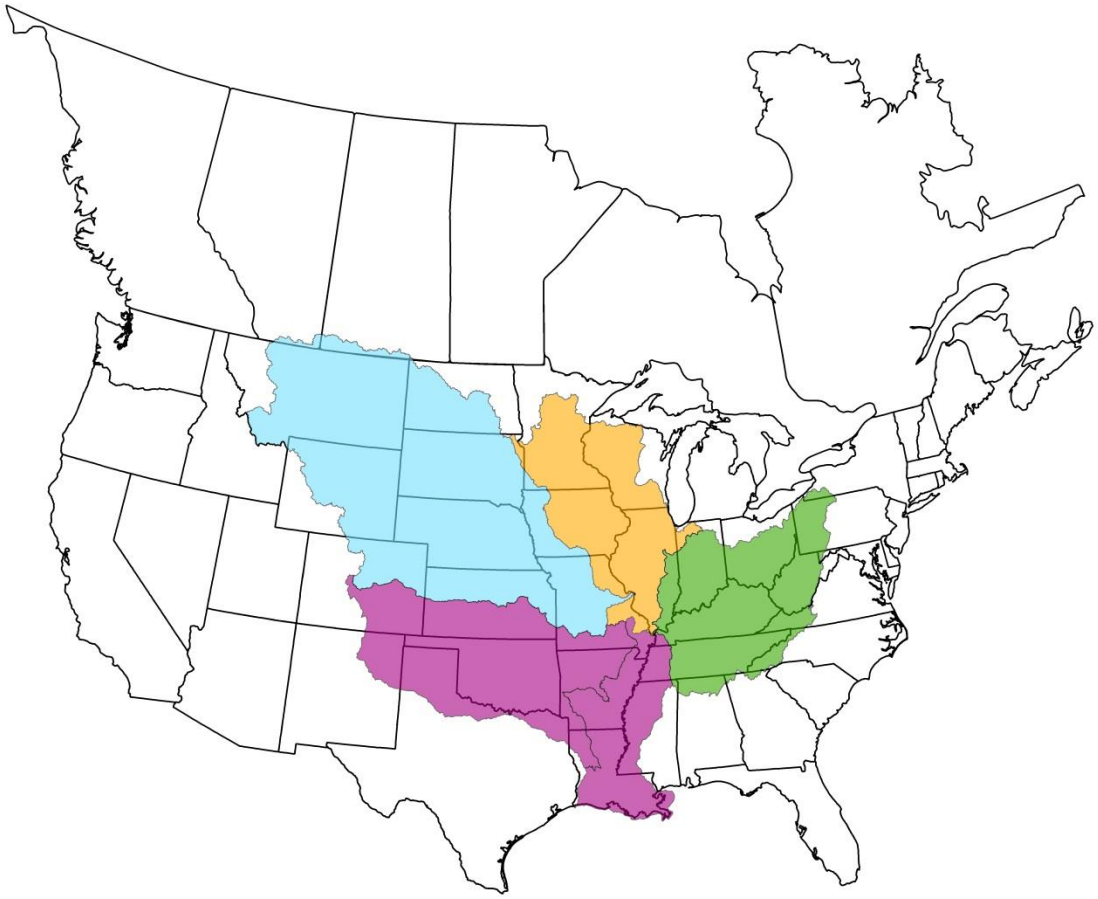
2019 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin



Prepared by the

Mississippi Interstate Cooperative Resource Association

Asian Carp Advisory Committee

2019

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Mississippi River Basin Overview

The Mississippi River and its tributaries comprise one of the largest and most 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estimated the economic output from recreational fishing in the Mississippi River Basin at more than $19 billion (USFWS, unpublished data).

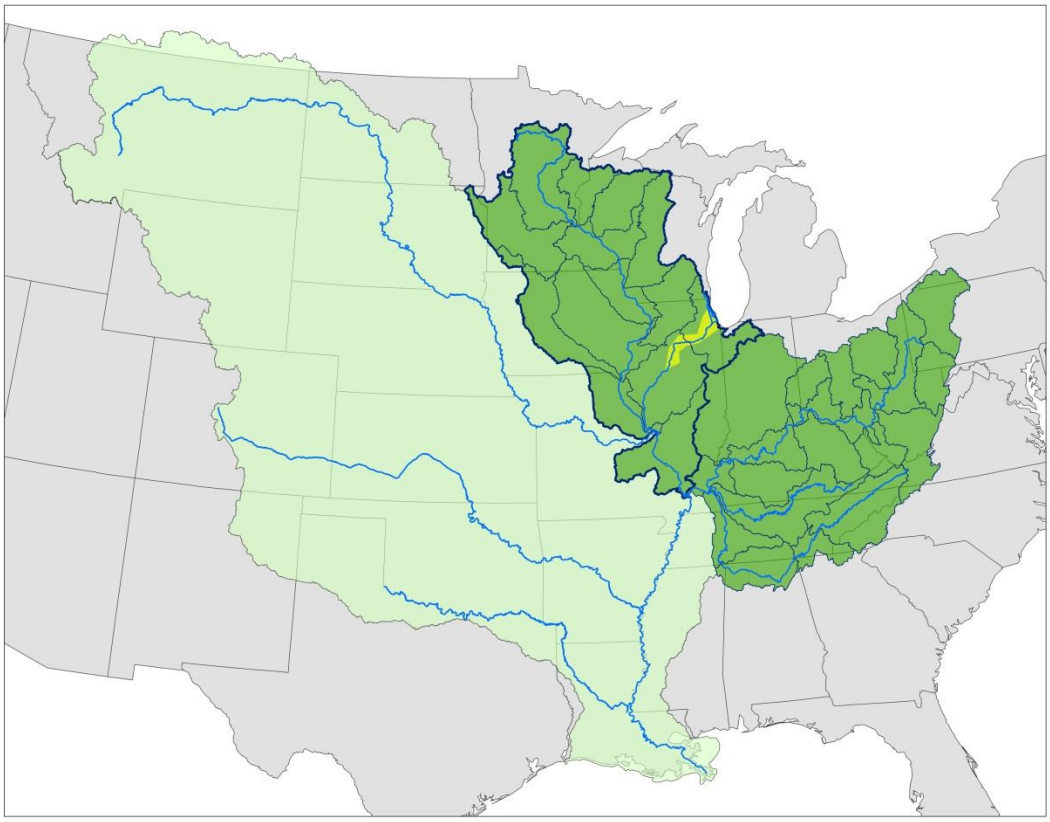


Figure 1. Map of the Mississippi River Basin which drains all or a portion of 31 states and 2 Canadian Provinces (green and light green). The dark green (Ohio and Upper Mississippi River sub-basins) and yellow (upper 175 miles of the Illinois River and Chicago Area Waterway System) areas on the map highlight the current spatial extent of funding from the U.S. Fish and Wildlife Service and other Federal sources (e.g. Great Lakes Restoration Initiative) to support implementation of Asian carp control and management actions in support of regional and national Asian carp management plan goals.

Aquatic Invasive Species Concerns

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 (i.e., 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 Missouri, lower Ohio and lower Cumberland rivers. The collection of young-of-the-year Black Carp in the Mississippi River Basin in 2016 is evidence that Black Carp are self-sustaining in the open reaches of the Mississippi River Basin.

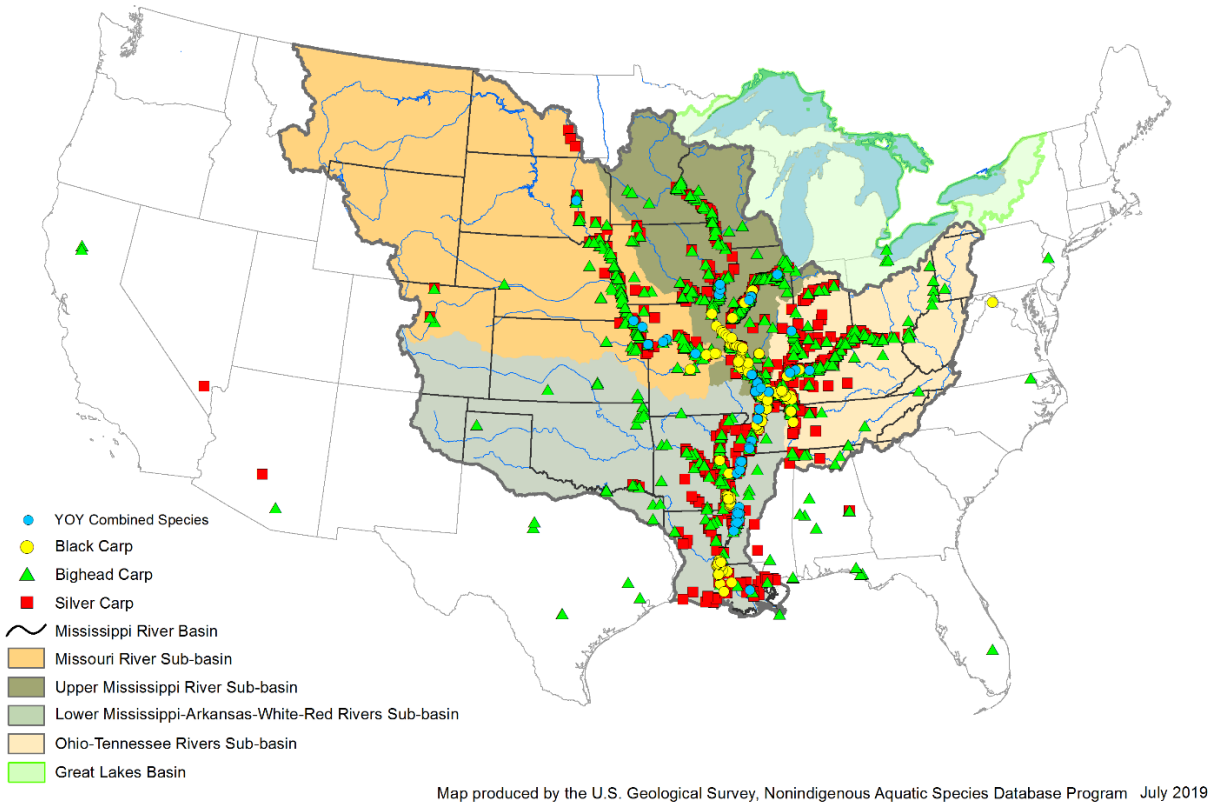


Figure 2. Distribution of Bighead Carp, Silver Carp, and Black Carp in the lower 48 states of the United States as reported to the USGS Nonindigenous Aquatic Species (NAS) Database as of July 2019. Shading indicates the sub-basin Asian carp partnerships of the greater Mississippi River Basin (Missouri River, Upper Mississippi River, Lower Mississippi-Arkansas-White-Red Rivers, and the Ohio-Tennessee Rivers) and the Great Lakes Basin. Asian carp Control Strategy Frameworks guide collaborative Asian carp efforts within each sub-basin.

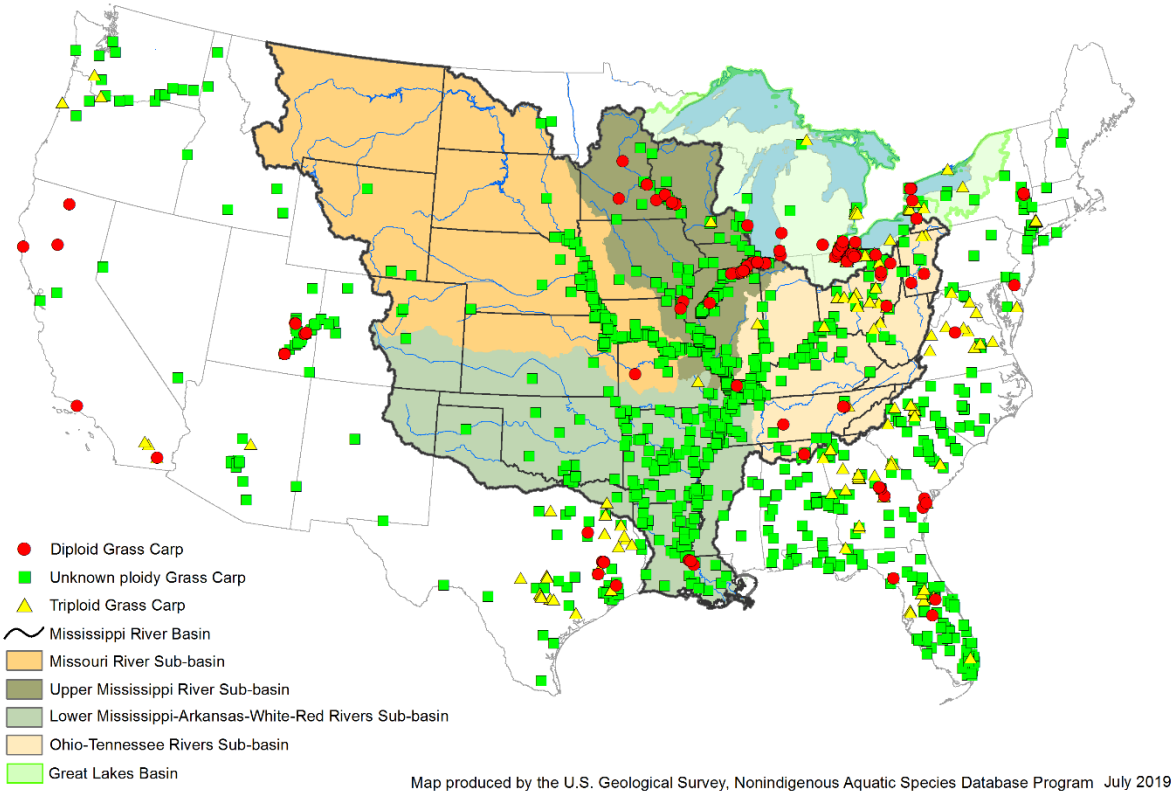


Figure 3. Distribution of Grass Carp in the lower 48 states of the United States as reported to the USGS Nonindigenous Aquatic Species (NAS) Database as of July 2019. Shading indicates the sub-basin Asian carp partnerships of the greater Mississippi River Basin (Missouri River, Upper Mississippi River, Lower Mississippi-Arkansas-White-Red Rivers, and the Ohio-Tennessee Rivers) and the Great Lakes Basin. Asian carp Control Strategy Frameworks guide collaborative Asian carp efforts within each sub-basin.

Mississippi River Basin Asian Carp Federal Authorization and Appropriations Overview

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 Ohio River Sub-basin (ORB) and Upper Mississippi River Sub-basin (UMRB). Congress appropriated $2.4 million in the USFWS's FY2015 budget for Asian carp prevention and control in the ORB and UMRB[1], 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

[1] Although no appropriations for Asian carp management and control in the ORB or UMRB were authorized in WRRDA 2014, the USFWS base appropriations specifically for Asian carp management and control in the ORB and UMRB that began in Fiscal Year 2015 are often referred to by partner agencies as "USFWS WRRDA funding".

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 deterrence 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 ORB and UMRB. FY2019 appropriations included an additional $600,000 to focus implementation of the Ohio River Basin Asian Carp Control Strategy Framework (ORB Framework) to the Tennessee and Cumberland Rivers, which are part of the ORB.

Table 1. 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 2015-2019, and the amount of agency funding provided by USFWS to the Ohio River Sub-Basin and Upper Mississippi River Sub-Basin partnerships to support implementation of priority Framework actions within these two portions of the Mississippi River Basin.

Fiscal Year	USFWS	Ohio River Basin	Upper Mississippi River Basin
2015	$2,400,000	$400,000	$400,000
2016	$2,600,000	$500,000	$500,000
2017	$3,100,000	$600,000	$600,000
2018	$4,800,000	$1,150,000	$1,050,000
2019	$5,400,000	$1,735,000	$1,055,000

Mississippi River Basin Coordination

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 regional 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, has an active role working with the sub-basin partnerships and planning teams to develop and implement sub-basin level Frameworks throughout the Mississippi River Basin. MICRA works with inter-agency partnerships in the ORB, UMRB, 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).

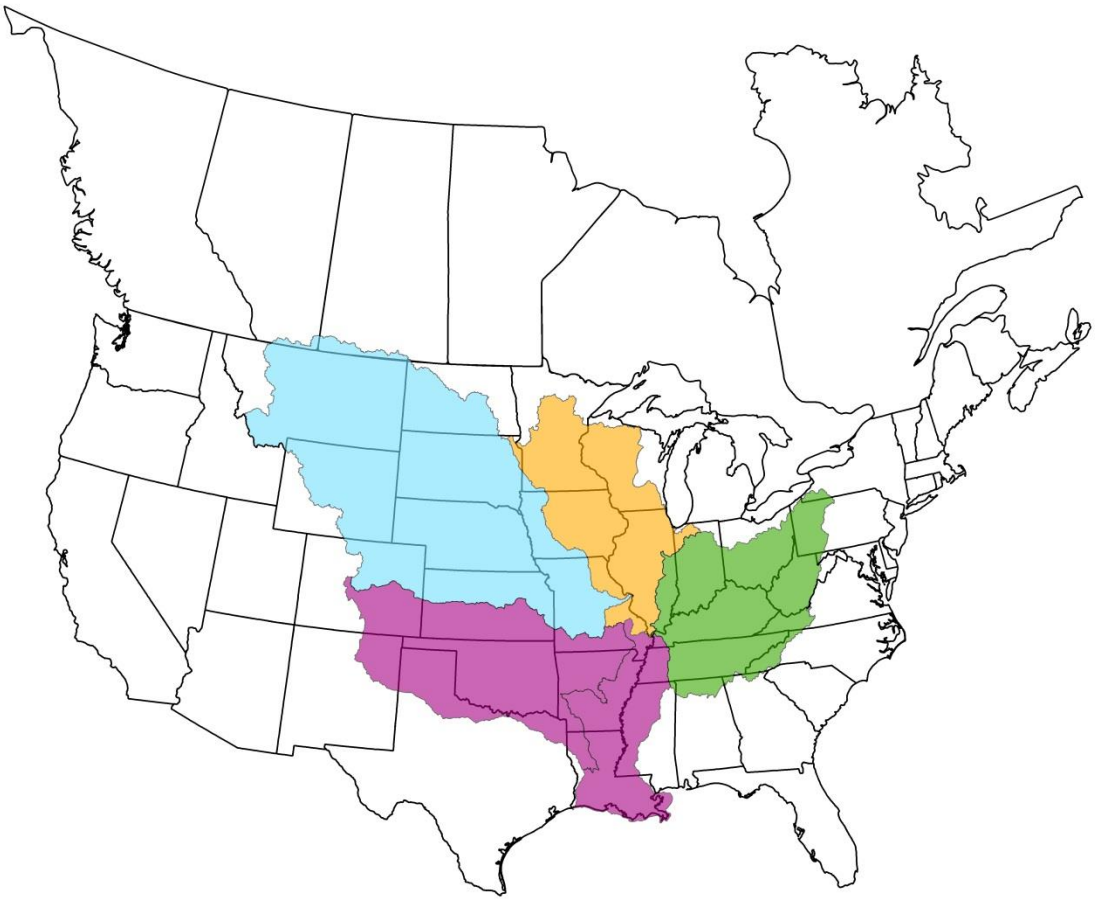


Figure 4. Development and implementation of Asian carp Frameworks in the Mississippi River Basin is broken down into four sub-basins including the Ohio River Sub-Basin (green; includes the Tennessee and Cumberland rivers), Upper Mississippi River Sub-Basin (yellow), Missouri River Sub-Basin (blue) and the Lower Mississippi River Sub-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 Waterway System (CAWS; Figure 1).

Missouri River Sub-Basin Inter-Agency Carp Partnership

The Missouri River Sub-Basin (MORB) comprises one-sixth of the continental United States and is surpassed in area only by the greater Mississippi River Basin in the U.S. It includes all or

parts of 10 states (Figure 5) and two Canadian provinces. Recognizing the increasing threat of Asian carp in the MORB, the Missouri River Natural Resources Committee (MRNRC) developed an Asian Carp Technical Committee (Committee) made up of representatives from ten states in the basin and five federal agencies. The Committee finalized the *Missouri River Basin Asian Carp Control Strategy Framework* to minimize the social, ecological, and economic impacts of invasive carp to the MORB. The Framework applies the National Plan at the Missouri River sub-basin level. Implementation of the Framework is unfunded yet representatives from each state in the MORB participate on the Committee. Current work, started by the state agencies in the MORB, attempts to address the top priorities identified by the committee, including defining the distribution of Asian carp within the sub-basin. However, current levels of funding are not sufficient to address priority needs. With additional funding, the Committee is prepared to implement priority projects including assessing population dynamics (size structure and abundance), and identifying potential locations for control. Additional agency staff, other governmental agencies, universities, and private organizations currently participate as cooperators.

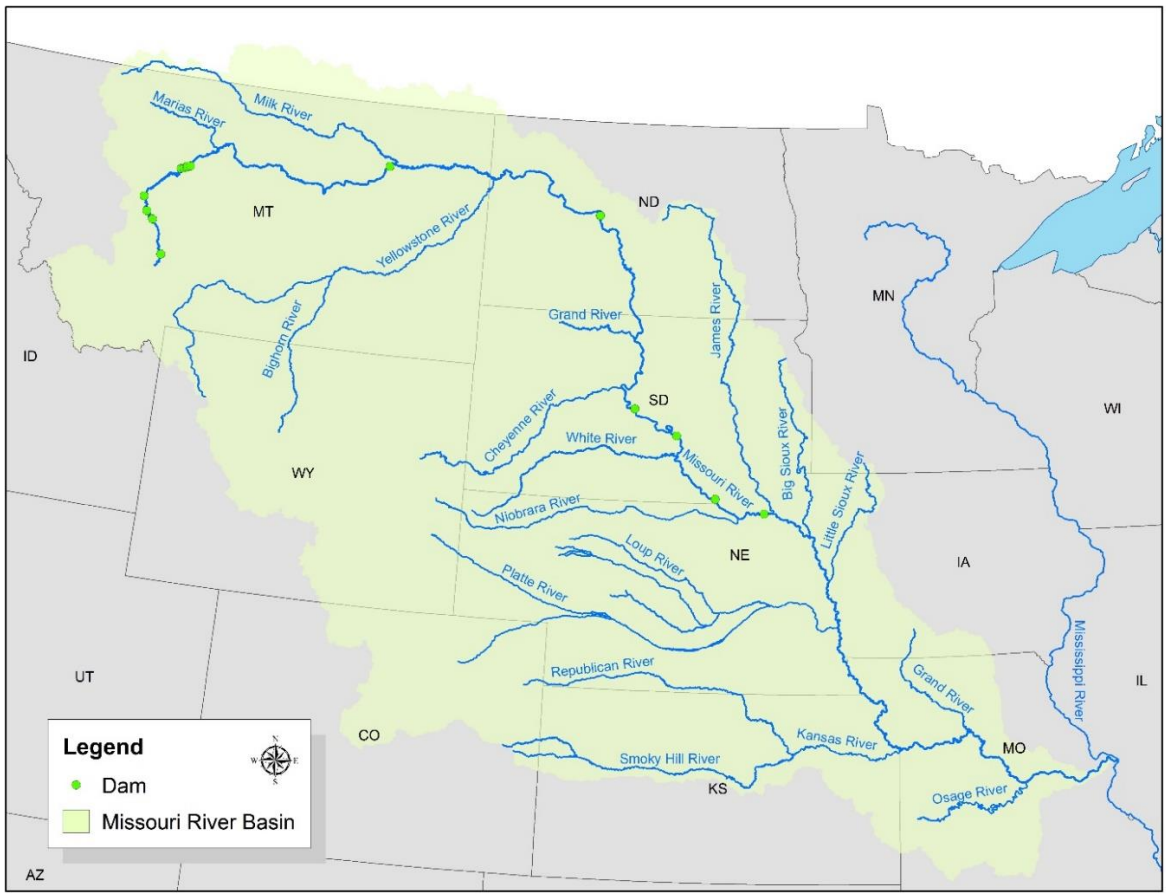


Figure 5. Map of the Missouri River Sub-Basin

Lower Mississippi River Sub-Basin Inter-Agency Asian Carp Partnership

The Lower Mississippi River Sub-Basin (LMRB) Asian Carp Control Strategy Framework geography includes the entirety of the Lower Mississippi River Sub-Basin, which includes the Arkansas, White, and Red river sub-basins (Figure 6). There are 11 states included Lower Mississippi and Arkansas-White-Red River Regions. All 11 states participate with federal agencies in a partnership, which developed an Asian Carp Control Strategy Framework for the entire region. The LMRB states currently have varying levels of involvement in Asian Carp monitoring and research that is funded by state dollars and several LMRB states are involved in Asian carp work in other sub-basins (ORB: Kentucky, Tennessee, and Mississippi; and UMRB: Missouri). The LMRB Asian Carp Team continues to determine the highest priority framework goals and strategies for implementation when funding becomes available.

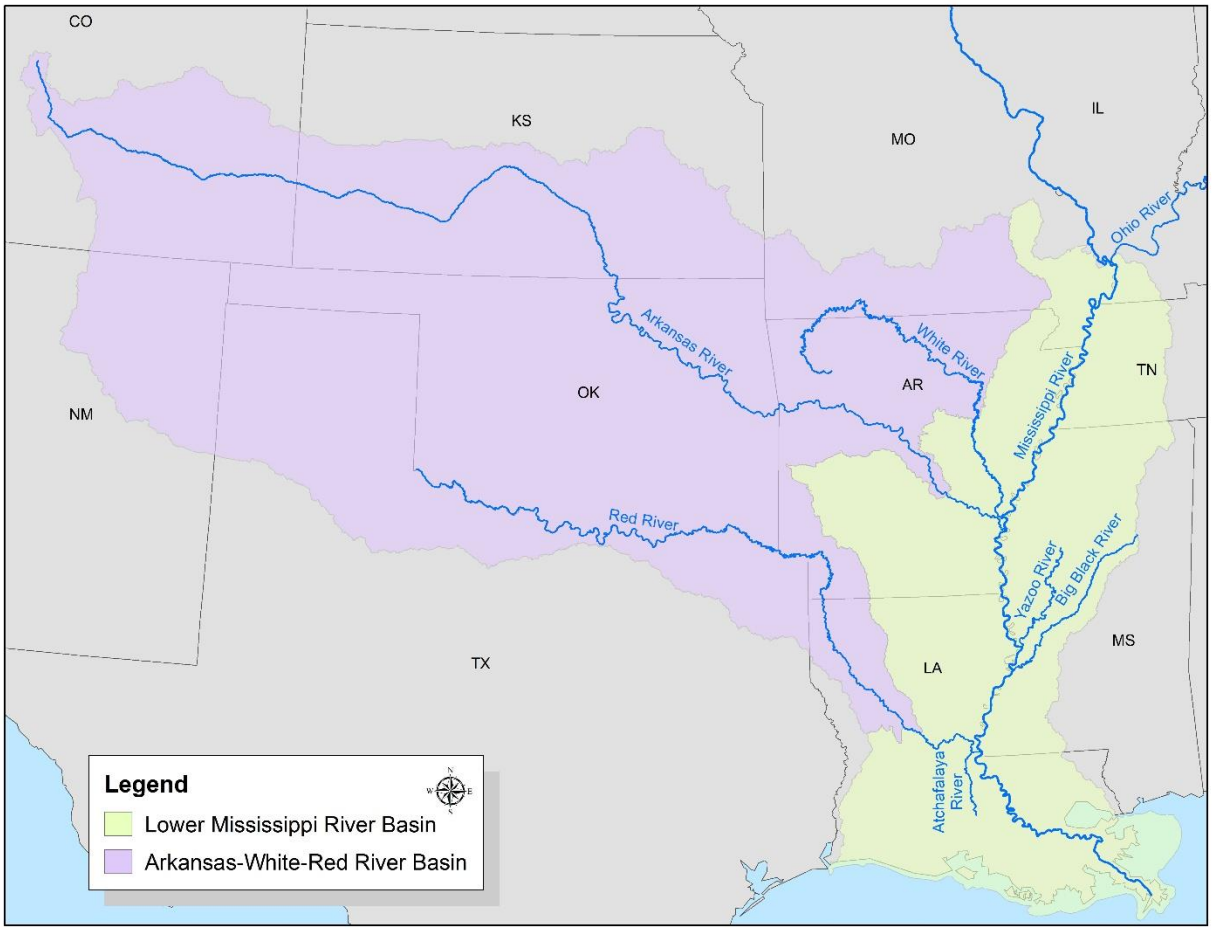


Figure 6. Map of the Lower Mississippi River Sub-Basin

Ohio River Sub-Basin Inter-agency Asian Carp Partnership

The Ohio River (OHR) flows through or along the border of Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia; these six states collaboratively manage fisheries in the mainstem OHR 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 limit the negative impacts of Asian carp in the ORB. 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 prevent further range expansion, reduce populations, better understand and minimize impacts of Asian carps, and improve communication and coordination in the basin. The Tennessee and Cumberland rivers (TNCR) are major tributaries to the mainstem OHR, and are therefore included as part of the ORB Framework. However, because independent funding was provided through legislation to the Tennessee and Cumberland River partners, two teams (ORFMT and TNCR) come together to implement the ORB Framework that was completed in October 2014.

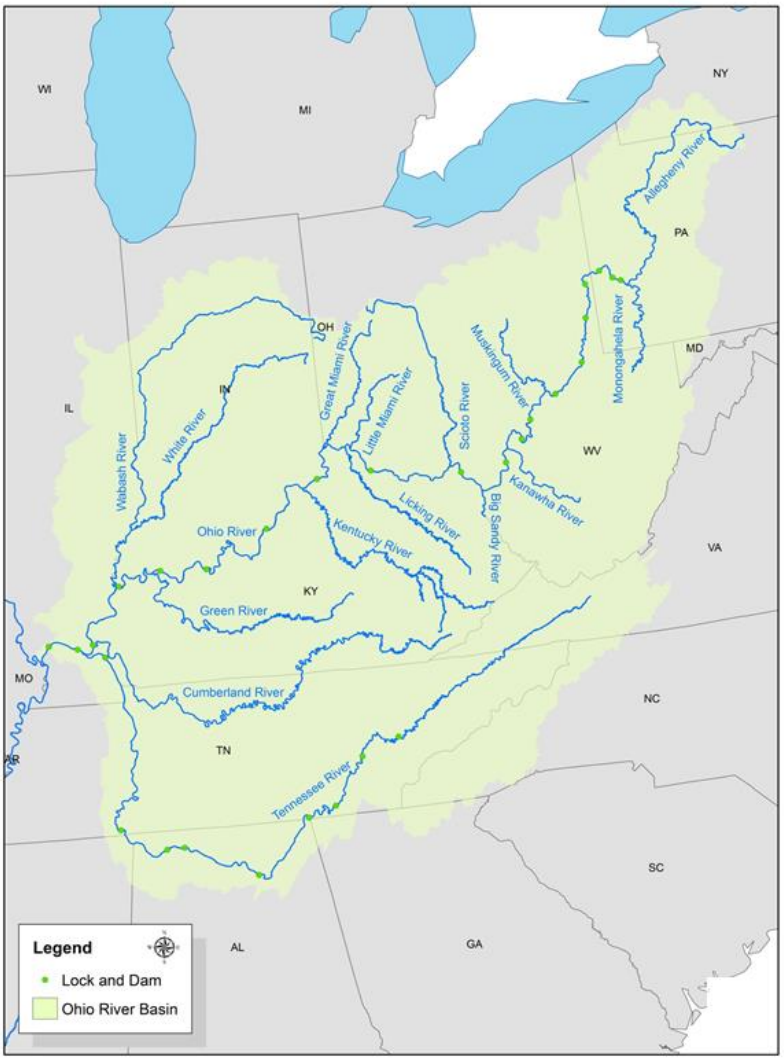


Figure 7. Map of the Ohio River Basin.

Upper Mississippi River Sub-Basin 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. 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 Team (UMRACT) to develop an Upper Mississippi River Basin Asian Carp Control Strategy Framework (UMRB Framework) to coordinate Asian carp prevention and control efforts in the UMRB. The UMRB Framework was completed in August 2018 as a regional stepdown plan from the National Plan and is based on the existing UMRCC's 2010 Fisheries Plan Goal 4.

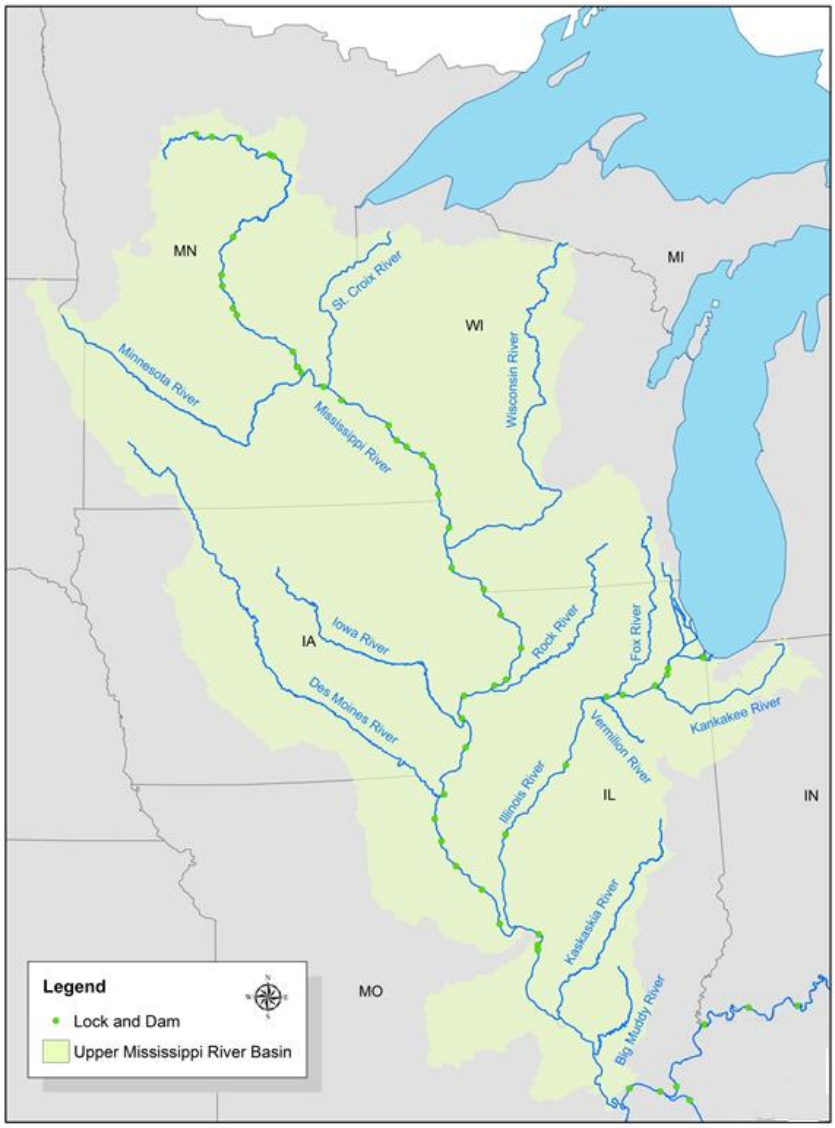
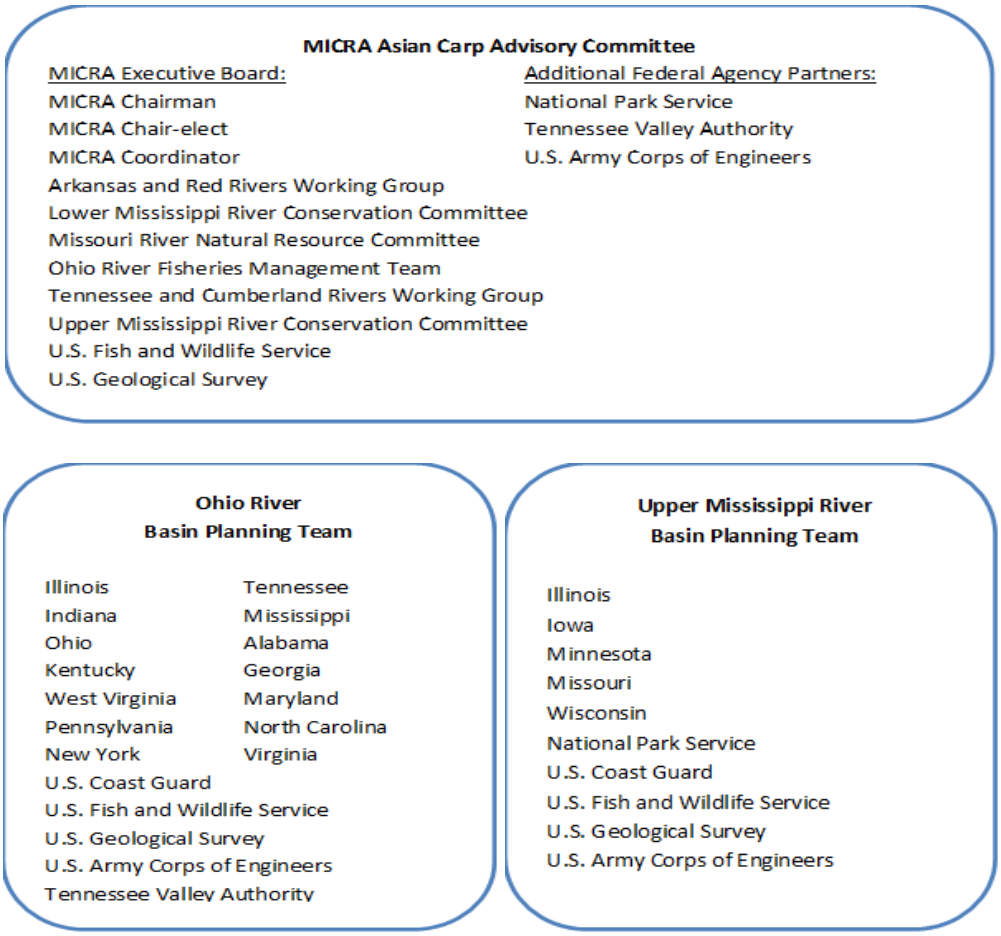


Figure 8. Map of the Upper Mississippi River Basin.

Mississippi River Basin Project Coordination Process

The Executive Boards of the regional sub-basin groups in the ORB and UMRB are comprised only by state agencies. To provide for 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 7). The ACAC consists of the MICRA Executive Board (i.e., one state agency representative from each of the six MICRA 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.



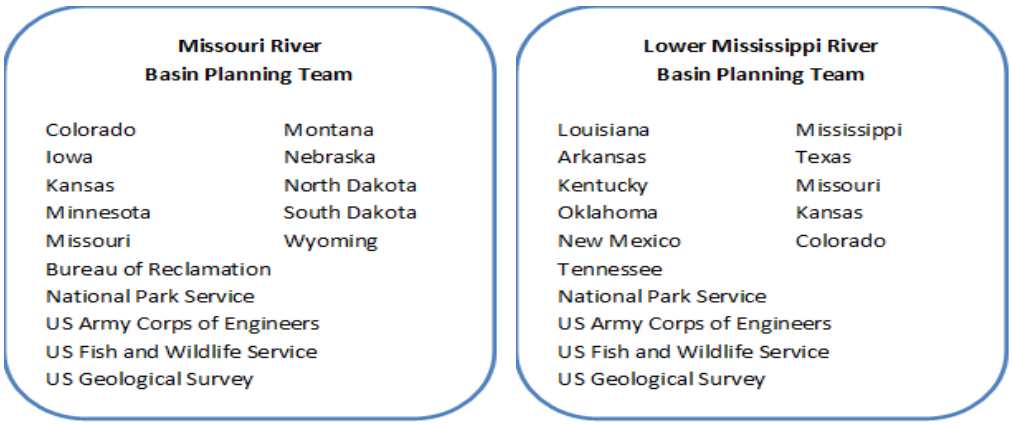


Figure 9. Structure for Inter-agency Coordination and Implementation of Asian Carp Control Strategy Frameworks in the greater Mississippi River Basin (Asian Carp Advisory Committee, previous page) and the Ohio River (previous page), Upper Mississippi River (previous page), Missouri River, and Lower Mississippi River Sub-Basins.

In the ORB and UMRB, where the USFWS has committed federal funding, sub basin teams determine priority projects from their respective frameworks for implementation, identify lead and cooperating agencies for each project, and develop annual project proposals that are compiled and submitted as a Mississippi River Basin proposal package to the USFWS for funding consideration. Approved projects are developed into detailed annual work plans and compiled in the annual 'Asian Carp Monitoring and Response Plan for the Mississippi River Basin' (MRP). The 2019 MRP is a compilation of seven (7) projects in the ORB (beginning on page 12) and five (5) projects in the UMRB (beginning on page 105) implemented, in part, with USFWS FY19 funds.

The Tennessee and Cumberland Rivers (TNCR) fall within the ORB and are included in the planning and implementation of projects as a part of the ORB Framework. ORB Projects 4 and 5 are the continuation of projects in the TNCR that were funded by USFWS in previous years. ORB Project 7 was developed by the TNCR states following the addition of $600,000 in the USFWS's FY2019 budget to support Asian Carp work specifically in the TNCR.

There are ongoing projects that arise from each of the sub-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 and Frameworks, 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, and inform planning for management and control actions in future years. The annual MRPs and interim annual reports are available on the MICRA website at: http://www.micrarivers.org/asian-carp-plans-and-reports/.

Ohio River Basin

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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 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 gather information on Asian carp distributions, behavior, and habitat use in the Ohio River basin (ORB) to aid and assess actions related to their removal, suppression, and containment.

The tasks outlined in this document would add a fifth year of surveillance and data concerning Asian carp in the Ohio River. The intentions of this effort are 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. Collaborative efforts from previous years have included fish community sampling, targeted sampling, and incorporation of additional data sources such as hydroacoustics to aid in better understanding distribution and densities of invasive carp. Success in these aforementioned areas provides an assessment tool that informs Asian carp control 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.

National Plan Goals Supported:

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 Strategy Supported:

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

Sub-basin Management Plan Goal Supported:
Monitoring and Response

Sub-basin Management Plan Strategy Supported:

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 population structure, 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. Monitor and survey for Asian carp presence in upstream areas where carp are rarely detected to inform response and containment efforts

Agency: Kentucky Department of Fish and Wildlife Resources

Project Activities, Methods, and Timetable:

Objective 1

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. 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. water temperatures should typically reside between 50°F – 65°F throughout the duration of spring sampling efforts). Electrofishing is conducted in a general downstream direction 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; however, all small, shad-like species should be dipped and examined thoroughly before being released 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 kept 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*. All 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 fin rays will be removed as needed from Asian carp for age and growth analysis. This will aid in providing the basin with age distributions and may be used for tracking mortality estimates. Length frequency and population size structures will be reported and used for following year-classes through time in

each pool and fish condition will provide states with information that may indicate removal success or population growth leading to decreases in condition.

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.

Objective 2
Community Fish Surveys
KDFWR will coordinate with agencies to conduct community fish surveys in Cannelton, McAlpine, and RC Byrd pools. Kentucky DFWR's focus in 2019 will be in the Cannelton and McAlpine 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.

Due to the limited size ranges of fish 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 community sampling. This will be an effort to expand the size range of species sampled using this gear type.

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 their location and condition. Data on Gizzard Shad condition, species richness and shifts in trophic guilds or dominant taxonomic groups will be reported annually.

Estimated Timetable:

Project Activity	Pool	Dates (Week Of…)	Year
Targeted Asian carp Sampling	Cannelton	April 08	2020
Targeted Asian carp Sampling	McAlpine	April 15	2020
Targeted Asian carp Sampling	Markland	April 22	2020
Community Surveys and Hydroacoustics	Cannelton	October 09	2020
Community Surveys and Hydroacoustics	McAlpine	October 18	2020
Project Executive Summary	N/A	October 30	2020
Incorporation of Additional Data Sources	N/A	December 23	2020
Project Technical Report	N/A	February 26	2021
Targeted Asian carp Sampling	Cannelton	April 06	2021
Targeted Asian carp Sampling	McAlpine	April 13	2021
Targeted Asian carp Sampling	Markland	April 20	2021
Community Surveys and Hydroacoustics	Cannelton	October 05	2021
Community Surveys and Hydroacoustics	McAlpine	October 12	2021
Project Executive Summary	N/A	October 19	2021

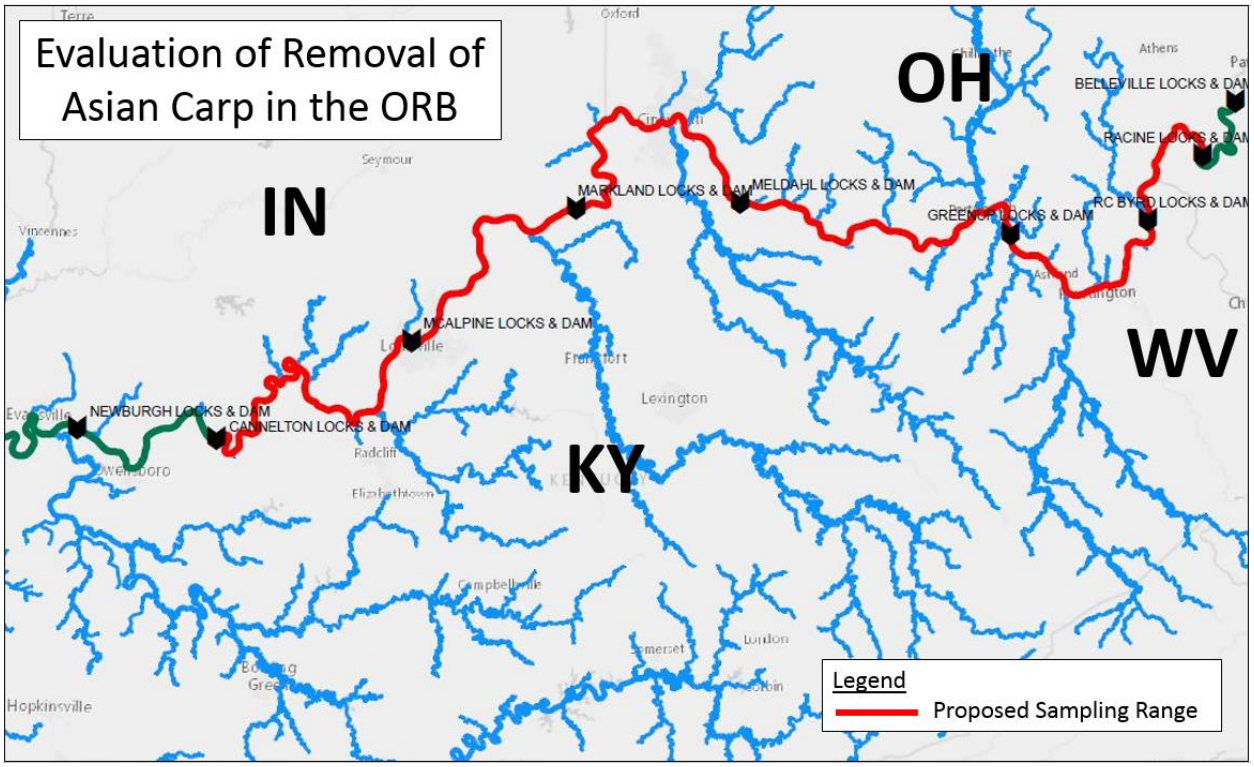

Figure 10. Proposed sampling range for KDFWR Asian carp evaluation in the Ohio River.

Agency: Indiana Department of Natural Resources

Project Activities, Methods, and Timetable:

Objective 1

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, however, 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. Side-imaging should be used to locate suitable areas and/or schools of carp during targeted sampling. All by-catch will be recorded.

Species, length, weight, and sex will be recorded for all carp captured. Information will be used to estimate relative abundances of *Hypophthalmichthys spp*. All 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 fin rays will be removed as needed from Asian carp for age and growth analysis.

Contract Fishing Landings

INDNR will provide three onboard observers from April through October to assist contract fishers, monitor catch, and record data. Observers will ride along with contract fishers daily. Observers will record location, effort, catch by species, bycatch mortality, and measure and weigh a subsample of daily Asian carp harvest to estimate total daily volume removed. They

will insure that all bycatch is released immediately. Observers will report back to biologists on a regular basis to inform and concentrate removal efforts in the most productive areas. INDNR will work closely with KDFWR to ensure contract fishers are be utilized in an efficient manner. All landings data will be sent to KDFWR (Removal Project Lead).

Objective 2

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, Millstone Creek, Clover Creek, Wolf Creek, Oil Creek, Little Blue River, Blue River, Wattson Creek, Buck Creek, Indiana Creek, Otter Creek, and the Salt River, and nine main channel sites. 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.

Estimated Timetable:

Project Activity	Pool	Dates	Year
Community Fish Surveys	Cannelton	October	2019
Project Executive Summary	N/A	October 30	2019
Project Technical Report	N/A	February 26	2020
Targeted Asian carp Sampling	Cannelton	April - May	2020
Observe Contract Fishing Landings	Cannelton	May-October	2020

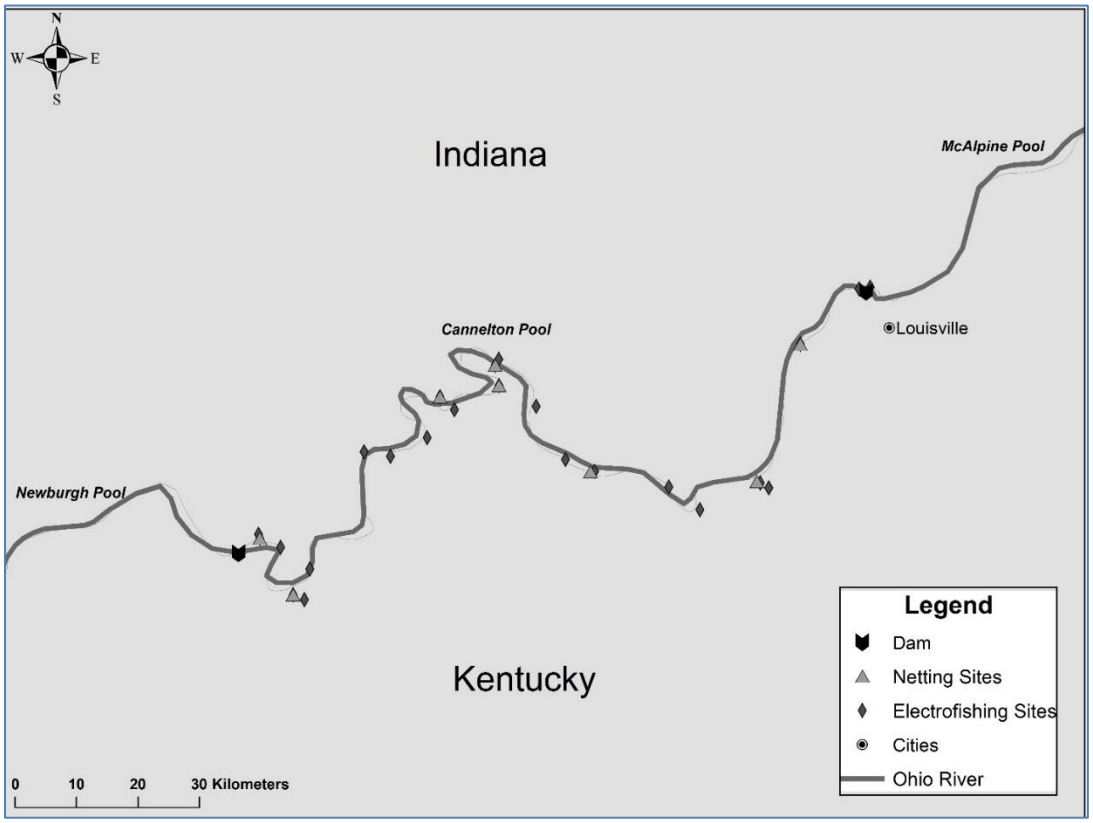

Figure 11. Proposed sampling locations for INDNR Asian carp evaluation in the Ohio River.

Agency: West Virginia Division of Natural Resources

Project Activities, Methods, and Timetable:

Objective 1
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*. All feral Asian carps captured during sampling will be removed from the system. Otoliths and 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.

Objective 2
Community Fish Surveys
WVDNR will assist and cooperate with agencies to conduct community fish surveys in Greenup, and RC 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, WVDNR conducts other fisheries 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.

Objective 3
eDNA Sampling
WVDNR will assist USFWS to conduct eDNA surveillance surveys in the upper Ohio River. Specifically, WVDNR will participate in sample collection in the New Cumberland, Montgomery and Willow Island pools of the Ohio River as well as the upper reaches of the Little Kanawha and Kanawha rivers. WVDNR staff will assist with collecting and processing water

samples on site according to USFWS sampling protocols. New or concerning positive results pf Asian carp DNA may lead to a targeted sampling effort to collect fish.

Estimated Timetable

Project Activity	**Pool**	**Dates**	**Year**
Targeted Asian carp Sampling	R.C. Byrd	April	2021
Targeted Asian carp Sampling	Greenup	April	2021
Community Fish Surveys	R.C. Byrd	October	2020
Community Fish Surveys	Greenup	October	2020
eDNA Sampling	New Cumberland, Willow Island, London on Kanawha R.	May/June	2021
Sportfish surveys	All WV Ohio River Pools	January-December	2020-21
Project Executive Summary	N/A	October	2020
Project Technical Report	N/A	February	2021
Targeted Asian carp Sampling	R.C. Byrd	April	2022
Targeted Asian carp Sampling	Greenup	April	2022
Community Fish Surveys	R.C. Byrd	October	2021
Community Fish Surveys	Greenup	October	2021
eDNA Sampling	New Cumberland, Willow Island, London on Kanawha R.	May/June	2022
Sportfish surveys	All WV Ohio River Pools	January-December	2021
Project Executive Summary	N/A	October	2021

Figure 12. Proposed sampling range for WVDNR evaluation of Asian carp in the Ohio River.

Agency: Pennsylvania Fish and Boat Commission (PFBC)

Project Activities, Methods, and Timetable:

Objective 2

Community Fish Surveys

Community fish surveys from 2008-2016 will be used to establish and refine future sampling locations. Boat electrofishing will consist of 10-minute transects across 17 fixed sites total. Ten transects will be sampled at each site. Typically, three to six fixed sites will be sampled in any given year. Sampling will be conducted using pulsed DC electrofishing gear operated at 25% duty cycle and 60 pps using variable voltages. Gill nets will be fished for 24-hour sets at nine sites across two 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. Beach seining will be conducted at six fixed sites in one pool. All fish captured during beach seining will be identified to lowest possible taxonomic level.

- 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 3

Monitoring and Early Detection

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
Gill Nets	New Cumberland, Montgomery on Ohio River	November	2019
Night Electrofishing	New Cumberland, Montgomery, Dashields on Ohio River	November/December	2019
Night Electrofishing	Pool 3 on Allegheny River, Emsworth on Allegheny River, Emsworth on Monongahela River, Pool 5 on Monongahela River	November/December	2019
eDNA Sampling	New Cumberland, Montgomery on Ohio River	May/June	2020
Night Electrofishing	New Cumberland, Montgomery, Dashields on Ohio River, Pool 2 and Pool 6 on Allegheny River, Pool 3 on Monongahela River	May/June	2020
Hoop Nets	Monongahela River	June	2020
Day Electrofishing	Montgomery on Ohio River; Pool 4 and 5 on Monongahela River; Pool 4 on Allegheny River	July	2020
Beach Seining	Montgomery on Ohio River	August	2020
Night Electrofishing	New Cumberland on Ohio River; Pool	September	2020

	4 on Allegheny River		
Gill Nets	Montgomery on Ohio River	November	2020
Night Electrofishing	New Cumberland, Montgomery, and Dashields on Ohio River	November/December	2020

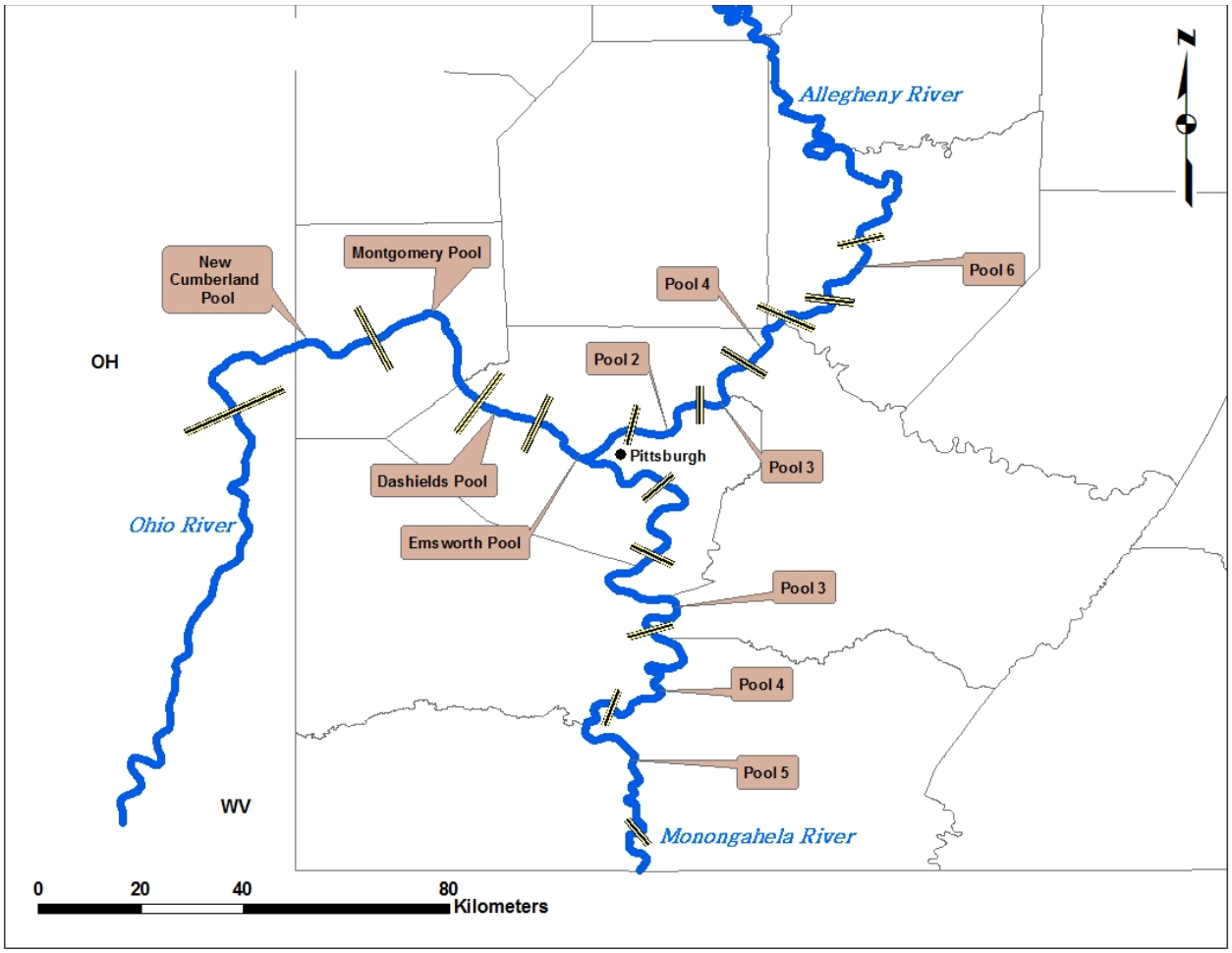

Figure 13. Map of PFBC project area, which includes the Upper Ohio, Allegheny, and Monongahela Rivers.

Table 2. Fixed site locations for targeted and community sampling 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	INDNR

Cannelton	Deer Creek - Lower	Gill Netting	IN	TRIB	INDNR
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	INDNR
Cannelton	Blue River Bar	Gill Netting	KY	MAIN	INDNR
Cannelton	McAlpine Lock & Dam	Boat Electrofishing	IN	TAILW	INDNR
Cannelton	Sand Island	Boat Electrofishing	KY	ISLBC	INDNR
Cannelton	Hughes Bar	Boat Electrofishing	IN	MAIN	INDNR
Cannelton	Salt River - Upper	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Salt River - Lower	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Otter Creek	Boat Electrofishing	KY	TRIB	INDNR
Cannelton	Hughes Bar	Gill Netting	IN	MAIN	INDNR
Cannelton	Salt River - Mouth	Gill Netting	KY	TRIB	INDNR
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 Electrofishing	WV	MAIN	WVDNR
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 Division of Natural Resources (WVDNR), West Virginia University (WVU), United States Fish and Wildlife Service (USFWS)

Statement of Need:

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 both the extent of spawning and recruitment 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 plan, the term 'Asian carp' is referring to Silver Carp and Bighead Carp (*Hypophthalmichthys* species), also known as bigheaded carp.

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. Previous sampling efforts on the Ohio River have documented adult Asian carp presence as far upstream as Robert C. Byrd Dam near Gallipolis Ferry, West Virginia. Densities of adult Asian carp are highest downstream of McAlpine Lock and Dam (Louisville, KY) and substantially decline farther upstream. Despite the high abundance of adults in Cannelton Pool, targeted juvenile sampling has only captured young-of-year (YOY) Asian carp as far upstream as Newburgh Pool, with the majority of the YOY being consistently produced in JT Myers Pool since 2016. For this reason, a consolidated effort to target YOY Asian carp in Cannelton Pool is warranted to more accurately define the extent of recruitment in the Ohio River.

Suspected reproduction of non-indigenous bigheaded carp, through the identification of Asian carp-type larvae, was documented in Meldahl Pool in 2016 by EA Engineering. In addition, Asian carp larvae were captured from Newburgh to McAlpine Pools in 2018 during last year's iteration this project. These previous efforts have been successful in collecting Asian carp eggs, embryos, and larvae in the Ohio River. However, defined spawning locations and the spatial extent spawning 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.

For the purposes of this study, eggs, embryos, and larvae will be used to verify spawning, and juvenile Asian carp will be used to identify recruitment. The collection of Asian carp eggs, embryos, and larvae to document spawning will be evaluated using ichthyoplankton sampling methods (i.e., surface trawling using bongo nets) and suspected bigheaded carp will be confirmed via genetic techniques. 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. In addition, crews will use surface trawling methods to extend the sampling window and therefore increase capture efficiency of YOY Asian carp. 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.

National Plan Goals Supported:

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 Strategy Supported:

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

Monitoring and Response

Sub-basin Management Plan Strategies Supported:

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 bigheaded carp spawning activity in the Ohio River above Markland Dam.
2. Identify tributaries of Newburgh, Cannelton, and McAlpine Pools in which spawning of bigheaded carp occurs.
3. Determine the geographic extent of Asian carp recruitment in the Ohio River.
4. Characterize potential Asian carp nursery areas when juvenile Asian carp are encountered.

Agency: Indiana Department of Natural Resources

Project Activities, Methods, and Timetable:

Objective 2
Indiana DNR will conduct and coordinate sampling for Asian carp eggs, embryos, and larvae within tributaries of high adult Asian carp abundance in Newburgh, Cannelton, and McAlpine pools. Specifically, INDNR will sample Little Pigeon Creek and Anderson River in Newburgh Pool, and Deer Creek and Clover Creek in 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 least twice at each site during ideal spawning conditions (water temperatures between 64 to 80°F with moderate to high flows) through June and July, 2019. Field staff will coordinate closely with KDFWR personnel to communicate when spawning patches begin to develop on female Asian carp and will use that knowledge as another indicator to sample. 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. A 50 ml aliquot of the original ethanol preservative will be pulled from each sample 24-48 hours after taken. Ethanol samples will then be submitted to Whitney Genetics Lab for quantitative PCR sampling to detect DNA from bigheaded carps eggs and larvae. Results from the PCR analysis will determine presence/absence of bigheaded carp eggs and or larvae in samples, and will be used to prioritize which samples will be further sorted. Pending PCR analysis, morphometric characteristics developed by Chapman and George (2011) will be used to identify suspected bigheaded carp eggs, embryos, and larvae. If necessary, a subsample of suspected bigheaded carp eggs, embryos, and/or larvae can then be sent to Whitney Genetics Laboratory for confirmation of species. Results will be used to locate spawning locations in the Ohio River Basin 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 via two ichthyoplankton tows above the confluence of the tributary. In addition, three tows will be taken within the tributary upstream of any potential Ohio River influence. Depth (m) and water temperature (^{0}C) will be recorded using a boat-mounted depth sounder at each sampling site.

Objective 3
Indiana DNR will conduct targeted sampling for juvenile Asian carp in Cannelton Pool of the Ohio River. 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. Previous sampling efforts regularly captured YOY in JT Myers Pool, occasional captured them in Newburgh Pool, and have not captured YOY Asian carp in Cannelton Pool despite the high relative abundance of adults present. Therefore, the juvenile electrofishing effort has been consolidated in 2019 to only include Cannelton Pool. This consolidated sampling will allow for a more thorough look at the potential for Asian carp recruitment in Cannelton Pool. Specific areas to be sampled will include Deer Creek, Millstone Creek, Clover Creek, Bull Creek, Town Creek, Sinking Creek, Poison Creek, Yellowbank Creek, Oil Creek, Spring Creek, Watson Creek, Little Blue River, Wolf Creek, Blue River, Indian Creek, Buck Creek, Otter Creek,

Mosquito Creek, and Salt River. 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. In addition, a 12-foot surface trawl will be used at these sites because it has proven effective for capturing young-of-year Asian carp.

Electrofishing samples will consist of at least one 15-minute transect 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. Surface trawl samples will consist of at least two 5-minute tows at each sample site. The surface trawl is constructed of an inner bag of 1 ¼" number 12 netting, and an outer bag of 3/16" 35 lb Delta style knotless mesh. The trawl is approximately 12 ft wide and 2 ft tall at the mouth, and is 18 ft long. Floats were added to the otter boards (12" x 24") and the float line of the trawl mouth to suspend the net on the surface. Tow lines are attached to the bow of the boat and the boat is motored in reverse between 1.5 to 2.0 mph. Juvenile Asian carp will be targeted with both electrofishing and trawling. Those collected will be 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).

Objective 4

Indiana DNR will conduct targeted sampling for juvenile Asian carp in Cannelton Pool. 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. Tributaries and embayments in Cannelton Pool of the Ohio River will be targeted with pulsed DC electrofishing and surface trawling 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
Compile executive summary on 2019 data	N/A	October	2019
Provide project technical report on 2019 data	N/A	March	2020
Juvenile AC Sampling	Cannelton	July and August	2020

Nursery Habitat Assessment	Cannelton	July and August	2020
Larval AC Sampling	Newburgh and Cannelton	June and July	2020
Process larval samples	N/A	July and August	2020

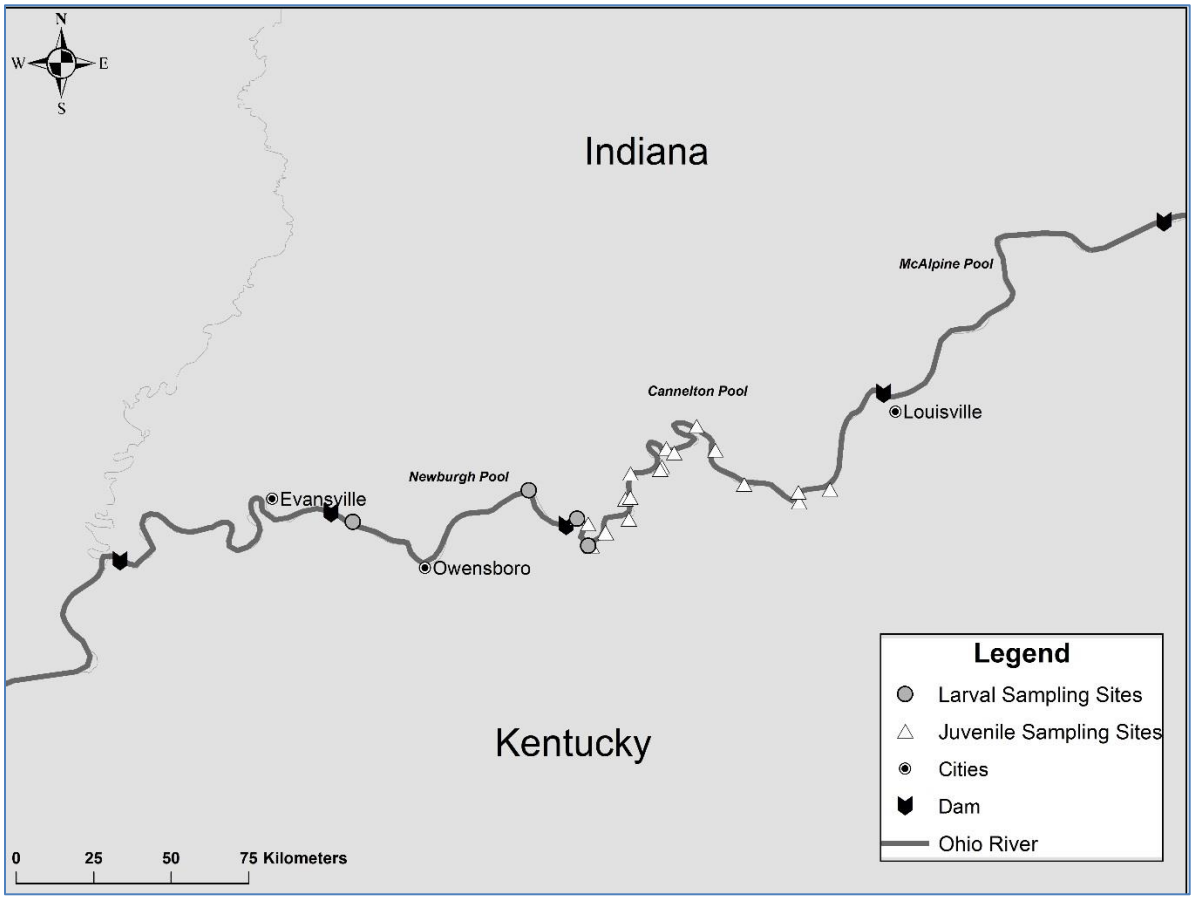

Figure 14. Proposed sampling sites for early life stages of Asian carp.

Agency: Kentucky Department of Fish and Wildlife Resources

Project Activities, Methods, and Timetable:

Objective 2
Kentucky DFWR will conduct sampling for Asian carp eggs, embryos, and larvae within tributaries of high adult Asian carp abundance in Cannelton and McAlpine pools. Specifically, KDFWR will sample Blue River and Salt River in Cannelton Pool, and Indiana-Kentuck Creek and Kentucky River in McAlpine Pool.

To evaluate relative abundance of Asian carp eggs, embryos, and larvae, conical ichthyoplankton tows (0.76m, 500 µm mesh) will be conducted at least twice at each site during ideal spawning conditions (water temperatures between 64 to 80°F with moderate to high flows) through June and July, 2019. Field staff will coordinate closely with INDNR personnel to communicate when spawning patches begin to develop on female Asian carp and will use that knowledge as another indicator to sample. 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. A 50 ml aliquot of the original ethanol preservative will be pulled from each sample 24-48 hours after taken. Ethanol samples will then be submitted to Whitney Genetics Lab for quantitative PCR sampling to detect DNA from bigheaded carps eggs and larvae. Results from the PCR analysis will determine presence/absence of bigheaded carp eggs and or larvae in samples, and will be used to prioritize which samples will be further sorted. Pending PCR analysis, morphometric characteristics developed by Chapman and George (2011) will be used to identify suspected bigheaded carp carp eggs, embryos, and larvae. If necessary, a subsample of suspected bigheaded carp eggs, embryos, and/or larvae can then be sent to Whitney Genetics Laboratory for confirmation of species. Results will be used to locate spawning locations in the Ohio River Basin 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 via two ichthyoplankton tows above the confluence of the tributary. In addition, three tows will be taken within the tributary upstream of any potential Ohio River influence. Depth (m) and water temperature (^{0}C) will be recorded using a boat-mounted depth sounder at each sampling site.

Objective 3
KDFWR will conduct targeted sampling for juvenile Asian carp in Cannelton Pool of the Ohio River. 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. Previous sampling efforts regularly captured YOY in JT Myers Pool, occasional captured them in Newburgh Pool, and have not captured YOY Asian carp in Cannelton Pool despite the high relative abundance of adults present. Therefore, the juvenile electrofishing effort has been consolidated in 2019 to only include Cannelton Pool. This consolidated sampling will allow for a more thorough look at the potential for Asian carp recruitment in Cannelton Pool. Specific areas to be sampled will include Deer Creek, Millstone Creek, Clover Creek, Bull Creek, Town Creek, Sinking Creek, Poison Creek, Yellowbank Creek, Oil Creek, Spring Creek, Watson Creek, Little Blue River, Wolf Creek, Blue River, Indian Creek, Buck Creek, Otter Creek,

Mosquito Creek, and Salt River. 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 allowing, additional gears (surface trawl, seine, etc.) may be used to evaluate their effectiveness for catching juvenile Asian carp.

Electrofishing samples will consist of at least one 15-minute transect 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; those collected will be 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).

Objective 4

KDFWR will conduct targeted sampling for juvenile Asian carp in Cannelton Pool. 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. Tributaries and embayments in Cannelton Pool of the Ohio River will be targeted with pulsed DC electrofishing and surface trawling 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 shared with INDNR for compilation 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	Cannelton	July and August	2020
Nursery Habitat Assessment	Cannelton	July and August	2020
Larval AC Sampling	Cannelton and McAlpine	June and July	2020
Process larval samples	N/A	July and August	2020
Send subsample of suspected AC to Whitney Lab for genetic confirmation	N/A	July and August	2020
Juvenile AC Sampling	Cannelton	July and August	2021

Nursery Habitat Assessment	Cannelton	July and August	2021
Larval AC Sampling	Cannelton and McAlpine	June and July	2021
Process larval samples	N/A	July and August	2021

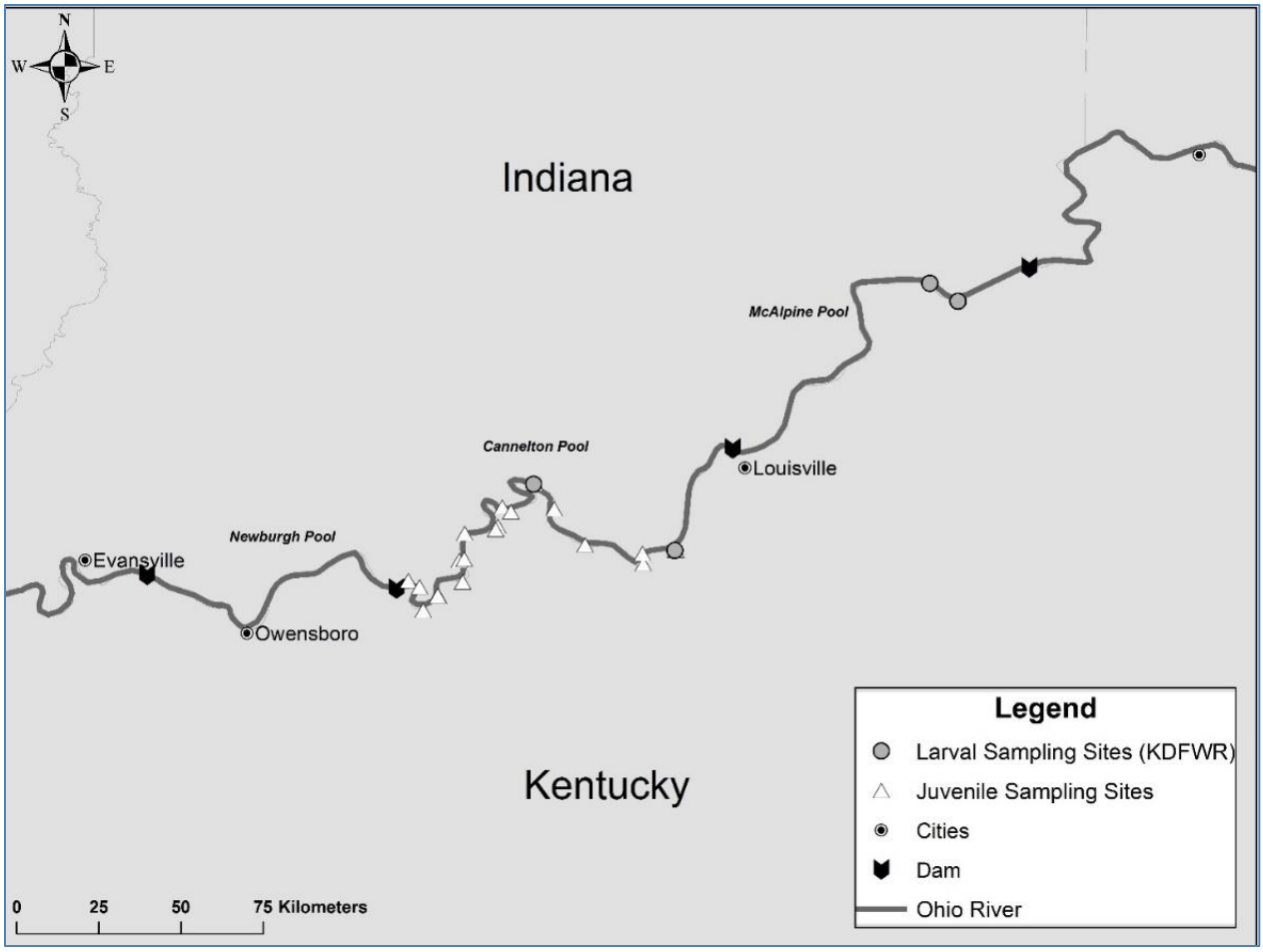

Figure 15. Proposed sampling locations for early life stages of Asian carp in the Ohio River.

Agency: West Virginia Division of Natural Resources

Project Activities, Methods, and Timetable:

WVDNR will contract with West Virginia University to complete this work. In addition, WVDNR will assist in sample collection within the R.C. Byrd and Greenup pools.

Objective 1
West Virginia University will coordinate and conduct sampling for bigheaded carp eggs, embryos, and larvae in RC Byrd, Greenup, Meldahl, and Markland pools. Specifically, WVDNR will sample at Kyger Creek Plant (R.C. Byrd Pool), Guyandotte River (Greenup Pool), Scioto River and J.M. Stuart Plant (Meldahl Pool), and Little Miami River and Hogan Creek (Markland Pool).

To evaluate relative abundance of bigheaded 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, 2019. 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. A 50 ml aliquot of the original ethanol preservative will be pulled from each sample 24-48 hours after taken. Ethanol samples will then be submitted to Whitney Genetics Lab for quantitative PCR sampling to detect DNA from bigheaded carps eggs and larvae. Results from the PCR analysis will determine presence/absence of bigheaded carp eggs and or larvae in each sample. In addition, morphometric characteristics developed by Chapman and George (2011) will be used to identify suspected bigheaded carp eggs, embryos, and larvae. WVU will send a subsample of suspected bigheaded carp eggs, embryos, and/or larvae to Whitney Genetics Laboratory for confirmation of species. 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	Markland, Meldahl, Greenup, and RC Byrd	May, June, and July	2020
Process samples to identify AC egg, embryo, and larvae	Newburgh, Cannelton, McAlpine, Markland, Meldahl, Greenup, and RC Byrd	June, July, and August	2020

Send subsample of suspected AC to Whitney Lab for genetic confirmation	N/A	June, July, August	2020
Send compiled larval data to INDNR	N/A	September	2020
AC egg, embryo, and larval sampling	Markland, Meldahl, Greenup, and RC Byrd	May, June, and July	2021
Process samples to identify AC egg, embryo, and larvae	Newburgh, Cannelton, McAlpine, Markland, Meldahl, Greenup, and RC Byrd	June, July, and August	2021
Send subsample of suspected AC to Whitney Lab for genetic confirmation	N/A	June, July, August	2021
Send compiled larval data to INDNR	N/A	September	2021

Figure 16. Proposed sampling locations for early life stages of Asian carp in the Ohio River.

Literature Cited

Chapman, D. C. and A. E. George. 2011. Developmental rate and behavior of early life stages of Bighead Carp and Silver Carp. U.S. Geological Survey Scientific Investigations Report 2011-5076. 62p.

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). Asian carps 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. Accordingly, their ability to colonize new areas with dense populations, inflict significant impacts on recreation and natural aesthetics, and alter the function of native ecosystems, places the Ohio River basin at considerable 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 (Tsehaye et al. 2013). These would work to prevent movement of the Asian carps into critical areas while decreasing propagule pressure. In addition, 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 being tested 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. Reports and speculation on removal efforts in the Illinois River have 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 2017 - 2018 were conducted in higher density pools after basin feedback identified a need to focus efforts in areas where agency crews could obtain higher yields considering the cost and time required to capture fish above Markland L&D. Recent modeling has also suggested that removal has more impact along the establishment front considering that populations above this point have little to no recruitment and abundances are primarily based on immigration (D. Glover, personal communication). Methods are proposed for 2019 that build off the successes in previous years.

National Plan Goal Supported:

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 Strategy Supported:

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;

Sub-basin Management Plan Goal Supported:
Population Control

Sub-basin Management Plan Strategy Supported:

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. Implement a removal program using contracted anglers within an intensive management zone to reduce carp population numbers below Markland Locks and Dam.
3. Develop an Ohio River Contingency Response Plan.

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

Project Activities, Methods, and Timetable:

Objective 1

Physical Removal of Asian Carps

Agency crews will remove Asian carps from the Ohio River, focusing on known or suspected areas of high density. Some focus will be shifted away from the Cannelton pool in 2019 to allow the use of contract angling to be incorporated along the intensive management zone. The majority of targeted areas will be within the main-stem river above McAlpine pool, or only a couple miles up contiguous tributaries. After some exploratory effort in 2018, some sites further up tributaries such as Salt River and the KY River will have focused removal of fish that may be using tributaries as refuges, nurseries, or transition areas for juvenile fish. 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. Additional data may be taken from fish to fill in fishery independent data gaps from monitoring and evaluation efforts. Exterminated fish may also 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.

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 and will thus be included in that annual report.

Objective 2

Implementation of Contract Anglers

Agency crews have focused primarily on removal of invasive carps in the Cannelton and McAlpine pools in the previous years. With field crews able to pull out estimates of 3,000 lbs or more in a day, and the pool's classification as the transition zone from the establishment to invasion font, Cannelton has been identified as a good candidate for implementing a contract fishing program to control Asian Carp populations. Contract anglers will be employed from to conduct removal during several months within the project period in the Cannelton pool. Previous efforts have shown that the removal of fish by agency crews can yield around 15,000 lbs per week. Using this as a conservative benchmark, it is probably realistic to anticipate one contracted crew to be capable of removing comparable amounts when compared to our methods. This would place expected yields around 360,000 lbs over a six-month period from just one crew, but catch will be highly dependent on seasonal changes and river conditions. It is our intent to use three contract vessels with anglers employed to target only Asian Carp species in high density areas. Contract vessels will be accompanied by on-board observers who will

document landings and by-catch from angling efforts. Yields may be subsampled several times throughout the program period to give managers a measure of differences between contract angler catch (fishery dependent data) and evaluation yields (fisheries independent data). This information will determine if supplemental efforts with alternative gears or strategies will be required to aid in population reductions in addition to contracted or commercial fishing. It is likely that commercial gears will target larger length-classes of fish and alternative routes for capturing smaller length-classes will be required to aid in fishery destabilization.

Objective 3

Develop an ORB Contingency Response Plan

KDFWR staff will work with basin partners to identify 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, an updated draft, and a summary of findings will be provided to the basin partners for comment and review.

Estimated Timetable:

Project Activity	Pool	Month(s)	Year
Removal	McAlpine – Meldahl and Large Tributaries	May 14 – Sept 24	2019
Removal	RC Byrd	June	2019
Removal	RC Byrd	July	2019
Removal	RC Byrd	August	2019
Removal	RC Byrd	September	2019
Project Executive Summary	N/A	October 30	2019
Removal	Cannelton	November	2019
Removal	Cannelton	December	2019
Removal	Cannelton	January	2020
Removal	McAlpine	February	2020
Project Technical Report	N/A	February 28	2020

Removal	McAlpine – Meldahl and Large Tributaries	May – September	2020
Removal	RC Byrd	Various	2020

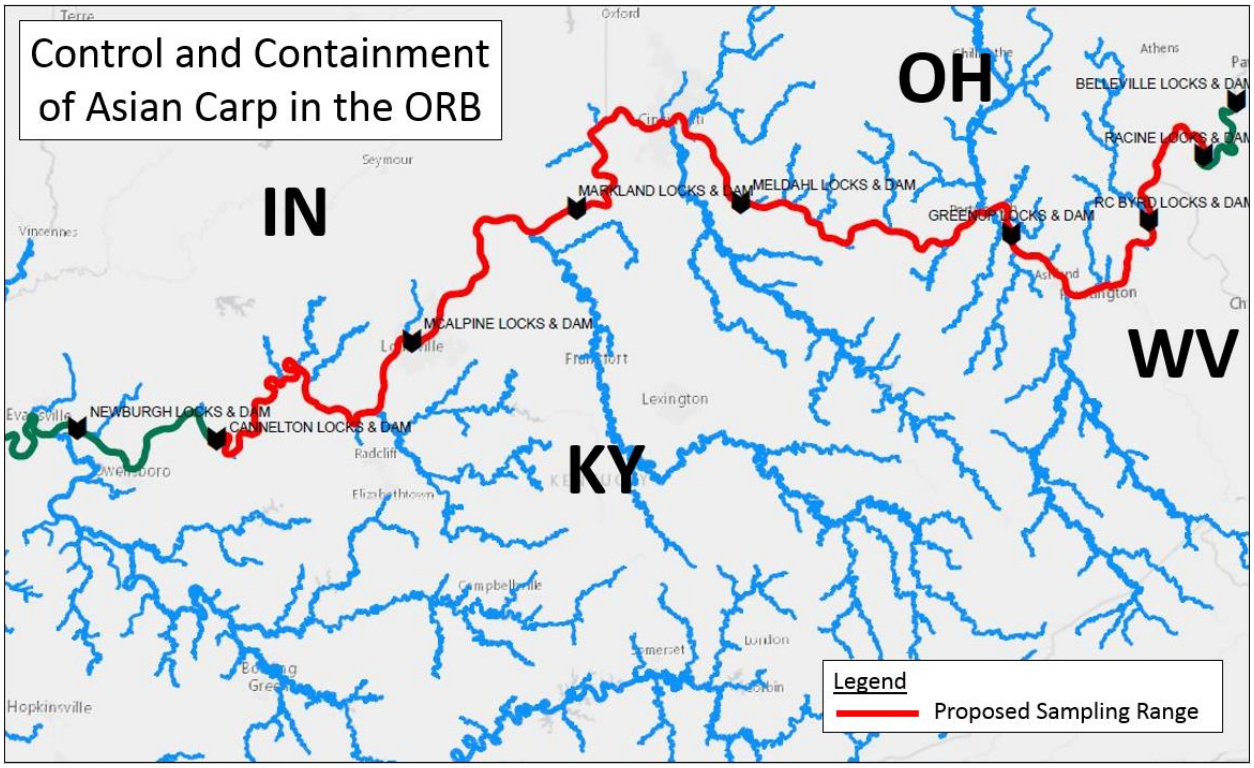

Figure 17. Proposed sampling range for Asian carp removal in the Ohio River.

Agency: West Virginia Division of Natural Resources (WVDNR)

Project Activities, Methods, and Timetable:

Objective 1

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. All Asian carps collected will be measured for total length, weighed, sexed and subsequently exterminated. Otoliths and/or pectoral fin rays will be removed 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.

Objective 3

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	July-Sept.	2020
Removal	Greenup	July-Sept.	2020
Response Plan Research	N/A	Jan-Dec	2020

Figure 18. Proposed range for Asian carp removal in the Ohio River.

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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 L&D

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

Agency Collaboration: Indiana Department of Natural Resources (INDNR), 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 Goal Supported:

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 Strategy Supported:

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.

Sub-basin Management Plan Goal Supported:
Prevention
Monitoring and response
Population control
Understanding Impacts
Communication

Sub-basin Management Plan Strategy Supported:

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.

Agency: USFWS

Estimated Timetable:

Month	Pool	Scheduled Work
April/May	All pools	Deploy receivers into mainstem Ohio River. Replace batteries in tributary and L&D receivers.
May/June through November (monthly)	All pools	Offloading data and maintenance of all receivers.
September & October	Markland & Meldahl	Asian carp tagging.
December	All pools	Retrieve receivers from the mainstem Ohio River. Final 2019 offload of data from tributary and L&D receivers.

Upper Ohio River Receiver Deployment Sites:

Due to the lack of detections, risk of loss, and increased need downstream, many of the receivers from Willow Island, Belleville, and Racine pools will not be deployed for the 2019 season. Receivers located in the lock approaches and lock chambers will remain, however, as risk of loss is very low while still providing some coverage. Receivers removed from these upper pools can then be utilized to replace lost receivers in areas of higher Asian carp densities or to extend the current array farther downstream in the Cannelton Pool. Proposed Upper Ohio River receiver deploy sites and removal sites are listed in the table below. Receivers located in the lock chambers and the lock approaches, as well as those located in the lower pools, are not included in this table.

Station Name	Pool	Location	River Mile	Latitude	Longitude
Below downstream tip of Broadback Island	Willow Island	Mainstem OHR	159.3	39.37781	-81.28009
Willow Island Dam Lower (2 receivers)	Belleville	Mainstem OHR	162.0	39.35684	-81.32556
Marietta Island	Belleville	Mainstem OHR	172.0	39.38577	-81.40773
Upper Muskingum Island	Belleville	Mainstem OHR	175.0	39.37910	-81.49093
Parkersburg Toll Bridge	Belleville	Mainstem OHR	183.0	39.28211	-81.56379
Parkersburg Railroad Bridge (2 receivers)	Belleville	Mainstem OHR	184.0	39.27096	-81.56475

Belleville Dam Upper	Belleville	Mainstem OHR	196.2	39.21483	-81.71732
Hocking River	Belleville	Tributary	199.3	39.19401	-81.75847
Hocking River Upper	Belleville	Tributary	199.3	39.20276	-81.77608
Portland Green	Racine	Mainstem OHR	214.5	39.02527	-81.77133
Ravenswood Bridge (Red)	Racine	Mainstem OHR	221.3	38.94175	-81.75945
Mill Creek Lower	Racine	Tributary	231.2	38.88989	-81.85007
Mill Creek Upper	Racine	Tributary	231.2	38.88852	-81.84469

= Spring deploy = Removed or not deployed

Table 3. Proposed upper Ohio River telemetry receiver deploy sites.

2019 Download Schedule:

Pool	April	May	June	July	August	September	October	November
Willow Isl.	USFWS	WVDNR	WVDNR	USFWS	WVDNR	USFWS	WVDNR	USFWS
Belleville	USFWS	WVDNR	WVDNR	USFWS	WVDNR	USFWS	WVDNR	USFWS
Racine	USFWS	WVDNR	WVDNR	USFWS	WVDNR	USFWS	WVDNR	USFWS
R. C. Byrd	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR	WVDNR
Greenup	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS	USFWS
Meldahl	OH D5	OH D5	OH D5	OH D5	OH D5	OH D5	OH D5	OH D5
Cincinnati to Meldahl L&D	OH D5	OH D5	OH D5	OH D5	OH D5	OH D5	OH D5	OH D5
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

Table 4. 2019 Telemetry receiver deployment schedule and agency responsibility.

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

Project Activities, Methods, and Timetable:

Objecive 1

Understand use of Tributaries

Most of KDFWR's receiver work in 2019 will continue to focus on the sites located within the first ~168 miles of the telemetry array, which encompasses all receiver stations in the Cannelton Pool, McAlpine Pool and the first half of the Markland Pool. KDFWR will also help with the maintenance and offload of this same area's temperature loggers, which the USFWS began attaching to each tributary's uppermost receiver stand back in the spring of 2017. As one of KDFWR's main responsibilities in the project, field crews plan to visit all tributary sites within their section of the array on a monthly basis, which is when the latest data will be offloaded from the receivers and/or any temperature loggers that are present. Beginning in 2019, KDFWR project biologists intend to use manual tracking in larger tributaries (i.e. Kentucky River) in an effort to relocate tagged Asian Carp (AC) that were last detected in these areas more than a year ago. The KDFWR will also continue to play a major role in preparing and analyzing all receiver data that partnering agencies offload and share by way of the project's FTP site (provided by ODOW). Unlike previous years, the KDFWR will also begin uploading the 2019 detections to FishTracks, which is online database that the USGS specifically developed for regional telemetry studies involving Asian Carp (AC). The KDFWR will also continue to gather environmental data (i.e. river levels and water temps) to determine if there's any correlation with when the AC are occupying the tributaries. The results from the analysis of the tagged AC detections and the environmental data will then be used to summarize the AC population's tributary usage for both the mid-year Report to Congress, and the project's 2019 Technical Report.

Objective 2

Delineate Upstream Distribution and Further Dispersal

Within KDFWR's section of the project's entire 500-mile array, the only receiver stations considered as "upstream sites" are those specifically located between Markland Lock & Dam (L&D) and Tanner's Creek. Regardless, in 2019, KDFWR will continue conducting the receiver work for this objective, which focuses primarily on tributary sites within the first half of the Markland Pool. Aside from attending to the established tributary stations, KDFWR's field crews will continue looking for new possible methods for establishing mainstem sites in this area, which has always been limited to a single navigation buoy. Despite the lack of mainstem receivers, the KDFWR will continue monthly site visits to offload the latest 2019 telemetry data, as well as any additional data from attached temperature loggers. As a way to offset the lack of mainstem sites in the lower Markland Pool, KDFWR project biologists plan to use manual tracking in 2019 to help relocate several tagged carp that were last detected in the area over a year ago. During late summer through the fall of 2019, KDFWR also plans to assist crews from the USFWS and INDNR in an effort to implant ultrasonic transmitters into adult Asian Carp that are specifically collected from the Markland and Meldahl Pools. KDFWR project biologists will

continue to prepare and error-check the datasets that partnering agencies offload from all receiver sites located upstream of Markland L&D. These datasets will be combined at certain times throughout 2019 and then uploaded to USGS' FishTracks site, as well as imported into a local offline database as a backup. This objective's detection data will be analyzed to produce results that can specifically describe the AC population's upstream distribution and the likelihood of their further dispersal up the Ohio River. This objective's latest results will be summarized for both the mid-year Report to Congress and the project's 2019 Annual Technical Report.

Objective 3

Inform Sampling Efforts via Telemetry Data

The KDFWR plans to begin field efforts in 2019 with the spring redeployment of mainstem receivers that were retrieved in December 2018 prior to being stored off-river for the winter season. This objective remains the driving force behind KDFWR's ongoing efforts to establish and maintain the mainstem sites located throughout the first two pools of the array. It also continues to be the primary motivation for either establishing new receiver stations and/or conducting manual tracking in areas where coverage is inadequate. Once the redeployment efforts are completed in 2019, KDFWR field crews will continue the monthly efforts to offload telemetry data from all mainstem stations in KDFWR's section of the array, as well as all other receiver stations that may not have been covered by previous objectives. Finally, during mid-December 2019, KDFWR field crews will once again attempt to retrieve VR2W's from buoys at mainstem sites and then move them to overwinter storage in order to avoid unusually high seasonal receiver losses. Throughout 2019, KDFWR biologists will periodically gather telemetry data that project partners have offloaded from the mainstem receivers in their area and then combine them with tagged carp detections from other sites (i.e. tributary and L&D). These combined datasets will then be uploaded to the FishTracks site and backed up on the local offline database that's maintained by KDFWR biologists. Ultimately, all tagged carp detections from 2019 will be analyzed along with the available environmental data to potentially locate new areas with high densities of AC that should be vulnerable to the gear types used during the agency's removal efforts and other fishing being conducted by contract anglers. Regardless of the outcome, the KDFWR will use all available results to summarize this objective for the mid-year Report to Congress and the 2019 Technical Report.

Objective 4

Quantify Locks & Dams Passage

The only Locks & Dam (L&D) projects within KDFWR's section of the telemetry array that are being monitored year-round for tagged carp passage are Markland L&D and, to a lesser degree, McAlpine L&D. In 2019, KDFWR will continue to work with the USFWS and USACE to maintain the existing stations that are associated with each L&D and then assist with potential efforts to improve receiver coverage around McAlpine L&D and the nearby Falls of the Ohio. The KDFWR field crews will also continue to make regular efforts to offload new data from VR2W's stationed in and around both Markland and McAlpine L&D's. Since the project's array contains six more L&D projects located upstream of the Markland Pool, this objective is also

tied into KDFWR's plans to assist with the multi-agency effort (USFWS, INDNR, WVDNR) to implant transmitters into additional Asian Carp from the Markland and Meldahl pools. The KDFWR's project biologists will continue to work with telemetry data from any stations that are associated with the L&D projects found within the boundaries of the receiver array. Tagged carp detections recorded by L&D receivers in 2019 will then be added to a dataset containing similar results from previous years (2013 - 2018). The KDFWR will use this data to identify any tagged AC that may have transferred from one pool to another, which is critical to the pool-to-pool movement probabilities that USFWS biologists recalculate annually for a model that their developing. Ultimately, the results obtained from L&D receivers and the specific details on pool-to-pool transfers will be used to address Asian Carp passage through Ohio River L&D's in both the mid-year Report to Congress and the Telemetry Project's 2019 Technical Report.

Objective 5

Estimate Probability of Survival

The KDFWR's monthly efforts to maintain and offload all receiver stations located in the Cannelton Pool, the McAlpine Pool and the first ~40 miles of the Markland Pool will be used to collect the 2019 telemetry data that USFWS biologists need to calculate monthly survival estimates.

Estimated Timetable:

Project Activity	Pool(s)	Month	Year
Redeployment of overwintering VR2W's & Start offloading data from tributary receivers	Cannelton, McAlpine & 1st half of Markland	April-May	2019
Conduct monthly efforts to Maintain & offload data from all receiver sites. Establish new receiver sites (as needed)	Cannelton, McAlpine & 1st half of Markland	May-November	2019
Conduct manual tracking when possible to relocate missing tagged AC in areas with poor receiver coverage	Cannelton, McAlpine & 1st half of Markland	June-October	2019
Assist with AC Tagging Efforts	Meldahl, Markland & McAlpine	August-October	2019
Offload data from tributary and L&D receivers. Retrieve VR2W's from all mainstem sites for overwinter storage	Cannelton, McAlpine & 1st half of Markland	December	2019

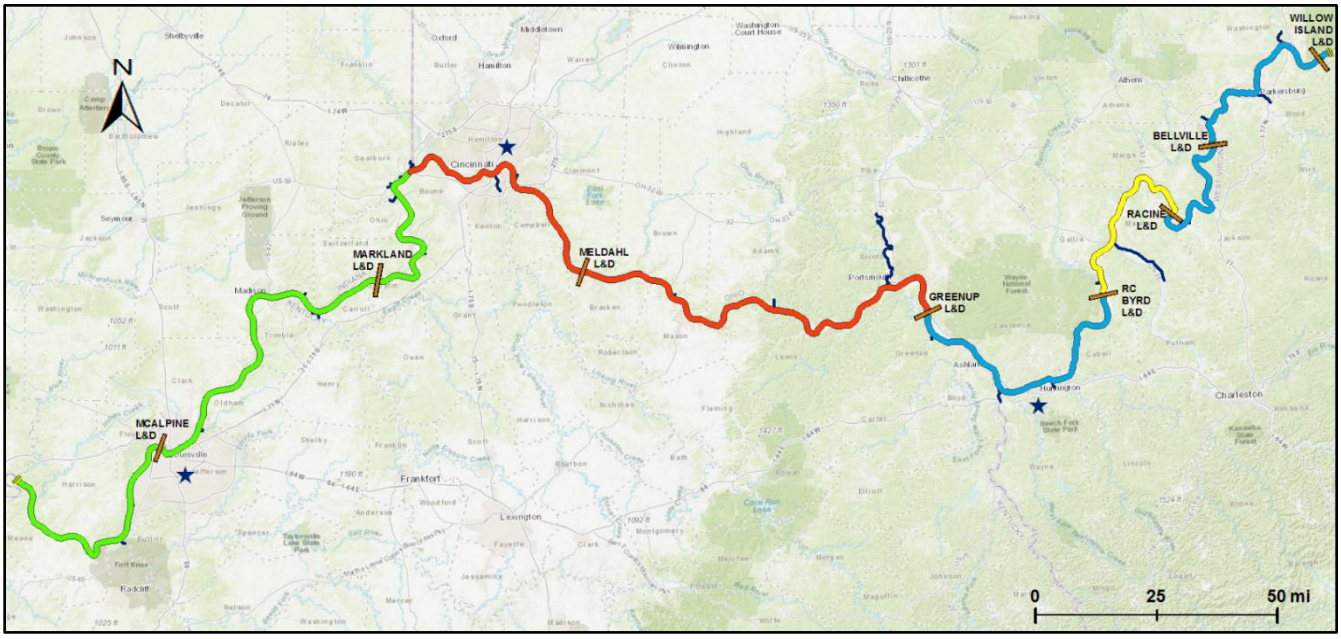

Figure 19. The project's 500+ mile receiver array that stretches between Leavenworth, IN (RM 662) and Newport, OH (RM 159).

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 (ADCNR), Tennessee Tech University (TTU)

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 in abundance 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. Master's theses completed in 2016 and 2018 were 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, the extent of spawning occurring within the systems, movement within the systems, 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.

In 2017, TTU commenced standardized, systematic sampling on Kentucky, Barkley, Cheatham, and Pickwick reservoirs to evaluate relative densities of Asian carp using gill nets and electrofishing. This project will fund another year of systematic sampling conducted in spring, summer, and fall at those reservoirs.

This ongoing work also aims to increase samples used to characterize populations (e.g., age and growth analysis). TWRA and KDFWR commenced inter-agency carp sampling in spring 2019 and our data and efforts further support those agencies needs on Asian carp population in the Tennessee and Cumberland rivers.

National Plan Strategies Supported:

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.

Sub-basin Management Plan Goal Supported:

Monitoring and Response

Sub-basin Management Plan Strategy Supported:

Strategy 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.
Strategy 2.7	Support research to improve capabilities to detect early stages of invasion and spawning populations of Asian carp.
Strategy 3.2	Support and accelerate research on sustainable, cost-effective means of long-term control methods.

Project Objectives:

1. Conduct systematic sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Tennessee and Cumberland rivers.
2. Asian carp surveillance and directed sampling in the Tennessee and Cumberland rivers that includes larval sampling and collaboration for controls and monitoring.

Agency: Tennessee Wildlife Resources Agency

Project Activities, Methods, and Timetable:

Proposed project activities for objectives. 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 over-night sets after seeing improved catches relative to short (2-hour) net sets. Active gears will also be utilized for Objectives 1 and 2. In 2019, summer sampling will utilize an electrified dozer trawl to capture fish and possibly detect young-of-year in late summer. All electrofishing will use pulsed-DC current (5-8 Amps, 535 Volts, 120 pulses per second). Survey sites for Objective 1 will be stratified by lake area (e.g., downsteam versus upstream) following the study design from previous years (see Map 1). Three strata in Kentucky and Barkley reservoirs where abundances are higher than in Cheatham and Pickwick reservoirs, which will have two spatial strata. Dozer trawl transects will have fixed time periods (e.g., 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. Sampling will enhance estimates 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) data will continue to be collected to help inform population models and potential spawning time.

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	Spring (May-June), Fall (October-November)	2019 - 2021
Adult Density Electrified Dozer Trawling	Kentucky, Barkley, Cheatham, and Pickwick	Summer	2019 - 2021

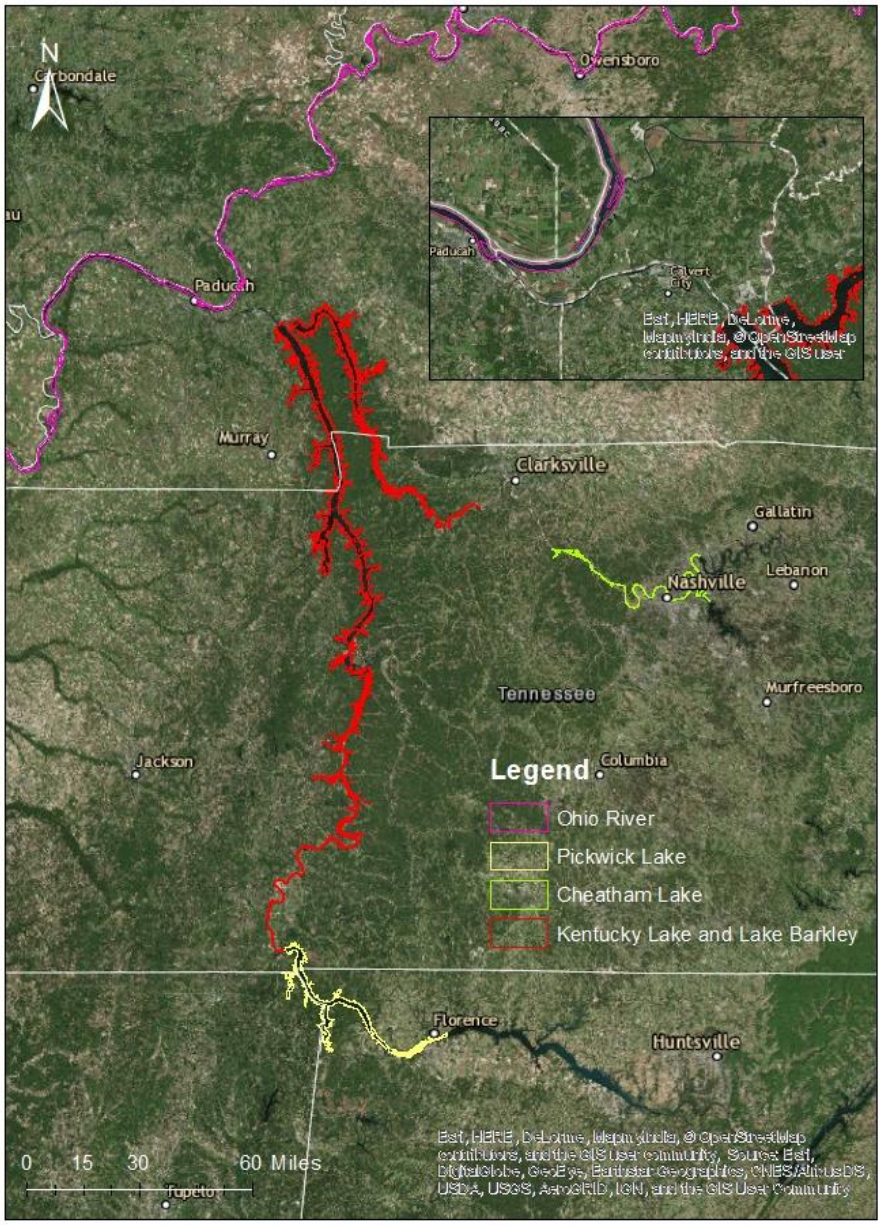

Figure 20. Proposed reservoirs for measuring relative density and population characteristics of Asian carp in the Tennessee River and Cumberland River.

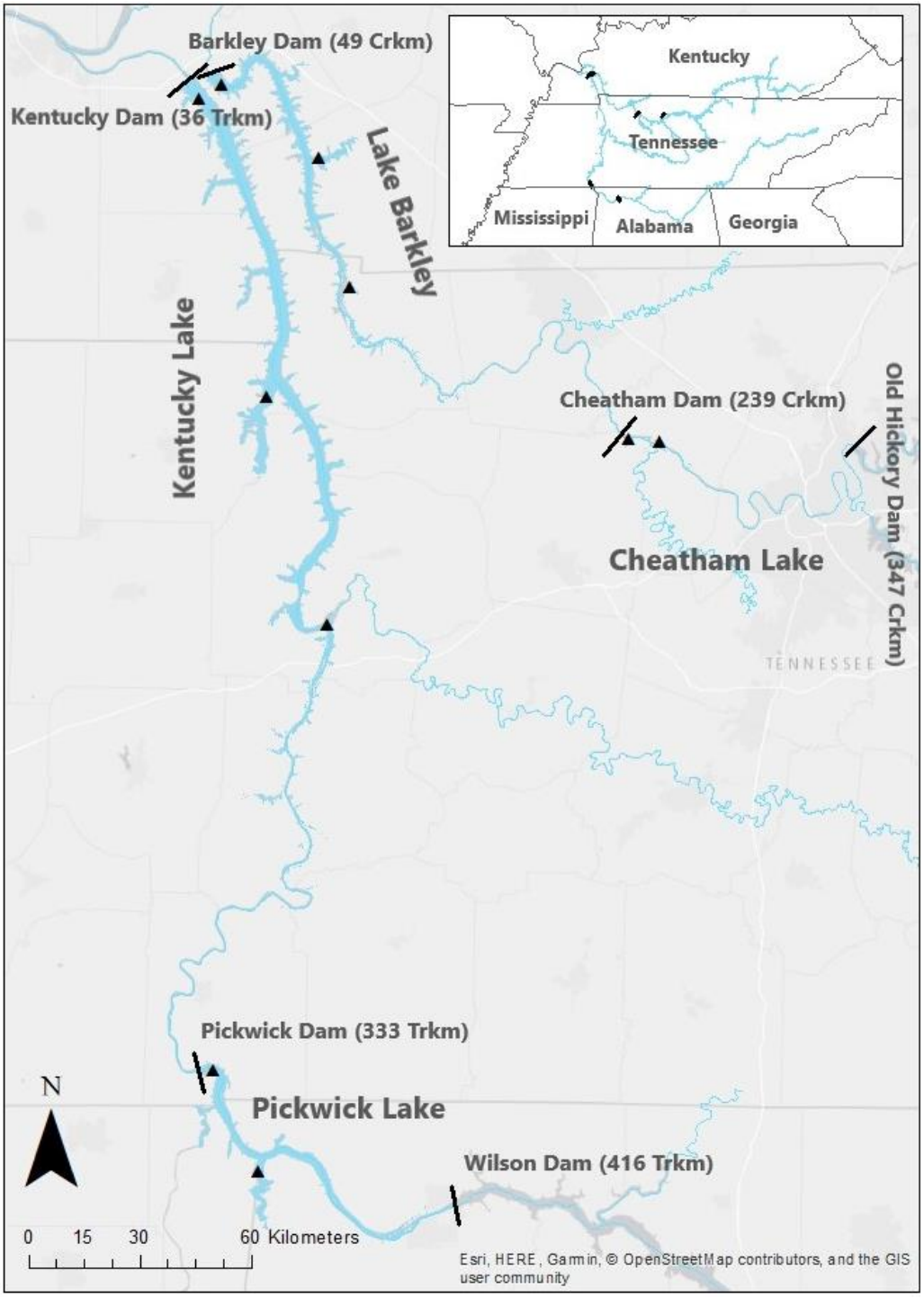

Figure 21. Standardized, systematic sampling areas for measuring relative density and population characteristics of Asian carp in the Tennessee River and Cumberland River. Sampled reservoirs include Barkley, Kentucky, Pickwick, and Cheatham.

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 150 Silver Carp with acoustic transmitters and engaged in active and stationary tracking of movements. MDWFP and

TTU have also tagged over 75 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.

National Plan Goal Supported:

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 Strategy Supported:

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 3.2.4	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;

Sub-basin Management Plan Goal Supported:

Prevention

Monitoring and Response

Sub-basin Management Plan Strategy Supported:

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 evaluate priority locations for deterrent placement to control movement of Asian Carp in the Tennessee and Cumberland rivers.
2. Collect baseline movement information among reservoirs to inform Asian carp deterrent efficacy and lock and dam passage.
3. Characterize the need for deterrents and priority locations for deterrent placement to control movement of Asian Carp in the Ohio River.

Agency: Tennessee Wildlife Resources Agency

Project Activities, Methods, and Timetable:

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 telemetry receivers are in place at all locks and dams in the Tennessee River from Kentucky Dam to Guntersville Dam to inform movement among locks and dams and across reservoirs. Receiver downloading and maintenance is a multi-state effort by KDFWR, TWRA, TTU, MDWFP, and ADCNR. A focused effort to increase the number of tagged Asian carp in the upper end of Kentucky Lake occurred in 2017 and 2018. TTU crews worked with TWRA and MDWFP to tag fish in upper Kentucky Reservoir and Silver Carp in Pickwick Reservoir. 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. The number of fish tagged will be increased in 2019 to help further inform movement through locks and dams.

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. Four individual fish were identified moving through Pickwick Dam, however no movement at Wilson Dam, and Wheeler Dam has been detected. 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
Acoustic Tag implantation	Kentucky	October and after	2019 and spring 2020 (until all tags are at-large)
Acoustic Receiver deployment and maintenance	Kentucky, Pickwick, Wilson, Wheeler, Cheatham, Old Hickory	Seasonally or as needed for maintenance	2019 and spring 2020

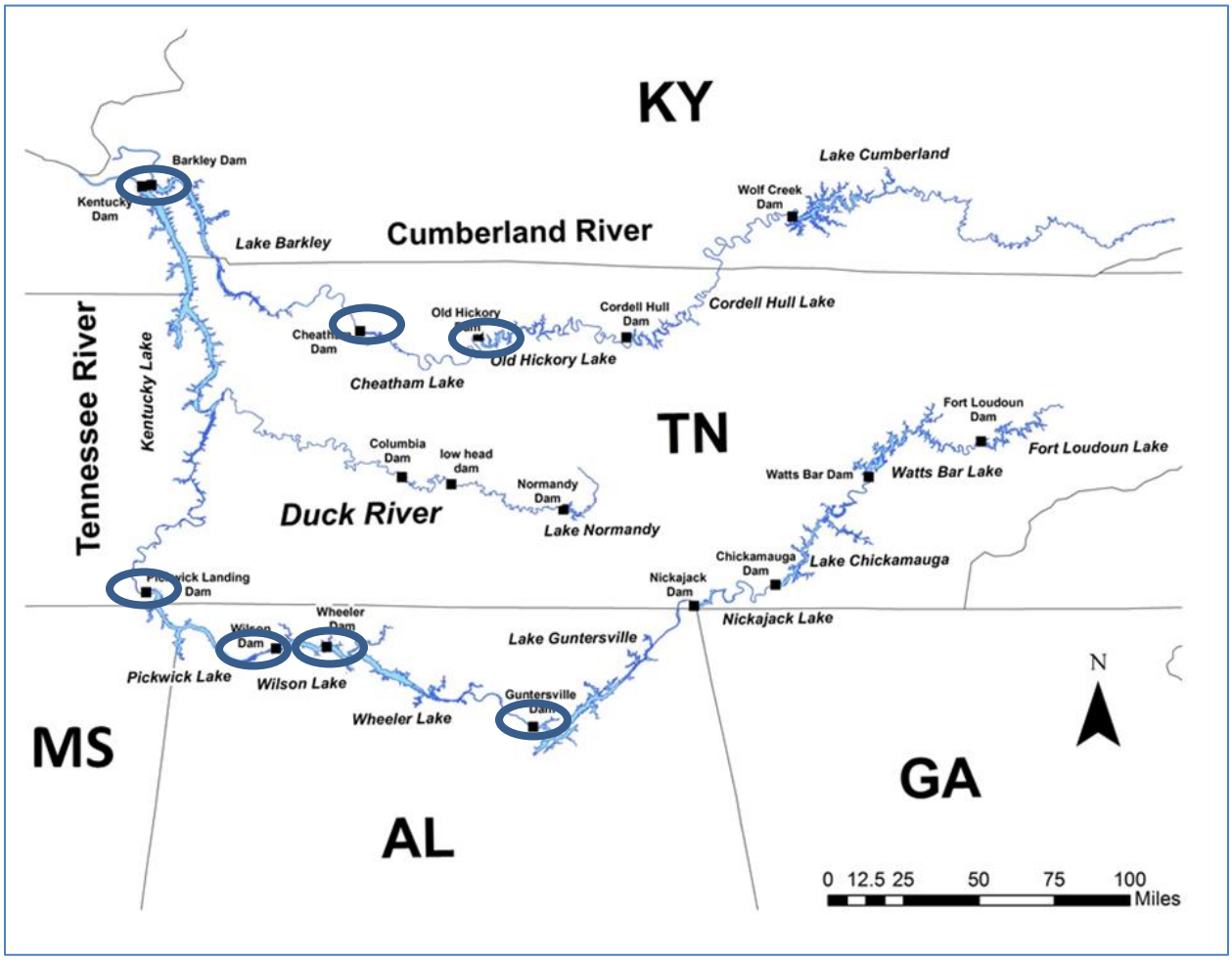

Figure 22. The Tennessee River and Cumberland River locks and dams (circled) that are monitored using acoustic telemetry receivers to measure Asian carp upstream invasion.

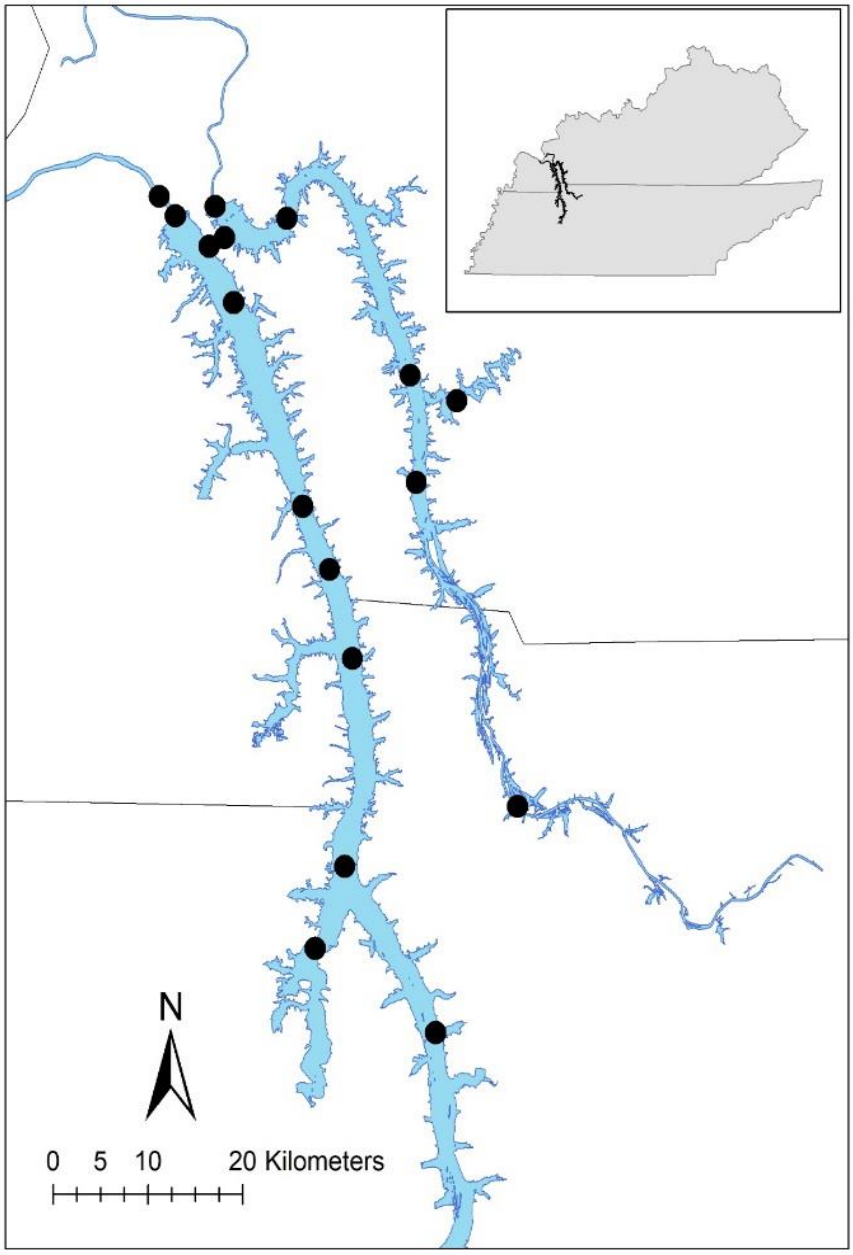

Figure 23. Locations in Kentucky and Barkley reservoirs that are monitored using acoustic telemetry receivers to measure Asian carp upstream invasion.

Agency: Kentucky Department of Fish and Wildlife Resources

Project Activities, Methods, and Timetable:

Objective 1
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 these meetings will be to identify and make necessary changes to the prioritized list of where deterrents to Asian carp movement are needed. Deterrent placement will be characterized by locations that will strategically reduce the potential of Asian carp expansion upstream in the Ohio, Tennessee, and Cumberland rivers. Locations for field testing of available deterrent strategies will also be determined.

Objectives 2 and 3
KDFWR continues to work with multiple agency partners to monitor the pool-to-pool movements of Asian carp in the middle Ohio River. Movements of Asian carp among pools and comparisons of the possible open river conditions at various Locks & Dams will be used to determine the best options for the placement of Asian carp deterrent technologies.

KDFWR plans to continue partnering with Murray State University to conduct tracking of tagged Asian Carp within Kentucky and Barkley lakes to determine diurnal movements, distances traveled, and habitat usage. These efforts are being expanded to the larger Tennessee and Cumberland river basin. Passage of Asian carp through lock chambers on the Tennessee and Cumberland rivers is also being assessed. In order to quantify fish passage and ultimately assess deterrence strategies in these river systems, tagging of additional Asian carp and placement of supplementary receivers is essential.

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 2019 through deployment of additional 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. 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. These will include 20 smallmouth buffalo, 20 paddlefish, and 20 freshwater drum in 2019. Fish will be captured through electrofishing and gill netting efforts and surgically implanted with transmitters. Tagging efforts will continue throughout 2019 or until all tags are utilized. In 2019 additional telemetry receivers will be 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 monthly 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	2019-2020
Receiver Deployment	KY Dam Tailwaters	July	2019
Receiver Deployment	Lake Barkley	September	2019
Receiver Deployment	Lower Cumberland River	July	2019
Implantation of Transmitters	Barkley Dam Tailwaters	March, April, October, November	2019-2020
Implantation of Transmitters	Lake Barkley	December, January	2019-2020
Downloading of Receivers	Kentucky Lake & Lake Barkley	Bi-Monthly	2019-2020
Downloading of Receivers	Kentucky Lock & Dam, Barkley Lock & Dam, Tailwaters	Monthly	2019-2020
Project Technical Report	N/A	February	2020

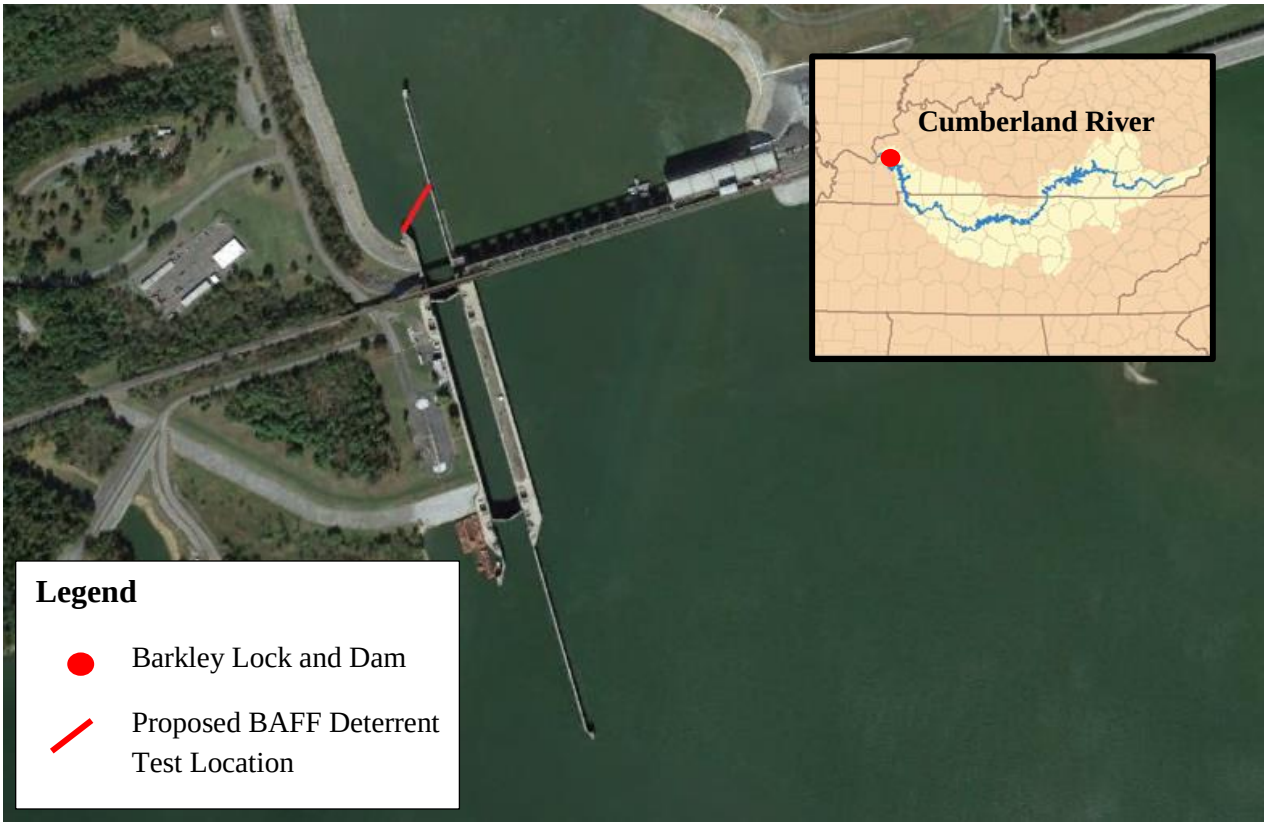

Figure 24. Proposed location for installation of Bio-Acoustic Fish Fence (BAFF) deterrent system for testing at Lake Barkley Lock and Dam on the Cumberland River. Kentucky Department of Fish and Wildlife Resources will assist in collection of baseline data and with monitoring of system effectiveness.

Project Title: Evaluation and Removal of Asian Carp in the Tennessee and Cumberland Basins

Geographic Location: Tennessee and Cumberland rivers and the northern section of the Tennessee-Tombigbee Waterway (Divide Cut and Bay Springs Lake).

Lead Agency: Tennessee Wildlife Resources Agency (TWRA)

Agency Collaboration: TWRA; Kentucky Department of Fish and Wildlife Resources (KDFWR); Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP); Alabama Department of Conservation & Natural Resources, Wildlife & Freshwater Fisheries Division (ALWFF); U.S. Fish and Wildlife Service (USFWS); U.S. Army Corps of Engineers; Tennessee Valley Authority; Tennessee Cooperative Fisheries Research Unit, Tennessee Technological University (TTU); and Mississippi State University.

Statement of Need:

As of 2019, all four species of Asian carp have been collected in the Tennessee and Cumberland rivers (TNCR). The states of Kentucky, Tennessee, Mississippi and Alabama have significant recreational and ecological resources at risk due to Asian carp. This project is needed to help implement portions of the national management and control plan for Asian carp (Conover et al. 2007) and portions of the Ohio River Basin Asian carp control strategy framework (Ohio River Fisheries Management Team 2014).

This project will further develop standardized protocols to assess abundance and population dynamics of Asian carp, and determine effectiveness of control measures. TWRA and KDFWR have invested in commercial carp removal programs, and the USFWS is funding a sound barrier at Barkley Lock. To measure the success of these control measures, agencies need standardized sampling methods that will allow comparisons among water bodies and over time. Foundational research on carp sampling has been conducted by USFWS, KDFWR, TWRA, and TTU using the USFWS Asian Carp Base Funds and local funding sources. These projects have tested many sampling methods, identifying the best available methods for sampling carp. This project will increase capacity for standardized sampling in TN and KY, and for the first time include projects in MS and AL. The inclusion of all four states is critical for the evaluation of carp populations in the TNCR.

In this project, KDFWR and MDWFP will evaluate the response by the native fish community and their fisheries in the presence of Asian carp. Fisheries managers need to understand these dynamics to evaluate the effectiveness of control levels, and to keep stakeholders informed. This work will complement ongoing projects in the TNCR. For example, the all state agencies have monitoring native sport fisheries in the TNCR, and the TVA has a long-term monitoring program for native fish communities in the Tennessee Valley. In this new project, the KDFWR will evaluate the response of native fishes, such as gizzard shad, buffalo, and paddlefish, which compete directly with bigheaded carp for zooplankton. KDFWR will also survey anglers to measure impacts on sport fishing in carp infested waters. The MDWFP will use historical data to assess potential changes in fish assemblages linked to Asian carp invasions.

The commercial fishing industry has been successful at harvesting carp using gillnets, but harvest rates are not meeting demands for carp in the markets. Due to cost and restrictions on commercial gear types, the private sector cannot easily test new methods. Development of more efficient carp removal methods would greatly benefit the TNCR and potentially other basins. As part of this project, the KDFWR will continue to evaluate new gears that could be used by resource managers and commercial fishers. This work will benefit all partners in the TNCR as we need highly effective removal methods that are designed for the habitats associated with the TNCR.

National Plan Goals Supported:

Goal 3	Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carps in the United States.
Goal 4	Minimize potential adverse effects of feral 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 Supported:

Strategy 3.1	Determine life history characteristics and build population dynamics models of Asian carps in the Mississippi River Basin.
Strategy 3.2	Increase the commercial harvest of Asian carps.
Strategy 3.4	Physical removal by natural resources management agencies.
Strategy 4.1	Enhance organisms adversely affected by Asian carps.
Strategy 6.1	Develop effective sampling gears and monitoring methods for all life stages of Asian carps in both standing and flowing water environments.
Strategy 6.2	Assemble information about the distribution, biology, life history, and population dynamics of bighead, black, grass, and silver carps.
Strategy 6.4	Develop an integrated management strategy to extirpate or reduce abundances of feral Asian carps.
Strategy 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.

Sub-basin Management Plan Goals Supported:
Monitoring and Response

Population Control

Understanding Impacts

Sub-basin Management Plan Strategy Supported:

Strategy 2.3	Implement contract surveillance of targeted Asian carp sampling to monitor the distribution and abundance Asian carp.
Strategy 3.2	Support and accelerate research on sustainable, cost-effective means of long-term control methods.
Strategy 4.1	Conduct collaborative inter-agency research to measure the distribution, movement, and habitat use of Asian carp in the middle Ohio River.
Strategy 4.2	Sponsor university research to explore the impacts of Asian carp on aquatic communities in the mainstem of the Ohio River and major tributaries.

Objectives:

1. Estimate Asian carp relative abundance, and population demographics in the Tennessee and Cumberland River basins to evaluate management actions.
2. Examine Asian carp impacts on native fish communities.
3. Target and remove Asian carp to suppress populations and reduce propagule pressure in the Tennessee and Cumberland River basins.

Agency: Kentucky Department of Fish and Wildlife Resources

Project Activities, Methods, and Timetable:

Objective 1
KDFWR will use a combination of standardized sampling, mark-recapture efforts, and monitoring of commercial harvest to evaluate relative changes in Asian Carp abundance. Standard sampling will be conducted at sixteen sites on Barkley and Kentucky reservoirs. These standard sites were selected to provide adequate sampling parameters, decrease conflict with anglers, and provide static locations to monitor changes in catch per unit effort (CPUE). Four embayment sites and four main channel sites were selected on each reservoir. These sites will be sampled once during the following seasons; spring (April), summer (July), and fall (October). A total of four nets will be fished at each location during sampling periods and in orientations specific to each location. Sampling will occur when the lake level is greater than 354' in areas where water depth is a minimum of 13ft. Nets will be deployed one hour before sunset and retrieved one hour after sunrise the following morning (according to the official rise and set tables). Specific coordinates will be determined for all sets, and nets will be set at the same locations each season and for each subsequent year of gill netting effort. Sinking experimental gill nets 10' in depth and 300' in total length with 100' panels of 3", 4", and 5" mesh will be fished with overnight sets. Gill nets will be 12' deep tied down to 10' every 8'. Each of the 100' panels of webbing will be hung with 30" stretch in 16" ties (3" square – 5 meshes per 16" of linear net, 4" square – 4 meshes per 16" of linear net and 5" square – 3 meshes per 16" of linear net). The webbing used in each of these panels will be constructed of 8 ply of .2mm twist mesh. Cross ties for these nets will be constructed from #15 white bonded twine through the webbing. Catch rates and species captured will be recorded for each gillnet mesh size used.

A mark-recapture study will be continued on Barkley and Kentucky reservoirs, to estimate relative abundance of silver carp in the reservoirs. Fish will be captured for tagging using short set gill nets < 4 hours. Gill netting will be conducted with a combination of floating and sinking gill nets comprised of the dimensions that are specified above. Additionally, electrofishing will be used to collect and drive the fish into the gill nets. Once collected, silver carp will be placed in holding tanks with water and processed as soon as possible in an effort to minimize stress and reduce tagging mortality. Total length (mm), weight (g) and gender will be recorded for each fish. After these metrics are collected each fish will be tagged with a Floy Tag Company, FT-4 Lock-on tag and released. These tags have unique identification numbers along with KDFWR contact information. Sampling efforts will be conducted over a week long period or until a sample size of 500 fish per reservoir has been reached during each tagging event. To provide an estimate of tag loss, a subset of 20% of the tagged fish will receive a secondary tag. Sites for tagging will be determined by the use of side scan on the day of field work. KDFWR has been successful in applying this technology to locate areas of high silver carp density for collection efforts. KDFWR anticipates tag return rates at least at the level previously observed with silver carp tagged for telemetry (4.7%). However, KDFWR will continue to increase communication with commercial fishermen about the importance of reporting the harvest of tagged silver carp. If return rates of tags appear to be low, KDFWR may offer an annual reward for tag return, in the form of a lottery drawing. Any tagged silver carp that are collected through other KDFWR efforts will be harvested from the reservoirs.

Through the KDFWR Asian Carp Harvest Program, commercial fishermen are required to report the total weight of harvested Asian carp species daily. Using data collected through ride-alongs with commercial fishers KDFWR can estimate average weight of individual silver carp captured through commercial harvest. This value can then be used to determine the number of individual silver carp harvested during the study period. Net dimensions will also be recorded from commercial fishers and used to correlate with the size of fish captured in those nets. This information may also be utilized in the assessment of Asian carp population demographics.

During the standard sampling described above, total length (mm), weight (g), gender and gonad weight (g) measurements will be taken from a subsample of 10 silver carp and 10 bighead carp at each discrete sample site. During fall sampling pectoral fin rays will be extracted from silver carp for aging, targeting a sample size of 100 fin rays from each reservoir. Additionally, data will be collected every other week from markets where carp are being exchanged. Total length (mm), total weight (g) and the total weight of gonads (g) will be collected from twenty randomly selected fish. However, if less than ten females were examined in the random sample, then additional female silver carp will be selected and the data collected to reach a sample size of ten. Gonad weight will be used to construct a timeline of gonadosomatic indices to estimate when silver carp spawning attempts are being made. Observations of spawning patches on bigheaded carps will also be recorded during field work. Demographics information may also be collected from Asian carp captured through other KDFWR sampling efforts and included in analysis. Silver carp movement information will be used to assist in determining when silver carp may be making spawning runs, and compared to environmental factors that may influence those behaviors.

Objective 2

During standard sampling described above, total length and weight data will be collected from bigmouth buffalo and paddlefish. Measurements will be used for determining condition factors through relative weight analysis. Values will be monitored over time to determine if Asian carp may be having a negative impact on the condition of these native fishes. These species have been chosen as they are often captured in gill nets and have shown evidence of competition for resources with Asian carp species in previous studies (Irons et al. 2007, Schrank et al. 2003).

Asian carp harvest continues to increase from Kentucky and Barkley Lakes through the Asian Carp Harvest Program (ACHP). KDFWR will continue to monitor the condition of sport fish species to identify any trends that may be associated with the increase removal of Asian carps. Information on sport fish has been gathered routinely throughout the past few decades by KDFWR's Western Fisheries District (WFD). Lengthy data sets on black bass, crappie, and catfish for the two reservoirs are maintained and added to with standardized sampling each year. This information will be used to compare sport fish condition (Wr) in correlation with harvest rates of Asian carps throughout the years.

Kentucky Dam tailwater and Barkley Dam tailwater will continue to be sampled with pulsed DC electrofishing in the spring and fall to assess species composition and relative abundance of represented fish species. Sampling in the Kentucky Dam tailwater will consist of three 15-minute runs on each bank of the river. Sampling in the Barkley Dam tailwater will consist of two 15-minute runs on each bank of the river. Electrofishing runs will be conducted in a downstream direction alongside the bank. Spring sampling in each tailwater will be conducted in one day during the months of April, May, and June. Fall sampling will be conducted one day during the

months of September, October, and November in each tailwater. Two dippers on the front of the boat will be utilized and effort will be made to capture all fish of every species. For each fish collected; species, and total length (mm) will be recorded, with weight (g) also being recorded during fall sampling. Where large numbers of a species are collected, subsamples will be used. This data will be compared to historical data collected by the KDFWR Western Fishery District personnel to assess changes in fish community over time.

Every third year, a random non-uniform probability creel survey will be conducted in each tailwater. To be consistent with past creel surveys, the survey will be conducted from February 15th through November 15th of the given year. Random selection will determine the day, the time period within the day, and which tailwater will be sampled on a given day. The creel clerk will work 5 days per week and in only one tailwater per day. The overall temporal sampling scheme per tailwater will be 10 days per month partitioned into three weekend days and seven week days. The creel survey will be divided into two separate parts (a) fishermen counts and (b) fishermen interviews. Information collected during the creel survey will be compared to data from historical surveys to determine changes in fish community, catch rates, angler use, and success.

Objective 3

KDFWR will continue to provide observers on commercial vessels to facilitate state efforts to target and remove Asian carp through the commercial industry, and to understand impacts of commercial fishing on non-target native species. Commercial fishers requesting to fish in the ACHP are required to turn in daily reports including information on the amount of fishing effort, the type of gear used, pounds harvested, and bycatch information. Fishermen are also required to list the number of fish captured for each species, which fish were harvested and released, as well as their disposition upon release. This information will then be compiled to assess the impacts of the Asian Carp Harvest Program on bycatch species.

To verify and identify underreporting, commercial fishers using the ACHP will also be observed through ride-alongs. Observers will collect all data required on commercial harvest logs with the addition of GPS fishing locations and net soak time. Staff will observe several different commercial fishermen throughout the year. Ride-alongs will be conducted when the fishermen are pulling their nets and harvesting fish. Exceptions will be made when commercial fishers are using short net soak times or drifting net sets. On these occasions, KDFWR staff will observe the commercial fisherman from start to finish of fishing activity. Ride-alongs will be conducted from a department boat closely following the commercial fishers to record catch. Observations will be analyzed both aggregately with daily reports turned in by commercial fishers and separately (i.e. ride along data). Data collected will be analyzed to determine the number of fishing trips, amount of bycatch by species, associated survival rates, and total pounds of Asian carp harvested through the ACHP.

KDFWR staff will conduct targeted removal of Asian carp through electrofishing and gillnetting as staff and funding are available. A significant portion of funding provided to KDFWR for this project will be used to test new gear types. Testing will be conducted as collaborative effort with entities including but not limited to; US Fish and Wildlife Service, US Geological Survey, commercial processors or fishermen, and other private entities. All gear types will be evaluated by appropriate staff from each agency or entity involved. KDFWR will support and assist in gear development and testing and will be present when experimental gears are tested. Data recorded

will include demographic data of fish species captured and bycatch. KDFWR will also use various media forums to provide public awareness and ensue law enforcement is aware of all special projects testing experimental gears. KDFWR will provide a thorough review of data collected during gear testing to evaluate efficiency in capturing Asian carp and determine potential impacts to sport fisheries.

Data on fish captured through all removal effort will be used to inform objectives 1 & 2.

Estimated Timetable:

Project Activity	Pool	Month	Year
Standard Asian Carp Sampling	Kentucky	July & October	2019
Standard Asian Carp Sampling	Barkley	July & October	2019
Silver Carp Marking Event	Kentucky	September	2019
Silver Carp Marking Event	Barkley	September	2019
Collection of Asian Carp Demographics Information	Kentucky	July - June	2019 – 2020
Collection of Asian Carp Demographics Information	Barkley	July - June	2019 – 2020
Ride Alongs with Commercial Fishermen	Kentucky	July - June	2019 – 2020
Ride Alongs with Commercial Fishermen	Barkley	July - June	2019 – 2020
Ride Alongs with Commercial Fishermen	Lower Tennessee River	July - June	2019 – 2020
Ride Alongs with Commercial Fishermen	Lower Cumberland River	July - June	2019 – 2020
Creel Survey	Lower Tennessee River	July - November	2019
Creel Survey	Lower Cumberland River	July -November	2019
Tailwater Community Survey	Lower Tennessee River	September - November	2019
Tailwater Community Survey	Lower Cumberland River	September - November	2019
Testing of Experimental Gears	Kentucky / Barkley	July-June	2019 – 2020

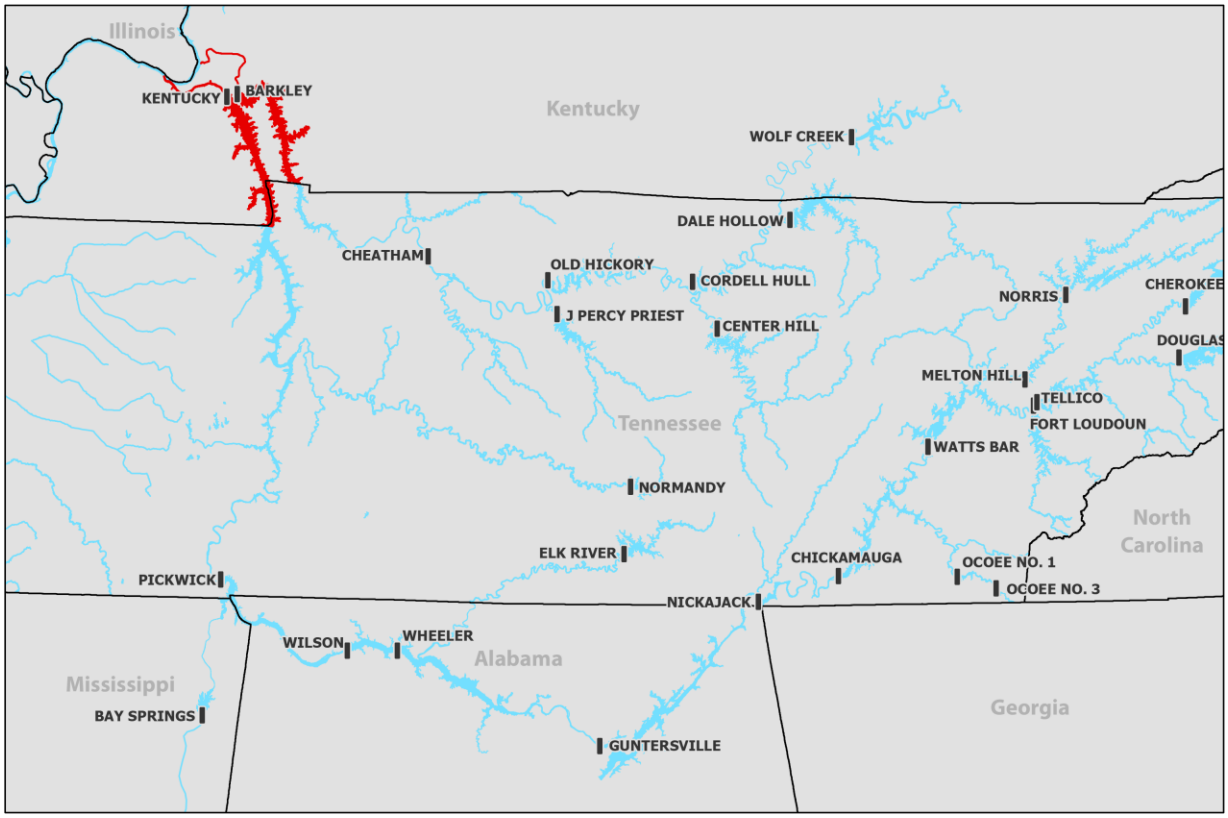

Figure 25. Areas in red indicate study area for KDFWR.

Agency: Tennessee Wildlife Resources Agency

Project Activities, Methods, and Timetable:

Objective 1

Procurement - TWRA will use gillnets, electrofishing boats, and ultimately electrified dozer trawls, to estimate relative abundance and characterize carp populations. TWRA has an adequate number of electrofishing boats, an inadequate supply of gillnets, and no dozer trawl boats. To meet Objective 1 TWRA will need to purchase gillnets, and purchase supplies and services to convert existing shocking boats into dozer trawls. This activity will start shortly after the funds are awarded, and the purchase of these items will take at least four months to complete, due to administrative processes and challenges finding vendors that have inventory of netting in stock. The retrofitting of boats to operate dozer trawls will also take considerable time. While these procurement steps are in process will we identify sample sites and use available gears to start carp gillnet and electrofishing surveys.

Gillnetting – TWRA staff will identify fixed sites in Kentucky (6 sites), Pickwick (1), Barkley (3), Cheatham (3), and Old Hickory (3) lakes to set clusters of gillnets. Each site will be sampled at least twice a year, once during summer (July-Sept) and again in the winter (Nov-Jan). At each site we will set four gillnets overnight. The nets will be distributed in the embayments from the mouth to the back of the embayment (approximately 10-foot depth). Individual nets will be 300-ft in length with 100-ft panels of 3-, 4-, and 5-in mesh. Nets will be 12-ft deep, hobbled to 10-ft every eight feet; nets will have 0.5-in foam core for the float line and 65-lb lead core for the lead line. The webbing used in each of these panels will be constructed of 8 ply, 0.2-mm twist mesh. Catch of all species will be recorded by mesh size. We are not attempting to herd fish into nets using electrofishing, acoustic boats, or any other method.

Electrofishing - We will establish fixed electrofishing sites in each lake: Kentucky (24 sites), Pickwick (6 sites), Barkley (8 sites), Cheatham (12 sites), and Old Hickory (12 sites). Shocking surveys will be conducted during the daytime using a high-frequency pulsed DC boat electrofishing. Voltage and amperage will be adjusted to achieve a 3,000-W power output, as possible (Stuck et al. 2015). Electrofishing transects may include a variety of habitat types (i.e., backwaters, channel borders, shoreline areas, open water). Electrofishing runs will be conducted for 15 minutes with two dip netters. Only carp species will be collected and catch rate will be calculated as fish/15 min.

As electrified dozer trawls are assembled, we will transition to those as the standard electrofishing surveys. Specifications of the dozer trawl will be similar to those currently operated by TTU and USFWS's Columbia Field Office. Each trawl sample will be conducted for 5 minutes. All species will be counted, and catch rates will be calculated as fish/5-min.

Fish Collected During Surveys –All carp species will be removed from the lake. Carp species (or a subsample) will be examined to determine species, length (mm), weight (g), and sex. Sex of bigheaded carp will be determined based on the morphology (serrated pectoral spines are males). During this project, TTU will be conducting complementary samples that will yield otoliths to estimate age and growth, and gonad measurements to determine gonadosomatic index. Unless additional samples are requested, we will not be removing otoliths or measuring gonads.

All non-carp species will be released. Gillnetted buffalo (*Ictiobus spp.*) and paddlefish (*Polyodon spathula*) will be measured (length and weight) to monitor condition of these species. These data will be use to prepare length and age frequency histograms, estimate growth rates, assess recruitment variability, and estimate mortality.

Commercial Surveys - Through the TWRA's Asian Carp Harvest Incentive Program (ACHIP), commercial fishermen and buyers are required to report the total weight of Asian carp that are harvested and purchased daily. To qualify for ACHIP fish must be harvested from Kentucky, Barkley, Cheatham, or Old Hickory lakes. TWRA staff will characterize the size and age structure of species harvested through ACHIP by collecting a subsample of harvested fish. TWRA staff will meet commercial fishers as they arrive at the market to offload catch, or conduct ride-along surveys. Commercial fishing surveys will be conducted at least 3 times a year (Mar-Apr, Jul-Aug, and Dec-Jan). We will record capture location and examine a subsample of carp to determine species, length (mm), weight (g), and sex. During this project, TTU will be conducting complementary samples that will yield otoliths to estimate age and growth, and gonad measurements to determine gonadosomatic index. Unless additional samples are requested, we will not be removing otoliths or measuring gonads during commercial surveys.

Estimated Timetable:

Project Activity	Pool	Month	Year
Procurement	-	Start ASAP	2019 and 2020
Electrofishing	Kentucky Lake	July-Sept and Nov-Jan	2020 and 2021
Gillnet	Kentucky Lake	July-Sept and Nov-Jan	2020 and 2021
Electrofishing	Pickwick lake	July-Sept and Nov-Jan	2020 and 2021
Gillnet	Pickwick Lake	July-Sept and Nov-Jan	2020 and 2021
Electrofishing	Barkley Lake	July-Sept and Nov-Jan	2020 and 2021
Gillnet	Barkley Lake	July-Sept and Nov-Jan	2020 and 2021
Electrofishing	Cheatham Lake	July-Sept and Nov-Jan	2020 and 2021
Gillnet	Cheatham Lake	July-Sept and Nov-Jan	2020 and 2021
Electrofishing	Old Hickory Lake	July-Sept and Nov-Jan	2020 and 2021
Gillnet	Old Hickory Lake	July-Sept and Nov-Jan	2020 and 2021
Commercial Surveys	Sample carp harvested within ACHIP program (Kentucky, Barkley,	Mar-Apr, Jul-Aug, and Dec-Jan	2020 and 2021

	Cheatham, and Old Hickory lakes)		

At the field level, TWRA will continue to coordinate with KDFWR, TTU, MDWFP, and ALWFF, and provide staff to participate in special field operations or training opportunities.

Figure 26. Areas in red indicate study area for TWRA

Agency: Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP)

Project Activities, Methods, and Timetable:

Objective 1
The section of Pickwick Lake within Mississippi, the canal section connecting the Yellow Creek arm to Bay Springs Reservoir (Divide Cut Canal), Bay Springs Reservoir, and the immediate channel below the lock at Bay Springs Reservoir will be sampled systematically using gillnetting and electrofishing.

Sampling will be conducted seasonally. Gangs of 300-ft gillnets by 12-ft deep with 3-, 4-, and, 5-inch square mesh (each mesh consisting of 3 panels) will be fished overnight in backwater areas adjacent to the main channels. Concurrently with gillnetting, boat-electrofishing will be conducted in shallow bays in water <6 ft deep. Various pulse frequencies will be considered, guided by new findings becoming available in the scientific literature. Voltage and amperage will be adjusted to achieve a 3,000-W power output, as possible (Stuck et al. 2015). Electrofishing transects may include a variety of habitat types (i.e., backwaters, channel borders, shoreline areas, open water). Catch will be quantified as presence/absence and as catch-per-unit of effort (number captured per overnight set or per hour of electrofishing). Viable methods for using angler sightings as indexes of abundance will be researched and implemented if appropriate. All fish collected will be measured for total length and weight, and lapilli otoliths will be removed. Age will be determined using methods reported by Seibert and Phelps (2013).

Radio telemetry will be used to assess the use of tributaries differing widely in discharges. There are currently about 250 radio tagged silver carp in the lower Tennessee River. Vemco stationary receivers will be installed at the entrance of a wide array of tributary sizes to monitor attraction relative to discharge, and potentially other variables associated with discharge composition.

Objective 2
MDWFP has been monitoring fish assemblages in Bay Springs Reservoir and the Yellow Creek Arm nearly annually for about three decades, and monitoring continues. Historical data will be used to assess potential changes in fish assemblages linked to Asian carp invasions. Analyses will be based on multivariate species similarity matrices. Potential effects of Asian carp may include reduced abundances of planktivores and recruitment of centrarchid species.

Estimated Timetable:

Project Activity	Location	Month	Year
Install Vemco receivers	Key locations within Pickwick Lake (MS section), Divide Cut Canal, and Bay Springs Reservoir	Sep	2019
Monitor Vemco receivers	All locations	Monthly beginning in Nov 2019	2019-2021
Targeted Asian carp sampling	Pickwick Lake (MS section)	Oct	2019

Targeted Asian carp sampling	Divide Cut Canal	Oct	2019
Targeted Asian carp sampling	Bay Springs Reservoir & channel below lock	Oct	2019
Community Surveys	Bay Springs Reservoir	Oct, Nov	2019
Fish aging and data analyses	All	Nov, Dec	2019
Targeted Asian carp sampling	Pickwick Lake (MS section)	Jan, Apr, Jul, Oct	2020
Targeted Asian carp sampling	Divide Cut Canal	Jan, Apr, Jul, Oct	2020
Targeted Asian carp sampling	Bay Springs Reservoir & channel below lock	Jan, Apr, Jul, Oct	2020
Fish aging and data analyses	All	Mar, May	2020
Project Progress Report	N/A	Oct	2020
Targeted Asian carp sampling	Pickwick Lake (MS section)	Jan, Apr	2021
Targeted Asian carp sampling	Divide Cut Canal	Jan, Apr	2021
Community Surveys	Pickwick Lake (MS section)	Apr	2021
Fish aging and data analyses	All	Mar, May	2021
Project Final Report	N/A	Oct	2021

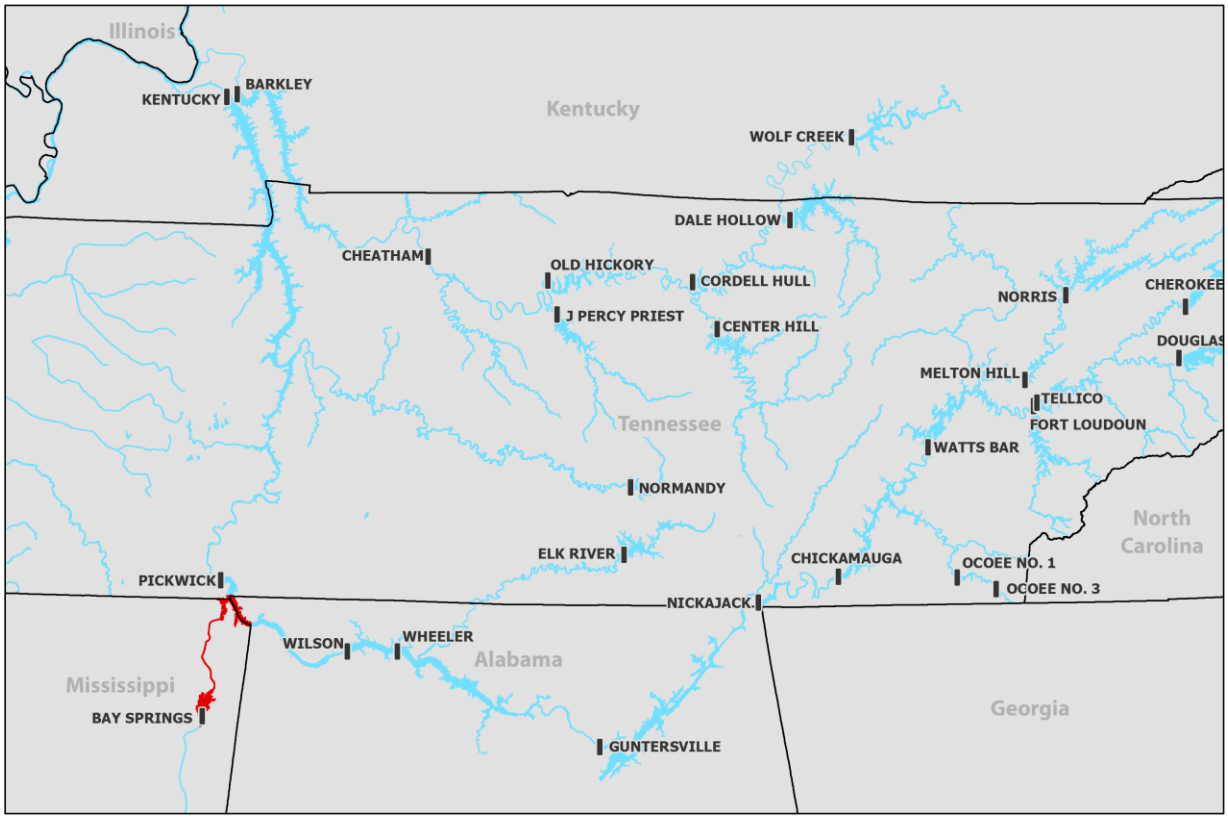

Figure 27. Areas in red indicate study area for MDWFP and their cooperators.

Agency: Alabama Division of Wildlife and Freshwater Fisheries (ALWFF)

Project Activities, Methods, and Timetable:

Objective 1
ALWFF will coordinate with cooperating agencies to conduct targeted sampling for Asian carp in the Tennessee River basin. In addition, ALWFF staff will be available to assist partner state agencies with sampling in their waters for training purposes. Initial work will focus on the region stretching from the state border with Tennessee and Mississippi eastward to Guntersville Dam (see map). ALWFF will survey Asian carp populations using a variety of standardized sampling methods, primarily gillnetting and electrofishing, to estimate relative abundance and population demographics. Surveys will be conducted at pre-determined sites throughout the region. The number of samples completed will be determined based on environmental conditions and future determinations of Asian carp distribution within the project area. Information obtained will be used to help define the "invasion front" of Asian carp in the Tennessee River basin within Alabama. All information from targeted sampling will be used to track future changes in relative abundance. Otoliths and/or fin rays will be removed as needed from Asian carp for age and growth analysis. Additional information may also be obtained through interaction with commercial and recreational anglers. Any data sources deemed relevant for this project will be reviewed and incorporated when possible.

Objective 3
All Asian carp collected during the project sampling period will be removed during the fish survey work described in Objective 1; however, any Asian carp collected with a tracking device will be documented and released immediately. This active removal of fish will be especially important to slow the upstream migration of Asian carp, since the leading edge of their migration in the Tennessee River basin is located in Alabama. All by-catch for each sampling gear will be recorded and any non-target fish will be released immediately after capture.

Estimated Timetable:

Project Activity	Location	Dates	Year
Targeted Asian Carp Sampling and Removal	Tennessee River Basin downstream of Guntersville Dam	March 1 – September 30	2020
Targeted Asian Carp Sampling and Removal	Tennessee River Basin downstream of Guntersville Dam	March 1 – September 30	2021
Project Executive Summary	N/A	December 31	2021

Figure 28. Areas in red indicate study area for ALWFF.

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Upper Mississippi River Basin

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Project Title: 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), 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 adaptive development and implementation of a comprehensive and complementary early detection and response 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 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.

National Plan Goal Supported:

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

National Plan Strategy Supported:

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

Sub-basin Management Plan Goal Supported:

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

Sub-basin Management Plan Strategy Supported:

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. Invasion Front Population Characteristics, Distribution, and Response Actions
   Provide relative population characteristics and distribution in the invasion front to help devise management strategies that minimize propagule pressure and population expansion of Asian carp. Employ reasonable response efforts to captures of carp.

2. Tracking Invasive Carp
   Use tracking data to review and revise sampling methodology to increase detection probability in low abundance areas.

Agency: Minnesota Department of Natural Resources

Project Activities, Methods, and Timetable:

Objective 1
Invasion Front Population Characteristics, Distribution, and Response Actions
Provide relative population characteristics and distribution in the invasion front to help devise management strategies that minimize propagule pressure and population expansion of Asian carp. Employ reasonable response efforts to captures of carp.

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 twice per month at all eight standardized sampling sites from mid-May through mid-July on the St. Croix River and Pool 2 of the Mississippi River to target the early life stages of invasive carps. 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. 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. A total of eight 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: four main channel, two side channel, and two backwater locations in each system. 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 the 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. 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 larger 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 contain sampling locations suitable for sampling with fyke nets. In these stretches of river, not all nets will be set. Mini-fyke and trap nets will be set on Monday, checked and re-set on Tuesday, Wednesday, and Thursday, and checked and pulled on Friday. 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.

Small seine

A small, 35-foot seine will be used to sample shallow water habitats for young fish from June through September on Pool 2 and the Minnesota River. Similar to mini-fyke netting, if a peak in the hydrograph is observed or once water temperatures reach 62-65º F (17 or 18º C), seining will commence approximately two weeks afterward to sample when young Invasive Carp would be most vulnerable to capture from small seine sampling. The seine measures 35 ft. long and 6 ft. deep with 3 ft. square bag (3 ft. x 3 ft. x 3 ft.) located at the center of the net, consisting of "Ace"-type nylon netting 1/8 in. mesh, with a mudline. The seine will be pulled using measured distance poles to standardize the length the seine is pulled before hauling in the catch and depth will be measured at the deepest location within the seine haul. 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.

Purse seine

A large purse seine will be used to sample deep water habitats on the St. Croix River for adult Invasive Carp throughout the year. A purse seine will be invaluable to sample previously under sampled deep habitats both for Invasive Carp and native planktivores. From our acoustic tagging results of the first Bighead Carp, this fish inhabited Lake St. Croix from Hudson, WI to Afton, MN throughout the year in water that was routinely deeper than 50 feet but only ventured to depths below 20 feet on rare occasions. While sampling for the tagged Bighead Carp, crews were also able to sample and tag an increased number of Paddlefish, a native planktivore with similar movement patterns and similar feeding niche.

The seine measures 2000 ft. long and 40 ft. deep with 5 inch stretched mesh (2 ½" square mesh). The seine will also be constructed in panels connected with ½" braided poly rope and snap links to allow for reconfiguration to allow crews to use the seine as a standard commercial beach seine. The seine will be set using a small boat pulling one end of the net in a circular manner from another boat carrying the remainder of the seine. Once the seine is deployed, a purse line on the bottom of the net will be pulled tight to entrap the fish present within and the net will be hauled by winch or by hand to allow for the sorting of the enclosed fish. It is expected that the state contract commercial fisherman will transport and haul this seine due to its size and the expertise commercial fishermen have with setting a commercial-sized net of this complexity.

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 eight 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 ageing structures will be taken from fish included in age and growth analyses.

For positive identification of large, unknown fishes, high resolution photographs will be preferred, whereas voucher specimens of small, unknown fishes will be kept, labeled and preserved in 90% ethanol for later identification. In both cases, fish will be referred to an ichthyologist for positive identification. At non-standardized sampling sites, most observed fish will be identified in the water and only fish needed to collect ageing 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.

Commercial Fishing

Commercial fishermen will be contracted to target Invasive Carp with both gill nets and seines on all monitored systems. MN DNR personnel will 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. In addition, commercial gill net and seine operations will be monitored when possible to observe for Invasive Carp. Sampling site locations, sampling dates, gear description, effort, habitat type (main channel border, backwater, wing dike, etc.), water depth, and crew details will be recorded for each net set.

Data Collection

Applicable effort data will be collected for each sampling deployment. All invasive carp captured will be considered for tagging as outlined in the MN DNR invasive carp permit. Tagged carp will be measured for total length and weight. Biologists will attempt to determine sex but it is difficult on live fish. All other invasive carp will be processed according standard operating procedures which include length, weight, gender, gonad examination/weight, and harvesting structures for further analysis at designated labs (i.e. USGS Columbia, MO). Structures includes otoliths for age and microchemistry, fin clips for genetics, breast patch to determine spawning history, and gonads for histology. Invasive carp catches remain very low in Minnesota waters making abundance estimates imprecise. Therefore MN DNR relies on other methods to indicate population changes: egg/larval/juvenile sampling, year to year comparison of captures, and spawning indicators. Other information; length, weight, sex, age, and maturity; will help characterize the leading edge population. Microchemistry analysis may provide insights on individual life history.

Data on non-target fish will collected as time and resources permit. Data may only be collected on high priority species such as lake sturgeon, paddlefish, smallmouth buffalo, and bigmouth buffalo. Data collected is entered into the MN DNR fish sampling electronic database.

Objective 2

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

Pursuant to Minnesota Statute 84D.05, Invasive Carp collected in Minnesota waters can be tagged and released by Minnesota Department of Natural Resources staff: "***Permit for invasive carp.*** *The commissioner may issue a permit to departmental divisions for tagging bighead, black, grass, or silver carp for research or control. Under the permit, the carp may be released into the water body from which the carp was captured. This subdivision expires December 31, 2021*." Based on the tagging results, researchers 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. This information will be used to inform detection and removal efforts.

In 2019, multiple Invasive Carp are permitted to be tagged and at liberty at one time and tracking of these fish will be done using both passive telemetry (using an elaborate receiver array already in place) and active tracking (using finer scale tracking techniques) to determine preferred habitats, movement patterns, and ultimately to re-capture tagged fish and remove other Invasive Carp caught. It will ultimately be the discretion of the permittee if a given Invasive Carp should be tagged and released based on variables including location of capture, time of year, river flows,

ability to successfully track the fish at staff levels available, as well as other contingencies dictated by the circumstances present and the in-depth knowledge of these species' biology and trends in movements and behaviors.

In 2019, a real-time receiver will be deployed on the St. Croix River to provide the details of the tagged Bighead Carp (or subsequent tagged Invasive Carp) through emails and/or text messages. Similar to acoustic receivers already in place, the receiver (a VEMCO VR2C cabled receiver) will be able to receive, decode, and log transmissions from tagged fish in the area including the fish's unique identification number. In addition, this receiver will be fitted with solar panels and a modem to transmit the data of specific fish electronically through 4G telecommunications to the MN DNR Invasive Carp crew without the need to be in the field actively tracking the fish. It is expected, this real-time receiver will be placed in an area that can be effectively blocked off and extensively sampled to provide the best opportunity for recapture or the capture of additional Invasive Carp schooling with the tagged individual.

The described activities require a special permit issued by DNR Division of Ecological and Water Resources (EWR). For more details regarding this permit, please contact the MN DNR for a copy. For results from the first tagged Invasive Carp in Minnesota, see the 2017 Invasive Carp Sampling Report and for the most up-to-date movement and temperature and depth information see the 2018 Invasive Carp Sampling Report.

Estimated Timetable:

Activity	**Time Period**	**Sampling**		**Effort**
		Events	**Days**	
Gill/Trammel Netting	March - November	40	20	50,000 feet of net
Electrofishing	May - September	48	20	2,000 minutes
Mini-Fyke/Trap Netting	June - September	50	10	40 net nights
Seining	June – September	20	5	20 seine hauls
Larval Trawling	May - July	160	12	160 pushes
Commercial Seining	Year round	6	6	6 seine hauls
Commercial Gill Netting	Year round	13	13	78,000 feet
Carp Tracking	Year round	Varies	Varies	unknown

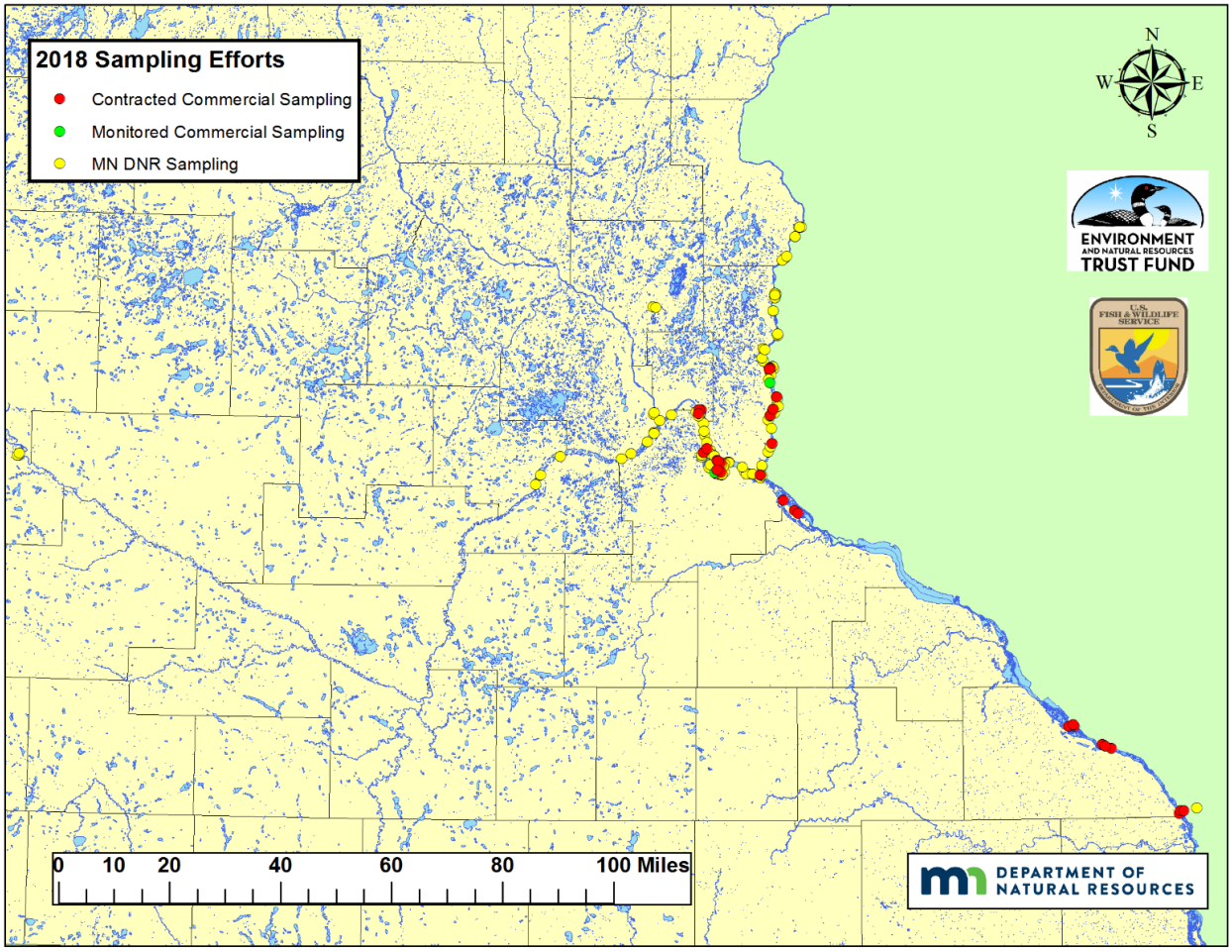


Figure 29. Minnesota DNR 2019 invasive carp sampling area. Map depicts 2018 sampling locations which will be similar in 2019.

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

Geographic Location: Most efforts will be conducted in or adjacent to the Intensive Management Zone (IMZ; pools 16-19). A limited amount of monitoring will take place outside this zone to detect any advance of the invasion and/or provide support data for the various components of this effort.

Lead Agency: USFWS

Agency Collaboration: IA DNR (Iowa State University), USGS, MDC, and ILDNR (Western Illinois University, Southern Illinois University, and Illinois Natural History Survey)

Statement of Need:
The UMR Asian carp partnership has identified the area from LD 15 downstream to LD 19 as the Intensive Management Zone (IMZ) for Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*Hypophthalmichthys molitrix*). Contracted removal efforts have been implemented in this zone since 2016, but the impact of those efforts are largely unknown. A robust stock assessment program is needed to more directly evaluate how populations of Asian carps may be affected by current contract removals and to forecast their future response to alternative removal strategies. A robust stock assessment program should incorporate information from multiple fishery-dependent and independent sources to provide the least-biased composite estimate of carp abundance, biomass, demographic distributions, and migratory tendencies. Therefore, the primary objective of this plan is to describe a unified stock assessment program that will provide a system of data-driven feedback loops that managers can use to evaluate the impacts of their previous management decisions and consider alternative management strategies for the future. This project is broken down into three project components and associated jobs to meet the specific project objectives described in the next section.

Objectives:

1. Determine population densities and demographic parameters of Silver and Bighead Carps in Pools 14-20 of the UMR in order to gauge efficacy of control efforts.
2. Document the extent of reproducing populations of Silver and Bighead Carps in the UMR.
3. Employ advanced modeling techniques to evaluate the impacts of controls on populations of Silver and Bighead Carps in Pools 16-20.

Project Component 1: Stock Assessment of Silver and Bighead Carps in Pools 14-20 of the UMR

Job 1.1: Hydroacoustics Surveys of adult Silver and Bighead Carps in UMR Pools 14-20

Job 1.2: Fishery-independent monitoring

Job 1.3: Fishery-dependent (contract removal) monitoring

Job 1.4: Telemetry

Project Component 2: Evaluation of inter-annual variations in reproduction/recruitment

Job 2.1: Ichthyoplankton monitoring in UMR and large tributaries

Job 2.2: Ichthyoplankton and juvenile fish monitoring in nursery habitats.

Project Component 3: Model development for evaluating effects of controls

The following section provides descriptions of the individual project components and their associated jobs, including how these activities support National Plan Goals and Strategies, Sub-basin Goals and Strategies, and potential deliverables.

Project Component 1: Stock Assessment of Silver and Bighead Carps in Pools 14-20 of the UMR

Job 1.1: Hydroacoustic Surveys of adult Silver and Bighead Carps in UMR Pools 14-20

Lead agency: USFWS

Project Activity	**Pool**	**Month**	**Year**
Hydroacoustic Surveys	14-20	Sept-Oct	2019

Objectives:

1. Determine population densities, biomass, and spatial distribution of Silver and Bighead Carps in Pools 14-20 of the UMR.
3. Employ advanced modeling techniques to evaluate the impacts of controls on populations of Silver and Bighead Carps in Pools 16-20.

Project Activities, Methods, and Timetable:
Hydroacoustic surveys will be used to obtain data on the relative abundance, size distribution, spatial distribution, and biomass of Bighead and Silver Carp in the UMR. Hydroacoustic sampling is the least size-biased sampling gear currently available to fisheries professionals, thereby providing more accurate relative abundance and size distribution information for stock assessment purposes. Furthermore, the large spatial coverage capabilities of hydroacoustics can provide more precise and accurate relative abundance estimates, particularly for patchily

distributed fish such as Asian carp. However, hydroacoustics is not a stand-alone gear, and does require physical fish sampling to separate the overall fish community size distribution into species-specific distributions. Hydroacoustics should be considered as a component of a larger comprehensive stock assessment program that is required for monitoring Asian carp populations and evaluating control efforts.

USFWS will conduct mobile hydroacoustic surveys to estimate relative abundance, size distribution, spatial distribution, and biomass of Silver Carp, Bighead Carp, and other species of interest in pools 14-20 of the UMR. Hydroacoustic data will be collected similar to that described in MacNamara et al. (2016). USFWS will use two horizontally oriented split-beam transducers (200 kHz; BioSonics, Inc.) offset in angle to maximize water column coverage. Prior to each survey, each transducer will be calibrated on-axis following Foote et al. (1987). Surveys will be conducted from mid-September through October at selected areas of the main channel, side channels, bays and backwaters of pools 14-20. Following Coulter et al. (2018), these pools will be subsampled using approximately four-mile long transects along the main channel such that a minimum of 35% of the main channel length of each pool will be sampled, in addition to adjacent off-channel habitats. Survey transects will primarily overlap with the locations of physical fish sampling (see Job 1.2 and Job 1.3).

Hydroacoustic data will be analyzed following MacNamara et al. (2016) using Echoview 9.0. Single targets will be detected using parameter values from Parker-Stetter et al. (2009). Multiple targets from a single fish will be grouped using Echoview's fish tracking algorithm to reduce the potential of over counting fish targets. The size of fish targets (total length; cm) will be estimated from mean acoustic target strength (dB) using a function specific to side-looking hydroacoustics (Love 1971). Hydroacoustic data will be informed by pool-specific fish community data that will be collected at each sample site using traditional fisheries gears. Specifically, pool-specific proportions of fish will be determined for each 1 cm length group from 15-120 cm TL for at least three groups of fish (i.e., Silver Carp, Bighead Carp, and other fish species). Length-specific proportions will then be used to categorize acoustically detected fish. Pool-specific length-weight regressions will then be used to estimate length-specific biomass for each species of interest, and density (numeric and mass) will be estimated.

Job 1.1 Contribution to Sub-Basin Asian Carp Management Objectives:

Including hydroacoustic surveys as part of our stock assessment of Asian carps in the UMR will allow us to more accurately evaluate and guide the long-term efficacy of contracted removal efforts (both from a large-scale pool-specific basis and a small-scale targeted effort basis). Hydroacoustic survey data will also inform the selection of optimal locations for deterrents to upstream movement, and evaluate deterrent strategies. Estimates of pool-specific relative abundance generated by hydroacoustic and traditional sampling data will also support Asian carp modeling efforts that serve as objective, data-driven decision support tools for informing management strategies. The resulting capabilities of a comprehensive stock assessment of Asian

carp populations in the UMR would contribute to the following sub-basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

- *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*
  Hydroacoustic sampling will help delineate fronts (i.e., presence, invasion, and established) and aid in the implementation and assessment of containment and control actions.
- *Strategy 2.2: Evaluate and implement deterrent measures at strategic pinch points to prevent dispersal of Asian carp while recognizing other fish management goals.*
  The large spatial coverage of hydroacoustic surveys will help to identify locations for new deterrent measures and also evaluate the efficacy of ongoing deterrent projects at multiple scales.

Goal 3: Control Populations-Eliminate populations of Asian carps in the UMR to limit their adverse effects.

- *Strategy 3.1: Remove Asian carp from the UMR using efficient and diverse methods.*
  Hydroacoustic sampling will help to evaluate the impact of removal on Asian carp populations and to identify best management practices.
- *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR.*
  Estimates of pool-specific relative abundance generated by hydroacoustic and traditional sampling data will inform Asian carp modeling efforts. Hydroacoustic sampling can also be used to evaluate harvest model strategies as they are implemented.
- *Strategy 3.4: Support research to improve existing or develop new control technologies*.
  Hydroacoustic sampling, as part of a comprehensive Asian carp stock assessment, can be used to evaluate the effectiveness of existing and new control technologies and identify new areas for control measure implementation.

Job 1.1 Contribution to National Plan Goals:

Although the focus of this document is at the sub-basin level, it should be noted that a stock assessment of Asian carps in the UMR would also contribute to a more comprehensive basin-wide stock assessment, complimenting hydroacoustic and traditional fishery data collection efforts that are ongoing in the Illinois and Ohio Rivers. This research would support the following National Plan Goals (Conover et al., 2007):

- *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 4: Minimize potential adverse effects of feral Bighead, Back, Grass, and Silver carps.*
- *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.*

Job 1.1 Deliverables:

Hydroacoustic surveys as a part of a comprehensive stock assessment program, will provide estimates of relative abundance, size distribution, spatial distribution, and biomass of adult Bighead and Silver Carp in the UMR. This information can be used to guide and evaluate the success of management and control efforts, identify "hot spots", in conjunction with telemetry, that could inform commercial removals and/or locations for deterrents, and provide data to inform harvest modeling efforts. The operator/administrator of the hydroacoustic surveys will submit a brief annual report to summarize the data.

Job 1.1 Literature Cited:

Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C. 223 pp.

Coulter, D.P., R. MacNamara, D.C. Glover, J.E. Garvey. 2018. Possible unintended effects of management at an invasion front: Reduced prevalence corresponds with high condition of invasive bigheaded carps. Biological Conservation 221: 118-126.

Foote, K.G., H.P. Knudsen, G. Vestnes, D.N. MacLennan, and E.J. Simmonds. 1987. Calibration of acoustic instruments for fish density estimation: a practical guide. ICES Cooperative Research Report 144: 1-57.

Love, R.H. 1971. Measurements of fish target strength: a review. Fisheries Bulletin 69: 703-715.

MacNamara, R., D. Glover, J. Garvey, W. Bouska, and K. Irons. 2016. Bigheaded carps (Hypophthalmichthys spp.) at the edge of their invaded range: using hydroacoustics to assess population parameters and the efficacy of harvest as a control strategy in a large North American river. Biological Invasions 18: 3293-3307.

Parker-Stetter, S.L., L.G. Rudstam, P.J. Sullivan, D.M. Warner. 2009. Standard operating procedures for fisheries acoustic surveys in the Great Lakes. Great Lakes Fisheries Commission Special Publication 09-01.

Job 1.2: Fishery-independent monitoring

Lead Agency: USFWS

Cooperating Agency: ILDNR (Illinois Natural History Survey-INHS)

Project Activity	**Pool**	**Month**	**Year**
INHS LTEF	16-21	June-Oct	2019
USFWS YOY sampling	14-20	July-Oct	2019

Objectives:

1. Estimate the relative size and species-specific distributions of the overall fish community in Pools 14-20 of the UMR.
2. Collect demographic information on Asian carp populations in the UMR.
3. Employ advanced modeling techniques to evaluate the impacts of controls on populations of Silver and Bighead Carps in Pools 16-20.

Project Activities, Methods, and Timetable:
Monitoring with traditional fisheries gears such as electrofishing and experimental-type gill nets with various mesh sizes provide opportunities to collect information on the relative abundance of species in the UMR fish community. Additionally, physical captures of Asian carp facilitate the collection of important demographic information (aging structures, individual lengths and weights, sex, tissue samples for genetic and physiologic studies, etc.). Fishery-independent fish sampling is also required to separate the overall fish community size distribution into species-specific distributions to facilitate the use of hydroacoustics surveys. Data derived from contract fishing with large mesh gill and hoop nets is heavily biased towards larger, adult fishes. Fishery-independent sampling using traditional sampling gears will be less size selective and provide more robust estimations of the fish community represented in the hydroacoustic surveys. The ability to detect small fishes could enhance our capacity to detect sources of Asian carp recruitment and deliver additional data to mathematical models exploring the response of not only Asian carps, but the UMR fish community to future contract harvest scenarios.

Partner institutions currently provide much of the fisheries independent data needed to monitor Asian carps in the UMR. The Illinois Natural History Survey's Illinois River Biological Station currently maintains an extensive standardized electrofishing program called the Long-term Survey and Assessment of Large River Fishes in Illinois or the Long-term Electrofishing Program (LTEF). The program uses pulsed-direct current (DC) electrofishing to sample fish

communities at randomly selected locations throughout pools 16-21 of the Mississippi River. The program operates on an annual sampling schedule but limits sampling to main channel border habitats. However, program administrators have agreed to include additional backwater and side channel sites during the final sampling period of 2019 (mid-September thru October), which will provide a more accurate assessment of the fish community in the IMZ and increase Asian carp collections for demographic work. In the future, directing additional funding to LTEF in the UMR could enable the program to expand and fill the observed need for a fishery-independent monitoring program, both as a source of supporting data to calibrate estimates of Asian carps derived from hydroacoustic surveys and as a source of information about the relative abundance of Asian carps within fish communities of the UMR.

Additionally, the USFWS conducts annual randomized and targeted efforts to sample young-of-year Asian carps in pools 14-20 using pulsed-DC electrofishing and dozer trawls. USFWS plans to continue this sampling in FY19 with the randomized efforts expanded to incorporate additional strata and the collection of important demographic information to supplement the current LTEF sampling efforts. This is particularly important for pools 14 and 15 which are not currently sampled as part of the LTEF program. USFWS sampling will begin in mid-summer and continue through October.

The combination of sampling efforts provided by the LTEF program and the USFWS in FY19 will provide the data necessary to achieve stated objectives. USFWS staff will be following an adaptive monitoring approach while implementing this program as an intertwined component of the larger comprehensive stock assessment. Sampling protocols may be re-evaluated in the future to include additional gears such as experimental-type gill nets or paupier trawls, depending on future data needs and funding availability.

Job 1.2 Contribution to sub basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

4. *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*

Goal 3: Eliminate populations of Asian carps in the UMR to limit their adverse effects.

5. *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR*
6. *Strategy 3.3: Identify and eliminate sources of Asian carp recruitment*

Job 1.2 Deliverables:

Fishery-independent sampling will provide information on the relative abundance of species in the UMR fish community and facilitate the collection of important demographic information (aging structures, individual lengths and weights, sex, tissue samples for genetic and physiologic studies, etc.). Fishery-independent data will inform hydroacoustic sampling as a part of a comprehensive stock assessment plan and can be used to evaluate Asian carp control measures. Data generated via fishery-independent sampling will be integrated into a regional database designed to facilitate rapid data processing and sharing with Asian carp researchers. These data will also be available to other researchers studying elements of UMR fish communities. The operator/administrator of this fishery-independent survey will submit a brief annual report to summarize the data.

Job 1.3: Fishery-dependent (contract removal) monitoring

Lead Agency: ILDNR (Illinois Natural History Survey)

Cooperating Agency: USFWS, Southern Illinois University

Project Activity	**Pool**	**Month**	**Year**
Contract Removal	14-20	April-Oct	2019

Objectives:

1. Determine population densities and demographic parameters of Silver and Bighead Carps in Pools 14-20 of the UMR.
3. Employ advanced modeling techniques to evaluate the impacts of controls on populations of Silver and Bighead Carps in Pools 16-20.

Project Activities, Methods, and Timetable:
Funding has been provided to conduct contracted removal as a control method through USFWS base funds and the harvest plan. Harvested fish from contracted removals will be the source of length, weight, age, GSI, fecundity, and natal origin/spatial life history for fish above Lock and Dam 19. These data will be used to populate 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 UMR populations/strategies. Fishery-dependent data may also be part of the

overall comprehensive stock assessment, and be used in conjunction with fishery-independent data to inform hydroacoustic sampling.

Job 1.3 Contribution to sub basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

- *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*

Goal 3: Eliminate populations of Asian carps in the UMR to limit their adverse effects.

- *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR*
- *Strategy 3.3: Identify and eliminate sources of Asian carp recruitment*

Job 1.3 Deliverables

Fishery-dependent sampling will provide information on the relative abundance of species in the UMR fish community and facilitate the collection of important demographic information (aging structures, individual lengths and weights, sex, tissue samples for genetic and physiologic studies, etc.). Fishery-dependent data will inform hydroacoustic sampling as a part of a comprehensive stock assessment plan and can be used to evaluate Asian carp control measures, and inform harvest models. An executive summary of the fishery dependent monitoring program will be provided by October annually and an annual technical report will be provided by March 1, for each calendar year during the project period.

Job 1.4: Telemetry

Lead Agency: USFWS

Cooperating Agency: ILDNR (Illinois Natural History Survey), USGS

Project Activity	**Pool**	**Month**	**Year**
Deploy Acoustic Array	14-20	April	2019
Implant Acoustic Tags in Asian carp	TBD	April-May	2019

Download Receiver Data	14-20	Annually or more frequently if warranted	2019

Objectives:

1. Document the extent of tagged Asian carp range, determine individual and mass movements of Asian carps among pools and tributaries of the UMR to inform contract removals, and to understand Asian carp response to removal efforts.
3. Inform advanced modeling techniques to evaluate the impacts of controls on populations of Silver and Bighead Carp in Pools 16-20.

Project Activities, Methods and Timetable:
The USFWS maintains an extensive acoustic telemetry network in Pools 5a-26. Over 300 Silver and Bighead Carp currently carry functional tags and provide information on the movements of Asian carps throughout the UMR. The primary functions of the telemetry program are to document the extent to which the tagged fish range, determine both individual and mass movements of Asian carps among pools and tributaries of the UMR, and identify priority locations for potential deterrent technologies. These data are needed to generate complex temporal-spatial analyses and contribute to development of an advanced population model.

Job 1.4 Contribution to sub basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

- *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*
- *Strategy 2.2: Evaluate and implement deterrent measures at strategic pinch points to prevent dispersal of Asian carp recognizing other fish management goals.*
- *Strategy 2.3: Support research to improve existing or develop new containment technologies.*

Goal 3: Eliminate populations of Asian carps in the UMR to limit their adverse effects.

- *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR*
- *Strategy 3.3: Identify and eliminate sources of Asian carp recruitment*

Job 1.4 Deliverables

Data generated from the telemetry program are being used to determine the extent to which these populations currently range and identify new sites for contract removal efforts. These data are

also being used to generate complex temporal-spatial analyses that will provide input into an advanced population model. The resultant data and model will allow evaluation of previously employed management actions, including removal efforts.

Project Component 2: Evaluation of inter-annual variations in reproduction/recruitment

Job 2.1: Ichthyoplankton monitoring in UMR and large tributaries

Lead Agency: IA DNR (Iowa State University)

Project Activity	**Pool**	**Month**	**Year**
Ichthyoplankton Sampling	14-20	May-Aug	2019
Data Processing	N/A	Sep-Dec	2019

Objective:

2. Document the extent of reproducing populations of Silver and Bighead Carp in the UMR.

Project Activities, Methods, and Timetable:
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 potential mates to find each other and spawn successfully. Comprehensive monitoring for larval and juvenile Asian carps in pools 14 thru 20 is needed to detect and quantify Asian carp reproduction (eggs and larvae), recruitment (juveniles), and any potential response of Asian carp reproduction and recruitment to control strategies. Ichthyoplankton sampling will take place every two weeks May through August. Data processing (e.g., egg and larval sorting and identification, and data analysis) will occur during the fall and winter months.

Job 2.1 Contribution to sub basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

3. *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*

Goal 3: Eliminate populations of Asian carps in the UMR to limit their adverse effects.

4. *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR*
5. *Strategy 3.3: Identify and eliminate sources of Asian carp recruitment*

Job 2.1 Deliverables:

Ichthyoplankton monitoring will detect and quantify the amount of Asian carp reproduction in the UMR and its larger tributaries, and identify the range of reproducing populations. This information can be used to inform control strategies and harvest models. A project summary report will be available to present to congress in October of each year and an annual technical report will be available March 1 for previous calendar year activities. The sampling techniques and methodology for this work will be disseminated in a reference manual.

Job 2.2: Ichthyoplankton and juvenile fish monitoring in nursery habitats.

Lead Agency: ILDNR (Illinois Natural History Survey)

Cooperating Agency: USFWS – La Crosse FWCO

Project Activity	**Pool**	**Month**	**Year**
Larval sampling	17-19	May-Sept.	2020
Juvenile Fish Sampling			2019

Objective:

2. Document the extent of reproducing populations of Silver and Bighead Carp in the UMR.

Project Activities, Methods, and Timetable:

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 potential mates to find each other and spawn successfully. Comprehensive monitoring for

larval and juvenile Asian carps in pools 14 thru 19 is needed to detect and quantify Asian carp reproduction (eggs and larvae), recruitment (juveniles), and any potential response of Asian carp production recruitment to control strategies. INHS 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 other week from May 22 until conditions are no longer conducive to Asian carp spawning. Sampling weeks will occur concurrently with commercial removal efforts. A total of 30 traps will be deployed each week and placed at randomly generated sites per pool. Traps will be deployed at a minimum of an hour after sunset and allowed to fish for approximately 60 minutes, contents removed and redeployed 2 additional times during the night (total of 10 traps per night). 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 95% ethanol 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. The USFWS will conduct randomized and targeted efforts to sample young-of-year Asian carps in pools 14-17 using pulsed-DC electrofishing and dozer trawls. There is some overlap with USFWS work included in this job and the YOY sampling that was detailed in Job 1.2.

Job 2.2: Contribution to sub basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

3. *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*

Goal 3: Eliminate populations of Asian carps in the UMR to limit their adverse effects.

4. *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR*
5. *Strategy 3.3: Identify and eliminate sources of Asian carp recruitment*

Job 2.2: Deliverables:

Ichthyoplankton and juvenile monitoring will detect and quantify Asian carp reproduction in the UMR and its nursery habitats, as well as, identify the range of reproducing populations. This information can be used to inform control strategies and harvest models. A project summary report will be available to present to congress in October 2019 and an annual technical report will be available March 1, 2020. The sampling techniques and methodology for this work will be disseminated in a reference manual.

Project Component 3: Model development for evaluating the effects of controls on density and behavior

Lead Agency: USFWS

Objective:

2. Employ advanced modeling techniques to evaluate the impacts of controls on populations of Silver and Bighead Carp in Pools 16-20.

Project Activities, Methods, and Timetable:
The USFWS will use data compiled across all partners to parameterize multiple models to estimate annual variations in Asian carp density, population and individual growth parameters, movement rates among pools, and habitat use. These models will help provide recommendations by identifying which pool(s) should be targeted 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.

Project Activity	**Pool**	**Month**	**Year**
Model Development and Evaluation	16-20	April-Dec	2019

Project Component 3 Contribution to sub basin Asian carp management objectives:

Goal 2: Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

3. *Strategy 2.1: Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.*

4. *Strategy 2.3: Support research to improve existing or develop new containment technologies.*

Goal 3: Eliminate populations of Asian carps in the UMR to limit their adverse effects.

- *Strategy 3.2: Build harvest models to adaptively manage Asian carp in the UMR*

Project Component 3 Deliverables:

These models will be used to identify which dynamic rate functions show the most promise of influencing success in control and deterrent efforts. In turn, it will help evaluate the effectiveness of different management strategies such as spatial allocation and intensity of harvest and/or upstream movement deterrence. Finally, modelling efforts will provide recommended removal quotas and identify priority geographic areas for control or removal. An annual summary of these model results will be drafted and shared with the UMR Asian carp partnership

Project Summary (All Components)

By achieving all field components related to this project; comprehensive stock assessment (hydroacoustic surveys, fishery-independent monitoring, and fishery-dependent monitoring), juvenile and ichthyoplankton sampling and telemetry monitoring of Asian carp populations in the UMR, the USFWS will be able to measure the efficacy of control programs and identify areas of opportunity for future management actions. Collectively, the field components of this project will provide robust estimates of Asian carp abundance, biomass, demographic parameters (aging structures, individual lengths and weights, sex, tissue samples for genetic and physiologic studies, etc.), spatial distributions, migratory tendencies and dynamic rate functions. Additionally, these variables will be used to parameterize Asian carp modeling efforts that serve as objective, data-driven decision support tools for informing management strategies. An understanding of these variables is critical to evaluating the impacts of management actions and identifying and developing future management strategies.

Project Title: Evaluation of fish passage for assessment of bigheaded carp deterrents at locks in the Upper Mississippi River

Geographic Location: Mississippi River Navigation Pools 14 to 20, with special emphasis on Lock and Dams 15 and 19

Lead agency: USGS

Agency Collaboration: USFWS, USACE, MDC, ILDNR (WIU, INHS), Iowa DNR

Statement of Need:
Invasive carp 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 physical and operational characteristics of Lock and Dam (LD) 19 restrict upstream migration of fishes because the only upstream fish passage route is through the lock chamber. This possible restriction of emigration into pools above Lock 19 may make that segment of the population more susceptible to control measures, such as overfishing. Lock and Dam 15, located at the upstream end of the Intensive Management Zone (IMZ), also serves a potential barrier as this system is rarely in open river condition.

Sound deterrents have been developed for limiting the range of fish, and those systems show promise in deterring bigheaded carps. To date, small scale sound deterrents have been tested on many native fish and Asian carps in labs, outdoor ponds, and small rivers, but they have not been tested on a larger scale such as at lock and dam structures on the large rivers where bigheaded carps are abundant. As a result, the USFWS with the support of many partner agencies and multiple funding sources is planning to test a sound deterrent at lock and dam facilities (e.g., Lake Barkley Dam, Cumberland River; Lock and Dam 19, Mississippi River). Given the plans to test sound deterrents, there is a need to collect baseline movement data on bigheaded carps and native fishes that can be used to aid planning and evaluation of an experimental sound deterrent. This project proposes continued collection of movement data using Vemco receiver arrays and acoustically tagged fish in the UMR to inform planning and evaluation of the potential experimental deterrent.

Data collected from the LD19 array during previous years have revealed some important differences in bigheaded carps that were originally collected from P19 versus P20. During 2017, 8 bigheaded carps (6 bighead carp and 2 silver carp) successfully passed upstream through the lock chamber at LD19. Of those 8, 7 were originally collected and tagged in P19 and only 1 of the successful upstream passages was completed by a bighead carp that originated from P20. These data suggest that bigheaded carps that originated from upstream of LD19 may have a greater motivation to return to P19 relative to those that originated from P20.

Previous years' efforts have contributed to our knowledge of when and how both native and invasive fishes move through the lock chamber for successful upstream passage at LD19. The VEMCO positioning system analysis has provided reasonable 2-D positioning in the lower downstream lock approach but it performs poorly in the upper-portion of the downstream lock approach near the lower miter gates. Data are still lacking on positioning bigheaded carp in the water column and the depth of the fish when they are present in the lock approach or lock chamber. One method to determine the depth of the fishes 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 2019 efforts will test this technology prior to implementing a complete study that depends upon its reliability. Three additional receivers will be deployed in the lock chamber to increase the likelihood of positioning fish in the lock chamber and to better study the behavior of fishes while barges are present.

A better understanding of the position and timing of native fish and bigheaded carp in the lock chamber and approach is needed to aid in deterrent design. FY19 funds are needed to purchase acoustic tags for increasing the number of tagged bigheaded carps and native species in Pools 16, 19, and 20. Data are currently being collected by MDC, WIU, USFWS and USGS from previously tagged fish moving through longitudinal and 2-dimensional arrays of Vemco acoustic receivers. Many of the previously tagged fish will continue to be tracked. Information gathered from these receiver arrays will provide insight on how these fishes are passing through these locks and dams, and how passages relate to lock operation and river traffic. This information will be used to guide the design and evaluate the effects of a deterrent system in the event that testing one is authorized.

National Plan Goal Supported:

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 Strategy Supported:

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 3.2.4 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;

Sub-basin Management Plan Goal Supported:

Prevention

Monitoring and Response

Sub-basin Management Plan Strategy Supported:

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

Project Objectives:

1. Assess fish passage rates at lock and dam structures in the IMZ on the Upper Mississippi River as an assessment tool for the future testing of Asian carp deterrents.
2. Support increasing receiver coverage in and around lock chambers to improve one-, two-, or 3-dimensional tracking of tagged fishes (native and invasive carps) in the lock approach and chamber
3. Increase receiver coverage in pools 19 and 20, and pools 14, 15, and 16 to enhance detection probabilities to ensure fish passages are documented
4. Analyze movement data to evaluate approach channel use, lock use, and dam passage by invasive carps and native species at LD 15 and 19
5. Use USACE Lock Queue Reports to inform the relationship between fish movements and behavior in relation to lock structures and operation
6. Determine suitability of depth sensitive transmitters for determining vertical position in the water column
7. Conduct planning or studies at strategic locations to better understand feasibility of and how to deploy deterrents at lock chambers to deter bigheaded carp while minimizing effects to native species

Agency: ILDNR

Project Activities, Methods and Timetable:

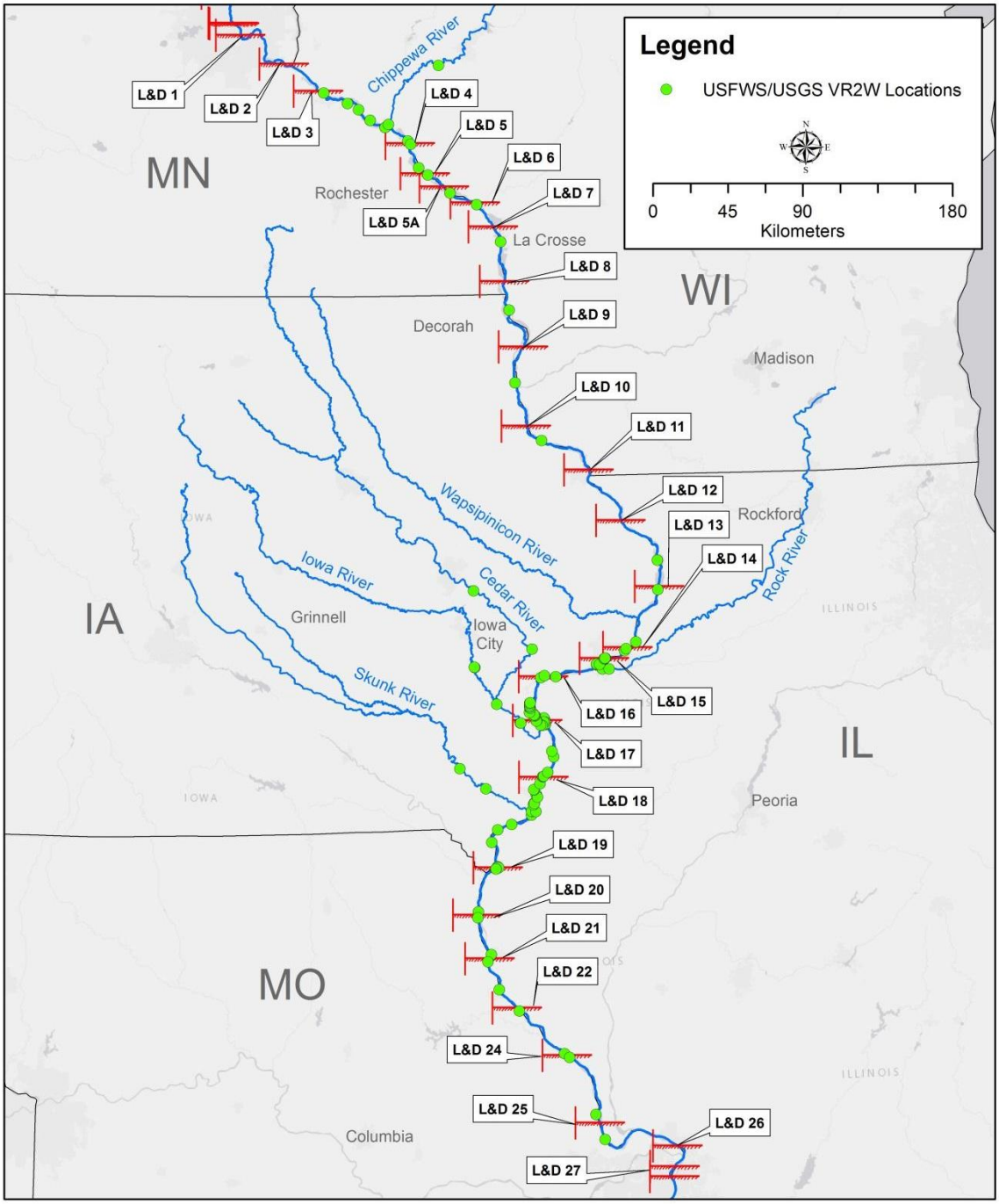
Objective 1
Collaborating agencies will continue to quantify native and non-native fish passage in the IMZ, with special emphasis on LD19 and LD15. The USFWS longitudinal remote receiver array will be redeployed in pools 5A-19 in the spring of 2019 and the MDC stationary array will be maintained in pools 19-26 (Figure 1). In 2018, MDC implanted transmitters into an additional 44 Bighead Carp, 47 Silver Carp, and 41 Paddlefish in P20, resulting in 407 active tags in native and invasive species in P20 during the year of 2018. WIU tagged 121 adult paddlefish in P14 and P16 in 2018. These fish will continue to be acoustically tracked to determine the frequency of dam passage and environmental conditions associated with passage in the IMZ. 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.

FY2019 funds will be used to purchase 300 Vemco tags to enhance the number of tagged Bighead Carp, Silver Carp, and native species (e.g. Bigmouth Buffalo) at large in P16, P19, and P20. These locations are being targeted to increase the number of telemetered fishes that could serve as challengers to passing LD15 and LD19.

During fall 2019, additional bigheaded carps and Bigmouth Buffalo will be tagged in P16 to increase tagged fish available near LD15. Additional bigheaded carps and native species may also be tagged in P19 and P20 during fall months. Fish tagging will be a collaborative effort between MDC, WIU, INHS, USFWS, and USGS. Individual fish will be weighed and measured for total length or fork length as appropriate. All acoustic transmitters will operate at the same frequency and ping duration as existing tags in this stretch of the river.

Estimated Timetable:

Project Activity	Pool	Month	Year
Deploy longitudinal receiver array	All locations	April-May	2019
Receiver downloads	All locations	June, September, Nov	2019-2020
Tagging	16, 19, 20	October, November	2019
Manual tracking	All locations	Biweekly or monthly	2019-2020
Receiver downloads	All locations	Varies by location: biannual at minimum	2019-2020



Map created by: Jeena Credico
Sources: USFWS, USGS, and Esri
Scale: 1:3,050,000
Projection: NAD 83 UTM Zone 15N

Figure 30. Locations of stationary receivers in the longitudinal array deployed in the Mississippi River basin.

Agency: USGS

Project: Evaluation of fish passage for assessment of bigheaded carp deterrents at locks in the Upper Mississippi River

Objectives:

1. Support increasing receiver coverage in and around lock chambers to improve one-, two-, or 3-dimensional tracking of tagged fishes (native and invasive carps) in the lock approach and chamber
2. Increase receiver coverage in pools 19 and 20, and pools 14, 15, and 16 to enhance detection probabilities to ensure fish passages are documented
3. Analyze movement data to evaluate approach channel use, lock use, and dam passage by invasive carps and native species at LD 15 and 19
4. Use USACE Lock Queue Reports to inform the relationship between fish movements and behavior in relation to lock structures and operation
5. Determine suitability of depth sensitive transmitters for determining vertical position in the water column
6. Conduct planning or studies at strategic locations to better understand feasibility of and how to deploy deterrents at lock chambers to deter bigheaded carp while minimizing effects to native species

Project Activities, Methods and Timetable:

Two-dimensional positioning arrays were deployed at Lock 15 (Figure 2; Oct 2016 to Nov 2018) and at Lock 19 (Figure 3; March 2017 to Nov 2018). These arrays will be redeployed in April 2019. Data recorded on remote receivers from acoustically tagged fish (already tagged or to be tagged by MDC, WIU, INHS, USGS, and/or USFWS) 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. Data from the lock approach arrays will allow computation of time spent in or near the lock approach and lock, and within pool receivers should confirm or refute successful passage. With adequate 2D resolution, heat maps will be created to identify areas of frequent use in the approach and lock at LD 15 and LD 19.

Depth sensitive transmitters were purchased in FY2018 and are being used to tag 25 Asian carp to determine if this technology will provide adequate resolution of 3D positioning in the lock approach and lock chamber at LD 19. Depth profiles will be created from a subset of these tags prior to implantation in fish to evaluate the depth accuracy of the tags within this study system. These tags will be implanted into bigheaded carps from P19 and P20 in spring of 2019.

The discrepancy in successful upstream passages between bigheaded carps from P19 versus P20 has prompted a decision to translocate some bigheaded carps in 2019. Adult Bighead Carp and Silver Carp (n = 50-100) will be collected during Spring 2019 in Pool 19, transported to Pool 20,

surgically implanted with an acoustic transmitter, then released into P20. These translocated fish will provide an opportunity to compare natural rates of passage versus passage by fishes that may have a greater motivation to return to P19. The translocated fish will also potentially increase the number of successful upstream passages which will enhance the amount of information available for designing an effective deterrent at LD19. All fish that are translocated will be noted in the database and will be treated separately for statistical analyses. Additional tagging and translocations may occur in Fall 2019. Telemetry tags for this effort will be contributed by USGS.

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 in 2019. All detection data will be shared among collaborating agencies. Modeling analyses will be completed by USGS to evaluate the relation between fish presence in the lock approaches at LD 15 and LD 19 relative to environmental factors and lock operation. Lock Queue Reports will be obtained from the USACE.

Estimated Timetable:

Project Activity	Pool	Month	Year
Deploy lock approach telemetry array	LD15, LD19	April-May	2019
Tagging and translocating	Collect from P19, move to P20	April, May, June (Possibly Oct, Nov)	2019
Post processing by Vemco	Lock 19	December	2019
Summarize time in approach vs passage	Lock 15 and 19	January-March	2020

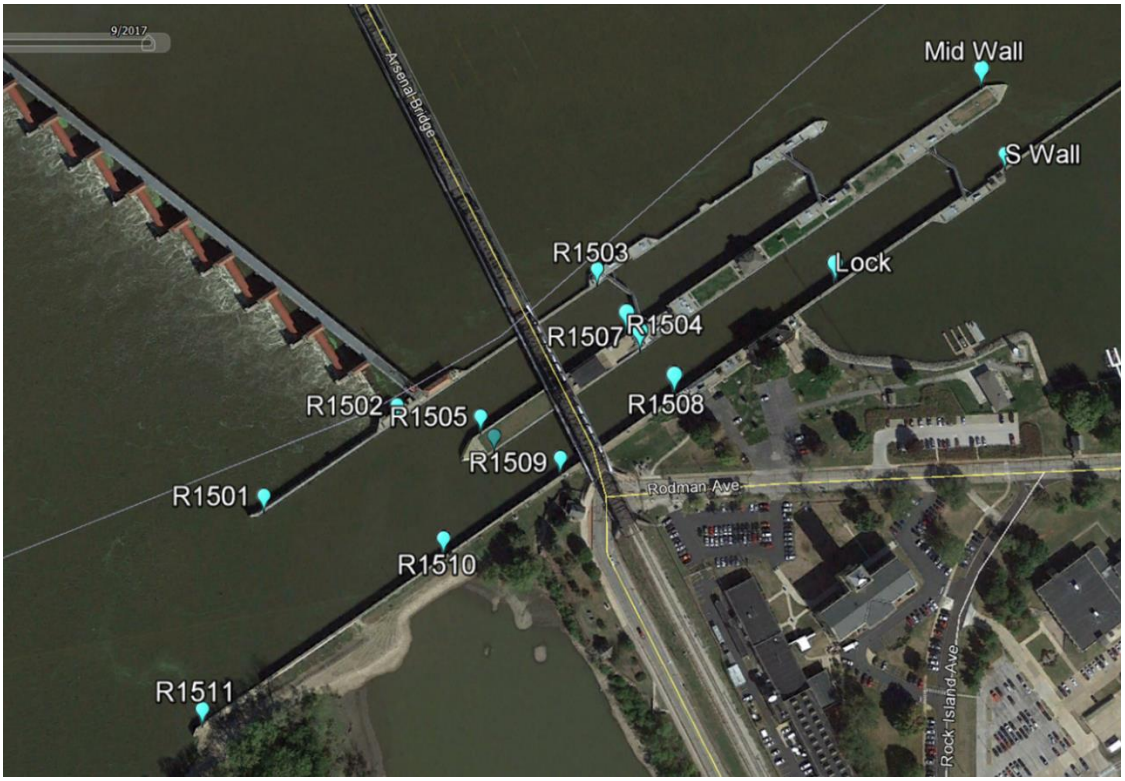


Figure 31. Location of receivers completing the 2D array in the lock approach at Lock 15.

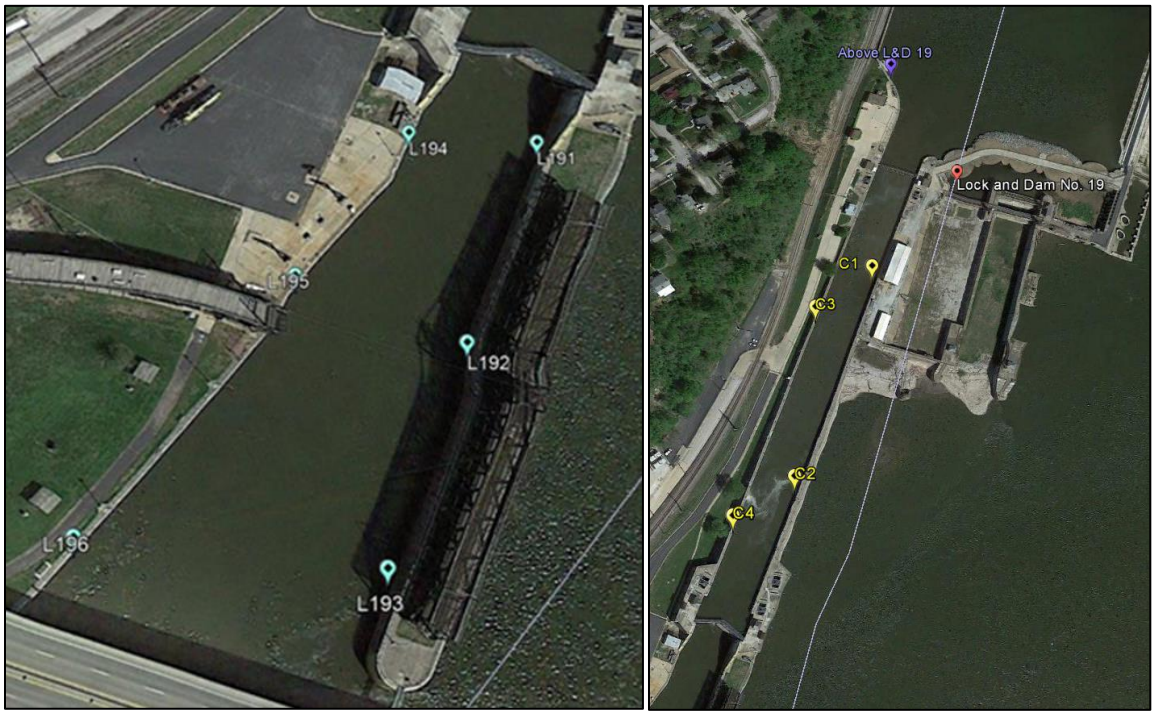


Figure 32. Location of receivers completing the 2D array in the lock approach at Lock 19. Receivers noted in blue are located in the downstream lock approach, receivers in yellow are located inside the lock chamber, and the receiver in purple is located in the upstream lock approach.

Project Title: Contract Fishing for Asian Carp Detection and Removal

Geographic Location: Upper Mississippi River Pools 14-19

Lead Agency: Illinois DNR/INHS

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.

National Plan Goal Supported:

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 Supported:

Strategy 3.3.2	Increase the commercial harvest of Asian carps.

Sub-basin Management Plan Goal Supported:

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

Sub-basin Management Plan Strategy Supported:

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. 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, 2020

Agency: Illinois DNR (Illinois Natural History Survey)

Project: Contract Fishing for Asian Carp Detection and Removal

Project Activities, Methods, 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
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.

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, 2020

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-La Crosse 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).

Estimated Timetable:

Project Activity	Pool	Month	Year
Jaw tagging	17-19	March-April	2020
Harvest	14-19	August-July	2019-2020
Intensive harvest	16-19	April	2020

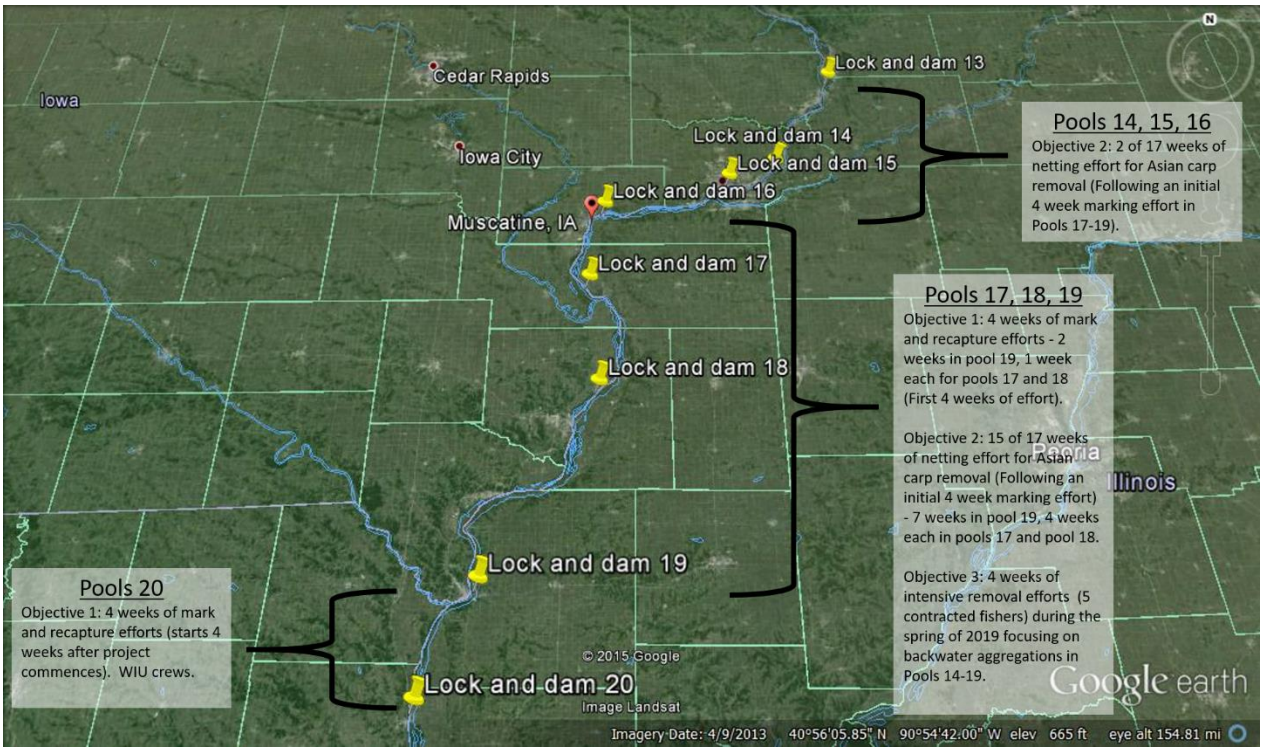


Figure 33. Project Area

Project Title: Conceptual framework development to provide Asian carp management information informing habitat manipulation programs.

Geographic Location: Upper Mississippi River System (UMRS)

Lead Agencies: Missouri Department of Conservation and USACE

Agency Collaboration: USGS, USFWS, other sub basin partners (Wisconsin DNR, Illinois DNR, Illinois INHS, Iowa DNR, and Minnesota DNR)

Statement of Need:

A need remains to provide general information to teams working on habitat manipulation projects on the Upper Mississippi River System regarding Asian carp. This includes communication of science-based management options to professional stakeholders possessing the common interest of improved Asian carp management at UMRS recreational angling sites. Methods promoting Asian carp removal or site avoidance provided to interested state and federal river managers working on habit manipulation projects would also serve as valuable outreach information. Efforts to work synergistically with ongoing Upper Mississippi River habitat manipulation techniques would also be explored.

National Plan Goals Supported:

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;

National Plan Strategies Supported:

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.

Sub-basin Management Plan Goal Supported:

Goal 5	Conduct effective intra and inter agency communications and outreach to improve the management and control of Asian Carps in the UMR.

Sub-basin Management Plan Strategy Supported:

Strategy 1.3	Enhance natural and desirable properties of the Upper Mississippi River ecosystem through preservation and restoration efforts.
Strategy 5.3	Use effective communication and outreach tools to inform anglers, recreational boaters, the public, politicians, friends groups and NGOs of the importance of Asian carp control and management.

Project Objectives:

1. Develop a conceptual framework using river manager expertise to inform teams working on habitat manipulation projects to improve UMRS Asian carp management.
2. Develop a Program Management Plan to communicate management options to professional stakeholders possessing the common interest of improved UMRS Asian carp management at recreational angling sites.

Agency: Missouri Department of Conservation

Project Activities, Methods, and Timetable:

Objectives 1 and 2
Project activities entail meetings with Upper Mississippi River sub basin members to coordinate information relevant to habitat projects, and specifically develop a conceptual framework (February meeting) and Program Management Plan (November meeting). These efforts will collate research and management information most relevant to habitat projects with an emphasis on Asian carp removal and site avoidance. Additionally, removal and site avoidance discussions will focus on synergistic opportunities with other ongoing UMRS habitat manipulation goals. The conceptual framework and Program Management Plan will be revisited periodically as needed to maximize benefits to habitat management professionals.

Estimated Timetable:

Project Activity	Pool	Month	Year
Meeting		February	2020
Meeting		November	2020

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

Strategy for eDNA Monitoring in the Upper Mississippi River Basin.....140

Project Title: Strategy for eDNA Monitoring in the Upper Mississippi River Basin

Geographic Location: Mississippi River Pools 8-19

Lead Agencies: U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey (USGS)

Statement of Need: When used as a monitoring tool, eDNA has a significantly lower false negative (fail to detect eDNA that is present) rate than other monitoring methods, such as electroshocking and gill netting, which have a very high false negative rate when animals are present in very low abundance (Darling and Mahon 2011). Utilizing multiple detection methods provides a balanced and more complete monitoring program in areas where the target species is rare. Efforts to monitor and remove Silver and Bighead Carp from the Upper Mississippi River are primarily focused below Lock and Dam 15. Conducting eDNA sampling upstream of this area as a long-term monitoring tool could provide early evidence to changes in the Asian carp presence in those pools where traditional capture gears are not heavily utilized.

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 3.2.4	Forecast, detect, and rapidly respond to new feral Asian carp introductions and range expansions.
Strategy 3.6.1	Develop effective sampling gears and monitoring methods for all life stages of Asian carps in both standing and flowing water environments.
Strategy 3.6.2	Assemble information about the distribution, biology, life history, and population dynamics of Bighead, Black, Grass, and Silver carps.

Sub Basin Goals:

Goal 2	Contain expansion of Asian carps in the UMR while minimizing impacts to native species movement.

Sub Basin Strategies:

Strategy 2.1	Continue the UMR comprehensive monitoring program to maintain a current understanding of Asian carp distribution at all life stages for early detection, prevention, response, control and containment.
Strategy 2.5	Develop and implement new early detection and monitoring tools to supplement eDNA

Project Objectives:

1. Sample for Asian carp eDNA in targeted areas of the Upper Mississippi River to maintain vigilance above the Intensive Management Zone (Pools 16-19)
2. Build and maintain a long-term eDNA data set to provide evidence of emergent populations or changing presence of Asian carp in pools where Asian carp are not readily captured by traditional methods

Agency: U.S. Fish and Wildlife Service

Project: Strategy for eDNA Monitoring in the Upper Mississippi River Basin

Objectives:

1. Determine if Silver and Bighead Carp eDNA is present in targeted backwaters in the pools immediately upstream of the Intensive Management Zone.
2. Inform managers of potential trends in Silver and Bighead Carp presence and provide data to support the prioritization of new backwaters to target with traditional capture methods
3. Refine detection probability and optimal sampling design of eDNA in the UMR

Project Activities, Methods and Timetable:
eDNA samples will be collected from pools 13, 14 and 16 (Figures 1-3). Pools 13 and 14 will be targeted because they are immediately upstream of the Intensive Management Zone (IMZ; Pools 16-19), where Bighead and Silver Carp have established reproducing populations. Pools 13 and 14 contain abundant backwater and off-channel habitat. Additionally, these pools are not sampled by other USFWS Asian carp monitoring efforts so eDNA can potentially give evidence to changes in Asian carp presence over time. Unpublished telemetry data from Pool 18 show that tagged fish move into backwater habitats in the spring, when water temperatures are between about 8-15 °C, and reside there prior to making spawning runs to tributaries (Kyle Mosel, USFWS, personal communication). Mize et al. (*in Review*) showed that the probability of detecting eDNA was greater in a UMR habitat characterized by low flow (e.g. a backwater) in the spring and fall, as compared to higher flow areas (e.g. tributary and impoundments). Therefore, backwaters in Pools 13 and 14 will be targeted in the spring and fall. Additional advantages of sampling backwaters in the spring and fall are that water temperatures are likely to be cooler, decreasing the rate of eDNA degradation in the water, and the flow in these habitats is low, increasing eDNA residence at the site. Seven backwater sites in Pool 13 (Figure 1) and twelve sites in Pool 14 (Figure 2) will be targeted. Sites were chosen based on flat pool bathymetry indicating depth greater than 4 feet at flat pool (USGS 2016). The goal of sampling Pool 13-14 is to assess trends in eDNA presence in backwaters over time and potentially use those data to prioritize areas to implement traditional capture gears to support Asian carp telemetry tagging and removal efforts outside of the IMZ, if desired in the future.

Additionally in the fall, one backwater site in Pool 16 (Figure 3) will be sampled for Asian carp eDNA, specifically, the backwater east of Credit Island. This site was selected because, a real-time telemetry receiver will be installed at this location and Asian carp have been observed and captured at this location in the past. The intention of collecting eDNA from this site would be to continually compare eDNA results to presence of telemetered fish. These data and the results from Pools 13 and 14 will be used to further refine detection probability and sampling design year after year. Sampling at the Pool 16 site will only be done during the fall event.

Based on recommendations from an eDNA occurrence model (Erickson et al., 2019; Mize et al., in revision), each backwater site will be sampled at a density of 1 sample per 0.01 km^2 with a minimum of 40 samples per site. Each sample will consist of 5, 50 mL conical tubes. Sampling

and processing procedures will follow the USFWS 2019 Quality Assurance Project Plan (QAPP).

Estimated Timetable:

Project Activity	**Pool**	**Number of Samples**	**Month**	**Year**
eDNA sampling	13-14	836	May	2019
eDNA sampling	13, 14, 16	880	October-November	2019

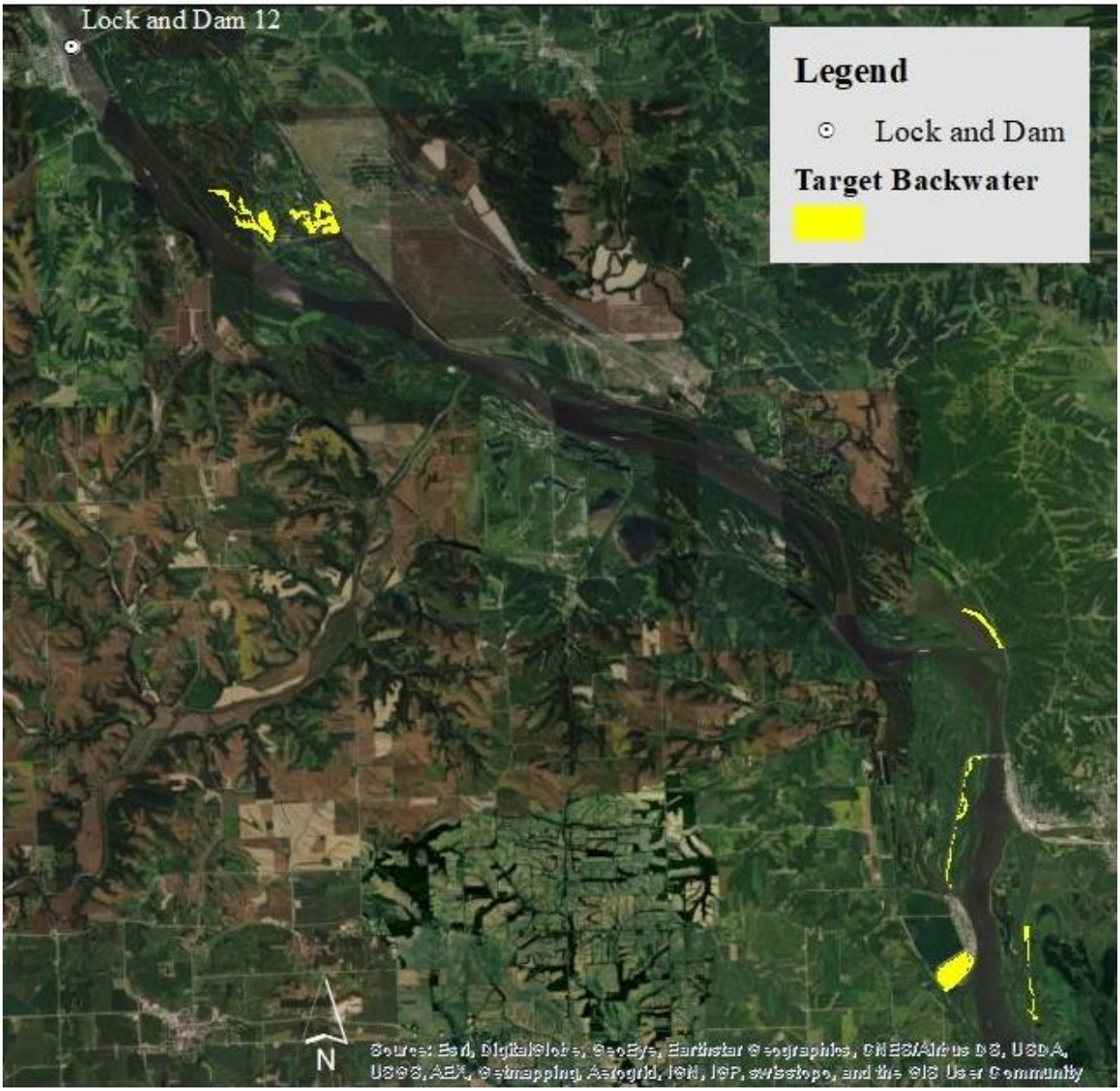


Figure 34. Backwater sites in Pool 13 of the Mississippi River that will be sampled for Asian carp eDNA in 2019.

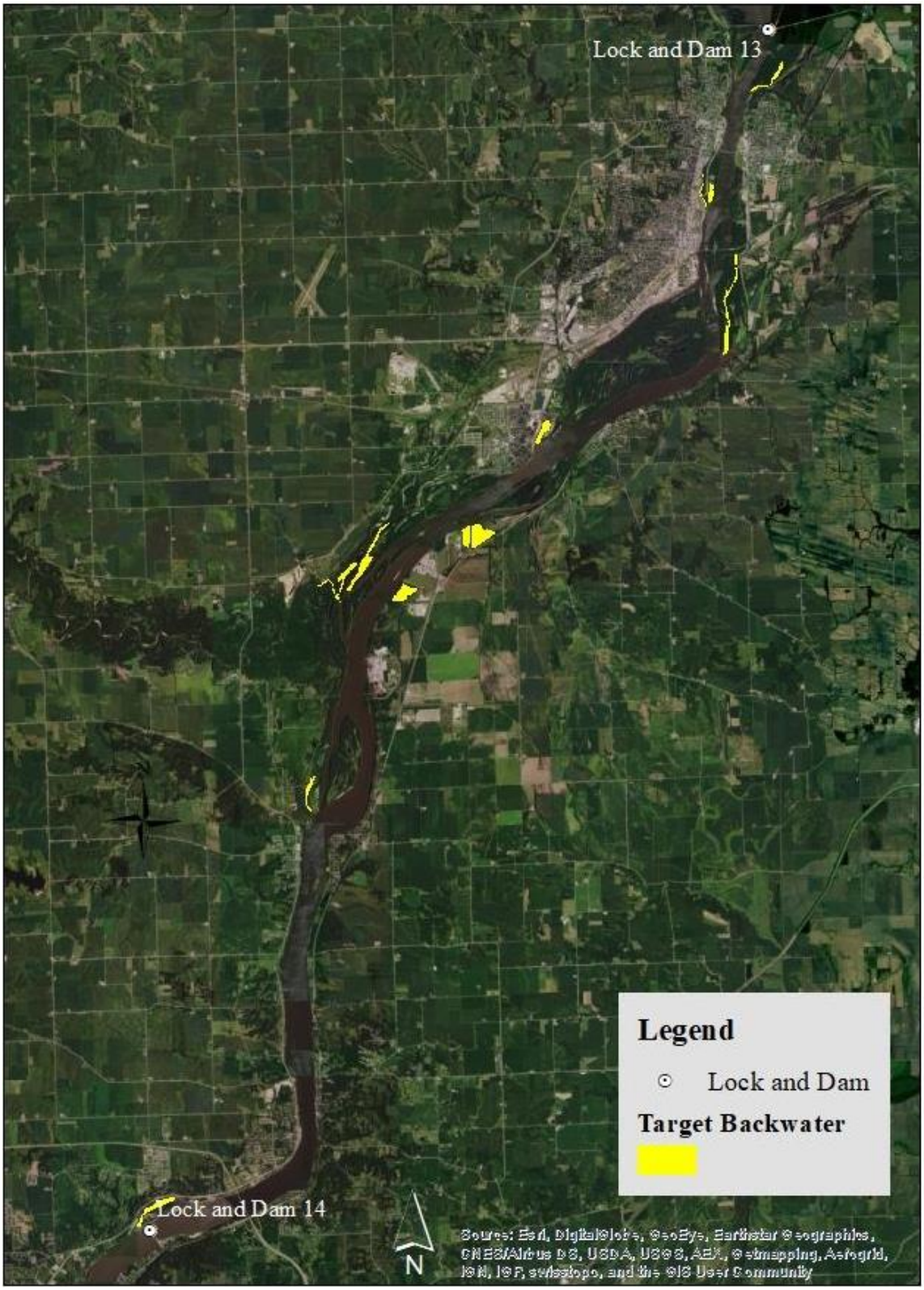


Figure 35. Backwater sites in Pool 14 of the Mississippi River that will be sampled for Asian carp eDNA in 2019.

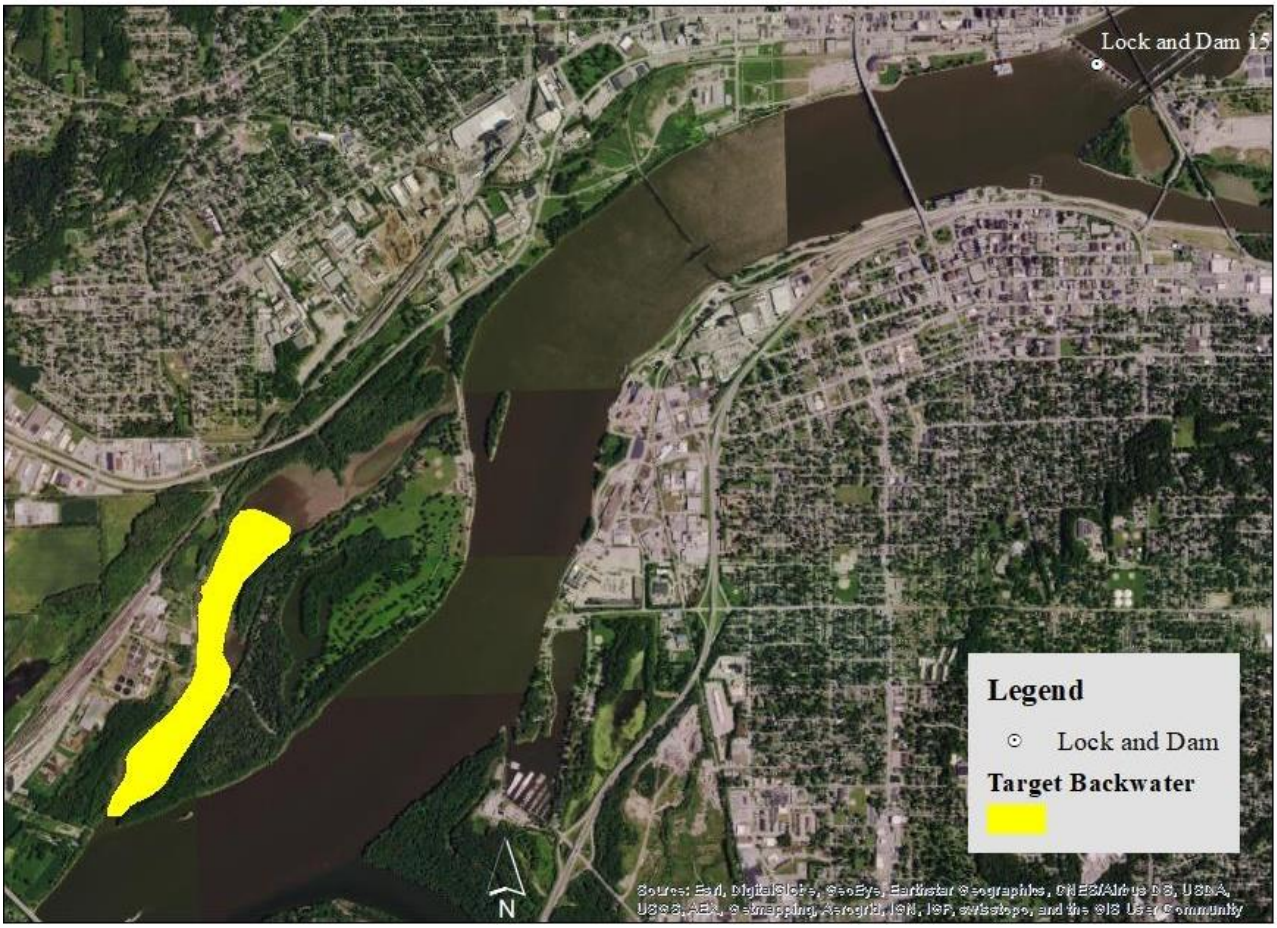


Figure 36. Backwater site in Pool 16 of the Mississippi River that will be sampled for Asian carp eDNA in 2019.

Agency: U.S. Geological Survey

Project: Strategy for eDNA Monitoring in the Upper Mississippi River Basin

Objectives:

1. Document upstream invasion of bigheaded carps with eDNA while developing a long-term sample set that can be used to assess impacts to native species before and after bigheaded carp invasion.

Project Activities, Methods and Timetable:

We will collect 50 - 50 mL surface grab samples from each selected pool. We will hold samples on dry ice until they are brought to the UMESC for processing. We will centrifuge samples at 5,000 x *g* for 30 minutes at 4°C, decant the water, and extract genomic DNA from the remaining pellet using the commercially available gMax Mini genomic DNA extraction kit (IBI Scientific). We will analyze samples in 4 replicates with the AD qPCR assay published by Erickson et al. (2017), with 3 additional replicates having synthetic DNA spiked in to check for inhibition. We will also reanalyze samples with positive detections using the Farrington et al. (2015) markers BHTM1/2 and SCTM4/5.

Estimated Timetable:

Project Activity	**Pool**	**Number of Samples**	**Month**	**Year**
eDNA sampling	8, 10, 12, 13, 17, 19	300	June-July	2019
eDNA sampling	8, 10, 12, 13, 17, 19	300	October-November	2019

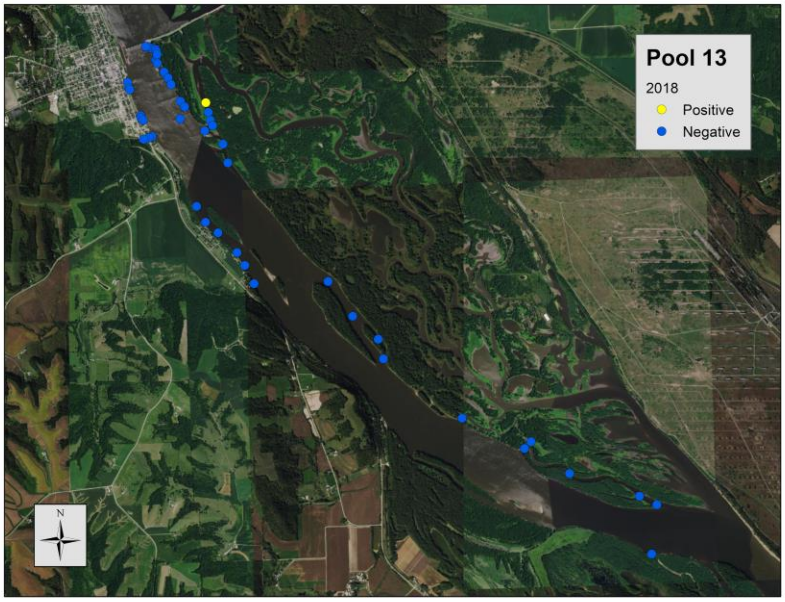


Figure 37. Map of Pool 13 sampling points. Points are color-coded to reflect 2018 sample results for bigheaded carp detection. Yellow = detection, Blue = non-detection.

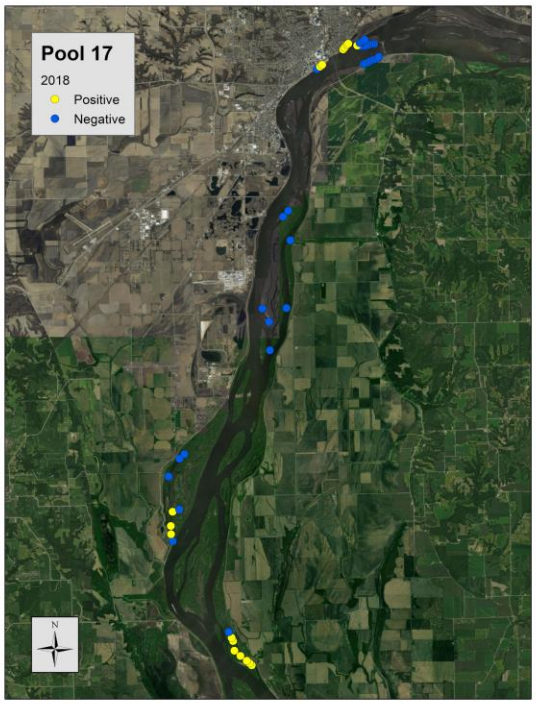


Figure 38. Map of Pool 17 sampling points. Points are color-coded to reflect 2018 sample results for bigheaded carp detection. Yellow = detection, Blue = non-detection.

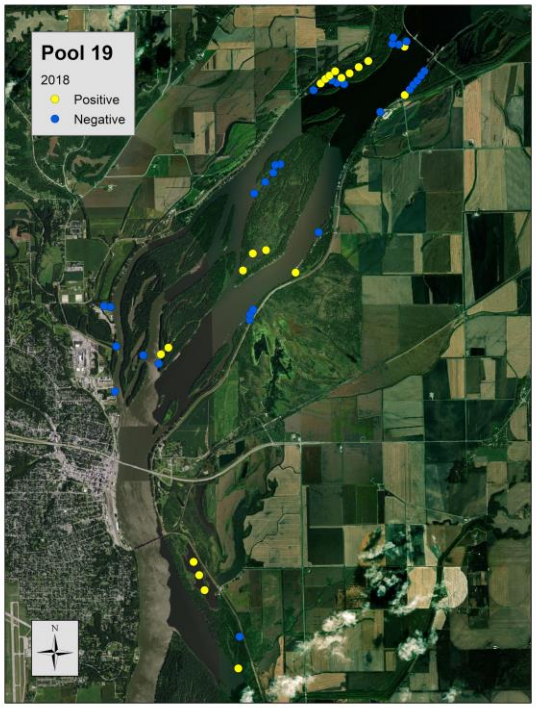


Figure 39. Map of Pool 19 sampling points. Points are color-coded to reflect 2018 sample results for bigheaded carp detection. Yellow = detection, Blue = non-detection.

Sampling locations for Pools 8, 10, and 12 will be determined in the field on the first sampling trip.

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Appendix B. Breakdown of USFWS base funding provided to states to support priority projects in the implementation of the Ohio River Sub-Basin and Upper Mississippi River Sub-Basin Asian Carp Control Strategy Frameworks.

OHIO RIVER BASIN	**$**	**1,735,000**

Agency	**Funding Amount**	
Project: Early Detection and Evaluation of AC Removal in the Ohio River		
Indiana	$	40,000
Kentucky	$	62,000
Pennsylvania	$	25,000
West Virginia	$	26,250
TOTAL PROJECT FUNDING	$	153,250
Project: Abundance and Distribution of early life stages of Asian carp in the Ohio River		
Indiana	$	12,000
Kentucky	$	7,500
West Virginia	$	3,750
TOTAL PROJECT FUNDING	$	57,250
Project: Control and Containment of Asian carp in the Ohio River		
Kentucky	$	665,000
West Virginia	$	9,000
TOTAL PROJECT FUNDING	$	674,000
Project: Relative Population Densities and Movement of Asian Carp in the Tennessee and Cumberland Rivers, Tributaries of the Ohio River		
Tennessee	$	123,000
TOTAL PROJECT FUNDING	$	123,000
Project: Deterrent Planning for Asian Carp in the Ohio River Basin		
Tennessee	$	43,000
Kentucky	$	57,000
TOTAL PROJECT FUNDING	$	100,000
Project: Quantifying lock and dam passage, habitat use, and survival rates of Asian carp in the Ohio River		
Kentucky	$	40,000
West Virginia	$	7,500
TOTAL PROJECT FUNDING	$	47,500

Project: Evaluation and Removal of Asian Carp in the Tennessee and Cumberland River Basins

KY / KDFWR	$	140,000
TN/TWRA / TTU	$	145,000
MS/ MDWFP	$	75,000
AL/ AWLFF	$	220,000
TOTAL PROJECT FUNDING	$	580,000

UPPER MISSISSIPPI RIVER BASIN	**$**	**1,055,000**

Agency	**Funding Amount**	

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

MN / DNR	$	103,000
TOTAL PROJECT FUNDING	$	103,000

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

IL / DNR	$	82,000
IA / DNR	$	95,000
TOTAL PROJECT FUNDING	$	177,000

Project: Contract Fishing for Asian Carp Detection and Removal

IL / DNR	$	670,000
TOTAL PROJECT FUNDING	$	670,000

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

IL / DNR	$	100,000
TOTAL PROJECT FUNDING	$	100,000

Project: Conceptual framework development to provide Asian carp Management information for habitat manipulation programs

USACE	$	5,000
TOTAL PROJECT FUNDING	$	5,000