2018 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin

Prepared by the

Mississippi Interstate Cooperative Resource Association

Asian Carp Advisory Committee

August 2018

Figure on cover page: Asian carp coordination and implementation of projects in the Mississippi River Basin is broken down into sub basins including the Ohio River Basin (green; includes the Tennessee and Cumberland rivers), Upper Mississippi River Basin (yellow), Missouri River Basin (blue) and the Lower Mississippi River Basin (purple; includes the Arkansas, Red, and White rivers).

Table of Contents

Introduction

The Mississippi River and its tributaries comprise one of the largest and most ecologically and economically valuable ecosystems in the world. The Mississippi River Basin is the fourth largest watershed in the world, and the largest watershed in the nation, draining all or part of 31 states and 2 Canadian provinces (Figure 1). The watershed measures approximately 1.2 million square miles, covers 41% of the continental United States, and includes numerous large tributary systems including the Arkansas, Illinois, Missouri, Ohio, Tennessee, Cumberland, Red, and White rivers. Recreational boating and fishing in the Mississippi River and tributaries support many local economies throughout the Mississippi River Basin. In 2015, the U.S. Fish and Wildlife Service (USFWS) estimated the economic output from recreational fishing in the Mississippi River Basin at more than $19 billion (USFWS, unpublished data).

Figure 1. Map of the Mississippi River Basin which drains all or a portion of 31 states and 2 Canadian Provinces (green and light green). This map also highlights the spatial extent of the current implementation of Asian carp prevention and control projects (Ohio and Upper Mississippi River Basins shaded dark green and the upper 175 miles of the Illinois River and Chicago Area Waterway System shaded yellow).

Aquatic Invasive Species (AIS) are having negative impacts and reversing recent progress made towards ecological rehabilitation and restoration in the Mississippi River Basin. Over the past two decades four species of Asian carp (Bighead Carp, Black Carp, Grass Carp, and Silver Carp)

have become a basin wide issue of concern for natural resource management agencies and the public. Bighead, Silver, and Grass carps have established self-sustaining populations and are spreading throughout the Mississippi River Basin (Figures 2 and 3). In recent years, Black Carp have been captured with increasing frequency in the Lower Mississippi, Upper Mississippi (below Lock and Dam 19), Illinois, lower Ohio and lower Cumberland rivers. With the collection of young-of-the-year Black Carp in the Mississippi River Basin in 2016, it is evident that Black Carp are likely self-sustaining in the mainstem river and some major tributaries within the Mississippi River Basin.

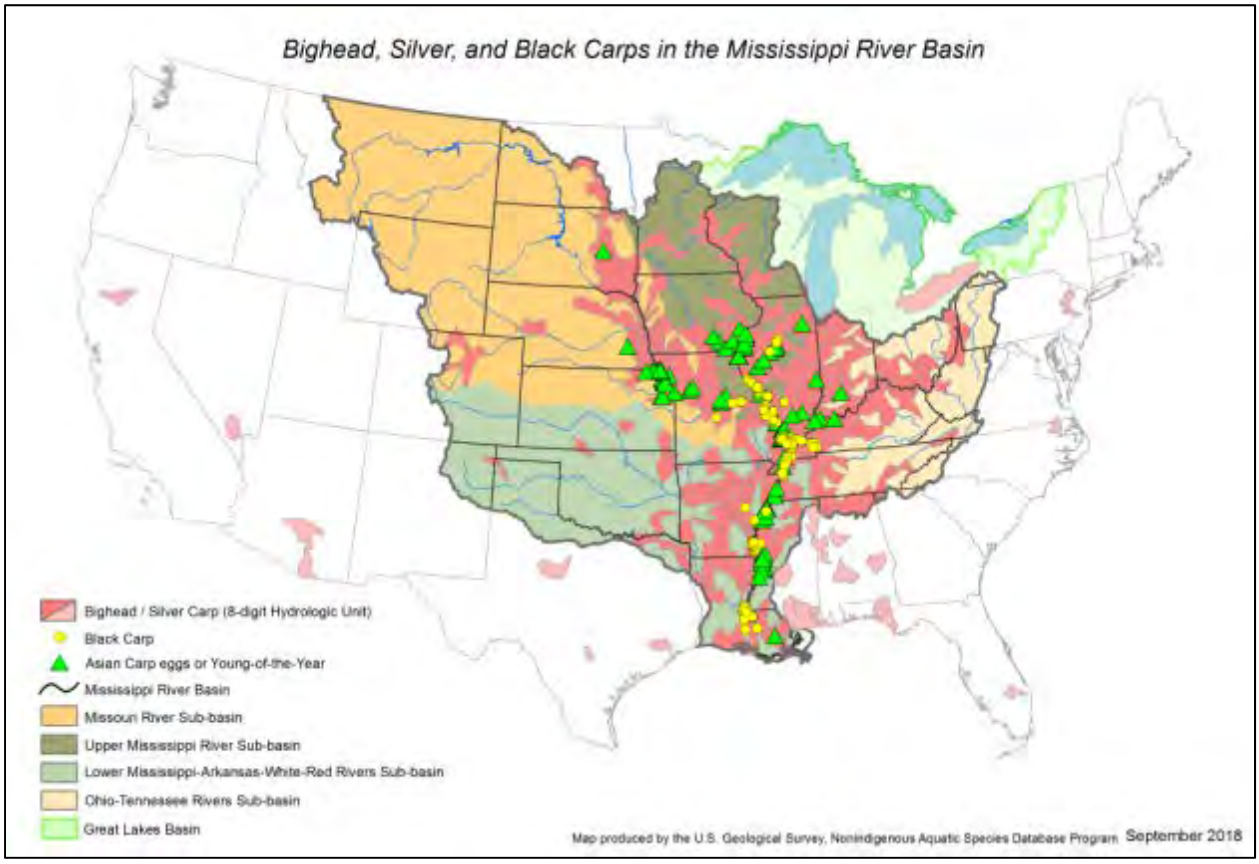

Figure 2. Distribution of Bighead Carp, Silver Carp, and Black Carps in the Mississippi River Basin as reported to the USGS Nonindigenous Aquatic Species (NAS) Database as of September 2018. Collections of Bighead Carp and Silver Carp by 8-digit Hydrologic Unit in the Mississippi River Basin are shaded dark pink; collections of Bighead Carp and Silver Carp by 8-digit Hydrologic Unit outside the basin are shaded light pink. Black Carp collections are indicated by yellow circles. Bighead Carp, Silver Carp, and Black Carp eggs or young-of-the-year are denoted with green triangles.

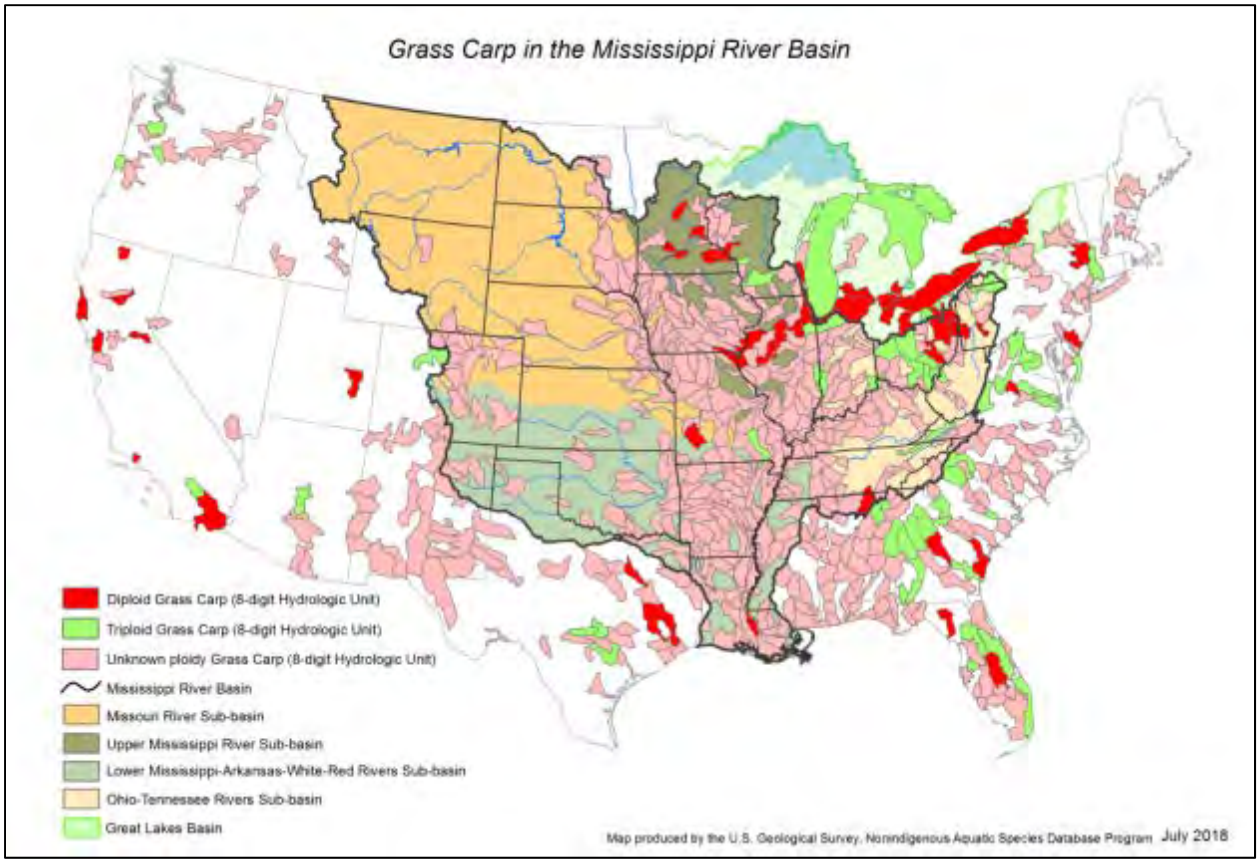

Figure 3. Distribution of Grass Carp in the Mississippi River Basin as reported to the USGS Nonindigenous Aquatic Species (NAS) Database as of July 2018.

The Aquatic Nuisance Species Task Force approved the national *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* (National Plan) for implementation in 2007. State fisheries management agencies and their federal partners formed multiple inter-agency partnerships to develop and implement regional Asian Carp Control Strategy Frameworks (Frameworks) to step-down implementation of the National Plan to the local level. The Mississippi Interstate Cooperative Resource Association (MICRA), a partnership of 28 state agencies with fisheries management jurisdiction in the Mississippi River Basin, works with regional inter-agency partnerships in the Upper Mississippi River sub-basin (UMRB), Ohio River sub-basin (ORB), Missouri River sub-basin (MORB), and the Lower Mississippi River sub-basin (LMRB) to provide for coordinated Asian carp management and control in the Mississippi River Basin (Figure 4). States have been working collaboratively with their partners at the sub-basin level to prevent the continued range expansion and population growth of Asian carp in the Mississippi River Basin to the extent possible with limited resources.

Figure 4. Asian carp coordination and implementation of projects in the Mississippi River Basin is broken down into sub basins including the Ohio River Basin (green; includes the Tennessee and Cumberland rivers), Upper Mississippi River Basin (yellow), Missouri River Basin (blue) and the Lower Mississippi River Basin (purple; includes the Arkansas, Red, and White rivers).

The Asian Carp Regional Coordinating Committee (ACRCC), a partnership of state, provincial, and United States and Canadian federal agencies and other stakeholders, has coordinated the development and implementation of an annual Asian Carp Control Strategy Framework (now called an Asian Carp Action Plan) to prevent the introduction and establishment of Bighead and Silver carp populations in the Great Lakes since 2010. The ACRCC Action Plan coordinates the implementation of projects to prevent and control the movement of Bighead and Silver carps from the Mississippi River Basin into the Great Lakes. Many of these projects are implemented in the uppermost 175 miles (282.6km) of the Illinois River and the Chicago Area Waterways System (CAWS; Figure 1). Asian carp prevention and control efforts in this small area within the Mississippi River Basin are addressed in the ACRCC Asian Carp Action Plan (https://www.asiancarp.us/Documents/2018ActionPlan.pdf).

On June 10, 2014, the United States Congress, in Section 1039 (b) of the Water Resources Reform and Development Act of 2014 (WRRDA), charged the USFWS, to work in coordination with the Secretary of the Army, the Director of the National Park Service (NPS), and the Director of the U.S. Geological Survey (USGS) to lead a multiagency effort to slow, and eventually eliminate, the spread of Asian carp in the ORB and UMRB. Congress appropriated $2.4 million in the USFWS's FY2015 budget for Asian carp prevention and control in the ORB and UMRB, providing the first substantial funding to address Asian carp populations in the Mississippi River Basin beyond the upper Illinois River and the CAWS (Table 1). USFWS

funding for Asian carp work in the ORB and UMRB increased to $2.6 million in FY2016. USFWS funding for Asian carp work in the ORB and UMRB totaled $3.1 million in 2017 with the addition of $500,000 by Congress specifically for the development and implementation of deterrent technologies in the field that are transferrable to other basins and potentially useful for other aquatic nuisance species. USFWS funding in FY2018 increased to $4.8 million and includes the addition of $1.7 million to "expand and perfect the combined use of contract fishing and deterrents" in the Ohio River and Upper Mississippi River. Through FY2018, Congress has not appropriated funding for Asian carp prevention and control actions in other sub-basins within the Mississippi River Basin (i.e. MORB or LMRB), or simply for the Mississippi River Basin as a whole (i.e., the Mississippi River and tributaries).

Table 1. Annual appropriations to USFWS, by funding priority, for Asian carp prevention and control work outside of the Great Lakes (beyond the upper Illinois River and the CAWS) from 2015-2018.

Appropriation	2015	2016	2017	2018
Framework Implementation	$2,400,000	$2,600,000	$2,600,000	$2,600,000
Development and Evaluation of Deterrents	$0	$0	$500,000	$500,000
Combined Use of Contract Harvest and Deterrents	$0	$0	$0	$1,700,000
Total Funding	$2,400,000	$2,600,000	$3,100,000	$4,800,000

The USFWS provided the ORB and UMRB sub-basin partnerships a total of $800,000 of the agency's base Asian carp funding to support implementation of priority Framework actions within these two portions of the Mississippi River Basin in FY2015 (Table 2). The increase in USFWS base funding in FY2016 and FY2017 resulted in the agency increasing funding support to the ORB and UMRB sub-basin partnerships for Framework implementation to a total of $1,000,000 each year. In FY2017, an additional $200,000 was provided to the sub-basin partnerships to evaluate and support field testing of deterrent technologies that are transferrable to other basins and potentially useful for other aquatic nuisance species. In FY2018, total funding support to the ORB and UMRB sub-basin partnerships for Framework implementation remained at $1,000,000. The additional $200,000 remained in support of field testing deterrent technologies, and an additional $1 million was provided for contract fishing and evaluation of Asian carp removal. Total FY2018 USFWS funding provided to the ORB and UMRB partnerships was $2.2 million.

Table 2. Total annual appropriations to USFWS for Asian carp prevention and control work outside of the Great Lakes (beyond the upper Illinois River and the CAWS) from 2015-2018, and the amount of agency base funding provided by USFWS to the Ohio River Sub-Basin (ORB) and Upper Mississippi River Sub-Basin (UMRB) to support Asian carp priorities within these two portions of the Mississippi River Basin.

Fiscal Year	USFWS	Total USFWS Base Funding to ORB and UMRB	USFWS Base Funding to ORB	USFWS Base Funding to UMRB
2015	$2,400,000	$800,000	$400,000	$400,000
2016	$2,600,000	$1,000,000	$500,000	$500,000
2017	$3,100,000	$1,200,000	$600,000	$600,000
2018	$4,800,000	$2,200,000	$1,150,000	$1,050,000

The USFWS met with state and federal agency partners in the ORB and UMRB in February and March 2015, respectively, to foster inter-agency coordination and to discuss planning, funding, and operations for Asian carp prevention and control. State representatives from both sub-basins recommended that the USFWS work through the existing MICRA partnership for basin-wide inter-agency Asian carp coordination, and multi-state project planning and implementation in the Mississippi River Basin. MICRA functions as an umbrella organization that provides coordination and communication among the multi-state partnerships that address interjurisdictional fishery management issues within regional sub-basin management units throughout the basin. Federal agencies with relevant authorities in the Mississippi River and tributaries also participate in the MICRA partnership. The existing multi-state sub-basin groups provide a forum for Asian carp coordination, project development, and implementation at the sub-basin level and MICRA provides a mechanism for basin-wide inter-agency coordination and collaboration.

The Executive Boards of the regional sub-basin groups in the ORB and UMRB (i.e., Ohio River Fish Management Team and Upper Mississippi River Conservation Committee) are comprised exclusively of state agencies. To provide for both state and federal agency executive level coordination on Asian carp prevention and control in the Mississippi River Basin, MICRA formed an Asian Carp Advisory Committee (ACAC) in 2016 (Figure 5). The ACAC consists of the MICRA Executive Board (i.e., one state agency representative from each of the six sub-basin groups, two federal entity members, MICRA Chairman, MICRA Chairman-elect, and MICRA Coordinator) and a single agency representative from key federal partners not on the MICRA Executive Board (i.e., National Park Service, U.S. Army Corps of Engineers, and Tennessee Valley Authority). The ACAC provides a mechanism for coordination, communication, and collaboration across the regional sub-basin efforts to provide for the most effective implementation of a Mississippi River basin-wide Asian carp prevention and control program.

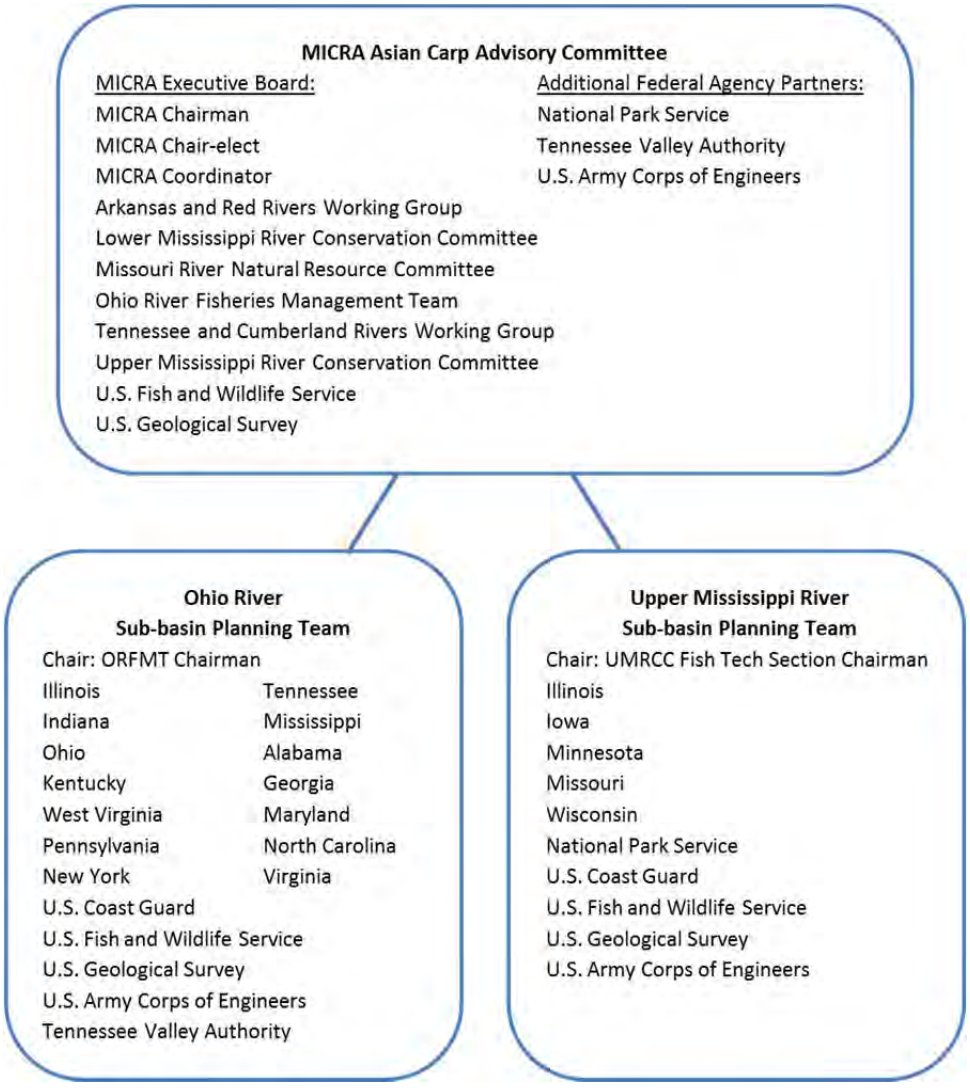

Figure 5. Structure for Inter-agency Coordination and Implementation of Asian Carp Control Strategy Frameworks in the Ohio River and Upper Mississippi River Basins.

MICRA has an active role working with the sub-basin partnerships and planning teams throughout the Mississippi River Basin to develop and implement sub-basin level Asian Carp Control Strategy Frameworks. Together, Frameworks for the LMRB, MORB, ORB, and UMRB provide for coordinated Asian carp management and control actions for the entire Mississippi River Basin (excluding the upper Illinois River and CAWS addressed in the ACRCC Action Plan). Each sub-basin partnership is working to manage and control Asian carp populations within only one portion of a much larger, interconnected basin, and therefore each sub-basin effort is dependent upon successful management and control throughout the remainder of the Mississippi River Basin. Similarly, the Mississippi River and Great Lakes basins are

interconnected. Successfully preventing Asian carp from spreading and establishing in the Great Lakes is ultimately dependent on successful management and control in the Mississippi River Basin as a whole, not just the upper Illinois River and CAWS. This is further supported by the analyses completed by the U.S. Army Corps of Engineers (USACE) for the Great Lakes and Mississippi River Interbasin Study that assessed the risk of aquatic nuisance species transfer between the two basins. MICRA provides a forum for basin wide coordination among the sub-basin partnerships and between the Mississippi River Basin and the Great Lakes Basin (i.e., ACRCC). National strategies for Asian carp prevention and control that include the entire Mississippi River Basin are paramount to long-term success.

In the ORB and UMRB, where the USFWS has committed federal funding for implementation of highest priority control strategy framework projects, MICRA actively works with the sub-basin planning teams to identify annual priorities, develop project proposals and work plans, and to prepare an annual 'Asian Carp Monitoring and Response Plan for the Mississippi River Basin' (MRP). The 2018 MRP describes FY2018 USFWS funded collaborative partnership efforts to manage and control Asian carp populations in the ORB and UMRB each year. Development of specific project plans for implementation of ORB and UMRB partnership projects with the additional $2.2 million in FY18 funding for contract fishing and evaluation of removal is ongoing. This document will be updated with current project plans when they are complete.

There are many projects that arise from each of the basin partnerships that are supported financially from other agency or outside sources of funding. These projects support the goals and objectives identified in the National Plan as well, and brief descriptions are provided for reference in Appendix A. Agencies collaborating on the USFWS funded partnership projects provide interim annual (calendar year) reports to track and evaluate progress, report results, propose recommendations for adaptive management, and inform planning for management and control actions in future years. The annual MRPs and interim annual reports are available to the public on http://www.micrarivers.org/asian-carp-plans-and-reports/.

Ohio River Basin (ORB) Inter-agency Asian Carp Partnership

The Ohio River flows through or along the border of Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia; these six states collaboratively manage fisheries in the mainstem Ohio River through the Ohio River Fisheries Management Team (ORFMT). The ORFMT recognized the magnitude of the Asian carp threat and the need for coordinated efforts to prevent the continued spread, explore strategies to reduce the abundance of established populations, and better understand the impacts of established populations. The ORFMT engaged the remaining ORB states and key federal partners in the development of an Ohio River Basin Asian Carp Control Strategy Framework (ORB Framework) to collaboratively prevent further range expansion, reduce populations, better understand and minimize impacts of Asian carps, and improve communication and coordination in the basin. Following completion of the ORB Framework in October 2014 the ORB partners formed an ORB Asian Carp Planning Team to

implement the ORB Framework. The ORB Asian Carp Planning Team met in 2017 to determine highest priority projects from the ORB Framework for implementation in 2018, identify lead and cooperating agencies for each project, and develop project proposals for USFWS funding consideration. ORB Asian Carp Planning Team project proposals were provided to the MICRA ACAC through the ORFMT, compiled with project proposals from the Upper Mississippi River Basin, and submitted as part of a Mississippi River Basin proposal package to the USFWS for funding consideration. The ORB Asian Carp Planning Team developed funded project proposals into full project work plans for implementation and inclusion in the 2018 MRP. FY2018 USFWS funded project plans for the ORB are presented beginning on page 10.

Upper Mississippi River Basin (UMRB) Inter-agency Asian Carp Partnership

The Upper Mississippi River Conservation Committee (UMRCC) is a partnership of the five mainstem Upper Mississippi River (UMR) states. The UMRCC Fisheries Technical Committee, which includes federal agency partners, completed a revised *Upper Mississippi River Fisheries Plan* in 2010 (Fisheries Plan). Goal 4 in the 2010 Fisheries Plan is to 'slow or eliminate the spread or introduction of aquatic nuisance species, including pathogens to the UMR.' The UMRCC Fisheries Technical Committee formed an Ad-hoc Asian Carp Planning Team to collaboratively develop an Upper Mississippi River Basin Asian Carp Control Strategy Framework (UMRB Framework) to coordinate Asian carp prevention and control efforts in the Upper Mississippi River. The UMRB Framework is designed as a regional stepdown plan from the National Plan and is based on the existing UMRCC's 2010 Fisheries Plan Goal 4. The Ad-hoc Asian Carp Planning Team met in 2017 to determine highest priority projects from the UMRB Framework for implementation in 2018, identify lead and cooperating agencies for each project, and develop project proposals for USFWS funding consideration. UMRB Ad-hoc Asian Carp Planning Team project proposals were provided to the MICRA ACAC through the UMRCC Executive Committee, compiled with project proposals from the Ohio River Basin, and submitted as part of a Mississippi River Basin proposal package to the USFWS for funding consideration. The UMRB Ad-hoc Asian Carp Planning Team developed funded project proposals into full project work plans for implementation and inclusion in the 2018 MRP. FY2018 USFWS funded project plans for the UMRB are presented beginning on page 86.

Ohio River Basin

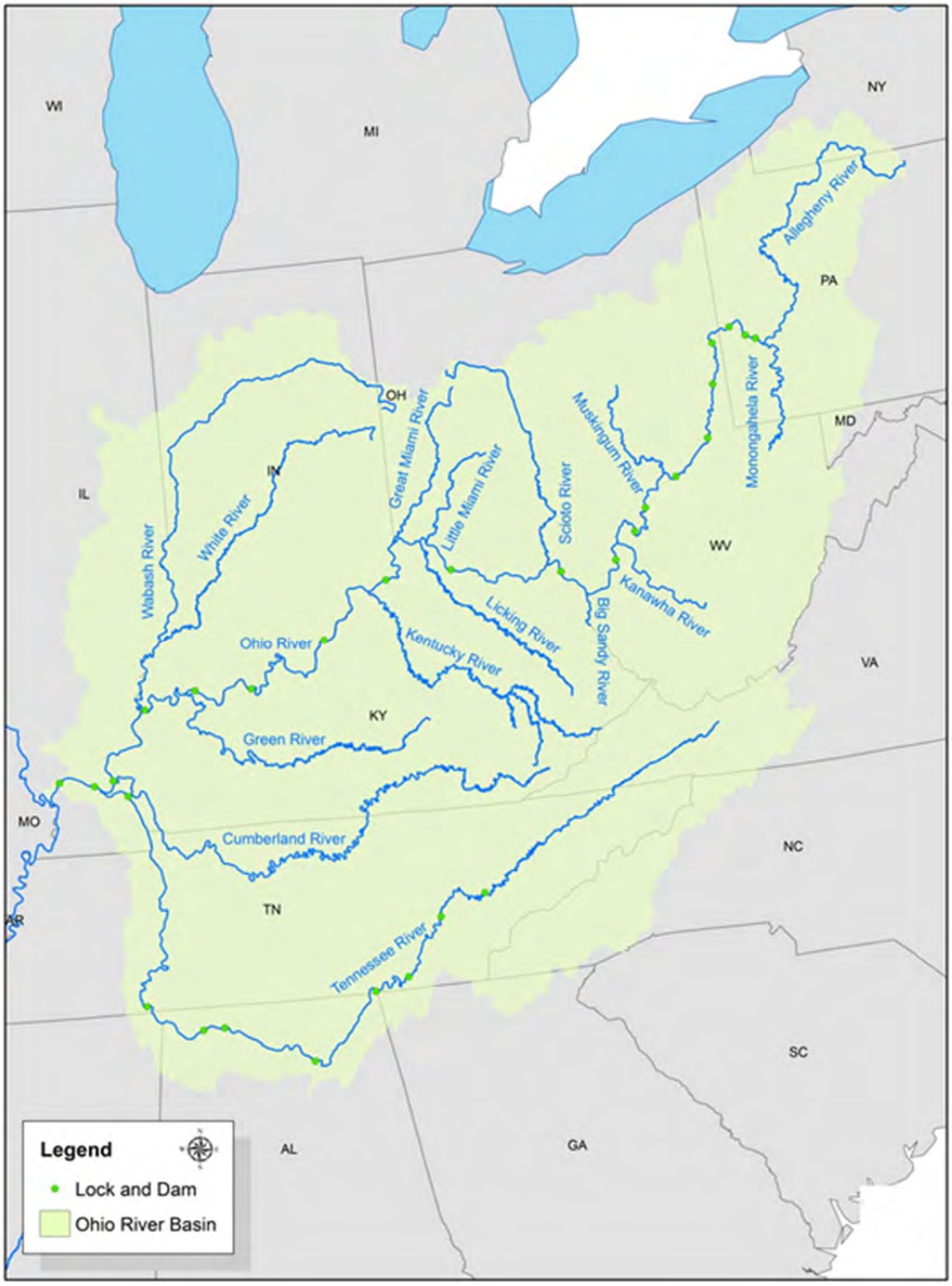

Figure 6. Map of the Ohio River Basin.

Project Title: Early Detection and Evaluation of Asian carp Removal in the Ohio River

Geographic Location: Ohio River basin, extending from the Cannelton pool (RM 720.7) to the Racine pool (RM 237.5) along with the Montgomery Island (RM 31.7) and New Cumberland (RM 54.4) pools of the Ohio River in addition to the Allegheny and Monongahela Rivers.

Lead Agency: Kentucky Department of Fish and Wildlife Resources (KDFWR)

Agency Collaboration: Indiana Department of Natural Resources (INDNR), Pennsylvania Fish and Boat Commission (PFBC), U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR)

Statement of Need: Invasive species are continually responsible for undesirable economic and environmental impacts across the nation (Lovell and Stone 2005, Pimentel et al. 2005, Jelks et al. 2008). Specifically, Asian carp have been successful invaders in the United States because of their tolerance and adaptability to a wide range of environmental conditions (Kolar et al. 2005, Zhang et al. 2016). The Ohio River provides a broad variety of potential habitats available to Asian carp. Their ability to quickly colonize novel habitats with dense populations, cause significant impacts on recreation, natural aesthetics, and the function of important native ecosystems puts the entire basin at risk. In response, it is necessary to gain information on Asian carp distributions, behavior, and habitat use in the Ohio River basin (ORB) to aid and assess their removal, suppression, and containment.

The tasks outlined in this document would add a fourth year of surveillance and data concerning Asian carp in the Ohio River. The intention of this data is to aid in early detection and evaluation of removal efforts. Effort and support from several partners and agencies (state, university, and federal) will be combined to work toward the project goals and objectives defined below. Collaborative efforts from previous years have included fish community sampling, targeted sampling, and incorporation of additional data sources such as hydroacoustics to gain a better understanding of distribution and abundance. Success in these aforementioned areas would provide an assessment tool that informs Asian carp prevention, removal, and response efforts annually. In addition, community data may aid in determining impacts of carp on native fish assemblages and provides incremental snapshots on which to assess the effectiveness of our removal strategies. This project provides an ongoing, coordinated approach to Asian carp management and suppression in the ORB.

Project Goals and Objectives:

National Plan Goals:

Goal 3.2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.5. Provide information to the public, commercial entities, and government agencies to improve effective management and control of bighead, black, grass, and silver carps in the United States;

Goal 3.6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States;

Goal 3.7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass and silver carps in the United States.

National Plan Strategies:

Strategy 3.2.3. Minimize the range expansion and ecological effects of feral populations of Asian carps in conjunction with management actions to enhance aquatic environments for the sustainability of native biological communities.

Strategy 3.2.4. Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions;

Strategy 3.3.1. Determine life history characteristics and build population dynamics models of Asian carps in the Mississippi River Basin;

Strategy 3.6.2. Assemble information about the distribution, biology, life history, and population dynamics of bighead, black, grass, and silver carps;

Strategy 3.6.5. Determine the demonstrated and probable ecological and economic effects of Asian carps in the United States and determine the degree to which these effects are negative;

Ohio River Goals:

Monitoring and Response

Ohio River Strategies:

2.2 State agencies of the Ohio River basin continue, or initiate, annual fisheries monitoring programs for the Ohio River and its tributaries to serve as an additional means of surveillance.

2.3 Implement a program of surveillance surveys targeting Asian carp to monitor their upstream range expansion as well as monitor changes of their distribution and abundance.

2.4 Survey areas upstream of McAlpine Lock and Dam complex to enhance surveillance and early detection capabilities.

2.8 Support research to improve capabilities to detect early stages of invasion and spawning populations of Asian carp.

Project Objectives:

1. Evaluate management actions using changes in the distribution and relative densities of Asian carp in the Ohio River through targeted sampling.
2. Evaluate indirect influence of Asian carp management actions on native fish community in the Ohio River.
3. Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.
4. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

Agency: Kentucky Department of Fish and Wildlife Resources

Project: Early Detection and Evaluation of Asian carp Removal in the Ohio River

Objectives:

1. Evaluate management actions using changes in the distribution and relative densities of Asian carp in the Ohio River through targeted sampling.
2. Evaluate indirect influence of Asian carp management actions on native fish community in the Ohio River.
3. Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.
4. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

Project Activities: Methods, and Timetable:

Targeted Sampling of Bigheaded Carps
KDFWR will coordinate with agencies to conduct targeted sampling for Asian carp along several pools, upriver of the Cannelton Locks and Dam complex (See map). Both pulsed-DC boat electrofishing and gill netting techniques will be utilized to target bigheaded carps at fixed sites along the river (Table 1). Electrofishing will be conducted during the day (0800 to 2100 hours local time) with one dipper in a general downstream direction. Sampling will begin in the spring of each year, around the second week of April, with a water temperature near 65°F during the sampling period (i.e. temperatures should typically reside between 60°F – 70°F throughout the duration of spring sampling efforts). Electrofishing is conducted in a general downstream direction using one dipper for 900 seconds. Carp should be targeted with pulsed-DC electricity at 80 pulses per second (PPS) and a 40% duty-cycle (or comparable settings). A power goal allowing the minimum transfer of 3000 Watts from water to fish will be targeted using suggested power settings from Burkhardt and Gutreuter (1995). Adjustment to the output can be made dependent on carp response. Increased driving speeds and pursuit of individual carp is allowed upon sightings. During this more aggressive boat maneuvering, all other fish species should be ignored and all small, shad-like species should be dipped and examined thoroughly before being release to avoid misidentifying young Asian carps. Banks and any structure within the sampling area are to be shocked thoroughly and the pilot is free to modify the forward and backward movement of the boat to permit the most effective collection of fish. The straight-line distance covered during electrofishing should be approximately 400m (~0.25 miles) of shoreline.

Gill netting will be conducted at fixed sites at the same time as boat electrofishing (Table 1). Each site will include 300ft of 4” square net and 300ft of 5” square net, making the overall targeted length of net fished at each site equal to 600ft total. Gill nets should be set perpendicular to the shoreline, but may need to be set parallel to shore in cases where flow makes this unreasonable. Nets will be actively set for 2 hours at a time with boat noise and herding techniques to drive fish into the gear. Records of catch will be recorded for each mesh size and if no fish are caught, a record indicating a catch of NoFish will be noted.

Due to the limited size ranges of carp that can be targeted with 4" and 5" bar mesh, an additional 150ft of 3" square (6" stretch) gill net will be added as an experimental addition to targeted sampling. This will be an effort to expand the size range of carp sampled using this gear type. Side-imaging should be used to locate suitable areas and/or schools of carp during targeted sampling. All by-catch will be recorded.

All information from targeted sampling will be used to track changes in relative abundances of *Hypophthalmichthys spp*. Additional non-targeted, feral carps captured during sampling will be removed from the system. All by-catch for each sampling gear will be recorded and any non-target fish (excluding Asian carps) will be released immediately after capture. Otoliths and pectoral fin rays will be removed as needed from Asian carp for age and growth analysis

Community Fish Surveys

KDFWR will coordinate with agencies to conduct community fish surveys in Cannelton, McAlpine, Markland, Meldahl, and Greenup pools. Sampling should begin in the fall of each year, around the first week of October, with a water temperature near 60°F during the sampling period (i.e. temperatures should typically reside between 55°F – 65°F throughout the duration of fall sampling efforts). Electrofishing is conducted in a general downstream direction using one dipper for 900 seconds. All fish entrained to the anodes should be dipped except when large schools of fish (e.g. Clupeids or Cyprinids) are encountered. When large schools blanket the water column, fish should be dipped continuously at a constant rate in a straight line distance until the school is passed. Community sampling is conducted with pulsed-DC electricity at 60 pulses per second (PPS) and a 25% duty-cycle (or comparable settings). A power goal allowing the transfer of 3000 Watts from water to fish should be targeted using suggested power goals from Burkhardt and Gutreuter (1995). Because output affects catch rates of fish with variations in size and species, it is important to maintain consistent power outputs during community sampling. For this reason, setting adjustments can be made depending on fish recovery and response to electricity, but it is suggested that the output power does not deviate from the suggested power goal by more than 20% (Gutreuter et al. 1995). The straight-line distance covered during electrofishing should be approximately 200m (~0.125 miles) of shoreline.

Gill nets will be fished at the same time boat electrofishing is conducted along eight fixed sites per pool. Each net set will be set and actively monitored for two hours with efforts to drive fish into the nets with boat noise. Each site will include 300ft of 4" square net and 300ft of 5" square net, making the overall targeted length of net equal to 600ft at each site. Gill nets should be set perpendicular to the shoreline, but may need to be set parallel to shore in cases where flow makes this unreasonable. Records of catch should be recorded for each mesh size and if no fish are caught, a record indicating a catch of NoFish should be noted.

All fish captured using either gear will be identified to the lowest possible taxonomic level and a total length (mm) and weight (kg) with be taken to evaluate conditions on select species. Asian carp will either be implanted with an acoustic transmitter or exterminated depending on the location.

Currently, ORFMT states conduct surveys along several tail waters, tributaries, and embayments of the Ohio River. Data collection during these surveys has been augmented to report Asian carp

captured during sportfish sampling and provide information on sportfish condition. All Asian carp collected will be identified, sexed (when applicable), and lengths will be noted when possible.

Incorporation of Additional Data Sources

Data collected outside of this project during activities focused around Asian carp in the ORB will be compiled and used to inform field sampling and analyses on bigheaded carp distribution and population characteristics. Collections such as ORSANCO's annual sampling data and tools like the USGS Nonindigenous Aquatic Species (NAS) database will be sourced to provide additional information on the range and confirmed sightings of Asian carps along the Ohio River and its tributaries. Additional data sources may be relevant for this project and will be considered and incorporated when possible.

Estimated Timetable

Project Activity	Pool	Dates (Week Of…)	Year
Targeted Asian carp Sampling	Cannelton	April 09	2018
Targeted Asian carp Sampling	McAlpine	April 16	2018
Targeted Asian carp Sampling	Markland	April 23	2018
Targeted Asian carp Sampling	Meldahl	April 30	2018
Targeted Asian carp Sampling	Greenup	May 07	2018
Community Surveys and Hydroacoustics	Meldahl	October 09	2018
Community Surveys and Hydroacoustics	Various	October 18	2018
Project Executive Summary	N/A	October 30	2018
Incorporation of Additional Data Sources	N/A	November 20	2018
Project Technical Report	N/A	February 26	2019
Targeted Asian carp Sampling	Cannelton	April 08	2019
Targeted Asian carp Sampling	McAlpine	April 15	2019
Targeted Asian carp Sampling	Markland	April 22	2019
Targeted Asian carp Sampling	Meldahl	April 29	2019
Targeted Asian carp Sampling	Greenup	May 06	2019

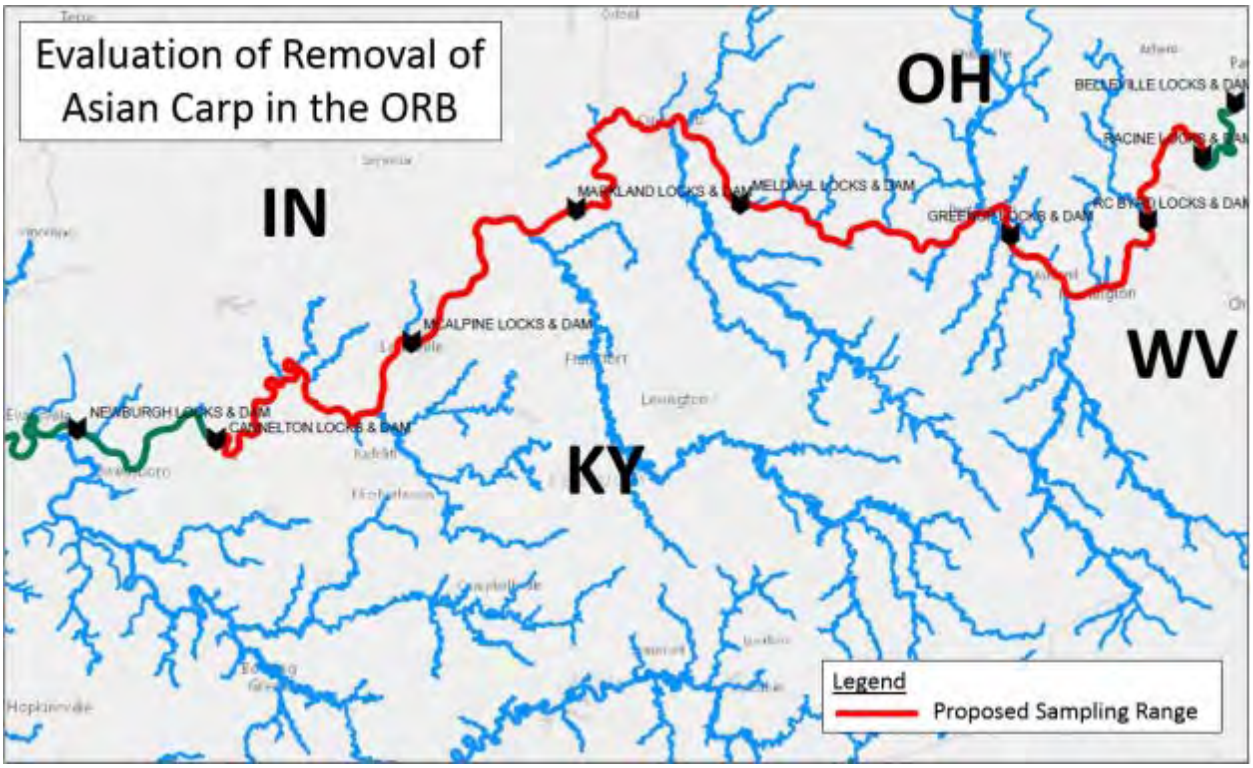

Figure 7. Map of the Ohio River where project activities will occur.

Agency: Indiana Department of Natural Resources

Project: Early Detection and Evaluation of Asian carp Removal in the Ohio River

Objectives:

1. Evaluate management actions using changes in the distribution and relative densities of Asian carp in the Ohio River through targeted sampling.
2. Evaluate indirect influence of Asian carp management actions on native fish community in the Ohio River.
3. Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.
4. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

Project Activities: Methods, and Timetable

Targeted Sampling of Bigheaded Carps
INDNR will assist partner agencies to conduct targeted sampling for Asian carp in the Cannelton Pool of the Ohio River. Both pulsed-DC boat electrofishing and gill netting techniques will be utilized to target bigheaded carps at fixed sites along the river (Table 1). Electrofishing will be conducted during the day (0800 to 2100 hours local time) with one dipper in a general downstream direction. Sampling will begin in the spring of each year, around the second week of April, with a water temperature near 55°F during the sampling period (i.e. temperatures should typically reside between 55°F – 65°F throughout the duration of spring sampling efforts). Electrofishing is conducted in a general downstream direction using one dipper for 900 seconds. Carp should be targeted with pulsed-DC electricity at 80 pulses per second (PPS) and a 40% duty-cycle (or comparable settings). A power goal allowing the minimum transfer of 3000 Watts from water to fish will be targeted using suggested power settings from Burkhardt and Gutreuter (1995). Adjustment to the output can be made dependent on carp response. Increased driving speeds and pursuit of individual carp is allowed upon sightings. During this more aggressive boat maneuvering, all other fish species should be ignored and all small, shad-like species should be dipped and examined thoroughly before being release to avoid misidentifying young Asian carps. Banks and any structure within the sampling area are to be shocked thoroughly and the pilot is free to modify the forward and backward movement of the boat to permit the most effective collection of fish. The straight-line distance covered during electrofishing should be approximately 400m (~0.25 miles) of shoreline.

Gill netting will be conducted at two fixed sites in Cannelton Pool (Table 1). Each site will include 300ft of 4” square net and 300ft of 5” square net, making the overall targeted length of net fished at each site equal to 600ft total. Gill nets should be set perpendicular to the shoreline, but may need to be set parallel to shore in cases where flow makes this unreasonable. Nets will be actively set for 2 hours at a time with boat noise and herding techniques to drive fish into the gear. Records of catch will be recorded for each mesh size and if no fish are caught, a record indicating a catch of NoFish will be noted.

Due to the limited size ranges of carp that can be targeted with 4" and 5" bar mesh, an additional 150ft of 3" square (6" stretch) gill net will be added as an experimental addition to targeted sampling. This will be an effort to expand the size range of carp sampled using this gear type. Side-imaging should be used to locate suitable areas and/or schools of carp during targeted sampling. All by-catch will be recorded.

Information will be used to estimate relative abundances of *Hypophthalmichthys spp*. Additional non-targeted, feral Asian carps captured during sampling will be removed from the system. All by-catch for each sampling gear will be recorded and any non-target fish (excluding Asian carps) will be released immediately after capture. Otoliths and pectoral fin rays will be removed as needed from Asian carp for microchemistry and age and growth analysis.

Community Fish Surveys

INDNR will cooperate with agencies to conduct community fish surveys in Cannelton pool. Boat electrofishing will consist of 15-minute transects across fixed sites including Deer Creek, Clover Creek, Poison Creek, Oil Creek, Spring Creek, Little Blue River, Blue River, Indiana Creek, Otter Creek, and the Salt River, and other smaller tributaries. Sampling should begin in the fall of each year, around the first week of October, with a water temperature near 65°F during the sampling period (i.e. temperatures should typically reside between 60°F – 70°F throughout the duration of fall sampling efforts). Electrofishing is conducted in a general downstream direction using one dipper for 900 seconds. All fish entrained to the anodes should be dipped except when large schools of fish (e.g. Clupeids or Cyprinids) are encountered. When large schools blanket the water column, fish should be dipped continuously at a constant rate in a straight line distance until the school is passed. Community sampling is conducted with pulsed-DC electricity at 60 pulses per second (PPS) and a 25% duty-cycle (or comparable settings). A power goal allowing the transfer of 3000 Watts from water to fish should be targeted using suggested power goals from Burkhardt and Gutreuter (1995). Because output affects catch rates of fish with variations in size and species, it is important to maintain consistent power outputs during community sampling. For this reason, setting adjustments can be made depending on fish recovery and response to electricity, but it is suggested that the output power does not deviate from the suggested power goal by more than 20% (Gutreuter et al. 1995). The straight-line distance covered during electrofishing should be approximately 200m (~0.125 miles) of shoreline.

Gill nets will be fished at the same time boat electrofishing is conducted along eight fixed sites per pool. Each net set will be set and actively monitored for two hours with efforts to drive fish into the nets with boat noise. Each site will include 300ft of 4" square net and 300ft of 5" square net, making the overall targeted length of net equal to 600ft at each site. Gill nets should be set perpendicular to the shoreline, but may need to be set parallel to shore in cases where flow makes this unreasonable. Records of catch should be recorded for each mesh size and if no fish are caught, a record indicating a catch of NoFish should be noted.

All fish captured using either gear will be identified to the lowest possible taxonomic level and a total length (mm) and weight (kg) with be taken to evaluate condition of select species. Asian carp will be exterminated after data collection.

Currently, ORFMT states conduct surveys on catfish, percids, black bass, and true bass at several tailwaters, tributaries, and embayments of the Ohio River. Data collection during these surveys has been augmented to report Asian carp captured during sportfish sampling and provide information on sportfish condition. All Asian carp collected will be identified, sexed (when applicable), and lengths will be noted when possible.

Estimated Timetable

Project Activity	**Pool**	**Dates**	**Year**
Targeted Asian carp Sampling	Cannelton	April	2018
Community Fish Surveys	Cannelton	October	2018
Project Executive Summary	N/A	October 30	2018
Project Technical Report	N/A	February 26	2019
Targeted Asian carp Sampling	Cannelton	April - May	2019
Community Fish Surveys	Cannelton	October	2019

Figure 8. Map of the Ohio River where INDNR project activities will take place.

Agency: West Virginia Division of Natural Resources

Project: Early Detection and Evaluation of Asian carp Removal in the Ohio River

Objectives:

1. Evaluate management actions using changes in the distribution and relative densities of Asian carp in the Ohio River through targeted sampling.
2. Evaluate indirect influence of Asian carp management actions on native fish community in the Ohio River.
3. Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.
4. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

Project Activities: Methods, and Timetable

Targeted Sampling of Bigheaded Carps
WVDNR will assist and cooperate with partner agencies to conduct targeted sampling for Asian carp along several pools, upriver of the Cannelton Locks and Dam complex. WVDNR will conduct targeted samples in the Greenup and R.C. Byrd pools. Both pulsed-DC boat electrofishing and gill netting techniques will be utilized to target bigheaded carps. Sampling will occur during the spring at fixed sites previously identified in earlier years' sampling. Electrofishing surveys will consist of timed 15-minute transects during the day at fixed sites throughout each pool. Gill nets will consist of two hour sets during the day at fixed sites throughout each pool. The number of samples completed will be dependent upon staff availability, environmental conditions, and distance travelled from boat ramps. Information will be used to help define the "invasion front" of adult bigheaded carps in the Ohio River and estimate relative abundances of *Hypophthalmichthys spp*. Additional non-targeted, feral Asian carps captured during sampling will be removed from the system. Otoliths and pectoral fin rays will be removed as needed from Asian carp for age and growth analysis. All by-catch for each sampling gear will be recorded and any non-target fish (excluding Asian carps) will be released immediately after capture.

Community Fish Surveys
WVDNR will assist and cooperate with agencies to conduct community fish surveys in Cannelton, McAlpine, Markland, Meldahl, Greenup, and RC Byrd pools. Specifically, WVDNR will conduct community surveys in the Greenup and R.C. Byrd pools. Both pulsed-DC boat electrofishing and gill netting techniques will be utilized. Boat electrofishing will consist of 15-minute transects throughout each pool during the day. Gill nets will consist of two hour sets during the day at fixed sites throughout each pool. Each net set will be actively monitored and effort will be expended to run fish into the nets with boat noise. The number of samples completed will be dependent upon staff availability, environmental conditions, and distance travelled from boat ramps. All fish captured using either gear will be identified to the lowest possible taxonomic level and a total length (mm) and weight (kg) with be taken to evaluate condition on select species. All Asian carp without surgically implanted transmitters will be exterminated upon capture.

Currently, ORFMT states conduct surveys at several tailwaters, tributaries, and embayments of the Ohio River. Data collection during these surveys has been augmented to report Asian carp captured during sportfish sampling and provide information on sportfish condition. All Asian carp collected will be identified, sexed (when applicable), and lengths will be noted when possible.

Estimated Timetable

Project Activity	**Pool**	**Dates**	**Year**
Targeted Asian carp Sampling	R.C. Byrd	April	2018
Targeted Asian carp Sampling	Greenup	April	2018
Community Fish Surveys	R.C. Byrd	October	2018
Community Fish Surveys	Greenup	October	2018
Targeted Asian carp Sampling	R.C. Byrd	April	2019
Targeted Asian carp Sampling	Greenup	April	2019
Sportfish surveys	All WV Ohio River Pools	May-July	2017-2018
Incorporation of Additional Data Sources	N/A	November-February	2017-2018

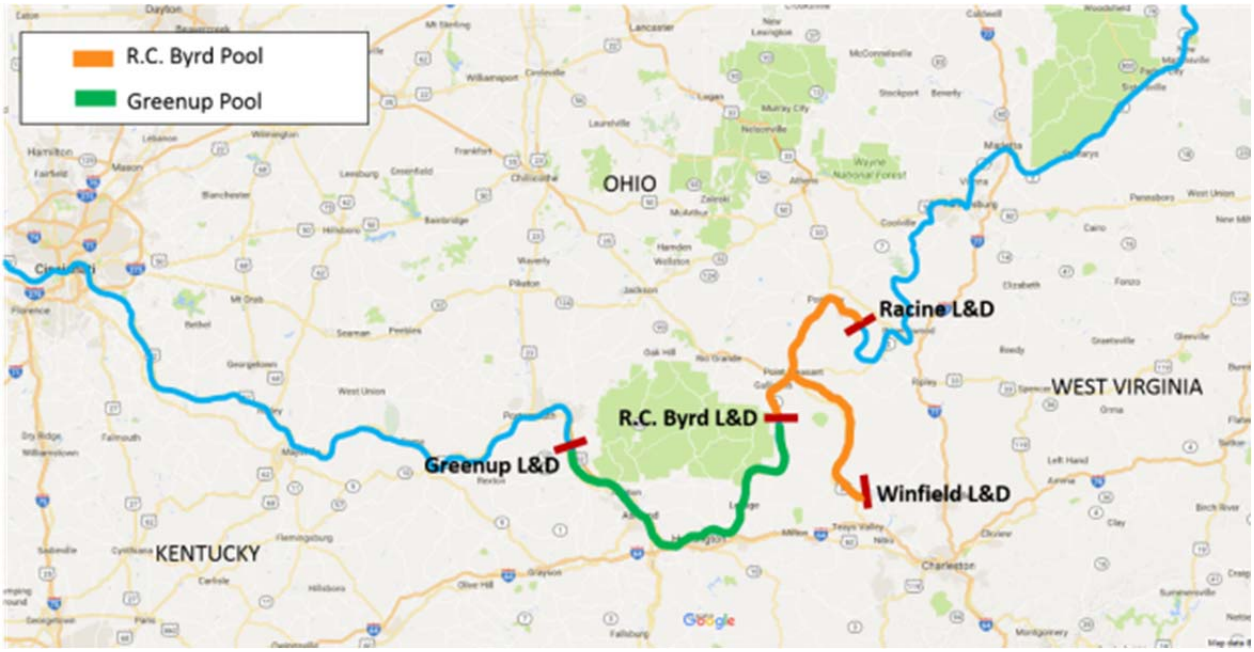

Figure 9. Map of WVDNR project activities.

Agency: Pennsylvania Fish and Boat Commission (PFBC)

Project: Early Detection and Evaluation of Asian carp Removal in the Ohio River

Objectives:

2. Evaluate indirect influence of Asian carp management actions on native fish community in the Ohio River.
4. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

Project Activities: Methods, and Timetable

Objective 2:
Community fish surveys from 2016 and before will be used to establish and refine future sampling locations. Boat electrofishing will consist of 15-minute transects across 28 fixed sites total. Gill nets will be fished for 24-hour sets at nine fixed sites across three pools. All fish captured using either gear will be identified to the lowest possible taxonomic level and a total length (mm) and weight (grams) will be taken to evaluate condition.

- compile and analyze data from community fish surveys in the Ohio River drainage in Pennsylvania.
- use data collected at sampling locations to determine the future use of each location.
- assist in the compiling and analyzing of data.
- collaborate with partners in drafting a project report.
- communicate and collaborate with partners when determining how current monitoring data can be used to guide future effort.
- assist other agencies in sampling efforts as possible

Objective 4:
PFBC will conduct targeted sampling for Asian carp again where early detection eDNA positives were found. Both pulsed-DC boat electrofishing and gill netting techniques will be utilized to target Asian carps. All by-catch for each sampling gear will be recorded and any non-target fish (excluding Asian carps) will be released immediately after capture.

- conduct eDNA sampling in the Pennsylvania portion of the Ohio River drainage.
- use data collected at sampling locations to determine the future use of each location.
- assist in the compiling and analyzing of data.
- communicate and collaborate with partners when determining how current monitoring data can be used to guide future effort.
- assist other agencies in sampling efforts as possible

Pennsylvania will continue to participate and work to keep abreast of Asian carp activity with USFWS, ACRCCC, MICRA, ORFMT, Ohio River states, and other partners.

Estimated Timetable

Project Activity	Pool	Month	Year
Night Electrofishing	New Cumberland on Ohio River	May	2018
eDNA Sampling	New Cumberland, Montgomery on Ohio River	June	2018
Day Electrofishing	Montgomery on Ohio River; L&D 3 on Monongahela River; L&D 4 on Allegheny River	July	2018
Hoop Nets	New Cumberland, Dashields, Emsworth on Ohio River	August	2018
Night Electrofishing	Allegheny River Sections 12 and 13	August	2018
Hoop Nets	New Cumberland, Emsworth on Ohio River	September	2018
Night Electrofishing	New Cumberland on Ohio River; L&D 3 on Allegheny River	September	2018
Gill Nets	Montgomery	November	2017
Night Electrofishing	Emsworth on Allegheny River; Emsworth on Monongahela River	December	2017

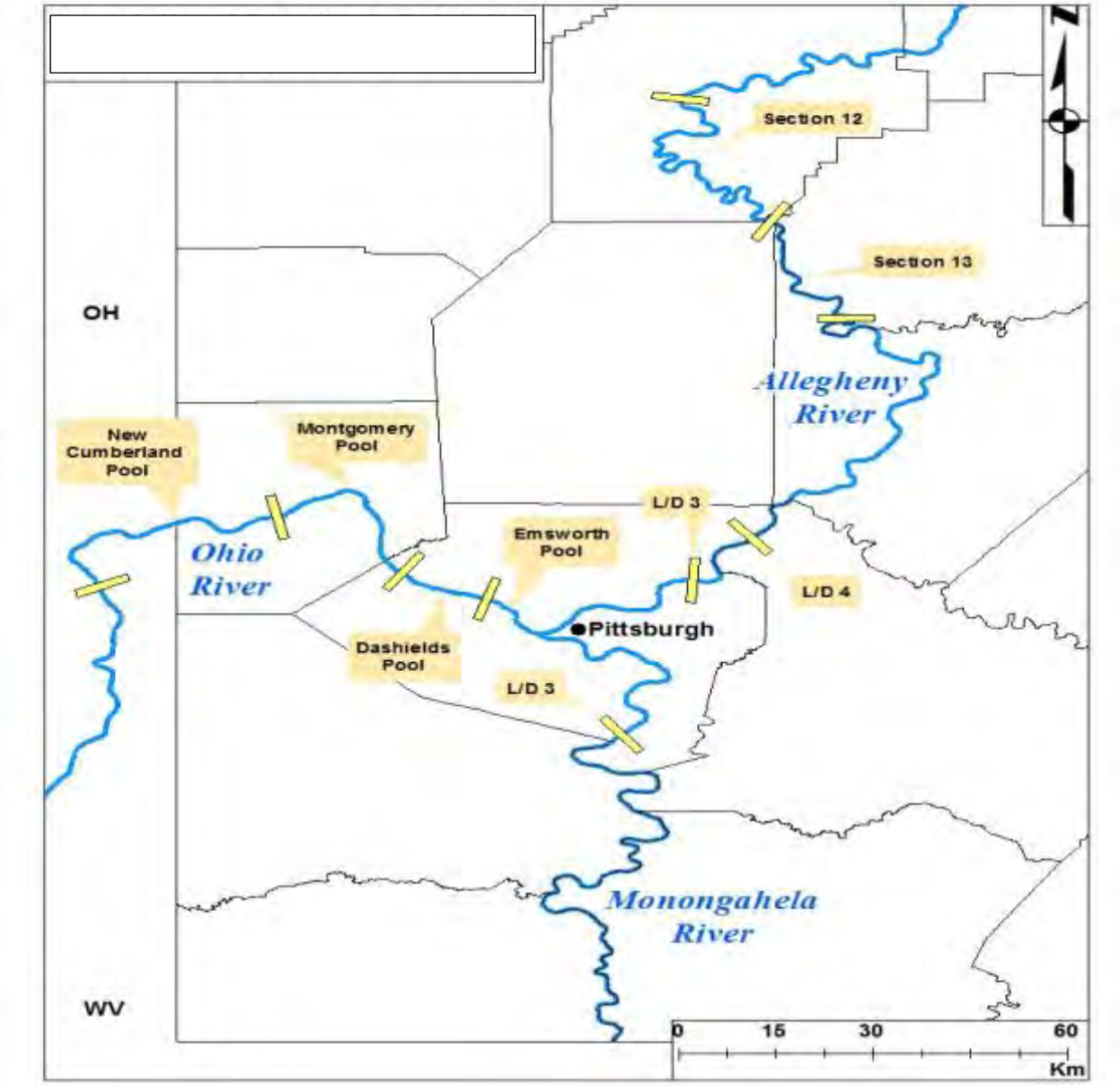

Figure 10. Map of PABFC project activities.

Sampling Sites:
Fixed site locations for targeted and community sampling (combined for all agencies) on the Ohio River between the Cannelton Lock and Dam and the Racine Lock and Dam.

Pool	Site Description	Gear	State	Type	Agency
Cannelton	Carter's Landing Bar	Boat Electrofishing	IN	MAIN	INDNR
Cannelton	Clover Creek - Upper	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Clover Creek - Lower	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Millstone Creek	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Deer Creek - Lower	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Deer Creek - Upper	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Clover Creek - Lower	Gill Netting	KY	TRIB	KDFWR
Cannelton	Deer Creek - Lower	Gill Netting	IN	TRIB	KDFWR
Cannelton	Oxbow Bend	Boat Electrofishing	IN	MAIN	INDNR
Cannelton	Wolf Creek	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Little Blue River	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Wattson Creek	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Flint Island	Boat Electrofishing	KY	MAIN	INDNR
Cannelton	Oil Creek	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Oxbow Bend	Gill Netting	IN	MAIN	INDNR
Cannelton	Little Blue River	Gill Netting	IN	TRIB	INDNR
Cannelton	Rock Run Bar	Boat Electrofishing	IN	MAIN	INDNR
Cannelton	Buck Creek	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Haunted Hollow Bar	Boat Electrofishing	IN	MAIN	INDNR
Cannelton	Indian Creek	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Blue River Bar	Boat Electrofishing	KY	MAIN	INDNR
Cannelton	Blue River	Boat Electrofishing	IN	TRIB	INDNR
Cannelton	Buck Creek	Gill Netting	IN	TRIB	KDFWR
Cannelton	Blue River Bar	Gill Netting	KY	MAIN	KDFWR

Cannelton	McAlpine Lock & Dam	Boat Electrofishing	IN	TAILW	KDFWR
Cannelton	Sand Island	Boat Electrofishing	KY	ISLBC	KDFWR
Cannelton	Hughes Bar	Boat Electrofishing	IN	MAIN	KDFWR
Cannelton	Salt River - Upper	Boat Electrofishing	KY	TRIB	KDFWR
Cannelton	Salt River - Lower	Boat Electrofishing	KY	TRIB	KDFWR
Cannelton	Otter Creek	Boat Electrofishing	KY	TRIB	KDFWR
Cannelton	Hughes Bar	Gill Netting	IN	MAIN	KDFWR
Cannelton	Salt River - Mouth	Gill Netting	KY	TRIB	KDFWR
McAlpine	Fourteen Mile Creek	Boat Electrofishing	IN	TRIB	KDFWR
McAlpine	Harrods Creek - Upper	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Harrods Creek - Lower	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Six Mile Island	Boat Electrofishing	IN	ISLBC	KDFWR
McAlpine	Beargrass Creek	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Toehead Island	Boat Electrofishing	KY	ISLBC	KDFWR
McAlpine	Harrods Creek - Lower	Gill Netting	KY	TRIB	KDFWR
McAlpine	Toehead Island	Gill Netting	KY	ISLBC	KDFWR
McAlpine	Corn Creek	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Patton's Creek	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Big Saluda Creek	Boat Electrofishing	IN	TRIB	KDFWR
McAlpine	Little Camp Creek	Boat Electrofishing	IN	TRIB	KDFWR
McAlpine	Eighteen Mile Creek	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Eighteen Mile Island	Boat Electrofishing	KY	ISLBC	KDFWR
McAlpine	Patton's Creek	Gill Netting	KY	TRIB	KDFWR
McAlpine	Eighteen Mile Island	Gill Netting	KY	ISLBC	KDFWR
McAlpine	Craig's Bar	Boat Electrofishing	IN	MAIN	KDFWR
McAlpine	Kentucky River - Upper	Boat Electrofishing	KY	TRIB	KDFWR

McAlpine	Kentucky River - Lower	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Little Kentucky	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Locust Creek	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Indian-Kentucky Creek	Boat Electrofishing	KY	TRIB	KDFWR
McAlpine	Craig's Bar	Gill Netting	IN	MAIN	KDFWR
McAlpine	Kentucky River - Mouth	Gill Netting	KY	TRIB	KDFWR
McAlpine	Markland L&D, KY	Boat Electrofishing	KY	TAILW	KDFWR
McAlpine	Markland L&D, IN	Boat Electrofishing	IN	TAILW	KDFWR
McAlpine	RM 534 Main	Boat Electrofishing	IN	MAIN	KDFWR
McAlpine	Plum Creek	Boat Electrofishing	IN	MAIN	KDFWR
McAlpine	Vevay Bar	Boat Electrofishing	KY	MAIN	KDFWR
McAlpine	Indian Creek	Boat Electrofishing	IN	TRIB	KDFWR
McAlpine	Markland L&D, IN	Gill Netting	IN	TAILW	KDFWR
McAlpine	Vevay Bar	Gill Netting	KY	MAIN	KDFWR
Markland	Big Sugar Creek	Boat Electrofishing	KY	TRIB	KDFWR
Markland	PaintLick Creek	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Craig's Creek - Upper	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Turtle Creek	Boat Electrofishing	IN	TRIB	KDFWR
Markland	Craig's Creek - Lower	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Belterra Embayment	Boat Electrofishing	IN	MAIN	KDFWR
Markland	Craig's Creek - Upper	Gill Netting	KY	TRIB	KDFWR
Markland	Belterra Embayment	Gill Netting	IN	MAIN	KDFWR
Markland	Big Bone - Upper	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Big Bone - Lower	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Gunpowder Creek	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Laugherty Island	Boat Electrofishing	IN	ISLBC	KDFWR

Markland	Grant's Creek	Boat Electrofishing	IN	TRIB	KDFWR
Markland	RM 514 Main	Boat Electrofishing	KY	MAIN	KDFWR
Markland	Arnold's Creek	Boat Electrofishing	IN	TRIB	KDFWR
Markland	Big Bone - Lower	Gill Netting	KY	TRIB	KDFWR
Markland	Big Bone - Upper	Gill Netting	KY	TRIB	KDFWR
Markland	Little Miami River	Boat Electrofishing	OH	TRIB	KDFWR
Markland	Licking River - Upper	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Licking River - Lower	Boat Electrofishing	KY	TRIB	KDFWR
Markland	Medoc Bar	Boat Electrofishing	KY	MAIN	KDFWR
Markland	Great Miami River	Boat Electrofishing	OH	TRIB	KDFWR
Markland	Tanner's Creek	Boat Electrofishing	IN	TRIB	KDFWR
Markland	Laughery Creek	Boat Electrofishing	IN	TRIB	KDFWR
Markland	Hogan Creek	Boat Electrofishing	IN	TRIB	KDFWR
Markland	Tanner's Creek	Gill Netting	IN	MAIN	KDFWR
Markland	Great Miami River	Gill Netting	OH	TRIB	KDFWR
Markland	Meldahl L&D, OH	Boat Electrofishing	OH	TAILW	KDFWR
Markland	Meldahl L&D, KY	Boat Electrofishing	KY	TAILW	KDFWR
Markland	RM 437 Main	Boat Electrofishing	OH	MAIN	KDFWR
Markland	Big Indian Creek	Boat Electrofishing	OH	TRIB	KDFWR
Markland	Twelvemile Creek	Boat Electrofishing	OH	TRIB	KDFWR
Markland	RM 456 Main	Boat Electrofishing	KY	MAIN	KDFWR
Markland	Big Indian Creek	Gill Netting	OH	TRIB	KDFWR
Markland	RM 456 Main	Gill Netting	KY	MAIN	KDFWR
Meldahl	Straight Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	White Oak Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	RM 426 Main	Boat Electrofishing	OH	MAIN	KDFWR

Meldahl	Bracken Creek	Boat Electrofishing	KY	TRIB	KDFWR
Meldahl	Locust Creek	Boat Electrofishing	KY	TRIB	KDFWR
Meldahl	Snag Creek	Boat Electrofishing	KY	TRIB	KDFWR
Meldahl	White Oak Creek	Gill Netting	OH	TRIB	KDFWR
Meldahl	Bracken Creek	Gill Netting	KY	TRIB	KDFWR
Meldahl	Cabin Creek	Boat Electrofishing	KY	TRIB	KDFWR
Meldahl	Red Oak Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Big Three Mile Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Eagle Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Lawrence Creek	Boat Electrofishing	KY	TRIB	KDFWR
Meldahl	Charleston Bar	Boat Electrofishing	KY	MAIN	KDFWR
Meldahl	Cabin Creek	Gill Netting	KY	TRIB	KDFWR
Meldahl	Straight Creek	Gill Netting	OH	TRIB	KDFWR
Meldahl	Ohio Brush Creek - Upper	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Ohio Brush Creek - Lower	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Ohio Brush Creek Island	Boat Electrofishing	KY	ISLBC	KDFWR
Meldahl	Manchester Island Two	Boat Electrofishing	KY	ISLBC	KDFWR
Meldahl	Isaacs Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Crooked Creek	Boat Electrofishing	KY	TRIB	KDFWR
Meldahl	Ohio Brush Creek - Mouth	Gill Netting	OH	TRIB	KDFWR
Meldahl	Manchester Island One	Gill Netting	KY	ISLBC	KDFWR
Meldahl	Greenup L&D, OH	Boat Electrofishing	OH	TAILW	KDFWR
Meldahl	Greenup L&D, KY	Boat Electrofishing	KY	TAILW	KDFWR
Meldahl	Pine Creek	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Little Scioto River	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Tygarts Creek	Boat Electrofishing	KY	TRIB	KDFWR

Meldahl	Scioto River - Upper	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Scioto River - Lower	Boat Electrofishing	OH	TRIB	KDFWR
Meldahl	Little Scioto River	Gill Netting	OH	MAIN	KDFWR
Meldahl	Scioto River - Lower	Gill Netting	OH	TRIB	KDFWR
Greenup	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
Greenup	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
Greenup	Guyandotte River	Boat Electrofishing	WV	TRIB	WVDNR
Greenup	Symmes Creek	Boat Electrofishing	OH	TRIB	WVDNR
Greenup	Twelvepole Creek	Boat Electrofishing	WV	TRIB	WVDNR
Greenup	Big Sandy River, I-64 bridge	Boat Electrofishing	WV	TRIB	WVDNR
Greenup	Big Sandy River, #2	Boat Electrofishing	WV	TRIB	WVDNR
Greenup	Ginat Run	Gill Netting	OH	TRIB	WVDNR
Greenup	Little Sandy River	Gill Netting	KY	TRIB	WVDNR
Greenup	Storm Creek*	Gill Netting	OH	TRIB	WVDNR
Greenup	Little Sandy, #1	Boat Electrofishing	KY	TRIB	WVDNR
Greenup	Little Sandy, #2	Boat Electrofishing	KY	TRIB	WVDNR
Greenup	Storm Creek	Boat Electrofishing	OH	TRIB	WVDNR
Greenup	Mainchannel Random	Boat Electrofishing	KY	MAIN	WVDNR
Greenup	Mainchannel Random	Boat Electrofishing	KY	MAIN	WVDNR
Greenup	Ginat Creek	Boat Electrofishing	OH	TRIB	WVDNR
Greenup	Big Sandy River - Mouth	Gill Netting	WV	TRIB	WVDNR
Greenup	Big Sandy River (additional upstream)	Gill Netting	WV	TRIB	WVDNR
Greenup	Twelvepole Creek	Gill Netting	WV	TRIB	WVDNR
Greenup	Guyan Creek	Boat Electrofishing	WV	TRIB	WVDNR
Greenup	RC Byrd L&D-gates	Boat Electrofishing	WV	TAILW	WVDNR
Greenup	RC Byrd L&D-locks	Boat Electrofishing	WV	TAILW	WVDNR
Greenup	Mainchannel Random	Boat	WV	MAIN	WVDNR

		Electrofishing			
Greenup	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
Greenup	Unnamed Island	Boat Electrofishing	WV	ISLBC	WVDNR
Greenup	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
Greenup	Guyandotte River Lower	Gill Netting	WV	TRIB	WVDNR
Greenup	Symmes Creek	Gill Netting	OH	TRIB	WVDNR
Greenup	Mainchannel Random*	Gill Netting	WV	MAIN	WVDNR
Greenup	Unnamed Island	Gill Netting	WV	ISLBC	WVDNR
Greenup	Guyan Creek	Gill Netting	WV	TRIB	WVDNR
Greenup	Mainchannel Random*	Gill Netting	WV	MAIN	WVDNR
RC Byrd	Racine L&D-gates	Boat Electrofishing	WV	TAILW	WVDNR
RC Byrd	Racine L&D-locks	Boat Electrofishing	WV	TAILW	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Trib-Sliding Hill Ck.	Boat Electrofishing	WV	TRIB	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Trib - Leading Ck.	Boat Electrofishing	OH	TRIB	WVDNR
RC Byrd	Chickamauga Creek	Gill Netting	OH	TRIB	WVDNR
RC Byrd	Gallipolis Island	Gill Netting	WV	ISLBC	WVDNR
RC Byrd	Raccoon Creek	Gill Netting	OH	TRIB	WVDNR
RC Byrd	Eightmile Island	Boat Electrofishing	WV	ISLBC	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Kyger Creek	Boat Electrofishing	OH	TRIB	WVDNR
RC Byrd	Old Town Creek	Boat Electrofishing	WV	TRIB	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Crooked Creek-Kanawha R.	Boat Electrofishing	WV	TRIB	WVDNR
RC Byrd	Three Mile Ck-Kanawha R.	Boat Electrofishing	WV	TRIB	WVDNR
RC Byrd	Leading Creek	Gill Netting	OH	TRIB	WVDNR

RC Byrd	Eightmile Island	Gill Netting	WV	ISLBC	WVDNR
RC Byrd	Gallipolis Island	Boat Electrofishing	WV	ISLBC	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Mainchannel Random	Boat Electrofishing	WV	MAIN	WVDNR
RC Byrd	Raccoon Creek	Boat Electrofishing	OH	TRIB	WVDNR
RC Byrd	Crab Creek	Boat Electrofishing	WV	TRIB	WVDNR
RC Byrd	Kan R - Crooked Creek	Gill Netting	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan R - N. Threemile Creek	Gill Netting	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan R - Fivemile Creek	Gill Netting	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan. R-Winfield L&D-gates	Boat Electrofishing	WV	TRIB-TAILW	WVDNR
RC Byrd	Kan. R -Winfield L&D-locks	Boat Electrofishing	WV	TRIB-TAILW	WVDNR
RC Byrd	Kan.R Mainchannel Random	Boat Electrofishing	WV	TRIB-MAIN	WVDNR
RC Byrd	Kan.R - Hurricane Creek	Boat Electrofishing	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan. R- 5 & 20 Mile Ck.	Boat Electrofishing	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan. R- 18Mile Ck.	Boat Electrofishing	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan.R Mainchannel Random	Boat Electrofishing	WV	TRIB-MAIN	WVDNR
RC Byrd	Kan R - Ninemile Creek	Gill Netting	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan R - Tenmile Creek	Gill Netting	WV	TRIB-TRIB	WVDNR
RC Byrd	Kan R - Thirteenmile Creek	Gill Netting	WV	TRIB-TRIB	WVDNR

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Project Title: Abundance and distribution of early life stages of Asian carp in the Ohio River

Geographic Location: Ohio River Basin

Lead Agency: Indiana Department of Natural Resources (INDNR)

Agency Collaboration: Kentucky Department of Fish and Wildlife Resources (KDFWR), West Virginia University (WVU), United States Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), Ohio River Valley Water Sanitation Commission (ORSANCO)

Statement of Need:

Understanding fish community interactions is a critical component of large-river ecology, especially the interactions of nonindigenous fishes on native fauna. Non-native large-bodied planktivores are capable of posing deleterious effects to large river ecosystems. In particular, the effects of Asian carp (i.e. Bighead Carp and Silver Carp) on native biota have received minimal attention. Asian carp are large bodied filter feeders native to Asia that were brought to the United States to control water quality in aquaculture facilities in the 1970's. After escaping such locations and because of their tolerance of a wide range of environmental conditions, Asian carp spread throughout the Mississippi River, Missouri River, and Ohio River basins and now inhabit many of the open waters of the United States (Kolar et al. 2005). Since that time, Asian carp abundance and biomass has increased substantially and are likely posing negative effects on aquatic systems (DeBoer et al. 2018). Planktivorous species like the bigheaded carp may compete with native biota (e.g., fishes, mollusks, invertebrates) or disrupt trophic interactions through direct reductions in primary and secondary productivity (i.e., phytoplankton and zooplankton; Sampson et al. 2009). In addition, native fishes during all life stages (i.e., larvae, juvenile, and adult) are likely deleteriously influenced by increasing numbers of these invasive filter feeders through the bottom up trophic cascade.

Specifically, Schrank et al. (2003) suggested Bighead Carp had deleterious effects on Paddlefish under experimental conditions. Furthermore, D. Chapman (Personal Communication) suggested Asian carp are posing deleterious effects on native fishes in the Missouri River. Irons et al. (2007) used data from the Long Term Resource Monitoring Program (LTRMP) in the Illinois River and suggested negative interactions between native fishes (Gizzard Shad and Bigmouth Buffalo) and Asian carp. Correspondingly, Phelps et al. (In Review) has also documented a decline in relative abundance and condition in native fishes in the Mississippi River as the relative abundance of bigheaded carp has increased. The overarching theme of the aforementioned studies suggests deleterious effects of Asian carp on native biota.

In order to limit the negative impacts of Asian carp populations and their further spread, efforts have increased to understand the distribution and abundance of Asian carp in the waters they currently inhabit. Prior to 2016, information on the distribution of Asian carp in the Ohio River was limited to targeted sampling on the leading edge of invasion above McAlpine Locks and Dam at RM 606 (see Monitoring and Response of Asian carp in the Ohio River) and sampling efforts in the lower Ohio River below JT Myers Locks and Dam (RM 846) conducted by the Illinois Department of Natural Resources (IDNR). These efforts have documented adult Asian

carp presence as far upstream as Robert C. Byrd Dam near Gallipolis Ferry, West Virginia. This is especially troubling given Asian carp adults have the propensity to move long distances in relatively short time intervals, can traverse lock and dam structures, and based on recent captures appear to be making upstream progression in the Ohio River (Tripp et al. 2013, N. Jackson, Personal Communication). Furthermore, confirmed Asian carp spawning events have occurred in tributaries (i.e., Wabash River) as far upstream on the Ohio River as JT Myers Locks and Dam. Suspected reproduction of non-indigenous bigheaded carp has also been documented in Meldahl Pool. Efforts in 2016 produced the first collection of juvenile Asian carp between JT Myers and Markland Locks and Dams. As the anecdotal studies above suggest, previous efforts have been successful in collecting Asian carp eggs, embryos, larvae and juveniles in the Ohio River. However, the spatial extent and intensity of Asian carp spawning and recruitment in the Ohio River remains a knowledge gap. Multiple years of data collection covering a broader spatial extent under a variety of environmental conditions will be necessary to fully understand Asian carp early life history among pools.

Acquiring a full understanding of the early life history information is imperative for evaluating the population status (i.e., extent of invasion). As defined in the Upper Mississippi River basin (Brent Knights and Ann Runstrom, personal communication), the extent of Asian carp invasion has three predominate levels (presence front, invasion front, and established front) that will guide specific management actions. The “presence front” is the most upstream extent of Asian carp capture where densities are low and reproduction has not occurred. The “invasion front” is that location(s) where reproduction (i.e., eggs, embryos, or larvae) has been observed but recruitment has yet to be documented. The “established front” is that location(s) where reproduction and recruitment to the adult life stage are currently occurring. Identifying the specific locations that differentiate the established, invasion, and presence fronts is crucial information for implementation of management or control efforts (e.g. targeted removal efforts, informing barrier or deterrent placement, etc). In order to identify these locations, quantifying abundance and distribution of Asian carp early life stages is needed.

For the purposes of this study, eggs, embryos, and larvae will be used to verify spawning while juvenile Asian carp will be used to identify recruitment. Many methods can be used to verify the presence of Asian carp spawning (Schrank et. al 2001; Deters et. al 2013) and recruitment (Haupt and Phelps 2016; Sleeper and Phelps In Review). The collection of Asian carp eggs, embryos, and larvae to document spawning are most generally evaluated using ichthyoplankton sampling methods (i.e., surface trawling using bongo nets). However, juvenile Asian carp can be sampled using a wide array of sampling gears. That being said, electrofishing provides a time efficient measure of juvenile Asian carp abundance, habitat use, and a readily available method available to most fisheries management biologists. As such, electrofishing will be used to measure recruitment. Other gears may be deployed as time permits to increase detection. In addition to sampling, participating agencies will collaborate with other fisheries professionals to inform them to report back with any confirmed findings of juvenile Asian carp within the basin. State partners will reach out to other biologists within their respective states and if a new instance is reported, will gather data and site location information if possible. These data will be compiled by the project lead and will be used to inform future planning efforts.

Project Goals and Objectives:

National Plan Goals:

Goal 3.2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.5. Provide information to the public, commercial entities, and government agencies to improve effective management and control of bighead, black, grass, and silver carps in the United States;

Goal 3.6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States;

Goal 3.7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass and silver carps in the United States.

National Plan Strategies:

Strategy 3.2.3. Minimize the range expansion and ecological effects of feral populations of Asian carps in conjunction with management actions to enhance aquatic environments for the sustainability of native biological communities.

Strategy 3.2.4. Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions;

Strategy 3.3.1. Determine life history characteristics and build population dynamics models of Asian carps in the Mississippi River Basin;

Strategy 3.6.2. Assemble information about the distribution, biology, life history, and population dynamics of bighead, black, grass, and silver carps;

Strategy 3.6.5. Determine the demonstrated and probable ecological and economic effects of Asian carps in the United States and determine the degree to which these effects are negative;

*Ohio River Basin Goal***:**

Monitoring and Response

Ohio River Basin Strategy:

2.2 State agencies of the Ohio River basin continue, or initiate, annual fisheries monitoring programs for the Ohio River and its tributaries to serve as an additional means of surveillance.

2.3 Implement a program of surveillance surveys targeting Asian carp to monitor their upstream range expansion as well as monitor changes of their distribution and abundance.

2.4 Survey areas upstream of McAlpine Lock and Dam complex to enhance surveillance and early detection capabilities.

2.8 Support research to improve capabilities to detect early stages of invasion and spawning populations of Asian carp.

Project Objectives:

1. Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae.
2. Determine the extent of Asian carp recruitment in the Ohio River via targeted sampling for juvenile Asian carp.
3. Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered.

Agency: Indiana Department of Natural Resources

Project: Abundance and distribution of early life stages of Asian carp in the Ohio River

Objectives:

1. Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae.
2. Determine the extent of Asian carp recruitment in the Ohio River via targeted sampling for juvenile Asian carp.
3. Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered.

Project Activities: Methods, and Timetable

Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae: Indiana DNR will conduct and coordinate sampling for Asian carp eggs, embryos, and larvae in Newburgh and Cannelton pools. Specifically, INDNR will sample at Clover Creek (Cannelton Pool), and the Anderson River and F.B. Culley Plant (Newburgh Pool).

To evaluate relative abundance of Asian carp eggs, embryos, and larvae, conical ichthyoplankton tows (0.76m, 500 µm mesh) will be conducted at each site once a week from early-May through late-July, 2018. A single ichthyoplankton net will be deployed on the side of the boat facing upstream, with each tow lasting 3 minutes. A flow meter will be used to determine water volume sampled. All contents will be rinsed into a 500 µm sieve and preserved in 95% ethanol for identification in the lab. Morphometric characteristics developed by Chapman and George (2011) Sleeper and Phelps (In Review) will be used to identify Asian carp eggs, embryos, and larvae. WVU will obtain all ichthyoplankton samples from INDNR, and process them within two weeks of receiving. Results will be used to estimate the extent of spawning activity in the Ohio River and thus will guide future management actions (e.g. targeted removal efforts and/or barrier placement considerations).

At each site, the main stem Ohio River will be sampled at the right descending, center, and left descending portions of the river. A fourth sample will be taken at each site either at the intake structure (power plant sites) or within the tributary mouth as tributaries may serve as a refuge for newly hatched larvae to escape the main channel flow. Depth (m) and water temperature (^{0}C) will be recorded using a boat-mounted depth sounder at each sampling site.

Determine the extent of Asian carp recruitment in the Ohio River via targeted sampling for juvenile Asian carp: Indiana DNR will conduct targeted sampling for juvenile Asian carp between JT Myers Locks and Dam and Markland Locks and Dam. Because typical nursery habitat in the form of shallow backwater areas is less prominent in the Ohio River, flooded creek mouths and tributaries likely serve as a substitute. Based on previous sampling efforts, the juvenile electrofishing effort has been scaled down in 2018 to only include three to five sites in each pool that would have the best likelihood of producing juvenile Asian carp: Hovey Lake, Hovey Lake Drain, Lost Creek, and Highland Creek will be sampled in JT Myers Pool; Sandy Creek, Blackford Creek, and two borrow pits (near RM 750) will be sampled in Newburgh Pool;

Deer Creek, Millstone Creek, and Clover Creek will be sampled in Cannelton Pool; Goose Creek, Harrods Creek, and Fourteen Mile Creek will be sampled in McAlpine Pool. Each site will be targeted with pulsed DC electrofishing during July and August, the time of year when juvenile Asian carp have been captured in the lower Ohio River in previous years. Time permitting, a 12-foot surface trawl will be used in select locations to test the efficacy of the novel gear type for young-of-year Asian carp sampling. This insight will be useful for modifying or adding to the sampling protocol (where applicable) to better identify the true extent of Asian carp recruitment in the Ohio River.

Electrofishing samples will consist of at least one 15-minute transects at each sample site, using an MLES Infinity control box set at 80 pulses per second and 40% duty cycle. Output will be standardized based on water conductivity. Juvenile Asian carp will be targeted, and those encountered will be collected, identified to species, geo-located and enumerated. When Asian carp are encountered, lengths and weights will be recorded and a subsample of aging structures will be collected; Otoliths will be taken from fish >200 mm, and fish <200 mm will be frozen whole and taken back to the lab for dissection of aging structures. Results will be used to estimate the extent of Asian carp recruitment in the Ohio River and thus will directly inform future management actions (e.g. targeted removal efforts and/or barrier placement considerations).

Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered: Indiana DNR will conduct targeted sampling for juvenile Asian carp between JT Myers Locks and Dam and Markland Locks and Dam. Because typical nursery habitat in the form of shallow backwater areas is less prominent in the Ohio River, flooded creek mouths and tributaries likely serve as a substitute. Based off of knowledge gained during previous sampling efforts, select tributaries that have been identified as likely Asian carp nurseries will be targeted with pulsed DC electrofishing during July and August, the time of year when juvenile Asian carp have been captured in the lower Ohio River in previous years. A suite of habitat measurements will be collected at each site to describe both the morphology characteristics (average depth, maximum depth, tributary width, presence/absence of woody debris and aquatic vegetation) of the tributary as well water quality parameters (water temperature, Secchi disk visibility, conductivity, pH, dissolved oxygen). Data will be compiled with previous years data to help categorize and identify areas that may provide the necessary habitat for Asian carp growth and development.

Estimated Timetable:

Project Activity	**Pool**	**Month**	**Year**
Juvenile AC Sampling	JT Myers, Newburgh, Cannelton, McAlpine	July and August	2018
Nursery Habitat Assessment	JT Myers, Newburgh, Cannelton, McAlpine	July and August	2018

Larval AC Sampling	Newburgh, Cannelton	May, June, and July	2018
Provide larval samples to WVU	Newburgh and Cannelton	June, July, and August	2018
Compile executive summary	N/A	October	2018
Provide project technical report	N/A	March	2019
Juvenile AC Sampling	JT Myers, Newburgh, Cannelton, McAlpine	July and August	2019
Nursery Habitat Assessment	JT Myers, Newburgh, Cannelton, McAlpine	July and August	2019
Larval AC Sampling	Newburgh, Cannelton	May, June, and July	2019
Provide larval samples to WVU	Newburgh and Cannelton	June, July, and August	2019

Figure 11. Project activity area for INDNR.

Agency: Kentucky Department of Fish and Wildlife Resources

Project: Abundance and distribution of early life stages of Asian carp in the Ohio River

Objectives:

1. Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae.

Project Activities: Methods, and Timetable

Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae: KDFWR will conduct sampling for Asian carp eggs, embryos, and larvae in Cannelton and McAlpine pools. Specifically, KDFWR will sample at Clifty Creek Plant and Kentucky River (McAlpine Pool), and Mill Creek Plant (Cannelton Pool).

To evaluate relative abundance of Asian carp eggs, embryos, and larvae, conical ichthyoplankton tows (0.76m, 500 µm mesh) will be conducted at each site once a week from early-May through late-July, 2018. A single ichthyoplankton net will be deployed on the side of the boat facing upstream, with each tow lasting 3 minutes. A flow meter will be used to determine water volume sampled. All contents will be rinsed into a 500 µm sieve and preserved in 95% ethanol for identification in the lab. Morphometric characteristics developed by Chapman and George (2011) Sleeper and Phelps (In Review) will be used to identify Asian carp eggs, embryos, and larvae. WVU will obtain all ichthyoplankton samples from KDFWR, and process them within two weeks of receiving. Results will be used to estimate the extent of spawning activity in the Ohio River and thus will guide future management actions (e.g. targeted removal efforts and/or barrier placement considerations).

At each site, the main stem Ohio River will be sampled at the right descending, center, and left descending portions of the river. A fourth sample will be taken at each site either at the intake structure (power plant sites) or within the tributary mouth as tributaries may serve as a refuge for newly hatched larvae to escape the main channel flow. Depth (m) and water temperature (^{0}C) will be recorded using a boat-mounted depth sounder at each sampling site.

Estimated Timetable:

Project Activity	Pool	Month	Year
Larval AC Sampling	Cannelton and McAlpine	May, June and July	2018
Provide larval samples to WVU	Cannelton and McAlpine	June, July, and August	2018
Larval AC Sampling	Cannelton and McAlpine	May, June and July	2019
Provide larval samples to WVU	Cannelton and McAlpine	June, July, and August	2019

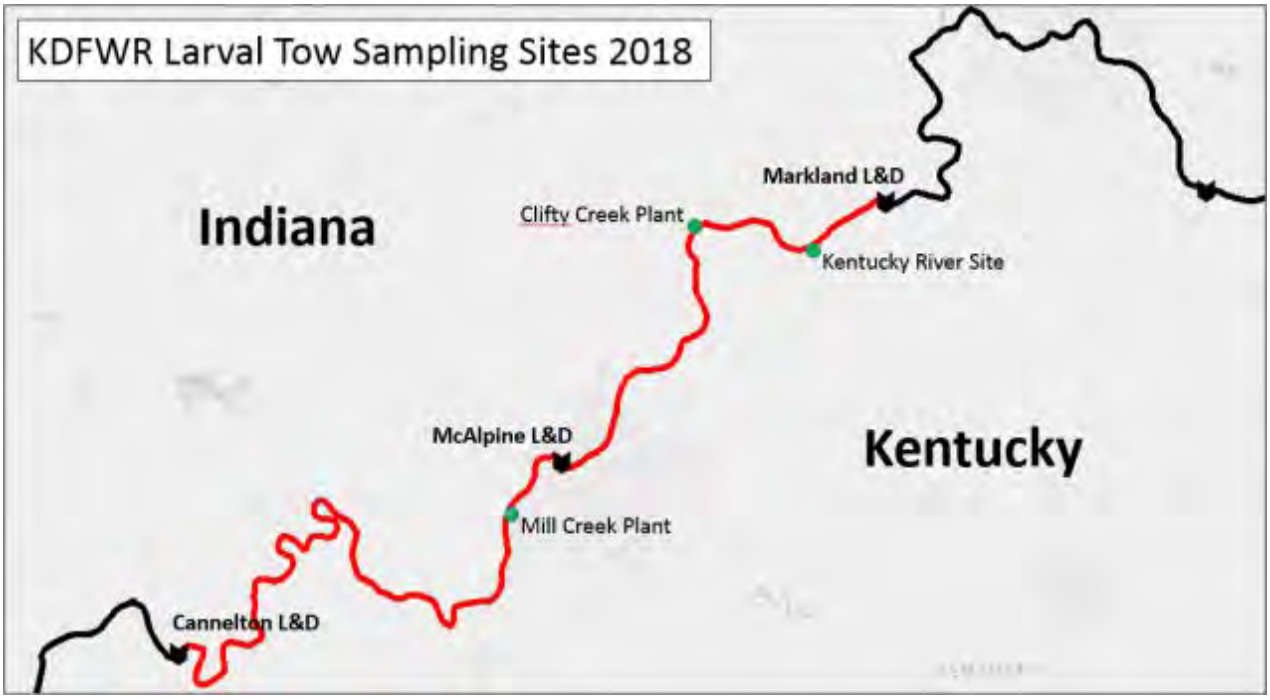

Figure 12. Project activity area for KDFWR.

Agency: West Virginia Division of Natural Resources (West Virginia University)

Project: Abundance and distribution of early life stages of Asian carp in the Ohio River

Objectives:

1. Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae.

Project Activities: Methods, and Timetable

Determine the extent of Asian carp spawning activity in the Ohio River via sampling for Asian carp eggs, embryos, and larvae: West Virginia DNR will assist WVU in conducting sampling for Asian carp eggs, embryos, and larvae in RC Byrd and Greenup pools. Specifically, WVDNR will assist in sampling at Kyger Creek Plant (R.C. Byrd Pool) and Guyandotte River (Greenup Pool).

To evaluate relative abundance of Asian carp eggs, embryos, and larvae, conical ichthyoplankton tows (0.76m, 500 µm mesh) will be conducted at each site once a week from early-May through late-July, 2018. A single ichthyoplankton net will be deployed on the side of the boat facing upstream, with each tow lasting 3 minutes. A flow meter will be used to determine water volume sampled. All contents will be rinsed into a 500 µm sieve and preserved in 95% ethanol for identification in the lab. Morphometric characteristics developed by Chapman and George (2011) Sleeper and Phelps (In Review) will be used to identify Asian carp eggs, embryos, and larvae. WVU will obtain all ichthyoplankton samples from WVDNR, and process them within two weeks of receiving. Results will be used to estimate the extent of spawning activity in the Ohio River and thus will guide future management actions (e.g. targeted removal efforts and/or barrier placement considerations).

At each site, the main stem Ohio River will be sampled at the right descending, center, and left descending portions of the river. A fourth sample will be taken at each site either at the intake structure (power plant sites) or within the tributary mouth as tributaries may serve as a refuge for newly hatched larvae to escape the main channel flow. If possible, velocity (m/s) will be measured using a Marsh-McBirney flow meter and depth (m) and water temperature (^{0}C) will also recorded using a boat-mounted depth sounder at each sampling site.

Estimated Timetable:

Project Activity	**Pool**	**Month**	**Year**
AC egg, embryo, and larval sampling	Greenup and RC Byrd	May, June, and July	2018
Provide larval samples to WVU	Greenup and RC Byrd	June, July, and August	2018
AC egg, embryo, and larval sampling	Greenup and RC Byrd	May, June, and July	2019
Provide larval samples to WVU	Greenup and RC Byrd	June, July, and August	2019

Figure 13. Map of project area for WVDNR.

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Project Title: Control and Containment of Asian Carp in the Ohio River

Geographic Location: Ranging from the Cannelton pool (RM 720) to the R.C. Byrd pool (RM 238). Some work has been conducted below the Cannelton pool in recent years and removal may extend down to the Smithland pool (RM 918).

Lead Agency: Kentucky Department of Fish and Wildlife Resources (KDFWR)

Agency Collaboration: West Virginia Division of Natural Resources (WVDNR)

Statement of Need:
Invasive species are continually responsible for undesirable economic and environmental impacts across the nation (Lovell and Stone 2005, Pimentel et al. 2005, Jelks et al. 2008). Specifically, Asian carp have been successful invaders in the United States because of their tolerance and adaptability to a wide range of environmental conditions and have steadily increased their range from the lower Mississippi River, into the Ohio River basin and beyond (Kolar et al. 2005, Zhang et al. 2016). Asian carp rapidly and densely colonize river reaches affecting the native food webs important to ecosystem function (Irons et al. 2007, Freedman et al. 2012). The Ohio River provides a broad variety of potential habitats available to Asian carp and with their ability to quickly colonize new areas with dense populations, inflict significant impacts on recreation, natural aesthetics, and the function of important native ecosystems, the Ohio River basin is at risk. In response, funding has been allocated in the basin to limit the impacts of Asian carp where they exist, as well as halt their spread into uninhabited waters.

There are currently few tools available to limit the negative impacts of Asian carp and their spread into new waters. Integrated pest management approaches typically include population control measures and barrier technologies that prevent movement of the Asian carps into critical areas while decreasing propagule pressure (Tsehaye et al. 2013). Implementation of barriers to slow Asian carp movement are widely believed to be an important aspect of the control of Asian carp throughout their range. Research and implementation of barrier projects are currently planned in the ORB, but can be very expensive and time consuming. While efforts to develop effective barriers are underway, the physical removal of Asian Carp remains the primary tool for limiting impacts and dispersal. Speculation on the removal of Asian Carp in the Illinois River has shown the promise of a fishery-induced collapse if removal is high and targets all size ranges of fish (Tsehaye et al. 2013). Efforts to remove fish in the Ohio River basin began in 2013 and will continue into the foreseeable future. Removal efforts in the ORB in 2016 - 2017 were focused in higher density pools after adjustments from lessons learned in 2015. Methods are proposed for 2018 that build off the successes in previous years.

Project Goals and Objectives:
National Plan Goals:

Goal 3.2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States;
Goal 3.3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass and silver carps in the United States.

National Plan Strategies:

Strategy 3.2.3. Minimize the range expansion and ecological effects of feral populations of Asian carps in conjunction with management actions to enhance aquatic environments for the sustainability of native biological communities.

Strategy 3.3.1. Determine life history characteristics and build population dynamics models of Asian carps in the Mississippi River Basin;

Strategy 3.3.2. Increase the commercial harvest of Asian carps;

Strategy 3.3.4. Physical removal by natural resources management agencies

Strategy 3.6.2. Assemble information about the distribution, biology, life history, and population dynamics of bighead, black, grass, and silver carps;

Strategy 3.6.4. Develop an integrated management strategy to extirpate or reduce abundances of feral Asian carps;

Ohio River Goals:

Population Control

Ohio River Strategy:

3.1 Encourage increased commercial harvest and implement contract fishing of Asian carp.

Project Objectives:

1. Target and remove Asian Carp to suppress populations and reduce propagule pressure in the Ohio River.
2. Develop an Ohio River contingency response plan.

Agency: Kentucky Department of Fish and Wildlife Resources (KDFWR)

Project: Control and Containment of Asian Carp in the Ohio River

Fiscal Year: 2018

Objectives:

1. Target and remove Asian Carp to suppress populations and reduce propagule pressure in the Ohio River.
2. Develop an Ohio River contingency response plan.

Project Activities: Methods, and Timetable:

Physical Removal of Asian Carps

The majority of nonindigenous carps targeted throughout this project will be euthanized upon capture. Some fish may be tagged with a sonic transmitter for tracking purposes to inform the Ohio River Telemetry Project. Agency crews will remove Asian carps from the Ohio River, focusing on known or suspected areas of high density. Agency efforts will rely on pulsed-DC electrofishing and gill nets, but other gear types may be used to increase catchability depending on sampling circumstances. Information from the literature, expertise of researchers, and commercial anglers will be employed to investigate improvements in capturing Asian carps at multiple life stages. Exterminated fish will be used to provide otoliths and/or pectoral fin rays for aging (Beamish 1981, Schrank and Guy 2002, Williamson and Garvey 2005, Seibert and Phelps 2013). All by-catch and collected fish will be identified, counted, and geo-referenced for reporting purposes.

Develop an ORB Contingency Response Plan

KDFWR staff will work with basin partners to identify what the aspects of an appropriate response plan for the Ohio River. Key elements of successful response plans implemented for invasive species in other water bodies will be reviewed and discussed in order to identify the appropriate actions that could be employed in the ORB. Focal areas and a summary of findings will be provided in a draft to the basin partners for comment and review.

Estimated Timetable:

Project Activity	Pool	Month(s)	Year
Removal	Cannelton - Greenup	May 14 – Sept 24	2018
Removal	RC Byrd	June	2018
Removal	RC Byrd	July	2018
Removal	RC Byrd	August	2018
Removal	RC Byrd	September	2018
Project Executive Summary	N/A	October 30	2018
Removal	Cannelton	November	2018
Removal	Cannelton	December	2018
Removal	Cannelton	January	2019
Removal	McAlpine	February	2019
Project Technical Report	N/A	February 28	2019
Removal	Cannelton - Greenup	May – September	2019
Removal	RC Byrd	Various	2019

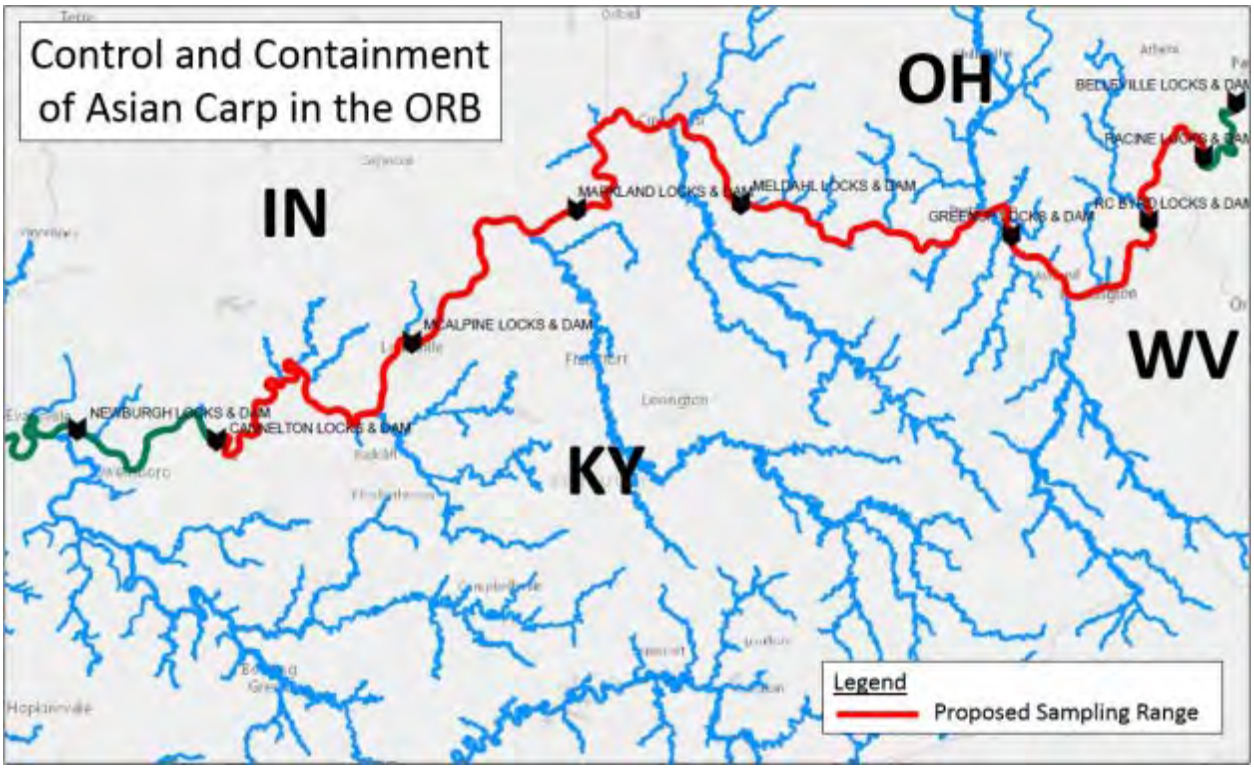

Figure 14. Map of project activities for KDFWR.

Agency: West Virginia Division of Natural Resources (WVDNR)

Project: Control and Containment of Asian Carp in the Ohio River

Objectives:

1. Target and remove Asian Carp to suppress populations and reduce propagule pressure in the Ohio River.
2. Develop an Ohio River contingency response plan.

Project Activities: Methods, and Timetable:

Physical Removal of Asian Carps

All nonindigenous carps targeted throughout this project will be euthanized upon capture. Agency crews will remove Asian carps from of the Ohio River in the R.C. Byrd and Greenup pools of the Ohio River, focusing on known or suspected areas of occurrence. Agency efforts will rely on pulsed-DC electrofishing and gill nets, but other gear types will be utilized to increase catchability depending on sampling circumstances. Information from the literature, expertise of researchers, and commercial anglers will be employed to investigate improvements in capturing Asian carps. Exterminated fish will be used to provide otoliths and/or pectoral fin rays for aging (Beamish 1981, Schrank and Guy 2002, Williamson and Garvey 2005, Seibert and Phelps 2013). All by-catch and collected fish will be identified, counted, and geo-referenced for reporting purposes.

Develop an ORB Contingency Response Plan

WVDNR staff will work with basin partners to identify what the aspects of an appropriate response plan for the Ohio River. Key elements of successful response plans implemented for invasive species in other water bodies will be reviewed and discussed in order to identify the appropriate actions that could be employed in the ORB. Focal areas and a summary of findings will be provided in a draft to the basin partners for comment and review.

Estimated Timetable:

Project Activity	Pool	Month(s)	Year
Removal	R.C. Byrd	June-Sept.	2018
Response Plan Research	N/A	Jan-Dec	2018

Figure 15. Map of project activities for WVDNR.

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Project Title: Quantifying lock and dam passage, habitat use, and survival rates of Asian carp in the Ohio River

Geographic Location: Ohio River Basin from Cannelton Pool to just upstream of Willow Island Lock and Dam

Lead Agency: U.S. Fish and Wildlife Service **(**USFWS)

Agency Collaboration: Kentucky Department of Fish and Wildlife Resources (KDFWR), Ohio Department of Natural Resources (ODNR), U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), West Virginia Division of Natural Resources (WVDNR)

Statement of Need:
Asian carp are spreading up the Ohio River and many of its tributaries. Populations of Asian carp have become well established in the lower and middle reaches of the Ohio River and are known to reproduce as far upstream as Louisville, Kentucky. The upper reaches of the Ohio River, as well as many upper basin tributary streams, may not be inhabited by Asian carp at present.

The need exists to prevent the establishment of these species into the upper portions of the Ohio and Tennessee River basins. Any information that we can learn about Asian carp distribution, abundance, and/or biology that could help managers to limit or stop their spread would be important for the protection of aquatic ecosystems.

Understanding the movement patterns of Asian carp is important from a variety of perspectives. The probability of large-scale movements across locks and dams is required to predict population range expansion and can facilitate determining how deterrents to movement across locks and dams could slow the progression of range expansion. Better knowledge of fine-scale movements related to habitat use and how these patterns are affected by time of day, season, flow, and other factors can increase our capture efficiency for removal efforts. Moreover, determining how patterns of movement change with increasing levels of removal is very important to determine whether these efforts are paying dividends, particularly if large-scale movement patterns or habitat use are related to population density.

Ultrasonic acoustic telemetry will be used to track both large-scale and fine-scale movements of Asian carp. This technology has many advantages over other approaches to quantifying movement patterns. For example, the probability of detection is typically very high with this technology and can therefore provide more precise and accurate estimates of movement compared to other approaches such as external marking. Quantifying movement or lack there-of, can be confounded with probability of survival in situations of low detection; therefore this advantage in increased detection probability cannot be overstated particularly due to the added benefit of obtaining precise estimates of survival rates. These movement data will help to better understand Asian carp dispersal and invasion dynamics, evaluate their ability to navigate the lock

and dam systems, and identify areas of seasonal congregations in the Ohio River and its tributaries.

National Plan Goals:

Goal 3.2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3.6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States;

Goal 3.7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass, and silver carps in the United States.

National Plan Strategies:

Strategy 3.2.1. Develop a national strategy and guidelines for science-based decision making concerning the need for continued and additional containment measures;

Strategy 3.2.3. Minimize the range expansion and ecological effects of feral populations of Asian carps in conjunction with management actions to enhance aquatic environments for the sustainability of native biological communities.

Strategy 3.2.4. Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions;

Strategy 3.2.6. Develop an information exchange network for agencies, organizations, and partners to communicate and share "real time" data to facilitate early detection and rapid response programs;

Strategy 3.3.1. Determine life history characteristics and build population dynamics models of Asian carps in the Mississippi River Basin;

Strategy 3.3.2. Increase the commercial harvest of Asian carps;

Strategy 3.3.4. Physical removal by natural resources management agencies;

Strategy 3.6.2. Assemble information about the distribution, biology, life history, and population dynamics of bighead, black, grass, and silver carps;

Strategy 3.6.3. Develop effective methods to contain feral Asian carp populations and prevent their farther spread;

Strategy 3.6.4. Develop an integrated management strategy to extirpate or reduce abundances of feral Asian carps;

Strategy 3.7.1. Develop an implementation program that effectively coordinates, oversees, and drives implementation efforts.

Ohio River Basin Goals:

Prevention;

Monitoring and response;

Population control;

Understanding impacts;

Communication.

Ohio River Basin Strategies:

1.4 Evaluate use of deterrent barriers at strategic locations to limit farther dispersal of Asian carp in the Ohio River basin;

1.5 Evaluate the use of operational changes at locks and dams to deter passage of Asian carp;

2.7 Support research to improve capabilities to detect early stages of invasion and spawning populations of Asian carp;

3.2 Support and accelerate research on sustainable, cost-effective means of long-term control methods;

4.1 Conduct collaborative inter-agency research to measure the distribution, movement, and habitat use of Asian carp in the middle Ohio River;

5.1 Maintain effective communication among the ORFMT, Ohio River basin partners, and regional coordinating groups.

Objectives:

1. Understand use of tributaries as potential sources for recruitment and routes of invasion into adjacent basins.
2. Delineate the upstream population distribution and potential for farther upstream dispersal.
3. Help inform contract fishing and agency sampling efforts utilizing telemetry data.
4. Quantify passage of Asian carp at Ohio River locks and dams.
5. Estimate probability of survival.

Download Schedule:

Pool	April	May	June	July	August	September	October	November
Willow Isl.	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS
Belleville	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS
Racine	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS
R. C. Byrd	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR
Greenup	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS
Meldahl	ODNR	ODNR	ODNR	ODNR	ODNR	ODNR	ODNR	ODNR
Cincinnati to Meldahl L&D	ODNR	ODNR	ODNR	ODNR	ODNR	ODNR	ODNR	ODNR
Markland L&D to Cincinnati	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR
McAlpine	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR
Cannelton	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR	KDFWR

Agency: U.S. Fish and Wildlife Service

Project: Quantifying lock and dam passage, habitat use, and survival rates of Asian carp in the Ohio River

Objectives:

1. Understand use of tributaries as potential sources for recruitment and routes of invasion into adjacent basins.
2. Delineate the upstream population distribution and potential for further upstream dispersal.
3. Help inform contract fishing and agency sampling efforts utilizing telemetry data.
4. Quantify passage of Asian carp at Ohio River locks and dams.
5. Estimate probability of survival.

Project Activities: Methods, and Timetable

Understand use of Tributaries
USFWS and its partners will coordinate the deployment, maintenance, and replacement of acoustic telemetry receivers within tributaries of the Ohio River. The data on these receivers will be offloaded as regularly as possible, with a goal of being completed no later than every other month. Due to the relatively high recovery rate of receivers left in the tributaries during the winter months, receivers will remain in place indefinitely to obtain a complete picture of tributary use throughout the year.

Delineate Upstream Movement
USFWS, with the assistance of its partners, will deploy receivers in the spring of 2018 after initial spring flooding subsides. Deployment locations will generally remain the same as the previous years, with changes occurring where necessary or deemed pertinent to obtaining better acoustic coverage. Receivers used for upstream movement will generally be attached to USCG channel marker buoys and will be maintained by the agency designated in the "2018 Download Schedule" with assistance from USFWS as needed or coordinated. These receivers will be removed in November or December to reduce the number of receivers lost.

Inform Contract Fishing and Agency Sampling
Data from both tributary and mainstem receivers will be used to inform contract and agency fishers of up-to-date densities of tagged Asian Carp within each pool. These tagged Asian Carp can be used as "Judas fish" to find greater concentrations of untagged fish for either removal or acoustic tagging.

Lock and Dam Passage
Receivers within the lock chambers and approaches of Markland, Meldahl, Greenup, R. C. Byrd, Racine, Belleville, and Willow Island locks and dams will continue to be maintained through 2018. These receivers help determine the mode (lock chamber vs. spillway) and frequency of dam passage within the Ohio River system. These receivers will also remain in the lock chambers and approaches year-round as they are well protected and are useful in determining last known pool occupancy when mainstem receivers are removed.

Probability of Survival

Probability of survival is important for informing aspects of the Asian Carp spatial explicit population model. This information can help determine the level of harvest required to reduce or maintain the current Asian Carp population levels. This survival probability will be calculated using a multistate model analysis of encounter histories for all tagged fish collected from all available receivers.

Estimated Timetable

Project Activity	**Pool**	**Dates**	**Year**
Mainstem receiver deployment	Cannelton – Willow Island	April	2018
Asian carp tagging	Markland and Meldahl	September - November	2018
Lock and dam receiver download	Markland – Willow Island	June - December	2018
Data analysis	N/A	December/as needed	2018
Mainstem receiver retrieval	Cannelton – Willow Island	November/December	2018

Agency: West Virginia Division of Natural Resources

Project: Quantifying lock and dam passage, habitat use, and survival rates of Asian carp in the Ohio River

Fiscal Year: 2018

Objectives:

1) Understand use of tributaries as potential sources for recruitment and routes of invasion into adjacent basins.
2) Delineate the upstream population distribution and potential for further upstream dispersal.
3) Help inform contract fishing and agency sampling efforts utilizing telemetry data.
4) Quantify passage of Asian carp at Ohio River locks and dams.
5) Estimate probability of survival.

Project Activities: Methods, and Timetable

Understand use of Tributaries
WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Delineate Upstream Movement
WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps. WVDNR will assume responsibility for maintaining, downloading and sharing data from receivers located in the R.C. Byrd Pool, including the portion within the Kanawha River. Upon completion of a contract agreement with VEMCO, WVDNR will purchase a VR100 and associated manual tracking equipment as well as additional receivers and tags (with funds from FY16) to assist with this project.

Inform Contract Fishing and Agency Sampling
WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Lock and Dam Passage
WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Probability of Survival

WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Estimated Timetable

Project Activity	**Pool**	**Dates**	**Year**
Asian carp removal	R.C. Byrd	June-September*	2018
Asian carp removal	Greenup	June-September*	2018
Response Protocol Research and Discussion	N/A	July-August	2018-2019

*Removal efforts can and likely will occur outside of the proposed time period when needed.

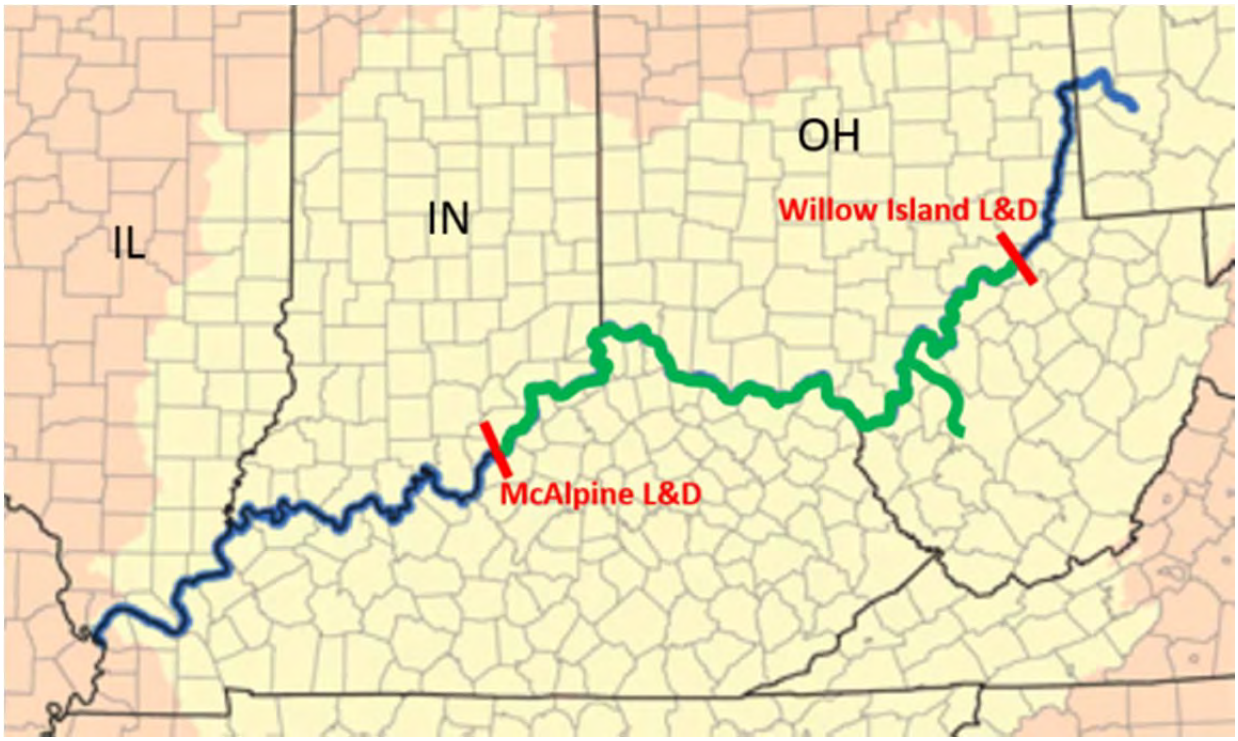

Figure 16. Map of Project Area.

Agency: Kentucky Department of Fish & Wildlife Resources (KDFWR)

Project Title: Quantifying lock and dam passage, habitat use, and survival rates of Asian carp in the Ohio River

Fiscal Year: 2018

Objectives:

1) Understand use of tributaries as potential sources for recruitment and routes of invasion into adjacent basins.
2) Delineate the upstream population distribution and potential for further upstream dispersal.
3) Help inform contract fishing and agency sampling efforts utilizing telemetry data.
4) Quantify passage of Asian carp at Ohio River locks and dams.
5) Estimate probability of survival.

Project Activities: Methods, and Timetable:

Understand use of Tributaries

The majority of KDFWR's receiver work in 2018 will focus on the stations located within the first 170 miles of the telemetry array, which encompasses both mainstem and tributary receivers in the Cannelton Pool, McAlpine Pool and the lower half of the Markland Pool. KDFWR will also help with the deployment and maintenance of temperature loggers, which, in 2017, started being attached to a receiver station in larger tributaries and on one mainstem receiver in each pool of the telemetry array. KDFWR will visit all tributary sites in their section of the array on a monthly basis in order to offload new telemetry data from VR2W's and the environmental data from any temperature loggers that are present. The preparation and analysis of the 2018 telemetry data will continue as it has in previous years and will include additional effort to integrate the water temperature data. These results should provide just enough information to allow the Asian Carp's tributary usage to be summarized for the mid-year Report to Congress, and then a more thorough explanation will be provided for the project's 2018 Technical Report.

Delineate Upstream Movement

Within the project's entire 500-mile telemetry array, receiver stations located above Markland Lock & Dam (L&D) are the only sites that are typically classified as being "upstream". Hence, according to this criterion, the lower half of the Markland Pool is the only upstream area within KDFWR's 170-mile section of the receiver array. In 2018, KDFWR's receiver work for this objective will primarily focus on maintaining tributary stations since this stretch of the Markland Pool contains only one of the navigation buoys that are required for the establishment of mainstem sites. However, KDFWR's project biologists will always be on the lookout for new deployment strategies that might allow additional mainstem receiver stations to be established within this section of the Markland Pool. Despite the low numbers of mainstem receivers, the KDFWR will continue making monthly efforts to offload new tagged carp detections and any associated temperature data. Additionally, every couple of months from May to October 2018, the KDFWR will join crews from the USFWS and/or West Virginia in order to sample the

Markland and Meldahl pools for adult Asian Carp that can be surgically implanted with ultrasonic transmitters. The KDFWR will once again prepare and error-check datasets the have been offloaded from each VR2W above the Markland Lock and Dam. Once all datasets have been combined into the 2018 telemetry database, the raw detection data will be reduced to the hourly/daily level before it's specifically analyzed to produce results that can help describe the upstream distribution of the Asian Carp population and the likelihood that they will continue to disperse even further upriver. The preliminary results for this objective will be used to produce a summary for the mid-year Report to Congress, while a more complete analysis conducted in late 2018 will provide results for the Annual Technical Report.

Inform Contract Fishing and Agency Sampling

KDFWR's annual field efforts will start during the early spring of 2018 with the redeployment of mainstem receivers that were pulled during mid-December 2017 and subsequently placed in overwinter storage. This was the primary objective behind KDFWR's past efforts to offload data from mainstem receiver stations located throughout the first two pools of the array. It has also been the reason for the regular establishment of new stations in areas where the existing receiver coverage may not be adequate. Hence, in 2018, project biologists will continue to conduct monthly efforts to offload telemetry data from the VR2W's at all mainstem sites within KDFWR's section on the receiver array, as well as any other stations that haven't been covered by previous objectives. Finally, during mid-December 2018, the KDFWR will once again retrieve VR2W's from mainstem stations and then securely store them off-river during the next few months to avoid heavy seasonal losses of receivers. The KDFWR will error-check, format and then combine the tagged carp detections from mainstem sites with those from the other habitat types (*i.e.*, tributary or lock and dam) located throughout the project's entire receiver array. The 2018 telemetry database will be reduced to hourly and/or daily tagged carp detections that will eventually produce results that the KDFWR can check against various environmental datasets, which will obtained from the project's own temperature loggers, as well as other agencies (*i.e.*, USGS) that collect the environmental data by default. These efforts will hopefully allow the KDFWR to determine if there are specific environmental variables, such as season, water temperature and river level, that strongly correlate with Asian Carp movements and habitat preferences. The identification of strongly correlated variables will eventually be tested even further to determine if any related river conditions can used to identify when Asian Carp are most likely to occupy areas where they are the most vulnerable to standard sampling gear. Regardless of how these efforts turn out, the KDFWR will provide the information needed to summarize this objective's results for the mid-year Report to Congress and the 2018 Technical Report.

Lock and Dam Passage Markland Lock & Dam (L&D) is the only such location within KDFWR's section of the array that's being regularly monitored for Asian Carp passage. The KDFWR will work with the USFWS and USACE to maintain the existing receiver stations around this location, and help establish any new ones that may be required to improve receiver coverage. The KDFWR will also help with other L&D projects located along the Kentucky border, which could include bolstering the telemetry project's coverage around McAlpine L&D and the Falls of Ohio. Regular efforts will be made to download detection data from VR2W's stationed around Markland L&D. Since there are six more L&D projects above the Markland

Pool that are being monitored, this objective is also tied into KDFWR's plans to participate in the multi-agency effort (USFWS, WVDNR) to sample adult carp from the Markland and Meldahl pools that can be implanted with ultrasonic transmitters. The KDFWR will once again error-check the telemetry data from receiver stations that are associated with the seven different L&D projects before adding these detections to the 2018 database. The KDFWR will eventually include the detections during their overall analysis for the project. Project biologists from the USFWS also plan to continue utilizing the 2018 L&D data to quantify the pool-to-pool movements that are required for a model that they're currently developing. Ultimately, all of these results will make it possible to address Asian Carp L&D passage in the mid-year Report to Congress and the 2018 Technical Report.

Probability of Survival

The KDFWR's monthly efforts to maintain and offload data from all receiver stations located in the Cannelton Pool, the McAlpine Pool and the lower half of the Markland Pool will be used to obtain the tagged carp detections that will populate the project's 2018 telemetry database, which is what USFWS biologists will utilize when calculating monthly survival estimates.

Estimated Timetable

Project Activity	**Pool(s)**	**Month**	**Year**
Redeployment of overwintering VR2W's & establish new stations (if needed)	McAlpine & Cannelton	March-April	2018
Start offloading data recorded by Tributary receivers during the winter months	Cannelton, McAlpine & 1st half of Markland	April	2018
Maintain receiver stations, Offload new telemetry data & Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	May	2018
Asian Carp Tagging Efforts	Markland & Meldahl	May-June	2018
Maintain receiver stations, Offload new telemetry data & Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	June	2018
Maintain receiver stations, Offload new telemetry data & Replace missing VR2W's (if needed)	Cannelton, McAlpine, 1st half of Markland	July	2018
Maintain receiver stations, Offload new telemetry data & Replace missing VR2W's (if needed)	Cannelton, McAlpine, 1st half of Markland	August	2018
Asian Carp Tagging Efforts	Markland, Meldahl	August - September	2018
Maintain receiver stations, Offload new telemetry data & Replace missing VR2W's (if needed)	Cannelton, McAlpine, 1st half of Markland	September	2018
Maintain receiver stations, Offload new telemetry data & Replace missing VR2W's (if needed)	Cannelton, McAlpine, 1st half of Markland	October	2018
Asian Carp Tagging Efforts	Markland, Meldahl	October	2018
Maintain receiver stations, Offload new telemetry data & Replace missing VR2W's (if needed)	Cannelton, McAlpine, 1st half of Markland	November	2018
Offload Data from Tributary Receivers & Pull mainstem VR2W's for overwinter storage.	Cannelton, McAlpine, 1st half of Markland	December	2018

Figure 17. The project's 500+ mile receiver array that stretches between Leavenworth, IN (RM 662) and Newport, OH (RM 159). In 2018, the KDFWR is responsible for maintaining all receiver stations located within the first 168-miles (green outline) of the array. After early spring redeployment efforts are completed, the 100+ receivers located throughout the remaining 333 miles of the array will be split up among other project partners that included the ODNR's 153-mile area (red outline) and USFWS's 140 miles of the array (blue outline), which was divided into two separate sections by the 40 mi long RC Byrd Pool (yellow outline) that the WVDNR will once again be responsible for in 2018.

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Beamish, R. J. 1981. Use of Fin-Ray Sections to Age Walleye Pollock, Pacific Cod, and Albacore, and the Importance of this Method. Transactions of the American Fisheries Society 110(2):287–299.

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Seibert, J. R., and Q. E. Phelps. 2013. Evaluation of Aging Structures for Silver Carp from Midwestern U.S. Rivers. North American Journal of Fisheries Management 33(4):839–844.

Williamson, C. J., and J. E. Garvey. 2005. Growth, Fecundity, and Diets of Newly Established Silver Carp in the Middle Mississippi River. Transactions of the American Fisheries Society 134(6):1423–1430.

Project Title: Relative Population Densities of Asian Carp in the Tennessee River and Cumberland River Tributaries of the Ohio River

Geographic Location: Ohio River Basin; Tennessee and Cumberland rivers

Lead Agency: Tennessee Wildlife Resources Agency

Agency Collaboration: Kentucky Department of Fish and Wildlife Resources (KDFWR), Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), Alabama Department of Conservation and Natural Resources, Murray State University, Tennessee Technological University (TTU), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS).

Statement of Need:

Adult bighead and grass carp have been recognized in the Tennessee and Cumberland rivers (tributaries to the Ohio River) for the last ten to fifteen years, but Silver Carp have only been collected within the Tennessee portion of the reservoirs for the last few years. These waterways are multi-jurisdictional and include waters within Kentucky, Tennessee, Mississippi, and Alabama. Thus, Asian carp invasion is a threat to multiple agencies and the valuable sport fisheries and ecosystems in their respective states. Asian carp reports suggest increasing immigration upstream in both systems, however there are many uncertainties regarding their abundance. A Master's Thesis completed in 2016 was the first rigorous evaluation of age and growth of Silver Carp and Bighead Carp in Kentucky and Barkley reservoirs. Currently, sub-basin agencies and universities are collaborating to enhance that preliminary work by surveying relative densities to inform control needs. The proposed projects described below will fill knowledge gaps necessary for understanding the distributions and habitat use of Asian carp populations in the Ohio River sub-basin and will provide better life history and population dynamics data for informing Tennessee River specific-models that are being applied in the Ohio River and other basins for estimating control needs and invasion impacts.

Efforts to understand and control Asian Carp in the Tennessee River and Cumberland River have increased recently and federal funding has the ability to further enhance control and management capabilities. In 2016, a multi-agency Asian Carp sampling and removal event was conducted in Kentucky and Tennessee waters of Kentucky Reservoir. Murray State University has implanted Silver Carp with acoustic transmitters and engaged in active and stationary tracking of movements. MDWFP and TTU have also deployed stationary receivers for detecting Asian Carp and those efforts will be continued. TWRA, KDFWR, TTU, USFWS, USGS, and other sub-basin cooperators are evaluating innovative gears for sampling Asian Carp in large reservoirs.

In 2017, TTU commenced sampling on Kentucky, Barkley, Cheatham, and Pickwick reservoirs to evaluate relative densities of Asian carp using gill nets and electrofishing. TTU, USFWS, and KDFWR worked together to sample Asian carp in the lower end of Kentucky and Barkley reservoirs using the USFWS paupier boat. Weights and lengths were recorded for most fish and TTU collected aging structures from a subsample of the catch.

In 2016 and 2017, TWRA and TTU received USFWS funding to increase sampling and movement data collection. Age structure characterization of existing populations is ongoing

(Tennessee Technological University) and may determine the frequency of missing year classes. Age structure removal and estimation for Asian Carp is challenging, and thus, an informal group of experts is being organized to assist throughout the basin and other invaded areas. In 2016, systematic sampling of Asian Carp to evaluate relative densities within and across multiple lakes in the Tennessee River and Cumberland River began and was continued through 2017 and early 2018 by integrated funding from TWRA, USFWS and USGS. This work is ongoing and also aims to increase samples used to characterize populations (e.g., age and growth analysis). A Master's thesis describing observed distribution patterns will be developed in fall 2018 and systematic sampling will continue through 2018. TTU, KDWFR and TWRA conducts electrofishing surveys to determine the leading edge of Asian carps in the mainstream and tributaries of Kentucky and Barkley reservoirs (Tennessee Wildlife Resources Agency) and this ongoing sampling will help inform sampling areas for understanding relative densities.

Project Goals and Objectives:

National Plan Goals:

Goal 2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States;

Goal 3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carps in the United States;

Goal 6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States.

Goal 7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass, and silver carps in the United States.

Ohio River Basin Goals

Monitoring and Response

Ohio River Basin Strategies

2.2 Continue annual fisheries monitoring programs conducted by state agencies in the Ohio River, its tributaries, and other waters throughout the basin as a general means of surveillance.

2.7 Support research to improve capabilities to detect early stages of invasion and spawning populations of Asian carp.

Project Objectives:

1. Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Tennessee and Cumberland rivers.

Agency: Tennessee Wildlife Resources Agency

Project: Relative Population Densities, Movement and Spawning Success of Asian Carp

Project Objectives:

1. Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Tennessee and Cumberland rivers.

Project Activities: Methods, and Timetable

Objective 1: Multi-season sampling using gill nets and electrofishing to evaluate relative adult abundance and density in Kentucky, Barkley, Cheatham and Pickwick reservoirs. Late summer and fall sampling to determine 2017 and 2018 year class success and strength;
Objective 1 methods will use experimental gill nets with panels measuring 3 inches to 5 inches (bar measure) of 8-ply twisted mono to sample adult Asian Carp. These nets were chosen following discussion with commercial fishers that target Asian carp to maximize retention and minimize gear destruction. Gill net set soak times will be overnight based on higher catch rates versus short sets (e.g., two hours) and minimal bycatch in 2017 sampling. Active gears will also be utilized for Objective 1. All electrofishing will use pulsed-DC current (5-8 Amps, 535 Volts, 120 pulses per second) and include two netters. We are in the development stage of a dozer trawl following the model from USFWS that we plan to experiment with in 2018 that will combine active electrofishing with trawling. With anticipated success, the dozer trawl will replace our standard electrofishing apparatus.

Survey sites for Objective 1 will be stratified by lake area (e.g., downsteam versus upstream) with three strata in Kentucky and Barkley reservoirs where abundances are higher than in Cheatham and Pickwick reservoirs, which will have two spatial strata. Standardized electrofishing sites will have fixed time periods of 900 seconds; all collected fish will be identified, and length and weight taken; otoliths will be taken from a subsample of collected fish in each length bin to allow later extrapolation to an age-length key. Proposed sampling will provide the first estimate of total mortality and survival for these reservoirs, which is a needed input for population models. Sex-ratio and a gonadosomatic index (female gonad weight to body weight ratio) will be developed to help inform population models and potential spawning time. At non-standardized sampling sites, observed fish will be identified in the water, and otoliths will be obtained from collected invasive carps. Recent experience with USFWS on their paupier boat suggests a need for increased exploration of innovative active gears for improving capture efficiency and sampling younger fish that will recruit into the adult population. Thus, innovative electrofishing gears and hydroacoustic technology will be evaluated as tools for effectively detecting and monitoring Asian carp in collaboration with USFWS sampling.

Sampling gears, locations, and timing of deployments for all objectives will be adapted to seasonal water temperatures to ensure minimal mortality of bycatch, valuable sportfish, and no detrimental effects to endangered species or valuable landscape features.

Estimated Timetable

Project Activity	Reservoir	Month	Year
Gill Netting	Kentucky, Barkley, Cheatham, and Pickwick	May, June, October, and November	2018 and 2019
Adult Density Electrofishing	Kentucky, Barkley, Cheatham, and Pickwick	June July, August, and September	2018 and 2019
Juvenile Electrofishing	Kentucky and Barkley	August, September, and October	2018 and 2019

Figure 18. Proposed reservoirs for Objective 1, measuring relative density and population characteristics of Asian carp in the Tennessee River and Cumberland rivers.

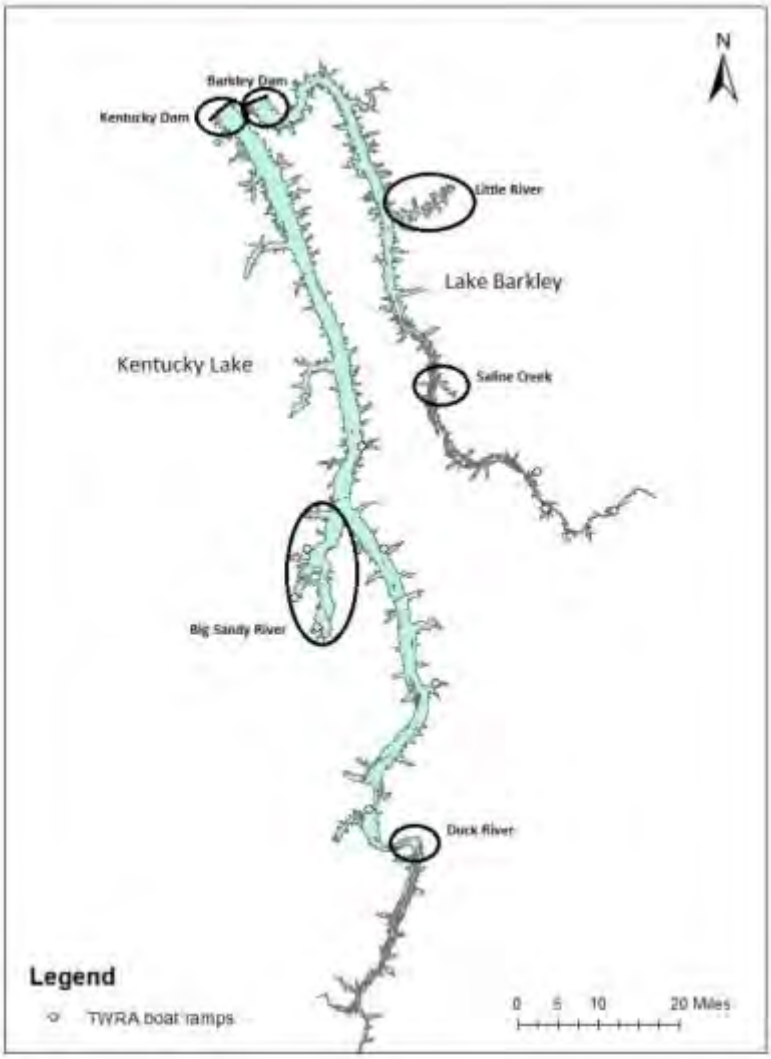

Figure 19. Sampling regions in Kentucky and Barkley reservoirs to evaluate relative population densities across the longitudinal gradient of the Tennessee and Cumberland rivers.

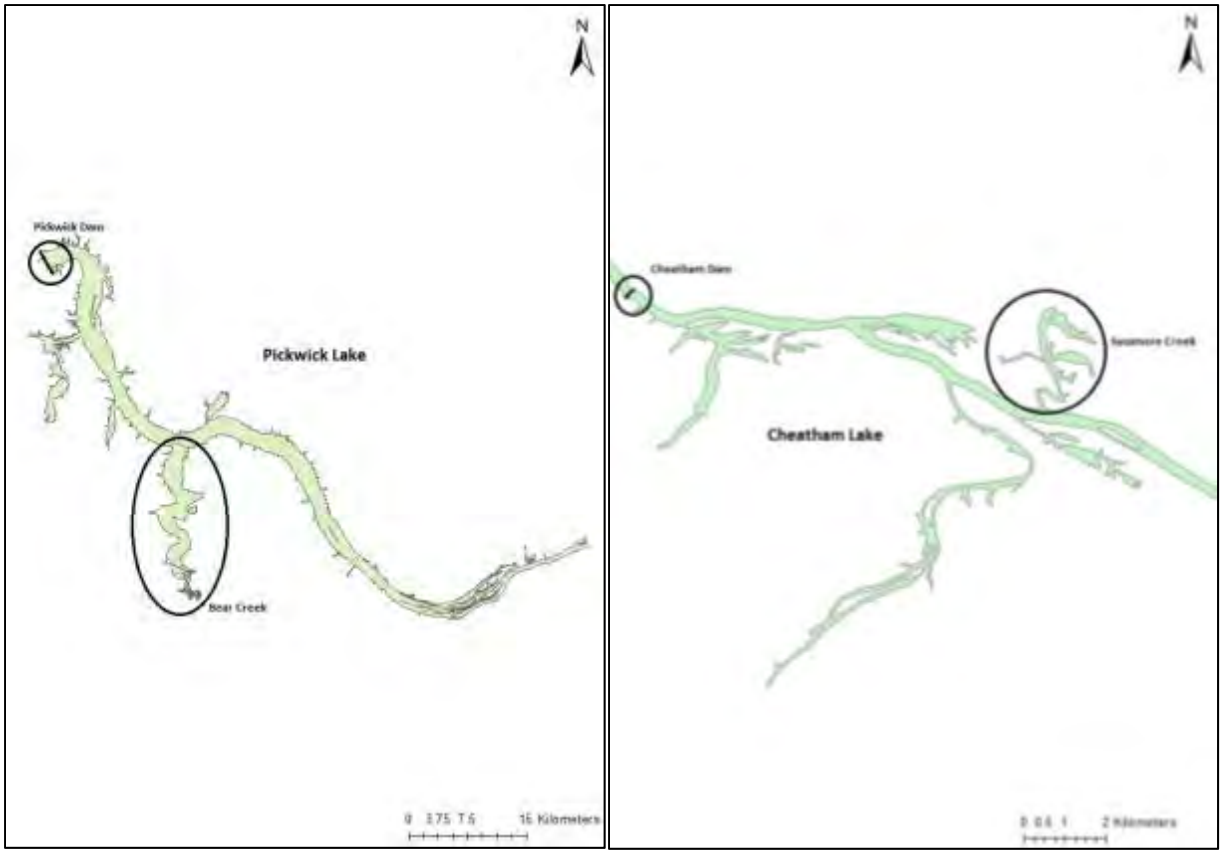

Figure 20. Sampling regions in Pickwick and Cheatham reservoirs to evaluate relative population densities across the longitudinal gradient of the Tennessee and Cumberland rivers.

Agency: Kentucky Department of Fish and Wildlife Resources

Project: Relative Population Densities, Movement and Spawning Success of Asian Carp in the Tennessee River and Cumberland Rivers, Tributaries of the Ohio River

Objectives:

1. Asian carp surveillance, early detection, distribution, and relative population characteristics in the Tennessee and Cumberland rivers.
2. Evaluate reproductive success, established leading edges, and age – 0 abundance of Asian carp in Kentucky and Barkley Reservoirs.

Project Activities: Methods, and Timetable

Asian Carp Surveillance
KDFWR has partnered with Murray State University (MSU) to conduct a telemetry study of Silver Carp on Kentucky Lake. Thirteen stationary receivers have been deployed throughout Kentucky Lake which KDFWR continues to download on a bimonthly schedule. Data is transferred to Dr. Spier at MSU for analysis. To date, 115 Silver Carp have been implanted with acoustic transmitters in Kentucky Lake by MSU and KDFWR staff. Tagged fish are monitored through stationary receivers as well as manual tracking trips made approximately once per week. In 2018, increased effort will be expended to 24-hour tracking of individual fish to determine diurnal movements, distances traveled, and habitat usage to inform removal efforts. Silver Carp are captured through electrofishing, gill nets, and Paupier nets, and then surgically implanted with acoustic transmitters. This project will be continued in 2018 and expanded to Lake Barkley to inform the Deterrent Strategy Planning for Asian Carp in the Ohio River Basin project. KDFWR communicates information gathered with other partners conducting telemetry efforts throughout the Tennessee and Ohio River basins.

The tailwaters of Kentucky Lake and Lake Barkley are home to the highest densities of Asian carp in Western Kentucky. Therefore, KDFWR conducts routine sampling efforts in the tailwaters to monitor impacts of the increasing densities of Asian carp on native sport fish. This sampling will be continued in 2018 and will be comprised of 15-minute DC electrofishing runs. Four runs will be conducted on the Barkley tailwaters and 6 runs on the Kentucky tailwaters. Effort will be made to capture every fish. All fish collected will be identified to the lowest taxonomic level and measured for length. Weights will be collected during sampling in fall months. Any Asian carp captured will be measured, a fin ray removed for aging, and euthanized. Information gathered will be compared to previous years to identify any trends that may be associated with increasing Asian carp populations.

In 2013 KDFWR initiated an Asian Carp Harvest Program (ACHP) which allows commercial fishers targeting Asian carp access to waters where commercial fishing was previously restricted. Commercial fishers utilizing this program are required to complete daily harvest logs where they report catch and bycatch information. By compiling this information KDFWR can determine the number of pounds of Asian carp harvested and any impacts increased commercial fishing may have on sport fish populations. In 2018 KDFWR will continue monitoring the ACHP through ride-alongs with commercial fishers, as well as review of daily harvest reports. KDFWR has also been exploring the applicability of a Public-Private-Partnership (P-3) to increase commercial

harvest of Asian carps. It is anticipated that this P-3 will become effective in 2018, potentially resulting in increased harvest of Asian Carp from Kentucky waters.
In 2018, KDFWR will aid in management of the first bowfishing tournament endorsed by the agency to incentivize removal of Asian carp and increase public awareness and education of Asian carp issues and research. This tournament will be Asian Carp only and all fish weighed in at the close of the tournament will be donated to proceeding facilities.

Asian Carp Early Detection and Distribution

KDFWR continues to engage in numerous public outreach opportunities to educate citizens about the potential impacts of Asian Carp on Kentucky's waterways. Members of the public are encouraged to report sightings of Asian Carp to KDFWR fisheries biologists. This information is used to inform sampling and removal efforts, and is submitted to the USGS Nuisance Aquatic Species database.

In 2016, KDFWR partnered with the USFWS to sample Kentucky Lake with Paupier nets designed by Innovative Net Systems and modified by the USFWS for capturing Asian Carp. The Paupier net is an electrified butterfly trawl that is effective for capturing Asian Carp in a variety if size classes. This effort was continued in 2017 during April, July, and October. In 2018 KDFWR plans to continue this partnership with the USFWS to broaden the scope of sampling locations on Kentucky Lake, Lake Barkley and their associated rivers. KDFWR is also working with Two Rivers Fisheries and the USGS to test experimental capture methods for Asian Carp in the Ohio, Tennessee and Cumberland River systems. KDFWR staff will be present during testing of any experimental gears to assess effectiveness for capturing Asian carp and determine any negative impacts posed to sport fish by the gear.

Asian Carp Relative Population Characteristics

Beginning in 2015, KDFWR partnered with a graduate student at Murray State University (MSU) to survey Silver Carp population demographics in Kentucky Lake. This effort was continued through 2016 on Kentucky Lake, and on Lake Barkley in 2017. KDFWR will continue assessing silver carp demographics of Silver Carp from Lake Barkley and Kentucky Lake throughout 2018. Measures including; length, weight, sex, gonad weight, and fin rays for aging will be taken from a subsample of Silver Carp harvested through the commercial fishery twice monthly. Asian carp age and growth, condition, mortality rates, and gonadosomatic index will be used to assess removal efforts as commercial fisheries continue to grow in Kentucky Lake and Lake Barkley. KDFWR realizes the need for determining relative abundance estimates for Asian Carp populations in Kentucky Lake and Lake Barkley. Therefore, in 2018 KDFWR will be conducting standardized sampling with gill nets to survey Asian Carp populations in the lakes. A mark-recapture study will also be conducted on Kentucky Lake and Lake Barkley to aid in population estimates. These two studies will be combined with information gathered through the commercial fishing industry to determine a relative abundance estimate of Asian carp in Kentucky and Barkley lakes.

Evaluate reproductive success, established leading edges, and age – 0 abundance of Asian carp in Kentucky and Barkley Reservoirs.

Young of year Asian carp have only been documented in Kentucky Lake and Lake Barkley in 2015. However, this occurrence was unexpected and appropriate sampling methods were not

utilized to effectively sample or conduct removal efforts of young of year Asian carp. Therefore, KDFWR has increased communication and coordination with partner agencies, Murray State University, and members of the public to report sightings of young of year Asian carp should they be present in the lakes in 2018. KDFWR is also collaborating with Murray State University to develop a contingency plan for if/when young of year Asian carp are again documented in the lakes. If an Asian carp spawning event is detected in Kentucky or Barkley lakes, movement data collected through the telemetry project will be utilized to determine when spawning runs occur and what environmental conditions encourage spawning activity. Continued monitoring of Asian carp GSI and observation of spawning patches will also provide information indicating spawning activity of Asian carps.

Estimated Timetable

Project Activity	**Location**	**Month**	**Year**
Electrofishing	Kentucky Lake Dam Tailwaters	April, May, June, September, October, November	2018
Electrofishing	Lake Barkley Dam Tailwaters	April, May, June, September, October, November	2018
Ride-alongs with Commercial Fishers Targeting Asian Carp	Mississippi, Ohio, Tennessee, and Cumberland River Systems	Twice Monthly	2018
Implementation of Public – Private – Partnership	Western Kentucky	To Be Determined	2018
Asian Carp Bowfishing Tournament	Tennessee and Cumberland River Systems	June	2018
Paupier Net Sampling	Tennessee and Cumberland River Systems	To Be Determined	2018
Experimental Gear Testing	Tennessee and Cumberland River Systems	To Be Determined	2018
Silver Carp Demographics Data Collection	Kentucky and Barkley Lakes	Twice Monthly	2018
Standardized Sampling	Kentucky and Barkley Lakes	April – November	2018
Mark – Recapture Study	Kentucky and Barkley Lakes	To Be Determined	2018
Development of Contingency Plan for YOY Asian Carp	N/A	N/A	2018

Project Title: Deterrent Strategy Planning for Asian Carp in the Ohio River Basin

Geographic Location: Ohio River Basin; Tennessee and Cumberland rivers

Lead Agency: Tennessee Wildlife Resources Agency

Agency Collaboration: Kentucky Department of Fish and Wildlife Resources (KDFWR), Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP), Alabama Department of Conservation and Natural Resources, U.S. Army Corps of Engineers (USACE), Tennessee Valley Authority (TVA), Murray State University, Tennessee Technological University (TTU), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS).

Statement of Need:

Adult bigheaded carp have invaded the Ohio River and its tributaries including the Tennessee and Cumberland rivers. Increased interest and efforts to install deterrents to minimize invasion are increasing, but rely on abundance and movement data to inform decisions on placement and baseline data to inform effectiveness.

Within the Ohio River, movement data have been collected to inform pool-to-pool movement and estimate trade-offs between deterrent location, deterrent effectiveness, and removal efforts for population control. Increased data within the Ohio River would further support these evaluations. In the Tennessee and Cumberland rivers, baseline movement and lock and dam passage data are at initial phases of collection and critical to understanding deterrent location and deterrent effectiveness.

Adult bigheaded have been recognized in the Tennessee and Cumberland rivers (tributaries to the Ohio River) for the last ten to fifteen years, but Silver Carp have only been collected within the Tennessee portion of the reservoirs for the last few years. These waterways are multi-jurisdictional and include waters within Kentucky, Tennessee, Mississippi, and Alabama. Thus, Asian carp invasion is a threat to multiple agencies and the valuable sport fisheries and ecosystems in their respective states. Asian carp reports suggest increasing immigration upstream in both systems, however there are many uncertainties regarding their abundance, their movement rates and timing, and if they are reproducing within the rivers. A Master's Thesis completed in 2016 was the first rigorous evaluation of age and growth of Silver Carp and Bighead Carp in Kentucky and Barkley reservoirs. Currently, sub-basin agencies and universities are collaborating to enhance that preliminary work by surveying relative densities to inform control needs, monitor movements through locks and dams to inform lock management and deterrent barriers, and determine if natural recruitment is occurring in the reservoirs. The proposed projects described below will fill knowledge gaps necessary for understanding movement within the Ohio River tributaries and lock and dam passage. Data will inform Tennessee River specific-models that include movement and control needs as are being applied in the Ohio River.

Efforts to understand and control Asian Carp in the Tennessee River and Cumberland River have increased recently and federal funding has the ability to further enhance control and management capabilities. Murray State University and KDFWR have implanted over 100 Silver Carp with

acoustic transmitters and engaged in active and stationary tracking of movements. MDWFP and TTU have also tagged over 50 Silver Carp in Kentucky and Pickwick reservoirs and deployed stationary receivers for detecting Asian Carp movements through lock and dams. Increasing the number of tagged fish in the systems will provide more precise information on invasion rates and timing to help inform barrier needs and efficacy.

Project Goals and Objectives:

National Plan Goals:

Goal 2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States;

Goal 6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States.

Goal 7. Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass, and silver carps in the United States.

National Plan Strategies:

Strategy 3.2.1 Develop a national strategy and guidelines for science-based decision making concerning the need for continued and additional containment measures;

Strategy 3.2.1 Develop a Decision Support System to assist natural resource managers in prioritizing specific locations for the construction, maintenance, monitoring, or removal of barriers to carp dispersal;

Strategy 3.2.4 Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions;

Strategy 3.6.2 Assemble information about the distribution, biology, life history, and population dynamics of bighead, black, grass, and silver carps;

Strategy 3.6.2 Describe movements and distribution of Asian carps in waters of the United States.

Ohio River Basin Goals:

Prevention
Monitoring and Response

Ohio River Basin Strategies:

1.4 Evaluate the use of deterrent barriers at strategic locations to limit further dispersal of Asian carp in the Ohio River basin.

Project Objectives:

1. Characterize the need for deterrents and priority locations for deterrent placement to control movement of Asian Carp in the Tennessee and Cumberland Rivers.
2. Characterize the need for deterrents and priority locations for deterrent placement to control movement of Asian Carp in the Ohio River Basin.
3. Enhance movement information among reservoirs and pools to help define deterrent placement and collect baseline movement data to help inform future deterrent efficacy.

Agency: Tennessee Wildlife Resources Agency

Project: Deterrent Strategy Planning for Asian Carp in the Ohio River Basin

Objectives:

1. Characterize the need for deterrents and priority locations for deterrent placement to control movement of Asian Carp in the Tennessee and Cumberland rivers
3. Enhance movement information among reservoirs and pools to help define deterrent placement and collect baseline movement data to help inform future deterrent efficacy.

Project Activities: Methods, and Timetable

Objective 1: TWRA will take a leading coordination role for basin partners to develop a deterrent plan for the Tennessee and Cumberland basins. Hundreds of river miles remain relatively untouched by Asian carp in the Tennessee and Cumberland rivers and our goal is to stop or reduce their use of locks. This project is an effort to streamline deterrent coordination so that when effective measures are identified partners can strategically and rapidly deploy them along the Tennessee and Cumberland rivers.

Coordinating agencies will meet once a year to discuss the status of carp populations, deterrent options, and prioritize deterrents along the Tennessee and Cumberland rivers. The Ohio River Management Team has been using a 2-d meeting format to prioritize activities and research needs for the containment of management of Asian Carp. These meetings, and quick follow up by meeting organizers, result in a timely allocation of limited carp base funds. We are proposing a similar model and pace to create an annual snapshot of where deterrents are needed in the basins. We would also describe the relative effectiveness needed at each location, as not all barriers will need to be 100% effective to have value.

The product of this work is a summary of the meeting, highlighting the perceived value of a deterrent at candidate location. A more robust publication is not warranted, as it will quickly be out-of-date. As needed, detailed publications could be funded as part of the permitting and planning process when deterrents are funded for deployment at a given site.

Objective 3: Required methods support monitoring, maintenance, and increasing capacity for acoustic telemetry movement data for Asian carp. Receivers will be monitored and maintained on a seasonal to 6-month frequency depending on battery lives and location. Vemco receivers have been placed at all locks and dams in the Tennessee River as well as in multiple reservoirs, in collaboration with ongoing Lake Sturgeon projects, to inform movement among locks and dams and across reservoirs. A focused effort to increase the number of tagged Asian carp in the upper end of Kentucky Lake to exceed a sample size of greater than 50 fish occurred in 2017 and 2018. TTU crews worked with TWRA and MDWFP to tag 43 fish in upper Kentucky Reservoir and 10 Silver Carp in Pickwick Reservoir, which was nearly all the transmitters they had. Tagging requires catching fish in good condition to have certainty of survival, and thus, very short set gill nets (e.g., 20 minutes) and electrofishing have been used to capture fish during cool water conditions. Fish are treated for minimal handling effects including electro-anesthesia and immediate release.

Data will be evaluated to determine when fish passage through locks was maximized (e.g., time of year) or how and when deterrents could best limit further upriver movements through locks and dams. Data from receivers at Pickwick Dam, Wilson Dam, and Wheeler Dam have not indicated passage of a transmitter tagged Silver Carp, however increasing the number of tagged fish in 2018 and 2019 will increase the probability of detecting movements through lock and dams. A Tennessee River acoustic telemetry network has been established to facilitate communication of receiver locations and positive tag detections and the network is in communication with Asian carp telemetry collaborations in the Mississippi River and other basins to develop data management plans.

Implementation of this project will not jeopardize the continued existence of any federally listed threatened or endangered species, or critically designated habitat. The purpose of this project is to conduct routine sampling and monitoring of Asian Carp and the fish communities they inhabit in the Ohio River watershed. No federally threatened/endangered fish, wildlife, or plant species will be impacted as a result of actions set forth in this project proposal. All sampling methodologies and techniques employed will be scientifically sound and the experimental designs shall be substantial in character and design.

Should any federally listed species be encountered or collected as a result of this project proposal, the Kentucky Department of Fish and Wildlife Resources or any of its agents shall immediately cease all sampling activities and notify the Kentucky Ecological Services (ES) Field Office. Any sampling activities shall not resume until notified to do so by the Kentucky ES Field Office. Please see the attached "Intra-Service Section 7 Biological Evaluation Form" for further information concerning this projects compliance with the Endangered Species Act.

This project complies with the United States Fish and Wildlife Service's (Department of the Interior) categorical exclusions under NEPA. Specifically, this project falls under categorical exclusion B(1) in 516 DM2, Appendix 1 "Research, inventory, and information collection activities directly related to the conservation of fish and wildlife resources which involve negligible animal mortality or habitat destruction, no introduction of contaminants, or no introduction of organisms not indigenous to the affected ecosystem ."

Estimated Timetable

Project Activity	**Reservoir**	**Month**	**Year**
Deterrents Meeting	All	June	2018
Acoustic Tag implantation	Kentucky	April and October	2018 and 2019 (until all tags are at-large)
Acoustic Receiver deployment and maintenance	Kentucky, Pickwick, Wilson, Wheeler	Seasonally or as needed for maintenance	2018 and 2019

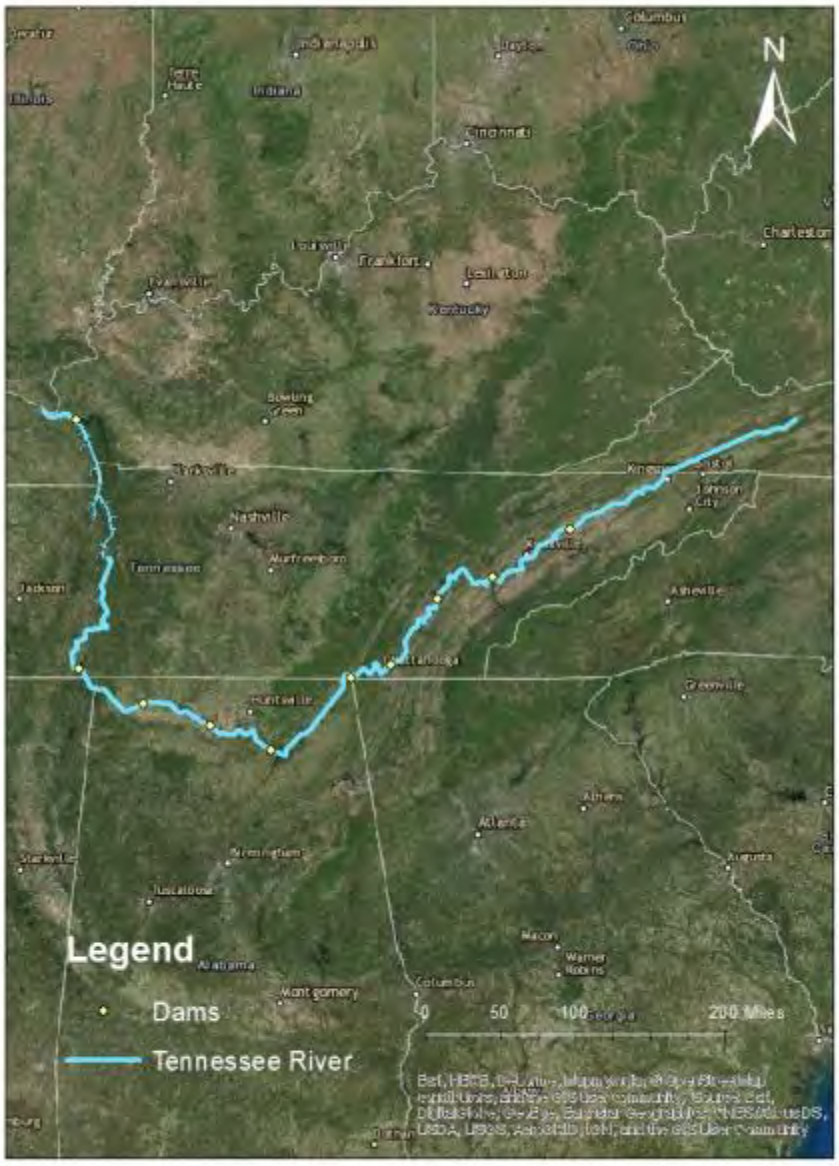

Figure 21. The Tennessee River and lock and dams (yellow diamonds) that are monitored using acoustic telemetry receivers to measure Asian carp upstream invasion.

Agency: Kentucky Department of Fish and Wildlife Resources

Project: Deterrent Strategy Planning for Asian Carp in the Ohio River Basin

Objectives:

1. Characterize the need for deterrents and priority locations for deterrent placement to control movement of Asian Carp in the Tennessee and Cumberland Rivers.
2. Characterize the need for deterrents and priority locations for deterrent placement to control movement of Asian Carp in the Ohio River Basin.
3. Enhance movement information among reservoirs and pools to help define deterrent placement and collect baseline movement data to help inform future deterrent efficacy.

Project Activities: Methods, and Timetable

Characterizing the Need for, and Placement of, Deterrents
KDFWR will participate in annual meetings with collaborating agencies to provide updates on the distribution of Asian Carp populations, identify available deterrent methods, and prioritize installation and maintenance of deterrents. The product of this meeting will be a prioritized list of where deterrents to Asian carp movement are needed to be deployed permanently to reduce the potential of Asian carp expansion upstream in the Ohio, Tennessee, and Cumberland rivers. Available deterrent strategies will also be identified and locations for field testing determined.

Asian Carp Movement Information: Ohio River
KDFWR continues to work with multiple agency partners to monitor the pool-to-pool movements of Asian carp in the middle Ohio River. This information will be used with historical movements among pools and comparisons of the possible open river conditions at various Locks & Dams to determine the best options for the placement of Asian carp deterrent technologies.

Asian Carp Movement Information: Tennessee and Cumberland Rivers
To date, Asian Carp telemetry efforts in Western Kentucky have focused on understanding the movement of Asian Carp within Kentucky Lake primarily to inform removal efforts. KDFWR plans to continue partnering with Murray State University to conduct manual tracking of tagged Asian Carp within the lake to determine diurnal movements, distances traveled, and habitat usage. These efforts have laid the ground work for this proposed project. Despite recent achievements, there are additional needs to effectively assess the passage of Asian carp through lock chambers on the Tennessee and Cumberland rivers. In order to assess fish passage and ultimately assess deterrent strategies in these river systems, tagging of additional Asian Carp and placement of supplementary receivers is essential.

Collection of Baseline Data to Inform Deterrent Efficacy
KDFWR is engaged in assisting the USFWS with testing of a Bio-Acoustic Fish Fence (BAFF) technology on the downstream approach to Lake Barkley Lock chamber (Map 1). KDFWR is assisting with collection of baseline movement information of Asian carp through the lock structure prior to installation of the deterrent via acoustic telemetry. These efforts will be continued in 2018 through deployment of an additional 5 telemetry receivers in the lower Cumberland River and Lake Barkley to assess passage of tagged fish. KDFWR will also tag an additional 100 bigheaded carp below and above the lock structure. A total of 50 individuals

representing some native fish species will also be implanted with acoustic transmitters to assess movement of those species around and through the lock structure prior to and following installation of the deterrent. Fish will be captured through electrofishing and gill netting efforts and surgically implanted with transmitters. Tagging efforts will continue throughout 2018 or until all tags are utilized. In 2018 two telemetry receivers will be re-deployed in the Kentucky Dam tailwaters to aid in detection of any tagged fish moving between the Tennessee and Cumberland river systems. All telemetry receivers will be maintained and data collected on a routine bimonthly schedule. Analysis of data collected in the Kentucky portions of the Tennessee and Cumberland rivers will continue to be a joint effort with Murray State University. Receiver locations, acoustic tag numbers, and data collected will be promptly communicated to project partners. Data collected by all partner agencies will be analyzed to determine when fish passage through lock chambers is greatest and how deterrents could best be utilized on the Tennessee and Cumberland rivers.

KDFWR will assist partner agencies with any additional baseline data collection needed prior to the installation of the BAFF deterrent system at Barkley Lock & Dam. In addition, KDFWR will provide assistance for monitoring the efficiency of the BAFF at deterring Asian carp movement through the lock structure and its effect on native fish species after installation.

Estimated Timetable

Project Activity	**Location**	**Month**	**Year**
24hr manual tracking	KY Lake	Seasonally	2018
Receiver Deployment	KY Dam Tailwaters	July	2018
Receiver Deployment	Lake Barkley	September	2018
Receiver Deployment	Lower Cumberland River	August	2018
Implantation of Transmitters	Barkley Dam Tailwaters	January, April, May, October, November	2018
Implantation of Transmitters	Lake Barkley	May and October	2018
Downloading of Receivers	Kentucky Lake & Lake Barkley	Bi-Monthly	2018
Downloading of Receivers	Kentucky Lock & Dam, Barkley Lock & Dam, Tailwaters	Monthly	2018
Project Technical Report	N/A	February	2019

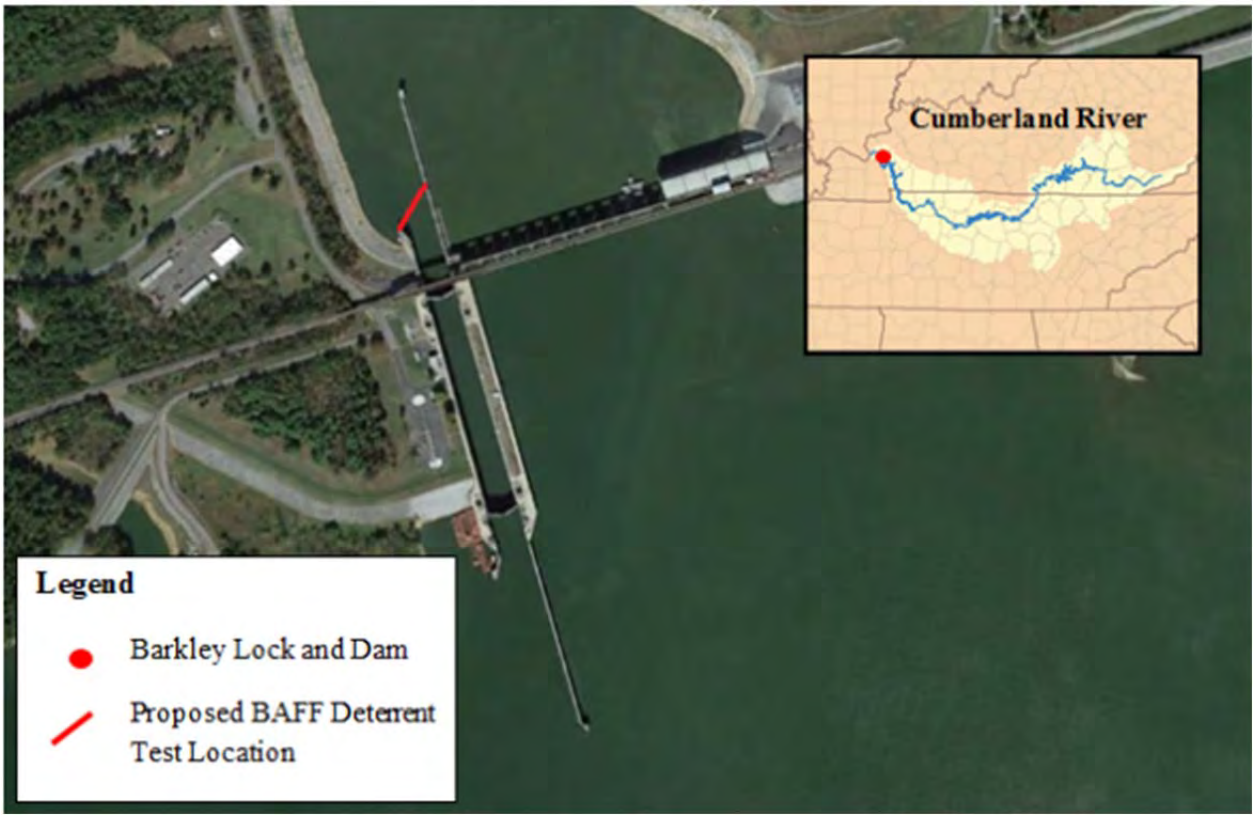

Figure 22. Proposed location for installation of Bio-Acoustic Fish Fence (BAFF) deterrent system for testing at Lake Barkley Lock and Dam on the Cumberland River. Kentucky Department of Fish and Wildlife Resources will assist with gathering baseline data and monitoring of system effectiveness.

Upper Mississippi River Basin

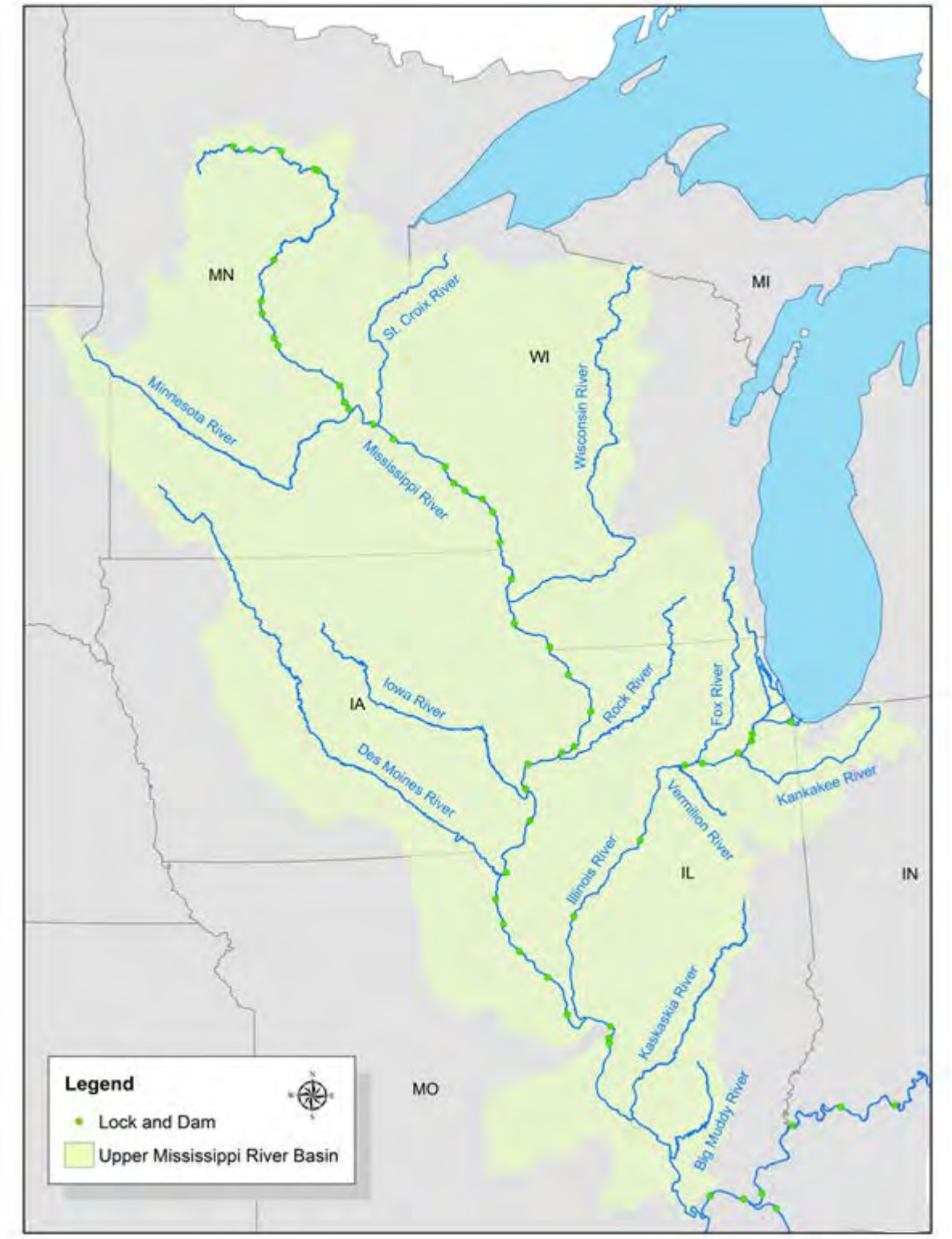

Figure 23. Map of the Upper Mississippi River Basin.

Project Title: Early Early Detection of Invasive carp on the invasion front in the Upper Mississippi River

Geographic Location: Mississippi River Pools 1-15 and associated tributaries

Lead Agency: Minnesota Department of Natural Resources

Agency Collaboration: USFWS, WI DNR, IA DNR (Iowa State University), MDC, IL DNR (Western Illinois University), NPS

Statement of Need:

Bighead carp *Hypophthalmichthys nobilis*, Black carp *Mylopharyngodon piceus*, Grass carp *Ctenopharyngodon idella*, and Silver carp *H. molitrix* (Invasive carp) are non-indigenous fishes that were introduced to the USA in the 1960s and 1970s from Asia for human consumption and biological control. Since that time, Invasive carp have expanded their range (e.g., escaping secure facilities) and are now occurring more frequently throughout the Upper Mississippi River Basin. Current scientific evidence supports a strong likelihood of negative impacts to native species (e.g., freshwater mussels and fishes). Preventing population expansion is the most cost effective way to limit negative impacts. Understanding current population dynamics and employing response actions are a key component in a deterrent and control strategy.

Partners will continue development and implementation of a comprehensive and complementary early detection and rapid assessment surveillance program for Bighead, Silver, Grass, and Black carps in the Upper Mississippi River Basin. The early detection program helps define the current presence, invasion, and established fronts and evaluate how these fronts change through time, important knowledge for management decisions. Additionally, this effort helps evaluate the effects of management actions: a commercial harvest program and the Upper Mississippi River Deterrent Strategy. Sampling uses a diverse array of traditional and novel gears to sample all potential life stages in targeted areas.

Prior to 2018, the monitoring project included the entire Upper Mississippi River. Using data collected from the monitoring project in 2015-2017, there is a better understanding of invasive carp populations throughout the river and the UMR Asian carp partnership (partnership) has identified zones of river where population differences exist for each species. There is an established zone, a management zone, a presence but unestablished zone, and the section where carp have not been found. Given the different objectives and sampling strategies in each zone, the UMR partnership decided to split the monitoring project into two projects. Though split, the monitoring participants will still be coordinating and communicating efforts throughout the basin. Additionally, some overlap will occur between the sections of river.

Understanding the population status in the presence zone is important for a variety of reasons. At this time, there are no deterrents in place on the Mississippi River. While lock and dams likely slow the upstream movement, invasive carp are still able to make it upstream as evidenced by captures in Minnesota. It is important to know where carp are established and are attempting to when deciding when and where to implement management strategies such as deterrents or

removal efforts. Also, response removal efforts may help delay populations from reaching numbers that result in successful spawning events. Lastly, having a strong data set helps managers measure the success of management efforts.

Project Goals and Objectives:

National Plan Goals:

Goal 2: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver carps in the United States.

National Plan Strategies:

Strategy 3.2.4. Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions.

Upper Mississippi River Basin Goals:

Monitor: Conduct distribution, status, and early detection monitoring in key locations.

Upper Mississippi River Strategies:

Strategy 4.2: Monitor for adult Asian carp in target areas of the UMR and/or tributaries
Strategy 4.3: Conduct ichthyoplankton sampling in target areas.
Strategy 4.4: Conduct YOY sampling with sites determined by successful egg/larval collection or observed spawning behavior.

Project Objectives:

1. Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.
2. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.
3. Use tracking data to review and revise sampling methodology to increase detection probability in low abundance areas.
4. Collaboratively work with UMR partners to develop appropriate actions to respond to capture of individuals in the rare to low density area.

Agency: Minnesota Department of Natural Resources

Project: Detection of Invasive carp on the invasion front in the Upper Mississippi River

Objectives:

1. Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.
2. Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.
3. Use tracking data to review and revise sampling methodology to increase detection probability in low abundance areas.
4. Collaboratively work with UMR partners to develop appropriate actions to respond to capture of individuals in the rare to low density area.

Project Activities: Methods, and Timetable

Invasive Carp Tracking

Objective 3: Use tracking data to review and revise sampling methodology to increase detection probability in low abundance areas.

The Minnesota Legislature granted the MN DNR the authority to use tagging as a research tool beginning July 1, 2017. Legislative approval was needed because the agency is putting an invasive species back into the water. The DNR tagged its first carp on July 28, 2017 in the St. Croix River. Fish biologists tracked its movement using active boat tracking and the passive receiver array present in the river system. Not only did the DNR learn about movements of the individual carp but also the amount of effort needed for tracking efforts on tagged fish. To adequately track invasive carp in the future, the MN DNR would like to add a dedicated, seasonal tracking crew.

The tracking crew would follow the standard operating procedures (SOP) developed by MN DNR Fisheries and which are included as part of the issued 2018 permit. A dedicated crew will allow the DNR to track tagged fish more frequently, track more individual fish, cover more Mississippi River length, and coordinate more removal events.

Based on the tagging results, MN DNR staff will gain a better understanding of movement patterns and habitat preferences, while posing a very low risk to native fish populations or risk of increasing Invasive Carp populations. Other states have already begun work of this nature in riverine environments and have shown significant results and ability to remove additional fish with this tagging method. This information will be used to inform sampling and removal efforts.

Contract Commercial Fishing

Objective 2: Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

Objective 4: Collaboratively work with UMR partners on the appropriate response actions to capture of individuals in the rare to low density area.

Commercial fishermen are contracted to target invasive carp with both gill nets and seines on all monitored systems. MN DNR personnel accompany contracted commercial fisherman to direct sampling locations and monitor efforts. Netting will occur at the discretion of MN DNR personnel in likely invasive carp habitats. Fish collected that are also needed for age and growth analysis or tagging may be utilized. Number of fish caught by species will be recorded during gill netting operations and total weight harvested will be requested from the commercial fisherman for both gill netting and seining operations.

Commercial fishing has proven to be the best invasive carp capture tool. The MN DNR utilize their contract fisher for routine sampling, response efforts, and recapturing tagged invasive carp. The MN DNR is seeking to increase contract fishing capability for expanded routine sampling, extended response efforts, and increased capacity for recapture efforts.

Targeted Sampling and Response

Objective 1: Use relative population characteristics and distribution to devise management strategies that minimize propagule pressure and population expansion of Asian carp.

Objective 2: Evaluate Asian carp presence in upstream areas where carp are rarely detected to inform future response and containment efforts.

With the continuing progression of Invasive carps up the Mississippi River, many waters are threatened by a potential invasion. A better understanding of the current status of Invasive Carp individuals or populations in the non-established zones will allow for more efficient efforts of preventing their spread and/or eradicating them if populations do exist. Standard fish sampling assessments have been ongoing for many years and these surveys have the potential to catch Invasive carps; however, the gears and methods used in these assessments are not the most efficient methods for capturing Invasive Carps. The purpose of this sampling effort is to use methodology and gears more specific to Invasive carps to monitor all life stages of Invasive Carps and associated native fishes in the non-established zone.

Larval Trawling

Larval trawling will be conducted once per month at standardized sampling sites from May through July on the St. Croix River and Pool 2 and 3 of the Mississippi River to target the early life stages of invasive carps. If time allows in 2017, larval sampling will also be opportunistically conducted in the Minnesota River. If a peak in the hydrograph is observed or once water temperatures reach 62-65º F (17 or 18º C), larval sampling will be conducted to sample during conditions believed to be required for invasive carps to spawn (N. Bloomfield, U.S. Fish and Wildlife Service, personal communication). A bow mounted icthyoplankton net (0.75 m x 3 m) consisting of 500 um mesh will be pushed near the surface into the current so that the velocity of the water entering the net is between 1.0 to 1.5 m/s. At sampling locations where no water current exists (e.g. backwaters), sampling will occur towards a random direction that will allow for a complete sample to be taken in a relatively linear path. A mechanical flow meter will be

placed in the mouth of the net to determine the volume of water sampled. Locations will be sampled in each standardized system with two, five-minute pushes being conducted at each location. Sampling locations are located in the following macro habitats: main channel, side channel, and backwater. Sample contents will be placed in containers labeled with sample location, name of water body, and date, and will be preserved in 10% buffered formalin for 24-48 hours, will be rinsed with water, and preserved in 90% ethanol. All fishes will be identified to lowest feasible taxonomic category and enumerated.

Mini-Fyke and Trap Netting

Mini-fyke and trap netting will be conducted from June through September in Pool 2 and the St. Croix River. Mini-fyke net sampling will be conducted at least once per field season for a week. If a peak in the hydrograph is observed or once water temperatures reach 62-65º F (17 or 18º C), larval sampling will be conducted immediately afterward. Mini-fyke netting will then commence approximately two weeks afterward to sample when young invasive carp would be most vulnerable to capture from mini-fyke sampling (N. Bloomfield, U.S. Fish Wildlife Service, personal communication). The mini-fyke nets consist of a double frame (27 in. x 39 in.), four hoops (2 ft.), a single throat, and a 25 ft. lead, with a square mesh size of 0.125 in. throughout. The standard trap nets consist of a double frame (36 in. x 72 in.), five hoops (30 in.), two throats, and a 40 ft. lead, with a square mesh size of 0.75 in. throughout. Up to six mini-fyke and four trap nets will be set during each sampling event. The number of net sets during each sampling event will depend on the stretch of river being sampled. Certain stretches of the river may not consist of many or any sampling locations suitable for sampling with fyke nets. In these stretches of river, not all nets will be set. If possible all fish will be identified and enumerated in the field. If positive identification is not possible, voucher specimens will be kept, labeled and preserved in 90% ethanol for later identification.

Electrofishing

Electrofishing will occur from May through September in a variety of habitats including backwaters, side channels, main channel borders, and over wing dikes. Sampling locations will consist of standardized sampling locations in Pool 2 of the Mississippi River, the St. Croix River, and the Minnesota River, and all other sampling events will occur at non-standardized locations in the aforementioned habitats at the discretion of the sampler. Standardized sampling locations were selected based on habitats invasive carps are likely to occupy and will be 500 m in length. The goal will be to sample with electrofishing for at least eight hours per month. Sampling at each of the standardized sampling locations will occur at a minimum of two times annually. At these set sampling locations, all observed fish will be collected, identified, measured, and weights and aging structures will be taken from fish included in age and growth analyses.

At non-standardized sampling sites, most observed fish will be identified in the water and only fish needed to for aging structures and invasive carps will be collected. This will reduce unnecessary processing time and will allow for greater sampling effort.

A smaller electrofishing boat with an outboard jet motor will be used to sample shallow backwaters, in conjunction with the larger electrofishing boat. It is believed that juvenile invasive carps are a limiting life stage to their populations' growth and that juvenile invasive carps likely overwinter in anoxic backwaters. Sites will be selected for non-standardized

electrofishing sampling based on accessibility for use with the smaller, jet-engine electrofishing vessel in Pool 2, the St. Croix River, and the Minnesota River.

Gill and Trammel Netting

Gill netting and trammel netting will occur from March through November as time allows. Stationary large mesh gill nets of depths from 8 to 24 ft. with square mesh sizes of 3.5 to 6 in. will be used to target adult invasive carps. Stationary trammel nets with outside wall square mesh sizes of 12 to 14 in. and inner square mesh sizes of 2 to 4 in. will also be used to target adult invasive carps. Stationary experimental gill nets 250 ft. in length and 6 ft. deep consisting of 50 ft. compliments of net with square mesh sizes 0.75, 1, 1.25, 1.5, 2 in. will be used to target juvenile invasive carps. Nets may be set either short term or overnight, with short-term sets favored when water temperatures are greater than 60º F.

Estimated Timetable

Activity	**Time Period**	**Sampling**		**Effort**
		Events	**Days**	
Gill/Trammel Netting	March - November	40	20	30,000 feet of net
Electrofishing	May - September	48	20	2,000 minutes
Mini-Fyke/Trap Netting	June - September	50	10	40 net nights
Larval Trawling	May - July	160	15	160 pushes
Commercial Seining	Year round	6	6	6 seine hauls
Commercial Gill Netting	Year round	16	16	100,000 feet
Carp Tracking	Year round	Varies	Varies	unknown

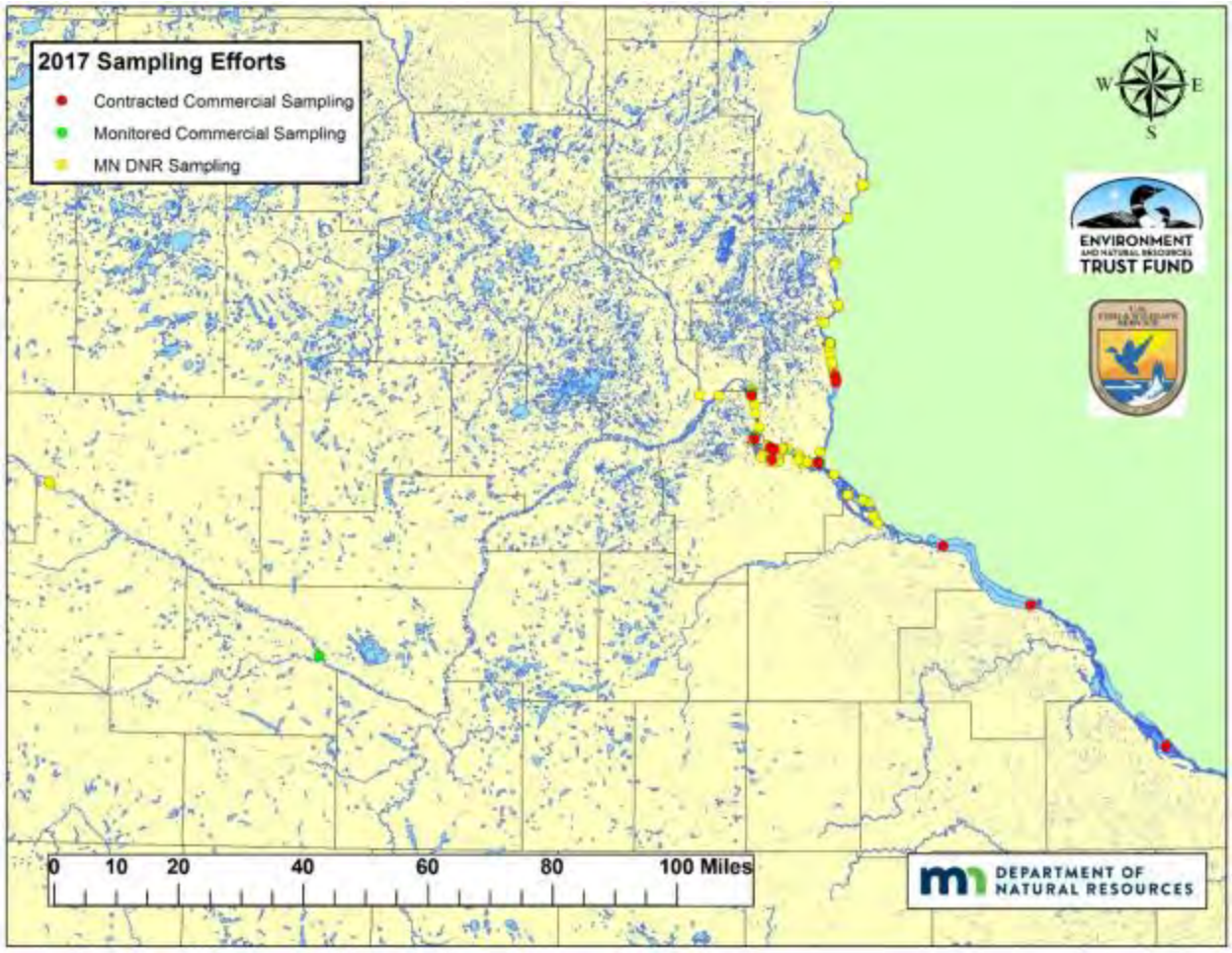

Figure 24. Minnesota DNR 2018 invasive carp sampling area. Map depicts 2017 sampling locations which will be similar in 2018.

Project Title: Evaluation of controls, impacts and behaviors of Asian carp in the lower UMR

Geographic Location: Mississippi River Pool 19 through Pool 13; Wisconsin River in Wisconsin; Des Moines, Skunk, Iowa, Wapsipinicon, Maquoketa, Turkey, and Upper Iowa rivers in Iowa; Rock and Illinois rivers in Illinois

Lead Agency: ILDNR (Western Illinois University)

Agency Collaboration: USFWS, IA DNR (Iowa State University), USGS, MDC

Statement of Need:
Evidence of Asian carp reproduction was detected as early as 2009 in pool 19 of the Upper Mississippi River, indicating that areas of the UMR above LD19 are capable of providing the hydrological requirements needed for successful Asian carp spawning, egg maturation, and development. This also indicates that adult Asian carp have reached densities high enough to allow for potential mates to find each other and spawn successfully. The highest abundance of adult Asian carp above LD19 occurs in pools 17, 18, and 19, and larvae and young-of-year Asian carp have been detected from pools 16, 18, and 19. Comprehensive monitoring of larval and juvenile Asian carp in pools 14 thru 19 is needed to detect and quantify Asian carp reproduction (eggs and larvae) and recruitment (juveniles) in the established front in response to commercial harvest of adults in pools 16-20 as well as their potential expansion into and above pool 15. A high magnitude spawning season occurred in 2016, which resulted in the detection of eggs, larva, and young of year recruits throughout the summer from several possible source locations. Ichthyoplankton tows identify potential source populations of egg production in the UMR above LD19. The spatial and resulting temporal separation between egg sampling events though can limit information on frequency and timing of production and does not typically inform on survival beyond the egg or free-floating yolk-sac larval stage. Conversely, larval light traps do inform on the magnitude and frequency of spawning and the survival to free-swimming larval stage, however the source population from where they were spawned is not able to be determined. Combining the complementary action of these gears provides frequency, magnitude and potential location information of free-swimming larval fishes. Following these cohorts throughout their first year can then contribute to growth and survival (sampling, otolith increment analysis) and adding further resolution to natal/nursery habitats (otolith microchemistry). The continued monitoring of this juvenile life stage is imperative to track production over time, especially to gauge the frequency and magnitude of spawning as a response to assess the effectiveness of contracted harvest and future deterrents. Additional evaluation of long-term metrics (body condition, growth, otolith microchemistry, relative abundance, exploitation rates, GSI, size structure, and fecundity) and deviation of those metrics from baseline values of adult fishes will serve as another tool to evaluate contracted harvest. Finally, age at maturity through gonad evaluation, dynamic rate functions (recruitment, mortality, and growth) obtained from these combined efforts plus transition probabilities obtained from telemetry will help populate spatially explicit models to increase the effectiveness of harvest. Monitoring Asian carp reproduction and the detection of larval Asian carp will be

imperative for understanding population responses to control measures (commercial harvest, fish barriers) and for informing the best management practices in the UMR above LD19.

Project Goals and Objectives:

National Plan Goals:

Goal 2: Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States.

National Plan Strategies:

Strategy 3.2.4. Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions.

Upper Mississippi River Goals:

Monitor: Conduct distribution, status, and early detection monitoring in key locations.

Upper Mississippi River Strategies:

Strategy 4.2: Monitor for adult Asian carp in target areas of the UMR and/or tributaries
Strategy 4.3: Conduct ichthyoplankton sampling in target areas.
Strategy 4.4: Conduct YOY sampling with sites determined by successful egg/larval collection or observed spawning behavior.

Project Objectives:

1. Delineate distribution and magnitude of Asian carp reproduction in the UMR.
2. Determine population abundances and associated demographics of Asian carp species in management zones.
3. Evaluate the need for and initiate population modeling of bigheaded carp in the intensive management zone (IMZ) to evaluate management actions.

Agency: Iowa State University

Project: Evaluation of controls, impacts and behaviors of Asian carp in the lower UMR

Objective:

1. Delineate distribution and magnitude of Asian carp reproduction in the UMR.

Project Activities: Methods, and Timetable

Ichthyoplankton tows (0.5 m diameter net) will be conducted at the surface at a constant boat speed relative to the shoreline up to four minutes depending on debris load every 14 days. A General Oceanics flowmeter will be mounted in the mouth of the net to estimate volume of water filtered during each tow. Three tows will be conducted at each site parallel to river flow. At tributary confluences, samples will be collected 1km upstream, 1 km downstream, and 1 km up tributary mouths to evaluate the contribution of tributaries to Asian carp reproduction. The first tow at each location will be in the main thalweg for drifting eggs and larvae (<24 hours post fertilization), the second in the middle of the river, and the third will be in an adjacent side channel for mobile larvae (>24 hours post fertilization). After each tow, ichthyoplankton net contents will be rinsed toward the cod end, placed in sample jars, and preserved in 95% ethanol.

Chlorophyll-*a* and zooplankton will be collected in conjunction with each icthyoplankton tow every 14 days. Samples will be collected from a stationary boat position in side channel and backwater habitats. Triplicate zooplankton samples will be collected at each site with an integrated tube sampler (5 cm diameter, 50 cm length), filtered through a 63-µm mesh sieve, combined into a composite sample, and preserved using Lugol's solution. Chlorophyll-*a* will be measured by filtering approximately 200 mL of water through a GF/F Whatman© glass fiber filter (47-µm porosity) then placed on ice. In the laboratory, zooplankton samples will be identified to suborder or family and enumerated for total density (number/L). Chlorophyll-*a* will be extracted with 90% acetone and quantified using a Fluorometer (Tuner Designs) to obtain chlorophyll concentrations (µm/L).

Estimated Timetable:

Larval sampling will take place once every two weeks May – August 2019. Data processing (e.g., egg and larval sorting and identification, and data analysis) will occur during the fall and winter months.

Project Activity	Pool	Month	Year
Egg and larval sampling	14-20	May-August	2019

Figure 25. Map depicting approximate eight locations where Asian carp will be sampled at the mouths of the Wapsipinicon, Rock (Illinois), Iowa, Skunk, and Des Moines rivers (red points), in pools 18 and 16, and a site in the Des Moines River. Possible Iowa DNR sampling site at the mouth of the Maquoketa River (blue square). Approximate locations of locks and dams depicted with black lines.

Agency: Western Illinois University (ILDNR)

Project: Evaluation of controls, impacts and behaviors of Asian carp in the lower UMR

Objective:

1. Delineate distribution and magnitude of Asian carp reproduction in the UMR.

Project Activities, Methods, and Timetable:

The sampling design includes deploying quadrafoil type larval light traps (Aquatic Research Instruments) in open and vegetated (if present), shallow backwater areas in pool 17, 18, and 19. Larval light trapping will be conducted every week from May 1 until conditions are no longer conducive to Asian carp spawning. A total of 36 traps will be deployed each week and placed at randomly generated sites within targeted backwater areas per pool. Traps will be deployed at a minimum of an hour after sunset (12 traps per night, per pool), allowed to fish for approximately 60-240 minutes. Water quality, site description, depth, coordinates and soak time will be recorded for all traps for each individual sampling event. Traps will be set far enough away from other traps to avoid the effects of light contamination from nearby traps. All contents will be preserved in formalin for 24 hours and stored in 95% ethanol (allowing for genetic confirmation) and all larva and fish will be enumerated and identified to the lowest possible taxonomic rank. If target species are identified, a subsample of 30 target species will be measured and staged.

Estimated Timetable:

May 1 until conditions are no longer conducive to Asian carp spawning. A total of 36 traps will be deployed each week and placed at randomly generated sites within targeted backwater areas per pool.. Data processing (e.g., egg and larval sorting and identification, and data analysis) will occur during the fall and winter months.

Project Activity	Pool	Month	Year
Larval sampling	17-19	May-September	2019

Objective:

2. Determine population abundances and associated demographics of Asian carp species in management zones.

Project Activities, Methods, and Timetable:

Up to 20 individual species will be collected from each 50 mm length group from each pool (Pool 16-Pool 19) to remove vertebrate (for back calculation), post cleithrum, pectoral spines, and otoliths (for age and microchemistry) for age and growth estimation. Comparative studies are being performed in the Illinois River to validate aging structures and once this has been accomplished, only the most appropriate aging structure will be used for age estimation of Mississippi River Asian carp. GSI is recorded for all stage IV and V female gonads with histological validation on a subset

of individuals and fecundity is estimated from each late reproductive stage female using gonad weight from fishes collected above Lock and Dam 19. Harvested fish will be the source of length, weight, age, GSI, fecundity, and natal origin/spatial life history for fish above Lock and Dam 19. In cooperation with USFWS, juvenile sampling will be conducted in Pools 19 and 20 and hatch date and natal environment will be assessed for 20 individuals from each 20 mm size class from each location sampled. Additionally, exploitation rates and population abundance will be inferred from jaw tag recaptures. These data will be used to populate necessary, and future models to help direct fishing efforts and determine a basin/pool strategy for effort allocation to minimize upstream movement. Such a draft model for the Illinois River exists and in partnership with USFWS we will seek to inform the models for insights into UMRS populations/strategies. Additionally, all population metrics and deviation of these metrics from an established baseline (surrogate for density) will help evaluate the effectiveness of harvest and detect changes in Asian carp populations..

Estimated Timetable:

July 1, 2018 until June 30, 2019 Asian carp will be harvested and demographic data collected from all fishes. Aging structures will be collected during a similar time frame in the fall, but body condition, size structure, and gonad assessment will continue year round. Jaw tag exploitation rates and population abundance will be evaluated throughout 2018 and new tags deployed in 2019 for year to year evaluations. Data processing and data analysis will occur during the fall and winter months.

Project Activity	**Pool**	**Month**	**Year**
Asian carp demographic info	14-19	July 2018-June 2019	2018

Map of Project Area:

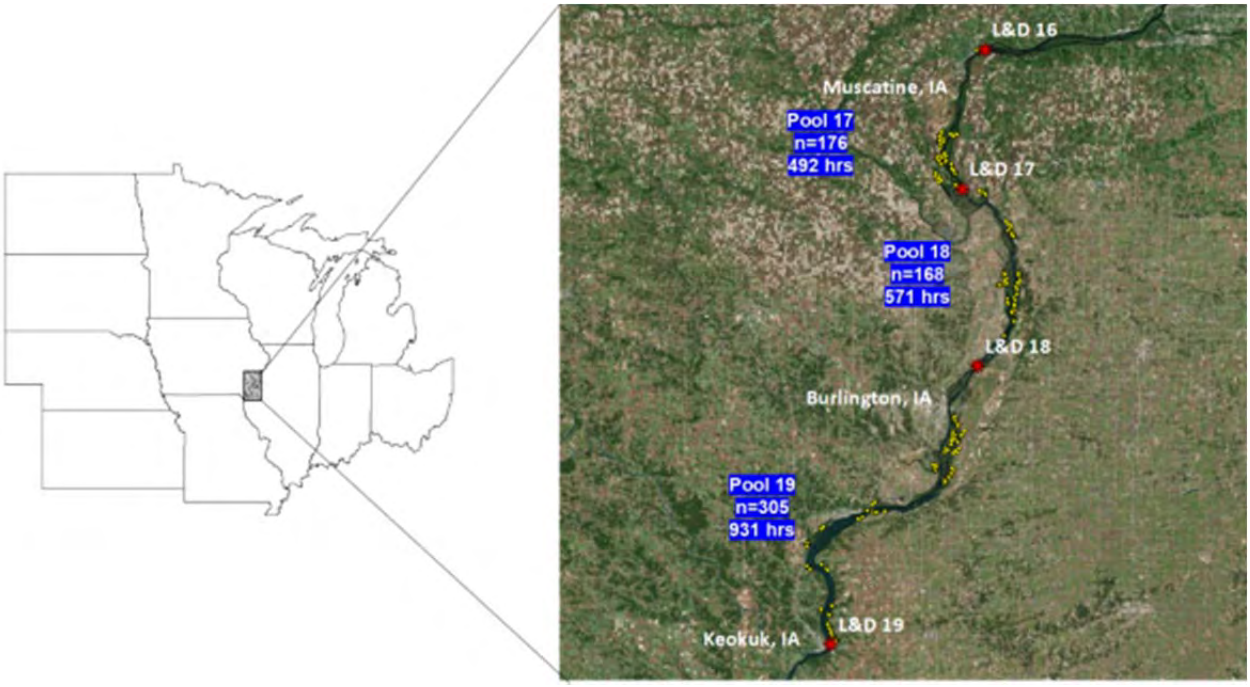

Figure 26. Light trapping locations for ILDNR.

Agency: USFWS

Collaborating Agencies: USGS, MDC, WIU

Project: Evaluation of controls, impacts and behaviors of Asian carp in the lower UMR

Objectives:

2. Determine population abundances and associated demographics of Asian carp species in management zones.
3. Evaluate the need for and initiate population modeling of bigheaded carp in the intensive management zone (IMZ) to evaluate management actions.

Project Activities: Methods, and Timetable

US Fish and Wildlife Service will use data compiled across all partners to parameterize a spatially explicit population model specifically for UMR Asian carp. The population model will help provide recommendations by identifying the most effective pool(s) for Asian carp removals (e.g., low-density leading edge vs high-density source populations), setting quotas for removals, identifying ideal location(s) for deterrent technology or barriers, and determining the required effectiveness for deterrent technology in terms of blocking passage, and prioritizing research that reduces uncertainty of risk.

- Aid in the compilation of length, weight, age, sex, and gonad mass data from all Asian carp captured during the 2018 field season.
- Use Bayesian hierarchical modeling approaches to estimate values, variability, and uncertainty for population model parameters including size structure and relative abundance, growth rates, size at maturity, and mortality; this technique allows us to leverage the large amount of data that has been collected on Asian carp throughout the entire Mississippi River Basin to increase precision.
- Integrate probabilities of pool-to-pool movement and pool-specific population demographics into Upper Mississippi River population model.
- Collaboratively determine with state partners the goal and timeline (e.g., minimize or eliminate abundance of Asian carp in Pool 14 within 5, 10, 25 years).
- Conduct population simulations under various management strategies involving combinations of harvest rates and deterrent technology efficacy (or degree of imperfection) at locations suggested by partners.
- Provide recommendations on which pool(s) maximize removal effectiveness.
- Provide recommendations on target harvest rates or quotas.
- Identify priority locations for potential deterrent technology
- Provide recommended effectiveness of deterrent technology at blocking Asian carp passage.

- Provide recommendations on data needs in priority of factors required to reduce uncertainty of risk.
- Maintain existing telemetry structure and target number of tagged Asian carp in the IMZ of the UMR.
- Collect demographic data by sampling for juvenile Asian carp in the IMZ .

Acoustic Telemetry

As fish emigrate or as transmitters die out; additional transmitters (up to 100) from USFWS and USGS will be used to tag fish in 2018 to meet current ongoing project targets (2 tagged fish per river mile). The V16-6H coded transmitters are programmed to transmit on a random delay from 30 to 90 seconds and have a battery life of 2,538 days. Fish will be measured for total length (mm), weighed (g), and sexed. Every acoustically tagged Asian carp will be fitted with an orange external jaw tag on the upper or lower jaw based on the two tag sizes in relation to the jaw (National Band and Tag Company #1242-28 or #1242-20). Short-term gill net sets will be used to capture Asian carp for implantation of acoustic transmitters. The number of Asian carp acoustically tagged per pool will vary depending on the number of transmitters currently present in each pool and the ability to capture fish.

Number of tags expiring within each year and total number of active tags for all pools.

	# Expiring within that year						
Species	2018	2019	2020	2021	2022	2023	Active for 2018
Bighead	-	35	-	-	-	70	105
Silver	36	26	-	-	4	88	154
Hybrid	-	6	-	-	1	9	16

Total number of active tags in 2018 by pool for bighead, silver and hybrid carp; (number proposed to be tagged by pool in 2018).

	Pools					
Species	16	17	18	19	20	Total
Bighead	34	18	33	38	5	128
Hybrid	2	6	6	7		21
Silver	23	93	11	49		176
Total	59 (20)	117 (30)	50 (30)	94 (20)	5	325

Acoustic Receiver Array

An array of receivers (Vemco Model VR2W) was first installed by USGS and USFWS in the fall of 2013. Most receivers are removed before ice-up and have been reinstalled each year since. Roughly 100+ receivers will be placed from Pool 5a down to Pool 26 again in 2018, but the majority will be placed from Pool 14 to Pool 19 to monitor movements within and among pools. Receivers that will be placed in Pools 20 to 26 are to complement 100+ Asian carp to be tagged by MDC. Real-time receivers will also be deployed in several backwaters to compliment commercial removal efforts.. This array bridges the gap between the Minnesota Department of Natural Resources array (Pool 1 to Pool 5) and the Missouri Department of Conservation array (Pool 19 to Caruthersville, MO) to create an array that spans almost 1,000 river miles. Data from stationary receivers will be downloaded quarterly and will provide information on gross movements, movement patterns, possible spawning events, and habitat use.

Mobile Tracking In pools where acoustically tagged numbers are low, active tracking will be used to increase the probability of capturing new fish to tag (i.e., Wisconsin River and Pools 14 and upstream). Two Asian carp were located on stationary receivers above Lock and Dam 15 during 2017.

Real time receivers

Realtime receivers will be deployed in Boston Bay (Pool 18) and Cleveland Slough (Pool 17) to provide realtime information to WIU and the contracted commercial fisherman. This will allow fishing efforts to be implemented exactly where and when Asian carp are known to present. A floating platform with U.S. Coast Guard approved lighting will be constructed to support the receiver and related antenna and power source. The receivers will be deployed and the structures and communication capabilities will be evaluated to determine whether additional receivers should be deployed in 2019.

Juvenile Monitoring

USFWS and WIU monitoring for recruitment evidence will continue in the management zone of pools 16-19, pools 14 and 15 above the management zone, and pool 20 below the management zone in 2018. Sampling will begin in mid-summer and continue through October. Dozer trawl and electrofishing will be the primary gears used to target YOY, although other gears may be deployed in special circumstances. A randomized electrofishing survey will occur once in spring and once in fall in pools 16-20 at a rate of one sample per 1.5 river miles. All habitats except main channel and isolated backwaters are included. Targeted sampling, including dozer trawling and electrofishing, will take place in summer and fall. Habitats that will be targeted include large flats on the channel border, tributary mouths, and backwaters. Attempts will be made to determine sex of all Asian carp captured. Sex determination on immature fish is challenging, but filling this data gap will add critical information for modelling population dynamics in the management zone and deciding on management actions.

All electrofishing will be standardized using pulsed-DC current corrected for temperature and specific conductivity to produce a potential transfer of 3000 W from water to fish at 60 pulses per second (Burkhardt and Gutreuter 1995). All electrofishing runs will be 15 minutes in length and proceed in a downstream direction where applicable. All electrofishing will include two netters. Power may be turned off/on to prevent driving fish. All fish will be netted.

The dozer trawl is a trawl that is pushed in front of the boat. It has a 2 m wide by 1 m tall rigid frame attached to a net with 35 mm mesh at the opening reducing to 4 mm at the cod end. The net extends under the boat and is 2.5 m long. Length and duration of trawl will be dependent on the site characteristics and available habitat.

All non-target fish collected will be identified and released. If positive identification is not possible, voucher specimens will be kept, labeled, and transferred to 10% buffered formalin or a formalin substitute for later identification. All Bighead Carp or Silver Carp will be weighed, measured, and transferred to ice for later positive identification, structure removal, and microchemistry analysis. A subsample may be transferred to 10% buffered formalin or a formalin substitute for preservation.

Project Activity	**Pool**	**Month**	**Year**
Asian carp demographic info	14-19	July 2018-June 2019	2018 and 2019
Deploy Acoustic Array	5A to 26	March and April	2018
Implant Acoustic Tags in Asian carp	17 and 18	April	2018
Implant Acoustic Tags in Asian carp	16 and 19	April and May	2018

Deploy Realtime Receivers	17 and 18	June	2018 and 2019
Download Receiver Data	10-19	Quarterly or more frequently if warranted	2018
Download Receiver Data	5a-9	Annually, or more frequently if warranted	2018
Juvenile monitoring	14-19	July – October	2018

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Project Title: Evaluation of fish passage for assessment of Asian Carp deterrents at multiple locks in the Upper Mississippi River

Lead Agency: U.S. Fish and Wildlife Service, La Crosse FWCO

Agency Collaboration: USACE, USGS, NPS, MN DNR, ILDNR, IADNR, WIDNR, MDC, Western Illinois University

Statement of Need:
Invasive carps are established in the upper, middle, and lower Mississippi River and their expansion upstream threatens a variety of aquatic ecosystem services including fishing and recreational boating. The upper Mississippi River contains a series of locks and dams that may already limit upstream movement of invasive carp, and thus their spread, by limiting population growth at the reproductive front and minimizing pioneer fish from moving upstream in the system. If severe enough, passage restrictions might hinder reproductive success of invasive carp at the reproductive front because of their requisite migratory and mass spawning behavior, and drifting egg and larval life stages. Population establishment has been slowed by restricted passage at Lock and Dam 19, where all upstream movement is confined to the lock chamber, and further upstream establishment above Pool 16 has been hindered by the infrequent open river conditions at Lock and Dams 15, and 14. The lack of or infrequent open river conditions at these pinch points make them candidates for Asian carp deterrents to further impede upstream establishment of Asian carp in the UMR.

A collaborative deterrent strategy for the UMR that was drafted with input from all five UMR states, defines an intensive management zone (IMZ) in the Upper Mississippi River (Figures 1 and 2). This zone includes the reach of river from lock and dam 19 to lock and dam 14, bracketing the invasion front of Asian carp in the UMR. Conceptually, near term efforts to control Asian carp in the IMZ would include reduction of immigration from a core population below lock and dam 19 into the IMZ through lock 19 and intensive efforts to reduce Asian carp abundance in the IMZ through removal and other control methods. Removal efforts have been underway since 2016 and will continue in 2018.

Prior to implementation of invasive species deterrent strategies, it is important to consider the longitudinal connectivity and passage of native fishes and the ability of Asian carp to pass through these locks and dams. Despite ongoing efforts to understand dam passage by both native fishes and introduced Asian carps in the UMR, much is still not understood and additional data and analyses are needed on existing passage abilities to determine the impact or effectiveness of any deterrent. Successful reduction in immigration and slowing the advance of Asian carp will require a thorough understanding of how, when, and why Asian carp move upstream through lock 19. An understanding of how native fish (including fish that are obligate mussel hosts) use the lock to migrate upstream is needed to avoid further impairing passage of these species.

Some native species have been tagged by MDC and WIU with previous years funding and some preliminary data on passage of those species has been obtained. In order to gain certainty and understanding in the observations and results of this effort, the number of tagged individuals needs to be increased. Additionally, previous year's efforts have contributed to our knowledge

of when Asian carp move through the lock, however data are still lacking on positioning of Asian carp in the water column when they approach and pass through the lock, and exactly where they move through the chamber. One method to determine this would utilize 3-dimensional positioning with depth sensitive acoustic tags and multiple receivers. There is some uncertainty on how well this technology will work in the lock chamber, therefore 2018 efforts will be to test this technology prior to implementing a complete study that depends upon its reliability.

The UMRCC Asian carp members working on deterrent evaluation and planning, identified the need to increase understanding of native fish passage through LD 19. The team identified three native species in addition to Paddlefish that were considered a priority in terms of understanding how a deterrent may impact native fishes. Bigmouth Buffalo were identified because their hearing capabilities are suspected to be similar to Asian carp and previous efforts show they currently pass through lock 19 rather frequently. Flathead Catfish were also selected because of their hearing capabilities although passage through the lock chamber has not yet been documented very well. Finally, the team identified the need to minimize any impact a deterrent may have on Lake Sturgeon, thus that species was also selected as a priority. The target number for tagging is 100 individuals of each species. In addition, depth sensitive transmitters will be implanted in 25 Asian carp. All tagging will be completed in Pool 20.

The evaluation of fish passage can be challenging, but is often assessed through the use of telemetry, hydroacoustics or intensive mark and recapture studies. An extensive network of acoustic receivers is in place in the lock approach at Lock and dam 19 and 15; above and below many dams on the Illinois, Mississippi, and Ohio rivers; and dispersed throughout several off channel areas that paddlefish are frequently found. Through close partnership with state and federal collaborators, the infrastructure is established and optimized to evaluate fish passage using acoustic telemetry in the UMR. Manual tracking will also contribute to knowledge of habitat use and movement.

Assessing paddlefish passage at Lock and Dams 14, 15 and 19 and Asian carp, Bigmouth Buffalo, Lake Sturgeon and Flathead Catfish at Lock and Dam 19 will serve a dual purpose. First, pre-deterrent data will inform the partnership to the frequency that native fish are able to make successful passage and identify the abiotic and biotic factors that contribute or hinder successful passage. Secondly, given the long battery life (5+ years) of these tags and the tagging of additional native fish in 2018, continued maintenance of the receiver network can potentially address the data gap on fish passage rates that his persisted since development of the navigation system.

Project Goals and Objectives:

National Plan Goals:
Goal 2: Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States

Goal 6: Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States.

National Plan Strategies:
Strategy 3.6.3. Develop effective methods to contain feral Asian carp populations and prevent their further spread.

Upper Mississippi River Basin Goals:
Goal 3.2 Containment
Goal 3.6 Research

Upper Mississippi River Basin Strategies
Strategy 3.2.2.1,
Strategy 6.1a
Strategy 6.1b
Strategy 6.5
Strategy 6.10

Project Objectives:

1. Assess fish behavior and passage at lock and dam structures on the Upper Mississippi River with emphasis at lock and dams 19, 15, and 14 as an assessment tool for the future testing of Asian carp deterrents.

Agency: IL DNR/ WIU

Project: Evaluation of fish passage for assessment of Asian Carp deterrents at multiple locks in the Upper Mississippi River

Objectives:

1. Assess fish behavior and passage at lock and dam structures on the Upper Mississippi River with emphasis at lock and dams 19, 15, and 14 as an assessment tool for the future testing of Asian carp deterrents.

Project Activities: Methods and Timetable

FY2018 funds will be used to tag up to 100 individuals in Pool 20 of each of the following species: Bigmouth Buffalo, Flathead Catfish, Lake Sturgeon, and Paddlefish. Depth sensitive transmitters will be purchased for implanting in 25 Asian carp. All tags purchased in FY18 will be implanted in fish from Pool 20. All acoustic transmitters will operate at the same frequency and ping duration as existing tags in this stretch of the river.

Adult paddlefish will be acoustically tracked to determine the frequency of dam passage and environmental conditions associated with passage at LD 14, 15 and 19. WIU will track fish every other week covering pools 14-19 and MDC will track fish in pool 20 on a monthly basis with assistance from WIU as needed. Adult Bighead Carp and Silver Carp (n=100) will be acoustically tagged to add to the existing Asian carp tagged in Pool 20 by MDC and evaluation will be consistent with current MDC efforts. Depth sensitive transmitters will be purchased in FY2018 to tag 25 Asian carp to determine if this technology will provide adequate resolution of 3D positioning in the lock approach and chamber. All fish will be predominantly tagged by MDC with effort by WIU, ISU, FWS, and USGS as needed.

If tags are acquired early enough in the year, tagging of fish from Pool 20 as identified above will be initiated in late 2018. Tagging will continue in 2019 until target numbers per species are reached. Individual fish will be weighed and measured for total length or fork length as appropriate.

Estimated Timetable

Project Activity	Pool	Month	Year
tagging	20	Sept., Oct., Nov.	2018
tagging	As needed	spring	2019
Manual tracking	Entire study reach	weekly	2018-2019
Receiver downloads	All locations	Varies by location: bi-monthly at minimum	2018-2019

Agency: FWS La Crosse FWCO and Midwest Fisheries Center/ USGS UMESC

Project: Evaluation of fish passage for assessment of Asian Carp deterrents at multiple locks in the Upper Mississippi River

Objectives:

1. Determine if existing infrastructure (limited by location and number of protected places to install receivers) and tag and receiver technology provide adequate resolution for 2D analysis in lock approach and chamber.
2. Quantify native and non-native fish passage at lock and dams 19, 15, and 14 as an assessment tool for the future testing of Asian carp deterrents (provide data to WIU and MDC).
3. Quantify native and non-native fish challenges in the approach and time spent in the approach resulting in successful and unsuccessful upstream passage.
4. Quantify upstream and downstream passages through lock and dams 15 and 14 in the absence of detections in the lock.
5. If data has adequate resolution, identify prominent areas of use in the approach and lock at 15 and 19 with 2D data and creation of a heat map (MFC – Jeena Credico). (Guide location of future deterrent)
6. Determine suitability of depth sensitive transmitters for determining vertical position in the water column.

Project Activities: Methods and Timetable

The remote receiver array will be redeployed in pools 6-19 in the spring of 2018. A 2D array has been in place a Lock 15 and 19 (Figure 3). Data recorded on remote receiver from acoustically tagged fish (already tagged or to be tagged by MDC and WIU) will be analyzed to determine pool to pool movement. Comparison of lock chamber receiver data to within pool receiver data will identify fish that have passed the dam without moving through the lock chamber. Even with poor resolution, 2D data should still allow computation of time spent in or near the lock approach and lock, and within pool receivers should confirm, or not, successful passage. With adequate 2D resolution, heat maps will be created to identify areas of frequent use in the approach and lock at 15 and 19.

Depth sensitive transmitters will be purchased in FY2018 to tag 25 Asian carp to determine if this technology will provide adequate resolution of 3D positioning in the lock approach and chamber at Lock 19. An attempt will be made to tag fish in fall of 2018, but given time and staff constraints, these tags will likely be implanted in spring of 2019.

FWS and USGS efforts will focus on maintenance and summary of remote receiver data collected on fish tagged in previous years by all agencies, and the fish that will be tagged by MDC and WIU in 2018. All detection data will be shared so that MDC and WIU can meet objective 2.

Estimated Timetable

Project Activity	Pool	Month	Year
Deploy Receiver Array	All locations	March-April	2018
Receiver downloads	All locations	June, September, November	2018-2019
Post processing by Vemco	Lock 15 and 19	November, December	2018
Summarize time in approach vs passage	Lock 15 and 19	January-February	2019
Deploy Receivers	All locations	March-April	2019

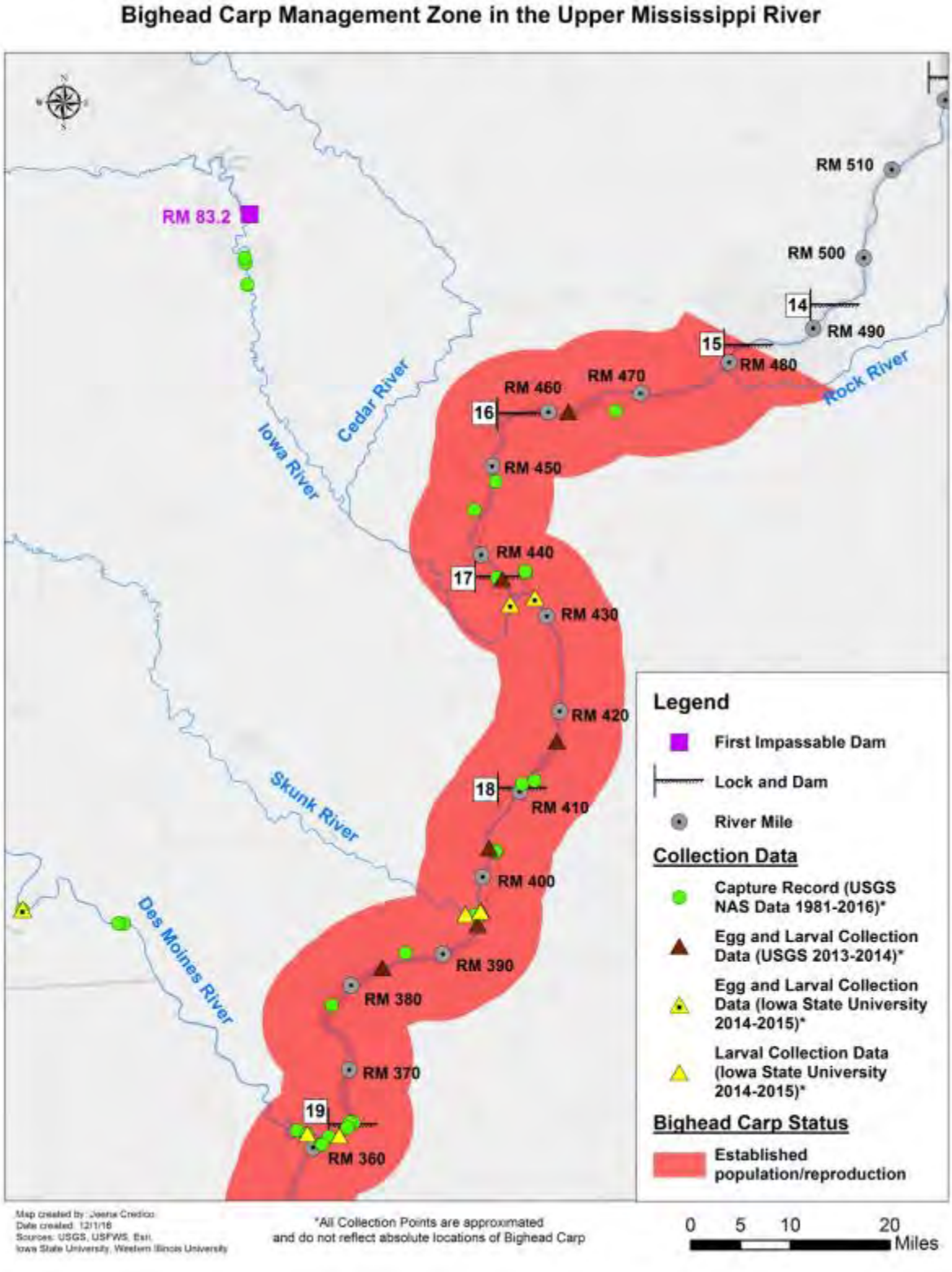

Figure 27. Management zone for Bighead Carp in the UMR as identified by the deterrent team.

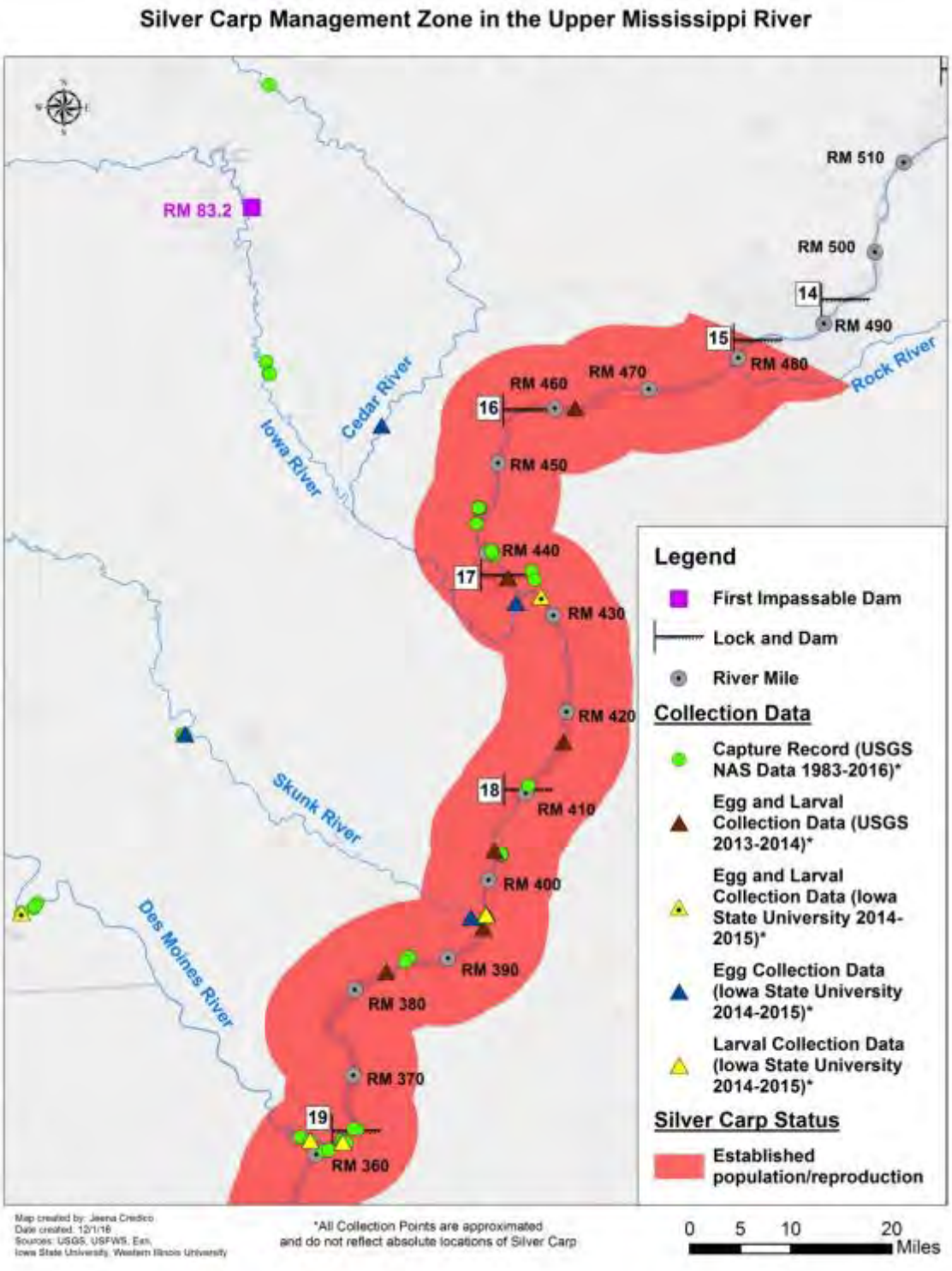

Figure 28. Management zone for Silver Carp in the UMR as identified by the deterrent team.

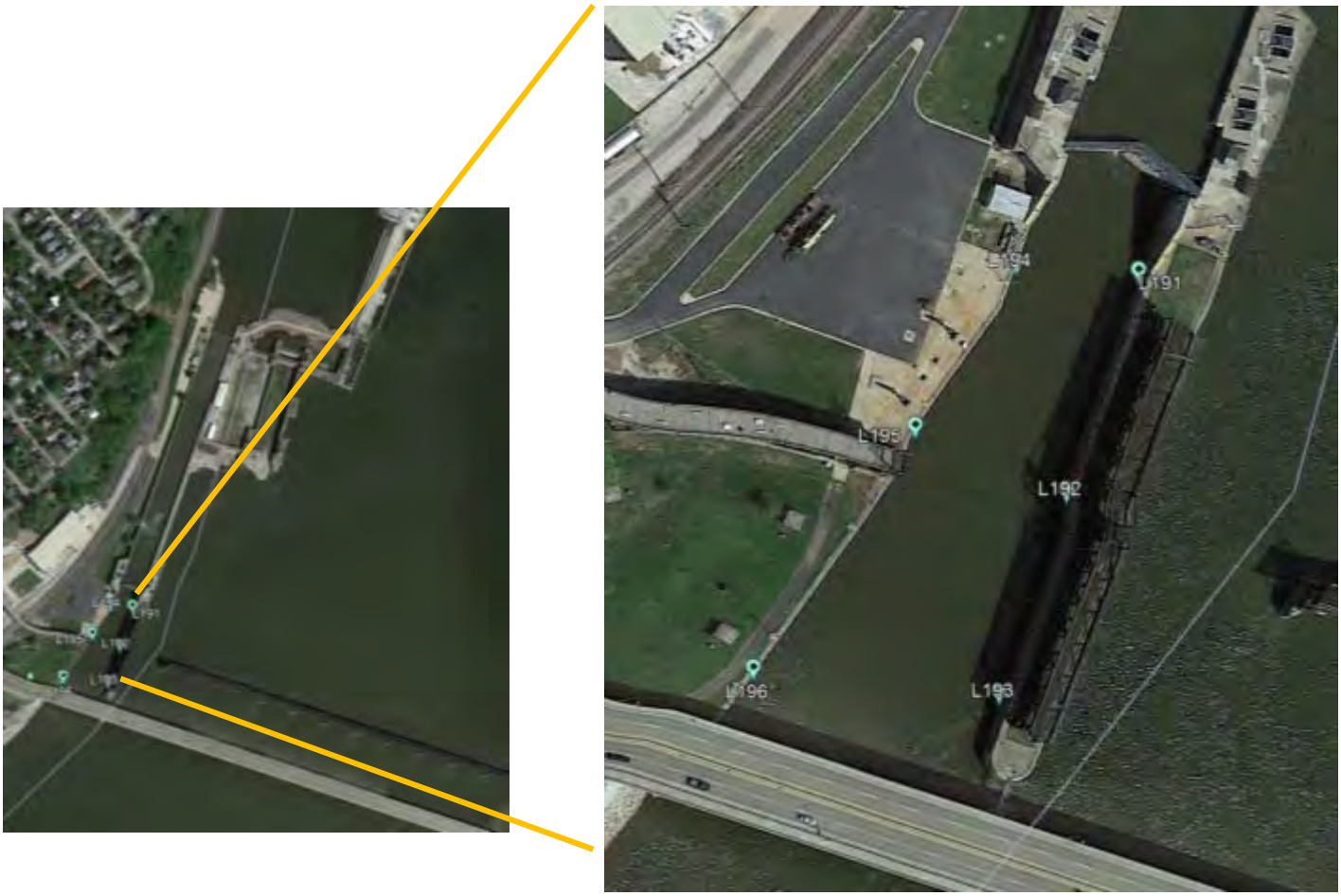

Figure 29. Location of receivers completing the 2D array in the lock approach at Lock 19.

Project Title: Contract Fishing for Asian Carp Detection and Removal in the Upper Mississippi River

Geographic Location: Upper Mississippi River Pools 14-19

Lead Agency: Illinois DNR/WIU

Agency Collaboration: Missouri Department of Conservation, Iowa DNR, USFWS

Statement of Need:
Adult bighead, grass, and silver carps are present in varying abundance in Upper Mississippi River (UMR) pools 19 through 14; however black carp have not been collected above Lock and Dam 19 (LD19). Bighead carp and silver carp (Asian carp) populations are increasing in abundance and expanding their upstream range within the Upper Mississippi River (UMR). Limited fish passage at Lock and dam 19 (LD19) has slowed their progression and establishment in UMR reaches above Keokuk, IA. However, the detection of young-of –year Asian carp above LD19, especially a large year class in 2016, indicates that Asian carp populations have reached densities capable of detectable reproduction. To combat this population expansion and decrease Asian carp densities at the established front (pools 16, 17, 18, and 19), additional measures are needed to monitor, control and manage Asian carp while densities are still low and manageable. We propose to use commercial fishers to intensively target Asian carp species for removal at the established front and invasion front (reaches above pool 17) and determine population abundance to determine the effects of harvest

Decreasing the abundance and removal of Asian carp by commercial fishers has been successfully executed in the upper IL River to decrease pressure on the electric dispersal barrier. This targeted system of removal is needed in the UMR above LD19 as populations have attained densities high enough to support reproduction and continue to be detected in far northern reaches of the UMR in Wisconsin and Minnesota. Lock and dam 19 is a high head dam with a maximum head difference of 38 ft, restricting all upstream fish passage to the 1200 foot lock chamber. Even though this limited passage has slowed the infiltration and establishment of Asian carp above LD19, they have now reached densities that are increasingly detectable (jumping silver carp), capable of finding mates to support reproduction, and can be sufficiently targeted in known areas of aggregation throughout their established front. The targeted removal of 100,000 – 200,000 lbs of Asian carp annually will help reduce their ecological impact, slow their spread and establishment in the UMR above LD19 and decrease their effective population size. Furthermore, by decreasing their population size we will reduce their opportunities to find mates (Allee effect) and reduce the probability of successful spawning interactions. Total counts and biomass will be recorded from all locations and fish will be available for further scientific inquiry (e.g., age and growth studies, genetic identity, morphometric identification, condition factor, etc.). Total counts and biomass will be directly correlated with recovered jaw tags and population estimates.

Asian carp will be individually jaw-tagged to estimate population estimates above LD19. Initial population estimates will be obtained by intensively sampling, marking with unique identifier jaw tags, and then releasing Asian carp back into the system during the initial 1-2 weeks of

commercial capture. Program MARK will be used to estimate population size as a function of recaptured (without replacement) versus initially marked and untagged individuals after weeks 1-2 above LD19. Population estimates and exploitation rates are needed to assess the efficiency and effectiveness of Asian carp sampling and removal efforts above LD19. Initial estimates will set future benchmarks for removal and determine the effectiveness of harvest on an annual basis as part of an adaptive strategy.

Evidence of Asian carp reproduction was detected as early as 2009 in pool 19, and indicates that areas of the UMR above LD19 are capable of providing the hydrological requirements needed for successful Asian carp spawning, egg maturation, and development. This is reinforced with FWS/USGS telemetry movement information. Furthermore, this indicates that Asian carp have reached densities high enough to allow for potential mates to find each other and spawn successfully. The highest abundance of adult Asian carp above LD19 occurs in pools 17, 18, and 19, and larvae and young-of-year Asian carp have been detected from pools 16, 18, and 19.

Project Goals and Objectives:

National Plan Goals:

Goal 3. Extirpate, or reduce to levels of insignificant effect, feral populations of Bighead, Black, Grass, and Silver Carps in the United States.

National Plan Strategy:

Strategy 3.3.2. Increase the commercial harvest of Asian carp.

Upper Mississippi River Goals:

Control Populations: Reduce the adverse effects of feral populations of Asian carps.

Upper Mississippi River Strategy:

Strategy 3.1. Physically remove Asian carps.

Project Objectives:

1) Determine population abundances of Asian carp species in UMR pools 17, 18, 19.
2) Targeted removal of Asian carp species in UMR pools 14-19 using contracted commercial fishers and intensive agency netting.
3) Assess the feasibility of commercial fishing to reduce Asian carp populations below LD19 in the UMR.

Agency: Illinois DNR (Western Illinois University)

Project: Contract Fishing for Asian Carp Detection and Removal

Project Activities, Methods, and Timetable:
The sampling design includes agency sampling and the use of contracted commercial fishers to intensively capture Asian carp species using a variety of trammel nets, gill nets, hoop nets, and a commercial seine. Nets used will be large mesh (3.0-5.0 inches (76.2-127 mm)) trammel or gill nets 8-10 feet (2.4-3 m) high and in lengths of 200 yards (182.9 m). Sets will be of short duration and include driving fish into the nets with noise (e.g., plungers on the water surface, pounding on boat hulls, or racing tipped up motors). In lower density areas, dead sets may be set over night (no more than 15 hours and only in water temperatures below 75 F) and emptied first thing each morning. Otherwise, nets will be attended at all times. Captured fish will be identified to species and enumerated. Species, numbers and condition (i.e., healthy, moribund, dead) of all non-target species captured in nets will be recorded and reported in interim reports. Locations of net sets will be recorded with GPS coordinates (decimal degrees preferred). A WIU or IL DNR biologist or technician will be assigned to each commercial net boat to monitor operations and record data. Netting efforts and locations of sets will be guided by the expertise of the commercial fishers and will also be informed by telemetry efforts by USGS and USFWS conducted as part of the intensive monitoring efforts within this reach.

WIU biologists will be assigned to each commercial net boat to monitor operations and record data. These duties will include recording species, length (mm), and weight (g), on up to 100 Asian carp species per boat, per day. Total length will be recorded for all or a subset of bycatch per boat, per day. Individual Asian carp species greater than 100 fish per boat, per day, will be counted and weighed in bulk to determine a total biomass removal for the day for each species. Duties also include monitoring the safe return of native bycatch, recording water quality data, tagged fish information and site information, monitoring for telemetered and tagged fish, and working with USFWS and USGS telemetry crews to help inform netting efforts. All telemetered fish captured will be returned to the water immediately. The tags will be decoded if possible before returning the fish to the water, and the information provided to the respective agency. All non-target bycatch will be identified to species, enumerated, and condition recorded (i.e. healthy, moribund, dead). All native bycatch will be returned to the water upon removal from the nets and all other non-native species will be removed, but total weights kept separate from Asian carp biomass.

All fish removed throughout the study will be transported daily to Darrick Garner (Palmyra, MO) or Shafer Fisheries (Fort Madison, IA) where all fish will be iced down in large totes and used as fertilizer or as cut bait. Fish cannot be marketed and sold by the contracted commercial fishers and the fish cannot be used for human consumption. All WIU biologists and technicians participating in the removal will be required to possess an Illinois sportfishing license.

Objective 1. Determine population abundances of Asian carp species in UMR pools 17, 18, 19
Two commercial fishing crews will operate for a total of four weeks in pools 17-19 (pool 17 = 1 week, pool 18 = 1 week, pool 19 = 2 weeks). Each commercial fisher boat crew will fish four consecutive weeks from 8 am to 5 pm, Tuesday – Friday. WIU biologists will be assigned to each commercial net boat to monitor operations and record data. All Asian carp captured

during the initial four weeks of effort will be marked with a uniquely numbered aluminum jaw tag and released.

WIU crews will use a compliment of standard fish sampling techniques (e.g., experimental gill nets [multiple mesh sizes], trammel nets, and hoop nets) to collect Asian carp species in the upper reaches of Pool 20 in the vicinity of LD19. Netting efforts and locations of sets will be guided by the expertise of the commercial fishers and will also be informed by MDC telemetry efforts conducted as part of the fish passage project work within P20. All Asian carp captured during the first four weeks of targeted sampling in Pool 20 will be marked with an aluminum jaw tag and released.

In all pools, non-target bycatch will be identified to species, enumerated, and condition recorded (i.e. healthy, moribund, dead) prior to release. All non-native species, other than Asian carp species, will be removed and transported daily to Darrick Garner (Palmyra, MO) or Shafer Fisheries (Fort Madison, IA).

Recapture events obtained during implementation of Objective 2 will allow for the calculation of population estimates. Program MARK will be used to obtain closed system population size estimates for pools 17-19 as a function of recaptured (without replacement) versus initially marked and untagged individuals.

Objective 2. Targeted removal of Asian carp species in UMR pools 14-19 using contracted commercial fishers and intensive agency netting

Following the initial four weeks of capturing, tagging, and releasing Asian carp in pools 17-19, two contracted commercial fishing crews will operate for a total of 17 weeks in pools 14-19 for targeted removal of Asian carps. Targeted removal efforts will alternate between pools, with approximately 15 of the 17 weeks of effort split between pools 17-19 (pool 17 = 4 weeks, pool 18 = 4 weeks, pool 19 = 7 weeks). Two weeks of effort will be devoted to pools 14-16, where Asian carp are present but not in high enough densities to effectively target large numbers of Asian carp.

Each commercial fisher boat crew will fish every other week from 8 am to 5 pm, Tuesday – Friday. Additional WIU watercraft will be used to assist commercial netting efforts, especially shallow water vessels capable of driving fishes from shallow American lotus beds and shallow backwaters. The goal for targeted removal of Asian carp species above LD 19 is 100,000-200,000 lbs.

Tagging of 2000-3000 silver carp and bighead carp in Pool 20 will be performed by WIU biologists to assess the movement of Asian carp through Lock and Dam 19 (detections will be recorded during objective 2 during harvest in Pools 14-19). One or two WIU boat crews will target Asian carp for removal on opposite weeks of commercial fisher efforts throughout the duration of the study.

Length and weight will be recorded from each Asian carp prior to being sacrificed; individual jaw tag numbers will be recorded for all recaptured Asian carp. Non-target bycatch will be identified to species, enumerated, and condition recorded (i.e. healthy, moribund, dead) prior to release. All non-native species, other than Asian carp species, will be removed and transported to Darrick

Garner (Palmyra, MO) or Shafer Fisheries (Fort Madison, IA) for use as liquid fertilizer

Objective 3. To intensively target backwaters in Pools 14-19 for Asian carp removal by contracted commercial fishers during periods of peak backwater aggregation for 4 weeks in March and April, 2018

Three additional fishing crews will fish and remove Asian carp for a 4 week period in March and April in Pools 14-19 (time period of high density Asian carp backwater aggregation). This four week window has consistently been shown by USFWS-LaCrosse to be a time of high density Asian carp aggregation in backwaters as they stage, conserve energy, and feed, prior to leaving the backwaters to spawn. This is the most predictable time to intensively target Asian carp populations in Upper Mississippi River backwaters. Given the large spatial scale of the Upper Mississippi River, this is a difficult distance to fish intensively and dedicate adequate fishing coverage during the spring high density backwater aggregation. Multiple crews spread out between the pools will allow for a much more effective and efficient harvest from Pools 17-19 and allow for mass removal within a small time frame. Additionally, since this is a predictable backwater staging time for the intensively fished lower pools (higher density pools), it is likely that upper pools that contain very low, hard to target densities, contain similar Asian carp backwater use and behavior during this time period. This would provide personnel to dedicate effort to these upper pools in this 4 week window, which would greatly enhance our success of removal in these areas. The unpredictable behavior of Asian carp outside of this time period, makes targeting low concentrations very difficult, especially in the absence of acoustically tagged fish in these areas. Commercial fishers during this time will also be required to assist with pound net deployment and emptying if these gears are utilized during this time.

Length and weight will be recorded from each Asian carp prior to being sacrificed; individual jaw tag numbers will be recorded for all recaptured Asian carp. Non-target bycatch will be identified to species, enumerated, and condition recorded (i.e. healthy, moribund, dead) prior to release. All non-native species, other than Asian carp species, will be removed and transported daily to Kibbe Field Station for Darrick Garner (Palmyra, MO) or Shafer Fisheries (Fort Madison, IA).

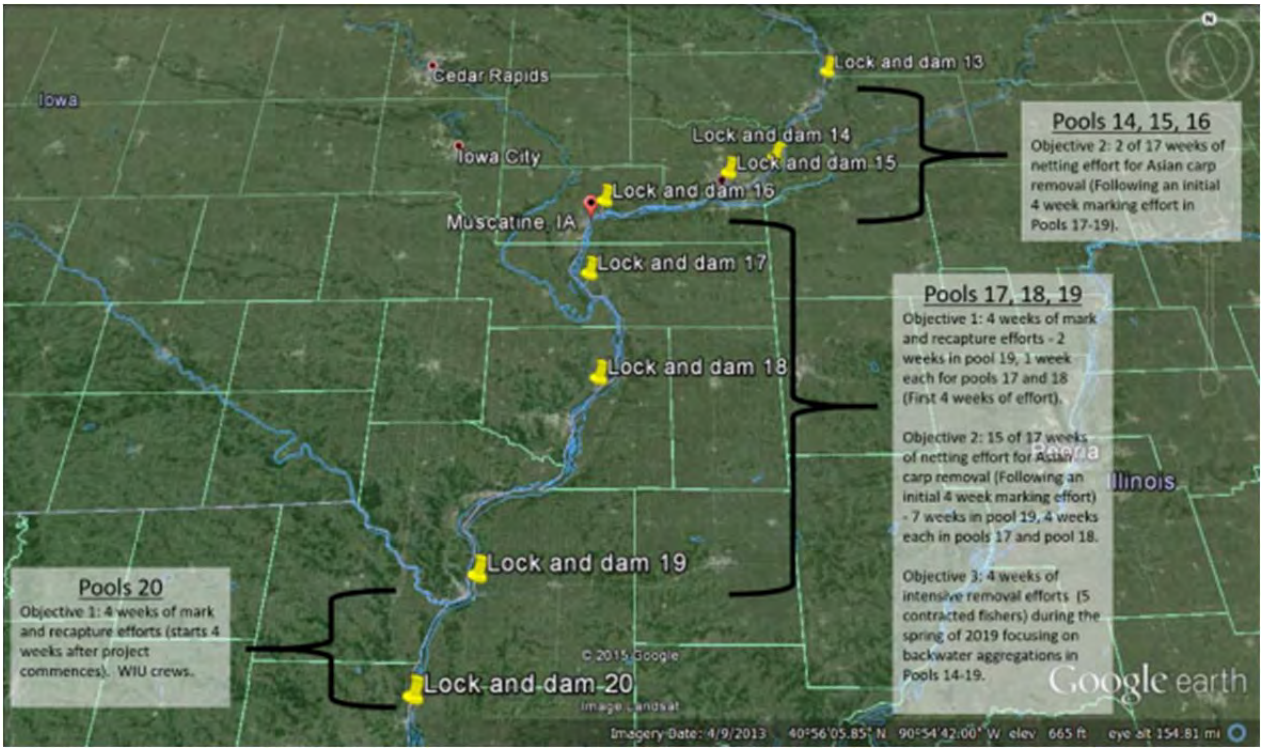

Figure 30. Map of ILDNR/WIU project area.

Appendix A.

Asian Carp projects supported by additional funding sources in the Ohio River Basin and Upper Mississippi River Basin.

Strategy for eDNA Monitoring in the Ohio River Basin

Participating Agencies: US Fish and Wildlife Service (Lead), Pennsylvania Fish and Boat Commission, West Virginia Department of Natural Resources, Kentucky Department of Fish and Wildlife Resources, Ohio Department of Natural Resources, Alabama Department of Conservation and Natural Resources, Mississippi Department of Wildlife, Fisheries, and Parks, Tennessee Wildlife Resources Agency

Location: eDNA samples in 2018 will be taken in the Muskingum River, mainstem Ohio and Tennessee Rivers, and important tributaries in the upper Ohio River. See sampling schedule for greater detail.

Objectives:

1. Determine whether Asian carp DNA is present in strategic locations in the Ohio River Basin to inform status of Asian carp
2. Detect Asian carp DNA in areas that have been monitored since 2009 to maintain annual data collection which may inform future work in the Ohio River Basin

Status: 2018 is a continuation of eDNA sampling that has occurred in the Ohio River since 2013. Sampling of the Tennessee River Basin was added in 2015 and a new locations were added in 2018, including: Flint Creek in Wheeler National Wildlife Refuge, Alabama; and Browns Lake (upper and lower) and Cummings Lake (both part of Raccoon Mountain Sloughs) in Nickajack Lake, Tennessee River, TN. These additions are in response to credible reports of Silver Carp by fishers.

eDNA Sampling: A total of 385 samples will be taken from the Tennessee River System, 170 samples from the Upper Ohio River and tributaries, 150 samples from the Muskingum River System, and 250 samples from West Virginia Waters. The 2017 QUALITY ASSURANCE PROJECT PLAN eDNA MONITORING OF BIGHEAD AND SILVER CARPS will be used as guidance for collection, processing, and chain-of-custody of water samples (Strakosh et al. 2013). In order to perform laboratory molecular analyses to detect eDNA, water samples will be collected from designated focus areas using sterilized collection tubes to be centrifuged and tested for Asian carp eDNA.

Samples will be taken from the top 4 cm of surface waters in areas of surface film accumulation such as in eddies, foamy areas, downstream of structures, and in backwaters. Wind direction and currents will be taken into consideration when selecting sampling locations. Depth, wind direction, water temperature, and geographic coordinates in decimal degrees will be measured and recorded at every sample location. Waypoints will be recorded at each water collection site.

eDNA has not been predesignated to be used as a trigger for rapid response actions. eDNA results will be communicated to the states in which they are collected as soon as they are available, and then posted on the USFWS eDNA webpage per USFWS communication protocol. States can request follow up eDNA sampling, and take actions based on their results at their discretion, potentially enlisting the assistance of the USFWS. A summary of all 2018 eDNA results will be made available at the end of the year.

Table 1**.** Site description, dates, and number of samples to be taken in the Ohio River Basin in 2018. Additional sites may be sampled for follow up at the request of state partners.

Tennessee River System- week of 3 April 2017

Bay Springs Lake	(n=50)
Wilson Tailwaters	(n=50)
Wheeler Tailwaters	(n=50)
Elk River	(n=25)
Flint Creek	(n=10)
Guntersville Tailwaters	(n=50)
Nickajack Tailwaters	(n=30)
Nickajack Lake (Mullen's Creek)	(n=15)
Nickajack Lake (Browns Lake lower)	(n=10)
Nickajack Lake (Browns Lake upper)	(n=5)
Nickajack Lake (Cummings Lake)	(n=15)
Chickamuga Tailwaters	(n=50)
Watts Bar Tailwaters	(n=50)

Muskingum River System- week of 17 April 2017

Muskingum River	(n=125)
Tuscarawas River	
Killbuck Creek	

West Virginia Waters- week of 1 May 2017

Willow Island Pool (proper)	(n=35)
Newell Run	(n=10)
French Creek	(n=10)
Danas Run	(n=10)
Middle Island Side Channel	(n=20)
Middle Island Creek	(n=15)
Little Kanawha River	(n=50)
Kanawha River	(n=100)

Upper Ohio River and Tributaries- week of 16 May 2017

New Cumberland Pool	(n=75)
Little Beaver Creek	(n=20)
Montgomery Island Pool	(n=75)

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