Biological Assessment

After-Action Webbers Falls Pool and Robert S. Kerr Pool Emergency Dredging and Open Water Disposal

Arkansas River Basin
Rogers, Wagoner, Cherokee, Muskogee, Haskell, Sequoyah, and Le Flore Counties,
Oklahoma

August 2021

Tulsa District
U.S. Army Corps of Engineers

Table of Contents

List of Figures

List of Tables

List of Attachments

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, TULSA DISTRICT
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AUGUST 30, 2021

OKESFO Online BA/BE Review Request

From: Amanda McGuire
U.S. Army Corps of Engineers
Regional Planning and Environmental Center
819 Taylor Street
Fort Worth, Texas 76102-0300

To: U.S. Fish and Wildlife Service
Oklahoma Ecological Services Field Office
9014 E. 21st St.
Tulsa, Oklahoma 74129

August 30, 2021

Re: Online Project Review Request
After-Action Biological Assessment for the Webbers Falls Pool and Robert S. Kerr Pool Emergency Dredging and Open Water Disposal

We have reviewed the referenced project using the Oklahoma Ecological Services Field Office's online project review process and have followed all guidance and instructions in completing the review. We completed our review on August 27, 2021 and are submitting our project review package in accordance with the instructions for further review.

Our proposed action consists of:
The Emergency Action Alternative included extensive dredging for an approximate total of 1.6 million cubic yards. The dredged material was placed in locations within 1,500 feet of dredging operations, with some variation depending on local conditions in the MKARNS and lake pools. The dredge and disposal areas are all located within USACE fee-owned property. The disposal areas have varying levels of environmental impact as dredged material was placed in existing disposal sites and other areas consisting of bottomland hardwood forest, emergent wetland, forested wetland, and open water habitats.

While some sediment disposal occurred in approved locations, others were not approved in any existing National Environmental Policy Act (NEPA) document. Due to implementation of the Emergency Action Alternative, compensatory mitigation will be required to compensate for the impacts to bottomland hardwood, emergent wetland, and forested wetland habitats. Mitigation is expected to occur on USACE fee-owned property. The preferred mitigation sites have also been evaluated for threatened and endangered species effect.

The location of the project and action area are identified on the enclosed map.

The emergency dredging and disposal was completed Spring 2021. The proposed mitigation is expected to begin construction in Fall 2022.

This project review is needed for a concurrence with USACE determinations. We are submitting a determination of “May Affect, and is Likely to Adversely Affect” for the northern long-eared bat (*Myotis septentrionalis)* and American burying beetle *(Nicrophorus americanus*). A determination of “May Affect, but is Not Likely to Adversely Affect” for Indiana bat (*Myotis sodalist)* and interior least tern *(Sterna antillarum)*. A determination of “No Effect” for gray bat (*Myotis grisescens*), Ozark big-eared bat (*Corynorhinus (=Plecotus) townsendii ingens),* piping plover *(Charadrius melodus),* red knot *(Calidris canutus rufa),* whooping crane *(Grus americana),* Ozark cave fish *(Amblyopsis rosae),* Neosho mucket *(Lampsilis rafinesqueana),* and rabbitsfoot *(Quadrula cylindrica cylindrica).*

The enclosed project review package provides the information about the species and critical habitat considered in our review, and the species conclusions table included in the package identifies our determinations for the resources that may be affected by the project.

For additional information, please contact Justyss Watson by phone at 817-886-1828 or by email at justyss.a.watson@usace.army.mil.

Sincerely,

Amanda McGuire

Amanda M. McGuire
Chief, Environmental Branch
Regional Planning and Environmental Center

Enclosure
Biological Assessment:
Species Conclusion Table
IPaC Species List and Action Area Map
Additional Maps
Project and Mitigation Area Photos
Oklahoma Natural Heritage Inventory Occurrences
Unionid Mussel Survey
2016 Final Biological Opinion

Executive Summary

The Regional Planning and Environmental Center of the U.S. Army Corps of Engineers (USACE) has prepared an Environmental Assessment (EA) analyzing the potential environmental impacts resulting from the dredging and disposal of sediment, otherwise known as the Emergency Action, from the Arkansas River into Waters of the U.S. (Arkansas River), emergent wetland, forested wetland, and bottomland hardwood forest habitat. In concurrence with the EA, this Biological Assessment (BA) has been prepared to evaluate the impacts of the Emergency Action on Federally listed threatened and endangered species. The submission of the BA will be completed in accordance with Section 7 of the Endangered Species Act (ESA) of 1973.

The Emergency Action included extensive dredging for an approximate total of 1.6 million cubic yards (cys). The dredged material was placed in locations within 1,500 feet of dredging operations, with some variation depending on local conditions in the MKARNS and pools. The dredge and disposal areas are all located within USACE fee-owned property. The disposal areas have varying levels of environmental impact because they were placed in existing disposal sites, bottomland hardwood forest, emergent wetland, forested wetland, and open water habitats. The areas that were previously bottomland hardwood forest, emergent wetland, forested wetland, and open water habitat were not approved in any existing National Environmental Policy Act document for USACE; therefore, the disposal within these habitat types is the focus of evaluation. Some of the open water disposal sites in Webbers Falls Pool and Robert S. Kerr Pool extend above the water, increasing the area and volume of sediment above the normal pool elevation.

Because these actions were implemented without prior environmental compliance, compensatory mitigation to the standards of 33 Code of Federal Regulations 332 is required to replace the habitats impacted by the Emergency Action. Upon completion of mitigation, permanent five-line barbed wire security fencing would be constructed around the newly created mitigation sites. Although the action has already occurred, the compensatory mitigation will account for the proposed conservation measures listed below:

- Habitat Mitigation,
- Best Management Practices,
- Avoidance, and
- Island Maintenance.

“No effect” is expected for gray bat (*Myotis grisescens*), Ozark big-eared bat (*Corynorhinus townsendii*), piping plover (*Charadrius melodus*), red knot (*Calidris canutus*), whooping crane (*Grus americana*), Ozark cave fish (*Amblyopsis rosae),* Neosho mucket (*Lampsilis rafinesqueana*), and rabbitsfoot (*Quadrula cylindrica*). These species are not expected to have utilized the open water, emergent wetland, forested wetland, or bottomland hardwood habitat adversely affected by the Emergency Action. In addition, these species are not likely to occur or be impacted within the proposed mitigation sites that will be constructed.

A “May Affect, but is Not Likely to Adversely Affect” determination is expected for Indiana bat (*Myotis sodalist*) and interior least tern (ILT) (*Sterna antillarum athalassos*). It is understood by USACE that the ILT was delisted on January 12, 2021. However, some actions associated with the emergency dredging and disposal occurred before the ILT delisting date; therefore, the ILT has been assessed in accordance with the ESA.

A “May Affect, and is Likely to Adversely Affect” determination is expected for northern long-eared bat (*Myotis septentrionalis*) and American burying beetle (*Nicrophorus americanus*).

Section 1. Description of the Action

The purpose of this Biological Assessment (BA) is to address the effect of the emergency dredging and disposal on the McClellan-Kerr Arkansas River Navigation System (MKARNS), otherwise known as the Emergency Action, on Section 7 of the Endangered Species Act (ESA) of 1973 listed species, listed as threatened or endangered under the ESA or their designated critical habitat. The development of the Arkansas River for navigation, flood control, hydroelectric power generation, and other purposes; was authorized by the Rivers and Harbors Act (RHA) of July 24, 1946. The U.S. Army Corps of Engineers (USACE) Tulsa District (SWT) has carried out the action above under 40 Code of Federal Regulations (CFR) 1506.12, which provides guidance for alternative arrangements for National Environmental Policy Act (NEPA) compliance. The USACE will implement habitat mitigation in association with the Emergency Action.

1.1. Project Description

The Emergency Action included extensive dredging in the locations shown in Table 1 for an approximate total of 1.6 million cubic yards (cys). The dredged material was placed in locations within 1,500 feet of dredging operations, with some variation depending on local conditions in the MKARNS and pools. See Attachment A – Project and Mitigation Area Maps for detailed dredging and disposal areas, as well as the proposed mitigation areas. The dredge and disposal areas are all located within USACE fee-owned property. The disposal areas have varying levels of environmental impact because they were placed in existing disposal sites, bottomland hardwood forest, emergent wetland, forested wetland, and open water habitats. The areas that were previously bottomland hardwood forest, emergent wetland, forested wetland, and open water habitat were not approved in any existing NEPA document for SWT; therefore, the disposal at within these habitat types are the focus of evaluation.

Selection of dredging equipment and method used to perform the dredging, as described in Engineering Manual M1110-2-5025 “Engineering and Design – Dredging and Dredged Material Disposal”, depends on the following factors:

- Physical characteristics of material to be dredged,
- Quantities of material to be dredged,
- Dredging depth,
- Distance to disposal area,
- Physical environment of the dredging and disposal areas,
- Contamination level of sediments,
- Method of disposal,
- Production required,
- Type of dredges available, and
- Cost.

The project used hydraulic dredging to remove loosely compacted sediment materials from the navigation channel. Hydraulic dredges remove and transport sediment in liquid slurry form. They are barge mounted and carry diesel or electric-powered centrifugal pumps with discharge pipes ranging from 6 to 48 inches in diameter. The pump produces a vacuum on its intake side, and atmospheric pressure forces water and sediments through the suction pipe. The slurry was transported by pipeline to a disposal area (see Figure 1). Pipeline dredges are commonly used for open water disposal adjacent to channels. Material from this dredging operation consists of a slurry with a solids concentration ranging from a few grams per liter to several hundred grams per liter (USACE, 2018).

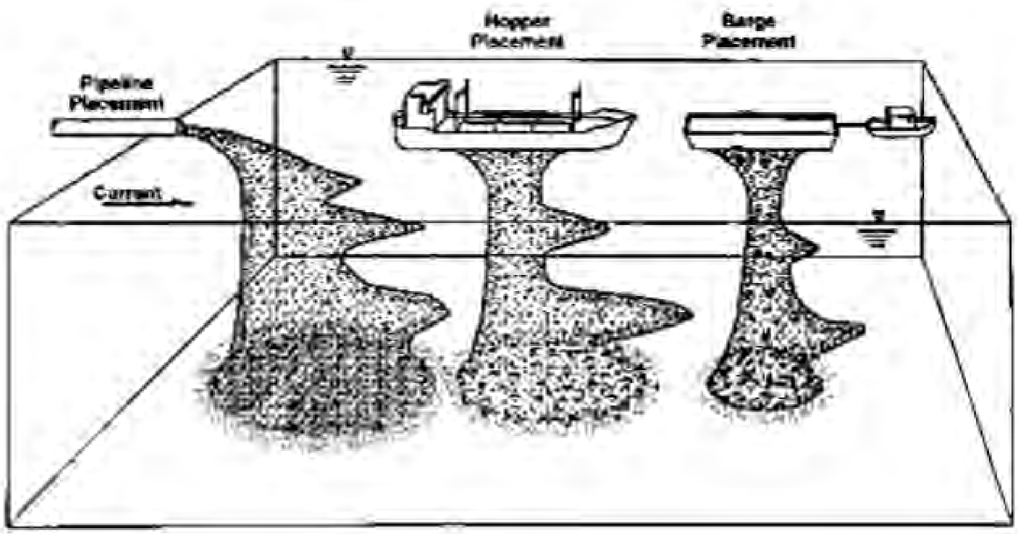

Figure 1. Plume Shape by Dredge Type

Table 1. Sediment Dredge and National Environmental Policy Act Approved and Unapproved Disposal Locations

Location	Arkansas River Navigation Mile	Cubic Yards Dredged	Disposal Location	Acres Impacted by Disposal	NEPA Approved Disposal Location
Sandtown Bottom	346-349	778,330	Open Water	97.7	No
			Emergent Wetland	16.4	No
Below Lock 16	366	70,322	Bottomland Hardwood Forest	10	No
Spaniard Creek	375	110,635	Open Water	146	No
Salt Creek	380	259,322	Open Water	1.3	No
			Emergent Wetland	7.4	No
			Forested Wetland	2.4	No
Stoney Point	355	76,444	Open Water	4.9	No
			Emergent Wetland	7.6	No
San Bois Creek	6.5 - 8	161,639	Open Water	30	No
Kerr Lake (RM 343)	343	55,586	Open Water	8.3	No
Three Forks	394.5 – 395	23,578	Disposal Site 16B	14.6	Yes
RM 400	400	13,875	Disposal Site 16A-1	14	Yes
Below Lock 18	421	35,688	Disposal Site 17A	30.3	Yes
Above Lock 18	422 – 422.5	37,367	Disposal Site 18C	11.6	Yes
Catoosa	445	14,525	Disposal Site 18B	11.5	Yes
Below Lock 14	319	21,578	Disposal Site 13A	1.5	Yes

In total, there were 10 acres of bottomland hardwood, 2.4 acres of forested wetland, 31.4 acres of emergent wetland, and 288.2 acres of open water habitat impacted by the Emergency Action. Because this action was used to address the sedimentation of the MKARNS, many adverse impacts were unavoidable.

Due to the disposal of sediment within emergent wetlands, forested wetlands, and bottomland hardwood forest; compensatory mitigation will be required and enacted in accordance with Section 404 of the Clean Water Act (CWA) and Section 10 of the River and Harbors Act. The mitigation standard for this project falls under 33 CFR § 332. Mitigation associated with this project will be evaluated alongside the Emergency Action within this BA.

In coordination with SWT Regulatory Office (RO), Table 2 displays the ratios required to compensate the adverse impacts as well as the resulting acres required to mitigate the action.

Table 2. Habitat Type, Acres Impacted, Ratio, and Required Mitigation Acreage Associated with the Emergency Action Alternative

Habitat Type	Impacted Acres	Mitigation Ratio	Required Mitigation Acres	Mitigation Method
Bottomland Hardwood	10	1.5:1	15	Creation
Forested Wetland	2.4	4.5:1	10.8	Creation
Emergent Wetland	31.4	2.5:1	78.5	Creation
Open Water	288.2	1:1	288.2	Self-Mitigating

The objective of the bottomland hardwood and wetland mitigation is to create a minimum of 15 acres of bottomland hardwood forest, 10.8 acres of forested wetland, and 78.5 acres of emergent wetland habitat in areas that would not be adversely impacted by creation of habitat and would be self-sustaining upon completion of mandatory monitoring and adaptive management guidelines. The mitigation sites included as part of this project are owned in fee by USACE and are currently used for agricultural practices such as haying and grazing, leaving them devoid of significant vegetation. However, the sites show appropriate characteristics for emergent wetland, forested wetland, and bottomland hardwood forest based on their topography and soils.

The objectives of SWT Operations Division to compensate the loss of bottomland hardwood and wetland habitat are listed below:

- Establish native plant communities for wildlife
    - Bottomland hardwood - Planting of herbaceous vegetation, shrubs, and trees
    - Forested Wetland - Planting of emergent wetland vegetation along with shrubs and trees
    - Emergent wetland - Planting of emergent wetland vegetation
- Develop and maintain hydrologic characteristics for created habitats

Some of the open water disposal sites in Webbers Falls Pool and Robert S. Kerr Pool extend above the water, increasing the area and volume of sediment above the normal pool elevation. It is assumed by USACE that the open water impacts as described above are self-mitigating; therefore, mitigation of open water will not occur as part of this project.

It was determined by USACE that the Emergency Action was the most practicable alternative compared to no action alternative, because it met the overall purpose and need of the project. However, it is understood there are still major adverse impacts to wetlands and Waters of the U.S. resulting from the Emergency Action.

1.1.1. Location

For the purposes of this BA, the discussion of "action area" will refer to an estimated boundary around the entirety of the MKARNS within Oklahoma state limits. The action area includes any areas associated with dredge work approved in past NEPA documents, as well as the Webbers Falls Pool and Robert S. Kerr Pool.

The refined "project area" is limited to discussions regarding dredging and disposal sites and areas proposed for mitigation work within USACE fee property. Essentially, the action area will be used to discuss overall conditions of the MKARNS while the project areas are used to evaluate on-site impacts from implementation of the Emergency Action and mitigation.

The action area geographically encompasses the MKARNS from the Port of Catoosa near Tulsa, Oklahoma to near the Arkansas state-boundary near Fort Smith (Figure 2).

Most project impacts discussed in the BA will be focused on the Webbers Falls Pool and the Robert S. Kerr Pool. The impacts to wetland, bottomland hardwood forest, and open water disposal are focused within the two pools mentioned above and are the areas that were not approved or addressed in the *Arkansas River Navigation Study Feasibility Report and Environmental Impact Statement (EIS) August 2005,* otherwise known in this document as the 2005 Arkansas River Navigation Study (USACE, 2005).

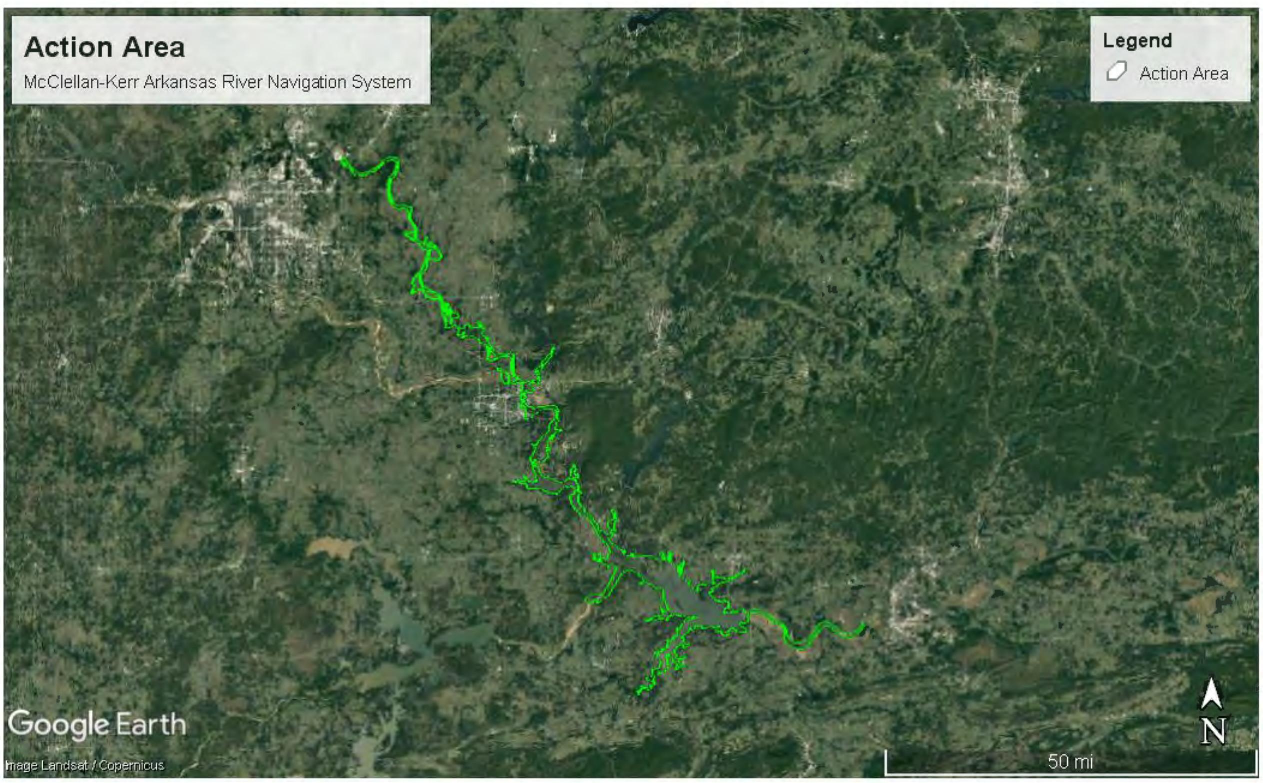

Figure 2. MKARNS Action Area

The overall Emergency Action focuses on the emergency dredging and disposal; however, consideration has also been given to those areas that will be impacted by environmental mitigation construction (described in Section 1.1.5). It should be noted that all areas evaluated for threatened and endangered species are included in Attachment A – Project and Mitigation Area Maps.

1.1.2. Description of Project Habitat

The MKARNS contains a diverse array of aquatic environments including major rivers and their tributaries, lakes, cutoffs, and wetlands that result in diverse habitats that support a variety of aquatic flora and fauna. Important riverine elements within the action area include the Arkansas River and its associated side channels, dikes, revetments, locks, dams, navigation pools, cutoffs, backwaters, and tributary mouths. Additionally, several major tributaries to the MKARNS have been impounded to create reservoirs that are managed to support recreational game fish populations, as well as shallow water habitats for fish, migratory waterfowl, and other aquatic biota.

The Arkansas River maintains a continuous turbid appearance due to sand and suspended silt. The water is slightly saline due to large, natural salt beds in Oklahoma and Kansas that the Arkansas River traverses. The aquatic resources within the MKARNS have undergone changes since the creation of the navigation channel. Prior to construction of the MKARNS, the Arkansas River was reported to fluctuate from very low flows to very high flows. During periods of low flow, sandbars occupied most of the riverbed. High-flow periods flooded riverbanks and adjacent low-lying areas, exposing new habitat, and providing additional food sources for aquatic species. High flows during pre-MKARNS construction were also important in maintaining the river's hydrological connection to various oxbow lakes.

After the completion of the MKARNS's impoundments, river flows stabilized and formed large pools, which increased surface water, deep water and backwater acreage. Consequently, the aquatic habitats of the system were altered. These changes increased available habitat for some species while decreasing habitat for others.

The MKARNS consists of a navigation channel with loose sand substrate, and channel borders that range from steep riprapped banks to extensive shallow mud flats. Most unionid beds or patches were primarily found in substrate consisting of a sand, silt, and clay mixture. This substrate mixture typically occurred as a transition zone between the clay, silt, or riprapped banks, islands, or dikes and the sand channel. This habitat was most frequently associated with a gently sloping shelf between two steeper slopes at depths of greater than 10 meters or gently sloping banks near islands, dikes, and river banks less than one meter deep.

The two primary forest communities in the action area are the bottomland hardwood forest community along the Arkansas River and the upland forest community. The bottomland hardwood forest community occurs within the floodplain of the Arkansas River or in riparian areas immediately adjacent to small streams. The dominant bottomland hardwood trees include cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), pecan (*Carya illinoensis*), box elder (*Acer negundo*), river birch (*Betula nigra*), black willow (*Salix nigra*), silver maple (*Acer saccharinum*), black walnut (*Juglans nigra*), sugarberry (*Celtis laevigata*), water oak (*Quercus nigra*), overcup oak (*Quercus lyrata*), and willow oak (*Quercus phellos*). Bald cypress (*Taxoidium distichum*) is also common.

The upland forest community on moist areas, generally on east facing or north facing slopes, is dominated by white oak (*Quercus alba*), black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), southern red oak (*Quercus falcata*), black gum (*Nyssa sylvatica*), and red maple (*Acer rubrum*). Flowering dogwood (*Cornus florida*), redbud (*Cercis canadensis*), ironwood (*Carpinus caroliniana*), pawpaw (*Asimina triloba*), basswood (*Tilia americana*), spice bush (*Lindera benzoin*), and red mulberry (*Morus rubra*) are typical understory species found on moist slopes.

The upland forest community in the action area exists on dry areas, usually the tops of high ridges, south facing slopes, and/or west facing slopes, and is characterized by generally slow growing species that are adapted to dry conditions and poor soils. This forest community, called the Cross Timbers, is a complex mosaic of upland forest, savanna, and glade that forms the broad ecotone between the eastern deciduous forests and the grasslands of the southern Great Plains. The presettlement Cross Timbers are believed to have covered over 30,000 square miles, extending from central Texas across Oklahoma into southeastern Kansas. The short, stout oaks of the Cross Timbers were not ideal for lumber production, so the original trees have often survived on steep terrain that was unsuitable for farming. Thousands of ancient post oak can still be found in eastern Oklahoma, and the Cross Timbers is one of the least disturbed forest types left in the eastern United States.

Cross Timbers overstory species include post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), eastern red cedar (*Juniperus virginiana*), black hickory (*Carya texana*), pignut hickory (*Carya ovalis*), bitternut hickory (*Carya cordiformis*), and shortleaf pine (*Pinus echinata*). Carolina buckthorn (*Rhamnus caroliniana*), rusty blackhaw (*Viburnum rufidulum*), winged elm (*Ulmus alata*), buckbrush (*Symphoricarpos orbiculatus*), and farkleberry (*Vaccinium arboreum*) are typical understory species adapted to dry conditions within the action area.

Fields that are not routinely maintained through mowing, burning, or disking are dominated by old field communities that consist of perennial grasses, forbs, and early successional woody species. Typical old field vegetation includes blackberry (*Rubus* spp.*),* Johnsongrass (*Sorghum halepense*), winged sumac (*Rhus copallina*), smooth sumac (*Rhus glabra*), eastern red cedar (*Juniperus virginiana*), winged elm, persimmon (*Diospyros virginiana*), mockernut hickory (*Carya tomentosa*), bitternut hickory (*Carya cordiformis*), sassafras (*Sassafras albidium*), and sweetgum (*Liquidambar styraciflua*). Frequently mowed areas are dominated by cool season grasses such as Kentucky bluegrass (*Poa pratensis*), tall fescue (*Festuca arundinacea*), and warm weather grass such as Bermuda grass (*Cynodon dactylon*).

Wetlands are present throughout the action area. They are primarily scattered across the floodplain of the Arkansas River valley. The USACE and U.S. Environmental Protection Agency (EPA) jointly define wetlands as: areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. A variety of wetland types are shown in Figure 3 and Figure 4. However, this mapping system is only an estimate and required field verification. On January 25th and 27th 2021, USACE personnel accessed the Emergency Action project areas to assess the impacts caused by the sediment disposal. The site visit confirmed that emergent wetlands, forested wetlands, and open water habitats were impacted by the Emergency Action.

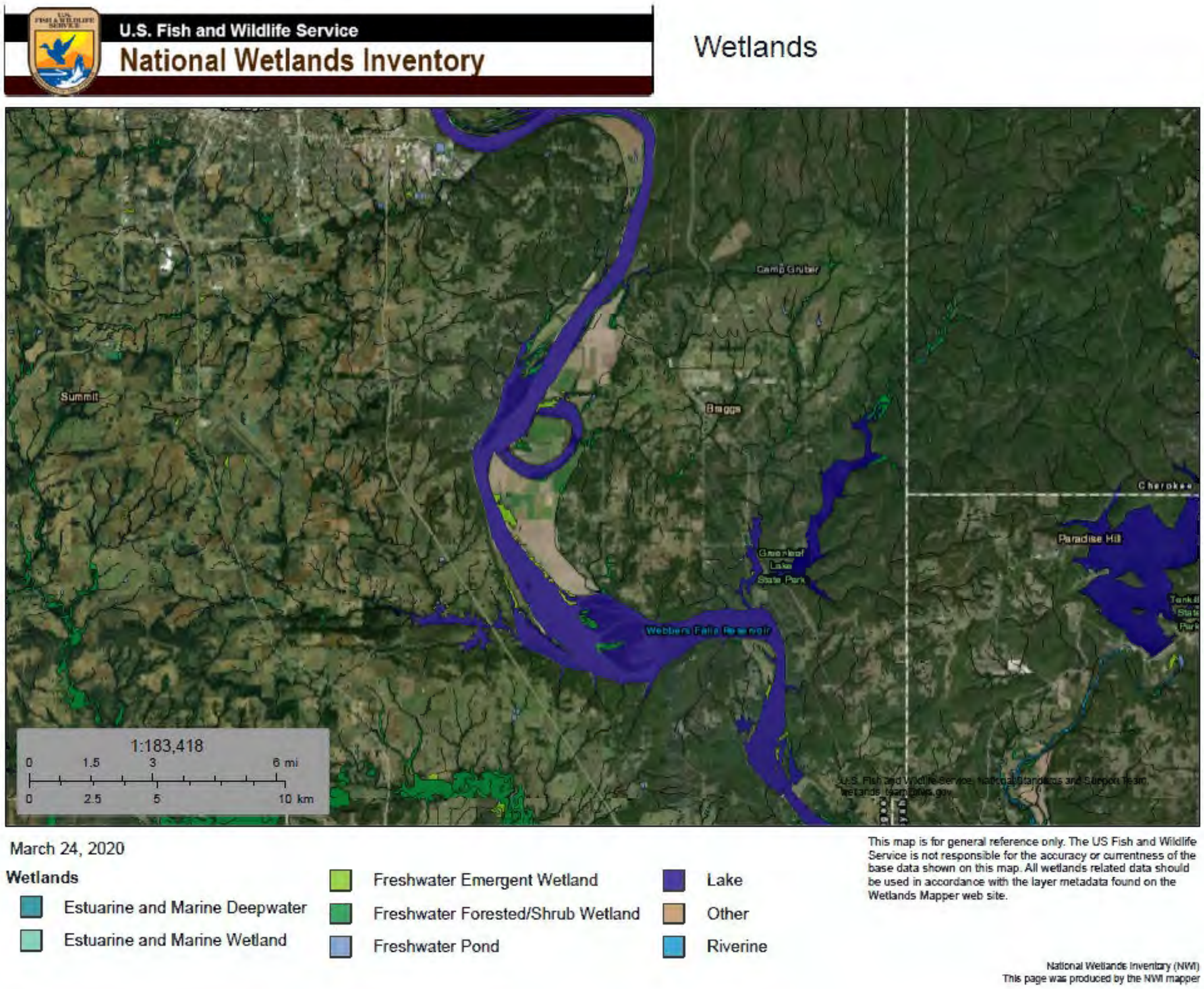

Figure 3. Wetland Types within the Action Area

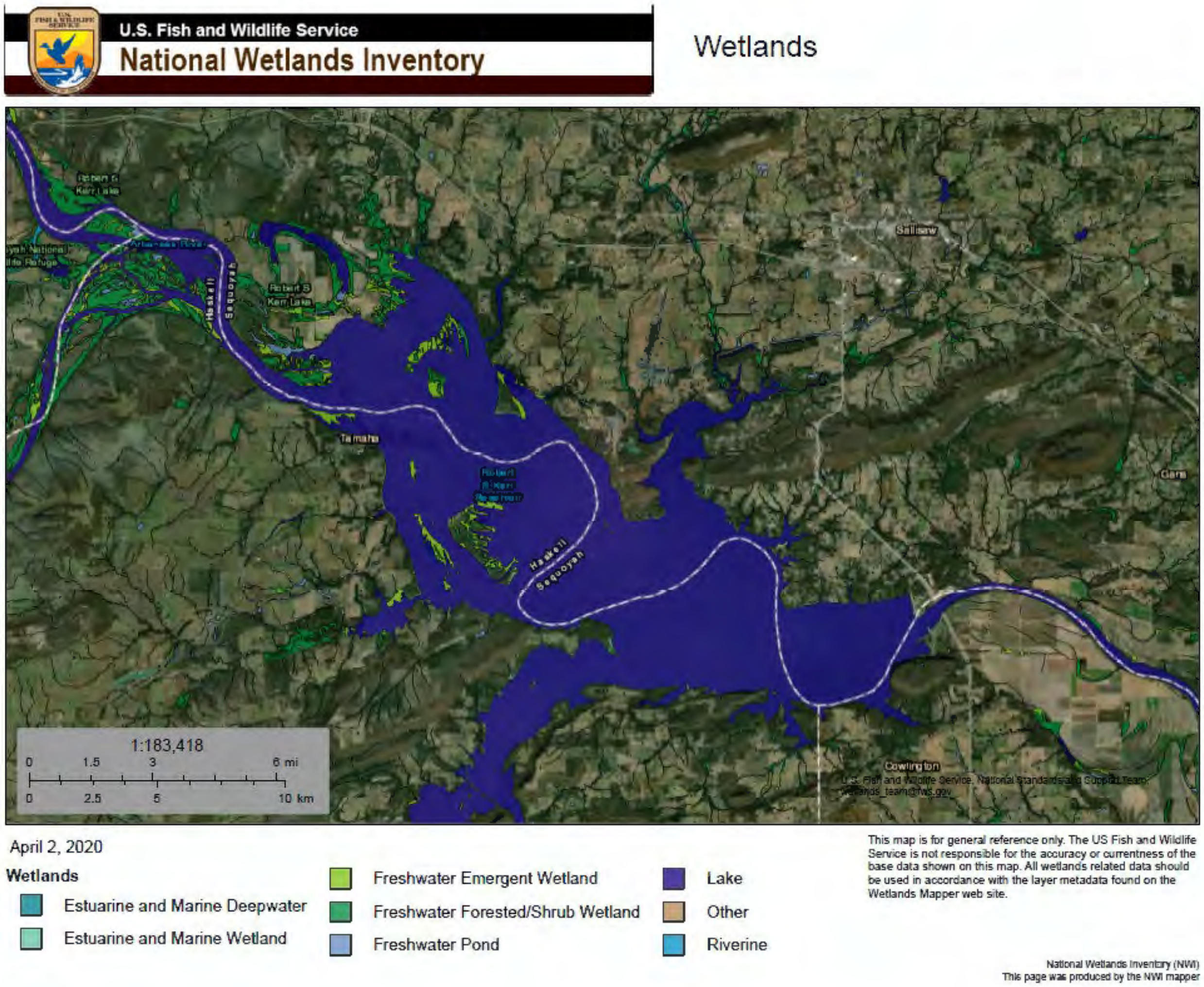

Figure 4. Wetland Types within the Action Area

The National Wetland Inventory (NWI) (2020) was primarily used to identify wetlands in the impacted project area as displayed in the figures above. The survey confirms and indicates a portion of the project areas are wetlands. The NWI maps convey a variety of riverine, lacustrine, and palustrine wetlands exist in the action area. The palustrine system includes forested, emergent, scrub-shrub, and aquatic bed classes. The riverine system includes lower perennial and intermittent subsystems as well as open water, streambed, unconsolidated bottom, and unconsolidated shore classes. The lacustrine system includes limnetic and littoral subsystems as well as open water, unconsolidated shore, unconsolidated bottom, and aquatic bed classes. Water regimes include temporarily flooded, seasonally flooded, semi-permanently flooded, intermittently exposed, and permanently flooded.

Broad floodplains along the Oklahoma portion of the MKARNS support bottomland forests of elm (*Ulmus spp*.), oak, hackberry (*Celtis occidentalis*), cottonwood and sycamore. The forest floor is heavily shaded, allowing for limited understory development. In poorly drained sites, sedges (*Carex spp*.), willows (*Salix spp*.) and buttonbush (*Cephalanthus occidentalis*) form thickets along wetland edges. These wetlands are typically found on the backside of broad stable flood plains. Sediment loading is limited to large flood events. Surface water accumulation is from both riverbank flooding and runoff from adjacent uplands.

At lower river elevations, wetlands consist of emergent herbaceous wetlands and forested wetlands characterized by rooted, herbaceous hydrophytes that typically grow in flooded soils. Emergent wetlands are found along the edge of the Arkansas River.

Emergent wetlands provide food and shelter for fish and wildlife species, including macroinvertebrates, which make up the foundation of the aquatic food chain, and habitat for various amphibians, reptiles, birds, and insects. Frogs and salamanders use emergent wetlands for breeding grounds and egg laying. Ducks and migratory birds use them for resting areas on migration routes and for nesting. Abundant aquatic insects provide a food source for fish, aquatic invertebrates, amphibians, reptiles, and birds, and break down organic material present in riverine and riparian wetland areas. Since these wetland communities are found in lower elevations, or are associated with more permanent open water habitats, they have been the most susceptible to disruptive and unnatural flow regimes resulting from the construction and operation of the lock and dam system within the MKARNS. Emergent wetland vegetative species within the project areas included cattail (*Typha spp*.), smartweed (*Polygonum spp*.), nutsedge (*Cyperus spp*.), soft rush (*Juncus effusus*), and other unidentified rushes.

Forested wetlands are open, occasionally flooded areas dominated by shrub and hardwood saplings mixed with emergent herbaceous vegetation. These wetland communities are found at elevations slightly above emergent wetland communities and adjacent to riverbanks where less frequent inundation by flows and reduced scour allows shrub and sapling strata to establish. Forested wetland tree species include American sycamore, elm, green ash, and black willow. Emergent wetland vegetation within the forested wetland habitats included soft rush, and shrubby species like buttonbush.

1.1.3. Project Proponent Information

The requesting agency and lead agency is the Department of Defense, U.S. Army Corps of Engineers, Tulsa District.

The point of contact is Justyss Watson; 819 Taylor Street Room 3A12, Fort Worth, Texas 76102; email Justyss.a.watson@usace.army.mil; phone number (817) 886-1828.

1.1.4. Project Purpose

Record rainfall in May and June 2019 in southern and southeastern Kansas and in northeastern Oklahoma caused approximately 15 USACE reservoirs in the Upper Arkansas River Basin, Verdigris River Basin, and Grand (Neosho) River Basin (all within Tulsa District), to fill to or exceed the top floodpool elevation. While Tulsa District worked diligently to lessen the effects of flooding downstream, significant and in some cases catastrophic flooding was unavoidable.

River flows, measured in cubic feet per second (cfs), were overwhelming within large portions of the river system. Below Keystone Dam, west of Tulsa, Oklahoma, the rate of river flow approached 300,000 cfs at its maximum volume. Approximately 50 miles southeast of Tulsa, Oklahoma on the Arkansas River below Muskogee, Oklahoma -

downstream from the Arkansas River confluence with the Verdigris River and the Grand (Neosho) River at the location known locally as "Three Forks" - the flow eclipsed 600,000 cfs in volume.

The Arkansas River within the Webbers Falls Pool, at a sustained volume of well over 600,000 cfs over a duration of more than a week, was carrying an enormous volume of sediment which was eroded from the three upstream feeder river basins and was passed through upstream dams and into the Navigation System, where much of it was subsequently deposited.

On May 23, 2019 two fully-loaded barges moored in Muskogee, Oklahoma tore loose and were carried downstream, where they collided with Webbers Falls Pool Lock and Dam 16 and sunk. After sinking the barges were forced against three of the structure's gates which had been fully open for the high river flow; because the two barges impeded the operation of the gates, those gates could not be closed. Removal of the barges/operation of the Webbers Falls gates was dependent on the emergency dredging action, specifically the portion within the Robert S. Kerr Pool. A tow barge was required to perform the extraction of the barges at Webbers Falls Lock and Dam 16, and the tow barge had to travel the channel upstream from Arkansas through the Robert S. Kerr Pool. The inability for vessels to safely navigate also delayed the removal of the barges. The barges were removed in 2019, but the impacts of the subsequent water draw-down as a result of their placement were significant. However, it is the opinion of USACE, that the water draw-down and subsequent impacts were not a result of the Federal emergency actions and therefore, will not be evaluated within this BA.

The sediment prohibited the safe passage of barge and similar size draft vessels between Robert S. Kerr Pool Lock and Dam and Webbers Falls Pool Lock and Dam 16. The purpose of the Emergency Action was to remove the sediment impounded as a result of the May and June 2019 floods.

1.1.5. Project Type and Deconstruction

This assessment is evaluating a multi-faceted project. The overall project type is dredging within the MKARNS and subsequent disposal of sediments in either NEPA approved or unapproved locations. For the purposes of this report, only those actions involving disposal in unauthorized locations will be accounted for in species determinations when referring to sediment disposal. Dredging is a regular occurrence within the MKARNS and has already been evaluated by the 2005 Arkansas River Navigation Study Feasibility Report and EIS; therefore, it is assumed by USACE that these impacts have occurred in the past and will have little to no effect on threatened and endangered species that has not already been covered under the 2016 Programmatic Biological Opinion (Attachment F) (USFWS, 2016a).

The timing and duration of sediment disposal varies for each location. However, it can be assumed that discharge occurred throughout the fall and winter of 2019, the entirety of 2020, and early 2021. It should be noted that multiple locations required separate dredging cuts, so the list below will reflect separate begin and end dates.

- Sandtown Bottom: Open Water and Emergent Wetland
    - August 2, 2019 to September 30, 2019
    - October 3, 2019 to October 24, 2019
    - October 28, 2019 to November 20, 2019
    - November 25, 2019 to December 8, 2019
    - December 10, 2019 to December 19, 2019
    - November 13, 2020 to December 22, 2020
- Below Lock 16: Bottomland Hardwood Forest
    - September 6, 2019 to October 1, 2019
    - October 11, 2020 to October 15, 2020
- Spaniard Creek: Open Water
    - October 21, 2019 to January 13, 2020
    - September 6, 2020 to October 3, 2020
- Salt Creek: Open Water, Emergent Wetland, and Forested Wetland
    - February 1, 2020 to March 7, 2020
- Stoney Point: Open Water and Emergent Wetland
    - October 21, 2020 to November 9, 2020
- San Bois Creek: Open Water
    - January 31, 2021 to April 21, 2021
- Kerr Lake: Open Water
    - January 21, 2021 to January 24, 2021
- Three Forks: Disposal Site 16B
    - March 13, 2020 to March 25, 2020
    - August 17, 2020 to August 28, 2020
- RM 400: Disposal Site 16A-1
    - March 29, 2020 to May 20, 2020
- Below Lock 18: Disposal Site 17A
    - June 9, 2020 to June 27, 2020
- Above Lock 18: Disposal Site 18C
    - July 1, 2020 to July 17, 2020
    - July 20, 2020 to July 24, 2020

- Catoosa: Disposal Site 18B
    - July 30, 2020 to August 9, 2020
- Below Lock 14: Disposal Site 18B
    - February 25, 2021 to March 10, 2021

1.1.5.1. Project Maps

Project maps can be found in Attachment A – Project and Mitigation Area Maps

1.1.5.2. In-Stream Dredging

This activity start date began August 2019 and ended March 2021. There are several locations associated with this activity, which are displayed in Attachment A – Project and Mitigation Area Maps. The Arkansas river miles associated with dredge are described in Table 1. It should be noted that dredging within the MKARNS has been evaluated in the past and is adequately described in the 2005 Arkansas River Navigation Feasibility Study and the 2012 Biological Assessment and 2016 Programmatic Biological Opinion (Attachment E and F).

The stressors for this activity include:

- Aquatic Features
    - Change in channel morphology
    - Increase in streamflow
- Environmental Quality Feature
    - Change in water temperature
    - Increase in water turbidity
- Landform (Topographic) Features
    - Change in topography
- Environmental Processes
    - Increase in erosion
    - Increase in sedimentation rates
- Human Activities
    - Increase in noise

1.1.5.3. Tree Removal

This activity began in June 2019 and concluded in July 2019. This action occurred along the eastern boundary of Muskogee County adjacent to Webbers Falls Pool Lock 16.

Approximately 10 acres were cleared of bottomland hardwood forest habitat. Tree species were approximately 10 to 20 inches diameter at breast height (DBH) in size and ranged between cottonwood, oak, and American sycamore. It is assumed because this site has already be adversely impacted by clearing, it will not be restored and will be permanently affected by the current and future sediment resulting from dredge.

The stressors for this activity include:

- Plant Features
  - Decrease in vegetation
  - Increase in fuel load
  - Increase in invasive plant species (native and non-native)
- Soil and Sediment
  - Increase in dust
  - Increase in soil compaction
- Human Activities
  - Increase in noise
  - Increase in soil disturbance

1.1.5.4. Dispose of Soils/Sediments

This activity start date began August 2019 and ended March 2021. There are several locations associated with this activity, which are displayed in Attachment A – Project and Mitigation Area Maps.

Disposal of sediment occurred in a variety of locations, as shown in Table 1. The unapproved disposal occurred in the Webbers Falls Pool and Robert S. Kerr Pool in Muskogee, Haskell, and Sequoyah Counties, Oklahoma (Table 3).

Table 3. Unapproved Disposal Locations and Habitat Types Impacted

Location	Habitat Type	Acres Impacted by Disposal
Sandtown Bottom	Open Water	97.7
	Emergent Wetland	16.4
Below Lock 16	Bottomland Hardwood Forest	10
Spaniard Creek	Open Water	146
Salt Creek	Open Water	1.3
	Emergent Wetland	7.4
	Forested Wetland	2.4
Stoney Point	Open Water	4.9
	Emergent Wetland	7.6
San Bois Creek	Open Water	30
Kerr Lake (RM 343)	Open Water	8.3

The stressors for this activity include:

- Plant Features
    - Decrease in vegetation
    - Increase in invasive plant species (native and non-native)
- Environmental Quality Features
    - Increase in water turbidity
- Landform (Topographic) Features
    - Change in topography
- Soils and Sediment
    - Increase in dust
    - Increase in soil compaction
- Environmental Processes
    - Increase in sedimentation rates
    - Increase in surface runoff
- Human Activities
    - Increase in noise
    - Increase in soil disturbance

1.1.5.5. Excavation, Grading, and Contouring

This activity is expected to occur with implementation of the mitigation plan. There are several locations associated with this activity, which are displayed in Attachment A – Project and Mitigation Area Maps. This activity is expected to promote development of low-lying areas for emergent and forested wetland habitat, which will lead to beneficial effects for Federally listed threatened and endangered species.

The stressors for excavation, grading, and contouring include:

- Plant Features
    - Decrease in vegetation
    - Increase in invasive plant species (native and non-native)
- Landform (Topographic) Features
    - Change in topography
- Soils and Sediment
    - Increase in dust
    - Increase in soil compaction
- Environmental Processes
    - Increase in surface runoff
- Human Activities
    - Increase in noise
    - Increase in soil disturbance

1.1.5.6. Installation of Permanent Fence

This activity is expected to occur with implementation of the mitigation plan. There are several locations associated with this activity, which are displayed in Attachment A – Project and Mitigation Area Maps. Although this activity will not directly beneficially affect Federally listed threatened and endangered species; it will indirectly beneficially affect those species by protecting the habitat mitigation areas described in Section 1.2.1.

The stressors for permanent fence installation include:

- Plant Features
    - Decrease in vegetation
- Soil and Sediment
    - Temporary increase in dust
    - Increase in soil compaction
- Human Activities
    - Temporary increase in noise
    - Increase in soil disturbance

1.1.6. Anticipated Environmental Stressors

This section describes the anticipated effects of the project on the aspects of the land, air, and water that have occurred due to the activities above. These are based on the activity deconstructions done in the previous section and will be used to inform the action area.

1.1.6.1. Animal and Plant Features

Individuals from the Animalia kingdom, such as raptors, mollusks, and fish. This feature also includes byproducts and remains of animals (e.g., carrion, feathers, scat, etc.), and animal-related structures (e.g., dens, nests, hibernacula, etc.).

Individuals from the Plantae kingdom, such as trees, shrubs, herbs, grasses, ferns, and mosses. This feature also includes products of plants (e.g., nectar, flowers, seeds, etc.).

<u>Decrease in Vegetation</u>

The decrease in vegetation regarding tree removal was conducted on 10 acres of USACE fee-owned property 0.5 miles downstream of Webbers Falls Pool Lock 16 (also known as Below Lock 16). This vegetation was cleared to accommodate the disposal of dredge from Arkansas River Navigation Mile 366. Stressor location is associated with the bottomland hardwood disposal area depicted on page MKARNS-EA-07 of Attachment A – Project and Mitigation Area Maps.

There was a decrease in vegetation on 31.4 acres of emergent wetland and 2.4 acres of forested wetland habitat. Decrease in vegetation in these habitats resulted from smothering or covering of plants by sediment disposal. This stressor would occur in those areas as depicted in Attachment A – Project and Mitigation Area Maps.

There will be a temporary decrease in vegetation within mitigation sites proposed, shown in Attachment A – Project and Mitigation Area Maps. It is expected that any grading and contouring would remove the top layer of soil and vegetation. Upon completion of any required earthwork at mitigation sites, native vegetation would be planted on bare areas to create new emergent and forested wetland and bottomland hardwood forest habitats.

Increase in Fuel Load

Fuel loading will increase with tree clearing. Tree clearing could potentially leave dead shrubs and trees within an area. Some cleared vegetation was left on site; however, most was either removed or covered with sand and sediment. It is not expected that there was a major increase in fuel load as a result of this stressor.

Stressor location is associated with the bottomland hardwood disposal area depicted in on page MKARNS-EA-07 of Attachment A – Project and Mitigation Area Maps.

No increase in fuel load within mitigation areas is expected to occur because large-scale vegetation removal will not be required.

Increase in Invasive Plant Species

Decrease in vegetation can lead to an increased rate of invasive species spread due to open areas. Increase in invasive plant species could occur in any wetland or bottomland hardwood forest habitats impacted by disposal of soil/sediment and tree clearing. In addition, spread of invasive species in the project area would occur due to natural occurrences such as wind and animal movement.

The decrease in vegetation regarding disposal of soils/sediments has the potential to occur on 31.4 acres of emergent wetland, 2.4 acres of forested wetland, and 10 acres of bottomland hardwood habitat. This stressor would occur in all areas depicted as disposal sites in Attachment A – Project and Mitigation Area Maps.

There will be a temporary decrease in vegetation within mitigation sites proposed, shown in Attachment A – Project and Mitigation Area Maps. It is expected that any grading and contouring would remove the top layer of soil and vegetation. Upon completion of any required earthwork at mitigation sites, native vegetation would be planted on bare areas to create new emergent and forested wetland and bottomland hardwood forest habitats. Invasive species are likely to inundate recently cleared areas; however, invasive species management will be a key element in the proposed mitigation work. Therefore, it can be expected that an increase of invasive plants species at the proposed mitigation sites would be negligible.

1.1.6.2. Aquatic Features

Bodies of water on the landscape, such as streams, rivers, ponds, wetlands, etc., and their physical characteristics (e.g., depth, current, etc.). This feature includes the groundwater and its characteristics.

Change in Channel Morphology

Sediment disposal within the Arkansas River is likely to have caused changes in channel morphology. Excessive sediment deposition can alter and degrade riverine and wetland habitats. It is expected that a channel morphology change would occur as a result of sediment settling between aquatic habitats such as vegetation, debris, root mats, rocky crevices, deep pools, etc. This can result in decreased cover, foraging, breeding, and spawning habitat for fish and other aquatic life. This stressor would occur in all areas depicted as open water or wetland disposal sites in Attachment A – Project and Mitigation Area Maps.

Changes in channel morphology are not expected to occur within the proposed mitigation sites because they will not be located within the Arkansas River channel.

1.1.6.3. Chemicals/Contaminants

Substances that pollute, spoil, or poison the environment (e.g., herbicides, heavy metals, oil, etc.).

Increase in Contaminants

The USACE has performed a “screening” level analysis of MKARNS sediment quality in support of both future O&M dredging needs (maintenance of nine foot channel) as well as impact assessment for channel deepening proposals described in the 2005 Arkansas River Navigation Study EIS. In general, constituents were reported at low detection frequencies and concentrations throughout the sampled Oklahoma portion of the MKARNS. The final result of the analysis is included in the 2005 Arkansas River Navigation Study EIS. It has been assumed that any sediment traveling downstream already existed within the MKARNS; therefore, new sediment testing was not conducted before dredging and disposal actions occurred.

Increases in contaminants are not expected to occur within the proposed mitigation sites and will be minimized through the use of Best Management Practices (BMPs) during construction.

1.1.6.4. Environmental Quality Features

Abiotic attributes of the landscape (e.g., temperature, moisture, slope, aspect, etc.).

Increase in Water Turbidity

An increase in suspended particulates and the concomitant turbidity levels is expected to have occurred during dredging and placement operations of material removed from the navigation channel. This stressor would have occurred in all areas not associated with a land-based disposal location or Below Lock 16.

Increases in water turbidity are not expected to occur within the proposed mitigation sites.

Change in Water Temperature

Water temperature changes can occur with increased sediment suspension and turbidity. Turbid waters can block natural sunlight and reduce the growth ability of aquatic vegetation, which can lead to changes in water temperature through decreased light and increased dissolved oxygen. Changes in water temperature are expected to have occurred within aquatic disposal sites.

Change in water temperature is not expected to occur within the proposed mitigation sites.

1.1.6.5. Landform (Topographic) Features

Topographic (landform) features that typically occur naturally on the landscape (e.g., cliffs, terraces, ridges, etc.). This feature does not include aquatic landscape features or man-made structures.

<u>Change in Topography</u>

Sediment disposal at Below Lock 16 created an overall change in topography. Dredged materials were pumped into the site. Some sediments were used to create a less than one-acre berm to avoid additional discharges or release from the action area.

Grading and contouring will be required at some of the proposed mitigation sites to create more suitable conditions for emergent and forested wetland vegetation. The changes will result in more low-lying areas that are able to hold more water, which will benefit emergent wetland vegetation growth.

1.1.6.6. Soil and Sediment

The topmost layer of earth on the landscape and its components (e.g., rock, sand, gravel, silt, etc.). This feature includes the physical characteristics of soil, such as depth, compaction, etc..

<u>Increase in Dust</u>

Tree removal is likely to have led to a temporary localized increase in dust within the action area at Below Lock 16.

An increase in dust may occur as a result of grading and contouring and installation of permanent fencing; however, it is assumed USACE will implement BMPs to reduce the overall impacts of dust on air quality.

<u>Increase in Soil Compaction</u>

Soil compaction is likely to have occurred during vegetation removal at Below Lock 16. Soil compaction would have been limited to the 10 acres of disturbance and the uppermost layer of soil in the action area.

Soil compaction may occur during construction of the mitigation sites through the use of heavy machinery for activities involving grading and contouring. Soil compaction regarding mitigation would be limited to the proposed mitigation areas.

1.1.6.7. Environmental Processes

Abiotic processes that occur in the natural environment (e.g., erosion, precipitation, flood frequency, photoperiod, etc.).

<u>Increase in Erosion</u>

The movement of material within the channel may lead to increased erosion around open water areas. Changes in channel morphology and decreased vegetation can alter streamflow. Even if the effect is minor, it is still likely to occur over time.

Increase in Sedimentation Rates

Sediment disposed within open water habitat is likely to move downstream over time, which would lead to increased rates of sedimentation throughout the Arkansas River. However, it should be noted that this sediment was already in the river due to the 2019 flooding and was relocated from one location within the river to another.

1.1.6.8. Human Activities

Human actions in the environment (e.g., fishing, hunting, farming, walking, etc.).

Increase in Noise

Noise within the project areas is expected to have occurred. However, any noise associated with dredging and disposal is a common occurrence within the MKARNS due to the regularly scheduled work and abundance of large watercraft utilizing the channel.

The increase in noise for vegetation removal at Below Lock 16 was temporary, between June and July of 2019, and localized.

Best Management Practices can be used to decrease impacts from noise. Any work conducted for the mitigation sites will follow all local, state, and Federal regulations. No nighttime work is expected to occur when constructing the proposed compensatory mitigation areas.

1.2. Conservation Measures

The conservation measures listed below will be enacted after-the-fact for the dredging and disposal work, along with the construction of wetland and bottomland hardwood forest habitat for compensatory mitigation.

1.2.1. Habitat Mitigation

The mitigation sites will be designed to improve a minimum of 78.5 acres of emergent wetland, 10.8 acres of forested wetland, and 15 acres of bottomland hardwood forest habitat by introducing native vegetation, managing exotic invasive or nuisance species, creating microtopography appropriate for wetlands, and diversifying vertical stratification through herbaceous vegetation, shrubs, and trees upon the conclusion of grading and fencing.

Stressors: Decrease in Vegetation and Increase in Invasive Plant Species.

1.2.2. Best Management Practices

The work associated with the emergency action has already occurred, so it is too late to implement BMPs. However, construction of habitat mitigation sites described above will require BMPs to ensure there will not be adverse impacts resulting from mitigation work.

Any development near Waters of the U.S. would require a site-specific Spill Prevention Plan during construction, which would include use of BMPs such as proper storage, handling, and emergency preparedness, reducing the risk of contamination.

The use of BMPs such as keeping equipment in good operating condition, proper training, and providing appropriate health and safety equipment would minimize the potential noise impacts associated with the project.

All fences to be removed will be dilapidated internal or boundary fences. All wire will be removed and disposed off Federal property or placed in roll off containers for recycling. Any wires grown over by trees will be cut where the wires enter and exit the tree and removed. Wires running into the ground will be pulled up as much as possible and cut below ground level.

All posts to be removed will be pulled up or cut off at ground level.. Any wooden posts with attached wire, or metal posts must be disposed of properly off Federal property. If sources for recycling are available, any metal post and/or wire removed must be recycled.

Any wooden post that shows evidence of bird nesting cavities will not be removed, but all attached wire will be cut and removed as close to the post as possible. Fence posts will be marked if there are any possible bird nesting sites along the proposed replaced fence lines.

All debris, trash, and other foreign material resulting from permanent fence installation operation shall be removed from the job sites. All work areas shall be cleaned and bladed level upon completion of the job tasks.

Stressors: Decrease in Vegetation, Increase in Fuel Load, Increase in Invasive Plant Species, Increase in Contaminants, Increase in Dust, Increase in Soil Compaction, Increase in Erosion, Increase in Sedimentation Rates, and Increase in Noise.

1.2.3. Avoidance

The work associated with the Emergency Action has occurred, so avoidance is impossible. However, the proposed mitigation efforts call for creation of emergent wetland, forested wetland, and bottomland hardwood forest habitats. Trees will always be avoided when practicable during construction. If tree removal cannot be avoided, USACE will follow phasing of activities to occur outside of the migratory bird nesting season and threatened and endangered bat summer roosting season. This conservation measure can be enacted by scheduling any necessary vegetation removal outside of the peak bird breeding and bat roosting season to the maximum extent practicable. However, tree removal is not expected to occur as a result of compensatory mitigation.

Stressors: Decrease in Vegetation, Increase in Fuel Load, Increase in Invasive Plant Species, Increase in Dust, Increase in Soil Compaction, Increase in Erosion, and Increase in Noise.

1.2.4. Island Maintenance

Although interior least tern (ILT) (*Sterna antillarum athalassos)* were delisted on January 12, 2021 due to recovery, they were a Federally listed as endangered at the time of the project. To ensure continued species' success, Stoney Point and Sandtown

Bottom disposal sites will be treated as they have in the past to promote ILT nesting habitat.

Stressors: Not Applicable

1.3. Prior Consultation History

The USFWS (2020 and 2021) Information for Planning and Consultation (IPaC) Official Species List was used to identify Federally listed species that may occur within the action area (Consultation Code: 02EKOK00-2021-SLI-07).

During informal consultation in 2020 and 2021, USACE and USFWS identified potential impacts to Federally threatened and endangered species, specifically the American burying beetle (ABB) (*Nicrophorus americanus*), Indiana bat (*Myotis sodalis*), Northern long-eared bat (NLEB) (*Myotis septentrionalis*), and ILT.

Due to the immediate need to conduct work for the Emergency Action, avoidance and minimization measures were not thoroughly enacted for ABB and NLEB. Interior least tern were considered during the placement of dredge materials. It is assumed that USACE will utilize the existing ABB and NLEB "Incidental Take" permits as described in the 2016 Biological Opinion.

1.3.1. Other Agency Partners and Interested Parties

Oklahoma Department of Wildlife Conservation has been consulted and will participate in a review of the Draft EA upon its release to the public. Don Groom, e-mail address: don.groom@odwc.ok.gov, is the point of contact for the review.

The DEQ has been consulted and Elena Jigoulina, e-mail address: elena.jigoulina@deq.ok.gov, is the point of contact for review of the CWA Section 404(b)(1) Analysis.

1.3.2. Other Reports and Helpful Information

Photos taken during the site visit at each action area and proposed mitigation site can be found in Attachment B – Project and Mitigation Area Photos.

A list of the Federally listed threatened and endangered species included in this project area can be found in Attachment C – Oklahoma Ecological Office Threatened and Endangered Species List (USFWS, 2021a).

Information regarding the Oklahoma Natural Heritage Inventory (OHNI) for Federally listed threatened and endangered species can be found in Attachment D – Oklahoma Natural Heritage Inventory Occurrences.

An Ecological Specialist, Inc. Unionid Mussel Survey on the McClellan-Kerr Arkansas River Navigation System can be found in Attachment E. This document describes the mussel surveys conducted in regard to the 2005 Arkansas River Navigation Feasibility Study EIS and the likely locations and presence of mussels within the MKARNS.

The Final Biological Opinion for the Programmatic Biological Opinion for operating multipurpose projects on the Red River, Arkansas River, Petit Jean River, and the Canadian River from Eufaula Lake to the Arkansas River confluence and all of the

McClellan-Kerr Arkansas River Navigation System within the Tulsa and Little Rock Corps Districts (2016) can be found in Attachment F of this document. The Final Biological Opinion describes actions associated with the MKARNS and the "Incidental Take" permits that USACE will be assuming use of regarding the Emergency Action and subsequent habitat mitigation.

Section 2. Species Effect Analysis

This section describes, species by species, the effects of the action on listed, proposed, and candidate species, and the habitat on which they depend. In this document, effects are broken down as direct interactions (something happening directly to the species) or indirect interactions (something happening to the environment on which a species depends that could then result in effects to the species). These interactions encompass effects that occur both during project construction and those which could be ongoing after the project is finished. All effects, however, should be considered, including effects from direct and indirect interactions and cumulative effects.

2.1. Gray Bat

The gray bat (*Myotis grisescens*) is a medium-sized bat with a wingspan of 10 to 11 inches. It has grayish-brown fur and is the only bat in its range with uni-colored dorsal hairs. The fur is usually gray in color but may be chestnut brown or russet. Other bats within its range have bi-colored or tri-colored dorsal hairs. The wing membrane of the gray bat connects at the ankle instead of the base of the first toe as in other members of the genus (USFWS, 2011a).

The distribution of the gray bat is limited to areas of the southeastern United States containing limestone caves. Major populations are located in Alabama, Arkansas, Kentucky, Missouri, and Tennessee. In Oklahoma, this species is known to occur in four counties in the northeastern part of the state and include Adair, Cherokee, Delaware, and Ottawa; however, the bats may occur in other counties (Mayes, Muskogee, Sequoyah, and Wagoner) but there have been no recent confirmed sightings (USFWS, 2011a).

Prior to the 2003 Biological Assessment, USACE personnel responsible for inspection of the dams and associated structures surveyed for the occurrence of bats for all the projects associated with the proposed action areas. In Oklahoma, bats were reported to occur at only Keystone and Tenkiller lakes. The replies from the projects surveyed in Arkansas along the MKARNS were negative with one exception; a single pipistrelle species was found at the Dardanelle Powerhouse. The USACE Tulsa District personnel conducted research on the big brown bat, Eptesicus fuscus, at Keystone Dam over a 3-year period (2004 – 2006); during the research, no other bat species were observed or captured from the dam (Perry, 2008).

Gray bat roosts almost exclusively in caves year-round and have very specific requirements. However, there are some reports of colonies using storm sewers and mines as roosts. Winter caves must be cold, deep, and with vertical walls. This species is very temperature sensitive; winter roosts must range in temperature between 42 degrees (º) Fahrenheit (F) and 52 ºF.

Summer caves must be warm (57 ºF – 77 ºF) or contain tightly restricted rooms that can trap the body heat of the roosting bats. Summer caves are usually located close to rivers and lake shorelines which are near the bats' feeding areas. Bats are known to range up to 12 miles from their colonies to feed (USFWS, 2011a).

The only habitat containing suitable limestone caves for this species within nearby USACE fee-owned property for Oklahoma, and within the range of this species, include the shoreline areas around Grand Lake, Markham Ferry Lake, Tenkiller Ferry Lake, and Fort Gibson Lake.

Very little, if any, suitable habitat containing caves is present for this species within the action areas. Due to the feeding range and foraging habits of this species it could use the shorelines of the MKARNS and associated lakes for feeding areas.

It is assumed there would be No Effect to gray bats as a result of the Emergency Action. The dredge and disposal of sediment into wetlands and open water habitats would have no effect on their roosting sites. In addition, the tree removal that occurred at Below Lock 16 would have negligible effects on their feeding patterns. There are no caves associated with any of the work conducted for the Emergency Action and mitigation, and any vegetation that was removed would not have been associated with nesting, brooding, or hibernacula for gray bat; therefore, it can be assumed these mobile species would have left the area upon implementation of the 10 acres of tree removal. Any direct, indirect, or cumulative effects from the tree removal would have no effect.

2.2. Indiana Bat

The Indiana bat is a medium-sized bat with a dull gray to chestnut colored fur dorsally, and pinkish white underparts. The basal portion of the hairs of the back are a dull gray color (USFWS, 2011d).

2.2.1. Status of the Species

2.2.1.1. Legal Status

The primary reasons for decline of the Indiana bat are considered to be commercialization of roosting caves, disturbances of hibernacula caves from spelunkers or vandals, poisoning from pesticides, periodic flooding of winter caves, cave or mine ceiling collapses, and loss of habitat due to channelization of streams (USFWS, 2011d).

White-Nose Syndrome (WNS) has become a major wildlife health concern for the population of bats since its emergence in 2006 (USFWS, 2011e). The WNS disease, caused by the fungus (*Geomyces destructans*) is estimated to have caused bat population declines that are as high as 97 percent (%) in some areas (USGS, 2011). *G. destructans* has been detected in the cave myotis (*Myotis velifer*) in Oklahoma and in the endangered gray bat in Missouri (USFWS, 2012a; USGS, 2011).

The Indiana bat was listed as endangered by the Service under the Endangered Species Preservation Act of October 15, 1966 on March 11, 1967 (32 FR 4001). Eleven caves and two mines in six states are designated as critical habitat: Illinois, Indiana, Kentucky, Missouri, Tennessee, and West Virginia (USFWS, 2007).

2.2.1.2. Recovery Plans

Available recovery plans for the Indiana bat can be found on the USFWS Environmental Conservation Online System (ECOS) species profile.

2.2.1.3. Life History Information

The Indiana bat is found primarily in the midwestern and eastern United States. The largest populations are in Arkansas, Indiana, Kentucky, Missouri, and Tennessee; eastern Oklahoma represents the western limit of its range. The bat's present range in Oklahoma includes Adair, Delaware, LeFlore, and Pushmataha counties (USFWS, 2011d). In Oklahoma, of the counties listed, the action area only extends through LeFlore counties (USFWS, 2011b). Although portions of Grand Lake and Markham Ferry Lake are located within the range of this species and probably contain suitable habitat for this species, these reservoirs were constructed and operated by the Grand River Dam Authority and are outside the purview of this BA.

Prior to the 2003 BA, USACE personnel responsible for inspection of the dams and associated structures surveyed for the occurrence of bats for all the projects associated with the action areas. In Oklahoma, bats were reported to occur at only Keystone, Eufaula, and Tenkiller lakes. Tulsa District personnel conducted research on the big brown bat (*Eptesicus fuscus)*, at Keystone Dam over a 3-year period (2004 – 2006); during the research, no other bat species were observed or captured from the dam (Perry, 2008).

The Indiana bat is migratory with approximately 85% of the entire known population hibernating in just seven caves (USFWS, 2011d). If the Indiana bat utilizes any of the action area, it would probably be as a summer resident. After the winter hibernation period, the colonies would disperse to summer areas, which are usually located along streams where the bats forage for flying insects.

Habitat requirements are similar to the gray bat in that they need limestone caves for hibernation, and caves with pools are preferred. They require stable temperatures from 39 ºF to 46 º F and 66 to 95% humidity. Because of these requirements, this species is highly selective of hibernacula. Low cave temperatures allow the bats to maintain a low metabolic rate throughout hibernation. Consequently, only a small percentage of caves meet the specific conditions required by Indiana bats. Maternity sites are in trees. During the summer months, they can be found under bridges, in old buildings, under tree bark, or in hollow trees generally associated with streams (USFWS, 2011d).

Identified Resource Needs

Table 4. Identified Resource Needs for Indiana Bat (USFWS 2007)

Resource Need	Metric
Hibernacula	Cool and humid caves or mines with stable temperatures, under 50°F but above freezing
	Near hibernacula

Forested Areas for Foraging and Roosting (Connectivity)	Trees with exfoliating bark and/or vertical crevices, typically use various pines (*Pinus* spp.), sycamore, ash, elm, hickory, maple, poplar, and oak.
	Average diameter between 16 to 24 inches. Average height between 52 to 85 feet tall.
	Tree-lined paths devoid of large openings for migration and foraging

2.2.1.4. Conservation Needs

The USFWS 2007 *Indiana Bat (Myotis sodalis) Draft Recovery Plan: Final Revision* indicates that the limiting factors on success of the species are the number of years over which bats are able to produce offspring; annual productivity; and survival of young to a reproductive age. Indiana bats need efficient access to high-quality foraging sites to maximize energy regulation throughout the year, as well as good conditions for effective thermoregulation to promote energy conservation in the bats. The availability of hibernacula and forest roosting sites is key throughout the range of the species (USFWS, 2007).

The availability of foraging habitat such as forests, streams and ponds, and riparian corridors are essential for the overall survival of the Indiana bat. Habitat connectivity allows superior movement of this species, which can maximize foraging success and energy conservation while traveling between summer foraging habitats and roosting areas (USFWS, 2007).

The Recovery Plan for Indiana bat states that project evaluations should include several considerations while considering the life history strategy of the Indiana bat:

- Significance of disruptions to roosting areas, hibernacula and summer colonies,
- Availability of hibernation habitat, and
- Connectivity of roosting/foraging sites and migration corridors and conservation of these areas.

2.2.2. Environmental Baseline

The environmental baseline describes the species' health within the action area only at the time of the consultation and does not include the effects of the action under review. Unlike the species information provided above, the environmental baseline is at the scale of the Action area.

2.2.2.1. Species Presence and Use

It is unlikely the species would use the action areas. The 2007 Recovery Plan suggests the extent of the Indiana bat range is focused within the Ozark-Central, Midwest, Appalachian Mountains, and Northeast recovery units. Although a small portion of the action area occurs within the Ozark-Central recovery unit; it is minimal and did not include any action areas that would have adversely affected the Indiana bat.

The tree clearing site, which included bottomland hardwood habitat with trees between 10 and 20 inches DBH, would be the most likely site to host Indiana bats. Both male and females are known to utilize narrow cracks within trees or the openings beneath exfoliating bark. This area had occurrences of various oak, cottonwood, and sycamore species that could potentially accommodate summer roosts due to their peeling or shaggy bark (USFWS, 2007).

2.2.2.2. Species Conservation Needs within the Action Area

The vegetation removal action area is not included in the conservation needs of the Indiana bat. Muskogee County is not located within the recovery unit and it is expected that the Indiana bat would not have occurred within the Below Lock 16 site in the summer of 2019. There is no record of Indiana bat using Muskogee County for summer roosting habitat; therefore, there are no species conservation needs within the action area.

2.2.2.3. Habitat Condition

Potential roosting habitat is the conservation need most affected by the Emergency Action. This area consisted of oaks, cottonwoods, and sycamores between 10 and 20 inches DBH. Other small trees and vines inundated nearby areas and an abundance of leaf litter was distributed upon the forest floor. The Below Lock 16 site is directly adjacent to the Arkansas River and had the potential to provide habitat connectivity between roosting and foraging sites. Nearby foraging sites could include habitats prevalent with flying terrestrial insects, while wetlands would have provided the need for emerged aquatic flying insects. It should be noted there is an abundance of this habitat type throughout the USACE fee-owned property. In addition, this site is located directly adjacent to the Webbers Falls Pool Lock and Dam 16 which experiences an abundance in noise and disruption. This site was also directly adjacent to an existing approved disposal area, which has been regularly utilized by SWT.

2.2.2.4. Influences

There are five factors associated with the Indiana bat that puts them in danger of becoming extinct under the ESA of 1973 (USFWS, 2007).

- Present or threatened destruction, modification, or curtailment of its habitat or range,
- Overutilization for commercial, recreational, scientific, or educational purposes,
- Disease or predation,
- Inadequacy of existing regulatory mechanisms, and
- Other natural or man-made factors affecting its continued existence.

The Indiana bat is not known to occur within the counties associated with sediment disposal or tree clearing. The USACE assumes there are no major influences within the project areas that would affect the production, numbers, or distribution of this species.

2.2.2.5. Additional Baseline Information

Species specific surveys were not conducted for this study. However, the recovery plan does not indicate presence of Indiana bat within Muskogee County. To supplement this datum, the Oklahoma Natural Heritage Inventory (OHNI) does not have any recorded sightings or individuals or hibernaculum in Muskogee County, see Attachment D – Oklahoma Natural Heritage Inventory Occurrences.

2.2.3. Effects of the Action

This section considers and discusses all effects on the listed species that are caused by the Emergency Action and are reasonably certain to occur, including the effects of other activities that would not have occurred but for the Emergency Action.

2.2.3.1. Indirect Interactions

Table 5. Indirect Interactions on Indiana Bat

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
Hibernacula	None	None	*No individuals will be affected.* No known hibernacula exist within the action areas.	*No individuals will be affected*
Forested Areas for Foraging and Roosting (Connectivity)	Decrease in vegetation	Habitat Mitigation	*No individuals will be affected.* The impact to 10 acres of bottomland hardwood forests along the Arkansas River would have an adverse effect on habitat connectivity. The reduction of available habitats amplifies the number of gaps within forests, creating stress on species dependent upon connectivity between foraging and migration areas. However, due to the small size of the tree removal at Below Lock 16 effects to foraging and connectivity are expected to be negligible.	*No individuals will be affected* Indiana bat could have utilized trees removed during construction; however, their presence is not expected within the action areas.

2.2.3.2. Direct Interactions

Direct impacts associated with tree removal at Below Lock 16 include crushing, displacement, and injury. No conservation measures for Indiana bat were in place at the time of the action. Although the habitat within the action area would be suitable for Indiana bat; no presence is assumed due to the location of the action area. The action area that required tree removal does not fall within a recorded county for summer roosting sites or the specified recovery units. Therefore, it is assumed there were no individuals directly impacted as a result of the Emergency Action.

2.2.4. Cumulative Effects

Cumulative effects are effects resulting from future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation.

Climate change, in combination with drought cycles, is likely to exacerbate existing threats to all species within the southwestern United States.

The Oklahoma Department of Transportation (ODOT) is proposing an MKARNS Mooring Modernization Project. This project will allow the replacement of existing structures that were not designed for extreme flood events, enhance harbor safety by eliminating damage to infrastructure due to loose barges, and expand the capacity for vessels within the waterway and prepare ports for increased freight demand within the MKARNS (ODOT, 2020). The project is expected to be completed in 2027.

2.2.5. Discussion and Conclusion

Determination: "May Affect, but is Not Likely to Adversely Affect "

The Indiana bat is not likely to have occurred within the tree removal site at Below Lock 16. This site is located in Muskogee County, Oklahoma which is outside of the range of USFWS Recovery Unit boundaries for the species' summer habitat. Hibernacula located outside of these units have not had an Indiana bat on record for over 50 years (USFWS, 2007). In addition, Muskogee County is not known to be within the recorded summer habitat of the Indiana bat range. The tree clearing at Below Lock 16 occurred in July 2019 and although there were direct adverse impacts to habitats that could have been potentially utilized by Indiana bat for foraging, USACE does not expect this species to occupy the area at the time of the action.

2.3. Northern Long-eared Bat

The NLEB is approximately three to 3.7 inches long with an average wingspan of nine to 10 inches. They will normally have medium to dark brown fur on their back with pale brown on their underside. This bat has relatively long ears, as compared to other species within the same genus (USFWS, 2015a).

2.3.1. Status of the Species

2.3.1.1. Legal Status

The NLEB is Federally listed as threatened wherever it is found. It was Federally listed in 2015 following studies that revealed a decline in populations from the spread of WNS. The NLEB is found across much of the eastern and north central U.S., occurring in 37 states. The impact from the spread of WNS has been greatest in populations occurring in the northeastern U.S. where it is estimated that approximately 99% of the population has been affected. Currently, WNS is known to occur in 25 of the 37 states where Northern long-eared bats occur and is expected to spread to the remaining states (USFWS, 2016b).

2.3.1.2. Recovery Plans

There is not an available recovery plan for NLEB.

2.3.1.3. Life History Information

The NLEB has a wide range, encompassing forested habitats in the summer and caves and mines (hibernacula) in the winter for hibernation. This species can use other habitats with similar conditions to caves and mines. White-nose syndrome is the most prominent threat to this species and has led to an extreme decline in NLEB population, sometimes exterminating up to 90 to 100% of a colony. There is no cure for WNS, so it is assumed there will be continual impacts from this disease to NLEB (USFWS, 2016b).

They are able to use a variety of forests and woodlands in the summer and will utilize cavities and crevices in live and dead trees. They do not prefer a single species of tree, as long as there are appropriate conditions for roosting. One tree can be home to one single NLEB or an entire colony, some of which can range in size from 30 to 60 individuals (USFWS, 2015a).

Their breeding begins in late summer or early fall. Northern long-eared bat females will store sperm over the hibernation period. After migration from their winter habitat to summer habitat, females will give birth to a single pup which will begin to fly around 18 to 21 days after being born. The estimated maximum life span for this species is 18.5 years (USFWS, 2015a).

Northern long-eared bats will hibernate in caves and cave-like structures, to conserve energy, as well as avoid the impacts from reduced food sources from November to March in southern regions (USFWS, 2016b). These caves or mines, to be appropriate for NLEB hibernation, must have constant temperatures, high humidity, and no air currents (USFWS, 2015a).

Identified Resource Needs

Table 6.Resource Needs for Northern Long-eared Bat (USFWS, 2015b)

Resource Need	Metric
Hibernacula	Constant cool temperatures between 32 and 48°F with high humidity and no air currents
Summer Habitat (Maternity Roosts)	Presence of live and dead trees that retain bark or have cracks and crevices.

2.3.1.4. Conservation Needs

The USFWS 2015 NLEB Final Listing states that WNS, impacts to hibernacula, loss or degradation of summer habitat, and wind farm operation are the most prominent threats to NLEB populations and survival. Overall, most conservation needs are difficult to implement. However, USFWS and its partners are working to minimize NLEB mortality through disease management, addressing wind turbine mortality, protecting hibernacula, and listing the species as Federally threatened.

Disease management has been addressed by a plan prepared by USFWS and partners to provide information to state and federal agencies, universities, and non-governmental organizations that will assist these groups with controlling the spread of WNS and addressing the effects caused by the disease (USFWS, 2015a). The USFWS is also working to minimize the impacts of wind turbines through research of bird and bat migration routes, operation of wind turbines to reduce impacts to birds and bats, and why bats are especially susceptible to wind turbine mortality. A *Midwest Wind Energy Habitat Conservation Plan* is being prepared by Federal and State resource agencies to provide an avenue to wind turbine owners to reduce the adverse impacts caused by their equipment to NLEB (USFWS, 2015a).

The listing of NLEB has afforded it protections through the ESA. The 2016 4(d) rule gives special consideration and protection to areas impacted by WNS during sensitive life stages (USFWS, 2016b). The 4(d) rule allows special protection to summer habitats and winter hibernacula. Forest management in summer habitat can be beneficial to NLEB; however, timing of forest management actions is especially important to avoid maternity roosts. In addition, poorly timed forest management practices can increase rates of adult mortality and cause disruption to roosting and foraging habitat. The forest management practices below should be implemented when NLEB are likely to occur within an action area (USFWS, 2015).

- Restricted tree removal to winter months (November 15 thru March 31).
- No additional, temporary nighttime lighting without limiting the light beam’s focus to the work/staging area.
- Ensure all operators, employees, and contractors working in areas of known or presumed bat habitat are aware of all environmental commitments, including all applicable BMPs.
- Modify all phases/aspects of the project (e.g., temporary work areas, alignments) to the extent practicable to avoid tree removal in excess of what is required to implement the project safely.
- Ensure tree removal is limited to that specified in project plans and ensure that contractors understand clearing limits and how they are marked in the field (e.g., install bright colored flagging/fencing prior to any tree clearing to ensure contractors stay within clearing limits).

In addition to summer habitat protection, winter hibernacula have also been given special consideration by Federal and state agencies. Many important caves and mines have been protection by natural resource agencies and conservation groups to ensure winter habitat are not adversely affected by human disturbance.

2.3.2. Environmental Baseline

2.3.2.1. Species Presence and Use

Northern long-eared bat may have used the bottomland hardwood forest habitat located at Below Lock 16. This site had a variety of tree species ranging from 10 to 20 inches DBH. The vegetation was cleared in the summer of 2019, which could have adversely impacted male and female NLEB. Adult species, in the best-case scenario would disperse from the area. In the worst-case scenario live individuals, including pups, would be harmed by heavy equipment activities or the action of tree removal. It should be assumed that any pups may have been adversely impacted by the Emergency Action due to the scheduling of the tree removal.

2.3.2.2. Species Conservation Needs within the Action Area

Although NLEB have a few conservation needs, only the conservation of summer habitat should be applied to the action area. To avoid and minimize direct impacts to NLEB, tree removal should be conducted during the winter months (November 16 thru March 31) when bats are hibernating in caves. No known hibernacula or maternity roost trees for NLEB occur in the general area. However, USACE did not conduct a presence survey before conducting tree removal at Below Lock 16. It should be assumed that the conservation needs listed below were not adequately followed before conducting work for the Emergency Action.

- Restricted tree removal to winter months (November 15 thru March 31)
- No additional, temporary nighttime lighting without limiting the light beam's focus to the work/staging area.
- Ensure all operators, employees, and contractors working in areas of known or presumed bat habitat are aware of all environmental commitments, including all applicable BMPs
- Modify all phases/aspects of the project (e.g., temporary work areas, alignments) to the extent practicable to avoid tree removal in excess of what is required to implement the project safely.
- Ensure tree removal is limited to that specified in project plans and ensure that contractors understand clearing limits and how they are marked in the field (e.g., install bright colored flagging/fencing prior to any tree clearing to ensure contractors stay within clearing limits).

2.3.2.3. Habitat Condition (general)

Summer Habitat (Maternity Roosts)

- Potential roosting habitat is the conservation need most affected by the Emergency Action. This area consisted of oaks, cottonwoods, and sycamores between 10 and 20 inches DBH. The Below Lock 16 site is directly adjacent to the Arkansas River and would have provided important habitat connectivity between roosting and foraging sites. Nearby foraging sites could include habitats prevalent with flying terrestrial insects, while wetlands would have provided the need for emerged aquatic flying insect. It should be noted there is an abundance of this habitat type throughout the USACE fee-owned property. In addition, this site is located directly adjacent to the Webbers Falls Pool Lock and Dam 16 which experiences an abundance in noise and disruption. This site was also directly adjacent to an existing disposal area, which has been regularly utilized by SWT.

2.3.2.4. Influences

There are no known hibernacula within the action areas, so it is assumed that hibernacula were not influenced by the Emergency Action. There are several factors that can be considered a threat to NLEB population; however, none is greater than WNS. If not for WNS, it is presumed that NLEB would be experiencing a dramatic decline in population levels (USFWS, 2016b).

The action area at Below Lock 16 is relevant to the conservation need “Summer Habitat (Maternity Roosts)”. Two common causes of habitat loss are conversion to other land uses and forest modification. Vegetation removal at this site caused a direct loss of forest to another land use type, disposal. Forest conversion is common throughout all states; however, impacts to NLEB are most likely to occur at a local scale. The NLEB Final Listing has additional information regarding influences to the species within its range.

2.3.2.5. Additional Baseline Information

Species specific surveys were not conducted for this the study. However, presence is assumed within the action areas at Below Lock 16 due to the failure to conduct NLEB surveys before removing vegetation.

2.3.3. Effects of the Action

2.3.3.1. Indirect Interactions

Table 7. Indirect Interactions on Northern Long-eared Bat

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
Loss or Degradation of Summer Habitat	Decrease in vegetation	None during Emergency Action dredging, disposal or tree removal Habitat Mitigation Avoidance	*Individuals assumed to have been affected.* 10 acres of bottomland hardwood habitat that could have potential for NLEB roosting. Upon implementation of the Mitigation Plan, USACE will not clear any trees	*Individuals assumed to have been affected.* Best-case scenario: Pups Worst-case scenario: All live individuals No individuals expected to be affected by habitat mitigation.

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
			on site to avoid adverse impacts to potential NLEB roosting habitat.	

2.3.3.2. Direct Interactions

Direct impacts associated with tree removal at Below Lock 16 include crushing, displacement, and injury. No conservation measures for NLEB were in place at the time of the action. Impacts to NLEB from tree removal, otherwise known as forest conversion, would be expected to vary depending on the timing, location (within or outside NLEB home range), and extent of removal. While bats can flee during tree removal, removal of occupied roosts (during spring through fall) may result in direct injury or mortality to some percentage of NLEB. This percentage would be expected to be greater if flightless pups or inexperienced flying juveniles were also present. Given the low inherent reproductive potential of NLEB (one pup per female per year), death of adult females or pups or both during tree felling could reduce the long-term viability of some of the WNS-impacted colonies if they are also in the relatively small percentage of forest habitat directly affected by forest conversion.

2.3.4. Cumulative Effects

Climate change, in combination with drought cycles, is likely to exacerbate existing threats to all species within the southwestern United States.

The ODOT is proposing an MKARNS Mooring Modernization Project. This project will allow the replacement of existing structures that were not designed for extreme flood events, enhance harbor safety by eliminating damage to infrastructure due to loose barges, and expand the capacity for vessels within the waterway and prepare ports for increased freight demand within the MKARNS (ODOT, 2020). The project is expected to be completed in 2027.

2.3.5. Discussion and Conclusion

Limited sampling during the Emergency Action failed to document NLEB on USACE-managed properties within the action area. However, given the mobility of this species and the limited sampling that has occurred, it is reasonable to assume that it was present in suitable habitats at the time of the action. There is potential for direct and indirect adverse effects to NLEB from the tree removal at the Below Lock 16 sediment disposal site.

For this reason, a “May Affect, and is Likely to Adversely Affect” determination was made for the NLEB. It is believed that the levels of incidental take stemming from the Emergency Action were minimal. However, it will be necessary to include the incidental take of NLEB impacts in the annual account under the 2016 Programmatic BO.

2.4. Ozark Big-eared Bat

The Ozark big-eared bat (*Corynorhinus townsendii*) is a medium-sized bat that weighs five to 13 grams, which is the largest of the five subspecies of *P. townsendii*. The Ozark big-eared bat has very large ears (over one inch) that connect at the base across the forehead. The snout has prominent lumps with fur that ranges in color from light to dark brown (USFWS, 2011c). Historically the Ozark big-eared bat was known from Oklahoma, Arkansas, and Missouri. While the bat is no longer known to occur in Missouri (USFWS, 1995), the bat is listed as endangered in Benton, Crawford, Franklin, Marion, and Washington Counties in Arkansas; within these counties, the bat is associated with the Arkansas River and Spavinaw Creek (USFWS, 2011b). The recovery plan for the species lists it as possibly occurring in Pope and Johnson counties in Arkansas as well (USFWS, 1995). In Arkansas, only four caves are presently known to be regularly used by this species. None of those caves are within the action area.

The Oklahoma population is estimated to range between 1,000-1,600 individuals, which are located in Adair County. Cherokee County is the only county where this species has been recorded within the action areas in Oklahoma; historically, it was found in Sequoyah County, but it does not occur there presently (USFWS, 2011b). The other two counties (Adair and Delaware) where the bat is known to or believed to occur are not in the action areas (USFWS, 2011b). Portions of Grand Lake and Markham Ferry Lake are located within the range of this species and probably contain suitable habitat for this species; however, these reservoirs were constructed and operated by the Grand River Dam Authority and are outside the purview of this BA.

The Ozark big-eared bat is found in caves, cliffs, and rock ledges associated with oak-hickory forests of the Ozarks (USFWS, 1995). They forage along the edges of upland forests for insects (primarily moths); edge habitat between forested and open areas is the preferred foraging area. The temperature of hibernacula ranges from 40 ºF to 50 ºF, and maternity caves range from 50 ºF to 59 ºF (USFWS, 2011c). This species migrates between hibernation and summer caves; the distance of migration can be from four to 40 miles (USFWS, 2011b). They have an affinity to return year after year to the same maternity sites and hibernacula (USFWS, 1995).

Prior to the 2003 Biological Assessment, USACE personnel responsible for inspection of the dams and associated structures surveyed for the occurrence of bats for all the projects associated within SWT. In Oklahoma, bats were reported to occur at only Keystone, Eufaula, and Tenkiller lakes. Tulsa District personnel conducted research on the big brown bat (*Eptesicus fuscus*) at Keystone Dam over a 3-year period (2004 – 2006); during the research, no other bat species were observed or captured from the dam (Perry, 2008).

It is assumed there would be “No Effect” to Ozark big-eared bats as a result of the Emergency Action. The dredge and disposal of sediment into wetlands and open water habitats would have no effect on their roosting or hibernacula sites. In addition, the tree removal that occurred at Below Lock 16 would have negligible effects on their foraging areas. There were no caves associated with any of the work conducted for the Emergency Action and any vegetation that was removed was not associated with nesting, brooding, or hibernacula for Ozark big-eared bat. Any direct, indirect, or cumulative effects from Emergency Action would have no effect.

2.1. Interior Least Tern

Interior least tern are the smallest members of the Laridae family; they are 21 to 24 centimeters (cm) long and have a 51 cm wingspan. Males and females resemble each other and are characterized by a black-capped crown, white forehead, grayish back and dorsal wing surfaces, snowy white underside, orange or yellow legs, and a black-tipped bill (Watson, 1996; Davis, 1968; Boyd and Thompson, 1985).

2.1.1. Status of the Species

2.1.1.1. Legal Status

The major cause of the species' decline has been attributed to the loss of nesting habitat due to reservoir construction and channelization projects, water discharge regimes associated with operation of main stem impoundments, uncontrolled vegetative growth on nesting islands, and recreational use of sandbars by humans (USFWS 1985).

The interior population of the least tern was listed as endangered on June 27, 1985 (USFWS, 1990). On January 12, 2021, the ILT was delisted by the USFWS due to recovery and will continue to be protected under the Migratory Bird Treaty Act. For the purposes of this report, it is assumed the ILT was under the protection of the ESA due to the timing of executed work for the Emergency Action.

2.1.1.2. Recovery Plans

Available recovery plans for the ILT can be found on the ECOS species profile.

2.1.1.3. Life History Information

Currently, there are three U.S. subspecies of *Sterna antillarum*. The interior least tern, breeds along the major tributaries of the Mississippi River Drainage and the Rio Grande. The California subspecies (*Sterna antillarum browni*) breeds from San Francisco Bay to Southern Baja, California.

The eastern least tern (*Sterna antillarum antillarum*) breeds along the Atlantic-Gulf Coast from the southern tip of Texas to southern Maine. The three subspecies are identical in appearance, morphology, habitat use characteristics, vocalizations, and behavior. Electrophoretic analysis of coastal versus interior subspecies revealed no genetic differences in Texas populations; only their breeding ranges distinguish them. Because of the taxonomic uncertainty, the Service chose to list those populations of least terns currently occurring in the interior of the U.S. (USFWS, 1990).

The interior least tern migrates through and nests within the action areas. It passes through the area in the spring and fall, and nests on sparsely vegetated islands or sandbars along the larger rivers and salt flats. They are piscivorous, feeding on small fish in the shallows of lakes, rivers, and ponds. Moseley (1976) believes them to be opportunistic feeders feeding on any fish within a certain size range.

Interior least terns are migratory birds with an inland distribution along major river systems in the interior U.S (USFWS, 2011f). Historically, ILT were distributed over the entire Great Plains between the Mississippi River and the Rocky Mountains. The range extended northward to Montana, south to Texas, west to New Mexico and eastern Colorado, and east to Indiana (USFWS, 1990).

In recent years, the breeding range of the ILT has decreased dramatically. Within the states where they still breed, their range is reduced, fragmented, and generally restricted to the less altered river segments. In Oklahoma, the birds occur along sandy stretches of the Canadian, Arkansas, Cimarron, and Red Rivers and at the Salt Plains National Wildlife Refuge (NWR). Interior least terns were also known to occur in Texas along the Rio Grande near Falcon, Amistad, and Lake Casa Blanca reservoirs; in the northern panhandle along the Canadian River; and in the eastern panhandle along the Prairie Dog Town Fork of the Red River (TPWD, 2011). Within the Red River system, they were known to nest from Arkansas to as far as west as Highway 207 in Texas (USACE 2003a).

Juveniles' fishing skills are still inadequate, and adults help with supplementing their diet. The southward fall migration of adults with young may be protracted due to differences in reproductive timing imposed by environmental conditions; however, migration northward into the U.S. is quite rapid (Thompson et al., 1997).

Identified Resource Needs

Table 8. Identified Resource Needs for Interior Least Tern (USFWS 1990)

Resource Need	Metric
Sparsely Vegetated Habitat for Nesting	Coastal: Elevated portions of level, unvegetated (less than 20%) unconsolidated substrates near foraging areas.
	Rivers: Sparsely vegetated sand and gravel bars within wide unobstructed river channel, or salt flats along lake shorelines.
	Artificial Nesting Habitat: Sand and gravel pits and dredge islands with sparse vegetation.
Presence of fish	Small sized with focus on Fundulus, Notropis, Campostoma, Pimephales, Gambusia, Blonesox, Morone, Dorosoma, Lepomis, and Carpiodes genera.

2.1.1.4. Conservation Needs

The recovery plan for the ILT population outlines strategies to protect and manage essential habitat to achieve and maintain a population size of 7,000 terns, which is broken down into sub-populations required in each area of the terns' interior range. This population size must be maintained for 10 years before the species can be down listed

(USFWS, 1990). The 1990 Recovery Plan for ILT lists the actions needed to ensure recovery of the species and includes: determining population trends and habitat requirements; protecting, enhancing, and increasing populations during breeding; managing reservoir and river water levels to the benefit of the species; developing public awareness and implementing educational programs about the ILT; and implementing law enforcement actions at nesting areas in conflict with high public use.

2.1.2. Environmental Baseline

2.1.2.1. Species Presence and Use

The action area pertinent to ILT, which includes Muskogee and Sequoyah Counties in Oklahoma, is home to breeding areas on the Arkansas River (USFWS, 1990).

All life stages are likely to use the open water and wetland disposal project areas within the Arkansas River. In Oklahoma, migration usually begins in mid- to late August with adults and young staging at prime fishing sites along the major rivers (Thompson et al., 1997). Interior least terns typically arrive in the project areas around May 15 and leave by August 22 (Lott, 2009). These birds are known inhabitants of the Arkansas River system and their nests are surveyed on a yearly basis.

Figure 5. Current Distribution of the Interior Least Tern

2.1.2.2. Species Conservation Needs within the Action Area

The USACE, SWT has been consulting with USFWS with respect to ILT on the Arkansas River since 1987. The Arkansas River population from Kaw Dam to Muskogee, Oklahoma, has been intensively surveyed since 1990 (Figure 6 and Figure 7). In partial fulfillment of the Reasonable and Prudent Measures (RPM) in the 2005 BO, the USACE, SWT created and maintained three interior least tern islands in the MKARNS; Kerr Island (created in 2006) and Stoney Point Island (created in 2009) were constructed in Robert S. Kerr Reservoir of the MKARNS, and Spaniard Creek Island (created in 2010) was constructed in the Webber Falls Pool of the MKARNS. Survey results from these islands were included in the Arkansas River, Oklahoma, from Kaw Reservoir to the Oklahoma/Arkansas state line interior least tern population survey results.

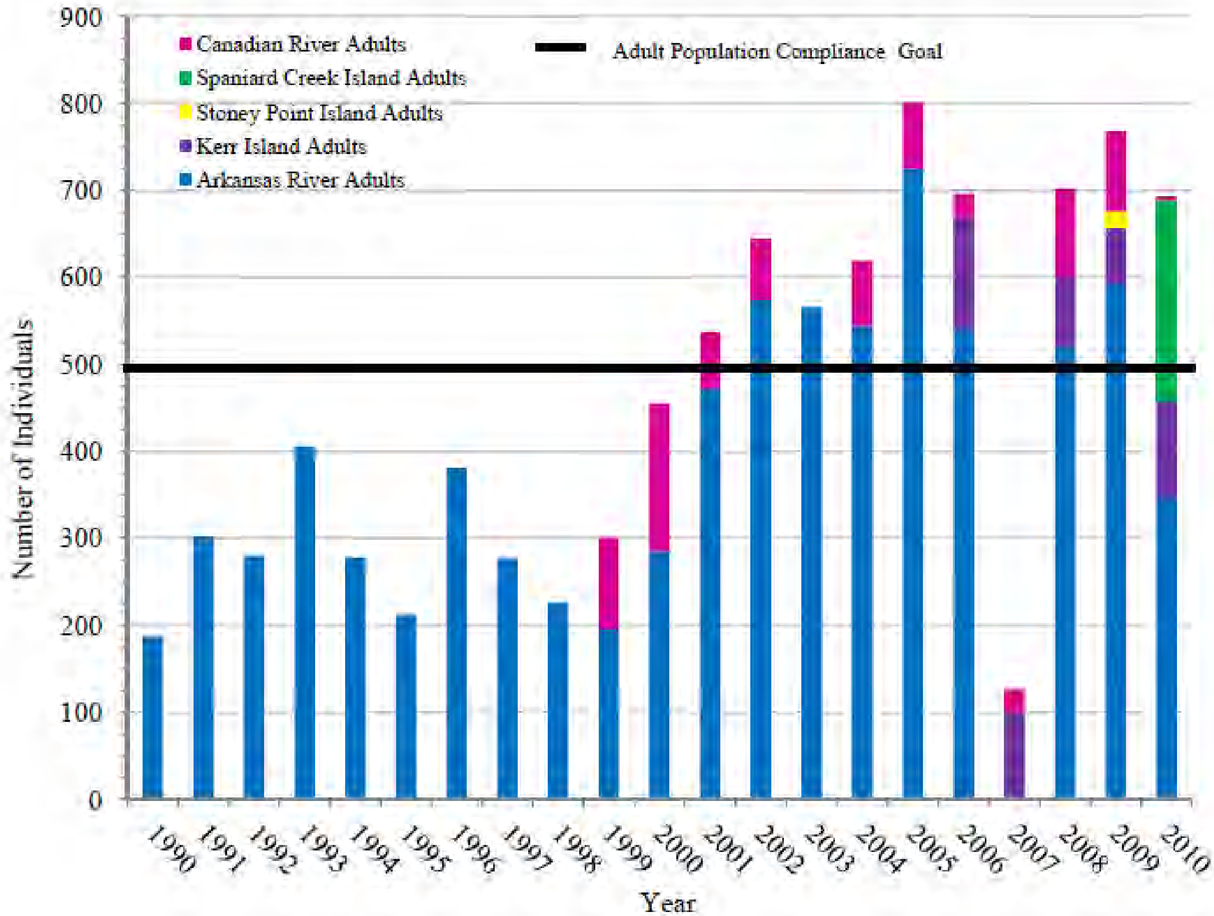

Figure 6. Survey results for adult interior least terns along the Arkansas River, Oklahoma, from Kaw Reservoir to the Oklahoma/Arkansas state line, including the Canadian River below Eufaula Dam to MKARNS.

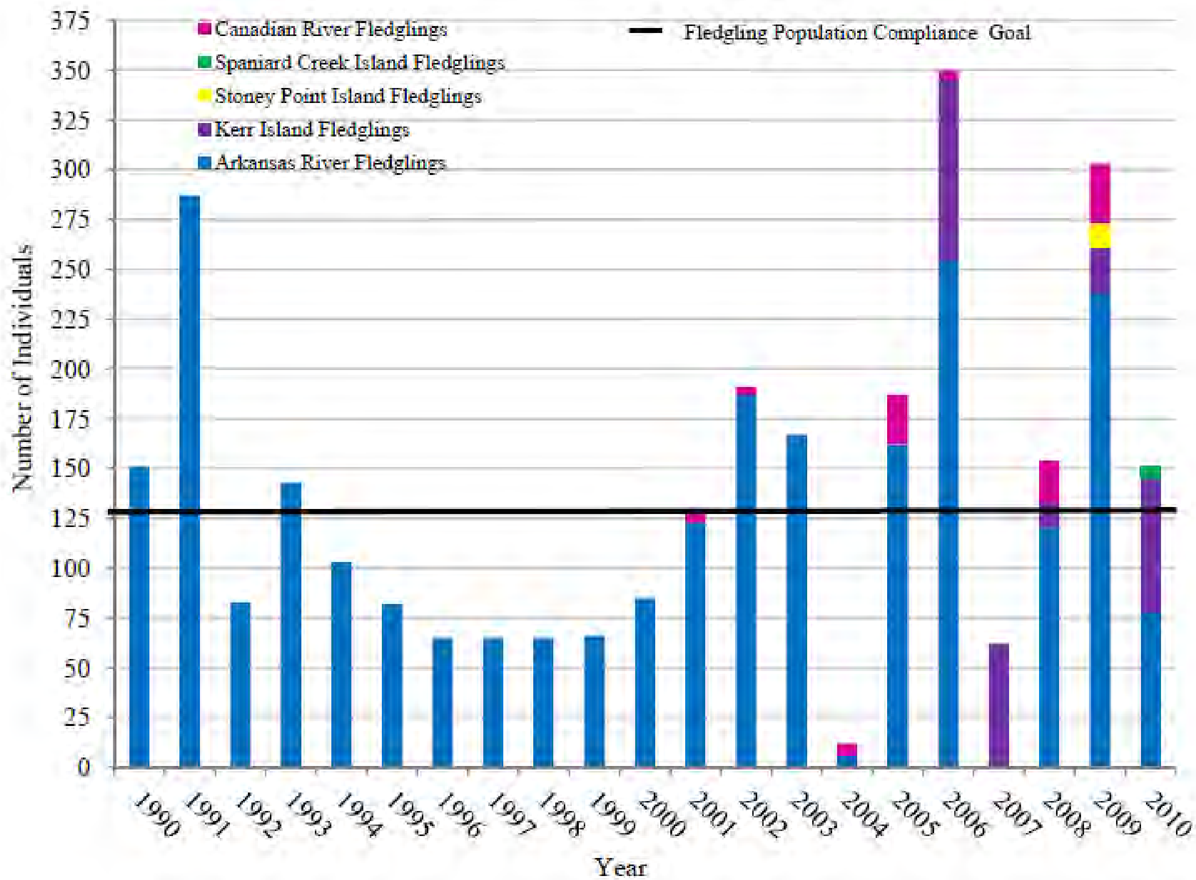

Figure 7. Survey Results for Interior Least Tern Fledglings along the Arkansas River, Oklahoma, from Kaw Reservoir to the Oklahoma/Arkansas State Line, including the Canadian River below Eufaula Dam to MKARNS

2.1.2.3. Habitat Condition (general)

Sparsely Vegetated Habitat for nesting (Coastal, Riverine, and Artificial)

- This resource is located throughout the action area and refined project areas. Upon implementation of the Emergency Action, additional nesting habitat for ILT were created at Sandtown Bottom, Salt Creek, Stoney Point, and San Bois Creek. It is likely that the disposal sites at Stoney Point and Sandtown Bottom will be managed on behalf of ILT habitat.

2.1.2.4. Influences

The elimination of most of the ILT nesting habitat within the Arkansas River can be attributed to channelization, irrigation, and the construction of reservoirs and pools. Due to unpredictable demands, water flow can greatly vary, which is supremely different than the historic conditions of the Arkansas River. High-river flows from rainfall wash away nests or inundate colonies, causing the population results to vary annually. This may cause ILT to initiate nests in poor quality locations, leading to additional problems (USFWS, 1990). Other factors that impact populations include human disturbance, geese disturbance, and predators.

Flows on the Arkansas River were significantly modified with the construction of Kaw and Keystone lakes. The river no longer exhibits the large annual flood events lasting for several days followed by longer periods of median flows. Releases during storm events are now made at lesser non-damaging rates over a protracted period of time. Modified releases during the ILT nesting season have not always been beneficial to least tern reproduction. Also, operation of these lakes for hydropower and water supply has created wide fluctuation in daily flows and created many periods of little or no flow.

Long-term effects on the nesting habitat for this species have also occurred as a result of constructing Kaw and Keystone Lakes but have not been quantified. Much of the sediment load transported by these rivers has become trapped behind the dams. This reduction in stream sediment transport combined with a reduction in large flow events and duration has impacted the quantity and quality of suitable nesting islands for this species. While it has been difficult to measure and quantify this loss, it has occurred and will continue to occur with operation of the reservoirs.

Implementation of the Emergency Action has created new suitable nesting habitat for this species where dredged materials have been beneficially disposed of and where the vegetation is regularly maintained. The Emergency Action could have both positive and negative effects to ILT. Strategic disposal of dredged materials created additional nesting areas which is beneficial to the species. Conversely, food sources used by the ILT could be exposed to contaminants, should they exist, released from sediments into the water column from dredging. The species primarily uses the Arkansas River from below Kaw Lake to Muskogee and the Canadian River from below Eufaula Lake to the Canadian River’s confluence with the MKARNS. Use of the remainder of the Oklahoma portion of the MKARNS by the ILT is limited to the constructed islands from the beneficial use of dredged material.

2.1.2.5. Additional Baseline Information

In Oklahoma, there are over 142 miles of river and over 17,297 acres of salt flats, which may contain interior least tern habitat (Hill, 1993). Based upon data collected since 1993, this figure is probably low. Monitoring of ILT colonies for fledging success in Oklahoma has been done sporadically at Optima Lake, at the Salt Plains NWR, and at the Little and Big Salt Plains. However, SWT has intensively monitored for least terns on the Arkansas River since 1990 and on the Canadian and Red rivers since 2000; site specific surveys along the MKARNS began in 2003 as habitat was created.

Kerr Island was constructed along the MKARNS at Arkansas River Navigation Mile 348.0 in the Robert S. Kerr Pool specifically for ILT habitat. Since the completion of the island in 2006, the terns have successfully nested and produced fledglings every nesting season (Figure 6 and Figure 7); on average (2006 – 2010), approximately 95 adults colonize the island, with an average of about 50 fledglings produced each season. The upstream end of the island was reinforced with rip rap to reduce what little erosion did take place. Prior to the 2010 nesting season, this island was capped with more sand to backfill the area behind the rip rap to provide more useable area for tern nesting. The SWT has sprayed herbicide to control the vegetation and has posted the island with signs to reduce human disturbance. Canada goose nest and egg depredation management efforts have also begun on this island in the spring of 2011.

Stoney Point Island was constructed along the MKARNS at Arkansas River Navigation Mile 354.0 in the Robert S. Kerr Pool specifically for tern habitat as well. The terns colonized the island upon completion of construction activities in 2009; the island was smaller than anticipated and only 19 adults colonized the island, producing 12 fledglings (Figure 6 and Figure 7). Due to the initial small size of the island, more dredge material was used to expand the island at the beginning of the 2010 nesting season; however, rapid vegetation encroachment may have prevented subsequent colonization. Vegetation control measures (controlled burn and herbicide spray), as well as Canada goose nest and egg depredation management efforts, were conducted in the spring of 2011 in preparation for the upcoming nesting season.

Spaniard Creek Island was constructed specifically for tern habitat in the Webbers Falls Pool section of the MKARNS at Arkansas River Navigation Mile 374.0 in 2010. Immediately upon completion, terns began nesting on this island. The peak adult population that colonized the island was 232; however, only 6 fledglings were produced from the site (Figure 6 and Figure 7). A river otter den was discovered during the last survey of the 2010 season and predation may have been the cause of fledgling loss.

2.1.3. Effects of the Action

2.1.3.1. Indirect Interactions

Table 9. Indirect Interaction for Interior Least Tern

Resource Need	**Stressors**	**Conservation Measures**	**Amount of Resource Impacted**	**Individuals Affected**
Sparsely Vegetated Habitat for Nesting (Coastal, Riverine, and Artificial)	Increase in Invasive Plant Species Change in Channel Morphology Change in Topography Increase in Erosion Increase in Sedimentation Rates Increase in Noise	Habitat Mitigation Best Management Practices Island Maintenance	*There will be beneficial impacts to this resource, so no individuals will be adversely affected.* Impacts to sparsely vegetated habitat for nesting are assumed to be beneficial due to the Emergency Action creation of sparsely vegetated lands at Salt Creek, Stoney	*There will be beneficial impacts to this resource, so no individuals will be adversely affected.* The magnitude of beneficial impacts to ILT outweigh any potential adverse effects to ILT from the project action.

Resource Need	**Stressors**	**Conservation Measures**	**Amount of Resource Impacted**	**Individuals Affected**
			Point, and Sandtown Bottom. Changes are expected to occur that will benefit ILT nesting grounds through the creation of new and/or improved areas as well as the continued vegetative maintenance of these areas for ILT.	
Presence of Aquatic Prey	Change in Water Temperature Increase in Water Turbidity	Habitat Mitigation	*There will be negligible impacts to this resource, so no individuals will be affected.* It can be assumed adverse effects to fish occurred as a result of wetland and open water disposal of sediment. However, it can be expected that most mobile species would be able to relocate to areas	*There will be negligible impacts to this resource, so no individuals will be adversely affected.*

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
			undisturbed by sediment disposal. In addition, ILT are opportunistic feeders and a change in the species of aquatic prey should have negligible impacts on ILT foraging. Small fish are a major food source for nesting least terns using the MKARNS. Dredging can disturb contaminants that may be contained in sediments and make them available for assimilation into the food chain, including the fish community which is the primary ILT food source. Additionally, the turbidity of the water during dredging operations is increased, which could	

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
			limit the visibility of prey species for the terns. The implementation of habitat mitigation would create more emergent wetlands. These wetlands would eventually yield adequate fish populations to supplement the ILT diet. In addition, wetlands can assist water turbidity and water temperature by filtering sediments.	

2.1.3.2. Direct Interactions

It can be assumed there would be a direct impact on nests and fledglings by crushing (death), displacement, or injury due to the disposal of sediment on emergent wetland habitats. There is potential that ILT were within the refined project areas at the time of sediment disposal. In addition to fledglings, it can be assumed adults and juveniles could have suffered crushing and injury if they were not able to flee the areas associated with the Emergency Action or were displaced by the work associated with the project.

2.1.4. Cumulative Effects

Climate change, in combination with drought cycles, is likely to exacerbate existing threats to all species within the southwestern United States.

The first cumulative effect is a proposed surface water delivery system as an irrigation source for a large area of southwest Little River County, Arkansas. It is being proposed by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) and is entitled the “Walnut Bayou Irrigation Project.” The proposed plan consists of installation of a surface water delivery system to pump water from the Red River into a series of canals, streams, and pipelines, which will deliver irrigation water to farms. The proposed plan would pump up to 385 cfs from the Red River during May through September, which coincides with the ILT nesting season. Potential impacts to this species include a reduction in stage of low flows on the Red River. This has the potential to increase the occurrence of land bridging of ILT nesting islands, which increases the risk of predation and human disturbance to nesting least terns. If implemented, this action could have additional impacts on nesting least terns over those occurring as a result of operational activities associated with existing USACE projects above Index, Arkansas. However, the plan was originally published in the Federal Register in 2004 and has yet to be implemented.

The second cumulative effect identified by the USACE concerns the long-term loss of nesting habitat in the Arkansas and Red rivers resulting from removal of sand and gravel for commercial purposes. This is especially true for the stretch of the Arkansas River from below Keystone Lake to Muskogee, Oklahoma, where numerous operators remove large amount of material daily. Over time, removal of this material for commercial purposes may contribute to shortages of sand available to the fluvial processes for creation and maintenance of island habitat for this species. Most of the commercial sand operations are suction dredge operations and are deemed non-regulated activities under Section 404 of the Clean Water Act. Consequently, these activities and any impacts on threatened or endangered species are largely uncontrolled.

2.1.5. Discussion and Conclusion

Implementation of dredging and disposal associated with the Emergency Action could have negative and positive impacts to ILT. With dredging there is potential to introduce otherwise unavailable contaminants into the aquatic environment for subsequent assimilation into the interior least tern food source. However, contaminants are not expected to be present within the sediments dredged and disposed. Conversely, strategic disposal of dredged material created additional successful nesting habitat as previously demonstrated in conjunction with maintenance dredging activities. There is potential for more of these initiatives if the proposed conservation measures are implemented. Therefore, the determination for Interior Least Tern is “May Affect, but is Not Likely to Adversely Affect”

2.2. Piping Plover

The piping plover (*Charadrius melodus)* is a migratory shorebird listed as endangered in the watershed of the Great Lakes and threatened in the remainder of its range (the Northern Great Plains, Atlantic coast, Gulf coast, the Bahamas, and the West Indies) (USFWS, 1985). The Northern Great Plains population of piping plover spends up to 10 months a year on its wintering ground along the Gulf coast and arrives on prairie breeding grounds in early May. During migration periods, they use large rivers, reservoir beaches, mudflats, and alkali flats (Haig, 1986). They feed on aquatic and terrestrial invertebrates. The migration and wintering period may last as long as 10 months (mid-July through mid-May). Migration to breeding grounds may occur from mid-February through mid-May, with peak migrations in March. Wintering piping plovers forage on invertebrates located on top of the sand or just below the surface along wrack lines (organic material including seaweed, seashells, driftwood, and other materials deposited on beaches by tidal action). Specific prey items may include polychaete marine worms, crustaceans, fly larvae, beetles, and bivalve mollusks (USFWS, 2012b).

This species is considered a migrant through the Oklahoma action areas. This species has been documented using the Great Salt Plains NWR in Oklahoma as stopover habitat during migration; however, it is thought that many individuals fly nonstop to the Gulf Coast from breeding grounds to the north.

Due to impoundment and channelization, virtually no piping plover nesting habitat occurs in the action area. No portion of the action area has been designated as critical piping plover habitat. Piping plovers are a transient species that rarely occur in the action area during migration between wintering grounds and breeding areas. Due to the lack of suitable nesting habitat in in the action area, dredging and disposal and the proposed conservation measures are not likely to affect piping plover populations or their nesting habitat. Any direct, indirect, or cumulative effects from project actions would have “No Effect”.

2.3. Red Knot

The red knot (*Calidris canutus*), is a medium to large shorebird with a weight of five ounces, a body length of nine to 10 inches, and a wingspan of 20 to 22 inches. During the breeding season, it has a rust-colored face, chest, and undersides, and dark brown wings. In winter, it has a gray head, chest, and upperparts and a white belly. It has long greenish legs and a pointed black bill. Males and females look similar, and juveniles resemble nonbreeding adults.

The red knot was listed as threatened on December 11, 2014 (79 FR 73706). The greatest threat to the red knot population is habitat loss in the U.S., followed by reduction of preferred prey items in nesting areas and along migration routes (USFWS, 2014). The red knot breeds in tundra habitat of the central Canadian arctic, between May and mid-July, and winters along the U.S. coastline from North Carolina to Texas and south to Tierra del Fuego in South America between July and May; however, non-breeding red knots are known to remain in Texas year-round. Wintering habitat includes tidal flats, beaches, and oyster reefs, where they feed primarily on small invertebrates, particularly clams (Newstead, 2012; Newstead et al., 2013; USFWS, 2011g). Long-term systematic population surveys are lacking for this species, but current estimates suggest Texas wintering populations may range between 50 and 2,000, with numbers increasing from survey counts in the early 1990s to recent counts in 2012. The increase in numbers does not necessarily reflect an increase in the population but may be due to an increase or variation in survey effort. Although rigorous population estimates are lacking, preliminary trends indicate prolonged decline followed by stabilization of small populations (USFWS, 2014).

Due to impoundment and channelization, virtually no red knot nesting habitat occurs in the action area. No portion of the action area has been designated as critical red knot habitat. Red knot are a transient species that rarely occur in the action area during migration between wintering grounds and breeding areas. Due to the lack of suitable nesting habitat in in the action area, dredging and disposal under the Emergency action is not likely to affect red knot populations or their nesting habitat. Any direct, indirect, or cumulative effects from project actions would have “No Effect.”

2.4. Whooping Crane

Whooping cranes are white, tall, have black legs and a reddish black head. Their habitat consists of marshes, shallow lakes, lagoons, salt flats, grain and stubble fields, and barrier islands (American Ornithologists’ Union, 1983 and Matthews and Moseley, 1990). Autumn migration normally begins in mid-September flying from Wood Buffalo National Park in central Canada, with most birds arriving on the wintering grounds at Aransas National Wildlife Refuge between late October and mid-November. Spring migration occurs during March and April. It has a diverse diet consisting of crabs, snails, fish, frogs, lizards, worms, insects, berries, grains, and acorns. Lakes, ponds, and other open water bodies in Central Texas may be briefly used as stopover habitat by whooping crane (NatureServe 2019A).

This species is an uncommon migrant occasionally stopping along rivers, in grain fields, and shallow wetlands in western Oklahoma. This species breeds mainly in northern Canada and winters along the Texas Gulf Coast. It passes through western Oklahoma each spring and fall migration. The Great Salt Plains NWR, near Jet, Oklahoma, is an important stopover area. This refuge is located approximately 180 miles northwest of the action area. Whooping cranes most commonly migrate through the western half of the state, typically east of Guymon, OK and west of Interstate 35. Although rare, cranes have been known to land on sites in central Oklahoma, including reservoirs in the Oklahoma City metropolitan area. While moving through Oklahoma, whooping cranes typically use shallow wetlands, marshes, the margins of ponds and lakes, sandbars, shorelines of shallow rivers, wet prairies and crop fields near water.

No portion of the action area has been designated as critical whooping crane habitat. Any direct, indirect, or cumulative effects from project actions would have “No Effect.”

2.5. Ozark Cave Fish

The Ozark cavefish is a small fish about 2-1/4 inches long. It is pinkish-white and blind. The Ozark cavefish lives in cave streams and springs (USFWS, 2021b). The cave ecosystem is often dependent upon bats (especially gray bats) as a source of energy and nutrients. Very little is known about the reproduction of the Ozark cavefish. Spawning is often triggered by spring floods. The greatest obstacle to the cavefish may be finding a potential mate at the right time. Because it cannot see, the cavefish depends on sensing water movement to find animals to eat. The cavefish primarily eats plankton. They also eat isopods, amphipods, crayfish, salamander larvae, and bat guano. The cavefish can be found in caves within the Springfield Plateau of the Ozark Highlands in Arkansas, Missouri, and Oklahoma. It is threatened by chemicals in groundwater, as well as the intentional sealing of cave entrances by humans, which cuts off the food supply to the ecosystem.

There were no caves associated with any of the work conducted for the Emergency Action. Any direct, indirect, or cumulative effects from Emergency Action would have “No Effect” on the Ozark cave fish.

2.6. Neosho Mucket

The Neosho Mucket (*Lampsilis rafinesqueana*) is a medium sized freshwater mussel, reach approximately four inches in length. This species is associated with streams that have shallow riffles and runs and are comprised of gravel substrate with moderate to swift currents. It historically occurred in 16 streams in the Illinois, Neosho, and Verdigris River basins in Arkansas, Kansas, Oklahoma, and Missouri. It is endemic to the Arkansas River system and of the nine extant streams only one population is viable. The Neosho mucket was listed as endangered on September 17, 2013 but was listed as a candidate for protection in May 1984 (USFWS, 2014).

The decline of Neosho mucket is primarily the result of habitat loss and degradation. The mussel requires flowing water with geomorphically stable river channels and banks with suitable substrate. It requires adequate food, presence and abundance of fish hosts, high quality water and sediment, and little to no competitors or invasive species (USFWS, 2014). Proposed critical habitat units occur in Benton and Washington Counties, Arkansas; Allen, Chase, Cherokee, Coffee, Elk, Greenwood, Labetter, Montgomery, Neosho, Wilson, and Woodson Counties, Kansas; Jasper, Lawrence, McDonald, and Newton Counties, Missouri; and Adair, Cherokee, and Delaware Counties, Oklahoma (Figure 8).

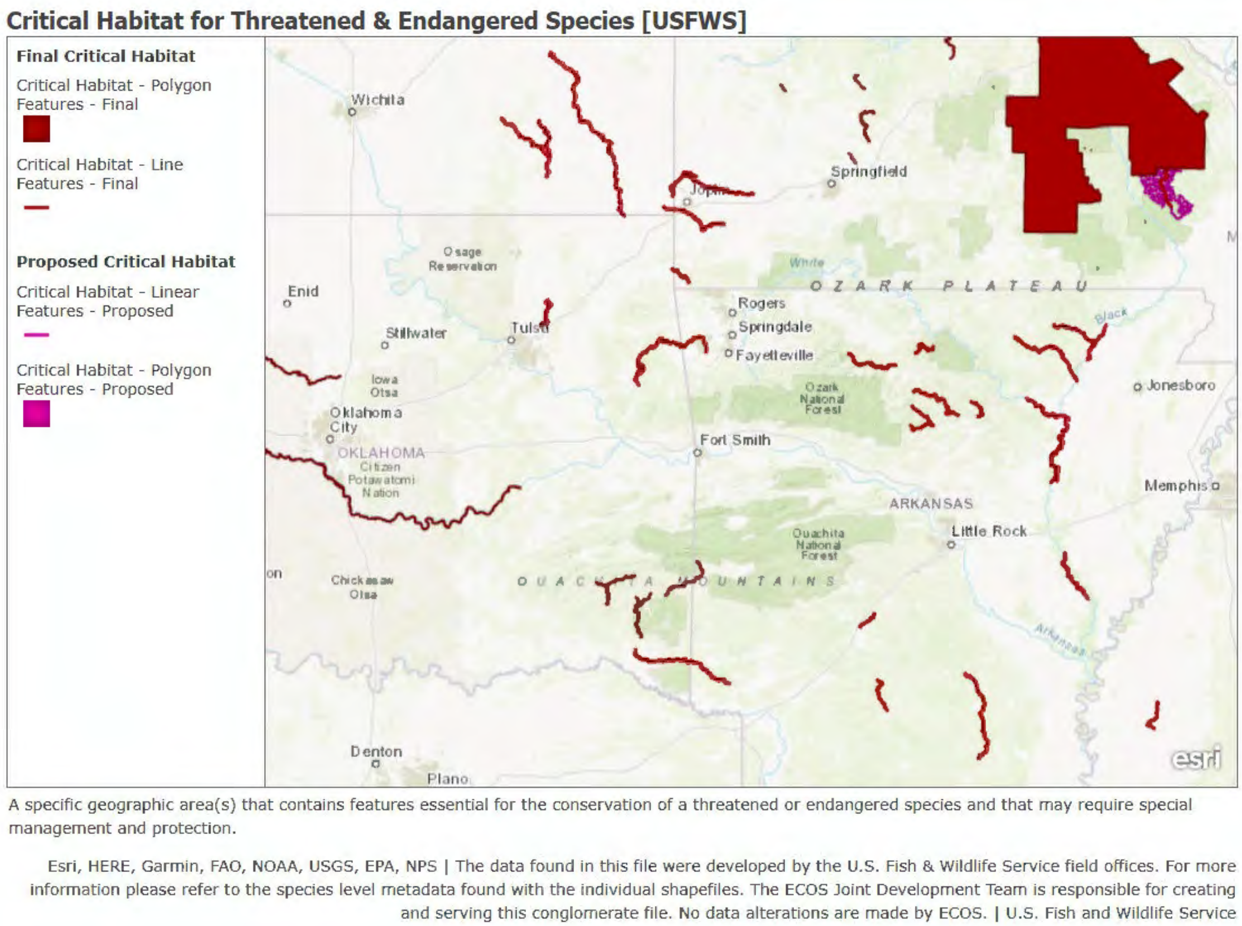

Figure 8. Neosho Mucket Critical Habitat in Western Oklahoma (USFWS, 2019a)

Cherokee County, Oklahoma is located with the action area; however, this location is not associated with the refined project areas (dredging, disposal, and tree removal). There are records indicating the Neosho mucket is not within areas impacted by the Emergency Action. The records search from OHNI indicates a lack of presence. This does not preclude the species from occurring within the area. However, a separate unionid survey conducted by Ecological Specialists, Inc. in 2006 (Attachment E – Ecological Specialists, Inc. Unionid Mussel Survey on the McClellan-Kerr Arkansas River Navigation System) indicates no presence within the surveyed portions of the MKARNS, which includes most of the action areas. A total of 5,467 live unionids of 27 species were collected, and two additional species were found only as weathered shells. *Quadrula quadrula* (27.6%), *Plectomerus dombeyanus* (23.4%), *Obliquaria reflexa* (15.5%), and *Amblema plicata* (10.5%) were the most abundant species. No threatened or endangered mussel species were collected. In combination with multiple reports, the lack of critical habitat in action areas, and the condition of the MKARNS as a deep open river channel, USACE assumes “No Effect” to Neosho mucket.

2.7. Rabbitsfoot

Rabbitsfoot (*Quadrula cylindrica cylindrica*) is a medium to large freshwater mussel, elongate and rectangular, reaching six inches in length. It is primarily an inhabitant of small to medium sized streams and some larger rivers. Historically, it occurred in 140 streams within the lower Great Lakes Subbasin and Mississippi River Basin. The historical range included Alabama, Arkansas, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Pennsylvania, Tennessee, and West Virginia. Populations within 51 of the extant streams are fragmented and restricted to short reaches (USFWS, 2014).

The most prominent causes of the decline of rabbitsfoot are impoundment, channelization, sedimentation, chemical contaminants, mining, and oil and natural gas development. Rabbitsfoot are similar to Neosho mucket because they also require flowing water with geomorphically stable river channels and banks with suitable substrate, adequate food, presence and abundance of fish hosts, high quality water and sediment, and little to no competitors or invasive species (USFWS, 2014). Proposed critical habitat units occur in Colbert, Jackson, Madison, and Marshall County, Alabama; Arkansas, Ashley, Bradley, Clark, Cleburne, Cleveland, Dallas, Drew, Fulton, Grant, Hot Spring, Independence, Izard, Jackson, Lawrence, Little River, Marion, Monroe, Montgomery, Newton, Ouachita, Randolph, Saline, Sevier, Sharp, Van Buren, White, and Woodruff Counties, Arkansas; Massac, Pulaski, and vermilion County, Illinois; Carroll, Pulaski, Tippecanoe, and White County, Indiana; Allen and Cherokee Counties, Kansas; Ballard, Edmonson, Green, Hart, Livingston, Logan, Marshall, and McCracken Couniesy, Kentucky; Hinds, Sunflower, Toshimingo, and Warren County, Mississippi; Jasper, Madison, and Wayne County Missouri; Coshocton, Madison, Union, and Williams Counties Ohio; McCurtain and Rogers Counties, Oklahoma; Crawford, Erie, Mercer, and Venango Counties, Pennsylvania; and Hardin, Hickman, Humphreys, Marshall, Maury, Montgomery, Perry, and Robertson Counties, Tennessee (Figure 9).

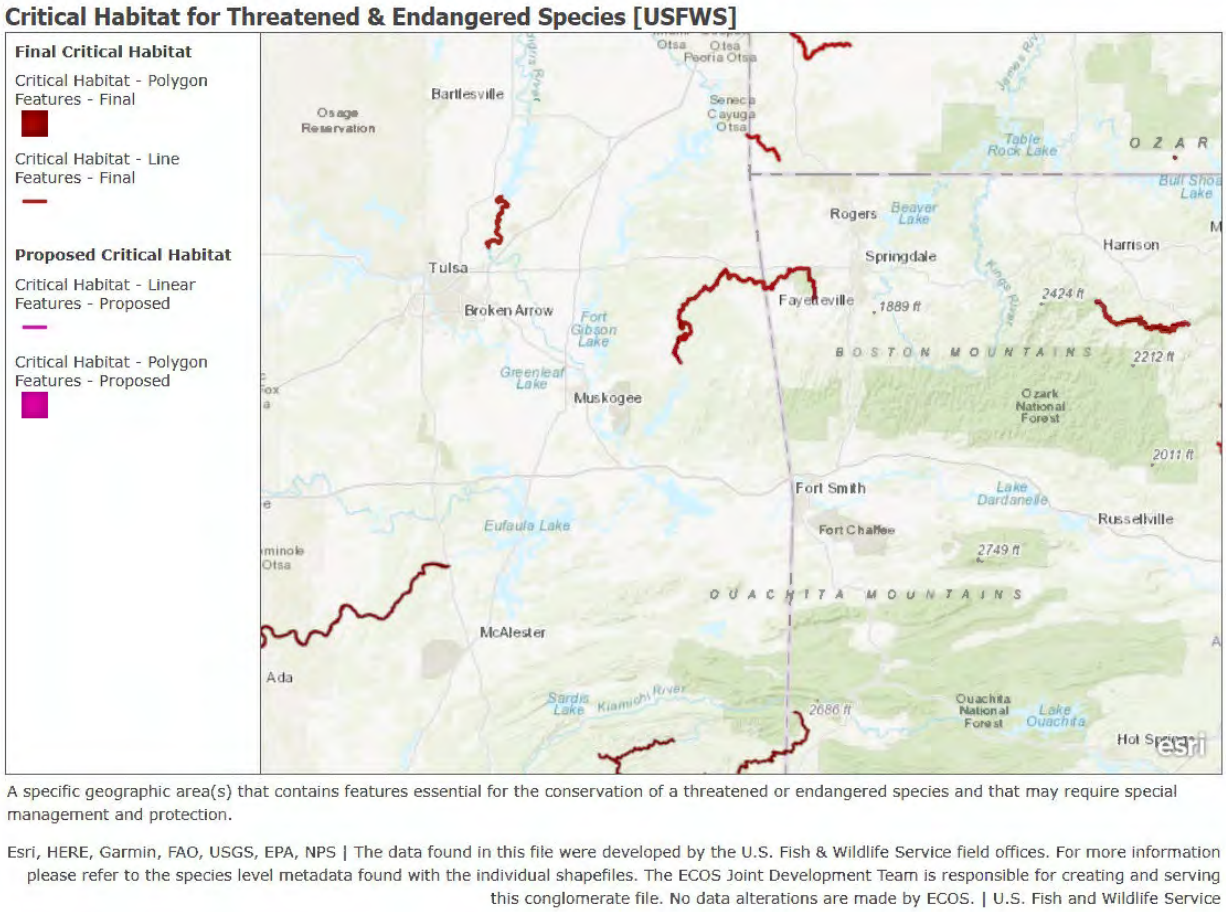

Figure 9. Rabbitsfoot Critical Habitat Critical Habitat in Western Oklahoma (USFWS, 2019a)

Rogers County, Oklahoma is located with the action area; however, Rogers County makes up a very small portion of area that was dredged and was not associated with any unapproved disposal locations. There are records indicating the rabbitsfoot is not within areas impacted by the Emergency Action. The records search from OHNI indicates a lack of presence. This does not preclude the species from occurring within the area. However, a separate unionid survey conducted by Ecological Specialists, Inc. in 2006 (Attachment E – Ecological Specialists, Inc. Unionid Mussel Survey on the McClellan-Kerr Arkansas River Navigation System) indicates no presence within the surveyed portions of the MKARNS, which includes most of the action areas. A total of 5,467 live unionids of 27 species were collected, and two additional species were found only as weathered shells. *Quadrula quadrula* (27.6%), *Plectomerus dombeyanus* (23.4%), *Obliquaria reflexa* (15.5%), and *Amblema plicata* (10.5%) were the most abundant species. No threatened or endangered mussel species were collected. In combination with multiple reports, the lack of critical habitat in action areas, and the condition of the MKARNS as a deep open river channel, USACE assumes “No Effect” to rabbitsfoot.

2.8. American Burying Beetle

The ABB is the largest species of its genus in North America measuring from 0.98 to 1.4 inches in length. It has a shiny black body with smooth and shiny black elytra with bright orange-red markings. The antennae are large, abruptly clubbed, and orange at the tip. It is a member of the Family Silphidae, which are known as the carrion or burying beetles due to their behavior of burying vertebrate carcasses which are used for brood chambers for their young (USFWS, 1991).

2.8.1. Status of the Species

Once widely distributed throughout eastern North America, this species has disappeared from most of its former range. The ABB was listed by the Service as endangered under the Endangered Species Act of 1973, as amended, on July 13, 1989 (54 FR 29652). No critical habitat was designated for this species.

2.8.1.1. Legal Status

The ABB is federally listed as 'Threatened' and additional information regarding its legal status can be found on the ECOS species profile.

2.8.1.2. Recovery Plans

Available recovery plans for the ABB can be found on the ECOS species profile.

2.8.1.3. Life History Information

This species was formerly known from much of eastern North America with its historical range described as being most of temperate eastern North America. Historically, its range included 35 states in the eastern and central United States and the southern edges of Canada. The easternmost record for the species is from Nova Scotia in Canada and the westernmost record is from central Montana. The northernmost record is from the upper peninsula of Michigan and the southernmost record is from Kingsville, Texas. More recently, it has been documented from Arkansas, Kansas, Kentucky, Missouri, Nebraska, Oklahoma, and Rhode Island. Presently, the current distribution encompasses eight states including Nebraska, Kansas, Arkansas, Rhode Island, Massachusetts, South Dakota, Texas and Oklahoma (USFWS, 1991). In Oklahoma, this species was originally thought to occur in only Latimer, Cherokee, Muskogee, and Sequoyah counties. More recently, it has been discovered in over 20 counties in Oklahoma including Atoka, Bryan, Cherokee, Choctaw, Coal, Craig, Haskell, Hughes, Johnston, Latimer, LeFlore, McCurtain, McIntosh, Muskogee, Okfuskee, Osage, Pittsburg, Pushmataha, Rogers, Sequoyah, Tulsa, and Wagoner (USFWS, 1991).

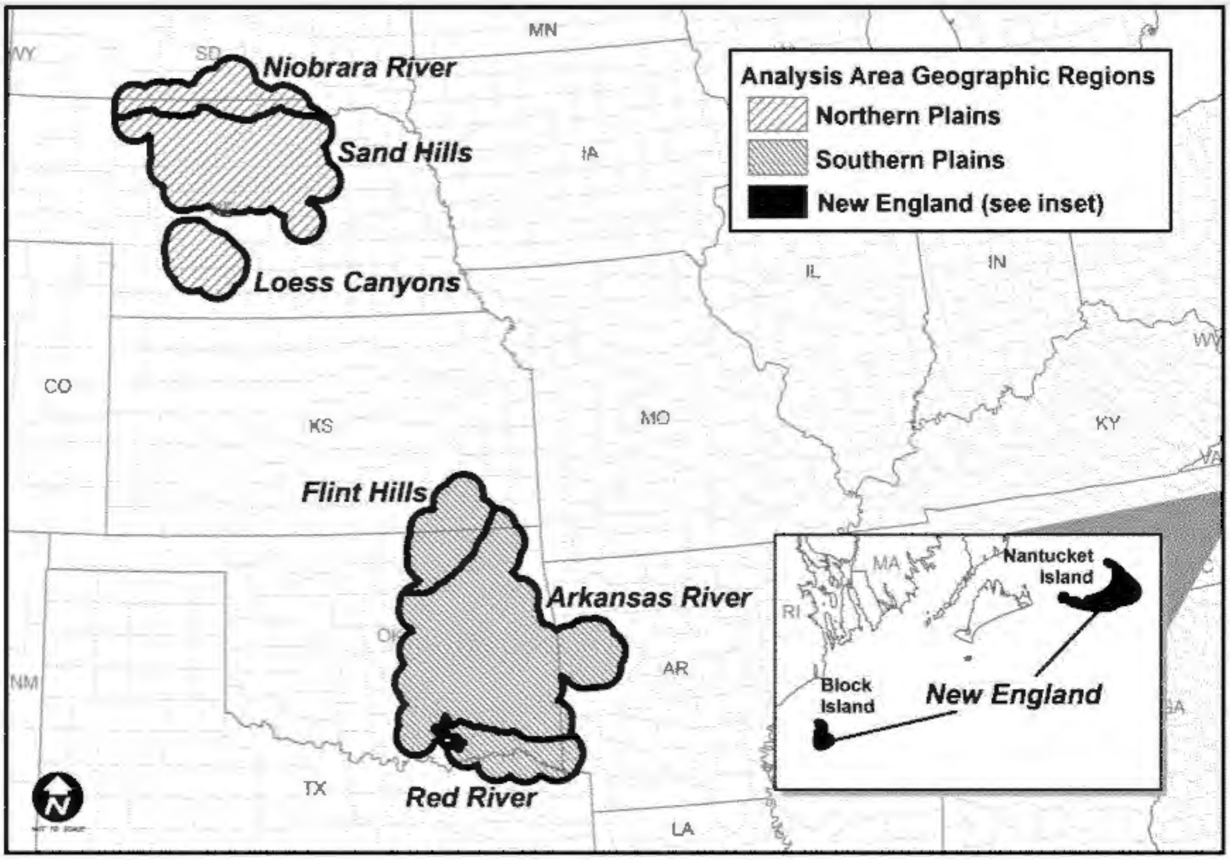

Figure 10. Distribution of American Burying Beetle (USFWS, 2019b)

The most stable populations occur in Arkansas, Oklahoma, and Rhode Island. In Latimer County, Oklahoma, the populations are found on private holdings. The Muskogee and Cherokee counties population occurs primarily on Federal lands licensed to the Oklahoma Army National Guard and the Oklahoma Department of Wildlife Conservation. The Arkansas populations occur on Federal lands including the Fort Chaffee Military Reservation, the Ozark National Forest, and the Ouachita National Forest. Given the mobility of this species, it is likely these represent a single population of this species.

Identified resource needs include:

Table 10. Identified Resource Need for American Burying Beetle

Resource Need	Metric
Carrion	Between the size of a dove or chipmunk
Habitat	Wide array of terrestrial-based habitat types

2.8.1.4. Conservation Needs

Conservation efforts have been enacted by USFWS to aid in the understanding of the life history of ABB and promote its recovery. These needs include publicizing the decline of ABB populations, soliciting information on collection records, studies on the reproductive ecology and population status in the field and in labs, investigating the causes of the species' decline, establishing captive breeding populations, surveying historical collection localities and de novo surveys, and the reintroducing captive raised beetles to historical habitat (USFWS, 1991)

2.8.2. Environmental Baseline

2.8.2.1. Species Presence and Use

The typical habitat types ABB use include oak-pine woodlands, open fields, oak hickory forests, open grasslands, and edge habitat. In Oklahoma, the habitat types where populations have been documented to occur vary from deciduous and coniferous forests to open pasture. The topography includes slopes, ridge tops and flat grasslands. The OHNI performed surveys in a large area of western Cherokee and eastern Muskogee Counties, Oklahoma. Three different habitat types were surveyed; oak-hickory forest (second and third growth), grassland, and bottomland hardwood forest. Slightly more individuals were collected in grasslands than in oak-hickory forests and fewer still were captured in the bottomland forest (Kozol et al., 1989).

With the wide distributional pattern of the species with respect to habitat types, it does not appear likely that vegetation and soil type are limiting factors. The beetle has been collected from mature virgin forests, open pastureland, and grasslands. While certain types of soil conditions are not suitable for carcass burial (such as very xeric, saturated, or loose sandy soils), the availability of appropriate carrion appears to be more of a limiting factor (Raithel, 1991). It is assumed due to their wide range of habitat types and mobility, they are likely to occur in all land-based action areas, including any proposed mitigation sites.

The MKARNS and associated operational and maintenance activities are located primarily in or along the floodplains of the Arkansas and Verdigris rivers. The habitats associated with this area are primarily bottomland hardwoods, agricultural areas, and wetlands. Very little, if any, of the preferred habitat for the ABB is found on USACE property associated with the MKARNS. However, given the mobility of this species, it is highly probable that it does, at times, occur on periphery areas of the MKARNS if suitable habitat and carrion are present. Because dredged material has been placed on upland sites and mitigation will occur on agricultural areas, as outlined in Section 2, there is potential for loss of habitat for this species. Therefore, activities associated with the emergency dredging and proposed habitat mitigation may affect this species.

2.8.2.2. Species Conservation Needs Within the Action Area

Conservation needs within the action area include pre-surveying and removing ABB from sites before implementation of construction.

2.8.2.3. Habitat Condition (General)

Natural Food Source (Carrion the size of a dove or a chipmunk)

- It is unknown the exact quantity of natural food sources for the ABB within the action areas. However, it can be assumed wildlife such as mice, squirrels, and small birds were present within the Below Lock 16 site. Adjacent areas were abundant with leaf litter, vines, and trees between 10 and 20 inches DBH. It can be assumed appropriate carrion for ABB were present within the impacted site. In addition to the dredge disposal site, the mitigation areas with existing agricultural uses may also be abundant in invertebrates and mice. Any invertebrates at a site have the likelihood of attracting small birds, amphibians, and reptiles.

2.8.2.4. Influences

The reason for decline of ABB population are not known. Some of the more widely accepted reasons include: direct habitat destruction through fragmentation, habitat loss, pesticides, predation or species-specific disease, interspecific Nicrophorus competition, and outdoor lighting (USFWS, 1991).

2.8.2.5. Additional Baseline Information

Species specific surveys were not conducted for this the study. American Burying Beetle occupancy of scrub-shrub, uplands, grasslands, agricultural lands, and bottomland hardwood forest is assumed due to the presence of suitable habitat.

The USACE has conducted surveys for ABB on several projects with negative results. Surveys have been conducted at selected areas at Keystone Lake, along Mingo and Fry creeks, Hugo Lake, Wister Lake, Fall River Lake, and Robert S. Kerr Pool. However, these surveys were completed for small areas where minor construction activities were proposed and did not include a survey of the entire project.

2.8.3. Effects of the Action

2.8.3.1. Indirect Interactions

Table 11. Indirect Interactions on American Burying Beetle

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
Natural food sources (carrion the size of a dove or a chipmunk)	Decrease in vegetation Change in topography Increase in invasive plant species	Habitat Mitigation	Approximately 10 acres of ABB habitat were impacted by the Emergency Action. It can be assumed this resource has been permanently impacted and will	*Individuals assumed to have been affected.* Construction activities and related habitat disturbance may temporarily reduce local rodent

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
	Increase in Dust Increase in Soil Compaction Increase in Noise Increase in Soil Disturbance		not be restored at the Below Lock 16 location.	populations that would provide carrion for ABBs. Destruction and alteration of vegetation through clearing, grading, and contouring can also reduce local rodent and bird populations that provide carrion. Some of these effects are temporary, like the case for the mitigation areas, but the disposal site will have a permanent effect. These indirect effects have the potential to impact individual ABBs, eggs, or larvae. It can be assumed the Habitat Mitigation conservation measure, although would have temporary adverse impacts, would eventually result in beneficial

Resource Need	Stressors	Conservation Measures	Amount of Resource Impacted	Individuals Affected
				impacts with improved habitat for carrion species through native species and invasive species management.

2.8.3.2. Direct Interactions

Any ABB present during bottomland hardwood forest removal and dredge disposal (10 acres) would, at best-case scenario, be dispersed from the area. The same can be said for any ABB present during construction of habitat mitigation areas through the change in land use from agricultural to emergent wetland, forested wetland, and bottomland hardwood forest (104.3 acres). In the worst-case scenario, live individuals would be harmed or killed by heavy equipment activities or the action of ground clearing.

Construction activities associated with Below Lock 16 and proposed mitigation areas may disturb soils in areas within the ABB's range and have the potential to harm, harass, or kill individuals. Typical individual construction projects are relatively short-term, usually completed in fewer than 60 days.

These activities could result in the direct mortality of individual ABBs or broods, or create conditions that lessen the chance of survival of individuals or broods. In summary, ground disturbance associated with disposal of dredged material could result in take of individual ABBs, eggs, or larvae in eastern Oklahoma.

2.8.4. Cumulative Effects

Climate change, in combination with drought cycles, is likely to exacerbate existing threats to all species within the southwestern United States.

Overall land use changes around the MKARNS can be considered a cumulative effect. Private land use can lead to the conversion of suitable habitats for ABB or can cause the slow degradation of these habitats. A decline in areas with appropriate native vegetation can reduce the availability of carrion species for ABB.

2.8.5. Discussion and Conclusion

Determination: "May Affect, and is Likely to Adversely Affect"

Limited sampling has failed to document American burying beetles on USACE-managed properties around the action area. However, given the mobility of this species and the limited sampling that has occurred, it is reasonable to assume that it is present in suitable habitats. There is; therefore, potential for direct and indirect adverse effects to ABB from the land use changes associated with the tree clearing, sediment disposal, and habitat mitigation. It is believed that the levels of take realized from the Emergency Actions were minimal. However, it will be necessary to include the take of American burying beetle impacts in the annual account under the 2016 BO.

Section 3. Critical Habitat Effects Analysis

There are no critical habitats within the action areas; therefore, none will be affected.

Section 4. Summary Discussion, Conclusion, and Effect Determinations

4.1. Effect Determination Summary

The Emergency Action was evaluated, and the effects determined in accordance with the ESA. Potential direct, indirect, and cumulative impacts identified are summarized, by species, below and in Section 4.2.

Table 12. Effect Determination Summary

Species (Common Name)	Scientific Name	Listing Status	Present in Action Area	Effect Determination
Gray Bat	*Myotis grisescens*	Endangered	No	No Effect
Indiana Bat	*Myotis sodalis*	Endangered	No	Not Likely to Adversely Affect
Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	Yes	Likely to Adversely Affect
Ozark Big-eared Bat	*Corynorhinus (=Plecotus) townsendii ingens*	Endangered	No	No Effect
Least Tern		Endangered	No	Not Likely to Adversely Affect
Piping Plover	*Charadrius melodus*	Threatened	No	No Effect
Red Knot	*Calidris canutus rufa*	Threatened	No	No Effect
Whooping Crane	*Grus americana*	Endangered	No	No Effect
Ozark Cave Fish	*Amblyopsis rosae*	Threatened	No	No Effect
Neosho Mucket	*Lampsilis rafinesqueana*	Endangered	No	No Effect

Rabbitsfoot	*Quadrula cylindrica cylindrica*	Threatened	No	No Effect
American Burying Beetle	*Nicrophorus americanus*	Threatened	Yes	Likely to Adversely Affect

4.2. Summary Discussion

The finding of "No Effect" for the above-listed species was based on several considerations. For some, their range is within the larger regional or county-wide areas but does not encompass the specific action areas because habitat or other ecological needs are not sufficient to support their presence. Other species may have previously occurred in the specific action areas but no longer occur there because of similar limitations. For above-listed species that may occur in or near the action areas the potential impacts from ongoing or proposed USACE actions were considered inconsequential.

This assessment further concludes that the Emergency Actions' direct, indirect, and cumulative effect "May Affect, but is Not Likely to Adversely Affect" the Indiana bat and ILT. The determination for the Indiana bat is a combination of the factors listed above. Although suitable habitat may have been present at Below Lock 16, it is likely the range of the bat is not included in the action areas based on regional maps, recovery plans, and information collected from OHNI.

With dredging there is potential to introduce otherwise unavailable contaminants into the aquatic environment for subsequent assimilation into the ILT food source. Conversely, strategic disposal of materials resulting from dredging actions has been used to create additional nesting habitat in the MKARNS. In addition, the creation of emergent and forested wetland habitat will beneficially impact aquatic invertebrates and fish that can supplement the diet of ILT.

In addition to these determinations, USACE has concluded the Emergency Action's direct, indirect, and cumulative effects "May Affect, and is Likely to Adversely Affect" the NLEB and ABB.

The ABB is the only species that has the potential to be adversely affected by the proposed mitigation. Because the mitigation sites are terrestrial-based, it is likely ABB could be on-site. However, this mitigation work is necessary to compensate for impacts to emergent wetlands, forested wetlands, and bottomland hardwood forests. It can be expected that an overall increase of these habitats will yield beneficial results for all species that may have been affected through the Emergency Action through increased available habitat, cover, and food sources.

Because the conservation measures normally associated with tree removal were not implemented, the NLEB may have been affected by the destruction of maternity roost trees in potential summer habitat. Habitat mitigation of bottomland hardwood forest will account for the creation of new trees available for roosting; however, this conservation measure will take some time to complete due to the growth requirements of appropriate species.

4.3. Conclusion

The project will have “No Effect” on gray bat, Ozark big-eared bat, piping plover, red knot, whooping crane, Ozark cave fish, Neosho mucket, and rabbitsfoot. The project “May Affect, but is Not Likely to Adversely Affect” Indiana bat and ILT. The project “May Affect, and is Likely to Adversely Affect” NLEB and ABB. There will be no impacts to critical habitat resulting from the Emergency Action and associated habitat mitigation.

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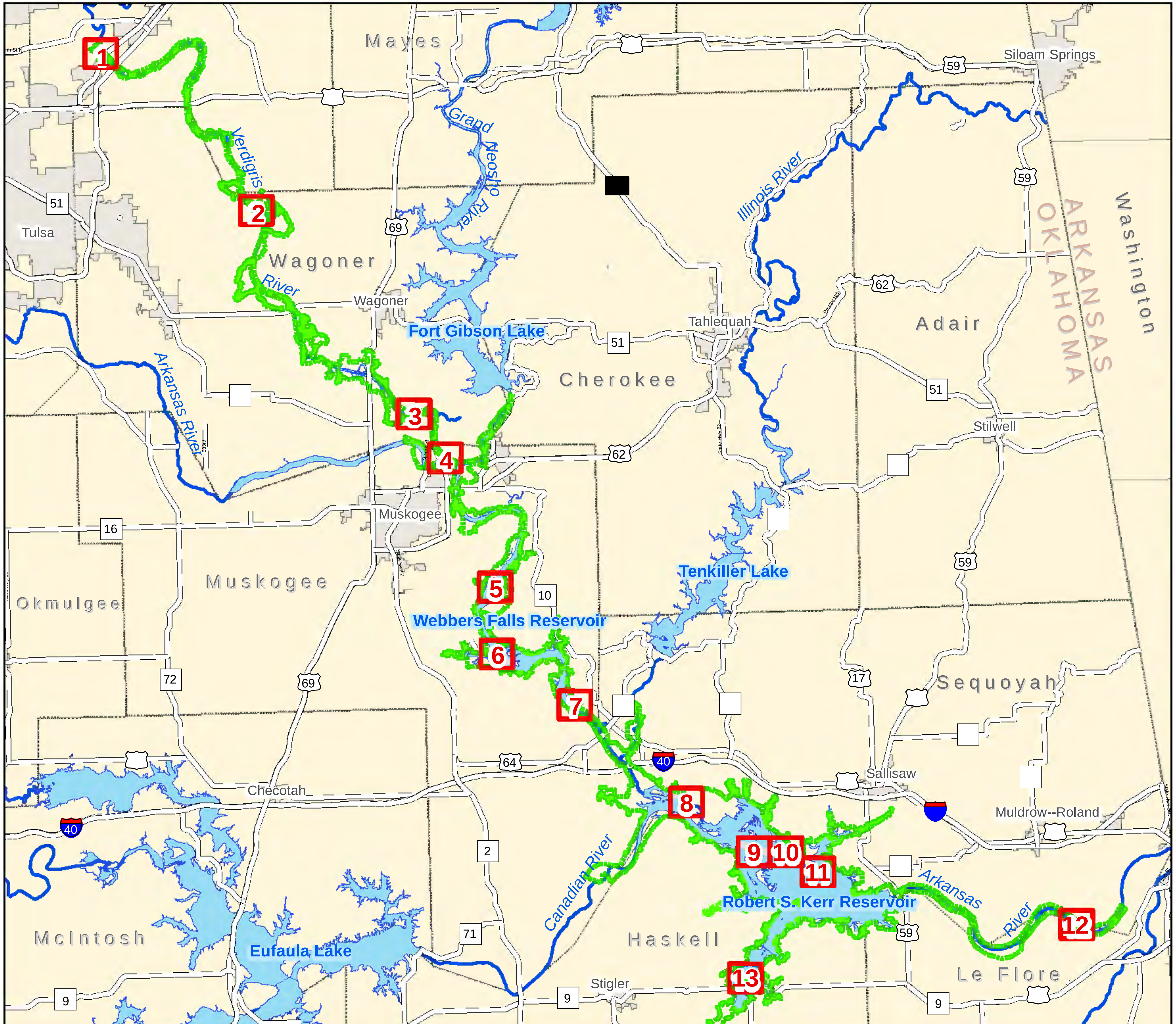
Attachment A



INDEX GRID
DREDGE AREA
STUDY AREA
DMMP DISPOSAL SITE

ADVERSE IMPACT

BOTTOMLAND HARDWOOD DISPOSAL SITE
EMERGENT WETLAND DISPOSAL SITE
FORESTED WETLAND DISPOSAL SITE
OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

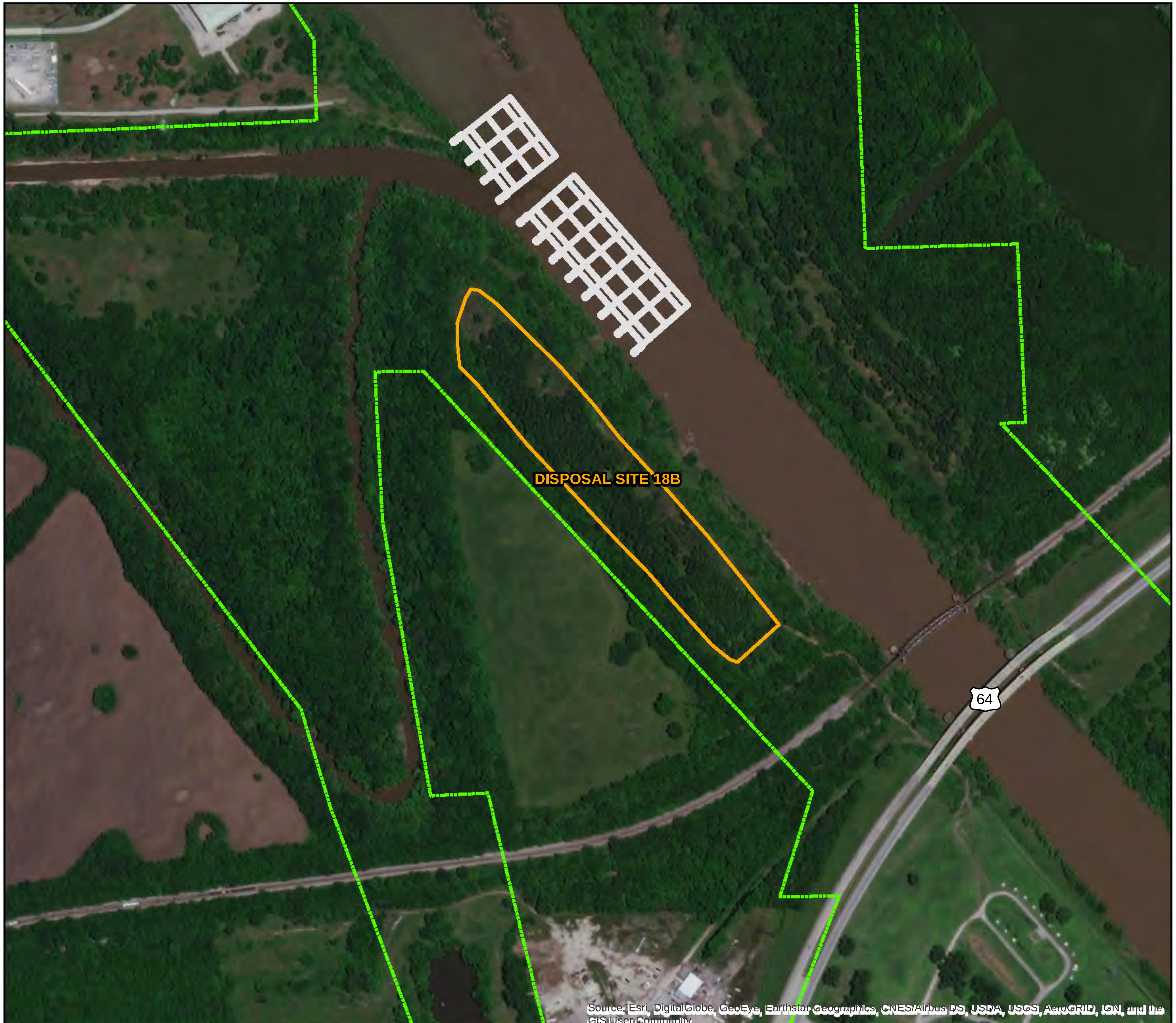
AFTER ACTION ENVIRONMENTAL ASSESSMENT

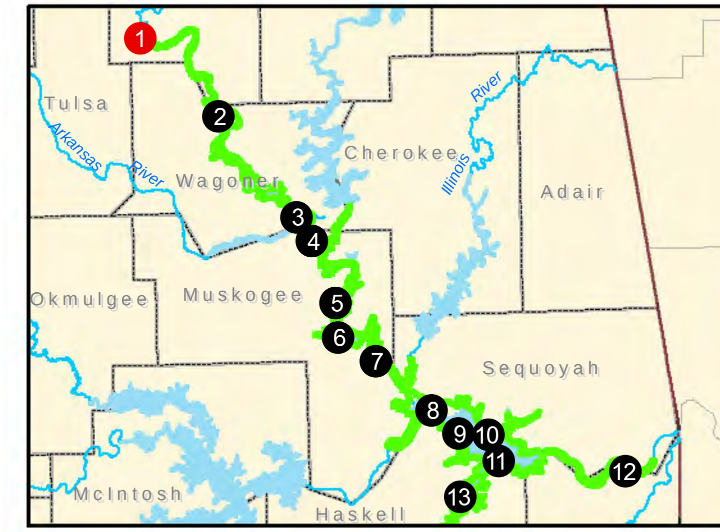
INDEX SHEET

N

0 3.75 7.5 15 Miles

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-00





DREDGE AREA
STUDY AREA
DMMP DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 01

N

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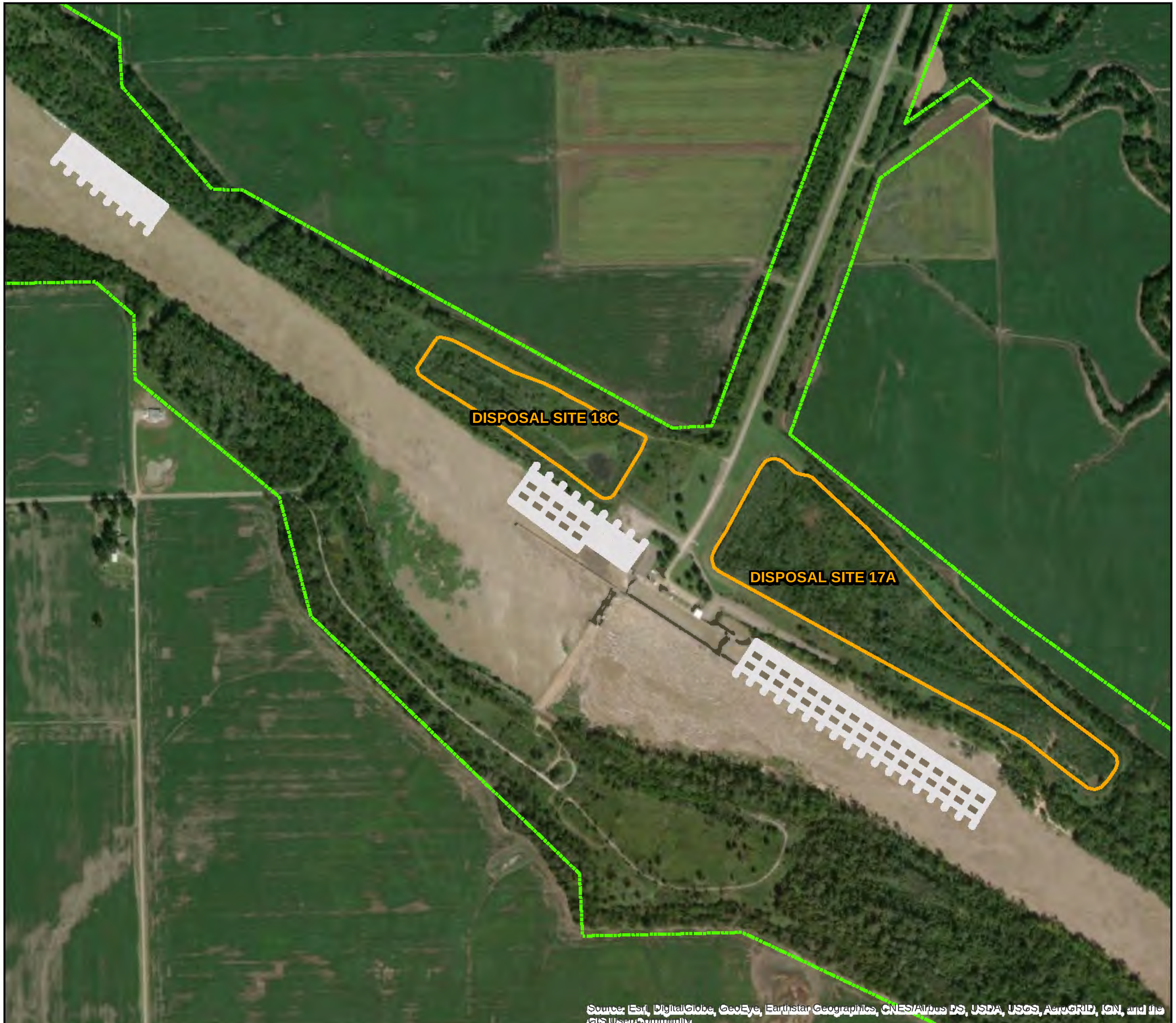

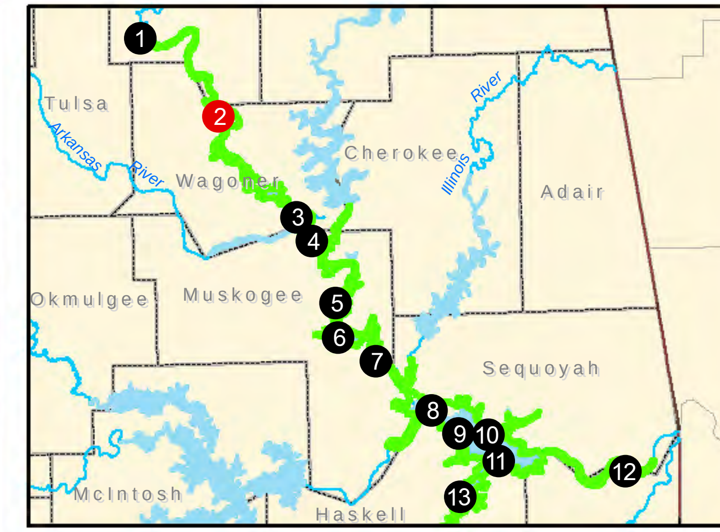

DREDGE AREA
STUDY AREA
DMMP DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 02

N

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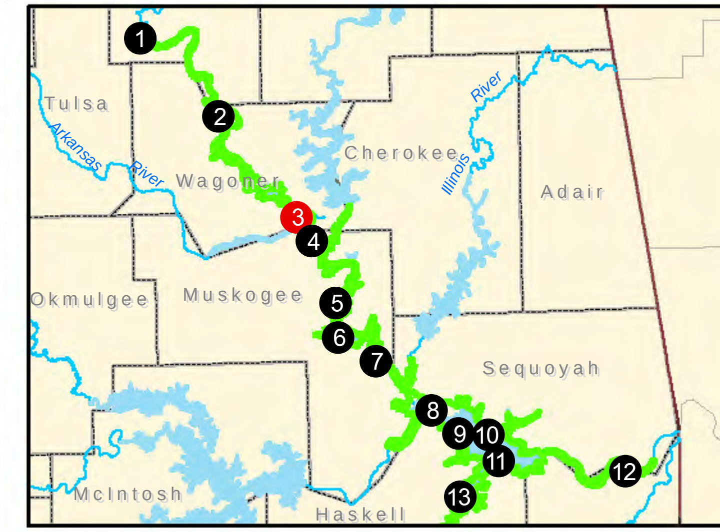
DATE:	MAP NO.
MARCH 2021	MKARNS-EA-02



STUDY AREA

DMMP DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 03

N

0 250 500 1,000 Feet

DATE: MARCH 2021

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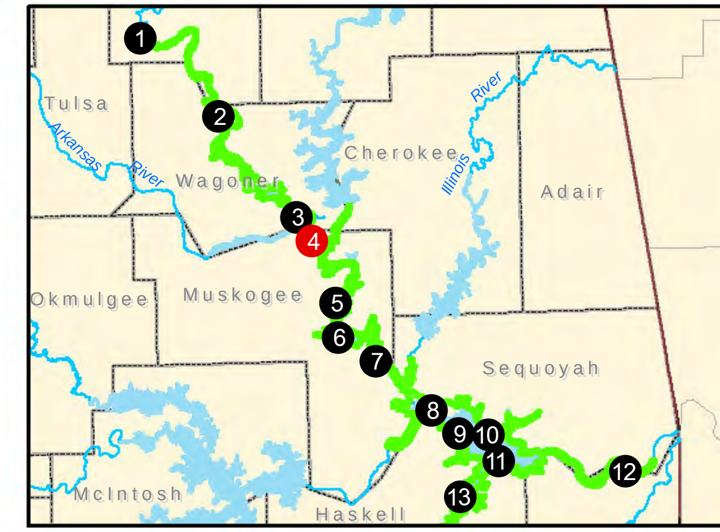

STUDY AREA

DMMP DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 04

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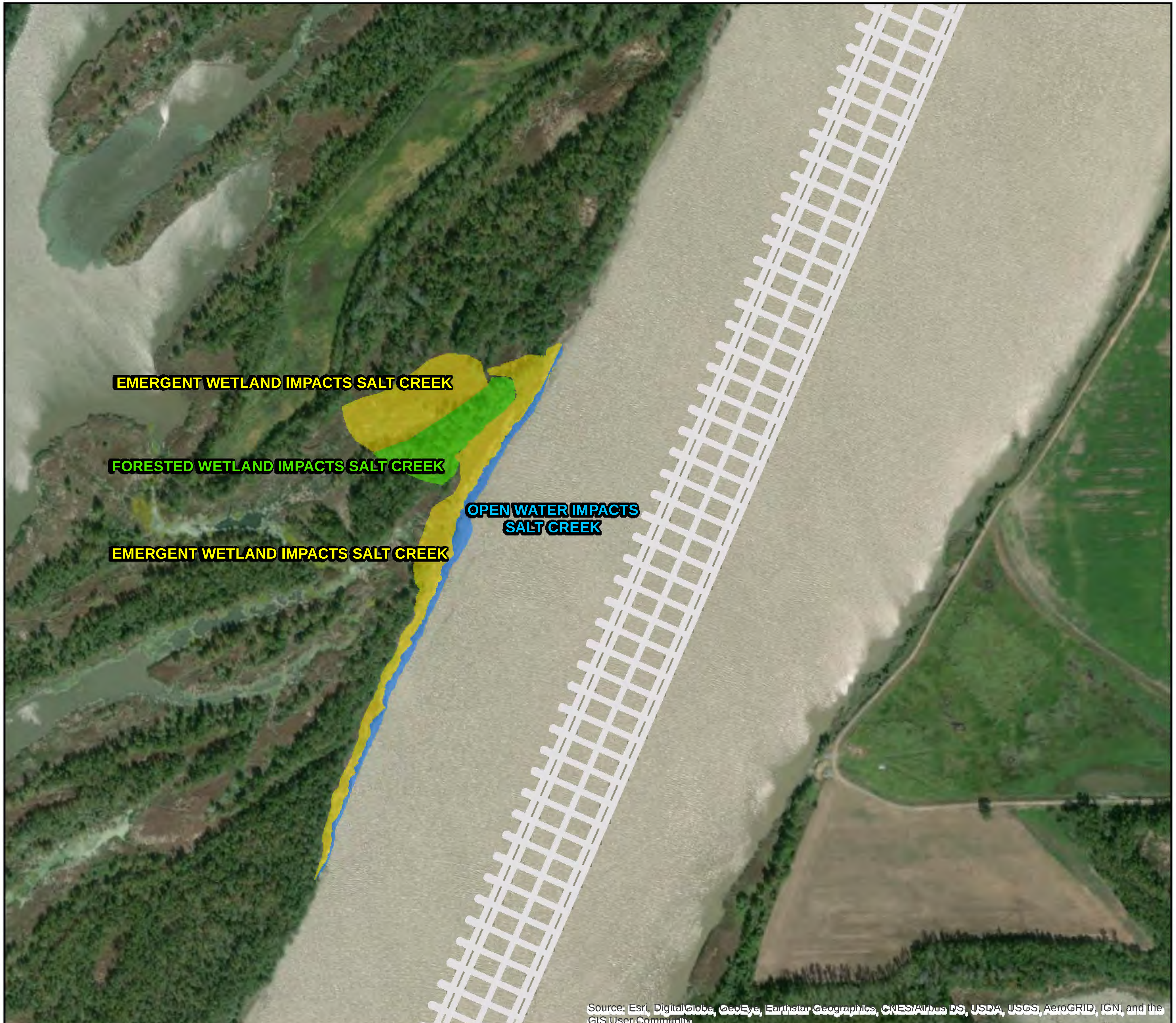
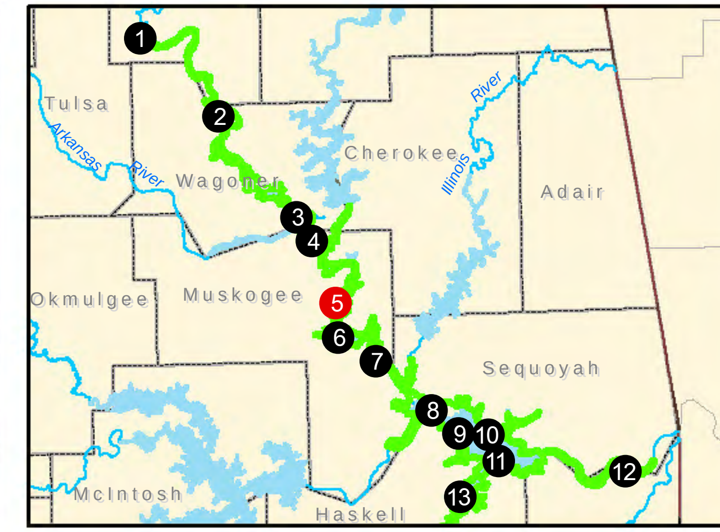
DATE:	MAP NO.
MARCH 2021	MKARNS-EA-04





DREDGE AREA

STUDY AREA

ADVERSE IMPACT AREAS

EMERGENT WETLAND DISPOSAL SITE

FORESTED WETLAND DISPOSAL SITE

OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 05

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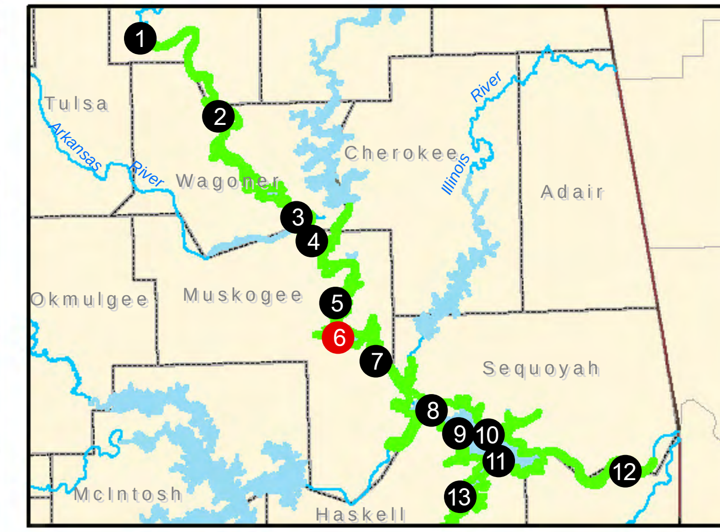

DREDGE AREA

STUDY AREA

ADVERSE IMPACT AREAS

OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 06

N

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DATE:	MAP NO.
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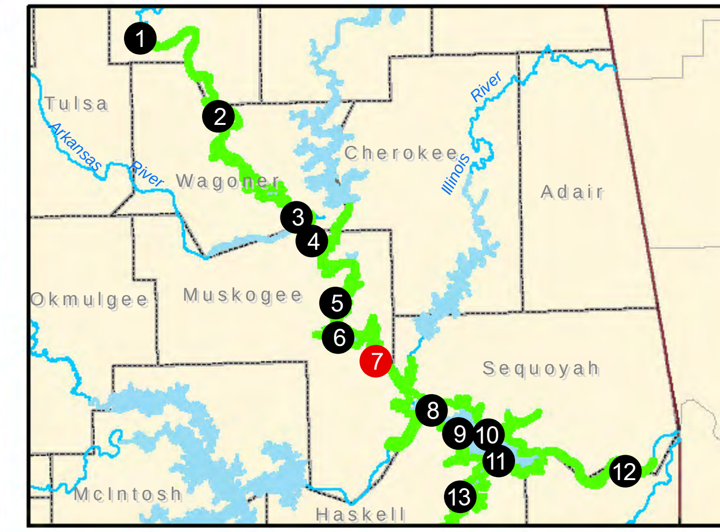


DREDGE AREA

ADVERSE IMPACT AREAS

BOTTOMLAND HARDWOOD DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

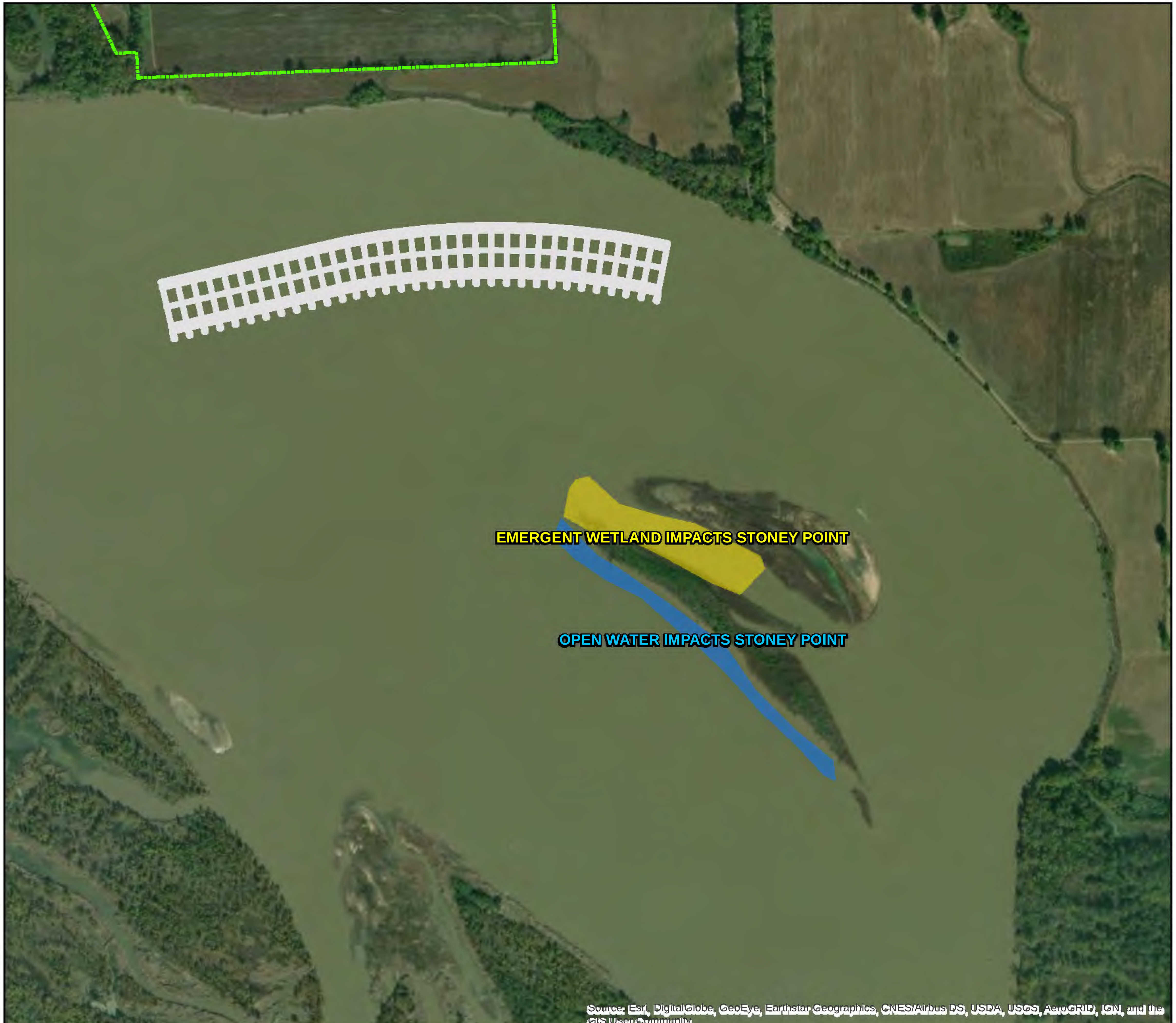
AFTER ACTION ENVIRONMENTAL ASSESSMENT

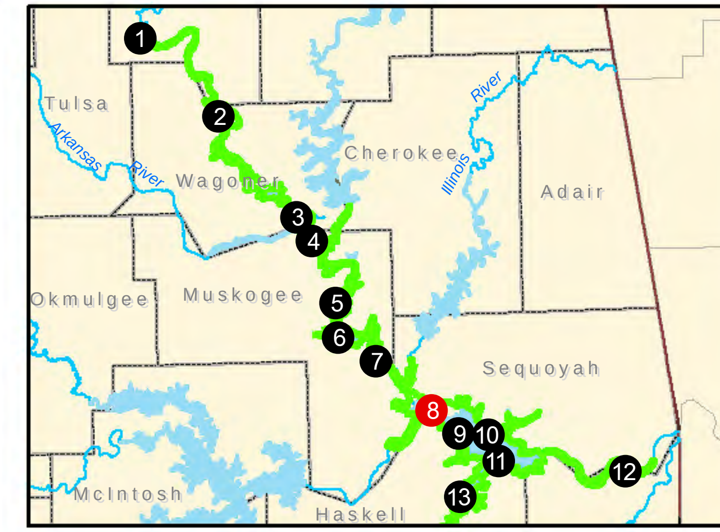
INDEX SHEET 07

N

0 300 600 1,200 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-07





DREDGE AREA
STUDY AREA

ADVERSE IMPACT AREAS

EMERGENT WETLAND DISPOSAL SITE
OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

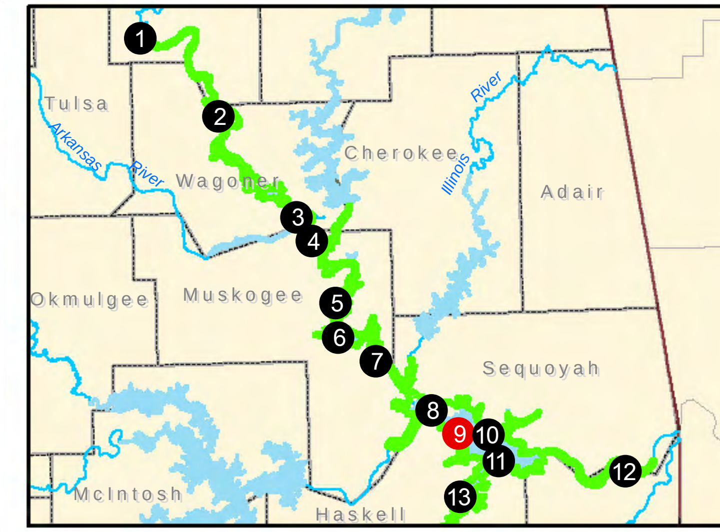
AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 08

N

0 350 700 1,400 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-08



DREDGE AREA
STUDY AREA
ADVERSE IMPACT AREAS
EMERGENT WETLAND DISPOSAL SITE
OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 09

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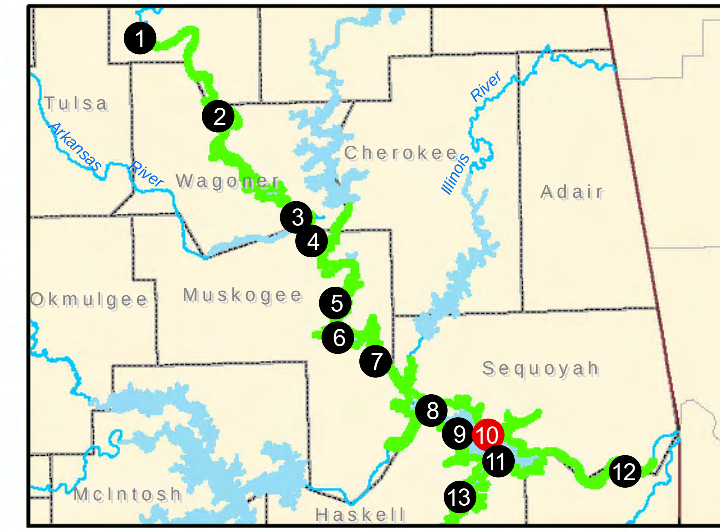
0 500 1,000 2,000 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-09



DREDGE AREA

STUDY AREA

ADVERSE IMPACT AREAS

OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

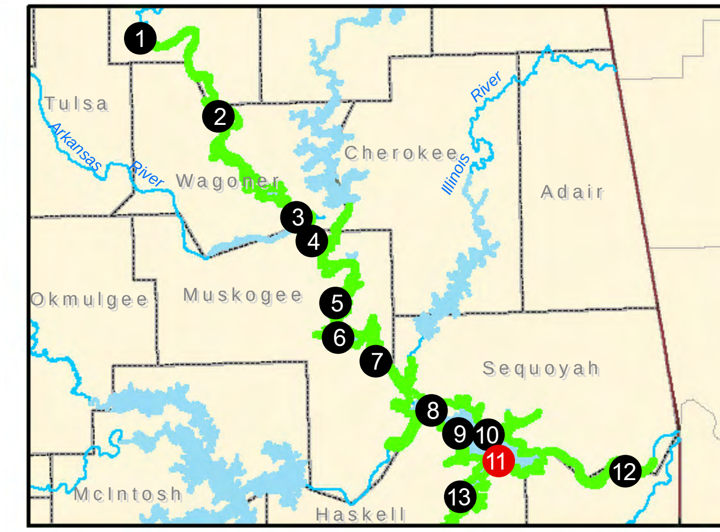
AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 10

N

0 450 900 1,800 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-10



DREDGE AREA
STUDY AREA
ADVERSE IMPACT AREAS
OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

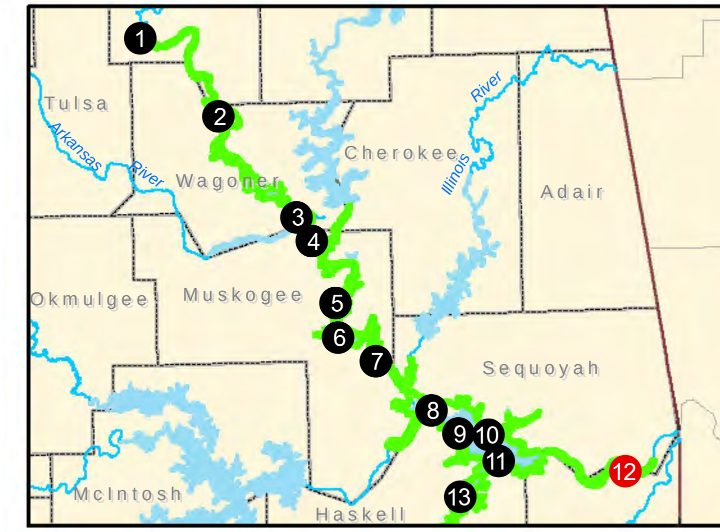
AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 11

N

0 250 500 1,000 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-11



DREDGE AREA
STUDY AREA
DMMP DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

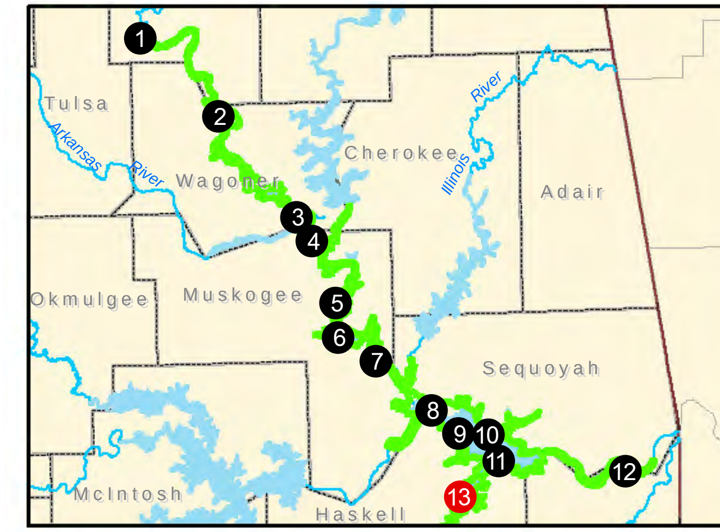
AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 12

N

0 250 500 1,000 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-12



DREDGE AREA

STUDY AREA

ADVERSE IMPACT AREAS

OPEN WATER DISPOSAL SITE

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

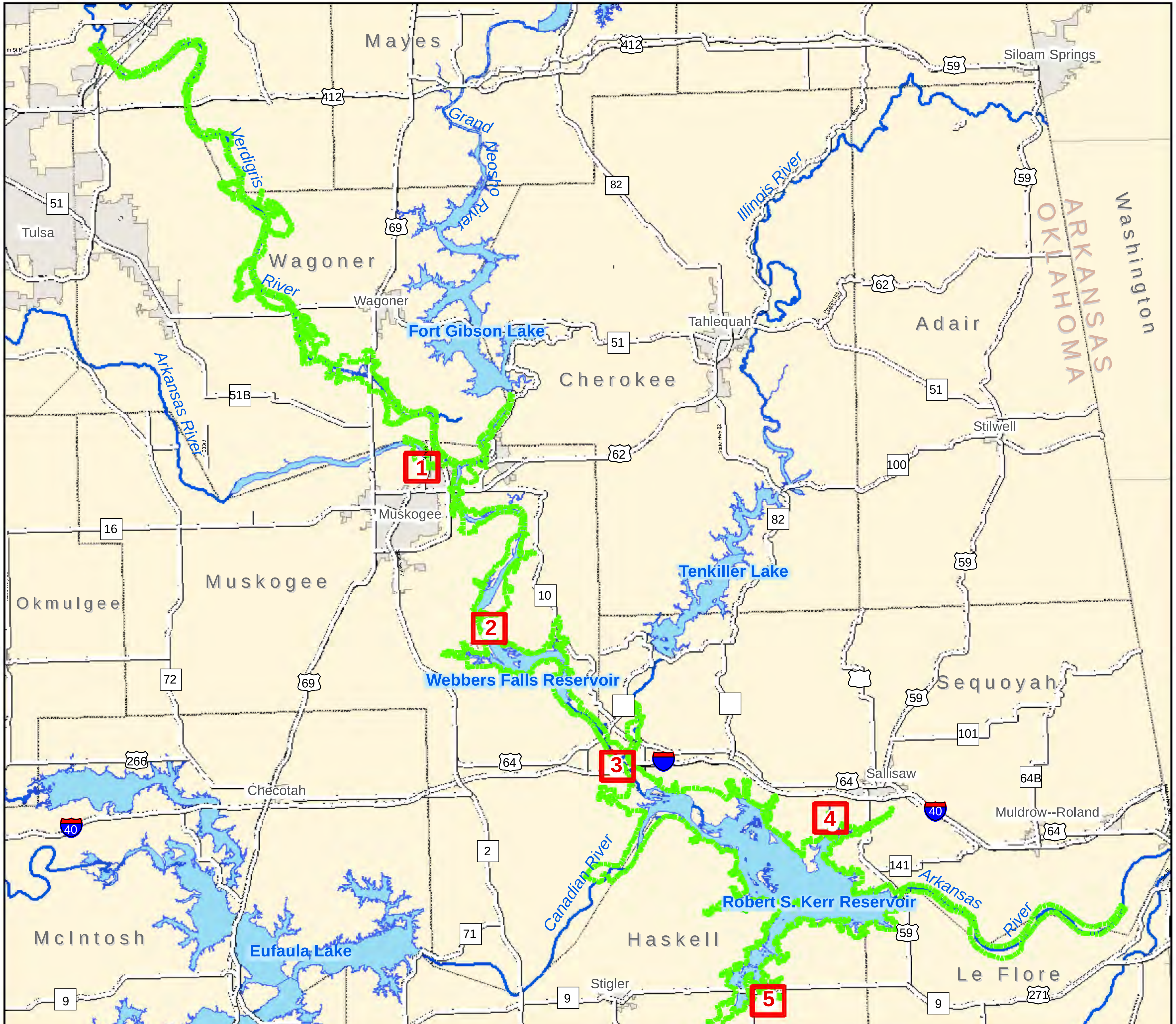
AFTER ACTION ENVIRONMENTAL ASSESSMENT

INDEX SHEET 13

N

0 450 900 1,800 Feet

DATE:	MAP NO.
MARCH 2021	MKARNS-EA-13



SECURITY FENCE
INDEX GRID
STUDY AREA
BOTTOMLAND HARDWOOD MITIGATION
EMERGENT WETLAND MITIGATION
FORESTED WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

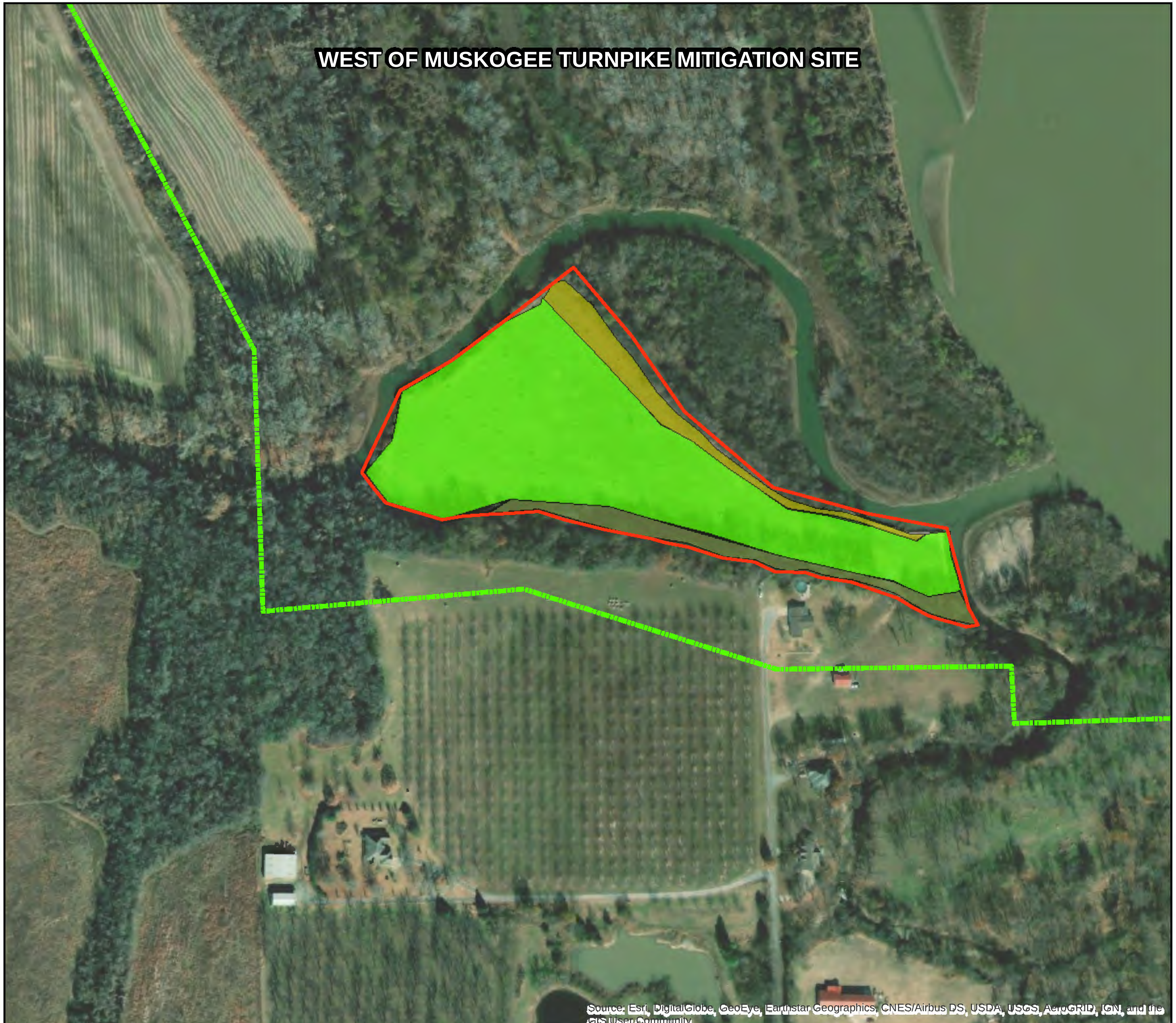
AFTER ACTION MITIGATION SITES

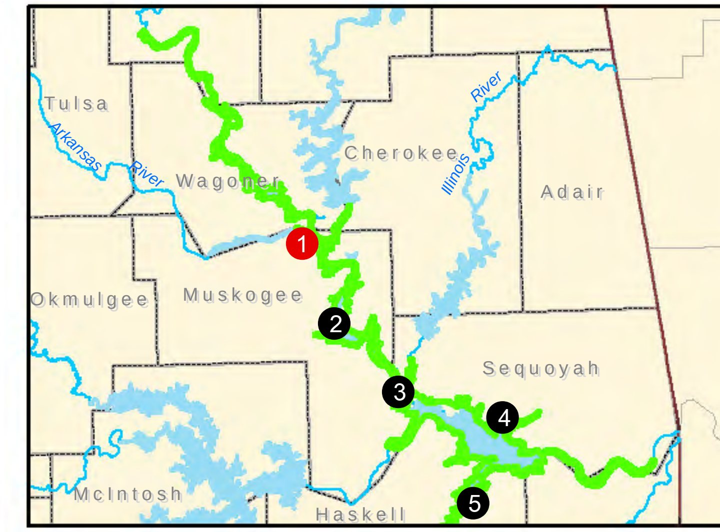
INDEX SHEET

N

0 3.75 7.5 15 Miles

DATE:	MAP NO.
JUNE 2021	MKARNS-MI-00





SECURITY FENCE

STUDY AREA

BOTTOMLAND HARDWOOD MITIGATION

EMERGENT WETLAND MITIGATION

FORESTED WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

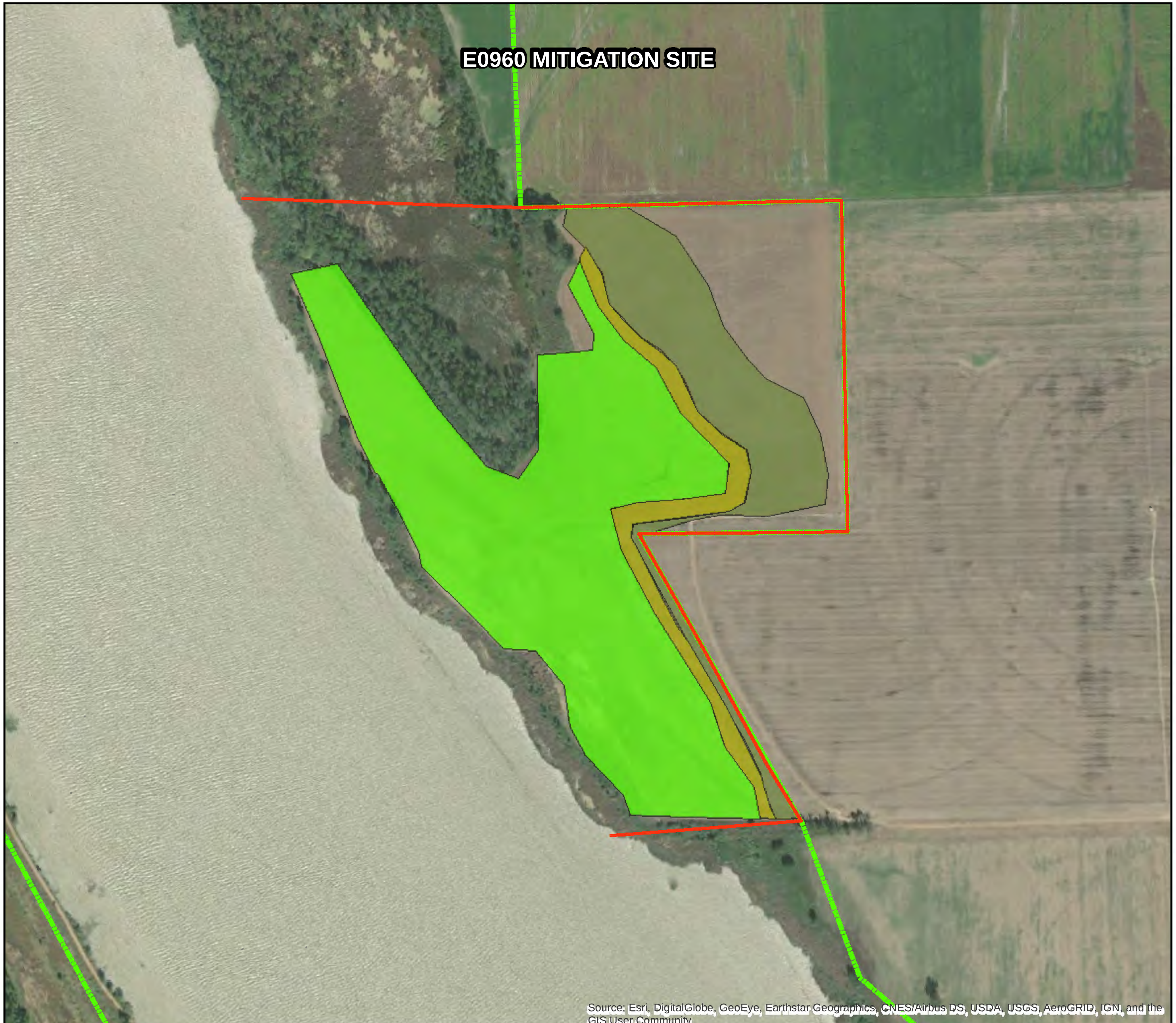
AFTER ACTION MITIGATION SITES

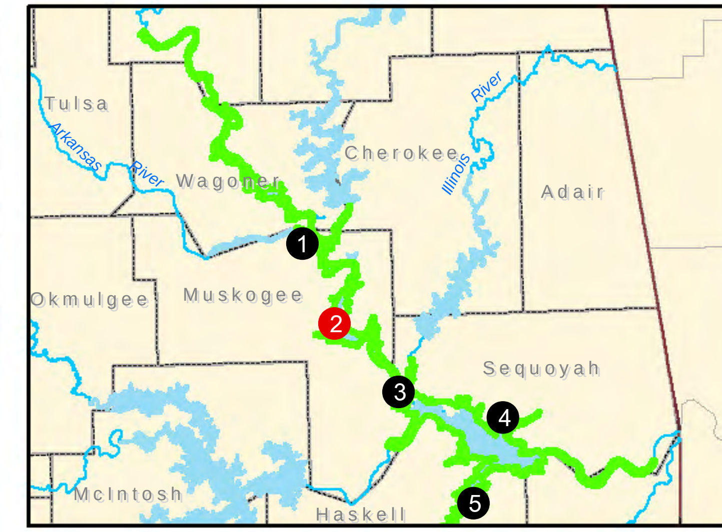
INDEX SHEET 01

N

0 150 300 600 Feet

DATE:	MAP NO.
JUNE 2021	MKARNS-MI-01





SECURITY FENCE
STUDY AREA
BOTTOMLAND HARDWOOD MITIGATION
EMERGENT WETLAND MITIGATION
FORESTED WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

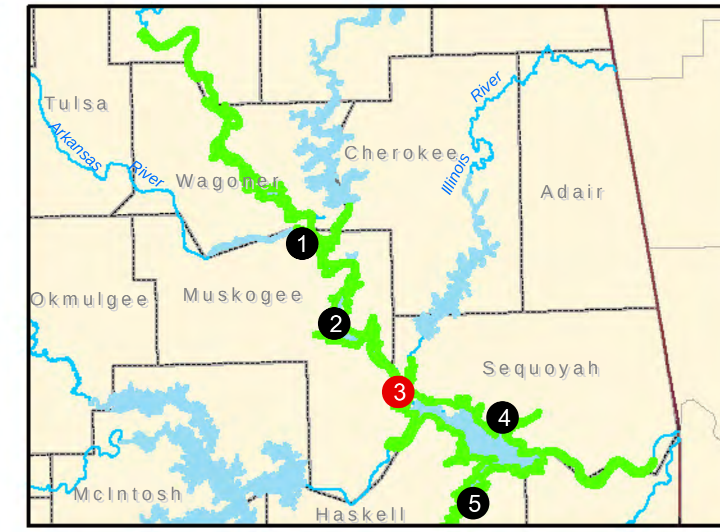
AFTER ACTION MITIGATION SITES

INDEX SHEET 02

N

0 250 500 1,000 Feet

DATE:	MAP NO.
JUNE 2021	MKARNS-MI-02



- SECURITY FENCE
- STUDY AREA
- BOTTOMLAND HARDWOOD MITIGATION
- EMERGENT WETLAND MITIGATION
- FORESTED WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

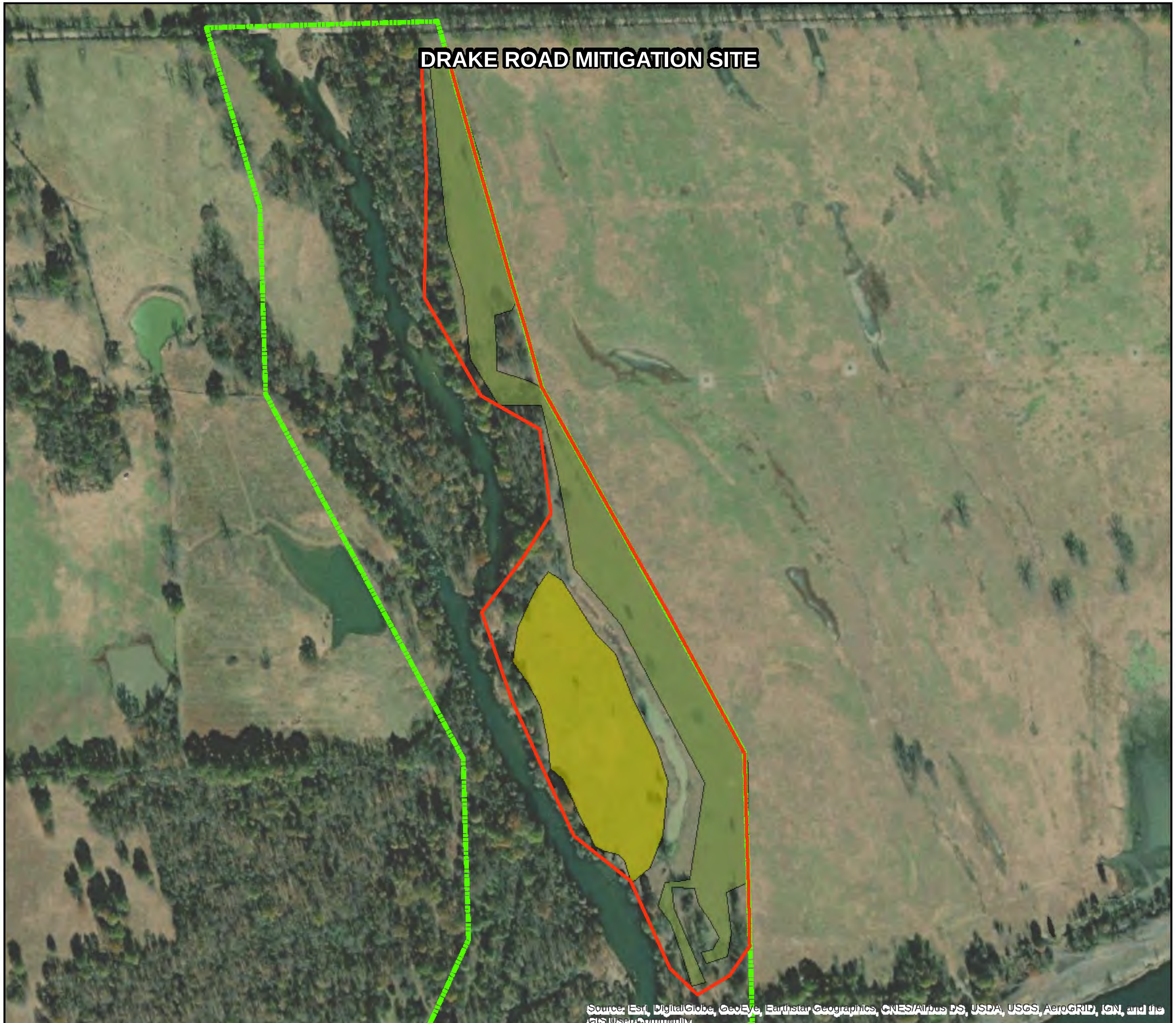
AFTER ACTION MITIGATION SITES

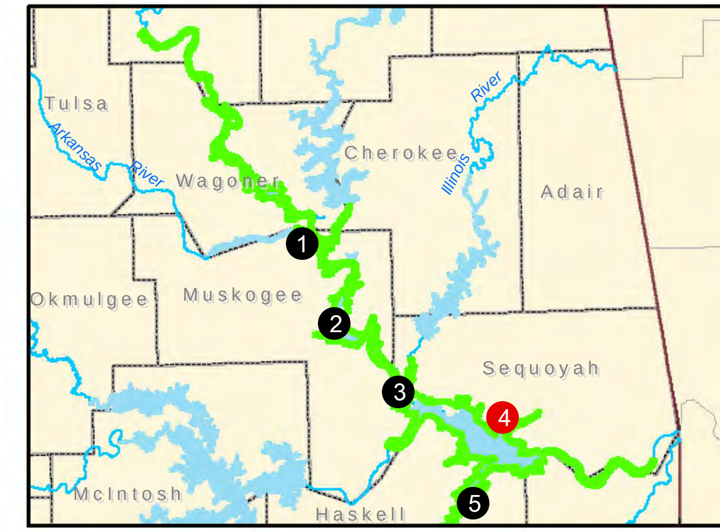
INDEX SHEET 03

N

0 125 250 500 Feet

DATE:	MAP NO.
JUNE 2021	MKARNS-MI-03





SECURITY FENCE
STUDY AREA
BOTTOMLAND HARDWOOD MITIGATION
FORESTED WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

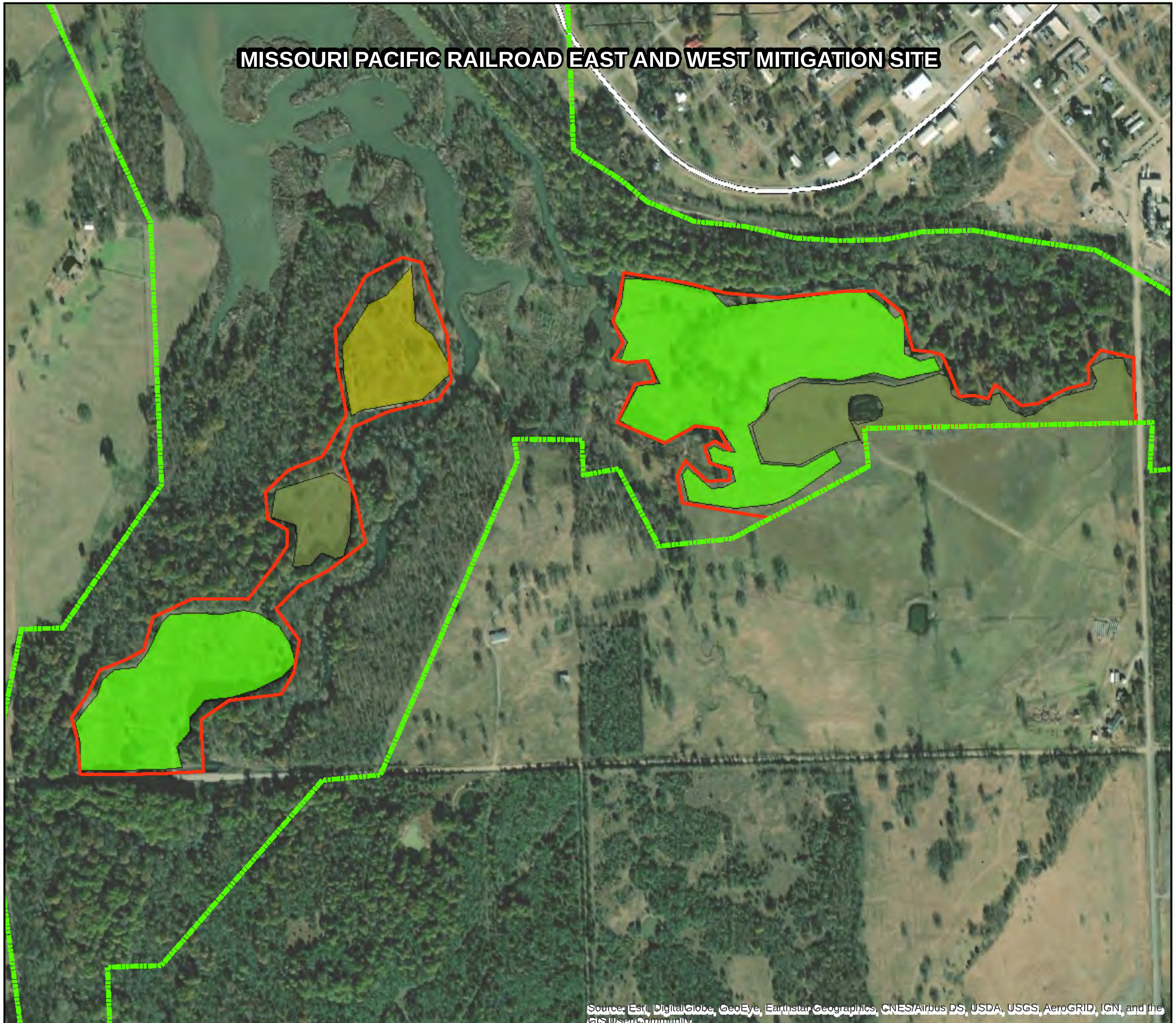
AFTER ACTION MITIGATION SITES

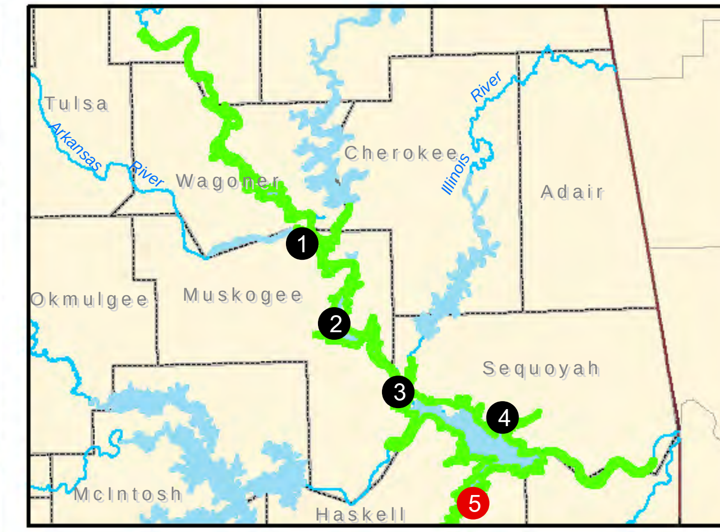
INDEX SHEET 04

N

0 225 450 900 Feet

DATE:	MAP NO.
JUNE 2021	MKARNS-MI-04





SECURITY FENCE
STUDY AREA
BOTTOMLAND HARDWOOD MITIGATION
EMERGENT WETLAND MITIGATION
FORESTED WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION MITIGATION SITES

INDEX SHEET 05

N

0 250 500 1,000 Feet

DATE:	MAP NO.
JUNE 2021	MKARNS-MI-05

INDEX GRID
STUDY AREA

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

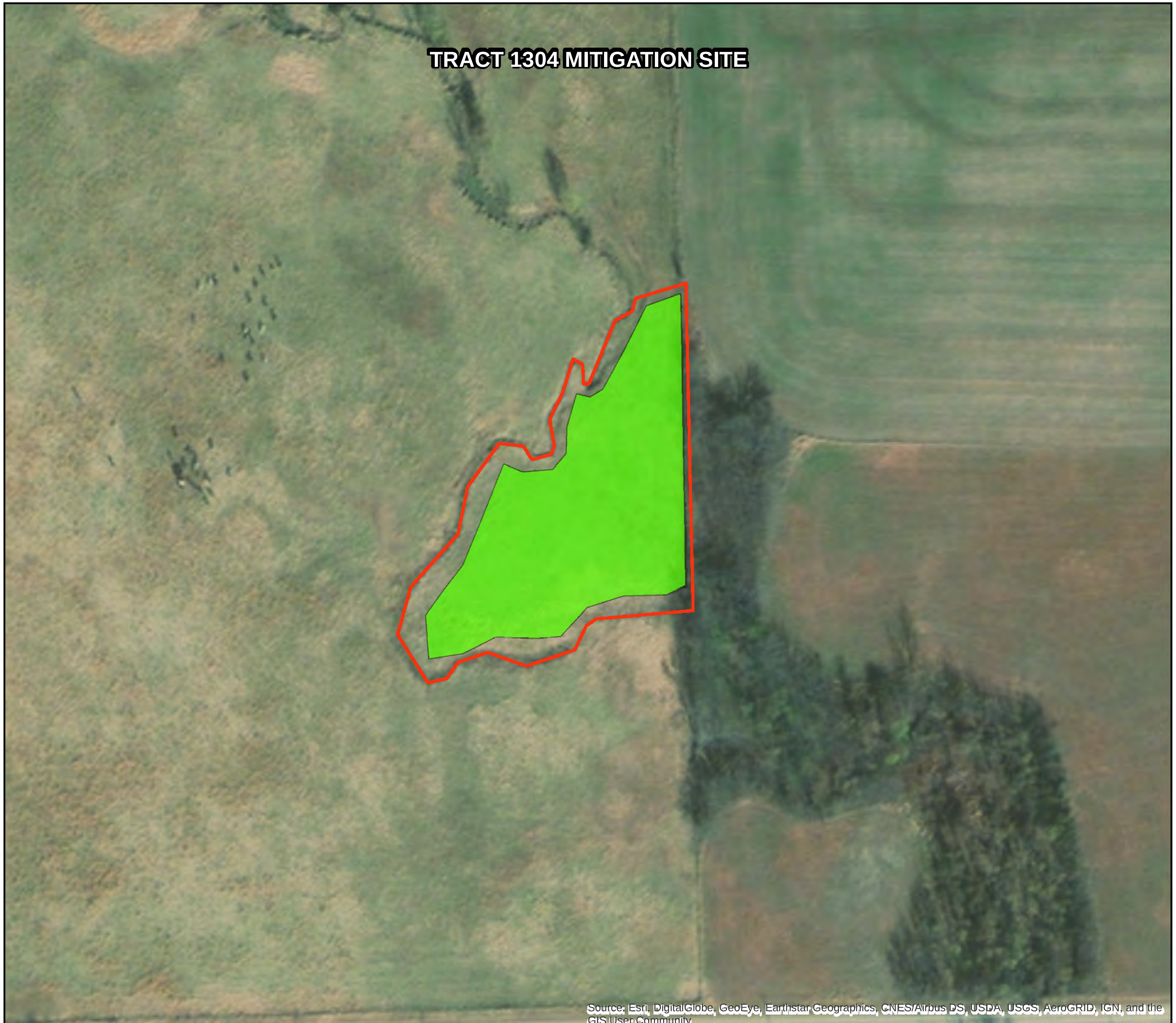
AFTER ACTION BACKUP MITIGATION SITES

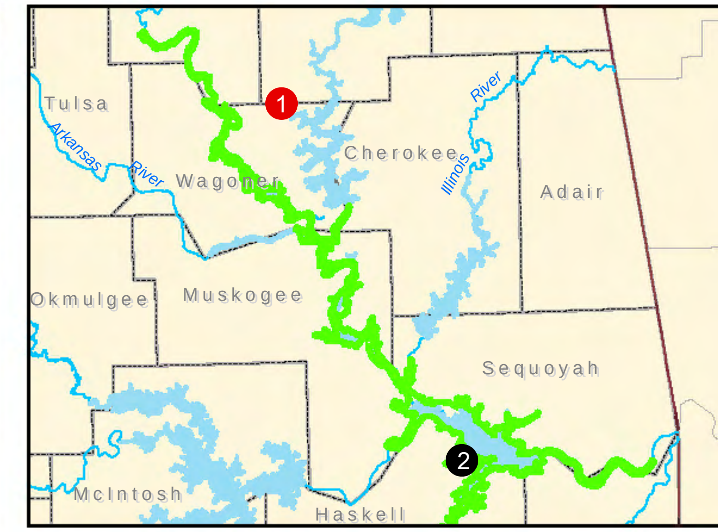
INDEX SHEET

N

0 3.75 7.5 15 Miles

DATE:	MAP NO.
AUGUST 2021	MKARNS-BM-00





SECURITY FENCE

EMERGENT WETLAND MITIGATION

U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

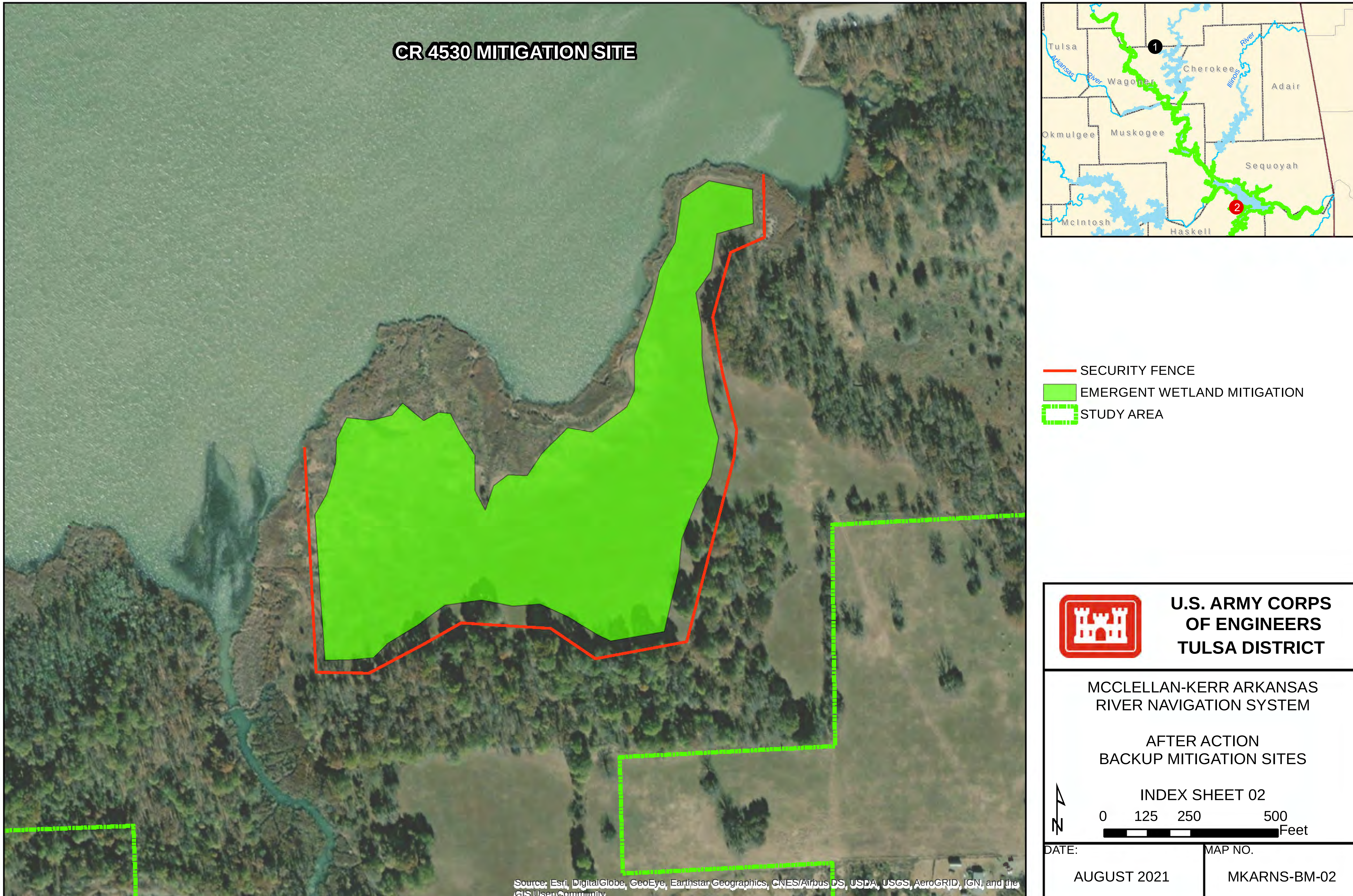
AFTER ACTION BACKUP MITIGATION SITES

INDEX SHEET 01

N

0 50 100 200 Feet

DATE:	MAP NO.
AUGUST 2021	MKARNS-BM-01



U.S. ARMY CORPS OF ENGINEERS TULSA DISTRICT

MCCLELLAN-KERR ARKANSAS RIVER NAVIGATION SYSTEM

AFTER ACTION BACKUP MITIGATION SITES

INDEX SHEET 02

DATE:	MAP NO.
AUGUST 2021	MKARNS-BM-02

Attachment B

PROJECT AREA PHOTOS


North – Below Lock 16


East – Below Lock 16


South – Below Lock 16


West – Below Lock 16


North – Salt Creek


East – Salt Creek


South – Salt Creek


West – Salt Creek

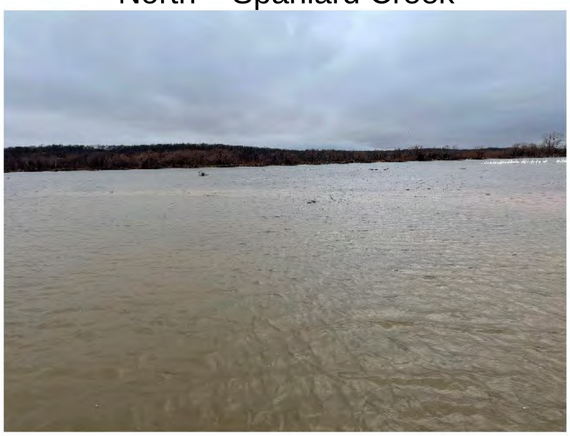
North – Sandtown Bottom

East – Sandtown Bottom

South – Sandtown Bottom

West – Sandtown Bottom

North – Spaniard Creek



South – Spaniard Creek

West – Spaniard Creek

North – Kerr Lake (RM 343)

East – Kerr Lake (RM 343)

South – Kerr Lake (RM 343)


North – Stoney Point


East – Stoney Point


South – Stoney Point


West – Stoney Point

San Bois Creek

San Bois Creek

San Bois Creek

San Bois Creek

PROPOSED MITIGATION AREA PHOTOS


West of Muskogee Turnpike


West of Muskogee Turnpike


West of Muskogee Turnpike


West of Muskogee Turnpike


E0960

E0960

E0960

E0960


North of I40


North of I40


North of I40


North of I40


Drake Road

Drake Road

Drake Road

Drake Road

Missouri Pacific Railroad East

Missouri Pacific Railroad East

Missouri Pacific Railroad East

Missouri Pacific Railroad East

Missouri Pacific Railroad West

Missouri Pacific Railroad West

Missouri Pacific Railroad West

Missouri Pacific Railroad West


CR4530


CR4530


CR4530


CR4530


Tract 1304


Tract 1304


Tract 1304


Tract 1304

Attachment C

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
Phone: (918) 581-7458 Fax: (918) 581-7467
http://www.fws.gov/southwest/es/Oklahoma/

In Reply Refer To: August 16, 2021
Consultation Code: 02EKOK00-2021-SLI-0783
Event Code: 02EKOK00-2021-E-07229
Project Name: MKARNS

Subject: Updated list of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq*.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Non-federal entities conducting activities that may result in take of listed species should consider seeking coverage under section 10 of the ESA, either through development of a Habitat Conservation Plan (HCP) or, by becoming a signatory to the General Conservation Plan (GCP) currently under development for the American burying beetle. Each of these mechanisms provides the means for obtaining a permit and coverage for incidental take of listed species during otherwise lawful activities.

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit through our Project Review step-wise process http://www.fws.gov/southwest/es/oklahoma/OKESFO%20Permit%20Home.htm.

Attachment(s):

- Official Species List

- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
(918) 581-7458

Project Summary

Consultation Code: 02EKOK00-2021-SLI-0783
Event Code: 02EKOK00-2021-E-07229
Project Name: MKARNS
Project Type: DREDGE / EXCAVATION
Project Description: After-Action EA regarding emergency dredging and disposal for the 2019 flooding.
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@35.733798,-95.22049320496131,14z

Counties: Oklahoma

Endangered Species Act Species

There is a total of 11 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Gray Bat *Myotis grisescens* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6329	Endangered
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened
Ozark Big-eared Bat *Corynorhinus (=Plecotus) townsendii ingens* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7245	Endangered

Birds

NAME	STATUS
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened
Whooping Crane *Grus americana* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/758	Endangered

Fishes

NAME	STATUS
Ozark Cavefish *Amblyopsis rosae* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6490	Threatened

Clams

NAME	STATUS
Neosho Mucket *Lampsilis rafinesqueana* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3788	Endangered
Rabbitsfoot *Quadrula cylindrica cylindrica* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/5165	Threatened

Insects

NAME	STATUS
American Burying Beetle *Nicrophorus americanus* Population: Wherever found, except where listed as an experimental population No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/66	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

The following FWS National Wildlife Refuge Lands and Fish Hatcheries lie fully or partially within your project area:

FACILITY NAME	ACRES
SEQUOYAH NATIONAL WILDLIFE REFUGE https://www.fws.gov/refuges/profiles/index.cfm?id=21640	20,917.939

Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
American Golden-plover *Pluvialis dominica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
American Kestrel *Falco sparverius paulus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9587	Breeds Apr 1 to Aug 31

NAME	BREEDING SEASON
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Sep 1 to Aug 31
Black-billed Cuckoo *Coccyzus erythropthalmus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9399	Breeds May 15 to Oct 10
Bobolink *Dolichonyx oryzivorus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 20 to Jul 31
Eastern Whip-poor-will *Antrostomus vociferus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 1 to Aug 20
Hudsonian Godwit *Limosa haemastica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Kentucky Warbler *Oporornis formosus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Apr 20 to Aug 20
Le Conte's Sparrow *Ammodramus leconteii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere
Lesser Yellowlegs *Tringa flavipes* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Prairie Warbler *Dendroica discolor* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 1 to Jul 31
Prothonotary Warbler *Protonotaria citrea* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Apr 1 to Jul 31
Red-headed Woodpecker *Melanerpes erythrocephalus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 10 to Sep 10
Rusty Blackbird *Euphagus carolinus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds elsewhere

NAME	BREEDING SEASON
Wood Thrush *Hylocichla mustelina* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 10 to Aug 31

Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence ( )

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ( )

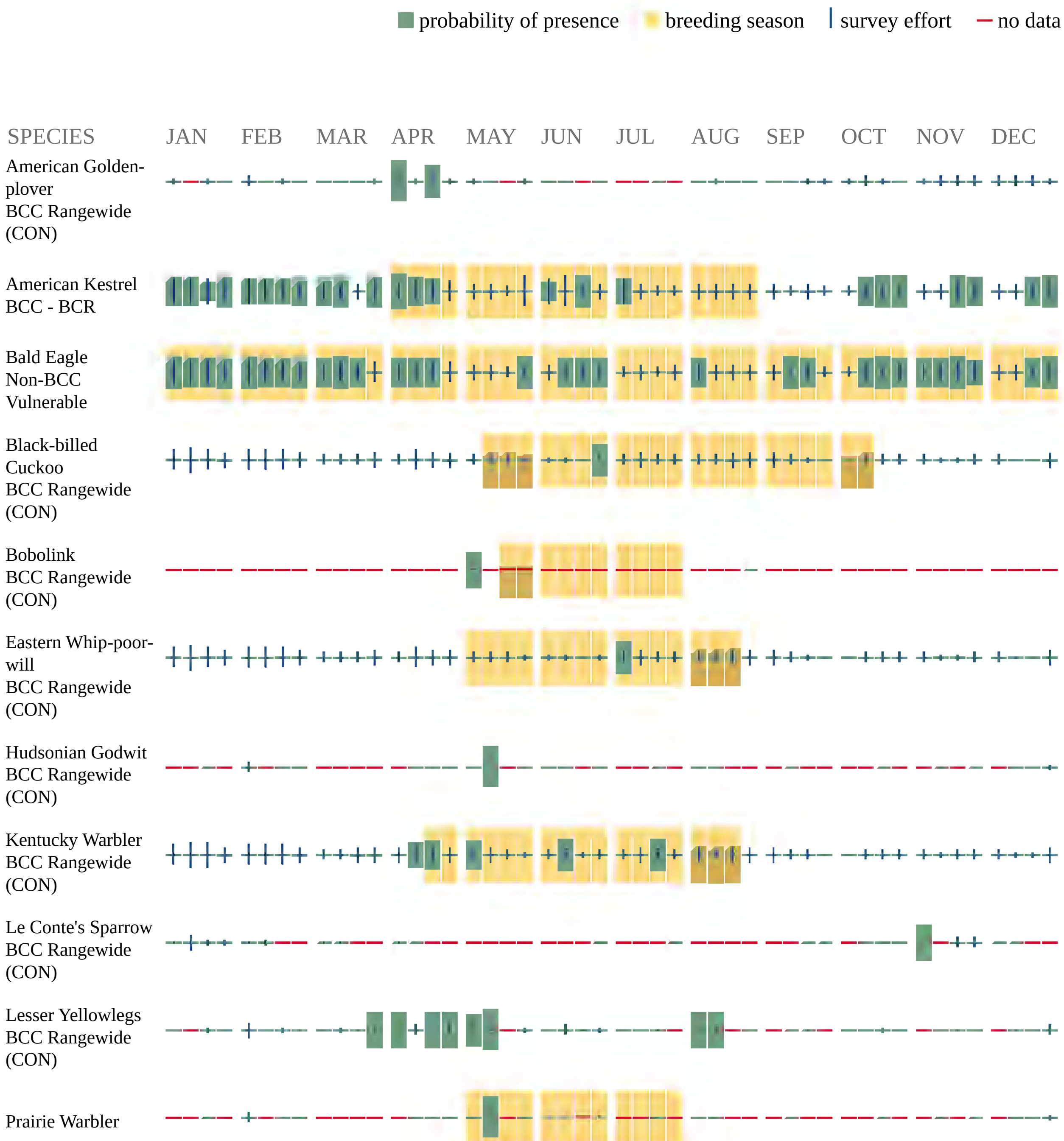
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

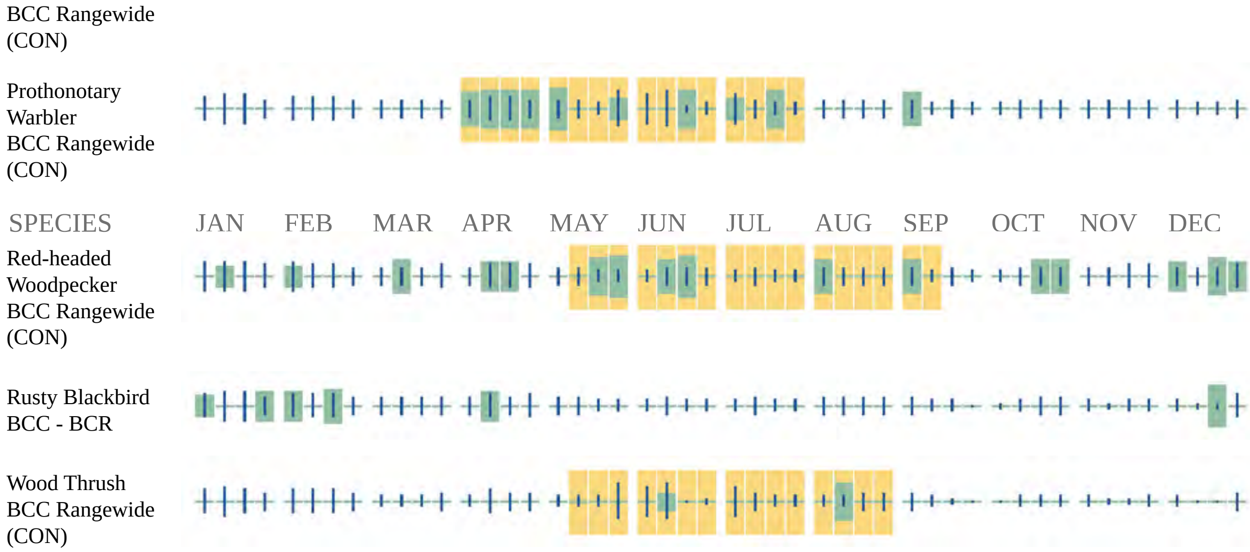
Survey Effort ( )

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.





Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?
The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects
For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?
If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report
The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

Due to your project's size, the list below may be incomplete, or the acreages reported may be inaccurate. For a full list, please contact the local U.S. Fish and Wildlife office or visit https://www.fws.gov/wetlands/data/mapper.HTML

LAKE

- L1UBH
- L1UBHh
- L1UBHx
- L2UBFh
- L2USCh

FRESHWATER EMERGENT WETLAND

- PEM1/USC
- PEM1/USCh
- PEM1A
- PEM1Ah
- PEM1C
- PEM1Ch
- PEM1F
- PEM1Fh

FRESHWATER FORESTED/SHRUB WETLAND

- PFO/EM1A
- PFO/EM1Ah
- PFO/EM1C
- PFO/EM1Ch
- PFO/SS1Ah
- PFO1/EM1A
- PFO1/EM1Ah
- PFO1/EM1C

- PFO1/EM1Ch
- PFO1/EM1F
- PFO1/SS1A
- PFO1/SS1Ah
- PFO1/SS1C
- PFO1/SS1Ch
- PFO1/SS6F
- PFO1A
- PFO1Ah
- PFO1C
- PFO1Ch
- PFO5/UBHh
- PFO5F
- PFO6Fh
- PSS/EM1Ah
- PSS/EM1C
- PSS/EM1Ch
- PSS/EM1Cx
- PSS1/EM1A
- PSS1/EM1Ad
- PSS1/EM1Ah
- PSS1/EM1C
- PSS1/EM1Ch
- PSS1/EM1Cx
- PSS1/EM1F
- PSS1/FO1C
- PSS1/UBF
- PSS1Ah
- PSS1C
- PSS1Ch
- PSS1F
- PSS1Fh

FRESHWATER POND

- PUBF
- PUBFh
- PUBFx

- PUBH
- PUBHh
- PUBHx

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
Phone: (918) 581-7458 Fax: (918) 581-7467
http://www.fws.gov/southwest/es/Oklahoma/

In Reply Refer To: August 30, 2021
Consultation Code: 02EKOK00-2021-SLI-2653
Event Code: 02EKOK00-2021-E-07660
Project Name: MKARNS Mitigation

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Non-federal entities conducting activities that may result in take of listed species should consider seeking coverage under section 10 of the ESA, either through development of a Habitat Conservation Plan (HCP) or, by becoming a signatory to the General Conservation Plan (GCP) currently under development for the American burying beetle. Each of these mechanisms provides the means for obtaining a permit and coverage for incidental take of listed species during otherwise lawful activities.

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit through our Project Review step-wise process http://www.fws.gov/southwest/es/oklahoma/OKESFO%20Permit%20Home.htm.

Attachment(s):

- Official Species List

- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Oklahoma Ecological Services Field Office
9014 East 21st Street
Tulsa, OK 74129-1428
(918) 581-7458

Project Summary

Consultation Code: 02EKOK00-2021-SLI-2653
Event Code: 02EKOK00-2021-E-07660
Project Name: MKARNS Mitigation
Project Type: ** OTHER **
Project Description: Proposed supplemental mitigation area for the MKARNS After-Action compensation.
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@36.0765736,-95.3823502341875,14z

Counties: Mayes County, Oklahoma

Endangered Species Act Species

There is a total of 6 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Gray Bat *Myotis grisescens* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6329	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Birds

NAME	STATUS
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened

Fishes

NAME	STATUS
Ozark Cavefish *Amblyopsis rosae* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/6490	Threatened

Insects

NAME	STATUS
American Burying Beetle *Nicrophorus americanus* Population: Wherever found, except where listed as an experimental population No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/66	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Lesser Yellowlegs *Tringa flavipes* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere

Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

■ probability of presence ■ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Lesser Yellowlegs BCC Rangewide (CON)												

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects
For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?
If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report
The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

RIVERINE

- R4SBC

Attachment D

OBS Ref. 2021-375-FED-ACE

Dear Ms. Watson, June 22, 2021

We have reviewed occurrence information on federal and state threatened, endangered or candidate species, as well as non-regulatory rare species and ecological systems of importance currently in the Oklahoma Natural Heritage Inventory database for the following location you provided:

Rogers, Wagoner, Cherokee, Muskogee, Haskell, Sequoyah, and Le Flore Counties

We found 735 occurrence(s) of relevant species within the vicinity of the project location as described.

Species Name	Common Name	Federal Status
Arcidens wheeleri	**Ouachita Rock Pocketbook**	**Endangered**
County	***TRS***	***Count***
Le Flore	Sec. 33-T3N-R22E	1
Le Flore	Sec. 31-T3N-R23E	1
Pushmataha	Sec. 1-T2N-R22E	1
Pushmataha	Sec. 2-T2N-R22E	2
Pushmataha	Sec. 5-T2N-R22E	1
Corynorhinus townsendii ingens	**Ozark Big-eared Bat**	**Endangered**
County	***TRS***	***Count***
Cherokee	Sec. 36-T14N-R23E	2
Haliaeetus leucocephalus	**Bald Eagle**	**Protected**
County	***TRS***	***Count***
Cherokee	Sec. 16-T15N-R23E	1
Cherokee	Sec. 18-T16N-R20E	1
Cherokee	Sec. 19-T16N-R20E	1
Cherokee	Sec. 28-T17N-R20E	2
Cherokee	Sec. 1-T17N-R22E	1
Cherokee	Sec. 12-T17N-R22E	2
Cherokee	Sec. 35-T17N-R22E	4
Cherokee	Sec. 13-T18N-R22E	3
Cherokee	Sec. 5-T18N-R23E	4
Haskell	Sec. 1-T7N-R20E	2
Haskell	Sec. 3-T9N-R19E	1
Haskell	Sec. 5-T9N-R19E	1
Haskell	Sec. 8-T9N-R20E	6
Haskell	Sec. 19-T9N-R20E	2
Haskell	Sec. 15-T9N-R22E	1
Haskell	Sec. 33-T10N-R18E	3
Haskell	Sec. 36-T10N-R18E	1
Haskell	Sec. 31-T10N-R19E	2
Haskell	Sec. 32-T10N-R19E	5
Haskell	Sec. 33-T10N-R19E	1
Haskell	Sec. 14-T10N-R20E	1
Haskell	Sec. 15-T10N-R20E	1
Haskell	Sec. 2-T10N-R22E	2
Haskell	Sec. 24-T10N-R22E	1
Haskell	Sec. 18-T10N-R23E	2
Haskell	Sec. 19-T10N-R23E	2

Haskell	Sec. 21-T10N-R23E	2
Haskell	Sec. 10-T11N-R21E	1
Haskell	Sec. 27-T11N-R22E	1
Haskell	Sec. 29-T11N-R22E	1
Haskell	Sec. 30-T11N-R22E	1
Haskell	Sec. 35-T11N-R22E	4
Haskell	Sec. 36-T11N-R22E	1
Le Flore	Sec. 36-T4N-R25E	1
Le Flore	Sec. 12-T6N-R25E	4
Le Flore	Sec. 9-T10N-R24E	1
Le Flore	Sec. 11-T10N-R24E	1
Le Flore	Sec. 13-T10N-R24E	1
Le Flore	Sec. 33-T10N-R25E	1
Le Flore	Sec. 34-T10N-R25E	1
Le Flore	Sec. 35-T10N-R26E	1
McIntosh	Sec. 21-T10N-R18E	1
McIntosh	Sec. 36-T10N-R18E	3
Muskogee	Sec. 3-T9N-R19E	3
Muskogee	Sec. 31-T10N-R19E	3
Muskogee	Sec. 22-T10N-R20E	2
Muskogee	Sec. 28-T10N-R20E	5
Muskogee	Sec. 6-T10N-R21E	2
Muskogee	Sec. 3-T11N-R21E	2
Muskogee	Sec. 21-T11N-R21E	2
Muskogee	Sec. 31-T11N-R21E	1
Muskogee	Sec. 2-T12N-R20E	4
Muskogee	Sec. 27-T12N-R20E	3
Muskogee	Sec. 34-T13N-R19E	1
Muskogee	Sec. 20-T13N-R20E	3
Muskogee	Sec. 29-T14N-R16E	2
Muskogee	Sec. 26-T14N-R19E	3
Muskogee	Sec. 22-T15N-R16E	1
Muskogee	Sec. 9-T15N-R17E	1
Muskogee	Sec. 18-T15N-R17E	4
Muskogee	Sec. 4-T15N-R19E	2
Muskogee	Sec. 25-T15N-R19E	2
Muskogee	Sec. 26-T15N-R19E	2
Muskogee	Sec. 19-T15N-R20E	1
Muskogee	Sec. 30-T15N-R20E	1
Muskogee	Sec. 31-T15N-R20E	1
Muskogee	Sec. 30-T16N-R16E	1
Muskogee	Sec. 36-T16N-R18E	1
Rogers	Sec. 32-T20N-R16E	2
Sequoyah	Sec. 9-T10N-R24E	1
Sequoyah	Sec. 13-T10N-R24E	2
Sequoyah	Sec. 29-T10N-R25E	1
Sequoyah	Sec. 32-T10N-R25E	2
Sequoyah	Sec. 33-T10N-R25E	1
Sequoyah	Sec. 24-T10N-R26E	3
Sequoyah	Sec. 25-T10N-R26E	4

Sequoyah	Sec. 6-T10N-R27E	1
Sequoyah	Sec. 7-T10N-R27E	2
Sequoyah	Sec. 1-T11N-R22E	1
Sequoyah	Sec. 4-T11N-R22E	3
Sequoyah	Sec. 5-T11N-R22E	4
Sequoyah	Sec. 10-T11N-R22E	2
Sequoyah	Sec. 12-T11N-R22E	3
Sequoyah	Sec. 17-T11N-R22E	4
Sequoyah	Sec. 20-T11N-R22E	2
Sequoyah	Sec. 23-T11N-R22E	2
Sequoyah	Sec. 24-T11N-R22E	1
Sequoyah	Sec. 6-T11N-R25E	2
Sequoyah	Sec. 27-T11N-R27E	1
Sequoyah	Sec. 3-T12N-R21E	1
Sequoyah	Sec. 16-T12N-R21E	1
Sequoyah	Sec. 17-T12N-R21E	1
Sequoyah	Sec. 18-T12N-R21E	1
Sequoyah	Sec. 20-T12N-R21E	1
Sequoyah	Sec. 21-T12N-R21E	1
Sequoyah	Sec. 28-T12N-R21E	1
Sequoyah	Sec. 34-T12N-R22E	1
Sequoyah	Sec. 34-T12N-R23E	1
Sequoyah	Sec. 23-T13N-R21E	1
Wagoner	Sec. 8-T15N-R16E	2
Wagoner	Sec. 32-T16N-R16E	2
Wagoner	Sec. 8-T16N-R18E	3
Wagoner	Sec. 9-T16N-R18E	1
Wagoner	Sec. 34-T16N-R18E	4
Wagoner	Sec. 4-T16N-R19E	5
Wagoner	Sec. 19-T16N-R19E	1
Wagoner	Sec. 35-T16N-R19E	2
Wagoner	Sec. 18-T16N-R20E	2
Wagoner	Sec. 27-T17N-R15E	1
Wagoner	Sec. 29-T17N-R15E	2
Wagoner	Sec. 31-T17N-R15E	3
Wagoner	Sec. 34-T17N-R15E	5
Wagoner	Sec. 30-T18N-R17E	2

Lampsilis rafinesqueana	**Neosho Mucket**	**Endangered**
County	***TRS***	***Count***
Cherokee	Sec. 22-T15N-R22E	1
Cherokee	Sec. 11-T16N-R22E	1
Cherokee	Sec. 12-T17N-R22E	1
Cherokee	Sec. 24-T17N-R22E	2
Cherokee	Sec. 25-T17N-R22E	1
Cherokee	Sec. 26-T17N-R22E	1
Cherokee	Sec. 3-T17N-R23E	1
Cherokee	Sec. 5-T17N-R23E	1
Cherokee	Sec. 13-T18N-R22E	1
Cherokee	Sec. 25-T18N-R22E	1
Cherokee	Sec. 5-T18N-R23E	1

Cherokee	Sec. 26-T19N-R23E	1
Cherokee	Sec. 34-T19N-R23E	2
Leptodea leptodon	**Scaleshell Mussel**	**Endangered**
County	***TRS***	***Count***
Le Flore	Sec. 33-T3N-R22E	1
Macrhybopsis tetranema	**Arkansas River Speckled Chub**	**Proposed Endangered**
County	***TRS***	***Count***
Sequoyah	Sec. 28-T10N-R26E	1
Sequoyah	Sec. 16-T12N-R21E	1
Myotis grisescens	**Gray Myotis**	**Endangered**
County	***TRS***	***Count***
Cherokee	Sec. 36-T14N-R23E	1
Myotis septentrionalis	**Northern Long-eared Bat**	**Threatened**
County	***TRS***	***Count***
Cherokee	Sec. 36-T14N-R23E	1
Cherokee	Sec. 19-T16N-R20E	1
Le Flore	Sec. 8-T1N-R25E	1
Le Flore	Sec. 15-T4N-R23E	1
Le Flore	Sec. 20-T4N-R23E	30
Le Flore	Sec. 23-T4N-R23E	2
Le Flore	Sec. 29-T4N-R23E	1
Le Flore	Sec. 24-T5N-R23E	1
Sequoyah	Sec. 1-T13N-R23E	2
Myotis sodalis	**Indiana Myotis**	**Endangered**
County	***TRS***	***Count***
Le Flore	Sec. 29-T4N-R23E	1
Nicrophorus americanus	**American Burying Beetle**	**Threatened**
County	***TRS***	***Count***
Cherokee	Sec. 12-T14N-R20E	1
Cherokee	Sec. 4-T14N-R21E	1
Cherokee	Sec. 5-T14N-R21E	2
Cherokee	Sec. 8-T14N-R21E	2
Cherokee	Sec. 16-T14N-R21E	1
Cherokee	Sec. 15-T15N-R21E	1
Cherokee	Sec. 20-T15N-R21E	2
Cherokee	Sec. 21-T15N-R21E	3
Cherokee	Sec. 23-T15N-R21E	2
Cherokee	Sec. 28-T15N-R21E	1
Cherokee	Sec. 32-T15N-R21E	2
Cherokee	Sec. 26-T16N-R20E	1
Cherokee	Sec. 27-T16N-R20E	1
Cherokee	Sec. 6-T16N-R21E	1
Cherokee	Sec. 9-T16N-R22E	1
Cherokee	Sec. 23-T18N-R21E	1
Cherokee	Sec. 26-T19N-R22E	1
Haskell	Sec. 22-T7N-R21E	1
Haskell	Sec. 3-T8N-R22E	1
Haskell	Sec. 5-T8N-R22E	1
Haskell	Sec. 5-T9N-R21E	2

Haskell	Sec. 6-T9N-R21E	1
Haskell	Sec. 8-T9N-R21E	1
Haskell	Sec. 9-T9N-R21E	1
Haskell	Sec. 13-T9N-R21E	1
Haskell	Sec. 15-T9N-R21E	5
Haskell	Sec. 17-T9N-R21E	1
Haskell	Sec. 23-T9N-R21E	2
Haskell	Sec. 24-T9N-R21E	2
Haskell	Sec. 25-T9N-R21E	1
Haskell	Sec. 36-T9N-R21E	1
Haskell	Sec. 7-T9N-R22E	1
Haskell	Sec. 18-T9N-R22E	1
Haskell	Sec. 21-T9N-R22E	1
Haskell	Sec. 18-T9N-R23E	1
Haskell	Sec. 25-T9N-R23E	1
Haskell	Sec. 26-T9N-R23E	1
Haskell	Sec. 28-T9N-R23E	4
Haskell	Sec. 23-T10N-R20E	1
Haskell	Sec. 25-T10N-R20E	1
Haskell	Sec. 26-T10N-R20E	1
Haskell	Sec. 36-T10N-R20E	1
Haskell	Sec. 5-T10N-R21E	2
Haskell	Sec. 9-T10N-R22E	2
Haskell	Sec. 32-T11N-R21E	1
Le Flore	Sec. 30-T1N-R23E	2
Le Flore	Sec. 30-T4N-R24E	1
Le Flore	Sec. 9-T4N-R25E	1
Le Flore	Sec. 30-T4N-R25E	1
Le Flore	Sec. 11-T6N-R23E	1
Le Flore	Sec. 14-T6N-R23E	1
Le Flore	Sec. 21-T6N-R23E	1
Le Flore	Sec. 17-T6N-R24E	1
Le Flore	Sec. 21-T6N-R25E	1
Le Flore	Sec. 6-T7N-R24E	2
Le Flore	Sec. 10-T7N-R24E	2
Le Flore	Sec. 12-T7N-R24E	3
Le Flore	Sec. 31-T7N-R25E	3
Le Flore	Sec. 32-T7N-R25E	1
Le Flore	Sec. 28-T8N-R23E	1
Le Flore	Sec. 30-T8N-R23E	1
Le Flore	Sec. 24-T8N-R24E	1
Le Flore	Sec. 31-T8N-R24E	2
Le Flore	Sec. 32-T8N-R24E	2
Le Flore	Sec. 33-T8N-R24E	1
Le Flore	Sec. 34-T8N-R24E	1
Le Flore	Sec. 9-T8N-R25E	1
Le Flore	Sec. 31-T8N-R25E	1
Le Flore	Sec. 33-T8N-R25E	1
Le Flore	Sec. 3-T9N-R24E	1
Le Flore	Sec. 8-T9N-R24E	1

Le Flore	Sec. 30-T9N-R24E	1
Le Flore	Sec. 31-T9N-R24E	1
Le Flore	Sec. 29-T10N-R26E	1
McIntosh	Sec. 1-T12N-R18E	2
McIntosh	Sec. 2-T12N-R18E	1
Muskogee	Sec. 2-T10N-R19E	1
Muskogee	Sec. 12-T10N-R19E	2
Muskogee	Sec. 16-T10N-R19E	1
Muskogee	Sec. 5-T10N-R20E	2
Muskogee	Sec. 6-T10N-R20E	1
Muskogee	Sec. 7-T10N-R20E	7
Muskogee	Sec. 8-T10N-R20E	1
Muskogee	Sec. 17-T10N-R20E	2
Muskogee	Sec. 7-T11N-R19E	2
Muskogee	Sec. 17-T11N-R19E	1
Muskogee	Sec. 22-T11N-R19E	2
Muskogee	Sec. 24-T11N-R19E	1
Muskogee	Sec. 29-T11N-R19E	5
Muskogee	Sec. 30-T11N-R19E	4
Muskogee	Sec. 31-T11N-R19E	3
Muskogee	Sec. 32-T11N-R19E	4
Muskogee	Sec. 19-T11N-R20E	1
Muskogee	Sec. 32-T11N-R20E	1
Muskogee	Sec. 5-T11N-R21E	1
Muskogee	Sec. 29-T11N-R21E	1
Muskogee	Sec. 2-T12N-R20E	1
Muskogee	Sec. 3-T12N-R20E	1
Muskogee	Sec. 28-T13N-R15E	1
Muskogee	Sec. 26-T13N-R16E	1
Muskogee	Sec. 21-T13N-R17E	1
Muskogee	Sec. 28-T13N-R17E	2
Muskogee	Sec. 29-T13N-R17E	1
Muskogee	Sec. 36-T13N-R17E	1
Muskogee	Sec. 7-T13N-R18E	1
Muskogee	Sec. 8-T13N-R18E	1
Muskogee	Sec. 9-T13N-R18E	1
Muskogee	Sec. 14-T13N-R18E	1
Muskogee	Sec. 27-T13N-R18E	2
Muskogee	Sec. 29-T13N-R18E	1
Muskogee	Sec. 30-T13N-R18E	1
Muskogee	Sec. 20-T13N-R19E	1
Muskogee	Sec. 21-T13N-R19E	1
Muskogee	Sec. 27-T13N-R19E	1
Muskogee	Sec. 2-T13N-R20E	1
Muskogee	Sec. 4-T13N-R20E	1
Muskogee	Sec. 11-T13N-R20E	3
Muskogee	Sec. 15-T13N-R20E	1
Muskogee	Sec. 25-T13N-R20E	1
Muskogee	Sec. 31-T13N-R20E	2
Muskogee	Sec. 32-T13N-R20E	1

Muskogee	Sec. 35-T13N-R20E	1
Muskogee	Sec. 1-T14N-R15E	1
Muskogee	Sec. 3-T14N-R15E	2
Muskogee	Sec. 1-T14N-R16E	1
Muskogee	Sec. 2-T14N-R16E	1
Muskogee	Sec. 3-T14N-R16E	1
Muskogee	Sec. 6-T14N-R16E	2
Muskogee	Sec. 20-T14N-R16E	1
Muskogee	Sec. 26-T14N-R16E	1
Muskogee	Sec. 36-T14N-R16E	1
Muskogee	Sec. 6-T14N-R17E	1
Muskogee	Sec. 10-T14N-R17E	1
Muskogee	Sec. 11-T14N-R17E	1
Muskogee	Sec. 13-T14N-R17E	1
Muskogee	Sec. 14-T14N-R17E	1
Muskogee	Sec. 32-T14N-R18E	1
Muskogee	Sec. 1-T14N-R20E	1
Muskogee	Sec. 3-T14N-R20E	1
Muskogee	Sec. 8-T14N-R20E	1
Muskogee	Sec. 9-T14N-R20E	2
Muskogee	Sec. 10-T14N-R20E	1
Muskogee	Sec. 11-T14N-R20E	2
Muskogee	Sec. 14-T14N-R20E	5
Muskogee	Sec. 15-T14N-R20E	2
Muskogee	Sec. 16-T14N-R20E	1
Muskogee	Sec. 17-T14N-R20E	1
Muskogee	Sec. 20-T14N-R20E	1
Muskogee	Sec. 24-T14N-R20E	4
Muskogee	Sec. 26-T14N-R20E	2
Muskogee	Sec. 33-T14N-R20E	2
Muskogee	Sec. 34-T14N-R20E	2
Muskogee	Sec. 35-T14N-R20E	1
Muskogee	Sec. 36-T14N-R20E	1
Muskogee	Sec. 4-T15N-R15E	1
Muskogee	Sec. 25-T15N-R15E	2
Muskogee	Sec. 27-T15N-R15E	2
Muskogee	Sec. 23-T15N-R16E	2
Muskogee	Sec. 24-T15N-R16E	2
Muskogee	Sec. 26-T15N-R16E	2
Muskogee	Sec. 27-T15N-R16E	2
Muskogee	Sec. 29-T15N-R16E	2
Muskogee	Sec. 10-T15N-R17E	2
Muskogee	Sec. 11-T15N-R17E	2
Muskogee	Sec. 12-T15N-R17E	2
Muskogee	Sec. 17-T15N-R17E	2
Muskogee	Sec. 18-T15N-R17E	4
Muskogee	Sec. 27-T15N-R17E	1
Muskogee	Sec. 13-T15N-R18E	1
Muskogee	Sec. 29-T15N-R19E	1
Muskogee	Sec. 3-T15N-R20E	2

Muskogee	Sec. 4-T15N-R20E	1
Muskogee	Sec. 13-T15N-R20E	2
Muskogee	Sec. 14-T15N-R20E	1
Muskogee	Sec. 16-T15N-R20E	1
Muskogee	Sec. 21-T15N-R20E	3
Muskogee	Sec. 22-T15N-R20E	2
Muskogee	Sec. 24-T15N-R20E	2
Muskogee	Sec. 26-T15N-R20E	2
Muskogee	Sec. 27-T15N-R20E	2
Muskogee	Sec. 28-T15N-R20E	1
Muskogee	Sec. 29-T15N-R20E	1
Muskogee	Sec. 32-T15N-R20E	1
Muskogee	Sec. 35-T15N-R20E	2
Muskogee	Sec. 36-T15N-R20E	3
Rogers	Sec. 2-T20N-R17E	1
Rogers	Sec. 10-T20N-R17E	3
Rogers	Sec. 16-T20N-R17E	1
Rogers	Sec. 20-T20N-R17E	1
Rogers	Sec. 20-T21N-R15E	1
Rogers	Sec. 3-T24N-R18E	1
Sequoyah	Sec. 5-T11N-R22E	1
Sequoyah	Sec. 7-T11N-R22E	1
Sequoyah	Sec. 30-T11N-R24E	1
Sequoyah	Sec. 31-T11N-R24E	1
Sequoyah	Sec. 34-T11N-R24E	2
Sequoyah	Sec. 36-T11N-R24E	1
Sequoyah	Sec. 1-T12N-R21E	1
Sequoyah	Sec. 3-T12N-R21E	1
Sequoyah	Sec. 9-T12N-R21E	1
Sequoyah	Sec. 21-T12N-R21E	1
Sequoyah	Sec. 28-T12N-R21E	1
Sequoyah	Sec. 7-T12N-R22E	1
Sequoyah	Sec. 9-T12N-R22E	3
Sequoyah	Sec. 13-T12N-R22E	1
Sequoyah	Sec. 14-T12N-R22E	1
Sequoyah	Sec. 15-T12N-R22E	1
Sequoyah	Sec. 18-T12N-R23E	1
Sequoyah	Sec. 23-T12N-R23E	1
Sequoyah	Sec. 24-T12N-R23E	1
Sequoyah	Sec. 19-T12N-R24E	1
Sequoyah	Sec. 20-T12N-R24E	1
Sequoyah	Sec. 21-T12N-R24E	1
Sequoyah	Sec. 23-T12N-R25E	1
Sequoyah	Sec. 24-T12N-R25E	1
Sequoyah	Sec. 20-T12N-R26E	1
Sequoyah	Sec. 21-T12N-R26E	2
Sequoyah	Sec. 22-T12N-R26E	1
Sequoyah	Sec. 8-T13N-R21E	2
Sequoyah	Sec. 12-T13N-R21E	1
Sequoyah	Sec. 25-T13N-R21E	1

Sequoyah	Sec. 26-T13N-R21E	1
Sequoyah	Sec. 31-T13N-R21E	2
Sequoyah	Sec. 32-T13N-R21E	1
Sequoyah	Sec. 6-T13N-R22E	2
Wagoner	Sec. 13-T16N-R16E	1
Wagoner	Sec. 24-T16N-R16E	1
Wagoner	Sec. 26-T16N-R16E	1
Wagoner	Sec. 35-T16N-R16E	1
Wagoner	Sec. 2-T16N-R18E	1
Wagoner	Sec. 13-T16N-R18E	1
Wagoner	Sec. 4-T16N-R19E	4
Wagoner	Sec. 5-T16N-R19E	5
Wagoner	Sec. 6-T16N-R19E	5
Wagoner	Sec. 4-T17N-R15E	1
Wagoner	Sec. 16-T17N-R16E	1
Wagoner	Sec. 25-T17N-R18E	4
Wagoner	Sec. 26-T17N-R18E	1
Wagoner	Sec. 29-T17N-R19E	1
Wagoner	Sec. 30-T17N-R19E	2
Wagoner	Sec. 31-T17N-R19E	5
Wagoner	Sec. 12-T18N-R15E	1
Wagoner	Sec. 25-T18N-R15E	1
Wagoner	Sec. 15-T18N-R16E	1
Wagoner	Sec. 19-T18N-R16E	1
Wagoner	Sec. 30-T18N-R16E	1
Wagoner	Sec. 9-T18N-R18E	1
Wagoner	Sec. 35-T18N-R18E	1
Wagoner	Sec. 28-T19N-R15E	1

Notropis girardi	**Arkansas River shiner**	**Threatened**
County	***TRS***	***Count***
Haskell	Sec. 7-T9N-R20E	1
Haskell	Sec. 31-T10N-R18E	1
McIntosh	Sec. 29-T10N-R18E	1
Sequoyah	Sec. 13-T10N-R26E	1
Sequoyah	Sec. 24-T10N-R26E	1
Wagoner	Sec. 19-T16N-R19E	2

Noturus placidus	**Neosho madtom**	**Threatened**
County	***TRS***	***Count***
Sequoyah	Sec. 16-T12N-R21E	2
Sequoyah	Sec. 23-T13N-R21E	1

Percina maculata	**Blackside darter**	**State Threatened**
County	***TRS***	***Count***
Cherokee	Sec. 24-T16N-R22E	1
Haskell	Sec. 16-T8N-R21E	1
Haskell	Sec. 17-T8N-R21E	1
Le Flore	Sec. 14-T4N-R25E	1
Le Flore	Sec. 25-T4N-R25E	1
Le Flore	Sec. 26-T4N-R25E	6

Percina nasuta	**Longnose darter**	**State Endangered**
County	***TRS***	***Count***

Le Flore	Sec. 15-T5N-R24E	1
Le Flore	Sec. 35-T5N-R25E	1
Le Flore	Sec. 21-T8N-R25E	1
Le Flore	Sec. 36-T8N-R25E	3
Sequoyah	Sec. 1-T12N-R26E	3
Sequoyah	Sec. 2-T12N-R26E	1
Sequoyah	Sec. 6-T12N-R27E	1
Sequoyah	Sec. 16-T12N-R27E	2
Sequoyah	Sec. 17-T12N-R27E	2
Sequoyah	Sec. 18-T12N-R27E	1
Sequoyah	Sec. 21-T12N-R27E	2
Sequoyah	Sec. 12-T13N-R26E	1
Sequoyah	Sec. 13-T13N-R26E	1
Sequoyah	Sec. 23-T13N-R26E	1
Sequoyah	Sec. 26-T13N-R26E	2
Sequoyah	Sec. 27-T13N-R26E	2
Sequoyah	Sec. 34-T13N-R26E	3
Sequoyah	Sec. 7-T13N-R27E	1
Sequoyah	Sec. 19-T13N-R27E	1

Percina pantherina	**Leopard darter**	**Threatened**
County	***TRS***	***Count***
Le Flore	Sec. 19-T1N-R23E	1
Le Flore	Sec. 22-T1N-R23E	1
Le Flore	Sec. 30-T1N-R23E	2
Le Flore	Sec. 7-T1N-R25E	1
Le Flore	Sec. 20-T1N-R25E	1
Le Flore	Sec. 30-T1N-R25E	1
Le Flore	Sec. 31-T1N-R25E	1
Le Flore	Sec. 19-T1N-R27E	1
McCurtain	Sec. 5-T1S-R27E	2

Platanthera praeclara	**western prairie fringed orchid**	**Threatened (Extirpated)**
County	***TRS***	***Count***
Rogers	Sec. 6-T22N-R17E	5

Quadrula fragosa	**Winged Mapleleaf**	**Endangered**
County	***TRS***	***Count***
Le Flore	Sec. 33-T3N-R22E	1
Pushmataha	Sec. 4-T2N-R22E	1

Theliderma cylindrica	**Rabbitsfoot**	**Threatened**
County	***TRS***	***Count***
Cherokee	Sec. 5-T17N-R23E	1
Cherokee	Sec. 25-T18N-R22E	1
Rogers	Sec. 27-T20N-R15E	1

Additionally, absence from our database does not preclude such species from occurring in the area.

If you have any questions about this response, please send me an email, or call us at the number given below.

Although not specific to your project, you may find the following links helpful.

ONHI, guide to ranking codes for endangered and threatened species:
http://www.oknaturalheritage.ou.edu/content/biodiversity-info/ranking-guide/

Information regarding the Oklahoma Natural Areas Registry:
https://okregistry.wordpress.com/

Todd Fagin
Oklahoma Natural Heritage Inventory
(405) 325-4700
tfagin@ou.edu

Attachment E

C.7

Arkansas River Navigation Study: Freshwater Mussel (Unionid) Survey

McClellan - Kerr Arkansas River Navigation Study: Freshwater Mussel (Unionid) Survey

Prepared for:

US Army Corps of Engineers
Tulsa and Little Rock Districts
Contracted by the Memphis District

Prepared by:

Ecological Specialists, Inc.
O'Fallon, Missouri

March 2005

(ESI no. 04-027)

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This study was conducted under U.S. Army Corps of Engineers (USACE), Memphis District contract DACW66-03-T-0082. Funds were provided by the Little Rock and Tulsa USACE Districts. Mr. Mark Smith managed the project for the Memphis District. Mr. Johnny McLean (Little Rock District) was the technical contact and provided project information. Mr. Smith served as dive coordinator/inspector for Memphis District, Mr. McLean, Mr. Aaron McGee and Mr. Paul Brown were dive coordinators/dive inspectors for the Little Rock District. Data on past studies and insight into Arkansas River unionids was provided by Mr. David Martinez (US Fish and Wildlife Service [USFWS}, Tulsa, OK), Mr. Chris Davidson (USFWS, Conway, AR), Mr. John Harris (Arkansas Highway and Transportation Department), and Mr. Bill Posey (Arkansas Game and Fish Commission). Ms. Heidi Dunn (Ecological Specialists Inc. [ESI]) was the Principal Investigator and field supervisor. Mr. Richard Hayward (ESI) was the dive coordinator for ESI, and he and Mr. Kendall Cranny served as dive supervisors for the two dive teams. Field assistance was provided by Mr. Josh Seagraves, Ms. Rebecca Winterringer, Mr. Eric Belt, Mr. Mota Reis, Mr. Dusty Witherwax, Mr. John Hancock, Mr. Jerry Fickenger. Ms. Dunn, Mr. Seagraves, and Mr. Belt prepared this report. They were assisted by Ms. Winterringer and Ms. Janee Kavanagh.

Table of Contents

List of Figures

List of Tables

1.0 Introduction

The Arkansas and Tulsa districts of the U.S. Army Corps of Engineers (USACE) are preparing an Environmental Impact Statement (EIS) on the improvement of the efficiency of the McClellan-Kerr Arkansas River Navigation System (MKARNS). The EIS evaluates the modification of flows to reduce the number of days that exceed 100,000 cubic feet per second (cfs) and deepening the channel from 9-feet (ft) to 12ft to accommodate larger vessels. The EIS is part of the MKARNS study that was initiated in a FY99 Congressional Add to study MKARNS operational issues in the Fort Smith, Arkansas area.

Since unionids could potentially be affected by dredging and dredge disposal in conjunction with channel deepening activities, part of the EIS will address impacts to freshwater unionid mussels (unionids) in the MKARNS, particularly federal and state threatened and endangered species (T&E species). The study area for the EIS geographically encompasses the entire MKARNS from the Port of Catoosa near Tulsa, OK downstream to its confluence with the Mississippi River in southeastern Arkansas, as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS. The unionid study was limited to the commercial navigation channel, Navigation Mile (NM) 8.5 to NM 450.0 (Figure 1-1), since this area would be affected by dredge and disposal activities. Approximately 109.8 and 118.2 river miles would need to be dredged to achieve an 11ft and 12ft channel, respectively (Table 1-1). Most of the material dredged from the Arkansas portion of the river will be placed in permitted disposal sites. Material from the Oklahoma portion of the river will primarily be placed on land, but some open water disposal will be needed.

North America's unionid fauna is the most diverse in the world, and consists of nearly 300 nominal species (Turgeon *et al*., 1998; Williams *et al*., 1993). This diverse group of sedentary filter feeding animals is an important ecological component of benthic communities in many riverine systems. However, pollution and modification of riverine systems has resulted in the decline of many unionid species. Over 10% of North American unionid species are already presumed to be extinct (McMahon and Bogan, 2001), and approximately one-third of the species in North America are listed or are proposed for listing on the Federal List of Endangered and Threatened Wildlife and Plants (USFWS, 2004a and 2004b). Factors that appear to be contributing to the decline of unionids include damming, dredging, siltation of backwater areas, navigation, floodplain development, commercial harvest, and zebra mussel infestation.

Dredging will displace unionids within dredge areas and disposal will bury unionids within disposal sites. In addition, increased turbulence and resuspended silt, which could occur during dredging and disposal, has been shown to reduce unionid growth (Yokley, 1976), feeding rates (Miller *et al*., 1984;

Aldridge *et al*., 1987), oxygen consumption, and nitrogen excretion (Aldridge *et al*., 1987). Sedimentation is detrimental to unionids, and is implicated in the decline and extinction of numerous species (Stansbery, 1971). Silt can clog unionid gills and filtration systems, preventing respiration and causing nutritive stress. Ellis (1936) demonstrated that most unionids died when covered by as little as 1.3 to 5.1cm of silt.

Little is known about unionid species composition and distribution in the MKARNS system. A few of the Arkansas River tributaries (White River, Verdigris, Poteau, Grand Rivers) are known to harbor unionids, but previous unionid studies in the main stem are limited to Isely's (1925) study of eastern Oklahoma (Verdigris River), Davison's (1997) work in the Dardanelle and Ozark pools, and Harris' (1992) study in Lake Dardanelle. Based on Isley (1925), Shepard (1982), Gordon (1982, 1984), Branson (1982, 1983, 1984), Harris and Gordon (1986), Harris (1992), Davidson (1997), and Vaughan and Spoooner (in press), 55 unionid species have been reported from the Arkansas River system (Table 1-2). Of these, 37 were found in Arkansas and 49 in Oklahoma. Federal and state T&E species records from the system include *Cyprogenia aberti* (Verdigris River; Isley, 1925) and *Quadrula cylindrica* (Neosho and Verdigris rivers; Branson, 1984), which are Oklahoma category II species, *Lampsilis abrupta* (White River; Gordon, 1982) and *Lampsilis powelli* (Neosho and Illinois rivers, Branson, 1984), which are federally endangered species, and *Lampsilis rafinesqueana* (Neosho and Illinois rivers, Branson, 1984), which is a candidate for federally endangered status. Branson (1983) reported *Potamilus capax* (federally endangered) from the Verdigris River, but the record was questioned by USFWS (1985). *Potamilus capax* is known from the White River (Arkansas), and was collected in 2003 within the lower 10 miles of the river (J.L. Harris, AHTD, personal comm., 2004).

Recent studies in the main stem of the MKARNS are limited to those of Davidson (1997) and Harris (1992). Davidson (1997) found 15 species in the Dardanelle Pool and 10 species in the Ozark Pool. Both authors found unionids primarily on mud flats near the banks, with *Plectomerus dombeyanus* and *Quadrula quadrula* being the dominant species. No federal or state listed species were found.

Since information on unionid species composition and distribution for MKARNS is limited, this study was conducted to 1) determine unionid distribution and species composition in the MKARNS, focusing on proposed dredge and dredge disposal areas, 2) how the project construction, operation, and maintenance of a deeper channel would affect unionid communities, and 3) assist in determining if any animals should be relocated.

2.0 Methods

The study area included the MKARNS from NM 8.5, downstream of the confluence with the White River, to NM 445 at the head of navigation (see Figure 1-1). Approximately 135 sites within the study area would need to be dredged to maintain a 12-ft channel (see Table 1-1). Qualitative spot diving was used to sample within and around 64 of the proposed dredge areas to determine unionid distribution, relative abundance, and species composition (Table 2-1).

Preliminary sample points were selected during a meeting in June 2004 with USACE (Little Rock and Tulsa Districts), USFWS (Oklahoma and Arkansas field offices), and Arkansas Game and Fish Commission (AGFC). Sites were selected and prioritized based on dredge and dredge disposal locations, likelihood of harboring unionids, particularly T&E species, and personal knowledge of the study area provided by Bill Posey (AGFC), John Harris (AHTD), Dave Martinez (OK, USFWS) and Chris Davidson (AR, USFWS). Additionally, points were added to coincide with fish and habitat sites (ERDC, 2004). Preliminary sample points were grouped into 51 sites (Table 2-1). Forty-three (43) of these sites encompassing 64 proposed dredge areas, seven proposed disposal areas, 16 maintenance dredge areas, 48 permitted disposal areas, and five areas reported to harbor mussel beds were sampled during three field trips: September 20 to 26, October 3 to 9, and December 7 to 14, 2004. Sites were distributed throughout the river and represented a variety of riverine habitats (Table 2-2).

Each site was divided into subsites based on habitat (i.e., cove, inside bend, island, midchannel, outside bend, oxbow, peninsula, straight reach, tailwater, tributary mouth) and proposed channel activity. Sample points within subsites were selected in the field based on likelihood of harboring unionids or to represent dredge or disposal areas. At each point, a diver visually and tacitly searched the river bottom for 5-min and collected any unionids or unionid shells. Depth, substrate type, presence of zebra mussels (*Dreissena polymorpha*), and a visual estimate of unionid density were recorded for each point. If unionids were encountered, additional 5-min dives were conducted to determine species composition. The position of each sample point was recorded in the field with a Trimble Pathfinder Pro or Humminbird Matrix 67 GPS system.

Collected unionids were categorized as live, freshly dead (FD-nacre lustrous, tissue present or absent; probably died within the past year), weathered shell (WD-nacre chalky, no tissue present, most of the periostracum intact; probably died more than one year ago), and subfossil (SF-no periostracum, entire shell extremely chalky, valves detached; probably died over 10 years and maybe centuries ago). Live and freshly dead unionids were further classified as juveniles (≤3 years old for Anodontinae and Lampsilinae; ≤5 years old for Ambleminae) or adults, identified, and counted.

Weathered and subfossil shells were noted as present. Unionids were returned to the river within their collection area. Freshly dead, weathered dead, or subfossil shells were retained.

Unionid abundance at each sample point was entered into ArcGIS along with coordinates of dredge and disposal sites to estimate unionid distribution with respect to proposed dredging or disposal areas. Points that yielded more than a few unionids were grouped and defined as patches (small areas containing unionids) or beds (long linear areas with unionids). For purposes of discussion, sites were grouped by navigation pool and by river reach. Reaches are defined as: Reach 1-NM 0 to 75.2 (mouth to Pine Bluff), Reach 2-NM 75.2 to 119.5 (Pine Bluff to Little Rock), Reach 3-NM 119.5 to 220.3 (Little Rock to Dardanelle), Reach 4-NM 220.3 to 308.7 (Dardanelle to Fort Smith), Reach 5-NM 308.7 to 394.0 (Fort Smith to Muskogee), Reach 6-NM 394.0 to 445.2 (Muskogee to Catoosa).

3.0 Results

In general, MKARNS consists of a navigation channel with loose sand substrate, and channel borders that range from steep rip rapped banks to extensive shallow mud flats. Unionids beds or patches were primarily found in substrate consisting of a sand, silt, and clay mixture. This substrate mixture typically occurred as a transition zone between the clay, silt, or rip rapped banks, islands, or dikes and the sand channel. This habitat was most frequently associated with a gently sloping shelf between two steeper slopes at depths of >10m or gently sloping banks near islands, dikes, and river banks <1m deep (Table 3-1). Evidence of previous zebra mussel infestation was found throughout the river, but only a few small zebra mussels were found attached to unionids in 2004. A total of 5,467 live unionids representing 27 species were collected, and two additional species were found only as weathered shells. *Quadrula quadrula* (27.6%), *Plectomerus dombeyanus* (23.4%), *Obliquaria reflexa* (15.5%), and *Amblema plicata* (10.5%) were the most abundant species (Table 3-2).

<u>3.1 Reach 1 (NM 0-75.2)</u>

Reach 1 extends from the confluence with the Mississippi River to Bunge Corporation dock near Pine Bluff, AR (see Figure 1-1a) and it includes the first 10 miles of the White River and Pools 1 through 4. Sites 1 through 7 as well as beds B1-1 through B6-1 and patches P1-1 through P7-2 lie within Reach 1. Fourteen dredge areas, approximately 22.9 miles, will be needed for the 11ft and 12ft channel alternatives (Table 3-1), and 35 permitted disposal areas occur within this reach (see Table 2-2). Ten of the 14 proposed dredge areas and 23 of the 35 permitted disposal areas fall within Sites 1-7. Habitats sampled included inside and outside bends, midchannel and straight reaches, islands, tributaries, and tailwaters. Most of the proposed dredge areas are midchannel or near an outside bend, with primarily unconsolidated sand substrate.

Unionid beds were observed downstream of Lock and Dam 1, in the Arkansas Post Canal, along the channel borders, and in a tributary mouth. Substrate in these areas consisted of mixtures of gravel/sand, sand/silt/clay, boulder/sand/clay, sand/silt, and silt/clay. Smaller patches of unionids were also found along channel borders, near islands, and in tributary mouths, also in sand/silt/clay substrate (see Table 3-1). A total of 3,053 live unionids representing 25 species were collected from Reach 1 (Table 3-2). *Plectomerus dombeyanus* (29.8%) was the dominant species followed by *Q. quadrula* (20.8%) and *A. plicata* (17.7%). No other species comprised more than 10% of the total. Species only found alive in Reach 1 included *Lampsilis cardium*, *Lampsilis siliquoidea*, *Lasmigona c. complanata*, and *Obovaria olivaria*, which were all collected within Sites 1 and 2. The highest catch per unit effort (CPUE) was observed in straight reaches, particularly those leading into bends (Table 3-3).

Most of the proposed dredge areas that occurred within sample sites were >100m from unionid beds or smaller patches. Exceptions to this include bed B1-1 that occurs adjacent to a maintenance dredge area, B2-1, B2-2, and B2-3 that occur within proposed dredge areas, and B4-1, B5-1, B6-1 and B7-1 and P4-1, P4-2, P7-1, and P7-2 that occur adjacent to proposed dredge areas (see Table 3-1; Figures 3-1 and 3-2).

Site 1 is the only site sampled in the lower White River (NM 0.0 – 10.4). Site 1 (NM 8.2 – 9.9) had three subsites: A - along the left descending bank, which includes the bankward edge of two permitted disposal sites and is adjacent to the maintenance dredge area; B - along the right descending bank, which lies adjacent to the maintenance dredge area; and C - at the confluence of the White River and Arkansas Post Canal, which will be unaffected by all channel modification activities (see Figure 3-1). Sample points were limited to near bank areas, as substrate immediately riverward consisted of unconsolidated sand. A total of 416 live unionids representing 17 species were found within Site 1 (Table 3-4). A few unionids (nine) were found scattered along both the left descending and the right descending banks, but the majority were confined to two concentrations: B1-1 and P1-1 (see Table 3-4 and Figure 3-1). Neither B1-1 nor P1-1 will be affected by the proposed 11ft or 12ft channel.

B1-1 is located on the right descending bank of the straight reach leading into a bend just downstream of the confluence with the Arkansas Post Canal (see Figure 3-1). The sampled area was limited to 100m. Only a few unionids were found downstream of the sampled area, however the upstream extent of the bed was not determined. The bed is located in a thin strip (<20m wide) of primarily sand substrate, mixed with gravel and silt that occurs between the steep rip rapped bank and the deeper sand channel. The channel riverward of this bed was a maintenance dredge area, but is now impounded by the Montgomery Point Lock and Dam near the mouth of the Mississippi River. At the time of the survey, depths in the bed exceeded 11m and the substrate consisted of a sand/gravel mixture. A total of 390 unionids representing 14 species were collected from B1-1 (see Table 3-4). Bed B1-1 had the highest likelihood of harboring *P. capax* (J.L. Harris, AHTD and B. Posey, AGFC, pers. comm., 2004), as this species has been found in the lower White River. However, statistical analysis indicated that most of the species within the bed were recovered, as regression analysis of log of cumulative individuals vs. cumulative species (R^2=0.98, p<0.01) indicates only one additional species would be collected with twice the effort (Figure 3-3). The presence of *P. capax* is therefore doubtful. *Quadrula quadrula* and *Quadrula aspera* were the dominant species. Density was estimated as 1 to 5 unionid/m^2, and CPUE averaged 35.5 unionids/5 min (Table 3-5). Only minimal recruitment appears to be occurring in this bed with only 2.5% of individuals collected ≤ 5 yrs. old. However, at least one young individual was collected for 43% of the species in the bed. Only one zebra per 10 unionids was collected.

P1-1 is located on the left descending bank of a straight reach immediately upstream of the confluence of the canal (Subsite C; see Figure 3-1). Unionids were concentrated in a narrow seam at the base of a clay bank, approximately 7.6m deep. Substrate consisted of a sand/silt/clay mixture. Both CPUE (5.7 vs. 35.5 unios/5min) and species richness (5 vs. 14) were much lower than in B1-1 (see Table 3-5). The dominant species was *Q. quadrula*. Recruitment in P1-1 was higher (11.8%) than in B1-1, and juveniles were collected for two of the five species (see Table 3-5).

Site 2A extended from Lock and Dam 1 to Lock and Dam 2 (NM 10.3 - 13.3) and Site 2B extended from Lock and Dam 2 to the upstream end of the Arkansas Post Canal (see Figure 3-1). All of the points surveyed within this site will be affected by dredging for both the 11ft and 12ft channel alternatives (see Table 2-1). Unionids within Site 2A were concentrated into two distinct areas; from the right bank to midchannel (B2-1), and in a thin strip at the bottom of the rip rap along the left bank (B2-2). While these beds are most likely not ecologically separated due to their close proximity, unionids were lacking from the primarily 100% clay that occurred between the beds. Within Site 2B unionids were found throughout the canal. A total of 1,111 unionids representing 19 different species were found within Site 2. *Plectomerus dombeyanus* (41%) and *A. plicata* (26%) were the dominant species (Table 3-6). No zebra mussels were found on unionids within Site 2.

B2-1 was defined as the area from midchannel to the right descending bank between Lock and Dams 1 and 2. Depth ranged from 2.4 to 4.9m and substrate was a mixture of sand, silt, and clay (see Table 3-3). Unionid densities ranged from approximately 1 to 5/m^2, and density decreased toward midchannel (see Table 3-6). CPUE averaged 38 unionids/5min, and 16 species were collected. Dominant species included *A. plicata*, *P. dombeyanus*, and *O. reflexa*. Juveniles were abundant, with 22% of the individuals being ≤5 years old, and 63% of the species represented by at least one juvenile (see Table 3-5). The distance between locks is approximately 4000m, and the channel is approximately 200m wide. If unionid density averaged 2.5 unionids/m^2 in B2-1, approximately 1,000,000 unionids could occur within this area.

Only a narrow strip of unionids, approximately 10m wide, were found to the left of midchannel at the base of the left descending bank (B2-2). Depth was 2.4m to 4.9m, and substrate along the left bank was primarily silt/clay. Unionids in B2-2 were less dense (≤1/m^2), and CPUE averaged 14.8 unionids/5min). Although only eight species were collected in B2-2, all of the species in B2-1 are likely to occur in B2-2 as well. Similar to B2-1, *P. dombeyanus* and *A. plicata* were the dominant species, and juveniles again made up a relatively large percentage (25.8%) of the total (see Table 3-

5). B2-2 is approximately 4000m long and 10m wide, with an average density of 1.0 unionid/m^2, approximately 40,000 unionids could occur in this bed.

Site 2B (NM 13.3 – 19) will be affected by dredging and contains B2-3 (see Figure 3-1). This bed is separated from B2-1 and B2-2 by Lock and Dam 2. Unionids at this location were evenly distributed throughout the canal, as opposed to the two seams displayed in the lower portion of the canal (B2-1 and B2-2). Substrate consisted primarily of clay with some silt. Depths ranged from 0.9m near the bank to 4.6m in the midchannel (see Table 3-3). Average unionid density ranged from 1 to 5 unionids/m^2, and CPUE averaged 17.1 unionids/5min (see Tables 3-5 and 3-6). Thirteen species were found and *P. dombeyanus*, *A. plicata* and *Lampsils teres* were the dominant species. Fewer juveniles representing less species were collected in B2-3 (4.3%) than in B2-1 and B2-2 (see Table 3-5). This portion of the canal is approximately 9000m long; if a 100m wide area is dredged and density is approximately 1/m^2, 900,000 unionids could be affected by dredging activities.

Site 3 (NM 19) is in the Arkansas River, immediately downstream of the head of the canal (see Figure 3-1). The right side of the channel is a shallow sand flat, and the left side is 3 - 13m deep rip rapped on the outside bend. This area is a permitted disposal site (see Figure 3-1 and Table 3-1). Three areas were sampled in this site and no unionids were collected. The sample immediately downstream of the canal was 12.6m deep with a clay and boulder substrate. At the mouth of the oxbow substrate was 100% boulder. Depth was 13m and decreased to approximately 1m as the diver approached the oxbow. Three freshly dead shells of *Leptodea fragilis* were found in the shallow area. Immediately downstream of the oxbow, depth increased to 13m and substrate was 100% sand.

The remainder of Pool 2 (NM 13.3 - 50.2) is fairly narrow and meandering (see Figure 3-1 and Figure 3-3). The channel is homogeneous unconsolidated sand beginning within 20m of the riverbanks. The highest concentrations of unionids were again found in straight reaches leading into bends but unionids were also found along both inside and outside bends as well as near tributary mouths and around islands. Unionids were limited to within 20m of a bank, dike, or island where substrate consisted primarily of a mix of sand, silt, and clay (see Table 3-3).

Site 4 (NM 23 - 24) is along a sharp bend, and contains three permitted disposal sites, one maintenance dredge area, and one proposed dredge area (see Figure 3-1). Site 4 was divided into three subsites: A - included the area riverward of the disposal site along the right bank, B - included the area near the disposal site on the left bank, and C - included the area along the left bank. No unionids were found beyond 20m off the bank in the channel, and no thus are not likely to be affected by proposed dredging (Table 3-7).

Site 4 yielded 864 unionids representing 13 different species concentrated in three aggregations: B4-1, P4-1 and P4-2 (Table 3-7). Bed B4-1 occurs within 20m of the left descending bank, along a shelf that is 3-4m deep at the upstream end and 5-8m near the middle of the bed. Unionids were found in shallow pockets (<2m deep) along the shelf in the downstream end of the bed (see Figure 3-1 and Table 3-7). Substrate was primarily sand, silt and clay with silt and clay between boulders in the middle portion. Density ranged from 1-10 unionids/m^2 (see Table 3-7), and CPUE averaged 36.7unionids/5 min (see Table 3-5). Recruitment was apparent with 9% of the unionids being juveniles, and 69% of the species were represented by at least one juvenile. Dominant species included *P. dombeyanus*, *Q. quadrula*, and *Potamilus purpuratus*. Bed B4-1 is approximately 600m shoreward of the proposed dredge area, and further protected by parallel dikes, and will not be affected by any dredge activity. However, B4-1 is shoreward of a permitted disposal area and should be considered in future disposal of dredge material.

P4-1 and P4-2 are located along the right descending bank, adjacent to a permitted land disposal area in what is known as the Pendleton Revetment. Substrate varied from clay with a thin layer of silt along the bank to primarily sand at inlets throughout the revetment. Six species were collected in P4-1 including *P. purpuratus*, *L. teres*, and *A. plicata* (see Table 3-5). Juveniles accounted for 15% of all individuals collected. P4-2 was located in an inlet of Pendleton Revetment just downstream of P4-1. Only three species were found in P4-2: *A. plicata*, *L. teres*, and *P. dombeyanus*. All individuals collected were ≥ 5 yrs old. These patches are approximately 100m from the proposed dredge area and should not be affected by dredge activity. Disposal of dredge material should not affect these patches if confined to the upland area.

One proposed dredge area occurs between NM 27.5 and 29.0, and permitted disposal areas are located on both banks (see Figure 3-2). No sampling was conducted in this area, however habitat appeared similar to Site 4. Unionids are not expected to occur in the channel and should not be affected by dredge activity. However, unionids may occur along the banks and near the inlets of side channels near the permitted disposal areas. Banks may need to be investigated to identify areas that should be avoided during future dredge disposal.

Site 5 (NM 30.0 – 33.0) includes a dredge area and two permitted disposal areas (see Figure 3-2). Site 5 was divided into three subsites: Subsite A is along the left descending bank (outside bend), and unionids were found in the permitted disposal area (P5-1), and in the mouth of Big Bayou Meto (B5-1); Subsite B included a midchannel dredge area, which had an unconsolidated sand substrate and did not harbor any unionids (Table 3-8); Subsite C was in an unaffected area among islands along the inside bend. The disposal area on the right bank did not appear conducive for unionid colonization and was not sampled. A total of 180 live unionids representing nine species were collected within Site 5, and *A. plicata*, *Q. quadrula*, *P. dombeyanus*, and *P. purpuratus* were the dominant species (Table 3-8). No unionids should be affected by dredge activity at this site. Additionally, the disposal of material along the right bank should not affect any unionids, and disposal on the left bank should only affect a small patch of unionids.

B5-1 is limited to a 3m strip along the right descending bank just inside the mouth of Big Bayou Meto (see Figure 3-2). The substrate consisted primarily of sand, silt, and clay, and depth was approximately 7.6m (see Table 3-5). Unionid density was low and CPUE averaged 12.8unionids/5 min. Nine species were collected and *Q. quadrula*, *P. dombeyanus*, *A. plicata*, and *Megalonaias nervosa* were the dominant species. Recruitment was evident with 15% of all individuals collected ≤ 5 yrs. old (see Table 3-5).

P5-1 is located among a series of islands and dikes in the disposal area along the outside bend. This was the only patch of unionids found within these islands. Substrate was clay and silt over sand, and depth ranged from 0.6 to 1.1m (see Table 3-8). Density was low, and CPUE averaged only 7.7unionids/5 min (see Table 3-5). Unionids representing four species were collected, and nearly 75% were *A. plicata*. No juveniles were collected.

At P5-2, unionids were confined to small area within a side channel along the inside bend between an island and the right descending bank. Depths ranged from 1.5 to 2.7m and the substrate consisted of a mix of sand and clay with a thin layer of silt (see Table 3-8). Density was low, and CPUE averaged 8.9unionids/5min. Unionids representing eight species were collected, and 5% were juveniles. Similar to P5-1, most of the unionids in this bed were *A. plicata* (see Table 3-5). This area should not be affected by dredging or dredge disposal.

One proposed dredge area occurs between Sites 5 and 6, at NM 32.8 - 33.7 (see Figure 3-2). The midchannel area of both Site 5 and 6 was unconsolidated sand with no unionids, and no unionids are expected to occur in the channel between NM 32.8 - 33.7. No additional dredge material disposal areas are planned in this area, therefore unionids that may occur along the riverbanks should not be affected.

Site 6 (RM 35-40) consists of a series of bends with disposal areas scattered along both banks and two dredge areas in the midchannel (see Figure 3-2). Substrate composition ranges from mixtures of sand, silt, and clay near the banks to 100% sand near midchannel. Samples were collected in the midchannel proposed dredge areas, and along both banks within and between permitted disposal sites (see Figure 3-2). Unionids were scattered along both banks throughout the site, and only two concentrations were found: P6-1 on the outside bend between two permitted disposal areas, and Bed 7 along a straight reach at the downstream end of a permitted disposal area. A total of 244 unionids representing 11 species were collected, and *O. reflexa* (29.5%), *A. plicata* (23.0%), *Q. quadrula* (22.5%) were the dominant species (Table 3-9). No unionids were found in the 100% sand substrate within the proposed dredge areas, and dredging will not affect any unionids at this site. With the exception of the B6-1, only a few unionids were found in permitted disposal areas.

P6-1 is located along the outside bend near the left descending bank between two disposal sites. Unionids were found in an area 0.9m deep where substrate was primarily sand with a small amount of silt and clay (see Table 3-3). CPUE averaged 16.3unionids/5 min. and <2% of the animals collected were juveniles (see Table 3-5). Seven species were collected and *O. reflexa*, *Q. quadrula*, *A. plicata*, and *P. purpuratus* were the dominant species. P6-1 should not be affected by dredge material disposal as long as it is contained within the permitted sites.

B6-1 is along the right descending bank at the downstream end of a disposal area and shoreward of a proposed dredge area (see Figure 3-2). The bed begins in shallow water (≤1m) near the edge of the rip-rapped bank. Density estimates averaged ≤1unionids/m^2 within the disposal area. Downstream of the disposal area along a natural bank, unionids were fairly dense (1 to 7/m^2) where the river bottom had a slight slope. The bed ends as the slope and the amount of silt in the substrate increased toward the outside bend. An average of 17unionids/5 min. were collected at the base of the clay bank. Ten species of unionids were collected, and *A. plicata*, *O. reflexa*, *Q. quadrula*, and *P. dombeyanus* were the dominant species. Recruitment appears to be relatively low, with only 4% of individuals ≤5 yrs. old (see Table 3-5). This bed could be affected by future dredge disposal activity.

Site 7 extends from Lock and Dam 3 tailwaters (NM 50.2) around two bends to approximately NM 44.0 (see Figure 3-2). Four proposed dredge areas, four maintenance dredge areas, and seven permitted disposal areas occur within the site. Substrate was a mixture of boulder, cobble, gravel, and sand in the tailwaters downstream of the lock, and nearly 100% sand in midchannel and along most of the channel borders. No unionids were collected in these substrate types, and the proposed dredge activity should not affect unionids (Table 3-10). Three small patches of unionids were found in substrate containing a mix of sand, silt, and clay. B7-1 is at the downstream end of the upstream most disposal site, P7-1 is along the inside bend at the edge of the second downstream disposal site, and P7-2 is in an unaffected tributary (Mud Lake-Little Bayou Meto). Sampling yielded 238 unionids representing nine species, and *Q. quadrula* (39.5%), *A. plicata* (19.7%), and *O. reflexa*

(19.3%) were the dominant species. Other than these three patches, Site 7 seemed devoid of unionids.

B7-1 is located along the right descending bank at the downstream end of a disposal near the tailwaters of Lock and Dam 3. Unionids are confined to an area at the base of the bank where substrate composition was a mix of cobble, gravel, sand, silt and clay, and depth ranged from 1.2 to 3.7m (see Table 3-3). CPUE was 15.0unionids/5 min. in B7-1, including individuals of eight different species. *Quadrula quadrula*, *P. dombeyanus*, and *A. plicata* were the dominant species (see Table 3-5). Very little recruitment was observed in this patch, as <2% of the unionids collected were juveniles. Although this patch will not be affected by dredging, it could be affected by dredge material disposal.

P7-1 is located in a disposal area along the downstream side of a dike near the center of the disposal area on the left descending bank (see Figure 3-2). Depth ranged from 3.1 to 5.0m, and substrate was a clay and sand mix (see Table 3-3). CPUE averaged 16unionids/5min and six species were collected in this patch. *Quadrula quadrula*, *A. plicata*, and *O. reflexa* were the dominant species (see Table 3-5). Similar to B7-1, few juvenile unionids (3% of total) were collected. Patch P7-1 is within a disposal area and in close proximity to a proposed dredge area.

P7-2 was located in Mud Lake/Little Bayou Meto near the confluence with the Arkansas River. Depths ranged from 0.8m to 3.4m and substrate was composed primarily of clay and sand with some silt and gravel (see Table 3-3). Five species were collected, including *Q. quadrula*, *O. reflexa*, *A. plicata*, *Pyganodon grandis*, and *P. dombeyanus*, and CPUE averaged 19.0unionids/5min (see Table 3-5). Recruitment was slightly higher in this patch, with 8.8% of the unionids collected being juveniles, and at least one juvenile collected for three of the five species.

No sites were sampled in Pool 3 due to a perceived lack of available habitat (J.L. Harris, AHTD, and B. Posey, AGFC, pers. comm., 2004). This included two proposed dredge sites, one maintenance dredge area, and six disposal areas that were not sampled. Based on the location of unionids in the sampled sites within this reach, unionids are unlikely to occur in the dredge areas. However, small patches of unionids may occur within or near permitted disposal areas.

3.1 Reach 2

Reach 2 extends from the Bunge Corporation Dock in Pine Bluff, AR (NM 75.2) to the Union Pacific Railroad (119.5) crossing in Little Rock, AR (see Figure 1-1b). This includes portions of Pools 4, 5, and 6. The Arkansas River in this Reach is similar to the upstream portions of Reach 1. The channel is approximately 500m wide with a substrate of primarily sand. Most of the riverbank is either rip rapped or within a dike field. Only two sites (Sites 8 and 9) were surveyed in this reach due to an apparent lack of suitable habitat influenced by factors such as urbanization and commercial dredging. Six areas (6.1 miles) within Reach 2 will need to be dredged for the 11ft and 12ft channel (see Table 2-1). Three of the six areas have adjacent permitted disposal sites. (Johnny- are there proposed disposal sites for the other 3 dredge areas?). Sites 8 and 9 each contained one proposed dredge and one permitted disposal area (Figures 3-4). Riverbanks were steep within these sites and substrate was a mix of unconsolidated sand and gravel in the channel (Tables 3-12 and 3-13). The narrow seam of sand, silt, and clay found between the channel and banks within Reach 1 was lacking in Reach 2, and very few unionids were found. Only 20 unionids representing four species, 70% of which were *Q. quadrula*, were found throughout the entire reach (see Table 3-2). Most samples yielded no unionids; however, Patch 10 was found between the islands at Warnings Bend Cutoff (RM 102.4) and the left descending bank (see Figure 3-4).

Site 8 (NM 100.8 to 103.8) encompasses one midchannel dredge area (NM 101.0 - 102.4) and a permitted disposal area within a dike field along the outside bend (see Figure 3-4). Substrate throughout the site is primarily unconsolidated sand and gravel from bank to bank (see Table 3-12). Some silt has accumulated within the dike field, but the only patch of suitable unionid substrate (sand, silt, clay mix) within the site was in a side channel near the downstream end of the site (see Figure 3-4). Eighteen (18) of the 20 unionids found in Reach 2 were collected at Site 8. *Quadrula quadrula* (72.2%), *O. reflexa* (22.2%), and *P. grandis* (5.6%) were the only species collected alive. Fresh shells of *L. fragilis* and a weathered shell of *Potamilus ohiensis* were also recovered.

Most samples in Site 8 did not yield any unionids; unionids were limited to a very small point in the disposal area, and P8-1 between the islands at Warnings Bend Cutoff (RM 102.4) and the left descending bank (see Table 3-12). P8-1 may not merit the status of a concentration of unionids, as CPUE (3.3unionids/5min) and species richness (N=2) were low compared to patches in the other reaches (Table 3-14). Unionids in P8-1 were found between 1.5 and 3.7m deep in substrates comprised primarily of sand with clay and some silt and detritus (Table 3-15).

Since no unionids occur within the channel area, proposed dredging should not affect any unionids within Site 8. Although a few unionids were found within the permitted disposal area, they are likely transient individuals as substrate is likely scoured and deposited during high water. Thus, disposal in the permitted area may affect a few individuals but not a stable community. P8-1 behind an island and therefore should be protected from any dredge or disposal activity.

Site 9 (NM 107 – 108.1) contains one proposed dredge area, most of which is a maintenance dredge area that was last dredged in 2003 (see Table 1-1). One permitted disposal area also occurs within this site along the left descending bank in a dike field downstream of Lock and Dam 6. Substrate ranged from 100% sand in the navigation channel to a mix of cobble, gravel, and sand near the banks. No suitable unionid substrate was found. Only two unionids, *Q. quadrula* and *L. fragilis*, were collected in Site 9 and were adjacent to a dike along the right descending bank (see Table 3-13 and Figure 3-4). Since no unionid habitat occurs within Site 9 few unionids will be affected by future dredging or disposal.

The four dredge areas that were not sampled within Reach 2 are unlikely to harbor unionids, based on the results of the two sampled dredge areas. The unsampled permitted disposal area between NM 95 - 96 is around an island at the downstream end of an oxbow. Unionid habitat may occur within or near this disposal area and it should be surveyed before any further disposal activity occurs.

3.3 Reach 3

Reach 3 extends from the Union Pacific Railroad crossing in Little Rock, AR (NM 199.5) to NM 220.3 near the Shoal Creek Light. This includes Pools 6 through 9 and a portion of Lake Dardanelle. The Arkansas River in this Reach is similar to Reach 2. Pools 6 through 9 are generally 500 to 700m wide, but slightly wider in some parts (>1000m wide near Site 11). Midchannel substrate is unconsolidated sand and gravel. Most of the riverbank is either rip rapped or within a dike field, and scattered unionids and low density patches of unionids were found where silt and clay have accumulated between the banks and the channel (Figures 3-5, 3-6, and 3-7). The upper portion of Pool 6 and downstream portion of Pool 7 are affected by the city of Little Rock. Other urban areas include Conway and Morrilton, Arkansas in Pool 8. The Lake Dardanelle portion of this reach is much wider and shallower, with extensive coves, islands, and tributaries (Figure 3-8). Russelville and Dardanelle, Arkansas occur within the upper end of Pool 9 and the lower end of Lake Dardanelle. Twenty-seven (27) areas totaling 11.8 miles of river will need to be dredged to achieve an 11ft channel and 46 areas totaling 17.1 miles of river will need to be dredged to achieve a 12ft channel (see Table 1-1). Additionally, 35 permitted disposal sites occur within this reach (see Table 2-2).

Ten sites within Reach 3, all in Lake Dardanelle, have previously been sampled for unionids (Table 3-14). Fourteen species were collected, and *P. dombeyanus* and *Q. quadrula* were the dominant species. Davidson (1997) indicated that scattered unionids occur throughout Lake Dardanelle in mud flat areas, but he found only two areas with more than a few unionids: NM 206.8 - 207.4, just upstream of Dardanelle Dam (our Site 22); and NM 209, at the mouth of Illinois River.

Eight unionid sites were sampled in Reach 3: four in Pool 7, two in Pool 8, one in Pool 9, and one in Lake Dardanelle (see Table 2-1). These eight sites contain 25 of the 46 proposed dredge areas, 15 of the 35 permitted disposal areas, and one area that was previously sampled by Davidson (1997) (see Table 2-1). Sixteen (16) proposed dredge sites and 11 permitted disposal sites were sampled (see Table 2-2; Table 3-15). A total of 927 unionids representing 17 species were collected in Reach 3 (see Table 3-2). *Quadrula quadrula* (27.6%) was the dominant species collected followed by *P. dombeyanus* (23.4%) and *O. reflexa* (15.5%). Unionids were most commonly associated with substrates comprised of a mixture of sand, silt, and clay; however, percentages of each varied with location. Patches of unionids were found around an island (Site 12, P12-1 to P12-6), along an outside bend (Site 13, P13-1), and in a tributary mouth (Site 13, P13-2; Table 3-16). Only three unionid beds were found and both were within mud flats: B11-1 in the pooled area upstream of Lock and Dam 6 (Site 11; see Figure 3-5), and B22-1 and B22-2 along the mud flats of the channel leading into Dardanelle Dam (Site 22; see Figure 3-8).

No sampling was conducted in the upper portion of Pool 6 (NM 119.5 - 125.3), which contains three permitted disposal areas and one dredge area (NM 124.8 - 125.1). The dredge area will be needed for both the 11 and 12ft channels. This dredge site is immediately downstream of Lock and Dam 7, and within the Little Rock city limits. Part of this dredge area is a maintenance dredge area, last dredged in 2003 (see Table 1-1). Neither of the unionid samples collected downstream of Lock and Dam 3 or Lock and Dam 6 yielded any unionids. This dredge site is unlikely to affect any unionid communities due to the effects of urbanization and previous dredging, and considering samples in similar habitat did not yield unionids.

Pool 7 (NM 125.3 to 155.9), however, included Sites 11 to 14 with B11-1 and P12-1 to P13-2 (Tables 3-17 and 3-18). These sites, which included 16 dredge and 10 permitted disposal sites, yielded 537 unionids representing 16 species (see Figures 3-5 and 3-6; see Table 3-17). *Obliquaria reflexa* and *Q. quadrula* were the most common species collected. Substrate composition varied with location of bed or patch; however, most areas are comprised of a mixture of sand, silt and clay (see Table 3-16).

Site 11 (NM 126.5 - 127.0) included one dredge area and two permitted disposal areas (see Figure 3-5). A total of 145 unionids representing 9 species were collected (Table 3-19). The most common species collected were *Q. quadrula* (29.7%), *P. ohiensis* (18.6%), *P. purpuratus* (15.2%), and *L. fragilis* (13.1%). A few scattered unionids were found in both disposal areas, however a low-density community (B11-1; 9.1unionids/5min) was found along the left descending bank (see Table 3-18).

This area also supported an established community of aquatic macrophytes. A few small zebra mussels occurred in the substrate at the upstream end of the bed, but none were found attached to unionids. Unionids were found in areas where depths were ≤3.7m and the substrate was composed of a mixture of gravel/sand/silt, silt/clay/zebra mussel shells, silt/clay/detritus, sand/silt/clay, and sand/clay (see Table 3-19). Nine unionid species were collected in B11-1 and the dominant species were *Q. quadrula*, *P. ohiensis*, *P. purpuratus*, and *L. fragilis*. This is the downstream most bed where the thinner-shelled species were abundant. Recruitment also appeared to be high as this area had the highest percentage of juveniles (54%) of any bed in this study. The bed is within 100m of the left descending bank, and seems to have been avoided by previous disposal activity. This bed should be further delineated and avoided during future disposal activity.

Five permitted disposal areas occur between Sites 11 and 12. These sites are along riverbanks and near islands; habitats that have yielded unionids at other sites (see Figure 3-5). These disposal areas should be surveyed for unionids prior to future disposal activity.

Site 12 (NM 134 - 135) is an unaffected area located around an island just downstream of a peninsula along the right descending bank. A total of 124 unionids representing 12 species were found in six patches. These patches occurred in shallow water (<2m depth, except one point at 3.5m) on a gently sloping shelf just riverward of *Justicia sp*. beds. *Quadrula quadrula* (46.8%) and *O. reflexa* (16.9%) were the dominant species (Table 3-20).

P12-1, P12-2, and P12-3 were all located along the riverward side of the islands in depths of 0.8m to 3.5m and a substrate of sand and clay or silt. Although habitat characteristics were similar among all patches community characteristics varied somewhat. Average CPUE ranged from 4.0 to 6.8unionids/5min, species richness ranged from 3 - 9, and percent juveniles ranged from 0 to 42% (see Table 3-14). In P12-1 and P12-3, *Q. quadrula*, *O. reflexa*, and *P. grandis* were the most common species. *Megalonaias nervosa*, *Q. quadrula*, and *Utterbackia imbecillis* were the dominant species in P12-2.

P12-4, P12-5, and P12-6 were found between the island and the right descending bank. Community characteristics also varied among these patches. Average CPUE was higher than in P12-1, P12-2, and P12-3, at (11 to 15unionids/5min). The relative abundance of juveniles varied from 20% to 36% in P12-4, P12-5, and P12-6 (see Table 3-14). In P12-4, only three species were collected and *Q. quadrula* was the dominant species. Unionids representing four species, *Q. quadrula*, *O. reflexa*, *L. teres*, and *U. imbecillis*, were collected from P12-5. *Anodonta suborbiculata*, *M. nervosa*, O. *reflexa*, and *Q. quadrula* were the most common of the seven species collected in P12-6.

Two dredge areas and two permitted disposal areas occur between Sites 12 and 13. Both dredge areas will only need to be dredged for the 12ft channel and should not affect unionids, as they occur midchannel. The permitted disposal area along the right descending bank covers a side channel and some islands, and habitat appears similar to Site 12. Depending on the extent of previous disposal activity, this disposal area may contain patches of unionids. The disposal area on the left descending bank occurs along a straight reach downstream of an outside bend; habitat that has yielded unionids at other sites. This area could also potentially harbor patches of unionids. Both areas should be investigated before future disposal activity.

Site 13 (NM 140 - 148) includes 13 dredge and five permitted disposal sites (see Figure 3-6). Samples within and between dredge and disposal sites yielded 265 live unionids representing 13 species (Table 3-21). Dominant species were *O. reflexa* (61.5%) and *Q. quadrula* (22.3%). Unionids were scattered along the right descending bank along a straight reach between an inside and outside bend (see Figure 3-6). Most of Site 13 had homogeneous sand or sand/gravel substrate. A few unionids were found within proposed dredge and permitted disposal sites where substrate contained more silt and clay (see Table 3-21). Two concentrations of unionids, P13-1 and P13-2, were found along the right descending bank, shoreward of a dredge area, and within a permitted disposal area near the confluence of the Fourche la Fave River. P13-1 is just downstream of the confluence with the Fourche la Fave River, in depths ranging from 0.5 to 2.1m, and in substrate of sand, silt, clay, and detritus (see Table 3-16). CPUE averaged 7.6unionids/5 min, but only yielded individuals of four species. Over 90% of the unionids in this bed were *O. reflexa* and *Q. quadrula*. This patch could be affected by future disposal activity.

P13-2 is on a shelf that ranges from 0.9m to 2.4m deep, along the left descending bank of the Fourche la Fave River just upstream of the confluence with the Arkansas River. Although this patch is small, CPUE averaged 31.0unionids/5min., including individuals of eight different species were collected (see Table 3-14). *Obliquaria reflexa* and *Q. quadrula* were the most common species, and the only individual of *Quadrula p. pustulosa* in Reach 3 was collected within this patch. Unionids in P13-2 were most commonly collected in substrate comprised of a mixture of sand, clay, gravel, and silt (see Table 3-18). P13-2 is within the mouth of the river, but the peninsula between the Fourche la Fave and Arkansas Rivers is a permitted disposal site. This patch had the highest CPUE in Reach 3 and needs to be protected from future disposal activity.

Four dredge areas and three permitted disposal areas occur between Sites 13 and 14. Three and four dredge areas will be required for the 11ft and 12ft channel alternatives, respectively (see Table 3-16).

All of the dredge areas are midchannel and should not affect any unionid communities. Two permitted disposal areas are along the inside bend on the left descending bank, and the third is within an island complex on the right descending bank. Depending on the extent of previous disposal activity, these disposal areas may contain patches of unionids. All three areas should be investigated before future disposal activity.

Site 14 (NM 153.0 to Lock and Dam 8) includes two proposed dredge areas that will be needed for both the 11ft and 12ft alternatives, and four permitted disposal areas. Substrate composition throughout the site was loose sand and gravel (Table 3-22). Only three *O. reflexa* were found in this site. All were collected from a point on the riverward edge of the inside bend permitted disposal area, at approximately NM 153.8 in a sand, gravel, and cobble substrate (see Figure 3-6). Neither dredging nor disposal will affect unionids in this area.

Three dredge areas occur between Sites 14 and 15 (see Table 3-15). These areas will only be needed for the 12ft channel alternative. All are midchannel, and substrate is most likely loose sand and gravel as are other midchannel sites in the Arkansas River. No impacts to unionids are expected in these areas. However, an island complex occurs on the inside bend between NM 158.0 and 160.0 that could be investigated for the presence of unionids.

Sites 15 and 16 are within Pool 8 (see Figure 1-1b). Site 15 (NM 164 to 165.3) is near mid-pool, and contains two proposed dredge areas. Only one is needed for the 11ft channel alternative, and an adjacent permitted disposal area (right descending bank; see Figure 3-7). A few tiny zebra mussels (most likely 2004 year class) were found in the substrate and on a few of the unionids. Substrate composition was >95% sand in nine of the 13 points sampled (Table 3-23). No unionids were found within sandy areas. A few unionids were found where substrate consisted of ≥10% silt or silt and clay on both the right and left banks near the downstream end of permitted disposal and at the edge of the proposed dredge area. This substrate occurred on a narrow shelf between the steeply sloping bank and the steep drop off into the navigation channel. Only nine unionids representing three species, *O. reflexa*, *P. purpuratus*, and *Q. quadrula*, were collected. No unionid patches or beds were found within Site 15, and only a few unionids may be affected by dredge or disposal activity.

Three and one dredge areas needed for the 12ft and 11ft alternative, respectively, and five permitted disposal sites occur between Sites 15 and 16 (see Table 3-15 and Figure 3-7). Unionids are unlikely to occur within the dredge areas, as they are located midchannel and along a sharp outside bend. Permitted disposal areas are within dike fields or island complexes, where patches of suitable habitat might occur. These areas should be surveyed for unionids before future disposal activity.

Site 16 (NM 174 - 176) is near the tailwaters of Lock and Dam 9 (see Figure 1-1b). The site includes two proposed and one maintenance dredge area, and one permitted disposal area (see Table 3-15 and Figure 3-7). Only 14 unionids representing five species were found within this site (Table 3-24). Channel depth ranged from 0.9 to 4.6m, inside bend depth ranged from 2.1 to 5.8m, and outside bend depth ranged from 0.8 to 6.1m (see Table 3-24). Zebra mussels covered ≤1% of the substrate within a few of the points sampled midchannel. Substrate in these habitats was primarily sand and gravel. Two unionids were found in the channel, but these are likely transient individuals. Most of the unionids at Site 16 (nine of four species) were found in the mouth of Point Remove Creek (NM 174.9). Tributary mouth depth was 1.5m, and substrate consisted of mostly clay, mixed with cobble, sand, silt, and zebra mussel shells (see Table 3-24). The remaining three unionids were found within and just upstream of the dike field on the outside bend where substrate was a mix of boulder, cobble, and silt or gravel, silt and clay. Even though this bank is not affected by disposal and has similar substrate to other areas in this reach where patches of unionids were found (sand, silt, clay mixture), the areas did not contain stable patches of unionids. Neither dredging nor disposal will affect unionids at this site.

One proposed dredge area for the 12ft channel alternative occurs in the Lock and Dam 9 tailwater (see Table 3-15). Dredging in this area is unlikely to affect any unionids. Three proposed dredge areas (11ft and 12ft alternatives) and one permitted disposal area occur between Lock and Dam 9 and Site 18 (see Figure 3-7). Since few unionids were found and substrate is primarily sand both upstream (Site 18) and downstream (Site 16), dredge and disposal activity in this reach (NM 176.0 – 182.0) is unlikely to affect unionids. The outside bend near NM 179.0 may contain a mud flat with some unionids, however this area will not be affected by dredge or disposal activity.

Pool 9 (NM 176.9 to 205.4) included only one site, Site 18 (NM 181.7 to 185.5). This site is located within a sharp river bend, and included one permitted disposal area along the inside bend, and three proposed dredge areas (two in the upstream approach to the outside bend and one downstream of the outside bend (see Figure 3-7). No samples were collected in the permitted disposal area, as no unionid habitat seemed likely based on bank characteristics. The left descending bank suggested unionid habitat, with a slight slope and *Justicia sp*. beds from the upstream to downstream end of the site. However, immediately riverward of the bank depth increased to 3.4 to 6.7m, and substrate was a mixture of boulder, cobble, gravel, and sand (Table 3-25). Only one *A. suborbiculata* was found (see Table 3-25). The channel was shallower than the outside bend, at 1.8 to 3.4m, but substrate was 100% sand. Only one *O. reflexa* was recovered. Neither dredging nor disposal activity will affect unionids at this site.

The remaining portion of Pool 9 contains four proposed dredge areas (only two for the 11ft alternative), one maintenance dredge area, and six permitted disposal areas. Unionids are unlikely to occur in either the proposed dredge areas or maintenance area, based on results from other sites within Pool 9. Unionids are also unlikely to occur in the permitted disposal areas, as both ortho-quadrangles and the navigation maps indicate that these areas are sanded in, and similar disposal areas in Pools 8 and 9 did not contain unionid habitat.

The lower portion of Lake Dardanelle (NM 205.4 - 220.3) is also part of this reach. Two proposed dredge areas (both only needed for the 12ft alternative) occur in the straight reach upstream of Lock and Dam 10 (Figure 3-8). Site 22 (NM 206.5 - 207.7) was the only site that fell within this section of the lake. Site 22 was located in a straight stretch just upstream of Lock and Dam 10, along the channel borders adjacent to and within the proposed dredge site at NM 207.0 - 207.6 (see Figure 3-8). The channel was very deep, 11.6m at the bankward edges, substrate was primarily sand, and no unionids were collected (Table 3-26). Zebra mussel shells were abundant and in places covered the entire substrate; however, very few live zebra mussels were observed and none were attached to unionids. Unionids were found from the edge of the proposed dredge area to both riverbanks (see Figure 3-8), in depths from 1.5m to 10.5m on the right descending bank (B22-1) and 3.1 to 9.3m on the left descending bank (B22-2). Substrate within B22-1 was sand, silt, clay and zebra mussel shells, and substrate within B22-2 was gravel, sand, clay, and zebra mussel shells (see Tables 3-16 and 3-26). Unionid densities decreased sharply near the edges of the dredge area, as depth increased and substrate changed to sand.

The right descending bank between NM 206.8 and 207.4 (part of B22-1) was previously surveyed by Davidson (1997), who sampled seven points that yielded 45 unionids of six species (see Table 3-14 and Figure 3-8). *Plectomerus dombeyanus* and *Q. quadrula* were the dominant species. Species collected by Davidson (1997) that were not found in this study included *Arcidens confragosus* and *P. ohiensis* (see Table 3-14).

In this study, two unionid concentrations were found within the site, one on each side of the dredge area. A total of 365 unionids representing eight species were collected from these beds (see Table 3-26). As in Davidson's (1997) study, *P. dombeyanus* (63.3%) and *Q. quadrula* (21.4%) were the dominant species collected. Species found in this study, but absent from Davidson's (1997) study included *A. suborbiculata*, *M. nervosa*, *P. grandis*, and *Q. aspera*. *Potamilus ohiensis*, collected by Davidson (1997), was only found as a weathered shell in 2004. The same eight species were found in both beds; however, B22-1 CPUE was higher than that of B22-2, averaging 12.0unionids/5min and

8.1unionids/5min, respectively (see Table 3-18). Juvenile unionids comprised at least 23% of the unionids collected in B22-1 (juveniles and adults were not differentiated in B22-2).

CPUE and species richness in B22-1 and B22-2 were comparable to beds found in Pools 2, 5, and 7 (see Tables 3-5 and 3-18). Recruitment (% juveniles) was >20% only in B2-1 and B2-2 (Pool 1 canal), B11-1 (Pool 7), B22-1 (Site 22), and Bed 33-1 in Reach 5; thus, these beds are worth protecting. The need for dredging near these beds is questionable, as depths were >10m at the edges of the channel. Widening the channel will impact these unionid communities, and dredging in the canal on the upstream end of Lock and Dam 10 should be avoided if possible. If avoidance is not an option then both beds should be further delineated and a buffer zone of at least 150m established between the beds and any dredging activity. Both channel borders along the proposed dredge area between NM 205.9 and 206.5 should also be investigated for unionids. If unionids are found, buffer zones between unionids and the dredge area should also be established. If dredging must occur closer than 150m from the unionid beds, unionids should be relocated before any dredge activity occurs. The unionid beds should be monitored for impacts, and the buffer zone should be monitored to determine to what extent substrate collapses within the buffer zone.

Upstream of the canal leading to Lock and Dam 22, the Arkansas River widens to form a shallow, wide lake, and inundates the mouths of Bay Ridge Creek, Illinois Bayou, and Delaware Creek (see Figure 3-8). All three of these coves were sampled by Davidson (1997). Only a few scattered unionids were found within Bay Ridge Cover (LD-4M) and along the peninsula upstream of Illinois Bayou (see Table 3-14). However, unionids were numerous within the Illinois Bayou Cove (see Table 3-14). A total of 536 unionids representing 12 species were found at three points within the cove (D97a; see Figure 3-8). Dominant species were *P. dombeyanus* and *Q. quadrula*, similar to the beds within Site 22. A small patch of unionids was found in the mouth of Delaware Creek (M5), but only 24 unionids were found, 23 of which were *Q. quadrula*.

The lake narrows between NM 214.0 and 221.0 (see Figure 3-8). Within this narrower reach Davidson (1997) sampled along the left descending bank near NM 215.8, along the inside bed near NM 218.2 (6M), and along the outside bend near the mouth of Shoal Creek (NM 220.0). Only a few unionids were found at 6M and near Shoal Creek. Three species and 17 unionids were found at two points near NM 215.8. However, Harris (1992) recovered 142 unionids representing seven species (mostly *P. dombeyanus* and *Q. quadrula*) along the inside bend near NM 216.8, and 72 unionids representing nine species (mostly *Q. quadrula*) on the opposite bank near the channel and within a cove between NM 217.8 to 218.6 (see Figure 3-8 and Table 3-14).

3.4 Reach 4 (NM 220.3 – 308.7)

Reach 4 extends from NM 220.3, near the Shoal Creek Light, to NM 308.7, near the mouth of the Poteau River, and includes portions of Lake Dardanelle, Ozark Lake, and Pool 13. Seven maintenance dredge areas occur in Reach 4, and 18 (13.6 miles) and 29 (33.8 miles) dredge sites will be needed for the 11ft and 12ft channel alternatives, respectively (see Table 1-1). Dredge material will be placed in 28 permitted disposal sites (see Table 2-2). One maintenance dredge area, nine proposed dredge areas, and four permitted disposal sites were sampled within Reach 4 in 2004 (see Table 2-2). The downstream portion of Lake Dardanelle (NM 221 to 237) is very wide (almost 3000m within Site 23), with numerous islands and mud flats. Site 23 occurs within this wide lake area (see Figure 1-1c), and Davidson (1997) found unionids at seven locations within this site (Table 3-27). Eight proposed dredge sites, one maintenance dredge site, and three permitted disposal sites are within this wider portion of Lake Dardanelle.

From NM 237.0 to approximately NM 249.0, the lake narrows to <1000m wide. In this stretch, the river is a series of slight bends, with islands (typically sanded in dike fields) on the inside bends and rip rapped banks along the outside bends. Davidson (1997) found only two unionids within this area (see Table 3-27). Five proposed dredge areas, two maintenance dredge areas, and seven permitted disposal areas occur in this narrower meandering section of Lake Dardanelle.

From approximately NM 250.0 to Ozark Dam the river is <500m wide and primarily consists of the navigation channel, with dike fields lining the inside bends. Two proposed dredge areas and one permitted disposal area occur in the narrower section leading up to the dam. Davidson (1997) sampled one site in the section (see Table 3-27).

Ozark Lake (NM 257.0 - 292.5) is narrower (<750m in the widest areas) and meandering (see Figure 1-1c and 1-1d). Dike fields with island complexes occur in the widest sections. Lake Ozark contains 14 proposed dredge areas, three maintenance dredge areas, and 12 permitted disposal areas. Three sites within Ozark Lake were sampled in 2004 (Sites 26, 27, and 28), and Davidson (1997) found unionids at seven sites, two of which fall within Site 26 (Table 3-28).

The four sites sampled in 2004 contained nine proposed dredge areas, one maintenance dredge area, four permitted disposal areas, and two patches previously found by Davidson (1997) (see Table 2-1). Samples were from midchannel, straight reach, and tailwater dredge areas, as well as inside and outside bend disposal areas (see Table 2-2). Unaffected habitats sampled included inside and outside bends, straight reaches, midchannels, islands, and tailwaters (see Table 2-2). A total of 388 unionids representing 14 species were collected in the four sites sampled in Reach 4 (see Table 3-2).

Plectomerus dombeyanus (34.0%), *Q. quadrula* (30.2%), and *O. reflexa* (21.7%) were the most common species. Most of the unionids found within sampled sites were collected from B23-1 and B23-2 (Site 23) and P26-1 and P26-2 (Site 26; Table 3-29). Davidson (1997) found 166 unionids representing eight species at 10 sites in Lake Dardanelle, and 134 unionids representing 10 species at seven sites in Lake Ozark (see Tables 3-27 and 3-28). *Quadrula quadrula* (42.7%), *P. dombeyanus* (19.3%), *P. grandis* (14.7%), and *O. reflexa* (14.3%) were the most commonly collected species (see Table 3-28). Between this study and Davidson (1997), 15 species have been found in Reach 4. Species found in this study but not by Davidson (1997) included *M. nervosa*, *Quadrula aspera*, *Truncilla donaciformis*, *Truncilla truncata*, and *U. imbecillis* (see Table 3-2). *Lasmigona complanata* was found by Davidson (1997), but not in this study (see Table 3-28).

<u>Lake Dardanelle (NM 220.3 – 256.7)</u>

One proposed dredge site (needed for both alternatives) and one maintenance dredge site (last dredged in 2002) occur between NM 220.3 and Site 23 (NM 225.5) (see Table 1-1 and Table 3-30). Davidson (1997) sampled several points within this section, and found unionids scattered along the outside bend, inside bend, and a few islands (see Figure 3-8). Catch per sample point ranged from 1.0 to 11.0, and six species were found (see Table 3-27). Both the dredge and maintenance dredge areas are within the main channel, and occur over 1km from points where unionids were found. Therefore, dredging in this area will not affect unionids. However, the nearest permitted disposal area is at NM 233, over 10 miles from the proposed dredge site. If a disposal area is needed in this area, proposed sites will need to be surveyed to avoid unionids.

Site 23, (NM 225.5 - 231.0) includes four dredge areas, two of which are not needed for the 11ft channel alternative (see Figure 3-8). A total of 311 unionids representing 13 species were found within Site 23, with *P. dombeyanus*. (42.1%), *Q. quadrula* (26.7%), and *O. reflexa* (18.0%) being the dominant species (Table 3-31). This area is a sharp bend in the river with numerous islands on the inside portion of the bend. Unionids were scattered throughout the site, with a few collected in most places where silt or clay were constituents of the substrate. The channel area was primarily sand, and only four unionids were found in the seven points sampled. Unionids were also scattered along the outside bend near NM 228.0, along the right bank straight reach shoreward of the proposed dredge site between NM 229.5 and 230.0 (primarily sand substrate), near many of the islands (substrate mostly sand), and along the right bank inside bend shoreward of the islands (substrate mostly clay with silt) (see Table 3-31). Davidson (1997) also found scattered unionids along the right descending bank shoreward of the islands: seven unionids representing four species within six sample points (see Table 3-27). Two areas were found where unionids were consistently collected: B23-1 and B23-2, both on the left descending bank leading into and out of the outside bend (see

Figure 3-8).

B23-1 was located along the upstream side of the outside bend. Unionids were concentrated on a 10m wide shelf between 2.0 and 7.3m deep, approximately 15 to 20m riverward of the bank. This shelf was 2.0 to 4.2m deep at the upstream end, and 4.6 to 7.3m deep near the downstream end. Substrate was mostly clay mixed with sand, covered with a thin layer of silt (Table 3-32). CPUE averaged 14.5unionids/5min. Eleven (11) species were found, and *P. dombeyanus* and *O. reflexa* were the most abundant species (see Table 3-29). Some recruitment was apparent, as over 50% of the species were represented by young animals. However, only 12% of the unionids collected were juveniles; similar to beds in Reaches 1 and 2 (2 to 26%, see Table 3-5), but less than the 23 to 54% juveniles in Reach 3 beds (see Table 3-18). The upstream portion of B23-1 was located behind a series of islands. This bed should not be affected by proposed dredging, as the upstream portion of the bed is over 500m from the proposed dredge site between NM 229.5 and 230.1, and the downstream portion is over 300m shoreward of the NM 228.5 to 228.8 dredge site (see Table 3-30).

B23-2 was located along the downstream side of the outside bend, just downstream of B23-1. These beds may not be ecologically separate, as fish are likely to travel between beds. However, depth between the beds ranged from 7.0 to 10.7m, and substrate contained less clay and more cobble, sand, and silt than within the beds. Only three unionids were found in this area (see Table 3-31). Within B23-2, unionids were found along a clay and silt shelf. Depth ranged from 1.5 to 10m deep, but was <2m at all points except two at the upstream end of the bed (see Table 3-31). Community characteristics in B23-2 were similar to B23-1. CPUE averaged 10.0unionids/5min, eight species were found, 11% of the unionids collected were juveniles, and *P. dombeyanus* and *Q. quadrula* were the dominant species (see Table 3-29). The upstream portion of B23-2 is approximately 250m shoreward of a proposed dredge area, and islands separate the downstream portion from the channel (see Figure 3-8). Dredging should not affect unionids in B23-2. However, the nearest disposal site is approximately three miles upstream. If additional disposal areas are needed within Site 23, the islands and riverbanks on the left descending side of the channel should be avoided.

Ten dredge sites (five for the 11ft alternative), and ten permitted disposal sites occur in the remainder of Lake Dardanelle. Proposed dredged sites occur in a variety of habitat types including midchannels, straight reaches, outside bends, and in the tailwaters of Lock and Dam 12 (see Table 3-30). Davidson (1997) sampled four locations in the upper part of Lake Dardanelle. Unionid densities appeared low in these sites with the densest areas yielding only three species and an average catch of 3.0unionds/sample point (see Table 3-27). None of Davidson's (1997) points were near proposed dredge or permitted disposal sites. Based on the location of B23-1 and B23-2, the right descending bank between NM 233.0 and 231.0 (particularly near the coves), and along the left descending bank downstream of Horsehead Creek (NM 235.5 – 234.0) have potential to harbor unionids. One proposed dredge area occurs within this section. At least the left descending bank and perhaps all of the moderate outside bends, particularly those near creek mouths and near dredge or disposal areas, should be surveyed before future dredge and disposal activity.

Sites 26, 27, and 28 in this study, and seven of Davidson's (1997) sites occur in Ozark Pool (NM 256.7 - 292.8; see Figure 1-1d). Fourteen (14) proposed dredge sites (10 for the 11ft channel alternative; see Table 3-30) and 12 permitted disposal sites occur within Lake Ozark. Dredging is not needed and no permitted disposal areas occur between Lock and Dam 12 (NM 257.0) and NM 271.0, thus no samples were collected in this study (see Figure 1-1d). Davidson (1997) found unionids at three sites within this section: the outside bend above the Lock and Dam (NM 257.4 - NM 258.0), the channel near NM 266.5, and the islands near NM 267.2 (see Table 3-28). A total of 44 unionids representing six species were recovered, 27 and 10 of which were *Q. quadrula* and *O. reflexa*, respectively (see Table 3-28). Davidson (1997) found the most unionids and species between NM 257.4 and NM 258. This is an outside bend near a creek mouth, similar to the habitat where beds were found in Lake Dardanelle. Since no dredge or disposal sites occur within the lower portion of Lake Ozark, unionids will not be affected by dredge or disposal activity. However, searching additional moderate outside bends could reveal additional unionid beds.

Two proposed dredge sites (both needed for 11ft and 12ft alternatives) occur within Site 26 (NM 269.5 - 273.0). A total of 51 unionids of seven species were found in this study, and *Q. quadrula* (49.0%) and *O. reflexa* (37.3%) were the dominant species (Table 3-33). Davidson (1997) sampled in the mouth of the Mulberry River, NM 272.0 and 273.0 (Figure 3-9), and found 16 unionids representing four species, *A. suborbiculata*, *P. ohiensis*, *P. grandis*, and *Q. quadrula* (see Table 3-28).

The proposed dredge areas were 3.1 to 4.6m deep, and substrate varied from clay and cobble to a mixture of gravel, sand, silt and clay. No unionids were found in the proposed dredge areas (see Table 3-33). Only three unionids were found on the right descending bank, shoreward of the proposed dredge areas. Depth ranged from 3.7 to 6.1m, and substrate was a mixture of gravel, sand, silt, and clay (see Table 3-33). Since no unionid concentrations occur near the proposed dredge sites, only a few scattered unionids could be affected by the proposed dredging.

The remainder of Site 26 will not be disturbed by dredging or disposal activities. The islands between NM 273.0 and 271.0 were in depths from 0.9 to 5.1m, and substrate comprised primarily of sand. The six unionids found in this area were in at depths of 1.5 and 5.1m, in clay and silt substrate (see Table 3-33). A patch of unionids was found at the mouth of the Mulberry River (see Figure 3-9). Unionids in P26-1 were located in depths ranging from 1.8 to 3.1m, in substrate of clay covered with silt (see Table 3-32). CPUE averaged 5.7unionids/5min, five species were found, and 12% of the unionids collected were juveniles (see Table 3-29). *Quadrula quadrula*, *O. reflexa*, and *P. grandis* were the dominant species. Species found in this tributary by Davidson (1997) that were not found in this study included *P. ohiensis* and *A. suborbiculata* (see Table 3-28). Species found in this study and not by Davidson (1997) included *A. confragosus*, *L. fragilis*, and *O. reflexa* (see Table 3-29).

No unionids were found in the channel downstream of the proposed dredge area (100% sand; see Table 3-33). Only a few scattered unionids were found along the islands downstream of the dredge areas along the left descending bank. Substrate was primarily clay, with some silt, but two sampled points had substrate of >90% sand. The three unionids recovered were riverward of patches of *Justicia sp*., in shallow water (≤1.5m) and where substrate was a clay and silt mix (see Table 3-33).

A second patch of unionids (P26-2) was found in 6.1m of water, in clay with silt substrate, along the right descending bank at the downstream end of Site 26 (see Figure 3-9). Only three species were collected (Q. quadrula, O. reflexa, and P. dombeyanus); CPUE averaged 7.3unionids/5min, and 5% of the unionids were juveniles (see Table 3-29). Neither of the unionid patches in this site will be affected by dredging or disposal activity.

Seven proposed dredge areas (four for the 11ft channel alternative, see Table 3-30), and six permitted disposal areas occur between Sites 26 and 27 (see Figure 3-9). No samples were collected within the channel or channel borders, but Davidson (1997) found a unionid bed in a cove along the left descending bank between NM 277.0 and 278.9 (see Table 3-28). He found six species and 73 unionids in nine sample points (average 8.1unionds/ point). Dominant species were *P. grandis*, *Q. quadrula*, and *O. reflexa* (see Table 3-28). This unionid bed is protected within the cove from any dredge or disposal activity. Dredging will occur midchannel and should not affect any unionids. Permitted disposal areas, particularly those along outside bends, could harbor patches of unionids and should be surveyed before future disposal activity.

Site 27 occurs along a sharp bend between NM 281.0 and NM 284.2 (see Figure 3-9). Two proposed dredge areas (both needed for 11ft and 12ft channel alternatives) are in the midchannel, and two permitted disposal areas are along the inside and outside bends (see Figure 3-9). The proposed dredge areas are 3.4 to 4.9m deep, and have primarily sand or gravel substrate (Table 3-34). Only 22 unionids representing five species were found within Site 27. The dominant species were *Q. quadrula* (31.8%), *O. reflexa* (31.8%), and *P. grandis* (22.7%). One *O. reflexa* was found in the channel. This was most likely a transient individual, as unionids cannot maintain position within a loose sand and gravel substrate. Unionids were also absent from the midchannel samples outside of the proposed dredge areas. The channel border along the right descending bank adjacent to the upstream dredge area did harbor a few scattered unionids. Scattered unionids were also found within the disposal areas near dikes. Unionids were found in depths of 0.9 to 1.8m, in substrate consisting of clay and silt mixture, with some sand within the outside bend disposal areas, and in primarily sand with some silt and clay within the inside bend disposal area (See Table 3-34). No unionids were found within the tributary mouth or outside bend area downstream of the proposed dredge area. No concentrations of unionids were found within Site 27. Dredging and disposal of material may affect a few scattered unionids, but will not affect any significant unionid resources.

Two proposed dredge sites (one for the 11ft alternative) and three permitted disposal sites occur between Sites 27 and 28 (see Figure 3-9). The proposed dredge areas are midchannel and unlikely to affect unionids. Davidson (1997) collected one sample midchannel near NM 289.7, and found one *L. fragilis* (see Table 3-28), which was likely a transient individual. Permitted disposal areas may contain a few patches of unionids if a silt and clay substrate is available. However, these areas are within a narrow channel, and no more than a few scattered unionids have been found in channel borders within Lake Ozark. Only a few unionids are likely to be affected by disposal activity in this area.

Site 28 (NM 288.8 - 292.0) is within the tailwaters of Lock and Dam 13 (see Figure 3-9). One proposed dredge area, and two permitted disposal areas occur within the site. The dredge area is along the outside bend in depths ranging from 3.1 to 4.6m. Substrate at the upstream end of the dredge area was cobble, gravel, and sand, and no unionids were found (Table 3-35). At the downstream end of the dredge area substrate was partly bedrock, with gravel and silt near the bank, and one *O. reflexa* was recovered. This again is likely a transient individual. Dredging with Site 28 should not affect any unionid communities. The disposal area along the left descending bank is within a dike field. Only one point was sampled near the end of a dike, as no areas appeared suitable for unionids. Depth at the sampled point was 1.8m, substrate was loose cobble, gravel, and sand, and no unionids were collected. The second disposal area is behind rip rap along the outside bend (see Figure 3-9). Depth was 4m, and substrate was bedrock, boulder, cobble, and gravel. Substrate was unsuitable for unionids, and no unionids were found. Since no unionid habitat occurs within these disposal areas, future disposal activity will not affect unionids.

Even the areas along the bank that were not near disposal areas had poor unionid habitat. The dike field along the right descending bank at the downstream end of the site was primarily boulder, cobble and sand (see Table 3-35). A small patch with some silt was found behind a dike, and one ***Q**. quadrula* was found. Along the inside bend, depth was <2m and substrate was primarily sand and silt. Two unionids were found on the downstream side of the bend in <1m of water. Both unionids had four tiny zebra mussels attached (see Table 3-35). The downstream most outside bend along the left descending bank was also rip rapped. Depth ranged from 1.5 to 6.4m, and substrate contained mostly boulder, cobble, and sand with some silt. One sample was primarily clay with silt, however no unionids were found.

The Arkansas portion of Pool 13 (NM 293.0 – 308.0) is also within Reach 4 (see Figure 3-9). Van Buren and Fort Smith, AR occur on the banks of the Arkansas River, which may affect water quality. No dredge areas are proposed, but four permitted disposal areas in this portion of Pool 13. No sampling was conducted in this part of Reach 4, due to the urban character of the area.

3.5 Reach 5

Reach 5 extends from NM 308.7, near the Oklahoma border, to NM 394.0, where MKARNS diverts from the Arkansas River to the Verdigris River (see Figure 1-1d and 1-1e). Four maintenance dredge sites (0.8 miles of river) occur within this reach. For the 11 and 12ft alternatives, 28 sites will need to be dredged, 40.1 river miles (see Table 1-1). Additionally, 15 aquatic disposal sites will be needed for placement of dredge material (Table 3-36). Two maintenance dredge areas, 21 proposed dredge areas, and 15 new disposal areas fell within the 15 sites sampled in this reach (see Table 2-1). A total of 407 samples were collected within the 37.9 river miles (45% of the reach). Twelve of the 15 sites were in the Arkansas River, one was in an oxbow, and two were within tributaries (Poteau River and San Bois Creek).

Arkansas River habitat varied within this reach. Most of the proposed dredge areas were within the channel, but dredging will also occur in cove, outside bend, tailwater, and tributary habitats (see Table 2-2). Most proposed disposal areas are near or over islands, but cove, inside bend, and peninsula habitats will also be affected. Many of the points sampled in this reach were outside the proposed dredge or disposal areas. At least one of each habitat type, in unaffected areas, was sampled (see Table 2-2).

Pools 13 and 14 consisted of a narrow meandering channel <300m wide. Five proposed dredge areas, two maintenance dredge areas, and two proposed disposal areas occur within these pools. Both disposal areas were sampled, and four of the five dredge areas were sampled. Poteau River occurs within Pool 13 (see Figure 1-1d). The Poteau River within the study areas is primarily a navigation channel. Both of the dredge areas in the Poteau were sampled.

The lower portion of Pool 15 is a wide lake (Lake Kerr), with several coves around the perimeter (see Figure 1-1d). Sallisaw and San Bois Creek feed into the lake. Upstream of Lake Kerr the river narrows to a meandering channel, with the exception of a wide shallow outside bend at NM 355. San Bois Creek within the study area consists of a channel, surrounded on both sides by wide shallow mud flats. Numerous islands and coves occur in the mud flats. Eleven of the 13 proposed dredge sites and 11 proposed disposal sites were sampled in Pool 15 (see Table 3-36).

Pool 16 from the dam to the confluence with the Verdigris River is primarily a narrow meandering channel, with a wide outside bend near NM 374, and a large oxbow near NM 380 (see Figure 1-1e). Four of the eight proposed dredge sites, and two proposed disposal sites were sampled in Pool 16 (see Table 3-36).

A total of 902 unionids of 21 species were collected in the 417 samples within this reach (see Table 3-2). Although the number of species in Reach 5 was high, two species, ***Q****. quadrula* (53%) and *O. reflexa* (24%), accounted for over 75% of all unionids collected. Only a few individuals (≤25) of other species were found. Most of these unionids (65%) and species (86%) were concentrated in small patches within Sites 30, 31, 32, 35, 36, 39, and 39 (Table 3-37, Figures 10, 11, 12, 13, and 14). The only unionid bed found was at Site 33, immediately above Lock 15, along the right descending bank (Figure 3-10).

In general, unionids were found near the bank, in areas with a gentle slope, and a substrate mixture of clay, sand, and silt (Table 38). These conditions occurred within most habitats, except the main channel and long outside bends. Catch per unit effort in proposed dredge areas was generally ≤3 unionids/5min (see Table 3-36). Only one patch (P35-2) was found within a proposed dredge area. CPUE in proposed disposal areas was slightly higher, as disposal areas are primarily in shallow water in coves, on islands, or along peninsulas. One patch (P35-1) and one bed (B33-1) were found in disposal areas (see Table 3-38).

In the Poteau River (Site 30; Table 3-39), a few uniondsw were found along the slopes at the edges of the channel in the downstream dredge area (DR-2). Some unionids will be affected by dredging in this area.

One patch of unionids (P31-1) was found along the inside bend within Site 31 (Table 3-40; see Figure 3-10). However, P31-1 is approximately 250m shoreward of the dredge area and should not be affected by dredging. Impacts within Site 31 will be limited to a few scattered unionids.

The dredge area in Site 32 contains a considerable amount (50 to 100%) of bedrock and boulder (Table 3-41). Only a few scattered unionids would be affected by dredging at Site 32. A patch of unionids was found in a small shallow cove, but P32-1 is approximately 250m downstream of the dredge area and should not be affected by this project.

Site 33 consists of two proposed disposal areas, both behind the dikes separating the lock approach from the channel borders; one on the right side and one on the left side (Figure 3-11). The only unionid bed in Reach 5 occurs in the area proposed for dredge disposal on the right side of the channel (B33-1; Table 3-42). This bed would be affected by disposal of dredge material and should be avoided if possible.

A few unionids were found at five of the six points sampled within the two proposed dredge areas in Site 34 (Table 3-43). Substrate within the dredge areas consisted of a mixture of sand, clay, and silt, which is the substrate preferred by unionids in the Arkansas River. A few unionids could be affected by dredging at this site; however, no concentrations of unionids were found, and unionids are likely scattered throughout this lake area. Thus, dredging is likely to affect only a small percentage of the unionids within this site.

Unionids were found throughout Site 35 (Table 3-44). The sampled area contained 271 of the 902 unionids collected in Reach 5 (30%), and 17 of the 19 species found in Reach 5 (see Table 3-44). Patches of unionids were found in gently sloping shallow areas with primarily clay and silt substrate. Water willow was common along the bank, shoreward of the patches. Four patches were found. P35-4 was in a cove near the upstream end of the site, and within 100m of the dredge area (see Figure 3-11 and Table 3-36). P35-2 was along the edge of the upstream dredge area, primarily along the riverward edge of an island, but extended into the channel and could be affected by dredging activity. P35-1 was the largest patch, and much of this patch would be buried by proposed disposal activity. This disposal site should be avoided if possible. P35-3 was in a cove, well away from proposed dredging and disposal activity. These dredge and disposal sites should be more thoroughly investigated before channel maintenance activity.

Unionids were also found scattered throughout Site 36 (Table 3-45). However, only one patch of unionids was found (P36-1). Although this patch was small, unionids within P36-1 were fairly dense (13.3/5minutes). However, only four species and no juvenile unionids were found within the patch. P36-1 is approximately 600m shoreward of the main channel dredge area (DR-1) and should not be affected by dredge activity. However, substrate within DR-1 is clay and silt, and unionids were found in 50% of the samples (see Table 3-45). Ten unionids were collected from the point near NM 343.8. Similarly, unionids were found at over 50% of the points sampled within DR-2 (Sallisaw Creek dredge area), with up to nine unionids at a few points. Both of these dredge areas should be investigated further before dredge activity. Unionids were also scattered throughout the proposed disposal area in the Sallisaw Creek cove (see Figure 3-11). Unionids were found in a strip of silt and clay substrate, approximately 20m from the bank. If disposal could be contained on land, it should not affect these unionids.

Most of Site 37 was too shallow for access. Since this sampling trip occurred under high to moderate flow conditions, much of this area is probably dry during low flow. No concentrations of unionids were found (Table 3-46). A few scattered animals may be affected by proposed disposal activity. However, if disposal is limited to shallow areas few unionids should be affected. Site 38 was also a complex of islands in very shallow water (Figure 3-12). Most of Site 38 was sand, and only four unionids of three species were found in 17 samples (Table 3-47). Dredge and disposal activity at Site 38 should not affect unionids.

Six patches of unionids were found in Site 39, primarily along the right descending bank (Figure 3-13). As at other sites, unionid patches were found either in small shallow areas with a gently sloping bank, or in deeper water at the interface of the riverbank and the channel in clay, silt, and sand substrate (Table 3-48). A few tiny zebra mussels were found on many of the unionids collected at this site. None of the unionid patches are within the dredge areas; however, P39-3 and P39-4 are within 100m of the dredge area, as the channel hugs the right descending bank. As long as dredging does not disturb the area within 20m of the riverbanks, unionids should not be affected by dredge activity within Site 39.

No patches of unionids were found within Sites 40 through 44. Several species of weathered shells were found at Site 40, suggesting the area supported unionids at one time. Additionally, substrate was a mixture of sand, silt, and clay and much of the area seemed conducive to unionids. A few unionids were found in both the dredge and disposal areas (Table 3-49). This area may require further investigation before dredge or disposal activity. Similarly, unionids and shells of six species were scattered throughout Site 41 (Table 3-50). Unionids may have previously occupied this area; however, most of the area near the islands was very shallow. Disposal within these islands should only affect a few unionids.

One unionid was found at the mouth of the oxbow at Site 42, and no unionids were found at Sites 43 or 44 (Tables 3-52, 3-53).

3.6 Reach 6

Reach 6 extends from NM 394, at the junction of the Grand River and the Arkansas River, and extends to the head of navigation on the Verdigris River (NM 445; see Figure 1-1e). Site 51 extended approximately 1 mile upstream of navigation. The Verdigris River has been extensively channelized. The channel is fairly straight and less than 100m wide (Figures 3-14, 3-15, and 3-16). The river is generally <3m deep along the banks, but depth increases rapidly to over 4m in most of the dredge areas (Tables 3-54 to 3-60). Approximately 22.3 river miles and 18 locations will need to be dredged for the 11 and 12ft channel alternatives (Table 3-61). No aquatic disposal areas are planned in Reach 6.

A total of 27.5 river miles and 227 points were sampled in Reach 6 (see Table 2-1). However, only 177 unionids of 10 species were collected (see Table 3-2). *Obliquaria reflexa* comprised 50% of the unionids collected. Species that were more common in Reach 6 than in other reaches included *Q. nodulata* (only collected in Reaches 1 and 6), *Q. p. pustulosa*, and *T. verrucosa* (see Table 3-2). In the early 1900's, this section of the Verdigris River harbored 19 unionid species, (see Table 1-2). Species that previously occurred in this reach that no longer seem to be present include *Cyprogenia aberti*, *Ellipsaria lineolata*, *Fusconaia flava*, *Lampsilis cardium*, *Pleurobema rubrum*, *Pleurobema sintoxia*, *Ptychobranchus occidentalis*, *Q. aspera*, *Quadrula metanevra*, *T. donaciformis* and *T. truncata* (see Table 1-2). Most of these species were not collected in this study (see Table 3-2). Additionally, *A. plicata* was the most abundant species collected by Isley (1925), and only a few individuals were found in Reach 6 in this study.

Fifteen of the 18 proposed dredge sites in Reach 6 were sampled. Habitats that will be affected include the main channel, inside bend, outside bend, straight reaches, and tailwaters (see Table 2-2). Samples were also collected from unaffected channel, inside bend, outside bend, oxbow (old channel), straight reach, tailwater, and tributary habitats. Only a few scattered unionids were found in most dredge areas, (see Table 3-61), primarily along the clay banks at the edge of the channel. However, one patch of unionids (P50-1) was found within the dredge area that extends from NM 441.6 to 443.3 (see Table 3-61). P50-1 is along a straight reach leading into an inside bend. The channel area is bedrock, and this patch occurs in the clay and silt substrate on the left side of the channel. Zebra mussels were found on several unionids within Site 50, and 50 tiny zebra mussels were found on each of two unionids (see Table 3-59). Only two other patches of unionids were found in Reach 6, P49-1 and 49-2. P49-1 was found near the bank, leading into an outside bend, and P49-2 was found near the bank leading into an inside bend (see Figure 3-16).

Few unionids will be affected by dredging in Reach 6. If possible, P50-1 should be avoided.

Site 51 was above navigation. Approximately 1 mile of river was searched, including straight reaches, inside bends, outside bends, and the channel. Substrate seemed suitable throughout the site; however, only one live *P. purpuratus* was found.

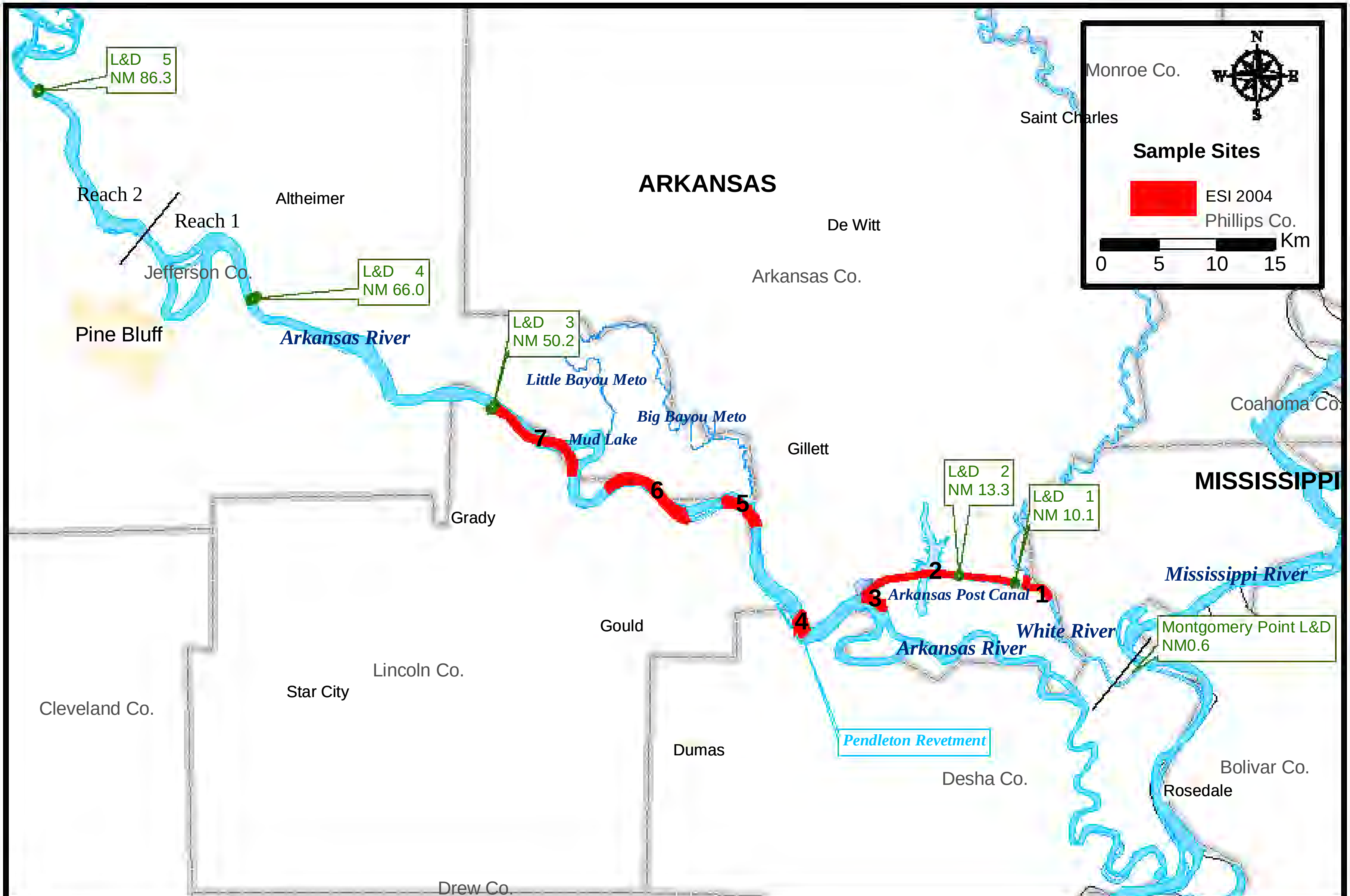

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Figure 1-1a. Overview of 2004 sample sites and locations of historical sample areas on the Arkansas and Verdigris Rivers, Reaches 1 and 2.

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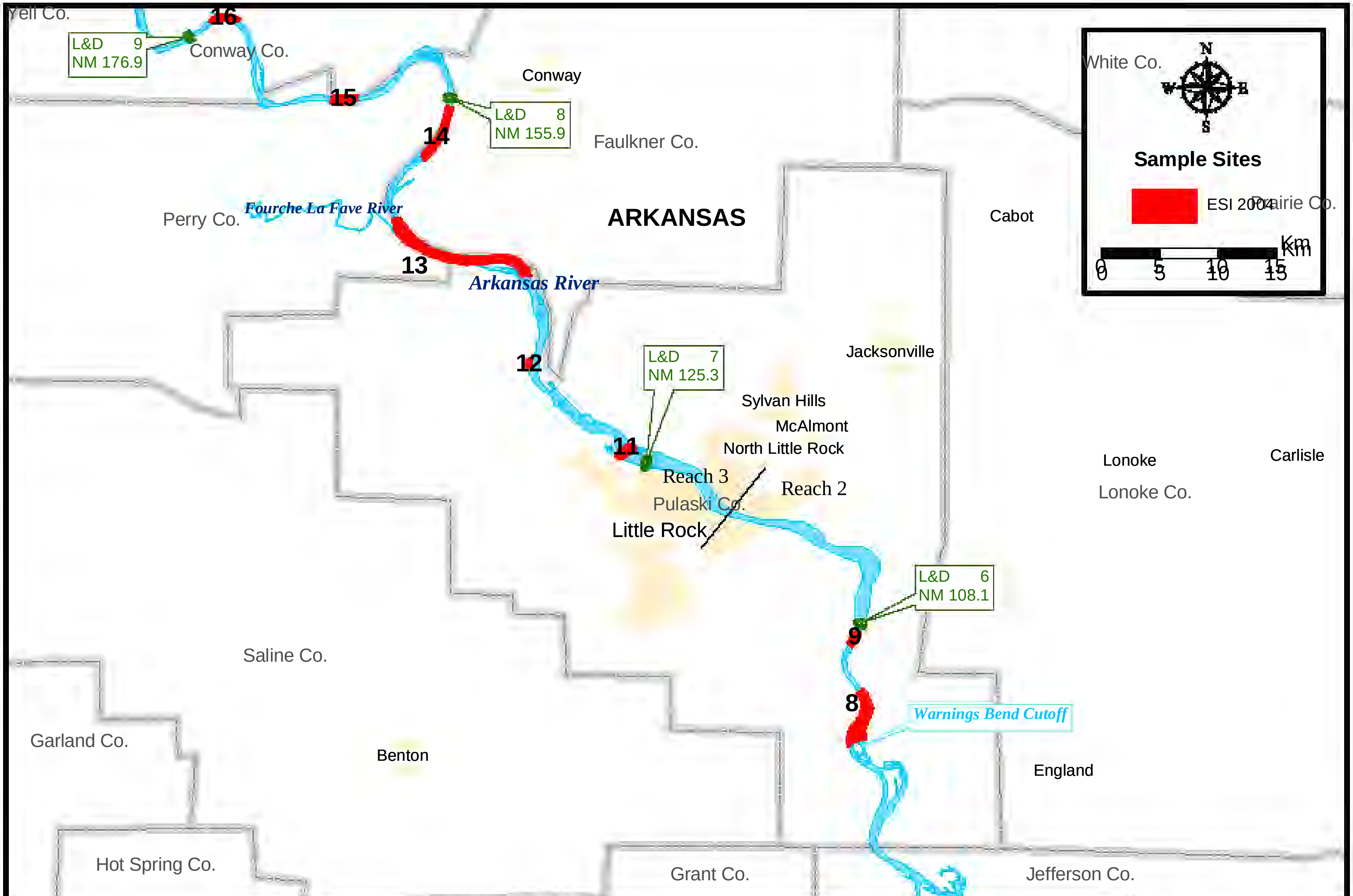

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Figure 1-1b. Overview of 2004 sample sites and locations of historical sample areas on the Arkansas and Verdigris Rivers, Reaches 2 and 3.

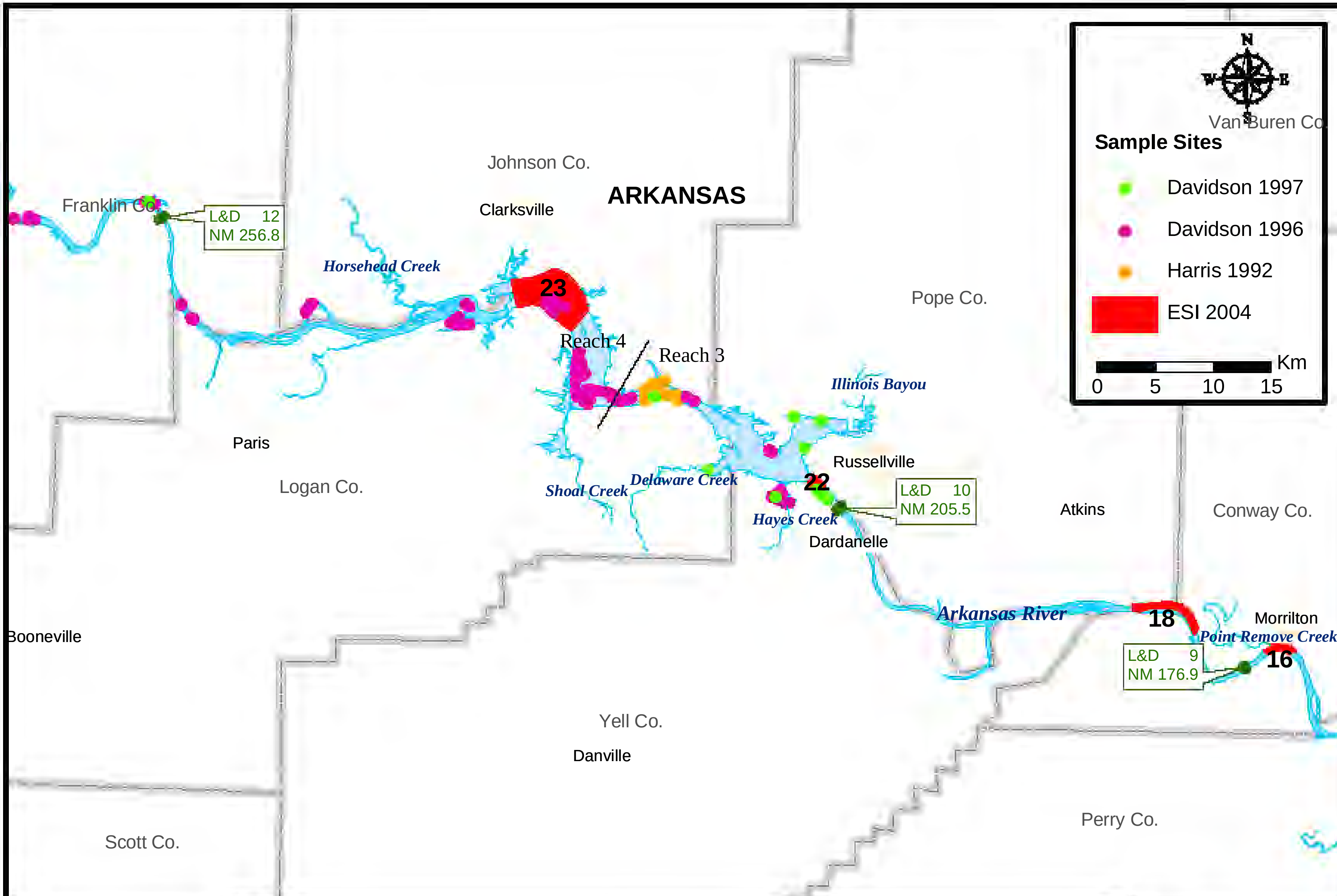

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Figure 1-1c. Overview of 2004 sample sites and locations of historical sample areas on the Arkansas and Verdigris Rivers, Reaches 3 and 4.

ESI

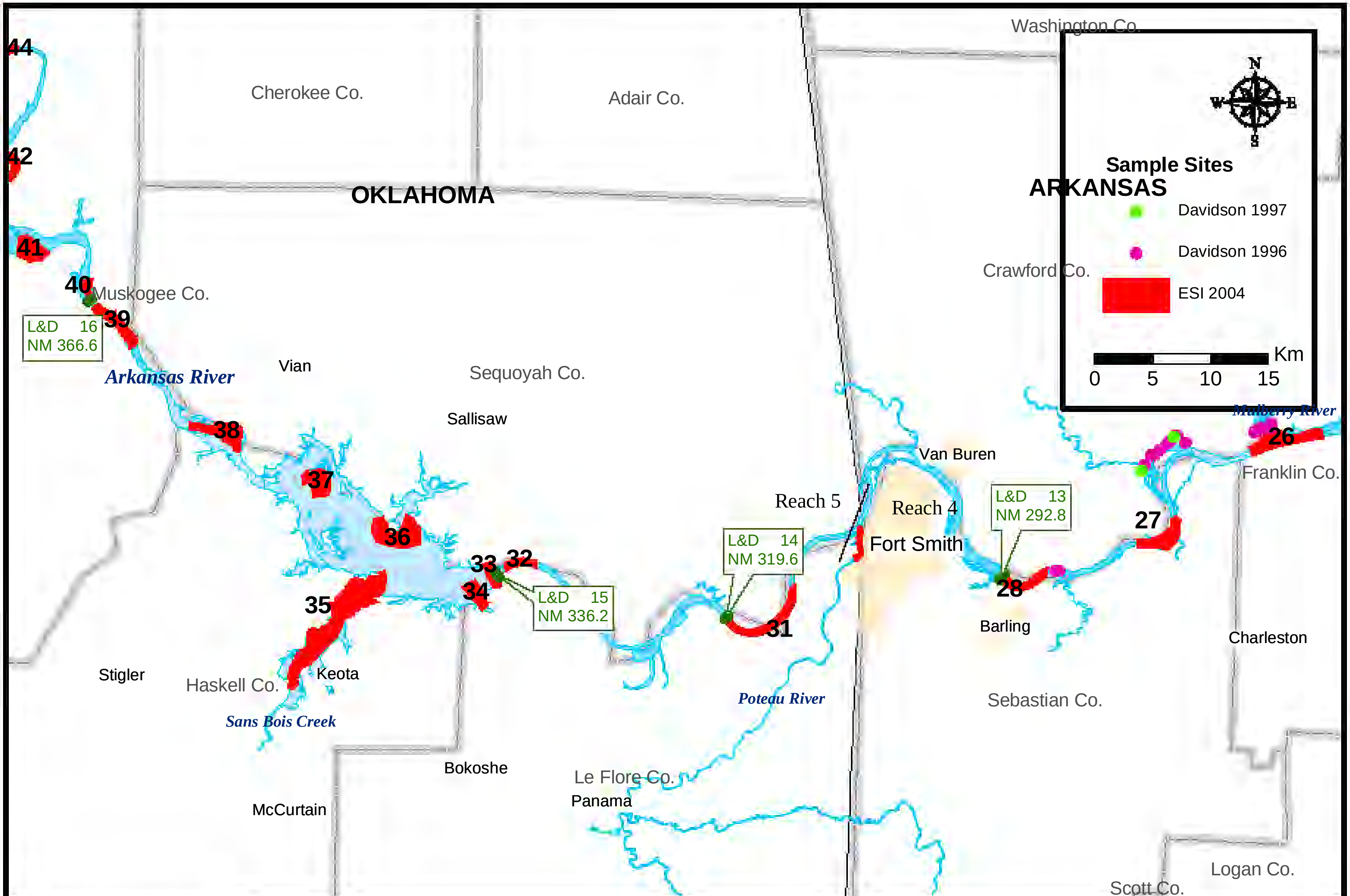

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Figure 1-1d. Overview of 2004 sample sites and locations of historical sample areas on the Arkansas and Verdigris Rivers, Reaches 4 and 5.

ESI

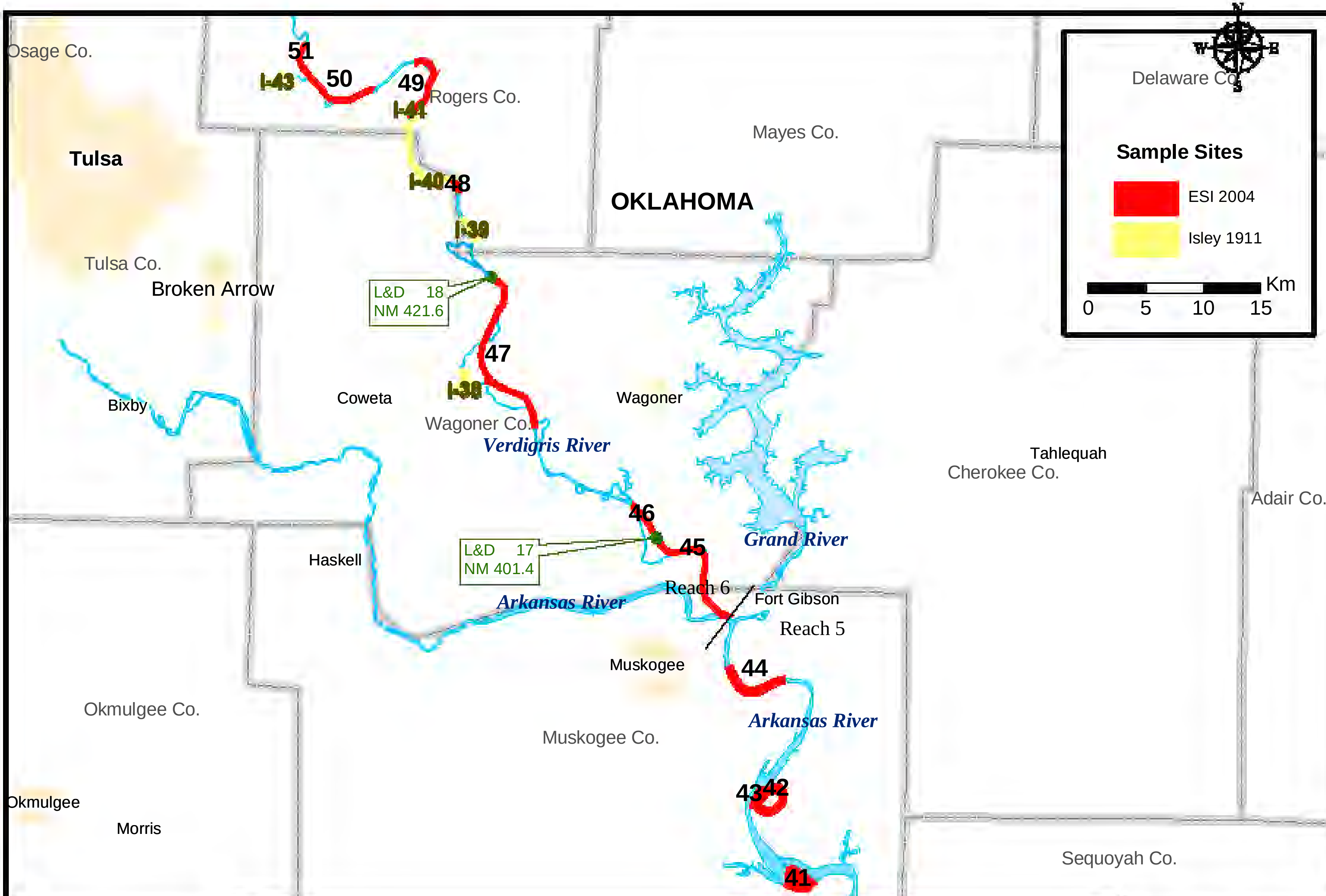

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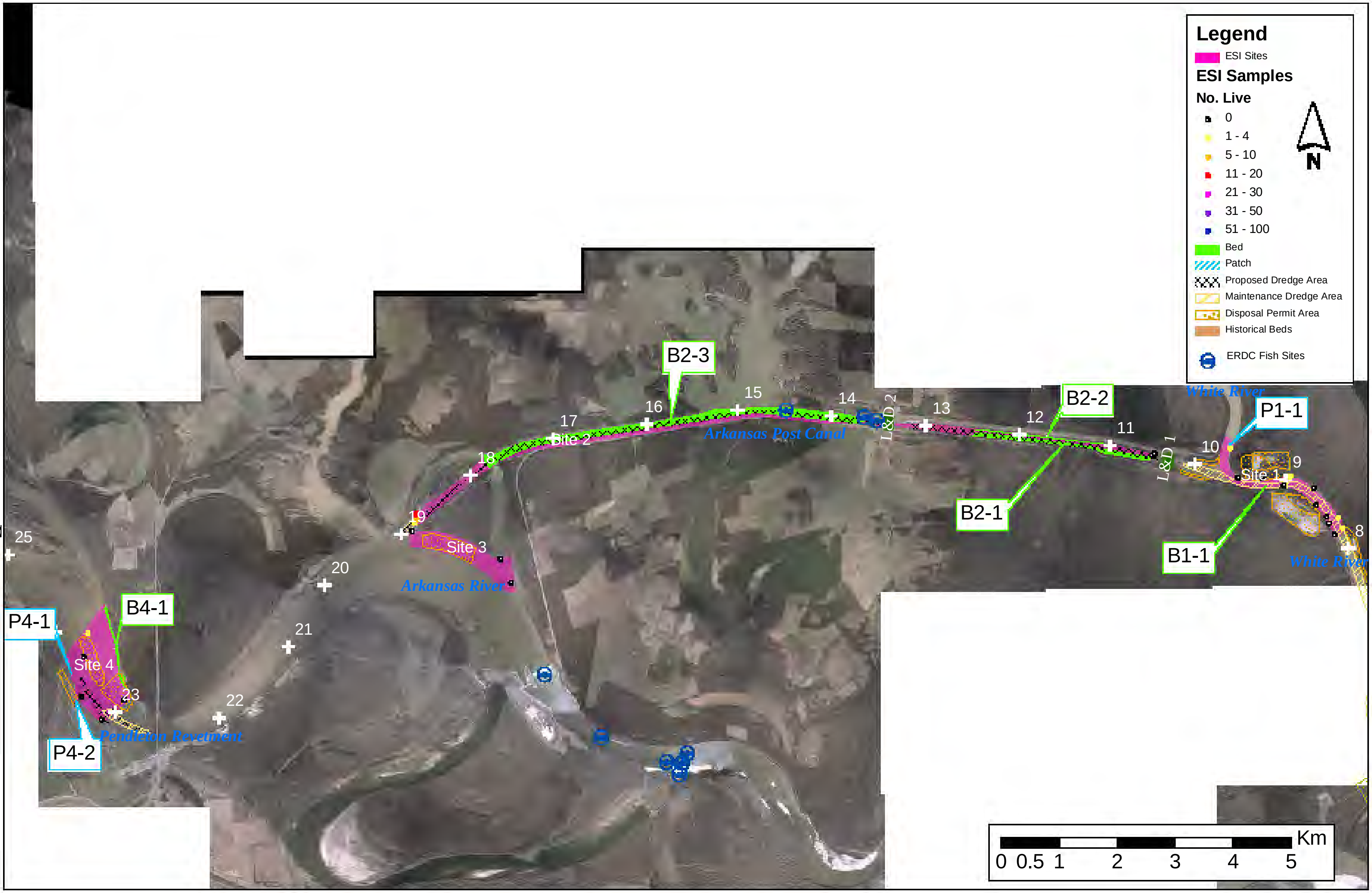
Figure 1-1e. Overview of 2004 sample sites and locations of historical sample areas on the Arkansas and Verdigris Rivers, Reaches 5 and 6.

ESI



F 9

ECOLOGICAL SPECIALISTS, INC.	Figure 3-1. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 1, Sites 1 to 4.	ESI

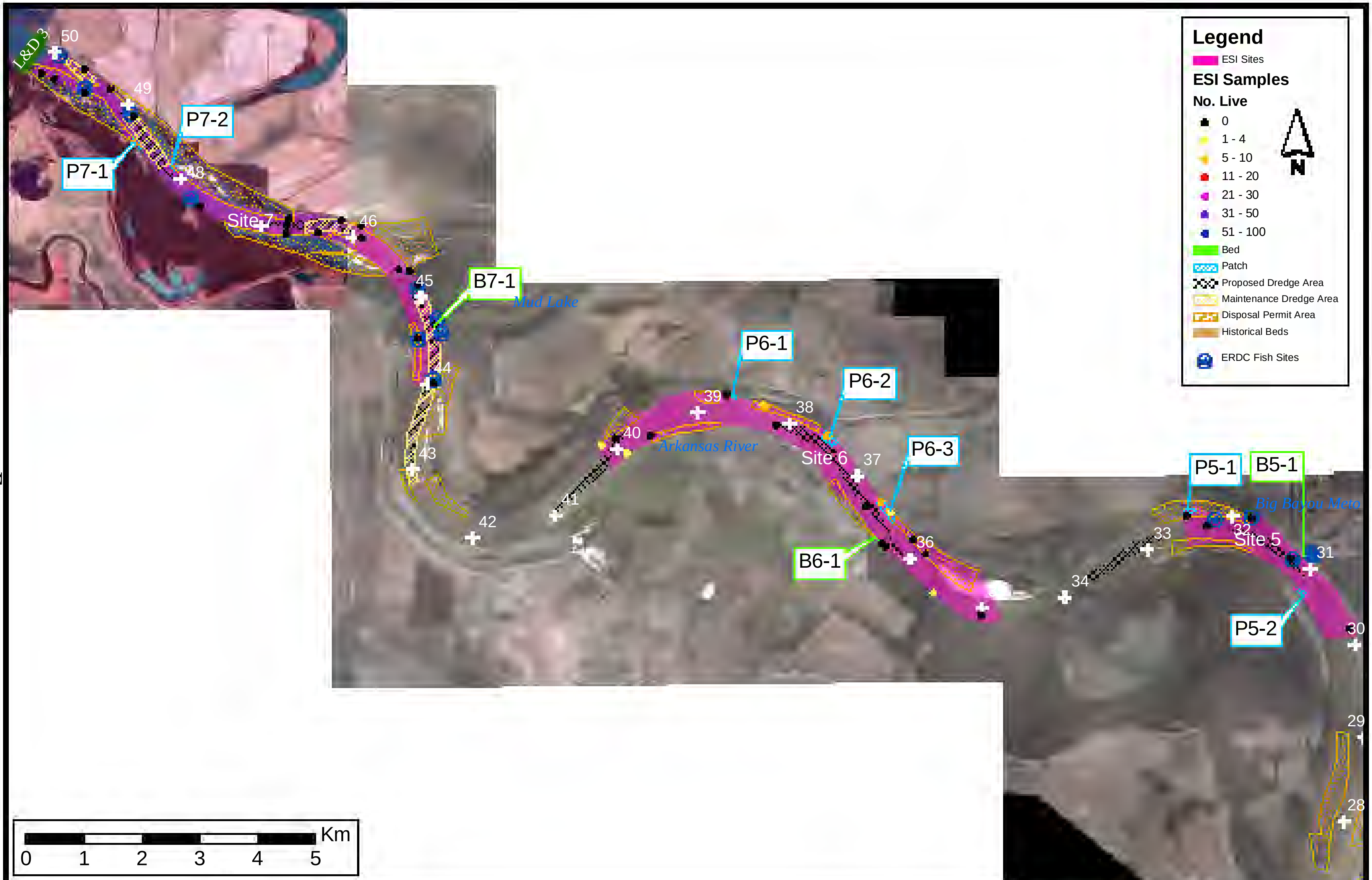


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Figure 3-2. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 1, Sites 5 to 7.

ESI

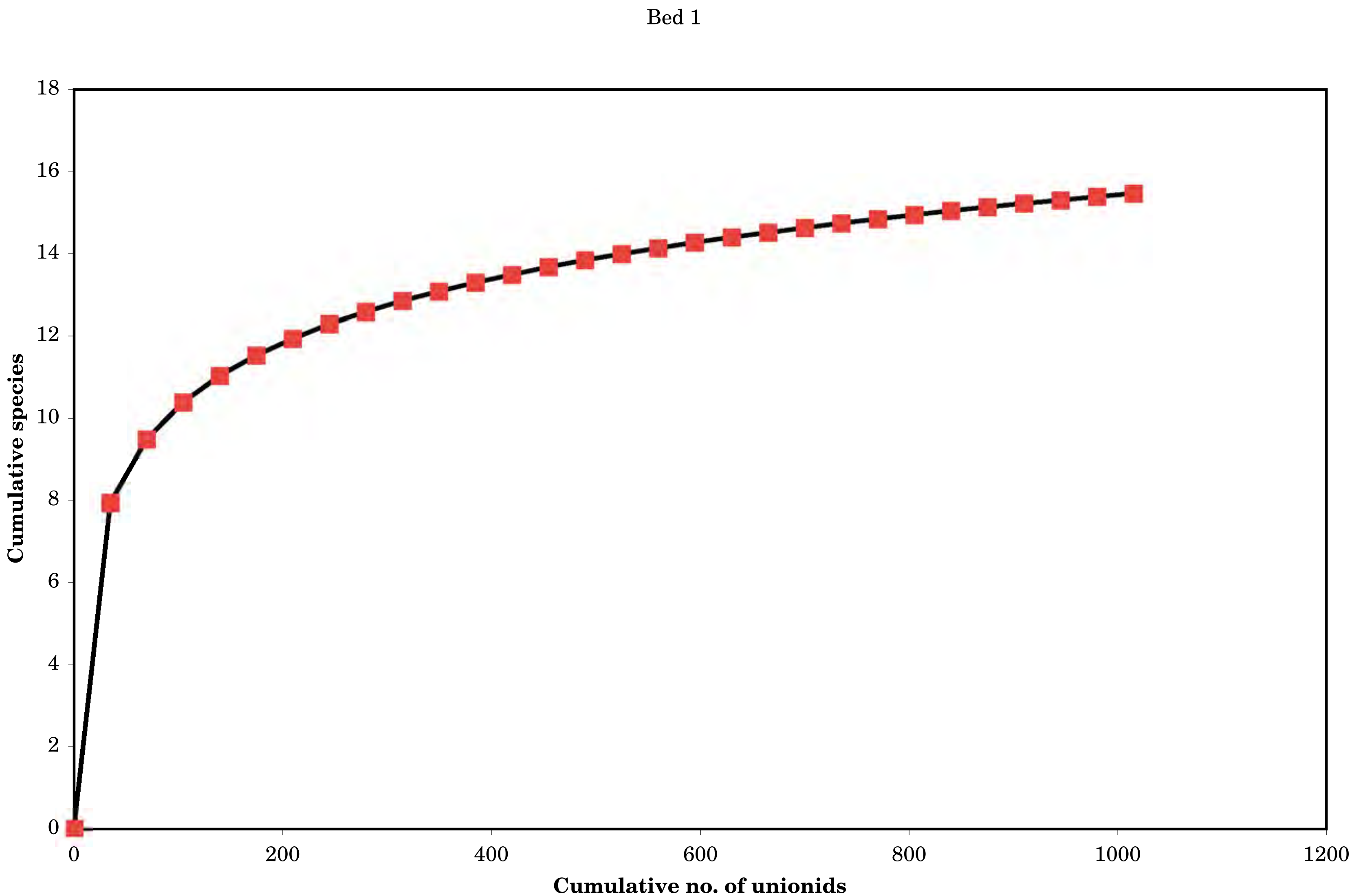

Figure 3-3. Species-Area curve based on samples collected from Bed 1, 2004.

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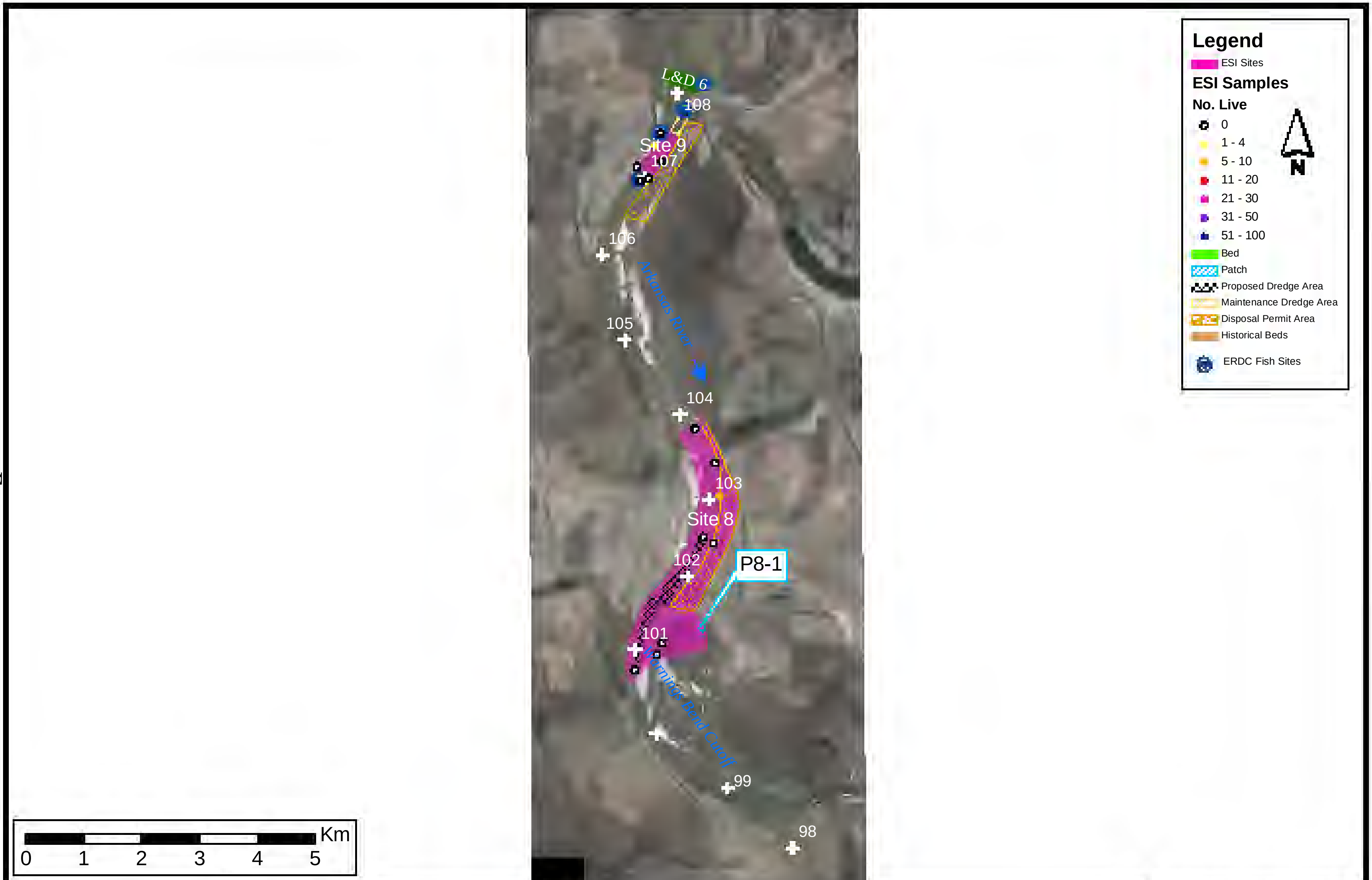
ESI



ECOLOGICAL SPECIALISTS, INC.

Figure 3-4. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 2, Sites 8 to 9.

ESI

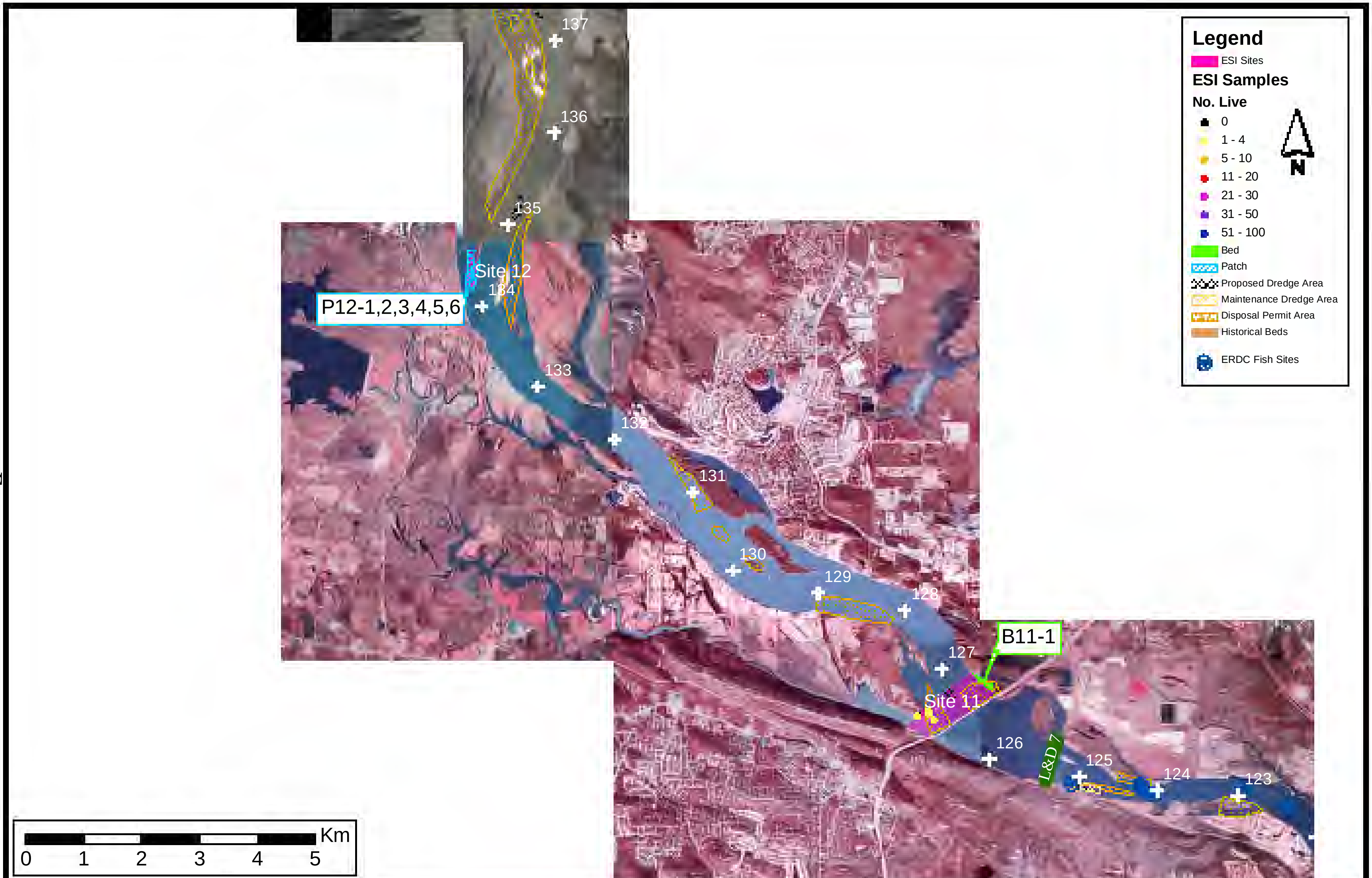


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Figure 3-5. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 3, Sites 11 to 12.

ESI

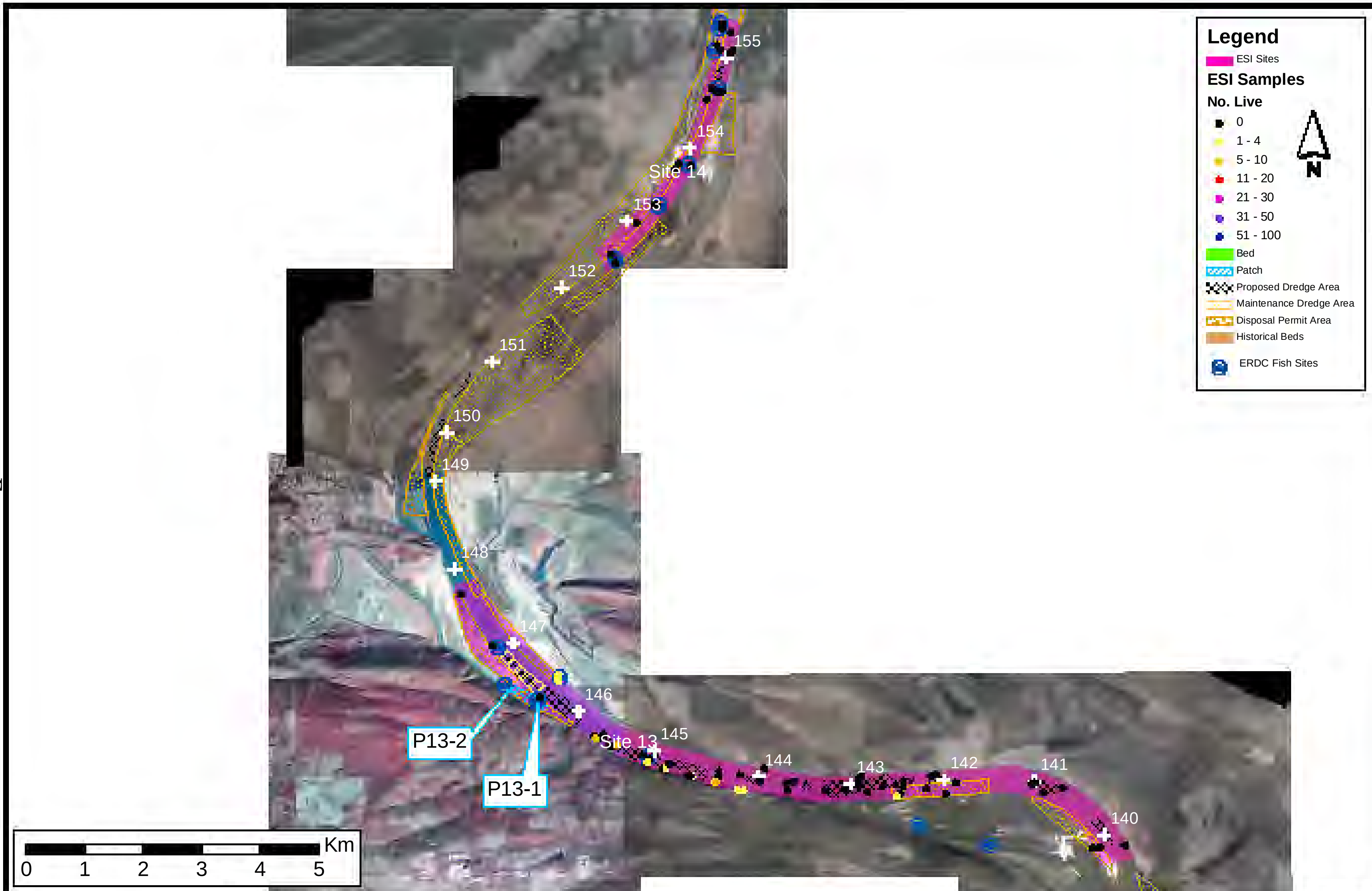

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Figure 3-6. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 3, Sites 13 to 14.

ESI

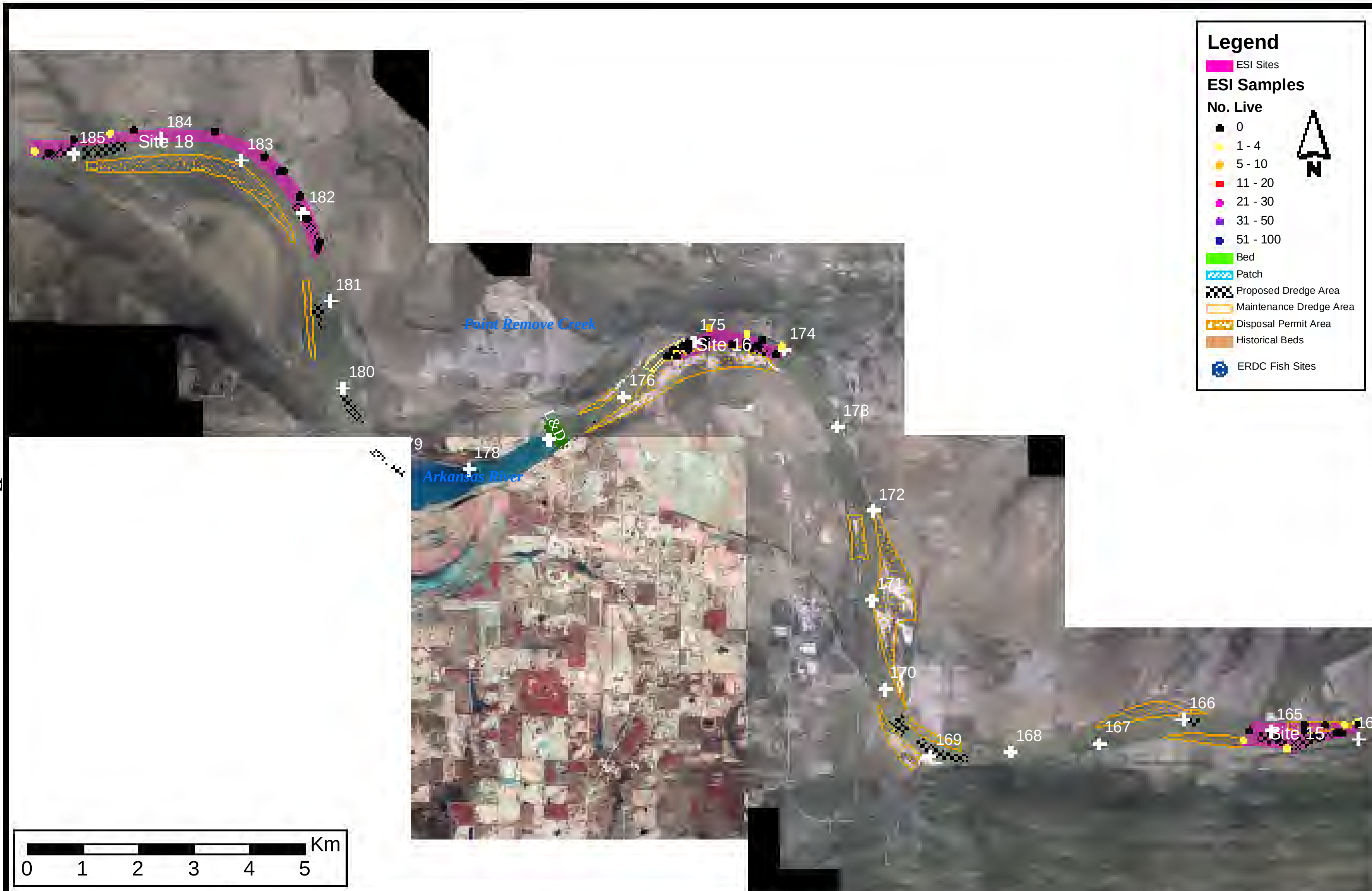

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Figure 3-7. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 3, Sites 15 to 18.

ESI

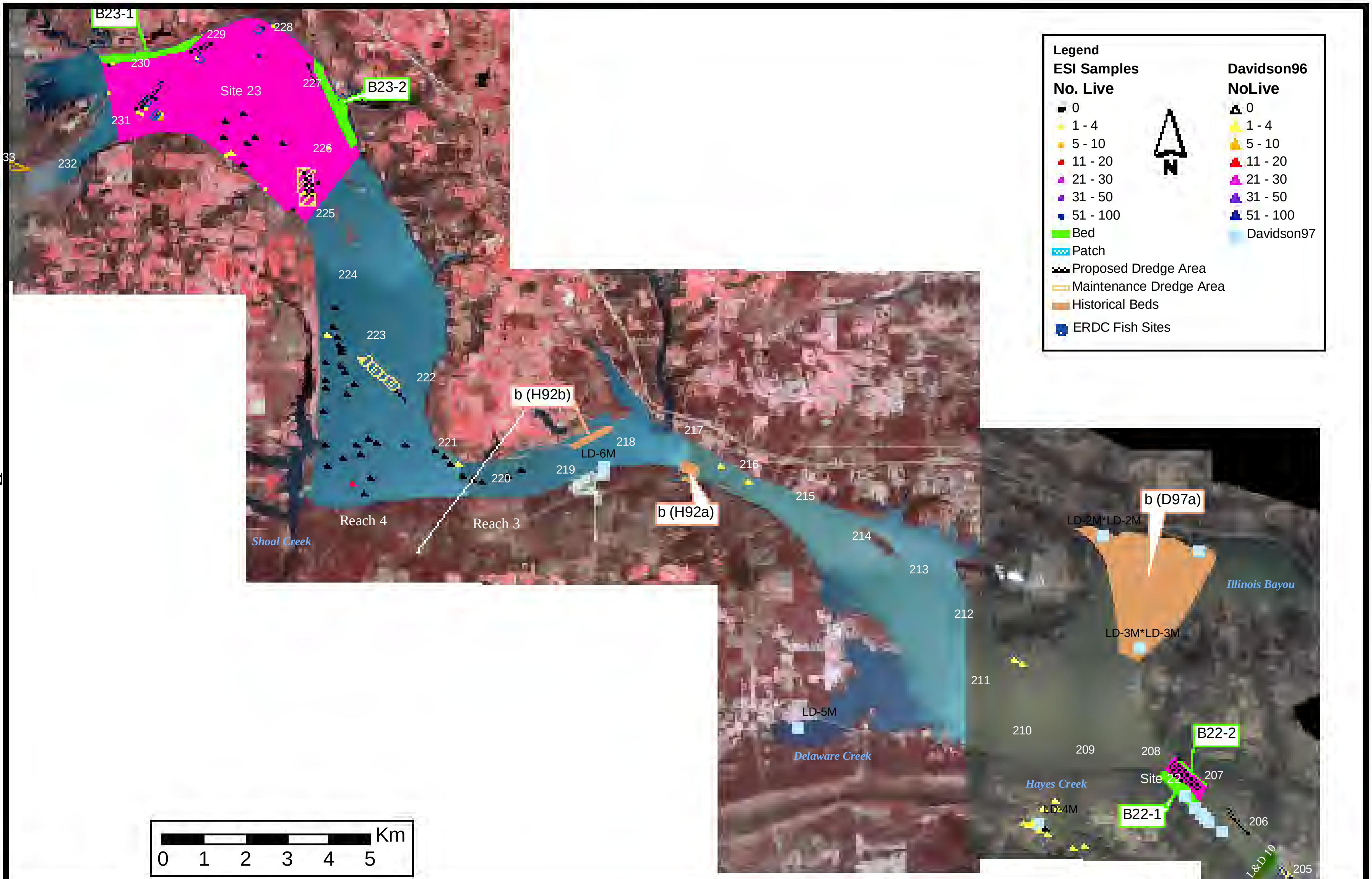

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Figure 3-8. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reaches 3 and 4, Sites 22 to 23.

ESI

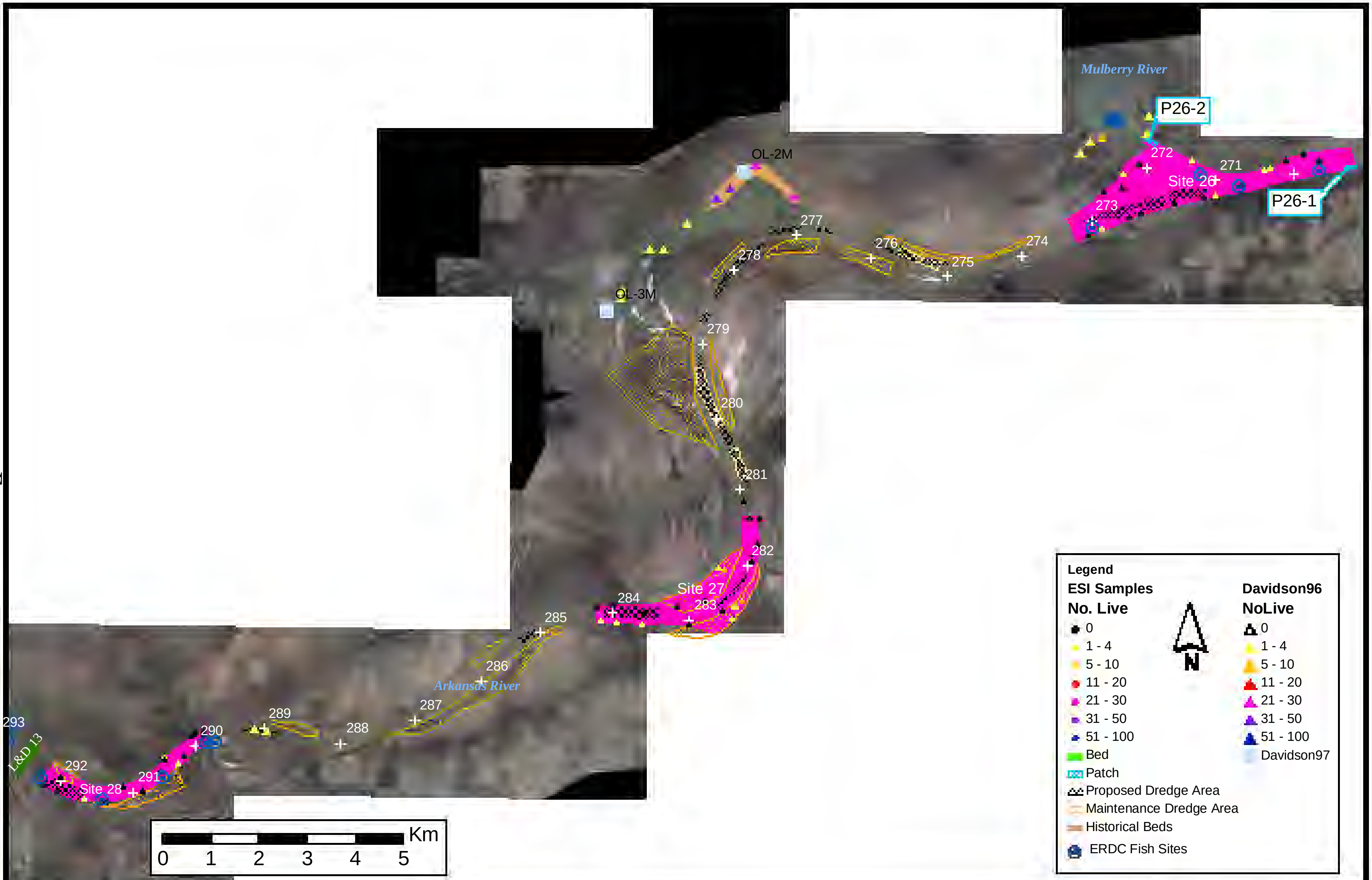

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Figure 3-9. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 4, Sites 26 to 28.

ESI

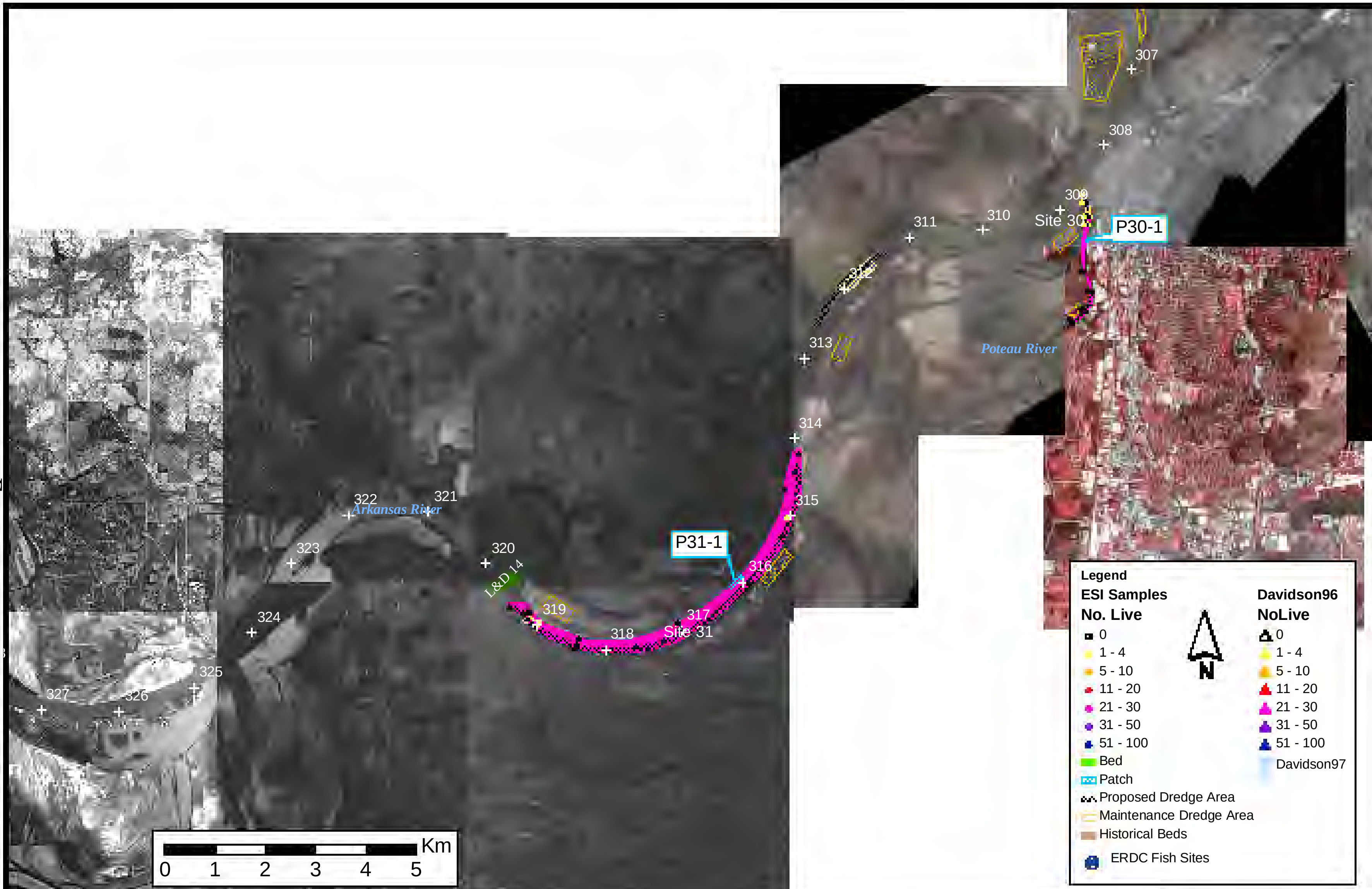

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Figure 3-10. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 5, Sites 30 to 31.

ESI

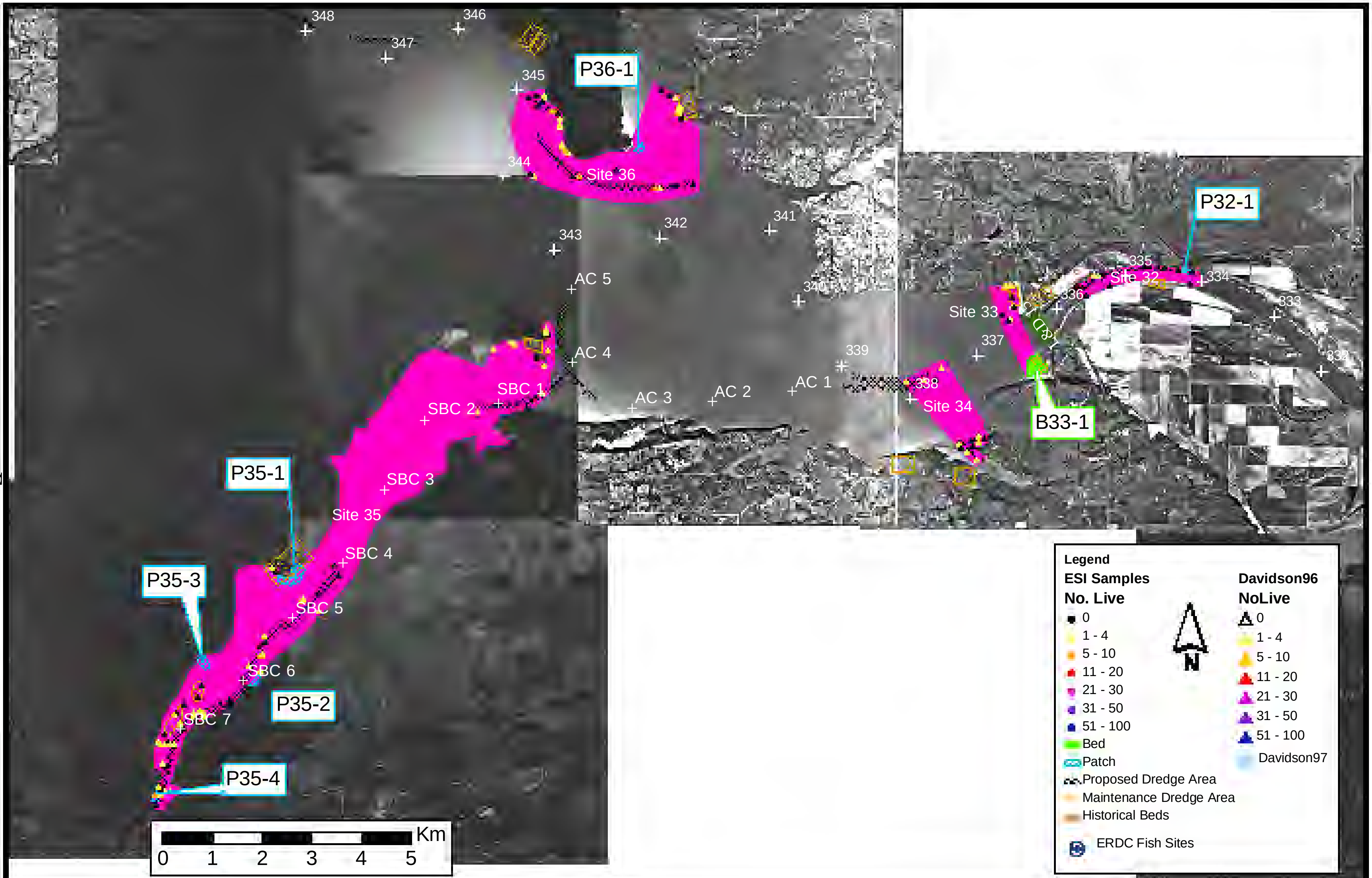

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Figure 3-11. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 5, Sites 32 to 36.

ESI

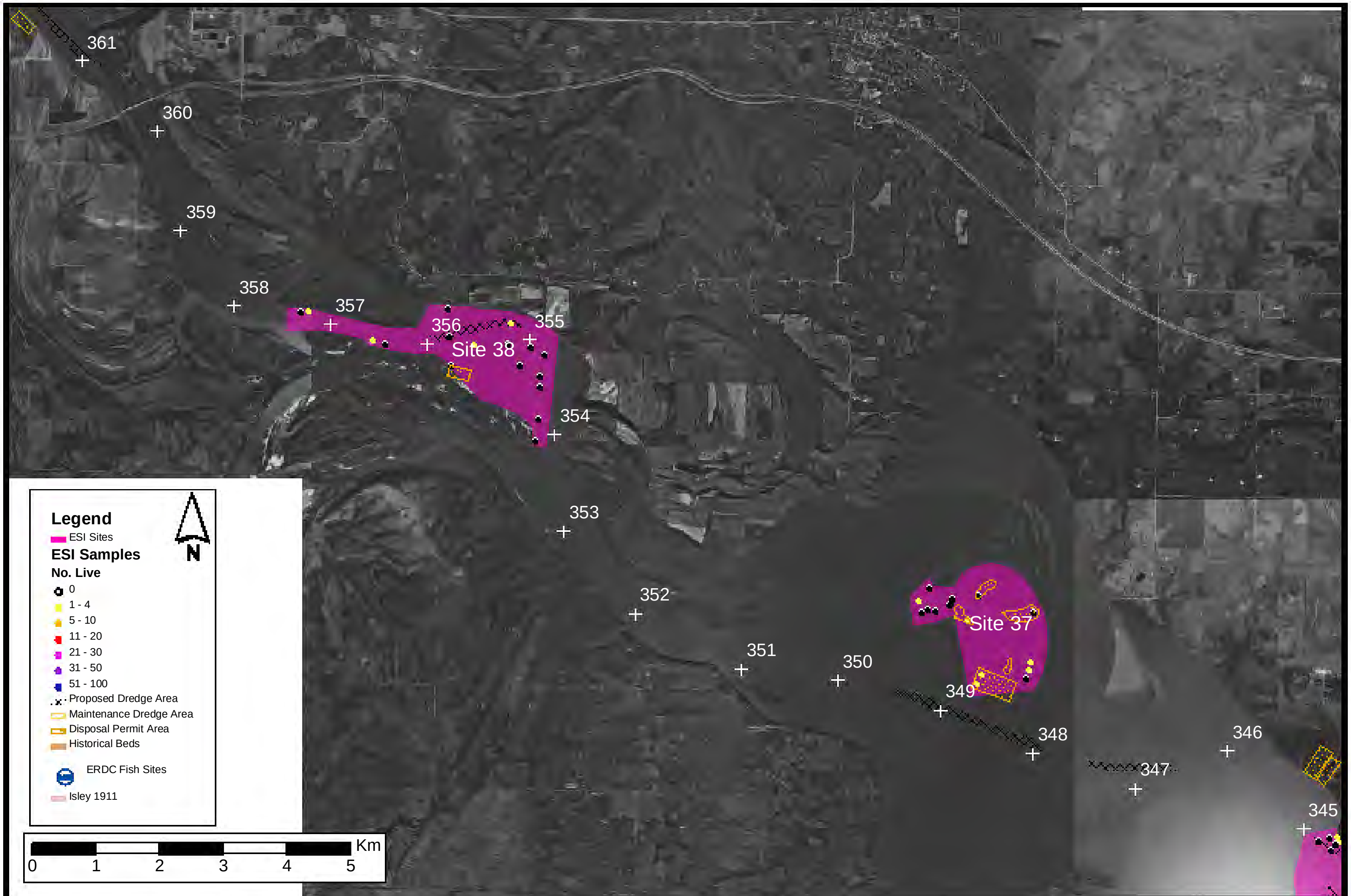

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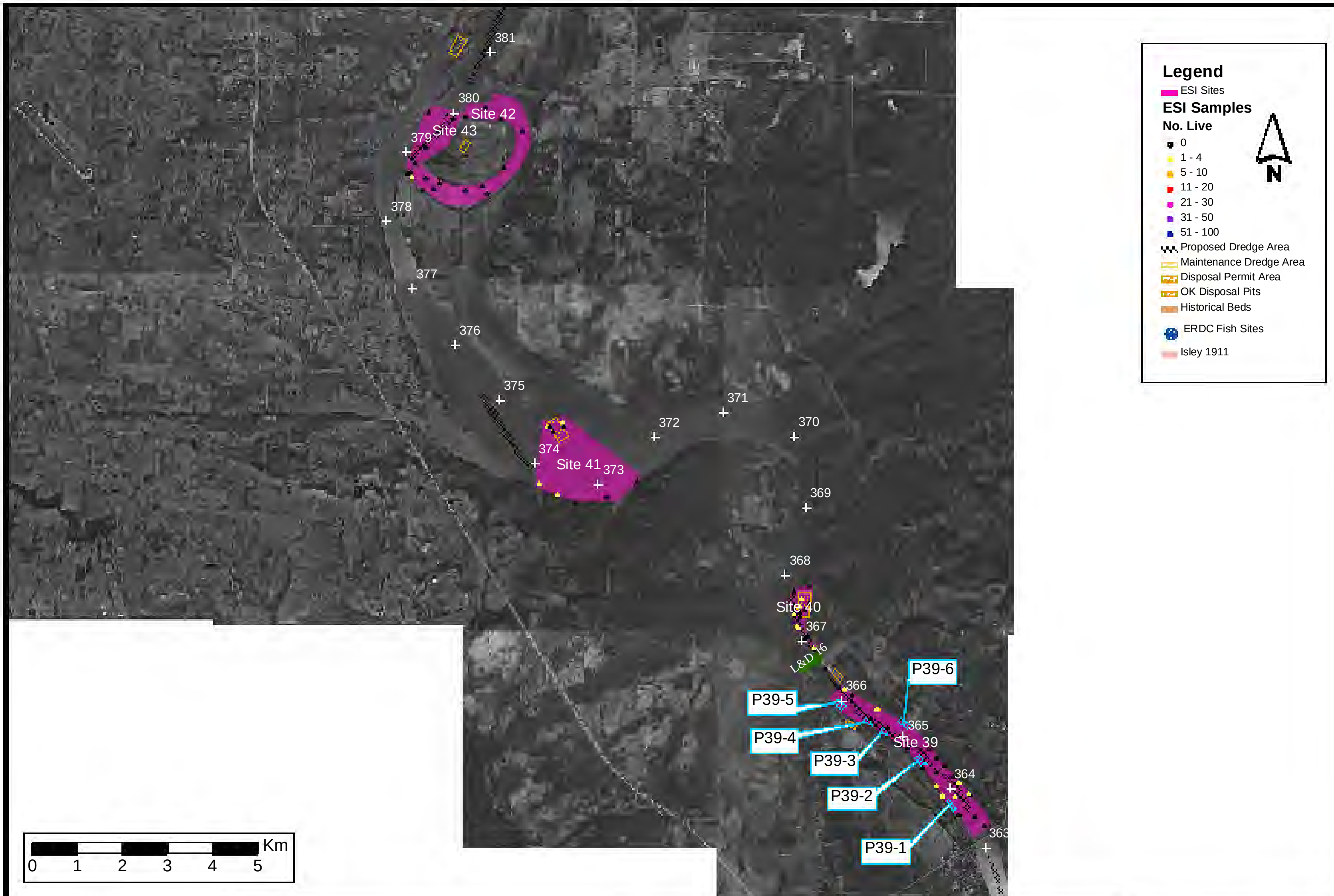
Figure 3-12. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 5, Sites 37 to 38.

ESI



ECOLOGICAL SPECIALISTS, INC.	Figure 3-13. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 5, Sites 39 to 43.	ESI

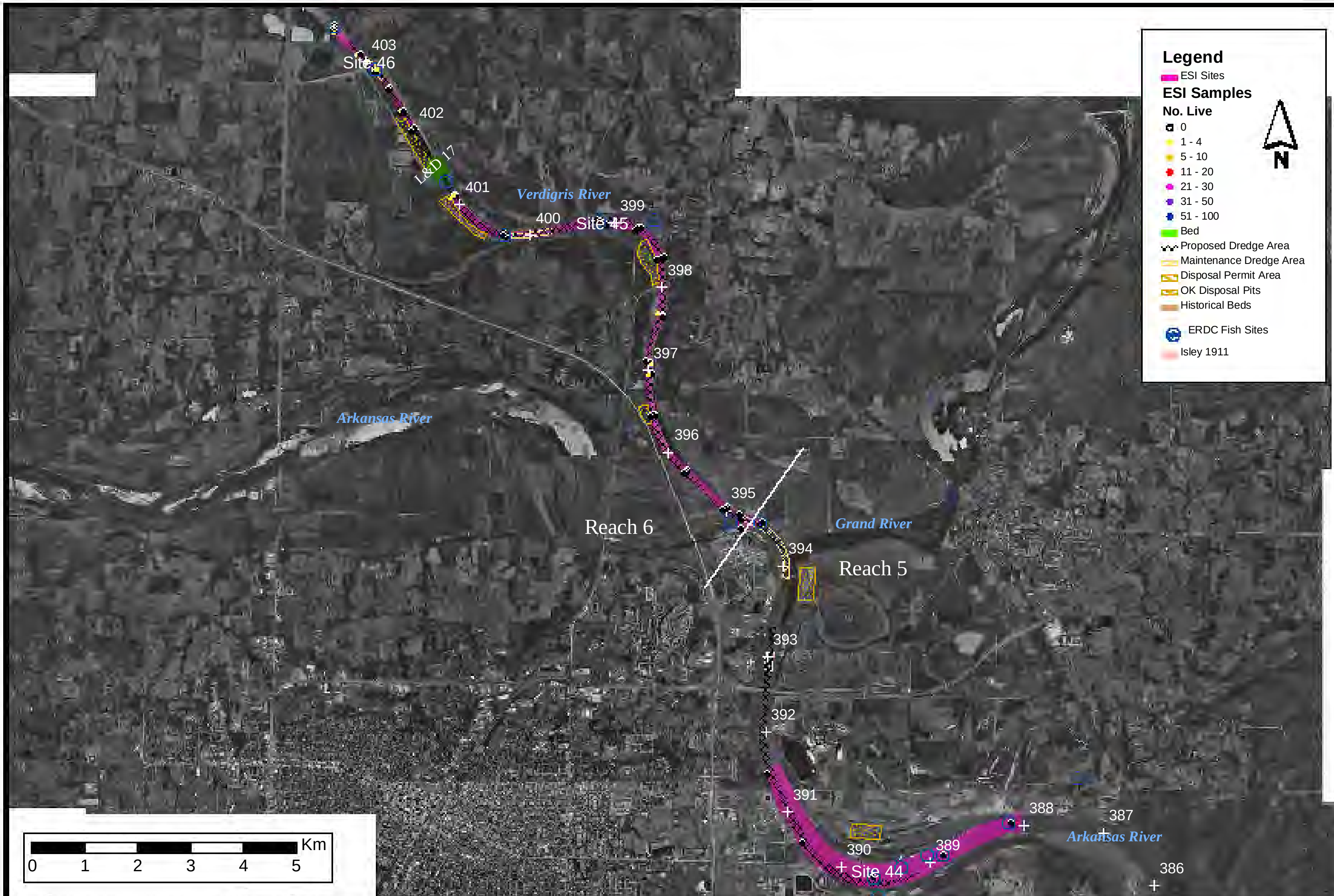


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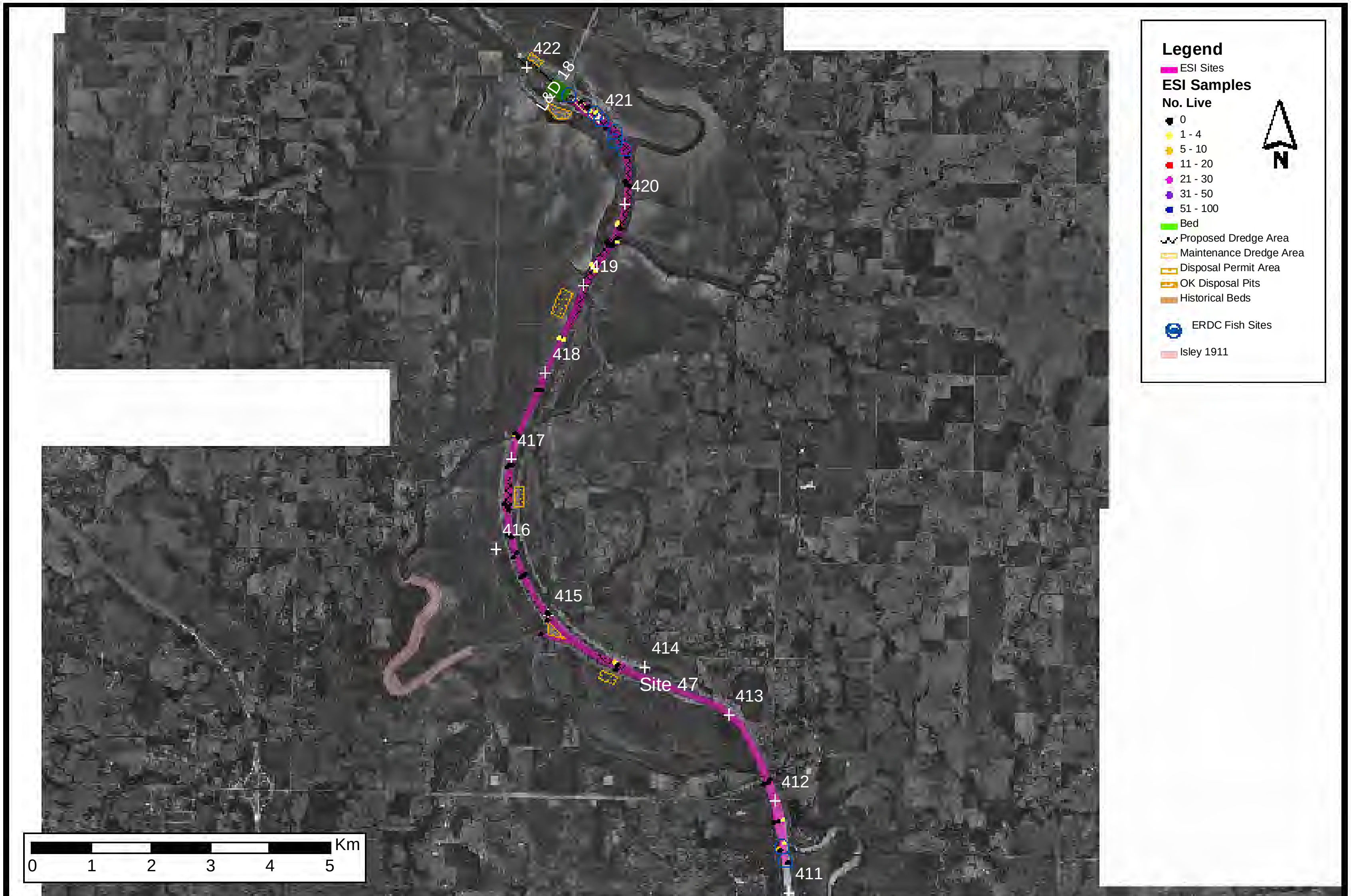
Figure 3-14. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reaches 5 and 6, Sites 44 to 46.

ESI



ECOLOGICAL SPECIALISTS, INC.

Figure 3-15. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 6, Site 47.

ESI

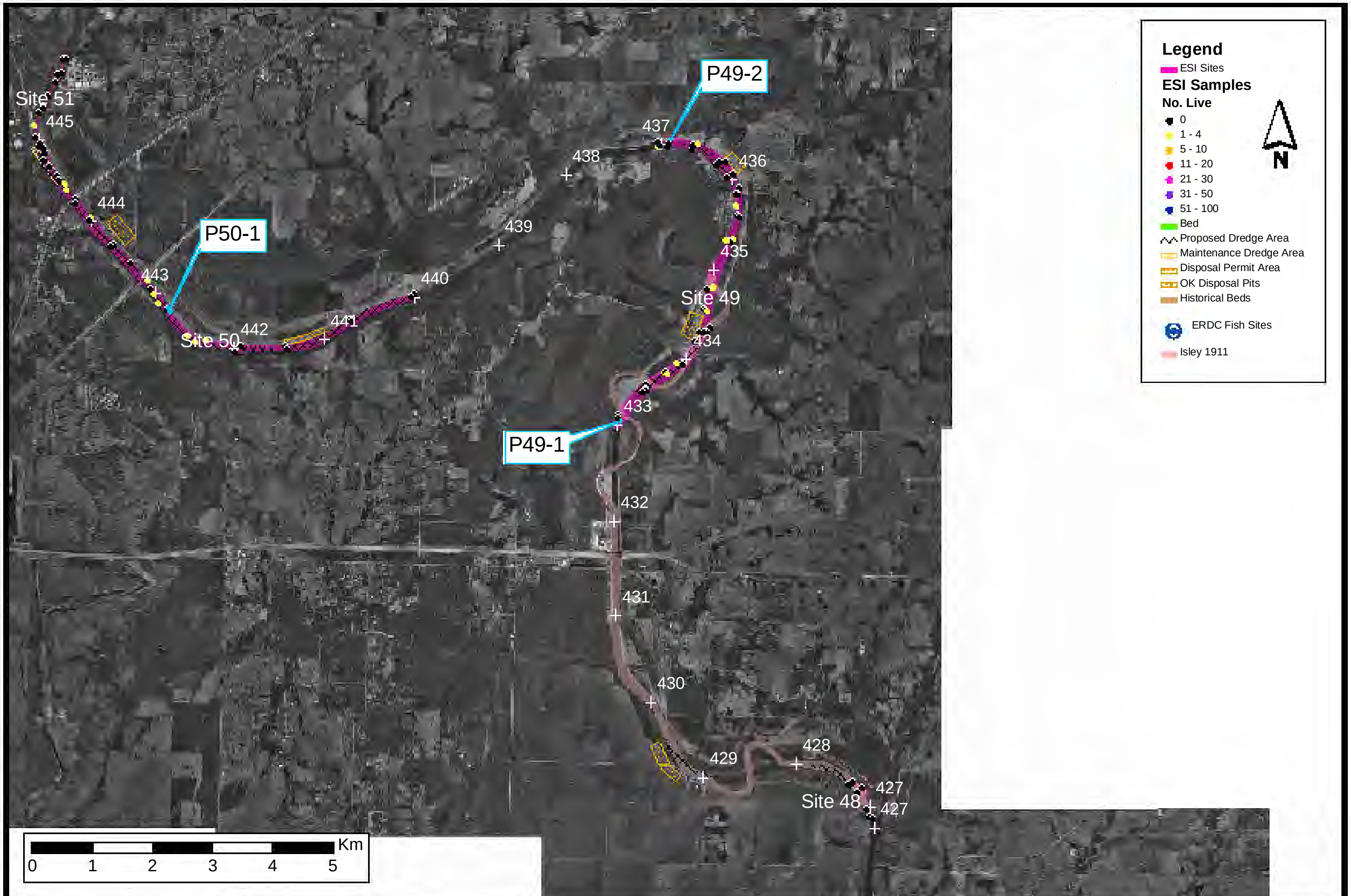


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Figure 3-16. Proposed 12ft channel maintenance activity with respect to unionid beds and patches, Reach 6, Sites 48 to 51.

ESI

Table 1-2. Species historically recorded from the Arkansas River drainage (page 1 of 2).

			Arkansas River			Verdigris River[6]			
Species[1]	AR[2]	OK[3]	Pool 10[4] Dardenell	Pool 12[5] Ozark	Total	Pool 17 Chouteau	Pool 18 N. Graham	Total	Total MKARNS
Actinonaias ligamentina	x	x	-	-	-	-	-	-	-
Alasmidonta marginata	x	x	-	-	-	-	-	-	-
Amblema plicata	x	x	3	1	4	7	159	166	170
Anodonta suborbiculata	x	-	6	5	11	-	-	-	11
Arcidens confragosus	x	x	6	5	11	-	-	-	11
Cyprogenia aberti (OK II)	x	x	-	-	-	-	-	5	-
Ellipsaria lineolata	x	x	-	-	-	-	8	8	8
Elliptio complanata	-	x	-	-	-	-	-	-	-
Elliptio dilatata	x	x	-	-	-	-	-	-	-
Fusconaia ebena	x	-	-	-	-	-	-	-	-
Fusconaia flava	x	x	7	-	7	-	9	9	16
Lampsilis abrupta (FE)	x	-	-	-	-	-	-	-	-
Lampsilis cardium	x	x	-	-	-	4		4	4
Lampsilis hydiana	x	x	-	-	-	-	-	-	-
Lampsilis powelli (FE)	-	x	-	-	-	-	-	-	-
Lampsilis rafinesqueana (FC)	-	x	-	-	-	-	-	-	-
Lampsilis satura	-	-	D	-	D	-	-	-	D
Lampsilis siliquoidea	x	x	-	-	-	-	-	-	-
Lampsilis teres	x	x	1	-	1	9	3	12	13
Lasmigona complanata	x	x	1	1	2	-	-	-	2
Lasmigona costata	x	x	-	-	-	-	-	-	-
Leptodea fragilis	x	x	9	1	10	8	-	8	18
Ligumia recta	x	x	-	-	-	-	-	-	-
Ligumia subrostrata	-	x	-	-	-	-	-	-	-
Megalonaias nervosa	x	x	2	-	2	2	15	17	19
Obliquaria reflexa	x	x	61	21	82	12	9	21	103
Obovaria jacksoniana	x	x	-	-	-	-	-	-	-
Obovaria olivaria	x	-	-	-	-	-	-	-	-
Plectomerus dombeyanus	x	-	477	-	477	-	-	-	477
Pleurobema cordatum	x	x	-	-	-	-	-	-	-
Pleurobema rubrum	-	x	-	-	-	7	178	185	185
Pleurobema sintoxia	-	x	-	-	-	-	135	135	135
Potamilus alatus	-	x	-	-	-	-	-	-	-
Potamilus capax (FE)[7]	-	x	-	-	-	-	-	-	-
Potamilus ohiensis	x	x	7	6	13	-	-	-	13
Potamilus purpuratus	x	x	-	-	-	2	-	2	2
Ptychobranchus occidentalis	-	x	-	-	-	-	5	5	5
Pyganodon grandis	x	x	23	38	61	-	-	-	61

Table 1-2. Species historically recorded from the Arkansas River drainage (page 2 of 2).

			Arkansas River			Verdigris River[6]			
			Pool 10[4]	Pool 12[5]		Pool 17	Pool 18		Total
Species[1]	AR[2]	OK[3]	Dardenell	Ozark	Total	Chouteau	N. Graham	Total	MKARNS
Quadrula cylindrica (OK II)	x	x	-	-	-	-	-	-	-
Quadrula nobilis (aspera)	-	x	-	-	-	12	-	12	12
Quadrula metanevra	x	x	-	-	-	-	15	15	15
Quadrula nodulata	x	x	-	-	-	-	-	-	-
Quadrula p. pustulosa	x	x	20	-	20	12	5	17	37
Quadrula quadrula	x	x	395	54	449	-	-	-	449
Strophitus undulatus	-	x	-	-	-	-	-	-	-
Toxolasma lividus	-	x	-	2	2	-	-	-	2
Toxolasma parvus	-	x	-	-	-	-	-	-	-
Tritigonia verrucosa	x	x	-	-	-	-	4	4	4
Truncilla donaciformis	-	x	-	-	-	12	-	12	12
Truncilla truncata	x	x	-	-	-	38	-	38	38
Uniomerus tetralasmus	x	x	-	-	-	-	-	-	-
Utterbackia imbecillis	x	x	D	-	D	-	-	-	D
Villosa arkansasensis	-	x	-	-	-	-	-	-	-
Villosa iris	-	x	-	-	-	-	-	-	-
Villosa lienosa	-	x	-	-	-	-	-	-	-
Total			1018	134	1152	125	545	675	1827
No. species = 55	38	48	14	10	15	12	12	19	26

[1]Nomenclature follows Turgeon et al. (1998), except *Q. aspera (=nobilis)* follows Watters (OSU, pers. comm. 2004)
FE=federally endangered (USFWS, 2004a), FC=federal candidate (USFWS, 2004b), OK II=Oklahoma category II (ODWC, 2005)
[2]Arkansas (Gordon, 1982, 1983-1984-White River site below Newport included; Harris and Gordon, 1986); Harris (,pers. Comm 2005)
[3]Oklahoma (Branson, 1982, 1983, 1984; Shepard, 1982; Vaughan and Spooner, in press)
[4]Pool 10 (Harris, 1992; Davidson, 1997-Lake Dardenelle)
[5]Pool 12 (Davidson, 1997-Ozark Lake)
[6]Verdigris River (Isley, 1925)
[7]Verdigris River record may be in error (USFWS, 1989)
D = dead shell

Table 2-2. Habitats of channel modification and unaffected areas within and between sites, MKARNS, 2004 (page 1 of 3).

	Within sites						Between sites				
	Dredge		Disposal		Not		Dredge		Disposal		
Habitat type	Maint.	Prop.	Perm.	Prop.	affected	Total	Maint.	Prop.	Perm.	Prop.	Total
Reach 1 (NM 0.0-75.2)											
Channel	4	5	-	-	2	11	-	4	-	-	4
Cove	-	-	-	-	-	-	-	-	-	-	-
Inside bend	-	-	6	-	3	9	-	-	6	-	6
Island	-	-	-	-	4	4	-	-	-	-	
Outside bend	1	2	7	-	8	18	-	-	3	-	3
Oxbow	-	-	-	-	-	-	-	-	-	-	-
Peninsula	-	-	-	-	-	-	-	-	-	-	-
Straight	1	2	3	-	8	14	-	-	3	-	3
Tailwater	1	1	2	-	1	5	1	-	1	-	2
Tributary	-	-	1	-	2	3	-	-	-	-	-
Reach 1 total	7	10	19	0	28	64	1	4	13	0	18
Reach 2 (NM 75.2-119.5)											
Channel	-	1	-	-	2	3	2	2	-	-	4
Cove	-	-	-	-	-	-	-	-	-	-	-
Inside bend	-	-	-	-	1	1	-	1	1	-	2
Island	-	-	-	-	1	1	-	-	1	-	1
Outside bend	-	-	1	-	-	1	-	-	-	-	-
Oxbow	-	-	-	-	-	-	-	-	-	-	-
Peninsula	-	-	-	-	-	-	-	-	-	-	-
Straight	-	-	-	-	-	-	-	-	-	-	-
Tailwater	-	-	1	-	1	2	2	2	3	-	7
Tributary	-	-	-	-	-	-	-	-	-	-	-
Reach 2 total	0	1	2	0	5	8	4	5	5	0	14

Table 2-2. Distribution of sample sites among habitats and channel maintenance areas, 2004 (Page 2 of 3).

	Dredge Areas		Disposal Areas		Not						
	Sampled		Sampled		affected		Not sampled		Not sampled		
Habitat type	Maint.	Prop.	Perm.	Prop.	Sampled	Total	Maint.	Prop.	Perm.	Prop.	Total
Reach 3 (NM 199.5-220.3)											
Cove	-	-	-	-	-	-	-	-	-	-	-
Inside bend	-	-	6	-	2	1	-	1	8	-	14
Island	-	-	1	-	1	-	-	-	5	-	6
Midchannel	1	19	-	-	3	35	-	15	-	-	-
Outside bend	-	3	3	-	5	5	-	2	1	-	4
Oxbow	-	-	-	-	-	-	-	-	-	-	-
Peninsula	-	-	1	-	-	-	-	-	-	-	1
Straight	1	2	3	-	5	5	-	2	8	-	11
Tailwater	-	-	1	-	-	4	2	2	-	-	1
Tributary	-	-	-	-	2	-	-	-	-	-	-
Reach 3 total	2	24	15	0	18	50	2	22	22	0	37
Reach 4 (NM 220.3-308.7)											
Cove	-	-	-	-	-	-	-	-	-	-	-
Inside bend	-	-	1	-	3	-	-	-	5	-	6
Island	-	-	-	-	7	-	-	-	10	-	10
Midchannel	1	8	-	-	4	30	5	16	-	-	-
Outside bend	-	-	2	-	4	2	1	1	2	-	4
Oxbow	-	-	-	-	-	-	-	-	2	-	2
Peninsula	-	-	-	-	-	-	-	-	-	-	-
Straight	-	-	-	-	6	2	-	2	6	-	6
Tailwater	-	1	1	-	-	2	-	1	-	-	1
Tributary	-	-	-	-	3	-	-	-	-	-	-
Reach 4 total	1	9	4	0	27	36	6	20	25	0	29

Table 2-2. Distribution of sample sites among habitats and channel maintenance areas, 2004 (Page 3 of 3).

	Dredge Areas		Disposal Areas		Not						
	Sampled		Sampled		affected		Not sampled		Not sampled		
Habitat type	Maint.	Prop.	Perm.	Prop.	Sampled	Total	Maint.	Prop.	Perm.	Prop.	Total
Reach 5 (NM 308.7-394.0)											
Channel		14			6	20	1	5			
Cove		1		3	11	15					3
Inside bend				1	5	6					1
Island				9	10	19					9
Outside bend		4			5	9	1	1			
Oxbow					1	1					
Peninsula				2	3	5					2
Straight					1	1					
Tailwater	1				2	3					
Tributary	1	2			2	5		1			
Total	2	21	0	15	46	84	2	7	0	0	15
Reach 6 (NM 394.0-445.2)											
Channel	2	5	-	-	5	12		3	-	-	3
Cove	-	-	-	-			-	-	-	-	-
Inside bend		4	-	-	8	12			-	-	-
Island			-	-					-	-	-
Outside bend		1	-	-	9	10			-	-	-
Oxbow			-	-	3	3			-	-	-
Peninsula			-	-					-	-	-
Straight	1	3	-	-	13	17			-	-	-
Tailwater	2	2	-	-		4			-	-	-
Tributary			-	-	1	1			-	-	-
Total	5	15	0	0	39	59	0	3	0	0	3

Table 3-1. MKARNS proposed dredge and permitted disposal areas with respect to unionid sample sites in Reach 1, 2004.

		Proposed dredge and permitted disposal areas							Unionids near proposed dredge and permitted disposal areas								
Reach	Pool	DR/DI	Dn NM	Up NM	Dist.	Site	Habitat[1]	Substrate[2]	B/P	Habitat[1]	Depth	Substrate	Dist from DR/DI (m)	Direction	CPUE	Species	% Juv.
1	0					1	Channel	Sd	B1-1	Straight	10.5-11.1	Sd/Gr	<50	Shoreward	36	14	3
									P1-1	Straight	7.6	Sd/St/Cl/Dt	400	Upstream	6	5	12
1	1	DR-1	10.3	13.3	3.0	2	Straight	Sd/St/Cl	B2-1	Straight	2.4-4.9	Cl/Sd/St	0	In	38	16	22
									B2-2	Straight	2.4-4.9	Cl/St/Sd	0	In	15	8	26
1	2	DR-1	13.3	19.0	5.7	2	Straight	St/Cl	B2-3	Straight	0.9-4.6	Cl/St	0	In	17	13	4
1	2	DI-1			0.5	3	Outside			Outside	3.1-12.6	Bd/Sd/Cl			0	0	0
1	2	DI-1/2	23.0	23.8	0.8	4	Straight	Sd/St/Cl	B4-1	Str., Ins.	1.1-7.6	Cl/Sd/Bd/St/Gr	0	In	37	13	9
1	2	DR-1	22.5	23.7	1.2	4	Outside	Bd/Sd/St	P4-1	Straight	3.1	Cl/Sd	100	Shoreward	4	6	15
									P4-2	Trib	-	-	100	Shoreward	4	3	0
1	2		27.5	29.0	1.5	NS	Channel										
1	2	DI-1	31.9	32.9	1.0	5	Outside	Sd/Cl/St	P5-1	Outside	0.6-1.1	Sd/Cl/St	0	In	8	4	0
1	2	DR-1	31.0	32.0	1.0	5	Channel	Sd	B5-1	Trib	7.6	Sd/Cl/St	200	Shoreward	13	9	16
									P5-2	Inside	1.5-2.7	Sd/Cl/St	400	Dnstream	9	8	5
1	2		32.8	33.7	0.9	NS	Channel										
1	2	DR-1	39.8	41.0	1.2	6	Channel	Sd		Channel	4.6	Sd	0	In	0	0	0
1	2	DI-1	39.7	40.0	0.3	6	Outside	Sd/St		Outside	1.5	Sd/St	0	In	2	1	0
1	2	DI-2	38.8	39.6	0.8	6	Inside	Gr/Sd		Inside	2.4	Gr/Sd	0	In	0	0	0
1	2	DI-3	38.8	39.0	0.2	6	Outside		P6-1	Outside	0.9	Sd/St/Cl	250	Dnstream	16	7	2
1	2	DI-4	37.8	38.4	0.6	6	Outside	Sd/St/Cl		Outside	0.8-4.6	Sd/St/Cl	0	In	3	5	0
1	2	DR-2	36.0	38.2	2.2	6	Channel	Sd		Channel	2.4	Sd	0	In	0	0	0
									P6-2	Outside	1.8-3.7	Cl/Sd/St	100	Shoreward	8	7	4
									P6-3	Straight	0.6-1.2	Cl/Sd/St	100	Shoreward	6	3	0
									B6-1	Straight	0.6-3.1	Cl/St/Sd/Dt	100	Shoreward	17	10	4
1	2	DI-5	36.4	37.1	0.7	6	NS										
1	2	DI-6	35.3	36.5	1.2	6	Outside	Sd/St		Outside	1.2-1.5	Sd/St	0	In	0	0	0
1	2	DR-1	49.5	50.0	0.5	7	TW	Bd/Cb/Gr/Sd		TW	5	Bd/Cb/Gr/Sd	0	In	0	0	0
1	2	DI-1	48.5	50.1	1.6	7	TW	Sd/Gr	P7-1	Outside	1.2-3.7	Sd/Gr/Cl/St/Cb	0	In	15	8	2
1	2	DI-2	46.8	49.3	2.5	7	Inside	Sd	P7-2	Inside	3.1-5.0	Sd/Cl/Gr	0	In	16	6	3
1	2	DR-2	48.0	49.0	1.0	7	Channel	Sd/Gr		Channel	6.1	Sd/Gr	0	In	0	0	0
1	2	DI-3	45.5	47.3	1.8	7	Inside	Sd/Cl/Gr		Inside	5.2-8.5	Sd/Cl/Gr	0	In	0	0	0
1	2	DR-3	46.0	47.0	1.0	7	Channel	Sd/Gr/Cb		Channel	2.1-6.1	Sd/Gr/Cb	0	In	0	0	0
1	2	DI-4	45.5	46.0	0.5	7	Outside	Sd/Bd/Cb/St/Cl		Outside	8.5-7.6	Sd/Bd/Cb/St/Cl	0	In	0	0	0
1	2	DR-4	42.8	45.0	2.2	7	Channel	Sd/Gr	B7-1	Trib	0.8-3.4	Cl/Sd/St/Gr	<100	Shoreward	19	5	9
1	2	DI-5	44.0	44.6	0.6	7	Inside	Gr/Sd/St		Inside	1.2	Gr/Sd/St	0	In	0	0	0
1	2	DI-6	43.4	44.2	0.8	7	Island	NS									
1	3		61.0	62.0	1.0	NS	Channel										
1	3		65.4	65.9	0.5	NS	Channel										
Total DI					13.9												
Total DR					22.9												

[1]TW = tailwaters, NS = not sampled
[2]Br = bedrock, Bd = boulder, Cb = cobble, Gr = gravel, Sd = sand, St = silt, Cl = clay, Dt = detritus

Table 3-2. Number of unionids and species collected within each MKARNS Reach, 2004.

	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 undulatus	-	-	-	-	-	-	-	-	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 truncata	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	

FD=freshly dead shell, WD=weathered dead shell

Table 3-3. Location, habitat characteristics, and CPUE[1] of unionid beds (B) and patches (P), MKARNS Reach 1, 2004.

Pool	0	0	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Site	1	1	2	2	2	4	4	4	5	5	5	6	6	6	6	7	7	7
Bed/Patch	B1-1	P1-1	B2-1	B2-2	B2-3	B4-1	P4-1	P4-2	B5-1	P5-1	P5-2	B6-1	P6-1	P6-2	P6-3	B7-1	P7-1	P7-2
Channel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cove	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inside bend	-	-	-	-	-	10.3	-	-	-	-	8.9	-	-	-	-	-	-	16.0
Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outside bend	-	-	-	-	-	-	-	-	-	7.7	-	-	16.3	8.3	-	-	15.0	-
Oxbow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peninsula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Straight	35.5	5.7	38.0	14.8	17.1	26.3	4.5	-	-	-	-	17.0	-	-	5.5	-	-	-
Tailwater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tributary	-	-	-	-	-	-	-	4.3	12.8	-	-	-	-	-	-	19.0	-	-
Ave. CPUE	35.5	5.7	38.0	14.8	17.1	36.7	4.5	4.3	12.8	7.7	8.9	17.0	16.3	8.3	5.5	19.0	15.0	16.0
Modification[2]																		
Existing	-	-	Canal	Canal	Canal	DI, DF	-	-	-	DI, DF	-	DI	DI	-	-	DF	DI	DI, DF
Proposed	-	-	DR	DR	DR	-	-	-	-	-	-	-	-	-	-	-	-	-
Depth (m)																		
min	10.5	-	2.4	2.4	0.9	1.1	-	-	-	0.6	1.5	0.6	-	1.8	0.6	0.8	1.2	3.1
max	11.1	7.6	4.9	4.9	4.6	7.6	3.1	-	7.6	1.1	2.7	3.1	0.9	3.7	1.2	3.4	3.7	5.0
Substrate																		
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Gravel	20	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	15	3
Sand	80	30	30	5	-	25	20	-	50	70	50	5	80	33	10	30	55	53
Silt	-	20	30	45	20	10	-	-	20	10	10	25	10	10	35	14	10	-
Clay	-	30	40	50	80	40	80	-	30	20	40	65	10	50	55	54	15	44
Detritus	-	20	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-
zebras/unionid	<1	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-

[1]CPUE = unionids/5min.
[2]DI = disposal, DR = dredge, DF = dike field

Table 3-4. Site 1 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	WR10	WR10	WR10	9.0	9.0
Bank	R	R	R	R	R	R	R	R	R	R	R	L	L	M	R	R
Bed/Patch	B1-1	B1-1	B1-1	B1-1	B1-1	B1-1	B1-1	B1-1	B1-1	B1-1	B1-1	P1-1	P1-1	P1-1		
Amblema plicata	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Fusconaia ebena	-	-	-	1	2	-	1	-	1	1	-	-	-	-	-	-
Lampsilis cardium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	-
Lasmigona c. complanata	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	1	-	3	1	1	1	2	7	3	5	-	-	-	-	WD
Obliquaria reflexa	4	2	-	2	2	-	2	2	1	-	2	1	2	-	-	-
Obovaria olivaria	-	-	-	-	3	-	1	1	-	-	-	-	-	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-
Potamilus purpuratus	1	1	-	1	-	1	-	-	1	-	-	-	-	-	-	-
Quadrula aspera	1	-	-	1	5	-	4	18	15	18	12	1	-	-	1	WD
Quadrula p. pustulosa	-	-	-	-	2	-	3	1	-	-	-	-	-	-	-	-
Quadrula quadrula	8	2	5	12	12	7	1	18	49	68	51	1	6	2	-	-
Tritogonia verrucosa	-	1	1	-	-	-	-	1	1	-	2	-	-	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Total	14	7	6	21	27	10	17	49	76	91	72	4	11	2	3	0
No. species live	4	5	2	7	7	4	9	10	8	5	5	4	4	1	3	0
No. species total	4	5	2	7	7	4	9	10	8	5	5	4	4	1	3	2
Appr. Density (no. /m^2)	1	1	1	3	-	-	5	5	5	5	5	-	-	-	-	-
Mean no./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification[2]																
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Inside	Inside
Depth (m)	10.5	10.5	10.5	-	-	-	11.1	10.5	-	-	-	7.6	7.6	7.6	8.5	10.5
Substrate																
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	10	10	10	10	20	20	20	20	20	-	-	-	-	50
Sand	90	90	80	80	80	80	80	80	80	80	80	30	30	-	-	50
Silt	5	10	10	10	10	10	-	-	-	-	-	20	20	-	30	-
Clay	-	-	-	-	-	-	-	-	-	-	-	30	30	-	10	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	20	20	-	-	-
Shell	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-4. Site 1 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	8.6	8.5	8.4	8.3	9.2	9.0	8.8	8.4	9.5	8.3		
Bank	R	R	R	R	L	L	L	L	L	L	Total	
Bed/Patch											No.	%
Amblema plicata	-	-	-	-	-	-	-	-	-	-	2	0.5
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	1	0.2
Fusconaia ebena	-	-	-	-	-	-	-	-	-	-	6	1.4
Lampsilis cardium	-	-	-	-	-	-	-	-	-	-	1	0.2
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	4	1.0
Lasmigona c. complanata	-	-	-	-	-	-	-	-	-	-	2	0.5
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	6	1.4
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	2	26	6.3
Obliquaria reflexa	-	-	-	-	-	-	-	1	-	-	21	5.0
Obovaria olivaria	-	-	-	-	-	-	-	-	-	-	5	1.2
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	3	0.7
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	5	1.2
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	76	18.3
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	6	1.4
Quadrula quadrula	-	-	-	-	-	1	-	-	-	-	243	58.4
Tritogonia verrucosa	-	-	-	-	-	-	-	2	-	-	8	1.9
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	1	0.2
Total	0	0	0	0	0	1	0	3	0	2	416	
No. species live	0	0	0	0	0	1	0	2	0	1	17	
No. species total	0	0	0	0	0	1	0	2	0	1	17	
Appr. Density (no. /m^2)	-	-	-	-	-	-	-	-	-	-		
Mean no./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	16.0	
Modification[2]												
Existing	-	-	-	-	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-	-	-	-	-		
Habitat	Inside	Inside	Inside	Straight	Outside	Outside	Outside	Outside	Straight	Straight		
Depth (m)	3.7	5.2	3.7	1.5	8.2	-	15.0	8.8	8.4	8.8		
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	25	-	25	-	25		
Cobble	-	-	-	-	-	25	-	25	-	25		
Gravel	-	-	-	-	-	25	-	25	-	25		
Sand	-	50	-	10	33	25	33	25	30	25		
Silt	10	20	20	80	33	-	33	-	10	-		
Clay	90	30	80	0	34	-	34	-	60	-		
Detritus	-	-	-	10	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-5. Species composition and CPUE within unionid beds and patches, Reach 1.

Pool	0	0	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Site	1	1	2	2	2	4	4	4	5	5	5	6	6	6	6	7	7	7
Bed/Patch no.	B1-1	P1-1	B2-1	B2-2	B2-3	B4-1	P4-1	P4-2	B5-1	P5-1	P5-2	B6-1	P6-1	P6-2	P6-3	B7-1	P7-1	P7-2
Amblema plicata	0.2	-	13.8	4.3	2.1	2.5	0.7	1.5	2.0	5.7	5.9	5.1	2.8	2.0	0.5	4.2	2.3	3.3
Anodonta suborbiculata	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	0.1	-	0.1	-	-	0.1	-	-	0.2	-	0.1	0.4	-	-	-	-	0.5	-
Fusconaia ebena	0.5	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis cardium	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis siliquoidea	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	1.0	0.5	2.8	2.1	1.0	1.0	1.5	0.3	-	0.1	0.7	-	-	0.5	-	0.3	-
Lasmigona c. complanata	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	0.5	-	0.1	0.5	-	0.3	0.3	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	2.2	-	0.9	0.5	0.1	2.5	-	-	1.8	-	-	0.3	-	0.3	-	-	-	-
Obliquaria reflexa	1.5	1.0	4.4	0.5	0.1	1.1	-	-	1.0	-	0.3	3.6	6.8	1.3	4.5	5.2	0.8	3.0
Obovaria olivaria	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus	0.3	-	11.3	4.5	10.0	16.9	0.3	0.5	2.7	-	0.2	2.4	0.3	0.3	-	0.3	2.3	1.8
Potamilus ohiensis	-	-	-	-	-	0.0	0.3	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	0.5	-	0.5	1.5	0.8	5.2	1.7	-	1.2	0.7	1.0	0.3	1.8	1.0	-	-	0.8	1.3
Pyganodon grandis	-	-	-	-	0.1	0.4	-	-	0.7	0.7	0.3	0.4	0.3	0.3	-	2.8	-	1.0
Quadrula aspera	6.7	0.3	1.2	0.3	0.1	0.8	-	-	-	-	-	0.1	0.3	-	-	-	0.3	-
Quadrula nodulata	-	-	1.5	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	0.5	-	0.4	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	21.2	3.0	3.1	-	1.4	5.7	-	-	3.0	0.7	0.9	3.6	4.3	3.0	-	6.5	8.0	5.8
Strophitus undulatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toxolasma parvus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla donaciformis	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-
Total no. individuals	390	17	608	59	447	843	13	7	77	23	80	119	65	25	11	114	60	64
No. of 5min samples	11	3	16	4	27	23	3	2	6	3	9	7	4	3	2	6	4	4
Average CPUE	35.5	5.7	38.0	14.8	17.1	36.7	4.3	3.5	12.8	7.7	8.9	17.0	16.3	8.3	5.5	19.0	15.0	16.0
No of species	14	5	16	8	13	13	6	3	9	4	8	10	7	7	3	5	8	6
% Juveniles	2.5	11.8	21.7	25.8	4.3	9.1	15.4	0.0	15.6	0.0	5.0	4.2	1.5	4.0	0.0	8.8	1.7	3.1
% of species w/ juveniles	42.9	40.0	62.5	50.0	38.5	69.2	33.3	0.0	44.4	0.0	12.5	30.0	14.3	14.3	0.0	60.0	14.3	33.3

Nomenclature follows Turgeon *et al.* (1998) except *Q. aspera* (T. Watters, OSU, pers. comm., 2004)
B=bed, P=patch

Table 3-6. Site 2 unionid species and habitat characteristics (page 1 of 4).

Approx. NM		12.5	12.5	11.5	11.5	11.5	11.5	10.5	10.5	10.5	10.5	12.5	12.5	11.5
Bank		R	R	R	R	R	R	R	R	R	R	M	M	M
Bed/Patch		B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1	B2-1
Amblema plicata		5	8	1	6	13	2	36	29	30	-	20	36	1
Anodonta suborbiculata		-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus		-	-	-	-	-	-	-	-	-	-	-	1	-
Fusconaia ebena		1	-	-	-	-	-	-	-	-	-	-	-	1
Fusconaia flava		-	-	-	-	-	-	-	-	-	-	1	-	-
Lampsilis cardium		-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis siliquoidea		-	-	-	1	-	-	-	-	-	-	-	-	-
Lampsilis teres		1	-	1	-	1	1	-	-	-	-	1	-	-
Leptodea fragilis		-	-	1	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa		-	-	-	-	-	-	3	1	1	-	1	4	-
Obliquaria reflexa		3	-	-	1	3	2	9	10	7	5	4	8	1
Plectomerus dombeyanus		3	4	2	7	15	6	20	15	10	6	10	40	1
Potamilus purpuratus		-	-	2	-	-	3	-	-	-	-	-	-	-
Pyganodon grandis		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera		-	-	-	-	-	-	2	3	1	2	2	3	-
Quadrula nodulata		1	-	-	1	-	-	6	5	4	2	-	2	1
Quadrula p. pustulosa		1	-	-	-	-	-	1	3	-	1	-	-	-
Quadrula quadrula		-	-	-	-	-	2	5	12	5	6	1	4	-
Truncilla truncata		-	-	-	-	1	-	-	-	-	-	-	-	-
Total		15	12	7	16	33	16	82	78	58	22	40	98	5
No. species live		7	2	5	5	5	6	8	8	7	6	8	8	5
No. species total		7	2	5	5	5	6	8	8	7	6	8	8	5
Appr. Density (no./m^2)		-	-	1	1	-	2	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
	Existing	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)		3.1	-	2.4	2.7	3.1	2.7	-	-	-	-	-	4.3	3.1
Substrate														
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	60	-	-	-	-	-	-	-	-	-	-
	Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sand	30	30	-	10	-	-	30	-	-	-	30	30	10
	Silt	30	30	20	40	40	40	30	-	-	-	30	30	50
	Clay	40	40	10	50	50	50	40	-	-	-	40	40	40
	Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
	Shell	-	-	10	-	10	10	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-6. Site 2 unionid species and habitat characteristics (page 2 of 4).

Approx. NM	11.5	11.5	11.5	12.5	12.5	12.5	11.5	18.8	17.8	15.5	15.5	15.5	15.5
Bank	M	M	M	L	L	L	L	R	R	R	R	R	R
Bed/Patch	B2-1	B2-1	B2-1	B2-2	B2-2	B2-2	B2-2	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3
Amblema plicata	13	19	2	5	4	4	4	1	2	1	-	3	2
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis cardium	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis siliquoidea	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	1	1	1	2	-	8	1	-	-	-	2	1	2
Leptodea fragilis	-	-	-	2	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	1	3	-	1	-	1	-	-	-	-	1	-	1
Obliquaria reflexa	8	8	1	2	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus	30	11	1	7	5	4	2	-	5	11	35	22	31
Potamilus purpuratus	3	-	-	2	-	2	2	-	-	2	-	3	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	4	2	-	-	-	-	1	-	-	1	-	1	1
Quadrula nodulata	1	1	-	-	-	-	-	-	-	1	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	1	-
Quadrula quadrula	7	8	-	-	-	-	-	-	-	1	-	2	1
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	68	53	5	21	9	19	10	1	7	17	38	33	38
No. species live	9	8	4	7	2	5	5	1	2	6	3	7	6
No. species total	9	8	4	7	2	5	5	1	2	6	3	7	6
Appr. Density (no./m^2)	5	2	1	1	1	-	<1	-	<1	<1	5	5	5
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)	-	4.9	-	-	-	-	-	3.7	2.7	4.3	2.4	-	1.5
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	35	-	-	-	-	-	-	-	-	-	-	-
Sand	5	-	-	-	-	-	5	30	30	-	-	-	-
Silt	5	15	-	60	45	-	45	50	50	-	15	-	10
Clay	90	50	-	40	50	-	50	20	20	95	80	-	90
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	5	-	-	-	-	5	5	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-6. Site 2 unionid species and habitat characteristics (page 3 of 4).

Approx. NM		14.5	13.8	13.8	13.8	13.8	18.8	17.8	15.5	14.5	14.5	13.8	18.8	18.8
Bank		R	R	R	R	R	M	M	M	M	M	M	L	L
Bed/Patch		B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3
Amblema plicata		1	2	1	-	2	-	-	5	1	1	-	11	9
Anodonta suborbiculata		-	-	-	-	-	-	-	-	-	-	-	1	-
Arcidens confragosus		-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena		-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava		-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis cardium		-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis siliquoidea		-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres		-	30	4	7	3	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa		-	-	-	-	-	-	-	1	-	-	-	-	-
Obliquaria reflexa		-	1	-	1	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus		5	7	7	12	11	5	-	8	14	9	-	10	6
Potamilus purpuratus		-	1	2	3	2	1	-	-	-	-	-	1	-
Pyganodon grandis		-	-	-	-	-	-	-	1	-	-	-	-	-
Quadrula aspera		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata		2	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula		-	1	1	-	3	4	-	3	2	1	1	4	1
Truncilla truncata		-	-	-	-	-	-	-	-	-	-	-	-	-
Total		8	42	15	23	21	10	0	18	17	11	1	27	16
No. species live		3	6	5	4	5	3	0	5	3	3	1	5	3
No. species total		3	6	5	4	5	3	0	5	3	3	1	5	3
Appr. Density (no./m^2)		-	<1	-	-	-	<1	-	-	-	-	<1	1	<1
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
	Existing	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)		-	2.4	-	2.7	-	4.6	2.7	-	4.6	-	4.3	1.5	1.5
Substrate														
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	20	-	-	-	-
	Cobble	-	-	-	-	-	-	-	-	5	-	-	-	-
	Gravel	-	-	-	-	-	-	-	-	10	-	-	-	-
	Sand	-	-	-	-	-	-	-	-	60	-	-	-	10
	Silt	5	20	20	20	-	10	-	-	5	-	-	-	10
	Clay	80	80	80	80	-	90	-	-	-	-	100	-	80
	Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
	Shell	15	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-6. Site 2 unionid species and habitat characteristics (page 4 of 4).

Approx. NM		18.8	17.8	15.5	14.5	14.5	13.8	13.8	13.8	10.5	10.5	Total	
Bank		L	L	L	L	L	L	L	L	M	L	No.	%
Bed/Patch		B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3	B2-3				
Amblema plicata		6	-	2	-	2	1	-	1	-	-	292	26.3
Anodonta suborbiculata		-	-	-	-	-	-	-	-	-	-	1	0.1
Arcidens confragosus		-	-	-	-	-	-	-	-	-	-	1	0.1
Fusconaia ebena		-	-	-	-	-	-	-	-	-	-	2	0.2
Fusconaia flava		-	-	-	-	-	-	-	-	-	-	1	0.1
Lampsilis cardium		-	-	-	-	-	1	-	-	-	-	1	0.1
Lampsilis siliquoidea		-	-	-	-	-	-	-	-	-	-	1	0.1
Lampsilis teres		2	-	-	-	-	1	1	1	-	-	73	6.6
Leptodea fragilis		-	-	-	-	-	-	-	-	-	-	3	0.3
Megalonaias nervosa		-	-	-	-	-	-	-	-	-	-	19	1.7
Obliquaria reflexa		-	-	-	1	-	-	-	-	-	-	75	6.8
Plectomerus dombeyanus		1	2	9	20	6	7	8	10	-	-	460	41.4
Potamilus purpuratus		-	-	-	3	-	1	-	2	-	-	35	3.2
Pyganodon grandis		1	-	1	-	-	-	-	-	-	-	3	0.3
Quadrula aspera		-	-	-	-	-	-	-	-	-	-	23	2.1
Quadrula nodulata		-	-	-	-	-	-	-	-	-	-	27	2.4
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	-	7	0.6
Quadrula quadrula		1	-	3	3	-	1	1	2	-	-	86	7.7
Truncilla truncata		-	-	-	-	-	-	-	-	-	-	1	0.1
Total		11	2	15	27	8	12	10	16	0	0	1111	
No. species live		5	1	4	4	2	6	3	5	0	0	19	
No. species total		5	1	4	4	2	6	3	5	0	0	19	
Appr. Density (no./m^2)		-	-	-	-	-	1	-	-	-	-	0 to 5	
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	22.7	
Modification													
	Existing	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal	Canal		
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge		
Habitat		Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight		
Depth (m)		-	0.9	2.4	-	-	2.4	1.8	-	4.0	3.1		
Substrate													
	Bedrock	-	-	-	-	-	-	-	-	-	-		
	Boulder	-	-	-	-	-	-	-	-	-	-		
	Cobble	-	-	-	-	-	-	-	-	-	-		
	Gravel	-	-	-	-	-	30	30	-	-	-		
	Sand	-	-	-	-	-	-	-	-	5	15		
	Silt	-	20	50	-	-	40	40	-	5	5		
	Clay	-	80	50	-	-	30	30	-	90	80		
	Detritus	-	-	-	-	-	-	-	-	-	-		
	Shell	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid		-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-7. Site 4 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	24.0	24.0	24.0	24.0	24.0	24.0	23.8	23.8	23.8	23.8	23.8	23.8	23.3
Bank	L	L	L	L	L	L	L	L	L	L	L	L	L
Bed/Patch	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1
Amblema plicata	5	6	6	6	-	1	1	5	3	2	7	2	-
Arcidens confragosus	-	1	-	-	-	-	-	1	-	-	-	-	-
Lampsilis teres	1	1	1	-	2	2	1	1	-	-	-	1	3
Leptodea fragilis	-	-	FD	-	1	-	-	FD	1	1	-	-	-
Megalonaias nervosa	-	5	13	1	1	3	1	8	6	4	4	2	-
Obliquaria reflexa	3	4	4	3	2	-	1	1	-	-	-	-	-
Plectomerus dombeyanus	23	31	28	32	26	21	22	6	4	27	4	14	6
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	8	11	18	15	10	16	4	1	4	1	3	5	-
Pyganodon grandis	1	-	1	-	-	-	1	-	-	-	1	2	-
Quadrula aspera	-	-	-	2	1	-	1	2	3	2	4	3	-
Quadrula quadrula	12	9	10	1	3	5	8	16	9	12	21	14	-
Utterbackia imbecillis	-	2	-	-	-	-	-	-	-	-	-	-	-
Total	53	70	81	60	46	48	40	41	30	49	44	43	9
No. species live	7	9	8	7	8	6	9	9	7	7	7	8	2
No. species total	7	9	9	7	8	6	9	10	7	7	7	8	2
Appr. Density (no./m^2)	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	5-10	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	DI, DF
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Inside
Depth (m)	3.4	3.7	3.6	-	-	-	7.6	7.6	7.6	6.1	6.1	5.8	1.2
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	50	75	75	75	75	75	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	5	-	-	-	-	-	-
Sand	50	50	50	50	50	50	-	-	-	-	-	-	20
Silt	10	10	20	20	20	20	5	5	5	5	5	5	-
Clay	40	40	30	30	30	30	40	20	20	20	20	20	80
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-7. Site 4 unionid species and habitat characteristics (page 2 of 3).

Approx. NM	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.5	23.5	23.5
Bank	L	L	L	L	L	L	L	L	L	L	R	R	R
Bed/Patch	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	B4-1	P4-1	P4-1	P4-1
Amblema plicata	-	1	-	-	-	-	3	3	6	-	1	1	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	1	1	1	1	1	1	-	-	2	1	2	-	1
Leptodea fragilis	-	-	-	-	-	-	1	1	-	1	-	-	1
Megalonaias nervosa	-	2	3	-	1	4	-	-	-	-	-	-	-
Obliquaria reflexa	1	1	-	2	3	1	-	-	-	-	-	-	-
Plectomerus dombeyanus	9	24	12	30	39	19	1	1	9	1	-	-	1
Potamilus ohiensis	-	-	-	-	-	-	-	-	1	-	-	-	1
Potamilus purpuratus	4	2	4	2	3	3	2	-	2	1	4	1	-
Pyganodon grandis	1	-	-	-	-	-	1	-	1	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	1	-	-	-	-	-	-
Quadrula quadrula	-	-	3	-	-	4	1	-	2	-	-	-	-
Utterbackia imbecillis	-	1	2	-	-	-	-	-	-	-	-	-	-
Total	16	32	25	35	47	32	10	5	23	4	7	2	4
No. species live	5	7	6	4	5	6	7	3	7	4	3	2	4
No. species total	5	7	6	4	5	6	7	3	7	4	3	2	4
Appr. Density (no./m^2)	-	-	-	-	-	-	-	<1	2	<1	<1	<1	<1
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Straight	Straight	Straight
Depth (m)	3.7	4.6	3.4	-	-	-	-	1.8	1.1	-	3.1	3.1	3.1
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	-	20	20	-	-	-	-	70	50	-	20	20	20
Silt	-	-	-	-	-	-	-	10	25	-	-	-	-
Clay	-	80	80	-	-	-	-	20	25	-	80	80	80
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-7. Site 4 unionid species and habitat characteristics (page 3 of 3).

Approx. NM	23.3	23.3	23.8	23.5	23.0	23.0	23.3	23.3		
Bank	R	R	L	L	L	R	R	R	Total	
Bed/Patch	P4-2	P4-2	DI-1	DI-1	DI-2	DR-1			No.	%
Amblema plicata	-	3	-	-	-	-	-	-	62	7.2
Arcidens confragosus	-	-	-	-	-	-	-	-	2	0.2
Lampsilis teres	2	1	-	-	-	-	-	-	28	3.2
Leptodea fragilis	-	-	-	-	-	-	-	-	7	0.8
Megalonaias nervosa	-	-	-	-	-	-	-	-	58	6.7
Obliquaria reflexa	-	-	1	-	-	-	-	-	27	3.1
Plectomerus dombeyanus	-	1	-	-	-	-	-	-	391	45.3
Potamilus ohiensis	-	-	-	-	FD	-	-	-	2	0.2
Potamilus purpuratus	-	-	-	-	-	-	-	-	124	14.4
Pyganodon grandis	-	-	-	-	-	-	-	-	9	1.0
Quadrula aspera	-	-	-	-	-	-	-	-	19	2.2
Quadrula quadrula	-	-	-	-	-	-	-	-	130	15.0
Utterbackia imbecillis	-	-	-	-	-	-	-	-	5	0.6
Total	2	5	1	0	0	0	0	0	864	
No. species live	1	3	1	0	0	0	0	0	13	
No. species total	1	3	1	0	1	0	0	0	13	
Appr. Density (no./m^2)	<1	<1	-	-	-	-	-	-		
Mean No./5min (CPUE) -	-	-	-	-	-	-	-	-	25.4	
Modification										
Existing	-	-	DI, DF	DI, DF	DI, DF	-	-	-		
Proposed	-	-	-	-	-	Dredge	-	-		
Habitat	Tributary	Tributary	Straight	Straight	Straight	Outside	Outside	Outside		
Depth (m)	-	-	2.3	5.5	1.8	3.1	1.2	-		
Substrate										
Bedrock	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	50	-	-		
Cobble	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-		
Sand	-	-	90	80	95	25	80	80		
Silt	-	-	10	10	5	25	20	20		
Clay	-	-	-	10	-	-	-	-		
Detritus	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	3	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-8. Site 5 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	31.3	31.3	31.3	31.3	31.3	31.3	32.5	32.5	32.5	30.5	30.5	30.5	30.5
Bank	L	L	L	L	L	L	L	L	L	R	R	R	R
Bed/Patch	B5-1	B5-1	B5-1	B5-1	B5-1	B5-1	P5-1	P5-1	P5-1	P5-2	P5-2	P5-2	P5-2
Amblema plicata	2	1	-	5	3	1	7	9	1	21	3	4	3
Arcidens confragosus	FD	-	-	1	-	-	-	-	-	-	-	1	-
Lampsilis teres	-	-	-	-	2	-	-	-	-	-	-	1	-
Megalonaias nervosa	-	-	-	6	4	1	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	2	2	2	-	-	-	-	2	-	-
Plectomerus dombeyan	-	1	1	2	5	7	-	-	-	-	1	-	-
Potamilus purpuratus	-	-	-	1	3	3	2	-	-	1	-	4	-
Pyganodon grandis	-	-	1	1	-	2	-	2	-	1	-	-	-
Quadrula quadrula	3	3	-	6	3	3	2	-	-	2	-	1	-
Toxolasma sp.	-	-	-	-	-	-	-	-	-	-	-	-	-
							-	-	-	-	-	-	-
Total	5	5	2	24	22	19	11	11	1	25	6	11	3
No. species live	2	3	2	8	7	7	3	2	1	4	3	5	1
No. species total	3	3	2	8	7	7	3	2	1	4	3	5	1
Appr. Density (no./m^2)	-	-	-	-	-	-	scattered	scattered	scattered	<1	scattered	scattered	scattered
Mean No./5min (CPUE	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	DF, DI	DF, DI	DF, DI	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Outside	Outside	Outside	Island	Island	Island	Island
Depth (m)	7.6	-	-	-	-	-	0.6	1.1	-	1.5	-	1.5	1.5
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	40	40	-	60	-	-	70	50	70	50	90	-	20
Silt	-	-	-	40	-	-	10	10	10	10	-	-	5
Clay	60	60	-	-	-	-	20	40	20	40	10	-	70
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	5
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-8. Site 5 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	30.5	30.5	32.5	31.3	31.3	31.0	30.4	32.3	31.9	30.5		
Bank	R	R	L	M	R	R	R	M	L	L	Total	
Bed/Patch	P5-2	P5-2	DI-1	DR-1							No.	%
Amblema plicata	6	1	-	-	9	5	1	-	-	-	82	45.6
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	2	1.1
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	3	1.7
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	11	6.1
Obliquaria reflexa	1	-	-	-	-	-	-	-	-	-	9	5.0
Plectomerus dombeyana	-	-	-	-	-	1	-	-	-	-	18	10.0
Potamilus purpuratus	1	1	-	-	-	-	2	-	-	-	18	10.0
Pyganodon grandis	-	-	-	-	-	1	1	-	-	-	9	5.0
Quadrula quadrula	4	-	-	-	1	-	-	-	-	-	28	15.6
Toxolasma sp.	-	-	-	-	-	-	WD	-	-	-	WD	
	-	-			-	-	-				-	
Total	12	2	0	0	10	7	4	0	0	0	180	
No. species live	4	2	0	0	2	3	3	0	0	0	9	
No. species total	4	2	0	0	2	3	4	0	0	0	11	
Appr. Density (no./m^2)	scattered	scattered	-	-	<1	<1	scattered	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	7.8	
Modification												
Existing	-	-	DF, DI	-	-	-	-	-	-	-		
Proposed	-	-	-	Dredge	-	-	-	-	-	-		
Habitat	Island	Island	Outside	Channel	Island	Island	Island	Channel	Island	Outside		
Depth (m)	1.5	1.5	3.1	5.2	1.5	2.7	1.5	2.1	3.5	7.3		
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-	-	-		
Sand	30	70	80	100	95	90	50	100	100	100		
Silt	10	10	20	-	5	10	40	-	-	-		
Clay	60	20	-	-	-	-	10	-	-	-		
Detritus	-	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-9. Site 6 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	36.5	36.5	36.5	36.5	36.5	36.5	36.5	38.8	38.8	38.8	38.8	37.8	37.8
Bank	R	R	R	R	R	R	R	L	L	L	L	L	L
Bed/Patch	B6-1	B6-1	B6-1	B6-1	B6-1	B6-1	B6-1	P6-1	P6-1	P6-1	P6-1	P6-2	P6-2
Amblema plicata	4	3	-	1	6	17	5	2	3	3	3	4	2
Arcidens confragosus	-	1	1	-	-	1	-	-	-	-	-	-	-
Lampsilis teres	WD	2	-	-	1	1	1	-	-	-	-	-	WD
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	1	1	-	-	-	-	-	1
Obliquaria reflexa	WD	-	2	2	8	8	5	15	8	4	-	1	1
Plectomerus dombeyanus	-	1	-	-	9	4	3	1	-	-	-	-	1
Potamilus ohiensis	WD	FD	-	-	-	-	-	-	-	-	-	-	FD
Potamilus purpuratus	WD	-	-	-	-	1	1	-	2	3	2	-	1
Pyganodon grandis	1	-	1	-	-	1	-	1	-	-	-	-	1
Quadrula aspera	-	-	-	-	-	1	-	-	-	1	-	-	-
Quadrula quadrula	3	3	4	2	3	10	-	8	6	3	-	7	1
Total	8	10	8	5	27	45	16	27	19	14	5	12	8
No. species live	3	5	4	3	5	10	6	5	4	5	2	3	7
No. species total	7	6	4	3	5	10	6	5	4	5	2	3	9
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Appr. Density (no./m^2)	1	<1	1	<1	1	7	3	-	-	-	-	1	1
Modification													
Existing	DI	DI	DI	DI	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Outside	Outside	Outside	Outside	Outside	Outside
Depth (m)	0.9	1.2	0.6	0.9	2.7	2.4	3.1	0.9	0.9	-	-	3.7	3.7
Substrate													
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	10	10	10	5	-	5	-	80	80	80	80	40	50
Silt	10	10	15	25	-	35	40	10	10	10	10	20	-
Clay	80	80	75	70	-	60	20	10	10	10	10	30	40
Detritus	-	-	-	-	-	-	40	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	10	10
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-9. Site 6 unionid species and habitat characteristics (page 2 of 3).

Approx. NM	37.8	36.5	36.5	36.5	36.5	40.0	39.8	38.3	38.3	36.3	36.0	40.0
Bank	L	L	L	L	L	L	R	L	L	L	L	L
Bed/Patch	P6-2	P6-3	P6-3	P6-3	P6-3	DI-1	DI-2	DI-4	DI-4	DI-6	DI-6	DR-1
Amblema plicata	-	-	-	1	-	-	-	-	2	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	1	-	-	1	-	-	WD	-	-	-	-
Leptodea fragilis	-	1	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	2	3	1	3	6	2	-	-	1	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	2	-	-	-	-	-	-	-	1	-	-	-
Pyganodon grandis	-	2	-	-	-	-	-	1	-	-	-	-
Quadrula aspera	-	1	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	1	2	-	-	-	-	-	-	1	-	-	-
Total	5	10	1	4	7	2	0	1	5	0	0	0
No. species live	3	6	1	2	2	1	0	1	4	0	0	0
No. species total	3	6	1	2	2	1	0	2	4	0	0	0
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Appr. Density (no./m^2)	1	-	-	<1	<1	-	-	<1	<1	-	-	-
Modification												
Existing	-	DI	DI	-	-	DI	DI	DI	DI	DI	DI	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	Dredge
Habitat	Outside	Straight	Straight	Straight	Straight	Outside	Inside	Outside	Outside	Straight	Straight	Channel
Depth (m)	1.8	4.0	4.0	1.2	0.6	1.5	2.4	4.6	0.8	1.5	1.2	4.6
Substrate												
Boulder	-	30	30	-	-	-	-	-	-	-	-	-
Cobble	-	30	30	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	50	-	-	-	-	-
Sand	10	20	20	10	10	95	50	30	73	90	90	100
Silt	10	20	20	30	40	5	-	30	-	10	10	-
Clay	80	-	-	60	50	-	-	40	25	-	-	-
Detritus	-	-	-	-	-	-	-	-	2	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-9. Site 6 unionid species and habitat characteristics (page 3 of 3).

Approx. NM	38.0	36.8	40.0	35.5	35.0	36.3	36.3	38.8	Total	
Bank	M	M	R	R	R	R	R	L		
Bed/Patch	DR-2	DR-2							No.	%
Amblema plicata	-	-	-	-	-	-	-	-	56	23.0
Arcidens confragosus	-	-	-	-	-	-	-	-	3	1.2
Lampsilis teres	-	-	1	-	-	-	-	-	8	3.3
Leptodea fragilis	-	-	-	-	-	-	-	-	1	0.4
Megalonaias nervosa	-	-	-	2	-	-	-	-	5	2.0
Obliquaria reflexa	-	-	-	-	-	-	-	-	72	29.5
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	19	7.8
Potamilus ohiensis	-	-	-	-	-	-	-	-	FD	
Potamilus purpuratus	-	-	-	1	-	-	-	-	14	5.7
Pyganodon grandis	-	-	-	-	-	-	-	-	8	3.3
Quadrula aspera	-	-	-	-	-	-	-	-	3	1.2
Quadrula quadrula	-	-	-	1	-	-	-	-	55	22.5
Total	0	0	1	4	0	0	0	0	244	
No. species live	0	0	1	3	0	0	0	0	11	
No. species total	0	0	1	3	0	0	0	0	12	
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	7.4	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-		
Modification										
Existing	-	-	-	-	-	-	-	-		
Proposed	Dredge	Dredge	-	-	-	-	-	-		
Habitat	Channel	Channel	Inside	Outside	Outside	Straight	Straight	Outside		
Depth (m)	4.9	2.4	5.2	2.7	6.1	1.5	3.7	9.6		
Substrate										
Boulder	-	-	-	80	-	-	-	20		
Cobble	-	-	25	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-		
Sand	100	100	25	10	100	-	-	50		
Silt	-	-	25	10	-	95	90	-		
Clay	-	-	25	-	-	5	10	30		
Detritus	-	-	-	-	-	-	-	0		
Shell	-	-	-	-	-	-	-	0		
Zebras/unionid	-	-	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-10. Site 7 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	44.5	44.5	44.5	44.5	44.5	44.5	48.7	48.7	48.7	48.7	48.0	48.0	48.0	48.0
Bank	L	L	L	L	L	L	R	R	R	R	L	L	L	L
Bed/Patch	B7-1	B7-1	B7-1	B7-1	B7-1	B7-1	P7-1	P7-1	P7-1	P7-1	P7-2	P7-2	P7-2	P7-2
Amblema plicata	7	3	5	3	2	5	1	6	2	-	1	4	4	4
Anodonta suborbiculata	-	-	-	-	-	WD	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Lampsilis teres	-	-	-	-	-	FD	1	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	FD	-	FD	-	-	-	-
Obliquaria reflexa	5	2	6	2	10	6	3	-	-	-	1	1	1	9
Plectomerus dombeyanus	-	-	1	-	1	-	5	1	3	-	-	1	2	4
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	FD
Potamilus purpuratus	-	-	-	-	-	-	2	-	1	-	-	3	-	2
Pyganodon grandis	-	-	1	7	2	7	-	-	-	-	2	-	1	1
Quadrula aspera	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Quadrula quadrula	12	2	9	5	5	6	11	11	9	1	5	12	3	3
Total	24	7	22	17	20	24	23	18	17	2	9	21	11	23
No. species live	3	3	5	4	5	4	6	3	6	2	4	5	5	6
No. species total	3	3	5	4	5	6	6	4	6	3	4	5	5	7
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Appr. Density (no./m^2)	4	1	2	1	3	1	3	2	2	1	-	-	-	-
Modification														
Existing	DF	DF	DF	-	-	-	DI	DI	DI	DI	DI, DF	DI, DF	DI, DF	DI, DF
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Outside	Outside	Outside	Outside	Inside	Inside	Inside	Inside
Depth (m)	3.4	3.4	1.5	1.8	0.9	0.8	2.7	1.2	1.5	3.7	5.0	3.1	3.1	-
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	10	-	-	10	-	-	-	-
Gravel	10	-	-	-	-	-	20	-	10	30	5	-	-	-
Sand	50	10	-	10	40	70	60	50	50	60	60	30	30	-
Silt	-	10	10	10	35	20	10	20	10	-	-	-	-	-
Clay	40	80	90	80	25	10	-	30	30	-	35	70	70	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-10. Site 7 unionid species and habitat characteristics (page 2 of 3).

Approx. NM	50.0	50.0	50.0	46.9	46.5	45.8	46.9	46.0	45.3	50.0	48.9	46.9	46.4	46.0
Bank	R	R	R	R	R	R	L	L	L	L	M	M	M	M
Bed/Patch	DI-1	DI-1	DI-1	DI-3	DI-3	DI-5	DI-2	DI-4	DI-4	DR-1	DR-2	DR-3	DR-3	DR-3
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species live	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	DI	DI	DI	DI, DF	DI, DF	DI	DI, DF	DI, DF	DI, DF	Dredge	Dredge	-	Dredge	-
Proposed	-	-	-	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	TW	TW	TW	Inside	Inside	Inside	Inside	Outside	Outside	TW	Channel	Channel	Outside	Channel
Depth (m)	3.7	5.5	3.1	5.2	8.5	1.2	2.1	7.6	8.5	4.9	6.1	4.3	6.1	2.1
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	10	-	25	-	-	-	-
Cobble	-	-	-	-	-	-	-	10	-	25	-	-	20	-
Gravel	10	10	-	30	-	45	-	-	-	25	5	-	30	-
Sand	90	90	100	70	50	35	100	80	80	25	95	100	50	100
Silt	-	-	-	-	-	20	-	-	10	-	-	-	-	-
Clay	-	-	-	-	50	-	-	-	10	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-10. Site 7 unionid species and habitat characteristics (page 3 of 3).

Approx. NM	44.0	47.5	45.5	49.5	45.1	44.6	Total	
Bank	M	R	M	L	L	L		
Bed/Patch	DR-4						No.	%
Amblema plicata	-	-	-	-	-	-	47	19.7
Anodonta suborbiculata	-	-	-	-	-	-	WD	
Arcidens confragosus	-	-	-	-	-	-	2	0.8
Lampsilis teres	-	-	-	-	-	-	1	0.4
Leptodea fragilis	-	-	-	-	-	-	FD	
Obliquaria reflexa	-	-	-	-	-	-	46	19.3
Plectomerus dombeyanus	-	-	-	-	-	-	18	7.6
Potamilus ohiensis	-	-	-	-	-	-	FD	
Potamilus purpuratus	-	-	-	-	-	-	8	3.4
Pyganodon grandis	-	-	-	-	-	-	21	8.8
Quadrula aspera	-	-	-	-	-	-	1	0.4
Quadrula quadrula	-	-	-	-	-	-	94	39.5
Total	0	0	0	0	0	0	238	
No. species live	0	0	0	0	0	0	9	
No. species total	0	0	0	0	0	0	12	
Mean No./5min (CPUE)	-	-	-	-	-	-	7.0	
Appr. Density (no./m^2)	-	-	-	-	-	-	0-4	
Modification								
Existing	Dredge	-	-	-	-	-		
Proposed	Dredge	-	-	-	-	-		
Habitat	Channel	Outside	Channel	TW	Outside	Outside		
Depth (m)	6.4	9.1	3.4	7.6	6.7	5.8		
Substrate								
Bedrock	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-		
Gravel	5	10	-	5	5	10		
Sand	95	90	100	90	95	90		
Silt	-	-	-	-	-	-		
Clay	-	-	-	5	-	-		
Detritus	-	-	-	-	-	-		
Shell	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-11. MKARNS proposed dredge and permitted disposal areas with respect to unionid sample sites in Reach 2, 2004.

			Proposed dredge and permitted disposal areas						Unionids near proposed dredge and permitted disposal areas								
Reach	Pool	DR/DI	Dn NM	Up NM	Dist.	Site	Habitat[1]	Substrate[2]	B/P	Habitat[1]	Depth	Substrate	Dist from DR/DI (m)	Direction	CPUE	Species	% Juv.
2	4		79.0	80.0	1.0												
2	4		85.8	86.2	0.4												
2	5		91.0	92.0	1.0												
2	5		95.0	97.0	2.0												
2	5	DI-1	101.5	103.8	2.3	8	Outside	Sd/St/Gr/Cb		Outside	3.1-9.6	Sd/St/Gr/Cb	0	In	2	2	0
									P8-1	Island	1.5 to 3.7	Sd/Cl/St/Dt	250	Shoreward	3	2	8
2	5	DR-1	101.0	102.4	1.4	8	Channel	Sd/Gr		Channel	2.7-4.3	Sd/Gr	0	In	0	0	0
2	5	DR-1	107.6	107.9	0.3	9	TW	Bd/Cb/Gr/Sd		TW	2	Cb/Sd	350	Dnstream	2	2	0
		DI-1	106.5	107.7	1.2	9	TW	Bd/Cb/Gr/Sd		TW	3.7-4.6	Bd/Cb/Gr/Sd	0	In	0	0	0
Total DI					3.5												
Total DR					6.1												

[1]TW = tailwaters, NS = not sampled
[2]Br = bedrock, Bd= boulder, Cb = cobble, Gr = gravel, Sd = sand, St = silt, Cl = clay, Dt = detritus

QA numbers HLD

Table 3-12. Site 8 unionid species and habitat characteristics.

Approx. NM	101.5	101.5	101.5	101.5	103.5	103.0	102.5	102.5	101.5	100.8	103.8	101.1	101.1	Total	
Bank	L	L	L	L	L	L	L	M	M	M	M	L	L		
Bed/Patch	P8-1	P8-1	P8-1	P8-1	DI-1	DI-1	DI-1	DR-1	DR-1	DR-1				No.	%
Leptodea fragilis	-	-	-	-	-	-	-	-	FD	-	-	-	-	FD	
Obliquaria reflexa	-	-	-	-	-	4	-	-	-	-	-	-	-	4	22.2
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	WD	WD	
Pyganodon grandis	1	-	-	-	-	-	-	-	-	-	-	-	-	1	5.6
Quadrula quadrula	1	1	5	5	-	1	-	-	-	-	-	-	-	13	72.2
Total	2	1	5	5	0	5	0	0	0	0	0	0	0	18	
No. species live	2	1	1	1	0	2	0	0	0	0	0	0	0	3	
No. species total	2	1	1	1	0	2	0	0	1	0	0	0	1	5	
Appr. Density (no./m^2)	<1	<1	<1	<1	-	<1	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	
Modification	-	-	-	-											
Existing	-	-	-	-	DI	DI, DF	DI, DF	-	-	-	-	DF	-		
Proposed	-	-	-	-	-	-	-	Dredge	Dredge	Dredge	-	-	-		
Habitat	Island	Island	Island	Island	Outside	Outside	Outside	Channel	Channel	Channel	Channel	Inside	Inside		
Depth (m)	3.4	3.7	2.6	1.5	9.6	4.6	3.1	4.3	2.7	4.3	4.3	3.1	1.5		
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	25	-	-	-	-	-	33	-	-		
Gravel	-	-	-	-	30	-	-	-	15	25	33	50	50		
Sand	50	50	75	75	30	90	90	100	85	75	34	50	50		
Silt	10	10	10	10	15	10	10	-	-	-	-	-	-		
Clay	40	40	10	10	-	-	-	-	-	-	-	-	-		
Detritus	0	0	5	5	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	1%	1%		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-13. Site 9 unionid species and habitat characteristics.

Approx. NM	107.3	107.0	107.6	107.5	107.1	107.0	Total	
Bank	L	L	R	R	R	M		
Bed/Patch	DI-1	DI-1					No.	%
Leptodea fragilis	-	-	-	1	WD	-	1	50
Potamilus ohiensis	-	-	-	FD	-	-	FD	
Potamilus purpuratus	-	-	-	-	WD	-	WD	
Quadrula quadrula	-	-	-	1	-	-	1	50
Total	0	0	0	2	0	0	2	
No. species live	0	0	0	2	0	0	2	
No. species total	0	0	0	3	2	0	4	
Appr. Density (no./m^2)	-	-	-	<1	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	0.3	
Modification								
Existing	DI, DF	DI, DF	DF	DF	-	-		
Proposed	-	-	-	-	-	-		
Habitat	TW	TW	TW	TW	TW	Channel		
Depth (m)	3.7	4.6	2.1	2.3	3.1	7.3		
Substrate								
Bedrock	-	-	-	-	-	-		
Boulder	-	100	-	-	-	-		
Cobble	60	-	-	70	-	-		
Gravel	20	-	-	-	30	-		
Sand	20	-	100	30	40	100		
Silt	-	-	-	-	-	-		
Clay	-	-	-	-	-	-		
Detritus	-	-	-	-	-	-		
Shell	-	-	-	-	30	-		
Zebras/unionid	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-14. Unionid species previously collected within Reach 3[1].

Site	Site 22 (D97)	IL Bayou D97a	Bay Ridge 4M	D2-211B	Delaware Cr. LD-5M		H92a	H92b	6M	Shoal Cr.	Reach 3
NM	206.8/207.4	209	209	211	213	215.8	216.8	217.8 to 218.6	218.2	220	
Habitat	Straight	Cove	Cove	Peninsula	Cove	Straight	Inside	Cove, chan.	Inside	Outside	Total
Dredge/disposal activity	DR										
Amblema plicata	-	1	-	-	-	-	1	1	-	-	3
Anodonta suborbiculata	-	1	-	-	-	-	1	1	-	-	3
Arcidens confragosus	1	1	-	-	-	-	1	2	-	-	5
Ellipsaria lineolata	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	7	-	-	-	-	-	-	-	-	7
Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-
Lampsilis satura	-	-	-	-	-	-	D	-	-	-	D
Lampsilis teres	-	1	-	-	-	-	-	-	-	-	1
Lasmigona complanata	-	1	-	-	-	-	D	D	-	-	1
Leptodea fragilis	1	3	-	-	-	4	D	D	-	-	8
Megalonaias nervosa	-	-	-	-	-	1	-	1	-	-	2
Obliquaria reflexa	1	25	-	-	-	-	6	7	-	-	39
Plectomerus dombeyanus	24	312	-	2	1	12	63	5	-	1	420
Pleurobema rubrum	-	-	-	-	-	-	-	-	-	-	-
Pleurobema sintoxia	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	3	-	-	-	-	-	D	3	-	-	6
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-
Ptychobranchus occidentalis	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	6	1	-	-	-	6	2	2	-	17
Quadrula apiculata	-	-	-	-	-	-	-	-	-	-	-
Quadrula metanevra	-	-	-	-	-	-	-	-	-	-	-
Quadrula pustulosa	-	20	-	-	-	-	-	-	-	-	20
Quadrula quadrula	15	158	4	-	23	-	64	50	2	1	317
Toxolasma lividus	-	-	-	-	-	-	-	-	-	-	-
Tritigonia verrucosa	-	-	-	-	-	-	-	-	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	D	-	-	-	-
Total	45	536	5	2	24	17	142	72	4	2	849
No. species	6	12	2	1	2	3	7	9	2	2	14

[1]Davidson (1997); Harris (1992)

NM = navigation mile

D = dead

Table 3-15. MKARNS proposed dredge and permitted disposal areas with respect to unionid sample sites in Reach 3, 2004.

			Proposed dredge and permitted disposal areas						Unionids near proposed dredge and permitted disposal areas								
Reach	Pool	DR/DI	Dn NM	Up NM	Dist.	Site	Habitat1	Substrate2	B/P	Habitat1	Depth	Substrate	Dist from DR/DI (m)	Direction	CPUE	Species	% Juv.
3	6	DR	124.8	125.1	0.3		TW	NS									
3	7	DR	126.6	126.8	0.2	11	Channel	NS	B11-1	Straight	1.2-3.7	Cl/Sd/St/Gr/Dt	700	Shoreward	9	9	54
3	7	DR	*137.3*	*137.4*	*0.1*		Channel	NS									
3	7	DR	*135.0*	*135.2*	*0.2*		Channel	NS									
3	7	DR	146.3	147.1	0.8	13	Outside	NS	P13-1	Outside	0.5-2.1	Sd/St/Cl	250	Shoreward	8	4	0
									P13-2	Tributary	0.9-2.4	St/Sd/Cl/Gr	300	Shoreward	31	8	3
3	7	DR	146.1	146.3	0.2	13	Straight	NS									
3	7	DR	*145.9*	*146.0*	*0.1*	13	Straight	NS									
3	7	DR	*145.5*	*145.7*	*0.2*	13	Outside	Sd/Cl/St/Gr		Outside	1.8-3.7	Sd/Cl/St/Gr	0	In	2	4	
3	7	DR	145.0	145.5	0.5	13	Channel	Sd/St/Cl/Dt		Channel	3.7-4.3	Sd/St/Cl/Dt	0	In	2	4	
3	7	DR	144.5	144.8	0.3	13	Channel	Sd/Cb		Channel	4.0	Sd/Cb			0	0	0
3	7	DR	144.0	144.1	0.1	13	Channel	Sd		Channel	4.0	Sd			0	0	0
3	7	DR	*143.4*	*143.4*	*0.0*	13	Channel	NS									
3	7	DR	142.5	143.2	0.7	13	Channel	Sd/Cl		Channel	3.1-3.7	Sd/Cl			0	0	0
3	7	DR	*142.2*	*142.3*	*0.1*	13	Channel	Sd		Channel	4.3	Sd			0	0	0
3	7	DR	*141.9*	*142.1*	*0.2*	13	Channel	Sd/Gr/St		Channel	4.9-5.2	Sd/Gr/St			0	0	0
3	7	DR	*140.6*	*140.9*	*0.3*	13	Channel	Sd/Gr		Channel	3.4-4.3	Sd/Gr			0	0	0
3	7	DR	*139.8*	*140.2*	*0.4*	13	Channel	NS									
3	7	DR	150.4	150.5	0.1		Channel	NS									
3	7	DR	149.6	150.1	0.5		Channel	NS									
3	7	DR	149.3	149.6	0.3		Channel	NS									
3	7	DR	*149.1*	*149.2*	*0.1*		Channel	NS									
3	7	DR	155.4	155.5	0.1	14	TW	NS									
3	7	DR	*154.5*	*154.7*	*0.2*	14	Channel	NS		Inside	2.1-6.1	Sd/Gr/Cb	1750.0	Dnstream	<1	1	

Table 3-15. MKARNS proposed dredge areas with respect to unionid sample sites in Reach 3, 2004 (page 2 of 2).

		Proposed dredge areas				Unionids near proposed dredge areas											
Reach	Pool		Dn NM	Up NM	Dist.	Site	Habitat	Substrate	B/P	Habitat	Depth	Substrate	Dist from dredge (m)	Direction	CPUE	Species	% Juv.
3	8	DR	*160.2*	*160.6*	*0.4*		Channel	NS									
3	8	DR	*159.3*	*159.4*	*0.1*		Channel	NS									
3	8	DR	*158.4*	*158.7*	*0.3*		Channel	NS									
3	8	DR	164.7	165.1	0.4	15	Channel	Sd		Straight	4.6-6.1	Sd/Cl/St/Gr	50	Shoreward	2	2	
3	8	DR	*164.4*	*164.6*	*0.2*	15	Channel	Sd		Straight	2.4-2.7	Sd/Cl/St	200	Dnstream	1	3	
3	8	DR	169.2	169.5	0.3		Outside	NS									
3	8	DR	*168.4*	*169.1*	*0.7*		Channel	NS									
3	8	DR	*165.9*	*166.0*	*0.1*		Channel	NS									
3	8	DR	174.9	175.2	0.3	16	Channel	Sd/Gr/Cb/St		Channel	0.9-4.6	Sd/Gr/Cb/St	0.0	In	<1	2	
3	8	DR	174.0	174.3	0.3	16	Channel	Sd/Gr/Cb		Outside	0.8-6.1	Cb/Gr/Sd/St/Cl/Dt	150.0	Shoreward	1	3	
						16				Tributary	1.5	Cb/Gr/Sd/St/Cl	400.0	Dnstream	9	4	
3	9	DR	180.8	180.9	0.1		Channel	NS									
3	9	DR	179.5	179.7	0.2		Inside	NS									
3	9	DR	178.7	179.2	0.5		Channel	NS									
3	8	DR	*176.4*	*176.5*	*0.1*		Straight	NS									
3	9	DR	184.9	185.3	0.4	18	Channel	Sd		Channel	1.8-3.4	Sd	0	In	<1	1	
3	9	DR	*184.3*	*184.8*	*0.5*	18	Channel	Sd		Straight	6.7	Sd/Bd/Gr	250	Shoreward	<1	1	
3	9	DR	181.6	182.0	0.4	18	Outside	Sd		Outside	3.7-4.9	Sd	0	In	0	0	0
3	9	DR	204.5	205.0	0.5		TW	NS									
3	9	DR	*199.1*	*199.8*	*0.7*		Channel	NS									
3	9	DR	*191.3*	*192.4*	*1.1*		Channel	NS									
3	9	DR	186.1	187.4	1.3		Outside	NS									
3	10	DR	205.9	206.5	0.6		Straight	NS									
3	10	DR	207.0	207.6	0.6	22	Channel	Sd	B22-1	Straight	1.8-10.5	Cl/Sd/St/shell	<50	Shoreward	12	8	23
									B22-2	Straight	3.1-11.4	Cl/Sd/Gr	<50	Shoreward	8	8	

Italics dredge areas are only for 12ft option
Cb = cobble, Gr = gravel, Sd = sand, St = silt, Cl = clay
TW = tailwater

Table 3-16. Location, habitat characteristics, and CPUE[1] of unionid beds (B) and patches (P), Reaches 2 and 3, MKARNS, 2004.

Reach	2	3	3	3	3	3	3	3	3	3	3	3
Pool	5	7	7	7	7	7	7	7	7	7	10	10
Site	8	11	12	12	12	12	12	12	13	13	22	22
Habitat	P8-1	B11-1	P12-1	P12-2	P12-3	P12-4	P12-5	P12-6	P13-1	P31-2	B22-1	B22-2
Cove	-	-	-	-	-	-	-	-	-	-	-	-
Inside bend	-	-	-	-	-	-	-	-	-	-	-	-
Island	3.3	-	6.8	4.0	5.3	15.0	14.0	11.0	-	-	-	-
Midchannel	-	-	-	-	-	-	-	-	-	-	-	-
Outside bend	-	-	-	-	-	-	-	-	7.6	-	-	-
Oxbow	-	-	-	-	-	-	-	-	-	-	-	-
Peninsula	-	-	-	-	-	-	-	-	-	-	-	-
Straight reach	-	9.1	-	-	-	-	-	-	-	-	12.0	8.1
Tailwater	-	-	-	-	-	-	-	-	-	-	-	-
Tributary	-	-	-	-	-	-	-	-	-	31.0	-	-
Ave. CPUE	3.3	9.1	6.8	4.0	5.3	15.0	14.0	11.0	7.6	31.0	12.0	8.1
Modification	NM		NM	NM	NM	NM	NM	NM		NM		
Existing		DI							DI, DF			
Proposed											Dredge	Dredge
Depth (m)												
min	1.5	1.2	0.8	0.9	-	-	-	-	0.5	0.9	1.8	3.1
max	3.7	3.7	1.1	3.5	-	1.8	-	-	2.1	2.4	10.5	11.4
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	1	-
Cobble	-	-	-	-	-	-	-	-	-	-	1	-
Gravel	-	5	-	-	-	-	-	-	-	2	1	20
Sand	62	25	25	50	73	-	-	-	50	35	30	30
Silt	10	15	40	-	23	-	-	-	30	42	20	1
Clay	25	50	35	50	-	-	-	-	20	21	35	40
Detritus	3	3	-	-	4	-	-	-	-	-	2	0
Shell	-	2	-	-	-	-	-	-	-	-	10	9
zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-

[1] CPUE = unionids/5min.
DI = disposal; DF = dike field; NM = no modification

Table 3-17. Unionid species collected in Reach 3, MKARNS, 2004.

	Pool 7					Pool 8			Pool 9	Pool 10
Site	11	12	13	14	Total	15	16	Total	18	22
Amblema plicata	-	-	6	-	6	-	-	-	-	-
Anodonta suborbiculata	3	2	-	-	5	-	-	-	1	4
Lampsilis teres	-	5	2	-	7	-	-	-	-	-
Leptodea fragilis	19	3	FD	FD	22	-	2	2	FD	10
Megalonaias nervosa	8	5	13	-	26	-	-	-	-	5
Obliquaria reflexa	7	20	163	3	193	3	4	7	1	6
Plectomerus dombeyanus	-	2	5	-	7	-	-	-	-	231
Potamilus ohiensis	27	2	-	-	29	-	WD	WD	-	WD
Potamilus purpuratus	22	3	1	WD	26	1	WD	1	FD	WD
Pyganodon grandis	11	11	7	-	29	-	2	2	-	19
Quadrula aspera	5	6	4	-	15	-	1	1	-	12
Quadrula p. pustulosa	-	-	1	-	1	-	-	-	-	-
Quadrula quadrula	43	58	59	WD	160	5	5	10	-	78
Truncilla donaciformis	-	-	2	-	2	-	-	-	-	-
Truncilla truncata	-	-	1	-	1	-	-	-	-	-
Utterbackia imbecillis	-	7	1	-	8	-	-	-	-	-
Total	145	124	265	3	537	9	14	23	2	365
No. live species	9	12	13	1	16	3	5	6	2	8
Total no. species	16	16	16	16	16	16	16	16	16	16

FD = fresh dead; WD = weathered dead

Table 3-18. Species composition and CPUE within unionid beds and patches, Reaches 2 and 3, MKARNS, 2004.

Reach	2	3	3	3	3	3	3	3	3	3	3	3
Pool	5	7	7	7	7	7	7	7	7	7	10	10
Site	8	11	12	12	12	12	12	12	13	13	22	22
Species	P8-1	B11-1	P12-1	P12-2	P12-3	P12-4	P12-5	P12-6	P13-1	P13-2	B22-1	B22-2
Amblema plicata		-	-	-	-	-	-	-	0.2	0.8	-	-
Anodonta suborbiculata		0.2	-	-	-	-	-	2.0	-	-	0.1	0.1
Arcidens confragosus		-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena		-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava		-	-	-	-	-	-	-	-	-	-	-
Lampsilis cardium		-	-	-	-	-	-	-	-	-	-	-
Lampsilis siliquoidea		-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres		-	0.3	-	-	-	2.0	1.0	-	0.3	-	-
Lasmigona c. complanata		-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		1.2	0.4	-	-	-	-	-	-	-	0.2	0.5
Megalonaias nervosa		0.4	-	1.0	-	-	-	2.0	-	-	0.0	0.5
Obliquaria reflexa		0.4	1.1	0.3	1.3	-	4.0	2.0	5.4	20.8	0.2	0.1
Obovaria olivaria		-	-	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus		-	-	0.3	-	1.0	-	-	-	0.8	7.5	5.5
Potamilus ohiensis		1.8	0.3	-	-	-	-	-	-	-	-	-
Potamilus purpuratus		1.3	0.1	0.3	-	-	-	1.0	-	-	-	-
Pyganodon grandis	0.3	0.6	0.8	-	1.3	-	-	1.0	0.2	0.8	0.6	0.5
Quadrula aspera		0.3	0.6	-	-	-	-	-	-	0.3	0.4	0.3
Quadrula nodulata		-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	0.2	-	-
Quadrula quadrula	3.0	2.9	3.1	1.0	2.7	13.0	6.0	2.0	1.8	6.8	2.9	0.6
Strophitus undulatus		-	-	-	-	-	-	-	-	-	-	-
Toxolasma parvus		-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa		-	-	-	-	-	-	-	-	-	-	-
Truncilla donaciformis		-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata		-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis		-	0.1	1.0	-	1.0	2.0	-	-	-	-	-
No. of individuals	13	136	54	12	16	15	14	11	38	186	300	65
No. of 5min samples	4	15	8	3	3	1	1	1	5	6	25	8
Average CPUE	3.3	9.1	6.8	4.0	5.3	15.0	14.0	11.0	7.6	31.0	12.0	8.1
No. of species	2	9	9	6	3	3	4	7	4	8	8	8
% Juveniles	7.7	54.4	11.1	41.7	0.0	20.0	28.5	36.3	0.0	3.2	23.4	-
% of species w/ juveniles	50.0	77.8	22.2	50.0	0.0	66.7	50.0	57.1	0.0	37.5	37.5	-

Nomenclature follows Turgeon *et al. (*1998)
Bolded: not all individuals were aged

Table 3-19. Site 11 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	126.8	126.8	126.8	126.8	126.7	126.7	126.7	126.6	126.6	126.6	126.6	126.6	126.5	126.5	126.6
Bank	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Replicate	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Bed/Patch	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1	B11-1
Anodonta suborbiculata	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-
Leptodea fragilis	1	-	-	2	3	-	5	-	1	-	1	1	1	1	2
Megalonaias nervosa	-	-	-	3	1	-	1	-	-	1	-	-	-	-	-
Obliquaria reflexa	-	-	3	1	-	-	-	-	1	-	-	1	-	-	-
Potamilus ohiensis	-	-	-	-	3	2	9	5	2	1	4	-	-	-	1
Potamilus purpuratus	-	-	-	3	2	2	2	4	2	1	-	3	-	-	-
Pyganodon grandis	1	-	-	1	1	2	-	-	1	-	-	-	-	1	2
Quadrula aspera	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	4	2	2	6	7	3	-	-	-	4	5	5	1	1	3
Total	6	2	5	21	19	10	17	9	7	7	10	10	2	3	8
No. species live	3	1	2	8	8	5	4	2	5	4	3	4	2	3	4
No. species total	3	1	2	8	8	5	4	2	5	4	3	4	2	3	4
Appr. Density (no./m^2)	1	<1	<1	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)	1.4	1.5	1.3	3.7	3.4	1.5	2.3	2.1	2.7	2.1	1.5	1.2	3.1	1.5	-
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	25	40	-	-	-	-	-	-	-	-	-	-	-	5
Sand	-	70	50	-	-	-	-	-	60	50	50	40	10	5	26
Silt	-	5	10	45	45	20	20	15	20	10	10	20	-	-	17
Clay	-	-	-	45	45	70	70	80	20	40	40	40	90	95	49
Detritus	-	-	-	-	-	10	10	5	-	-	-	-	-	-	2
Shell	-	-	-	10	10	-	-	-	-	-	-	-	-	-	2
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	1%	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI = Disposal, DF = Dike Field, FD = Fresh Dead Shell, NM = Navigation Mile, TW = Tailwaters, WD = Weathered Dead Shell

Table 3-19. Site 11 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	126.5	126.6	126.5	126.6	126.6		
Bank	R	R	R	R	R		
Replicate	A	A	A	A	A	Total	
Bed/Patch						No.	%
Anodonta suborbiculata	-	-	-	-	-	3	2.1
Leptodea fragilis	-	-	1	-	-	19	13.1
Megalonaias nervosa	-	-	-	-	2	8	5.5
Obliquaria reflexa	-	-	-	1	-	7	4.8
Potamilus ohiensis	-	-	-	-	-	27	18.6
Potamilus purpuratus	-	-	-	2	1	22	15.2
Pyganodon grandis	-	2	-	-	-	11	7.6
Quadrula aspera	-	-	-	-	-	5	3.4
Quadrula quadrula	-	-	-	-	-	43	29.7
Total	-	2	1	3	3	145	
No. species live	-	1	1	2	2	9	
No. species total	-	1	1	2	2	9	
Appr. Density (no./m^2)	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	7.3	
Modification							
Existing	-	-	DI	DI	DI		
Proposed	-	-	-	-	-		
Habitat	Peninsula	Peninsula	Peninsula	Peninsula	Peninsula		
Depth (m)	0.9	1.5	3.1	1.2	-		
Substrate							
Bedrock	-	-	-	-	-		
Boulder	5	-	-	-	-		
Cobble	5	-	-	-	-		
Gravel	50	-	-	10	-		
Sand	40	50	100	65	-		
Silt	-	-	-	-	-		
Clay	-	50	-	25	-		
Detritus	-	-	-	-	-		
Shell	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-		

DI = Disposal, DF = Dike Field, FD = Fresh Dead Shell, NM = Navigation Mile, TW = Tailwaters, WD = Weathered Dead Shell

Table 3-20. Site 12 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	134.3	134.3	134.3	134.3	134.3	134.3	134.3	134.3	134.4	134.4	134.4	134.4	134.4	134.4
Bank	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Bed/Patch	P12-1	P12-1	P12-1	P12-1	P12-1	P12-1	P12-1	P12-1	P12-2	P12-2	P12-2	P12-3	P12-3	P12-3
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	1	-	-	WD	-	1	-	-	-	-	-	-	-
Leptodea fragilis	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	1	1	1	-	-	-
Obliquaria reflexa	1	4	1	1	-	-	-	2	-	1	-	2	2	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Potamilus ohiensis	1	-	-	-	-	1	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	WD	-	1	-	-	-	1	-	-	-
Pyganodon grandis	1	-	1	-	1	-	2	1	-	-	-	1	1	2
Quadrula aspera	1	1	-	-	-	1	1	1	-	-	-	-	-	-
Quadrula quadrula	2	3	1	3	2	3	5	6	-	2	1	7	1	-
Utterbackia imbecillis	-	1	-	-	-	-	-	-	3	-	-	-	-	-
Total	7	12	3	4	3	5	10	10	4	5	3	10	4	2
No. species live	6	6	3	2	2	3	5	4	2	4	3	3	3	1
No. species total	6	6	3	2	4	3	5	4	2	4	3	3	3	1
Appr. Density (no./m^2)	1	1	1	1	1	1	2	1	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island
Depth (m)	0.8	0.8	-	-	1.1	0.9	0.8	-	3.5	0.9	1.8	-	-	-
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	25	25	25	25	20	-	50	50	50	50	-	75	75	70
Silt	50	50	50	50	40	20	25	25	-	-	-	25	25	20
Clay	25	25	25	25	40	80	25	25	50	50	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-20. Site 12 unionid species and habitat characteristics (page 2 of 2).

Approx. NM Bank Bed/Patch	134.4 R P12-4	134.5 R P12-5	134.6 R P12-6	134.4 R	134.3 R	134.4 R	Total No.	%
Anodonta suborbiculata	-	-	2	-	-	-	2	1.6
Lampsilis teres	-	2	1	-	WD	-	5	4.0
Leptodea fragilis	-	-	-	-	-	-	3	2.4
Megalonaias nervosa	-	-	2	-	-	-	5	4.0
Obliquaria reflexa	-	4	2	-	-	-	20	16.1
Plectomerus dombeyanus	1	-	-	-	-	-	2	1.6
Potamilus ohiensis	-	-	-	-	-	-	2	1.6
Potamilus purpuratus	-	-	1	-	-	-	3	2.4
Pyganodon grandis	-	-	1	-	-	-	11	8.9
Quadrula aspera	-	-	-	-	1	-	6	4.8
Quadrula quadrula	13	6	2	-	1	-	58	46.8
Utterbackia imbecillis	1	2	-	-	-	-	7	5.6
Total	15	14	11	0	2	0	124	
No. species live	3	4	7	0	2	0	12	
No. species total	3	4	7	0	3	0	12	
Appr. Density (no./m^2)	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	6.2	
Modification								
Existing	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-		
Habitat	Island	Island	Island	Island	Island	Island		
Depth (m)	1.8	-	-	-	0.9	3.5		
Substrate								
Bedrock	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-		
Sand	-	-	-	90	50	-		
Silt	-	-	-	5	-	-		
Clay	-	-	-	5	50	-		
Detritus	-	-	-	-	-	-		
Shell	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, W D=Weathered Dead Shell, R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-21. Site 13 unionid species and habitat characteristics (page 1of 6).

Approx. NM	146.5	146.5	146.5	146.5	146.5	146.5	144.3	144.3	143.7	146.3	146.3	144.1	144.5
Bank	R	R	R	R	R	R	R	R	M	L	L	L	R
Bed/Patch	P13-2	P13-2	P13-2	P13-2	P13-2	P13-2							
Amblema plicata	1	-	1	1	1	1	-	-	-	-	-	-	-
Lampsilis teres	1	-	1	WD	WD	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	1
Obliquaria reflexa	34	49	16	17	7	2	-	-	-	-	1	-	-
Plectomerus dombeyanus	1	2	-	1	1	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	WD	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	1	-	2	2	-	-	-	-	-	-	-	-	-
Quadrula aspera	2	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	1	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	22	8	8	2	1	-	-	-	-	4	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	1
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	62	60	28	23	10	3	0	0	0	4	1	0	2
No. species live	7	4	5	5	4	2	0	0	0	1	1	0	2
No. species total	7	4	5	6	5	2	0	0	0	1	1	0	2
Appr. Density (no./m^2)	2	2	2	2	1	1	-	-	-	-	-	-	-
Mean No./5min (CPUE)													-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Channel	Channel	Channel	Inside	Inside	Inside	Outside
Depth (m)	0.9	1.8	2.4	1.2	0.9	0.9	4.6	4.6	4.6	1.4	3.1	3.1	4.0
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	10	-	-	-	-	-	30	15		20	-	20	5
Sand	50	50	10	10	20	70	60	80	100	60	95	50	90
Silt	10	50	70	50	40	30	10	5	-	10	5	10	5
Clay	30	-	20	40	40	-	-	-	-	10	-	20	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	1%	-	-	-	-	-	-	-	-	0.5%	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-21. Site 13 unionid species and habitat characteristics (page 2 of 6).

Approx. NM	144.5	144.1	144.1	143.7	139.9	146.5	146.4	146.4	146.5	146.5	142.5	141.9	140.0
Bank	R	R	R	R	R	R	R	R	R	R	M	M	R
Bed/Patch						P13-1	P13-1	P13-1	P13-1	P13-1	DI-3	DI-3	DI-4
Amblema plicata	-	-	-	-	-	-	-	-	1	-	-	-	-
Lampsilis teres	-	WD	-	-	-	-	WD	WD	-	-	-	-	-
Leptodea fragilis	-	-	-	-	WD	WD	-	-	-	-	-	FD	-
Megalonaias nervosa	6	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	3	2	5	4	13	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	WD	-	-	WD	-	-	-	-
Pyganodon grandis	1	-	-	-	-	-	-	-	1	-	-	-	-
Quadrula aspera	-	1	1	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	1	-	-	-	5	1	1	2	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	1	-	-	-	-	-	-	-	-	-	-
Total	7	1	3	0	0	3	7	6	7	15	0	0	0
No. species live	2	1	3	0	0	1	2	2	4	2	0	0	0
No. species total	2	2	3	0	1	3	3	3	5	2	0	1	0
Appr. Density (no./m^2)	-	-	-	-	-	<1	<1	<1	<1	<1	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-			
Modification													
Existing	-	-	-	-	-	DI,DF	DI,DF	DI,DF	DI,DF	DI,DF	DI	DI	DI
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Channel	Channel	Inside
Depth (m)	4.3	1.8	3.0	4.6	8.2	1.5	2.1	0.8	0.8	0.5	3.1	3.7	0.6
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	25	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	20	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	5	-	20	-	25	-	-	-	-	-	-	-	-
Sand	25	-	10	100	75	35	20	80	90	10	-	100	80
Silt	25	40	30	-	-	35	30	10	5	80	100	-	20
Clay	-	10	7	-	-	30	50	10	5	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	0.50%	-	-	-	-	-	-	-	0.50%	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-21. Site 13 unionid species and habitat characteristics (page 3 of 6).

Approx. NM		140.0	147.1	147.5	146.4	142.5	142.5	422.2	142.0	145.5	145.3	145.2	144.9	144.1
Bank		R	R	R	R	R	R	M	R	R	R	R	R	M
Bed/Patch		DI-4	DI-1	DI-1	DI-2	DI-3	DI-3	DI-3	DI-3	DR-9	DR-9	DR-9	DR-9	DR-7
Amblema plicata		-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres		-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	FD	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa		-	-	-	-	-	-	-	-	-	-	1	-	-
Obliquaria reflexa		-	-	-	-	1	-	-	-	3	-	-	-	-
Plectomerus dombeyanus		-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus		-	WD	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula		-	-	-	-	-	-	-	-	2	-	-	-	-
Truncilla donaciformis		-	-	-	-	-	-	-	-	1	-	-	-	-
Truncilla truncata		-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis		-	-	-	-	-	-	-	-	-	-	-	-	-
Total		0	0	0	0	1	0	0	0	6	0	1	0	0
No. species live		0	0	0	0	1	0	0	0	3	0	1	0	0
No. species total		0	2	0	0	1	0	0	0	3	0	1	0	0
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)										-	-	-	-	-
Modification														
	Existing	DI	DI,DF	DI,DF	DI,DF	DI	DI	DI	DI	-	-	-	-	-
	Proposed	-	-	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Inside	Outside	Outside	Outside	Straight	Straight	Straight	Straight	Channel	Channel	Channel	Channel	Channel
Depth (m)		1.8	4.6	6.7	3.4	2.4	2.1	5.8	3.1	4.3	3.7	4.3	4.0	4.0
Substrate														
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	50	80	-	-	-	-	-
	Cobble	-	20	5		-	-	25	10	-	-	-	20	-
	Gravel	0.5	35	40	70	10	-	-	10	-	-	-	-	-
	Sand	99.5	2.5	50	30	90	100	25		10	100	35	80	97
	Silt	-	2.5	5	-	-	-	-	-	30	-	60	-	3
	Clay	-	-	-	-	-	-	-	-	30	-	5	-	-
	Detritus	-	-	-	-	-	-	-	-	30	-	-	-	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate		-	-	-	1%	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-21. Site 13 unionid species and habitat characteristics (page 4 of 6).

Approx. NM		143.9	143.9	143.5	143.3	143.0	143.0	142.8	142.8	142.5	142.5	142.1	142.1	141.0
Bank		M	M	M	M	L	L	M	M	M	M	L	L	M
Bed/Patch		DR-7	DR-7	DR-6	DR-6	DR-5	DR-5	DR-5	DR-5	DR-5	DR-5	DR-3	DR-3	DR-2
Amblema plicata		-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres		-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	FD	-	-	FD	-
Megalonaias nervosa		-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa		-	-	-	-	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus		-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus		-	-	-	-	-	-	-	-	-	-	-	WD	-
Pyganodon grandis		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula		-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla donaciformis		-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata		-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis		-	-	-	-	-	-	-	-	-	-	-	-	-
Total		0	0	0	0	0	0	0	0	0	0	0	0	0
No. species live		0	0	0	0	0	0	0	0	0	0	0	0	0
No. species total		0	0	0	0	0	0	0	0	1	0	0	2	0
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
	Existing	-	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel
Depth (m)		4.0	4.0	-	-	-	-	3.7	3.1	4.3	3.7	4.9	5.2	3.4
Substrate														
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gravel	-	-	-	-	-	-	-	-	-	-	-	30	-
	Sand	100	100	80	100	100	100	99.5	99	100	100	100	-	100
	Silt	-	-	-	-	-	-	-	-	-	-	-	20	-
	Clay	-	-	20	-	-	-	-	-	-	-	-	-	-
	Detritus	-	-	-	-	-	-	-	1	-	-	-	-	-
	Shell	-	-	-	-	-	-	0.5	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate		1%	-	-	-	-	-	-	-	-	-	0.50%	0.50%	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-21. Site 13 unionid species and habitat characteristics (page 5 of 6).

Approx. NM	141.0	140.9	140.8	143.0	145.6	145.6	145.6	145.6	145.6	145.5	145.2	145.0	145.0
Bank	M	M	L	L	R	R	R	R	R	R	R	R	R
Bed/Patch	DR-2	DR-2	DR-2	DR-5	DR-10	DR-10	DR-10	DR-10	DR-10	DR-10	DR-9	DR-9	DR-9
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	WD	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	1	-	-	-	-	-	-	-	1
Obliquaria reflexa	-	-	-	-	-	-	-	-	6	-	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	WD	1	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	2	-	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	1	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	9	0	0	0	1
No. species live	0	0	0	0	0	0	0	0	3	0	0	0	1
No. species total	0	0	0	2	2	0	0	0	3	0	0	0	1
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Channel	Channel	Channel	Straight	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside
Depth (m)	4.3	4.3	4.0	4.0	2.1	3.7	3.7	3.7	1.8		3.4	2.1	4.9
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	90	-
Cobble	-	-	-	-	30	-	-	-	-	-	-	10	10
Gravel	10	5	-	80	15	45	5	5	-	-	5	-	-
Sand	90	95	100	15	25	45	95	95	60	-	95	-	60
Silt	-	-	-	-	10	10	-	-	10	-	-	-	-
Clay	-	-	-	-	35	-	-	-	30	-	-	-	30
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	5	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-21. Site 13 unionid species and habitat characteristics (page 6 of 6).

Approx. NM Bank Bed/Patch		144.6 R DR-8	144.6 R DR-8	144.6 R DR-8	Total No.	%
Amblema plicata		-	-	-	6	2.3
Lampsilis teres		-	-	-	2	0.8
Leptodea fragilis		-	-	-	FD	
Megalonaias nervosa		3	-	-	13	4.9
Obliquaria reflexa		-	-	-	163	61.5
Plectomerus dombeyanus		-	-	-	5	1.9
Potamilus purpuratus		-	-	-	1	0.4
Pyganodon grandis		-	-	-	7	2.6
Quadrula aspera		-	-	-	4	1.5
Quadrula p. pustulosa		-	-	-	1	0.4
Quadrula quadrula		-	-	-	59	22.3
Truncilla donaciformis		-	-	-	2	0.8
Truncilla truncata		-	-	-	1	0.4
Utterbackia imbecillis		-	-	-	1	0.4
Total		3	0	0	265	
No. species live		1	0	0	13	
No. species total		1	0	0	14	
Appr. Density (no./m^2)		-	-	-		
Mean No./5min (CPUE)		-	-	-	3.9	
Modification						
	Existing	-	-	-		
	Proposed	Dredge	Dredge	Dredge		
Habitat		Outside	Outside	Outside		
Depth (m)		4.6	4.6	4.6		
Substrate						
	Bedrock	-	-	-		
	Boulder	25	-	-		
	Cobble	20	-	-		
	Gravel	5	5	-		
	Sand	25	90	100		
	Silt	25	5	-		
	Clay	-	-	-		
	Detritus	-	-	-		
	Shell	-	-	-		
Zebras/unionid		5	-	-		
Zeb coverage of substrate		-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge,
NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
M=Midchannel, L=Left desc. bank. B=Bed, P=PatchR=Right desc. bank,

Table 3-22. Site 14 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	155.2	154.6	155.1	155.0	154.6	153.9	152.5	155.2	155.2	155.0	155.0	154.6	154.5
Bank	L	L	L	L	L	L	L	R	R	M	R	R	R
Bed/Patch							DI-1	DI-2	DI-2	DI-2	DI-2	DI-2	DI-2
Leptodea fragilis	-	-	-	-	-	FD	WD	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	WD	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	WD	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species live	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species total	0	0	0	0	0	1	3	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	DI	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Channel	Channel	Outside	Outside	Outside	Outside	Outside	Inside	Inside	Inside	Inside	Inside	Inside
Depth (m)	-	-	-	-	-	3.7	6.1						-
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	10	-	-	-	-	-	-
Gravel	5	-	90	40	-	100	80	10	-	-	-	-	-
Sand	95	100	10	60	100	-	10	90	100	100	100	100	100
Silt	-	-	-	-	-	-	-	-	-	-	-	-	-
Clay	-	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	1	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-22. Site 14 unionid species and habitat characteristics (page 2 of 2).

Approx. NM		152.5	153.0	153.2	153.2	153.8	153.8	153.8	153.8		
Bank		M	M	M	M	R	R	R	R	Total	
Bed/Patch		DI-2	DI-2	DI-2	DI-2	DI-2	DI-2	DI-2	DI-2	No.	%
Leptodea fragilis		-	-	-	WD	-	-	FD	-	FD	
Obliquaria reflexa		-	-	-	-	-	3	-	-	3	100
Potamilus purpuratus		-	-	-	-	-	WD	WD	-	WD	
Quadrula quadrula		-	-	-	WD	-	-	-	-	WD	
Total		0	0	0	0	0	3	0	0	3	
No. species live		0	0	0	0	0	1	0	0	1	
No. species total		0	0	0	2	0	2	2	0	4	
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	0.1	
Modification											
	Existing	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF		
	Proposed	-	-	-	-	-	-	-	-		
Habitat		Inside	Inside	Inside	Inside	Inside	Inside	Inside	Inside		
Depth (m)		6.1	2.7	2.4	-	2.1	2.1	2.4	3.7		
Substrate											
	Bedrock	-	-	-	-	-	-	-	-		
	Boulder	-	-	-	-	-	-	-	-		
	Cobble	-	-	-	-	-	20	25	-		
	Gravel	80	-	-	-	50	10	25	10		
	Sand	10	100	90	-	50	70	50	90		
	Silt	10	-	-	-	-	-	-	-		
	Clay	-	-	-	-	-	-	-	-		
	Detritus	-	-	-	-	-	-	-	-		
	Shell	-	-	10	-	-	-	-	-		
Zebras/unionid		-	-	-	-	-	-	-	-		
Zeb coverage of substr		-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-23. Site 15 unionid species and habitat characteristics.

Approx. NM	164.2	164.2	164.5	164.9	165.2	164.8	165.2	164.0	164.0	164.1	164.4	164.6	164.6		
Bank	M	M	M	M	M	R	R	L	L	L	L	M	L	Total	
Bed/Patch	DR-1	DR-1	DR-1	DR-2	DR-2		DI-1	DI-2	DI-2	DI-2	DI-2	DI-2	DI-2	No.	%
Obliquaria reflexa	-	-	-	-	-	1	1	1	-	-	-	-	-	3	33.3
Potamilus purpuratus	-	-	-	-	-	-	-	1	-	-	-	-	-	1	11.1
Quadrula quadrula	-	-	-	-	-	1	1	2	-	1	-	-	-	5	55.6
Total	0	0	0	0	0	2	2	4	0	1	0	0	0	9	
No. species live	0	0	0	0	0	2	2	3	0	1	0	0	0	3	
No. species total	0	0	0	0	0	2	2	3	0	1	0	0	0	3	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	
Modification															
Existing	-	-	-	-	-	-	DI	DI	DI	DI	DI	DI	DI		
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	-	-	-	-	-	-	-	-		
Habitat	Channel	Channel	Channel	Channel	Channel	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight		
Depth (m)	3.7	2.7	3.4	3.8	3.7	4.6	6.1	2.4	2.7	-	4.3	2.7	-		
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-		
Gravel	-	-	5	-	-	10	25	-	-	-	-	-	-		
Sand	100	100	95	100	100	50	65	40	100	80	100	100	100		
Silt	-	-	-	-	-	15	10	20	-	-	-	-	-		
Clay	-	-	-	-	-	25	-	40	-	20	-	-	-		
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	20	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	1%	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-24. Site 16 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	175.6	175.2	175.2	175.2	175.1	175.0	175.0	174.4	174.4	174.3	174.3	174.8	174.1
Bank	M	M	M	M	M	M	M	M	M	M	M	M	M
Bed/Patch	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-1	DR-1	DR-1	DR-1		
Leptodea fragilis	-	-	-	1	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	1	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	2	0	0	0	0	0	0	0	0	0
No. species live	0	0	0	2	0	0	0	0	0	0	0	0	0
No. species total	0	0	0	2	0	0	0	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	Dredge	Dredge	Dredge	Dredge	Dredge	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-
Habitat	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel
Depth (m)	3.7	4.6	4.0	2.4	3.1	0.9	3.7	4.6	2.4	3.1	3.7	3.1	4.6
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	10	-	-	-	-	-	-	-	-	-	5	-	-
Gravel	50	30	50	50	30	30	-	-	-	-	15	-	-
Sand	30	70	50	50	70	70	100	100	100	100	80	100	100
Silt	10	-	-	-	-	-	-	-	-	-	-	-	-
Clay	-	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	1%	1%	-	-	0.50%	-	0.50%	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-24. Site 16 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	174.8	175.2	174.8	174.5	174.4	174.2	174.1		
Bank	L	R	M	L	L	L	L	Total	
Bed/Patch		DI-1	DI-1					No.	%
Leptodea fragilis	-	-	-	-	-	-	1	2	14.3
Obliquaria reflexa	3	-	-	-	-	-	WD	4	28.6
Potamilus ohiensis	-	-	-	-	-	-	WD	WD	-
Potamilus purpuratus	-	-	-	-	-	-	WD	WD	-
Pyganodon grandis	1	-	-	-	-	-	1	2	14.3
Quadrula aspera	1	-	-	-	-	-	-	1	7.1
Quadrula quadrula	4	-	-	-	1	-	WD	5	35.7
Total	9	0	0	0	1	0	2	14	
No. species live	4	0	0	0	1	0	2	5	
No. species total	4	0	0	0	1	0	6	7	
Appr. Density (no./m^2)	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	0.7	
Modification									
Existing	-	DI, DF	DI, DF	DI, DF	DF	DF	DF		
Proposed	-	-	-	-	-	-	-		
Habitat	Tributary	Inside	Inside	Inside	Outside	Outside	Outside		
Depth (m)	1.5	2.4	5.8	2.1	3.7	6.1	0.8		
Substrate									
Bedrock	-	-	-	-	-	-	-		
Boulder	-	-	-	-	30	-	-		
Cobble	10	-	-	-	30	25	-		
Gravel	-	10	25		30	25	60		
Sand	15	45	70	95	5	25	15		
Silt	15	45	-	-	5	25	10		
Clay	50	-	-	-	-	-	15		
Detritus	-	-	-	-	-	-	-		
Shell	10	-	5	5	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	10%	-	0.50%		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-25. Site 18 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	185.4	185.3	182.0	182.0	181.8	181.8	184.9	184.6	184.3	183.4	183.4	182.8
Bank	M	M	L	L	L	L	L	L	L	L	L	L
Bed/Patch	DR-3	DR-3	DR-1	DR-1	DR-1	DR-1						
Anodonta suborbiculata	-	-	-	-	-	-	-	1	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	FD	FD	FD	-	-	-
Obliquaria reflexa	1	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	FD	-	-	-	-	-
Total	1	0	0	0	0	0	0	1	0	0	0	0
No. species live	1	0	0	0	0	0	0	1	0	0	0	0
No. species total	1	0	0	0	0	0	2	2	1	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-	-	-	-	-
Habitat	Channel	Channel	Outside	Outside	Outside	Outside	Straight	Straight	Straight	Outside	Outside	Outside
Depth (m)	1.8	3.4	4.6	4.0	4.9	3.7	4.3	6.7	6.7	5.2	4.9	5.2
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	50	25	-	-
Cobble	-	-	-	-	-	-	-	-	-	25	-	-
Gravel	-	-	5	-	2	-	50	-	50	25	-	-
Sand	100	100	95	100	98	100	50	100	-	25	100	100
Silt	-	-	-	-	-	-	-	-	-	-	-	-
Clay	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-
Zebra coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-25. Site 18 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	182.8	182.5	182.5	182.5	182.2	182.2	182.2		
Bank	L	L	L	L	L	L	L	Total	
Bed/Patch								No.	%
Anodonta suborbiculata	-	-	-	-	-	-	-	1	50
Leptodea fragilis	-	WD	-	-	-	-	-	FD	
Obliquaria reflexa	-	-	-	-	-	-	-	1	50
Potamilus purpuratus	-	-	-	-	-	-	-	FD	
Total	0	0	0	0	0	0	0	2	
No. species live	0	0	0	0	0	0	0	2	
No. species total	0	1	0	0	0	0	0	4	
Appr. Density (no./m^2)	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	0.1	
Modification									
Existing	-	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-	-		
Habitat	Outside	Outside	Outside	Outside	Outside	Outside	Outside		
Depth (m)	5.5	5.2	5.2	3.4	4.3	5.2	4.6		
Substrate									
Bedrock	-	-	-	-	-	-	-		
Boulder	-	-	-	-	25	-	-		
Cobble	-	-	10	25	25	-	-		
Gravel	-	-	50	25	25	-	-		
Sand	100	100	40	25	25	90	100		
Silt	-	-	-	-	-	-	-		
Clay	-	-	-	25	-	-	-		
Detritus	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	10	-		
Zebras/unionid	-	-	-	-	-	-	-		
Zebra coverage of substrate	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-26. Site 22 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	207.3	207.5	207.5	207.5	207.5	207.6	207.6	207.6	207.6	207.6	207.6	207.6
Bank	M	R	R	R	R	L	R	R	R	R	R	R
Bed/Patch		B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1
Anodonta suborbiculata	-	-	1	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	1	-	-	-	-	4	-	-	-	-	1
Megalonaias nervosa	-	-	-	-	-	-	-	1	-	-	-	-
Obliquaria reflexa	-	1	-	-	-	-	-	2	-	-	-	1
Plectomerus dombeyanus	-	13	4	15	4	1	5	11	5	11	11	3
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	WD	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	1	-	-	-	-	-	-	-	-	-	1
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	1	-	-	1	1	4	8	9	9	9	3
Total	0	17	5	15	5	2	13	22	14	20	20	9
No. species live	0	5	2	1	2	2	3	4	2	2	2	5
No. species total	0	5	3	1	2	2	3	4	2	2	2	5
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	-	-	-	-	-	-	-	-	-	-	-
Habitat	Channel	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)	11.6	1.8	2.1	5.5	6.1	6.4	6.4	7.0	7.0	7.0	7.0	10.5
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	15	-	-	-	-	-	-	-	-	-	-
Cobble	-	15	-	-	-	-	-	-	-	-	-	-
Gravel	-	10	-	-	-	-	-	-	-	-	-	-
Sand	95	30	45	45	45	70	60	70	70	70	90	95
Silt	5	30	-	-	-	-	-	5	5	5	-	-
Clay	-	-	45	45	45	20	20	20	20	20	5	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	10	10	10	10	20	5	5	5	5	5
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-26. Site 22 unionid species and habitat characteristics (page 2 of 3).

Approx. NM	207.4	207.4	207.4	207.4	207.4	207.4	207.4	207.3	206.9	206.8	206.8	206.8
Bank	R	R	R	R	R	M	M	M	R	R	R	R
Bed/Patch	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	B22-1	
Anodonta suborbiculata	1	-	-	-	1	-	-	-	-	-	-	-
Leptodea fragilis	WD	-	FD	-	-	WD	WD	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	1	-
Plectomerus dombeyanus	15	21	12	9	5	5	9	4	5	7	3	-
Potamilus ohiensis	-	-	-	WD	-	-	-	-	-	WD	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	3	5	-	-	-	-	1	-	-	-	2	-
Quadrula aspera	-	-	-	-	-	-	-	4	3	1	-	-
Quadrula quadrula	1	-	2	1	-	1	1	2	3	3	1	-
Total	20	26	14	10	6	6	11	10	11	11	7	0
No. species live	4	2	2	2	2	2	3	3	3	3	4	0
No. species total	5	2	3	3	2	3	4	3	3	4	4	0
Appr. Density (no./m^2)	1	1	1	-	-	-	1	<1	<1	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)	3.0	1.5	1.5	1.5	4.9	6.7	3.0	6.1	6.4	7.6	1.2	0.6
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-
Sand	-	-	10	-	-	-	-	-	-	-	-	100
Silt	80	10	20	40	90	20	80	-	-	-	-	-
Clay	-	80	60	50	-	60	-	90	80	80	90	-
Detritus	20	10	-	10	-	-	-	-	-	-	-	-
Shell	-	-	10	-	10	20	20	10	20	20	10	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	30%	30%	5%	-	100%	-	100%	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-26. Site 22 unionid species and habitat characteristics (page 3 of 3).

Approx. NM Bank Bed/Patch	206.8 R B22-1	206.9 R B22-1	207.6 L B22-2	207.6 L B22-2	207.6 L B22-2	207.6 L B22-2	207.6 L	206.9 L B22-2	206.9 L B22-2	206.9 L B22-2	Total No.	%
Anodonta suborbiculata	-	-	-	-	-	-	-	-	1	-	4	1.1
Leptodea fragilis	WD	-	-	1	1	1	-	-	-	1	10	2.7
Megalonaias nervosa	-	-	1	1	-	2	-	-	-	-	5	1.4
Obliquaria reflexa	-	-	-	1	-	-	-	-	-	-	6	1.6
Plectomerus dombeyanus	9	-	8	4	8	3	-	11	9	1	231	63.3
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	WD	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	WD	-
Pyganodon grandis	1	1	-	-	3	1	-	-	-	-	19	5.2
Quadrula aspera	1	1	-	-	-	-	-	2	-	-	12	3.3
Quadrula quadrula	2	11	-	-	2	-	-	-	2	1	78	21.4
Total	13	13	9	7	14	7	0	13	12	3	365	
No. species live	4	3	2	4	4	4	0	2	3	3	8	
No. species total	5	3	2	4	4	4	0	2	3	3	10	
Appr. Density (no./m^2)	2	2	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	10.7	
Modification												
Existing												
Proposed												
Habitat	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight		
Depth (m)	6.1	7.6	3.1	6.4	8.2	9.3	11.4	4.6	-	-		
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	80	80	-		
Sand	-	-	45	40	20	20	-	10	10	50		
Silt	60	80	10	-	-	-	-	-	-	-		
Clay	30	-	45	60	80	80	-	10	10	-		
Detritus	-	-	-	-	-	-	-	-	-	-		
Shell	10	20	-	-	-	-	-	-	-	50		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-27. Unionid species previously collected within Reach 4, Lake Dardanelle[1].

Species	D220 220.0 outside	D220.5 220.5 inside	D221 221.0 island	D221 221.0 outside	D223 222.8-223.5 island	Site 23 D226 226-226.7 island	D233 233.0 cove	D243.9 243.9 oxbow	D244 244.0 island	D251 250.9-251.5 midchannel	Dardanelle 220-251.0 Total
Amblema plicata											
Anodonta suborbiculata	-	-	-	-	-	-	2	-	1	-	3
Arcidens confragosus	-	-	-	-	1	-	-	-	-	-	1
Ellipsaria lineolata	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-	-	-	-	-
Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-
Lampsilis satura	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-
Lasmigona complanata	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	1	1
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	1	5	6	8	1	-	-	-	1	22
Plectomerus dombeyanus	1	21	19	3	13	1	-	-	-	-	58
Pleurobema rubrum	-	-	-	-	-	-	-	-	-	-	-
Pleurobema sintoxia	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	1	-	-	-	-	-	1
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-
Ptychobranchus occidentalis	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	2	1	3	-	-	-	6
Quadrula apiculata	-	-	-	-	-	-	-	-	-	-	-
Quadrula metanevra	-	-	-	-	-	-	-	-	-	-	-
Quadrula pustulosa	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	1	-	8	15	21	4	19	1	-	5	74
Toxolasma lividus	-	-	-	-	-	-	-	-	-	-	-
Tritigonia verrucosa	-	-	-	-	-	-	-	-	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	-	-
Total	2	22	32	24	46	7	24	1	1	7	166
No. species	2	2	3	3	6	4	3	1	1	3	8
Points sampled[2]	2	2	5	6	12	6	8	1	1	3	46
Unionids per point	1.0	11.0	6.4	4.0	3.8	1.2	3.0	1.0	1.0	2.3	3.6

[1]Davidson (1997)
[2]Only points with unionids counted
DI = Disposal, DF = Dike Field, FD = Fresh Dead Shell, NM = Navigation Mile, TW = Tailwaters, WD = Weathered Dead Shell

Table 3-28. Unionid species previously collected within Reach 4, Ozark Lake[1].

Species	D258 257.4-258 outside	D266.5B 266.5 midchannel	D267.2 267.2 island	Site 26 D272 272 tributary	Site 26 D273 273 tributary	D278 277-278.9 cove	D289.7 289.7 midchannel	Pool 12 Ozark Total		Reach 4 Total No.	%
Amblema plicata	-	-	-	-	-	1	-	1	-	1	0.3
Anodonta suborbiculata	-	-	-	-	5	-	-	5	-	8	2.7
Arcidens confragosus	2	-	-	-	-	3	-	5	-	6	2.0
Ellipsaria lineolata	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-	-	-	-	-
Lampsilis ovata	-	-	-	-	-	-	-	-	-	-	-
Lampsilis satura	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-
Lasmigona complanata	1	-	-	-	-	-	-	1	-	1	0.3
Leptodea fragilis	-	-	-	-	-	-	1	1	-	2	0.7
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	8	-	2	-	-	11	-	21	-	43	14.3
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	58	19.3
Pleurobema rubrum	-	-	-	-	-	-	-	-	-	-	-
Pleurobema sintoxia	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	2	-	1	1	2	-	-	6	-	7	2.3
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-
Ptychobranchus occidentalis	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	1	-	-	5	-	32	-	38	-	44	14.7
Quadrula apiculata	-	-	-	-	-	-	-	-	-	-	-
Quadrula metanevra	-	-	-	-	-	-	-	-	-	-	-
Quadrula pustulosa	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	20	4	3	-	3	24	-	54	-	128	42.7
Toxolasma lividus	-	-	-	-	-	2	-	2	-	2	0.7
Tritigonia verrucosa	-	-	-	-	-	-	-	-	-	-	-
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis											
Total	34	4	6	6	10	73	1	134		300	
No. species	6	1	3	2	3	6	1	10		11	
Points sampled[2]	5	1	2	2	3	9	1	23		69	
Unionids per point	6.8	4.0	3.0	3.0	3.3	8.1	1.0	5.8		4.3	

[1]Davidson (1997)
[2]Only points with unionids counted
DI = Disposal, DF = Dike Field, FD = Fresh Dead Shell, NM = Navigation Mile, TW = Tailwaters, WD = Weathered Dead Shell

Table 3-29. Species composition and CPUE within unionid beds and patches, Reaches 4 and 6.

Reach	4	4	4	4	6	6	6
Pool	10	10	12	12	18	18	18
Site	23	23	26	26	49	49	50
Species	B23-1	B23-2	P26-1	P26-2	P49-1	P49-2	P50-1
Amblema plicata	-	0.1	-	-	-	-	-
Anodonta suborbiculata	-	-	-	-	-	-	-
Arcidens confragosus	0.1	0.3	0.3	-	-	-	-
Fusconaia ebena	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-
Lampsilis cardium	-	-	-	-	-	-	-
Lampsilis siliquoidea	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-
Lasmigona c. complanata	-	-	-	-	-	-	-
Leptodea fragilis	0.1	-	0.3	-	-	0.25	1.00
Megalonaias nervosa	0.1	-	-	-	-	-	-
Obliquaria reflexa	2.7	0.9	1.3	3.3	6.00	3.50	3.00
Obovaria olivaria	-	-	-	-	-	-	-
Plectomerus dombeyanus	6.0	4.6	-	0.3	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	0.20
Potamilus purpuratus	-	-	-	-	-	-	0.40
Pyganodon grandis	0.5	0.6	1.0	-	-	-	-
Quadrula aspera	0.9	0.3	-	-	-	-	-
Quadrula nodulata	-	-	-	-	-	0.50	0.20
Quadrula p. pustulosa	-	-	-	-	2.00	-	0.60
Quadrula quadrula	3.8	3.0	2.7	3.7	-	0.50	-
Strophitus undulatus	-	-	-	-	-	-	-
Toxolasma parvus	-	-	-	-	-	-	-
Tritogonia verrucosa	-	-	-	-	0.33	0.25	0.80
Truncilla donaciformis	0.1	0.3	-	-	-	-	-
Truncilla truncata	0.1	-	-	-	-	-	-
Utterbackia imbecillis	0.2	-	-	-	-	-	-
No. of individuals	174	70	17	22	25	20	31
No. of 5min samples	12	7	3	3	3	4	5
Average CPUE	14.5	10.0	5.7	7.3	8.3	5.0	6.2
No of species	11	8	5	3	3	5	7
% Juveniles	11.5	11.4	11.8	4.5	0.0	15.0	6.5
% of species w/ juveniles	54.5	37.5	40.0	33.3	0.0	40.0	28.6

Nomenclature follows Turgeon *et al.* (1998) except *Q. aspera* (T. Watters, OSU, pers. comm., 2004

Table 3-30. MKARNS proposed dredge areas with respect to unionid sample sites in Reach 4, 2004.

		Proposed dredge areas						Unionids near proposed dredge areas								
Reach	Pool	Dn NM	Up NM	Dist.	Site	Habitat	Substrate	B/P	Habitat	Depth	Substrate	Dist from dredge (m)	Direction	CPUE	Species	% Juv.
4	10	221.5	221.9	0.4	NS	Channel										
4	10	225.2	225.4	0.2	23	Channel	Sd	B12	Straight	1.5-10.0	Cl/St	NA	Shoreward	10	8	11.4
4	10	226.7	226.9	0.2	23	Channel	Sd	B12	Straight	1.5-10.0	Cl/St	250	Shoreward	10	8	11.4
4	10	228.5	228.8	0.3	23	Channel	Sd	B11	Outside	2.0-7.3	Cl/St/Sd/Dt	300	Shoreward	14.5	11	11.5
4	10	229.5	230.1	0.6	23	Straight	Sd	B11	Outside	2.0-7.3	Cl/St/Sd/Dt	500	Shoreward	14.5	11	11.5
4	10	232.8	233.4	0.6	NS	Channel										
4	10	233.5	233.9	0.4	NS	Channel										
4	10	235.9	236.4	0.5	NS	Channel										
4	10	237.3	239.1	1.8	NS	Straight										
4	10	240.6	240.9	0.3	NS	Channel										
4	10	241	241.1	0.1	NS	Channel										
4	10	241.6	242.1	0.5	NS	Outside										
4	10	249.5	249.9	0.4	NS	Channel										
4	10	253.7	253.9	0.2	NS	Channel										
4	10	256.2	256.2	0	NS	TW										
4	12	271.4	271.9	0.5	26	Straight	Cl/Sd/St/Dt	P19	Trib	1.8-3.1	Cl/St	NM		5.7	5	11.8
4	12	272	273	1	26	Straight	Cl/Sd/Cb/Gr/St	P20	Straight	6.1	Cl/St	2500	Dnstream	7.3	3	4.5
4	12	274.9	275.3	0.4	NS	Inside										
4	12	275.4	276	0.6	NS	Inside										
4	12	276.5	276.7	0.2	NS	Channel										
4	12	276.9	277.3	0.4	NS	Channel										
4	12	277.5	278.4	0.9	NS	Channel										
4	12	278.7	278.8	0.1	NS	Channel										
4	12	279.2	281	1.8	NS	Channel										
4	12	281.9	282.9	1	27	Channel	Sd/Gr/St									
4	12	283.6	284.5	0.9	27	Channel	Sd									
4	12	285.2	285.4	0.2	NS	Channel										
4	12	289	289.4	0.4	NS	Channel										
4	12	291.8	292.4	0.6	28	TW	Gr/Sd/Br/Cb/St									
Reach 4				15.5												

DI = Disposal, DF = Dike Field, FD = Fresh Dead Shell, NM = Navigation Mile, TW = Tailwaters, WD = Weathered Dead Shell

Table 3-31. Site 23 unionid species and habitat characteristics (page 1 of 4).

Approx. NM	230.2	230.2	230.2	230.2	230.2	230.2	230.2	230.2	229.1	229.1	229	229	227.1	227.1	227.1
Bank	L	L	L	L	L	L	L	L	L	L	M	L	L	L	L
Bed/Patch	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-1	B23-2	B23-2	B23-2
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	FD	1	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	1	-	1	3	4	6	2	3	5	7	1	2	-
Plectomerus dombeyanus	-	3	2	4	3	7	1	7	12	4	16	13	7	6	2
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	1	-	1	-	4	-	-	-	-	-	-	1	1
Quadrula aspera	2	1	1	-	3	3	-	-	-	-	1	-	-	-	-
Quadrula quadrula	3	4	7	6	4	3	4	7	3	1	2	2	4	-	1
Truncilla donaciformis	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-
Truncilla truncata	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Total	5	8	13	11	13	17	16	20	17	8	24	22	12	11	4
No. species live	2	3	6	3	6	5	6	3	3	3	4	3	3	4	3
No. species total	2	3	6	3	6	6	6	3	3	3	4	3	3	4	3
Appr. Density (no./m^2)	1	1	1	1.5	1.5	2	2	<1	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Staight	Staight	Staight
Depth (m)	2.1	2.0	3.4	3.4	3.4	3.7	4.0	4.3	4.6	4.6	7.3	6.1	1.5	9.1	10.0
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	10	10	10	-	-	-	-	-	-	-	40	40	-	-	-
Silt	30	30	10	10	20	20	10	-	20	20	60	60	20	25	25
Clay	60	60	70	80	70	80	85	-	80	80	-	-	80	70	70
Detritus	-	-	10	10	10	-	5	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	5	5
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-31. Site 23 unionid species and habitat characteristics (page 2 of 4).

Approx. NM		226	226	226	226.5	227	227	225.9	225.8	230.5	230.5	230.5	230.6	230.5	230.4
Bank		L	L	L	L	M	L	M	R	R	R	R	M	R	R
Bed/Patch		B23-2	B23-2	B23-2	B23-2	DR-3	DR-3	DR-1	DR-1	DR-4	DR-4	DR-4			
Amblema plicata		-	1	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus		-	-	2	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa		-	2	1	-	-	-	-	1	-	-	2	-	1	-
Plectomerus dombeyanus		4	7	3	3	-	-	-	-	-	1	-	-	1	-
Potamilus ohiensis		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis		1	1	-	-	-	-	-	-	-	-	-	1	-	-
Quadrula aspera		1	1	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula		2	7	1	6	-	-	-	-	-	-	-	1	-	-
Truncilla donaciformis		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		8	19	7	9	0	0	0	1	0	1	2	2	2	0
No. species live		4	6	4	2	0	0	0	1	0	1	1	2	2	0
No. species total		4	6	4	2	0	0	0	1	0	1	2	2	2	0
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	<1	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
	Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-	-
Habitat		Staight	Staight	Staight	Tributary	Channel	Channel	Channel	Channel	Straight	Straight	Straight	Island	Straight	Island
Depth (m)		1.8	1.8	1.8	1.8	4.6	4.0	4.0	4.0	3.4	4.6	3.7	6.4	5.7	5.2
Substrate															
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gravel	-	-	-	-	-	-	-	-	-	5	30	-	-	-
	Sand	-	-	-	-	100	100	95	100	100	90	70	60	-	95
	Silt	10	10	10	10	-	-	5	-	-	5	-	20	10	5
	Clay	90	90	90	90	-	-	-	-	-	-	-	20	90	-
	Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate		-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-31. Site 23 unionid species and habitat characteristics (page 3 of 4).

Approx. NM	230.3	230.3	230	230	230	230	230	230	229.2	228.5	228.1	228	228	227
Bank	L	L	R	R	R	R	R	R	R	L	L	L	M	R
Bed/Patch														
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	2	-	-	3	-	1	2	1	1	-	-	-	-	-
Plectomerus dombeyanus	1	-	-	2	1	3	4	2	-	-	-	1	-	2
Potamilus ohiensis	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	1	1	1	4	-	-	-	1	-	3
Truncilla donaciformis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	4	0	0	6	2	5	7	8	1	0	0	3	0	6
No. species live	3	0	0	3	2	3	3	4	1	0	0	3	0	3
No. species total	3	0	0	3	2	3	3	4	1	0	0	3	0	3
Appr. Density (no./m^2)	<1	<1	-	1	<1	<1	<1	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Island	Island	Straight	Island	Island	Island	Island	Island	Island	Outside	Outside	Outside	Island	Inside
Depth (m)	1.8	1.8	6.1	3.1	3.4	0.6	3.1	3.1	3.7	10.0	7.0	10.7	2.7	3.1
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	20	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sand	-	90	70	40	30	10	20	10	100	-	100	10	70	-
Silt	90	5	30	20	10	30	10	30	-	50	-	50	30	10
Clay	5	5	-	40	60	60	70	50	-	50	-	20	-	90
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	5	-	-	-	-	-	-	10	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-31. Site 23 unionid species and habitat characteristics (page 4 of 4).

Approx. NM	227	227	226.6	226	226	225.8		
Bank	R	R	L	M	R	M	Total	
Bed/Patch							No.	%
Amblema plicata	-	-	1	-	-	-	2	0.6
Arcidens confragosus	-	-	-	-	-	-	4	1.3
Leptodea fragilis	-	-	-	-	-	-	3	1.0
Megalonaias nervosa	-	-	-	-	-	-	1	0.3
Obliquaria reflexa	2	1	-	1	-	-	56	18.0
Plectomerus dombeyanus	1	2	3	1	2	-	131	42.1
Potamilus ohiensis	-	-	-	-	-	-	1	0.3
Pyganodon grandis	-	-	-	-	1	-	11	3.5
Quadrula aspera	-	-	-	-	-	-	13	4.2
Quadrula quadrula	2	1	-	-	1	-	83	26.7
Truncilla donaciformis	-	-	-	-	-	-	3	1.0
Truncilla truncata	-	-	-	-	-	-	1	0.3
Utterbackia imbecillis	-	-	-	-	-	-	2	0.6
Total	5	4	4	2	4	0	311	
No. species live	3	3	2	2	3	0	13	
No. species total	3	3	2	2	3	0	13	
Appr. Density (no./m^2)	-	-	-	-	1	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	6.3	
Modification								
Existing	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-		
Habitat	Inside	Inside	Island	Island	Inside	Channel		
Depth (m)	2.4	2.4	1.8	0.6	2.4	0.9		
Substrate								
Bedrock	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-		
Cobble	-	-	5	-	-	-		
Gravel	-	-	-	-	10	-		
Sand	-	-	-	50	10	90		
Silt	10	10	5	50	20	10		
Clay	90	90	90	-	60	-		
Detritus	-	-	-	-	-	-		
Shell	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell, R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-32. Location, habitat characteristics, and CPUE1 of unionid beds (B) and patches (P), Reaches 4, 5, and 6, MKARNS, 2004.

		4	4	5	4	4	5	5	5	5	5	5	5	5	6	6	6
Pool		10	10	15	12	12	13	13	14	15	15	15	15	15	18	18	18
Site		23	23	33	26	26	30	31	32	35	35	35	36	39	49	49	50
Habitat		B11	B12	B13	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30	P31
Cove		-	-	13.4	-	-	-	-	5.4	-	-	3.7	-	-	-	-	-
Inside bend		-	-	-	-	-	-	9.3	-	-	-	-	-	12.2	-	8.3	-
Island		-	-	-	-	-	-	-	-	-	7.8	-	-	-	-	-	-
Midchannel		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outside bend		14.5	-	-	-	-	-	-	-	-	-	-	-	-	5.0	-	-
Oxbow		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Penninsula		-	-	-	-	-	-	-	-	7.0	-	-	13.3	-	-	-	-
Straight reach		-	10.0	-	-	7.3	-	-	-	-	-	-	-	-	-	-	6.2
Tailwater		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tributary		-	-	-	5.7	-	4.5	-	-	-	-	-	-	-	-	-	-
Ave. CPUE		14.5	10.0	13.4	5.7	7.3	4.5	9.3	5.4	7.0	7.8	3.7	13.3	12.2	5.0	8.3	6.2
Modification[2]																	
	Existing	-	-	-	-	-	-	DF	-	-	-	-	-	-	-	-	-
	Proposed	-	-	DI	-	-	-	-	-	-	-	-	-	-	-	-	DR
Depth (m)																	
	min	2.0	1.5	1.5	1.8	6.1			0.9	0.9	0.9	0.9	2.1	1.5			1.5
	max	7.3	10.0	3.4	3.1	6.1	0.9	0.9	2.1	1.5	1.5	1.2	3.4	4.0	3.9	4.5	4.0
Substrate																	
	Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sand	10	-	40	-	-	-	50	45	-	-	10	-	70	-	20	-
	Silt	25	15	20	10	10	75	50	5	50	5	-	50	10	25	20	20
	Clay	60	85	40	90	90	25	-	50	50	90	90	50	20	50	60	80
	Detritus	5	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-
	Other	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Zebras/unionid		-	-	1.5	-	-	-	-	-	-	-	-	-	3.5	-	-	2
Zeb coverage of substrate		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] CPUE = unionids/5min.
DI = Disposal, DF = Dike Field, FD = Fresh Dead Shell, NM = Navigation Mile, TW = Tailwaters, WD = Weathered Dead Shell

Table 3-33. Site 26 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	271.9	271.9	271.9	269.4	269.4	269.4	272.6	272.5	272.0	271.0	273.0	272.9	272.7
Bank	L	L	L	R	R	R	R	R	R	R	R	R	L
Bed/Patch	P26-1	P26-1	P26-1	P26-2	P26-2	P26-2	DR-2	DR-2	DR-2	DR-1			
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	1	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	1	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	2	2	-	1	8	1	-	-	-	-	-	-	-
Plectomerus dombeyanus	-	-	-	1	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	FD	-
Pyganodon grandis	2	1	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	1	4	3	4	2	5	-	-	-	-	-	1	-
Total	7	7	3	6	10	6	0	0	0	0	0	1	0
No. species live	5	3	1	3	2	2	0	0	0	0	0	1	0
No. species total	5	3	1	3	2	2	0	0	0	0	0	2	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	-	-	-
Habitat	Tributary	Tributary	Tributary	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Island
Depth (m)	2.1	1.8	3.1	6.1	6.1	6.1	4.6	3.1	3.4	4.3	4.9	6.1	1.5
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	30	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	20	-	25	-
Sand	-	-	-	-	-	-	10	50	-	40	60	25	50
Silt	10	10	20	10	10	10	10	10	-	20	10	25	-
Clay	90	90	80	90	90	90	70	40	70	20	30	25	50
Detritus	-	-	-	-	-	-	10	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-33. Site 26 unionid species and habitat characteristics (page 2 of 2).

Approx. NM Bank Bed/Patch	272.5 L	272.3 L	272.1 L	271.5 L	271.0 R	270.6 R	270.5 L	270.3 L	270.1 L	269.9 L	269.8 L	Total No.	%
Anodonta suborbiculata	-	-	-	-	-	-	1	-	-	-	-	1	2.0
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	1	2.0
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	1	2.0
Obliquaria reflexa	-	-	-	2	1	-	-	2	-	-	-	19	37.3
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	1	2.0
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	FD	
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	3	5.9
Quadrula quadrula	-	2	-	1	1	-	1	-	-	-	-	25	49.0
Total	0	2	0	3	2	0	2	2	0	0	0	51	
No. species live	0	1	0	2	2	0	2	1	0	0	0	7	
No. species total	0	1	0	2	2	0	2	1	0	0	0	8	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	2.1	
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-	-	-	-	-	-		
Habitat	Island	Island	Island	Island	Straight	Channel	Island	Island	Island	Island	Island		
Depth (m)	4.3	1.5	0.9	5.1	3.7	5.5	1.5	0.9	0.9	2.7	7.6		
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-	-	-	-		
Sand	100	30	90	-	30	100	-	-	95	-	90		
Silt	-	10	10	20	50	-	10	10	5	10	10		
Clay	-	60	-	80	20	-	90	90	-	90	-		
Detritus	-	-	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-34. Site 27 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	284.1	284.0	283.6	282.3	281.5	281.8	284.2	283.4	283.6	281.5	281.5	281.7	283.0
Bank	R	L	M	M	M	M	L	R	R	R	R	R	R
Bed/Patch	DR-2	DR-2	DR-2	DR-1									DI-1
Obliquaria reflexa	1	-	-	-	-	-	-	2	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	1	-	-	-	-
Total	1	0	0	0	0	0	0	2	1	0	0	0	0
No. species live	1	0	0	0	0	0	0	1	1	0	0	0	0
No. species total	1	0	0	0	0	0	0	1	1	0	0	0	0
Appr. Density (no./m^2)	<0.5	-	-	-	-	-	-	<0.5	<0.5	-	-	-	-
Mean No./5min (CPUE)													-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	DI, DF
Proposed	Dredge	Dredge	Dredge	Dredge	-	-	-	-	-	-	-	-	-
Habitat	Channel	Channel	Channel	Channel	Channel	Channel	Straight	Straight	Straight	Tributary	Tributary	Outside	Outside
Depth (m)	3.4	4.6	3.7	4.9	3.7	4.9	4.9	3.1	2.4	4.9	4.6	3.4	1.8
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	25	-
Boulder	-	-	-	-	-	-	60	-	-	-	-	65	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	50
Gravel	-	70	-	-	-	45	-	-	-	-	-	10	50
Sand	100	20	90	100	99	45	30	30	90	10	-	-	-
Silt	-	10	10	-	1	10	10	35	10	10	10	-	-
Clay	-	-	-	-	-	-	-	35	-	70	60	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	30	-	-
Shell	-	-	-	-	-	-	-	-	-	10	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	25	-	-	-	-
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-34. Site 27 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	282.7	282.7	282.7	282.6	282.5	283.1	282.8	282.1	282.1		
Bank	R	R	M	M	R	L	L	L	L	Total	
Bed/Patch	DI-1	DI-1	DI-1	DI-1	DI-1	DI-2	DI-2	DI-2	DI-2	No.	%
Obliquaria reflexa	-	-	-	-	-	-	-	3	1	7	31.8
Potamilus ohiensis	-	-	1	-	-	-	-	-	-	1	4.5
Pyganodon grandis	-	1	1	-	2	-	-	1	-	5	22.7
Quadrula aspera	-	1	-	-	1	-	-	-	-	2	9.1
Quadrula quadrula	-	-	1	1	3	-	-	1	-	7	31.8
Total	0	2	3	1	6	0	0	5	1	22	
No. species live	0	2	3	1	3	0	0	3	1	5	
No. species total	0	2	3	1	3	0	0	3	1	5	
Appr. Density (no./m^2)	-	-	<0.5	<0.5	0.5	-	-	<0.5	<0.5		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	1.0	
Modification											
Existing	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF	DI, DF		
Proposed	-	-	-	-	-	-	-	-	-		
Habitat	Outside	Outside	Outside	Outside	Outside	Inside	Inside	Inside	Inside		
Depth (m)	3.4	1.2	0.9	1.8	1.8	2.4	3.4	0.9	0.9		
Substrate											
Bedrock	-	-	-	-	-	-	-	-	-		
Boulder	80	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	60	-	-		
Sand	20	10	10	10	10	80	30	70	70		
Silt	-	40	40	40	20	20	10	10	10		
Clay	-	50	50	50	70	-	-	20	20		
Detritus	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-35. Site 28 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	292	291.4	290.9	290.3	290.2	292	291.9	291.6	291.1	290.5	290.4
Bank	L	R	R	R	R	R	R	R	L	M	L
Replicate	A	A	A	A	A	A	A	A	A	A	A
Bed/Patch	DI-1	DI-2	DI-2	DI-2	DI-2	DR-1	DR-1	DR-1			
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	FD
Obliquaria reflexa	-	-	-	-	-	-	-	1	-	-	1
Quadrula quadrula	-	-	-	1	-	-	-	-	-	-	1
Total	0	0	0	1	0	0	0	1	0	0	2
No. species live	0	0	0	1	0	0	0	1	0	0	2
No. species total	0	0	0	1	0	0	0	1	0	0	3
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	<0.5
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-
Modification											
Existing	DI, DF	DI	DI	DF	DF	-	-	-	-	-	-
Proposed	-	-	-	-	-	Dredge	Dredge	Dredge	-	-	-
Habitat	Inside	Outside	Outside	Outside	Outside	TW	TW	TW	Inside	Channel	Inside
Depth (m)	1.8	4	4	1.7	3.4	3.7	3.1	4.6	1.8	3.1	0.9
Substrate											
Bedrock	-	50	-	-	-	-	-	40	-	-	-
Boulder	-	50	50	25	5	-	-	-	-	-	-
Cobble	15	-	25	40	10	5	25	-	-	-	25
Gravel	35	-	25	-	-	75	25	50	-	-	-
Sand	50	-	-	10	83	20	50	-	80	100	50
Silt	-	-	-	25	-	-	-	10	20	-	25
Clay	-	-	-	-	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	2	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	4
Zeb coverage of substrate	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-35. Site 28 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	290.4	289.8	289.8	289.8	289.8	289.8		
Bank	L	L	L	L	L	M		
Replicate	B	A	A	A	B	A	Total	
Bed/Patch							No.	%
Leptodea fragilis	-	-	-	-	-	-	FD	-
Obliquaria reflexa	-	-	-	-	-	-	2	50
Quadrula quadrula	-	-	-	-	-	-	2	50
Total	0	0	0	0	0	0	4	
No. species live	0	0	0	0	0	0	2	
No. species total	0	0	0	0	0	0	3	
Appr. Density (no./m^2)	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	0.2	
Modification								
Existing	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-		
Habitat	Inside	Outside	Outside	Outside	Outside	Outside		
Depth (m)	1.8	6.4	3.1	1.5	2.4	5.5		
Substrate								
Bedrock	-	-	-	-	-	-		
Boulder	-	-	-	-	50	50		
Cobble	-	50	-	20	25	25		
Gravel	-	25	-	-	-	-		
Sand	90	12.5	-	60	-	25		
Silt	10	12.5	30	20	25	-		
Clay	-	-	70	-	-	-		
Detritus	-	-	-	-	-	-		
Shell	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-		
Zeb coverage of substrate	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell, R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-36. MKARNS proposed dredge areas with respect to unionid sample sites in Reach 5, 2004.

	Proposed dredge and disposal areas								Unionids near proposed dredge and disposal areas								
Reach	Pool	DR/DI	Dn NM1	Up NM	Dist.	Site	Habitat	Substrate2	B/P	Habitat	Depth	Substrate	Dist from dredge (m)	Direction	CPUE	Species	% Juv.
5	13	DR-2	P 1.2	2.0	0.8	30	Trib.	Br/St/Sd/Gr/Cb/Cl		Tributary	1.2-5.2	Br/St/Sd/Gr/Cb/Cl	0	In	0	0	0
									P30-1	Tributary	0.9	St/Cl	1000	Dnstream	5	6	59
5	13	DR-1	P 0	0.4	0.4	30	Trib.	St/Cl/Sd/Cb/Bd		Tributary	0.6-6.1	St/Cl/Sd/Cb/Bd	0	In	1	8	69
5	13	DR	311.3	312.6	1.3	NS	Outside										
5	13	DR-3	317.4	319.5	2.1	31	Outside	Br/Gr/Sd/Bd		Channel	2.4-4.0	Br/Gr/Sd/Bd	0	In	0	0	0
5	13	DR-2	315.4	317.4	2.0	31	Outside	Br/Cb/Gr/Sd		Channel	3.4-4.0	Br/Cb/Gr/Sd	0	In	0	0	0
									P31-1	Inside	0.9	Sd/St	250	Shoreward	9	2	0
5	13	DR-1	314.2	315.4	1.2	31	Channel	Gr/Bd/Sd		Channel	2.4-4.6	Gr/Bd/Sd	0	In	<0.5	1	0
5	14	DR-1	334.0	336.1	2.1	32	Outside	Bd/Br/Gr/Sd		Outside	3.1-4.3	Bd/Br/Gr/Sd	0	In	1	2	0
									P32-1	Cove	0.9-2.1	Cl/Sd/St	250	Dnstream	5	7	37
5	14	DI-1	336.4	336.5	0.1	33	Cove	Sd/Cl/St	B33-1	Cove	1.5-3.4	Sd/Cl/St	0	In	13	9	26
5	14	DI-2	336.4	336.5	0.1	33	Cove			Cove	0.9-5.8	Cl/Sd/St	0	In	2	4	5
5	15	DR-1	337.7	338.8	1.1	34	Channel	Sd/Cl/St		Channel	4.0-4.6	Sd/Cl/St	0	In	2	2	33
5	15	DR-2	SM 0	0.5	0.5	34	Cove	Cl/Sd/St/Cb/Gr		Cove	0.9-4.3	Cl/Sd/St/Cb/Gr	0	In	2	2	57
5	15	DR-3	AC 0	0.3	0.3	34	Channel			NS							
5	15	DR-1	AC 3.5	4.9	1.4	35	Channel	Cl/St/Sd		Peninsula	0.6-2.1	Sd/Cl/St/Dt	250	Shoreward	1	2	0
5	15	DR-2	SB 0	1.3	1.3	35	Channel	Cl/St/Sd		Channel	2.4-9.8	Cl/St/Sd	0	In	0	2	100
5	15	DI-1	SB 0	0.2	0.2	35	Peninsula	Cl/Sd/St/Gr		Peninsula	0.9-1.1	Cl/Sd/St/Gr	0	In	2	1	0
5	15	DI-2	SB 4.2	87.0	0.5	35	Peninsula	Cl/St/Sd	P35-1	Peninsula	0.9-1.5	Cl/St/Sd	0	In	7	9	5
5	15	DI-3	SB 6.3	6.6	0.2	35	Island	Cl/St		Island	2.1-2.4	Cl/St	0	In	0	0	0
5	15	DI-4	SB 6.9	7.5	0.5	35	Island	Cl/St		Island	0.9-1.5	Cl/St	0	In	1	5	20
5	15	DR-3	SB 4	8.2	4.2	35	Channel	Cl/St/Sd/Gr/Cb/Bd/Dt	P35-4	Cove	1.2-2.1	Cl/St/Sd/Dt	<100m	Shoreward	8	9	2
5	15								P35-3	Cove	0.9-1.2	Cl/Sd	700	Shoreward	4	6	12
5	15								P35-2	Island	0.9-1.5	Cl/Sd/Gr	<100m	Shoreward	8	6	3
5	15	DI-1	342.1	342.3	0.2	36	Cove	Cl/St/Gr/Sd		Cove	0.5-3.4	Cl/St/Gr/Sd	0	In	2	5	5
5	15	DR-1	342.3	344.5	2.2	36	Channel	Cl/St/Sd		Channel	2.7-6.4	Cl/St/Sd	0	In	3	4	11
									P36-1	Peninsula	2.1-3.4	St/Cl	600	Shoreward	13	4	0
5	15	DR-2	344.2	345.0	0.5	36	Peninsula	Cl/St/Sd/Bd		Peninsula	1.5-3.4	Cl/St/Sd/Bd	0	In	4	1	0
5	15	DR	346.5	347.4	0.9	NS	Channel										
5	15	DR-1	347.8	349.4	1.6	37	Channel			Island	0.6	Cl/St/Sd	450	Shoreward	1	1	0
5	15	DI-1	348.0	348.3	0.3	37	Island	Sd/Gr		Island	0.9	Sd/Gr	0	In	0	0	0
5	15	DI-2	348.4	348.8	0.4	37	Island	Cl/St		Island	0.9-1.2	Cl/St	0	In	2	1	0
5	15	DI-3	348.4	348.5	0.1	37	Island			Island	1.2	Cl/St	250	Riverward	2	3	33
5	15	DI-4	348.9	349.0	0.1	37	Island	Sd/St		Island	0.9	Sd/St	0	In	0	0	0
5	15	DI-5	348.9	349.4	0.2	37	Island	Cl/St		Island	0.9	Cl/St	0	In	1	1	100
5	15	DR-1	355.4	356.4	1.0	38	Channel	Sd/St		Channel	3.4-3.7	Sd/St	0	In	1	1	0

Table 3-36. MKARNS proposed dredge areas with respect to unionid sample sites in Reach 5, 2004.

	Proposed dredge and disposal areas								Unionids near proposed dredge and disposal areas								
Reach	Pool	DR/DI	Dn NM1	Up NM	Dist.	Site	Habitat	Substrate2	B/P	Habitat	Depth	Substrate	Dist from dredge (m)	Direction	CPUE	Species	% Juv.
5	15	DI-1	355.4	355.6	0.2	38	Island	Sd/St		Island	0.9	Sd/St	0	In	0	0	0
5	15	DR	361.2	363.3	2.1	NS	Channel										
5	15	DR-1	363.9	366.5	2.6	39	Channel	Gr/Bd/Sd		Channel	4.6-5.5	Gr/Bd/Sd	0	In	1	1	0
5	15								P39-1	Straight	3.0-4.5	Cl/Sd/St/Dt	250	Shoreward	5	6	25
5	15								P39-2	Inside	1.5-3.0	Cl/Sd/St/Gr	125	Shoreward	4	4	15
5	15								P39-3	Inside	2.0-4.0	Sd/Cl/St/Gr	<100	Shoreward	9	5	7
5	15								P39-4	Inside	1.5	Sd/St/Gr/Cl	<100	Shoreward	15	4	7
5	15								P39-5	Tailwater	2.5	Cl/St/Sd	250	Shoreward	6	6	8
									P39-6	Straight	0.9-1.2	Cl/St	200	Shoreward	3	2	22
5	16	DR-1	366.6	367.6	1.0	40	Channel	Cl/St/Sd/Bd/Cb		Channel	0.8-5.0	Cl/St/Sd/Bd/Cb	0	In	1	7	8
5	16	DI-1	367.5	367.7	0.2	40	Inside	Cl/St/Sd		Island	0.6-1.2	Cl/St/Sd	0	In	1	3	33
5	16	DR-1	374.0	375.3	1.3	41	Channel			Outside	2.0-3.0	Cl/St/Sd/Dt	300	Dnstream	1	3	0
5	16	DI-1	373.9	374.3	0.3	41	Island	Cl/St		Islands	0.5-2.1	Cl/St	0	In	1	3	0
5	16	DR-1	379.1	379.9	0.8	43	Channel	Sd/Cl/St		Channel	3.7-7.0	Sd/Cl/St	0	In	0	0	0
5	16					42	Oxbow			Oxbow	1.8	Cl/St	400	Shoreward	<0.5	1	0
5	16	DR	380.3	381.8	1.5	NS	Channel										
5	16	DR	B 0	0.2	0.2	NS	Tributary										
5	16	DR	382.9	384.4	1.5	NS	Channel										
5	16	DR-1	388.0	391.5	3.5	44	Outside	Sd		Outside	4.3-4.6	Sd/Gr	0	In	0	0	0
5	16									Channel	4.0-5.2	Sd			0	0	0
5	16	DR	394.0	395.2	1.2	NS	Outside										
Reach 5 DR miles					40.4												
DI miles					3.6												

1P = Poteau R., SM = Short Mountain Cove, AC = Alternate channel, SB = San Bois R., B = Boudinot R.
2Br = bedrock, Cb = cobble, Gr = gravel, Sd = sand, St = silt, Cl = clay, Dt = detritus
NA = unionids separated from channel by islands

Table 3-37. Species composition and CPUE within unionid beds and patches, Reach 5.

Reach	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pool	13	13	14	15	15	15	15	15	15	15	15	15	15	15	15
Site	30	31	32	33	35	35	35	35	36	39	39	39	39	39	39
Species	P30-1	P31-1	P32-1	B33-1	B35-1	B35-2	B35-3	B35-4	P36-1	P39-1	P39-2	P39-3	P39-4	P39-5	P39-6
Amblema plicata	-	-	-	-	0.6	1.0	0.9	0.2	-						
Anodonta suborbiculata	-	-	-	0.2	0.2	-	-		1.0						
Arcidens confragosus	0.2	-	-	-	-	-	-	0.3	-						
Fusconaia ebena	-	-	-	0.1	-	-	0.1		-						
Fusconaia flava	-	-	-	-	0.1	1.0	-		-	0.3					
Lampsilis cardium	-	-	-	-	-	-	-		-						
Lampsilis siliquoidea	-	-	-	-	-	-	-		-						
Lampsilis teres	-	-	-	-	0.1	-	-		-						
Lasmigona c. complanata	-	-	-	-	-	-	-		-						
Leptodea fragilis	0.2	-	0.2	0.1	-	-	-	0.2	-	0.3	1.3	2.3	0.7	0.5	0.3
Megalonaias nervosa	-	-	-	0.1	-	-	-	0.2	-						
Obliquaria reflexa	1.5	2.8	3.8	2.0	0.7	1.3	0.4	0.8	0.3	1.3	2.3	5.0	13.3	3.5	2.7
Obovaria olivaria	-	-	-	-	-	-	-		-						
Plectomerus dombeyanus	-	-	-	-	-	-	-		-						
Potamilus ohiensis	0.2	-	0.2	0.7	0.1	0.3	-		-	1.7		0.3	0.3	0.5	
Potamilus purpuratus	-	-	0.2	-	-	-	0.6		-						
Pyganodon grandis	0.5	-	-	0.6	0.4	-	-	0.2	0.3						
Quadrula aspera	-	-	0.2	-	-	-	-	0.3	-						
Quadrula nodulata	-	-	-	-	-	-	-		-						
Quadrula p. pustulosa	-	-	-	0.2	-	-	-		-	0.7		0.7		0.5	
Quadrula quadrula	2.0	6.5	0.6	9.6	4.7	4.0	1.3	6.0	11.7	1.0	0.3	1.0	0.7	0.5	
Strophitus undulatus	-	-	-	-	-	-	-		-						
Toxolasma parvus	-	-	-	-	-	-	-		-						
Tritogonia verrucosa	-	-	-	-	0.1	0.3	0.4		-						
Truncilla donaciformis	-	-	-	-	-	-	-		-		0.3			0.5	
Truncilla truncata	-	-	-	-	-	-	-		-						
Utterbackia imbecillis	-	-	0.2	-	-	-	-		-						
No. of individuals	27	37	26	161	63	31	26	49	40	16	13	28	45	12	9
No. of 5min samples	6	4	5	12	9	4	7	6	3	3	3	3	3	2	3
Average CPUE	4.5	9.3	5.4	13.4	7.0	7.8	3.7	8.2	13.3	5.3	4.3	9.3	15.0	6.0	3.0
No of species	6	2	7	9	9	6	6	9	4	6	4	5	4	6	2
% Juveniles	59.3	0.0	37.0	26.1	4.8	3.2	11.5	2.0	0.0	25.0	15.4	7.1	6.7	8.3	22.2
% of species w/ juveniles	66.7	0.0	42.9	88.9	33.3	16.7	50.0	16.700	0.0	33.3	50.0	20.0	50.0	16.7	100.0

Nomenclature follows Turgeon *et al.* (1998) except *Q. aspera* (T. Watters, OSU, pers. comm., 2004

Table 3-38. Location, habitat characteristics, and CPUE[1] of unionid beds (B) and patches (P), Reach 5, MKARNS, 2004.

Reach	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pool	13	13	14	15	15	15	15	15	15	15	15	15	15	15	15
Site	30	31	32	33	35	35	35	35	36	39	39	39	39	39	39
Species	P30-1	P31-1	P32-1	B33-1	P35-1	P35-2	P35-3	P35-4	P36-1	P39-1	P39-2	P39-3	P39-4	P39-5	P39-6
Channel															
Cove			5.4	13.4			3.7	8.2							
Inside bend		9.3									4.3	9.3	15.0		
Island						7.8									
Outside bend															
Oxbow															
Peninsula					7.0				13.3						
Straight reach										5.3					3.0
Tailwater														6.0	
Tributary	4.5														
Ave. CPUE	4.5	9.3	5.4	13.4	7.0	7.8	3.7	8.2	13.3	5.3	4.3	9.3	15.0	6.0	3.0
Modification															
Existing															
Proposed				DI	DI	Dredge									
Depth (m)															
min	0.9	0.9	0.9	1.5	0.9	0.9	0.9	1.2	2.1	3.0	1.5	2.0	1.5	2.5	0.9
max	0.9		2.1	3.4	1.5	1.5	1.2	2.1	3.4	4.0	3.0	4.0			1.2
Substrate															
Bedrock															
Boulder															
Cobble				5											
Gravel				15		5					5	5	20		
Sand		60	40	35	5		10			15	35	55	35	5	
Silt	75	40	5	20	20	10		25	50	15	15	15	15	10	20
Clay	25		55	25	75	85	90	70	50	65	45	25	30	85	80
Detritus								5		10					
Shell															
zebras/unionid				<0.1						<0.1	2.2	1.8		3.1	

[1] CPUE = unionids/5min.
DI = disposal; DF = dike field; NM = no modification

Table 3-39. Site 30 unionid species and habitat characteristics (page 1 of 4).

Approx. NM	P0.7	P0.7	P0.7	P0.7	P0.7	P0.7	P0.5	P0.5	P0.5	P0.5	P0.5	P0.5	P0.5	P0.5	P0.5	P0.5
Bank	R	R	R	R	R	R	R	M	M	M	M	M	M	M	M	L
Bed/Patch	P30-1	P30-1	P30-1	P30-1	P30-1	P30-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1
Arcidens confragosus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Megalonaias nervosa	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	3	2	1	-	3	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	1	-	3	5	3	1	1	-	-	-	-	1	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	1	7	3	4	5	7	2	1	0	0	0	0	1	0	1	1
No. species live	1	4	2	2	1	3	2	1	0	0	0	0	1	0	1	1
No. species total	1	4	2	2	1	3	2	1	0	0	0	0	1	0	1	1
Appr. Density (no./m^2)	-	-	-	-	-	-	<0.5	<0.5	-	-	-	-	<0.5	-	<0.5	<0.5
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary
Depth (m)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2.1	3.1	4.3	4.3	4.3	5.5	6.1	6.1	4.9
Substrate																
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	20	10	60	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	20	30	-	-	-
Sand	-	-	-	-	-	-	-	-	-	-	-	20	60	40	-	-
Silt	75	75	75	75	75	75	50	50	50	60	60	20	-	-	50	60
Clay	25	25	25	25	25	25	50	50	50	40	40	20	-	-	50	40
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-39. Site 30 unionid species and habitat characteristics (page 2 of 4).

Approx. NM	P0.4	P0.4	P0.4	P0.4	P0.4	P0.4	P0.4	P0.4	P0.4	P0.4	P0.1	P0.1	P0.1	P0.1	P0.1	P0.1
Bank	R	M	M	M	M	M	M	M	M	L	R	M	M	M	M	M
Bed/Patch	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	WD	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	1	-	-	-	-	-	-	1	-	FD	-	-	-	-	-
Potamilus ohiensis	-	-	-	FD	-	-	-	-	-	1	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	FD	-	-	-	-	-
Pyganodon grandis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	1	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Total	1	2	1	1	0	0	0	0	1	3	0	0	0	0	0	0
No. species live	1	2	1	1	0	0	0	0	1	3	0	0	0	0	0	0
No. species total	1	2	1	2	0	0	0	0	1	3	2	0	1	0	0	0
Appr. Density (no./m^2)	<0.5	<0.5	<0.5	<0.5	-	-	-	-	<0.5	<0.5	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary
Depth (m)	1.5	1.5	0.6	2.7	3.7	4.6	4.9	4.6	3.1	1.2	0.9	1.8	4.3	4.9	5.5	5.2
Substrate																
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	10	80	-	60	10	-
Cobble	-	-	-	-	-	-	20	5		-	80	10	-	20	-	-
Gravel	-	-	-	-	-	-	20	5		-	-	10	-	-	-	-
Sand	-	-	-	-	-	-	40	60		-	-	-	-	10	-	-
Silt	80	80	80	50	50	80	10	15	80	50	10	-	-	10	80	50
Clay	20	20	20	50	50	20	10	15	20	50	-	-	-	-	10	50
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-39. Site 30 unionid species and habitat characteristics (page 3 of 4).

Approx. NM	P0.1	P0.1	P0.1	P0.1	P2.0	P2.0	P2.0	P2.0	P2.0	P2.0	P1.7	P1.7	P1.7	P1.7	P1.7	P1.7
Bank	M	M	M	L	R	M	M	M	M	L	R	M	M	M	M	M
Bed/Patch	DR-1	DR-1	DR-1	DR-1	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
No. species live	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
No. species total	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary
Depth (m)	4.9	4.0	4.3	3.7	4.3	4.6	4.6	5.2	5.2	4.6	1.2	3.1	3.1	3.7	3.4	4.0
Substrate																
Bedrock	-	-	-	-	-	-	99	99	99	99	-	96	-	-	-	100
Boulder	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	1	25	15	10	-
Gravel	-	5	-	-	10	5	-	1	-	-	-	1	50	25	50	-
Sand	-	-	-	-	-	-	-	-	-	1	50	1	25	40	40	-
Silt	90	85	45	55	70	70	1	-	1	-	50	1	-	20	-	-
Clay	10	10	45	35	20	20	-	-	-	-	-	-	-	-	-	-
Detritus	-	-	10	10	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-39. Site 30 unionid species and habitat characteristics (page 4 of 4).

Approx. NM Bank Bed/Patch	P1.7 L DR-2	P1.3 R DR-2	P1.3 M DR-2	P1.3 M DR-2	P1.3 M DR-2	P1.3 M DR-2	P1.3 L DR-2	P1.1 R	P1.1 L	Total No.	%
Arcidens confragosus	-	-	-	-	-	-	-	-	-	1	2.3
Leptodea fragilis	-	-	-	-	-	-	-	-	-	2	4.7
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	1	2.3
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	11	25.6
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	3	7.0
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	FD	
Pyganodon grandis	-	-	-	-	-	-	-	-	-	5	11.6
Quadrula aspera	-	-	-	-	-	-	-	-	-	3	7.0
Quadrula quadrula	-	-	-	-	-	-	-	-	-	16	37.2
Utterbackia imbecillis	-	-	-	-	-	-	-	-	-	1	2.3
Total	0	0	0	0	0	0	0	0	0	43	
No. species live	0	0	0	0	0	0	0	0	0	9	
No. species total	0	0	0	0	0	0	0	0	0	10	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	0.6	
Modification											
Existing	-	-	-	-	-	-	-	-	-		
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-		
Habitat	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary	Tributary		
Depth (m)	4.6	2.1	3.7	4.0	4.3	4.3	4.0	2.1	6.1		
Substrate											
Bedrock	-	100	100	99	98	100		-	-		
Boulder	-	-	-	-	-	-		-	-		
Cobble	30	-	-	-	-	-		-	-		
Gravel	50	-	-	-	-	-	20	-	-		
Sand	20	-	-	-	1	-	50	-	-		
Silt	-	-	-	1	-	-	30	50	40		
Clay	-	-	-	-	-	-		50	60		
Detritus	-	-	-	-	-	-		-	-		
Shell	-	-	-	-	1	-		-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-40. Site 31 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	316.0	316.0	316.0	316.3	318.4	317.0	317.0	317.0	316.3	319.2	319.2	319.2	318.4	318.4
Bank	L	L	L	L	L	L	L	L	L	L	L	L	R	M
Bed/Patch	P31-1	P31-1	P31-1	P31-1						DR-3	DR-3	DR-3	DR-3	DR-3
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	1	1	3	6	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	9	9	4	4	-	-	-	-	-	-	-	-	-	-
Total	10	10	7	10	0	0	0	0	0	0	0	0	0	0
No. species live	2	2	2	2	0	0	0	0	0	0	0	0	0	0
No. species total	2	2	2	2	0	0	0	0	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	DF	DF	DF	DF	DF	DF	DF	DF	DF	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Inside	TW	TW	TW	Channel	Outside
Depth (m)	0.9	-	-	-	2.4	-	2.1	3.1	-	2.4	2.4	2.4	2.4	4.0
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	100
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	80	-
Cobble	-	-	-	-	-	-	100	10	-	-	-	-	-	-
Gravel	-	-	-	-	25	60	-	30	-	75	75	75	10	-
Sand	100	50	50	50	75	20	-	30	50	25	25	25	10	-
Silt	-	50	50	50	-	20	-	30	50	-	-	-	-	-
Clay	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	<1%	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-40. Site 31 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	317.6	317.5	317.3	316.0	315.0	314.4	314.4	319.4	319.2	317.0	314.8	314.2		
Bank	M	R	M	R	M	R	M	R	R	L	L	R	Total	
Bed/Patch	DR-3	DR-3	DR-2	DR-2	DR-1	DR-1	DR-1						No.	%
	-	-	-	-	-	-	-	-	-	-	-	-		
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	FD	-	FD	
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	11	28.9
Potamilus purpuratus	-	-	-	-	1	-	-	-	-	-	-	-	1	2.6
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	26	68.4
Total	0	0	0	0	1	0	0	0	0	0	0	0	38	
No. species live	0	0	0	0	1	0	0	0	0	0	0	0	3	
No. species total	0	0	0	0	1	0	0	0	0	0	1	0	4	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	1.5	
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-		
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-	-	-	-		
Habitat	Channel	Outside	Channel	Outside	Channel	Outside	Channel	TW	TW	Channel	Inside	Outside		
Depth (m)	3.1	3.1	3.4	4.0	3.7	2.4	4.6	1.5	3.4	5.2	3.1	4.3		
Substrate														
Bedrock	-	100	100	50	-	-	100	-	100	-	-	-		
Boulder	-	-	-	50	-	-	-	-	-	80	-	100		
Cobble	50	-	-	-	-	-	-	-	-	10	-	-		
Gravel	50	-	-	-	30	80	-	-	-	10	-	-		
Sand	-	-	-	-	70	20	-	75	-	-	100	-		
Silt	-	-	-	-	-	-	-	25	-	-	-	-		
Clay	-	-	-	-	-	-	-	-	-	-	-	-		
Detritus	-	-	-	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-41. Site 32 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	334.2	334.2	334.2	334.2	334.2	335.5	335.3	335.3	335.2	334.5	334.3	335.6	335.6	335.2
Bank	L	L	L	L	L	L	L	L	L	L	L	L	R	R
Bed/Patch	P32-1	P32-1	P32-1	P32-1	P32-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1		
Leptodea fragilis	-	-	FD	1	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	4	3	2	9	1	-	2	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	1	FD	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	1	-	2	-	-	-	2	-	-	-	-	-	-
Utterbackia imbecillis	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Total	4	5	5	12	1	0	2	2	0	0	0	0	0	0
No. species live	1	3	4	3	1	0	1	1	0	0	0	0	0	0
No. species total	1	3	5	4	1	0	1	1	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-
Habitat	Cove	Cove	Cove	Cove	Cove	Channel	Outside	Outside	Outside	Outside	Outside	TW	Inside	Inside
Depth (m)	0.9	1.5	1.8	2.1	-	3.4	3.1	3.1	4.3	4.3	3.1	3.4	3.1	2.7
Substrate														
Bedrock	-	-	-	-	-	80	-	-	-	100	-	50	50	-
Boulder	-	-	-	-	-	10	50	50	80	-	90	50	25	-
Cobble	-	-	-	-	-	10	-	-	-	-	-	-	25	40
Gravel	-	-	-	-	-	-	25	25	10	-	5	-	-	50
Sand	50	45	45	30	25	-	25	25	10	-	-	-	-	10
Silt	-	5	5	20	-	-	-	-	-	-	-	-	-	-
Clay	50	50	50	50	75	-	-	-	-	-	5	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-41. Site 32 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	334.9	334.1	334.7	334.2	334.1		
Bank	R	R	L	L	L	Total	
Bed/Patch						No.	%
Leptodea fragilis	-	-	-	-	-	1	3.2
Obliquaria reflexa	-	-	-	-	-	21	67.7
Potamilus ohiensis	-	-	-	-	-	1	3.2
Potamilus purpuratus	-	-	-	-	-	1	3.2
Quadrula aspera	-	-	-	-	-	1	3.2
Quadrula quadrula	-	-	-	-	-	5	16.1
Utterbackia imbecillis	-	-	-	-	-	1	3.2
Total	0	0	0	0	0	31	
No. species live	0	0	0	0	0	7	
No. species total	0	0	0	0	0	7	
Appr. Density (no./m^2)	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	1.6	
Modification							
Existing	-	-	-	-	-		
Proposed	-	-	-	-	-		
Habitat	Channel	Inside	Cove	Outside	Outside		
Depth (m)	2.4	4.0	2.4	4.7	4.6		
Substrate							
Bedrock	-	-	-	-	-		
Boulder	-	20	-	25	-		
Cobble	-	60	-	25	80		
Gravel	50	20	-	-	-		
Sand	50	-	90	40	10		
Silt	-	-	10	10	5		
Clay	-	-	-	-	5		
Detritus	-	-	-	-	-		
Shell	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile,
TW=Tailwaters, WD=Weathered Dead ShellR=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-42. Site 33 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	336.4	336.4	336.4	336.4	336.4	336.3	336.3	336.2	336.2	336.2	336.2	336.2	336.7	336.7	336.6
Bank	R	R	R	R	R	R	R	R	R	R	R	R	L	L	L
Bed/Patch	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	B33-1	DI-2	DI-2	DI-2
Anodonta suborbiculata	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Fusconaia ebena	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Leptodea fragilis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Obliquaria reflexa	4	3	3	3	-	1	-	1	1	2	1	5	1	-	-
Potamilus ohiensis	3	-	1	-	-	-	2	-	2	-	-	-	-	-	-
Pyganodon grandis	1	3	-	-	1	-	2	-	-	-	-	-	-	-	1
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1
Quadrula p. pustulosa	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	10	9	14	8	7	9	4	14	18	6	8	8	1	1	3
Total	18	16	18	11	10	12	9	15	21	8	9	14	5	1	5
No. species live	4	4	3	2	3	4	4	2	3	2	2	3	3	1	3
No. species total	4	4	3	2	3	4	4	2	3	2	2	3	3	1	3
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	<1
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI
Habitat	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove
Depth (m)	3.4	3.4	2.3	3.4	3.4	3.4	3.4	3.4	3.4	1.5	1.5	1.5	3.1	4.6	2.3
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	25	25	25	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	25	25	25	-	-	-	-	40	40	40	-	-	-
Sand	40	40	25	25	25	40	40	40	40	40	40	40	40	-	20
Silt	20	20	10	10	10	20	20	20	20	10	10	10	10	20	10
Clay	40	40	15	15	15	40	40	40	40	10	10	10	50	80	70
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	2.0	-	-	0.7	2.0	0.2
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-42. Site 33 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	336.6	336.6	336.5	336.5	336.5	336.7	336.5	336.5		
Bank	L	L	L	L	L	M	L	L	Total	
Bed/Patch	DI-2	DI-2	DI-2	DI-2	DI-2				No.	%
Anodonta suborbiculata	FD	-	-	-	-	-	-	-	2	1.1
Fusconaia ebena	-	-	-	-	-	-	-	-	1	0.6
Leptodea fragilis	-	-	-	-	-	-	-	-	1	0.6
Megalonaias nervosa	-	-	-	-	-	-	-	-	1	0.6
Obliquaria reflexa	1	-	-	-	-	-	-	-	26	14.4
Potamilus ohiensis	-	-	-	-	-	-	-	-	8	4.4
Pyganodon grandis	-	1	-	-	-	-	-	-	9	5.0
Quadrula aspera	1	1	-	1	-	-	-	-	7	3.9
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	2	1.1
Quadrula quadrula	1	2	-	-	-	-	1	-	124	68.5
Total	3	4	0	1	0	0	1	0	181	
No. species live	3	3	0	1	0	0	1	0	10	
No. species total	4	3	0	1	0	0	1	0	10	
Appr. Density (no./m^2)	<1	<1	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	7.9	
Modification										
Existing	-	-	-	-	-	-	-	-		
Proposed	DI	DI	DI	DI	DI	-	-	-		
Habitat	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove		
Depth (m)	2.4	2.7	5.8	3.7	0.9	7.6	5.2	3.4		
Substrate										
Bedrock	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-		
Sand	-	30	10	70	60	-	-	40		
Silt	20	-	10	5	10	80	80	20		
Clay	80	70	80	25	30	20	20	40		
Detritus	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-		
Zebras/unionid	0.6	1.0	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell, R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-43. Site 34 unionid species and habitat characteristics (page 1 of 2).

Approx. NM		338.0	337.7	337.7	337.7	337.7	337.7	337.6	337.5	337.5	337.4	337.4	337.4
Bank		M	M	R	R	R	R	R	R	R	R	R	R
Bed/Patch		DR-1	DR-1	DR-2	DR-2	DR-2	DR-2						
Potamilus ohiensis		-	1	-	-	-	4	-	-	-	-	-	-
Quadrula quadrula		2	-	2	-	1	-	-	-	1	-	1	-
Total		2	1	2	0	1	4	0	0	1	0	1	0
No. species live		1	1	1	0	1	1	0	0	1	0	1	0
No. species total		1	1	1	0	1	1	0	0	1	0	1	0
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-
Modification													
	Existing	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-	-	-	-	-	-
Habitat		Channel	Channel	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove
Depth (m)		4.0	4.6	3.7	0.9	4.3	4.0	4.6	2.7	1.5	0.6	1.8	0.9
Substrate													
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	-	-	-	-
	Cobble	-	-	-	20	-	-	-	-	-	10	-	25
	Gravel	-	-	-	20	-	-	-	-	-	5	-	25
	Sand	34	40	-	50	34	34	-	-	-	45	-	-
	Silt	33	20	20	10	33	33	30	5	10	-	10	-
	Clay	33	40	80	-	33	33	70	95	90	40	90	50
	Detritus	-	-	-	-	-	-	-	-	-	-	-	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-43. Site 34 unionid species and habitat characteristics (page 2 of 2).

337.6 M	337.5 M	Total No.	%
-	1	6	46.2
-	-	7	53.8
0	1	13	
0	1	2	
0	1	2	
-	-		
-	-	0.9	
-	-		
-	-		
Channel	Channel		
5.5	5.5		
-	-		
-	-		
-	-		
-	-		
34	34		
33	33		
33	33		
-	-		
-	-		
-	-		
-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, D
R=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 1 of 7).

Approx. NM	SB4.7	SB4.6	SB4.6	SB4.6	SB4.6	SB4.5	SB4.2	SB4.2	SB4.2	SB6.0	SB6.0	SB5.8	SB5.8	SB6.0	SB6.0
Bank	L	L	L	L	L	L	L	L	L	M	R	R	R	L	L
Bed/Patch	P35-1	P35-1	P35-1	P35-1	P35-1	P35-1	P35-1	P35-1	P35-1	P35-2	P35-2	P35-2	P35-2	P35-3	P35-3
Amblema plicata	1	2	-	-	-	-	2	-	-	3	-	-	1	1	1
Anodonta suborbiculata	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	1	-	-	-	-	-	-	-	4	-	-	-	-
Lampsilis teres	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	4	-	-	-	2	-	-	2	3	-	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Pyganodon grandis	-	-	-	-	-	1	1	2	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	WD	-	-	-	-	-
Quadrula quadrula	2	2	6	2	3	-	7	13	7	6	3	6	1	2	-
Tritogonia verrucosa	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
Total	3	4	11	4	3	2	12	15	9	12	10	7	2	4	2
No. species live	2	2	3	3	1	2	4	2	2	5	3	2	2	3	2
No. species total	2	2	3	3	1	2	4	2	2	5	3	2	2	3	2
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	1	1	1	0.5	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	DI	DI	DI	DI	DI	DI	DI	DI	DI	Dredge	-	-	-	-	-
Habitat	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Channel	Island	Island	Island	Cove	Cove
Depth (m)	1.5	1.5	1.5	0.9	0.9	0.9	1.5	1.5	1.5	1.5	1.5	0.9	0.9	1.2	1.2
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	10	10	-	-
Sand	5	5	5	10	10	10	-	-	-	-	-	-	-	10	10
Silt	5	5	5	10	10	10	50	50	50	5	5	10	10	-	-
Clay	90	90	90	80	80	80	50	50	50	90	90	80	80	90	90
Detritus	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-			-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 2 of 7).

Approx. NM	SB6.0	SB6.0	SB6.0	SB6.0	SB6.0	SB7.9	SB7.8	SB7.8	SB7.8	SB7.8	SB7.8	SB7.9	SB7.8	SB7.8	SB7.8
Bank	L	L	L	L	L	L	L	L	L	L	L	M	M	M	M
Bed/Patch	P35-3	P35-3	P35-3	P35-3	P35-3	P35-4	P35-4	P35-4	P35-4	P35-4	P35-4	DR-3	DR-3	DR-3	DR-3
Amblema plicata	-	-	-	2	2	-	-	-	1	-	-	-	2	-	-
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
Fusconaia ebena	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-	-	-	-	FD	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	WD	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	WD	-	1	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
Obliquaria reflexa	-	-	1	2	-	1	1	2	-	1	-	-	1	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	2	-	-	WD	WD	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	1	1	-	-	-	WD	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	WD	-	-
Quadrula quadrula	3	-	2	2	-	11	9	4	2	5	5	-	-	-	-
Tritogonia verrucosa	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-
Total	4	1	3	8	4	14	13	7	4	6	5	0	3	0	1
No. species live	2	1	2	4	2	4	5	3	3	2	1	0	2	0	1
No. species total	2	1	2	4	2	4	7	5	3	2	2	1	3	0	1
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge
Habitat	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Channel	Channel	Channel	Channel
Depth (m)	1.2	1.2	0.9	0.9	-	1.2	2.1	1.5	1.2	-	-	2.4	1.8	3.1	3.1
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-
Sand	10	10	10	10	10	10	10	-	-	-	-	10	5	25	55
Silt	-	-	-	-	-	10	20	10	10	10	80	10	-	-	5
Clay	90	90	90	90	90	80	70	80	80	80	20	80	90	25	30
Detritus	-	-	-	-	-	-	-	10	10	10	-	-	-	25	5
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 3 of 7).

Approx. NM	SB7.4	SB7.4	SB7.4	SB7.4	SB7.4	SB7.2	SB7.2	SB7.2	SB7.2	SB7.0	SB7.0	SB6.9	SB6.9	SB6.9	SB6.8	SB6.8
Bank	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Bed/Patch	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Anodonta suborbiculata	-	-	-	-	-	-	-	-	WD	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Fusconaia ebena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Obliquaria reflexa	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	1	-	1	-	-	-	1	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	2	2	2	-	-	-	-	-	-	1	-	-	-	1
Tritogonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	2	4	4	0	1	0	1	0	0	2	2	1	0	2
No. species live	0	0	1	3	2	0	1	0	1	0	0	2	2	1	0	2
No. species total	0	0	1	3	2	0	1	0	2	0	0	2	2	1	0	2
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel
Depth (m)	2.4	3.1	0.9	1.5	1.8	1.8	3.1	1.5	2.1	1.2	2.4	1.5	2.3	2.7	1.5	1.8
Substrate																
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Sand	-	-	50	40	20	10	10	30	-	-	-	-	-	-	-	-
Silt	80	90	-	-	60	50	70	30	80	50	50	20	20	50	60	-
Clay	20	10	50	60	20	40	20	40	20	50	40	80	80	50	40	90
Detritus	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 4 of 7).

Approx. NM		SB6.8	SB6.8	SB6.8	SB6.6	SB6.6	SB6.3	SB6.3	SB6.0	SB5.8	SB5.7	SB5.6	SB5.5	SB5.5	SB5.3	SB5.3	SB4.4
Bank		M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Bed/Patch		DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3
Amblema plicata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anodonta suborbiculata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava		-	-	WD	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa		-	-	1	-	-	-	-	-	1	-	3	1	-	-	-	-
Plectomerus dombeyanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus		-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera		-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula		3	-	2	1	-	-	-	-	1	3	5	4	2	-	1	-
Tritogonia verrucosa		-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
Total		4	1	3	2	1	0	0	0	3	3	9	5	3	0	1	0
No. species live		2	1	2	2	1	0	0	0	3	1	3	2	2	0	1	0
No. species total		2	1	3	2	1	0	0	0	3	1	3	2	2	0	1	0
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																	
	Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel
Depth (m)		1.8	4.9	1.8	1.8	1.8	3.7	4.3	3.4	0.9	3.2	1.2	1.2	0.9	2.7	3.4	4.3
Substrate																	
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	-	25	25	-	-	-	-	-
	Cobble	25	-	-	-	-	-	-	-	-	25	15	-	40	-	-	-
	Gravel	25	-	10	-	-	-	-	-	10	25	45	40	40	-	-	-
	Sand		-	-	-	-	-	-	-	-	25	-	-	10	-	-	-
	Silt		70	10	40	40	15	70	10	10	-	10	10	10	50	45	10
	Clay	50	20	80	50	50	80	30	80	80	-	5	50	-	50	55	90
	Detritus		10	-	10	10	5	-	10	-	-	-	-	-	-	-	-
	Shell									-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	1.4	-	-	-	-
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 5 of 7).

Approx. NM		SB4.1	SB4.0	SB0.6	SB1.2	SB1.0	SB0.4	SB7.1	SB6.9	SB6.9	SB6.4	SB6.3	SB4.8	SB4.8	SB7.8
Bank		M	M	R	M	M	M	L	L	L	L	L	L	L	R
Bed/Patch		DR-3	DR-3	DR-2	DR-2	DR-2	DR-2	DI-4	DI-4	DI-4	DI-3	DI-3	DI-2	DI-2	
Amblema plicata		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anodonta suborbiculata		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	-	-	-	-	-	1
Megalonaias nervosa		-	-	-	-	-	-	-	-	1	-	-	-	-	-
Obliquaria reflexa		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plectomerus dombeyanus		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis		-	-	-	1	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula		-	-	-	-	-	1	-	-	-	-	-	1	-	-
Tritogonia verrucosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		0	0	0	1	0	1	0	0	1	0	0	1	0	1
No. species live		0	0	0	1	0	1	0	0	1	0	0	1	0	1
No. species total		0	0	0	1	0	1	0	0	1	0	0	1	0	1
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
	Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	DI	DI	DI	DI	DI	DI	DI	-
Habitat		Channel	Channel	Channel	Channel	Channel	Channel	Island	Island	Island	Island	Island	Penins.	Penins.	Cove
Depth (m)		3.1	4.3	6.1	4.0	9.8	2.4	1.8	1.5	0.9	2.1	2.4	0.9	1.5	1.2
Substrate															
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sand	-	-	-	-	-	5	-	-	-	-	-	10	-	-
	Silt	10	5	50	50	75	5	50	40	40	50	40	-	10	85
	Clay	90	95	50	50	25	90	50	60	60	50	60	90	90	15
	Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr		-	-	-	-	-	-								-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 6 of 7).

Approx. NM	SB7.8	SB5.7	SB4.6	SB7.3	SB7.3	SB7.2	SB6.5	SB6.0	SB4.7	SB4.7	SB1.0	SB0.7	SB0.5	SB0.2	SB0.2	SB0.1
Bank	R	R	R	L	L	L	L	L	L	L	L	L	L	L	L	L
Bed/Patch																
Amblema plicata	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcidens confragosus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia ebena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	1	1	-	-	-	-	-	1	-	-	-	-	-	-	-
Plectomerus dombeyanus	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Quadrula quadrula	2	1	1	1	3	3	-	-	-	-	2	4	1	-	1	2
Tritogonia verrucosa	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Total	2	3	2	2	3	4	0	0	8	1	2	4	1	0	1	2
No. species live	1	3	2	2	1	2	0	0	2	1	1	1	1	0	1	1
No. species total	1	3	2	2	1	2	0	0	2	1	1	1	1	0	1	1
Appr. Density (no./m^2)	-	-	<1	-	-	-	-	-	<1	<1	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Cove	Cove	Penins.	Island	Island	Island	Island	Cove	Island	Island	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.
Depth (m)	1.8	0.9	0.6	0.9	0.9	0.9	2.4	2.1	0.6	0.6	0.9	0.9	0.9	0.9	1.1	1.2
Substrate																
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	40	-	5	5	5	-	-	-	-	-	15	15	-	-	-
Sand	-	-	50	20	20	20	-	-	10	10	45	25	25	50	10	10
Silt	80	10	10	-	-	-	50	65	20	20	10	25	25	20	10	10
Clay	20	40	30	75	75	75	50	35	70	70	45	35	35	30	80	80
Detritus	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-														

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-44. Site 35 unionid species and habitat characteristics (page 7 of 7).

Approx. NM		SB0.1	SB0.1	SB0.1		
Bank		L	L	L		
Bed/Patch					No.	%
Amblema plicata		-	-	-	20	7.4
Anodonta suborbiculata		-	-	-	2	0.7
Arcidens confragosus		-	-	-	3	1.1
Fusconaia ebena		-	-	-	1	0.4
Fusconaia flava		-	-	-	6	2.2
Lampsilis teres		-	-	-	1	0.4
Leptodea fragilis		-	-	-	2	0.7
Megalonaias nervosa		-	-	-	6	2.2
Obliquaria reflexa		-	1	-	33	12.2
Plectomerus dombeyanus		-	-	-	1	0.4
Potamilus ohiensis		-	-	-	3	1.1
Potamilus purpuratus		-	-	-	5	1.8
Pyganodon grandis		-	-	-	9	3.3
Quadrula aspera		-	-	-	11	4.1
Quadrula p. pustulosa		-	-	-	1	0.4
Quadrula quadrula		-	2	1	159	58.7
Tritogonia verrucosa		-	-	-	8	3.0
Total		0	3	1	271	
No. species live		0	2	1	17	
No. species total		0	2	1	17	
Appr. Density (no./m^2)		-	-	-		
Mean No./5min (CPUE)		-	-	-	2.9	
Modification						
	Existing	-	-	-	1.33333	
	Proposed	-	-	-		
Habitat		Penins.	Penins.	Penins.		
Depth (m)		1.2	2.1	2.1		
Substrate						
	Bedrock	-	-	-		
	Boulder	-	-	-		
	Cobble	-	-	-		
	Gravel	-	-	-		
	Sand	45	34	34	22.6667	
	Silt	10	33	33	22	
	Clay	45	33	33	22	
	Detritus	-	-	-	0	
	Shell	-	-	-		
Zebras/unionid		-	-	-		
Zeb coverage of substr						

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-45. Site 36 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	342.9	343.9	344.9	342.3	342.3	342.3	342.3	342.3	342.3	342.3	342.3	342.3	342.3	344.8
Bank	L	L	L	L	L	L	L	L	L	L	L	L	L	M
Bed/Patch	P36-1	P36-1	P36-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DR-1
Anodonta suborbiculata	1	1	1	-	1	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	1	1	1	FD	-	1	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Pyganodon grandis	-	-	1	-	-	-	1	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	12	14	9	1	-	1	3	-	2	6	2	-	-	-
Strophitus undulatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	13	15	12	2	2	1	4	1	2	7	2	0	0	0
No. species live	2	2	4	2	2	1	2	1	1	2	1	0	0	0
No. species total	2	2	4	2	2	2	2	1	1	2	1	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	DI	DI	DI	DI	DI	DI	DI	DI	DI	DI	Dredge
Habitat	Penins.	Penins.	Penins.	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Cove	Channel
Depth (m)	3.4	2.1	-	3.1	1.2	0.5	1.5	2.1	4.0	3.4	1.8	3.4	0.6	2.7
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	25	-
Gravel	-	-	-	50	50	35	-	-	-	-	-	-	30	-
Sand	-	-	-	15	-	-	-	40	-	-	-	-	10	10
Silt	50	50	50	15	20	20	10	40	40	40	40	55	20	10
Clay	50	50	50	15	25	45	90	20	60	60	60	45	15	80
Detritus	-	-	-	5	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	2.0	1.1	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-45. Site 36 unionid species and habitat characteristics (page 2 of 3).

Approx. NM		343.8	342.7	342.5	342.2	342.2	344.9	344.9	344.9	344.9	344.8	344.6	344.6	344.5	344.4	343.9
Bank		M	M	M	M	M	L	L	L	L	L	L	L	L	L	M
Bed/Patch		DR-1	DR-1	DR-1	DR-1	DR-1	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	
Anodonta suborbiculata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	-	WD	-	-	-	-	-
Obliquaria reflexa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera		-	-	-	1	-	-	-	-	1	-	-	-	-	-	1
Quadrula quadrula		8	3	-	5	-	-	-	2	1	-	9	9	-	2	2
Strophitus undulatus		-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Total		10	3	0	6	0	0	0	3	2	0	9	9	0	2	3
No. species live		3	1	0	2	0	0	0	2	2	0	1	1	0	1	2
No. species total		3	1	0	2	0	0	0	2	2	1	1	1	0	1	2
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
	Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-
Habitat		Channel	Channel	Channel	Channel	Channel	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Channel
Depth (m)			4.6	4.6	4.6	6.4	3.4	3.4	2.4	2.4	1.5	2.1	2.1	2.7	0.9	3.1
Substrate																
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	-	-	-	-	-	-	-	-	-	10	10	-	-	-
	Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Gravel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sand	10	-	-	-	-	-	-	-	-	-	-	-	-	80	-
	Silt	10	50	70	50	75	60	80	50	70	50	10	10	50	20	20
	Clay	80	50	30	50	25	40	20	50	30	50	80	80	50		80
	Detritus	-	-	-	-	-	-	-	-	-	-				-	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-45. Site 36 unionid species and habitat characteristics (page 3 of 3).

Approx. NM Bank Bed/Patch	343.9 M	344.8 L	344.5 L	344.5 L	344.0 L	344.0 L	344.0 L	344.0 L	343.2 L	342.6 L	342.5 L	Total No.	%
Anodonta suborbiculata	-	-	-	-	-	-	-	-	-	-	-	4	3.0
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	WD	
Obliquaria reflexa	-	-	1	-	-	1	-	-	-	-	-	6	4.5
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	2	1.5
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	3	2.2
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	3	2.2
Quadrula quadrula	-	-	3	3	2	7	7	2	-	-	-	115	85.8
Strophitus undulatus	-	-	-	-	-	-	-	-	-	-	-	1	0.7
Total	0	0	4	3	2	8	7	2	0	0	0	134	
No. species live	0	0	2	1	1	2	1	1	0	0	0	7	
No. species total	0	0	2	1	1	2	1	1	0	0	0	8	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	3.4	
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-	-	-	-	-	-		
Habitat	Channel	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Penins.	Cove	Cove		
Depth (m)	3.1	2.4	3.1	3.1	3.4	3.4	3.4	3.4	0.9	1.8	3.4		
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	5	5	-	-	-	-	-	-	-		
Cobble	-	-	5	5	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-	-	50	-		
Sand	-		5	5	-	-	-	-	10	-	-		
Silt	20	80	5	5	20	20	20	20	-	30	80		
Clay	80	20	80	80	80	80	80	80	90	20	20		
Detritus	-	-	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-46. Site 37 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	349.4	349.4	349.4	348.9	348.9	348.7	348.7	348.5	349.6	349.6	349.5	349.5
Bank	L	L	L	L	L	L	L	L	L	L	L	L
Bed/Patch	DI-5	DI-5	DI-5	DI-4	DI-5	DI-2	DI-2	DI-3				
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	WD
Obliquaria reflexa	-	-	-	-	-	-	-	-	1	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	1	2	1	-	-	-	1	-
Total	0	0	0	0	1	2	1	0	1	0	1	0
No. species live	0	0	0	0	1	1	1	0	1	0	1	0
No. species total	0	0	0	0	1	1	1	0	1	0	1	1
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	DI	DI	DI	DI	DI	DI	DI	DI	-	-	-	-
Habitat	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island	Island
Depth (m)	0.6	1.5	1.5	0.9	0.9	0.9	1.2	0.6	0.6	0.6	0.6	0.6
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	10	-	-	-	-
Sand	80	40	40	90	-	-	-	90	5	25	10	10
Silt	10	20	-	10	40	25	25	-	5	25	10	10
Clay	10	20	40	-	60	75	75	-	80	25	80	80
Detritus	-	20	20	-	-	-	-	-	10	25	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-46. Site 37 unionid species and habitat characteristics (page 2 of 2).

Approx. NM Bank Bed/Patch	349.5 L	349.4 L	348.5 L	348.5 L	348.5 L	Total No.	%
Lampsilis teres	-	-	-	-	-	WD	
Obliquaria reflexa	-	-	-	1	1	3	23.1
Potamilus ohiensis	-	-	-	-	1	1	7.7
Quadrula quadrula	-	-	-	3	1	9	69.2
Total	0	0	0	4	3	13	
No. species live	0	0	0	2	3		
No. species total	0	0	0	2	3		
Appr. Density (no./m^2)	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-		
Modification							
Existing	-	-	-	-	-		
Proposed	-	-	-	-	-		
Habitat	Island	Island	Island	Island	Island		
Depth (m)	3.4	0.6	1.2	1.2	1.2		
Substrate							
Bedrock	-	-	-	-	-		
Boulder	-	-	-	-	-		
Cobble	-	-	-	-	-		
Gravel	-	-	-	-	-		
Sand	-	80	-	-	-		
Silt	25	10	30	30	30		
Clay	25	10	70	70	70		
Detritus	50	-	-	-	-		
Shell	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-47. Site 38 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	355.8	355.1	355.8	356.4	356.3	355.5	355.1	355.0	354.9	354.6	354.6	354.0
Bank	M	M	R	R	R	R	R	R	R	R	R	R
Bed/Patch	DR-1	DR-1	DI-1									
Leptodea fragilis	-	-	-	-	-	1	-	-	-	-	-	-
Obliquaria reflexa	-	1	-	1	-	-	-	-	-	FD	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	1	0	1	0	1	0	0	0	0	0	0
No. species live	0	1	0	1	0	1	0	0	0	0	0	0
No. species total	0	1	0	1	0	1	0	0	0	1	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	DI	-	-	-	-	-	-	-	-	-
Habitat	Channel	Channel	Island	Island	Island	Inside	Inside	Inside	Inside	Inside	Inside	Island
Depth (m)	3.4	3.7	0.9	7.0	6.7	2.7	1.1	0.9	0.6	4.6	0.9	1.5
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	20	-	-	-	-	5	-	-
Gravel	-	-	-	-	30	-	-	-	-	-	-	-
Sand	50	100	80	40	20	95	100	100	50	40	-	99
Silt	50	-	20	50	30	-	-	-	50	5	50	-
Clay	-	-	-	10	-	-	-	-	-	50	50	1
Detritus	-	-	-	-	-	5	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-47. Site 38 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	353.9	354.7	357.2	357.2	355.8		
Bank	R	M	L	L	L	Total	
Bed/Patch						No.	%
Leptodea fragilis	-	-	-	-	-	1	25
Obliquaria reflexa	-	-	-	-	-	2	50
Potamilus ohiensis	-	-	-	1	-	1	25
Total	0	0	0	1	0	4	
No. species live	0	0	0	1	0	3	
No. species total	0	0	0	1	0	3	
Appr. Density (no./m^2)	-	-	-	-	-	-	
Mean No./5min (CPUE)	-	-	-	-	-	-	
Modification							
Existing	-	-	-	-	-		
Proposed	-	-	-	-	-		
Habitat	Island	Channel	Island	Island	Outside		
Depth (m)	-	2.3	2.6	-	-		
Substrate							
Bedrock	-	-	-	-	-		
Boulder	-	-	-	-	-		
Cobble	-	-	-	-	-		
Gravel	-	-	-	-	40		
Sand	10	50	50	50	-		
Silt	10	-	40	40	20		
Clay	80	50	10	10	40		
Detritus	-	-	-	-	-		
Shell	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-48. Site 39 unionid species and habitat characteristics (page 1 of 4).

Approx. NM	366.0	366.0	365.5	365.5	365.5	365.5	365.5	365.3	365.3	365.3	364.5	364.5
Bank	R	R	R	R	R	L	L	R	R	R	R	R
Bed/Patch	P39-5	P39-5	P39-4	P39-4	P39-4	P39-6	P39-6	P39-3	P39-3	P39-3	P39-2	P39-2
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	-	-	-	-	-	-	-	-	-	-	-	-
Lampsilis teres	-	-	-	-	WD	-	-	-	-	-	-	-
Leptodea fragilis	FD	1	-	2	-	-	1	1	4	2	1	2
Obliquaria reflexa	6	1	27	12	1	6	1	4	6	5	6	-
Potamilus ohiensis	1	-	-	-	1	-	-	-	1	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula aspera	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	1	-	-	-	-	-	-	-	1	1	-	-
Quadrula quadrula	-	1	1	-	1	-	-	-	2	1	-	1
Truncilla donaciformis	1	-	-	-	-	-	-	-	-	-	1	-
Total	9	3	28	14	3	6	2	5	14	9	8	3
No. species live	4	3	2	2	3	1	2	2	5	4	3	2
No. species total	5	3	2	2	4	1	2	2	5	4	3	2
Appr. Density (no./m^2)	-	-	2	1	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	TW	TW	Inside	Inside	Inside	Straight	Straight	Inside	Inside	Inside	Inside	Inside
Depth (m)	2.5	-	1.5	1.5	1.5	0.9	1.2	-	4.0	2.0	-	3.0
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	20	-	40	-	-	15	-	-	-	-
Sand	5	-	35	30	40	-	-	25	70	70	65	30
Silt	10	10	20	20	10	20	20	25	10	10	10	20
Clay	85	90	25	50	10	80	80	35	20	20	25	50
Detritus	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	6.2	-	-	-	-	-	-	2.4	3.1	-	1.9	1.7
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-48. Site 39 unionid species and habitat characteristics (page 2 of 4).

364.5 R P39-2	363.8 R P39-1	363.8 R P39-1	363.8 R P39-1	366.0 M DR-1	365.5 M DR-1	365.3 M DR-1	364.9 M DR-1	364.3 M DR-1	363.9 M DR-1	366.0 R	365.0 R	364.5 R	364.1 R	364.0 R	364.0 R
-	-	-	-	-	-	-	-	-	-	-	-	-	WD	-	-
-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	-	-	1	-	-	-	-	-	-	-	-	-	-	FD	FD
1	2	1	1	-	-	-	-	-	1	-	-	-	1	1	1
FD	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
-	1	-	1	-	-	-	-	-	FD	-	-	-	FD	-	-
-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	3	6	7	0	0	0	0	0	1	0	0	0	1	3	1
2	2	4	5	0	0	0	0	0	1	0	0	0	1	3	1
3	2	4	5	0	0	0	0	0	2	0	0	0	3	4	2
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-							-	-	-	-	-	-
Inside	Straight	Straight	Straight	Dredge Channel	Dredge Channel	Dredge Channel	Dredge Channel	Dredge Channel	Dredge Channel	TW	Inside	Inside	Straight	Straight	Straight
1.5	3.0	4.5	4.0	4.6	4.6	4.6	4.8	5.5	4.7	7.5	1.0	4.0	1.5	1.0	1.5
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
-	-	-	-	-	-	-	50	-	-	-	-	-	-	-	-
20	-	-	-	90	90	90	50	80	90	-	15	15	10	-	-
10	15	20	10	10	5	10	-	20	-	-	25	25	35	20	20
10	15	10	20	-	5	-	-	-	-	-	20	20	20	20	20
60	65	60	60	-	-	-	-	-	-	-	40	40	30	50	50
-	5	10	10	-	-	-	-	-	-	-	-	-	5	10	10
-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-
3.0	-	-	0.1	-	-	-	-	-	-	-	-	-	3	0.3	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-48. Site 39 unionid species and habitat characteristics (page 3 of 4).

363.6 R	363.6 R	364.0 M	363.5 M	363.4 M	366.1 L	366.0 L	365.2 L	365.1 L	365.1 L	364.7 L	664.5 L	364.4 L	364.1 L	364.0 L
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	1	-	-	-	-	-	1	-	WD	-	-	-	-
-	-	1	-	-	1	-	-	1	-	-	-	-	-	2
-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
-	-	-	-	-	-	-	-	-	2	-	-	-	-	1
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	2	0	0	1	0	1	2	2	0	0	0	0	4
0	0	2	0	0	1	0	1	2	1	0	0	0	0	3
0	0	2	0	0	1	0	1	2	1	1	0	0	0	3
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Straight	Straight	Channel	Channel	Channel	TW	TW	Tributary	Outside	Outside	Straight	Straight	Straight	Straight	Straight
2.5	4.0	3.0	4.9	4.8	-	2.1	1.5	3.4	-	-	3.4	3.4	2.4	4.3
-	-	-	100	-	-	-	-	-	-	-	100	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	15	-	-	50	-	-	-	-	-	20	-	-	30	-
30	35	25	-	50	-	90	-	-	-	50	-	30	10	-
35	35	40	-	-	-	10	-	-	-	10	-	-	-	5
15	10	20	-	-	-	-	50	20	20	20	-	30	30	30
15	5	15	-	-	-	-	50	80	80	-	-	40	30	65
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-48. Site 39 unionid species and habitat characteristics (page 4 of 4).

364.0 L	364.0 L	363.9 L	363.9 L	Total No.	%
-	-	-	-	WD	
-	-	-	-	2	1.4
-	-	-	-	WD	
-	-	-	-	18	12.3
1	1	-	-	91	62.3
-	-	FD	-	9	6.2
-	-	-	1	1	0.7
-	-	-	-	1	0.7
1	1	-	-	8	5.5
-	-	-	1	14	9.6
-	-	-	-	2	1.4
2	2	0	2	146	
2	2	0	2	9	
2	2	1	2	11	
-	-	-	-		
-	-	-	-	3.1	
-	-	-	-		
-	-	-	-		
Straight	Straight	Straight	Straight		
4.3	4.3	2.4	2.4		
-	-	-	-		
-	-	-	-		
-	-	-	-		
-	-	-	-		
5	5	-	100		
30	30	50	-		
65	65	50	-		
-	-	-	-		
-	-	-	-		
-	-	-	-		
-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-49. Site 40 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	367.8	367.5	367.5	367.4	367.4	367.4	367.3	367.7	367.6	367.5	367.2	367.2
Bank	L	L	L	L	L	L	L	M	M	M	M	M
Bed/Patch	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DI-1	DR-1	DR-1	DR-1	DR-1	DR-1
Amblema plicata	-	FD	-	-	-	-	-	-	-	-	1	-
Anodonta suborbiculata	-	1	-	FD	-	FD	FD	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	FD	FD	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	1	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	1	-	-	2
Potamilus ohiensis	-	-	-	WD	-	-	-	-	FD	-	-	-
Pyganodon grandis	-	-	WD	FD	1	WD	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	1	-	WWD	-	WD	FD	-	-	-	2	-
Total	0	2	0	0	1	0	0	0	2	0	3	2
No. species live	0	2	0	0	1	0	0	0	2	0	2	1
No. species total	0	3	1	4	1	3	2	0	4	1	2	1
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-
Modification												
Existing	DF	DF	DF	DF	DF	DF	DF	-	-	-	-	-
Proposed	DI	DI	DI	DI	DI	DI	DI	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Inside	Inside	Inside	Inside	Inside	Inside	Inside	Channel	Channel	Channel	Channel	Channel
Depth (m)	7.3	0.9	1.2	0.9	0.6	-	0.9	4.5	5.0	1.0	4.5	3.0
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-	-
Sand	15	-	-	-	40	-	-	-	25	-	-	-
Silt	4	20	20	20	20	-	20	25	50	50	40	20
Clay	80	80	80	80	40	-	80	75	25	50	60	75
Detritus	1	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	5
Zebras/unionid	-	0	-	-	0	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-49. Site 40 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	367.0	366.9	367.5	367.0		
Bank	M	M	L	L	Total	
Bed/Patch	DR-1	DR-1			No.	%
Amblema plicata	-	-	-	-	1	6.3
Anodonta suborbiculata	-	-	-	-	1	6.3
Leptodea fragilis	FD	-	FD	-	FD	
Megalonaias nervosa	-	-	-	-	1	6.3
Obliquaria reflexa	-	-	1	-	4	25.0
Potamilus ohiensis	FD	-	1	FD	1	6.3
Pyganodon grandis	-	-	1	-	2	12.5
Quadrula p. pustulosa	-	1	-	-	1	6.3
Quadrula quadrula	-	-	2	-	5	31.3
Total	0	1	5	0	16	
No. species live	0	1	4	0	8	
No. species total	2	1	5	1	9	
Appr. Density (no./m^2)	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	1.0	
Modification						
Existing	-	-	-	-		
Proposed	Dredge	Dredge				
Habitat	Channel	Channel	Inside	Inside		
Depth (m)	4.3	-	1.0	0.8		
Substrate						
Bedrock	-	-	-	-		
Boulder	15	-	-	-		
Cobble	10	-	-	-		
Gravel	-	-	-	-		
Sand	-	45	-	25	6.4	
Silt	50	30	50	50	34.3	
Clay	25	25	50	25	40.7	
Detritus	-	-	-	-	0.0	
Shell	-	-	-	-		
Zebras/unionid	-	-	-	-		
Zeb coverage of substr	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-50. Site 41 unionid species and habitat characteristics.

Approx. NM	373.9	373.9	373.8	373.7	373.7	373.8	373.5	373.2	373.0	372.5		
Bank	L	L	L	L	L	R	R	R	R	R	Total	
Bed/Patch	DI-1	DI-1	DI-1	DI-1	DI-1						No.	%
Lasmigona c. complanata	-	-	-	-	-	WD	-	-	-	-	WD	
Leptodea fragilis	-	-	-	-	-	-	FD	FD	FD	WD	FD	
Obliquaria reflexa	2	-	-	-	-	2	1	-	-	-	5	45.5
Potamilus ohiensis	-	-	-	2	-	-	-	FD	FD	-	2	18.2
Pyganodon grandis	-	-	-	1	-	-	1	-	-	-	2	18.2
Quadrula quadrula	-	-	-	-	-	2	-	-	-	WD	2	18.2
Total	2	0	0	3	0	4	2	0	0	0	11	
No. species live	1	0	0	2	0	2	2	0	0	0	4	
No. species total	1	0	0	2	0	3	3	2	2	2	6	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	1.1	
Modification												
Existing	-	-	-	-	-	-	-	-	-	-		
Proposed	DI	DI	DI	DI	DI	-	-	-	-	-		
Habitat	Island	Island	Island	Island	Island	Outside	Outside	Outside	Outside	Outside		
Depth (m)	0.5	0.5	0.6	2.1	-	2.0	2.5	2.0	3.0	3.0		
Substrate												
Bedrock	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-	-	-	-	-		
Sand	-	-	-	-	-	-	-	25	60	-		
Silt	10	10	10	10	10	25	20	35	15	10		
Clay	90	90	90	90	90	75	80	15	25	90		
Detritus	-	-	-	-	-	-	-	25	-	-		
Shell	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	2	-	1	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-51. Site 42 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	380.2	380.1	380.1	380.0	379.9	379.7	379.5	379.3	379.2	379.1	379.1
Bank	L	L	L	L	L	L	L	L	L	L	L
Bed/Patch											
Anodonta suborbiculata	-	-	-	-	-	-	WD	-	-	-	-
Lasmigona c. complanata	-	-	-	-	-	-	-	-	WD	-	-
Quadrula aspera	-	-	-	-	WD	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	WD	-	-
Toxolasma parvus	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0	0
No. species live	0	0	0	0	0	0	0	0	0	0	0
No. species total	0	0	0	0	1	0	1	0	2	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-
Modification											
Existing	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-
Habitat	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow	Oxbow
Depth (m)	1.5	1.8	2.1	1.8	2.5	1.5	2.0	3.0	2.0	2.0	1.5
Substrate											
Bedrock	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	-
Sand	-	-	-	-	-	50	-	5	10	50	25
Silt	10	30	30	10	45	25	20	95	60	25	25
Clay	90	70	70	90	50	25	80	-	30	25	50
Detritus	-	-	-	-	5	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	2	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-51. Site 42 unionid species and habitat characteristics (page 2 of 2).

Approx. NM Bank Bed/Patch	379.0 L	378.9 L	378.9 L	378.9 L	Total No.	%
Anodonta suborbiculata	-	-	-	-	WD	
Lasmigona c. complanata	-	-	-	-	WD	
Quadrula aspera	-	-	-	-	WD	
Quadrula quadrula	-	-	-	-	WD	
Toxolasma parvus	-	-	-	1	1	100
Total	0	0	0	1	1	
No. species live	0	0	0	1	1	
No. species total	0	0	0	1	5	
Appr. Density (no./m^2)	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	0.1	
Modification						
Existing	-	-	-	-		
Proposed	-	-	-	-		
Habitat	Oxbow	Oxbow	Oxbow	Oxbow		
Depth (m)	5.0	1.5	1.5	1.8		
Substrate						
Bedrock	-	-	-	-		
Boulder	-	-	-	-		
Cobble	-	-	-	-		
Gravel	-	-	-	-		
Sand	-	-	25	-		
Silt	80	10	20	30		
Clay	20	90	55	70		
Detritus	-	-	-	-		
Shell	-	-	-	-		
Zebras/unionid	-	-	-	-		
Zeb coverage of substr	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-52. Site 43 unionid species and habitat characteristics.

Approx. NM Bank Bed/Patch		380.0 M DR-1	379.5 M DR-1	379.2 M DR-1	379.0 M DR-1	379.9 R	379.0 M	Total
Total		0	0	0	0	0	0	0
No. species live		0	0	0	0	0	0	0
No. species total		0	0	0	0	0	0	0
Appr. Density (no./m^2)		-	-	-	-	-	-	
Modification								
	Existing	-	-	-	-	-	-	
	Proposed	Dredge	Dredge	Dredge	Dredge	-	-	
Habitat		Channel	Channel	Channel	Channel	Island	Oxbow	
Depth (m)		5.5	5.2	6.1	7.0		3.7	
Substrate								
	Bedrock	-	-	-	-	-	-	
	Boulder	-	-	-	-	-	-	
	Cobble	-	-	-	-	-	-	
	Gravel	-	-	-	-	-	-	
	Sand	100	90	100	95	-	-	
	Silt	-	5	-	5	10	30	
	Clay	-	5	-	-	90	70	
	Detritus	-	-	-	-	-	-	
	Shell	-	-	-	-	-	-	
Zebras/unionid		-	-	-	-	-	-	
Zeb coverage of substr		-	-	-	-	-	-	

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-53. Site 44 unionid species and habitat characteristics.

Approx. NM	391.5	390.6	389.6	388.8	388.2	
Bank	R	R	M	M	M	
Replicate	A	A	A	A	A	Total
Bed/Patch	DR-1	DR-1	DR-1			
Total	0	0	0	0	0	0
No. species live	0	0	0	0	0	0
No. species total	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	
Modification						
Existing	-	-	-	-	-	
Proposed	Dredge	Dredge	Dredge	-	-	
Habitat	Outside	Outside	Outside	Channel	Channel	
Depth (m)	4.3	4.6	2.7	4.0	5.2	
Substrate						
Bedrock	-	-	-	-	-	
Boulder	-	-	-	-	-	
Cobble	-	-	-	-	-	
Gravel	50	-	-	5	-	
Sand	50	100	-	90	100	
Silt	-	-	-	5	-	
Clay	-	-	-	-	-	
Detritus	-	-	-	-	-	
Shell	-	-	-	-	-	
Zebras/unionid	-	-	-	-	-	
Zeb coverage of substr	-	-	-	-	-	

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-54. Site 45 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	395.0	401.2	401.2	400.6	400.6	399.4	399.4	399.4	398.9	398.5	397.8	396.6	395.8	395.2	395.2	395.0
Bank	M	M	M	M	M	L	M	R	M	M	L	M	M	M	R	L
Replicate	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Bed/Patch																
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	FD	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species live	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species total	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
Existing	Dredge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	**Dredge**	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Channel	Channel	Channel	**Channel**	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel
Depth (m)	4.0	4.0	5.0	3.0	3.0	5.0	5.5	4.5	5.5	4.0	3.4	4.0	5.0	6.0	6.0	5.5
Substrate																
Bedrock	-	-	-	-	-	-	50	-	-	-	-	45	45	-	-	100
Boulder	-	-	-	-	-	-	-	-	-	-	90	15	25	-	10	-
Cobble	-	-	-	-	-	-	-	-	20	-	-	5	10	-	10	-
Gravel	-	-	-	-	-	-	15	-	30	-	10	5	5	-	-	-
Sand	100	-	-	25	20	30	15	90	50	-	-	20	7	45	25	-
Silt	-	75	75	25	10	10	10	9	-	-	-	5	8	10	10	-
Clay	-	25	25	50	70	60	10	-	-	100	-	5	-	45	45	-
Detritus	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	8	-	-	1	50

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-54. Site 45 unionid species and habitat characteristics (page 2 of 3).

Approx. NM	392.2	392.1	400.5	398.9	398.5	400.6	398.5	389.9	399.5	399.3	397.8	397.8	396.6	395.8	395.2	392.3	392.2
Bank	M	L	R	R	R	L	L	L	L	R	R	M	R	R	L	R	L
Replicate	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Bed/Patch																	
Amblema plicata	-	-	-	-	-	-	-	WD	-	-	-	-	-	WD	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	WD	1
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	WD	-	-	1
Total	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
No. species live	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
No. species total	0	0	0	0	0	0	0	1	0	0	2	0	0	2	0	1	2
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																	
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Channel	Channel	Inside	Inside	Inside	Outside	Outside	Outside	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)	4.6	5.0	2.0	3.1	3.7	3.0	2.1	4.0	2.5	3.0	3.0	4.6	5.0	4.8	6.0	4.0	1.8
Substrate																	
Bedrock	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	5	90	50	50	3	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	5	-	40	50	2	-	-
Gravel	-	-	-	-	-	15	-	-	-	-	-	10	-	-	20	-	-
Sand	90	60	20	-	100	30	-	-	30	30	-	-	5	-	25	95	40
Silt	5	10	-	-	-	15	70	-	10	30	10	-	5	-	10	5	40
Clay	-	30	80	-	-	40	30	-	60	30	80	-	-	-	40	-	-
Detritus	5	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	20
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	5	10	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-54. Site 45 unionid species and habitat characteristics (page 3 of 3).

Approx. NM	392.1	401.2	401.2	396.6	395.8	394.9	394.7	392.1	392.1		
Bank	M	L	R	L	L	R	L	L	L		
Replicate	A	A	A	A	A	A	A	A	B	Total	
Bed/Patch										No.	%
Amblema plicata	-	-	1	-	-	-	-	-	-	1	7.7
Leptodea fragilis	-	-	-	-	-	-	-	WD	-	2	15.4
Obliquaria reflexa	-	-	3	-	-	-	-	3	-	8	61.5
Potamilus purpuratus	1	-	-	-	-	-	-	-	-	1	7.7
Quadrula quadrula	-	-	-	-	-	-	-	-	-	1	7.7
Total	1	0	4	0	0	0	0	3	0	13	
No. species live	1	0	2	0	0	0	0	1	0	5	
No. species total	1	0	2	0	0	0	0	2	0	5	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	0.3	
Modification											
Existing	-	-	-	-	-	-	-	-	-		
Proposed	Dredge	Dredge	Dredge	-	-	-	-	-	-		
Habitat	Straight	TW	TW	Straight	Straight	Inside	Outside	Straight	Straight		
Depth (m)	5.0	3.5	1.0	4.0	4.8	2.7	5.5	2.0	3.5		
Substrate											
Bedrock	40	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-		
Cobble	5	-	-	-	8	-	-	-	-		
Gravel	10	50	-	-	7	20	-	-	-		
Sand	7	20	25	35	25	50	-	20	20		
Silt	8	-	50	10	10	30	60	20	20		
Clay	25	30	25	55	50	-	40	50	50		
Detritus	5	-	-	-	-	-	-	10	10		
Shell	-	-	-	-	-	-	-	-	-		
Zebras/unionid	0	-	-	-	-	-	-	-	-		
Zeb coverage of substr	35	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-55. Site 46 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	402.8	402.2	403.1	402.6	402.0	402.8	402.2	403.1	402.6	402.0	402.8	402.2	403.5
Bank	R	R	R	R	R	M	M	L	L	L	L	L	R
Bed/Patch	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	FD
Obliquaria reflexa	-	-	1	-	-	-	-	-	FD	-	-	-	1
Potamilus ohiensis	-	-	-	-	-	-	1	-	-	-	1	-	-
Total	0	0	1	0	0	0	1	0	0	0	1	0	1
No. species live	0	0	1	0	0	0	1	0	0	0	1	0	1
No. species total	0	0	1	0	0	0	1	0	1	0	1	0	2
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	Dredge	-	-	-	-	Dredge	-	-	-	-	Dredge	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	-
Habitat	Straight	Straight	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Straight	Straight	Straight
Depth (m)	1.8	-	2.1	4.0	2.7	4.0	4.0	2.7	4.0	2.7	2.7	-	3.0
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	15	-	-	-	-
Cobble	-	20	-	5	40	-	-	-	-	30	30	-	10
Gravel	30	-	-	10	-	75	5	30	-	-	-	-	-
Sand	-	20	-	20	-	25	5	-	25	-	-	20	25
Silt	-	20	30	40	-	-	5	-	20	40	40	20	25
Clay	70	40	70	25	60	-	85	70	30	30	30	60	40
Detritus	-	-	-	-	-	-	-	-	10	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	10	-	10	-	-	5	-	10	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-55. Site 46 unionid species and habitat characteristics (page 2 of 2).

Approx. NM Bank Bed/Patch	403.5 M	403.5 M	403.5 M	403.5 L	Total No.	%
Leptodea fragilis	-	-	-	-	FD	-
Obliquaria reflexa	-	-	-	-	2	50
Potamilus ohiensis	-	-	-	-	2	50
Total	0	0	0	0	4	
No. species live	0	0	0	0	2	
No. species total	0	0	0	0	3	
Appr. Density (no./m^2)	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	0.2	
Modification						
Existing	-	-	-	-		
Proposed	-	-	-	-		
Habitat	Channel	Channel	Straight	Straight		
Depth (m)	7.0	6.5	8.0	6.0		
Substrate						
Bedrock	-	-	-	-		
Boulder	-	-	-	-		
Cobble	-	-	-	-		
Gravel	20	5	15	-		
Sand	60	20	45	15		
Silt	20	20	15	10		
Clay	-	55	25	75		
Detritus	-	-	-	-		
Shell	-	-	-	-		
Zebras/unionid	-	-	-	-		
Zeb coverage of substr	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-56. Site 47 unionid species and habitat characteristics (page 1 of 5).

Approx. NM		420.3	420.3	420.5	420.3	421.3	421.2	421.2	421.0	420.4	420.3	419.8	419.8	419.8	419.7	419.0
Bank		R	R	M	M	L	L	L	L	L	L	R	R	R	R	R
Bed/Patch		DR-4	DR-4	DR-4	DR-4	DR-4	DR-4	DR-4	DR-4	DR-4	DR-4	DR-3	DR-3	DR-3	DR-3	DR-3
Amblema plicata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	1	FD	-	-	-	WD	-	-	-
Megalonaias nervosa		-	-	-	-	-	-	-	-	WD	-	-	-	-	-	-
Obliquaria reflexa		-	-	-	-	-	-	-	-	-	-	5	5	1	-	1
Pleurobema cordatum		-	-	-	-	-	-	-	-	WD	-	-	-	-	-	-
Potamilus ohiensis		WD	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Potamilus purpuratus		-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Pyganodon grandis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	-	-	-	-	-	-	FD	-	1	-	-	1
Quadrula quadrula		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Tritogonia verrucosa		-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Total		0	0	0	0	0	0	1	1	0	0	7	6	2	0	3
No. species live		0	0	0	0	0	0	1	1	0	0	2	3	2	0	3
No. species total		1	0	0	0	0	0	1	2	2	1	2	3	2	0	3
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
	Existing	-	-	-	-	Dredge	Dredge	Dredge	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Inside	Inside	Channel	Channel	TW	TW	TW	Island	Channel	Outside	Inside	Inside	Inside	Inside	Straight
Depth (m)		4.5	4.5	3.0	5.0	3.0	1.0	2.0	1.0	4.3	3.5	1.8	1.8	3.0	3.4	-
Substrate																
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	8	7	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cobble	7	8	15	30	-	-	-	-	-	30	-	-	-	-	-
	Gravel	8	10	25	30	-	-	5	-	100	25	5	10	30	-	-
	Sand	15	25	50	30	10	20	25	20	-	30	10	15	30	-	-
	Silt	7	10	10	10	10	10	10	10	-	15	5	10	10	-	25
	Clay	55	40	-	-	70	60	50	70	-	-	80	65	30	10	75
	Detritus	-	-	-	-	10	10	10	-	-	-	-	-	-	90	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		-	-	-	-	-	-	2	-	-	-	2.9	1.3	13.0	-	-
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-56. Site 47 unionid species and habitat characteristics (page 2 of 5).

Approx. NM		419.8	419.8	419.7	419.7	419.0	419.8	419.7	419.7	419.0	416.5	416.5	416.5	414.3	414.3	414.3
Bank		M	M	M	M	M	L	L	L	L	R	M	L	R	M	L
Bed/Patch		DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-3	DR-2	DR-2	DR-2	DR-1	DR-1	DR-1
Amblema plicata		-	-	WD	-	-	WD	-	-	-	-	-	-	-	-	-
Leptodea fragilis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	FD
Megalonaias nervosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa		1	-	-	-	-	-	-	-	1	-	-	-	-	-	5
Pleurobema cordatum		-	-	WD	WD	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus		-	-	-	-	-	WD	-	-	-	-	-	-	-	-	-
Pyganodon grandis		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa		-	-	-	WD	2	FD	-	FD	-	-	-	-	-	-	-
Quadrula quadrula		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		2	0	0	0	2	0	0	0	1	0	0	0	0	0	5
No. species live		2	0	0	0	1	0	0	0	1	0	0	0	0	0	1
No. species total		2	0	2	2	1	3	0	1	1	0	0	0	0	0	2
Appr. Density (no./m^2)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification																
	Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat		Channel	Channel	Channel	Channel	Channel	Outside	Channel	Outside	Straight	Straight	Channel	Straight	Channel	Channel	Straight
Depth (m)		5.0	3.0	4.3	4.3	4.9	3.0	5.2	4.3	2.4	3.4	4.3	4.3	4.0	4.0	5.0
Substrate																
	Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Boulder	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
	Cobble	-	10	-	-	-	20	-	-	-	-	-	-	-	-	-
	Gravel	30	25	100	100	80	20	80	-	-	-	100	100	60	75	-
	Sand	30	25	-	-	20	20	20	-	-	100	-	-	15	25	-
	Silt	10	15	-	-	-	20	-	40	25	-	-	-	10	-	50
	Clay	30	15	-	-	-	20	-	50	75	-	-	-	15	-	50
	Detritus	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-
	Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid		10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	2.6
Zeb coverage of substr		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-56. Site 47 unionid species and habitat characteristics (page 3 of 5).

Approx. NM	414.3	415.9	415.6	415.0	415.0	418.4	417.2	417.2	416.9	416.1	412.2	411.8	411.6	411.6
Bank	L	R	R	R	R	R	R	R	R	R	R	R	R	R
Bed/Patch	DR-1													
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Leptodea fragilis	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	1	2	-	-	-	-	-	1	-
Pleurobema cordatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	FD	-
Quadrula nodulata	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	1	-	-	-	-	-	-	2	-
Tritogonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Total	1	0	0	0	0	2	6	0	0	0	0	0	5	0
No. species live	1	0	0	0	0	2	4	0	0	0	0	0	4	0
No. species total	1	0	0	0	0	2	4	0	0	0	0	0	5	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Outside	Outside	Outside	Oxbow	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight
Depth (m)	5.0	5.0	3.0	5.0	4.5	3.7	3.1	3.1	6.7	4.0	4.0	3.1	5.0	5.5
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	50	25	50	-	-	-	-	-	-	-	-	-	-
Cobble	-	25	50	25	-	-	-	-	-	-	-	-	-	-
Gravel	25	13	15	-	-	-	-	-	100	100	-	-	-	-
Sand	12	-	-	-	-	-	-	-	-	-	20	-	-	-
Silt	38	10	-	-	85	-	15	15	-	-	10	20	5	40
Clay	25	2	10	25	15	-	85	85	-	-	70	80	95	60
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	20	-
Zeb coverage of substr	-	-	-	1	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-56. Site 47 unionid species and habitat characteristics (page 4 of 5).

Approx. NM	418.4	417.9	417.2	416.9	416.1	415.9	415.6	412.2	411.8	415.0	417.9	415.9	415.6	415.0	419.7
Bank	M	M	M	M	M	M	M	M	M	M	M	L	L	L	L
Bed/Patch															
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleurobema cordatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	FD
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species live	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
No. species total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Inside	Straight	Inside	Inside	Inside	Oxbow
Depth (m)	5.5	4.0	5.8	5.5	6.7	6.0	7.0	5.5	4.0	5.0	5.2	6.5	6.5	5.0	5.0
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	100	-	-	-	3	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50
Cobble	45	-	-	-	-	25	25	-	-	-	-	-	-	12	-
Gravel	45	75	75	75	90	40	25	80	90	-	75	-	-	13	50
Sand	10	15	15	25	-	25	-	20	10	-	15	50	-	5	-
Silt	-	10	10	-	10	-	-	-	-	-	10	25	50	5	-
Clay	-	-	-	-	-	10	50	-	-	-	-	25	50	62	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-56. Site 47 unionid species and habitat characteristics (page 5 of 5).

Approx. NM Bank Bed/Patch	419.7 L	419.7 L	419.7 L	419.7 L	418.4 L	417.9 L	417.2 L	416.9 L	416.1 L	412.2 L	411.8 L	411.6 L	411.5 L	Total No.	%
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2.0
Leptodea fragilis	-	FD	-	-	-	-	-	-	-	-	-	-	-	2	3.9
Megalonaias nervosa	-	-	-	-	-	-	-	-	-	-	-	-	-	WD	
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	2	-	25	49.0
Pleurobema cordatum	-	-	-	-	-	-	-	-	-	-	-	-	-	WD	
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-	3	5.9
Potamilus purpuratus	-	1	-	1	-	-	-	-	-	-	1	-	-	5	9.8
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	FD	
Quadrula nodulata	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2.0
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	4	7.8
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	1	-	-	6	11.8
Tritogonia verrucosa	-	-	-	-	1	-	-	-	-	-	-	-	-	4	7.8
Total	0	1	0	1	1	0	0	0	0	0	2	2	0	51	
No. species live	0	1	0	1	1	0	0	0	0	0	2	1	0	9	
No. species total	0	2	0	1	1	0	0	0	0	0	2	1	0	12	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	2.3	
Modification															
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-		
Habitat	Oxbow	Oxbow	Oxbow	Oxbow	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight	Straight		
Depth (m)	5.0	5.3	5.3	5.2	3.1	6.1	5.8	4.9	6.1	4.0	3.7	2.5	4.0		
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-		
Boulder	-	-	-	-	-	-	-	-	-	25	-	-	-		
Cobble	-	-	-	-	25	-	-	-	75	25	-	-	3		
Gravel	10	-	-	-	75	-	75	-	-	25	-	-	2		
Sand	-	-	-	-	-	-	15	-	-	25	-	-	-		
Silt	-	50	50	10	-	30	10	40	-	-	20	50	-		
Clay	90	50	50	90	-	70	-	60	25	-	80	50	95		
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-57. Site 48 unionid species and habitat characteristics.

Approx. NM	427.4	427.4	427.3	427.0	426.9	426.9	427.4	427.3	
Bank	R	M	R	R	M	M	L	L	
Bed/Patch	DR-1	DR-1							Total
Total	0	0	0	0	0	0	0	0	-
No. species live	0	0	0	0	0	0	0	0	-
No. species total	0	0	0	0	0	0	0	0	-
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-
Modification									
Existing	-	-	-	-	-	-	-	-	
Proposed	Dredge	Dredge	-	-	-	-	-	-	
Habitat	Inside	Channel	Inside	Inside	Channel	Channel	Outside	Outside	
Depth (m)	1.5	7.9	4.2	4.8	4.5	5.1	7.9	4.2	
Substrate									
Bedrock	-	-	-	-	-	-	-	-	
Boulder	-	-	-	-	-	-	-	-	
Cobble	-	-	-	-	-	-	60	-	
Gravel	-	-	-	-	-	-	-	-	
Sand	-	-	-	-	-	-	-	-	
Silt	-	40	50	40	50	-	-	50	
Clay	-	60	50	60	50	100	40	50	
Detritus	-	-	-	-	-	-	-	-	
Shell	-	-	-	-	-	-	-	-	
Zebras/unionid	-	-	-	-	-	-	-	-	
Zeb coverage of substr	-	-	-	-	-	-	-	-	

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-58. Site 49 unionid species and habitat characteristics (page 1 of 4).

Approx. NM	436.9	436.9	436.9	436.9	433.0	433.0	433.0	436.8	436.3	436.1	436.8	436.3	436.8
Bank	L	L	L	L	L	L	L	R	R	R	M	M	L
Bed/Patch	P49-2	P49-2	P49-2	P49-2	P49-1	P49-1	P49-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	1	-	-	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	2	6	5	1	8	6	4	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata	-	1	-	1	-	-	-	-	-	-	-	-	1
Quadrula p. pustulosa	-	-	-	-	2	3	1	-	-	-	-	-	-
Quadrula quadrula	-	2	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa	-	1	-	-	1	-	-	-	-	-	-	-	1
Total	3	10	5	2	11	9	5	0	0	0	0	0	2
No. species live	2	4	1	2	3	2	2	0	0	0	0	0	2
No. species total	2	4	1	2	3	2	2	0	0	0	0	0	2
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Outside	Outside	Outside	Outside	Inside	Inside	Inside	Inside	Inside	Inside	Channel	Channel	Outside
Depth (m)	3.9	3.9	3.9	3.9	5.0	4.0	4.8	3.9	1.5	4.5	6.0	4.8	3.9
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	-	-	-	50	70	-
Sand	-	-	-	-	30	20	25	-	-	-	25	20	-
Silt	25	25	25	25	30	20	25	40	10	25	25	10	25
Clay	50	50	50	50	40	60	50	60	80	50	-	-	50
Detritus	25	25	25	25	-	-	-	-	10	25	-	-	25
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	5%	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-58. Site 49 unionid species and habitat characteristics (page 2 of 4).

Approx. NM	436.3	434.3	434.2	434.0	433.8	433.5	434.3	434.0	433.8	433.5	433.5	434.3	433.8	433.5
Bank	L	R	R	R	R	R	M	M	M	M	M	L	L	L
Bed/Patch	DR-1	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus ohiensis	-	-	-	-	1	-	-	-	-	-	-	-	FD	-
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata	-	-	-	1	-	-	-	-	-	-	-	-	1	-
Quadrula p. pustulosa	-	-	-	-	FD	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	0	1	1	0	0	0	0	0	0	0	2	0
No. species live	0	0	0	1	1	0	0	0	0	0	0	0	2	0
No. species total	0	0	0	1	2	0	0	0	0	0	0	0	3	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Outside	Straight	Straight	Inside	Straight	Straight	Channel	Channel	Channel	Channel	Channel	Straight	Outside	Straight
Depth (m)	3.0	4.0	5.0	2.8	5.0	3.8	4.0	5.5	4.5	5.0	4.8	-	2.5	2.0
Substrate														
Bedrock	-	65	-	-	50	-	30	45	-	50	100	-	-	-
Boulder	-	-	25	-	-	25	5	-	-	25	-	-	-	25
Cobble	-	-	-	-	-	-	10	-	-	-	-	-	-	15
Gravel	-	1	25	-	-	20	20	5	100	25	-	-	-	45
Sand	-	7	-	20	20	-	20	20	-	-	-	5	-	-
Silt	20	7	15	40	20	30	15	30	-	-	-	5	50	10
Clay	50	20	15	40	10	25	-	-	-	-	-	90	50	5
Detritus	30	-	20	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-58. Site 49 unionid species and habitat characteristics (page 3 of 4).

Approx. NM	435.8	435.6	435.6	435.3	435.3	433.0	437.1	437.0	434.8	434.6	437.1	437.0	435.8	435.5
Bank	R	R	R	R	R	R	R	R	R	R	M	M	M	M
Bed/Patch														
Lampsilis teres	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	1	-	-	-	1	-	1	-	-	-	-	-
Obliquaria reflexa	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Potamilus ohiensis	-	FD	-	-	-	-	-	WD	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Quadrula nodulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	1	1	1	1	0	2	0	1	0	0	0	0	0
No. species live	0	1	1	1	1	0	2	0	1	0	0	0	0	0
No. species total	0	2	1	1	1	0	2	1	1	0	0	0	0	0
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Inside	Inside	Inside	Inside	Inside	Outside	Straight	Straight	Straight	Straight	Channel	Channel	Channel	Channel
Depth (m)	5.0	1.5	0.8	1.0	5.8	4.0	3.0	5.1	1.8	5.0	5.4	6.0	7.0	6.5
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	25	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	25	-	-	-	25	-	-	10	10
Sand	40	20	15	15	25	-	100	-	25	5	40	20	50	50
Silt	20	20	15	15	20	5	-	40	25	20	20	30	15	10
Clay	20	60	70	70	50	45	-	60	40	50	40	50	25	30
Detritus	10	-	-	-	5	-	-	-	10	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-58. Site 49 unionid species and habitat characteristics (page 4 of 4).

Approx. NM	435.5	435.3	434.6	433.0	434.4	436.1	435.9	435.3	437.1	434.8	434.8	434.6		
Bank	M	M	M	M	M	L	L	L	L	L	L	L		
Bed/Patch													No.	%
Lampsilis teres	-	-	-	-	-	-	-	-	-	-	-	-	1	1.6
Leptodea fragilis	-	-	-	-	-	-	-	1	-	-	-	1	7	11.3
Obliquaria reflexa	-	-	-	-	-	-	-	-	-	-	-	-	33	53.2
Potamilus ohiensis	-	-	-	-	-	-	-	-	-	1	-	-	2	3.2
Potamilus purpuratus	-	-	-	-	-	-	-	-	-	-	-	-	2	3.2
Quadrula nodulata	-	-	-	-	-	-	-	-	-	1	-	-	6	9.7
Quadrula p. pustulosa	-	-	WD	-	-	-	-	FD	-	-	-	-	6	9.7
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	2	3.2
Tritogonia verrucosa	-	-	-	-	-	-	-	-	-	-	-	-	3	4.8
Total	0	0	0	0	0	0	0	1	0	2	0	1	62	
No. species live	0	0	0	0	0	0	0	1	0	2	0	1	9	
No. species total	0	0	1	0	0	0	0	2	0	2	0	1	9	
Appr. Density (no./m^2)	-	-	-	-	-	-	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	1.2	
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-		
Proposed	-	-	-	-	-	-	-	-	-	-	-	-		
Habitat	Channel	Channel	Channel	Channel	Tributary	Outside	Outside	Outside	Straight	Straight	Straight	Straight		
Depth (m)	5.0	7.0	5.0	5.0	3.5	4.5	5.0	5.0	3.0	5.5	5.8	4.5		
Substrate														
Bedrock	-	-	-	-	-	-	-	-	-	15	-	-		
Boulder	-	-	-	-	-	-	-	-	-	-	-	-		
Cobble	-	-	-	-	-	-	-	-	-	-	-	-		
Gravel	33	-	25	-	-	-	-	10	-	-	20	-		
Sand	33	60	35	-	7	-	2	15	-	50	10	25		
Silt	34	5	5	-	8	20	8	10	50	20	20	25		
Clay	-	30	35	100	85	70	87	60	50	-	50	50		
Detritus	-	5	-	-	-	10	3	5	-	15	-	-		
Shell	-	-	-	-	-	-	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-		
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-59. Site 50 unionid species and habitat characteristics (page 1 of 3).

Approx. NM	442.8	442.8	442.8	442.8	442.8	444.7	444.6	444.5	444.3	444.2	444.0	443.7	444.5	444.4	444.2
Bank	L	L	L	L	L	M	M	M	M	M	M	M	L	L	L
Bed/Patch	P50-1	P50-1	P50-1	P50-1	P50-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1	DR-1
Amblema plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	4	-	1	-	-	-	-	-	-	-	-	-	-
Obliquaria reflexa	2	5	7	1	-	-	-	-	-	-	WD	-	-	1	-
Potamilus ohiensis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	WD	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	2	-	1	-	-	-	-	1	-	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa	1	3	-	FD	-	-	-	-	-	-	-	-	-	-	-
Total	4	11	13	2	1	0	0	0	1	0	0	0	0	1	0
No. species live	3	4	4	2	1	0	0	0	1	0	0	0	0	1	0
No. species total	3	4	5	3	1	0	0	0	1	0	1	0	0	1	0
Appr. Density (no./m2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification															
Existing	-	-	-	-	-	Dredge	Dredge	Dredge	-	-	-	-	Dredge	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Straight	Straight	Straight	Straight	Straight	Channel	Channel	Channel	Channel	Channel	Channel	Channel	Straight	Straight	Straight
Depth (m)	2.5	2.5	2.5	1.5	1.5	5.0	4.8	4.3	4.5	4.5	4.2	4.2	4.0	3.0	2.7
Substrate															
Bedrock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	80	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	10	30	90	-	25	-	-	-	-
Sand	-	-	-	-	-	-	-	30	-	90	25	100	-	-	-
Silt	50	20	20	10	10	60	-	40	10	10	-	-	80	50	20
Clay	50	80	80	90	90	-	-	-	-	-	50	-	20	50	80
Detritus	-	-	-	-	-	40	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	2	5	4	-	-	-	-	1	-	-	-	-	1	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-59. Site 50 unionid species and habitat characteristics (page 2 of 3).

Approx. NM	444.0	443.7	443.4	442.3	443.0	442.9	443.1	442.7	442.5	442.3	442.0	443.2	441.5	440.7
Bank	L	L	L	R	R	R	M	M	M	L	L	L	M	M
Bed/Patch	DR-1	DR-1	DR-1	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-2	DR-3	DR-3
Amblema plicata	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptodea fragilis	-	-	-	FD	-	-	-	-	-	-	-	1	-	-
Obliquaria reflexa	1	-	-	-	-	-	-	-	1	1	-	1	-	-
Potamilus ohiensis	-	-	FD	-	1	-	-	-	-	-	-	-	-	-
Potamilus purpuratus	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Pyganodon grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula nodulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quadrula p. pustulosa	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Quadrula quadrula	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Tritogonia verrucosa	1	-	-	-	1	1	-	-	-	-	-	-	-	-
									-					
Total	3	0	0	1	2	2	0	0	2	1	0	2	0	0
No. species live	3	0	0	1	2	2	0	0	2	1	0	2	0	0
No. species total	3	0	1	2	2	2	0	0	2	1	0	2	0	0
Appr. Density (no./m2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification														
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge	Dredge
Habitat	Straight	Straight	Straight	Outside	Straight	Straight	Channel	Channel	Channel	Inside	Inside	Straight	Channel	Channel
Depth (m)	2.7	3.3	2.7	5.3	3.0	1.5	5.0	5.5	6.0	4.0	2.5	3.0	4.8	4.2
Substrate														
Bedrock	-	-	-	-	-	-	100	-	-	-	-	-	-	-
Boulder	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobble	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gravel	-	-	-	-	-	-	-	45	-	-	10	-	30	-
Sand	-	-	-	-	-	5	-	-	90	-	-	-	70	100
Silt	20	20	30	50	40	25	-	40	-	40	10	80	-	-
Clay	80	80	70	50	60	70	-	15	10	60	80	20	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	50	5.5	0.5	-	-	-	50	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-59. Site 50 unionid species and habitat characteristics (page 3 of 3).

Approx. NM	440.0	441.5	440.7	440.0	444.8	442.0		
Bank	M	L	L	L	L	R		
Bed/Patch	DR-3	DR-3	DR-3	DR-3				
Amblema plicata	-	-	-	-	-	-	1	2.2
Leptodea fragilis	-	-	-	-	-	-	6	13.0
Obliquaria reflexa	-	-	-	-	-	-	20	43.5
Potamilus ohiensis	-	-	-	-	-	-	2	4.3
Potamilus purpuratus	-	-	-	-	-	-	3	6.5
Pyganodon grandis	-	-	-	-	-	-	WD	
Quadrula nodulata	-	-	-	-	-	-	1	2.2
Quadrula p. pustulosa	-	-	-	-	-	-	5	10.9
Quadrula quadrula	-	-	-	-	-	-	1	2.2
Tritogonia verrucosa	-	-	-	-	-	-	7	15.2
Total	0	0	0	0	0	0	46	
No. species live	0	0	0	0	0	0	9	
No. species total	0	0	0	0	0	0	10	
Appr. Density (no./m2)	-	-	-	-	-	-		
Mean No./5min (CPUE)	-	-	-	-	-	-	1.3	
Modification								
Existing	-	-	-	-	-	-		
Proposed	Dredge	Dredge	Dredge	Dredge	-	-		
Habitat	Channel	Inside	Inside	Straight	Straight	Oxbow		
Depth (m)	3.0	3.0	3.9	5.7	3.0	2.0		
Substrate								
Bedrock	-	-	-	-	-	-		
Boulder	-	-	-	-	40	-		
Cobble	-	-	-	-	-	-		
Gravel	-	-	-	-	-	-		
Sand	-	-	-	60	-	-		
Silt	30	10	30	40	30	10		
Clay	70	80	70	0	30	90		
Detritus	-	10	-	-	-	-		
Shell	-	-	-	-	-	-		
Zebras/unionid	-	-	-	-	-	-	4.5	
Zeb coverage of substr	-	-	-	-	-	-		

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-60. Site 51 unionid species and habitat characteristics (page 1 of 2).

Approx. NM	AB0.9	AB0.7	AB0.1	AB0.0	444.9	AB0.5	AB0.4	AB0.4	AB0.3	AB0.8	AB0.6	AB0.3	AB0.1
Bank	R	R	R	R	R	M	M	M	M	M	M	M	M
Bed/Patch													
Leptodea fragilis	-	-	-	-	-	-	-	-	WD	-	-	-	-
Potamilus purpuratus	-	-	-	-	WD	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-	-	-	-
No. species live	-	-	-	-	-	-	-	-	-	-	-	-	-
No. species total	-	-	-	-	1	-	-	-	1	-	-	-	-
Appr. Density (no./m2)	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	-	-	-	-	-
Modification													
Existing	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed	-	-	-	-	-	-	-	-	-	-	-	-	-
Habitat	Straight	Straight	Inside	Outside	Outside	Straight	Straight	Straight	Outside	Channel	Channel	Channel	Channel
Depth (m)	-	-	4.0	4.0	4.0	3.5	4.5	4.5	4.3	-	4.5	4.9	6.4
Substrate													
Bedrock	-	-	-	-	-	-	-	-	-	100	100	-	-
Boulder	-	-	-	50	-	-	-	-	40	-	-	-	30
Cobble	50	-	-	50	-	-	-	-	40	-	-	50	30
Gravel	50	-	50	-	25	-	10	-	10	-	-	50	30
Sand	-	-	50	-	15	40	35	10	10	-	-	-	-
Silt	-	-	-	-	20	10	15	40	-	-	-	-	10
Clay	-	100	-	-	40	50	40	50	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-
Shell	-	-	-	-	-	-	-	-	-	-	-	-	-
Zebras/unionid	-	-	-	-	-	-	-	-	-	-	-	-	-
Zeb coverage of substr	-	-	-	-	-	-	-	-	-	-	1	-	-

AB = Distance above navigation (NM 445.0 ends navigable waterway)

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 3-60. Site 51 unionid species and habitat characteristics (page 2 of 2).

Approx. NM	AB0.0	AB0.9	AB0.0	AB0.2	AB0.3	AB0.0	445.0	444.9	
Bank	M	L	L	L	L	L	L	L	
Bed/Patch									
Leptodea fragilis	-	-	-	-	-	-	-	-	WD
Potamilus purpuratus	-	-	-	1	-	-	-	-	1
Total	-	-	-	1	-	-	-	-	1
No. species live	-	-	-	-	-	-	-	-	
No. species total	-	-	-	1	-	-	-	-	
Appr. Density (no./m2)	-	-	-	-	-	-	-	-	
Mean No./5min (CPUE)	-	-	-	-	-	-	-	-	0.0
Modification									
Existing	-	-	-	-	-	-	-	-	
Proposed	-	-	-	-	-	-	-	-	
Habitat	Channel	Straight	Straight	Outside	Inside	Inside	Inside	Inside	
Depth (m)	6.4	3.5	2.2	3.7	3.4	4.0	4.5	4.0	
Substrate									
Bedrock	-	-	-	-	-	-	-	-	
Boulder	-	-	10	-	-	50	-	10	
Cobble	50	-	-	-	-	-	-	-	
Gravel	25	-	80	-	-	25	40	-	
Sand	25	-	10	-	25	-	40	20	
Silt	-	-	-	20	25	-	20	70	
Clay	-	100	-	80	-	-	-	-	
Detritus	-	-	-	-	50	25	-	-	
Shell	-	-	-	-	-	-	-	-	
Zebras/unionid	-	-	-	-	-	-	-	-	
Zeb coverage of substr	-	-	-	-	-	-	5	-	

AB = Distance above na

DI=Disposal, DF=Dike Field, DR=Dredge, FD=Fresh Dead Shell, DR=Dredge, NM=Navigation Mile, TW=Tailwaters, WD=Weathered Dead Shell
R=Right desc. bank, M=Midchannel, L=Left desc. bank. B=Bed, P=Patch

Table 4-1. Summary of impacts to unionids and mitigation suggestions.

Reach	Site	dredge/disposal	Impact Major impact	Moderate	Minor impact	Mitigation suggestions
1	1	dredge		x		delineate bed and protect from future dredging if necessary, monitor for impacts of impoundment
	2	dredge	x			relocate # unionids to other areas, possibly placing a subset in a refugia to be reintroduced at a later date
	4	disposal		x		protect B4-1 from disposal activity if possible
	6	disposal		x		protect B6-1 from disposal activities if possible
	7	disposal		x		protect B7-1 and P7-1 from disposal activities if possible
2	8	disposal			x	none, will only affect scattered unionids
	9	disposal		?		recommend sampling disposal area NM95-96 before disposal activities occur
3	11	disposal		x		delineate bed and protect from future disposal activities if possible
	13	disposal		x		protect P13-1 & P13-2 from future disposal activities if possible
	22	dredge		x		monitor B22-1 &B22-2 & establish 150m buffer zone between bed and dredge area
5	31	dredge			x	none, will only affect a few scattered unionids
	33	dredge		x		avoid B33-1 if possible
	34	dredge			x	none, will only affect a few scattered unionids
	35	disposal		x		avoid P35-1 if possible
	39	dredge			x	avoid all areas within 20m of banks if possible
6	50	dredge			x	Avoid P50-1 if possible
	51	no activity				This area seemed suitable for unionids, possible mitigation site

Table 4-1. Number of unionid beds and patches, their occurrence in dredge and disposal areas.

			Dredge Sites	nids in dredge sites		Disposal sites	nids in dredge sites	
Reach	Beds	Patches	No. sampled	No. beds	No. patches	No. sampled	No. beds	No. patches
1	8	10	10	3	0	19	2	4
2	1	0	1	0	0	1	0	0
3	3	8	24	2	0	15	1	1
4	2	2	9	0	0	4	0	0
5	1	14	21	0	1	2	0	2
6	0	3	15	0	1	0	0	0
Total	15	37	80	5	2	41	3	7
% with beds or patches			8.8			24.4		

4.0 Summary and Conclusions

The MKARNS study area extends from the mouth of the Mississippi River (NM 0) to the head of navigation at NM 445 (see Figure 1-1). To achieve an 11ft channel, 113 locations (117.0 river miles) will need dredging, and to achieve the 12ft channel alternative 141 locations (124.0 river miles) will need dredging (see Table 1-1). In Reaches 1 through 4, permitted disposal areas will meet the needs of dredge material disposal. In Reaches 5 and 6, additional aquatic disposal sites will be needed.

Unionid samples were collected from 42 sites, which covered 129.9 river miles. A total of 1,202 samples were collected, which included 80 of the 141 dredge locations, 15 proposed disposal areas, and 40 permitted disposal areas. Points were also sampled in habitats that would not be affected by dredging or disposal of dredge material.

In general, unionid beds consisted of a thin strip of unionids (typically <25m wide) at the interface of the silt or riprap that occurs along the bank and the nearly 100% sand channel. Substrate in these areas was an equal mix of clay, sand, and silt. Patches of unionids were found along the banks and in coves, with gently sloping banks. Many of the patches of unionids were found riverward of water willow beds. Unionids were absent from homogeneous substrate, such as the 100% sand in the channel and areas near the bank that contained a high percentage of silt.

Very few unionid beds or patches were found within the MKARNS. These scattered patches and beds although a major unionid resource, are the only unionids within the MKARNS, and should be avoided whenever possible. Unionids were most abundant in Reach 1, Reach 3, and Reach 5. Eight beds and 10 patches were found in Reach 1 (Table 4-1). B1-1 was downstream of Lock and Dam 1 along the edge of a maintenance dredge area, B2-1, B2-2, and B2-3 were found in the Arkansas Post Canal (dredge areas), B4-1 and B6-1 were within permitted disposal areas, and B5-1 and B7-1 were in the mouths of tributaries. Four of the 10 patches in Reach 1 also fall within permitted disposal areas (see Table 4-1). Dredging will have a major impact on the unionids in the Arkansas Post Canal, and dredge disposal will affect unionids in B4-1, P5-1, B6-1, P6-1, P7-1, and P7-2. Disposal will not affect as many unionids as dredging in the Post Canal, but very few patches and beds of unionids were found throughout the river due to the lack of habitat.

Only one patch of unionids (P8-1) was found in Reach 2, and CPUE in Patch 8-1 averaged only 3.3 unionids/5min sample. This patch will not be affected by dredge or disposal. The disposal area at NM 95.0 was not sampled in this study, but habitat looks similar to habitat where unionids patches were found. This area should be investigated before disposal activity.

Three unionid beds and eight patches were identified in Reach 3 (see Table 4-1). Two of the three beds were in dredge areas, and the third bed is within a permitted disposal site. Beds 22-1 and 22-2 were the most significant beds in this reach. These beds were on the edges of the channel in the approach to Dardanelle Lock and Dam, and would be impacted if dredging widens the channel. Beds and patches within disposal areas should be delineated and avoided during future disposal activity.

Dardanelle and Ozark Lake were studied by Davidson (1997). His study and this study found unionids in most areas sampled; however, few large beds or dense patches were found. Two unionid beds and two patches were found in Reach 4 in this study. Davidson (1997) found unionid beds in coves and backwater areas that were not sampled in this study. Neither the patches nor beds found in Reach 4 were in dredge or disposal areas.

Much of Reach 5 outside of the main channel is very shallow and probably dries out during low water. Unionids are limited to areas that are inundated most of the time. They can move to deeper water or tightly close their valves to avoid dessication; however, repeated exposure often leads to high mortality. Deeper areas had either very loose sand and gravel substrate or very hard bedrock and boulder substrate. Since few areas with suitable depth and substrate occur in this reach, unionids were primarily limited to small patches. The only bed found, was within a proposed disposal site just upstream of Lock and Dam 15. Substrate was sand, clay and silt, and depth ranged from 1.5 to 3.4m. Four small unionid patches were found in San Bois Creek. P35-1 falls within a proposed disposal area and P35-2 falls within a dredge area. However, unionids were scattered along the edges of the channel, within coves, and around most of the islands and peninsulas that were sampled in San Bois Creek. Unionids will be moderately affected by dredging and disposal within the Creek.

Six patches of unionids were found along the edges of the channel downstream of Lock and Dam 15. Most areas with gentle slope to the bank, water willows on the bank, and clay, sand, silt substrate contained unionids. However, no unionids were found within proposed dredge areas. If areas within 20m of the bank are avoided, unionids should be protected.

Most of Reach 6 was devoid of unionids. The channel stretched from bank to bank, with <10m between the channel and the bank. Most of the bank areas were too shallow for unionids. Three patches were found within the nearly 15 miles that were sampled. Only one of the patches P50-1 was near a dredge area. Although only a few unionids would be affected by dredging in this area, only a few occur within the reach. Any unionids found within Reach 6 should be protected.

The MKARNS does not provide an abundance of habitat for unionids. All of the species in the river are common, and the river does not support a signifcant unionid community. However, since unionids were only found in a few areas, any disturbance to unionid beds and patches would affect a large portion of the unionid community in that area. Therefore, the 11ft and 12ft channel alternatives will have a moderate impact to the MKARNS unionid community. Areas known to harbor unionids should be avoided where possible, and areas that may harbor unionid beds or patches between the sampled sites should be investigated for unionids before dredge or disposal activity. The only area that cannot be avoided is the Arkansas Post Canal. The canal provides some of the best unionid habitat in the navigation system.

5.0 Mitigation Recommendations

The largest impact the 11ft or 12ft channel alternatives will have to unionids will be to the beds in the Arkansas Post Canal. As many as 2×10^6 unionids could occur in the canal; however, all of the species in the canal are common and no federal or state T&E species were found. To mitigate the impact to these unionids, some could be moved upstream into the Verdigris River within Site 51, where habitat seems suitable but no unionids were found. These animals would need to be checked annually for a few years to determine survival, growth, and reproduction. Unionids could also be moved to and stored at Mammoth Spring National Fish Hatchery, then seeded back into the canal after dredging. The fish hatchery can hold up to 10,000 unionids. Unionids from the canal could also be used to enhance unionid communities in other Arkansas Rivers.

Beds 22-1 and 22-2 should be protected from dredge activity. To protect these beds, they should be delineated before dredging activity occurs. Dredging should not occur within >150m from the beds. If dredging is to occur within 150m of the beds, unionids should either be relocated or surveyed for impacts for a few years following dredge activity.

In general, beds and patches found within permitted and proposed disposal sites should be avoided. Relocation of the unionids from these beds/patches would not be prudent. Since so little unionid habitat occurs in the river, preservation of unionid habitat should be a higher priority than preserving individual animals. Additionally, areas between sites that appear to have unionid habitat should be investigated before dredging or disposal activity.

Since dredging and disposal activity within the MKARNS system that is associated with the 11ft and 12ft channel alternatives will moderately affect the systems unionid community, a river wide management plan should be developed to protect unionids. Unionid beds and patches should be selected at intervals throughout the study area. These beds should be quantitatively sampled to establish current density, recruitment, mortality, and species richness. Unionid community trends should be assessed annually for at least five years, then a subset of sites assessed each year for five additional years.

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Attachment F

FINAL BIOLOGICAL OPINION

U.S. Fish and Wildlife Service
Endangered Species Act Section 7 Consultation

U.S Fish and Wildlife Service Reference: FWS/R2/OKES/2013-F-0391, 2013-F-0935

Programmatic Biological Opinion for operating multipurpose projects on the Red River, Arkansas River, Petit Jean River, and the Canadian River from Eufaula Lake to the Arkansas River confluence, and all of the McClellan Kerr Arkansas River Navigation System (MKARNS) within the Tulsa and Little Rock Corps Districts

Consulting Agency:
U.S. Army Corps of Engineers (Corps) and Southwestern Power Administration (SWPA)

Biological Opinion Conducted By:
U.S. Fish and Wildlife Service
Oklahoma Ecological Services Field Office
Tulsa, Oklahoma

Approved:

Jonna E. Polk

Jonna Polk, Field Supervisor
Oklahoma Ecological Services Field Office

July 12, 2016
Date

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INTRODUCTION

This transmits the U.S. Fish and Wildlife Service's (Service) revision to the existing Programmatic Biological Opinion (PBO) (2013-F-0935) finalized in April, 2013, pursuant to section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq*.). This joint U.S. Army Corps of Engineers (Corps) and Southwestern Power Administration (SWPA) action involves operating multipurpose projects on the Red River from Lake Texoma to Index, Arkansas, the Canadian River from Eufaula Lake to the Arkansas River confluence, the Petit Jean River from Blue Mountain Lake to the Arkansas River confluence, and all of the McClellan Kerr Arkansas River Navigation System (MKARNS) excluding Grand Lake and Hudson Lake. The USACE reservoirs in Kansas, Oklahoma and Texas that have operational releases into the MKARNS and Red River are also included, excluding several projects listed below. The Corps is the lead Federal agency for this consultation.

At least thirty federally-listed species occur in or near the Action Area. The Corps determined in their Biological Assessment (BA) that only three are likely to be affected by the proposed action (when the Grand Lake, Hudson Lake, Sardis Lake, Hugo Lake, Pine Creek, Broken Bow, and Millwood Projects are excluded, as described in below Description of Proposed Action). Amendments to the BA and PBO were incorporated to address the northern long-eared bat (*Myotis septentrionalis;* NLEB) listing (threatened), that was published April 2, 2015. The Service concurs with the determination that the endangered American burying beetle *Nicrophorus americanus* (ABB), interior population of the least tern *Sternula antillarum* (hereafter referred to as least tern) and NLEB may be affected by the proposed action. The Corps and SWPA, when applicable, have proposed or agreed to incorporate actions recommended by the Service to minimize adverse effects to these species, but adverse effects to the ABB, least tern and NLEB are not completely avoided by the proposed action. This revised Biological Opinion (RBO) updates minimization measures and incidental take for the ABB and adds incidental take for the NLEB. Minor extensions in compliance dates were incorporated for the least tern, but no revisions for incidental take were necessary. No changes were necessary for any other federally listed species.

This opinion emphasizes anticipated effects of the proposed action on the least tern, American burying beetle, and NLEB. The RBO is based on the best available scientific and commercial information, including the Corps BA, Service files, pertinent literature, discussions with recognized species authorities, and other reliable sources. A complete administrative record of this consultation is on file in the Oklahoma Ecological Service's Field Office (OKES) in Tulsa.

CHRONOLOGY OF SECTION 7 EVENTS/CONSULTATION HISTORY

The Corps operated Kaw and Keystone reservoirs on the Arkansas River in Oklahoma under the provisions of a biological opinion completed on March 16, 1998, followed by a re-initiation of consultation that addressed many additional Corps projects and a biological opinion completed on June 27, 2005.

A chronology of previous section 7 consultation activities prior to 2005 on the Arkansas, Red, and Canadian River system in Oklahoma can be found in the Service's opinions dated March 16, 1998, and June 27, 2005. These opinions provide a history of all activities and correspondence from the start of informal consultation in 1986 to issuance of the opinions in 1998 and 2005. The following is an update of all events and issues with respect to the consultation since issuance of the 1998 and 2005 opinions.

Between June 2005 and February 2011 the Little Rock and Tulsa districts of the Corps and SWPA monitored, evaluated, and coordinated adjustments of project operations under the 2005 opinion. However, portions of the proposed action have changed and the five-year moving average of adult and fledgling numbers only met the compliance levels set in the 2005 opinion for the Arkansas River, Oklahoma portion of the project area. The five-year averages for both adults and fledglings were not met on the Red River and only adult numbers met the five-year compliance standards on the Arkansas River, Arkansas. In addition, the 2005 opinion's requirements of maintaining suitable habitat for nesting, monitoring and evaluating habitat conditions, and reducing predation and human disturbance were not sufficiently met. Based on the above issues, the Service recommended, prior to and during the 2011 least tern nesting season, that the Corps/SWPA re-initiate consultation for the proposed activities covered by the 2005 opinion. A separate consultation was initiated for modifications (through a 404 permit) to Zink Dam on the Arkansas River in Tulsa, Oklahoma.

On February 14, 2012, the Corps provided a biological assessment for the re-initiation of consultation. On March 12, 2012, the Corps/SWPA and Service staff met to discuss the Service's concerns with project operations on several mussel species included in the biological assessment. Additionally, the Service requested additional information regarding the Arkansas Navigation Feasibility Study. The Corps provided the additional information in letters dated March 27 and 28, 2012, and requested that the Service remove two federal projects, Hugo and Sardis Lakes, from their original biological assessment. Other Corps/SWPA projects on the Little River system were excluded in the biological assessment, because the Little River confluence with the Red River is downstream of Index, Arkansas. The Service initiated formal consultation on March 27, 2012, in a letter dated April 3, 2012. On August 14, 2012, the Corps/SWPA requested an extension and amended the biological assessment to include modifications to the Eufaula Project and adding several reservoirs in Oklahoma, Kansas, and Texas to address the effects of flood pool operations on ABBs. A draft biological opinion was submitted to the Corps/SWPA for their review on September 18, 2012. The Corps and SWPA provided comments and met with the Service on November 19, 2012. Potential changes were discussed with Corps/SWPA staff and a revised draft biological opinion was submitted to the Corps on January 14, 2013. Additional comments were submitted by the Corps/SWPA on February 12, 2013 and a meeting to discuss those comments was held on February 26, 2013. Comments were considered and the final PBO was completed and sent to the Corps/SWPA on April 10, 2013.

During the Spring and Summer of 2014, new scientific information became available for the ABB and new Service recommendations were developed to minimize and avoid take of ABBs. The new recommendations for ABB surveys and minimization measures required changes in the Corps proposed actions. The Service recommended reinitiation of consultation and discussed potential revisions with Corps staff. The Corps requested reinitiation of consultation in a letter dated August 12, 2014 and staff suggested additional revisions to programmatically address potential take related to multiple Corps permits for utility easements, mowing and vegetation management, and other common actions on Corps lands. The Corps provided estimates to quantify (acres) the potential ABB take related to these common actions in September and October of 2014 and proposed enhancement and protection of habitat on Corps lands to provide mitigation for the incidental take and impacts to ABB habitat. The NLEB listing (threatened), was published April 2, 2015, and effects of the proposed action were reviewed for this species. A draft RBO was provided to the Corps/SWPA for review on July 29, 2015 and comments were sent to the Service via several emails during the remainder of 2015 and April-June of 2016. Comments were considered and the final RBO was completed and sent to the Corps/SWPA on July 12, 2016.

DESCRIPTION OF PROPOSED ACTION

The proposed action is the operation and maintenance of Corps multi-purpose projects for portions of the Arkansas River, Red River, and Canadian River in Kansas, Oklahoma, Texas, and Arkansas, and the Petit Jean River in Arkansas. The proposed action includes flood control, water quality, fish and wildlife, navigation, water supply, recreation, and hydropower operations (including SWPA operations). This includes Dam Safety and Interim Risk Reduction Plans for Keystone Dam and the Corps actions in compliance with the 2005 biological opinion, including incidental take and implementation of reasonable and prudent measures for the least tern, ABB, and NLEB. These actions include building and maintenance of multiple least tern nesting islands. Some islands have already been constructed in the MKARNs system and Kerr Island has had relatively high fledgling per breeding pair ratios compared to the nearby river system, the Canadian River below Eufaula Dam. Other nesting islands have been created in the Arkansas portion of the MKARNS with mixed success. The Corps' creation of these islands has benefited least tern nesting success for this portion of the action area.

During the least tern nesting season, site-specific conditions throughout the action area in the Tulsa and Little Rock Districts will be monitored and discussed by the least tern coordination team via regularly-scheduled and recurring meetings/conference calls. It is anticipated that these meetings/calls will be conducted weekly unless conditions do not warrant this frequency. During normal operations, and unless site-specific conditions warrant deviations to protect nesting least terns, the Corps will conduct reservoir pool management and associated reservoir releases in accordance with criteria in existing, approved reservoir water control manuals (WCM) throughout the action area. When conditions develop that pose a threat to nesting least terns, as determined by the Corps after consultation with the Service and least tern team, the Corps will expeditiously request a deviation from WCM procedures to protect nesting terns to the maximum extent possible within current authorities and consistent with authorized project purposes. The deviation request will be tailored in such a way that it is clear that it is for the purpose of compliance with the ESA, is a high priority, and requires a timely decision. The decision regarding a requested deviation will be shared with the least tern team as soon as it is received and resulting changes to reservoir operations, if any, implemented as expeditiously as possible.

The proposed action also includes natural resource management activities on specified portions of Corps multi-purpose projects licensed to the Oklahoma Department of Wildlife Conservation (ODWC) in Oklahoma. Examples of activities anticipated to be conducted by the ODWC on licensed lands include new fence installation or replacement, grazing leases, establishment and maintenance of firebreaks, establishment of food plots for wildlife use and management, construction and maintenance of wetland s. construction of minor access roads, prescribed burning, mowing and brush cutting around existing facilities, and similar actions related to land management for fish and wildlife purposes.

The proposed actions also include the Dredge Material Disposal Management Plan (Action Area II) and the Arkansas River Navigation Feasibility Study (Action Area III) for the Verdigris and Arkansas Rivers. A more complete description of the proposed actions is provided in the BA (USACE 2012) and is incorporated by reference. The proposed action described in the BA was subsequently modified on March 28, 2012, in a letter from the Corps to exclude and modify operations at Sardis and Hugo Lakes in Oklahoma and initiate consultation for those operations at a later date. The Service believes that these operations may affect the Ouachita rock pocketbook (*Arcidens wheeleri*) and scaleshell mussel (*Leptodea leptodon*). The Service recommends initiating formal consultation for the Pine Creek and Broken Bow Projects because these projects have potential to affect the two listed mussels mentioned above and leopard darters (*Percina pantherina*). The Millwood Project is also in the Little River System and may affect federally listed mussels. The Service agrees that a separate consultation would allow for additional discussions to take place and the remainder of the proposed action to continue on schedule. However, until that consultation is completed, the Corps currently has no exemption from section 9 of the Act for take related to operations at these projects.

Except for the Arkansas River Navigation Feasibility Study, the Corps has again excluded specific action areas associated with operations at Grand and Hudson lakes. The Corps is not responsible for operation of these projects when the water surface elevations are below the flood control pool. However, the existing Corps flood control operations at Grand Lake occasionally flood gray bat (*Myotis grisescens*) maternity caves and may adversely affect ABBs in the flood pool and Neosho madtom (*Noturus placidus*) habitat upstream within the effects of the reservoir flood storage. It is unlikely that flood control operations could be sufficiently altered to completely avoid adverse effects to federally-listed species, and formal consultation regarding these operations likely will be required to comply with section 7 of the Act. We continue to recommend that this consultation include the Federal Energy Regulatory Commission, because some of their ongoing and future actions (such as hydropower generation and a potential new rule curve) are interrelated with the Corps flood control operations at Grand and Hudson Lakes. Until that consultation is completed, the Corps currently has no exemption from section 9 of the Act for take related to flood control operations at Grand and Hudson Lakes.

The BA was again modified on August 14, 2012, to add potential revisions to the shoreline management plan development at Lake Eufaula (Roundtree Landing Public Use Area) with a lease of approximately 335 acres and approximately 75 acres of soil disturbing activities such as roads, trails, etc., with the proposed action. The proposed development would include multiple recreational facilities such as a marina, camping, outdoor classrooms, swim beaches, nature center, hiking and biking trails, and would be part of the Carlton Landing resort community on adjacent private lands.

Through reinitiation, the proposed action was amended in 2014 to include land use changes, natural resource management measures, real estate out-grants, easements, leases, consents to mineral exploration, and shoreline management activities. The Corps provided estimates to quantify (acres) of potential ABB take related to these common actions in September and October of 2014 and proposed enhancement and protection of habitat on Corps lands to provide mitigation for the incidental take and impacts to ABB habitat. Additional changes were incorporated in April of 2015 to address land use changes, natural resource management measures, real estate out-grants, easements, leases, consents to mineral exploration and shoreline management activities in Arkansas and potential effects of flood pool storage to the NLEB.

Land Use Changes - These changes may include temporary or permanent impacts to habitat. Land use changes can include modification of existing or establishment of new recreation areas. Some changes may result from the reclassification of Civil Works project lands. Examples of changes include construction of restrooms, water and wastewater treatment systems, parks, roads, boat ramps, parking areas, playgrounds, camp sites, utility infrastructure, and other recreation-related projects. The Corps estimates up to 20 acres of temporary (Tulsa District) and 62 (47 in the Tulsa District, 15 in the Little Rock District) acres of permanent impacts could occur annually due to land use changes within the action area.

Natural Resource Management Measures - Examples of natural resource management include food plots for wildlife, prescribed fire and construction and maintenance of fire breaks, access control structures, fences, access roads, timber harvest/sales, grazing leases, thinning or control of woody vegetation, control of invasive vegetation and re-establishing native vegetation, stream bank stabilization and erosion control. For natural resource management measures, the Corps estimates up to 11,735 (11,385 in the Tulsa District, 350 in the Little Rock District) acres of temporary and 50 (all in the Tulsa District) acres of permanent impacts could occur annually within the action area. The Tulsa District estimate includes 9,145 acres of temporary impacts from ODWC activities on Corps licensed areas.

Real Estate Out-Grants and Easements - Temporary and permanent impacts may occur from out-grants of real property. Temporary impacts may include installation and maintenance of utilities and upland dredge material disposal. Permanent impacts may include installation of structures such as sidewalks, buildings, roads, boat ramps, parking areas, campgrounds, utilities, fences, entryways, improvements or additions to existing structures, wastewater treatment systems, drainage improvements and erosion control. Easements and leases may include pipelines, utility lines, roadways and mineral exploration/extraction. The Corps estimates up to 218 (203 in the Tulsa District, 15 in the Little Rock District) acres of temporary and 63 (all in the Tulsa District) acres of permanent impacts could occur annually for these types of activities within the action area.

Shoreline Management - The Corps issues shoreline management permits for activities such as construction or clearing of walking pathways, landings, bank stabilization, fire breaks, and reversal of vegetative succession, this includes mowing and clearing of vegetation. The Corps estimates up to 20 acres of temporary (Tulsa District) and 138 (135 in the Tulsa District, 3 in the Little Rock District) acres of permanent impacts could occur annually for these types of activities within the action area.

Mitigation – The Corps proposes to develop an ABB mitigation and management plan within 18 months of the completion of this consultation. The Corps proposes to set aside and manage approximately 2,000 acres in the Tulsa District and 1,350 in the Little Rock District to provide mitigation for anticipated impacts.

MKARNS Dredge Material Disposal Management Plan (Verdigris and Arkansas rivers, Oklahoma)

The River & Harbor Act of 1946 authorized USACE to maintain the MKARNS navigation channel to a nine-foot depth. Maintenance of a 12-foot channel depth was subsequently authorized by Section 136 of the Energy and Water Development Appropriations Act of 2004 (Section 136 of Public Law 108-137) in an effort to match higher tow drafts found in the lower Mississippi River. However, the deepening has been delayed by a lack of Congressional funding so maintenance of the nine-foot target is ongoing. This maintenance is primarily done by dredging which is a chief measure in the suite of maintenance strategies employed by USACE to ensure navigation mission success. A variety of river training structures are also used to promote natural scouring and reduce maintenance dredging needs.

The removal, transport, and placement of sediments are the primary components of the dredging process. After the sediment has been removed with the most appropriate means it is transported from the dredging site to the designated disposal area. This transport operation is accomplished using the dredge itself or with barges or pipelines equipped with booster pumps. The dredged material is then placed in open-water, island, or upland disposal locations chosen using site availability and access, governing regulations, and environmental considerations. Dredge disposal sites are typically located as close as possible to expected dredging locations. Disposal of dredged material accumulated through maintenance of the MKARNS channel has been in sites designated in the Operations and Maintenance Plan (O&M Plan; USACE 1974). These sites were approved in an associated EIS (USACE 2005a).

Since completion of the MKARNS in 1971, some authorized dredged material disposal sites have reached capacity (primarily in Oklahoma) and new disposal sites are required to accommodate future navigation channel maintenance activities. This is especially true if Congress provides funds for deepening the MKARNS to 12 feet. The Dredge Material Disposal Management Plan (USACE 2005a) constitutes a 20-year strategy for disposal of dredged material accumulated while maintaining the Oklahoma portion of the MKARNS through 2023. A total of 23 dredge material disposal sites are identified in the Dredge Material Disposal Management Plan which is in Action Area II. All have been approved for use in the Arkansas River Navigation Final EIS (USACE 2005b) for which a Record of Decision was signed. Of the 23 sites 10 require containment structure (e.g., dike) construction. Seven of these disposal sites have been built and five are active. The remaining 13 disposal sites do not require construction for use. Four of these are active disposal sites while nine remain inactive. For this BO, all 23 sites are evaluated for potential impacts on federally-listed species.

Arkansas River Navigation Feasibility Study (Verdigris and Arkansas Rivers, Oklahoma-Arkansas, Phases I and II)

In 2005 the USACE, Tulsa and Little Rock districts completed a combined Arkansas River Navigation Feasibility Study consisting of two phases. The overall purpose of the study was to identify alternatives for maintaining and improving the MKARNS while meeting other congressionally-authorized purposes for the projects within the network. Implementation of the most beneficial and feasible changes to the MKARNS would make the system more reliable and efficient for moving cargo while reducing flood risk. Details about this study and its findings can be found in the Arkansas River Navigation Study Final Feasibility Report (USACE 2005a).

Implementation of this plan is authorized by Section 136 of the Energy and Water Development Appropriations Act of 2004 (Section 136 of Public Law 108-137). However, the project has been delayed by a lack of Congressional funding. Should the plan be put in place mitigation would be conducted by USACE for adverse impacts associated with the actions. The mitigation plan has been developed in coordination with the Service, Arkansas Game and Fish Commission, and the Oklahoma Department of Wildlife and Conservation. Mitigation for terrestrial and aquatic impacts would consist of a combination of avoidance, minimization, and compensation and would be associated with terrestrial habitat loss resulting from the disposal of dredged material, aquatic resources impacts and habitat loss resulting from dredging and dredged material disposal, aquatic habitat loss caused by raising and extending dikes and revetments, and impacts to Federally-listed species.

DESCRIPTION OF ACTION AREAS

This opinion addresses effects to federally-listed species related to Corps studies and operational and management activities on projects located within these areas:

- The main stem of the Arkansas River from Kaw Reservoir to Muskogee, Oklahoma, the MKARNS, and the impacts of 11 operational Oklahoma reservoirs associated with releases into the MKARNS downstream to the mouth of the White River in Arkansas and then to the Mississippi River. These operational reservoirs include Keystone Lake, Oologah Lake, Grand Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake. Other Corps projects in the Arkansas River watershed and not directly associated with the MKARNS, but included for this consultation, are the Elk City (Kansas), Pearson-Skubitz Big Hill (Kansas), Heyburn, Birch, and Skiatook Lakes in Oklahoma, and Blue Mountain and Nimrod reservoirs in Arkansas.
- Lake Eufaula and a total of 27 miles of the Canadian River from Eufaula Dam to the confluence of the MKARNS.
- Lake Texoma and approximately 240 miles of the Red River from below Denison Dam to Index, Arkansas, and the impacts of Pat Mayse lake (Texas) operations on water flow in the Red River.

A more complete description is provided in the BA and 2013 Biological Opinion.

Action Area I - Arkansas River (Kaw Lake to Muskogee, Oklahoma)

Kaw Lake is a main stem impoundment on the Arkansas River located at river mile 653.7. This reservoir was constructed by the Corps for flood control, water supply, water quality, recreation, and fish and wildlife and became operational in May 1976. Keystone Lake is also a main stem impoundment bisecting the Arkansas River at river mile 538.8, about 15 miles upstream of Tulsa, Oklahoma. This reservoir was constructed by the Corps for flood control, water supply, hydroelectric power, navigation, and fish and wildlife and became operational on November 20, 1964. Water released from Kaw and Keystone dams in the form of regulated flood flow, water quality, water supply, and hydropower releases contributes to main stem flows on the Arkansas River. Reaches within Action Area I to be considered and evaluated in this opinion are defined as follows:

- The 97-mile reach of the Arkansas River from Kaw Lake to Keystone Dam.
  The 58-mile reach of the main stem of the Arkansas River from below Keystone Dam to its confluence with the Verdigris River and the MKARNS at navigation mile 395 (See Figure 1).

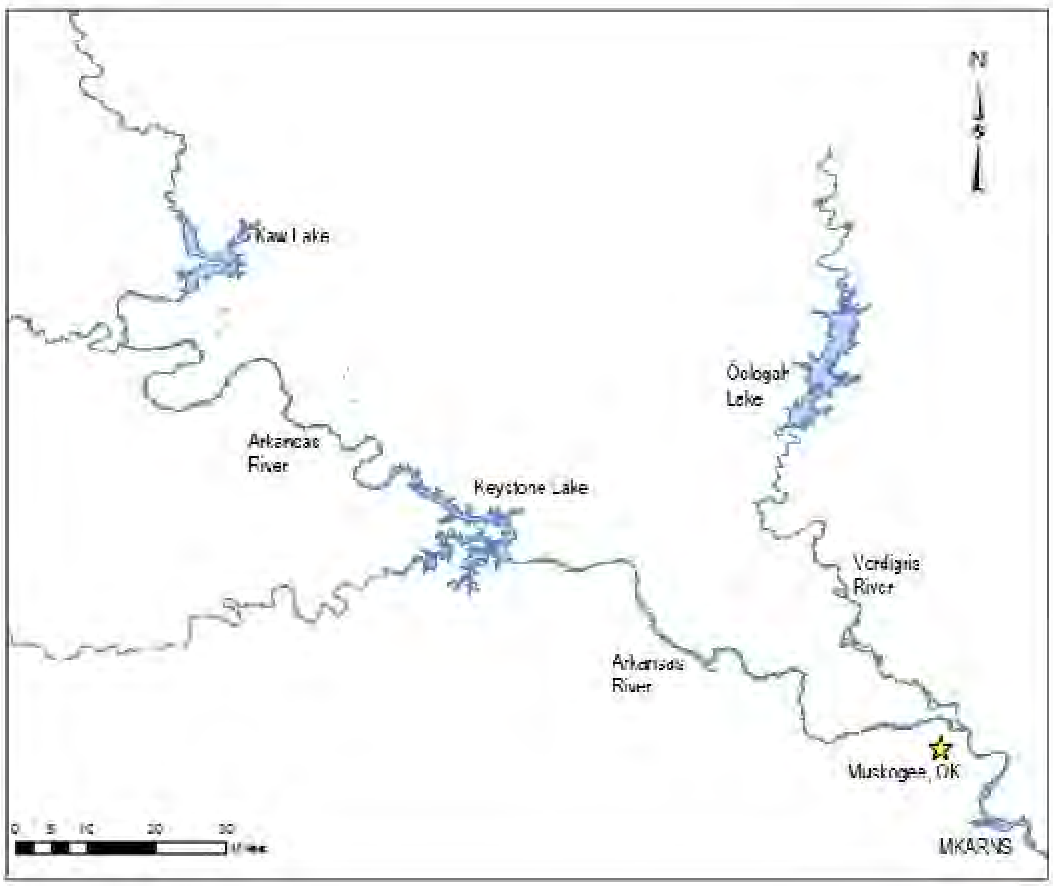


Figure 1. Kaw Lake to Muskogee, Oklahoma

Action Area II and III - McClellan-Kerr Arkansas River Navigation System

The MKARNS action area (Figure 2) is approximately 445 miles in length and consists of a series of 18 locks and dams. Currently, the Corps, Tulsa District and Little Rock District cooperatively control flows in the Arkansas River system in Kansas, Oklahoma, and Arkansas. However, the Little Rock District's operational flexibility in controlling flows is very limited.

The action area for the ARNS includes the MKARNS from the Port of Catoosa near Tulsa, Oklahoma, downstream to the confluence of the Mississippi River in southeastern Arkansas, as well as 11 reservoirs in Oklahoma that influence river flow within the MKARNS. The Oklahoma portion of the MKARNS includes approximately 140 navigation miles of channel. Channel widths vary throughout, including 250 feet along the Arkansas River, 150 feet along the Verdigris and Poteau rivers, and 225 feet along the Sans Bois Creek. The depth of the navigation channel is approximately 9 feet minimum throughout the MKARNS.

The reaches of Action Area II to be considered and evaluated in this opinion are defined as follows:

- Along either side of the MKARNS from the head of navigation on the Verdigris River at Catoosa, Oklahoma, navigation mile 445.2, to the lower limits of the Oklahoma portion of the MKARNS at navigation mile 308.5.

Action Area III reaches to be considered and evaluated in this opinion are shown in Figure 2 and defined as follows:

- A 50-mile reach of the Verdigris River from the Port of Catoosa to Muskogee (navigation miles 445-394).
- Lower Arkansas River, which comprises 375 miles of the MKARNS (navigation miles 394 to 19).
- The Arkansas Post canal, a 9-mile canal connecting the Arkansas River to the lower portion of the White River (navigation miles 19 to 10).
- The lower 10 miles of the White River (navigation miles 10 to 0).
- The lower Arkansas River downstream of Dam 2 (not formally part of the MKARNS). This portion of the Arkansas River is included in the Arkansas River Navigation Study project area because MKARNS river flows may also influence this segment of the river.
- Eleven reservoirs in Oklahoma may influence flows on the upper Arkansas River when operated for flood control, water supply, hydroelectric power, fish and wildlife, recreation, and other benefits. These include Keystone Lake, Oologah Lake, Pensacola (Grand) Lake, Lake Hudson, Fort Gibson Lake, Tenkiller Ferry Lake, Eufaula Lake, Kaw Lake, Hulah Lake, Copan Lake, and Wister Lake. Other Corps projects in the Arkansas River watershed (not associated with the MKARNS), but included for this consultation for the operation of their flood pools, are the Elk City , and Pearson-Skubitz Big Hill reservoirs in Kansas, Heyburn, Birch, and Skiatook reservoirs in Oklahoma, and Blue Mountain and Nimrod reservoirs in Arkansas.

Figure 2. McClellan-Kerr Arkansas River Navigation System.

Action Area IV - Canadian River, Oklahoma

The Canadian River originates in Colfax County, New Mexico, and flows southeasterly through New Mexico and easterly through the Texas Panhandle. It enters Oklahoma and forms the boundary between Ellis and Roger Mills counties. The river then travels eastward some 410 miles across the state of Oklahoma and joins the Deep Fork River and North Canadian River to form Eufaula Lake. Eufaula Lake was constructed by the Corps on the Canadian River at mile 27.0, and became operational in September 1964. Project purposes are flood control, water supply, hydroelectric power, and navigation (sediment control). The Canadian River exits Eufaula Dam and flows eastward to its confluence with the MKARNS near navigation mile 357 and the Haskell County and Muskogee County line.

For assessment purposes, this component of the opinion is defined as follows:

- The 27-mile reach of the main stem of the Canadian River downstream of Eufaula Dam to its confluence with the MKARNS at navigation mile 359.3.

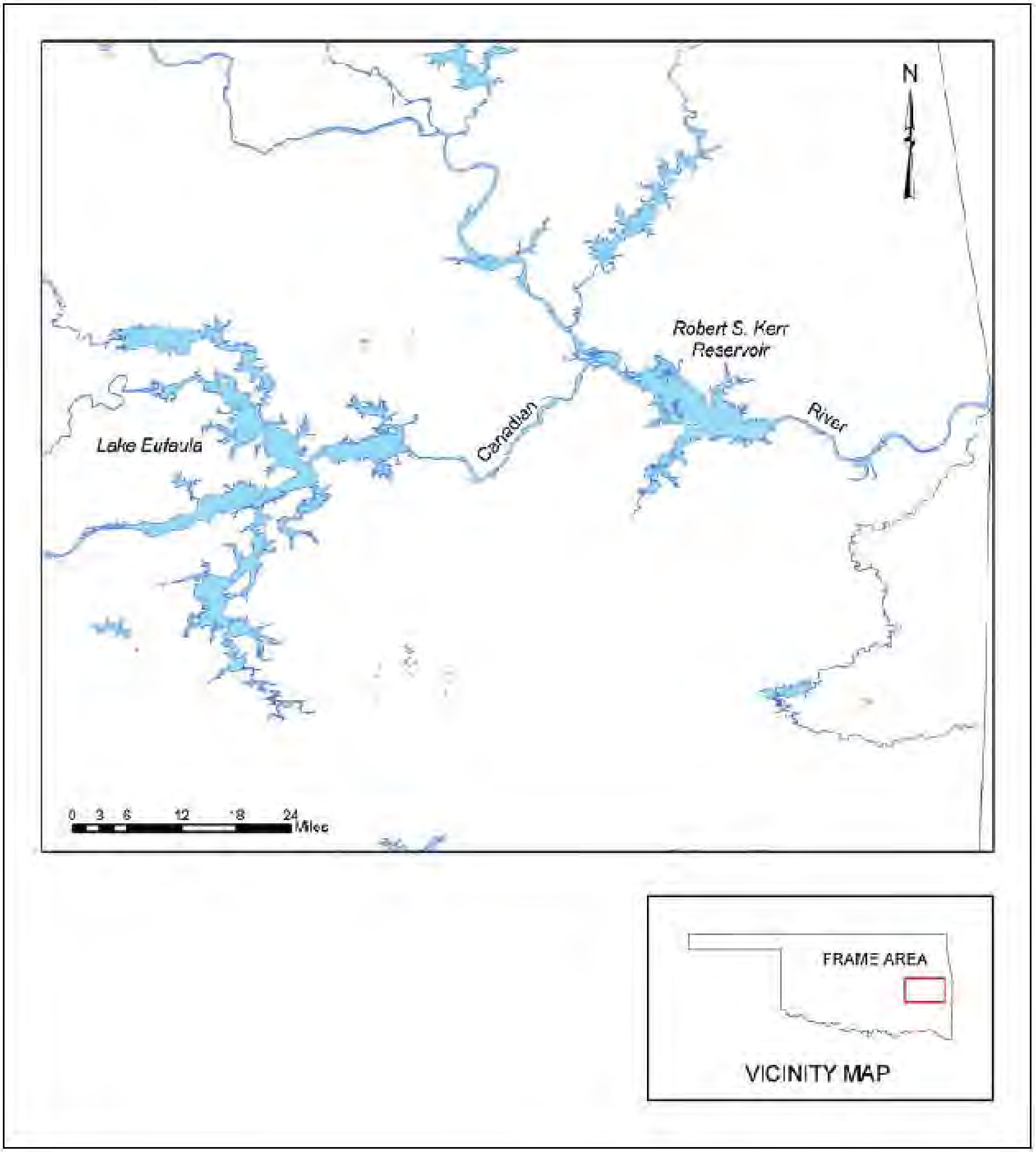


Figure 3. Canadian River, Oklahoma, downstream from Eufaula Reservoir.

Action Area V - Red River, Lake Texoma to Index, Arkansas; Texas; and Oklahoma

The main stem of the Red River has a total length of 1,217 miles with a total drainage area of 94,450 square miles of which 73,671 square miles actually contribute to flows. The Oklahoma portion of the basin is comprised of 22,791 square miles while 24,463 square miles lie within Texas. There are 29 stream segments totaling 1,616 stream miles within the Red River basin. One of these segments (i.e., a mainstem reach of Red River between Denison Dam and

Index, Arkansas) occurs within the action area and is described in subsequent text. The basin also includes 32 significant reservoirs of which four are USACE projects (i.e., Texoma, Pat Mayse, Sardis, and Hugo lakes) that occur within the action area and are described herein. Action areas associated with Broken Bow and Pine Creek lakes are within the Red River basin below Lake Texoma but are being excluded from this opinion because outflows from these USACE projects enter the Red River downstream of Index, Arkansas which is outside the assessed area. Additionally, the Corps has requested to exclude Sardis and Hugo lake operations from this opinion and plan to initiate consultation for those operations at a later date.

Lands surrounding the Red River and Lake Texoma have various vegetation types typical of the transitional Osage Savanna biotic district (Blair and Hubbell 1938) in which it occurs. Much of these lands have been cultivated or cleared for ranch operations resulting in a mosaic of cultivated fields and pastures interrupted by narrow bands of woodlands and an extensive road network. Typical crops in the project area include cotton, winter wheat, and peanuts while pastures contain a mixture of native and introduced grasses. Oil and gas production are also primary land uses within the area.

The Red River is one of the two major river systems draining Oklahoma. The River originates from small streams in eastern New Mexico and gradually runs eastward approximately 517 miles to the Oklahoma-Arkansas State line in southwestern Arkansas. In its extreme western reaches it is composed of the Prairie Dog Town Fork of the Red River, which flows southeasterly to form the southern border of Oklahoma east of the 100th meridian. At the confluence of the Prairie Dog Town Fork of the Red River with the Salt and North Forks of the Red River, it continues as the State's southern border but is referred to simply as the Red River. In Oklahoma, there are 22,791 square miles of contributing drainage area to the Red River. At river mile 725.9, the main stem of the Red River is bisected by Denison Dam (Lake Texoma), which was constructed by the Corps for flood control, water supply, hydroelectric power, regulating flows, and improving navigation. Upon exiting Denison Dam, the river flows approximately 240 miles to Index, Arkansas, which is the eastern limit of the Corps, Tulsa District.

Lake Texoma was formed by impoundment of the Red River (Denison Dam; River Mile 725.9) about five miles northwest of Denison, Grayson County, Texas. The reservoir has two major arms, including the Red and Washita rivers. These arms, the main pool, and other principal tributary segments inundate portions of Bryan, Johnston, Love, and Marshall counties, Oklahoma, and Cooke and Grayson counties, Texas. The general topography of Lake Texoma is rolling to hilly with occasional escarpments and benches. In many places, the valley slopes are steep resulting in rugged hills with shoreline cliffs and promontories. Topography of other typical shorelines range from gently sloping flats with sandy beaches to rocky areas with steep, wooded hillsides.

For assessment purposes, this opinion will assess the impacts of operating Lake Texoma on all federally-listed species on the Red River to the eastern limits of the Tulsa District. The limits of Action Area V are defined as follows:

- Lake Texoma.
- The 240-mile reach of the Red River below Denison Dam to Index, Arkansas.

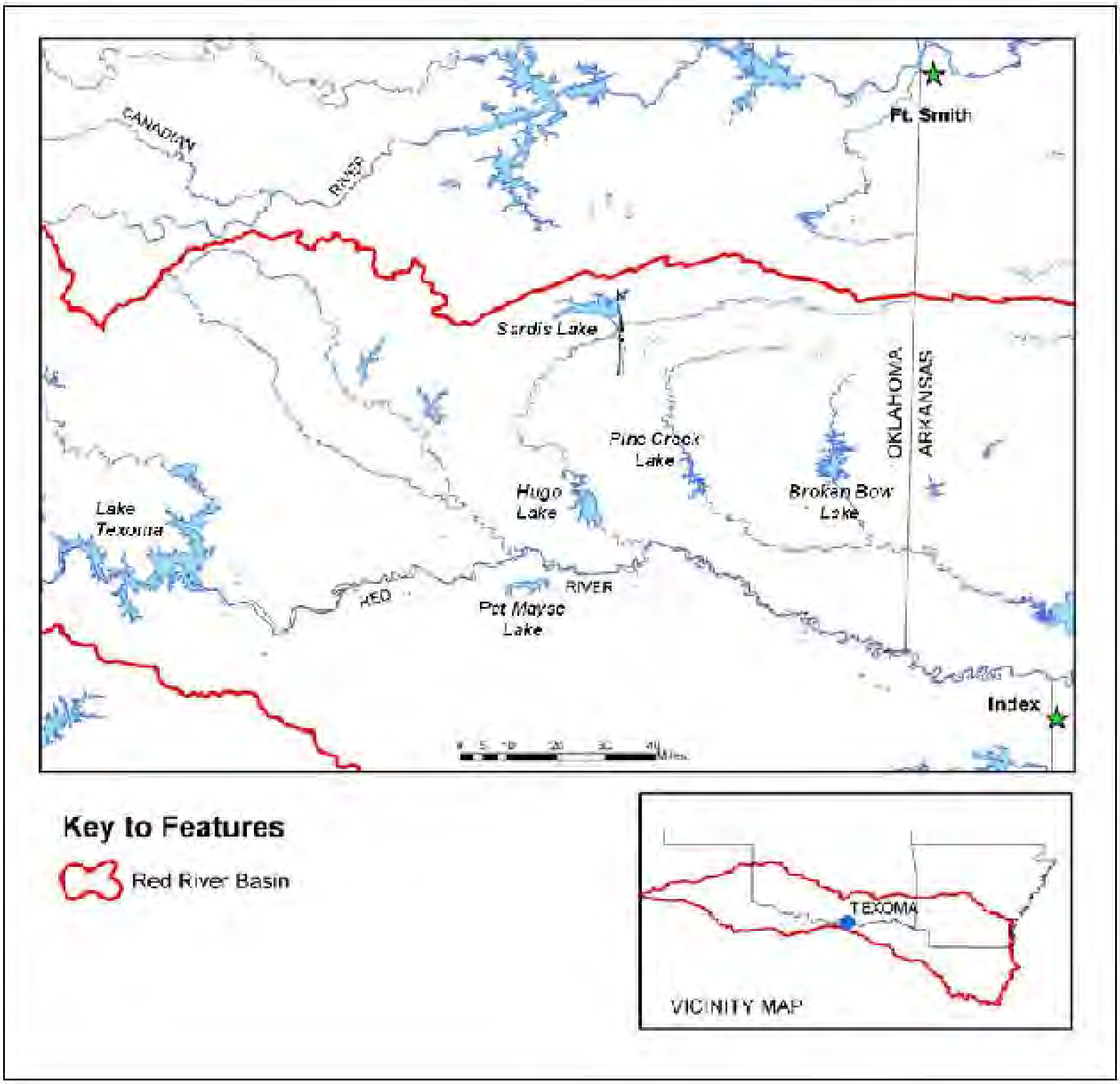


Figure 4. Red River, Oklahoma, Texas, Arkansas. Downstream from Denison Dam, Lake Texoma.

STATUS OF AFFECTED SPECIES

At least thirty federally-listed species historically occurred in or near the Action Area; however, existing information indicates that only the endangered ABB, threatened NLEB, and endangered least tern are likely to be affected by the proposed action. The ABB, NLEB, and least tern are the only species addressed in this consultation.

American Burying beetle

A summary of current information is provided below but new information is expected in the upcoming years and this biological opinion is intended to be a relatively long term, programmatic document. Information on ABB life history and status is available and updated frequently on the Service's Oklahoma Ecological Services Office website (***http://www.fws.gov/southwest/es/Oklahoma/ABB_Add_Info.htm***),

Species Description

The ABB is the largest silphid (carrion beetle) in North America, reaching 1.0 to 1.8 inches in length (Wilson 1971, Anderson 1982, Backlund and Marrone 1997). Size, particularly pronotal width, is highly correlated with weight (Kozol et al. 1988). Pronotal width of ABBs ranged from 0.344 – 0.500 inches in a laboratory study and 0.314 – 0.497 inches at Block Island. The beetles are black with orange-red markings. The hardened elytra (wing coverings) are smooth, shiny black, and each elytron has two scallop shaped orange-red markings. The pronotum (hard back plate of the front portion of the thorax of insects) over the mid-section between the head and wings, is circular in shape with flattened margins and a raised central portion. The most diagnostic feature of the ABB is the large orange-red marking on the raised portion of the pronotum, a feature shared with no other members of the genus in North America (Service 1991). The ABB also has orange-red frons (the upper, anterior part of the head), and a single orange-red marking on the clypeus, which is the lower face located just above the mandibles. Antennae are large, with notable orange club-shaped tips.

Gender can be determined from markings on the clypeus; males have a large, rectangular, red marking and females have a smaller, triangular, red marking. Age of adults is determined by intensity of appearance. The markings of teneral ABBs (young beetles emerging during late summer) are brighter and appear more uniform in color while the exoskeleton is softer and in general more translucent. The pronotum of a mature, early summer adult tends to be darker than the markings on its elytra, with the former appearing dark orange to red and the latter appearing orange. The senescent (mature, post-breeding) ABB has pale elytral markings and are more scarred. They often have pieces missing from the margin of the pronotum or elytra, have cracks in the exoskeleton, and/or are missing appendages such as tarsi, legs, or antennae (Service 2008a).

Life History

The life history of the ABB is similar to that of other burying beetles (Kozol et al. 1988; Pukowski 1933; Scott and Traniello 1987; Wilson and Fudge 1984). The ABB is a nocturnal species that lives only for one year. The beetles are active in the summer months and bury themselves in the soil for the duration of the winter. Immature beetles (tenerals) emerge in late summer, over-winter as adults, and comprise the breeding population the following summer (Kozol 1990b). Adults and larvae are dependent on carrion for food and reproduction. They must compete for carrion with other invertebrate species, as well as vertebrate species.

Winter Inactive Period: When the nighttime ambient air temperature is consistently below 60°F (15.5°C), ABBs bury into the soil and become inactive (Service 1991). In Oklahoma, this typically occurs from late September and until mid-May (Service 2008b), approximately 8 to 9 months. However, the length of the inactive period can fluctuate depending on temperature. Recent studies indicate that ABBs bury to depths ranging from 0 to 8 inches in Arkansas (Schnell et al. 2007). Others have found depths ranging from 0 – 27 inches (Hoback 2011). Habitat structure (i.e., woodland vs. grassland) does not appear to be an influencing factor in over-winter survival rate in Oklahoma (Holloway and Schnell 1997).

Preliminary data suggest that over-wintering results in significant mortality (Bedick et al. 1999). Winter mortality may range from 25 percent to about 70 percent depending on year, location, and availability of carrion in the fall (Schnell et al. 2007; Raithel 1996-2006, unpubl. data, as cited in Service 2008b). Over-wintering ABBs with access to a vertebrate carcass in the fall had a survival rate of 77 percent versus a 45 percent survival rate for ABBs that did not have access to a carcass (Schnell et al. 2007).

Summer Active Period: The ABB is active in the summer months, emerging from their winter inactive period when ambient nocturnal air temperatures consistently exceed 60º F. They are most active from two to four hours after sunset, with no captures recorded immediately after dawn (Walker and Hoback 2007, Bedick et al. 1999). During the daytime, ABBs are believed to bury under the vegetation litter. The ABB begin rearing broods soon after emergence from overwintering. During late May and early June ABBs secure a mate and carcass for reproduction. The reproductive process takes approximately 48-69 days.

In Oklahoma, ABBs are typically active from mid-May to late-September. Weather, such as rain and strong winds, result in reduced ABB activity (Bedick et al. 1999). However, on Block Island, Rhode Island, burying beetles were successfully trapped repeatedly on both rainy and windy nights provided the temperature was above 59º F (15º C, Kozol et al. 1988). Capture rates for ABBs are highest from mid-June to early-July and again in mid-August (Kozol et al. 1988, Bedick et al. 2004, Service 1991).

Movement

Having wings, ABBs are strong fliers and have been reported moving nightly distances ranging from 0.16 to 7.24 km (0.10 to 4.5 miles) in various parts of their range (Bedick et al. 1999, Creighton and Schnell 1998, Jurzenski et al. 2011, Schnell et al 1997-2006). In Oklahoma, ABBs have been recorded to move approximately 10 km (6.2 miles) in 6 nights (Creighton and Schnell 1998). In Nebraska, one ABB was reported to move, wind-aided, approximately 30 km (18.6 miles) in one night (Jurzenski et al. 2011) establishing the longest record of a 1-night movement by an ABB and demonstrating a potential dispersal distance of almost 30 km (19 miles).

Feeding

When not involved with brood rearing, carrion selection by adult ABBs for food can include an array of available carrion species and size (Trumbo 1992). ABBs also capture and consume live insects. Burying beetles are capable of finding a carcass between one and 48 hours after death at a distance up to 2 miles (3.22 km, Ratcliffe 1996). Success in finding carrion depends upon many factors including availability of optimal habitats for small vertebrates (Lomolino and Creighton 1996), density of competing invertebrate and vertebrate scavengers, individual searching ability, reproductive condition, and temperature (Ratcliffe 1996). Kozol et al. (1988) found no significant difference in the ABBs preference for avian verses mammalian carcasses. At Fort Chaffee, Holloway and Schnell (1997) found that ABBs numbers were higher in areas with high densities of small mammals (Service 2008b).

Habitat

Feeding Habitat: ABBs are considered feeding habitat generalists and have been successfully live-trapped in several vegetation types including native grasslands, grazed pasture, riparian zones, coniferous forests, mature forest, deciduous forest with little undergrowth, and oak-hickory forest, as well as on a variety of various soil types (Creighton et al. 1993; Lomolino and Creighton 1996; Lomolino et al. 1995; Service 1991, Service 2008b, Walker 1957). Ecosystems supporting ABB populations are diverse and include primary forest, scrub forest, forest edge, grassland prairie, riparian areas, mountain slopes, and maritime scrub communities (Ratcliffe 1996; Service 1991). The ABB readily moves between different habitats (Creighton and Schnell 1998, Lomolino et al. 1995) (Service 2008b). Using baited pitfall traps, Holloway and Schnell (1997), found significant correlation between the number of ABBs captured and the biomass of mammals (0-200 g), and combined mammals and birds at Fort Chaffee, Arkansas. Adult and teneral ABBs do not need to bury carcasses for feeding and soil types are not a limiting factor for feeding habitat.

Reproduction Habitat: The ABB needs to bury a carcass in the soil for successful brood rearing and reproduction, and soils that are too hard or too compact may limit their ability to create a suitable brood chamber. Likewise, soils that are too loose, such as those with too much sand, will not support the walls of the chamber and, therefore, are also not suitable for brood chambers. Furthermore, soil moisture has also been found to be a key component of their habitat and is most likely a limiting factor for ABB in some areas, especially during drought (Bedick *et al.* 2006). Therefore, certain soil conditions such as very xeric (dry), or loose soils, sandy soils, and highly saturated soils, are generally accepted to be unsuitable for carcass burial and thus are unlikely reproductive habitats (Smith *et al.* 2000). Reproductive success was found to be higher in forest verses grassland where more carcasses were buried. Nevertheless, of the carcasses buried in the two different vegetation types, brood size did not seem to be influenced by vegetation characteristics (Lomolino and Creighton 1996). In the southern portion of their range, ABBs occur in forests with substantial litter layers and deep, loose soils as well as grasslands or bottomland forests where the substrate is conducive for carcass burial (Lomolino and Creighton 1996; Creighton *et al*. 1993).

While studies indicate that the ABB is a habitat generalist in terms of feeding, it is likely more restricted when selecting burial sites for breeding. Holloway and Schnell (1997) found significant correlations between the numbers of ABBs caught in traps and the biomass of mammals and birds, irrespective of the predominant vegetation (Service 2008b).

Reproduction

Reproductive activity usually begins in mid-May to June once temperatures become suitable and is completed in mid-August. Immediately upon emergence from their winter hibernation, ABBs begin searching for a mate and proper sized carcass for reproduction. Burying beetles are capable of finding a carcass between one and 48 hours after death at a distance up to 2 miles (3.22 km – Ratcliffe 1996). Parental care in this genus is elaborate and unique because both parents participate in the rearing of young (Bartlett 1987, Fetherston et al. 1990, Scott 1990, and Trumbo 1990), with care by at least one parent, usually the female, being critical for larval survival (Ratcliffe 1996). In Nebraska, Bedick et al (1999) found that ABBs reproduce only once per year. However, in a laboratory setting, Lomonlino and Creighton (1993) found that five of eight ABB pairs succeeded in producing a second brood. While early research indicated that ABBs reproduce only once per year (univoltine), others have found that many ABBs are capable and successful in producing a second brood during the same season (bivoltine) (Kozol 1990, Bedick et al. 1999, Lomolino and Creighton 1993, Billman et al. 2014a, 2014b) where temperatures remain suitable for longer durations (i.e., the southern portions of their range). Teneral adults (i.e., recently molted individuals) may be reproductively active, raising the possibility of two generations per year (USFWS 1991). Teneral adults have regularly and successfully bred and reproduced in captive colonies within 2-3 weeks of eclosure (Bob Merze and Lou Perrotti personel communication 2016). Adults (F1 generation) may potentially breed twice and their young-of-the year (F2 generation) may breed at least once within the same active season in the southern populations.

Immediately upon emergence from their winter hibernation, ABBs begin searching for a mate and a proper carcass for reproduction. Once a carcass has been found, inter-specific as well as intra-specific competition occurs until usually only a single dominant male and female burying beetle remain (Scott and Traniello 1989).

The ABB typically out-competes other burying beetles as a result of its larger size (Kozol et al. 1988). The pair buries the carrion within a brood chamber constructed around the carcass. Male and female ABBs typically cooperatively bury a carcass, but individuals of either sex are capable of burying a carcass alone (Kozol et al. 1988). In Oklahoma, ABBs are thought to select deep, loose soils in grasslands or forests where the substrate is conducive to burial of carcass (Lomolino and Creighton 1996; Creighton et al. 1993). Once underground, both parents strip the carcass of fur or feathers, roll the carcass into a ball and treat it with anal and oral secretions that retard the growth of mold and bacteria. The female ABB lays eggs in the soil near the carcass. Brood sizes of ABBs can sometimes exceed 25 larvae, but 12-18 is more typical (Kozol 1990).

One or both of the parents may remain with the pupae for several days and at least one parent, usually the female, may remain with the pupae until they pupate (Kozol 1995). The reproductive process from carcass burial to eclosure (emergence from pupae) is about 48 to 65 days (Bedick et al. 1999, Kozol 1995, Ratcliffe 1996). Females are reproductively capable immediately upon eclosure. The young beetles emerging in summer over-winter as adults, and comprise the breeding population the following summer (Kozol 1990).

While the ABB has life history requirements similar to other carrion beetles, it is the largest *Nicrophorus* in North America and requires a larger carrion item to reach its maximum reproductive potential (*i.e.*, to raise a maximum number of offspring) than the other burying beetles (Service 1991, Kozol et al. 1988, Trumbo 1992). Preferred carrion sources for reproduction are dead birds and mammals weighing from 1.7-10.5 ounces (48.19 – 297.67 g), with an optimum weight of 3.5-7.0 ounces (100 – 200 g, Service 1991).

Status and Distribution

Status: The ABB was proposed for federal-listing in October 1988 (53 FR 39617) and designated as an endangered species on July 13, 1989 (54 FR 29652), and retains this status. Critical habitat has not been designated for the ABB. The Final Recovery Plan was signed on September 27, 1991. At that time (1991), only two, disjunct, natural populations occurred at the extremities of the species historic range of 35 states, i.e., four counties in Oklahoma and one small island off the coast of Rhode Island (Service 2008a). Due to the severity of the species decline, and uncertainty about the causes for that decline, the focus was on recovery actions targeted to significant near-term improvement in the status of the species, rather than addressing the range of objectives and criteria to bring about full recovery. Therefore, criteria were developed for downlisting, but not for recovery (Service 1991, 2008a).

Since the Recovery Plan was developed in 1991, numerous other populations have been discovered, and the recovery objective of reducing the immediate threat of extinction through discovery or establishment of new populations has been met (Service 2008a). Currently at least four eco-regions support ABB populations estimated at greater than 1,000 ABBs (Service 2008a). Based on extinction modeling by K. Holzer, Amaral et al. (eds.) (2005) surmised that populations of greater than 1,000 ABBs have the potential to remain demographically viable over the long term in the absence of severe catastrophic events or reductions in carrying capacity through reduced carcass availability, habitat loss or fragmentation. However, the 2008 five year review (Service 2008a) found that, based on the information available, the ABB remains endangered throughout its current range due to lack of populations in the Southeast and Great Lakes States and remaining threats to the populations (Service 2008a).

Distribution: Historically, the geographic range of the ABB included over 150 counties in 35 states, covering most of temperate eastern North America and the southern borders of three eastern Canadian provinces (Service 1991; Peck and Kaulbars 1987). However, documentation of records is not uniform throughout this broad historical range. More records exist from the Midwest into Canada and in the northeastern United States than from the southern Atlantic and Gulf of Mexico region (Service 1991). During the 20th century, the ABB disappeared from over 90 percent of its historical range (Ratcliffe 1995). The last ABB specimens along the mainland of the Atlantic seaboard, from New England to Florida, were collected in the 1940s (Service 1991). At the time of listing, known populations were limited to one on Block Island, Rhode Island; and one in Latimer County, Oklahoma. After the species was listed in 1989, survey efforts increased and the ABB was discovered in more locations, particularly in South Dakota, Nebraska, Arkansas, and Oklahoma.

Currently, the ABB is known to occur in eight states: on Block Island off the coast of Rhode Island, Nantucket Island off the coast of Massachusetts, eastern Oklahoma, western Arkansas (Carlton and Rothwein 1998), Loess Hills in south-central Nebraska and Sandhills in north-central Nebraska (Ratcliffe 1996, Bedick et al. 1999), Chautauqua Hills region of southeastern Kansas (Sikes and Raithel 2002), south-central South Dakota (Backlund and Marrone 1995, 1997; Ratcliffe 1996), northeast Texas (Godwin 2003), and Missouri (personal communication with Bob Mertz, St. Louis Zoo, May 30, 2013). The ABBs in Missouri are part of a nonessential experimental population (under section 10(j) of the ESA) that was reintroduced in 2012. Most populations are located on private land. Populations known to exist on public land include: Ouachita National Forest, Arkansas / Oklahoma; Ozark-St. Francis National Forests, Arkansas; Camp Gruber, Oklahoma; Fort Chaffee, Arkansas; Lake Eufaula, Oklahoma; McAlester Army Ammunition Plant (MCAAP), Sequoyah National Wildlife Refuge, Oklahoma; Block Island National Wildlife Refuge, Several Oklahoma Department of Wildlife Conservation Wildlife Management Areas, Oklahoma; Rhode Island; Valentine National Wildlife Refuge, Nebraska; and Camp Maxey, Texas.

Confirmed Oklahoma ABB sightings since 1992 include the following counties: Atoka, Bryan, Cherokee, Choctaw, Coal, Craig, Creek, Haskell, Hughes, Johnston, Latimer, Le Flore, Lincoln, Marshall, Mayes, McCurtain, McIntosh, Muskogee, Okfuskee, Okmulgee, Osage, Payne, Pittsburg, Pontotoc, Pottawatomie, Pushmataha, Rogers, Seminole, Sequoyah, Tulsa, and Wagoner, and Washington (29 counties). Additional counties with ABB habitat and potential occurrence due the proximity to the above counties include: Adair, Carter, Delaware, Garvin, Kay, Love, McClain, Murray, Nowata, Ottawa, and Pawnee.

A smaller number of surveys have been conducted for scientific research and are more appropriately designed to draw more specific conclusions. Scientifically designed survey data have been collected annually or biennially from McAlester Army Ammunition Plant, Camp Gruber, Ouachita National Forest, Connors State College, The Nature Conservancy's Tallgrass Prairie Preserve and Weyerhaeuser lands in Oklahoma, and at Fort Chaffee in Arkansas. These surveys provide trend data for the ABB. Surveys for the ABB have been conducted annually at Camp Gruber since 1992. ABB captures at these locations typically fluctuate on an annual or biennial basis, but in general ABB numbers appear stable or increasing, with the exception of the Weyerhaeuser lands. All of these areas, except for Weyerhaeuser lands in McCurtain County, provide large tracts of relatively natural habitat managed in such a way as to mimic the historic disturbance regime. Weyerhaeuser conducted annual surveys from 1997 to 2006. Surveys suggest the ABB population is greatly reduced or potentially extirpated from the southern-most tip of McCurtain County. However, relatively few surveys have been conducted in this area since 2008 to verify the status of the ABB in that area. The existing scientifically designed surveys indicate Camp Gruber, Fort Chaffee, and The Tallgrass Prairie Preserve represent areas with a relatively high density of ABBs. These surveys also demonstrate that populations can fluctuate on an annual basis. In 2010, reports from researchers at The Tallgrass Prairie Preserve in Osage County, Oklahoma indicated a healthy population of around 1,400 ABB (personal communication with Carrie Hall 2011), in 2011the population was estimated to be around 500, and in 2012 the population was estimated between 2,554 - 4,379 beetles (Howard *et al.* 2012). These reports provide some estimates of the ABB status on a local basis and document relatively large fluctuations between years.

In Texas, the ABB has been found on Camp Maxey, Lamar County from 2004 - 2008, and a single ABB was documented at the Nature Conservancy's Lennox Woods, Red River County in 2004. No ABBs have been documented at Camp Maxey from 2009 - 2012, despite intensive surveying.

The sentinel population of ABBs on Block Island off the coast of Rhode Island is considered stable, as is the population of ABBs in southern Tripp County, South Dakota. The moderately large Nebraska Loess Hills population was thought to be declining in 2006 and 2007, but that short-term decline was likely caused by the effects of drought on carrion availability (W. Hoback, pers. comm., March 24, 2011) and that population has increased in recent years with relief from the drought. Based on trapping efforts over the last 2 years in the Nebraska Sandhills, many more ABBs occur in this population than previously recognized. In 2010, more than 1,000 ABBs were trapped on and near Project lands in Nebraska with relatively limited trapping. Population levels in Oklahoma and Arkansas fluctuate every other year or so, but downward or upward trends in the long term are difficult to ascertain. Fort Chaffee in western Arkansas and Camp Gruber in eastern Oklahoma have robust populations that, along with populations in Nebraska, are believed to be resilient to the effects of stochastic weather events (Service 2008a). Little information is available on trends in the small populations of ABB in Kansas and there is some evidence that a small population of ABBs in northern Lamar County, Texas, may be declining or extirpated.

Population Estimate: Although ABB are relatively easy to capture, population estimates of ABB are problematic. The standard mark and re-capture technique used to estimate population size assumes that marked and unmarked individuals are equally likely to be captured, and that a substantial number of the animals would be recaptured from one trapping period to the next. However, due to ability of the ABBs to range widely and their reproductive strategy that includes retreating underground for several weeks, these assumptions may not apply. This may be less of a problem for the insular population on Block Island, Rhode Island where, because of the relatively small size of the island (2,614 ha), a significant proportion of the population can be monitored. Elsewhere, however, precise estimates of absolute or even relative densities remain a challenge (Service 2008a).

Because the ABB completes its lifecycle in one year, each year's population levels are largely dependent on the reproductive success of the previous year. Therefore, populations may be cyclic (due to weather, disease, etc.), with high numbers and abundance in one year, followed by a decline in numbers the succeeding year. These short-term stochastic events should not have long-term effects in robust populations (Service 2008a). Schnell et al. (1997-2003, 1997-2005) reported that areas of high concentration appeared to shift annually throughout Fort Chaffee, Arkansas and Camp Gruber, Oklahoma, even though land use within each area stayed relatively stable (Service 2008b). Losses associated with one-time or short-duration pulse are less likely to affect population survival than longer-duration adverse effects.

False negatives are possible outcomes of ABB surveys. Standard transects on Camp Gruber that resulted in ABB captures in one year failed to capture ABBs in another year. Surveys conducted in a given area have resulted in ABB captures during one survey effort, but surveys conducted in the same area within the same active season have resulted in negative ABB captures. This indicates a relatively rapid turnover rate in the trappable ABB population due to factors such as natural mortality, dispersal, and burrowing underground and attending carrion/broods (Creighton and Schnell 1998).

Reasons for Decline

The ABB's uneven distribution and density, and their vulnerability to extinction are likely due to the species having specialized resource requirements with carrion being a finite resource widely scattered in space and time (Karr 1982, Pimm et al.1988, Peck and Kaulbars 1987). Data available for the ABB on Block Island, Rhode Island supports the contention that the primary mechanism for the species rangewide declines "lies in its dependence on carrion of a larger size class relative to that used by all other North American burying beetles, and that the optimum-sized carrion resource base has been reduced throughout the species range" (Service 1991).

Since the middle of the 19th century, certain animal species in the favored weight range for ABBs have either been eliminated from North America or significantly reduced over their historic range (Service 1991), including the passenger pigeon (*Ectopistes migratorius),* and greater prairie-chicken (*Tympanchus cupido)*. The passenger pigeon was estimated at one time to have been the most common bird in the world, numbering 3 to 5 billion (Ellsworth and McComb 2003). There were once as many passenger pigeons within the approximate historic range of the ABB as there are numbers of birds of all species overwintering in the United States today. Black-tailed prairie dogs (*Cynomys ludovicianus)* which occur in the northern portion of the ABB's range have drastically declined (Miller et al. 1990) and previously dense populations of these black-tailed prairie dogs mammals may also have supported ABBs (Service 2008a).

During the westward expansion of settlement in North America, the removal of top-level carnivores such as the grey wolf (*Canis lupis)* and eastern cougar (*Puma concolor)* occurred simultaneously with land use changes that fragmented native forest and grasslands and created more edge habitats (such as the edge between forest and grassland, or grassland and cropland). These two processes resulted in meso-carnivores becoming more abundant. Mid-sized carnivores prey on small mammals and birds and directly compete with carrion beetles for carrion.

Fragmentation of large contiguous habitats into smaller pieces or patches of habitat may increase species richness, but the species composition usually changes. Fragmentation of forests and grasslands cause a decrease of indigenous species and an increase in meso-carnivores that thrive in areas disturbed by humans such as: American crow (*Corvus brachyrhynchos)*, raccoon (*Procyon lotor)*, red fox (*Vulpus fulva)*, opossum (*Didelphis virginiana)*, striped skunk (*Mephitis*

mephitis), rats (*Neotoma* spp. and *Sigmodon* spp.), coyotes (*Canis latrans),* feral cats (*Felis domesticus*), and other opportunistic predators (Wilcove et al. 1986). In this way, historically large expanses of natural habitat that once supported high densities of indigenous species are now artificially fragmented, supporting fewer or lower densities of indigenous species that once supported ABB populations, and also facilitating increased competition for limited carrion resources among the "new" predator/scavenger community. A number of these species, especially the raccoon and striped skunk, have undergone dramatic population increases over the last century (Garrott et al. 1993), and the coyote and opossum have expanded their range. These scavengers may extend hundreds of feet from edges into forest in eastern North America. Matthews (1995) experimentally placed 64 carcasses in various habitats in Oklahoma where ABBs and the roundneck sexton beetle (*N. orbicollis*, another type of burying beetle) had been previously documented, then tracked the organisms that scavenged them. Of the carcasses, 83 percent were claimed by ants, flies, and vertebrate scavengers; about 11 percent were claimed by the roundneck sexton beetle, and only one was claimed by ABBs.

Although much of the evidence suggesting the reduction of carrion resources as a primary mechanism of decline is circumstantial, this hypothesis fits the temporal and geographical pattern of the disappearance of ABBs, and is sufficient to explain why ABBs declined while related species did not. ABBs are the largest species of burying beetle in the New World (Western Hemisphere) and require carcasses of 3.5 to 7.0 ounces (99.22 to 198.45 g, Kozol et al. 1988) to maximize its fecundity, whereas all other burying beetles can breed abundantly on much smaller carcasses, with the smaller species using carcasses of 0.11 to 0.18 ounces (3.12 to 5.10 g, Trumbo 1992). In a fragmented ecosystem, larger species have been shown to be negatively affected before smaller species, a phenomenon that has been well-documented with carrion and dung beetles in South America (Klein 1989).

Analysis of the Species/Critical Habitat Likely to be Affected

The implementation of the various projects and related soil disturbance may potentially affect up to 293,414 acres of ABB habitat throughout the Action Area. No critical habitat has been designated for the ABB; therefore, none will be affected.

Interior Least Tern

Only minor changes are necessary for least tern related portions of this RBO. Basic life history and the most recent range-wide information for the interior population of least terns are available in the 2013 five year review and other documents at:
http://ecos.fws.gov/speciesProfile/profile/speciesProfile?spcode=B07N

Northern Long-Eared Bat

The final rule (Federal Register vol. 80, no. 63) is the best available information on NLEB life history and biology, threats, distribution and overall status. The following is summary from that rule.

Life History and Biology

The NLEB is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. The key stages in its annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy (independent flight)/weaning, fall migration and swarming. NLEB generally hibernate between mid-fall through mid-spring each year. Spring migration period likely runs from mid-March to mid-May each year, as females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. Young are born between mid-June and early July, with nursing continuing until weaning, which is shortly after young become volant in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

Summer habitat and ecology

Suitable summer habitat[1] for NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats such as emergent wetlands and adjacent edges of agricultural fields, old fields and pastures. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

Many species of bats, including the NLEB, consistently avoid foraging in or crossing large open areas, choosing instead to use tree-lined pathways or small openings (Patriquin and Barclay 2003, Yates and Muzika 2006). Further, wing morphology of the species suggests that they are adapted to moving in cluttered habitats. Thus, isolated patches of forest may not be suitable for foraging or roosting unless the patches are connected by a wooded corridor.

Upon emergence from the hibernacula in the spring, females seek suitable habitat for maternity colonies. NLEB actively form colonies in the summer (Foster and Kurta 1999) and exhibit fission-fusion behavior (Garroway and Broders 2007), where members frequently coalesce to form a group (fusion), but composition of the group is in flux, with individuals frequently departing to be solitary or to form smaller groups (fission) before returning to the main unit (Barclay and Kurta 2007). As part of this behavior, northern long-eared bats switch tree roosts often (Sasse and Pekins 1996), typically every 2 to 3 days (Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). NLEB maternity colonies range widely in size, although 30-60 may be most common (Service 2014). NLEB show some degree of interannual fidelity to single roost trees and/or maternity areas. Male NLEB are routinely found with females in maternity colonies. NLEB use networks of roost trees often centered around one or more central-node roost trees (Johnson et al. 2012). NLEB roost networks also include multiple alternate roost trees and male and non-reproductive female NLEB may also roost in cooler places, like caves and mines (Barbour and Davis 1969, Amelon and Burhans 2006).

NLEB roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches dbh). NLEB are known to use a wide variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. NLEB have also

1 See the Service's current summer survey guidance for our latest definitions of suitable habitat.

been occasionally found roosting in structures like barns and sheds (particularly when suitable tree roosts are unavailable).

Young NLEB are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant between early July and early August.

Migration

Males and non-reproductive females may summer near hibernacula, or migrate to summer habitat some distance from their hibernaculum. NLEB is not considered to be a long distance migrant (typically 40-50 miles). Migration is an energetically demanding behavior for the NLEB, particularly in the spring when their fat reserves and food supplies are low and females are pregnant.

Winter habitat and ecology

Suitable winter habitat (hibernacula) includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by NLEB during the winter that have yet to be documented. Generally, NLEB hibernate from October to April depending on local climate (November-December to March in southern areas and as late as mid-May in some northern areas).

Hibernacula for NLEB typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

NLEB tend to roost singly or in small groups (Service 2014), with hibernating population sizes ranging from a just few individuals to around 1,000 (Service unpublished data). NLEB display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940, Whitaker and Rissler 1992, Caceres and Barclay 2000). NLEB have shown a high degree of philopatry to the hibernacula used, returning to the same hibernacula annually.

Spring Staging and Fall Swarming habitat and ecology

Upon arrival at hibernacula in mid-August to mid-November, NLEB “swarm,” a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum as they had been mating at. A majority of bats of both sexes hibernate by the end of November (by mid-October in northern areas).

After hibernation ends in late March or early April (as late as May in some northern areas), most NLEB migrate to summer roosts. Females emerge from hibernation prior to males. Reproductively active females store sperm from autumn copulations through winter. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as "staging," a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

In general, NLEB use roosts in the spring and fall similar to those selected during the summer. Suitable spring staging/fall swarming habitat consists of the variety of forested/wooded habitats where they roost, forage, and travel, which is most typically within 5 miles of a hibernaculum. This includes forested patches as well as linear features such as fencerows, riparian forests and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure. Isolated trees are considered suitable habitat when they exhibit the characteristics of a suitable roost tree and are less than 1,000 feet from the next nearest suitable roost tree, woodlot, or wooded fencerow.

Threats

No other threat is as severe and immediate for the NLEB as the disease white-nose syndrome (WNS). It is unlikely that NLEB populations would be declining so dramatically without the impact of WNS. Since the disease was first observed in New York in 2007 (later biologists found evidence from 2006 photographs), WNS has spread rapidly in bat populations from the Northeast to the Midwest, Southeast and recently was documented in Washington State. Population numbers of NLEB have declined by 99 percent in the Northeast, which along with Canada, has been considered the core of the species' range. Although there is uncertainty about how quickly WNS will spread through the remaining portions of these species' ranges, it is expected to spread throughout their entire ranges. In general, the Service believes that WNS has significantly reduced the redundancy and resiliency of the NLEB.

Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines. Specifically, declines due to WNS have significantly reduced the number and size of NLEB populations in some areas of its range. This has reduced these populations to the extent that they may be increasingly vulnerable to other stressors that they may have previously had the ability to withstand. These impacts could potentially be seen on two levels. First, individual NLEB sickened or struggling with infection by WNS may be less able to survive other stressors. Second, NLEB populations impacted by WNS, with smaller numbers and reduced fitness among individuals, may be less able to recover making them more prone to extirpation. The status and potential for these impacts will vary across the range of the species.

Bats affected, but not killed by WNS during hibernation may be weakened by the effects of the disease and may have extremely reduced fat reserves and damaged wing membranes. These effects may reduce their capability to fly or to survive long-distance migrations to summer roosting or maternity areas.

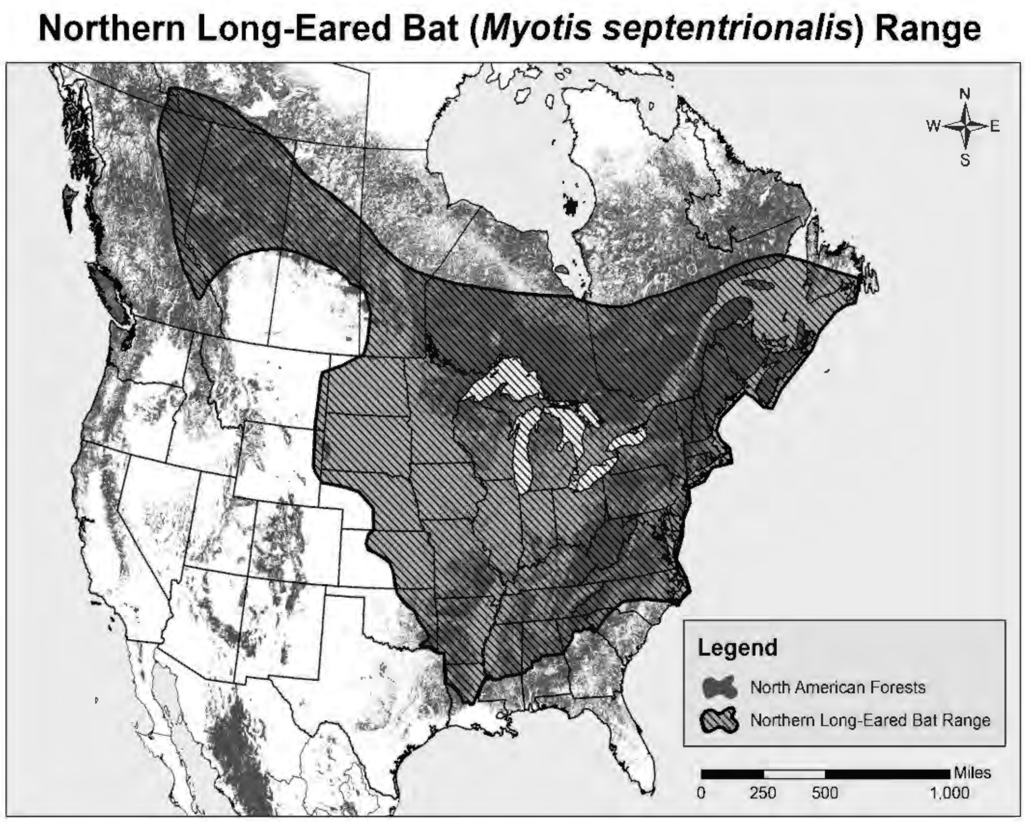
In areas where WNS is present, there are additional energetic demands for northern long-eared bats. For example, WNS-affected bats have less fat reserves than non-WNS-affected bats when they emerge from hibernation (Reeder et al. 2012; Warnecke et al. 2012) and have wing damage (Meteyer et al. 2009; Reichard and Kunz 2009) that makes migration and foraging more challenging. Females that survive the migration to their summer habitat must partition energy resources between foraging, keeping warm, successful pregnancy and pup-rearing, and healing and may experience reduced reproductive success. In addition, with wing damage, there may be an increased chance of WNS-affected bats being killed or harmed as a result of proposed action. Again, this is particularly likely if timber harvest or burns are conducted early in the spring (April – May) when bats have just returned, have damaged wings, and are exposed to colder temperatures when torpor is used more frequently.

Over the long-term, sustainable forestry benefits NLEB by maintaining suitable habitat across a mosaic of forest treatments. However, forest practices can have a variety of impacts on the NLEB depending on the quality, amount, and location of the lost habitat, and the time of year of clearing. Depending on their characteristics and location, forested areas can function as summer maternity habitat, staging and swarming habitat, migration or foraging habitat, or sometimes, combinations of more than one habitat type. Impacts from tree removal to individuals or colonies would be expected to range from indirect impact (e.g., minor amounts of forest removal in areas outside NLEB summer home ranges or away from hibernacula) to minor (e.g., largely forested areas, areas with robust NLEB populations) to significant (e.g., removal of a large percentage of summer home range, highly fragmented landscapes, areas with WNS impacts).

Lastly, there is growing concern that bats, including the NLEB (and other bat species) may be threatened by the recent surge in construction and operation of wind turbines across the species' range. Mortality of NLEB has been documented at multiple operating wind turbines/farms. The Service is now working with wind farm operators to avoid and minimize incidental take of bats and assess the magnitude of the threat.

Rangewide Status

The NLEB ranges across much of the eastern and north central United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Nagorsen and Brigham 1993; Caceres and Pybus 1997; Environment Yukon 2011) (Figure X). In the United States, the species' range reaches from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east through the Gulf States to the Atlantic Coast (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006). The species' range includes the following 37 States (plus the District of Columbia): Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Historically, the species has been most frequently observed in the northeastern United States and in Canadian Provinces, Quebec and Ontario, with sightings increasing during swarming and hibernation (Caceres and Barclay 2000). However, throughout the majority of the species' range it is patchily distributed, and historically was less common in the southern and western portions of the range than in the northern portion of the range (Amelon and Burhans 2006).



Although they are typically found in low numbers in inconspicuous roosts, most records of NLEB are from winter hibernacula surveys (Caceres and Pybus 1997). More than 780 hibernacula have been identified throughout the species' range in the United States, although many hibernacula contain only a few (1 to 3) individuals (Whitaker and Hamilton 1998). Known hibernacula (sites with one or more winter records of northern long-eared bats) include: Alabama (2), Arkansas (41), Connecticut (8), Delaware (2), Georgia (3), Illinois (21), Indiana (25), Kentucky (119), Maine (3), Maryland (8), Massachusetts (7), Michigan (103), Minnesota (11), Missouri (more than 269), Nebraska (2), New Hampshire (11), New Jersey (7), New York (90), North Carolina (22), Oklahoma (9), Ohio (7), Pennsylvania (112), South Carolina (2), South Dakota (21), Tennessee (58), Vermont (16), Virginia (8), West Virginia (104), and Wisconsin (67). NLEB are documented in hibernacula in 29 of the 37 States in the species' range. Other States within the species' range have no known hibernacula (due to no suitable hibernacula present, lack of survey effort, or existence of unknown retreats).

The current range and distribution of NLEB must be described and understood within the context of the impacts of WNS. Prior to the onset of WNS, the best available information on NLEB came primarily from surveys (primarily focused on Indiana bat or other bat species) and some targeted research projects. In these efforts, NLEB was very frequently encountered and was considered the most common myotid bat in many areas. Overall, the species was considered to be widespread and abundant throughout its historic range (Caceres and Barclay 2000).

WNS has been particularly devastating for NLEB in the northeast, where the species was believed to be the most abundant. There are data supporting substantial declines in NLEB populations in portions of the Midwest due to WNS. In addition, WNS has been documented at more than 100 NLEB hibernacula in the southeast, with apparent population declines at most sites. WNS has recently been found in Washington State, but is not currently known to be present in other western states. The NLEB is considered rarer in the western extremes of its range. We expect further declines as the disease continues to spread across the species' range.

Critical Habitat

Critical habitat has not been proposed for the NLEB.

Conservation Needs of the Species

The species' conservation needs define what is needed in terms of reproduction, numbers, and distribution to ensure the species is no longer in danger of extinction. The conservation needs should be defined in the species' recovery outline or plan. Since there is no recovery plan or recovery outline available at this time, we will outline the conservation needs based on our current understanding of the species.

We find that the primary conservation need of the NLEB is to reduce the threat of WNS. This includes minimizing mortality in WNS-affected areas, and slowing the rate of spread into currently unaffected areas. In addition, NLEB that continue to exist within WNS-affected areas need to be able to continue to survive and reproduce in order to stabilize and/or increase the populations. This can be done by reducing the other threats to the species, as listed above. Therefore, efforts to protect hibernacula from disturbances need to continue. This should include restricting human access to hibernacula particularly during the hibernation period, constructing and maintaining appropriately designed gates, and restoring microhabitat conditions in hibernacula that have been altered. Efforts should also be made to protect and restore (in some cases) adequate fall swarming habitat around hibernacula. Known maternity habitat should be maintained, and the removal of known roost trees, particularly when pregnant females and/or young are present should be reduced. Research to identify important hibernacula and summer areas and to delineate the migratory relationship between summering and wintering populations should also be pursued.

ENVIRONMENTAL BASELINE

The environmental baseline, as defined in 50 CFR §402.02, focuses on the action area and includes past and present impacts of all Federal, state, or private actions in the action area; the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation; and the impact of state and private actions within the action area which are contemporaneous with the consultation in progress. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action.

American Burying Beetle

Status of the Species within the Action Area

We are providing existing information, but the status is likely to change. This is a programmatic biological opinion that could be in effect for many years. The ABB is an annual species and the status will vary within and between years due to changing local and regional weather patterns. The most current information for ABBs can be found at the Service website for each state in the Action Area: ***(http://www.fws.gov/southwest/es/Oklahoma/ABB_Add_Info.htm), (http://www.fws.gov/kansases/), (http://www.fws.gov/arkansas-es/), (http://www.fws.gov/southwest/es/ArlingtonTexas/)***.

Most of the ABB range within the Action Area is in Oklahoma. Numerous ABB surveys have been conducted throughout eastern Oklahoma but there are no routine or designed surveys to assess the ABB populations in the entire Action Area. The majority of these surveys are associated with projects such as road construction, oil and gas projects, and similar development activities that may result in soil disturbance and impacts to ABB habitat. To determine whether ABBs may occur within these project areas, project proponents contract with permitted surveyors to conduct surveys for ABB. Because these surveys are associated with development projects that limit their temporal and spatial distribution, only limited conclusions can be drawn. The known ABB range in Oklahoma has expanded, but this could be explained by increased survey effort and area.

A smaller number of surveys are conducted for scientific research and are more appropriately designed to draw more specific conclusions. Scientifically designed survey data have been collected annually or biennially from MCAAP, Camp Gruber, Ouachita National Forest, Connors State College, The Nature Conservancy's Tallgrass Prairie Preserve and Weyerhaeuser lands in Oklahoma, and Fort Chaffee in Arkansas. These surveys provide trend data for the ABB. Surveys for the ABB have been conducted annually at Camp Gruber since 1992. ABB captures at these locations typically fluctuate on an annual or biennial basis, but in general ABB numbers appear stable or increasing, with the exception of the Weyerhaeuser lands. All of these areas, except for Weyerhaeuser lands in McCurtain County, provide large tracts of relatively natural habitat managed in such a way as to mimic the historic disturbance regime. Weyerhaeuser conducted annual surveys 1997-2006. Surveys suggest the ABB population is greatly reduced or potentially extirpated from the southern-most tip of McCurtain County. However, relatively few surveys have been conducted in this area since 2008 to verify the status in that area. The existing scientifically designed surveys indicate Camp Gruber, Fort Chaffee, and The Tallgrass Prairie Preserve represent areas with relatively high capture rates of ABBs. These surveys also demonstrate that populations can fluctuate on an annual basis. In 2010, reports from researchers at The Nature Conservancy's Tallgrass Prairie Preserve in Osage County indicated a healthy population of around 1,400 ABB (personal communication with Carrie Hall 2011), in 2011the population was estimated to be around 500, and in 2012 the population was estimated between 2,554 – 4,379 beetles (Howard et. al 2012). These reports provide some estimates of the ABB status on a local basis and document relatively large fluctuations between years. This RBO is intended to cover actions over an extended time period and ABB populations are expected to fluctuate on an annual basis.

The Service identified areas in Oklahoma, known as ABB Conservation Priority Areas (CPAs), where positive surveys have been relatively concentrated over the last 10 years. These CPAs may change with new survey information and the most recent CPAs are identified on the Service website (http://www.fws.gov/southwest/es/Oklahoma/ABB_Add_Info.htm).

Factors Affecting Species' Environment within the Action Area

To adequately evaluate the effects of actions covered in this RBO, the Service must consider the individual and cumulative impacts from these activities on ABBs. Additionally, the Service must also consider other, separate effects currently ongoing and likely to occur in the foreseeable future that also could have adverse impacts to the ABB within the Action Area.

Research and Recovery Permits

Currently over 100 entities or individuals in Oklahoma and Arkansas possess valid section 10(a)(1)(A) scientific research permits under which some authorized take of ABBs can occur. Most of these permits authorize surveys, which contribute to our understanding of where ABBs occur so that projects do not inadvertently cause take, but do not have any associated research. All research conducted under these permits must further conservation efforts for the species. The loss of some individual ABBs over the short-term from research is allowed as the research, when applied to conservation efforts, should provide long-term benefits. The Service requires that every available precaution be implemented to reduce and/or eliminate authorized take associated with research activities.

Habitat Conservation Plans

A Habitat Conservation Plan (HCP) and related 10(a)(1)(B) incidental take permit was issued in 1996 to Weyerhaeuser for ABBs on their lands in southeast Oklahoma. The Weyerhaeuser HCP is valid for 35 years (1996-2031) and identifies the following as foreseeable activities likely to be implemented by Weyerhaeuser over that period: 28,000 acres (average of 800 acres per year) of forest will potentially be harvested; 16 ponds constructed; 10 or fewer food plots planted; Environmental Protection Agency-approved application of pesticides for control of pales weevil (*Hylobius pales*) damage to planted pine seedlings; ROW vegetation control; 2 miles of road construction; 20 acres of mineral, oil or gas exploration; and no more than 600 acres of cattle grazing. Minimization and mitigation measures included: a research program to study the habitat affinities of the ABB; baseline surveys of the area for the ABB; incorporation of strategies developed from research in Weyerhaeuser's forest management strategy; minimization of pesticide use only use pesticides approved by the EPA; and minimize the disturbance associated with logging activities. From 1997 to 2006, Weyerhaeuser lands were surveyed for the ABB annually, and habitat sampling was conducted to determine effects from timber management on ABBs. From 1997 to 2006, the following numbers of ABBs were captured: 106, 64, 26, 41, 16, 25, 85, 19, 0, and 0, respectively. The population is potentially extirpated from this area (Schnell 2011), but survey effort has been suspended since 2007.

The TransCanada Keystone Gulf Coast Pipeline's (Keystone) Habitat Conservation Plan (HCP) was issued in 2012 for the Keystone XL pipeline project, including approximately 485 miles of 36-inch diameter oil pipeline from Cushing, Oklahoma to near Nederland, Texas. The Keystone HCP is valid for 50 years and covers construction and maintenance of the pipeline. Both temporary and permanent impacts to habitat and individuals were identified in Creek, Okfuskee, Seminole, Hughes, Coal, Atoka, and Bryan counties, Oklahoma. Anticipated effects include temporary impact to up to 435 acres (176 hectares) and permanent impact to 17 acres (6.9 hectares)of potential ABB habitat by construction, impact to approximately 33 acres (13.4 hectares)of potential ABB habitat by fragmentation due to the permanent alteration of existing cover type (from forest to grassland) in areas that are not already fragmented, and 65 acres (26.3 hectares)of impacts to ABB habitat during operations and maintenance of the project (in addition to the 485 acres [196 hectares]of impacts described above). Keystone has contracted with the Common Ground Capital, LLC (CGC) and WLLL, LLC (WLLL) to develop a Permittee Responsible Conservation Project Site. CGC-WLLL will manage the 865-acre"Keystone McAlester Conservation Area".

An Industry Conservation Plan (ICP) for Oil and Gas related industries was issued in 2014 and an amendment approved in 2016. Oil and Gas Industry Conservation Plan (ICP) was prepared to support incidental take permits for the federally listed American burying beetle (ABB) (*Nicrophorus americanus*) resulting from activities associated with geophysical exploration (seismic), development, extraction, transport, and/or distribution of crude oil, natural gas, and/or other petroleum products and maintenance, operation, repair, and decommissioning of oil and gas pipelines and well field infrastructure (referred to as covered activities). The ICP is a habitat conservation plan prepared by the Service for covered activities within the proposed Planning Area, in which federally listed or protected species are known, or are likely to occur. Individual oil and gas companies would apply for an ESA 10(a)(1)(B) permit for incidental take of the ABB associated with activities covered in the ICP and agree to comply with the terms and conditions of the ICP. In the ICP, the Service has defined incidental take in terms of the number of acres of occupied ABB habitat disturbed by covered activities. Oil and gas industry activities described in the amended ICP would be covered as follows: All applications for coverage under the amended ICP must be received by May 20, 2019. All permitees must submit their Individual Project Plans (IPP) by May 20, 2022, to use the authorization in their permits, and all construction related to approved IPPs must be completed by May 20, 2025. Operation and maintenance activities are authorized until the permit expires May 20, 2039.

The ICP Planning Area consists of 45 counties in Oklahoma. They are as follows: Adair, Atoka, Bryan, Carter, Cherokee, Choctaw, Cleveland, Coal, Craig, Creek, Delaware, Garvin, Haskell, Hughes, Johnston, Kay, Latimer, Le Flore, Lincoln, Love, Marshall, Mayes, McClain, McCurtain, McIntosh, Murray, Muskogee, Noble, Nowata, Okfuskee, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Pushmataha, Rogers, Seminole, Sequoyah, Tulsa, Wagoner, and Washington. The Planning Area covers approximately 22,858,163 acres (9,250,370 hectares) or 35,716 square miles (92,504 square kilometers). A maximum of 32,234 acres of occupied ABB habitat within the Action Area, in the form of harm, harassment, and/or mortality will be authorized by the ICP.

ESA Section 7 Consultations

The Service consults on many proposed actions potentially impacting the ABB. Project types evaluated included pipelines, roads, quarries, communication towers, residential housing development, bridges, mining, petroleum exploration/extraction/production, commercial development, recreational development, transmission lines, and water and waste water treatment facilities. Impacts from these activities vary in size and duration, with projects such as quarries being hundreds of acres and having permanent impacts, to water treatment facilities of a few acres with both permanent and temporary impacts. Most of these consultations are informal, result in no take of the ABB, and thus do not provide for incidental take. However, there are several existing and multiple pending formal consultations that would include some level of incidental take of ABBs. Most take is related to temporary actions with soil disturbance.

Other ABB Conservation Efforts Ongoing Within the Action Area

Two ABB Conservation Banks (currently about 4,000 acres) have been approved in Oklahoma to help provide mitigation opportunities for section 10 or 7 related impacts and more are anticipated.

Interior Least Tern

No revisions are necessary for the least tern and the Corps/SWPA have been in compliance with all least tern-related terms and conditions in the PBO. Status within the Action Area is described within the five year review (http://ecos.fws.gov/docs/five_year_review/doc4294.pdf). Least tern numbers have been relatively stable and reproductive success has been above the 10 year average in most of the Action Area since 2012.

We are providing existing information, but the status is likely to change. This is a programmatic biological opinion that could be in effect for many years. Least tern numbers are monitored within the Action Area and the status will vary within and between years due to changing river flows and regional weather patterns. The most current information for least terns in the Action Area would be in the annual report for this RBO.

Northern Long-eared Bat

Status of the Northern Long-eared Bat in the Action Area

There is very little known about the status of NLEBs near the Corps projects in this action area. However, there is suitable habitat in or near most of the projects and NLEBs have been documented near most of the action area in Arkansas and eastern Oklahoma. Information relative to each state is provided. NLEBs are known from 41 hibernacula in Arkansas, although there are typically few individuals (*e.g.,* fewer than 10 individuals) observed (Sasse 2012, unpublished data). Saugey *et al.* (1993, p. 104) reported the NLEB to be rather common during fall swarming at abandoned mines in the Ouachita Mountains. Additionally, Heath *et al.* (1986, p. 35) found 57 pregnant females roosting in a mine in the spring of 1985. Summer surveys in the Ouachita Mountains of central Arkansas from 2000–2005 tracked 17 males and 23 females to 43 and 49 dayroosts, respectively (Perry and Thill 2007, pp. 221–222). In 2013 summer surveys in the Ozark St. Francis National Forest, the NLEB was the most common species captured (Service 2014, unpublished data). *Pseudogymnoascus destructans* (Pd) was first detected in the State in the winter of 2011–2012; however, WNS was confirmed at different sites (than where Pd was first confirmed) in 2013–2014. NLEB mortality was documented (five individuals) from one of the sites where WNS was first confirmed in 2013–2014 (WNS Workshop 2014, pers. comm.). Mortality of NLEBs from WNS was observed in the State's largest hibernacula in 2015; 2015 surveys found 120 northern long-eared bats in that hibernacula, where counts in recent years often numbered 200 to 300 (Bitting 2015, pers. comm.).

The NLEB is known to occur in seven counties along the eastern edge of Oklahoma (Stevenson 1986, p. 41). The species is known from nine hibernacula, where typically they are observed in low numbers (*e.g.,* 1 to 20 individuals). However, a larger colony uses a cave on the Ouachita National Forest in southeastern Oklahoma (LeFlore County) during the winter (9 to 96 individuals) and during the fall (9 to 463 individuals) (Perry 2014, pers. comm.). A large colony uses a cave in Adair County during fall and winter (recently captured and banded over 600 individuals) (Fuller 2016, pers. Comm.). NLEBs have been recorded from 21 caves (7 of which occur on the Ozark Plateau National Wildlife Refuge) during the summer. The species has regularly been captured in summer mist-net surveys at cave entrances in Adair, Cherokee, Sequoyah, Delaware, and LeFlore Counties, and are often one of the most common bats captured during mist-net surveys at cave entrances in the Ozarks of northeastern Oklahoma (Stark 2013, pers. comm.; Clark and Clark 1997, p. 4). Small numbers of NLEB (typical range of 1 to 17 individuals) also have been captured during mist-net surveys along creeks and riparian zones in eastern Oklahoma (Stark 2013, pers. comm.; Clark and Clark 1997, pp. 4, 9–13). PD has spread to 3 counties in Oklahoma as of 2016 (Adair, Cherokee, Delaware).

In Kansas, the NLEB was first documented in 1951, when individual bats were documented hibernating in the gypsum mines of Marshall County (Schmidt *et al.* 2015, unpaginated). The status of the gypsum mines as hibernaculum in Kansas is widely unknown. NLEBs were thought to only migrate through central Kansas until pregnant females were discovered in northcentral Kansas in 1994 and 1995 (Sparks and Choate 1995, p. 190). Since then, NLEBs have been considered relatively common in riparian woodlands in Phillips, Rooks, Graham, Osborne, Ellis, and Russel Counties (Schmidt *et al.* 2015, unpaginated).

Factors Affecting Species' Environment within the Action Area

To adequately evaluate the effects of actions covered in this RBO, the Service must consider the individual and cumulative impacts from these activities on NLEBs. Additionally, the Service must also consider other, separate effects currently ongoing and likely to occur in the foreseeable future that also could have adverse impacts to the NLEB within the Action Area.

Research and Recovery Permits

Currently two entities or individuals possess valid section 10(a)(l)(A) scientific research permits under which some authorized take of NLEB can occur in Oklahoma (one permit) or Arkansas (one permit). These permits authorize surveys which typically do not result in mortality of the organism. Occasionally research is associated with these permits but the research must further conservation efforts for the species. The Service requires that every available precaution be implemented to reduce and/or eliminate authorized take associated with any research activities.

Section 7(a)(2) Consultations

The Service consults on a few proposed actions potentially impacting the NLEB in Oklahoma and Arkansas. Project types evaluated included pipelines, roads, railroads, mines, and military activities. Most of these consultations are informal and do not result in take of the NLEB. The Service has conducted a National programmatic consultation regarding certain transportation (highway and railroad) projects with the Federal Highway Administration and Federal Railroad Administration. This consultation was not expected to adversely affect the NLEB or the Indiana bat and no incidental take is anticipated. The Service also conducted a National programmatic consultation regarding specific Military operations and activities on Army National Guard installations. This consultation also was not expected to adversely affect the NLEB and no incidental take was anticipated.

There are at least two National formal programmatic consultations that would include some level of incidental take of NLEB. These include continued implementation of U.S. Forest Service (USFS) Land and Resource Management Plans and certain surface coal mining and reclamation activities approved through the U.S. Office of Surface Mining (OSM). The USFS BO was a non-jeopardy opinion with estimated take of 25,735 volant adult and juvenile NLEB in the form of harassment, all within roosting areas and mostly resulting from prescribed burning. Additionally, the USFS action was expected to harm up to 5,666 non-volant NLEB pups, all within maternity roosting areas, and mostly resulting from prescribed burning. The OSM consultation was a non-jeopardy opinion. However the BO determined that the amount of take for all affected species was unquantifiable.

The Service expects to reinitiate consultation in the near future with the Natural Resources Conservation Service on implementation of the Healthy Forests Reserve Program (HFRP) in Oklahoma to address the NLEB.

The Service recently consulted formally on the Shady Point Mine, Leflore County Oklahoma under the OSM National programmatic consultation. No take of NLEB was anticipated.

<u>Habitat Conditions in the Action Area</u>

Habit conditions vary from agricultural row crops to mature forest. Large portions of the Action Area are forest or a mixture of forest and grasslands that could provide potential summer habitat for the NLEB.

<u>Conservation Needs of the Species in the Action Area</u>

The conservation needs of the species in the Action Area are similar to the needs rangewide. Portions of the action area provide habitat for migrating, and summering NLEB, and NLEB in the portions of the Action Area have already been affected by WNS. Therefore, within the

Action Area the conservation needs include: 1) maintaining suitable habitat conditions in identified maternity areas and reducing the removal of roost trees; 2) searching for previously unidentified areas of maternity activity; and 3) conducting research to understand the migration patterns of NLEB that use the area during the summer.

EFFECTS OF THE ACTION

American Burying Beetle

Adverse impacts to ABB occur from ground disturbance associated with construction and subsequent soil disturbance. Construction activities associated with dredged material disposal pits and other proposed actions may disturb soils in areas within the ABB's range and have the potential to harm, harass, or kill individuals. Typical individual construction projects are relatively short-term, usually completed in fewer than 60 days. However, maintenance and additional disposal of dredged material are recurring impacts over the life of the project. Additionally, adverse impacts to the ABB may occur though increases in flooding frequency of flood pool lands in upstream reservoirs contributing flow to the Arkansas River.

Some land management activities, land use changes, and permitted actions have potential for adverse effects through temporary and permanent impacts. Actions such as natural resource management measures, real estate out-grants, shoreline management activities, leases, and easements may include soil disturbance and vegetation destruction or alteration that could adversely affect ABBs. Corps actions could include mowing, prescribed burns, creation or maintenance of trails, roads, parking lots, campgrounds, wastewater treatment, recreational facilities, leases, easements for mineral exploration/extraction, pipelines or utility lines, or other actions that may adversely affect ABBs and their habitat.

Direct Effects

Direct adverse impacts to ABBs during their inactive and active periods may occur as a result of impacts from clearing vegetation; soil compaction due to heavy equipment operation; fuel and chemical contamination of the soil; grading; soil excavation and filling; and revegetation and reseeding of disturbed areas. Construction of roads, recreation facilities, buildings and other permanent structures would also eliminate and fragment suitable habitat.

During construction of dredge disposal pits and access roads, soil is excavated and vegetation is cleared. Excavating soils, clearing vegetation and constructing access roads involve displacement of soils that could uncover ABBs. Uncovered ABBs could be exposed to predation, adverse environmental conditions, or crushed by equipment. If construction occurs during the active season, ABB broods could be displaced during soil excavation, adults could be separated from larvae/eggs, and/or both could be crushed by equipment. Revegetation and associated planting activities could result in further disturbance as described above.

In addition, use of heavy construction equipment, such as bulldozers, excavators, track hoes, and back hoes during road and dredge spoil disposal pit construction could compact the soils. Soil compaction could result in destroying ABB brood chambers, including adults and larvae; and preventing use by ABBs for carcass burial if construction takes place during the reproductive season. If construction takes place during the winter season, adult individuals could be crushed and ABB re-emergence in late spring or early summer could be prohibited.

The periodic disposal of dredged material has the potential to bury adults and larvae if previously deposited materials provide suitable soils. The frequency of dredging and subsequent disposal in dredge disposal pits is highly variable and the potential for take related to periodic disposal will vary from pit to pit.

All of these activities could result in the direct mortality of individual ABBs or broods, or create conditions that lessen the chance of survival of individuals or broods. In summary, ground disturbance associated with disposal of dredged material could result in take of individual ABBs, eggs, or larvae in eastern Oklahoma.

Direct mortality of the ABB may occur during maintenance and operational activities at Corps projects addressed in this biological opinion. Excavating soils, clearing vegetation and construction involve displacement of soils that could uncover ABBs. Uncovered ABBs could be exposed to predation, adverse environmental conditions, or crushed by equipment. If construction occurs during the active season, ABB broods could be displaced during soil excavation, adults could be separated from larvae/eggs, and/or both could be crushed by equipment. Revegetation and associated planting activities could result in further disturbance as described above.

Phase I of the Arkansas River Navigation Study (ARNS) has potential to extend the effect of a flood and the time required to reduce the elevation in 8 upstream reservoirs contributing flow to the Arkansas River. Increased flooding frequency and use of flood pools within these reservoirs may affect suitable and occupied ABB habitat. Direct mortality may occur during flooding events through drowning of adult ABBs and destroying brood chambers containing larvae and adults. As sedimentation of reservoirs increases, storage capacities of the reservoirs may be reduced, increasing the likelihood of flood pool use and more frequently flooding suitable habitat for the ABB. Some reservoirs such as Hulah have significant reductions in flood storage and others have very little, but all are expected to suffer sediment-related loses over time. Flood pools within the potential ABB range include Elk City and Pearson-Skubitz Big Hill projects in Kansas and Tenkiller Ferry, Eufaula, Hulah, Wister, Keystone, Oologah, Ft. Gibson, Copan, Skiatook, Birch, Kaw, Heyburn, and Texoma in Oklahoma. Blue Mountain Lake is in Arkansas and Pat Mayse and portions of the Texoma Project flood pools are in Texas. Other Corps reservoirs or flood pools such as Hugo, Pine Creek, Broken Bow, Hudson, and Grand Lakes may also be in potential ABB range, but are not included in this consultation and will be addressed in subsequent section 7 consultations. The flood control provided by these reservoirs reduces the frequency of downstream flooding and any flooding-related take of ABBs in suitable habitat within the downstream floodplains.

Indirect Effects

Indirect effects are those project related effects which are reasonably certain to occur, but later in time. Construction activities and related habitat disturbance may temporarily reduce local rodent populations that would provide carrion for ABBs. Destruction and alteration of vegetation through mowing, clearing, disking, and spraying can also reduce local rodent and bird populations that provide carrion. Some of these effects are temporary, but some areas are mowed routinely and have a more permanent effect if vegetation is maintained at a short height. Construction of buildings, roads, parking lots, boat ramps, campgrounds, sewage treatment facilities, recreational equipment and other more permanent structures impact habitat on a long-term basis and can fragment or reduce the suitability of surrounding habitat.

Increased flood frequency and maintenance and operational activities of ABB habitat within the Corps land can indirectly affect the ABB by limiting or reducing available carrion or the loss, fragmentation, and alteration of suitable habitat. Reduced flood frequency in downstream floodplains may also affect vegetation, abundance of species that would provide suitable carrion, and land use/habitat fragmentation. These effects appear to be both positive and negative and have not been studied or quantified. Although the ABB appears to use various habitat types, the role of vegetation composition and soil type as limiting factors is unclear. However, the creation of edge habitat may result in unsuitable habitat conditions for the ABB and potentially lead to increased competition for prey resources and scavengers.

Interior Least Tern

No revisions other than minor time extensions for completion of a management plan and nesting habitat development are necessary for the least tern and the Corps/SWPA are in compliance with all least tern-related terms and conditions in the PBO. Least tern numbers have been relatively stable and reproductive success has been above the baseline 10 year average in most of the Action Area since 2013.

Northern Long-Eared Bat

Potential effects to the NLEB include direct and indirect effects. Direct effects occur when bats are present while the activities are being conducted; indirect effects occur later in time. Effects will vary based on the type of the proposed activity.

Our analysis of effects for NLEB entails: (1) evaluating individual NLEB exposure to action-related stressors and response to that exposure; (2) integrating those individual effects (exposure risk and subsequent response) to discern the consequences to the populations to which those individuals belong; and (3) determining the consequences of any population-level effects to the species rangewide.

Effects to Hibernating Bats and/or Hibernacula

Neither direct nor indirect effects are anticipated to wintering NLEB or their hibernacula from the proposed action.

Effects to Bats during Spring/Summer and/or to Spring/Summer Habitat

Death/Injury

Risk of death or injury of individual NLEB from timber harvest or other tree removal varies depending on the timing of activities, the location, type of harvest, and extent of removal.

The timing of tree removal activities greatly influences the likelihood of exposure and the extent of impacts on individual bats and their populations. Female NLEB typically roost colonially, with their largest population counts occurring in the spring, presumably as one way to reduce thermal costs for individual bats (Foster and Kurta 1999). While bats do have the ability to flee their roosts during tree removal, removal of occupied roosts during the active season while bats are present (spring through fall) will likely cause injury or mortality to the roosting bats. During the entire active season, bats are likely to be injured or killed during the spring months when bats often use torpor (temporary unresponsive state) to survive cool weather and low prey availability. Bats are further likely to be killed or injured during early to mid-summer (approximately June-July) when flightless pups or inexperienced flying juveniles are present. Removal of trees outside these periods is less likely to result in direct injury or mortality when the majority of bats can fly and are more dispersed.

The location of timber harvest activities also influences the likelihood and extent of impacts. Timber harvest activities outside of NLEB summer home ranges or away from hibernacula will not result in death or injury to individuals. The greatest risk of take is associated with projects within known NLEB home ranges (calculated from radio telemetry or estimated based on capture or detection of NLEB [see Service 2014]) where no or few roost trees have been located. This is because occupancy probability has already been established at 100% but it is unclear where the core roosting area is located [and these areas are not protected from in-season removal. The risk of death or injury of bats from timber harvest or other tree removal within known home ranges with documented roost trees is less as some of the trees occupied by roosting bats should be left undisturbed during the pup season]. Areas outside of known home ranges have some probability of occupancy from 0-100%.

Lastly, the likelihood and extent of impacts are influenced by the type/scope of the timber harvest/tree removal relative to the amount of remaining suitable roosting and foraging habitat. Within a given home range NLEB use multiple roosts throughout the season. Therefore, only a certain number of roosts are anticipated to be occupied in any given day and within any given year. Therefore, the risk of encountering roosting NLEB during a given forest treatment is associated with the percentage of home range impacted and the type of forest treatment. Larger acreages of treatment have greater risk than smaller acreages. Similarly, clearcuts have greater risk than selective harvest treatments (individual or group) because more trees in a given treatment area will be removed.

Based on the proposed action relatively few timber harvests and no clear cuts would be proposed within the Action Area but tree removal (in some form) could occur through many actions on Corps lands.

Response to Removal or Alteration of Roosting/Foraging Habitat

The best available data indicate that the NLEB shows a varied degree of sensitivity to timber harvesting practices so long as there are sufficient roosts available for their use (Menzel et al. 2002, Owen et al. 2002). In central Arkansas, the three classes of mixed pine-hardwood forest that supported the majority of the roosts were partially harvested or thinned, unharvested (50–99 years old), and group selection harvest (Perry and Thill 2007). Forest size and continuity are also factors that define the quality of habitat for roost sites for NLEB. Lacki and Schwierjohann (2001) stated that silvicultural practices could meet both male and female roosting requirements by maintaining large-diameter snags, while allowing for regeneration of forests.

In addition to impacts on roost sites, timber harvest practices can also affect foraging and traveling habitat, and thus, NLEB fitness. In southeastern Missouri, the NLEB showed a preference for contiguous tracts of forest cover (rather than fragmented or wide open landscapes) for foraging or traveling and, different forest types interspersed on the landscape increased likelihood of occupancy (Yates and Muzika 2006). Similarly, in West Virginia, female NLEB spent most of their time foraging or travelling in intact forest, diameter-limit harvests (70–90 year-old stands with 30–40 percent of basal area removed in the past 10 years), and road corridors, with no use of deferment harvests (similar to clearcutting) (Owen et al. 2003). In Alberta, Canada NLEB avoided the center of clearcuts and foraged more in intact forest than expected (Patriquin and Barclay 2003). On Prince Edward Island, Canada, female NLEBs preferred open areas less than forested areas, with foraging areas centered along forest-covered creeks (Henderson and Broders 2008). In general, NLEBs prefer intact mixed-type forests with small gaps (i.e., forest trails, small roads or forest covered creeks) in forest with sparse or medium vegetation for foraging and traveling rather than fragmented habitat or areas that have been clearcut.

Timber harvest activities do not typically lead to permanent losses of suitable roosting, foraging, or traveling habitat for NLEB. Many timber harvest regimes will result in minimal change in terms of providing suitable roosting or foraging habitat for NLEB. For example, selective harvest regimes are not anticipated to result in alterations of forest to the point where NLEB would be expected to significantly alter their normal behaviors. This is because the treatment areas will still be forested with small openings. Similarly, small patch cuts, wildlife openings, and forest roads would be expected to serve as foraging areas or travel corridors. Therefore, the only impacts of concern from these forest treatments are the potential for death or injury during active season tree removal.

However, localized long-term reductions in suitable roosting and/or foraging habitat can occur from various forest practices. For example, large clearcuts (that remove a large portion of a known or assumed home range) would result in a temporary “loss” of forest for NLEB. In these cases, “temporary” would be for many years (amount of time to reproduce suitable roosting/foraging habitat). Foraging would be possible prior to roosting depending on the juxtaposition of cuts to other forest regimes.

As stated above, NLEB have been found in forests that have been managed to varying degrees and as long as there is sufficient suitable roosting and foraging habitat within their home range and travel corridors between those areas, we would expect NLEB colonies to persist in managed landscapes.

In addition to the type of timber harvest, the extent of impact from timber harvest related habitat modifications is influenced by the amount of suitable habitat available within and nearby NLEB home ranges. Some portions of the NLEB's range are more forested than others. In areas with little forest or highly fragmented forests (e.g., western U.S. edge of the range, central Midwestern states; impact of forest loss would be disproportionately greater than similar sized losses in heavily forested areas (e.g., Appalachians and northern forests). Also, the impact of habitat loss within a northern long-eared bat's home range is expected to vary depending on the scope of removal. Silvis et al. (2014) modeled roost loss of NLEBs and Silvis et al. (2015) removed known NLEB roosts during the winter in the field to determine how this would impact the species. Once tree removal totaled 20–30 percent of known roosts, a single maternity colony network started showing patterns of break-up. As explained in the Status of Species section, sociality is hypothesized to increase reproductive success (Silvis et al. 2014); thus, smaller colonies are expected to have lower reproductive success.

Longer flights to find alternative suitable habitat and colonial disruption may result from removal of roosting or foraging habitat. NLEB emerge from hibernation with their lowest annual fat reserves, and return to their summer home ranges. Since NLEBs have summer home range fidelity (Foster and Kurta 1999; Patriquin et al. 2010; Broders et al. 2013), loss or alteration of forest habitat may put additional stress on females when returning to summer roost or foraging areas after hibernation. Females (often pregnant) are forced to seek out new roosts or foraging areas and must expend additional, but limited, energy. Hibernation and reproduction are the most energetically demanding periods for temperate-zone bats, including the NLEB (Broders et al. 2013). Bats may reduce metabolic costs of foraging by concentrating efforts in areas of known high prey profitability, a benefit that could result from the bat's local roosting and home range knowledge and site fidelity (Broders et al. 2013). Cool spring temperatures provide an additional energetic demand, as bats need to stay sufficiently warm or enter torpor (state of mental or physical inactivity). Entering torpor comes at a cost of delayed parturition; bats born earlier in the year have a greater chance of surviving their first winter and breeding in their first year of life (Frick et al. 2009). Delayed parturition may also be costly because young of the year and adult females would have less time to prepare for hibernation (Broders et al. 2013). Female NLEB typically roost colonially, with their largest population counts occurring in the spring, presumably as one way to reduce thermal costs for individual bats (Foster and Kurta 1999). Therefore, similar to other temperate bats, NLEB have multiple high metabolic demands (particularly in spring), and must have sufficient suitable roosting and foraging habitat available in relatively close proximity to allow for successful reproduction.

In summary, timber harvests and tree clearing associated with road-related activities could have both adverse and beneficial effects on habitat suitability for the NLEB. Only minor portions of the action area are proposed for any tree removal and there will be large amounts of unaffected, intact forested habitat available. As a result, we conclude that the overall habitat suitability or availability within the action area should be minimally affected by timber harvest and tree removal activities under the proposed action.

Prescribed Burning

The Corps has proposed conducting prescribed fires within the NLEB range during the winter hibernation period to minimize any incidental take of the bats. However, some bats can become active during this period due to warmer than normal weather. Most of the action area is not near a known hibernacula and this reduces any risks of bats being in the area affected by a prescribed burn. Conducting prescribed fires outside the hibernation period could result in direct mortality or injury to NLEB by burning, heat exposure, or smoke inhalation. Bats also may be exposed to elevated concentrations of potentially harmful compounds within the smoke (e.g., carbon monoxide and irritants) (Dickinson et al. 2009). Exposure risk depends on a variety of factors including height of roosts, timing and behavior of fire, winds, proximity of fire to roosts. Risk of direct mortality and injury to bats from prescribed fire is low as long as fire intensity and crown scorch height are low (Dickinson 2010). Waiting until temperatures are a bit warmer in spring reduces more frequent use of torpor and should allow NLEB to more easily flush (Dickinson 2010). Avoiding burns during July will also help prevent loss of pups that may be too heavy for adults to carry. Due to the anticipated timing of the burns, [torpid adults and/or non-volant young] will not be present during the majority of the burns and most bats should be mobile during the burning activities. In summary, we expect minimal lethal take from prescribed fires and these adverse effects are expected to be short-term and localized.

Response to Removal or Alteration of Roosting/Foraging Habitat

Indirect effects may include short-term loss of roost trees and decreases in prey abundance, followed by long-term increases in roost abundance and suitability, and in prey abundance (Boyles and Aubrey 2006, Dickinson 2010, Dickinson et al. 2009, Johnson et al. 2009, Johnson et al. 2010, Lacki et al. 2009, Timpone et al. 2009). These types of both adverse and beneficial effects have been noted for both the Indiana bat and the NLEB. While there are some differences in roosting and foraging habitat preferences between these species, there is also much overlap in habitat usage between these species, and in most cases general conclusions based on research on one species will also be applicable to the other.

Prescribed fire can create a greater abundance of potential roost trees for NLEB because fires can cause bark of live trees to peel away from the sapwood creating the sloughing bark that is often used for roosting (Johnson et al. 2010). The availability of suitable roosts (including roosts with cavities and exfoliating bark) is greater in burned areas compared to unburned areas (Boyles and Aubrey 2006, Dickinson et al. 2009, Johnson et al. 2010). NLEB have been found to use roost extensively in burned habitats immediately after prescribed burning (Lacki et al. 2009) with roosts shifting from primarily beneath bark before burning to inside cavities after burning.

Tree species that consistently form high quality bat roosts include shellbark hickory (*Carya laciniosa*), shagbark hickory (*C. ovata*), and white oak (*Quercus alba*). Regeneration of white oak and hickory increases as a result of low-intensity fires and/or repeated fires below open canopies (Johnson et al. 2010, Dickinson et al. 2009). Similarly, fire creates canopy gaps that allow for regeneration of shade-intolerant species such as black locust, a preferred roost tree species for the NLEB in some locations (Dickinson et al. 2009, Johnson et al. 2009). Therefore, over the long-term, prescribed fire is anticipated to increase the abundance of tree species that form high quality NLEB roosts.

Fires can also create a more open canopy structure that can improve roost quality by increasing the amount of solar radiation reaching the roost. Canopy light penetration was higher and canopy tree density was lower in burned forest than in unburned forest (Boyles and Aubrey 2006). Additionally, canopy gaps in the burned area are associated with slightly higher maximum daily temperatures at roost trees (Johnson et al. 2009). Higher roost temperatures could facilitate more rapid growth of developing juvenile bats (Johnson et al. 2009). As a result, the abundance of trees with characteristics suitable for roosting, and the percentage of the forested area with suitable bat roosts, should be increased after fires (Boyles and Aubrey 2006). Studies in West Virginia found that the NLEB responded favorably to prescribed fire by using new roost trees that were located in canopy gaps created as a result of the fire (Johnson et al. 2009). Conversely, fire may also destroy or accelerate the decline of existing roost trees, particularly of older snags, by burning the bases of the trees and weakening their structure, causing them to fall over quicker (Johnson et al. 2009, Dickinson et al. 2009). One study found that up to 20 percent of existing standing snags were lost post-fire, and that few new snags were created (Lacki et al. 2009).

In summary, prescribed fire may result in both adverse and beneficial effects on roosting habitat through immediate loss of existing roosts and creation of some new roosts, followed by short-term increases in the suitability of remaining and created roosts, and long-term changes in forest composition towards a greater abundance of trees likely to create suitable roosts in the future. Unfortunately, existing data are insufficient to fully quantify or compare the relative impact of these adverse and beneficial effects. For instance, the long-term tradeoff between roost creation and roost loss in mixed oak forests under burning regimes is unknown (Dickinson et al. 2009). One research project concluded that prescribed fire, at minimum, provoked no response from the Indiana bat in terms of roost tree selection, and in some cases may create additional roost resources (Johnson et al. 2010). As a result, we conclude the overall effect of the prescribed fire portion of the proposed action on roost availability may be neutral to potentially beneficial.

Prescribed fire may affect foraging habitat by changing the structure of the forest and by changing the abundance of prey within the area (Dickinson et al. 2009). NLEBs have shown a preference for foraging in heavily forested mid-slope areas, regardless of burn condition, suggesting these bats feed in and around closed canopies and are likely clutter-adapted (Lacki et al. 2009). These studies suggest that the reduction in canopy closure as a result of prescribed burning could have a negative effect on foraging suitability for the NLEB. However, that same data do not indicate that bats avoid foraging in or around areas that have been burned. For example, the size of female NLEB home ranges and core areas did not vary between bats radio tracked before and after fires, and the home ranges of these bats were located closer to burned habitats following fires than to unburned habitats (Lacki et al. 2009). The researchers for this study suggest that NLEBs responded to habitat alterations resulting from prescribed fires by shifting the location of their foraging areas to take advantage of changes in insect prey availability (Lacki et al. 2009). Immediately after fires, insect abundance typically declines (Lacki et al. 2009). Therefore, fires conducted in the late winter and early spring may reduce abundance of bat prey during critical periods when bats are coming out of hibernation, are migrating, or are pregnant (Johnson et al. 2009). However, over a longer-term (within one year), abundance of coleopterans (beetles), dipterans (flies), and all insects combined has been shown to increase following prescribed fires (Lacki et al. 2009). These increases can last for up to 16 years post-burn. Because lepidopterans (moths and butterflies), coleopterans, and dipterans are important groups of insect prey for *Myotis* species, researchers have concluded that fire does indeed improve foraging conditions in the long-term by increasing prey quantity in the form of insects attracted to post-fire dead wood (Lacki et al. 2009, Dickinson 2010). As a result, we conclude that prescribed fire may have a short-term adverse and long-term beneficial effect on prey abundance, and thus foraging habitat suitability in the action area.

Given NLEBs frequent use of live trees and snags, multiple roosting structures, and ability to arouse and move during fires, and positive or neutral response for roosting and foraging within burned areas, NLEB are expected to experience minimal impacts from prescribed fire.

Effects from Noise, Disturbance: Noise and vibration and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities of the NLEB. Many activities may result in increased noise/vibration/disturbance that may result in effects to bats.

Bats may be exposed to noise/vibration/disturbance from various Corps/SWPA activities near their roosting, foraging, or swarming areas.

Significant changes in noise levels in an area may result in temporary to permanent alteration of bat behaviors. The novelty of these noises and their relative volume levels will likely dictate the range of responses from individuals or colonies of bats. At low noise levels (or farther distances), bats initially may be startled, but they would likely habituate to the low background noise levels. At closer range and louder noise levels (particularly if accompanied by physical vibrations from heavy machinery and the crashing of falling trees) many bats would probably be startled to the point of fleeing from their day-time roosts and in a few cases may experience increased predation risk. For projects with noise levels greater than usually experienced by bats, and that continue for multiple days, the bats roosting within or close to these areas are likely to shift their focal roosting areas further away or may temporarily abandon these roosting areas completely.

There is limited literature available regarding impacts from noise (outside of road/traffic) on bats. Gardner et al. (1991) had evidence that an NLEB conspecific, Indiana bat, continued to roost and forage in an area with active timber harvest. Also see the timber harvest Section above regarding other similar studies for NLEB. They suggested that noise and exhaust emissions from machinery could possibly disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment. Callahan (1993) noted that the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree. However, his last exit count at this roost was conducted 18 days prior to the exit count of zero.

Indiana bats have also been documented roosting within approximately 300 meters of a busy state route adjacent to Fort Drum Military Installation (Fort Drum) and immediately adjacent to housing areas and construction activities on Fort Drum (US Army 2014).

Bats roosting or foraging in all of the examples above have likely become habituated to the noise/vibration/disturbance. Novel noises would be expected to result in some changes to bat behaviors.

NLEB that are currently present in the forest are expected to be tolerant of existing noise, vibration, and disturbance levels; therefore, noise/vibration/disturbance from existing actions are not expected to result in any response by bats.

Herbicides

Herbicides may be used to control weed species including noxious or invasive plants throughout the action area. Treatment of targeted plant species will result in a reduction in the amount and frequency of mowing activities. In addition, herbicides are used to control vegetation in site-specific areas, such as around buildings, etc. Treatments typically occur in spring, early summer or fall. Herbicide application is generally applied once during the year either by hand or from a truck-mounted boom sprayer having spray heads designed to minimize drift. Application occurs during the day when bats are roosting, and often in the morning to avoid and minimize wind-induced drift. Since herbicide will be applied to vegetation growing at heights much lower than typical roosts for NLEB, no overspray is expected to reach locations where bats may be roosting.

It is possible that some non-water safe herbicide could accidentally get into surface waters from either overspray or drift, which may affect bat's drinking water and/or cause bats to ingest chemicals through drinking or through bioaccumulation from eating affected insects. However, this is very unlikely due to the minimal amounts of herbicide generally used to remove unwanted vegetation. Herbicide application is only one of several methods used to control vegetation. Alternative methods include manual and mechanical removal and biological treatments. In addition, all herbicides will be used in accordance to their label instructions and herbicides applicators will be appropriately licensed. Effects from herbicide exposure or indirect effects to insects (prey) consumed by the NLEB are insignificant and discountable, very unlikely to occur, or cannot be detected or measured.

Effects from Structure Maintenance/Removal Activities

NLEBs have been found roosting in structures such as barns, houses, sheds, and bridges (particularly when suitable roost trees are unavailable). For example, Broders and Forbes (2004) noted that some use of bat boxes and human made structures, like shutters, has been documented. Benedict and Howell (2008) captured 11 NLEBs in barns. Timpone et al. (2010) reported NLEBs used an abandoned barn as a maternity in conjunction with the little brown bat (*Myotis lucifugus*). They also documented use of an equipment shed as a NLEB roost site. Other structures such as dams and storm water drains have been used as NLEB hibenacula.

If work is conducted while bats are present, they may be harassed during activities causing stressors such as noise and vibration at the roost location. Butchkoski and Hassinger (2002) documented an Indiana bat maternity colony using an abandoned structure. If a structure is altered during the summer maternity season we expect a range of impacts depending on when in the maternity season the impacts occur. If impacts occur early in the maternity season then the females may abort their pups. If bats are forced to flee from roosts during daytime, they may experience greater risk of predation. Also, bats (primarily non-volant pups or adults using torpor during cool temperatures) may be injured or killed by being crushed.

The majority of operations and maintenance of existing structures will result in no effects to bats. Projects that are specifically designed to exclude bats (e.g., remove bats in public buildings) can be done to minimize impacts to bats.

In summary, maintenance of structures without any signs of bats should result in no effects to NLEB. If there is observed bat activity (or signs of frequent bat activity), The Corps/SWPA will avoid maintenance activity bat exclusions or similar structure alteration during the active season unless there are concerns about human health/safety/property and coordinate with the local Service FO.]

Summary of Effects

Impacts to Individuals

Potential effects of the action include direct effects to NLEB present within the action area when activities are being conducted, and indirect effects as a result of changes in habitat suitability. Direct effects include mortality, injury, harm, or harassment as a result of removal or burning of roost trees.

Indirect effects from the action may result from habitat modification and primarily involve changes to roosting and foraging suitability. Timber harvests and tree clearing associated with Corps activities could have both adverse and beneficial effects on habitat suitability for the NLEB. Prescribed fire may also result in both adverse and beneficial effects on roosting habitat through loss and creation of existing roosts, and long-term changes in forest composition towards a greater abundance of suitable roosts in the future. Prescribed fire may also have a short-term adverse and long-term beneficial effect on prey abundance, and thus foraging habitat suitability in the action area. The overall effect of the prescribed fire portion of the proposed action on habitat suitability may be neutral to potentially beneficial. Given the scope of the projects in relation to the overall action area, these projects will not substantially alter the overall availability or suitability of NLEB roosting or foraging habitat.

Some land management activities, land use changes, and permitted actions have potential for adverse effects through temporary and permanent impacts. Actions such as natural resource management measures, real estate out-grants, shoreline management activities, leases, and easements may include vegetation destruction or alteration that could adversely affect NLEBs. Corps actions could include mowing, prescribed burns, creation or maintenance of trails, roads, parking lots, campgrounds, wastewater treatment, recreational facilities, leases, easements for mineral exploration/extraction, pipelines or utility lines, or other actions that may directly and indirectly adversely affect NLEBs and their habitat. Some of the effects are expected to be temporary and other actions have permanent effects. Some land management actions (such as burning) may have short term adverse effects, but are beneficial on a longer term basis. None of the proposed actions will alter the amount or extent of mortality or harm to NLEB resulting directly from WNS. No cumulative effects are expected.

The flooding of thousands of acres of timber within the flood pools of Corps reservoirs has the greatest potential for killing or harming NLEBs. The trees can be under water for hours to months and can happen at any time of year. Lethal take of pups can occur if flooding of maternity trees occurs when non-volant pups are present. Flood storage is part of the projects purpose and the Corps has only limited abilities to minimize the adverse effects. The higher elevations of the individual flood pools are usually infrequently used, but the frequency of flooding is unpredictable over any given time period. Flood water storage can also affect the habitat and some trees will be stressed and die if they are inundated for extended periods of time. This extended flood storage could at least temporarily increase the number of suitable roost trees in subsequent years.

Impacts to Populations

We recognize the potential for a small amount of lethal take of adults and/or pups and reduced reproductive success due to the proposed action, but we believe, the NLEB colonies affected should be able to sustain the worst-case losses discussed above. Most of the forested habitat on Corps projects will remain forested and protected to some degree in the proposed action. The habitat should continue to support populations of NLEB unless they are impacted by WNS or other factors.

Impacts to the Species

No component of the proposed action is expected to reduce the reproduction, numbers, or distribution of the NLEB rangewide. While we recognize that the status of the species is uncertain due to WNS, given the environmental baseline, and the intensity, frequency, and duration of the project impacts, we find that the proposed project is unlikely to have population-level impacts, and thus, is also unlikely to decrease the overall reproduction, numbers, or distribution of the NLEB. Therefore, we do not anticipate a reduction in the likelihood of both survival and recovery of the species as a whole.

CUMMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Any actions conducted on Corps lands will either be conducted by the Corps, or will require approval by the Corps and thus will require separate section 7 consultations if the actions are not covered by this RBO. Therefore, cumulative effects, as defined in the ESA, are not expected to occur on Corps lands.

CONCLUSION

American Burying Beetle

Some ABBs may be disturbed or killed during dredged material disposal pit construction, dredged material disposal, and related ground disturbance activities, but most of the effects are expected to be infrequent and of short duration. ABB habitat currently existing within the flood pool may be submerged under water, likely for infrequent, short durations, but potentially disturbing or killing ABBs within the area. This an unavoidable consequence of flood control and a primary project purpose for most reservoirs. All incidental take related to flood pool storage is quantified and addressed in this biological opinion. The flood control also reduces flooding of downstream floodplain habitat and may reduce flooding-related take of ABBs in these areas.

Some land management activities, land use changes, and permitted actions have potential for adverse effects through temporary and permanent impacts. Actions such as natural resource management measures, real estate out-grants, shoreline management activities, leases, and easements may include soil disturbance and vegetation destruction or alteration that could adversely affect ABBs. Corps actions could include mowing, prescribed burns, creation or maintenance of trails, roads, parking lots, campgrounds, wastewater treatment, recreational facilities, leases, easements for mineral exploration/extraction, pipelines or utility lines, or other actions that may directly and indirectly adversely affect ABBs and their habitat. Some of the effects are expected to be temporary and some land management actions (such as burning) may have short term adverse effects but are beneficial on a longer term basis.

Interior Least Tern

The greatest impact of the proposed action is to nesting habitat quantity and quality. The project reservoirs reduce the frequency of flood events and reduce sediment transport necessary for building and maintaining tern nesting habitat. Periodic high flow events are likely to occur that will restore some nesting habitat, but less frequently than natural conditions due to continuing flood control efforts. The quality and quantity of tern nesting habitat will decline following those high flow events (provided those events do not reoccur within 3-5 years) and project-related flood control operations and impacts on sediment transport would hasten the decline. Most tern nesting habitat in the Action Area could remain in poor condition for relatively long periods of time with the proposed action. The adverse indirect effects such as predation, human disturbance, and trampling by livestock, associated with the poor habitat conditions, could increase or remain at relatively high levels until protective measures are implemented.

Poor quality, low elevation nesting habitat makes flooding of nests and chicks more likely and increases the potential for take. Manipulation of water releases to reduce flooding of nests has and would continue to reduce the adverse effects , but the ability of the Corps/SWPA to protect nesting terns is limited when most nesting is at sites with very low elevations. Maintenance of created nesting habitat in the navigation system can provide relatively high quality habitat with low risks of flooding and would provide some successful reproduction when most other sites are negatively affected by flooding. Overall, the proposed action is likely to adversely affect terns in a manner similar to the existing operations.

Northern Long-Eared Bat

Some land management activities, land use changes, and permitted actions have potential for adverse effects through temporary and permanent impacts. Actions such as natural resource management measures, real estate out-grants, shoreline management activities, leases, and easements may include vegetation destruction or alteration that could adversely affect NLEBs. Corps actions could include mowing, prescribed burns, creation or maintenance of trails, roads, parking lots, campgrounds, wastewater treatment, recreational facilities, leases, easements for mineral exploration/extraction, pipelines or utility lines, or other actions that may directly and indirectly adversely affect NLEBs and their habitat. Many other Corps lands are gradually becoming more forested due to a lack of fire or disturbance and will increase the potential habitat for NLEB. Some of the effects are expected to be temporary and other actions have permanent effects. Some land management actions (such as burning) may have short term adverse effects, but are beneficial on a longer term basis. None of the proposed actions will alter the amount or extent of mortality or harm to NLEB resulting directly from WNS. Timing of the actions can minimize the effects and most Corps lands will maintain or increase habitat potential for NLEB. No cumulative effects are expected.

The flooding of thousands of acres of timber within the flood pools of Corps reservoirs has the greatest potential for killing or harming NLEBs. The trees can be under water for hours to months and can happen at any time of year. Lethal take of pups can occur if flooding of maternity trees occurs when non-volant pups are present. Flood storage is part of the projects purpose and the Corps has only limited abilities to minimize the effects of flood pool storage. The upper portions of the flood pools are usually infrequently used, but the frequency of flooding is unpredictable over any given time period. Flood water storage can also affect the habitat and some trees will be stressed and die if they are inundated for extended periods of time. This extended flood storage could increase the number of suitable roost trees in subsequent years.

BIOLOGICAL OPINION

Section 7(a)(2) of the Act requires federal agencies to ensure that any action authorized, funded, or carried out by such agency is not likely to: 1) jeopardize the continued existence of any endangered or threatened species, or 2) result in the destruction or adverse modification of critical habitat. The term, "jeopardize the continued existence of", means to reduce appreciably the likelihood of both the survival **and** recovery of listed species in the wild by reducing the species' reproduction, numbers, or distribution. Jeopardy opinions must present reasonable evidence that the project will jeopardize the continued existence of the listed species or result in destruction or adverse modification of critical habitat.

After reviewing the current status of the ABB, NLEB and least tern, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the Service’s opinion that the action, as proposed, is not likely to jeopardize the continued existence of these species, and is not likely to destroy or adversely modify designated critical habitat. No critical habitat has been designated for these species, therefore, none will be affected. However, the proposed action likely will result in incidental take of ABBs, NLEBs, and least terns.

INCIDENTAL TAKE

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior or behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and 7(o)(2), taking that is incidental to, and not intended as a part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by the Corps, and SWPA, when applicable, so that they become binding conditions for the exemption in section 7(o)(2) to apply. The Corps, and SWPA, when applicable, have a continuing duty to regulate the activity covered by this incidental take statement. If the Corps or SWPA, when applicable, (1) fails to assume and implement the terms and conditions or (2) fails to require a contractor to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(I)(3)].

AMOUNT OR EXTENT OF TAKE ANTICIPATED

American Burying Beetle

Take, in the form of killing, harming, and/or harassment, is difficult to precisely quantify and usually cannot be estimated in terms of numbers of individuals. The Service expects incidental take of ABB will be difficult to detect for the following reasons: 1) the ABB has a small body size making it hard to locate, which makes encountering dead or injured individuals unlikely; 2) ABB losses may be masked by annual fluctuations in numbers and highly concentrated movements; and 3) ABBs spend a substantial portion of their lifespan underground. These complications result in difficulty enumerating or estimating the quantity of ABBs necessary to accurately estimate the amount or extent of take. Consequently, the Service believes using habitat area as a surrogate for take should be employed as the best method to quantify the amount of take that is likely to occur. Take of all ABBs occurring on the affected habitat (measured in acres) is anticipated.

Some ABBs may be disturbed and harmed, harassed, or killed during dredged material disposal pit construction, dredged material disposal, maintenance and operation of Corps facilities, or other ground disturbance activities. Approximately 1,100 acres would be disturbed to create dredged material disposal pits in the Tulsa District. The Corps must reinitiate consultation with the Service if more than 1,100 acres of ABB habitat are disturbed during these activities.

Take of adult ABBs and brood chambers containing larvae and adults may occur during use of the flood pool in areas with suitable habitat for the ABB. In ABB range, approximately 297,151 acres of Flood Control Pool (Flood Control Pool acres – Conservation Pool acres) at Elk City (10,229 acres) and Pearson-Skubitz Big Hill (280 acres) projects in Kansas and Tenkiller Ferry (7,900 acres), Eufaula (42,000 acres), Hulah (9,880 acres), Wister (15,980 acres), Keystone (36,291 acres), Oologah (27,489 acres), Ft. Gibson (31,100 acres), Copan (8,931 acres), Skiatook (3,500 acres), Birch (1,202 acres), Kaw (22,940 acres), Heyburn (2,867 acres), and Texoma (66,732 acres OK and TX) in Oklahoma. Blue Mountain (8,090 acres) in Arkansas, Pat Mayse (1,740 acres) and portions of the Texoma Project flood pools in Texas occur within Corps projects. The percentage of the 297,151 flood pool acres that contain suitable habitat for the ABB is currently unknown and difficult to determine due to changing habitat conditions and water elevations. All flood pool acres are considered suitable and occupied ABB habitat for the purposes of this consultation. Occupied habitat within the flood pools could change over time, but would be very difficult to accurately monitor.

The Service anticipates that if flood events occur at every reservoir within the action area, all ABBs occurring within these 297,151 acres could be taken. Historically, reservoirs have been at the top of the flood control pool less than one percent of the time (pool elevation duration curves from Corps water control manual) and it would be extremely rare for all of the flood pool storage at all listed reservoirs to be used at the same time or in the same year. The actual area of flood pool storage used each year will be provided in the annual report.

If the flood pool is increased at any of the projects included in this consultation, the Corps must reinitiate consultation regarding take for ABBs in flood control areas.

The proposed action was amended in 2014 to include land use changes, natural resource management measures, real estate out-grants, easements, leases, consents to mineral exploration and shoreline management activities.

Land Use Changes- These changes may include temporary or permanent impacts to habitat. Land use changes can include modification of existing or establishment of new recreation areas. Some changes may result from the reclassification of Civil Works project lands. Examples of changes include construction of restrooms, water and wastewater treatment systems, parks, roads, boat ramps, parking areas, playgrounds, camp sites, utility infrastructure, and other recreation-related projects. The Corps estimates up to 20 acres of temporary (Tulsa District) and 62 (47 in the Tulsa District, 15 in the Little Rock District) acres of permanent impacts could occur annually due to land use changes within the action area.

Natural Resource Management Measures- Examples of natural resource management include food plots for wildlife, prescribed fire and construction and maintenance of fire breaks, access control structures, fences, access roads, timber harvest/sales, thinning or control of woody vegetation, limited grazing for habitat management, fencing to control human or livestock access, construction and maintenance of wetlands/ponds, control of invasive vegetation and re-establishing native vegetation, stream bank stabilization and erosion control. For natural resource management measures, the Corps estimates up to 11,735 (11,385 in the Tulsa District, 350 in the Little Rock District) acres of temporary and 50 (all in the Tulsa District) acres of permanent impacts could occur annually within the action area. The Tulsa District estimate includes 9,145 acres of temporary impacts from ODWC activities on Corps licensed areas.

Real Estate Out-Grants and Easements- Temporary and permanent impacts may occur from out-grants of real property. Temporary impacts may include installation and maintenance of utilities and upland dredge material disposal. Permanent impacts may include installation of structures such as sidewalks, buildings, roads, boat ramps, parking areas, campgrounds, utilities, fences, entryways, improvements or additions to existing structures, wastewater treatment systems, drainage improvements and erosion control. Easements and leases may include agricultural leases (grazing, farming and haying), pipelines, utility lines, roadways and mineral exploration/extraction. The Corps estimates up to 218 (203 in the Tulsa District, 15 in the Little Rock District) acres of temporary and 63 (all in the Tulsa District) acres of permanent impacts could occur annually for these types of activities within the action area.

Shoreline Management- The Corps issues shoreline management permits for activities such as construction or clearing of walking pathways, landings, bank stabilization, fire breaks, and reversal of vegetative succession, this includes mowing and clearing of vegetation. The Corps estimates up to 20 acres of temporary (Tulsa District) and 138 (135 in the Tulsa District, 3 in the Little Rock District) acres of permanent impacts could occur annually for these types of activities within the action area.

Mitigation – The Corps proposes to develop an ABB mitigation and management plans within 18 months of the completion of this consultation. The Corps proposes to set aside and manage approximately 2,000 acres in the Tulsa District and 1,350 in the Little Rock District to provide mitigation for anticipated impacts.

Management of the mitigation area would also have potential for take. Actions that are necessary and provide long-term ABB habitat benefits such as prescribed fire, mechanical thinning of woody vegetation, reestablishing native vegetation, and control of invasive vegetation or animals could include take and temporary adverse impacts to habitat. No more than 20 percent of suitable habitat in the mitigation area should be disturbed in any year.

Summary

- Approximately 1,100 acres were proposed to be disturbed to create dredged material disposal pits.
- Approximately 75 acres at the Eufaula Project include soil disturbing activities such as

roads, trails, etc., with the Roundtree Landing Public Use Area development in the PBO.

- If flood events occur at every reservoir within the action area, all ABBs occurring within the 297,151 acres of flood pool storage (of projects with potential ABB presence) could be taken.
- This RBO anticipates an annual total of up to 11,993 acres of temporary impacts and 313 acres of permanent impacts related to land use changes, natural resource management measures, real estate out-grants, easements, leases, consents to mineral exploration and shoreline management activities could occur.
- A total of 1,175 acres of incidental take is allowed for specific projects that includes the combined dredge disposal pits and the Roundtree Landing Public Use Area development project. A total of 310,319 acres of incidental take (in some form) are allowed for exemption on an annual basis under this RBO. Temporary impacts account for 310,006 acres of the total. The majority of this take is related to reservoir flood pool storage and most of these acres would rarely be inundated.

The total or annual ABB take (in acres) outlined above is the maximum allowed for exemption under this RBO. If total or annual take is approaching these limits, the Corps/SWPA should reinitiate consultation to ensure take limits are not exceeded.

Interior Least Tern

Take estimates for least terns have not changed or been revised in the RBO. Only minor revisions are necessary for the least tern and the Corps and SWPA are in compliance with all least tern –related terms and conditions in the PBO. Least tern numbers have been relatively stable and reproductive success has been good in most of the Action Area since 2013.
The estimates (averages) of existing numbers of adult and fledgling terns by river reach for 2006-2011 are used as a baseline in the PBO:

A. Arkansas River, Oklahoma, Kaw Reservoir to Oklahoma/Arkansas state line (excluding created islands in the navigation system), including the lower Canadian River below Eufaula Reservoir –415 adults and 163 fledglings annually.
B. Arkansas River, Arkansas – 383 adults and 73 fledglings annually.
C. Red River, Lake Texoma to Index, Arkansas – 545 adults and 100 fledglings annually.

The combined total for existing adult and fledgling annual numbers (averages) in the entire Action Area (excluding created islands in the navigation system) is 1,343 adults and 336 fledglings. This represents the existing baseline that should be maintained and used as a compliance goal.

Take of up to 1,500 eggs and chicks is possible in some years. When habitat is poor, take of at least 300-600 eggs and chicks is expected in most years. We assume all adults in the Action Area (1,990 is the highest count to date) could be harmed or harassed by flooding and other impacts associated with the proposed action.

The Corps/SWPA must reinitiate consultation with the Service if direct and indirect take occurs to the degree that the number of adults and fledglings, for the Action Area, average (over a five year period) fewer than the combined total numbers identified above (A-C). Five year averages of annual numbers can be less than existing averages for individual river reaches as long as the averages for the total Action Area meets or exceeds 1,343 adults and 336 fledglings.

Northern Long-Eared Bat

Take of NLEBs may occur during use of the flood pool in areas with suitable habitat for the NLEB. Adult NLEBs could be disturbed and displaced and pups could drown if maternity trees are inundated. Maternity trees could be downed by flood waters or killed by frequent or extended inundation during the growing season. In the NLEB range, approximately 311,901 acres of Flood Control Pool (Flood Control Pool acres – Conservation Pool acres) at Elk City (10,229 acres) and Pearson-Skubitz Big Hill (280 acres) projects in Kansas and Tenkiller Ferry (7,900 acres), Eufaula (42,000 acres), Hulah (9,880 acres), Wister (15,980 acres), Keystone (36,291 acres), Oologah (27,489 acres), Ft. Gibson (31,100 acres), Copan (8,931 acres), Skiatook (3,500 acres), Birch (1,202 acres), Kaw (22,940 acres), Heyburn (2,867 acres), and Texoma (66,732 acres OK and TX) in Oklahoma. Blue Mountain (8,090 acres) and Nimrod (14,750) in Arkansas, Pat Mayse (1,740 acres) and portions of the Texoma Project flood pools in Texas occur within Corps projects. The percentage of the 311,901 flood pool acres that contain suitable habitat for the NLEB is currently unknown and difficult to determine due to changing habitat conditions and water elevations. All flood pool acres are considered suitable and occupied NLEB habitat for the purposes of this consultation. Occupied habitat within the flood pools could change over time, but would be very difficult to accurately monitor.

The Service anticipates that if flood events occur at every reservoir within the action area, all NLEBs occurring within these 311,901 acres could be harmed, or harassed and pups could killed if maternity trees are inundated when they are not volant. Historically, reservoirs have been at the top of the flood control pool less than one percent of the time (pool elevation duration curves from Corps water control manual) and it would be extremely rare for all of the flood pool storage at all listed reservoirs to be used at the same time or in the same year. The actual area of flood pool storage used each year will be provided in the annual report.

If the flood pool is increased at any of the projects included in this consultation, the Corps must reinitiate consultation regarding take for NLEBs in flood control areas.

EFFECT OF THE TAKE

American Burying Beetle

Approximately 1,100 acres of soil disturbance is anticipated with the dredge disposal associated proposed action and is a very small percentage of the total project area. Approximately 75 acres of soil disturbing activities such as roads, trails, etc., at the Eufaula Project were included with the proposed action in the PBO. Flooding disturbance would be temporary and may occur at a maximum of 297,151 acres (combined for multiple reservoirs), which is less than 3% of land within the ABB range in Oklahoma. Most of the acres associated with flood pool storage are rarely inundated and usually only for a few weeks or months. Most of the incidental take described above was previously exempted in the PBO.

In addition to the incidental take related to flood pool storage, this RBO anticipates an annual total of up to 11,993 acres of temporary impacts and 313 acres of permanent impacts related to land use changes, natural resource management measures, real estate out-grants, easements, leases, consents to mineral exploration and shoreline management activities. However, most of the temporary impacts are intended to enhance habitat for ABBs and have a beneficial effect in subsequent years. For example, most of the annual temporary take is associated with prescribed fire and other wildlife management actions. These actions are supported by the Service for maintaining and enhancing ABB habitat.

The Corps proposes to develop an ABB mitigation and management plan within 18 months of the completion of this consultation. The Corps will protect and manage approximately 3,350 acres to provide mitigation for anticipated impacts and some of the acres of temporary take is related to actions necessary for managing the mitigation lands.

In the accompanying opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the ABB or adverse modification of critical habitat.

Least Tern

Our review of information that has become available since the 2005 opinion indicates that the adult least tern numbers have increased in some areas. However, this may be partially due to increased survey effort; in addition, not all least tern populations have increased and some areas have documented recent declines. For example adult least tern counts in the Action Area have declined somewhat since 2005. Approximately 17,591 adult terns is the most recent rangewide estimate (Lott 2006). We evaluated new information on the species and its habitat within the Action Area. Least terns in the Action Area currently may account for approximately 11 percent of the listed entity (1,990 action area /17,591 rangewide) based on the most recent population estimate.

We suspect that fledge ratios and numbers of nesting birds may decline in the Action Area during periods with poor nesting habitat quantity and quality. Habitat conditions were relatively poor in most of the Action Area from 2000-2006 and 2010-2014. However, relatively high flow events do periodically occur and 2015 high flow events did restore some habitat and tern nesting success for an unknown duration. We expect tern nesting habitat conditions to fluctuate over time, and be negatively impacted by the proposed action. However, if the existing average numbers of adults and fledglings are maintained, the least tern populations in the Action Area should remain relatively stable. The proposed action should be able to average and maintain existing levels of reproductive success (average of 336 fledglings) and that should be adequate to support existing tern populations (average of 1,343 adults) and meet or exceed existing recovery plan goals. In the PBO, the Service determined that the anticipated take was not likely to result in jeopardy to the least tern or adverse modification of critical habitat.

Only minor revisions are necessary for the least tern and the Corps/SWPA are in compliance with all least tern –related terms and conditions in the PBO. Least tern numbers have been relatively stable and reproductive success has been at or above the 10 year average in most of the Action Area since 2013. For this RBO, the Service determined that the anticipated take is not likely to result in jeopardy to the least tern or adverse modification of critical habitat.

Northern Long-Eared Bat

Incidental take is exempted for the flood pool storage of several reservoirs in the NLEB range, with approximately 311,901 acres of incidental take. In most years only a small percentage of these acres would actually be inundated for flood water storage and the effects are temporary. Adult NLEBs could be disturbed and displaced and pups could drown if maternity trees are inundated during the pup season, but the effects are limited to the flood pools and not expected to significantly affect local populations. The presence and status of NLEBs are unknown in most of the project area and this RBP is assuming presence for all of the flood pools. The 311, 901 acres are scattered through Kansas, Oklahoma, and Arkansas and affect only a small percentage of NLEB habitat in the action area.

After reviewing the current status of this species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the NLEB. No critical habitat has been designated for this species; therefore, none will be affected.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the take of ABBs, least terns, and NLEBs.

American Burying Beetle

To minimize potential take of the ABB, the Service recommends the following RPMs for proposed construction/soil disturbance projects that may impact the ABB:

1. For non-emergency proposed projects/permits/easements within the ABB range - Prior to project site disturbance, survey for ABBs and implement minimization measures if the survey is positive for the ABB. The Corps/SWPA can choose not to do surveys for ABBs, if they assume presence, implement minimization measures, and provide/require mitigation for unavoidable incidental take related to actions covered by this RBO.

2. Maintain and improve suitable habitat on Corps/SWPA properties within the ABB range.

Interior Least Tern

RPMs for the Least Tern have only minor revisions in the RBO (relative to the PBO). To minimize potential take of least terns, the Service recommends the following RPMs:

1. Maintain suitable habitat for nesting least terns in the Action Area by:
   a) providing adequate flows to create and maintain nesting habitat, and/or

b) artificially or mechanically enhancing, constructing, and maintaining nesting habitat.

2. Monitor, evaluate, and adjust operations as needed to minimize take of least terns.

3. Reduce predation and human disturbance of least terns in the Action Area.

Northern Long-Eared Bat

The final 4(d) rule and accompanying biological opinion was published in the *Federal Register* on January 14, 2016 and took effect on February 16, 2016. For more information on the special rule for the northern long-eared bat, go to **http://www.fws.gov/midwest/endangered/mammals/nleb/index.html**. The Service's final 4(d) rule for NLEB exempts the take of NLEB from the section 9 prohibitions of the ESA, when such take occurs as follows (see the final 4(d) rule for more information):

Most of the Corps/SWPA actions (other than flood pool storage) would be covered by the final 4(d) rule. The Service has developed a streamlined process for section 7 consultation and compliance with the 4(d) rule (available at http://www.fws.gov/midwest/endangered/mammals/nleb/s7.html), related to the NLEB. The proposed actions may affect the northern long-eared bat; however, other than flood pool storage, there are no effects beyond those previously disclosed in the Service's programmatic biological opinion for the final 4(d) rule dated January 5, 2016. Any taking that may occur incidental to this project is not prohibited under the final 4(d) rule (50 CFR §17.40(o)). This project is consistent with the description of the proposed action in the programmatic biological opinion, and the 4(d) rule does not prohibit incidental take of the northern long-eared bat that may occur as a result of this project. Therefore, the programmatic biological opinion satisfies the Corps responsibilities under ESA section 7(a)(2) relative to the northern long-eared bat for all described actions other than flood pool storage. Please keep in mind that the Corps/SWPA must report any departures from the plans submitted; results of any surveys conducted; or any dead, injured, or sick northern long-eared bats that are found to the appropriate Service field offices.

The incidental take that is carried out in compliance with the final 4(d) rule does not require exemption in this Incidental Take Statement. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions because all incidental take has already been exempted. The remainder of this analysis addresses the incidental take resulting from those elements of the proposed action that are not covered by the 4(d) rule.

To minimize potential take of the NLEB, the Service recommends the following RPMs for proposed projects that may impact the NLEB.

1. Minimize take related to any tree removal or inundation and comply with section 7 responsibilities and the 4(d) rule.

TERMS AND CONDITIONS FOR IMPLEMENTATION

In order to be exempt from the prohibitions of section 9 of the Act, the Corps and SWPA, when applicable, must comply with the following terms and conditions which implement the RPMs described above and outline required reporting/monitoring provisions. These terms and conditions are non-discretionary.

American Burying Beetle

Terms and Conditions for RPM 1

1. The Corps will evaluate the likelihood of ABBs occurring within the project area by generating an official species list at http://ecos.fws.gov/ipac/. If the project site is inside the ABB range (i.e., ABB listed in the official species list), the Corps will evaluate the project area for suitable ABB habitat using the most current information for ABBs at the Oklahoma ES Service website ***http://www.fws.gov/southwest/es/Oklahoma/ABB_Add_Info.htm*** or at the Arkansas ES website **http://www.fws.gov/arkansas-es/** for projects occurring in Arkansas

   a. If suitable ABB habitat would be impacted, the Corps will have a section 10 permitted biologist conduct presence/absence surveys (if feasible) using established survey procedures found on our website at http://www.fws.gov/southwest/es/Oklahoma/ABB_Add_Info.htm, for Oklahoma **or** the most recent guidance found on the Arkansas ES website at http://www.fws.gov/arkansas-es/

   b. If surveys are not feasible or practical, the Corps may assume presence, implement minimization measures, and provide mitigation using the most current recommendations on the Service website, as described in the proposed action. If a survey for a project site is positive for the ABB, or presence is assumed, take will be avoided and minimized to the greatest extent practicable. Minimization measures and mitigation should follow the most current guidance provided on our website.

2. The Corps must provide an annual report to the Services Oklahoma and Arkansas Ecological Services Field Offices detailing the ABB areas (acres) impacted by soil disturbance. This report must include a copy of all ABB survey results and reasonable and prudent measures implemented.

Terms and Conditions for RPM 2

The Corps will develop an ABB mitigation and management plan within 18 months of the completion of this consultation for Service review and approval. The Corps proposes to protect and manage/improve habitat on existing Corps lands to provide mitigation for impacts. The Corps proposes to provide long term protection and actively manage approximately 3,350 acres to provide mitigation for anticipated impacts. The Corps will begin ABB surveys in 2016 and consult with the Service to identify potential mitigation lands for the ABB mitigation and management plan.

Least Tern

RPMs and terms and conditions for the Least Tern have only minor revisions in the RBO. Deadlines for nesting habitat creation/enhancement and a few reports have minor extensions relative to RPMs in the PBO.

Terms and conditions for RPM 1 - Maintain suitable habitat for nesting least terns in the Action Area.

Suitable nesting habitat can be established and maintained by provision of appropriate river flows and/or mechanically or artificially enhanced, constructed, and maintained sites. High flows and floodpool releases do periodically enhance and create tern nesting habitat, but flood control operations reduce the frequency and amplitude of releases. To maintain tern nesting habitat over any extended period of time, it is likely that constructing and enhancing habitat will be necessary in combination with periodic natural restoration through high flow events. As our knowledge of river habitat conditions and tern populations change over time, the exact locations, design, and number of constructed nesting sites may be modified if approved by the Service. Sites may be enhanced or constructed through dredge disposal, cooperative efforts with sand and gravel operations, floating structures, mitigation in association with 404 permits for proposed bridge or dam projects, and other options. Initially, all constructed nesting habitat must be at locations approved by the Service and meet the following criteria (floating structures excluded, criteria for these have not been developed yet):

a) Substrate – Nesting substrates consist of well drained particles ranging in size from fine sand to small stones < 1 in. (2.5 cm) in diameter.
b) Size/Shape – Nesting areas should be a minimum of 1 ac (0.4 ha), and preferably 5-10 ac (2-4 ha) in size; circular to oblong in shape, maximizing surface area; slopes may vary for individual sites but chicks must have access to water; surface height above water to exceed 18 in. (45.7 cm) at nest initiation (usually May or June).
c) Visibility – Smooth topography with < 10 % early successional vegetation.
d) At least 50% of the enhanced or constructed nesting habitat must be in place by April 2020 and 100% by April 2023.
e) If a created or enhanced island is not utilized by least terns for nesting after 2 nesting seasons, the area will be re-evaluated and potentially modified based on Service recommendations. If least terns still do not utilize these areas (within 2 years) for nesting following potential modifications, additional habitat should be created or enhanced in its place.

The Corps Regulatory Program will, pursuant to permitting and mitigation requirements of Section 10 of the Rivers and Harbors Act of 1899 (33 U.S. Code 403) and Section 404 of the Clean Water Act (33 U.S. Code 1344), allow discharges of dredged spoil or fill material to be used to construct islands, where feasible, and in coordination with the Service and appropriate state agencies such as the Arkansas Game and Fish Commission. Restoration actions initiated by the Service or state agencies will be allowed to place fill for construction of islands outside of the navigation channel and designated disposal areas for the purposes of habitat restoration and recovery of listed species. Volumes of fill and flood storage for these areas will be compensated for by reductions in the available volumes of adjacent approved disposal areas and/or through calculated volumes removed from the same pool through dredging.

Least terns will not use created nesting habitat exclusively and existing data indicate it is not realistic to expect nesting colonies within river habitat to average more than 20 nests per site. However, islands created in the MKARNS by the Corps (Spaniard Creek Island and Kerr) been shown to have much higher use, with as many as 138 nests observed on these islands in 2010. Habitat should be distributed across an area (as opposed to concentrated in one place) to avoid nesting failure at multiple nesting islands during a localized flooding, storm events, predation, or human disturbance.

1. Nesting habitat will be provided and maintained to support the minimum population (currently at least 1,343 adults and 336 fledglings). Habitat at an elevation that will not flood at flows of at least a 10-year frequency (as measured over the period of record and including the water elevation fluctuations due to barge traffic for the MKARNS) will be created or enhanced to provide more suitable nesting habitat.

    a. Habitat may be created or enhanced within the Project Area (Red River from Lake Texoma to Index, Arkansas and/or Arkansas River (Kaw Reservoir downstream to and including the MKARNS, the Canadian River (Eufaula Reservoir downstream to the MKARNS). At least four islands have been created and partially maintained within the MKARNS system-in the Tulsa District. Nesting and nesting success has varied in the islands each year, but Kerr island has had multiple years of successful nesting. More than 12 islands have already been created and vegetative mulching and spraying of herbicide has been performed on some of them in Arkansas. Vegetative control will continue and expand into the future, both for created islands and natural habitat.
    b. At least four additional nesting sites must be created or enhanced and maintained within the Oklahoma portion and 12 islands in the Arkansas portion of the Action Area (additional to nesting sites present in 2013). All created or enhanced nesting sites will be at elevations that will not flood on at least a 10-year frequency (as measured over the period of record and including the water elevation fluctuations due to barge traffic) for the MKARNS. These nesting sites and any future sites developed should include vegetation removal and predator control, conducted and evaluated on an annual basis, and must meet criteria a-d above.

2. Arkansas River, Arkansas - Dredge spoil will be utilized to create and/or enhance potential least tern nesting habitat at sites recommended and approved by the Service and the Corps. The dredge spoil islands will be monitored and evaluated by the Service and the Corps, as discussed in Part 5, during the breeding season. Suitable nesting habitat will be maintained as defined by criteria a through c listed above at sites recommended

by the Service, pending post construction monitoring and evaluation. An average of at least one nesting island per pool, or 12 islands (with the Dardanelle pool counting as 2 for pools 10 &11), will be constructed and/or enhanced and maintained to provide sustainable and viable nesting habitat above an elevation that will not flood during the breeding season on at least a ten year frequency (as measured over the period of record and including the water elevation fluctuations due to barge traffic). The location and number of nesting islands per navigation pool will be based on monitoring and evaluation of tern use, sustainability, habitat quality, and viability as determined by the Service and the Corps. Of the 12 islands, at least 1 (each) must be maintained in pools 2, 5, 7, 8, 9, 10, and 12. The islands will be constructed/enhanced and maintained where determined appropriate and feasible by the Service and the Corps based on previously described methods and considerations.

3. The Corps will monitor and evaluate the created or enhanced island/sandbar habitat annually to determine if physical and biological requirements of the least tern are being achieved. The Corps shall assess the potential for creating nesting habitat in the MKARNS and use this information to direct efforts to restore or create additional tern nesting sites in the navigation system. The Corps shall report the data for created or vegetation-managed nesting habitat separately from natural nesting habitat. If the created island/sandbars are not being utilized as anticipated, then the Corps will evaluate and implement methods to improve the habitat suitability. The Corps will coordinate these actions with the Service.

<u>Terms and Conditions for RPM 2</u> - Monitor, evaluate, and adjust operations to minimize take of least terns.

1. The Corps will monitor and evaluate the effect of reservoir releases on nesting least terns. Information collected under RPM 3, including elevations of sandbars and nests in relationship to water levels, plus any additional information necessary to assess flooding, human disturbance, predation, and impacts to forage fish populations, will be examined and used to adjust or adapt least tern management guidelines and other Corps actions that may affect least terns. The Corps will utilize its authorities and operational flexibility in adjusting flows and other pertinent actions to reduce the flooding and landbridging of least tern nesting sites. The Corps will coordinate frequently and in a timely manner with the Service when it has determined that increased flow releases may flood terns or decreased flows may landbridge tern nesting sites. During these consultations, the Corps will provide the Service its recommendations to reduce flooding and landbridging. Nesting habitat shall be a priority and other management actions implemented to meet or exceed the minimum adult and fledgling numbers established for the Action Area.

2. By March 1, 2017, the Little Rock District of the Corps will develop a Least Tern Management Plan with guidelines similar to in scope to the document developed by the Tulsa District, but specific to navigational parameters and features of Little Rock District projects. At a minimum this document will include least tern management guidelines for each project and coordination procedures and contacts for April-September of each year. The Corps will coordinate the development of this document with the Service to

minimize take of terns. This document, once approved by the Service, will be incorporated into the Corps future actions and will supersede any previous guidelines.

3. The Corps will conduct annual least tern monitoring at all nesting sites on the Arkansas, Canadian, and Red rivers within the Action Area, including reservoirs and the river reaches between reservoirs. In addition, terns have been identified nesting on rooftops adjacent to the Arkansas River in the Arkansas River Valley. Monitoring these nesting sites in addition to the island nesting locations will allow for a more accurate population assessment along with comparison and contrasting of the nesting sites to improve our understanding of the habitat quality and overall population numbers. Previous studies suggest that these rooftop colonies may be essential to the recovery and conservation of this species and directly influenced by flows on the Arkansas River. These sites are an important part of the monitoring and recovery effort and monitoring and collecting information on these colonies is essential to state and range wide population assessments. The Corps will develop a monitoring plan with specific information on how monitoring will be conducted; this plan should be developed with input from the Interior Least Tern Working Group, but must be approved by the Service. Information to be collected will include, but not be limited to, the number of adult terns, elevation of nests and freeboard representing the highest and lowest nests at each nesting site, locations (as measured with a global positioning system) in latitude and longitude or UTMs of nesting sites, evidence of land bridging, evidence of predation or disturbance, and number of nests, chicks and fledglings. In conducting the annual least tern surveys, the Corps will continue to collect information on mortality, injury, and productivity. The number and type of mortality (in categories currently used by the Corps) will be recorded for adults, chicks, eggs, and nests along with any other useful observations. The Corps will record mortality caused by its operations, any measures taken to reduce mortality, and the effectiveness of these measures to reduce take. The Corps also will collect information on annual productivity, including the number of fledglings per breeding pair.

4. In accordance with other annual reporting requirements in this Opinion, the Corps will provide to the Service, by March 1 of each year, the information collected as described by these Terms and Conditions along with analyses, conclusions, and recommendations.

<u>Terms and conditions for RPM 3</u> - Reduce predation and human disturbance of least terns.

1. The Corps/SWPA will evaluate various measures to reduce predation of least terns, focusing on nesting areas with historically high predation. The Corps will prepare a report describing its findings from the predation reduction evaluation, along with its recommendations. This report will be completed by January 1, 2018.

2. The Corps/SWPA will implement measures approved by the Service to reduce predation at all constructed or enhanced least tern nesting sites.

3. The Corps shall post signs at least tern nesting sites and boat ramps that the Service and Corps/SWPA deem could be affected by human disturbance and may benefit from posting signs (e.g., large colonies, areas with high human use, sites used by

boaters, ATV's or other ORV's, sites with history of human disturbance). If requested by the Service, the Corps will attempt to contact landowners of nesting sites not managed or controlled by the Corps to obtain permission to post signs. If landowner permission is granted, the signs will be placed at strategic locations and densities to best deter human entry. The signs should clearly deny entry, describe the potential for death and injury of least terns from entry, the penalties under the ESA for harming a threatened or endangered species, and general information on the life history of least terns. The Corps/SWPA will coordinate with Service and State personnel on any nesting sites requiring surveillance and/or enforcement action.

4. All personnel involved with surveying, studying, maintaining habitat, and related activities will be trained to use current methods to avoid impacting terns and hold a current section 10(a)(1)(A) recovery permit if the activities have potential for take.

5. At least tern nesting sites managed or controlled by the Corps, monitor and manage recreation and other activities to avoid or minimize human disturbance. This may include signs, education, a tern monitor on site at areas with high disturbance, potential contracts with Oklahoma Department of Wildlife Conservation and Arkansas Game and Fish Commission to have game wardens monitor properties, surveillance equipment on site, enforcement by Corps rangers for posted closed areas, or other options.

6. The Corps/SWPA will conduct a public outreach and education program on the conservation of the least tern. In addition to using traditional outreach products and activities (e.g., brochures, videos, interpretative programs, posters), the Corps will coordinate with the Service to produce and distribute Public Service Announcements about least terns in the Action Area.

Northern Long-Eared Bat

<u>Terms and conditions for RPM 1</u>

1. The Corps will conduct all tree removal in compliance with section 7 responsibilities and the most current final 4 (d) rule for NLEB.

PROCEDURES FOR HANDLING AND DISPOSING OF INTERIOR LEAST TERNS

Upon locating a dead or injured adult or juvenile least tern, the Oklahoma or Arkansas Ecological Services Field Office should be notified as expeditiously as possible. Care will be taken in handling sick or injured specimens to ensure effective treatment and when handling dead specimens to preserve biological materials in the best possible state for later analysis of cause of death. The finder must ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

All dead or moribund individuals will be frozen and the date and location of collection recorded.

These specimens should then be furnished to the university, museum, or agency specified by the Service.

PROCEDURES FOR HANDLING AND DISPOSING OF ABBS

If a dead or impaired ABB is found, care should be taken in its handling to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. The dead or impaired ABB should be photographed prior to disturbing it or the site. The Service is to be notified within three (3) calendar days upon locating a dead or injured ABB. Initial notification must be made to the nearest U. S. Fish and Wildlife Service Law Enforcement Office, at (918) 581-7469, then the Oklahoma Ecological Services Field Office, at (918)581-7458 or Arkansas Ecological Services Field Office at (501) 513-4488. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information.

All dead or moribund adults should be salvaged by placing them on cotton in a small cardboard box as soon as possible after collection. The date and location of collection should be included with the container. Specimens should then be furnished to the Sam Noble Museum of Natural History at the University of Oklahoma in Norman for deposition in their collection of invertebrates, or to another suitable site approved by the Service.

PROCEDURES FOR HANDLING AND DISPOSING OF NLEB

The Corps shall make all reasonable efforts to educate personnel to report any sick, injured, and/or dead bats (regardless of species) located in the action area immediately to the appropriate Service field office. No one, with the exception of trained staff or researchers contracted to conduct bat monitoring activities, should attempt to handle any live bat, regardless of its condition. If needed, the Service will assist in species determination for any dead or moribund bats. Any dead bats believed to be NLEB will be transported on ice to the appropriate Service field office. Care must be taken in handling dead specimens to preserve biological material in the best possible state. In conjunction with the care of sick and injured fish or wildlife and the preservation of biological materials from dead specimens, the Corps has the responsibility to ensure that information relative to the date, time, and location of NLEB, when found, and possible cause of injury or death of each is recorded and provided to the Service.
In the extremely rare event that someone has been bitten by a bat, please keep the bat in a container and contact the local health department.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the amount or extent of the incidental take limit is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs and terms and conditions provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs and terms and conditions.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans or develop information. Implementation of these measures would help facilitate recovery of the least tern.

A. The Corps and SWPA should continue coordination of the least tern coordination team (LTCT) to identify and implement the goals of this Opinion. The team will be responsible for ensuring implementation of future conservation measures; tracking, evaluating, and documenting the results of those measures; and tracking and documenting sufficient progress in conserving this listed species. The LTCT should involve additional agencies or groups, as appropriate, with biological and engineering expertise. The LTCT should coordinate with the Interior Least Tern Working Group to improve implementation of monitoring and recovery measures.
B. Conduct least tern monitoring on river reaches upstream of Corps reservoirs. Least tern populations nesting on the Cimarron, Canadian, and Red rivers upstream of Corps reservoirs should be monitored to help determine movements of terns from downstream areas during and after flood events or other disturbances. The reproductive success of these terns should be monitored to determine the comparative nesting success of terns above and below Corps reservoirs.
C. The Corps/SWPA should initiate other studies as appropriate to investigate the long-term effects of riverbed changes/sediment transport and their impacts to least tern nesting habitat, forage availability, and forage areas.
D. The Corps/SWPA should initiate studies to evaluate the abundance and availability of forage fish for least terns during the nesting season. The effects of operational flows on forage fish also should be investigated to develop modifications of flows to benefit forage fish populations. The abundance and availability of forage may be a limiting factor to the success of nesting least terns.
E. The Corps/SWPA should research and develop methods to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches downstream of reservoirs. Restoration or enhancement of habitat, such as notching dikes, could improve habitat for terns and fish.
F. The Corps/SWPA should conduct or assist in research (including surveys) on the ABB to fill data gaps regarding the ecology and biology of the ABB. Data gaps involving the ABB include: reproductive habitat, reproductive life history in southern portions of the range, surveys to determine distribution and abundance within the action area, overwintering habitat, and diurnal active season habitat. The Service recommends coordinating research proposals with the Oklahoma and Arkansas Field Offices.
G. The Corps/SWPA should conduct or assist in surveys and research on the NLEB to fill data gaps regarding the ecology and biology of the NLEB. Data gaps involving the

NLEB include: distribution and abundance within the action area, locations of hibernacula and maternity roosts within the action area,

In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or benefit listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in your biological and environmental assessments. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation of consultation.

Thank you for the information and cooperation provided by the Corps/SWPA in this consultation. Questions or comments should be referred to Kevin Stubbs (918-382-4516) or kevin_stubbs@fws.gov of this office.

cc: U.S. Fish and Wildlife Service, Arkansas ESFO, Conway, Arkansas,

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