	3.24	0.22	0.00	0.20

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	8.0	9.8	25.8	10.8	2.6	1.6
748.0	1.6	3.4	2.5	1.3	0.1	0.2
749.0	1.2	2.5	2.0	0.9	0.0	0.1
750.0	1.0	2.0	1.6	0.5	0.0	0.1
751.0	0.7	1.4	1.3	0.3	0.0	0.1
752.0	0.5	1.0	1.0	0.1	0.0	0.1

Pensacola (Grand) Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	27.32	30.64	86.05	34.60	8.66	5.47
748.0	5.48	11.03	8.22	4.50	0.23	0.51
749.0	4.26	8.33	6.55	2.87	0.00	0.49
750.0	3.20	6.10	5.44	1.84	0.00	0.20
751.0	2.43	4.68	4.24	1.15	0.00	0.20
752.0	1.55	3.24	3.24	0.27	0.00	0.20

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
745.0	8.2	9.5	25.8	10.7	2.7	1.6
748.0	1.6	3.4	2.5	1.4	0.1	0.2
749.0	1.3	2.6	2.0	0.9	0.0	0.1
750.0	1.0	1.9	1.6	0.6	0.0	0.1
751.0	0.7	1.5	1.3	0.4	0.0	0.1
752.0	0.5	1.0	1.0	0.1	0.0	0.1

Hudson Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	19.16	20.42	21.75	13.32	6.98	6.69
622.0	9.53	14.76	12.27	7.92	0.75	1.01
624.0	6.09	12.38	8.99	5.19	0.30	0.80
626.0	4.59	9.17	6.88	3.43	0.00	0.40
630.0	1.77	4.68	4.31	1.44	0.00	0.00
635.0	0.00	0.50	0.30	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	5.7	6.3	6.5	4.1	2.2	2.0
622.0	2.9	4.6	3.7	2.5	0.2	0.3
624.0	1.8	3.8	2.7	1.6	0.1	0.2
626.0	1.4	2.8	2.1	1.1	0.0	0.1
630.0	0.5	1.5	1.3	0.4	0.0	0.0
635.0	0.0	0.2	0.1	0.0	0.0	0.0

Hudson Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	19.05	20.51	21.07	14.52	7.92	7.35
622.0	9.68	14.81	12.73	8.06	1.05	0.95
624.0	6.09	12.29	9.09	5.19	0.40	0.70
626.0	4.69	9.18	6.83	3.49	0.00	0.40
630.0	1.71	4.38	4.24	1.54	0.00	0.00
635.0	0.00	0.50	0.30	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
620.0	5.7	6.4	6.3	4.5	2.5	2.2
622.0	2.9	4.6	3.8	2.5	0.3	0.3
624.0	1.8	3.8	2.7	1.6	0.1	0.2
626.0	1.4	2.8	2.0	1.1	0.0	0.1
630.0	0.5	1.4	1.3	0.5	0.0	0.0
635.0	0.0	0.2	0.1	0.0	0.0	0.0

Fort Gibson Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	41.43	37.95	48.75	33.67	11.70	12.41
558.0	18.12	21.18	28.34	16.41	4.66	3.16
560.0	8.34	16.36	16.10	7.95	1.72	0.60
565.0	4.00	10.60	8.00	3.90	0.10	0.10
570.0	2.98	6.84	5.56	2.26	0.00	0.00
580.0	0.00	0.93	1.07	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	12.4	11.8	14.6	10.4	3.6	3.7
558.0	5.4	6.6	8.5	5.1	1.4	0.9
560.0	2.5	5.1	4.8	2.5	0.5	0.2
565.0	1.2	3.3	2.4	1.2	0.0	0.0
570.0	0.9	2.1	1.7	0.7	0.0	0.0
580.0	0.0	0.3	0.3	0.0	0.0	0.0

Fort Gibson Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	42.03	37.38	49.20	33.70	12.15	12.23
558.0	16.83	21.07	29.19	19.05	4.96	3.72
560.0	8.50	16.08	16.77	10.21	2.16	1.24
565.0	4.30	10.60	8.00	4.10	0.10	0.10
570.0	2.98	6.82	5.46	2.42	0.00	0.00
580.0	0.00	0.93	1.07	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
556.0	12.6	11.6	14.8	10.4	3.8	3.7
558.0	5.1	6.5	8.8	5.9	1.5	1.1
560.0	2.5	5.0	5.0	3.2	0.7	0.4
565.0	1.3	3.3	2.4	1.3	0.0	0.0
570.0	0.9	2.1	1.6	0.8	0.0	0.0
580.0	0.0	0.3	0.3	0.0	0.0	0.0

Tenkiller Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	39.66	42.75	49.68	43.06	16.62	8.70
636.0	17.37	22.90	34.52	27.26	8.60	2.41
638.0	8.92	17.19	22.20	11.63	2.78	0.39
640.0	6.91	14.75	13.65	6.08	0.74	0.00
650.0	2.79	7.72	5.33	1.94	0.00	0.00
660.0	1.26	2.37	2.26	0.56	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	11.9	13.3	14.9	13.3	5.2	2.6
636.0	5.2	7.1	10.4	8.5	2.7	0.7
638.0	2.7	5.3	6.7	3.6	0.9	0.1
640.0	2.1	4.6	4.1	1.9	0.2	0.0
650.0	0.8	2.4	1.6	0.6	0.0	0.0
660.0	0.4	0.7	0.7	0.2	0.0	0.0

Tenkiller Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	39.47	43.40	48.23	44.21	18.66	9.14
636.0	17.04	22.67	32.46	29.41	9.62	3.30
638.0	8.94	16.89	22.71	15.37	4.45	0.63
640.0	7.05	14.37	14.80	7.74	1.20	0.00
650.0	2.82	7.75	5.32	1.94	0.00	0.00
660.0	1.20	2.36	2.25	0.55	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
634.0	11.8	13.5	14.5	13.7	5.8	2.7
636.0	5.1	7.0	9.7	9.1	3.0	1.0
638.0	2.7	5.2	6.8	4.8	1.4	0.2
640.0	2.1	4.5	4.4	2.4	0.4	0.0
650.0	0.8	2.4	1.6	0.6	0.0	0.0
660.0	0.4	0.7	0.7	0.2	0.0	0.0

Eufaula Lake - Monthly Pool Elevation Duration
Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
586.0	23.90	44.88	54.67	45.72	17.01	10.01
587.0	9.99	23.30	36.03	22.89	5.83	2.81
588.0	6.70	16.63	19.81	6.47	1.17	0.92
590.0	4.33	12.15	8.33	3.22	0.36	0.40
595.0	1.45	3.51	3.05	0.45	0.00	0.00
598.0	0.17	0.91	1.25	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
586.0	7.2	13.9	16.4	14.2	5.3	3.0
587.0	3.0	7.2	10.8	7.1	1.8	0.8
588.0	2.0	5.2	5.9	2.0	0.4	0.3
590.0	1.3	3.8	2.5	1.0	0.1	0.1
595.0	0.4	1.1	0.9	0.1	0.0	0.0
598.0	0.1	0.3	0.4	0.0	0.0	0.0

Eufaula Lake - Monthly Pool Elevation Duration
Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
586.0	24.04	45.58	53.96	46.83	17.79	11.10
587.0	9.90	23.00	35.07	26.70	6.97	2.93
588.0	6.52	16.96	21.26	9.37	1.74	0.86
590.0	4.09	12.19	9.75	3.36	0.39	0.40
595.0	1.45	3.61	3.05	0.45	0.00	0.00
598.0	0.17	0.91	1.25	0.00	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
586.0	7.2	14.1	16.2	14.5	5.5	3.3
587.0	3.0	7.1	10.5	8.3	2.2	0.9
588.0	2.0	5.3	6.4	2.9	0.5	0.3
590.0	1.2	3.8	2.9	1.0	0.1	0.1
595.0	0.4	1.1	0.9	0.1	0.0	0.0
598.0	0.1	0.3	0.4	0.0	0.0	0.0

Wister Lake - Monthly Pool Elevation Duration

Existing Operation

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	90.06	92.52	77.54	48.78	27.93	31.90
480.0	36.32	49.24	34.85	10.56	2.44	2.37
482.0	26.33	38.34	26.58	6.49	1.38	1.53
485.0	16.76	26.55	19.98	4.65	0.61	0.52
490.0	8.58	15.41	12.41	2.74	0.30	0.00
500.0	2.04	5.01	4.04	0.51	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	27.0	28.7	23.3	15.1	8.7	9.6
480.0	10.9	15.3	10.5	3.3	0.8	0.7
482.0	7.9	11.9	8.0	2.0	0.4	0.5
485.0	5.0	8.2	6.0	1.4	0.2	0.2
490.0	2.6	4.8	3.7	0.8	0.1	0.0
500.0	0.6	1.6	1.2	0.2	0.0	0.0

Wister Lake - Monthly Pool Elevation Duration

Operations Only 60,000 cfs Bench Plan

Pool Elevations	Percent of Time Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	89.39	92.14	77.89	50.47	28.86	31.91
480.0	36.34	49.18	35.65	13.29	2.73	2.35
482.0	26.45	38.24	27.10	7.24	1.21	1.55
485.0	16.92	26.91	20.17	4.72	0.61	0.51
490.0	9.16	15.49	12.26	2.54	0.30	0.00
500.0	2.03	4.99	4.03	0.56	0.00	0.00

Pool Elevations	Number of Days per Month Elevation Equaled or Exceeded					
	April	May	June	July	August	September
478.0	26.8	28.6	23.4	15.6	8.9	9.6
480.0	10.9	15.2	10.7	4.1	0.8	0.7
482.0	7.9	11.9	8.1	2.2	0.4	0.5
485.0	5.1	8.3	6.0	1.5	0.2	0.2
490.0	2.7	4.8	3.7	0.8	0.1	0.0
500.0	0.6	1.5	1.2	0.2	0.0	0.0

Elevations of the Conservation, Flood, and Surcharge Pools at the Eleven Primary Flow Modifying Reservoirs in Oklahoma

Reservoir	Top Conservation Pool	Top Flood Pool	Top Surcharge Pool
Copan	710.0	732.0	738.0
Hulah	733.0	765.0	767.0
Oologah	638.0	661.0	666.0
Kaw	1010.0	1044.5	1047.5
Keystone	723.0	754.0	757.0
Pensacola (Grand)	745.0	755.0	NA
Hudson (Markham Ferry)	619.0	636.0	NA
Fort Gibson	554.0	582.0	NA
Tenkiller	632.0	667.0	671.0
Eufaula	585.0	597.0	600.0
Wister	478.0	502.5	NA

APPENDIX E

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Comments on Sediment Analysis and Recommendations for Future Sediment Analysis

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
222 South Houston, Suite A
Tulsa, Oklahoma 74127
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/
02-14-01-I-0385

February 11, 2005

Stephen Nolen
Chief, Environmental Analysis and Compliance Branch
U.S. Army Corps of Engineers
1645 S. 101st East Ave.
Tulsa, Oklahoma 74128-4609

Dear Mr. Nolen:

This letter transmits planning information for the U.S. Army Corps of Engineers (Corps) Arkansas River Navigation Study (ARNS), Arkansas and Oklahoma. The U.S. Fish and Wildlife Service (Service) previously provided planning information in a Planning Aid Report dated April 2, 2001, and planning assistance letters dated May 5, 2004 (pertaining to aquatic habitat assessment methodology), and June 15, 2004 (pertaining to dredging, dredged material disposal sites, and mitigation for disposal impacts). The Service is currently preparing a detailed coordination act report (CAR) that would provide more specific planning information related to ARNS. The forthcoming CAR will 1) provide information on existing fish and wildlife resources, 2) identify fish and wildlife–related issues, opportunities, and planning objectives; 3) provide the Service's evaluation of impacts to fish and wildlife resources as a result of the proposed project, 4) discuss measures to avoid and minimize environmental impacts, and 5) provide recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources.

The Service has most recently been working cooperatively with Corps staff on the aquatic impact assessments for impacts that would be associated with dredging, disposal of dredged material in aquatic environments, and construction of new river training structures. We appreciate the Corps staff's receptiveness to previous comments and concerns provided by the Service and our state partners, the Oklahoma Department of Wildlife Conservation and the Arkansas Game and Fish Commission to date.

The comments provided here serve to 1) identify fish and wildlife–related concerns pertaining to the sediment quality of material that would be dredged during maintenance of the nine-foot navigation channel and for the proposed channel deepening component of the ARNS, and 2) to provide recommendations for future sediment analyses. The comments are based on our review of the information pertaining to the sediment sampling analysis for most of the Oklahoma portion of the McClellan Kerr ARNS you provided by electronic mail on January 21, 2005. This letter is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 b) of the Act.

The Service believes that the study design (sample site selection, sample size, field sampling methods, constituents selected for analysis, chemical methods employed, and the quality control and assurance procedures) and rationale for data interpretation were adequate to meet the objectives of the screening level analysis. The Service believes additional analyses for pre-disposal characterization should be performed prior to project implementation in order to ensure that unnecessary impacts to the environment are avoided or minimized, as discussed below.

Particle Size Analysis

Concentrations of trace elements do not appear to be at levels that would represent a threat to the aquatic environment if the samples are from areas of deposition and not sand substrate. We believe information pertaining to the particle size of the sediments would be necessary before a more definitive conclusion could be made (de Groot, 1995). The Service recommends that particle size analysis for the samples be employed to 1) facilitate comparison of elemental concentrations in sediment among locations within the navigation system and 2) identify areas of concern, as necessary.

Cadmium

The majority of the sediment samples indicate non-detection for cadmium at concentrations ranging from 0.5 and 1.0 ppm. Although sediment quality standards do not exist in the U. S., the detection limits for cadmium are very near the sediment quality threshold value of 1 ppm recommended by the guideline used to interpret the data (MacDonald et al., 2000), and the 0.6 ppm value established by the Province of Ontario sediment quality standards (Persaud et al., 1993). Therefore, the Service believes that cadmium levels have not been adequately evaluated by the subject screening level analysis. We recommend more sensitive procedures be utilized to adequately detect cadmium levels in sediment prior to implementation of dredging activities.

Organochlorine Pesticides

Concentrations of organochlorine pesticides in the sediment samples were low and below the threshold levels used for data interpretation. These findings suggest an overall lack of existing significant contamination from these compounds. However, we believe that the potential for biomagnification of organochlorine pesticides in the food chain (*e.g.*, water - fish – bald eagles) as a result of the proposed channel deepening project has not been fully addressed by the subject screening level sediment analysis.

Dredging activities and the disposal of dredged material in aquatic disposal sites could remobilize any organochlorine pesticides in the navigation channel and, thereby, make the compounds more available to fish. Although we do not have any evidence that suggests ongoing detrimental effects of organochlorine pesticide contamination on fish and wildlife species that occur in or within the vicinity of the navigation channel, the dredging that would occur for the proposed channel deepening project would greatly exceed current levels performed for operation and maintenance purposes.

Organochlorines reach subsequently higher concentrations in the fats of animals as they are moved up through the food chain (*i.e.*, biomagnification) in the aquatic environment (Gobas et al., 1993; Suedel et al., 1994). Fish are better indicators of adverse effects of organochlorine contamination on fish and wildlife species than sediment due to biomagnification. Therefore, the Service recommends that the Corps examine the concentrations of organochlorine pesticides in

fish (*e.g.*, blue catfish *Ictalurus furcatus*, and carp *Cyprinus carpio*) taken from areas that have recently been dredged for operation and maintenance of the 9-foot channel. We believe this analysis in conjunction with the subject screening level sediment analysis would more thoroughly answer whether there are likely to be any concerns pertaining to biomagnification of organochlorine pesticides in the food chain as a result of the proposed channel deepening project.

We appreciate the opportunity to participate in this study during the planning phase, and look forward to further coordination. If you have any questions, please contact Richard Stark or Dan Martin at 918-581-7458, extensions 240 and 233, respectively.

Sincerely,

Jerry J. Brabander
Field Supervisor

cc: FWS, Regional Director (ARD-ES), Attn: Dean Watkins, Albuquerque, NM
FWS, Arkansas ES Field Office,Field Supervisor, Attn: Marge Harney, Conway, AR
FWS Sequoyah National Wildlife Refuge, Manager, Vian, OK
FWS White River National Wildlife Refuge, Manager, DeWitt, AR
FWS Holla Bend National Wildlife Refuge, Manager, Dardanelle, AR
ODWC, Director, Attn: Fisheries and Natural Resources, Oklahoma City, OK
ODWC, Director, Attn: Water Quality Programs Division 0207, Oklahoma City, OK
ODWC, Northeast Regional Office, Attn: Mike Plunkett and Randy Hyler,Porter, OK
US Army Corps of Engineers, Chief, Planning and Environmental, , Tulsa, OK
US Environmental Protection Agency, Attn: 6WQ-EM , Dallas, TX
Arkansas Game and Fish Commission, Director, Attn: Craig Uyeda, Little Rock, AR
Arkansas Waterways Commission, Director, Little Rock, AR
Department of Arkansas Heritage, Director, Little Rock, AR

References

De Groot, A. J. 1995. Metals and sediments: a global perspective. Pp. 1 – 20. in H. E. Allen (Ed.) Metal contaminated aquatic sediments. Ann Arbor Press, Inc., Ann Arbor.

Gobas, F.A.P.C., J.R. McCorquodale, and G.D. Haffner. 1993. Intestinal absorption and biomagnification of organochlorines. Environ. Toxicol. Chem 12: 567-576.

Macdonald, D. D., C. G. Ingersoll, and T. A. Berger. 2000. Development and evaluation of concensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxicol. 39: 20-31.

Persuad, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment and Energy, Toronto, Ontario. 27 pp.

Suedel, B.C., J.A. Boraczek, R.K. Peddicord, P.A. Clifford, and T.M. Dillon. 1994. Trophic transfer and biomagnification potential of contaminants in aquatic ecosystems. Rev. Environ. Contam. Toxicol. 136: 21-89.

APPENDIX F

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Recommendations for
Tree Plantings, Monitoring, and Remedial Actions
for Bottomland Hardwood Restoration Sites

Recommended Trees

Hydrology and soil characteristics will be the most important factors for determining suitability of the recommended species. Species selection for each area should be based on soil and anticipated hydrologic conditions. The Service recommends the following species to provide quality habitat for wildlife:

Shumard oak *Quercus shumardii*
Bur oak *Q. macrocarpa*
Northern red oak *Q. rubra*
Pin oak *Q. palustris*
Black walnut *Juglans nigra*
American plum *Prunus americana*
Mexican plum *P. mexicana*
Pecan *C. illinoensis*
Bitternut hickory *C. cordiformis*
Sugarberry *Celtis laevigata*
Hackberry *C. occidentalis*
Red mulberry *Morus rubra*
Deciduous holly *Ilex decidua*
Rusty blackhaw *Virburnum rufidulum*
Persimmon *Diospyros virginiana*

Planting Recommendations.

Establishing a greater number of oak species, other non-oak hard mast species, and additional light seeded woody species will produce restorations with species diversity and function comparable to natural sites (Allen, 1997). The practice of establishing only a few species should be avoided because it will likely limit the overall diversity, which will, in turn, limit the overall function of the restored bottomland hardwood wetland.

Many of the recommended species are shade intolerant. Dense plantings can lead to rapid canopy closure that can actually limit naturally derived species diversity. Openings and gaps in plantings will foster richer species diversity derived from adjacent or dispersed seed sources (Allen, 1997). Openings and gaps also will break-up the "plantation" appearance that row planting often generates.

The Service recommends the following specific planting recommendations to provide quality habitat for wildlife:

- Plant 2 – 4-inch diameter trees.
- Plant a bottomland hardwood community type that is based on the soil-moisture regime (*i.e.*, degree of inundation, timing and duration of flooding, soil texture and color, probability of annual flooding) at the site.
- Avoid straight-line rows such as used in a pecan orchard. The trees should be stagger-planted or planted in curved rows with openings and gaps.

- Leave openings and/or gaps unplanted to allow for some natural colonization and the slower establishment of randomly dispersed, shade intolerant woody species that will not establish after canopy closure.
- Plant a much higher proportion of hard mast species (*i.e.*, the oaks, black walnut, and hickory) than soft mast species (e.g., 75 hard:25 soft). The soft mast species will likely come in through natural colonization.
- Use spacings of 12 x 12 or 15 x 15 feet to avoid rapid canopy closure that can limit naturally derived species diversity and provide quality habitat for wildlife.
- Mix species within rows to avoid homogeneous stands.

Trees per acre can be determined by:

43,560/spacing.

For example, 15 x 15 spacing = 43,560/225 = 194 trees per acre.

Monitoring Plan

The Corps should develop a monitoring plan for the bottomland hardwood restoration sites through interagency coordination to determine progress, mitigation success, and need for remedial actions. We offer the following recommendations for the development of a monitoring plan:

- Monitor the bottomland hardwood restoration sites by conducting at least two surveys per year for a minimum of five years.
- The monitoring protocol should include vegetation surveys and restored hydrology verification, and should document the following
    - tree survival rates
    - natural regeneration of native tree and shrub species
    - new species colonization
    - tree growth and condition
    - hydric soil morphology and development according to the Corps standard protocol for performing hydric soil determinations.
- Survival of 75% of the planted trees would indicate successful woody vegetation establishment.
    - Replacement of trees should occur at the end of each monitoring year to maintain the appropriate number. However, should natural colonization of native bottomland hardwood tree species offset the loss of any planted trees, additional plantings would not be necessary.

References

Allen, J.A., 1997. Reforestation of bottomland hardwoods and the issue of woody species diversity. Restoration Ecology, vol. 5 No. 2, pp. 125-134.

BRAD HENRY, GOVERNOR

GREG D. DUFFY, DIRECTOR

DEPARTMENT OF WILDLIFE CONSERVATION

1801 N. LINCOLN P.O. BOX 53465 OKLAHOMA CITY, OK 73105 PH. 521-3851

June 16, 2005

Mr. Richard Stark
US Fish and Wildlife Service
Oklahoma Ecological Services
222 S. Houston, Ste A
Tulsa, OK 74127

Re: Arkansas River Navigation System (ARNS) Study response to the Draft Coordination Act Report (CAR)

Dear Mr. Stark,

This is in response to the draft CAR submitted to the Oklahoma Department of Wildlife Conservation (ODWC) for review on June 8, 2005. The final CAR will be included in the US Army Corp of Engineers (USACE) feasibility report on the Arkansas River Navigation System (ARNS) project. The final CAR will identify the effects of the proposed actions on fish and wildlife resources within the project area, provide recommendations to appropriately compensate for unavoidable impacts to fish and wildlife resources, and provide recommendations conducive to maintaining the value of the fish and wildlife resources associated with the navigation system. The CAR reflects the fish and wildlife issues of concern to ODWC as modified by the following comments.

In September 2004, a draft CAR was reviewed and comments were provided by the ODWC to the USFWS along with a copy of the August 2004 correspondence to the USACE concerning revisions to the scope of the Environmental Impact Statement (EIS). These comments have been adequately incorporated into both the draft EIS dated April 2005 and the draft CAR. However, incomplete aquatic impacts analysis and mitigation plan provisions remain significant deficiencies of the CAR. It is understood by the ODWC that these issues will be addressed as a supplement to the CAR.

The ODWC concurs with the position of the USFWS concerning the ARNS, mitigation goals and recommendations as set forth in the CAR. The ODWC further agrees with and supports the compensatory mitigation plan for terrestrial impacts and the identification of potential aquatic impacts. The ODWC supports recommendations 2, 5, 7, 8, 9 and believe these issues have been adequately addressed by the working group and in the CAR. However, several issues continue to persist and are listed below:

1. **The ODWC supports the designation of Pool 15 as a mussel sanctuary and will continue to work cooperatively with the USACE in this matter**. Impacts to mussel populations and associated mitigation efforts have been addressed in a letter from the USFWS to the USACE dated May 11, 2005. This letter was in response to a report prepared by Ecological Specialists, Inc. (ESI) based on a study that was conducted to determine unionid distribution and species composition in the navigation system. In general, the mitigation recommendations provided by the USFWS appear to be adequate to help avoid and minimize project impacts to freshwater mussels.

2. **The final mitigation plan should include fully funded, long-term monitoring efforts for the life of the project (approximately 50 years) and should be modeled after the concept paper in appendix C of the CAR**. Further, a mitigation bank should be fully funded to compensate for aquatic and terrestrial long term impacts. Such funds should be available for maintaining all mitigation measures for the life of the project. All funds should be appropriated at the beginning of the project to insure that mitigation recommendations are met. The following recommendations are in response to specific language in the CAR and the need for compensatory mitigation and long term monitoring:

a. **Page 167, paragraph 2: The USACE should attempt to restore all gravel habitat removed during the construction process; however, it is unlikely the USACE will be able to maintain the quantity and quality of gravel habitats necessary to fully mitigate for losses.** The USFWS states "The Service believes that through project design and modifications and mitigation, these gravel habitats can be conserved and possibly even restored to many locations along the river. Relocation efforts should be followed with long-term monitoring and adaptive management to ensure mitigation features can provide both conservation and restoration of these habitats within this system." Current plans call for the USACE to place gravel behind notches in dikes or to over-dredge within the channel and backfill with gravel at a lower depth. It is likely that only small areas of gravel habitat will be maintained behind notches in dikes due to annual variability in hydrologic conditions. Further, in-channel restorations are unlikely to succeed due to changes in the hydraulic conditions caused by dredging the channel to a deeper depth.

The ODWC does support the proposed gravel restoration efforts if proper long-term monitoring studies are conducted to evaluate the quantity and quality of restoration attempts and if a mitigation bank is set up during initial funding to mitigate for unsuccessful mitigation events. If gravel restoration efforts fail, the funds in the mitigation bank should be used to restore stream and reservoir habitat located outside of the navigation channel but within the overall navigation system.

b. **Page 177: Long term monitoring should be conducted throughout the life of the project.** The table on page 177 recommends a shorter period (less than 5 years) for long-term monitoring of gravel restoration projects, substrate boring and classification, and substrate profiling. This recommendation should be changed to reflect a longer monitoring period of at least 10 to 20 years or a 50-year flood event.

c. **Pages 192 and 193:** The ODWC supports recommendation12, however, long term monitoring should be defined as the life of the project which is 50 years.

e. **The USACE should obtain additional agricultural land and license it to the ODWC for dredged material disposal sites.** The ODWC should have an opportunity to review and provide input into the location of the disposal pits, associated access roads, and any necessary mitigation. .

f. **Operation and maintenance of constructed wetlands and bottomland hardwood forests should be funded annually by the USACE.** Mitigation options at disposal sites 379.1 L-DI and 389.7 L-DI were previously agreed upon by cooperating agencies; however the CAR does not specify funding for operation and maintenance.

d. **A Memorandum of Understanding (MOU) between USACE, USFWS, ODWC and other appropriate entities should be employed to help ensure funding for mitigation and long term monitoring will be available for the duration of the project.** This MOU should contain a funding plan for mitigation, long term monitoring and a means of communication among cooperating agencies.

3. **Page 188: Recommendation 4 suggests further contaminant analysis of the dredged material will be performed by the USACE in order to minimize environmental and human health impacts. The CAR should contain additional language that describes: 1) a short term and long term monitoring plan for dredging activities and 2) an emergency response protocol for sites located near the Sequoyah Fuels Corporation industrial site (SFP) in Gore, Oklahoma and other areas of interest within the project boundaries.** The SFP and other areas of interest will require additional sediment sampling to assess the extent that dredging activities will cause resuspension and dispersal of contaminants into the ecosystem . More specific methodology and parameters to address these issues can be agreed upon in a Memorandum of Understanding (MOU) between the USACE and cooperative agencies .

Of particular concern is the SFP which is a decommissioned uranium conversion facility. The facility's primary function during operation was to convert uranium oxide into uranium hexafluoride and further processed into fuel resources for commercial nuclear power reactors. Although the plant has been decommissioned,

there continues to be an industrial discharge which includes but is not limited to raw water basin overflow, process area storm water, storm water overflow from the South Yellowcake sump emergency overflow and Calcium Fluoride Clarifier overflow, the laundry, storm water runoff from an on site building, pond no. 2, solid waste burial areas and facility grounds. The outfall is a commingled outfall that discharges into the Illinois River upstream of the confluence with the Arkansas River.

Recently, Sequoyah Fuels Corporation applied for an industrial wastewater discharge permit renewal. Changes from the previous permit include the addition of discharge limits for Uranium and Thorium230, a monitoring requirement for Chemical Oxygen Demand (COD), technology based limit for TSS, an effluent monitoring requirement for Total Selenium, and background monitoring requirements for Cadmium and Total Mercury. Except for these supplemental requirements, existing monitoring and parameter requirements will remain the same. The new discharge limits are based on the results of a pollutant screen submitted by the discharger and reflect pollutants found in the water column. Other documentation assesses land application of Raffinate and other potential pathways for contaminants. Based on this and other historical information , it is likely that contaminants remain on site and thus, plausible pathways may still exist.

Due to new recommended discharge limits, and lack of current baseline data, the USACE should implement a work plan for sediment analysis in accordance with Annual Book of ASTM Standards (Volume 11.05) and/or *EPA Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manua*l (EPA-823-B-01-002). Sample locations should include at a minimum sites above, below, and adjacent to the SFP sufficient to capture the extent of pollutant dispersal into the water column and sediment deposition.. Baseline data should be collected prior to, concurrent with, and upon completion of dredging activities. This monitoring effort is a proactive attempt at preventing contaminants from being released into the ecosystem. While the USACE is not responsible for the source, a release of contaminants from dredging activities could result in delayed completion of the proposed ARNS project, emergency remediation, restoration and loss and/or injury to fish and other wildlife resources.

Appendix E of the EIS contains information regarding USACE sediment sampling and testing. During a sediment study conducted along the ARNS, samples were analyzed for the following parameters: semi-volatile organics, organics, organ chlorine pesticides, PCBs, total cyanide, TOC, total metals (As, Ba, Cd, Cu, Cr, Pb, Fe, Mn, Hg, Ag, Se and Zn. Additional parameters to be monitored at the SFP location should include a Nitrogen series, Uranium, Thorium 230, Radium 226, other radio-isotopes if deemed appropriate.

4. **Page 182**: In order to enhance recreational opportunities, the USACE should install fishing piers located on National Wildlife Refuge's (NWRs), Wildlife Management Areas (WMAs) and local government owned property.

5. **Pages 193 and 194**: The ODWC supports recommendations 13, 14, 15, and 16, but feels that the following language should be incorporated into the last sentence of number 13: "scrubbing stations for zebra mussel control should be constructed at appropriate locations on all reservoirs that support the navigation system".

6. **Page 188:** The ODWC supports recommendation number 1; however, specific language needs to be included that indicates minimum flow releases will be conducted in a manner that maintains water quality standards set by the Oklahoma Water Resources Board (OWRB).

7. **Lake level management plans should be developed for affected Oklahoma reservoirs in coordination with the ODWC.** Above normal water levels could have an effect on the composition of vegetation available to wildlife on ODWC WMAs. Further, increased water levels could have a derogatory effect on leased agricultural land by decreasing crop yield available for revenue and to wildlife. Further, fluctuating water levels in reservoirs affected by ARNS could have detrimental reproduction and recruitment effects on fisheries resources. These impacts can be ameliorated with properly developed water level management plans.

In general, the ODWC agrees with the contents of the CAR; however significant issues still persist. While most issues have been adequately addressed and incorporated into the CAR, a complete mitigation plan, long term monitoring and sediment analysis for contaminants remain deficient. Therefore, the ODWCs position on this matter is summarized as follows:

- In general, the ODWC supports the contents of the CAR
- Although the ODWC supports the contents of the CAR, significant deficiencies remain as a result of an expedited time schedule for the project.
- Deficiencies include impacts to freshwater mussels, incomplete mitigation plan, lack of a long term monitoring plan and agreed upon time frame for such monitoring, sediment sampling for contaminants analysis, and funding commitment by the USACE for mitigation and long term monitoring
- The ODWC will concur with the CAR contingent upon the following commitments from the USACE:

    - a commitment from the USACE that mussel sanctuaries will be considered and established in agreed upon areas of the navigation system

    - a commitment by the USACE that the deficiencies in the CAR will be resolved by the USACE and approved by all cooperative agencies

    - a commitment from the USACE that all mitigation, mitigation banking, and long term monitoring will be implemented

- a commitment from the USACE and USFWS that issues unable to be resolved at the time of concurrence by the ODWC will be provided as a supplement at a later date and incorporated into the CAR

Thank you for the opportunity to review the CAR and provide comments. If questions arise, please do not hesitate to call the ODWC Natural Resources Section at (405)521-4663

Greg D. Duffy,
Director

cc: Miles Tolbert, Oklahoma Secretary of the Environment
USACE, Tulsa District
USACE, Little Rock District

APPENDIX G

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Recommended Mitigation Features for Aquatic Impacts Caused by Dredging,

Aquatic Disposal of Dredged Material and Construction/Modification

of River Training Structures

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
Canal								
15.3R	Reconnect Lower Merrisach Lake to Canal with culvert or water control structure for fish passage	540	0.5	0.4	0.3	0.1	0.1	0.1
15.3 L	Place woody habitat in Merrisach Lake	10	0.6	0.5	0.4	0.9	0.8	0.7
18.9 L	Place woody habitat in Arkansas Post bay	10	0.6	0.5	0.4	0.9	0.8	0.7
Pool 2								
19.0 R	Construct fish passage through lower Merrisach Lake	n/a	n/a	n/a	n/a	n/a	n/a	n/a
19.0R	Construct island	56	0.3	0.3	0.2	0.3	0.3	0.3
19.8L	Notch existing revetment (1)	31	0.5	0.3	0.1	0.7	0.7	0.7
22.8R	Maintain entrance to Coal Pile by periodically dredging	724	0.8	0.6	0.4	1	1	1
23.6 R	Avoid RB disposal	15	0.5	0.5	0.5	0.5	0.5	0.5
23-24L	Construct string of islands	48	0.7	0.5	0.3	0.8	0.9	1
23-24L	Construct string of islands	40	0.7	0.5	0.3	0.8	0.9	1
24.7 R	Maintain fish passage/entrance to Echubby Lake through culvert modification, control structures, and/or dredging	302	0.6	0.3	0.1	1	1	1
25.1 L	Place woody habitat in backwater bay	10	0.6	0.5	0.4	0.9	0.8	0.7
25.1 L	Restore/maintain fish passage to Moody Old River Lake through culvert modification, control structures, and/or dredging	206	0.2	0.1	0.1	0.9	0.9	0.9

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
24-25L	Notch modified revetment (2) and modified dike (1)	455	1	0.9	0.8	1	1	1
26.5 R	Restore/maintain fish passage to unnamed cutoff through culvert modification, control structures, and/or dredging	145	0.2	0.1	0.1	0.9	0.9	0.9
27L	Avoid aquatic disposal, utilize land	20	0.2	0.2	0.2	0.2	0.2	0.2
27.5-29R	Notch modified dikes (4) and existing dike (1)	88	0.8	0.6	0.4	0.8	0.8	0.8
27.8-28.5L	Notch modified revetment (1) and existing dike (1)	54	1	0.8	0.6	1	1	1
31.7-32.8R	*Existing tern island – enhance/create islands where feasible and avoid June-August construction, utilize disposal area and extend d/s to NM 31.0R	64	0.7	0.7	0.7	0.7	0.8	0.9
32.2R	Restore/maintain fish passage/entrance to Bicker Lake backwater channel by avoiding disposal, culvert modification, control structures, and/or periodically dredging	383	0.2	0.1	0.1	0.9	0.9	0.9
32L	Notch revetment (4) and existing dike (1)	275	0.5	0.3	0.1	0.5	0.5	0.5
31.8-33.1L	Avoid LB disposal, utilize RB, notch modified revetment (4) and existing dike (1) across backwater	62	1	0.8	0.6	1	1	1
35 R	Notch modified dikes (2)	21	0.5	0.4	0.3	0.5	0.5	0.5

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
36.5 R	Restore/maintain fish passage/entrance to Jones Lake through culvert modification, control structures, and/or dredging	189	0.2	0.1	0.1	0.9	0.9	0.9
35.3-36.5 L	*Existing tern island – enhance/create islands where feasible and avoid June-August construction	97	0.3	0.4	0.5	0.7	0.7	0.7
36-36.5 L	Notch modified dikes (3) and existing dike (1)	63	0.2	0.2	0.1	0.2	0.2	0.2
36.4	Mussel bed monitoring adjacent to disposal area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
36.4-37.0 R	Extend disposal area u/s to 38.1R, avoid blocking entrance to chute at 36.4R	24	0.5	0.4	0.3	0.5	0.5	0.5
36.4 R	Avoid blocking entrance to chute	19	0.5	0.4	0.3	0.5	0.5	0.5
37.8-38.4 L	Avoid disposal, utilize RB.	20	0.6	0.6	0.6	0.6	0.6	0.6
38.8 L	Avoid disposal, utilize RB, notch modified revetment	15	0.6	0.6	0.6	0.6	0.6	0.6
38.5-38.8 R	Extend islands downstream, increase island, RB disposal	47	0.4	0.4	0.3	0.6	0.6	0.6
39.8L	Notch modified revetment at 39.3L and 39.7L	57	0.7	0.6	0.5	0.7	0.7	0.7
38.8-39.6R	Existing tern island, notch existing dikes (5) and enhance/construct tern islands where feasible	37	0.1	0.1	0.1	0.5	0.6	0.7
40R	Notch existing revetment/dike (1)	5	0.5	0.5	0.4	0.5	0.5	0.5

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
39.8-40.0L	Avoid disposal, utilize RB, investigate terrestrial disposal if needed	16	0.2	0.2	0.2	0.2	0.2	0.2
42.1-42.7L	Existing tern island, use disposal to enhance/construct tern islands, notch backside of existing dikes to maintain flow and islands 42.5L	38	0.2	0.2	0.2	0.3	0.3	0.3
42.3-43.3L	Construct islands and notch existing (3) dikes	100	0.1	0.1	0.1	0.3	0.3	0.3
42.8-44.6R	Notch existing and modified dikes (10-12)	58	0.3	0.3	0.2	0.3	0.3	0.3
42.8-43R	Utilize this disposal area, notch existing and modified dikes (10-12) and extend disposal u/s	10	0.3	0.3	0.2	0.3	0.3	0.3
43.4-44.1L	Avoid disposal in LB aquatic areas, utilize land and RB disposal, notch existing dikes/revetments (3)	73	0.3	0.3	0.3	0.4	0.4	0.4
44-44.7	Utilize AR44.3R-D for disposal and extend d/s to 43.0R	18	0.1	0.1	0.1	0.1	0.1	0.1
44.6L	Maintain a 1/2 mile boating lane at the entrance to Little Bayou Meto (44.6L) and 1/2 mile lane at u/s end of Bayou Meto by periodically dredging	344	0.4	0.3	0.2	0.5	0.5	0.5
46.2R	Notch modified revetment/dike (1)	6	0.1	0.1	0.1	0.1	0.1	0.1
45.4-46L	Avoid disposal in aquatic areas of AR45.3L-D, dispose on land or preferably on RB	44	0.4	0.4	04	0.4	0.4	0.4
45.4-47.3 R	Construct islands where feasible in AR46.5R-D, utilize two most d/s cells for disposal first, notch dikes/revetments (4-8)	170	0.4	0.3	0.2	0.6	0.6	0.6

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
48.7-48.9R	Notch modified dikes (4)	25	0.3	0.2	0.1	0.3	0.3	0.3
46.8-49.2L	Utilize land within cells for disposal at AR48.0L-D, avoid aquatic areas	119	0.2	0.2	0.2	0.2	0.2	0.2
48.8 L	Restore/maintain fish passage to English Lake through culverts modification, control structures, and/or dredging.	246	0.2	0.1	0.1	0.9	0.9	0.9
49.0 L	Construct fish passage structure through levee, ditches, and English Lake tributary around dam 4.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
48.7-50.2R	Utilize land within cells for disposal in 49.4R-D, avoid aquatic areas, notch existing revetments/dikes in two most u/s cells (2)	108	0.3	0.3	0.2	0.4	0.4	0.4
49.6-49.9	Utilize existing in-channel disposal	11	0.2	0.2	0.2	0.2	0.2	0.2
Pool 3								
50.9L	Maintain entrance to Swan Lake by periodically dredging	388	0.7	0.6	0.5	0.7	0.7	0.7
51.0 L	Place woody habitat in backwater	10	0.7	0.6	0.5	0.9	0.8	0.7
58.3L	Notch revetment at 58.3L	48	0.5	0.5	0.4	0.7	0.7	0.7
61.0-62.1L	Probable tern island on RB, avoid aquatic areas in AR61.4L-D, utilize land within disposal cells or enhance/create tern islands on RB	47	0.4	0.4	0.4	0.4	0.4	0.4
61.5-62.5R	Place disposal in string of islands along RB	30	0.2	0.2	0.1	0.2	0.2	0.3
64-65R	Avoid disposal in AR64.5R-D, notch existing revetments and/or dikes (3)	44	0.5	0.5	0.4	0.6	0.6	0.6

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
64.8-65.3L	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	38	0.5	0.5	0.5	0.5	0.5	0.5
66.0-66.4 L	Construct fish passage structures through levees around dam 4.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
65.2-65.6L	Utilize AR65.2L-D or in-channel disposal at AR65.5Channel-D	12	0.4	0.4	0.4	0.4	0.4	0.4
Pool 4								
69.3 L	Construct fish passage structure through Plum Bayou around dam 4.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
70.0-70.7	Notch two longest existing dikes (2)	132	0.6	0.5	0.4	0.7	0.7	0.7
70.6	Maintain channel to backwater by periodically dredging	56	0.4	0.3	0.2	0.5	0.5	0.5
71.3	Dredge canals at Island Harbor Estates	20	0.5	0.5	0.4	0.6	0.7	0.7
72.0 R	Place woody habitat in Lake Langhofer	10	0.5	0.5	0.4	0.9	0.8	0.7
75.3L	Maintain channel to backwater by periodically dredging	10	0.5	0.4	0.3	0.6	0.6	0.6
78.7L	Dredge mouth of Pastoria Bend chute and periodically dredge to maintain and notch existing dike (1) if needed to open access to backwater	123	0.5	0.4	0.3	0.7	0.7	0.7
78.9-79.7L	79.0L - First option - Inquire about upland disposal on Pine Bluff Arsenal property first to avoid any impacts, second option - investigate island disposal upstream on LB at 80.1, third option to place in proposed location and notch modified dikes (4)	20	0.2	0.2	0.1	0.2	0.2	0.2

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
80.0-82.0L	Place disposal along dike fields to create islands and notch backside of dikes (9) at 80-82L	96	0.2	0.2	0.1	0.2	0.2	0.2
82.6R	Notch existing dike and maintain entrance to backwater at 82.6R by periodically dredging	82	0.4	0.4	0.3	0.6	0.7	0.8
82.5-85.5R	Notch existing dikes along RB (14)	252	0.5	0.4	0.3	0.6	0.6	0.6
84.7 L	Construct fish passage structure through levee around dam 5 and restore/maintain fish passage through Hensley Island Old River Lake	n/a	n/a	n/a	n/a	n/a	n/a	n/a
85.5-85.8R	Avoid disposal if possible and utilize in-channel disposal	33	0.7	0.7	0.7	0.7	0.7	0.7
85.9L	Construct boat ramp immediately d/s of Dam No. 5 if feasible							
85.6-85.8	Utilize in-channel disposal	4	0.4	0.4	0.4	0.4	0.4	0.4
Pool 5								
87.7L	Investigate dredging channel into oxbow lake to restore/maintain fish passage to Hensley Island Old River Lake and to accommodate construction of a fish passage structure through the levee around dam 5.	219	0.5	0.4	0.3	0.9	0.9	0.9
90.5-91.0L	Construct island(s) at 90.5-91.0L behind underwater revetment	21	0.2	0.2	0.1	0.2	0.2	0.2
91.4-91.7R	Recommend constructing island downstream at 90.5-91.0L behind underwater revetment, if proposed location must be utilized, place disposal off bank and create island(s) and notch backside of existing dikes	78	0.6	0.5	0.4	0.7	0.7	0.7

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
91.5L	Bank stab and revetment at 91.5 is needed (current – 0.3)	12	0.3	0.2	0.1	0.5	0.5	0.5
92.6L	Notch existing revetment (1) and maintain entrance to backwater by periodically dredging	13	0.4	0.3	0.2	0.6	0.6	0.6
94L	Notch existing revetment (1)	5	0.5	0.5	0.5	0.6	0.6	0.6
94.3-96.3L	Avoid aquatic disposal in uppermost cells of AR95.5L-D, extend disposal area d/s to create a series of islands for a braided system and terns, notch existing dikes (5) to enhance backwater areas	144	0.8	0.8	0.7	0.9	0.9	1
96.0-98.2R	Enlarge and utilize RB disposal, investigate disposing behind modified revetment and dikes, investigate terrestrial disposal if needed	42	0.2	0.2	0.2	0.2	0.2	0.2
98.5R	Notch existing revetment to access backwater (1)	2	0.5	0.1	0	0.6	0.6	0.6
99.4L	Notch existing revetment to access backwater (1)	2	0.3	0.1	0	0.4	0.4	0.4
100.3-101.1L	Notch existing dikes (2)	156	0.4	0.3	0.2	0.5	0.6	0.7
100.6-101.3	Utilize this area as alternative disposal site	74	0.1	0.1	0.1	0.1	0.1	0.1
101L	Existing tern island on LB, avoid work during nesting season	104	0.1	0.1	0.1	0.1	0.1	0.1
102-104R	Utilize RB disposal as alternative, construct/enhance tern islands if feasible	83	0.1	0.1	0.1	0.1	0.1	0.1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
101.5-103.7L	Avoid disposal, notch existing dikes (10-12) for flow-through and to enhance diversity	161	0.9	0.9	0.8	1	1	1
103.7 L	Restore/maintain fish passage to Georgetown Lake through culvert modification, control structures, and/or dredging	249	0.2	0.2	0.1	0.8	0.8	0.8
105.2-106.0L	Existing tern island(s), avoid work during nesting season, construct high water notches in dikes (4) to restore and maintain islands	102	0.1	0.1	0.1	0.8	0.8	0.8
106.1 R	Construct fish passage structures through series of chutes around dam 6.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
106.5-107.7L	Avoid aquatic disposal in AR107.1L, utilize land areas or in-channel disposal	78	0.8	0.8	0.8	0.8	0.8	0.8
Pool 6								
108.2 L	Place woody habitat in backwater	10	0.6	0.5	0.4	0.9	0.8	0.7
110.4L	Notch dike and reconnect Willow Beach Park backwater and oxbow to river (current – 0.1)	42	0.1	0.1	0	1	1	1
113-114L	Notch underwater dikes on backside of islands (4)	31	0.5	0.5	0.5	0.6	0.6	0.6
116.2R	Dredge backwater at 116.2R	6	0.1	0.1	0.1	0.2	0.2	0.2
116.6-116.8R	Notch existing dikes 116.6 to 116.8R (2) *may have already been done	10	0.4	0.4	0.4	0.5	0.5	0.5
117.1-117.7R	Notch existing dikes (3)	10	0.3	0.3	0.2	0.4	0.4	0.4
122.9-123.6R	Notch existing dikes (2-4) for flow-through and access	25	0.3	0.2	0.1	0.4	0.4	0.4

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
123.7L	Notch existing dike for access and fish passage	5	0.3	0.2	0.1	0.3	0.3	0.3
124.8L	Prefer in-channel disposal	2	0.6	0.6	0.6	0.6	0.6	0.6
124.8-124.2	Avoid disposal in AR124.8L-D, utilize in-channel disposal	10	0.6	0.6	0.6	0.6	0.6	0.6
124.8-125.1	Utilize in-channel disposal at AR124.8 Channel-D	12	0.4	0.4	0.4	0.4	0.4	0.4
125.0 L	Construct fish passage structures through series of chutes around dam 7.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pool 7								
126.7-127.4L	Utilize LB disposal and notch modified dikes (4)	45	0.2	0.2	0.2	0.5	0.5	0.5
127.0 L	Mussel bed monitoring adjacent to disposal area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
127.5 L	Restore/maintain fish passage to backwater through vegetation management, control structures, and/or dredging	100	0.6	0.3	0.1	1	1	1
128.0 R	Place woody habitat in Maumelle River bay	10	0.5	0.5	0.5	0.9	0.8	0.7
131.0 L	Dredge upper end of Rector Brake to improve habitat	41	0.3	0.2	0.1	0.6	0.6	0.6
131.0 L	Place woody habitat in Rector Brake	10	0.3	0.2	0.1	0.9	0.8	0.7
131.8-132.5R	Notch upper end of modified revetment (1)	31	0.2	0.2	0.2	0.6	0.6	0.6

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
133.5-135.2L	Avoid aquatic disposal on LB, utilize land disposal on island or construct another island on RB, notch longest existing dike for flow-through (*potential existing tern site)	82	0.7	0.7	0.7	0.8	0.8	0.8
134.2R	Notch existing revetment (1) at 134.2R and existing dike (1) at 134.7R for fish passage and access to Mill Bayou	213	0.4	0.4	0.3	0.5	0.5	0.5
135-138.2R	Avoid disposal in aquatic areas, utilize island disposal, (*potential existing tern site), notch two lower dikes	270	0.8	0.6	0.4	0.9	0.9	0.9
139.5-141R	Avoid disposal from 140R u/s to 141R to prevent blockage of opening between islands, utilize 140R d/s to tip of island	36	0.9	0.9	0.8	0.9	0.9	0.9
141.5-142.5R	Utilize disposal behind raised and extended L-dikes at 142.0R	86	0.2	0.2	0.1	0	0	0
142.5-143.4R	Notch modified dikes (2) at entrance to beaver dam channel for flow-through	30	0.7	0.5	0.3	0.8	0.8	0.8
143.7-144.2	Construct L-dike or revetment and use disposal to slope and protect bank	38	0.3	0.2	0.1	0.4	0.4	0.4
145.2-146.2L	Notch modified dikes (7)	50	0.6	0.5	0.4	0.7	0.7	0.7
146.5	Mussel bed monitoring adjacent to disposal area	n/a	n/a	n/a	n/a	n/a	n/a	n/a
146.5-147.5L	* Existing tern island – enhance/construct a series of islands along LB where feasible, notch dikes (5), move disposal from LB to RB for excess disposal	102	0.4	0.3	0.2	0.5	0.5	0.5
146.3R	Avoid disposal in this area	37	1	1	1	1	1	1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
146.8-147.8R	Utilize land within disposal cells	29	0.4	0.2	0	0.4	0.4	0.4
147.8-150L	Avoid disposal from 149-150L that would block the entrance to backwater area, utilize disposal area d/s of 149L	124	0.4	0.3	0.2	0.3	0.3	0.3
148.7-150.4R	Avoid disposal, notch dike at 149R	49	0.8	0.7	0.6	0.9	0.9	0.9
150-151.7L	Avoid disposal from 150-151L that would block side channel and backwater entrance, construct a series of tern islands where feasible, notch existing dike at 150.8L for fish passage and backwater entrance	220	0.5	0.5	0.4	0.8	0.8	0.8
154-154.6L	Utilize land disposal within cells at AR154.1L-D	16	0	0	0	0	0	0
155.4L	Utilize land within cell at AR155.4L-D	7	0	0	0	0	0	0
155.6R	Notch existing revetment (2)	9	0.3	0.3	0.3	0.5	0.5	0.5
Pool 8	Avoid disposal from 149-150L that	124	0.4	0.3	0.2	0.5	0.3	0.3
158.8-159.2	Utilize existing island for disposal and/or construct tern islands	9	0.5	0.5	0.4	0.5	0.5	0.5
161.2-162.2L	Notch dikes from 161.2-162.2L 161.2	36	0.7	0.5	0.3	0.8	0.8	0.8
163.6-165.2R	163.6-165.3 - Revetment is needed for bank stabilization		0.1	0.1	0.2	0.3	0.4	05
164.2-164.7	Avoid LB disposal, investigate moving RB revetment out and utilizing disposal as bank stabilization	43	0.5	0.5	0.4	0.5	0.5	0.5
164.5-165.2	Maintain fish passage by placing a notch on upstream end of revetment for flow in and out of Plummerville cutoff, and notch raised dikes (3), maintain entrance by periodically dredging	61	0.9	0.7	0.5	1	1	1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
165.5-166.2	Avoid disposal in AR166.0R-D	53	0.8	0.8	0.8	0.8	0.8	0.8
165.8-167.0	Avoid aquatic disposal, dispose on land within cells, notch existing revetment (4)	25	0.7	0.6	0.5	0.8	0.8	0.8
169.2-169.8	Utilize AR169.4R-D for disposal first	58	0.1	0.1	0.1	0.1	0.1	0.1
168.7-169.5	Utilize AR169.4R-D for disposal first, AR169.0L-D second, construct tern islands where feasible	33	0.1	0.1	0.1	0.3	0.3	0.4
169.4-169.7	Notch raised dikes (4)	34	0.1	0.1	0	0.3	0.3	0.2
169.6-172	Notch raised dike at 170.1L and existing dikes at 170.7L and 171L, utilize land within cells for disposal or create/enhance tern island, (*existing tern island)	144	0.6	0.5	0.4	0.7	0.7	0.7
174.1-176.7R	Utilize land disposal on Lentz property, notch dikes 4 feet from top for high water (4)	138	0.4	0.4	0.4	0.5	0.5	0.5
176.2-176.4	Avoid disposal in AR176.2L-D, utilize RB land disposal on Lentz property	14	0.4	0.4	0.4	0.4	0.4	0.4
Pool 9								
177.7 R	Restore/maintain fish passage to oxbow through control structure and levee.	76	0.2	0.2	0.2	0.9	0.9	0.9
179.3-179.7R	Utilize disposal at 179.6R behind recommended revetment	17	0.6	0.6	0.6	0.6	0.6	0.6
180.2	Notch existing dike at 180.2R for fish passage and access to backwater	30	0.7	0.7	0.6	0.9	0.9	0.9

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
180.4-181.3	Extend disposal area upstream to raised dike at 181.5R and dispose along bank downstream of dike, notch dikes (2)	18	0.4	0.3	0.2	0.4	0.4	0.4
181.8-184.9	Notch existing and raised dikes (8-10) and create a series of islands for braided system and terns	256	0.7	0.7	0.6	0.8	0.9	0.9
185.8-186.4	Avoid disposal in AR186.2L-D, create artificial gravel bar downstream of dikes from 185L-186L	20	0.6	0.6	0.5	0.7	0.7	0.7
187.2	Notch long L-dike at 187.2R (2)	112	1	0.9	0.9	1	1	1
186.9-189.9	*Existing least tern island - avoid construction during nesting, limited disposal to avoid elevating island and maintain fish access to backwater, notch revetment and dikes (3-6) for flow-through, fish passage and access	325	1	0.8	0.6	1	1	1
189.2	189.2 - Notch revetment and dikes for fish passage and access to backwater	347	0.8	0.7	0.6	0.9	0.9	0.9
188.9-190.4	*Existing least tern island, avoid disposal, notch raised revetment (1) and existing dike (1), utilize area upstream at 191R for disposal	82	0.8	0.7	0.6	0.8	0.8	0.8
190R	Notch Sweeden island dike in chute on RB lowest for fisheries access	46	0.8	0.5	0.3	1	1	1
190.5-192R	New dredge disposal alternative to 189.5L will create elevated vegetated shoreline on Sweeden Island	67	0.1	0.1	0. 1	0.1	0.2	0.2
189.9-190.5	Notch modified revetment in two places	26	0.6	0.6	0.5	0.6	0.6	0.6
194.0 R	Restore/adjust Holla Bend Weir	546	0.8	0.7	0.7	0.9	0.9	0.9

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
193.6-195L	Notch existing dikes (5) in AR194.1L-D	112	0.2	0.2	0.2	0.3	0.3	0.3
197.2-197.9	Utilize approved disposal area	7	0.1	0.1	0.1	0.1	0.1	0.1
200.2	Utilize land disposal within cells from 200.8L d/s to 200L, avoid disposal u/s of 200.8L	69	0.5	0.5	0.5	0.5	0.5	0.5
204.6-205.1	Utilize in-channel disposal (gravel)	60	0.8	0.8	0.8	0.8	0.8	0.8
Pool 10								
206.2R	206.2 - Utilize in-channel disposal on right bank	33	0.8	0.8	0.8	0.8	0.8	0.8
208.9 R	Place woody habitat in Dardanelle Bay	10	0.6	0.6	0.6	0.9	0.8	0.7
211.5 R	Place woody habitat in Delaware Bay	10	0.6	0.6	0.6	0.9	0.8	0.7
217.5 L	Place woody habitat in Kenner Cove	10	0.7	0.6	0.5	0.9	0.8	0.7
222.0 R	Place woody habitat in Dublin/Shoal Bay	10	0.8	0.7	0.6	0.9	0.8	0.7
222.5R	Construct islands along RB if feasible	10	0.3	0.3	0.3	0.6	0.7	0.8
225.5L	Construct islands along LB if feasible	10	0.3	0.3	0.3	0.6	0.7	0.8
227.0 L	Place woody habitat in Cabin Creek bay	10	0.9	0.8	0.7	1	1	0.9
230.5 L	Place woody habitat in Spadra Creek bay	10	0.3	0.3	0.2	0.8	0.7	0.6
227.2, 229, 230, 233.5, 233.3, and 234	Construct islands where feasible	20	0.5	0.5	0.5	0.6	0.7	0.8
232R	No adverse impact, bank stabilization is needed at this area	2	0.4	0.4	0.4	0.7	0.8	0.8
232.5 R	Place woody habitat in Cane Creek bay	10	0.6	0.6	0.5	0.9	0.8	0.7

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
233	Utilize land disposal in AR233.0L-D if needed	6	0	0	0	0	0	0
235-236.8R	Notch existing dike and raised dike (2-3) in AR236.0R-D	288	0.6	0.3	0.1	0.6	0.6	0.6
236.6	236.6L - Dispose in terrestrial site preferred at 236.6L	40	0.6	0.6	0.6	0.6	0.6	0.6
238.5-239.9L	*Existing tern island at 239.5L, avoid disposal in AR238.5L-D, alternately use 240.1-241.0 L, investigate terrestrial disposal, create and/or extend island, notch land side of dikes, do not cut off backwater at 241.1L	162	0.9	0.9	0.8	0.9	0.9	0.9
238.5-241.2	Maintain and/or notch existing and modified dikes (3)	383	0.8	0.7	0.6	0.9	0.9	0.9
239.5R	239RB-Maintain fish access through revetment. Modified revetment along RB will have no adverse impacts	176	0.8	0.7	0.6	0.8	0.8	0.8
241.8-242.2	Prefer to use this low value area for disposal	31	0.3	0.3	0.3	0.3	0.3	0.3
242-244.1L	Avoid disposal in AR242.2L-D at entrance to Hartman Lake, utilize AR241.8R-D and AR244.0R-D if needed, deepen notch in modified revetment	41	0.5	0.5	0.4	0.6	0.6	0.6
243.7-244.2L	243.8L - Notch revetment and dike at u/s end to Hartman lake to allow flow-through and fish passage	100	0.3	0.3	0.2	0.8	0.8	0.8

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
244R	Utilize two downstream cells for disposal if needed and notch two existing upper dikes for fish passage and access	10	0.4	0.3	0.3	0.4	0.4	0.4
243.8-246.8L	Avoid disposal (none currently scheduled) in AR245.6L-D, notch dike d/s of most d/s island at 244.5L	202	0.6	0.6	0.5	0.7	0.7	0.7
249R	Alternate disposal site for AR248.0R-D	16	0.1	0.1	0.1	0.1	0.1	0.1
249.7L	Alternate disposal site for AR248.0R-D	16	0.1	0.1	0.1	0.1	0.1	0.1
254.1-254.5	Alternative disposal site inside closed revetment at 254.1L, no previously approved disposal area indicated on map	4	0.1	0.1	0	0	0	0
251.8-253.8L	Notch dikes (5-10) on left and right bank up and downstream	103	0.6	0.5	0.4	0.7	0.8	0.8
255.7-256.1R	Use AR256.2L-D for disposal instead of AR256.0R-D	8	0.3	0.2	0.1	0.5	0.6	0.6
255.9-256.2L	Prefer to use this terrestrial area for disposal	9	0	0	0	0	0	0
Pool 12								
257.5 L	Place woody habitat in Gar Creek bay	10	0.6	0.5	0.5	0.9	0.8	0.7
268.0 L	Place woody habitat in White Oak Bayou bay	10	0.8	0.8	0.7	0.9	0.9	0.8
271.2-273R	Recommend disposal site along RB	40	0.1	0.1	0.1	0.1	0.1	0.1
272.0 L	Place woody habitat in Mulberry River bay	10	0.7	0.6	0.6	0.9	0.8	0.7
273.7-276L	Avoid disposal in AR274.0L-D and AR275.0L-D, alternatively use RB disposal to create or enlarge islands,	48	0.4	0.4	0.3	0.4	0.4	0.5

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
275-276	Notch modified dikes (3)	48	0.4	0.4	0.3	0.4	0.4	0.4
275.7-276.4R	Notch modified dikes (2) that connect to shoreline and extend RB disposal downstream within dike field	56	0.1	0.1	0.1	0.6	0.6	0.7
275.2-276.6R	Notch dikes (2) that connect to shoreline	120	0.5	0.5	0.4	0.6	0.6	0.6
276.8-277.5R	Avoid backwater disposal in 277.0R-D, place disposal on land and d/s along bottom end to extend island	17	0.2	0.2	0.2	0.2	0.2	0.2
278.9-280.3L	At AR279.5L-D avoid disposal in aquatic areas, utilize land within disposal area and AR280.0R-D	384	1	1	1	1	1	1
279-280.1L	Notch modified revetment at 279L and 280.2L to maintain high value for backwater area	384	1	1	1	1	1	1
279-280.1R	Utilize AR280.0R-D for disposal and construction of string of islands, notch modified dikes (4) to create and maintain backwater channel	57	0.5	0.5	0.4	0.5	0.5	0.5
280.6-280.9	280.8L - Notch modified dikes (3)	32	0.7	0.7	0.6	0.7	0.7	0.7
281.9-283.3L	Place disposal on lower end of disposal area on existing sand bars, construct islands where feasible, avoid disposal from 283.2-283.5L	140	0.7	0.7	0.6	0.7	0.7	0.7
283.1-283.9L	283.9L - Notch modified revetment in upper cell (High priority)	175	0.7	0.6	0.5	1	1	1
283.5-284.7R	Recommend constructing new disposal at 284R	33	0.1	0.1	0.1	0.1	0.1	0.1

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
284.7-287.4	Avoid disposal in d/s cells on LB and RB, prefer disposal d/s in new area	126	0.7	0.7	0.6	0.7	0.7	0.7
285.6-286.2L	Extend disposal area to 286.2L dike, place disposal behind dikes on LB from 286.2-285.6L to create islands and maintain gravel instream, notch modified (2) and existing (2) dikes	19	0.7	0.7	0.6	0.7	0.7	0.7
288.4-289L	Avoid disposal in AR289.0L-D and place dredged gravel along right bank downstream and extend downstream gravel bar at 289.7R	21	0.7	0.7	0.6	0.7	0.7	0.7
288.8-289.8	Recommended alternate disposal site	20	0.4	0.4	0.4	0.4	0.4	0.4
290R	Notch existing dike if feasible	10	0.1	0.1	0	0.6	0.6	0.6
290.5-291.4R	Utilize dry cells in this disposal area	48	0.1	0.1	0.1	0.1	0.1	0.1
291.8-292.3L	Avoid disposal at 292.3L	22	0.7	0.7	0.7	0.7	0.7	0.7
Pool 13	Extend disposal area to 286.2L dike	19	0.7	0.7	0.6	0.7	0.7	0.7
293.0 R	Place woody habitat in Massard Creek bay	10	0.6	0.6	0.6	0.9	0.8	0.7
307.5 L	Dredge channel and notch dike at 307.0 L bank	20	0.1	0.1	0	0.6	0.6	0.6
305.3-306R	Notch revetment at 305.7 and 306R	60	0.7	0.6	0.5	0.8	0.8	0.9
OK Pool 13	downstream and extend downstream							
309.8-310.3	Notch 4 dikes for scour	24	0.5	0.4	0.3	0.8	0.8	0.8
310.4	Notch parallel dikes (1) for scour	13	0.3	0.2	0.2	0.6	0.6	0.6
311.5-313.7	New Dikes, designed to maintain variable habitat (J-hook)	13	0.1	0.1	0.1	0.4	0.3	0.2

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
314.8-315.8	New & existing dikes LD recommend J-hook design	5	0.3	0.3	0.3	0.6	0.5	0.5
Pool 14								
320-321	Notch 3 interior dikes	34	0.6	0.5	0.4	0.8	0.8	0.8
321-323	Notch 5 dikes	128	0.8	0.8	0.8	0.9	0.9	0.9
323.7 - 323.9	Notch 2 dikes	7	0.6	0.4	0.3	0.7	0.7	0.7
323-324	Notch 9 dikes	208	0.6	0.4	0.3	0.8	0.8	0.8
326.7-328.1	notch 7 dikes interior/exterior	48	0.5	0.4	0.3	0.7	0.7	0.7
Pool 15								
336.4	Create marsh & fish nursery habitat; variable depth 6in - 2ft/ riprap protection, NOTE: Site will be avoided to preserve mussel bed	11	0.4	0.4	0.4	0.7	0.7	0.7
348.3	Add to existing island	20	0.6	0.6	0.6	0.6	0.6	0.6
353.5-354.3	aquatic area converted to terrestrial with rip rap	3	0.6	0.6	0.6	0.6	0.6	0.6
355	Create 3 - 10 acre tern island w/riprap in Sequoyah National Wildlife Refuge	31	0.6	0.5	0.4	0.7	0.6	0.5
360.6	Notch 2 dike	12	0.5	0.4	0.4	0.7	0.7	0.7
361-363	Relocate gravel to dike field on left descending bank at 360.6. Relocate downstream between rm 360 - 361; monitor & adapt as needed	36.7	1.0	1.0	1.0	1.0	1.0	1.0

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
Sans Bois Creek								
sbc 0.4	Aquatic disposal area; create high quality marsh; variable depth 6-in - 2 ft; mussels should be protected from impacts resulting from disposal	100	0.4	0.3	0.2	0.6	0.6	0.6
sbc.4.8	Create HQ marsh; variable depth 6-in - 2 ft. Note: Site should be redesigned to preserve mussel patch; aquatic disposal will only occur if mussels won't be impacted	90	0.4	0.4	0.4	0.6	0.6	0.6
sbc 6.6	Expand island, design to avoid impacts to mussels; height of disposal will be 6 in - 2 ft below water surface	10	0.4	0.4	0.4	0.4	0.4	0.4
sbc 6.9	Expand island, design to avoid impacts to mussels; height of disposal will be 6 in - 2 ft below water surface	10	0.4	0.4	0.4	0.4	0.4	0.4
Pool 16								
367.5-367.7	1st priority avoid designated site, move disposal to outside of lock guide wall, armored protection; notch 1 dike	38	0.8	0.7	0.6	0.9	0.9	0.9
367.4	Alternative disposal site for 367.5 - create tern island/w riprap	38	0.3	0.3	0.3	0.3	0.3	0.3
374-375	Relocate gravel downstream to rm 373; monitor & adapt as needed	1.23	0.8	0.8	0.8	0.8	0.8	0.8
379-380	Dredge upper end of oxbow; maintain upper/lower openings	405	0.4	0.3	0.2	0.6	0.6	0.6
383.2	Dredge mouth of Hopewell Creek	1	0.4	0.3	0.2	0.4	0.4	0.4
392.1-393.0	Notch dikes, create tern island in middle cell	40	0.8	0.4	0.2	0.8	0.8	0.8

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
393	Relocate gravel to dike fields created on Right descending banck at rm 392.1-393.0; monitor & adapt as needed	0.83	0.8	0.8	0.8	0.8	0.8	0.8
393.2 - 394.1	1st priority dispose in terrestrial cell, notch internal & lower end dikes; 2nd priority dispose in dike cell above and below bridge. L	39	0.7	0.6	0.5	0.9	0.9	0.9
393.8-394.6	Notch added dikes to avoid fill; design to minimize fill (J-hook)	35	0.5	0.4	0.3	0.5	0.5	0.5
395	Relocate gravel to dike fields on left descending bank at rm 393.8; monitor & adapt as necessary	3.54	0.8	0.8	0.8	0.8	0.8	0.8
398.8	Dredge upper/lower end Okay oxbow install culvert structure	1	0.4	0.3	0.2	0.5	0.5	0.5
Pool 17								
402	Relocate gravel upstream to rm 403.5 – 404; monitor & adapt as necessary	7.42	0.8	0.8	0.8	0.8	0.8	0.8
407	Dredge Upper/lower end Tullahassee Loop; rework culvert structure	1	0.4	0.4	0.4	0.5	0.5	0.5
408.8	Dredge mouth of Strawberry Creek	23	0.4	0.3	0.2	0.5	0.5	0.5
408.9	dredge mouth of Billy Creek Cutoff	138	0.4	0.3	0.2	0.6	0.6	0.6
414.7	Dredge at culvert structure	87	0.4	0.3	0.2	0.6	0.6	0.6
416.7	Dredge/rework culvert structure	122	0.4	0.4	0.4	0.6	0.6	0.6
418.8	Dredge/rework culvert structure	36	0.4	0.4	0.4	0.6	0.6	0.6
419.5	Dredge mouth of Bull Creek	34	0.4	0.3	0.2	0.4	0.4	0.4
421	Relocate gravel to rm 417-418.5; monitor & adapt as needed	20	0.8	0.8	0.8	0.8	0.8	0.8

Navigation Mile	Recommended Mitigation Feature	Acres	HSI without project			HSI with project		
			11	31	51	11	31	51
Pool 18								
426.7	Dredge mouth of Commodore Creek	9	0.4	0.3	0.2	0.4	0.4	0.4
439.7	Dredge lower end of oxbow	8	0.4	0.3	0.2	0.4	0.4	0.4
442	Dredge lower end of oxbow	22	0.4	0.3	0.2	0.4	0.4	0.4

* n/a indicates not applicable non-habitat specific mitigation and/or biological mitigation

APPENDIX H

To

June 2005 USFWS

Final

Fish and Wildlife Coordination Act Report

on the

Arkansas River Navigation Study, Arkansas and Oklahoma

Recommended Mitigation Features for

Freshwater Mussel Impacts

IN REPLY REFER TO:

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1500 Museum Road, Suite 105
Conway, Arkansas 72032
Tel.: 501/513-4470 Fax: 501/513-4480

April 29, 2005

Johnny McLean
U. S. Army Corps of Engineers
Environmental Section
P. O. Box 867
Little Rock, Arkansas 72203-0867

Dear Mr. McLean:

The U. S. Fish and Wildlife Service (Service) has completed our review of the Draft *McClellan-Kerr Arkansas River Navigation Study: Freshwater Mussel (Unionid) Study* prepared by Ecological Specialists, Incorporated (ESI). The Little Rock and Tulsa Districts of the U. S. Army Corps of Engineers (Corps) are preparing an Environmental Impact Statement that evaluates the modification of flows and deepening the channel from nine to twelve feet in the McClellan-Kerr Arkansas River Navigation System (MKARNS) from the Port of Catoosa near Tulsa, Oklahoma to the confluence with the Mississippi River in Arkansas. The Service (Conway and Tulsa Field Offices) and Arkansas Game and Fish Commission (AGFC) met with the Corps and ESI in June, 2004 to select and prioritize mussel sampling sites based on dredge and dredge disposal locations, potential mussel habitat, past surveys, and personal knowledge of the study area.

ESI conducted mussel surveys from September through December, 2004 and submitted their draft findings from the mussel survey in March, 2005. Preliminary discussions on the draft mussel report and mitigation recommendations were discussed during a conference call between the Service (Conway and Tulsa Field Offices), Corps (Little Rock and Tulsa Districts), AGFC, and ESI on April 20, 2005. The Arkansas Field Office (AFO) of the Service submits the following comments regarding the draft mussel study report and our recommendations for minimizing impacts to the Arkansas River freshwater mussel fauna (Arkansas portion only; Tulsa Field Office will submit comments for the OK portion). Our comments are separated into three categories: 1) Revisions, edits, and comments to the ESI draft mussel study report, 2) mitigation recommendations for freshwater mussels, and 3) long term monitoring and protection recommendations.

Recommendations for Revisions, Edits, and Comments to the ESI Draft Mussel Study Report

To date, only one *Potamilus capax* has been found in the lower White River system and their primary range in Arkansas includes the St. Francis River basin and dike fields along the Mississippi River. Therefore, the reach of MKARNS downstream of Lock and Dam 3 has the greatest likelihood of harboring *Potamilus capax*, not just Bed B1-1. This mistake needs to be corrected on page 6.

The report needs to include species area curves for all beds downstream of Lock and Dam 3.

The ability of a survey to detect a species depends on sampling design and effort. For cryptic animals like mussels, presence-absence can rarely be established absolutely, except for small areas. In a large area such as the canal, it is not possible to say with certainty that *Potamilus capax* is truly absent from the area. Instead, one must say that *Potamilus capax* was not detected given *X* effort and *Y* design. The challenge is to reduce the chance of missing *Potamilus capax* to an acceptable level. This is where species area curves are of importance to indicate the likelihood of encountering additional species with more effort.

Depending on results from species area curves for mussel beds between Bed B1-1 and Lock and Dam 3, additional sampling effort may be required to ensure that no *Potamilus capax* are present. Given the number of mussels in the canal it is questionable without seeing a species area curve whether a 5 minute sample every 317 meters (m) is sufficient to detect *Potamilus capax* considering the number of mussels present in the canal. If curves show that extensive effort may be required to detect another species then additional sampling may not be required. A decision will be determined by the Service and AGFC and will be dependent upon the amount of effort required to significantly reduce the likelihood of encountering an additional species. Consideration to sample effort and design, species area curves, and the likelihood of encountering additional species should be incorporated in the final report.

Page 2, line 17 delete *Lampsilis powellii* (Neosho and Illinois River, Branson, 1984). *Lampsilis powellii* is an endemic to the upper Ouachita River system in Arkansas. Any reference to this species occurring in the Neosho and Illinois Rivers by Branson (1984) is a misidentification.

State in the methods section the criteria used to distinguish "Patches" from "Beds".

Work with the Service, Corps, and AGFC to incorporate mitigation and monitoring recommendations into the final report.

Mitigation Recommendations for Freshwater Mussels

Very few mussel beds and patches were discovered during 2004 surveys within the permitted and proposed dredge disposal sites. These mussel beds and patches collectively represent a major portion of the MKARNS mussel fauna and are a significant resource. However, relocation of mussel beds and patches outside of the Arkansas Post Canal is not prudent because it is a greater priority to preserve the few disjunct areas of suitable mussel habitat in the system than preserve individuals. The Corps indicated in the March 20, 2005 conference call that there would be some flexibility with the location of disposal sites. The Corps should work closely with the Service, AGFC, and ESI to establish alternate disposal areas or restrict disposal in permitted and new sites to no closer than 100 m lateral and downstream and 300 m upstream of defined patches and beds.

The largest concentration of mussels (approximately 2 million) in the MKARNS occurs in Mussel Beds B2-1, B2-2, and B2-3 located in the Arkansas Post Canal (canal). The estimate of 2 million mussels is based on qualitative sampling (41 five minute samples) and there may be

considerable variability in the number of mussels present. Quantitative samples would have yielded more validity to mussel community estimates in the canal, but are not available at this time. However, the recommendations presented below should be sufficient to help reestablish the canal.

The Corps intends to dredge the entire Arkansas Post Canal using a cutter head dredge. To mitigate and compensate for the mussel and mussel habitat losses in MKARNS, the Service's AFO is recommending the following combination of translocation and propagation.

Arkansas Post Canal and Merrisach Lake – Merrisach Lake is adjacent to the Arkansas Post Canal and may serve as a refugia or temporary holding location for mussels that will be used to reestablish the canal should suitable habitat persist post-dredging. Approximately 12,000 m of shoreline habitat (excluding shallow areas in the back of coves) is available in Merrisach Lake. A thorough survey of the lake is required to determine the exact amount of suitable habitat and should be conducted prior to any relocation. Either floating cages or metal cages placed on the substrate should be used to hold mussels in the lake. The decision on what type of cage to use should be based on habitat suitability in the lake. Assuming that a 1 m wide area of suitable habitat exists along the shoreline and five mussels/m^2 are relocated into the lake, 60,000 mussels could be temporarily held at this location. Composition of the relocated mussels should closely resemble that which occurs in the canal at this time (refer to Table 3-6 in ESI's draft report). These mussels will be relocated back to the canal following dredging activities and when it is determined by the Service and AGFC that suitable habitat exists. The use of cages should greatly reduce the amount of time and effort required to move mussels back into the canal.

Propagation and the subsequent release of juveniles, in addition to the relocated individuals, will help compensate for the mortality of approximately 1.9 million mussels and any mortality associated with relocation and temporary holding in Merrisach Lake. A bottleneck occurs in the life cycle of freshwater mussels due to their dependency of a suitable fish host to complete their life cycle. Essentially, we are not recommending captive breeding but rather the collection of gravid females from the wild, providing access to a suitable fish host to allow glochidia to transform to juveniles, and subsequently releasing 2 month old juveniles back to the canal. With juvenile survival rates often low, a 3 year propagation effort at a rate of 1 million juveniles per year is needed. The proportion of juveniles released should be as close as practical to mussel community composition in the canal prior to dredging. American Fisheries Society Special Publication 30, *Investigation and Monetary Values of Fish and Freshwater Mussel Kills*, provides replacement costs per juvenile for each species.

If suitable habitat does not exist in the canal following dredging activities, the AFO and AGFC will determine relocation and juvenile release sites at other locations in the Arkansas portion of the MKARNS as needed.

White River – Several species that occur in the canal are components of the White River mussel fauna. These include *Fusconaia ebena*, *F. flava*, *Lampsilis cardium*, *L. siliquoidea*, *L. teres*, *Quadrula aspera*, *Q. nodulata*, and *Truncilla truncata*. These species should first be moved into Merrisach Lake at the same composition that they currently occur in the canal. All excess individuals encountered during relocation efforts will be relocated to mussel beds in the lower

White River portion of the MKARNS. However, the number relocated should not exceed 10,000 individuals and extra effort to find these species is not required.

Lake Dardanelle – The mussel community in Lake Dardanelle has been devastated in recent years by commercial shelling and zebra mussels. However, the lake still has a vast amount of suitable mussel habitat along the shoreline and on shallow flats adjacent to the river channel. The lake's mussel community would benefit from individuals being relocated from the canal to the lake. Piney Bay (approximately 215 acres of suitable habitat) would be the top priority in the lake since it historically had lower densities of zebra mussels compared to other locations in the lake. Thirty thousand (30,000) mussels should be relocated from the canal to Piney Bay. The species relocated should consist only of those species which are known to occur in Lake Dardanelle and that are sublegal harvest size (see AGFC regulations). Mussels should be stocked at an average density not to exceed 3 mussels/m^2. By relocating mussels to Lake Dardanelle, the amount of occupied mussel habitat will be increased in the MKARNS thereby helping to offset any habitat loss related to dredging activities.

Long Term Monitoring and Protection Recommendations

Monitoring is critical to determine success or failure of relocation and juvenile release efforts. Each mussel relocation site should have a plan developed for monitoring. At a minimum the monitoring plan should consist of explicit monitoring goals, reporting requirements, and monitoring responsibilities. Monitoring goals at a minimum should include two components: 1) relocation site monitoring should be conducted annually for the first three years following relocation (required) and once every other year thereafter for seven years or until there is evidence of success or failure, 2) at least three mussel beds, to be determined by the AFO and AGFC, adjacent to disposal sites in Arkansas should be monitored within six months following a high water event (100,000 cfs) and should include monitoring associated with a minimum of 3 high water events. Monitoring should include quantitative components and be statistically comparable across years.

Additionally, the relocation sites should be protected to ensure that the mitigation goal can be achieved. Efforts to relocate the mussels, establish replacement beds, and monitor these sites will be in vain if the mussels are harvested. The AGFC and/or the Corps should implement regulations and/or habitat mitigation easements for these areas to prevent mussels from being harvested. We believe failure to provide protection to these sites is inadequate to meet mitigation goals.

We request that a meeting be scheduled for early May between the AFO, AGFC, and Corps to discuss in more detail the relocation of disposal areas and potential for avoiding impacts to mussel beds near disposal areas. We also strongly encourage the Corps to use a dredge other than a cutter head in the Arkansas Post Canal. A less destructive dredge would increase the likelihood of mussels passing through the dredge unharmed. Scientists have expressed an interest in collecting unharmed mussels from the disposal material at Arkansas Post Canal for use in taxonomic studies with specimens to be housed at the Arkansas State University Museum of Zoology Mollusk Collection.

We thank you for your interest in the conservation of freshwater mussels. If you have any questions or project plan changes, please notify Chris Davidson at 501-513-4481. Thank you for your continued cooperation with our agency.

Sincerely,

David H. Kampwerth
Acting Field Supervisor

cc w/encl: Heidi Dunn, Ecological Specialists Inc.
Bill Posey, Arkansas Game and Fish Commission
David Martinez, USFWS Tulsa Field Office
Sandy Stiles, USACE Tulsa District

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
222 South Houston, Suite A
Tulsa, Oklahoma 74127
918/581-7458 / (FAX) 918/581-7467

In Reply Refer To:
FWS/R2/OKES/0
2-14-05-I-0419
0385

May 11, 2005

Johnny McLean
U.S. Army Corps of Engineers
Environmental Section
P. O. Box 867
Little Rock, Arkansas 72203 – 0867

Dear Mr. Mclean:

This letter transmits planning information for the U.S. Army Corps of Engineers (Corps) Arkansas River Navigation Study (ARNS), Arkansas and Oklahoma. The U.S. Fish and Wildlife Service (Service) has most recently been working cooperatively with Corps staff on the assessment of potential impacts to aquatic resources as a result of the proposed channel deepening feature of ARNS and the development of mitigation measures for these impacts. Freshwater mussels (unionids) could be impacted by proposed dredging and disposal activities.
Ecological Specialists, Inc. (ESI) conducted a study to determine unionid distribution and species composition in the navigation system. The Tulsa and Conway Field Offices of the Service and the Arkansas Game and Fish Commission participated in a preliminary planning session with the Corps and ESI during June 2004 to select and prioritize mussel sampling points. ESI conducted mussel surveys during September, October and December 2004. The Oklahoma Ecological Services Field Office of the Service has reviewed the draft McClellan – Kerr Arkansas River Navigation Study: Freshwater Mussel (Unionid) Survey prepared by ESI.

The comments provided here pertain to freshwater mussel resources in the Oklahoma portion of the study area. The Conway field office is preparing comments for the Arkansas portion of the study. Our comments serve to provide 1) suggested revisions to the draft report, 2) preliminary ideas for mitigation of potential impacts on freshwater mussels and 3) long-term monitoring needs. This letter is submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. et seq.), but is not intended to fulfill the reporting requirements of Section 2 (b) of the Act.

General Comments

The new surveys by ESI found no federally-listed or proposed threatened or endangered species within the MKARNS, but did find productive, diverse (29 species total) mussel communities within most reaches of the system. As the ESI authors point out, unionids are an important ecological component of many freshwater ecosystems (Strayer *et al.* 1999, Vaughn *et al.* 2004). They are additionally valued by humans for their significant commercial, scientific, cultural and aesthetic importance (Stansbery and Stein 1971, Williams *et al.* 1993). Of the multiple factors listed by the ESI authors as contributing to recent mussel declines, all but commercial harvest are associated with development and operation of major navigation systems such as the MKARNS.

The proposed project would affect mussels and mussel habitats, most directly by dredging and disposal of dredged materials in conjunction with producing a minimum 12-foot channel depth. The potential exists not

only for direct removal and burial of mussels, but also for effects on nearby mussels from dispersion of temporarily suspended sediments and destabilization of substrates adjacent to the excavated channel. In addition, the expected operation of larger barges in the MKARNS would increase re-suspension of sediments and other turbulence-related effects in the system. The Service does not anticipate that flow-modification features of the project would adversely affect mussel resources in the MKARNS.

The survey results verify that mussel resources are not distributed uniformly throughout the MKARNS, but rather occur in relative concentrations, the larger of these described as beds and patches. In general, efforts should be made to avoid effects on mussel habitats by locating dredge and disposal sites away from identified mussel concentrations. Open water distances necessary to protect mussels from dispersing sediments would vary by substrate type, with 30 horizontal meters probably sufficient for predominantly sandy substrates but 100-150 horizontal meters probably needed for silty substrates. Other site-specific factors (*e.g.*, currents, vertical separation of mussels and channel activities) may alter minimum distances needed; however, distances of these or similar magnitudes should be adopted as a general standard.

Where constraints (*e.g.*, location of the existing channel) prevent use of such distances, silt curtains or other obstructions should be employed to protect mussel concentrations from dispersing sediments. Effectiveness of the distances indicated for protecting mussel habitats in the MKARNS is not known specifically, and should be evaluated during project implementation. Based on initial evaluations, standard distances should be enlarged if necessary.

Where it is not possible to avoid mussel concentrations (*e.g.*, where these are in close proximity to required dredging sites) the Corps should attempt relocation of mussels and restoration of habitats not threatened by the current project. These measures are needed to compensate for unavoidable losses. Because effectiveness of such measures can vary widely, their use should include provisions for monitoring and remedial efforts, to ensure that mitigation levels sought using these approaches are met. In most cases, the Service does not place a high priority on relocation of low mussel concentrations ("few" or "scattered" mussels). Instead, we believe that efforts would be better directed into mussel habitat restoration to compensate for impacts to low mussel occurrences.

The survey found that mussel resources vary widely across the breadth of the MKARNS. In general, the more downstream reaches of the system contain more and larger mussel concentrations, whereas upper reaches of the system contain fewer and smaller concentrations. Species richness and occurrence of particular species also ranged widely, with 11 of the 29 species found in the survey being detected in only one or two of the six surveyed reaches. This variation demonstrates a differing status of mussel resources in different parts of the MKARNS, which is relevant to conservation planning. Natural factors, including biogeographical distinctions, partly underlie the observed differences. Van der Schalie and Van der Schalie (1950) and Parmalee and Bogan (1998) both recognized an Ozarkian unionoid province, distinct from the surrounding Interior Basin province, based on presence of added, endemic taxa within a definable region. The Ozarkian province of those authors overlies the Arkansas River mainstem from southern Kansas into western Arkansas.

Accordingly, the Service believes it is not appropriate to treat mussel resources equally or interchangeably throughout the MKARNS. Surveyors found very limited mussel occurrences in the Verdigris River, for example, but recommended that any unionids found within that river be protected. The Verdigris River once constituted one of Oklahoma's most productive and diverse mussel streams (Isely 1914, 1925), and mussel habitats and communities remaining there probably are vital to sustaining a remnant of the historical fauna. In contrast, lower portions of the MKARNS likely could suffer loss of limited patches or beds without jeopardizing the status of their mussel fauna. As a result, the Service recommends that a higher resource value be placed on mussels in the Oklahoma portion of the project, based on relative scarcity. Impacts to all mussel patches and beds in Oklahoma should be avoided, minimized, and compensated to the extent practicable.

Suggested Revisions to the Draft Report

The review of past unionid studies on the Arkansas River and species of special status includes a few mostly minor errors. Most significant of these is the inclusion of *Lampsilis powellii*, the Arkansas fatmucket. This species is currently considered to occur in upper portions of the Saline and Ouachita rivers and the Caddo River (Gordon and Harris 1985, Harris et al. 1997). Several erroneous records of the species exist from the Arkansas River system, all or most based on specimens of *Lampsilis rafinesqueana*, the Neosho mucket. Lorraine Frierson described the latter species fairly recently (1927, 1928) compared to most mussel species, prior to which Neosho mucket specimens were assigned to *L. powellii*, first described in 1852. Gordon and Harris (1985) sorted out the confusion of records involving these species; their published interpretation has been followed by others.

The erroneous report of *Potamilus capax* from the Verdigris River was not Branson (1983) but Branson (1963), and the recovery plan questioning that record was USFWS (1989), not (1985). Branson (1984) described his and other Oklahoma records as erroneous. Branson reported *Quadrula cylindrica* from the Neosho and Verdigris rivers in his 1982 paper, not the 1984 paper. Other minor errors include citing Davidson (1997) as Davison (1997), Shepard and Covich (1982) as Shepard (1982), and Vaughn and Spooner (2004) as Vaughan and Spoooner (in press). These errors should be corrected.

The authors do not provide definitions for a mussel patch and a mussel bed. Please identify the differences used to distinguish between a patch and bed.

The report states, on page 28, that "407 samples were collected" from Reach Five on page 28. However, on page 29, the report states "that 21 species were collected in 417 samples within this reach." This inconsistency should be corrected.

The report states on page 30 that four mussel patches were found at Site 35. Table 3-37 identifies these areas as mussel beds. This inconsistency should be corrected.

Preliminary Mitigation Recommendations

The Service's overall conservation goal is to protect, conserve, and/or enhance important fish and wildlife resources. Our objective is to avoid or minimize habitat value losses, and where appropriate to mitigate/compensate for unavoidable resource losses.

The Service recommends the Corps consider the following preliminary mitigation ideas to avoid and minimize project impacts to freshwater mussels in Oklahoma.

1) A variety of additional surveys should be performed prior to project implementation. Certain project dredge sites, maintenance dredge sites, and aquatic disposal sites were not included in the initial surveys. Prior to finalizing project plans, many omitted sites should be surveyed where conditions indicate a reasonable probability for mussel concentrations to be present. Initial surveys identified many parameters useful for indicating probable mussel occurrences (*e.g.*, presence of certain substrates, vegetation, tributary mouths, bathymetry, etc.). In addition, large or incompletely surveyed mussel concentrations may require additional surveys for complete delineation. Alternative disposal sites selected to avoid impacts to known mussel patches/beds also should be surveyed. Should a bed or patch be located, mitigation features should be developed through interagency coordination to avoid, minimize or compensate impacts.
2) The single mussel bed and 6 of the 17 mussel patches located in the Oklahoma portion of the MKARNS would be impacted by the proposed channel deepening feature. Additionally, unionids were found in at least 50% of the samples in dredge areas DR-1 and DR-2. The Service recommends that the

3) Corps consider the preliminary mitigation measures provided in the following table to avoid and minimize impacts to freshwater mussel concentrations in Oklahoma.

Mussel Patch/Bed	Impact	Recommended Mitigation Measure
B33-1	The bed occurs within proposed dredged material disposal site OK336.4R-DI.	Do not use disposal site OK336.4R-DI. Dispose of dredged material planned for that location at proposed disposal area OK336.3L-DI (beach nourishment site) by expanding site OK336.3L-DI.
P35-1	The patch occurs within proposed dredged material disposal site OKSBC4.8L-DI.	Reduce the area of the proposed disposal site so that disposal would not occur within 100 meters of the mussel patch. Investigate the feasibility of a) increasing the amount of dredged material that would be disposed of at OKSBC6.6L-DI and OKSBC6.9L-DI; and b) disposing of dredged material at the smaller of the two islands located about 0.25 miles east of OKSBC4.8L-DI.
P35-2	The patch is primarily along the riverward edge of an island and extends into the channel where dredging is proposed.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P35-4	The patch occurs within 100 meters of a proposed dredge area.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P39-3	The patch occurs within 100 meters of a proposed dredge area.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P39-4	The patch occurs within 100 meters of a proposed dredge area.	Investigate the feasibility and effectiveness of employing silt curtains during dredging activity to minimize impacts.
P50-1	The patch occurs within a proposed dredge area.	Either a) temporarily relocate mussels to P49-2 (closest patch) utilizing holding cages and return to original site if suitable substrate remains after dredging; or b) permanently relocate mussels to P49-2 if suitable habitat/substrate would not remain at P50-1 after dredging activity.
DR-1	Unionids were found in 50% of samples collected from this proposed main channel dredge area.	Relocate mussels to P36-1(area which should not be impacted by the proposed project), or B33-1 (area which would not be impacted by the proposed project if the recommended mitigation measure for this site is implemented).
DR-2	Unionids were found in over 50% of samples collected from the proposed Sallisaw Creek dredge area.	Relocate mussels to P36-1(area which should not be impacted by the proposed project), or B33-1 (area which would not be impacted by the proposed project if the recommended mitigation measure for this site is implemented).

3) The Corps should work with the State of Oklahoma to designate Pool 15 as a mussel sanctuary due to the relative abundance of habitat conducive to mussel patches and beds in the area.
4) The draft report indicated that areas conducive for mussels were found throughout site 40; however, only a few mussels were located. We believe this may be due to the limited sampling effort dictated by time constraints. We recommend a more thorough investigation of disposal site OKOK367.2L-DI prior to project implementation.
5) Mussel habitat restoration projects should be implemented to compensate for impacts to areas of low mussel occurrences ("few" or "scattered" mussels). Candidate sites for mussel relocations or restoration of mussel habitat include the old river channel at NM 400 - 403 and in the Verdigris River upstream of NM 445 (Port of Catoosa). Additional surveying and evaluation is needed at these sites to assess current limiting factors and restoration potential.

The eventual effectiveness of many measures recommended by the Service to address mussel impacts cannot be predicted accurately at present. As a result, it will be important for the Corps to provide for short-term and long-term monitoring to verify levels of effectiveness achieved. Avoidance distances, shielding with silt curtains, relocation of mussels to new locations, and maintenance/restoration of mussel habitats all should be included in the monitoring programs. Monitoring results should be evaluated and where mitigation measures fall short, remedial steps should be taken to fulfill resource objectives.

The costs for wildlife resource mitigation measures should be cost-shared at rates for the purpose causing the loss, in accordance with section 906 (c) WRDA 1986, section 333 WRDA 1992, and section 2 (d) of the FWCA. Additionally, in accordance with sections 906 (a) (1) (A) and 906 (a) (1) (B) WRDA 1986, mitigation should be performed prior to or concurrent with project implementation.

We appreciate the opportunity to participate in this study during the planning phase, and look forward to further coordination. If you have any questions, please contact Richard Stark or David Martinez at 918-581-7458, extensions 240 and 228, respectively.

Sincerely,

Jerry J. Brabander
Field Supervisor

cc: Regional Director (ARD-ES), FWS, Albuquerque, NM (Attn: Dean Watkins)
Director, ODWC, Oklahoma City, OK (Attn: Fisheries and Natural Resources Section)
ODWC, Northeast Regional Office, Porter, OK (Attn: Mike Plunkett and Randy Hyler)
U.S. Army Corps of Engineers Planning and Environmental, Tulsa, OK (Attn: Sandra Stiles)
Director, ODEQ, Oklahoma City, OK (Attn: Water Quality Programs Division 0207)
Regional Administrator, Environmental Protection Agency, Dallas, TX (Attn: 6WQ-EM)
Field Supervisor, U. S. Fish and Wildlife Service, Conway, AR (Attn: Marge Harney)
Manager, Sequoyah National Wildlife Refuge, Vian, OK

References

Branson, B.A. 1963. New mollusk records from Oklahoma and their zoogeographical significance. Trans. Kansas Acad. Sci. 66(3):501-512.

Branson, B. A. 1982. The mussels (Unionacea:Bivalvia) of Oklahoma –Part 1: Ambleminae. Proceedings of the Oklahoma Academy of Sciences 62:38-45.

Branson, B. A. 1983. The mussels (Unionacea:Bivalvia) of Oklahoma –Part 2: The Unioninae, Pleurobemini and Anodontini. Proceedings of the Oklahoma Academy of Sciences 63:49-59.

Branson, B. A. 1984. The mussels (Unionacea:Bivalvia) of Oklahoma –Part 1: Lampsilini. Proceedings of the Oklahoma Academy of Sciences 64:20-36.

Davidson, C. L. 1997. Analysis of mussel beds in the Little Missouri and Saline Rivers, Blue Mountain, Ozark, and Dardanelle Lakes, Arkansas. Unpublished M. S. Thesis, Arkansas State University, 56pp.

Frierson, L.S. 1927. A classified and annotated check list of the North American naiads. Baylor Univ. Press, Waco, TX. 1-111.

Frierson, L.S. 1928. Illustrations of Unionidae. Nautilus 41(4):138-139.

Gordon, M.E. and J.L. Harris. 1985. Distribution of *Lampsilis powelli* (Lea) (Bivalvia: Unionacea). Nautilus 99(4):142-143.

Harris, J.L., P.J. Rust, A.C. Christian, W.R. Posey II, C.L. Davidson, and G.L. Harp. 1997. Revised status of rare and endangered Unionacea (Mollusca: Margaritiferidae, Unionidae) in Arkansas. J. Arkansas Acad. Sci. 51:66-89.

Isely, F.B. 1914. Mussel streams of eastern Oklahoma. U.S. Dept. Commerce, Bureau of Fisheries, Economic Circular (9):1-4.

Isely, F.B. 1925. The fresh-water mussel fauna of eastern Oklahoma. Proc. Oklahoma Acad. Sci. 4:43-118.

Parmalee, P.W. and A. E. Bogan. 1998. The freshwater mussels of Tennessee. University of Tennessee Press, Knoxville, TN. xii + 328 p.

Shepard, W. D., and A. P. Covich. 1982. The unionid fauna of Ft. Gibson Reservoir and the Grand (Neosho) River in Oklahoma: comments on a proposed increase in water level. Southwestern Naturalist 27:359-361.

Stansbery, D.H. and C.B. Stein. 1971. Why naiades (pearly freshwater mussels) should be preserved. Testimony before U.S. House of Representatives, Committee on Government Operation, 92nd Congress, First Session, 14 June 1971:2177-2179.

Strayer, D.L., N.F. Caraco, J.J. Cole, S. Findlay, and M.L. Pace. 1999. Transformation of freshwater ecosystems by bivalves. BioScience 49:19-27.

U. S. Fish and Wildlife Service. 1989. A recovery plan for the Fat Pocketbook Pearly Mussel *Potamilus capax* (Green 1832). USFWS. Atlanta, GA. 22pp.

Van der Schalie, H. and A. Van der Schalie. 1950. The mussels of the Mississippi River. Amer. Midl. Nat. 44(2):448-466.

Vaughn, C.C., K.B. Gido, and D.E. Spooner. 2004. Ecosystem processes performed by unionid mussels in stream mesocosms: Species roles and effects of abundance. Hydrobiologia 527(1)35-47.

Vaughn, C.C. and D.E. Spooner. 2004. Status of the mussel fauna of the Poteau River and implications for commercial harvest. Amer. Midl. Nat. 152(2):336-346.

Williams, J.D., M.L. Warren Jr., K.S. Cummings, J.L. Harris, and R.J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. Fisheries 18(9):6-22.