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

2017

Prepared by the

Mississippi Interstate Cooperative Resource Association

Asian Carp Advisory Committee

August 2017

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Introduction

The 2017 Monitoring and Response Plan provides a summary of the collaborative partnership efforts planned in Fiscal Year 2017 to implement Asian Carp Control Strategy Frameworks developed for the Ohio River Basin (ORB) and Upper Mississippi River Basin (UMRB), two sub-basins within the larger Mississippi River Basin (Figure 1). These sub-basin control strategy frameworks are step-down plans of the national *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* (National Plan). The National Plan was approved for implementation by the Aquatic Nuisance Species Task Force in 2007; however, until recently, minimal resources have been available to prevent the continued range expansion and population growth of Asian carp in the Mississippi River Basin. States have been working with their partners at the sub-basin level to assess the status of Asian carp populations and implement management and control actions to the extent possible with limited resources.

Figure 1. Map outlining the Mississippi River Basin which drains all or a portion of 31 states and 2 Canadian Provinces. The Ohio River and Upper Mississippi River sub-basins are shaded dark green.

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 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 reach of the Illinois River (42 miles; 69.2 km) and the Chicago Area Waterways System (CAWS; 60 miles; 96.6 km). Asian carp prevention and control efforts in this small area within the Mississippi River Basin

are addressed in the ACRCC Asian Carp Action Plan (http://asiancarp.us/documents/2017ActionPlan.pdf).

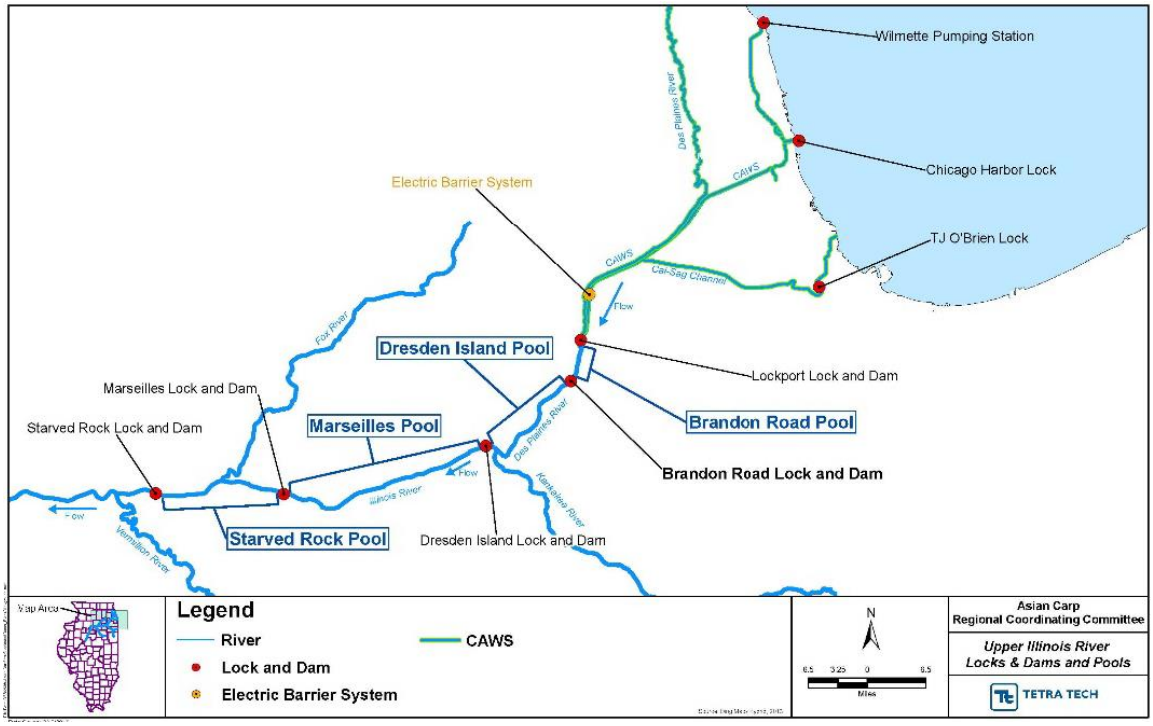

Figure 2. Map of the Upper Illinois River and Chicago Area Waterway System (CAWS) addressed in the ACRCC Asian Carp Action Plan (Source: 2017 Asian Carp Action Plan, www.asiancarp.us)

Bighead, Silver, and Grass carps have been established in the Mississippi River Basin, including the lower reaches of the ORB and UMRB for more than two decades (Figures 3 and 4). In recent years, Black Carp have been captured with increasing frequency in the Lower Mississippi River, Upper Mississippi River below Lock and Dam 19, the lower Illinois River, and the Lower Ohio River (Figure 3). With the collection of young-of-the-year Black Carp in the Mississippi River Basin in 2016, it is evident that Black Carp are likely self-sustaining in the open reach of the Mississippi River.

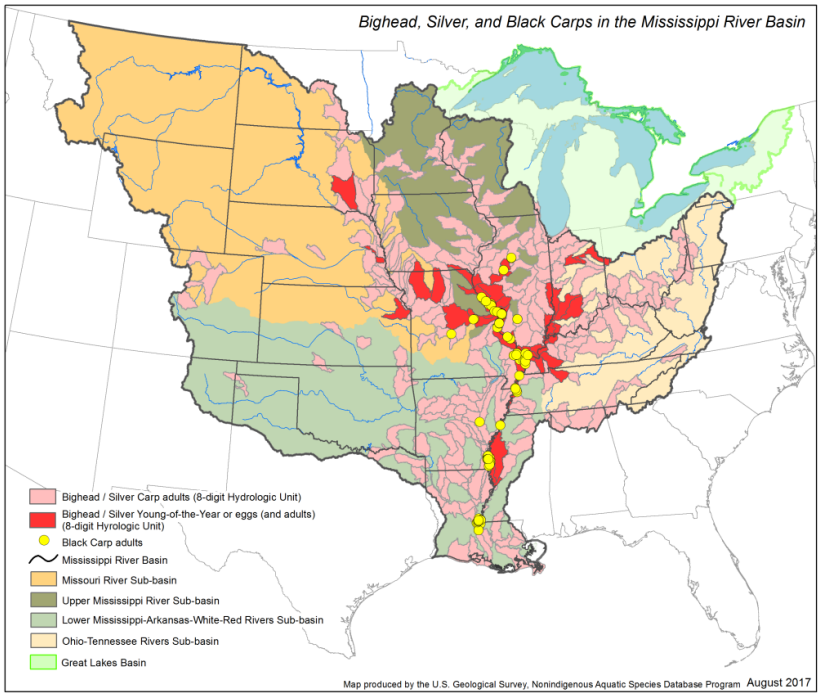

Figure 3. Distribution of Bighead Carp, Silver Carp, and Black Carp in the Mississippi River Basin as reported to the USGS Nonindigenous Aquatic Species (NAS) Database as of August 2017.

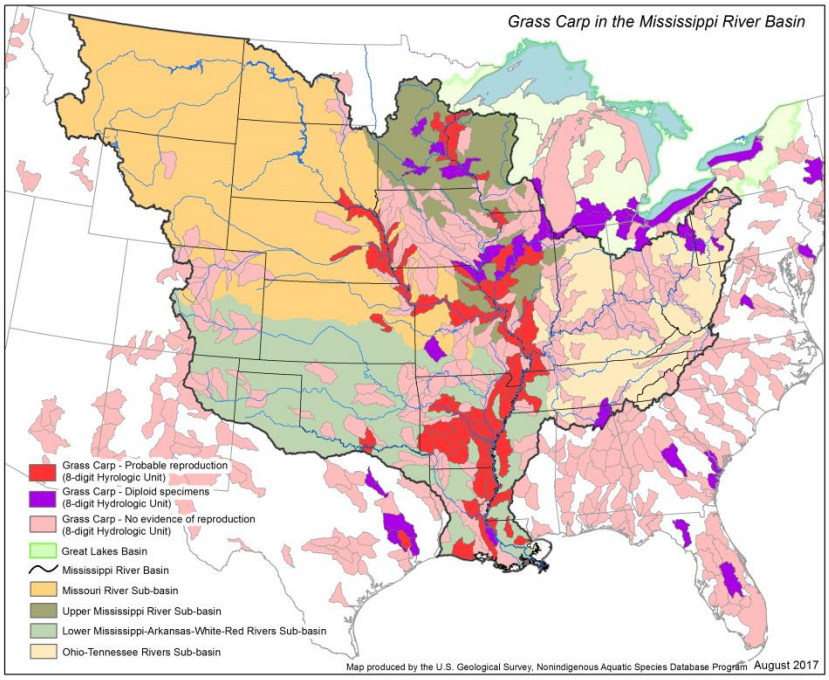

Figure 4. Distribution of Grass Carp in the Mississippi River Basin as reported to the USGS Nonindigenous Aquatic Species (NAS) Database as of August 2017.

On June 10, 2014, the United States Congress, in Section 1039 (b) of the Water Resources Reform and Development Act of 2014 (WRRDA), charged the USFWS, to work in coordination with the Secretary of the Army, the Director of the National Park Service (NPS), and the Director of the U.S. Geological Survey (USGS) to lead a multiagency effort to slow, and eventually eliminate, the spread of Asian carp in the ORB and UMRB. Congress appropriated $2.37 million in the USFWS's FY2015 budget for Asian carp prevention and control in the ORB and UMRB, providing the first substantial funding to address Asian carp populations in the Mississippi River Basin beyond the upper Illinois River and the CAWS. USFWS funding for Asian carp work in the ORB and UMRB increased to $2.62 million in FY2016. Congress appropriated an additional $700,000 in FY2017 for development and implementation of technologies in the field that are transferrable to other basins and potentially useful for other aquatic nuisance species. USFWS funding for Asian carp work in the ORB and UMRB totaled $3.32 million.

The USFWS provided the sub-basin partnerships with $800,000 of the agency's base Asian carp funding to support implementation of the frameworks in both the ORB and UMRB in FY2015. The increase in USFWS base funding in FY2016 and FY 2017 resulted in the agency increasing funding support to the sub-basin partnerships to $1,000,000 each year. In FY2017, an additional $200,000 was provided to the sub-basin partnerships to evaluate and support field testing of deterrence technologies that are transferrable to other basins and potentially useful for other aquatic nuisance species.

The USFWS met with state and federal agency partners in the ORB and UMRB in February and March 2015, respectively, to foster inter-agency coordination and to discuss planning, funding, and operations for Asian carp prevention and control. State representatives from both sub-basins recommended that the USFWS work through the Mississippi Interstate Cooperative Resource Association (MICRA) for executive level Asian carp coordination and multi-state project planning and implementation in the Mississippi River Basin.

MICRA is a partnership of 28 state agencies with fisheries management jurisdiction in the Mississippi River Basin. Federal agencies with relevant authorities in the Mississippi River and tributaries also participate in the MICRA partnership. MICRA functions as an umbrella organization that provides coordination and communication among the multi-state partnerships that address interjurisdictional fishery management issues within six Mississippi River sub-basins: Upper Mississippi, Lower Mississippi, Ohio, Tennessee-Cumberland, Missouri, and Arkansas-Red. The existing multi-state sub-basin groups provide a forum for Asian carp coordination, project development, and implementation at the sub-basin level and MICRA provides a mechanism for basin-wide inter-agency coordination and collaboration.

MICRA formed an Asian Carp Advisory Committee (ACAC) to provide for state and federal agency executive level coordination on Asian carp prevention and control in the Mississippi River Basin (Figure 5). The ACAC consists of the MICRA Executive Board (i.e., one state agency representative from each of the six sub-basin groups, two federal entity members, MICRA Chairman, MICRA Chairman-elect, and MICRA Coordinator) and a single agency representative from key federal partners not on the MICRA Executive Board. The ACAC provides a mechanism for coordination, communication, and collaboration across the regional

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

sub-basin efforts to provide for the most effective implementation of a Mississippi River basin-wide Asian carp prevention and control. The Executive Boards of the regional sub-basin groups in the ORB and UMRB are comprised only by state agencies. The ACAC provides an opportunity for federal agency partners to participate in the decision making process at the executive level.

MICRA has an active role working with the partnerships and planning teams throughout the Mississippi River Basin to develop and implement sub-basin level Asian Carp Control Strategy

Frameworks. In the ORB and UMRB, where the USFWS has committed federal funding for implementation of highest priority control strategy framework projects, MICRA actively works with the sub-basin planning teams to identify annual priorities, develop project proposals and work plans, and to prepare an annual 'Asian Carp Monitoring and Response Plan for the Mississippi River Basin' (MRP). The MRP describes USFWS funded collaborative partnership efforts to manage and control Asian carp populations in the ORB and UMRB each year. There are many projects that arise from each of the basin partnerships that are supported financially from other agency or outside sources of funding. These projects support the goals and objectives identified in the National Plan as well and as a result, brief descriptions are provided for reference in Appendix A. Agencies collaborating on the USFWS funded partnership projects provide interim annual (calendar year) reports each year to track and evaluate progress, report results, propose recommendations for adaptive management, and inform planning for management and control actions in future years. The annual MRPs and interim annual reports are made available to the public on www.asiancarp.us.

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 prevent the continued spread, explore strategies to reduce the abundance of established populations, and better understand the impacts of established populations. The ORFMT engaged the remaining OHR basin states and key federal partners in the development of an Ohio River Asian Carp Control Strategy Framework (Ohio River Framework) to collaboratively prevent further range expansion, reduce populations, better understand and minimize impacts of Asian carps, and improve communication and coordination in the basin. Following completion of the Ohio River Framework in October 2014 the OHR basin partners formed an OHR Planning Team to implement the Ohio River Framework. The OHR Planning Team met in February 2017 to determine highest priority projects from the Ohio River Framework for implementation in 2017, identify lead and cooperating agencies for each project, and develop project proposals for USFWS funding consideration. OHR Planning Team project proposals were provided to the MICRA ACAC through the ORFMT, compiled with project proposals from the Upper Mississippi River basin, and submitted as part of a Mississippi River Basin proposal package to the USFWS for funding consideration. The OHR Planning Team developed funded project proposals into full project work plans for implementation and inclusion in the 2017 MRP. Project implementation and coordination between agencies occurred at the field level and was not a function of the OHR Planning Team.

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 members undertook the collaborative development of an Upper Mississippi River Asian Carp Control Strategy Framework (UMR Framework) to coordinate Asian carp prevention and control efforts in the Upper Mississippi River. The UMR Framework is designed as a regional stepdown plan from the National Plan and is based on the existing UMRCC's 2010 Fisheries Plan Goal 4. The Fisheries Technical Committee formed an Ad-hoc

Asian Carp Planning Team to coordinate the collaborative development and implementation of the UMR Framework, determine highest priority projects from the UMR Framework for implementation in 2017, identify lead and cooperating agencies for each project, and develop project proposals for USFWS funding consideration. UMR Planning Team project proposals were provided to the MICRA ACAC through the UMRCC Executive Committee, compiled with project proposals from the Ohio River basin, and submitted as part of a Mississippi River Basin proposal package to the USFWS for funding consideration. The UMR Planning Team developed funded project proposals into full project work plans for implementation and inclusion in the 2017 MRP. Project implementation and coordination between agencies occurred at the field level and was not a function of the UMR Planning Team.

Project Plans

The ORB and UMRB partnerships held meetings (face-to-face and teleconference) to collaboratively identify Asian Carp Control Strategy Framework priority needs, determine cooperating agencies and funding needs for each project, and to develop project proposals and work plans. The 2017 MRP includes nine project plans funded (in full or in part) by USFWS FY2017 base funding to address the highest priority prevention and control needs for Asian carp in the ORB and UMRB as identified by the respective sub-basin planning teams. Project plans and schedules are included as a guideline for implementation; however actual plans and implementation schedules may vary as actions are undertaken. Most projects included in the MRP will begin in 2017, but may include additional field work in 2018. Additional Asian carp projects funded by USFWS and other sources that contribute to implementation of the ORB and UMRB Frameworks are included in Appendix A.

Ohio River Basin

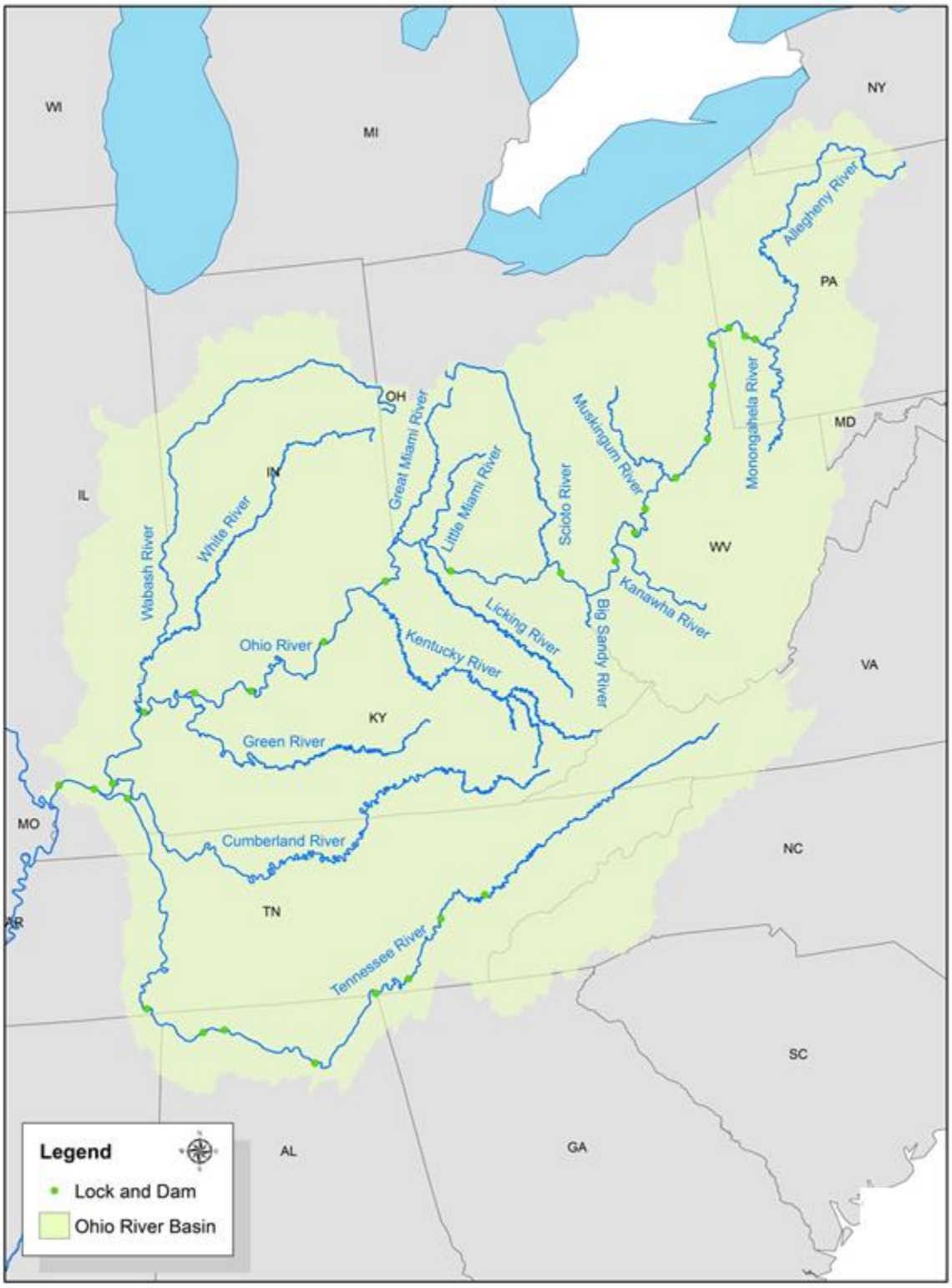

Figure 6. Map of the Ohio River Basin.

Project Title: Monitoring and Response of Asian Carp in the Ohio River

Geographic Location: Ohio River Basin

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:

Asian carp have been successful invaders in the waters of the United States because of their tolerance and adaptability to a wide range of environmental conditions (Kolar et al. 2005, Zhang et al. 2016). Their ability to quickly colonize novel habitats with dense populations threatens the function of important native ecosystems. The Ohio River basin provides a broad variety of potential habitats available to invading Asian carp. As a result, it is necessary to gain information on Asian carp distributions, behavior, and habitat use in the Ohio River basin (ORB) to aid in their removal, suppression, and containment.

The tasks outlined in this project plan represent a third year of funding for Asian carp monitoring in the Ohio River Basin distributed among five state agencies including partner agencies (state and federal) that did not request funding. Collaborative efforts have included fish community sampling in six pools of the Ohio River resulting in an understanding of Asian carp densities as well as baseline information on native fish assemblages. Success in the aforementioned areas in previous years results in a shift in 2017 to target Asian carp with focused effort in the spring and conduct fall community sampling to coincide with hydroacoustics surveys being conducted by the USFWS. The outcome of previous accomplishments includes an understanding of Asian carp distribution, habitat use, and timing of spawning which are parameters used in making decisions about deterrence, control and containment in the Ohio River Basin.

Project Goals and Objectives:

National Plan Goal Supported:

- Goal 3.2. Contain and control the expansion of populations of bighead, black, grass, and silver carps in the United States;
- Goal 3.3. Extirpate, or reduce to levels of insignificant effect, 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 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 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. Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Ohio River.
2. Conduct community surveys in order to monitor fish populations in the Ohio River.
3. Compile and incorporate additional data from other state and federal entities on Asian carp and fish communities in the Ohio River.

Agency: Kentucky Department of Fish and Wildlife Resources

Project Title: Monitoring and Response of Asian Carp in the Ohio River

Objectives:

1 Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Ohio River.
2 Conduct community surveys in order to monitor fish populations in the Ohio River.
3 Compile and incorporate additional data from other state and federal entities on Asian carp and fish communities in the Ohio River.

Project Activities: Methods, and Timetable:

Targeted Sampling of Bigheaded Carps
KDFWR will lead and cooperate with agencies to conduct targeted sampling for Asian carp along several pools, upriver of the Cannelton Locks and Dam complex. Both pulsed-DC boat electrofishing and gill netting techniques will be utilized to target bigheaded carps. Information will be used to estimate relative abundances of *Hypophthalmichthys spp*. and generate occupancy estimates for carp in each pool. Additional non-targeted, Asian carps captured during sampling will be removed from the system. Pools intended for targeted sampling include Cannelton, McAlpine, Markland, Meldahl, Greenup, and RC Byrd. All by-catch for each sampling gear will be recorded and any non-target fish (excluding Asian carps) will be released immediately after capture.

Mobile Hydroacoustic Surveys
KDFWR will work with USFWS to conduct mobile hydroacoustic surveys to estimate relative abundance, spatial distribution, size distribution, and biomass of bigheaded carps and other species of interest at select locations above the Cannelton Locks and Dam complex. Two horizontally oriented, split-beam transducers (200 kHz; BioSonics Inc.) will be used to maximize water column coverage parallel to the shoreline both upriver and downriver of sites sampled with traditional gears. Because species specificity cannot be determined from single frequency hydroacoustics, pool-specific community data collected using traditional gears will be used to inform hydroacoustic surveys. Data will be analyzed following MacNamara et al. (2016) using Echoview 7.0 software (Love 1971, Parker-Stetter et al. 2009, MacNamara et al. 2016).

Community Fish Surveys
KDFWR will lead and cooperate with agencies to conduct community fish surveys in Cannelton, McAlpine, Markland, Meldahl, Greenup, and RC Byrd pools. Boat electrofishing will consist of 15-minute transects across 24 fixed sites per pool. Gill nets will be fished for two hours at a time, during the day, across eight fixed sites per pool. Each net set will be actively monitored and effort will be expended to run fish into the nets with boat noise. All fish captured using either gear will be identified to the lowest possible taxonomic level and a total length (inches) and weight (pounds) with be taken to evaluate condition. Asian carp will either be implanted with an acoustic transmitter or exterminated depending on the location. Otoliths and pectoral fin rays will be removed as needed from Asian carp for microchemistry and age and growth analysis.

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

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 monitoring and will be considered and incorporated when possible.

Estimated Timetable:

Project Activity	Pool	Dates (Week Of…)	Year
Targeted Asian carp Sampling	Cannelton	April 10	2017
Targeted Asian carp Sampling	McAlpine	April 17	2017
Targeted Asian carp Sampling	Markland	April 24	2017
Targeted Asian carp Sampling	Meldahl	May 01	2017
Targeted Asian carp Sampling	Greenup	May 08	2017
Community Surveys and Hydroacoustics	McAlpine	October 02	2017
Community Surveys and Hydroacoustics	Markland	October 09	2017
Community Surveys and Hydroacoustics	Meldahl	October 16	2017
Community Surveys and Hydroacoustics	Greenup	October 23	2017
Community Surveys and Hydroacoustics	Cannelton	October 30	2017
Project Executive Summary	N/A	October 30	2017
Incorporation of Additional Data Sources	N/A	November 20	2017
Project Technical Report	N/A	February 26	2018
Targeted Asian carp Sampling	Cannelton	April 09	2018

Targeted Asian carp Sampling	McAlpine	April 16	2018
Targeted Asian carp Sampling	Markland	April 23	2018
Targeted Asian carp Sampling	Meldahl	May 01	2018
Targeted Asian carp Sampling	Greenup	May 07	2018

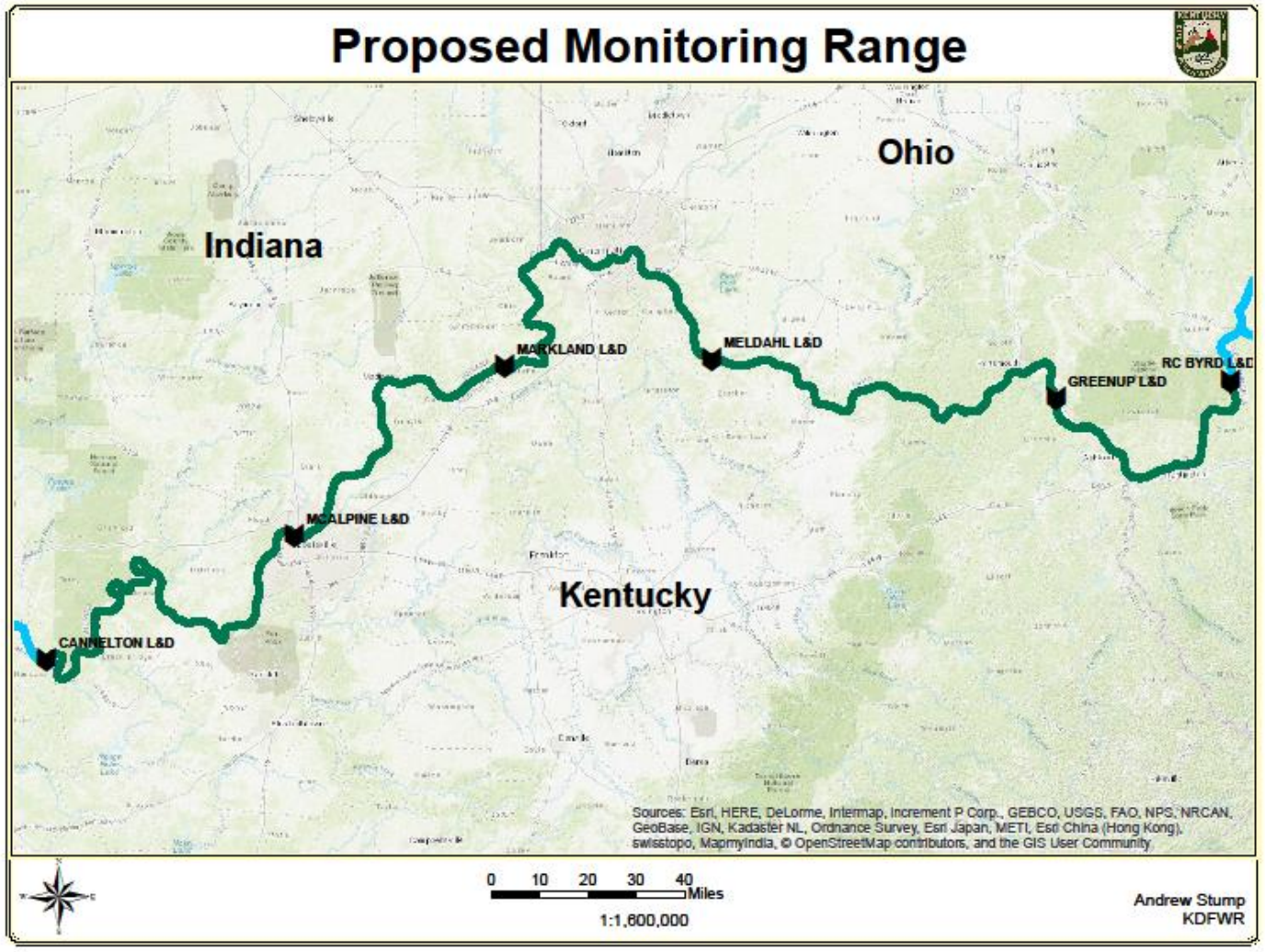

Figure 7. Project Area for the KDFWR portion of the Monitoring and Response of Asian Carp in the Ohio River project.

Agency: West Virginia Division of Natural Resources

Project Title: Monitoring and Response of Asian Carp in the Ohio River

Objectives:

1 Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Ohio River.
2 Conduct community surveys in order to monitor fish populations in the Ohio River.
3 Compile and incorporate additional data from other state and federal entities on Asian carp and fish communities in the Ohio River.

Project Activities: Methods, and Timetable

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

Community Fish Surveys
WVDNR will assist and cooperate with agencies to conduct community fish surveys in Cannelton, McAlpine, Markland, Meldahl, Greenup, and RC Byrd pools. WVDNR will conduct community surveys in the Greenup and R.C. Byrd pools. Both pulsed-DC boat electrofishing and gill netting techniques will be utilized. Boat electrofishing will consist of 15-minute transects throughout each pool during the day. Gill nets will consist of two hour sets during the day at fixed sites throughout each pool. Each net set will be actively monitored and effort will be expended to run fish into the nets with boat noise. The number of samples completed will be dependent upon staff availability, environmental conditions, and distance travelled from boat ramps. All fish captured using either gear will be identified to the lowest possible taxonomic level and a total length (inches) and weight (pounds) will be taken to evaluate condition. Asian carp will either be implanted with an acoustic transmitter or exterminated depending on the location. Otoliths and pectoral fin rays will be removed as needed to ascertain other types of important information (i.e., natal origin and age).

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

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 monitoring and will be considered and incorporated when possible.

Estimated Timetable

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

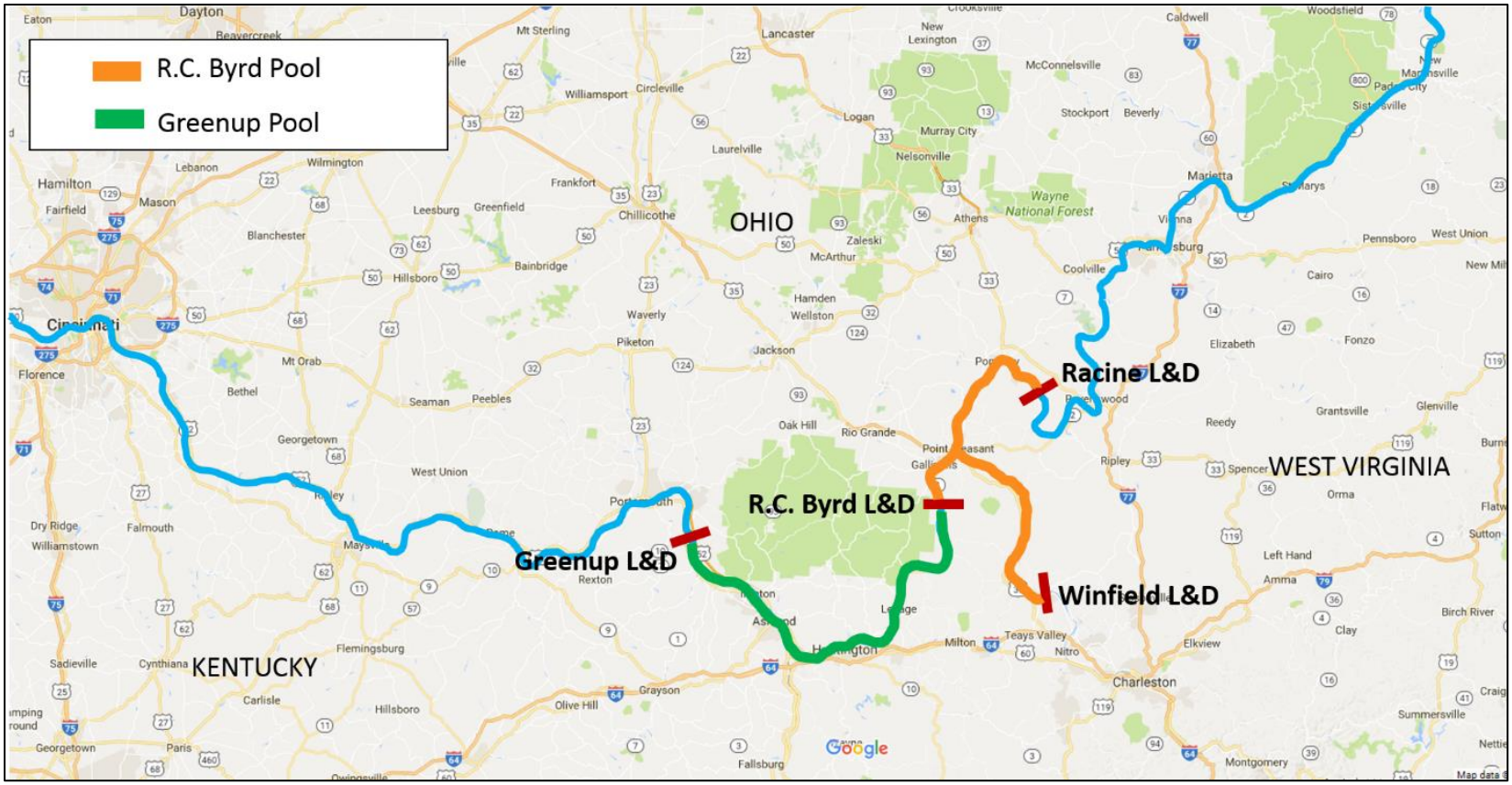

Figure 8. Project area map of the West Virginia Division of Natural Resources portion of the Monitoring and Response of Asian Carp in the Ohio River project.

Agency: Pennsylvania Fish and Boat Commission (PFBC)

Project Title: Monitoring and Response of Asian carp in the Ohio River

Objectives:

1 Conduct targeted sampling for the purposes of early detection, surveillance, and monitoring of Asian carp in the Ohio River drainage in Pennsylvania.
2 Conduct community surveys to monitor fish populations in the Ohio River drainage in Pennsylvania and predict potential impacts from an Asian carp invasion.
3 Compile and incorporate additional data from other state and federal entities on Asian Carp and fish communities in the Ohio River drainage.

Project Activities: Methods, and Timetable:

Objective 1: 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

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

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

Objective 3: Currently, ORFMT states conduct surveys on catfish, percids, black bass, and true bass at several tailwaters, tributaries, and embayments of the Ohio River. Data collection during

these surveys will continue to report if Asian carp are captured during sportfish sampling and provide information on sportfish condition.
Pennsylvania will continue to participate and work to keep abreast of Asian carp activity with USFWS, ACRCCC, MICRA, ORFMT, Ohio River states, and other partners.

Estimated Timetable:

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

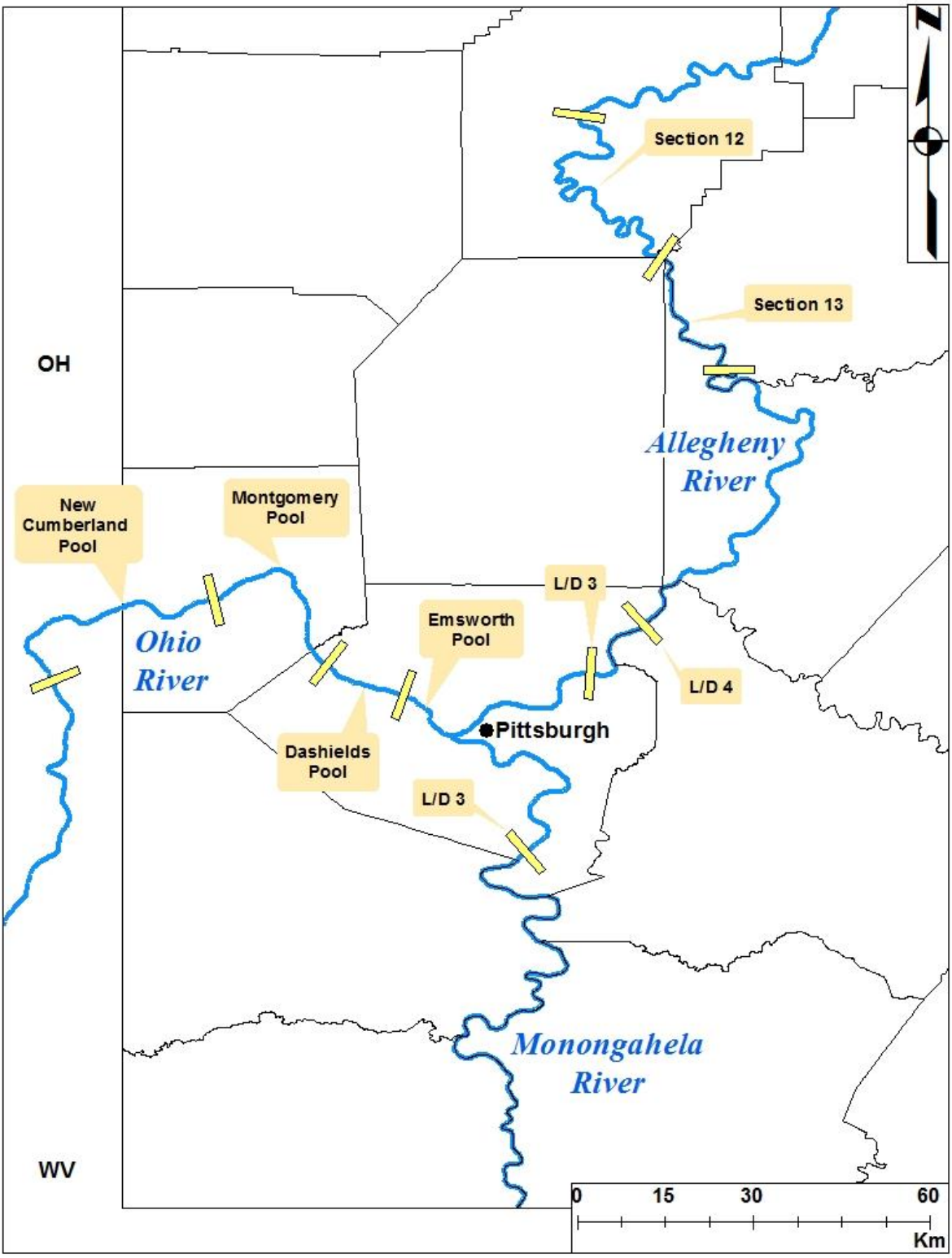

Figure 9. Project area map of the Pennsylvania Fish and Boat Commission portion of the Monitoring and Response of Asian Carp in the Ohio River project.

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

Geographic Location: Ohio River Basin

Lead Agency: Indiana Department of Natural Resources (INDNR)

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

Statement of Need:

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

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

In order to limit the negative impacts of Asian carp populations and their further spread, efforts have increased to understand the distribution and abundance of Asian carp in the waters they currently inhabit. Prior to 2016, information on the distribution of Asian carp in the Ohio River was limited to targeted sampling on the leading edge of invasion above McAlpine Locks and Dam at RM606 (see Monitoring and Response of Asian carp in the Ohio River) and sampling efforts in the Lower Ohio River below JT Meyers Locks and Dam (RM 846) conducted by the Illinois Department of Natural Resources (IDNR). These efforts have documented adult Asian

carp presence as far upstream as Robert C. Byrd Dam near Gallipolis Ferry, West Virginia. This is especially troubling given Asian carp adults have the propensity to move long distances in relatively short time intervals, can traverse lock and dam structures, and based on recent captures appear to be making upstream progression in the Ohio River (Tripp et al. 2014, N. Jackson, Personal Communication).

Confirmed Asian carp spawning events have occurred in tributaries (i.e., Wabash River) as far upstream on the Ohio River as JT Myers Locks and Dam. Suspected reproduction of non-indigeneous bigheaded carp has also been documented in Meldahl Pool. Last year (2016) marked the earliest efforts of targeted juvenile Asian carp sampling in the Ohio River to determine the extent of population recruitment. A total of $28,750 was allocated to the project ($21,000 USFWS base funding, $7,750 state match funding) which provided the funds necessary for partners within INDNR, KDFWR, and USFWS to conduct targeted juvenile sampling in JT Myers, Newburgh, Cannelton, and McAlpine Pools of the Ohio River. This project yielded the first collection of juvenile Asian carp between JT Myers and Cannelton Locks and Dams. More specifically, the majority of juvenile Asian carp were captured at two locations in JT Myers Pool (Hovey Lake and Inland Marina) and one young-of-year carp was captured in Newburgh Pool. The preliminary results suggest the current "established population" range to be as far upstream as Cannelton Lock and Dam. As the anecdotal studies above suggest, previous efforts have been successful in collecting Asian carp eggs, embryos, larvae and juveniles in the Ohio River. However, the spatial extent and intensity of Asian carp spawning and recruitment in the Ohio River remains a knowledge gap. Multiple years of data collection covering a broader spatial extent under a variety of environmental conditions will be necessary to fully understand Asian carp early life history among pools.

Acquiring a full understanding of the early life history information is imperative for evaluating the population status (i.e., extent of invasion). The extent of invasion has three predominate levels (presence front, invasion front, and established front) and will guide specific management actions. The "presence front" is the most upstream extent of Asian carp capture where densities are low and reproduction has not occurred. The "invasion front" is that location(s) where reproduction (i.e., eggs, embryos, or larvae) has been observed but recruitment has yet to be documented. The "established front" is that location(s) where reproduction and recruitment to the adult life stage are currently occurring. Identifying the specific locations that differentiate the established, invasion, and presence fronts is crucial information for implementation of management or control efforts. In order to identify these locations, quantifying abundance and distribution of Asian carp early life stages is needed. For the purposes of this study, eggs, embryos, and larvae will be used to verify spawning while juvenile Asian carp will be used to identify recruitment. Many methods can be used to verify the presence of Asian carp spawning (Schrank et. al 2001; Deters et. al 2013) and recruitment (Haupt and Phelps 2016). The collection of Asian carp eggs, embryos, and larvae to document spawning are most generally evaluated using ichthyoplankton sampling methods (i.e., surface trawling using bongo nets). However, juvenile Asian carp can be sampled using a wide array of sampling gears. That being said, electrofishing provides a time efficient measure of juvenile Asian carp abundance, habitat use, and a readily available method available to most fisheries management biologists. As such, electrofishing will be used to measure recruitment. Other gears may be deployed as time permits to increase detection.

In addition to the following work outlined below by funded project partners, additional effort on this project will be completed by WVDNR and USFWS. To assist in completing objectives outlined below, WVDNR will assist with targeted ichthyoplankton tows for Asian Carp eggs and larvae in the Greenup and R.C. Byrd pools. Also, USFWS will assist with targeted juvenile sampling in McAlpine Pool throughout July and August, 2017.

Project Goals and Objectives:

National Plan Goal Supported:

- Goal 3.2. Contain and control the expansion of populations of bighead, black, grass, and silver carps in the United States
- Goal 3.3. Extirpate, or reduce to levels of insignificant effect, 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 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 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.
2.9 Support research to improve capabilities to detect early stages of invasion and spawning populations of Asian carp.

Project Objectives:

1. Define the "invasion front" of Asian carp in the Ohio River via sampling for Asian carp eggs, embryos, and larvae.
2. Define the "established front" of Asian carp in the Ohio River via targeted sampling for juvenile Asian carp.
3. Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered.
4. Identify other sources of fish sampling data in the Ohio River Basin that may inform previous objectives (ORSANCO, EA Engineering, agency biologists, etc.).

Agency: West Virginia Division of Natural Resources / West Virginia University

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

Objectives:

1. Define the "invasion front" of Asian carp in the Ohio River via sampling for Asian carp eggs, embryos, and larvae.

Project Activities, Methods, and Timetable:
West Virginia University will conduct and coordinate sampling for Asian carp eggs, embryos, and larvae in Meldahl, Greenup, and RC Byrd pools. Specific areas of sampling will be at Little Threemile Creek (Meldahl Pool), Little Sandy/Big Sandy Rivers (Greenup Pool), and Kyger Creek (RC Byrd Pool).

To evaluate relative abundance of Asian carp eggs, embryos, and larvae, conical ichthyoplankton tows (0.76m, 500 µm mesh) will be conducted at each site every two weeks from June until August, 2017. A single ichthyoplankton net will be deployed on the side of the boat facing upstream, with each tow lasting 3 minutes. All contents will be rinsed into a 500 µm sieve and preserved in 95% ethanol for identification in the lab. Morphometric characteristics developed by Chapman and George (2011) will be used to identify Asian carp eggs, embryos, and larvae.

At each site, the mainstem Ohio River will be sampled below, within, and above the tributary, in that order. Tributaries will be sampled in the center of the channel, with the first sample taken at the most downstream site that was deemed not influenced by the Ohio River. Samples taken above and below the tributary will be conducted on the adjacent mainstem channel border. 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 Garmin at each sampling site.

Estimated Timetable:

Project Activity	**Pool**	**Month**	**Year**
AC egg, embryo, and larval Sampling	Meldahl, Greenup, and RC Byrd	June July and August	2017

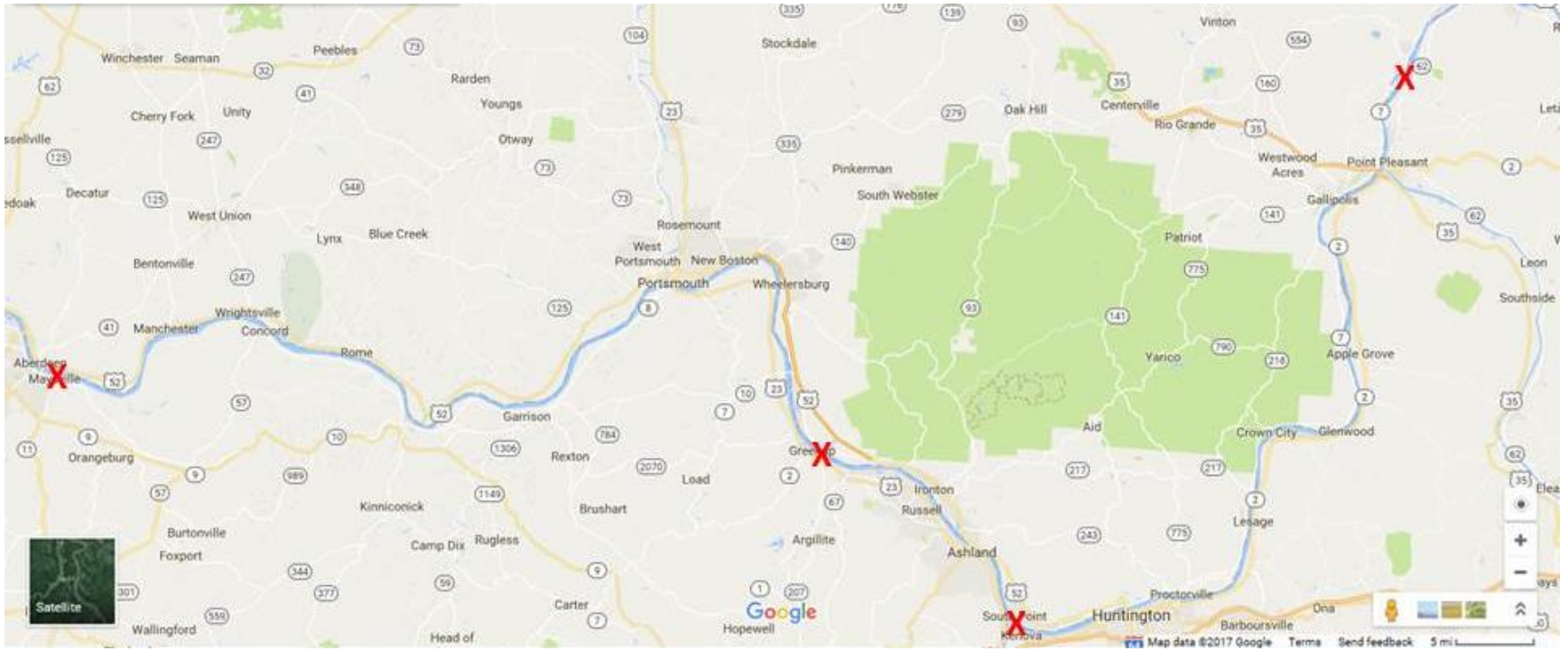

Figure 10. Egg, embryo, and larval Asian carp areas of sampling areas (denoted by red X and moving west to east) will be at Little Threemile Creek near Maysville, Kentucky, Little Sandy River near Greenup, Kentucky, Big Sandy Rivers near Huntington, West Virgnia and, and Kyger Creek near Cheshire, Ohio.

Agency: Indiana Department of Natural Resources

Project Title: Abundance and Distribution of Early Life Stages of Asian Carp in the Ohio River

Objectives:

2. Define the "established front" of Asian carp in the Ohio River via targeted sampling for juvenile Asian carp.
3. Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered.
4. Identify other sources of fish sampling data in the Ohio River Basin that may inform previous objectives (ORSANCO, EA Engineering, agency biologists, etc.).

Project Activities, Methods, and Timetable:

Objective 2: Indiana DNR will conduct targeted sampling for juvenile Asian carp between JT Myers Locks and Dam and Cannelton Locks and Dam. Because typical nursery habitat in the form of shallow backwater areas is less prominent in the Ohio River, flooded creek mouths and tributaries likely serve as a substitute. Tributaries large enough for entrance with a shocking boat have been identified and 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. Specific tributaries sampled will include Hovey Lake, Bayou Creek, Canoe Creek, Pigeon Creek, Inland Marina, Green River, Cypress Creek, Little Pigeon Creek, Sandy Creek, and the Anderson River, among other smaller tributaries in J.T. Myers and Newburgh Pools.

Electrofishing samples will target 15-minute transects, but may vary based on the size of each tributary. Juvenile Asian carp will be targeted, and those encountered will be collected, identified to species, geo-located and enumerated. When Asian carp are encountered, lengths and weights will be recorded and a subsample of aging structures will be collected; Otoliths will be taken from fish >400 mm, Otoliths and/or pectoral spines will be taken from fish 200 to 400 mm, and fish <200 mm will be frozen whole and taken back to the lab for dissection of aging structures.

Communication will take place with researchers in other river basins (Illinois, Mississippi) who have identified specific gears and/or methods that effectively capture juvenile Asian carp. Certain gears/methods (mini-fyke nets, surface trawls, etc.) will be experimented with in the lower pools of the Ohio River Basin in areas with higher juvenile carp presence to determine if they can increase detection probabilities of juveniles in areas of low density. This insight will be useful for modifying or adding to the sampling protocol (where applicable) to better identify the true "established front" of Asian carp in the Ohio River.

Objective 3: Targeted sampling for Juvenile Asian carp in flooded creek mouths and tributaries will take place in the lower Ohio River throughout July and August, 2017. A suite of habitat measurements will be collected at each sampling 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). These habitat variables will build on the current dataset and will help inform characteristics of potential Asian carp nursery areas.

Objective 4: Indiana DNR will collaborate with other fisheries professionals within the state to inform them to report back with any confirmed findings of juvenile Asian carp within the basin. If a new Asian carp occurrence is reported, Indiana DNR 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.

Estimated Timetable:

Project Activity	**Pool**	**Month**	**Year**
Juvenile AC Sampling	JT Myers and Newburgh	July and August	2017
Nursery Habitat Assessment	JT Myers and Newburgh	July and August	2017
Larval AC Sampling	JT Myers	June to August	2017
Other Sources of Sampling Data	N/A	June to October	2017
Juvenile AC Sampling	JT Myers and Newburgh	July and August	2018
Nursery Habitat Assessment	JT Myers and Newburgh	July and August	2018
Other Sources of Sampling Data	N/A	June to October	2018

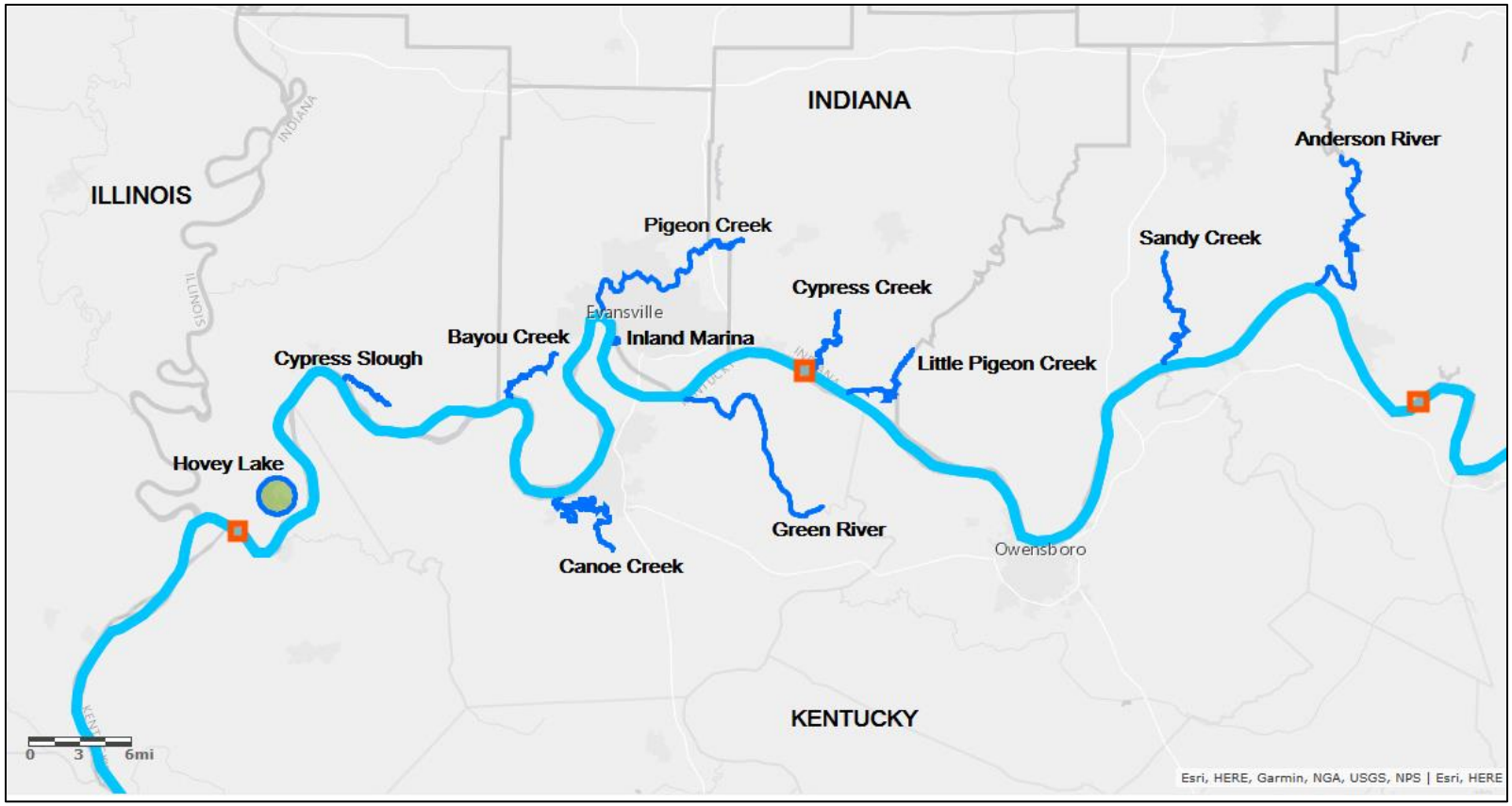

Figure 11. Project area map of the Indiana DNR portion of the Abundance and Distribution of Early Life Stages of Asian Carp in the Ohio River project.

Agency: Kentucky Department of Fish and Wildlife Resources

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

Objectives:

2. Define the "established front" of Asian carp in the Ohio River via targeted sampling for juvenile Asian carp.
3. Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered.
4. Identify other sources of fish sampling data in the Ohio River Basin that may inform previous objectives (ORSANCO, EA Engineering, agency biologists, etc.).

Project Activities, Methods, and Timetable:

Objective 2: KDFWR will conduct targeted sampling for juvenile Asian carp between JT Myers Locks and Dam and McAlpine Locks and Dam. Because typical nursery habitat in the form of shallow backwater areas is less prominent in the Ohio River, flooded creek mouths and tributaries likely serve as a substitute. Tributaries large enough for entrance with a shocking boat have been identified and 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. Specific tributaries sampled will include Deer Creek, Clover Creek, Poison Creek, Oil Creek, Spring Creek, Little Blue River, Blue River, Indiana Creek, Otter Creek, and the Salt River, among other smaller tributaries in J.T. Myers and Newburgh Pools.

Electrofishing samples will target 15-minute transects, but may vary based on the size of each tributary. Juvenile Asian carp will be targeted, and those encountered will be collected, identified to species, geo-located and enumerated. When Asian carp are encountered, lengths and weights will be recorded and a subsample of aging structures will be collected; Otoliths will be taken from fish >400 mm, Otoliths and/or pectoral spines will be taken from fish 200 to 400 mm, and fish <200 mm will be frozen whole and taken back to the lab for dissection of aging structures.

Objective 3: Targeted sampling for Juvenile Asian carp in flooded creek mouths and tributaries will take place in the lower Ohio River throughout July and August, 2017. A suite of habitat measurements will be collected at each sampling 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). These habitat variables will build on the current dataset and will help inform characteristics of potential Asian carp nursery areas.

Objective 4: Kentucky DFWR will collaborate with other fisheries professionals within the state to inform them to report back with any confirmed findings of juvenile Asian carp within the basin. If a new Asian carp occurrence is reported, data and site location information will be gathered if possible and sent to the project lead. These data will be compiled by the project lead and will be used to inform future planning efforts.

Estimated Timetable:

Project Activity	Pool	Month	Year
Juvenile AC Sampling	JT Myers and Newburgh	July and August	2017
Nursery Habitat Assessment	JT Myers and Newburgh	July and August	2017
Other Sources of Sampling Data	N/A	June to October	2017
Juvenile AC Sampling	JT Myers and Newburgh	July and August	2018
Nursery Habitat Assessment	JT Myers and Newburgh	July and August	2018
Other Sources of Sampling Data	N/A	June to October	2018

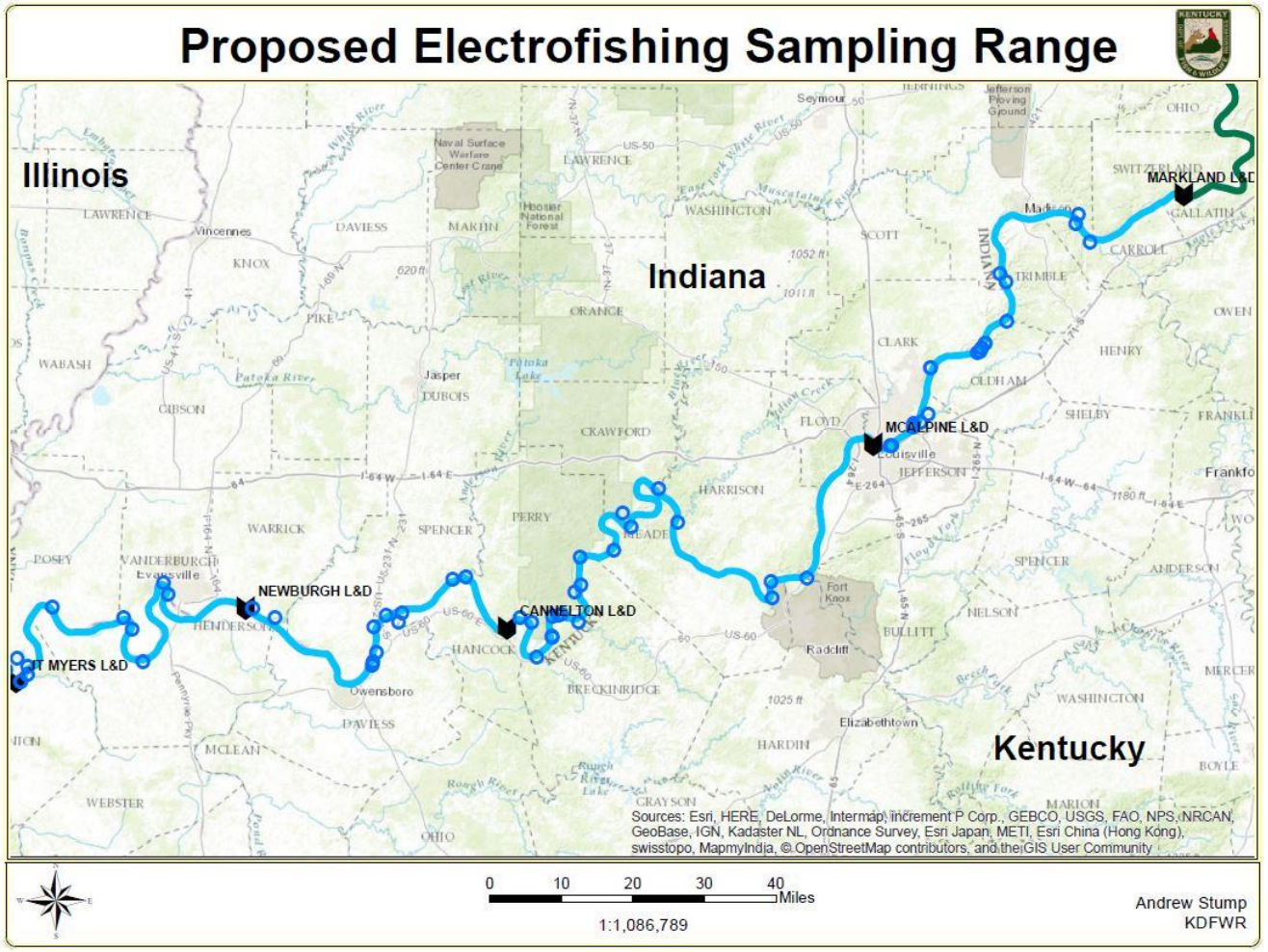

Figure 12. Project area map of the Kentucky DFWR portion of the Abundance and Distribution of Early Life Stages of Asian Carp in the Ohio River project.

Project Title: Asian Carp Containment and Suppression in the Upper Ohio River

Geographic Location: Ohio River Basin

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

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR), West Virginia University (WVU)

Statement of Need:

Since their introduction in the Mississippi River basin, Asian carp (silver carp, bighead carp, and grass carp) have steadily increased their range. Asian carp rapidly and densely colonize river reaches affecting the native food web in large river ecosystems (Irons et al. 2007, Freedman et al. 2012). As a result, significant 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 include barrier technologies that prevent movement of the Asian carps into critical areas as well as the targeted removal of Asian carp below barriers to decrease propagule pressure (Tsehaye et al. 2013). Planning and implementation of barriers to Asian carp movement are widely believed to be an important aspect of the containment of Asian carp in the Mississippi River basin. However, implementation of barrier projects can be very expensive and require an understanding of the distribution and abundance of invading carps, which can take years to collect. Efforts to gather this data in the Ohio River basin began in 2015 and will continue into the foreseeable future.

The leading edge of the Asian carp invasion on the Ohio River is located above Markland Locks and Dam (RM 531). Asian carp abundance above this point is relatively low, and the majority of fish captures occur in the lower portions of tributaries. Past multi-agency sampling and removal projects have successfully targeted Asian carp in select tributaries along this stretch of river. Removal of Asian carp within these pools may act as a buffer that reduces the number of Asian carp migrating upriver; in addition, it lowers the likelihood of successful reproduction and may buy managers time to plan and implement barriers inhibiting farther Asian carp expansion.

Partnerships within this project include agencies who are not requesting funding, but play an instrumental role in the achievement of project goals. In addition to the proposed work outlined below, USFWS and WVU plan to provide support, gear, and coordinate with state agencies when completing this project's objectives.

Project Goals and Objectives:

National Plan Goal Supported:

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

Goal 3.3. Extirpate, or reduce to levels of insignificant effect, 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 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 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. Surgically implant acoustic transmitters in Asian carp between Markland and Greenup Locks and Dams.
2. Remove Asian carp from the Ohio River, above Markland dam.
3. Attempt to contain carp below the exclusion point for tolerable upriver expansion.
4. Explore the development of an Ohio River response protocol.

Agency: West Virginia Division of Natural Resources

Project Title: Asian Carp Containment and Suppression in the Upper Ohio River

Objectives:

1. Surgically implant acoustic transmitters in Asian carp between Markland and Greenup Locks and Dams.
2. Remove Asian carp from the Ohio River, above Markland dam.
3. Attempt to contain carp below the exclusion point for tolerable upriver expansion.
4. Explore the development of an Ohio River response protocol.

Project Activities, Methods, and Timetable:

Objective 1: WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will assist and cooperate with partner agencies conducting activities associated with this objective where applicable.

Objective 2: WVDNR will assist and cooperate with agencies to remove Asian carp in the Meldahl, Greenup, and RC Byrd pools. Crews will remove Asian carp from the Greenup and R.C. Byrd pools focusing on tributaries and other known or suspected areas with increased Asian carp density. Efforts in the R.C. Byrd Pool will focus on Raccoon and Crab Creeks and the area upstream of the old lock chambers of R.C. Byrd Dam. Additional sites in both pools will be added as Asian Carp are found during other sampling efforts, and as we learn more about the habitat preferences of Asian carp in the Ohio River. Telemetry data and/or public sightings will also inform removal efforts. Sampling efforts will rely on pulsed-DC electrofishing and gill netting. Gill net sets will be actively monitored and effort will be expended to run fish into the nets with electrofishing and/or boat noise. All Asian Carp encountered will be exterminated. Otoliths and pectoral fin rays will be removed as needed from Asian carp for microchemistry and age and growth analysis (Beamish 1981, Schrank and Guy 2002, Williamson and Garvey 2005, Seibert and Phelps 2013).

Objective 3: WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will assist and cooperate with partner agencies conducting activities associated with this objective where applicable.

Objective 4: WVDNR staff will work with basin partners to identify what the aspects of an appropriate response plan should look like for the Ohio River. Partner agencies will collaborate to identify key elements of successful response plans implemented for invasive species in other water bodies and discuss the ability to implement similar key response elements to the pools along the Ohio River.

Estimated Timetable:

Project Activity	**Pool**	**Dates**	**Year**
Asian carp removal	R.C. Byrd	June-September*	2017

Tagging (Assisting KDWFR)	Meldahl	June-September*	2017
Asian Carp Removal	Meldahl, RC Byrd, Greenup	June-September*	2017
Asian Carp Containment	RC Byrd, Greenup	June-September*	2017
Response Protocol Research and Discussion	N/A	July-August	2017-2018

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

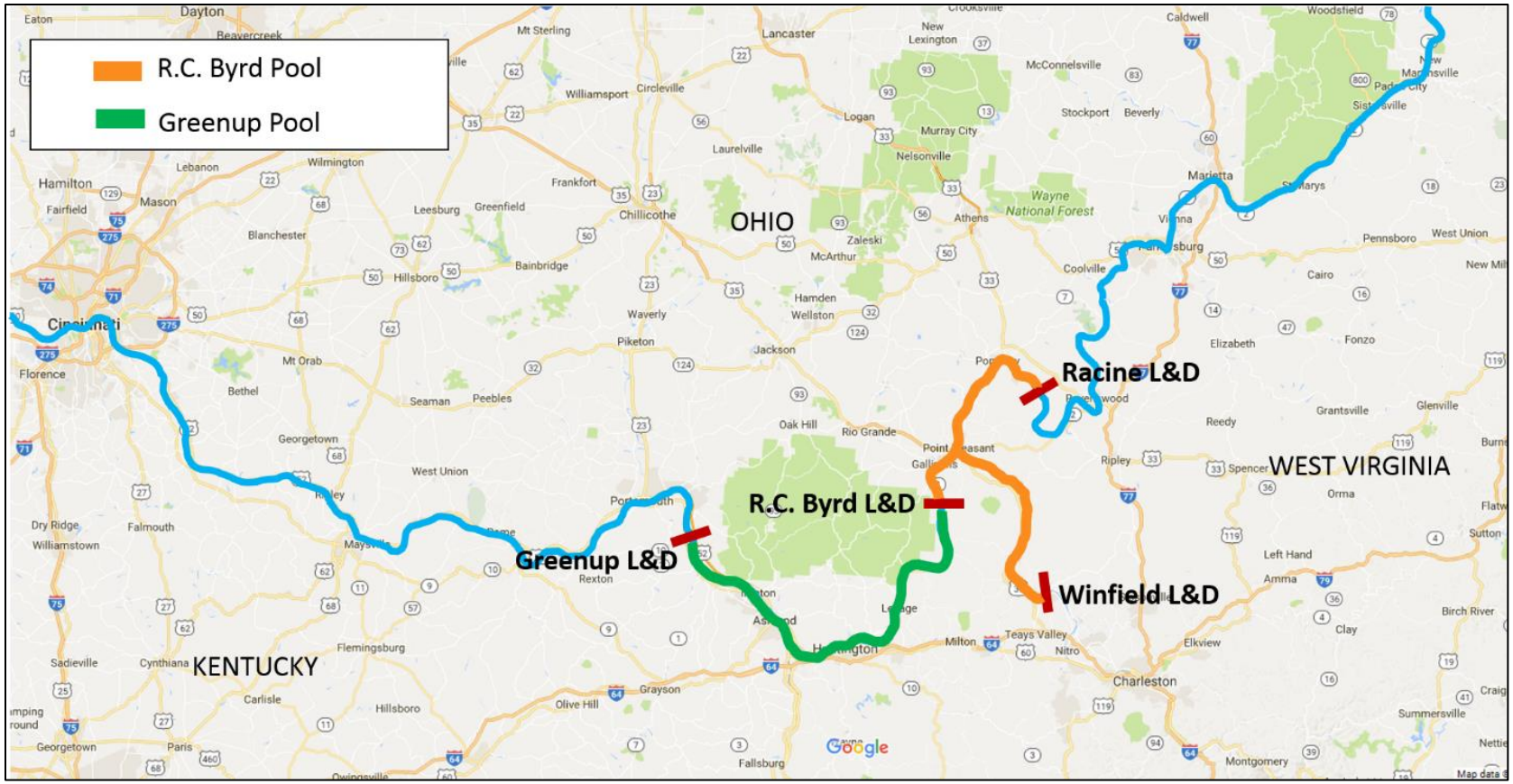

Figure 13. Project area map of the West Virginia DNR portion of the Asian Carp Containment and Suppression in the Upper Ohio River project.

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

Project Title: Asian Carp Containment and Suppression in the Upper Ohio River

Objectives:

1. Surgically implant acoustic transmitters in Asian carp between Markland and Greenup Locks and Dams.
2. Remove Asian carp from the Ohio River, above Markland dam.
3. Attempt to contain carp below the exclusion point for tolerable upriver expansion.
4. Explore the development of an Ohio River response protocol.

Project Activities, Methods, and Timetable:
The majority of nonindigenous carps targeted throughout this project may be euthanized upon capture. However, it will be a primary goal to tag bigheaded carps with a transmitter in order to increase the number of tagged fish in lower-density pools. This will contribute to the assemblage of fish that can be tracked through the Ohio River Telemetry Project. Exterminated fish will be used to provide otoliths and 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.

Objective 1: It will be a primarily focus in this project to tag carp in the lower-density pools of the Ohio River. Transmitters will be surgically implanted into bighead and silver carp and fish will be released after their recovery. Effort to increase the number of tagged fish will vary by pool and will likely depend on the recommended target set by USFWS and partner agencies working on the telemetry efforts along the invasion front. Only fish in good condition after capture will be surgically implanted with transmitters and tagging will cease after the targeted number of fish is met for each pool. All fish captured beyond the targeted number will be euthanized and used for the harvest of aging structures.

Objective 2: Crews will remove Asian carp from the Ohio River by focusing on tributaries and other known or suspected areas with increased Asian carp density. Sampling locations that typically have an Asian carp presence have been identified throughout the 2015 and 2016 season; additional sites will be added as we learn more about the habitat preferences of Asian carp in the Ohio River. Sampling efforts will rely on pulsed-DC electrofishing and gill netting. Other gear types may be used to increase catchability depending on sampling circumstances. Telemetry will remain a tool for locating tagged Asian carp in low-density areas.

Objective 3: KDFWR will attempt to respond to reports from USFWS, WVDNR, and WVU when groups of *Hypophthalmichthys spp.* are sighted or captured in the Greenup or RC Byrd pools. Removal efforts will focus on areas where fish are reported; however, due to the transient nature of these species, response efforts will be brief and determined by scheduling availability. Available personnel and funding for this objective is low and may be determining factors in the level of KDFWR's participation in a response effort.

Objective 4: KDFWR staff will work with basin partners to identify what the aspects of an appropriate response plan should look like for the Ohio River. Partner agencies will collaborate

to identify key elements of successful response plans implemented for invasive species in other water bodies and discuss the ability to implement similar key response elements to the pools along the Ohio River.

Estimated Timetable:

Project Activity	**Pool**	**Dates (Week Of…)**	**Year**
Suppression and Tagging	Markland	June 12	2017
Suppression and Tagging	Meldahl	July 03	2017
Suppression and Tagging	Markland	July 31	2017
Suppression and Tagging	Meldahl	August 28	2017
Suppression and Removal	Greenup	September 11	2017
Suppression and Removal	RC Byrd	September 11	2017
Project Executive Summary	N/A	October 30	2017
Project Technical Report	N/A	February 26	2018

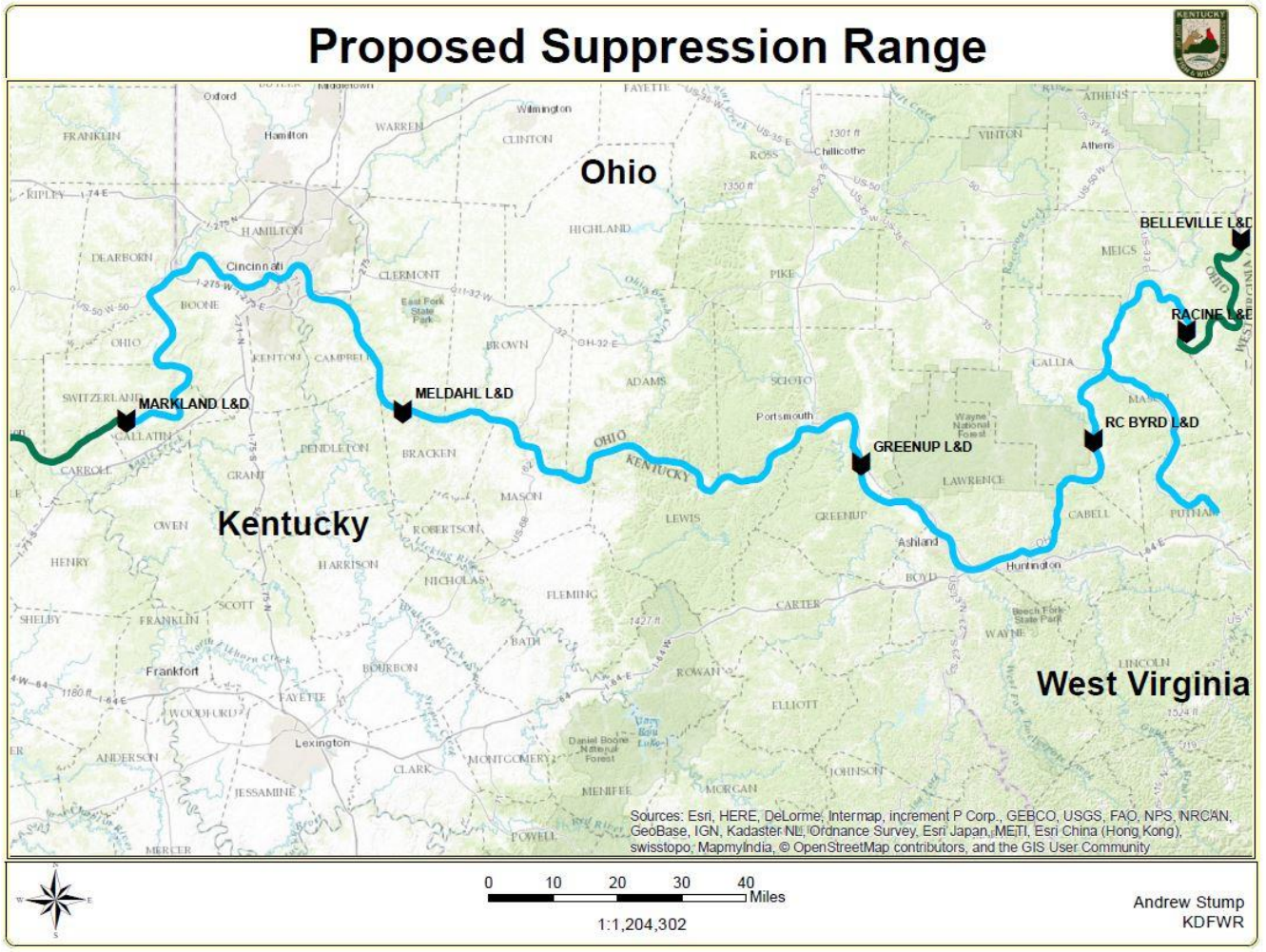

Figure 14. Project area map of the Kentucky DFWR portion of the Asian Carp Containment and Suppression in the Upper Ohio River project.

Project Title: Control and Removal of Asian carp in the Ohio River

Geographic Location: Ohio River Basin

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

Agency Collaboration: U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service (USFWS)

Statement of Need:
Since their introduction in the Mississippi River basin, Asian carp (Silver carp, Bighead carp, and Grass carp) have steadily increased their range. Asian carp rapidly and densely colonize river reaches affecting the native food webs important large river ecosystem function (Freedman et al. 2012, Irons et al. 2007). As a result, significant 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 might include barrier technologies that prevent movement of the Asian carps into critical areas as well as the targeted removal of Asian carp below barriers to decrease propagule pressure (Tsehaye et al. 2013). This planning and implementation of barriers to slow Asian carp movement are widely believed to be an important aspect of the control of Asian carp in the Mississippi River basin. However, implementation of barrier projects can be very expensive and require an understanding of the distribution and abundance of invading carps, which can take years to collect. Efforts to gather this data in the Ohio River basin began in 2015 and will continue into the foreseeable future. Currently, the best tool for limiting impacts and dispersal of Asian carps is the physical removal of fish.

Removal of Asian carp has shown promise in the Illinois River where collapse of the Asian carp fishery may be possible if removal is high and targets all size ranges of fish (Tsehaye et al. 2013). Removal efforts in 2016 were focused in higher density pools after adjustments from lessons learned in 2015, when project activities began. Methods are proposed for 2017 that build off the successes in 2016 and incorporate a larger suite of existing information as well some experimentation that will lead to improvements in removal efficiency.

Project Objectives:
1. Target and remove all size classes of Asian carp below Markland Locks and Dam.
2. Compare novel sampling techniques, and gear types that increase carp capture.

Project Activities: Methods, and Timetable:

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. Exterminated fish will be used to provide otoliths and 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.

Objective 1: Agency crews will remove Asian carps from the Ohio River, focusing on known or suspected areas of high density. Agency efforts will rely on pulsed-DC electrofishing and gill nets, but other gear types may be used to increase catchability depending on sampling circumstances. Information from the literature, expertise of researchers, and commercial anglers will be employed to investigate improvements in capturing Asian carps at multiple life stages. All removal effort focused on population control will be conducted downriver of Markland Dam, where Asian carp densities are relatively high and large-scale removal is possible.

Objective 2: The need for population control and reduction of propagule pressure is important in slowing the upriver expansion of bigheaded carps. An understanding of relative gear efficiencies will be necessary when guiding managers considering a sustainable management strategy with the lowest cost to effort approach. Traditional gill netting methods met limited success in 2015-2016 and boat electrofishing is costly and unrealistic when considering expansive pest control strategies. As a result, a priority of this project will be to identify sampling conditions, locations, and techniques that target bigheaded carps and alleviate obstacles that may deter sustainable control procedures.

Estimated Timetable:

Project Activity	Pool	Dates (Week Of…)	Year
Possible Removal	Cannelton	May 15	2017
Possible Removal	McAlpine	May 22	2017
Scheduled Removal	Cannelton	May 29	2017
Scheduled Removal	Cannelton	June 05	2017
Scheduled Removal	McAlpine	June 26	2017
Scheduled Removal	Cannelton	July 10	2017
Scheduled Removal	McAlpine	August 14	2017
Scheduled Removal	Cannelton	September 04	2017
Scheduled Removal	McAlpine	September 25	2017

Project Executive Summary	N/A	October 30	2017
Possible Removal	Cannelton	November 20	2017
Scheduled Removal	McAlpine	December 04	2017
Scheduled Removal	Cannelton	December 18	2017
Scheduled Removal	McAlpine	January 08	2018
Scheduled Removal	Cannelton	January 22	2018
Scheduled Removal	McAlpine	February 05	2018
Scheduled Removal	Cannelton	February 19	2018
Project Technical Report	N/A	February 26	2018
Scheduled Removal	McAlpine	March 05	2018
Scheduled Removal	Cannelton	March 19	2018

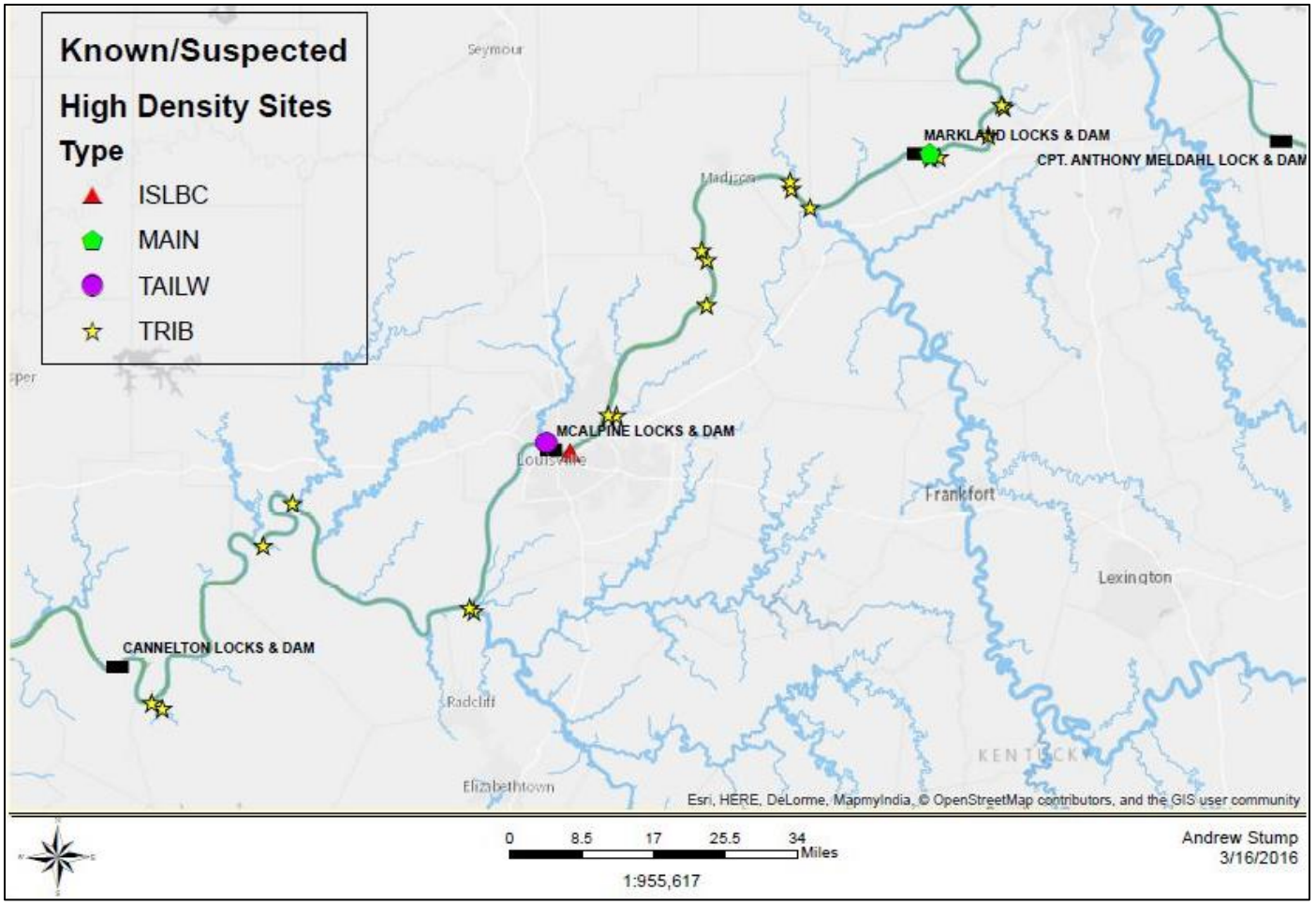

Figure 15. Sites of known or suspected high densities of Asian carp in Cannelton, McAlpine, and Markland pools. Only those sites below Markland Locks and Dam will be sampled during removal.

Project Title: Distribution, Movement, and Lock and Dam Passage of Asian Carp in the Ohio River through Acoustic Telemetry

Geographic Location: Ohio River Basin

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. Results to date using ultrasonic acoustic telemetry indicate that large-scale movements of Asian carp (i.e., pool to pool movement) appears to be occurring by a few number of individuals within the population, with Bighead Carp being more mobile than Silver Carp. This information is important to devise best management strategies such as whether population reduction may be more beneficial than containment fishing at the periphery of population. That said, current estimates of movement probabilities are hampered by low sample sizes.

Ultrasonic acoustic telemetry will be used to track movements of Asian carp and build upon a four year database of movement. 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.

For the 2017 season, the USFWS will purchase 30 additional VR2W stationary acoustic receivers for deployment into tributaries and upstream approaches to lock chambers. 150 additional V-16 transmitters will also be purchased to replace transmitters reaching the end of their battery life, as well as to increase the number of tagged carp in the Markland and Meldahl pools. To understand tributary use and movement as it pertains to water temperature, 30 HOBO temperature loggers will be purchased and deployed within tributaries of interest, as well as into each of the pools.

The USFWS will assist with the re-deployment and downloading of the stationary receivers as scheduled by the partners. All downloaded data will be uploaded to the ODNR FTP data sharing site. USFWS, in conjunction with partners, will analyze data to better quantify small-scale movement (e.g., habitat use), large-scale movement (e.g., pool to pool), lock usage, aggregation

areas, tributary usage, and overall movement patterns. These data will be summarized in the annual project report.

Partnerships within this project include agencies who are not requesting funding, but play an instrumental role in the achievement of project goals. In addition to the proposed work outlined below, ODNR plans to provide support, gear, and coordinate with state and federal agencies for activities associated with this project in the Meldahl Pool. In addition, USACE will provide support for activities occurring at lack and dam structures, and USGS will provide gear and support and coordinate with participating agencies.

Project Goals and Objectives:

National Plan Goal Supported:

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

National Plan Strategy Supported:

- Strategy 3.2.3. Minimize the range expansion and ecological effects of 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 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 3.3.2. 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

Sub-basin Management Plan Goal Supported:

Understanding Impacts

Sub-basin Management Plan Strategy Supported:

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

Project Objectives:

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

Agency: West Virginia Division of Natural Resources

Project Title: Distribution, Movement, and Lock and Dam Passage of Asian Carp in the Ohio River through Acoustic Telemetry

Objectives:

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

Project Activities, Methods, and Timetable:

Objective 1: WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Objective 2: WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps. WVDNR will assume responsibility for maintaining, downloading and sharing data from receivers located in the R.C. Byrd Pool, including the portion within the Kanawha River. Upon completion of a contract agreement with VEMCO, WVDNR will purchase a VR100 and associated manual tracking equipment as well as additional receivers and tags (with funds from FY16) to assist with this project.

Objective 3: WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Objective 4: WVDNR is not requesting funding for this objective, therefore has no planned actions. WVDNR will continue to assist USFWS in all aspects of this objective including, but not limited to: setting, replacing, or removing receivers, downloading data, sharing data, sharing significant findings, capturing and tagging of Asian Carps.

Estimated Timetable

Project Activity	**Pool**	**Dates**	**Year**
Asian carp removal	R.C. Byrd	June-September*	2017
Asian carp removal	Greenup	June-September*	2017
Response Protocol Research and Discussion	N/A	July-August	2017-2018

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

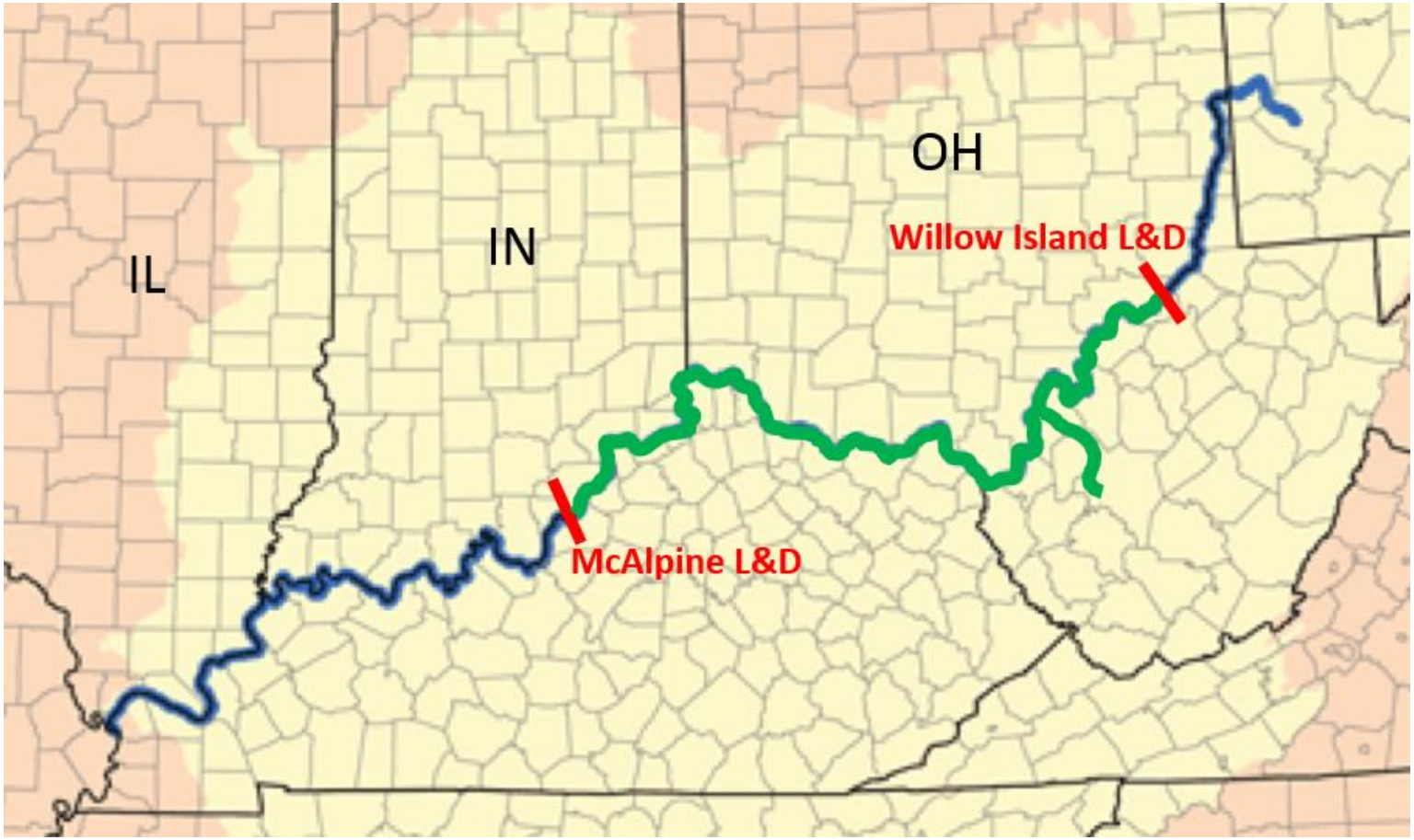

Figure 16. Project area map for the West Virginia DNR portion of the Distribution, Movement, and Lock and Dam Passage of Asian Carp in the Ohio River through Acoustic Telemetry project.

Agency: Indiana Department of Natural Resources

Project Title: Distribution, Movement, and Lock and Dam Passage of Asian Carp in the Ohio River through Acoustic Telemetry

Objectives:

1. Understand use of tributaries as potential sources for recruitment and routes of invasion into adjacent basins.

Project Activities, Methods, and Timetable:

Indiana DNR will assist in targeted sampling for Asian carp in the Markland Pool and its tributaries. Specific sampling sites may include Bryant Creek, Big Bone Creek, Gunpowder Creek, Grants Creek, Arnold Creek, Middle Creek, Woolper Creek, Laughery Creek, Hogan Creek, and Tanners Creek, and other smaller tributaries within the pool. Both pulse DC boat electrofishing and gill netting techniques will be utilized to target *Hypophthalmichthys spp*. All by-catch for each sampling gear will be recorded and any non-target fish (excluding Asian carps) will be released immediately after capture. Asian carp large enough will be implanted with an acoustic tag; all other Asian carp will be removed from the system.

Estimated Timetable:

Project Activity	Pool	Month	Year
Asian carp Tagging	Markland	May to September	2017
Asian carp Tagging	Markland	May to September	2018

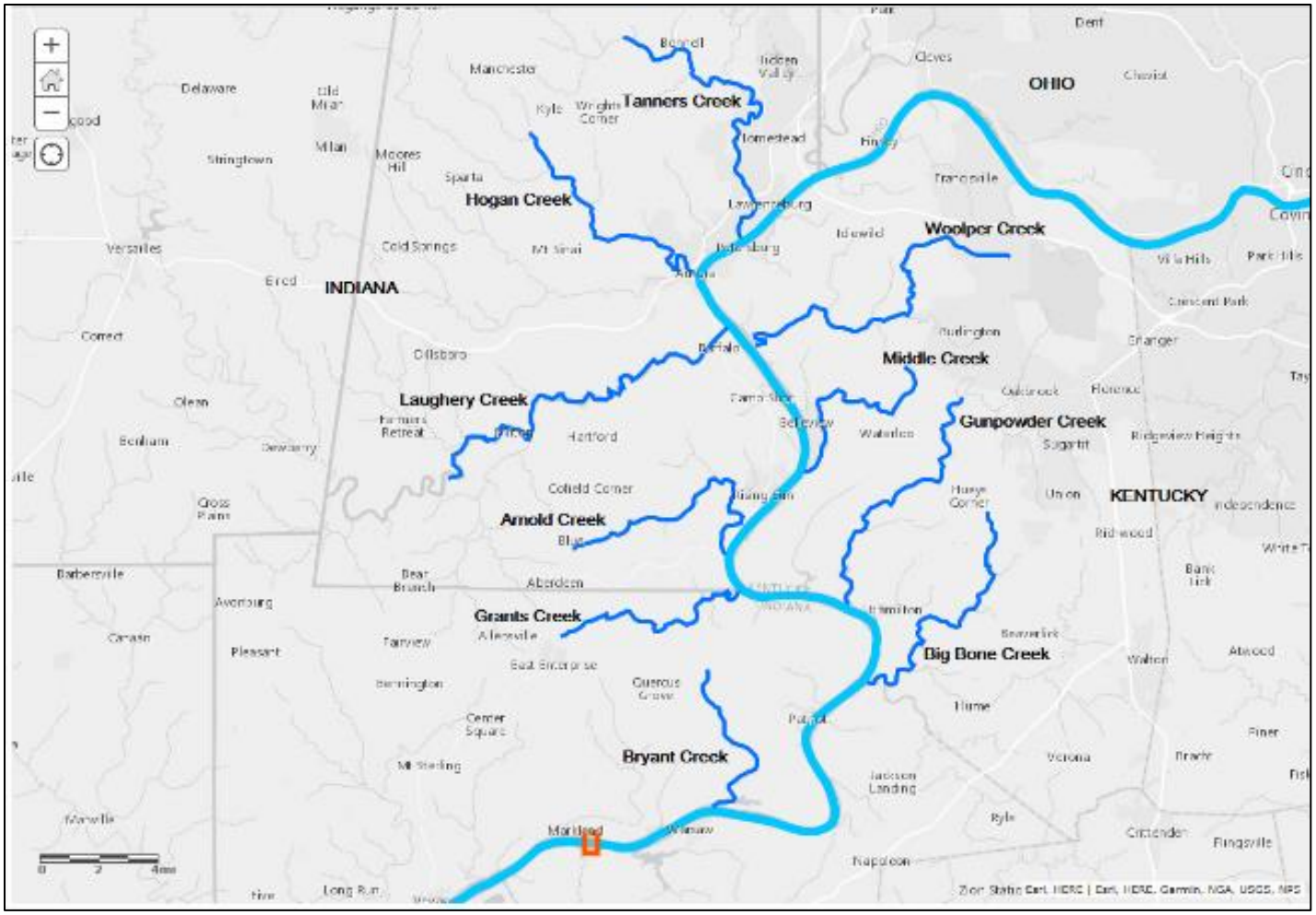

Figure 17. Project area map for the Indiana DNR portion of the Distribution, Movement, and Lock and Dam Passage of Asian Carp in the Ohio River through Acoustic Telemetry project.

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

Project Title: Distribution, Movement, and Lock and Dam Passage of Asian Carp in the Ohio River through Acoustic Telemetry

Objectives:

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

Project Activities: Methods, and Timetable:

Objective 1: The majority of KDFWR's 2017 receiver work will focus on stations within the first 170 miles of the telemetry array, which encompasses the Cannelton Pool, McAlpine Pool and initial 40+ miles of the Markland Pool. Aside from maintaining VR2W's at existing sites, the KDFWR will assist USFWS with their efforts to establish new stations in tributaries with inadequate receiver coverage. KDFWR will also help with the deployment and maintenance of temperature loggers, which, in 2017, will start being attached to a receiver station in larger tributaries that are spread throughout the telemetry array. KDFWR will then make monthly visits to all tributary sites within their section of the array in order to offload both the telemetry data from the VR2W's and the environmental data from any nearby temperature loggers. The preparation and analysis of this telemetry data will initially continue the same way it has in past years. However, beginning in 2017, there will be an additional effort to include any available temperature data in the telemetry analysis to determine if this specific variable has a substantial influence over the AC population's usage of that tributary. These results should provide just enough information for the Asian Carp's tributary usage to be summarized for the mid-year Report to Congress, and then a more thorough explanation will be added to the project's 2017 Technical Report.

Objective 2: Of this project's entire 500-mile telemetry array, a site is classified as "upstream" if it is above Markland Lock & Dam. Hence, using this criteria with the 170-mile section that KDFWR works on, the only location receiving the distinction of being an "upstream area" is the upper 40+ miles of this section, which happens to coincide with the entire lower half of the Markland Pool. KDFWR's receiver work (with the USFWS) for this objective in 2017 will focus on establishing new mainstem and tributary stations. Specific attempts at establishing new tributary stations may take a little more time/effort at those sites that have also been selected to receive temperature loggers. This area of the Markland Pool is unique because there is only one navigation buoy throughout this entire stretch of river. Hence, new deployment strategies could be needed before additional mainstem receiver stations can be properly established. Despite lower receiver numbers, the KDFWR will make monthly efforts to offload all new detections of tagged carp and any available temperature data. Additionally, every other month from April to October 2017, the KDFWR will join crews from USFWS, WVDNR and INDNR to sample the Markland and Meldahl pools in order to collect adult Asian Carp that can be surgically implanted

with ultrasonic transmitters. The KDFWR will once again prepare and error-check datasets the have been offloaded from each VR2W above the Markland Lock and Dam. Once all datasets have been combined into the 2017 telemetry database, the raw detection data will reduced to the hourly/daily level before it's specifically analyzed to produce the results that can help describe the upstream distribution of the AC population and the likelihood that they will continue dispersing further upstream. The preliminary results for this objective will be used to produce a summary for the mid-year Report to Congress, while a more complete analysis conducted in late 2017 will provide results for the Annual Technical Report.

Objective 3: KDFWR's annual field efforts start in the early spring with the redeployment of VR2W's to their mainstem stations after having been stored off-river for the entire winter season. This objective is the primary force behind the regular maintenance of mainstem receiver sites in KDFWR's section of the array, as well as the efforts to establish new stations in areas where the existing VR2W coverage may not be adequate. The last of KDFWR's receiver work in December 2017 will primarily be completed to reduce the chances of losing VR2W's, and it will require visits to all mainstem receiver sites in order to obtain the VR2W's that need to be securely stored off-river for the winter. The KDFWR will continue to focus on its section of the array during monthly efforts to offload telemetry data from all mainstem VR2W's, as well as any other stations that won't be covered by other project objectives. These detections will be combined with data from receiver stations at the other habitat types (i.e. tributary or lock & dam). The KDFWR will error-check, format and combine raw data from all 500+ miles of the array into the 2017 telemetry database, which will then be reduced into a dataset of hourly and/or daily detections. These datasets will be analyzed to produce results that the KDFWR can check against environmental data, which will obtained from several sources, including the project's own temperature loggers and the websites of those agencies (i.e. USGS) that provide access to the data that they collect by default. The idea is to identify environmental variables, such as season, water temperature and river level, that strongly correlate to the movements and habitat preferences of Asian Carp. The identification of correlated variables will eventually lead to KDFWR field tests that will use current river conditions to identify locations where Asian Carp are vulnerable to standard sampling efforts. Regardless of the success of these efforts, the KDFWR plans to provide information needed to summarize this objective's activities for both the mid-year Report to Congress and the 2017 Technical Report.

Objective 4: Markland Lock & Dam (L&D) is the only one in KDFWR's section of the array that is currently being monitored for Asian Carp passage. The KDFWR will work with the USFWS and USACE to maintain the existing receiver stations around this location, and if needed, help establish new ones. The KDFWR will also help with other L&D projects located along the Kentucky border, which includes possible improvements to the receiver coverage around McAlpine L&D and the Falls of Ohio. Regular efforts will be made to download detection data from VR2W's stationed around Markland L&D. Since there are six more L&D projects above the Markland Pool that are being monitored, this objective is also tied into KDFWR's plans to participate in the multi-agency effort (USFWS, WVDNR, INDNR) to sample adult carp from the Markland and Meldahl pools that can be implanted with ultrasonic transmitters. The KDFWR will once again error-check the telemetry data from receiver stations around seven different L&D projects before adding these detections to the 2017 database. The KDFWR will eventually include these detections during their overall analysis for the project. The USFWS also has plans

to utilize this specific data to quantify pool-to-pool movements for the model that they are developing. Ultimately, all of these results will make it possible to address Asian Carp L&D passage in the mid-year Report to Congress and the 2017 Technical Report.

Estimated Timetable:

Project Activity	Pool(s)	Month	Year
Redeployment of overwintering VR2W's & establish new stations (if needed)	McAlpine, Cannelton	March	2017
Asian Carp Tagging Efforts	Markland, Meldahl	April	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	May	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	June	2017
Asian Carp Tagging Efforts	Markland, Meldahl	June	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	July	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	August	2017
Asian Carp Tagging Efforts	Markland, Meldahl	August	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	September	2017
Asian Carp Tagging Efforts	Markland, Meldahl	September	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	October	2017
Asian Carp Tagging Efforts	Markland, Meldahl	October	2017
Receiver maintenance, data offloads and Establish new stations (if needed)	Cannelton, McAlpine, 1st half of Markland	November	2017
Data offloads (Tributaries); Pull mainstem VR2W's for overwinter storage.	Cannelton, McAlpine, 1st half of Markland	December	2017

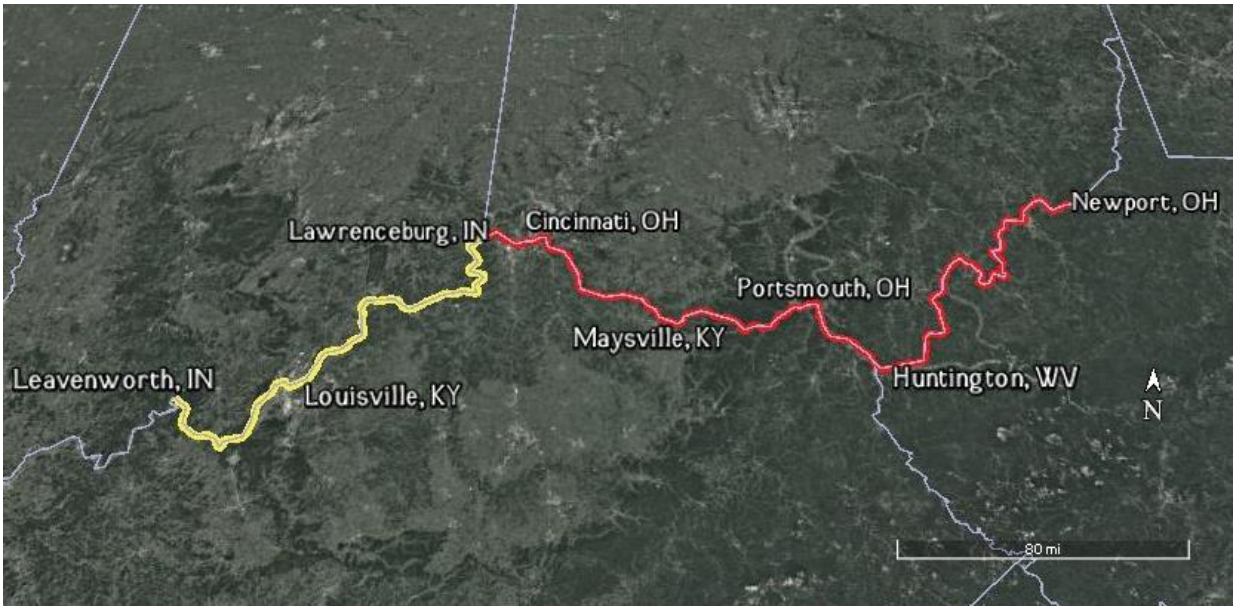

Figure 18. A map of the entire 500-mile receiver array that spans from Leavenworth, IN to just below Newport, OH. The first 170-mile stretch (yellow outline) is the section for KDFWR's receiver work, while the sites within the remaining 330 miles of the array (red outline) are maintained by multiple agencies (ODNR, WVDNR and USFWS).

Project Title: Relative Population Densities, Movements, and Spawning Success of Asian Carp in the Tennessee River and Cumberland rivers, Tributaries of the Ohio River

Geographic Location: Ohio River Basin; Tennessee and Cumberland rivers

Lead Agency: Tennessee Wildlife Resources Agency

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

Statement of Need:

Adult bighead and grass carp have been recognized in the Tennessee and Cumberland rivers (tributaries to the Ohio River) for the last ten to fifteen years, but Silver Carp have only been collected within the Tennessee portion of the reservoirs for the last few years. These waterways are multi-jurisdictional and include waters within Kentucky, Tennessee, Mississippi, and Alabama. Thus, Asian carp invasion is a threat to multiple agencies and the valuable sport fisheries and ecosystems in their respective states. Asian carp reports suggest increasing immigration upstream in both systems, however there are many uncertainties regarding their abundance, 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 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.

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

In 2017, TTU commenced sampling on Kentucky, Barkley, Cheatham, and Pickwick reservoirs to evaluate relative densities of Asian carp using gill nets and electrofishing. TTU, USFWS, and KDFWR worked together to sample Asian carp in the lower end of Kentucky and Barkley

reservoirs using the USFWS paupier boat. Weights and lengths were recorded for most fish and TTU collected aging structures from a subsample of the catch.
Funding for Asian carp monitoring and research has primarily been from state agencies collaborating in the Tennessee River and Cumberland River. In 2015 and 2016, initial sampling for Asian Carp commenced in Barkley and Kentucky reservoirs by Tennessee Tech University. This effort resulted in a Master's student thesis that included the first description of population age structure and capture of over 100 age-0 Asian carp within the reservoirs (manuscript in review). The Master's thesis evaluated effective sampling gear for collection of Asian carp (Tennessee Technological University) and highlighted a need for exploration and development of active gears that will enhance sampling large reservoirs. The thesis also illustrated many knowledge gaps about Asian Carp in large reservoirs that will need to be resolved to develop management targets. In 2016, TWRA and TTU received USFWS funding to increase sampling and movement data collection. Age structure characterization of existing populations is ongoing (Tennessee Technological University) and may determine the frequency of missing year classes. In 2016, systematic sampling of Asian Carp to evaluate relative densities within and across multiple lakes in the Tennessee River and Cumberland River began and will be continued through 2017 by integrated funding from TWRA, USFWS and USGS. This work is ongoing and also aims to increase samples used to characterize populations (e.g., age and growth analysis). TWRA conducts electrofishing surveys to determine the leading edge of Asian carps in the mainstream and tributaries of Kentucky and Barkley reservoirs (Tennessee Wildlife Resources Agency) and multiple agencies and universities participated in an Asian Carp removal effort at Kentucky Reservoir in 2016.

Project Goals and Objectives:

National Plan Strategies Supported:

- Goal 2. Contain and control the expansion of populations of bighead, black, grass, and silver carps in the United States
- Goal 3. Extirpate, or reduce to levels of insignificant effect, 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:

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

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

Project Objectives:

1. Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Tennessee and Cumberland rivers.
2. Evaluate lock and dam passage of Asian Carp and movements among reservoirs
3. Evaluate reproductive success, established leading edges, and age – 0 abundance of Asian carps in Kentucky and Barkley reservoirs.

Agency: Tennessee Wildlife Resources Agency

Project Title: Relative Population Densities, Movements, and Spawning Success of Asian Carp in the Tennessee River and Cumberland rivers, Tributaries of the Ohio River

Objectives:

1. Conduct targeted sampling for the purpose of surveillance, early detection, distribution, and relative population characteristics of Asian carp in the Tennessee and Cumberland rivers.
2. Evaluate lock and dam passage of Asian Carp and movements among reservoirs
3. Evaluate reproductive success, established leading edges, and age – 0 abundance of Asian carps in Kentucky and Barkley Reservoirs.

Project Activities, Methods, and Timetable:

Proposed project activities for 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 2: Continued monitoring, maintenance, data management, and implantation of ultrasonic telemetry tags in Asian Carp to measure movements among Tennessee River locks and dams; Objective 3: Larval fish tows, light traps, electrofishing, and mini-fyke net sampling to measure in-lake reproduction and potential recruitment bottlenecks.

Objective 1: Methods will use experimental gill nets with panels measuring 3 inches to 5 inches (bar measure) of 8-ply twisted mono to sample adult Asian Carp. These nets were chosen following discussion with commercial fishers that target Asian carp to maximize retention and minimize gear destruction. Gill net set soak times will be short (one to two hours) when water temperatures are warm to minimize mortality of bycatch including paddlefish. Over-night sets will be considered during cool temperature months because catches are anecdotally higher and survival of bycatch will also be maximized (e.g., paddlefish; Bettoli and Scholten 2006). Active gears will also be utilized for Objectives 1 and 3. All electrofishing will use pulsed-DC current (5-8 Amps, 535 Volts, 120 pulses per second) and include one netter. Survey sites for Objective 1 will be stratified by lake area (e.g., downsteam versus upstream) with three strata in Kentucky and Barkley reservoirs where abundances are higher than in Cheatham and Pickwick reservoirs, which will have two spatial strata. Standardized electrofishing sites will have fixed time periods of 900 seconds; all collected fish will be identified, and length and weight taken; otoliths will be taken from a subsample of collected fish in each length bin to allow later extrapolation to an age-length key. Proposed sampling will provide the first estimate of total mortality and survival for these reservoirs, which is a needed input for population models. Sex-ratio and a gonadosomatic index (female gonad weight to body weight ratio) will be developed to help inform population models and potential spawning time. At non-standardized sampling sites, observed fish will be identified in the water, and otoliths will be obtained from collected invasive carps. Recent experience with USFWS on their paupier boat suggests a need for increased exploration of innovative active gears for improving capture efficiency and sampling younger fish that will recruit into the adult population. Thus, innovative electrofishing gears and hydroacoustic

technology will be evaluated as tools for effectively detecting and monitoring Asian carp in collaboration with USFWS sampling.

Objective 2: Methods require monitoring, maintenance, and increasing capacity for acoustic telemetry movement data for Asian carp. Receivers will be monitored and maintained on a seasonal to 6-month frequency depending on battery lives and location. Vemco receivers have been placed or are in the process of being placed at all locks and dams in the Tennessee River as well as in multiple reservoirs, in collaboration with ongoing Lake Sturgeon projects, to inform movement among locks and dams and across reservoirs. A focused effort to increase the number of tagged Asian carp in the upper end of Kentucky Lake to exceed a sample size of greater than 50 fish will occur in 2017 and 2018. Currently, sampling efforts have been limited by catching fish in good condition to consider implanting a tag and having certainty of survival. In fall 2017, during cool water conditions, an intensive marking effort will occur and be sustained through spring of 2018 to conduct surgeries. An improvement in sampling gears (gill nets and electrofishing equipment) will facilitate capture in the upcoming year(s) to enhance our ability to capture Asian carp. 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. 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.

Objective 3: Larval sampling will be conducted using a bow mounted icthyoplankton net (0.75 m x 3 m) consisting of 500 um mesh. The larval tow nets will be placed on booms on the front of the boat and the nets 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. Each location will be sampled with two, five-minute pushes. 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, rinsed with water, and preserved in 90% ethanol.

Quadrafoil type larval light traps will be deployed at randomly generated sites inembayments and backwaters to target recently hatched invasive carp. Traps will be deployed at a minimum of one hour after sunset (10 traps at a time), allowed to fish for approximately 60 – 120 minutes, contents removed and redeployed if needed. Water quality, bucket description, site description, depth, coordinates and soak time will be recorded for all traps for each individual sampling event. Traps will be set far enough away from other traps to avoid the effects of light contamination from nearby traps. All contents will be preserved in formalin and all larva and fish will be enumerated and identified to the lowest possible taxonomic rank.

Mini-fyke nets will be utilized to determine presence and abundance of fingerling Asian carp within Kentucky and Barkley reservoirs. Day-time electrofishing surveys and the mini-fyke nets have been shown to provide additional information on juvenile abundance when deployed in shallow waters. Sampling sites will occur in random areas within each reservoir and Mini-fyke

nets will be set over-night. Sets will comply with standardized sampling protocol developed for fall trap netting. Mini-fyke nets were determined as a cost-effective method for sampling juvenile Asian carp in river-floodplains (Collins et al. 2017), but their efficiency has not been evaluated in large reservoirs.

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

Estimated Timetable:

Project Activity	**Reservoir**	**Month**	**Year**
Gill Netting	Kentucky, Barkley, Cheatham, and Pickwick	May, June, October, and November	2017 and 2018
Adult Density Electrofishing	Kentucky, Barkley, Cheatham, and Pickwick	June July, August, and September	2017 and 2018
Juvenile Electrofishing	Kentucky and Barkley	August, September, and October	2017 and 2018
Acoustic Tag implantation	Kentucky	Fall and Winter (water temp dependent)	2017 and 2018 (until all tags are at-large)
Acoustic Receiver deployment and maintenance	Kentucky, Pickwick, Wilson, Wheeler	Seasonally or as needed for maintenance	2017 and 2018
Community Electrofishing	Kentucky and Barkley	April, September, and October	2017 and 2018
Larval Tows	Kentucky and Barkley	March, April, May, June, and July	2017
Mini-fyke netting	Kentucky and Barkley	September	2018
Juvenile light traps	Kentucky and Barkley	March, April, May, June, and July	2017 (2018 if no larval fish are collected in 2017)

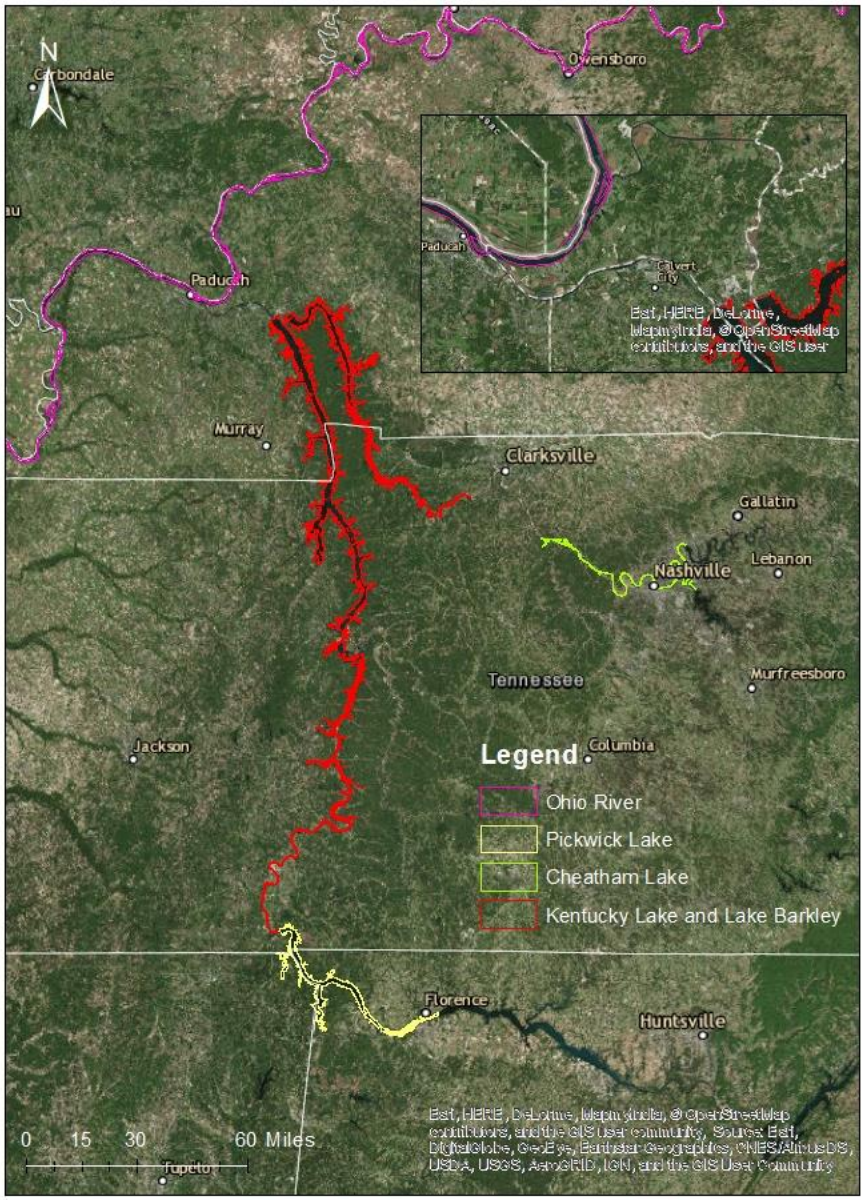

Figure 19. Proposed reservoirs for Objective 1, measuring relative density and population characteristics of Asian carp in the Tennessee River and Cumberland River; and Objective 3, measuring larval and juvenile density in Kentucky and Barkley reservoirs.

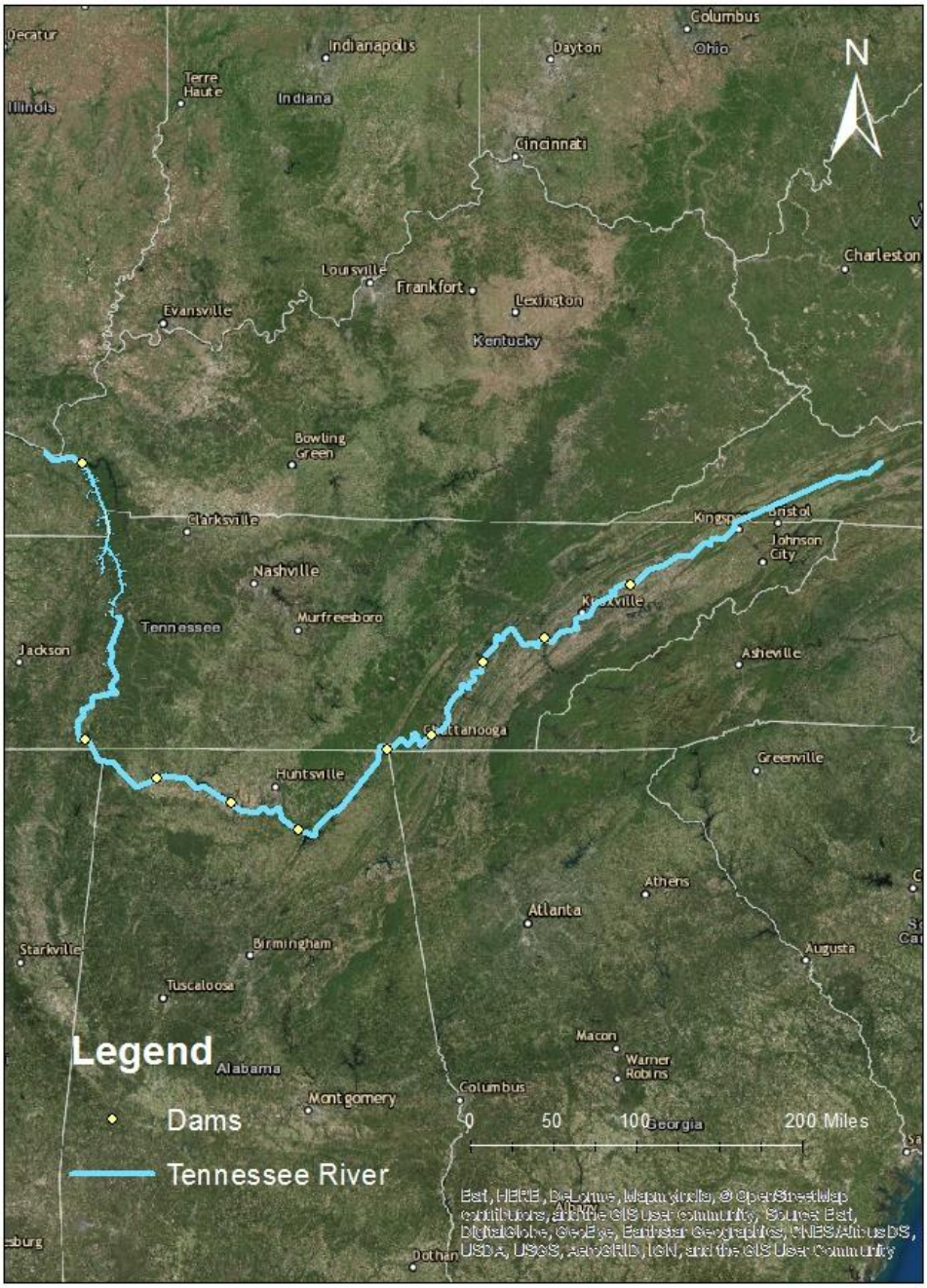

Figure 20. The Tennessee River and lock and dams (yellow diamonds) that will be monitored to measure Asian carp upstream invasion.

Agency: Kentucky Department of Fish and Wildlife Resources

Project Title: Relative Population Densities, Movements, and Spawning Success of Asian Carp in the Tennessee River and Cumberland rivers, Tributaries of the Ohio River

Objectives:

2. Evaluate lock and dam passage of Asian Carp and movements among reservoirs

Project Activities, Methods, and Timetable:

To date, Asian Carp telemetry efforts in Kentucky have focused on understanding the movement of Asian Carp within Kentucky Lake primarily to inform removal efforts. KDFWR plans to continue manual tracking of tagged Asian Carp within the lake to determine diurnal movements, distances traveled, and habitat usage. These efforts have laid the ground work for this project. Despite recent achievements, there are additional needs to effectively assess the passage of Asian carp through lock chambers on the Tennessee River. In order to assess fish passage and ultimately assess deterrence strategies in the Tennessee River system, additional receivers and tagging of Asian Carp below Kentucky Lock & Dam is essential. In the fall of 2017 two telemetry receivers will be deployed in the Kentucky Dam tailwaters and one receiver will be added upstream of Kentucky Lock & Dam. Receivers will also be deployed in Lake Barkley Lock & Dam and its' tailwaters to detect any tagged fish that may pass from the Tennessee River to the Cumberland River. In the fall of 2017 silver carp and bighead carp will be captured below Kentucky Dam through electrofishing and gillnetting in order to be surgically implanted with acoustic transmitters. This effort may also continue into the spring of 2018 or until all 150 tags are utilized. All telemetry receivers will be maintained and data collected on a routine bimonthly schedule. 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 River.

Estimated Timetable:

Project Activity	Location	Month	Year
24hr manual tracking	KY Lake	Seasonally	2017 and 2018
Receiver Deployment	Upstream of KY Dam	August	2017
Receiver Deployment	KY Dam Tailwaters	September	2017
Receiver Deployment	Barkley Lock and Dam	September	2017
Receiver Deployment	Barkley Dam Tailwaters	September	2017
Implantation of Transmitters	KY Dam Tailwaters	October, November, December	2017
Implantation of Transmitters	KY Dam Tailwaters	March and April	2018

Downloading of Receivers	Kentucky Lake, KY Dam Tailwaters, Lake Barkley Lock and Dam	Seasonally as needed	2017 and 2018

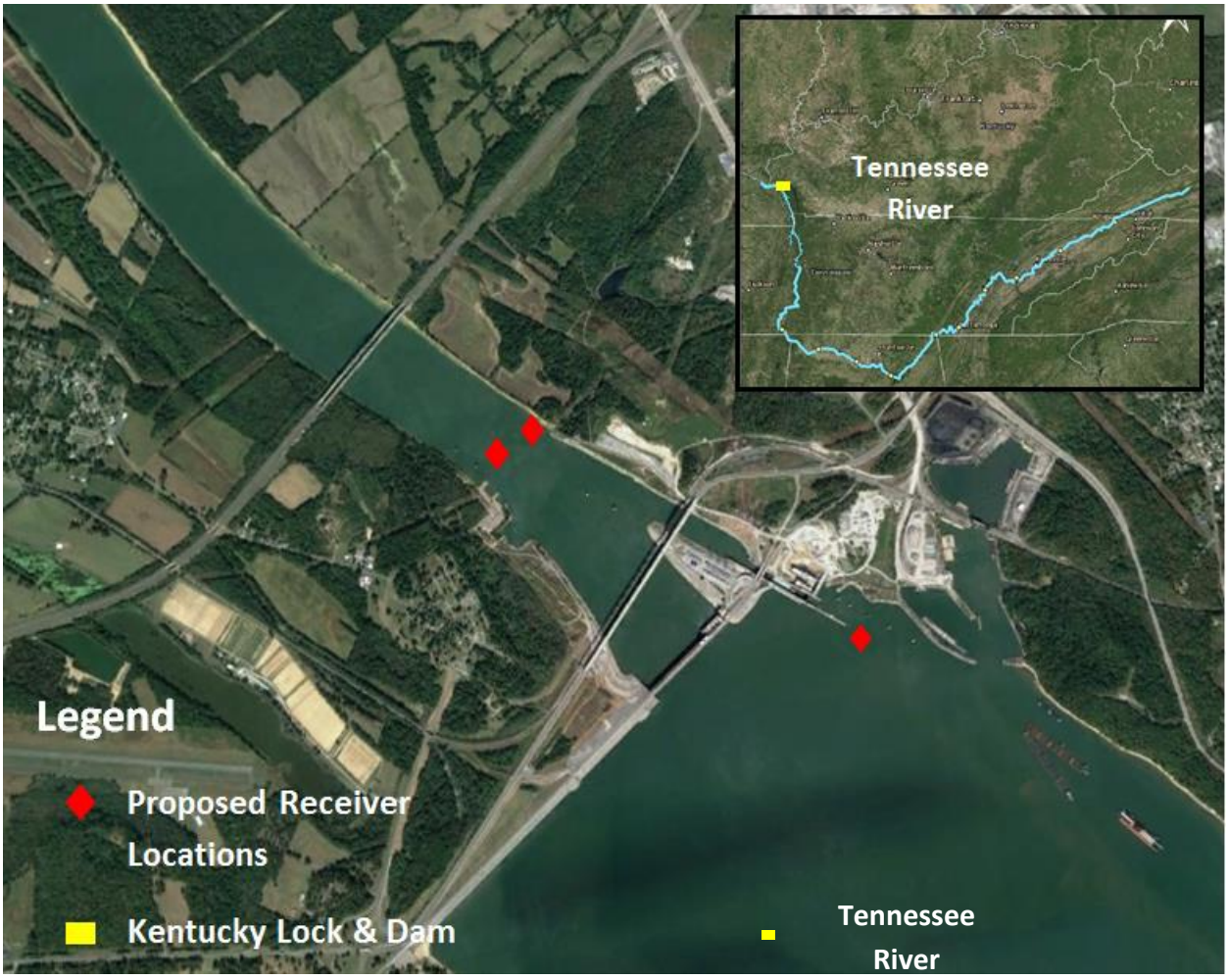

Figure 21. Proposed receiver locations in the Kentucky Lock & Dam tailwaters and upstream of the lock chamber. These receivers will be monitored to measure passage of Asian carp through the lock chamber and inform deterrence strategies.

Upper Mississippi River Basin

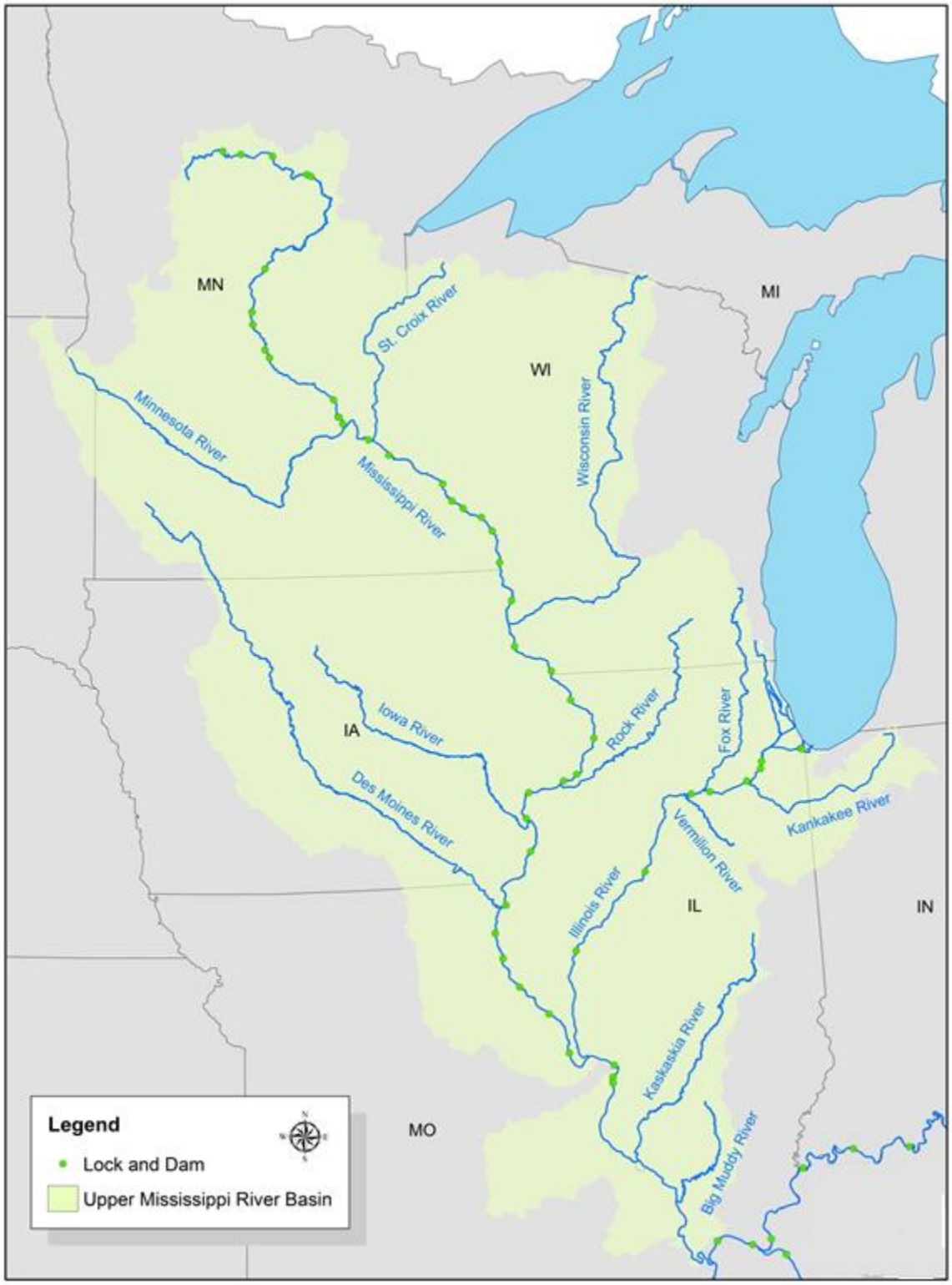

Figure 22. Map of the Upper Mississippi River Basin.

Project Title: Upper Mississippi River Monitoring Program

Geographic Location: Mississippi River Pool 19 through Pool 1; St. Croix and Minnesota rivers in Minnesota; Wisconsin River in Wisconsin; Des Moines, Skunk, Iowa, Wapsipinicon, Maquoketa, Turkey, and Upper Iowa rivers in Iowa; Rock and Illinois rivers in Illinois

Lead Agency: Minnesota DNR

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

Statement of Need:
On June 10, 2014, the President signed into law the Water Resources Reform and Development Act of 2014 (WRRDA). As a part of WRRDA, the United States Fish and Wildlife Service (USFWS) was authorized, in collaboration with the National Parks Service (NPS) and United States Geological Survey (USGS), to take actions to slow, and eventually eliminate, the spread of Asian carp in the Upper Mississippi River Basin (UMRB) and Ohio River Basin (ORB) and tributaries. Those actions include provision of technical assistance, coordination, best practices, and support to state and local governments engaged in activities to decrease and eventually eliminate that threat. This lead to the creation of the UMRB invasive carp workgroup comprised of representatives from Minnesota, Wisconsin, Iowa, Illinois, Missouri, USGS, USFWS, NPS, US ACE, and Upper Mississippi River Conservation Committee.

Prior to the formation of the UMRB invasive carp workgroup in 2014, individual states had been conducting monitoring and response actions with varying degrees of effort. Starting with the 2015 field season, state and federal agencies began a collaborative effort for monitoring and assessing invasive carp populations in the UMR. The WRRDA bill also mandated an annual report to Congress for activities outside the Great Lakes. This report includes a summary of the progress, findings, and funding of the UMRB monitoring program. The UMRB invasive carp workgroup also annually reviews and recommends changes for the program.

The four species of carp are found in varying abundances in the UMRB. Black carp have not been collected above Lock and Dam 22. Adult Bighead, Grass, and Silver carps are present in varying abundance in Pools 19 through Pool 13, but resource managers do not have a clear understanding of population dynamics within each pool. The comprehensive surveillance program is intended to provide empirical data to define the current invasion status throughout the UMR above Lock and Dam 19 by defining the current presence front (i.e., occasional collection of an individual fish), invasion front (i.e., high numbers of adults collected), and the established front (i.e., areas with verified spawning and recruitment to Age-1) of the four species of invasive carp and evaluate how these fronts change through time.

In fiscal year 2017, UMR partners will continue development and implementation of a comprehensive and complementary early detection, monitoring, and population assessment program for Bighead, Silver, Grass, and Black carps in the UMRB. This is fundamental information that will inform all aspects of prevention and control such as where to target early detection monitoring, where to consider containment measures such as deterrent barriers, where to target management actions to disrupt spawning and recruitment, and where to target control activities. Additionally, this effort will help evaluate the effects of proposed management actions

(e.g., adult harvest, barrier at Lock and Dam 19). Sampling will use a diverse array of traditional and novel gears to sample all potential life stages in targeted areas.

The monitoring program is one segment of the UMR invasive carp effort. The findings help guide and evaluate other segments of the collaborative effort including the development of deterrents and implementing an effective harvest program. Results from 2015 and 2016 were used to develop distribution maps for each of the species. The information was combined with deterrent technology knowledge, lock and dam data, and control activity options to begin developing a deterrent strategy. The strategy identifies locations to slow upstream movements and intensive management zones for targeted activities to impact carp populations (i.e. commercial fishing). More detailed information can be found in the "Deterrence of Asian carp in the UMR" project plan.

Project Goals and Objectives:

National Plan Goal Supported:

- Goal 2. Contain and control the expansion of 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 Asian carp introductions and range expansions.

Sub-basin Management Plan Goal Supported:
Monitoring: Conduct distribution, status, and early detection monitoring in key locations.

Project Objectives:

1. Annually delineate geographic boundaries of the various stages (reproduction, recruitment, adults) of invasion and monitor invasive carp population changes at the presence front.

Agency: Minnesota DNR

Project Title: Upper Mississippi River Monitoring Program

Objectives:

1. Annually delineate geographic boundaries of the various stages (reproduction, recruitment, adults) of invasion and monitor invasive carp population changes at the presence front.

Project Activities, Methods, and Timetable:

Introduction

With the continuing progression of invasive carps up the Mississippi River, Minnesota waters are threatened by a potential invasion. A better understanding of the current status of invasive carp individuals or populations in Minnesota 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 in Minnesota's major rivers 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. To date, invasive carps in Minnesota have been primarily caught by commercial fishermen. The purpose of this sampling effort is to use gears and methods more specific to invasive carps to monitor all life stages of invasive carps and associated native fishes in the Mississippi, St. Croix, and Minnesota rivers.

Sampling Sites

Standard sampling occurs in Navigational Pools 2 and 3 of the Mississippi River, the St. Croix River, and the Minnesota River. Navigational Pool 2 of the Mississippi River spans approximately 52 km from Lock and Dam 1 in St. Paul, MN to Lock and Dam 2 near Hastings, MN. Pool 3 spans approximately 29 km from Lock and Dam 2 near Hastings, MN, to Lock and Dam 3 upstream of Red Wing, MN. In the St. Croix River, effort will be focused over an 83 km long span from the dam near Taylors Falls, MN to the confluence with the Mississippi River near Prescott, WI. In the Minnesota River, effort will be focused over an 80 km long span from River Mile 50 at Belle Plaine, MN to the confluence with Pool 2 of the Mississippi River near St. Paul, MN. In addition, contract commercial fishermen will be utilized throughout these systems to monitor for invasive carp and as rapid response actions if invasive carp are found or are presumed to be present.

Sampling Methods

Gears, methods, and habitats to focus sampling were derived from a collection of personal communications with biologists who have been sampling invasive carps (V. Santucci, Illinois Department of Natural Resources, personal communication; J. Lamer, Western Illinois University, personal communication) and conducting research on the most efficient gears to sample invasive carps (M. Diana, Illinois Natural History Survey, personal communication), along with a variety of literature that included sampling techniques and habitat preferences (Lohmeyer and Garvey 2009; Williamson and Garvey 2005; Dettmers et al. 2001; DeGrandchamp et al. 2007; Kolar et al. 2007; DeGrandchamp et al. 2008; Wanner and Klumb 2009; ACRCC 2012). All fish captured will be identified, weighed, and measured, and 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 site.

Invasive Carp
If an invasive carp is collected, it will be placed in a secure location to prevent escapement and will be transported back to Region 3 Headquarters. Invasive carp will then be processed at Region 3 Headquarters and samples will be analyzed in-house and sent to various labs around the country for analysis. Protocols are established for all species of invasive carp. The Minnesota Department of Natural Resources (MN DNR) will process fish in-house and age all individuals, as well as collect stable isotope samples. For all invasive carp species, histology, ageing, and genetics samples will also be sent to U.S. Geological Survey's Columbia Environmental Research Center (CERC) for analysis. For Black Carp and Grass Carp, eyes are removed, prepared, and sent to the U.S. Fish and Wildlife Service's Whitney Genetics Lab for ploidy analysis. In addition, genetic samples (fin clip) are sent to both Loren Miller (MN DNR) and CERC. A gonad sample to determine sex and maturity, as well as otoliths, vertebrae, postcleithrum, and fin rays are sent to CERC for aging. The right lapillus otolith and right postcleithrum are sent to Greg Whitledge at Southern Illinois University for microchemistry analysis.

Native Species Age and Growth Analysis
Aging structures will be taken and sex and maturity will be determined for Bigmouth Buffalo, and Smallmouth Buffalo *Ictobius bubalus* captured in Pool 2 and the St. Croix River. In Pool 2, River Carpsucker *Carpiodes carpio*, Highfin *Carpiodes velifer*, and Quillback *Carpiodes cyprinus* will also be aged and sex and maturity will be determined (see below). In reproductively mature females of these five species, gonadosomatic index (GSI) values will be calculated by measuring the weight of the entire gonads in proportion to the mass of the individual. A sub-sample of individuals will also be analyzed to estimate the total number of eggs present by excising approximately 10 grams of gonads, counting the number of eggs, and extrapolating total number of eggs using the total gonad weight.

In addition, Paddlefish are currently a state listed threatened species in Minnesota; therefore low abundances and the lack of a non-lethal aging method for Paddlefish make sacrificing fish to acquire ages unjustifiable. From Paddlefish mortalities, dentary bones will be removed (after eye-fork lengths are obtained) and, after cleaning and sectioning with a low-speed isomet saw, will be used to determine ages by observing annuli (similar to the methods of Reed et al. 1992 and Hoxmeier and DeVries 1997).

For the previously mentioned species, lengths, weights and aging structures (except for Paddlefish) will be collected as follows: for fish less than 300 mm, up to 5 individuals in each 1 cm length group and for fish 300 mm and greater up to ten individuals in each 25 mm length group. Lengths and weights of the previously mentioned species (including Paddlefish) will also be used to evaluate condition factor.

Fish Tagging Efforts
Currently several species of fish in the Mississippi River Pool 2 and the St. Croix River are part of ongoing tagging studies and when encountered they will be tagged according to species specific guidelines. These species include Flathead Catfish *Pylodictis olivaris* and Channel Catfish *Ictalurus punctatus* in Pool 2 and Lake Sturgeon *Acipenser fulvescens*, Muskellunge *Esox masquinongy*, White Bass *Morone chrysops*, Flathead Catfish, and Channel Catfish in the

St. Croix. In both Pool 2 and the St. Croix River, Paddlefish *Polyodon spathula* will also be tagged. Smallmouth Buffalo and Bigmouth Buffalo in Pool 2 will be tagged with T-bar tags along with secondary marking (clipping one pelvic fin) to track movements, estimate a population depletion rate from commercial fishing, and validate aging using the second pelvic fin and otoliths from re-captured fish that have been at liberty 1+ years. In 2015 and 2016, over 2,800 buffalo have been tagged and an additional 1,500 tags have been allocated for 2017. As part of another study, we will also continue monitoring movements of native species, including Smallmouth and Bigmouth Buffalo, tagged with VEMCO acoustic tags using passive acoustic receivers and actively tracking tagged fish.

Species Count

With the increased sampling efforts, multiple species that occur in low abundances or species that are not typically caught with conventional gears are likely to be encountered. Since 2006, 68 different species of fish have been confirmed in Pool 2 of the Mississippi River (Schmidt and Proulx 2009, personal observations), and a similar species count likely exists for Pool 3 and the St. Croix River. A species list will be added to for all species encountered and positively identified on these systems. For positive identification of large, unknown fishes, high resolution photographs will be preferred, whereas voucher specimens of small, unknown fishes may be collected. In both cases, fish will be referred to an ichthyologist for positive identification.

Larval Trawling

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

Mini-Fyke and Trap Netting

Mini-fyke and trap netting will be conducted from June through September in Pool 2 and the St. Croix River. Mini-fyke net sampling will be conducted at least once per field season for a week. If a peak in the hydrograph is observed or once water temperatures reach 62-65º F (17 or 18º C), larval sampling will be conducted immediately afterward. Mini-fyke netting will then commence

approximately two weeks afterward to sample when young invasive carp would be most vulnerable to capture from mini-fyke sampling (N. Bloomfield, U.S. Fish Wildlife Service, personal communication). The mini-fyke nets consist of a double frame (27 in. x 39 in.), four hoops (2 ft.), a single throat, and a 25 ft. lead, with a square mesh size of 0.125 in. throughout. The standard trap nets consist of a double frame (36 in. x 72 in.), five hoops (30 in.), two throats, and a 40 ft. lead, with a square mesh size of 0.75 in. throughout. Up to six mini-fyke and four trap nets will be set during each sampling event. The number of net sets during each sampling event will depend on the stretch of river being sampled. Certain stretches of the river may not consist of many or any sampling locations suitable for sampling with fyke nets. In these stretches of river, not all nets will be set. Mini-fyke and trap nets will be set on Monday, checked and re-set on Tuesday and Wednesday, and checked and pulled on Thursday. 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 (N. Bloomfield, U.S. Fish Wildlife Service, personal communication). The seine measure 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.

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 aging 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 aging structures and invasive carps

will be collected. This will reduce unnecessary processing time and will allow for greater sampling effort.

A smaller electrofishing boat with an outboard jet motor will be used to sample shallow backwaters, in conjunction with the larger electrofishing boat. It is believed that juvenile invasive carps are a limiting life stage to their populations' growth and that juvenile invasive carps likely overwinter in anoxic backwaters. Sites will be selected for non-standardized electrofishing sampling based on accessibility for use with the smaller, jet-engine electrofishing vessel in Pool 2, the St. Croix River, and the Minnesota River.

Gill and Trammel Netting

Gill netting and trammel netting will occur from March through November as time allows. Stationary large mesh gill nets of depths from 8 to 24 ft. with square mesh sizes of 3.5 to 6 in. will be used to target adult invasive carps. Stationary trammel nets with outside wall square mesh sizes of 12 to 14 in. and inner square mesh sizes of 2 to 4 in. will also be used to target adult invasive carps. Stationary experimental gill nets 250 ft. in length and 6 ft. deep consisting of 50 ft. compliments of net with square mesh sizes 0.75, 1, 1.25, 1.5, 2 in. will be used to target juvenile invasive carps. Nets may be set either short term or overnight, with short-term sets favored when water temperatures are greater than 60º F. The goal will be to sample approximately 3000 feet of net set per month.

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.

Invasive Carp Spawning Potential Modelling

Minnesota Department of Natural Resources personnel are in discussions with the U.S. Geologic Survey to determine the potential of conducting a Fluvial Egg Drift Simulator, or FluEgg modelling, to predict if invasive carp could successfully reproduce in the St. Croix River and determine areas exist where invasive carp larvae and eggs would be most susceptible to being sampled in larval gear and would potentially reach the gas bladder inflation stage when larvae are able to swim out of the current and look for backwater habitats to inhabit and grow to maturity. FluEgg is "a three-dimensional Lagrangian model capable of evaluating the influence of flow velocity, shear dispersion and turbulent diffusion on the transport and dispersal patterns of invasive carp eggs is presented. The model's variables include not only biological behavior (growth rate, density changes) but also the physical characteristics of the flow field, such as mean velocities and eddy diffusivities"(Garcia et al. 2015).

Invasive Carp Tagging
The DNR is proposing to tag one or two invasive carp at a time with acoustic tags and track these fish 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, and other contingencies dictated by the circumstances present and the in-depth knowledge of these species' biology and trends in movements and behaviors.

Both Silver Carp and Bighead Carp form tight schools, so if a tagged fish schools with other individuals, we will effectively be able to track the individual and other individuals of the same or similar species using what is called the "Judas fish technique." With this information, tagged fish can be tracked and effectively netted to ensure re-capture and removal of other invasive carp found in the school. Other states have already begun work of this nature in riverine environments and have shown significant results and ability to remove additional fish with this tagging method. By tagging one or two invasive carp, we are likely to see an increase in the number of additional invasive carp caught and ultimately increase the state's effectiveness at removing these species from our waterways. Response actions will be taken using commercial fishermen when tagged fish are in jeopardy of being lost due to tag duration being nearly depleted, the fish reaching an area of potential escapement from the tracking devices, or when needed to support removal of other conspecifics.

The impacts of releasing wild-caught invasive carp back into the wild have been considered and are believed to be minimal when compared to the potential information gained from this project. While potentially sexually mature, there have not been any signs of reproduction occurring in Minnesota waters despite extensive fisheries sampling, including larval and juvenile fish sampling. Further, the concern for Silver Carp to jump and injure recreationists is low to non-existent at this time due to low population abundances. Silver Carp, when population levels are high, are known to jump when disturbed and to date this has not been observed in Minnesota. Finally, at the start of this project, only one or two fish will be tagged and released and all other invasive carp will be euthanized. The DNR will take all reasonable measures to ensure all tagged fish are tracked and their locations known through active tracking and an extensive passive tracking network. Comprehensive removal efforts will be employed to remove tagged and un-tagged fish from Minnesota waters.

In fisheries biology, individual tagged fish have been effectively used to find conspecifics using the Judas technique, following "Judas fish" (Johnsen and Hasler 1977; Penne and Pierce 2008; Bajer et al. 2011; Patil et al. 2014). The University of Minnesota has conducted field trials using radio tagged Common Carp (*Cyprinus carpio*) in Minnesota lakes as "Judas fish" to find schools and inform removal efforts. Research using juvenile Silver and Bighead Carp in the lab has shown that both species aggregate strongly forming tight schools and are unlikely to be randomly distributed (Ghosal et al. 2016), further supporting the use of the Judas technique to exploit the shoaling behaviors of these species to find conspecifics and other invasive carp species. The U.S.

Geologic Survey (USGS) has performed telemetry on Silver Carp in Pool 19 of the Mississippi River, an area of low invasive carp density (but not as low as Minnesota habitats). In that study, sometimes more than one tagged fish were present in close proximity and sonar of tagged fish often identified many other large fish in close proximity (Duane Chapman, USGS, personal communication). These are indications that the Judas fish technique would be adaptable to invasive carps.

There are several other studies being conducted in other states to support this tagging effort and better inform managers of the biology of these species and support removal efforts (see Appendix 7 for a summary of other researchers tagging invasive carp in the U.S.). A project currently underway by Dr. James Lamer (Western Illinois University) has shown that tagged Bighead Carp and Silver Carp can be reliably tracked and subsequently netted to increase the number of individuals captured in areas of low abundance. A number of other organizations are also tagging and tracking invasive carp, including the U.S. Fish and Wildlife Service, the Missouri Department of Conservation, and the Michigan Department of Natural Resources. In 2016, the Kentucky Department of Fish and Wildlife will begin tagging and tracking invasive carp. In Pool 19 of the Mississippi River, USGS successfully conducted field work in 2015 using Judas Silver Carp. Several tagging studies have been published from the Illinois River (Peters et al. 2006; DeGrandchamp et al. 2008), and Mississippi River near Lock and Dam 19 (Tripp et al. 2013).

Determination of Sex of Invasive Carp from Blood Samples

November 29 through December 1, 2016 MN DNR personnel traveled to Illinois to work with Western Illinois University researcher Dr. Jim Lamer along with commercial fishermen to track acoustically tagged Silver and Bighead Carp in Pools 17 through 20. In addition to gaining experience tracking tagged invasive carp, MN DNR staff were able to collect 61 blood samples to determine if hormone levels in blood could be used to determine the sex and maturity of fish without lethal analysis. Ten males and ten female Silver and Bighead Carp were collected and nine male and ten female Grass Carp were collected. Approximately 10 ml of blood was drawn for plasma hormone analysis in the field and placed in a Vacutainer tube with heparin. Surgical incisions were made in the field to validate sex and reproductive status of individuals. Blood samples were immediately put on ice and centrifuged within 12 hours. Plasma was extracted from centrifuged samples and plasma was then placed in a deep freezer.

Plasma sex steroids, including estradiol, testosterone, and 11-ketotestosterone, regulate spawning behavior and gonad development in many fish species. Concentrations of these sex steroids follow predictable cycles that have been used to accurately determine sex and reproductive status of many fish species. This research will help determine if estradiol, testosterone, 11-ketotestoreone, and vitellogenin could be used to determine sex and reproductive condition in Silver, Bighead, and Grass Carp. If this proves to be effective, it will also be used to test temporal changes in sex steroid concentrations to identify potential spawning dates.

Analyses of these samples are currently being analyzed by Dr. Joshua Lallaman at St. Mary's University in Winona, MN. Overall differences in mean plasma hormone concentrations between sex and reproductive condition will be tested using a 2-Factor ANOVA and a stepwise-discriminant function analysis will be used to determine if sex and spawning condition could be

correctly classified by hormone concentrations. If this research shows potential for determining sex and maturity, invasive carp caught in Minnesota will also be sampled in this manner for confirmation of this method.

Stable Isotope Analysis of Pool 2 Food Chain

This project is funded by the Environment and Natural Resources Trust Fund for 2 years (2017 and 2018). The purpose of this project is to use stable isotope analysis to examine the aquatic food web within Pool 2 of the Mississippi River and provide baseline trophic data before invasive carp establishment. Any invasive carp caught will be euthanized and processed according to state sampling protocols and a fin clip will be taken to determine trophic niche overlap with native fish to better understand the potential for management of native fish to control the spread of invasive carp and retain biological diversity.

Our goal is to collect 30 samples per species/species group per year for 2 years (2017 and 2018) in lower Pool 2. The sampling area will focus downstream of River Lake and extend to Lock and Dam 2 near Hastings. Samples are planned to be dried (using Cabela's Pro Series Dehydrator), stored in vacuum seal bags, and frozen. Samples will be sent to the University of California-Davis for pre-processing and Carbon (C^{13}) and Nitrogen (N^{15}) analysis.

Baseline samples will be collected from zebra mussels, crayfish, snails, phytoplankton, zooplankton, invertebrates, detritus, leaves, and submerged aquatic vegetation during the summer (May-July). For mussels we will sample zebra mussels, with 30 samples taken per year with sample size depending on the size of individual zebra mussels. Crayfish and snails (dominant species of each) will be collected from hand picking or grab samples with 30 samples collected per year. A 63 micrometer plankton tow net and 500 micrometer plankton trawl net will be used to collect phytoplankton and zooplankton samples. Zooplankton (Cladocerans and Rotifers) will be allowed to evacuate their gut contents in refrigerated water, picked to isolate 30 individuals per sample, and dried. Upon sampling, the 3 most abundant species of primary consumer invertebrates will be dried and analyzed (which will likely include a Scrapper/Shredder (nymph mayfly), a Collector/Gatherer (Chironomid), and a Filter Feeder (nymph caddisfly, Hydropsychid)). In addition, 30 samples will be collected for each of the 3 most abundant predatory invertebrate species. Thirty samples of detritus and leaves will be collected from 5 sites spaced through the sampling season. Submerged aquatic vegetation (curly-leaf pondweed, Eurasian watermilfoil, and Vallisneria) will be collected at 5 sites and the samples will be pooled based on the most abundant species per site. Baseline samples will be collected multiple times per year, May through August, and plankton samples will be split into 4 or 5 distinct samples per field season.

Fish will be collected using a variety of gears with length and weight information collected for all sampled individuals. Fish sampling will focus primarily during the fall (August-October). Predator fish species will include Flathead Catfish, Channel Catfish, Sauger, and Walleye. Prey species will include Gizzard Shad [*both large (individuals 1 year old or older, > 280 mm) and small size individuals (young of the year individuals or < 280 mm)], Emerald Shiners, Bluegill [both large (>80 mm) and small size (< 80 mm) individuals], Silver Redhorse, Shorthead Redhorse, and Freshwater Drum *Aplodinotus grunniens*. Other species analyzed will include any invasive carp (Silver, Bighead, or Grass Carp) and Paddlefish, as well as 30 Common Carp

Bigmouth Buffalo, and Smallmouth Buffalo. Fish, excluding invasive carp, will have a fin clip taken, tagged using an external Floy tag to ensure the same fish are not sampled multiple times over the course of this study, and released alive. For all fish species (except Bluegill, Gizzard Shad, Paddlefish, and invasive carp) individuals sampled will be tallied using length frequency bins to best achieve a wide range of lengths to determine if differences exist in trophic signature among size classes for each species.
**Age-at-length determinations for Gizzard Shad are based on previous research conducted by East Metro Fisheries staff.*

Estimated Timeline:

Activity	**Time Period**	**Sampling**		**Effort**
		Events	**Days**	
Gill/Trammel Netting	March - November	20	10	10,000 feet of net
Electrofishing	May - September	48	20	1,000 minutes
Mini-Fyke/Trap Netting	June - September	40	8	40 net nights
Seine	June - September	20	4	20 seine hauls
Larval Trawling	May - July	150	15	300 pushes
Commercial Seining	Year round	5	5	5 seine hauls
Commercial Gill Netting	Year round	7	7	50,000 feet of net
Stable Isotope Samples	August - October	Varies	Varies	600 samples
Carp Tracking	Year round	Varies	Varies	unknown

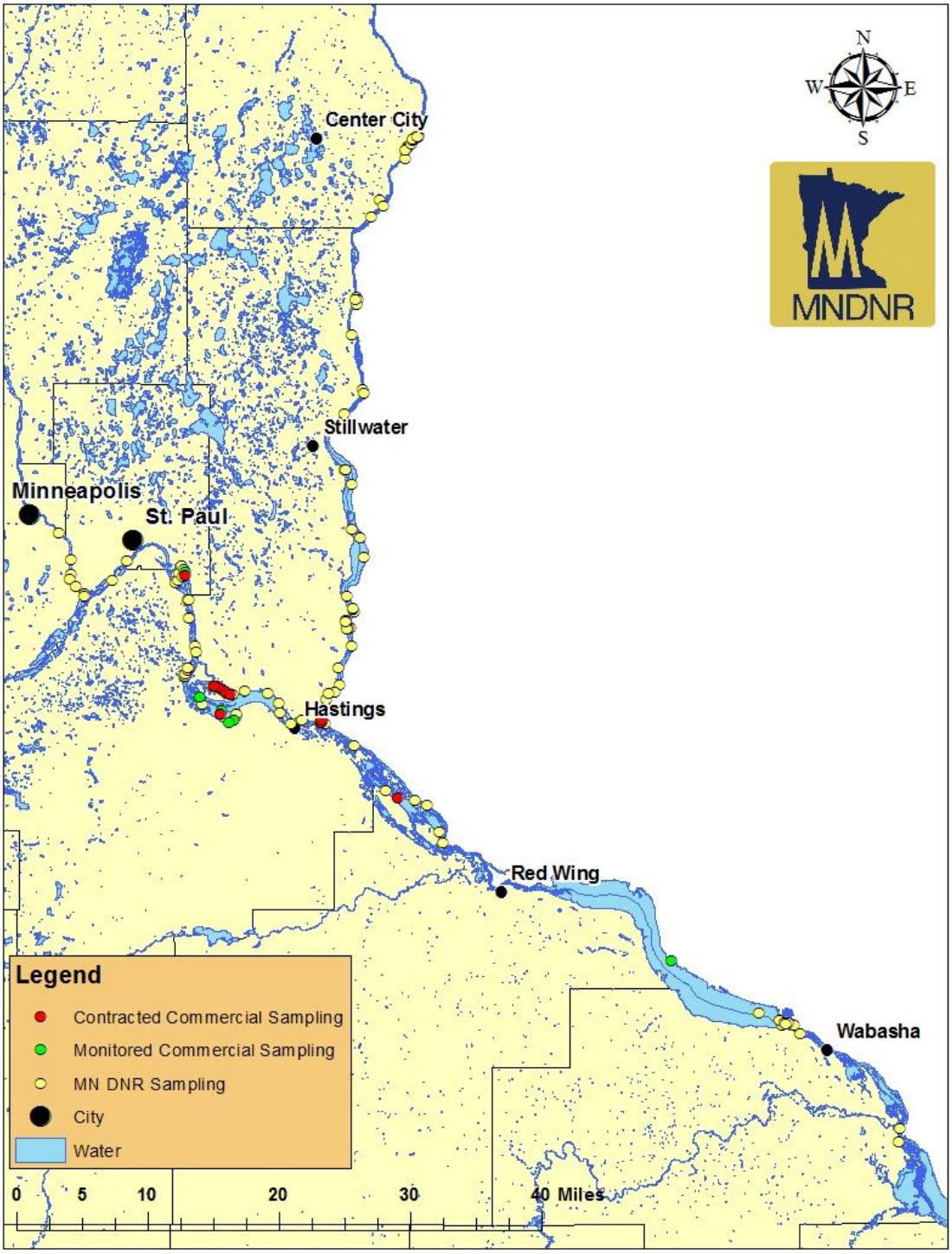

Figure 23. Minnesota DNR 2017 invasive carp sampling area. Map depicts 2016 sampling locations which will be similar in 2017

Agency: Iowa State University

Project Title: Upper Mississippi River Monitoring Program

Objectives:

1. Delineate geographic boundaries of the various stages (reproduction, recruitment, adults) of invasion and monitor invasive carp population changes at the presence front.

Project Activities, Methods, and Timetable:
Previous work at Iowa State University suggests that fall electrofishing provides the best representative sample (largest size distribution and high catch rates) for adult Asian carp. Thus, adult and juvenile Asian carp will be sampled once per year during fall 2016 at each of eight sites (Figure 1) using pulsed DC boat electrofishing. Fish will be identified as a Silver, Bighead, or Silver x Bighead Carp hybrid using meristic and morphometric features (Kolar et al. 2007), weighed (0.001 kg), measured (total length; 1 mm), and lapilli otoliths will be removed for age estimation and potential microchemistry analysis. Gender will be determined based on visual inspection of gonads (male, female, juvenile, or unknown).

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

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

Estimated Timetable: Larval sampling will take place once every two weeks May – August 2018. Adult Asian carp sampling will occur once at each site during September or October 2018. Data processing (e.g., egg and larval sorting and identification, fish aging, and data analysis) will occur during the fall and winter months.

Project Activity	Pool	Month	Year
Egg and larval sampling	14-20	May-August	2018
Adult sampling	14-20	September-November	2018

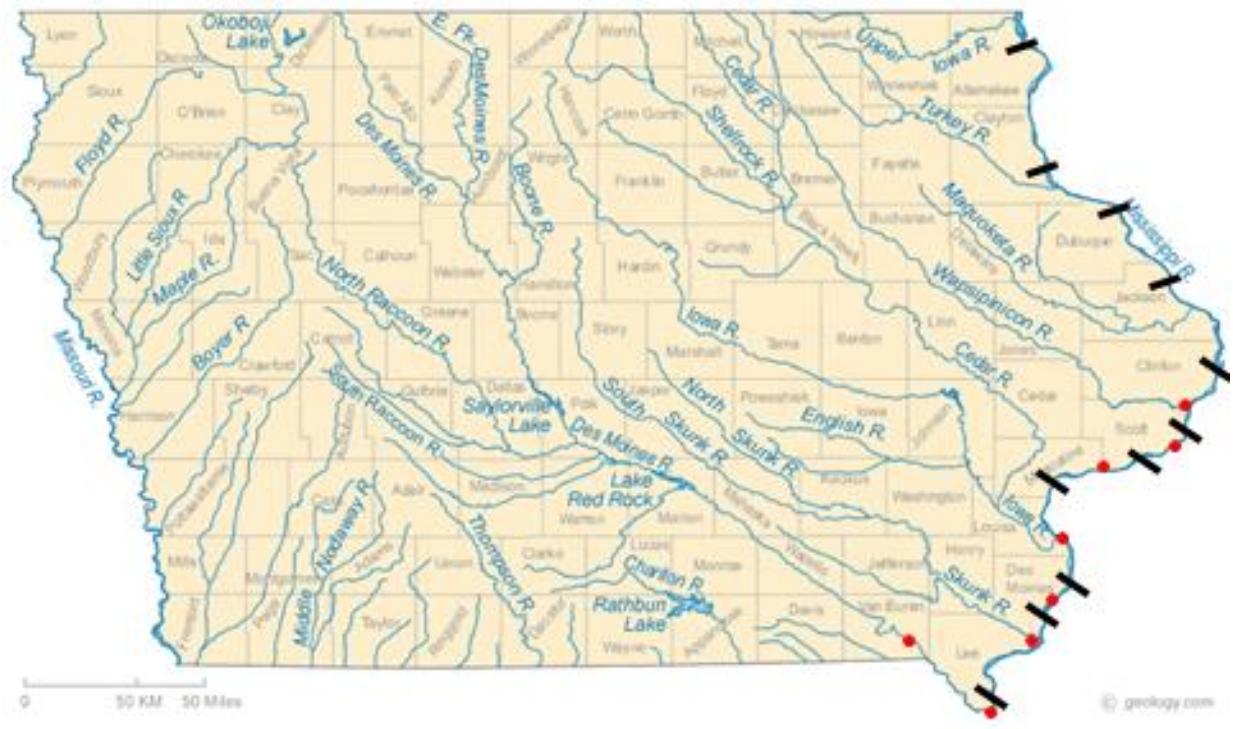

Figure 24. Map depicting approximate eight locations where Asian carp will be sampled at the mouths of the Wapsipinicon, Rock (Illinois), Iowa, Skunk, and Des Moines rivers (red points), in pools 18 and 16, and a site in the Des Moines River. Possible Iowa DNR sampling site at the mouth of the Maquoketa River (blue square). Approximate locations of locks and dams depicted with black lines.

Agency: Western Illinois University (ILDNR)

Project Title: Upper Mississippi River Monitoring Program

Objective:

1. Annually delineate geographic boundaries of the various stages (reproduction, recruitment, adults) of invasion and monitor invasive carp population changes at the presence front.

Project Activities, Methods, and Timetable:
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. 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. A need exists to comprehensively monitor for larval Asian carp in pools 17, 18 and 19 to detect and quantify larval Asian carp establishment in the established front. Monitoring Asian carp reproduction and the detection of larval Asian carp will be imperative for informing the best management practices in the UMR above LD19.

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

Data and results will be summarized for an annual interim report. Non-target bycatch will be identified to family and the synchrony of emergence will be reported for native and Asian carp species. Number and location of Asian carp capture will be reported to the UMR partnership and summarized and reported for quarterly and final reports.

Estimated Timetable:
Use larval light traps in pool 17, 18, and 19 backwaters to monitor for the presence of larval Asian carp: May 22, 2017 -September 31, 2017.

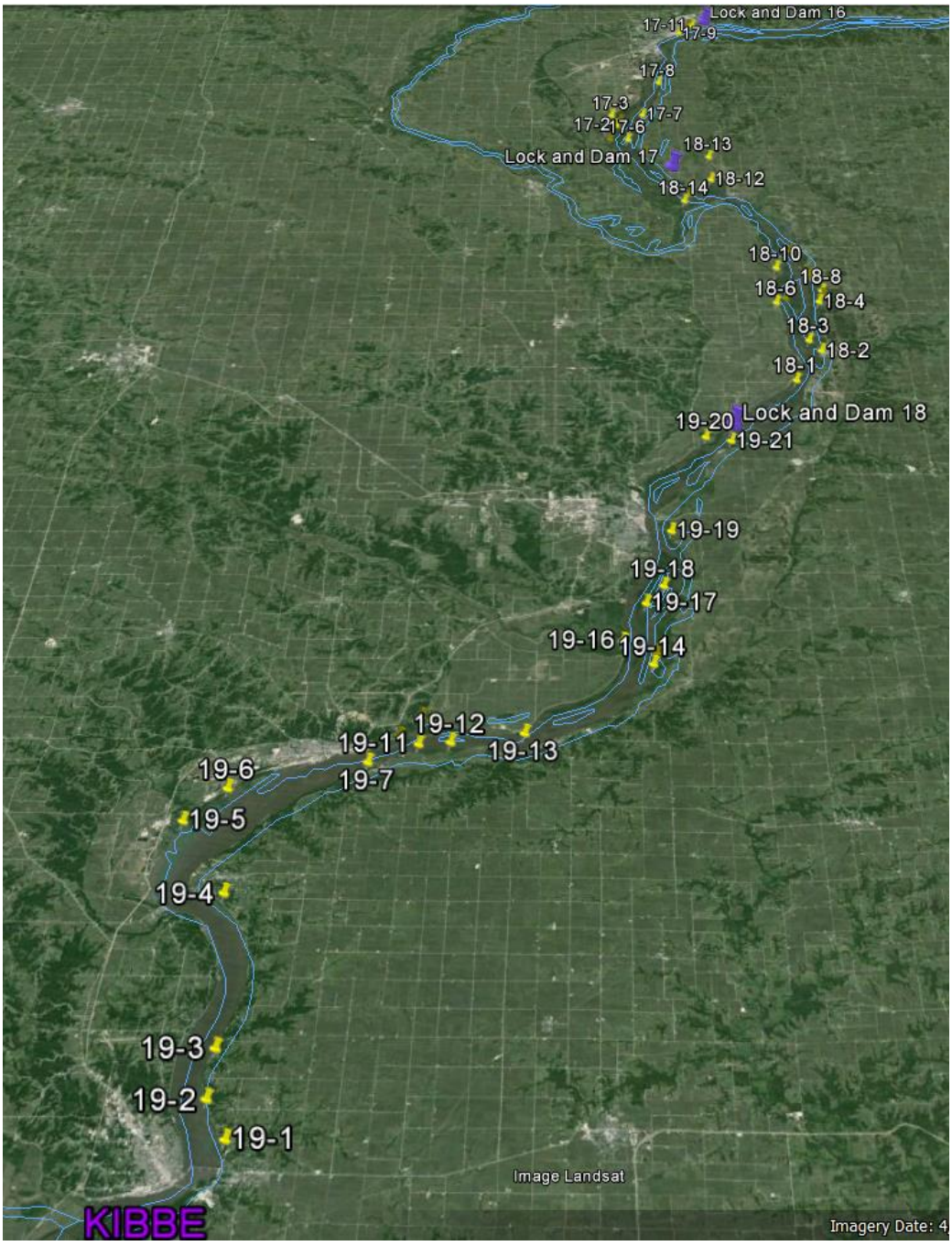

Figure 25. Larval light trap sampling locations in three pools of the Upper Mississippi River (17, 18 and 19).

Project Title: Collaborative strategy for deterrent barrier research, design, implementation, and assessment to minimize the spread of Asian carps in the Upper Mississippi River

Lead Agency: USFWS

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

Statement of Need:
Invasive carps are established in the upper, middle, and lower Mississippi River and their expansion upstream threatens a variety of aquatic ecosystem services including fishing and recreational boating. The upper Mississippi River contains a series of locks and dams that may already limit upstream movement of invasive carp, and thus their spread, by limiting population growth at the reproductive front and minimizing pioneer fish from moving upstream in the system. If severe enough, passage restrictions might hinder reproductive success of invasive carp at the reproductive front because of their requisite migratory and mass spawning behavior, and drifting egg and larval life stages.

At the time of this writing, a collaborative deterrent strategy for the UMR is in the final stages of review. This document defines an intensive management zone (IMZ) in the Upper Mississippi River that includes an area from lock and dam 19 to lock and dam 14, bracketing the invasion front of Asian carp in the UMR. In concept, the IMZ would be bracketed by effective barriers to Asian carp passage at the upper and lower ends and intensive efforts to reduce Asian carp abundance in between. The goal of this project is to pursue and expand on the recommendations in the UMR deterrent strategy report including 1) identifying the steps necessary to deploy deterrents, 2) implementing and evaluating the use of promising deterrent technologies 3) evaluating the utility of operational modifications at locks and dams 4) maximizing native fish passage. Important information gaps and research needs regarding fish passage, fish distribution and movement around dams, dam design and hydrology, deterrent design and effectiveness, and gate operations should be filled as preliminary implementation steps begin.

The USFWS received additional funding in FY2017 to be used specifically to test a sound deterrent in the presence of high densities of Asian carp with the goal of identifying a mechanism for preventing upstream passage of Asian carp through lock chambers. One method for assessing the effectiveness of fish deterrents is using acoustic telemetry to assess fish passage rates. Fish passage through locks and dams on the UMR has been studied for many years. Specifically, the study of Asian carp and native fish passage is ongoing at lock and dam 19 and in other locations. As deterrence planning is underway, the UMR Asian carp partnership added an objective to this project to expand and focus telemetry efforts on fish passage rates at key locations identified in the UMR deterrent strategy and targeted by ongoing deterrence planning.

Multiple agencies are involved in ongoing research of the utility of deterrence technologies and their potential in limiting the distribution of Asian carp in the UMR:

<u>Minnesota</u>
- University of Minnesota – Twin Cities

    - Model the effect of gate operations on fish passage at Lock and Dam 5
    - Continue field evaluation of gate flow modeling at Lock and Dam 2 and acoustic speakers at Lock and Dam 8. This work is on contract with the MN DNR.
- University of Minnesota – Duluth
    - Continue research on complex noise technology
- Minnesota State – Mankato
    - Complete analysis of data collected as identified with MN DNR contract.
    - Final report due in December 2017.
    - Project looks as geomorphological characteristics and habitat suitability in order to aid in deterrent strategy decisions on the Minnesota River.
- Minnesota River Watershed
    - Construct an electric barrier to protect Madison/Eagle Lakes system
    - Construct an electric barrier to protect Elysian/Buffalo Lakes system
- Continue telemetry project to understand riverine fish movements
- The MN DNR will be issuing a RFP for a feasibility study at Lock and Dam 5
    - Compile the current state of knowledge of the complex noise technology
    - An accounting of all costs associated with construction, operation, and maintenance
    - An accounting of all technical problems and equipment failures associated with existing projects
    - Pre-engineering data to inform potential design work
    - A synopsis of US Army Corps of Engineers requirements and support and Wisconsin support
    - An assessment and recommendations on the suitability and effectiveness of deterrent technologies at proposed site

<u>Missouri</u>

- Continue to quantify native and non-native fish passage at Lock and Dam 19 in the Upper Mississippi River using telemetry (MDC)
    - Maintain VR2 array
    - Manual Track Pool 20 once per month
    - Re-implant transmitters on harvested fish if necessary

<u>USFWS</u>

- In collaboration with USGS, evaluate approach channel and lock use by Invasive carp and native species at LD 14, 15 and 19 with telemetry, hydroacoustic technologies and traditional gears
- A final report on the ARIS study of fish use in Lock 19 will be completed in FY17.
- Two week-long pilot sampling events will be conducted in 2017 to gather behavior, movement, and community data of fish at Lock 14 and 15 using the ARIS camera and traditional gears during the time frame Asian carp will most likely seek passage through lock structures.
- Electrofishing and/or gill net surveys will be conducted within the lock chambers and in the approach directly downstream of the locks to gain a general knowledge of the fish community using those areas.

- Develop a more robust pre-deterrent sampling plan for 2018, which will be necessary to fully evaluate the effects of deterrent implementation in the future.

USACoE

- In collaboration with USGS and others, conduct or support studies at strategic locations to better understand how to deploy deterrents at lock chambers to deter Invasive carp while minimizing effects to native species.

USGS

- Complete report on Invasive carp passage through locks and dams in UMR (Telemetry USFWS_USGS)
- Complete report on recruitment sources for adult Invasive carp captured in Pools 19 and 20 (Otolith microchemistry USGS_SIU_MDC)
- Continue study of recruitment sources for Invasive carp in the emerging population between LD15 and LD19 (Otolith microchemistry USGS_WIU_SIU)
- In collaboration with USFWS, evaluate approach channel and lock use, and dam passage by Invasive carp and native species at LD 14, 15 and 19 with telemetry, hydroacoustic technologies and traditional gears
- In collaboration with USACOE, update analysis of open river conditions at UMR dams using hydrological data from 1996 to present.
- In collaboration with USACOE and others, conduct studies at strategic locations to better understand how to deploy deterrents at lock chambers to deter Invasive carp while minimizing effects to native species.

Project Goals and Objectives:

National Plan Goal Supported:

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

- Strategy 3.6.3 Develop effective methods to contain Asian carp populations and prevent their further spread.

Sub-basin Management Plan Goal Supported:
Containment
Research

Project Objectives:

1. Evaluate promising technologies and strategic locations, and complete UMR deterrent strategy report
2. Participate in regional workshops and webinars to better understand the state-of-the-science on and steps needed to test and deploy deterrent technologies at locks and dams
3. Support ongoing efforts to better understand the application of deterrents in lock chambers for invasive carp while minimizing effects on natives in the UMR
    a. Support efforts to test CO2 application at strategic locations in the UMR
    b. Support development of plans to test complex sound applications at strategic locations in the UMR
4. Quantify native and non-native fish passage at lock and dam 19, 15, and 14 as an assessment tool for the future testing of Asian carp deterrents.

Agencies: Minnesota DNR, Wisconsin DNR, USACE, USFWS, USGS

Project Title: Collaborative strategy for deterrent barrier research, design, implementation, and assessment to minimize the spread of Asian carps in the Upper Mississippi River

Objectives:

1 Evaluate promising technologies and strategic locations, and complete UMR deterrent strategy report
2 Participate in regional workshops and webinars to better understand the state-of-the-science on and steps needed to test and deploy deterrent technologies at locks and dams
3 Support ongoing efforts to better understand the application of deterrents in lock chambers for invasive carp while minimizing effects on natives in the UMR
    a. Support efforts to test CO2 application at strategic locations in the UMR
    b. Support development of plans to test complex sound applications at strategic locations in the UMR

Project Activities, Methods and Timetable:

Participant agencies will continue the development and implementation plan for the UMR deterrent strategy. Specific tasks include:

- Complete final report on a deterrent strategy for the UMR
- Participate in regional workshops and webinars to better understand the state-of-the-science on and steps needed to prepare for and deploy deterrent technologies at locks and dams
- Begin implementing steps, as identified at regional workshops and webinars, and approved by management authorities, needed to deploy deterrent technologies at strategic locks and dams
- In collaboration, conduct or support studies at strategic locations to better understand how to deploy deterrents at lock chambers to deter Invasive carp while minimizing effects to native species.

Estimated Timetable

Project Activity	Pool	Month	Year
Strategy Meeting #1	UMR	September	2017
Strategy Meeting #2	UMR	October	2017
Strategy Meeting #3	UMR	November	2017

Agency: Western Illinois University

Project Title: Collaborative strategy for deterrent barrier research, design, implementation, and assessment to minimize the spread of Asian carps in the Upper Mississippi River

Objectives:

4. Quantify native and non-native fish passage at lock and dam 19, 15, and 14 as an assessment tool for the future testing of Asian carp deterrents.

Project Activities, Methods, and Timetable:
Asian carp are present in varying abundance in the Upper Mississippi River. Their establishment has been initially slowed by restricted passage at Lock and Dam 19, where all upstream movement is confined to the lock chamber, and further upstream establishment above Pool 16 has been hindered by the infrequent open river conditions at Lock and Dams 15, and 14. The lack of or infrequent open river conditions at these pinch points make them candidates for Asian carp deterrents to impede further upstream establishment of Asian carp in the UMR. However, before the implementation of invasive species deterrent strategies, it is important to consider the longitudinal connectivity and passage of native fishes and the ability of Asian carp to pass through these locks and dams. Despite ongoing efforts to understand dam passage by both native fishes and introduced Asian carps in the UMR, additional effort is critical to assess the effect of deterrents on these communities. Passage of paddlefish and Asian carp, highly mobile and migratory fish species that often experience habitat overlap,will be evaluated through Lock and dams 14, 15, and 19 in the UMR.

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

Interest in paddlefish as a species of conservation need is ongoing. Their value to commercial fishers has led some states to limit harvest, and their capacity for long range movements across management jurisdictions has led to a call for management at the regional scale. An ongoing study by the Missouri Department of Conservation includes assessing Paddlefish passage at lock and dam 19 on the UMR. This project will expand those efforts by contributing additional acoustic tags for paddlefish tagging below lock and dam 19 and expanding the range of the study to include lock and dam 14 and 15. Continued focus on paddlefish as an assessment of native fish passage is warranted due to the aforementioned potential for long distance movements (allowing evaluation of several passage events at several dams), their habitat overlap with Asian carp, and their large size, which minimizes the effect of tag weight on the swimming ability and behavior of the fish.

The use of paddlefish to assess fish passage at Lock and Dams 14 and 15 and Asian carp at Lock and Dam 19 will serve a dual purpose. First, pre-deterrent data will inform the partnership to the frequency that native fish are able to make successful passage and identify the abiotic and biotic factors that contribute or hinder successful passage. Secondly, given the long battery life (5+ years) of these tags and the potential addition of tags in the future, these fish and support network can potentially also be used to evaluate the effects that deterrents have on native fish passage. Asian carp species and native surrogates (paddlefish) will be used to assess dam passage at LD 19, LD 15, and LD 14. Adult paddlefish will be acoustically tracked to determine the frequency of dam passage and environmental conditions associated with passage. Adult Bighead carp and Silver carp (n=100) will be acoustically tagged to add to the existing Asian carp tagged in Pool 20 by MDC and evaluation will be consistent with current MDC efforts. Asian carp will be predominantly tagged by MDC with effort by WIU and ISU as needed. Additional paddlefish will be tagged by MDC in 2017 and 2018 to evaluate passage at LD19 using tags as part of a previous project. Adult paddlefish for the study will be netted as bycatch from contracted Asian Carp removal efforts and targeted with 5" bar mesh gill nets by WIU biologists. A total of 100 paddlefish will be surgically implanted with acoustic transmitters operating at the same frequency and ping duration as existing tags in this stretch of the river. We will be evaluating two major pinch points to fish passage in the UMR to determine the frequency that fish are able to travel upstream and downstream through the dam and what conditions are necessary to facilitate this passage. Therefore, we will tag paddlefish in 2 locations to assess their ability to traverse these three pinch points. Paddlefish (n=50) will be implanted with tags in Pool 16 just below Lock and Dam 15 (second pinch point) after targeting in areas of known aggregation (Credit Island, Lake Potter, tailwater, etc.) and 50 fish will be tagged in Pool 15 to assess passage through Lock and Dam 14 (third pinch point) in suspected areas of aggregation (above dam, wing dams). Fork length, weight, fin clip, location, date and time of capture will be recorded for each fish and most tagging will be completed in the summer/fall of 2017 and finished in the spring of 2018 if necessary. Paddlefish implanted with an acoustic tag will also receive a jaw tag to signify a recapture and prompt quick return to the water or excision of the tag if recovered from a dead fish. The high mobility and migratory nature of paddlefish make them an ideal candidate for movement and detection of dam passage and creates a large sample size as a whole for evaluation across the small, semi-continuous spatial scale of this study for this species.

Acoustically tagged fish will be manually tracked weekly along pre-determined grids within the study reach. Importantly, the extensive VR2W network maintained by the FWS- La Crosse, USGS, MDC, and MNDNR will be leveraged to evaluate use of the lock approach channels at Lock and Dam 19 and Lock and Dam 15, to evaluate passage at all dams detected by receivers above and below each dam, and also assess lateral movements to quantify backwater and tributary habitat use. In close collaboration with these agencies, data sharing will be necessary and coordinated to establish home range, quantify the frequency and timing of dam passage on Lock and Dams 16-20, and determine habitat use.

Estimated Timetable:

Project Activity	Pool	Month	Year
tagging	20, 16, 15	Sept., Oct., Nov.	2017
tagging	As needed	spring	2018

Manual tracking	Entire study reach	weekly	2017-2018
Receiver downloads	All locations	Varies by location: bi-monthly at minimum	2017-2018

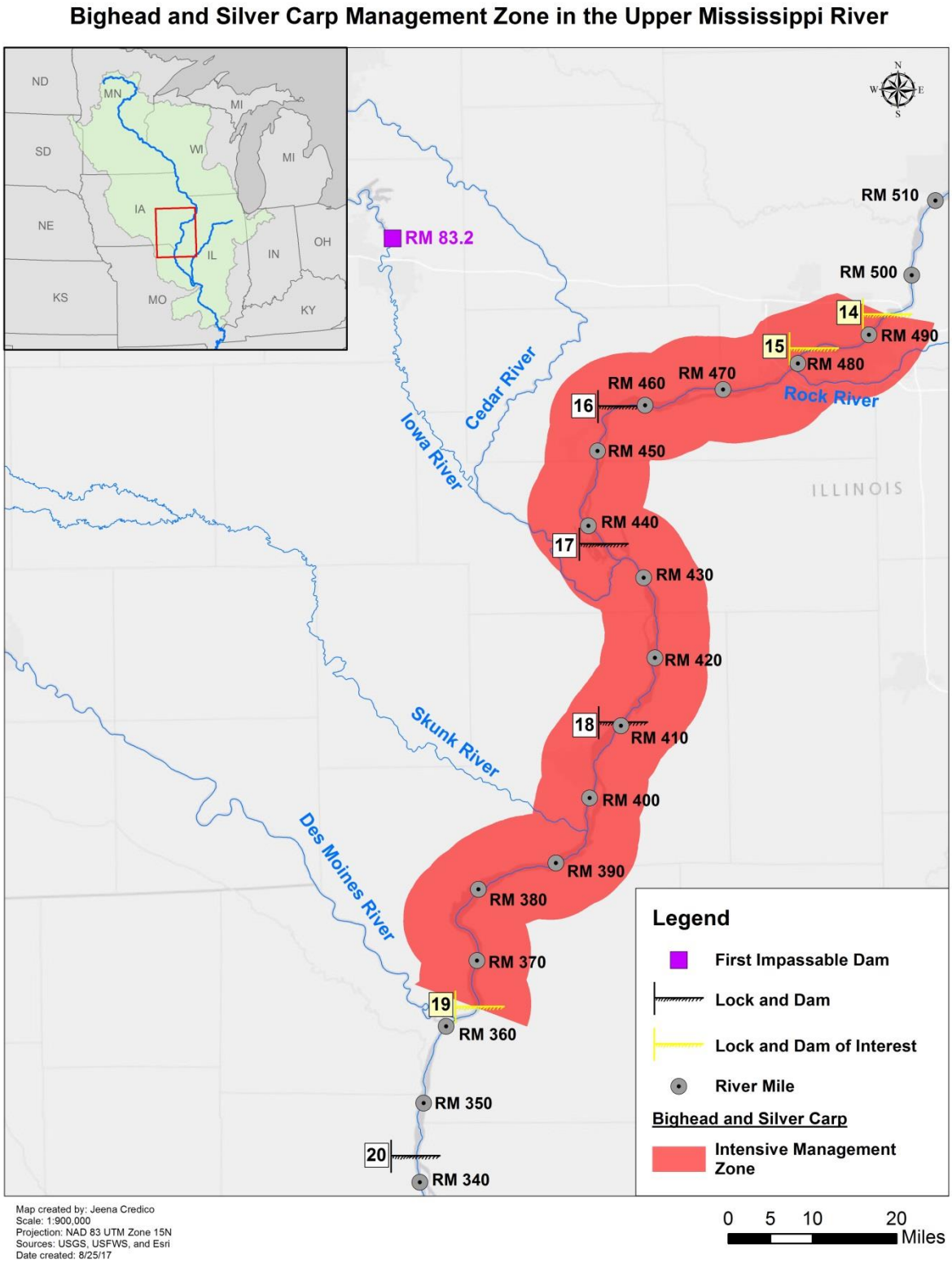

Figure 26. Management zone for Bighead and Silver Carp in the UMR as identified by the deterrent team.

Project Title: Contract Fishing for Asian Carp Detection and Removal

Geographic Location: Upper Mississippi River

Lead Agency: Illinois DNR (Western Illinois University)

Agency Collaboration: Iowa DNR, FWS, USGS, MDC, MN DNR, WI DNR

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

Asian carp will be individually jaw-tagged to estimate population estimates above LD19. Initial population estimates will be obtained by intensively sampling, marking with unique identifier jaw tags, and then releasing Asian carp back into the system during the initial 1-2 weeks of commercial capture. Program MARK will be used to estimate population size as a function of recaptured (without replacement) versus initially marked and untagged individuals after weeks 1-2 above LD19. Population estimates and exploitation rates are needed to assess the

efficiency and effectiveness of Asian carp sampling and removal efforts above LD19. Initial estimates will set future benchmarks for removal and determine the effectiveness of harvest on an annual basis as part of an adaptive strategy.

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

Project Goals and Objectives:

National Plan Goal Supported:

- Goal 3. Extirpate, or reduce to levels of insignificant effect, 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 populations of Asian carps.

Project Objectives:

1. To fish and remove Asian carp populations (guided by fishermen knowledge and telemetry efforts) in Pools 16-19 of the Upper Mississippi River using contracted commercial fishers to reduce Asian carp populations in the management zone while reducing reproductive potential and density pressure on upstream pinch points (Lock and Dams 15,14) throughout the year.
2. To intensively target backwaters in Pools 14-19 for Asian carp removal by contracted commercial fishers during periods of peak backwater aggregation for 4 weeks in March and April, 2018
3. To jaw-tag Asian carp in Pools 17-19 to establish annual population estimates and gage effectiveness of harvest at reducing populations and allow for the long term determination of survival probability within the management zone.

Agency: Illinois DNR (Western Illinois University)

Project Title: Contract Fishing for Asian Carp Detection and Removal

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

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

All fish removed throughout the study will be transported daily to Gregg Hochderffer (Sioux Falls, SD) or Shafer Fisheries (Fort Madison, IA) where all fish will be iced down in large totes and used as fertilizer. 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 Gregg Hochderffer (Sioux Falls, SD) 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: Following the initial four weeks of capturing, tagging, and releasing Asian carp in pools 17-19, two contracted commercial fishing crews will operate for a total of 17 weeks in pools 14-19 for targeted removal of Asian carps. Targeted removal efforts will alternate between pools, with approximately 15 of the 17 weeks of effort split between pools 17-19 (pool 17 = 4 weeks, pool 18 = 4 weeks, pool 19 = 7 weeks). Two weeks of effort will be devoted to pools 14-16, where Asian carp are present but not in high enough densities to effectively target large numbers of Asian carp.

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

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

Length and weight will be recorded from each Asian carp prior to being sacrificed; individual jaw tag numbers will be recorded for all recaptured Asian carp. Non-target bycatch will be identified to species, enumerated, and condition recorded (i.e. healthy, moribund, dead) prior to release. All non-native species, other than Asian carp species, will be removed and transported to Gregg Hochderffer (Sioux Falls, SD) or Shafer Fisheries (Fort Madison, IA) for use as liquid fertilizer

Objective 3: Three additional fishing crews will fish and remove Asian carp for a 4 week period in March and April in Pools 14-19 (time period of high density Asian carp backwater aggregation).

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

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

Estimated Timetable

Objective l. Targeted removal of Asian carp species in UMR pools 14-20 using commercial fishers and intensive netting protocols-(July I, 2017 -June 30, 2018)

Objective 2: Determine Asian carp population abundance through intense targeted sampling above LD19 in the UMR (July l, 2017-July 31,2017)

Objective 3: Use larval light traps in pool I 7, I 8, and 19 backwaters to monitor for the presence of larval Asian carp. (May 22, 2017 -September 31, 2017).

Objective 4: Acoustically tag and monitor 100 paddlefish and 100 Asian carp species in the fall of 2017 to assess frequency and timing offish passage at Lock and Dam 15 and 16 (paddlefish), and Lock and Dam 19 (Asian carp). (July 1, 2017-June 30, 2018).

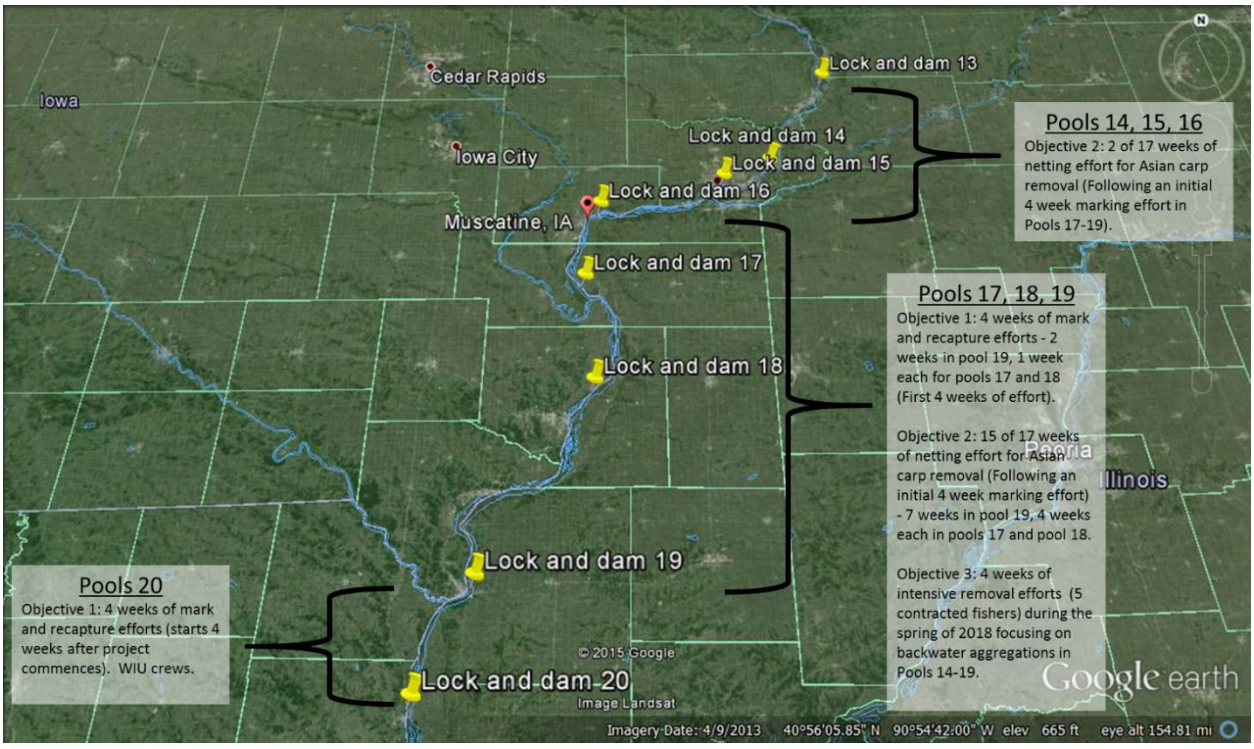

Figure 27. Project area map for the Contract Fishing for Asian Carp Detection and Removal project.

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

Ohio River

Project Title: Hydroacoustic survey of bighead and silver carp in the Ohio River

Geographic Location: Each pool of the Ohio River from Cannelton to RC Byrd

Lead Agency: US Fish and Wildlife Service-Carterville FWCO (USFWS)

Participating Agencies: Kentucky Department of Fish and Wildlife Resources (KDFWR)

Statement of Need:

Bighead (*Hypophthalmichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*) are a management priority in the Ohio River. In order to use resources most efficiently, control and containment measures should target locations and sizes of fish that will provide the greatest return. We can make predictions about the effectiveness of management using the current status of populations of invasive and native fishes and population dynamics. Population modeling can test all proposed combinations of management in a short amount of time, with minimal cost and risk. However, we do not have the data that are necessary to evaluate the effectiveness of management (both simulated and actual).

We will use hydroacoustic surveys to obtain data on the relative abundance, size distribution, spatial distribution, and biomass of bighead and silver carp in the Ohio River. Bighead and silver carp are difficult to sample with traditional gears due to their use of a wide variety of habitat types across a large spatial scale, and their differing susceptibility to capture across species and gears (MacNamara et al. 2016). Hydroacoustics may be able to sample these species with less bias, providing a more accurate representation of relative population characteristics among pools.

Project Objectives:

Estimate characteristics of bighead and silver carp populations in each sampled pool, including:

1. Relative abundance
2. Size distribution
3. Spatial distribution
4. Biomass

Project Activities, Methods, and Timetable:

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 six pools of the Ohio River (Cannelton, McAlpine, Markland, Greenup, Meldahl, and R.C. Byrd). Hydroacoustics 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 (Figure 1). Surveys will be conducted

in the main channel and any tributaries within the sampling site. Transects will be run parallel to the shoreline, in number and spacing sufficient to cover the entire width of the channel. Prior to each survey, each transducer will be calibrated on-axis following Foote et al. (1987).

Hydroacoustics data will be analyzed following MacNamara et al. (2016) using Echoview 7.0. 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 overcounting fish targets. 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).

Species-specific information cannot be determined from single-frequency hydroacoustics data. Therefore, our hydroacoustics data will be informed by pool-specific fish community data that KDFWR will collect at each sampling site using traditional fisheries gears. Specifically, pool-specific proportion 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. Density (numeric and mass) will be estimated following MacNamara et al. (2016).

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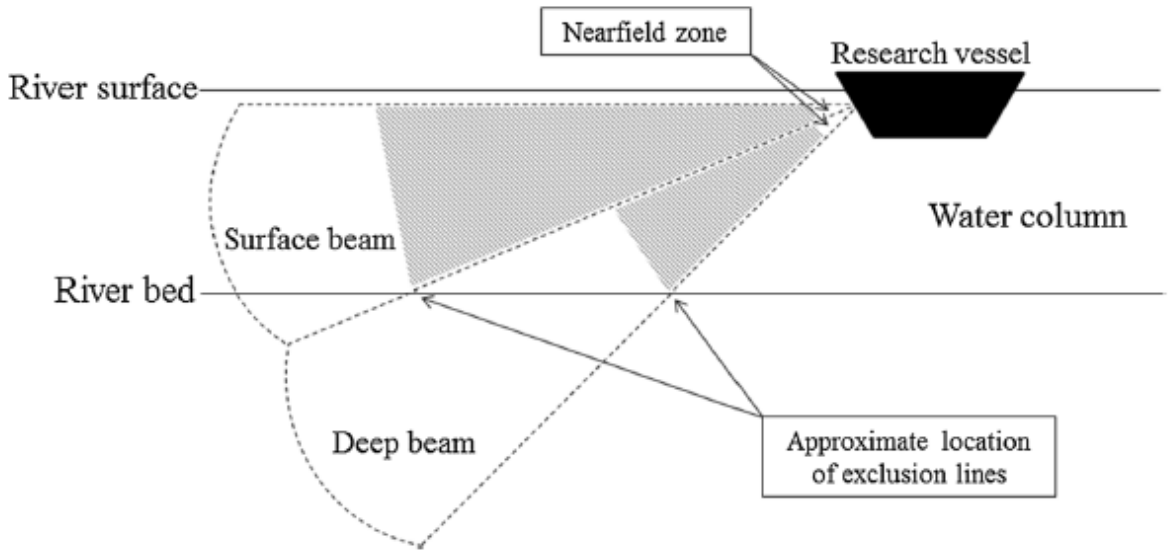

Figure 1. Conceptual overview of the orientation of two side-looking split-beam hydroacoustics transducers with effective beam angles offset to maximize water column coverage (adapted from MacNamara et al. 2016). The gray shaded area of the acoustic beams between the near-field and bottom exclusion lines indicate the area in which acoustic targets can be detected.

Project Title: eDNA Monitoring in the Ohio River Basin

Geographic Location: Muskingum River, mainstem Ohio and Tennessee Rivers, and important tributaries in the upper Ohio River. See sampling schedule for greater detail.

Lead Agency: USFWS

Agency Collaboration: Pennsylvania Fish and Boat Commission, West Virginia Department of Natural Resources, Kentucky Department of Fish and Wildlife Resources, Ohio Department of Natural Resources, Alabama Department of Conservation and Natural Resources, Mississippi Department of Wildlife, Fisheries, and Parks, Tennessee Wildlife Resources Agency

Project Objectives:

1. Determine whether Asian carp DNA is present in strategic locations in the Ohio River Basin to inform status of Asian carp

2. Detect Asian carp DNA in areas that have been monitored since 2009 to maintain annual data collection which may inform future work in the Ohio River Basin

Project Activities, Methods, and Timetable:

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

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

eDNA has not been predesignated to be used as a trigger for rapid response actions. eDNA results will be communicated to the states in which they are collected as soon as they are available, and then posted on the USFWS eDNA webpage per USFWS communication protocol. States can request follow up eDNA sampling, and take actions based on their results at their discretion, potentially enlisting the assistance of the USFWS. A summary of all 2017 eDNA results will be made available at the end of the year.

Expected Timetable:
Site description, dates, and number of samples to be taken in the Ohio River Basin in 2017. Additional sites may be sampled for follow up at the request of state partners.

Tennessee River System- week of 3 April 2017

Bay Springs Lake	(n=50)
Wilson Tailwaters	(n=50)
Wheeler Tailwaters	(n=50)
Elk River	(n=25)
Guntersville Tailwaters	(n=50)
Nickajack Tailwaters	(n=30)
Nickajack Lake (Mullen's Creek)	(n=20)
Chickamuga Tailwaters	(n=50)
Watts Bar Tailwaters	(n=50)

Muskingum River System- week of 17 April 2017

Muskingum River	(n=125)
Tuscarawas River	
Killbuck Creek	

West Virginia Waters- week of 1 May 2017

Willow Island Pool	(n=100)
Little Kanawha River	(n=50)
Kanawha River	(n=100)

Upper Ohio River and Tributaries- week of 16 May 2017

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

Project Title: Black Carp Monitoring and Specimen Analysis

Geographic Location: Waters within and surrounding the current known range of black carp, including the Middle and Upper Mississippi River, Illinois River, Missouri River, Ohio River, Wabash River, and others.

Lead Agency: US Fish and Wildlife Service, Region 3

Agency Collaboration: Southern Illinois University, Missouri Department of Conservation, USGS Columbia Environmental Research Center, US Army Corps of Engineers-Engineer Research and Development Center, Kentucky Department of Fish and Wildlife Resources, Illinois Department of Natural Resources, Minnesota Department of Natural Resources

Statement of Need:

Black carp (*Mylopharyngodon piceus*) are the most recently-introduced of the 4 species of Asian carp. Black carp were first released in the United States in 1994, during a flood at a Missouri aquaculture farm (Nico et al. 2005). Their current known range includes parts of the Mississippi, Illinois, Missouri, Kaskaskia, and Cache Rivers (Nico and Neilson 2017). Black carp captures are being reported more frequently, with more reported in the past year than in any previous year (Nico and Neilson 2017). MDC also found young-of-year black carp in an agricultural ditch near Cape Girardeau, MO last year, the first evidence of reproduction in US waters (Davis 2016). Black carp are molluscivores, and therefore their spread may pose a threat to native freshwater mussel and snail communities.

Little is known about the biology, actual impacts, or range of black carp. This project accelerates the research on black carp in an attempt to obtain pertinent information before further spread occurs. The project coordinates work by the U.S. Fish and Wildlife Service (FWS), the Missouri Department of Conservation (MDC), Southern Illinois University (SIU), the U.S. Geological Survey (USGS), and the U.S. Army Corps of Engineers' Engineer Research and Development Center (ERDC), with the assistance of the Kentucky Department of Fish and Wildlife Resources (KDFWR), the Illinois Department of Natural Resources (IDNR) and the Minnesota Department of Natural Resources (MNDNR).

Objectives:

1. Estimate current range of black carp
2. Monitor future spread of black carp
3. Determine best methods and habitats for capturing black carp
4. Collect specimens for morphometric, genetic, ploidy, microchemistry, fecundity, and diet analysis

Project Activities, Methods, and Timetable:

MDC, SIU, and USFWS will use multiple gear types including hoop nets, gill nets, and electrofishing to sample for black carp along the leading edge of their invasion front. MDC will sample Missouri waters, SIU will cover Illinois waters, and USFWS will cover the Ohio River and tributaries. Each group will record similar data on methods and conditions so that results may be consolidated for a final report. The data will be used to estimate the current range of

black carp, establish sampling sites to monitor future spread of black carp, and to determine suitable methods and conditions for capturing black carp.

Black carp specimens will be obtained via the multi-agency sampling effort, contracted commercial fishing, and voluntary reporting by the public for use in multiple analyses. A $100 bounty for each black carp, provided by IDNR and administered by SIU, will continue to be offered in 2017. Carcasses will be sent to USGS-Columbia for diet, morphometric, and fecundity analysis. Diet analysis may be useful for determining which mollusk species and waters are most at risk from black carp invasion. Morphometric analysis will help identify characteristics that reliably distinguish black carp from grass carp (*Ctenopharyngodon idella*), which are very similar in appearance. Age-at-maturity and annual timing of spawning can be obtained from fecundity/maturity analysis. Eyeballs and/or blood or tissue samples will be sent to the USFWS-La Crosse Fish Health Center and ERDC for ploidy and genetic analysis. An eDNA marker has been developed for black carp but has not been verified in the field; genetic samples may be used for developing sampling protocols or additional markers. Otoliths will be sent to SIU for microchemistry analysis.

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Nico, L.G., and M.E. Neilson. 2017. *Mylopharyngodon piceus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. https://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=573 Revision Date: 7/21/2016

Project Title: Diel sampling of Asian carp in Kentucky Lake and Lake Barkley

Lead Agency: USGS-CERC

Participating Agencies: US Fish and Wildlife Service, Columbia Fish and Wildlife Conservation Office, Kentucky Department of Fish & Wildlife, Tennessee Cooperative Fisheries Research Unit, and Murray State University

Statement of Need:
Kentucky Lake and Lake Barkley are large run-of-the-river reservoirs located on the lower Tennessee River and lower Cumberland River, respectfully. These two reservoirs serve as a major economic and recreational resource for the state of Kentucky due to their abundant populations of sportfish including paddlefish, black bass, blue catfish, white bass, and panfish. Recent invasion by Asian carp (Silver carp *Hypophthalmichthys molitrix*; bighead carp *H. nobilis*) within these systems has threatened these economic and recreational opportunities. Asian carp have the ability to outcompete native fish species for forage, become overpopulated, and present a harmful environment for recreational boaters (Irons et al 2007; Sass et al 2010; Pyron et al 2017). However, Asian carp have been proven to be difficult to effectively capture. Ongoing studies have shown promise in increasing catch through a novel gear known as the paupier. Modeled after shrimp trawlers in the Gulf of Mexico, the paupier is an electrified butterfly trawl developed by the U.S. Fish and Wildlife Service - Columbia Fish and Wildlife Conservation Office (CFWCO). This gear has the ability to sample a wide range of sizes and species presenting an opportunity to allow for the assessment of a population and fish community. Preliminary data suggests that Asian carp experience a diel movement throughout the water column allowing them to become more vulnerable to catch at different times of the day. U.S. Fish and Wildlife Service – Columbia Fish and Wildlife Conservation Office is conducting a study to identify the most effective time to capture Asian carp. Results from this study will contribute to the management of Asian carp in Kentucky Lake by determining the best time of day and season to effectively sample Asian carp and provide crucial information on the population. The objectives of this study are as follows:

Project Objectives:
(1) Evaluate the most effective time of day and season to sample Asian carp in Kentucky Lake and Lake Barkley
(2) Describe the population characteristics of Asian carp in Kentucky Lake and Lake Barkley

Project Activities, Methods, and Timetable:
Sampling Sites: Two sites (Big Bear and Sledd Creek; Figure 1A&B) in Kentucky Lake and one site (above the dam) in Lake Barkley (Figure 1C) will be sampled. Big Bear embayment is a large backwater located on the western side of lower Kentucky Lake. Maximum depth is approximately 1-6m and depths are relatively uniform across the pelagic area of Big Bear embayment. Sledd Creek embayment is the first western embayment located upstream from Kentucky dam. Depths range from 1- 6m with the pelagic area of Sledd Creek remaining fairly uniform at 5m. Lake Barkley will be sampled directly above the Barkley dam. Depths range from 3m in the pelagic portion of the reservoir and will reach up to 9m in the river channel.

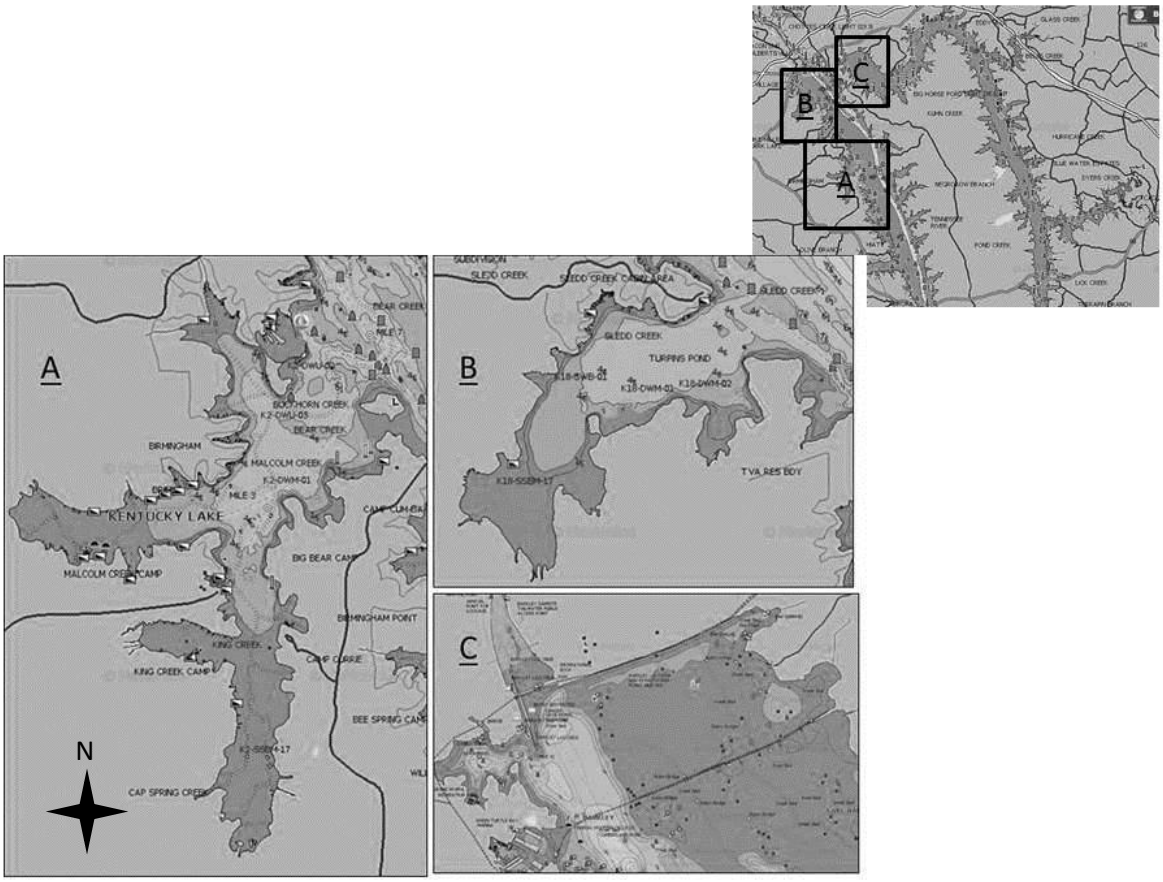

Figure 5. Sampling locations in Kentucky Lake (Big Bear [A] and Sledd Creek [B]) and Lake Barkley (above the dam [C]).

Gear:

Paupier: The paupier is an electrified butterfly trawl that consists of a 4.0m wide by 1.5m deep rigid frame on either side of the boat with the nets consisting of 38mm mesh in the body reducing to 6mm mesh in the cod (Figure 2). Three cable dropper anodes are affixed to booms 3-4m in front of the paupier frames and spaced 1.9-2.5m (Miranda and Kratochvíl 2008). An 18cm hemisphere anode is suspended in each paupier frame approximately 1.0m behind the net opening. Electrofishing settings will be 30 hertz and 15% duty cycle. The speed for each run will target 4.8kph (3.0 mph). Frames can operate at a variety of depths from 1 m to 3 m and will target depths $\geq$ 0.3m above the substrate or as is deemed safe.

Figure 6. An aerial view of a paupier shows the rigid frames on both sides and booms extending in front of the boat.

Data collection: Sampling will occur from April – November with one sampling event occurring in each season (e.g. spring, summer, and fall). Sampling will commence two hours prior to sunset and continue into the night, not to exceed five hours past sunset. Transects within each site will be randomly chosen for sampling. Sixteen transects will be sampled in each site with the opportunity to conduct more samples if time allows as long as they are random and don't repeat transects. The direction of the sampling transect will be randomly selected and each trawl sample will target five minutes. Transects along the shoreline will follow the contour whereas open water transects will be sampled in a straight line. Sampling technique, total time, and whether a transect is near shore or open water will be recorded for each deployment. All fish will be identified to species and enumerated for each run. Unknown specimens will be preserved and identified at a later date. Total length (mm) and weight (g) of all Asian carp will be recorded for eight random samples in each site. Total counts will be taken for each 100mm length group of Asian carp on the remaining sample runs. All sportfish captured will be measured for length and weight. Samples will be unloaded to a support boat for data collection when appropriate. Asian carp will be removed while all other fish will be checked for any health conditions and returned to the water.

When necessary, subsamples will be collected, as determined by the crew lead. A subsample is defined as dividing an unmanageable collection of one species of fish into a representative manageable sample in which lengths and weights are recorded along with the total number of fishes in the collection (Gutreuter et al. 1995). Subsampling of large (> 300mm) Asian carp will

use modified methods described by Bettoli and Maceina (1996) where the lengths and weights will be taken for ≥ 50 random individuals. The remaining fish in that sample will be measured to 100mm length groups (i.e., < 100mm, 100-199mm, etc.) and a total count will be given for each 100mm length group. Other species and small fish subsampling will use methods described by Bettoli and Maceina where lengths and weights will be taken from ≥ 100 random individuals of a subsample. The total weight will be determined from that subsample then the total weight will be calculated for the remaining sample. Total count will be calculated:

Total count = total sample weight/average individual weight

Gear Evaluation Data analysis: Catch rate (fish/5 min) and size distributions of Silver Carp will be analyzed for each site and season. Catch rate data will be $\log_{10}(x + 1)$ transformed to correct for proportionality between the standard deviations and means and compared through repeated-measures analysis of variance (ANOVA) with a Tukey's test for multiple comparisons. Differences in length-frequency distributions for sites and seasons will be determined using nonparametric Kolmogorov-Smirnov tests. All analyses will be performed in R (R Development Core Team, 2013) and statistical significance for all analyses is declared at $\alpha = 0.05$.

A Generalized Linear Mixed Model (GLMM) will be used to examine the nature and strength of the relation between variables (i.e., time, season, depth) and Asian carp abundance. An Akaike's Information Criterion (AIC) will be used to select the most parsimonious model out of a set of *a priori* candidate models.

Sample size estimates for monitoring efforts will be obtained using two methods. A targeted sampling of 125 stock size individuals is suggested by Quist et al. (2009) to appropriately assess a population. Therefore, sample sizes needed to obtain 125 stock size (250–450mm; Phelps and Willis 2013) Silver Carp will be calculated. The second, sample size estimate will be calculated using a resampling procedure to determine the number of deployments needed to achieve a relative standard error of 25% or less around the mean catch rate of stock size Silver Carp for 80% of the samples based on Koch et al. (2014).

Fulton condition factor (K; Pope and Kruse 2007) will be used to assess the overall condition of Asian carp. Differences between 100mm length groups, sites, and season will be assessed using an analysis of covariance (ANCOVA) with length as the covariate.

Length-weight relationships of Asian carp will be $\log_{10}$ transformed for linearity. Differences in length-weight regression between sites and seasons will be tested using an analysis of covariance (ANCOVA) with length as the covariate (Pope and Kruse 2007).

Estimated Timetable:
March–April 2017
Gear preparation, field logistics planning, crew scheduling

April 10–14
Field sampling, data entry

July 10–July 14
Field sampling, data entry

October 2–6
Field sampling, data entry

November 13–17
Field sampling, data entry

Novemeber 2017
Data entry, data analysis

December 2017–February 2018
Annual report generation

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Sass, G. G., T. R. Cook, K. S. Irons, M. A. McClelland, N. N. Michaels, T. M. O'Hara, and M. R. Stroub. 2010. A mark–recapture population estimate for invasive Silver Carp (*Hypophthalmichthys molitrix*) in the La Grange Reach, Illinois River. Biological Invasions 12:433–436.

Project Title: Impacts of Asian Carp Harvest Program (ACHP) on sport fish in Kentucky

Geographic Location: Kentucky water of Kentucky Lake and Lake Barkley, the lowermost mainstem reservoirs on the Tennessee and Cumberland Rivers, respectively.

Lead Agency: Kentucky Department of Fish and Wildlife Resources

Statement of Need:

Kentucky is the home to fertile waters including the intersection of some of the nation's largest rivers. These rivers and their associated reservoirs provide rich fisheries resources, which support a long tradition of commercial fishing in Kentucky waters. In 2015, commercial fishers reported the harvest of 185,852lbs of flesh and 12,206 lbs of eggs during the 2015-2016 commercial season. Silver carp (1,207,933 lbs; 32.5%), blue catfish (850,186 lbs; 22.9%), and channel catfish (654,495 lbs; 17.6%) were the most harvested species in the 2015 commercial fishing season with most harvest occurring in the Ohio River, Kentucky Lake, and Lake Barkley (88% of commercial harvest).

In 2013, the KDFWR created an Asian Carp Harvest Program (ACHP) to increase commercial harvest of Asian carp in Kentucky waters. This program enabled commercial fishing access in areas that are popular sport fisheries such as below dams and in reservoirs at times of year when historically there has been little commercial fishing effort. As a result, KDFWR built strict oversight into the regulation including daily reporting of harvest and bycatch by commercial fishers. Kentucky Lake and Lake Barkley are two of the largest reservoirs in the United States east of the Mississippi River. These reservoirs represent a 1.2billion dollar sportfish and recreational boating industry that is very important to western Kentucky. Subsequently, the KDFWR created a 5cent/lb subsidy to incentivize the commercial harvest of Asian carp from Kentucky Lake and Lake Barkley specifically, as well as a program to investigate gear efficiencies in capturing Asian carp.

As fishing effort for Asian carp increases and the types of gears used expands, it is important to monitor the impacts of commercial fishing on the important sport fisheries of these systems. This program provides the opportunity to monitor the direct impacts of commercial fishing on sport fish in Kentucky. It also allows oversight of the removal of Asian carp and the collection of data that is used to track the population dynamics of Asian carp populations (See Asian Carp Demographics Project Plan).

Project Objectives:

1. Monitor sport fish by catch in the Asian carp harvest program (ACHP) through review of commercial fishing reported harvest as well as ride alongs with commercial fishers.

2. Facilitate payment of Asian carp subsidy funds by verifying harvest location of fish, sale of fish to participating fish buyers, and submission of appropriate paperwork to finance cabinet.

Project Activities, Methods, and Timetable:

The Asian carp commercial fishery will continue to be monitored to assess commercial effort, harvest, and impacts on bycatch, specifically sportfish. 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. Commercial 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 ACHP on bycatch species, specifically sport fish. Commercial fishers using the ACHP will also be observed through ride alongs conducted by KDFWR representatives to collect the same information with some additions including waypoints of locations fished and soak times of gillnets. Observations by KDFWR during ride alongs will be analyzed both aggregately with daily reports turned in by commercial fishers and separately (i.e. ride along data). Data collected from commercial fishing reports 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.

Comercial fishermen who participate in the Asian carp subsidy program will communicate with KDFWR staff to meet at an agreed upon location to verify harvest location of fish. KDFWR staff will then follow the commercial fishermen to the processor to witness sale of fish and submit the appropriate paperwork for fishermen to be paid in a timely manner.

Location: The scope of this project is statewide, however most field work will be conducted in Kentucky Lake and Lake Barkley, reservoirs on the Tennessee and Cumberland Rivers, respectively. Submission of appropriate subsidy paperwork and data analysis will occur at the KDFWR Western Fisheries District office in Murray, KY.

Expected Results and Benefits: The implementation of the ACHP has been a key element in the increased harvest of Asian carp from Kentucky waters. Thus far the ACHP has not resulted in any observed negative impacts to the sport fishery in Kentucky Lake or Lake Barkley. However, the commercial industry surrounding the harvest of Asian carp continues to grow and bekons the need to continue monitoring impacts as commercial fishing pressure increases. We plan to continue evaluating this fishery for the next five years. The information gathered through this study will benefit managers of the commercial industry and recreational fishermen. By recording waypoints for locations fished, the analysis of fishing locations over time will be used to inform future targeted monitoring and removal efforts. We expect increased interest in the Asian carp subsidy in the coming years as more commercial fishermen begin to harvest Asain carp from

Kentucky Lake and Lake Barkley. This will benefit the recreational fishery of the lakes by removing more Asian carp and reducing the potential for competition between Asain carps and sport fish species.

Project Schedule: March 2017 – December 2020: Bi-weekly ride alongs with commercial fishermen.

March 2017 – April 2018: Verify harvest and sale of Asian carp by commercial fishermen enrolled in the subsidy program for as long as funds are available.

November 2017: Data analysis and interim report development.

December 2017 - February 2018: Data analysis and final report development.

Project Title: Identifying New Gear Types for Capturing Asian Carp

Geographic Location: Field work will be conducted on Lake Barkley and Kentucky Lakes and their associated river systems. Data analysis will be conducted at the KDFWR Western Fisheries District office.

Lead Agency: Kentucky Department of Fish and Wildlife Resources

Statement of Need:

Asian carp have become a successful invader throughout the Mississippi River basin because they tolerate a wide range of environmental conditions, produce many young, and exhibit fast growth rates (Kolar et al. 2007). Silver and bighead carp (*Hypophthalmicthys molitrix* and *Hypophthalmicthys nobilis*) have been present in Kentucky Lake and Lake Barkley since 2004. The only tool currently available to decrease the number of Asian carp in our waters is removal. In Kentucky Lake and Lake Barkley, a significant and expanding commercial fishery for Asian carp has developed in the past five years with harvest totaling over 1.2 million pounds in 2016. This commercial fishery relies almost wholly on gillnets for the gear used to harvest Asian carp. This method has proven effective for capturing adult Asian carp. However, silver carp are often seen jumping over the nets or swimming along the nets without becoming entangled in them. Gillnets are also size selective and most commercial fishermen use 4.25-inch and 5-inch mesh nets which capture adult Asian carp but are not efficient in capturing juvenile Asian carp.

In order for commercial fishing to have a measurable impact on Asian carp populations other gear types need to be explored. Research and oversight of alternative gear types is needed in order to monitor the impacts that experimental gears may have on sport fish as bycatch. The continued removal of Asian carp from Kentucky waters is essential to protecting the 1.2-billion-dollar recreational boating and sport fishing industry provided by Lake Barkley and Kentucky Lake.

Project Objective:

Identify and evaluate new gear types for capturing silver and bighead carp in Kentucky Lake and Lake Barkley.

Project Activities, Methods, and Timetable:

New gear types will be identified and evaluated by KDFWR staff. If commercial processors or fishermen are involved in development and/or testing of experimental gears KDFWR's involvement will be to support and assist in gear development and testing as staff and equipment are available. KDFWR staff will be present when any experimental gear is tested in order to record data from fish captured and monitor bycatch of sport fish. KDFWR will also work with the public and law enforcement on occasions when necessary that they be informed of experimental gear testing. A testing period of no less than one year and during multiple seasons will be required for any experimental gear type before it is eligible for review to be legalized for commercial use. KDFWR will provide a thorough review of data collected during the testing period of experimental gears to evaluate efficiency in capturing Asian carp and determine

potential affects to sport fishery. Standards of bycatch will be specified by KDFWR for experimental gears and those will be followed precisely. KDFWR will be explicit with other invested parties in that testing of a gear will not guarantee approval for use on commercial scale.

Expected Results and Benefits: Information gathered through testing of experimental gears will be used to assess efficiency of each gear for harvesting Asian carp. Gears that prove to be more efficient at harvesting Asian carp or differing life stages of Asian carp without negatively impacting the sport fishery of the Lakes will continue to be used by KDFWR staff and may be approved for use by commercial fishermen. By increasing gear types available to commercial fishermen, more Asian carp will be removed from the lakes, improving sport fish habitat and the experience of recreational boaters.

Estimated Timetable:

March 2017 – February 2018: Test experimental gears for capturing Asian carp

November 2017: Data analysis and interim report development.

December 2017 - February 2018: Data analysis and final report development.

Literature Cited:

Kolar, C. S., D. C. Chapman, W. R. Courtenay, C. M. Housel, J. D. Williams, and D. P. Jennings. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment. American Fisheries Society, Bethesda, Maryland. Special Publication 33.

Project Title: Asian Carp Demographics in Kentucky Lake

Project Lead: Kentucky Department of Fish and Wildlife Resources

Agency Collaboration: Murray State University, RCB Fish Compnay

Geographic Location:

Field work will be conducted in Kentucky Lake and Lake Barkley in Kentucky waters. Data collection from commercially harvested fish will take place at compliant commercial processing facilities. Lab work and data analysis will be conducted at the KDFWR Western Fisheries District office, Murray State University Fisheries Lab in Murray, KY, and RCB Fish Company in Ledbetter, KY.

Statement of Need:

After their introduction into Arkansas public waters in the 1980's (Freeze and Henderson 1980), Asian carp (bighead carp, *Hypophthalmichthys nobilis* and silver carp, *Hypophthalmichthys molitrix*) quickly spread throughout the Mississippi River basin. Adult Asian carp were reported in Kentucky Lake and Lake Barkley as early as 2004, with populations increasing annually. Juvenile Asian carp were captured in the Kentucky Lake tailwater in 2010 and 2015, and were also verified in Kentucky Lake in 2015.

The only tool currently available to decrease the number of Asian carp in our waters is removal. In Kentucky Lake and Lake Barkley, a significant and expanding commercial fishery for Asian carp has developed in the past five years with harvest totaling over 1.2 million pounds in 2016. In 2013, the KDFWR created an Asian Carp Harvest Program (ACHP) that allows commercial fishermen, targeting Asian carp, to fish in otherwise closed waters under close supervision. This program affords the opportunity to monitor the status of Asian carp population dynamics which provide a tool to assess the effectiveness of commercial removal efforts. While the commercial fishery is likely to reduce Asian carp biomass, adequate understanding of population dynamics is critical in the development of an effective fishing policy to reduce competition with sport fishes (Tsehaye et al. 2013).

The potential of the Asian carps to affect our native aquatic ecosystems has led state, regional, and federal authorities to identify them as priority aquatic nuisance species (ANS) and specifically call for limiting their distribution and impacts where eradication is elusive (Mahala 2008, ORFMT 2014, Conover, 2007). Asian carp have become a successful invader throughout the Mississippi River basin because they tolerate a wide range of environmental conditions, produce many young, and exhibit fast growth rates (Kolar et al. 2007). Asian carps have been shown to compete with native species of fish (Freedman et al. 2012, Irons et al. 2007, Schrank et al. 2003), but the impacts of Asian carp on native food webs is not well understood. Asian carp and our most popular sport fish are many times removed in the food pyramid, but Asian carp

may create bottom up indirect affects that would limit sport fish production. Furthermore, juvenile sport fish rely on plankton for food, leading to concerns that Asian carps compete directly with juvenile sport fish at the most critical life stage. As a result, Asian carp research and monitoring is increasing throughout the Mississippi River basin in an effort to limit the Asian carps' potential negative impacts on native fish production.

In fall of 2016 KDFWR orchestrated the first sampling event designed to identify methods for standardized Asian carp sampling in Kentucky Lake. To date, Asian carp efforts in the Mississippi River Basin have been focused on large river environments. Very little information exists on capturing Asian carp in large mainstem reservoirs like Kentucky Lake. Asian carp demographic information gathered through this effort is needed to identify vulnerabilities at all life stages of Asian carp and aid in removal. Information about the production of carp, where they reproduce, and the fate of the young carp will provide information that will help limit competition between Asian carp and sport fish.

Project Objectives:

1. Investigate Asian carp age and growth, condition, gonadosomatic index, sex ratios, and fecundity for baseline data to be used to assess removal efforts as commercial fisheries grow in Lake Barkley.
2. Establish a long-term monitoring plan for sampling silver and bighead carp in the northern portion of Kentucky Lake.
3. Compare gear types for capturing juvenile Asian carp in Kentucky Lake and Lake Barkley.
4. Estimate hatch date of Asian carp and potential spawning areas using Kentucky Lake hydrology data.

Project Activities, Methods, and Timetable:

Asian carp samples will be collected from the commercial fishery bi-monthly to assess population dynamics in Lake Barkley. Each month, total length, total weight, gonad weight, and sex will be recorded and the left pectoral fin ray removed from twenty silver carp. In addition, otoliths will be removed from 100 silver carp sampled in order to make comparisons between aging structures. Similar data will be collected from bighead carp when available. These data will be analyzed to identify trends in population parameters over time including recruitment, growth rates, and mortality rates. The gonadosomatic index will be used to estimate the timing and occurrence of spawning. These values will also be compared to data collected from silver and bighead carp captured in Kentucky Lake during previous years.

The Kentucky Lake Asian carp sampling effort will consist of gill netting crews, electrofishing, Paupier nets, and Mamou trawl sampling strategies. There will be two sampling periods, one in late spring and one in the fall, during which some combination of these gears will be used.

Multiple agencies and universities will be invited to assist in sampling efforts. Spring sampling will utilize the Paupier nets provided by the USFWS to repeat experimental design used in the fall of 2016 and compare results between seasons. Murray State University (MSU) students had some success capturing juvenile Asian carp in Kentucky Lake with electrofishing in 2016, therefore electrofishing will also be conducted during spring sampling in an effort to capture juvenile Asian carp if they are present in the Lake. Electrofishing effort will be focused primarily in embayments and shallow areas where escape from this gear type is difficult for fish. A Mamou trawl provided by MSU will also be utilized during spring sampling in an effort to capture young of year and juvenile Asian carp that may have been spawned in Kentucky Lake. When young of year or juvenile Asian carp are encountered, total length and weight will be recorded and specimens will be frozen. These specimens will then be transferred to Dr. Greg Whitledge at SIU-Carbondale for microchemistry analysis. From this data, hatch dates and locations can be estimated. These data will be compared to available hydrology data to identify potential spawning areas in Kentucky Lake. Gill netting effort will be expended during both spring and fall sampling with an emphasis on the fall sampling period in order to make a more effective comparison to the previous years' data collection. The USFWS will also assist in fall sampling with the Paupier nets, their schedule permitting. All fish will be identified and recorded. All Asian carp will be measured and weighed. Ten gizzard shad per site will be measured and weighed. Ten bigmouth buffalo per site will be measured and weighed. Some crews will be designated to keep adult silver carp alive to be implanted with sonic tags for Kentucky Lake silver carp tracking study being conducted. Other crews will either euthanize adult Asian carp after measurements are taken.

Efforts will be made to procure samples of Asian carp and data from other agencies and universities conducting field sampling in Kentucky Lake such as Tennessee Tech University, Murray State University, TWRA, and TVA.

Expected Results and Benefits: Asian carp age and growth, condition, gonadosomatic index, sex ratios, and fecundity will be used to assess removal efforts as commercial fisheries grow in Lake Barkley. The removal of Asian carp from Kentucky waters will decrease the potential for competition between Asian carp and sport fish and will also improve sport fish habitat.

Information gathered through long-term standardized monitoring of Asian carp populations in Kentucky Lake will be used to analyze changes in population dynamics over time. Gears used in sampling efforts will be analyzed for efficiency in capturing Asian carps and bycatch of sportfish will also be monitored. This will enable biologists to make informed decisions regarding removal of Asian carp in Kentucky Lake for the benefit of sport fishes.

Estimated Timetable:

March 2017 – April 2018: Bi-monthly collection of Asian carp data from processing plants.

June 2017: Kentucky Lake spring sampling event.

August 2017: Analyze YOY Asian carp otoliths collected during 2015 sampling.

October 2017: Kentucky Lake fall sampling event.

November 2017: Data analysis and interim report development.

December 2017 - February 2018: Data analysis and final report development.

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Project Title: Kentucky Lake and Lake Barkley Tailwater Sport fish Assessment

Geographic Location: The Kentucky Lake Tailwater electrofishing and creel survey will extend from the dam to the I-24 bridge (225.8 acres at normal pool). The Barkley Lake tailwater electrofishing and creel survey will extend from the dam to the US 62 bridge (75.2 acres at normal pool).

Agency Lead: Kentucky DFWR

Statement of Need:

After their introduction into Arkansas public waters in the 1980's (Freeze and Henderson 1980), Asian carp (Bighead carp, *Hypophthalmichthys nobilis* and Silver carp, *Hypophthalmichthys molitrix*) quickly spread throughout the Mississippi River basin. Asian carp were reported in the commercial fisheries in Kentucky in the late 1990's, and have steadily increased their range and numbers since. Currently, the Asian carp populations in the Kentucky Lake (Tennessee River) and Lake Barkley (Cumberland River) tailwaters are the highest density in the state.

The tailwaters below dams offer ample bank access, concentration of flowing water, abundant food, and limitation to upstream passage of fish. As a result, many tailwaters are popular recreational fishing destinations with high angler effort and success (Miller and Chance 1954; Groen and Schmulbach 1978). Similar to other tailwater fisheries, the Kentucky Lake and Lake Barkley tailwaters provide unique and popular fisheries because overall fish densities are high, and many different sport fishing opportunities exist in a small area. In the early 1990's anglers took over 70,000 fishing trips for over 200,000 angler hours to these tailwaters annually. The most recent creel survey was conducted in 2007 below Kentucky Dam. The dominant sport fisheries in both locations have been catfish and *Morone* spp. making up 60-80% of the angler effort. Asian carp densities have increased dramatically in the tailwaters, and fishing guides and anglers have expressed concerns that the sport fisheries have declined as a result.

Asian carp have the potential to negatively affect tailwater fisheries in various ways. Asian carp have been shown to change the trophic dynamics of a large river ecosystem by changing the way native fish feed, and the food that is available to them (Freedman et al. 2012). If Asian carp are affecting the food web dynamics of the ecosystem, we may see changes in the fish community over time. In their highest densities, Asian carp may outcompete other fish species for space, which may be apparent through decreasing species diversity in an area. Finally, Asian carp may directly compete with native fish for food, causing declines in native fish condition through time (Irons et al. 2007; Schrank et al. 2003). These parameters can be monitored through routine surveys of the fish community.

Growing populations of Asian carp may also have a social impact on our sport fisheries. Some anglers may not fish in the tailwaters because they fear the Asian carp will jump in their boat, creating a mess, or even causing an injury. At their highest densities, schools of Asian carp make

fishing difficult, as it may be impossible to drop bait to the bottom of the river without snagging a carp. These issues could lead to decreases in fishing effort and success. Angler use and success from historical creel surveys completed prior to the introduction of Asian carp will be compared to current surveys to determine potential impacts of Asian carp on our tailwater fisheries.

Project Objectives:

1. Monitor species composition and abundance of fish from Barkley Dam tailwaters and Kentucky Dam tailwaters to identify trends over time and make comparisons to historical data.
2. Compare current creel survey angler use and catch statistics to those collected in previous years' surveys conducted in the Kentucky Dam tailwater and Barkley Dam tailwater.
3. Compare current tailwater angler opinions about the impacts of increasing densities of Asian carp on their fishing effort and success.
4. Collect baseline data on the growing bowfishing fishery in each tailwater.

Project Activities, Methods, and Timetable:

Kentucky Dam tailwater will be sampled with pulsed DC electrofishing in the spring and fall to assess species composition and relative abundance of represented fish species. For each fish collected, total length (mm), weight (kg), and species will be recorded. Where large numbers of a species are collected, subsamples will be collected for length and weight to decrease sample processing time. These data will be compared to historical data collected by the KDFWR Western Fishery District personnel to assess changes in fish community over time.

A random non-uniform probability creel survey will be conducted in each tailwater from March-December 2018. 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.

(a) Fishermen will be counted one time during the six-hour work period. Only those people actually fishing will be counted. Counts will be separated by east and west bank anglers, and boat anglers.
(b) Fishermen interviews will be conducted by directly contacting fishermen in the tailwater. Both boat and bank anglers will be questioned concerning their fishing trips. The creel clerk will be responsible for determining the best time to be at the ramp in order to maximize effort in intercepting boat fishermen. A minimum of two hours each day will be spent at the boat ramp. The rest of the work day will be spent interviewing anglers.

Expected Results and Benefits: Through electrofish sampling we expect to determine if fish abundance and species composition at Barkley Dam tailwaters and Kentucky Dam tailwaters has been impacted by Asian carp. We will compare these data to historical data and identify trends regarding changes in native fish species. From this information we can determine if Asian carp are having negative impacts on sport fish populations in the tailwaters.

In 2018 a creel survey will be conducted in order to compare current creel survey angler use and catch statistics to those collected in previous years' surveys conducted in the Kentucky Dam tailwater and Barkley Dam tailwater. We will also compare current tailwater angler opinions about the impacts of increasing densities of Asian carp on fishing effort and success. This information will be beneficial to KDFWR staff as management decisions are made regarding Asian carp and the sport fishery in the tailwaters.

Project Schedule

April – November 2017: Sample Kentucky Dam tailwaters and Lake Barkley Dam tailwaters (electrofishing)

November 2017: Data analysis and interim report development.

December 2017-March 2016: Data analysis and final report development.

February 2018 –November 2018: Creel Survey in Lake Barkley and Kentucky Lake tailwaters

April, May, October, November 2018: Sample Kentucky Dam Tailwaters and Barkley Dam Tailwaters (electrofishing)

Literature Cited

Freedman, J. A., S. E. Butler, and D. H. Wahl. 2012. Impacts of invasive Asian carps on native food webs. Final Project Report – Illinois Indiana Sea Grant.

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Project Title: Tracking Silver Carp Movement in Kentucky Lake

Geographic Location: Field work will be conducted in Kentucky Lake and Kentucky Lake tailwaters.

Lead Agency: Murray State University

Collaborating Agencies: Kentucky DFWR, Tennessee WRA, Mississippi DWFP, Tennessee Technological University, USACE

Statement of Need:

Silver carp have been in Kentucky Lake since approximately 2004, but little is known about how these fish behave in a large reservoir. Understanding movement patterns of silver carp in Kentucky Lake is critical to properly manage these fish. By tracking the movement of silver carp we can:

- Quantify spatial and temporal movements within the reservoir
- Determine which habitats of the lake are most used by silver carp
- Characterize the influence of environmental factors such as water temperature and discharge on movement patterns
- Gain vital information about potential reproduction of these species in Kentucky Lake, such as:
    - timing and duration of spawning runs
    - location of spawning habitat
- Determine if the silver carp are using the lock chamber at Kentucky Dam to gain access to Kentucky Lake

With this information we can estimate silver carp productivity via bioenergetics models, and we can identify locations where silver carp congregate and are vulnerable to targeted removal. We could also determine if the population of silver carp in Kentucky Lake is a resident, self-sustaining population or if this population depends upon constant recruitment of fish through Kentucky Lock and Dam. We will also strive to identify critical spawning habitat for this species in Kentucky Lake to aid in the control of silver carp reproduction.

Project Objective:

1. Understand movement patterns, habitat use, spawning patterns, and immigration/emigration of silver carp in Kentucky Lake.

Project Activities, Methods, and Timetable:

An additional 200 silver carp will be tagged in Kentucky Lake to bring the total of tagged fish to 269. These fish will be tracked both manually from a boat and also by stationary receivers deployed throughout Kentucky Lake (Figure 1). Silver carp will be captured via electrofishing and gillnetting as soon as water temperatures are amenable. We will coordinate with local commercial fishermen to increase our probability of capturing silver carp. Gillnets will be

constantly monitored and checked frequently to reduce stress and mortality. Once captured, adult Silver carp will be implanted with Vemco V13 transmitters, tagged with a jaw tag, and released near the Hancock Biological Station. Forty silver carp will also be tagged and released in the Kentucky Lake tailwaters to better assess upstream movement of silver carp through the Lock chamber at Kentucky Lake Dam. Adult silver carp will be used in order to increase the chance of detecting the spawning runs. Intense manual tracking effort will be expended daily during the first two weeks after tagging to determine areas to focus future tracking trips.

Five more stationary receivers will be deployed in order to improve our coverage of Kentucky Lake. Stationary receivers are still needed in the canal between Kentucky Lake and Lake Barkley, below the Kentucky Lake Dam tailwaters, and at the mouth of various large embayments in Kentucky Lake. Manual tracking will be done once per week supplemented by KDFWR staff as they are available throughout the year. Effort will be distributed based upon our initial manual tracking plus the detections from the stationary receivers. When a fish is located, its position and habitat will be recorded. KDFWR will also assist in downloading information from stationary receivers throughout Kentucky Lake once a month.

We will use environmental data (water temperature, flow, weather, etc.) collected by the Hancock Biological Station as part of their long term, continuous monitoring of such data in Kentucky Lake. Once we have identified patterns in silver carp movement in Kentucky Lake we will attempt to correlate this movement with the environmental data.

Expected Results and Benefits: Gain a basic understanding of the movement patterns of silver carp in a large reservoir. We expect to obtain the following information about silver carp in Kentucky Lake:

1) An estimation of average distance traveled per day during different seasons
2) Identification of areas where silver carp congregate during different seasons
3) Record which habitat types are used by silver carp
4) Determine if and when silver carp make spawning runs and what environmental factors seem to trigger these runs.
5) If spawning runs are detected, locate areas where silver carp spawn and record the type of habitat used for spawning
6) Measurement of the rate of emigration out of Kentucky Lake (and potential re-immigration back into the lake)

The benefits to obtaining such information would be:

- Determine areas where the Silver Carp congregate so that we could direct targeted removal of these fish
- Use information on daily movement in bioenergetics models to estimate the productivity of these fish in Kentucky Lake
    - Productivity information would assist in understanding the commercial potential of silver carp in Kentucky Lake
    - Productivity information would enable estimates of effort required to reduce silve carp populations

- If silver carp are spawning in Kentucky Lake, we could predict when the spawning runs occur based upon environmental conditions and determine where spawning takes place
    - Perhaps with such information we could effectively target the removal of both spawning adults and larval fish
- If we determine that silver carp are using the lock in Kentucky Dam, we could target removal at the lock
- If emigration/immigration occurs, we could study the long-range movement patterns of silver carp which would help construct a more thorough understanding of their movement patterns

We expect that this project could lay the groundwork for future research. For example, if emigration occurs we could coordinate with other researchers to determine the long-range movement patterns of silver carp once they leave Kentucky Lake. Or, we might be able to measure the rate of immigration of silver carp into Kentucky Lake via detection of fish tagged by other research teams outside of Kentucky Lake.

Estimated Timetable:
April 2017: Tag 30 additional silver carp and release in Kentucky Lake

Spring 2017: Deploy VR2W receivers in Kentucky Lake Dam tailwaters and in the canal between Kentucky and Barkley lakes.

Spring 2017: Tag 50 silver carp and release in the Kentucky Lake Dam tailwaters

March 2017 – April 2018: Manually track tagged silver carp in Kentucky Lake weekly

March 2017 – April 2018: Assist with downloading data from stationary receivers in Kentucky Lake

Fall 2017: Begin deploying receiver array in Lake Barkley

November 2017: Data analysis and interim report development.

December 2017 - February 2018: Data analysis and final report development.

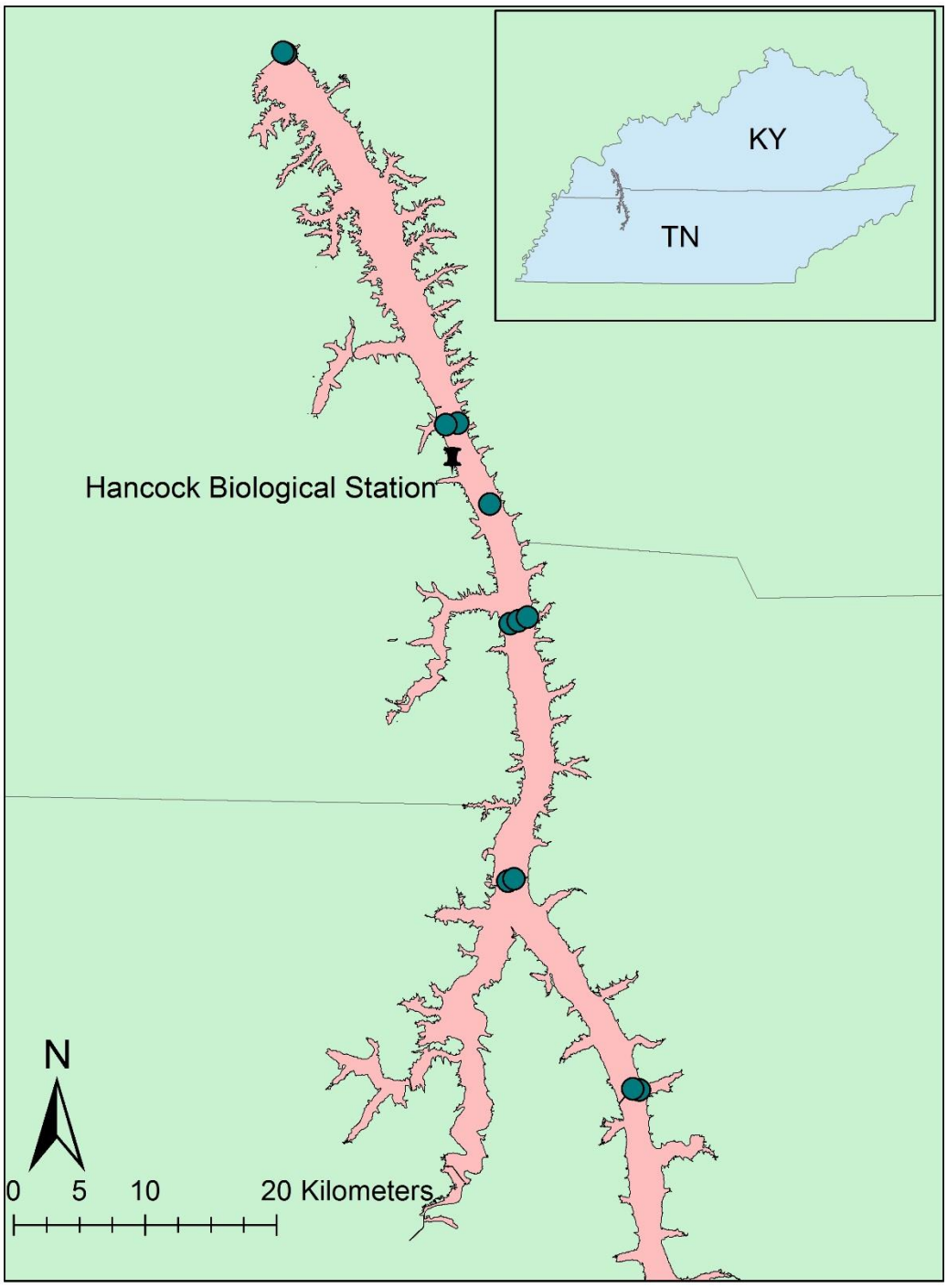

Figure 1. Location of VR2W passive receivers throughout Kentucky Lake.

Upper Mississippi River

Project Title: Identifying Asian Carp Recruitment Sources in the Upper Mississippi River Using Otolith Chemistry to Inform Asian Carp Management

Geographic Location: Upper Mississippi River and tributaries, Pool 19 and upstream.

Lead Agency: Southern Illinois Universtiy – Carbondale

Agency Collaboration: USGS (funding), Western Illinois University

Statement of Need:
Efforts to control abundance and curtail further range expansion by bigheaded carps will require knowledge of knowledge of natal environments (sources of recruits) supporting bigheaded carp populations in key management zones (e.g., near invasion fronts or in other locations where controlling bigheaded carp abundance is particularly important) to focus control efforts aimed at limiting early life stages and recruitment and ultimately achieve sustainable population control. The reproductive front, defined here as the upstream most reach where reproduction has been confirmed, in the main stem Upper Mississippi River for both Bighead Carp and Silver Carp is between Lock and Dam 19 near Keokuk, Iowa and Lock and Dam 15 near Davenport, Iowa (Larson et al., in press). This 190-km reach has been designated as a bigheaded carp management zone where control and containment measures are being used (i.e., removal by contract fishing) or considered (e.g., deterrents at Lock and Dam 19) to reduce abundance of bigheaded carps in the management zone and prevent more fish from migrating into this reach from downstream (MICRA 2016). Keeping adult abundance low in this reach, and preventing immigration from below, might eventually reduce or eliminate reproduction there, and also minimize the source of "pioneer" fish available to move further upstream and eventually establish. Lock and Dam 19 is a high-head dam, thus limiting fish passage to the lock chamber; this limited avenue for fish passage may be contributing to lower abundance of bigheaded carps upstream of Lock and Dam 19. However, the relative contributions of reproduction in the management zone and immigrants from downriver to the emerging populations of bigheaded carps upstream of Lock and Dam 19 are unknown. Better understanding the natal sources at this reproductive front in the Upper Mississippi River above Lock and Dam19 will inform current and future management strategies and could help determine if existing (harvest to limit reproduction and recruitment in the management zone) or proposed (deterrents at Lock and Dam 19 to limit immigration from downriver) control and containment strategies are achieving management objectives.

Concentrations and isotopic ratios of some chemical elements found in fish otoliths reflect those of the environment in which a fish lives. Otoliths also contain a record of fish age and growth. Chemical "signatures" of environments occupied by a fish are permanently retained, enabling the potential for reconstruction of an individual fish's environmental history from elemental and stable isotopic analyses of specific locations in otoliths (Pracheil et al. 2014). Advantages of this technique include the ability to infer natal environment and movement patterns of individual fish without the need to mark and recapture large numbers of fish and its applicability to all life stages (especially its value for inferring early life history when fish are too small for application of conventional tagging and marking techniques). A recent study in the Illinois River applied

otolith chemistry to identify environments used by adult bigheaded carps during early life (Norman and Whitledge 2015). Differences in water chemistry between the Upper Mississippi River, its tributaries, and both the Middle Mississippi (downstream of the Missouri River confluence) and Missouri rivers (Zeigler and Whitledge 2011; Whitledge et al. in preparation) enable application of this technique to Upper Mississippi River. Inferring passage through Lock 19 by individual fish is also possible if that individual's natal environment is on the opposite side of Lock and Dam 19 from the fish's collection location.

Grass Carp have established reproducing populations in the Illinois and Middle/Lower Mississippi rivers. Reproducing populations of Grass Carp are found in the Mississippi River as far upstream as pool 19 (and probably pool 13). Regulations regarding possession and use of Grass Carp for aquatic macrophyte control in ponds vary among states, with some states permitting possession and use of diploid (fertile) or tripoid (sterile) Grass Carp, some states requiring use of tripoid (sterile) Grass Carp, and some states (including Wisconsin and Minnesota) that prohibit possession or stocking of Grass Carp. Most aquaculture production of Grass Carp in the U.S. occurs in south-central and southeastern states. However, there is limited information on whether Grass Carp collected in Wisconsin and Minnesota waters of the Upper Mississippi River and tributaries are the result of illegal introductions of aquaculture-origin fish or movement of wild fish from locations farther downriver. Recent and ongoing research at SIU has indicated that otolith chemistry can be used to identify the source of Grass Carp collected from the Great Lakes and Upper Mississippi watersheds. Otolith chemistry data for 12 adult Grass Carp captured in Minnesota and Wisconsin sections of the Upper Mississippi River (Pool 11 and upstream) to date indicate a mixture of wild fish (primarily from downriver) and illegal introductions of aquaculture-origin fish (G. Whitledge, unpublished). Additional otolith chemistry data for Grass Carp collected in the Upper Mississippi River would be helpful to determine the extent to which natural recruitment vs. introduced fish are contributing to the emerging population of Grass Carp in the upstream portion of the Upper Mississippi River. Knowledge of the contributions of natural recruitment and introductions to this emerging population of Grass Carp will inform managers regarding allocation of control efforts aimed at limiting natural reproduction and immigration vs. enforcement of regulations prohibiting importation of Grass Carp from other states.

Objectives:

1) Identify the principal natal environments supporting the emerging bigheaded carp populations in the Upper Mississippi River (pools 16-19) using otolith chemistry and infer Lock 19 passage by individual fish based on natal environment and collection location.

2) Estimate relative contributions of the Upper Mississippi River and tributaries to the 2016 year class of bigheaded carps in Pools 18-19 and compare natal environments supporting the 2016 year class to those supporting recruitment of earlier year classes.

3) Assess the extent to which natural recruitment vs. introduced fish are contributing to the emerging population of Grass Carp in Wisconsin and Minnesota sections of the Upper Mississippi River and infer natal river for wild fish.

Project Activities, Methods, and Timetable:
Water samples for analysis of stable oxygen isotope ratio (expressed as $\delta^{18}O$) and for analysis of strontium:calcium (Sr:Ca) and barium:calcium (Ba:Ca) ratios will be collected from the Upper Mississippi River, its tributaries, and the Missouri and Middle Mississippi rivers during summer and fall 2017 when age-0 bigheaded carps are likely to be present. Age-0 (n=150) and adult (n=300) bigheaded carps for otolith chemistry analyses were collected from pools 16-19 by Western Illinois University during summer and fall 2016. Lapilli otoliths are removed from each fish and analyzed for stable oxygen isotope ($\delta^{18}O$) and elemental (Sr:Ca, Ba:Ca, Mg:Ca) compositions to infer environmental history (and Lock 19 passage, when possible) of individual fish.

Otolith core (the portion of the otolith that reflects a fish's early life) chemistry data for bigheaded carps will be compared with predicted chemical "signatures" of potential natal environments to identify natal environment for each fish. Statistical analyses will assess: 1) interannual persistence of differences in water chemistry among potential natal environments for bigheaded carps collected in pools 16-19, 2) whether natal environments supporting emerging bigheaded carp populations differ among fish collection locations, 3) whether relative frequency of individuals that passed through Lock 19 has changed over time or differs among year classes, and 4) for age-0 fish collected from pools 18-19 during 2016, whether the distribution of natal environments supporting this year class differs from earlier year classes.

Grass Carp collected in the Upper Mississippi River (section of the river between Pools 2 and 11) will be obtained from state or federal agencies sampling this section of the river during the project time period or from fish captured by commercial fishermen that are transferred to agency personnel. Otoliths from Grass Carp collected from Pools 18-19 by Western Illinois University will also be used for this project (expected to be wild fish in this section of the Mississippi River; data from these fish will be used to verify that otolith core chemistry of wild fish from this section of the river matches expected values). Lapilli otoliths will be removed from each fish and analyzed for $\delta^{18}O$, Sr:Ca, Ba:Ca, and Mg:Ca as described above for bigheaded carps. Otolith core chemistry data for Grass Carp collected from the Upper Mississippi River will be compared to existing otolith chemistry data from aquaculture-origin Grass Carp and wild Grass Carp from the Illinois and Middle Mississippi rivers (G. Whitledge, unpublished) to determine whether individual Grass Carp collected in the Upper Mississippi River are of aquaculture origin or are wild fish (natural recruitment). For fish determined to be of wild origin, otolith core chemistry data will also be used to infer natal river using the approach described above for bigheaded carps. Differences in relative frequencies of aquaculture-origin and wild Grass Carp among navigation pools and fish sizes/ages will be assessed (subject to distribution of sample sizes among locations and fish sizes/ages).

Analysis of data to address objective 1 will be completed during summer 2017. Otoliths to address objective 2 have been collected by Western Illinois University. Efforts to obtain additional Grass carp otoliths to address objective 3 and analysis of otoliths for objectives 2 and 3 will begin in July 2017. Project will be completed by June 30, 2018.

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Zeigler, J.M. and G.W. Whitledge. 2011. Otolith trace element and stable isotopic compositions differentiate fishes from the middle Mississippi River, its tributaries, and floodplain lakes. Hydrobiologia 661:289-302.

Project Title: Upper Mississippi River Invasive Carp Monitoring

Participating Agencies: Minnesota Department of Natural Resources (lead), Iowa Department of Natural Resources/Iowa State University, Illinois Department of Natural Resources/Western Illinois University, Missouri Department of Conservation, and USFWS

Project Activites, Methods, and Timetable:

Acoustic Telemetry
Minnesota DNR maintains an array of 50 stationary acoustic receivers (Vemco Model VR2W) in the Mississippi River from the Coon Rapids Pool to Pool 5; the St. Croix River to Taylors Falls, MN; and the Minnesota River to Shakopee, MN (Figure 1). USFWS/USGS has increased the number of stationary receivers maintained from 56 in 2015 to 85 for 2016 and 125 in 2017. USFWS maintains the array from Pool 5A (RM 737) to LD 15 and USFWS and USGS maintain the array from LD 15 to Pool 26 (RM 235) (Figure 2). Stationary receivers have been deployed on navigation buoys above and below dams in all pools from 5A through 19 and in lock chambers at locks 15 and 19 to monitor movement within and among pools and determine if fish utilize the lock chamber for inter-pool movement. In 2017, stationary receivers were also deployed in select backwaters of the Mississippi River and in four major tributaries (Skunk, Iowa, Rock, and Cedar Rivers). The Missouri Department of Conservation (MDC) maintains an array of 28 stationary acoustic receivers (Vemco Model VR2W) above, below, and inside the lock chamber at LD 19 and at locations downstream to Cairo, IL (Figure 3). A total of 363 Bighead, Silver and hybrid Asian carp from Pools 16-20 were implanted with acoustic transmitters by the USFWS from 2013-2017. At the start of the 2017 field season, 313 of the transmitters will still be active.

USFWS and USGS will use gill and trammel nets (7.6, 8.9, 10.2, 10.8, and 12.7 cm bar mesh) to collect and tag 66 Bighead and Silver carp from pools 16 through 19 with coded acoustic transmitters (Vemco, Model V16-6H; 69kHz, 16mm diameter, 95mm length, 34g). V16 coded transmitters have a 2543 day battery life and a random delay from 30 to 90 seconds. Each transmitter will be tested before implantation for recognition with a portable receiver and hydrophone (Vemco Model VR-100 and Vemco Model VH-165). Fish will be held in a holding tank or net with oxygenated water, anesthetized with carbon dioxide gas, and implanted with transmitters according to surgical procedures described by Summerfelt and Smith (1990). Individual fish will also be tagged with uniquely numbered orange Monel jaw bands printed with contact information placed on the upper jaw. Following surgery, fish will be placed in a recovery tank saturated with dissolved oxygen before release near the capture site.

Movement of tagged fish within and among pools will be monitored throughout the UMR with an expansive array of 125 stationary receivers. USFWS and MN DNR receivers above Lock and Dam 15 will be downloaded two times per year during the spring and fall seasons. In the Pools where tagged invasive carp are present or could be present (Pools 15-19, and upstream as necessary), data from stationary receivers will be downloaded monthly during the field season to provide information on gross movements of tagged fish.

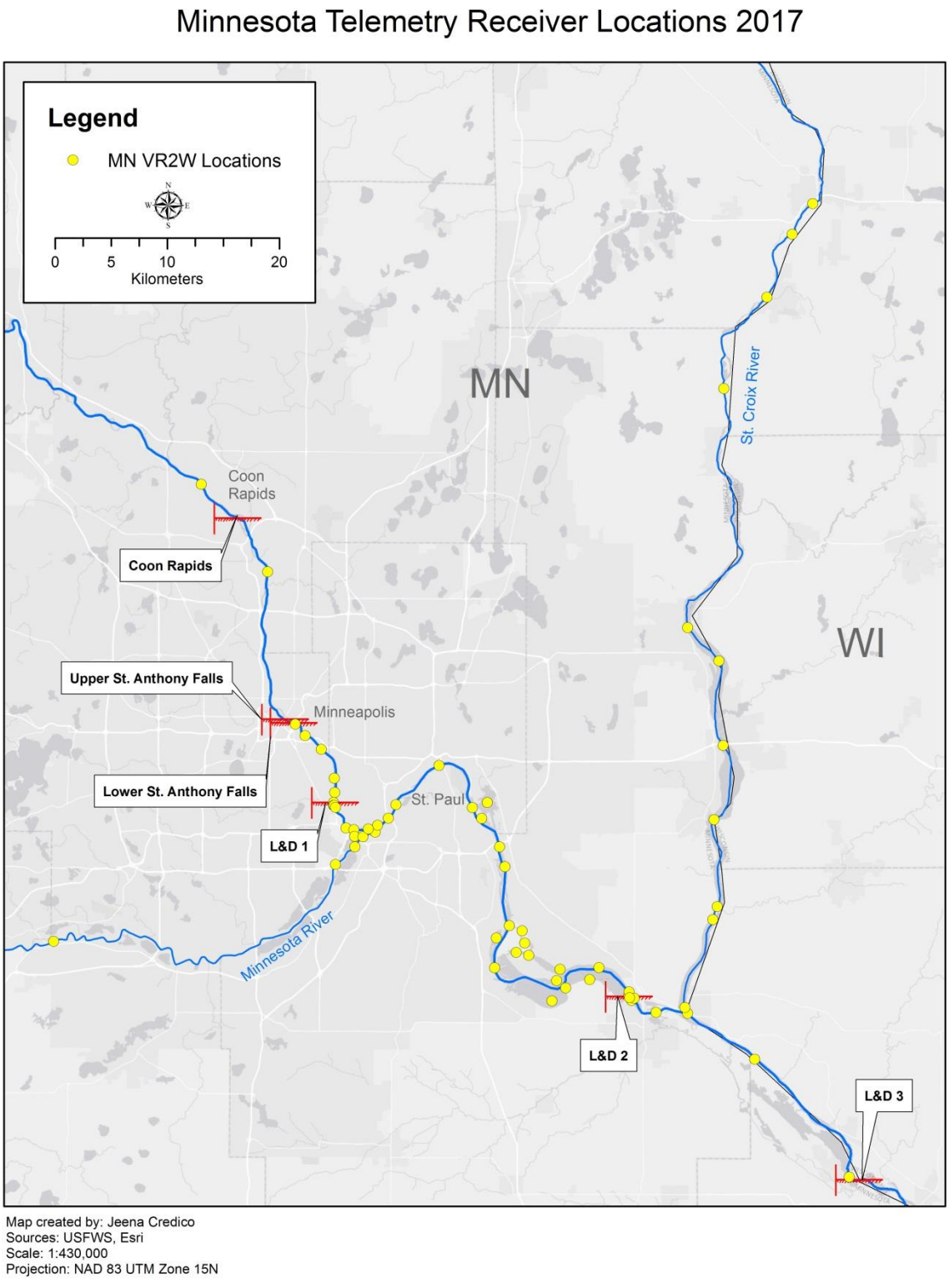


Figure 1. Locations of remote receivers maintained by Minnesota DNR in the Upper Mississippi River basin in 2017.

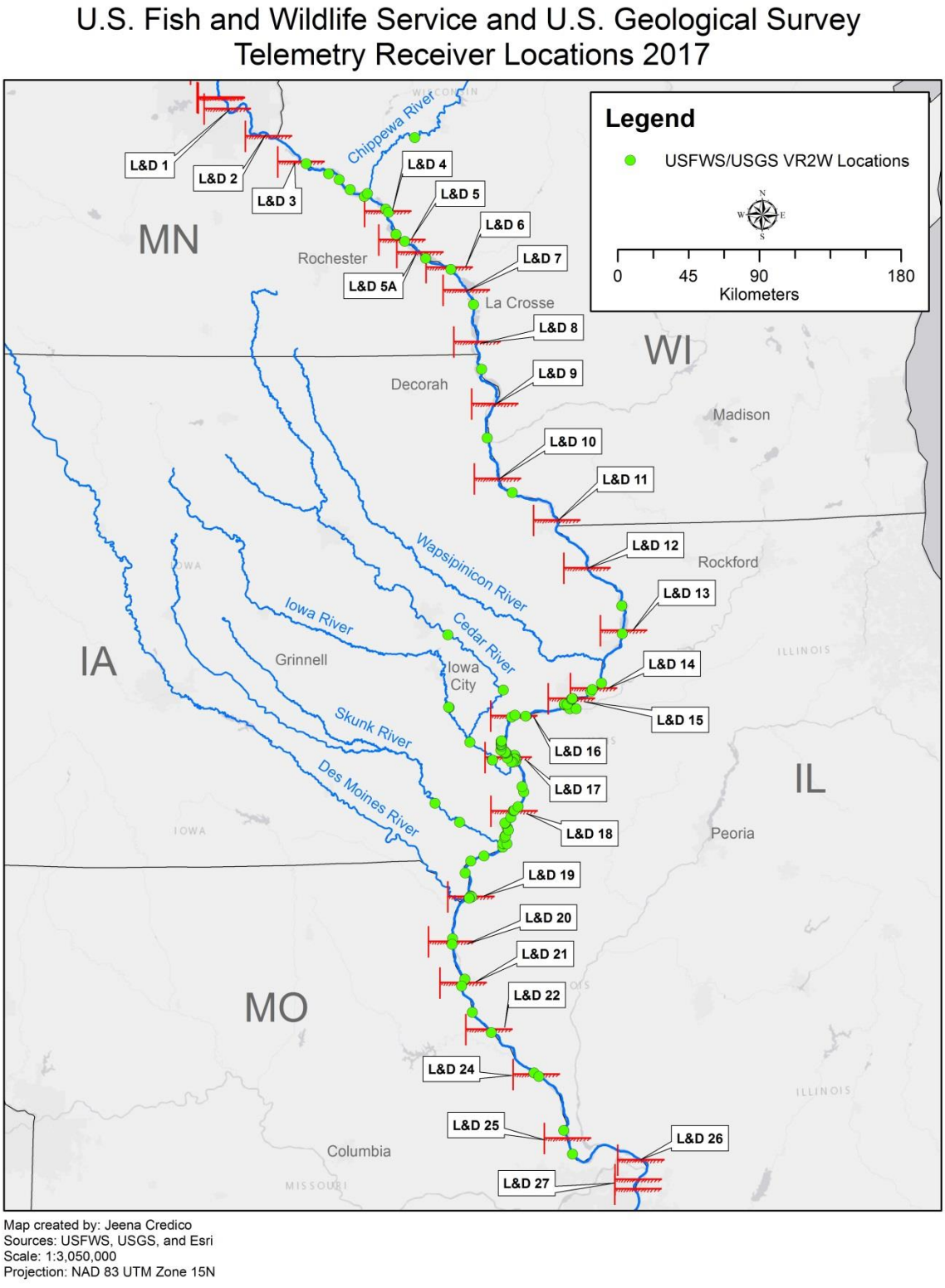


Figure 2. Locations of remote receivers maintained by USFWS and USGS in the Upper Mississippi River basin in 2017.

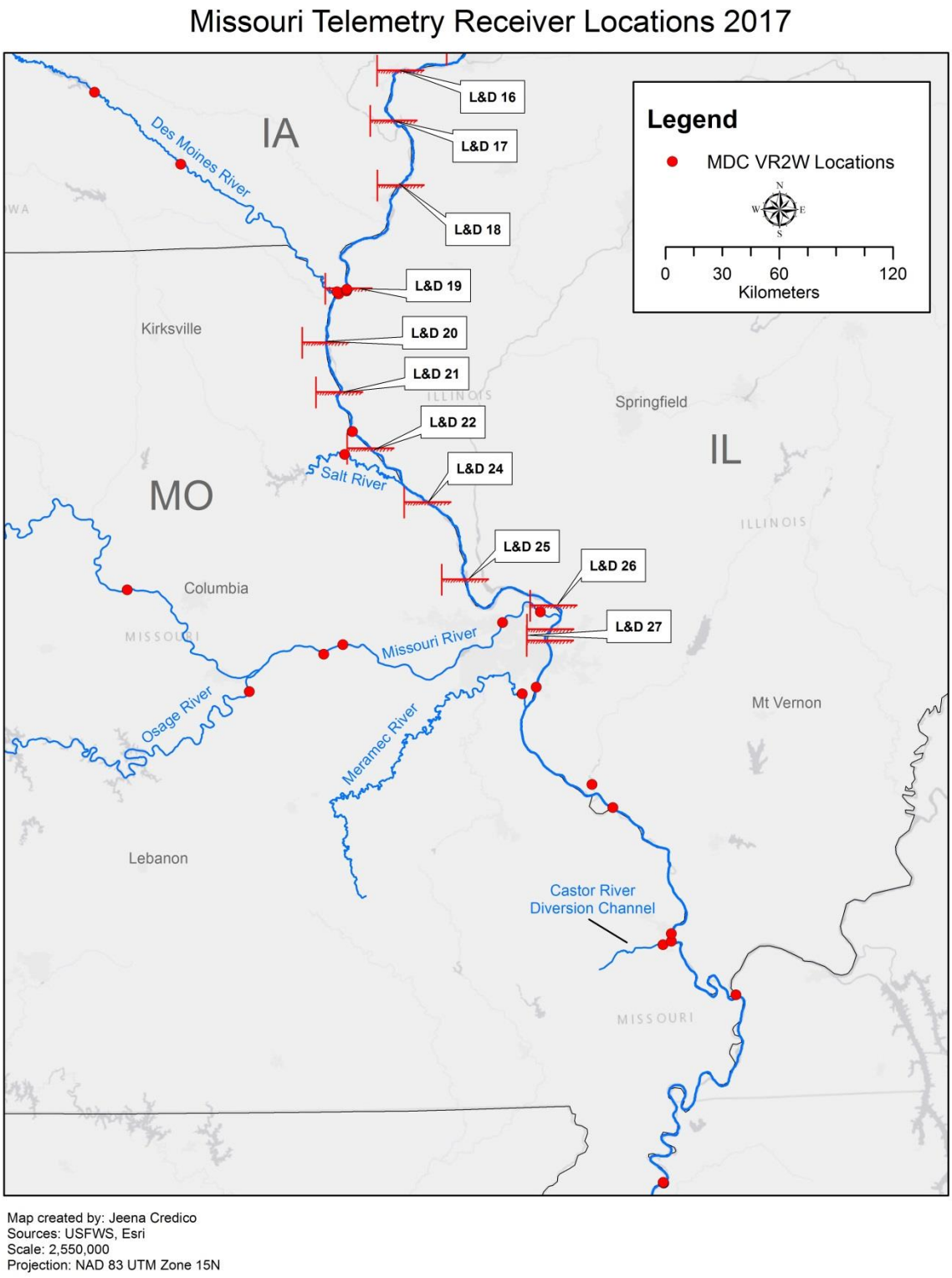


Figure 3. Locations of remote receivers maintained by Missouri DOC in the Upper Mississippi River basin in 2017.

River conditions permitting, USFWS will conduct mobile telemetry monthly to determine habitat use and movement on a finer scale than what is detected with the remote receivers. Standardized point transects spaced every 0.33 miles will be used during 2017 to provide efficient and consistent coverage. An approximate total of 144 river miles will be covered by manual tracking each month in 2017 using the point transect design. Monthly tracking will provide manual tracking locations outside of stationary receiver coverage. Depth (m) and temperature (°C) will be recorded at sites where tagged fish are located.

Two-dimensional Vemco Position System (VPS) arrays will be installed in lock approaches at LD 15 and LD 19 (Figures 4 and 5) to determine how fish use and approach the lock. The array at LD 15 will consist of 15 receivers. Four of the receivers will be installed such that they can detect tagged fish passing through the lock. The auxiliary lock at LD 15 will be undergoing maintenance in 2017 so will not be operational. A total of six receivers will be installed in the lock approach at LD 19. In addition to the 2-D array, Missouri Department of Conservation has a receiver inside and above the lock chamber at LD 19, and FWS maintains 3 receivers above the dam to help determine how many fish pass upstream through the lock.

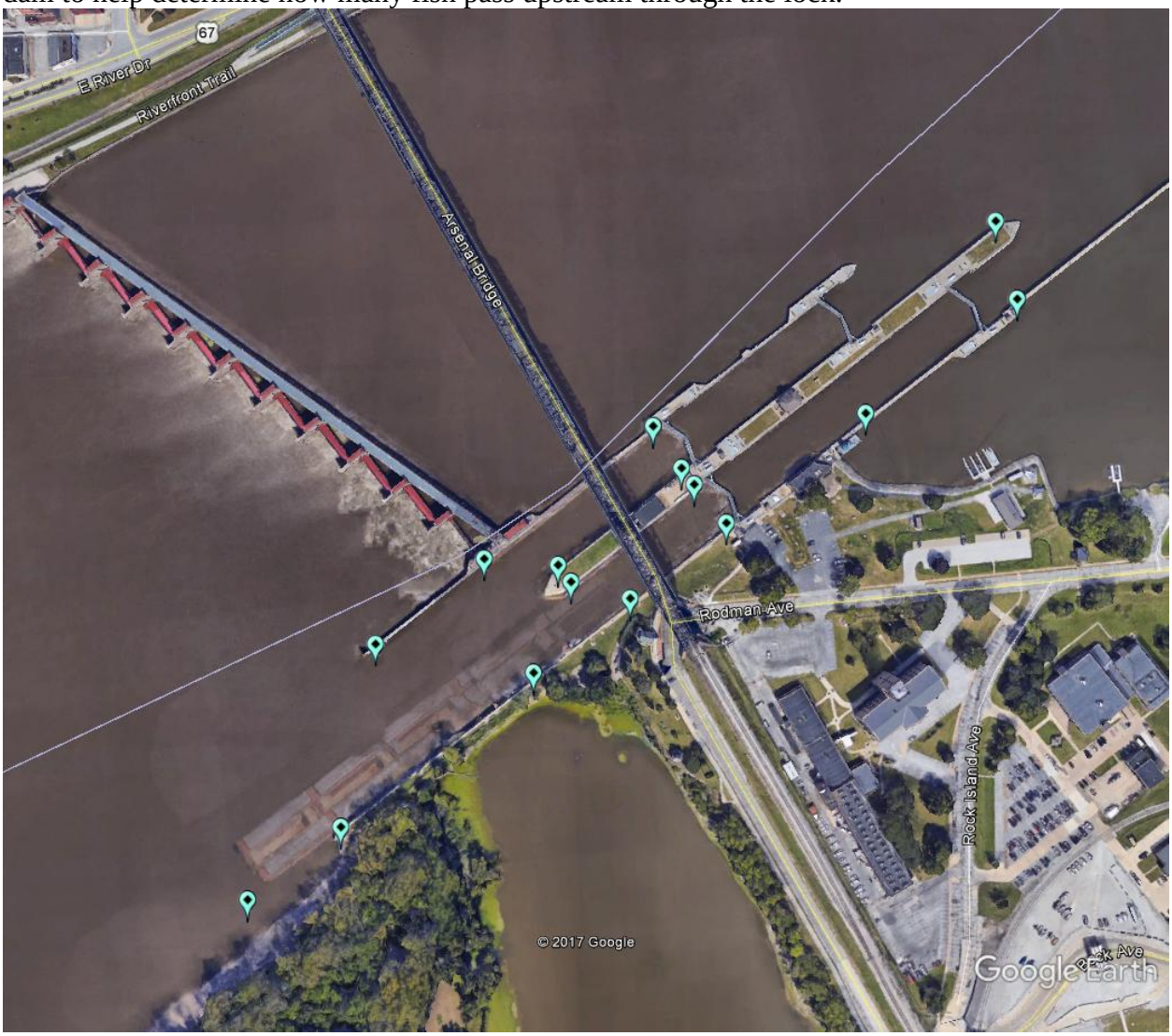


Figure 4. Location of receivers to be installed at Lock 15.

Figure 5. Location of receivers to be installed at Lock 19.

Egg and Larval Sampling

La Crosse FWCO conducted ichthyoplankton monitoring in Pools 8 through 13 in 2016, which was a continuation of efforts to monitor reproduction conducted by USGS and MN DNR in previous years. No Bighead, Silver, Grass or Bighead Carp were identified in the 2016 samples. La Crosse FWCO will continue ichthyoplankton sampling in the same area in 2017 with some modification to sample methods and study design.

Beginning April 2017, USFWS La Crosse FWCO staff will tow conical nets with very fine mesh (500 μm) in main channel, channel border, and backwater habitats scattered throughout Pools 8-13 of the Upper Mississippi River. Tows in the main channel target drifting eggs and larvae. Tows along channel borders and in backwater habitats where water velocity is reduced target mobile larvae (>24 hours post fertilization). Contents of the net are rinsed toward the cod end, placed in sample jars, preserved in 95% non-denatured ethanol, and returned to the laboratory for processing. In the laboratory, eggs and larvae are separated from detritus (lots and lots of detritus!), counted, and preserved for morphometric and, if necessary, genetic, identification.

Fishes are differentiated as larval or juveniles based on fin development. Fish recognized as having a full complement of fins are categorized as juvenile fish.

Juvenile monitoring
Juvenile and YOY sampling efforts by La Crosse FWCO, Columbia FWCO, and WIU resulted in noteworthy captures in 2016, expanding the area of known Silver Carp recruitment up into the upper reach of Pool 18.

USFWS Monitoring for juvenile Asian carp will take place in pools 14-20. Gears will include DC electrofishing and Dozer Trawling. Sampling will be broken into two parts: Population monitoring and Young-of-Year monitoring. Population monitoring will occur once in spring and once in fall in pools 16-20. It will consist of fixed sites and random sites in pools 16-20 and utilize DC electrofishing. Random sites will be selected at a rate of one sample per 1.5 river miles. Asian carp collected will contribute to population dynamics studies and data will be used to track long-term population abundance. Young-of-Year monitoring will occur in August and September in pools 14-19. Small tributaries, marinas, and backwaters will be targeted for sampling. Dozer trawling will be used in August, while DC electrofishing will be used in September to target larger juveniles. Asian carp collected will contribute to population dynamics studies.

Adult Monitoring
When feasible and with appropriate state agency approval, USFWS La Crosse FWCO will conduct large mesh gillnetting and electrofishing in Pools 2 through 13 at sites with appropriate Asian carp habitat (deep areas in plankton rich backwaters), where previous captures have been reported and/or in response to recent capture events. Stationary large mesh gill nets of depths from 2.4 to7.3 m with square mesh sizes of 8.9 to15.2 cm will be used to target adult invasive carps. Stationary trammel nets with outside wall square mesh sizes of 30.5 to 35.6 cm and inner square mesh sizes of 5.1 to10.2 cm will also be used to target adult invasive carps. Stationary experimental gill nets 76.2 m in length and 1.8 m deep consisting of 515.2 m compliments of net with square mesh sizes 19.1,25.4, 31.8, 38.1, 50.8 mm 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 15.6º C. Species, number, and condition (i.e., healthy, moribund, dead) of non-target species captured in nets will be recorded and reported. Any Asian carp captured in Pool 10 through 16 will be implanted with acoustic transmitters with appropriate state agency approvals. Asian carp captured above Lock and Dam 9 will be removed and sacrificed, and otoliths collected for age and microchemistry analysis. Eye tissue will be collected for ploidy analysis from Grass and Black carp.

Estimated Timetable:
A list of primary gears, sampling time periods, estimated annual sampling events and days spent sampling, and estimated annual effort for each gear used by USFWS to target invasive carps in Mississippi River Pools 8-19 for 2016.

Gear	Time Period	Sampling		Effort
		Events	Days	
Gill/Trammel Netting (Pools 8-13)	April - September	4	4	~ 20sets, 6,000 ft of net
Electrofishing (Pool 19)	April, Sept, Oct	5	15	50 EF runs
Larval Trawling	July-September	10	10	240 trawls
Dozer Trawl	August	1	4	40 trawls
Receiver Download (Pools 16-19)	April – November	8	16	1 crew, 2 people per crew, 16 days=32 staff days
Receiver Download (Pools 5A-15)	Spring and Fall	2	6	1 crew, 2 people per crew, 6 days per year =12 staff days
Manual Tracking	April-November	8	36	2 crews, 2 people per crew, 4 days per week, 8 weeks per year=128 staff days

Project Title: eDNA sample collection to support calibration of eDNA for use in surveillance of Bighead and Silver carp DNA in the Upper Mississippi River

Participating Agencies: U.S. Fish and Wildlife Service Midwest Fisheries Center (La Crosse Fish and Wildlife Conservation Office and Whitney Genetics Laboratory) and U.S. Geological Survey Upper Midwest Environmental Sciences Center

Statement of Need:
Sampling for DNA of Bighead and Silver carp in the Upper Mississippi River (UMR) began in 2015 as part of the early detection and monitoring program and has included pools 5a, 6, 8, and 9 and portions of the St. Croix River. In this time about 1600 samples have been collected with only one positive detection even though live Asian carp have been captured in some of the sampled pools. In 2015, 5 bighead carp were captured in the St. Croix River and in 2017 a silver carp was also captured there. Additionally, in 2016 two bighead carp were captured within the sampling reaches, one in Pool 8 and one in Pool 5a. A calibration study to determine effective sample density has never been conducted for the Upper Mississippi River and instead, these events have been designed based on calibration and sampling suggestions for the Illinois River. Therefore, it is unknown whether the overwhelmingly negative results in past UMR events are actually reflective of the Asian carp presence in the sample reaches. Rather, these negative results may be a function of detection power, and could be providing false security for river managers. Because of these lingering questions, eDNA sampling in 2017 will be conducted for the purpose of providing field data to support research efforts to refine our understanding of eDNA use for surveillance of Asian carp in the Upper Mississippi River.

Objectives:
1) Better inform when, where, and what sample size is adequate to effectively use eDNA as an Asian carp monitoring tool in the UMR.
2) Determine detection probability of eDNA in the UMR.
3) Determine the optimal spatial sampling pattern and design for eDNA as a monitoring tool in the UMR

Project Activities, Methods, and Timetable:
Collection of eDNA samples will take place in three habitat types in and adjacent to Pool 18 of the UMR at three time points in 2017. This pool was chosen because there are multiple years of telemetry data documenting the large-scale movements of tagged bighead and silver carp. Based on these data, three habitat types were identified that have been shown to have varying levels of Asian carp occupancy throughout the year: backwater, tributary, and above spillway structures. Unpublished telemetry data from Pool 18 show that tagged fish move between and among these habitat types throughout the year based on water temperature, water level, and spawning activities (Kyle Mosel USFWS, personal communication). Specific locations have been identified within and adjacent to Pool 18 that represents these habitat types: Boston Bay (backwater), Iowa River (tributary), and above dam 18 and 17 spillways (Figures 1-4). All three locations will be sampled during three time points to increase the probability of detecting Asian carp. Data from telemetry work will be used to inform the timing of each of these sampling events. In general, the first sampling will occur in the spring, when Asian carp are expected to be grouped in backwaters. The second will occur in late May to June with the intent of detecting

Asian carp in tributaries when temperature and water levels are optimal for spawning. The third event will occur in late fall as water level and temperature decrease and Asian carp group above spillway structures.

Unpublished eDNA and telemetry data from pools 17 and 19 was used to determine a robust sampling design for each habitat type per time point with a high probability of detecting bighead and silver carp (Chris Merkes and Richard Erickson USGS, personal communication). Merkes and Erickson have created an occupancy model which takes into consideration the high number of zero detections in eDNA monitoring as well as the probability of detection in all steps of the eDNA process (collection, concentration, extraction, and amplification). The model determined that a minimum of 100 eDNA samples (taken as 33 triplicate samples) should be collected in all habitat types at the three time points. Sampling points will be randomly assigned prior to sampling and additional points may be added to ensure coverage of all areas. Field blanks will be taken in addition to the 33 minimum triplicates at each location for QA/QC purposes. Samples collected in 2017 will be used to test the model recommendations and also add data to further refine the model. The La Crosse Fish and Wildlife Conservation Office will lead the field sampling and sample concentration steps. The Whitney Genetics Lab will extract and amplify the samples to determine whether they are positive or negative for bighead and/or silver carp DNA. Lastly, the Upper Midwest Environmental Science Center will be responsible for the refinement of the occupancy model.

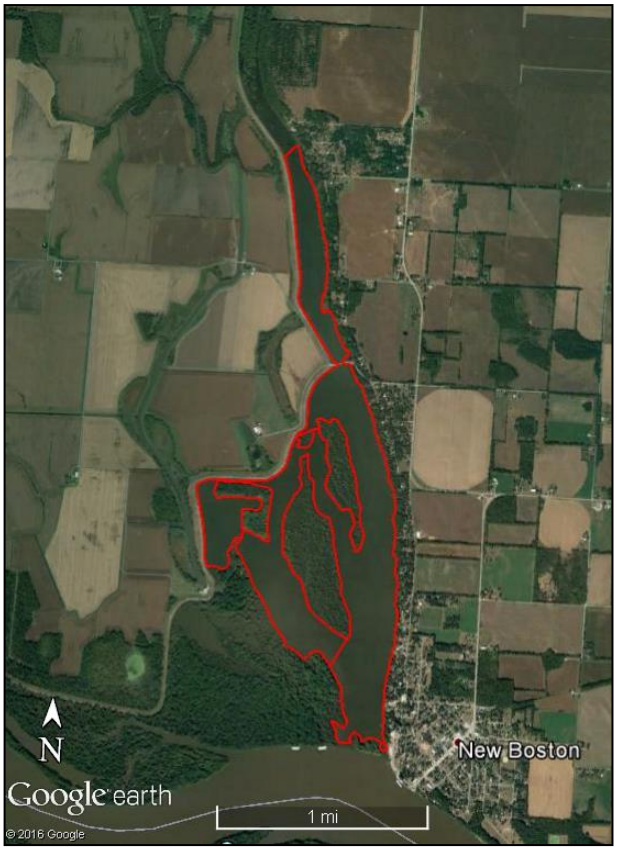


Figure 1. Areas of Boston Bay backwater to be sampled for Asian carp eDNA in 2017.

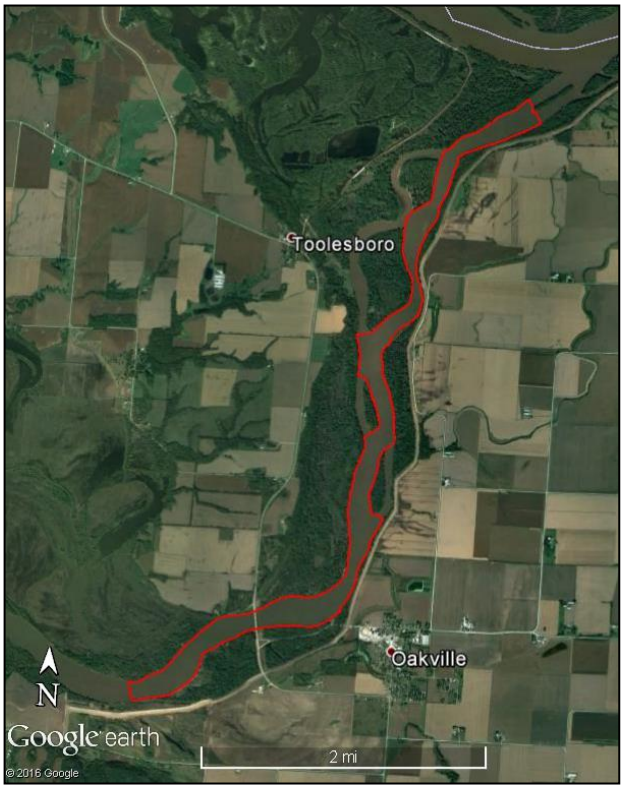


Figure 2. Area of the Iowa River to be sampled for Asian carp eDNA in 2017.

Figure 3. Area above the dam 18 spillway to be sampled for Asian carp eDNA in 2017.

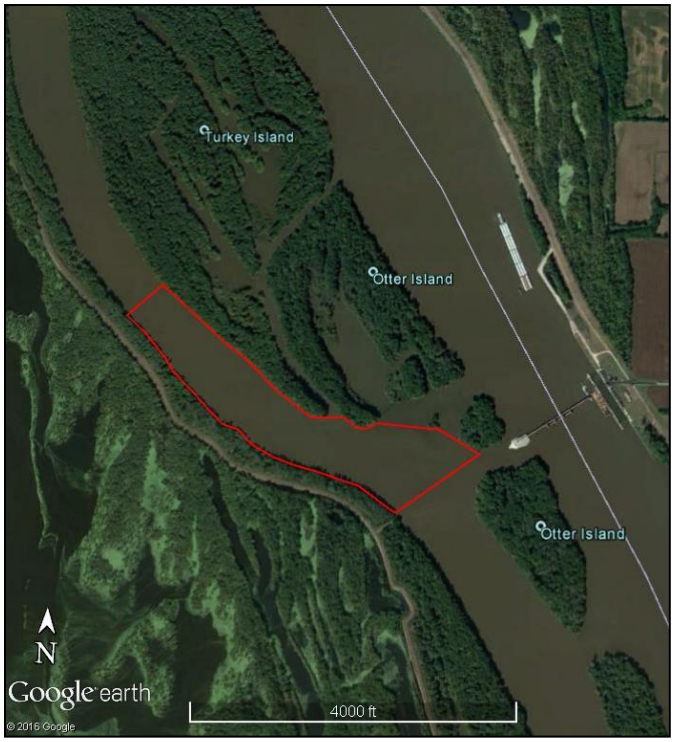


Figure 4. Area above the dam 17 spillway to be sampled for Asian carp eDNA in 2017.

Project Title: Deterrent Evaluation at Lock and Dam 8

Lead Agencies: University of Minnesota, U.S. Fish and Wildlife Service

Statement of Need:
The Minnesota Aquatic Invasive Species Research Center, with the Sorensen laboratory as project lead, installed acoustic speakers on the doors to the lock chamber at Lock and Dam 8 in June 2014. The speakers are still in operation. The Sorensen laboratory, with funding from the state of Minnesota and USFWS, has an evaluation of this work in progress. Field work began in spring of 2016 and will continue in 2017.

USFWS will assist the Sorenson laboratory in capturing and tagging Common Carp (as a surrogate for Asian carp) with acoustic tags. Fish will be monitored do determine fish movement in response to speaker operation.

Project Title: Pilot survey of fish community and behavior at Lock and Dams 14 and 15 in support of site evaluation for Asian carp deterrent technology

Participating Agencies: U.S. Fish and Wildlife Service, La Crosse Fish and Wildlife Conservation Office, Midwest Fisheries Center (Lead), Southern Illinois University

Statement of Need:
Asian carp are thought to negatively impact native fish communities in areas where their populations have been able to flourish in the Mississippi River and its tributaries below Lock and Dam 19. Lock and Dam 19 (19) of the Mississippi River, located near Keokuk, Iowa is one of the largest locks and dams on the river and has served as a bottleneck for the upstream movement of the invasive Asian carps because passage is only possible through the lock chamber. While mass movements of Asian carp into the Upper Mississippi River above 19 have been hindered, the population in the pools immediately above this location has increased and successful reproduction is now being documented (USFWS 2016).

Due to the confirmed shift of the reproductive front of Asian carp above 19, and in an effort to protect the Upper Mississippi River watershed from the potentially devastating impacts of Asian carp, state and federal entities have increased discussion regarding the implementation of technologies to deter the passage of Asian carp at specific locations. Lock and Dam 19 is being considered because it already serves as a bottle neck to Asian carp passage. Although a population has formed above this location, the addition of passage deterrents could cut off further movement of Asian carp from downstream, thereby decreasing additional population sourcing from below. In addition to 19 however, Lock and Dams 14 and 15 are also being considered because, similar to 19, most fish passage must occur through the lock chamber because these two dams infrequently go into uncontrolled, or open-river, condition where the gates are out of the water during times of flooding (Wilcox 1999). These two dams are also located at the upstream edge of the established and reproductive population above Lock and Dam 19. All options for deterring Asian carp at this location are on the table, but those under heaviest consideration at this time include sound and CO_2.

Should deterrents be implemented in one or all of these locations, evaluation of their effectiveness to deter Asian carp and native species migrations will be conducted. In order to evaluate the behavior and composition of the post-deterrent fish community, there is a need to collect pre-deterrent data so that changes to the community composition or behavior are more evident and measureable.

Objectives:
1) Evaluate behavior and movement of fish through the lower and upper miter gates of the main and auxiliary locks at Lock and Dam 14 (14) and the main and auxiliary locks at Lock and Dam 15 (15).
2) Identify size and spatial distribution of fish, and survey the fish community, adjacent to the downstream miter gates and in the approach channel of main and auxiliary locks
3) Identify size and spatial distribution of fish, and survey the fish community, within the lock chambers

Project Activities, Methods, and Timeline:
All data will be collected over the course of one week for the main and auxiliary locks at Lock and Dam 14 and one additional week in June for the main and auxiliary locks at Lock and Dam 15. The number of replicates in a day/week will depend on weather and navigational traffic. Due to the operating schedule of the auxiliary lock at 14, survey efforts at this location will be conducted on the weekend. This project will not impede navigational traffic and will instead be conducted in between barge tows and around recreational traffic. This project will require lock staff to be in communication with the USFWS lead on the boat when data is being collected as there will be occasions when lock chamber doors need to be opened and closed, and the pit will need to be filled and emptied upon request. The USFWS crew will have a marine radio on board for communication.

Objective 1: Fish behavior and movement through the lower and upper miter gates will be evaluated using an ARIS Explorer 3000 (Sound Metrics). The ARIS sonar camera is mounted to a boat to allow for imagery to be captured in multiple locations around the lock system. Imagery will be collected at two locations in each lock chamber (Figures 1-2). With the miter gates open, the boat will be tied to the open miter gates and the ARIS will collect fish passage imagery for 15 minutes at a time, viewing across the chamber at the lock entrance, perpendicular to flow.

After collection, fish passage imagery collected using the ARIS will be evaluated by three independent reviewers. Fish counts and movement will be analyzed and the averages of the three reviewers will be calculated. Comparisons will be made between the main and auxiliary locks at 14 and 15. Interpretation of these data can be subjective, so a fourth reviewer will be utilized in the event that one of the original three reviews is substantially different from the others for a particular image file.

Objective 2 & 3: Spatial and size distribution of fish will be identified in the downstream and upstream approach channels of the main and auxiliary locks (Objective 2) as well as the lock chambers (Objective 3) by conducting mobile hydroacoustics surveys (Figures 3-5). A boat with hydroacoustic equipment will begin by surveying the upstream approach channel, then proceed into the lock chamber (with full pit) and conduct a survey there. Once finished in the lock chamber, the pit will be emptied and another survey will be conducted in the downstream approach channel (may have to wait a half-hour for bubbles to clear from the area before beginning survey).

The fish community will be surveyed in these areas using boat-mounted pulsed DC electrofishing and one dip netter (Figures 3-5). Conductivity and water temperature will be measured and the LTRMP standardized electrofishing power settings table will be used to ensure appropriate power goals are met while electrofishing (Gutreuter et al. 1995). Fish will be identified to species, counted, and measured for total length (TL) except sturgeon and paddlefish, which will be measured for fork length (FL) and eye to fork length (EFL), respectively. All fish measuring over 254mm TL (10 inches) will be tagged with a uniquely numbered Floy tag.

Additionally, in the downstream approach channels just below the miter gates, and inside the lock chamber, the fish community will be sampled with 3-3.5” x 12-24’ gill nets (Figures 3-5). Nets will be set within 100 yards of the lock chamber doors in the approach channel (Objective

2) and in a zig-zag pattern inside the lock chamber (Objective 3) for up to 30 minute (as time between navigational traffic allows). Fish will be driven by pounding on the boat and then the nets will be pulled. Similar to fish captured by electrofishing, all fish will be identified to species, counted, measured, and Floy tagged (if applicable). Netting and electrofishing efforts will be conducted on at least two separate days to see if any tagged fish are recaptured. Catch per unit effort (CPUE) will be calculated for each gear and migratory and potentially migratory species will be identified (Wilcox et al. 2004).

Figure 1. Locations where stationary ARIS imagery will be collected in the main chamber (yellow) and auxiliary chamber (red) of Lock 14.

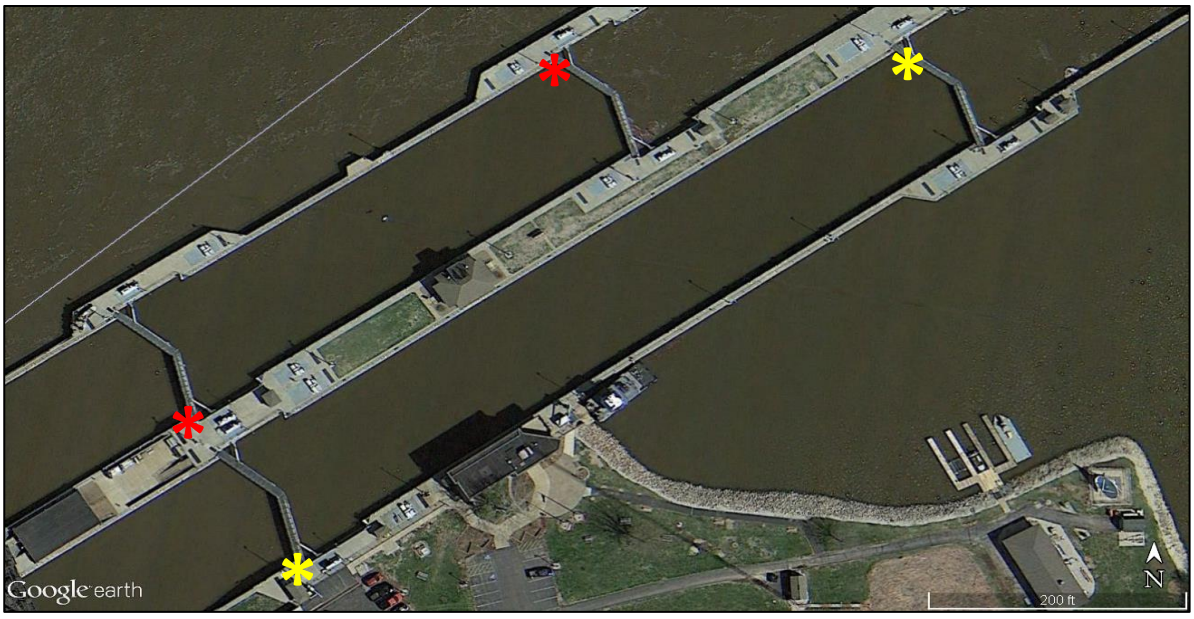


Figure 2. Locations where stationary ARIS imagery will be collected in the main chamber of Lock 15 (yellow).

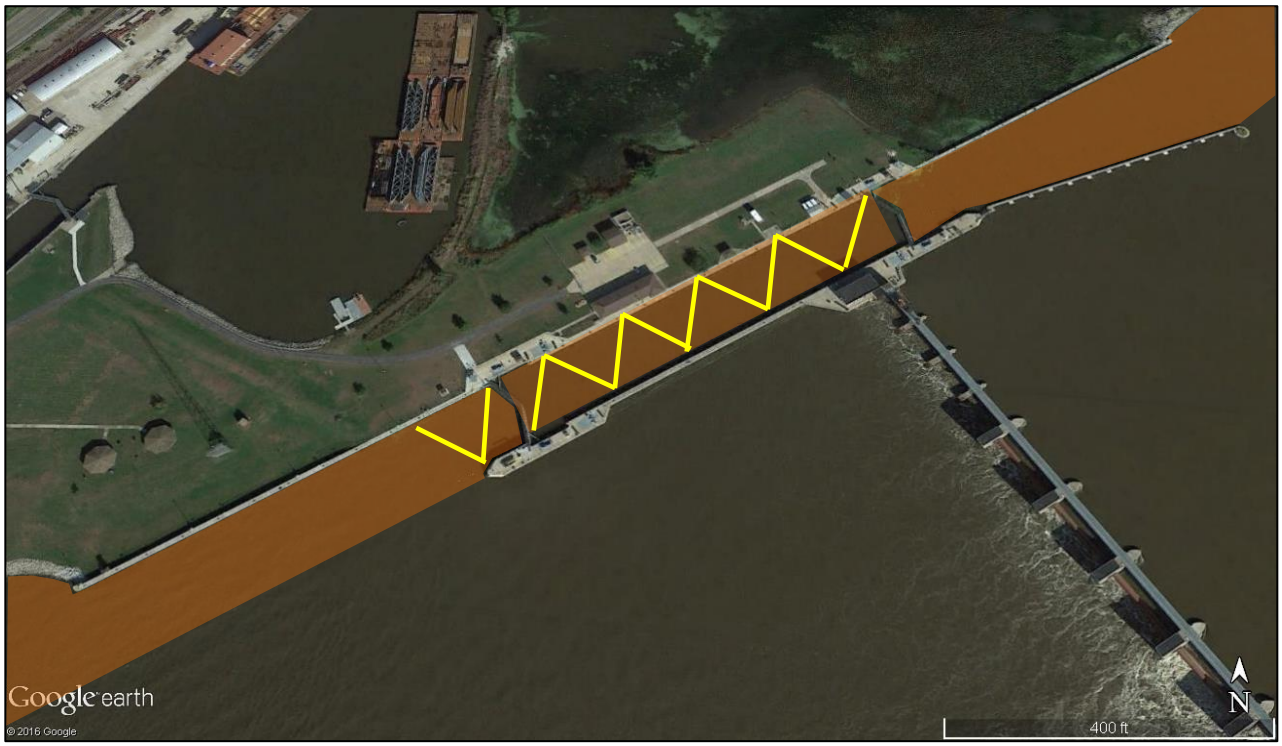


Figure 3. Areas where pulsed DC electrofishing and hydroacoustic surveys (orange) will be conducted, and gill will be nets (yellow) will be set at the main chamber of Lock 14.

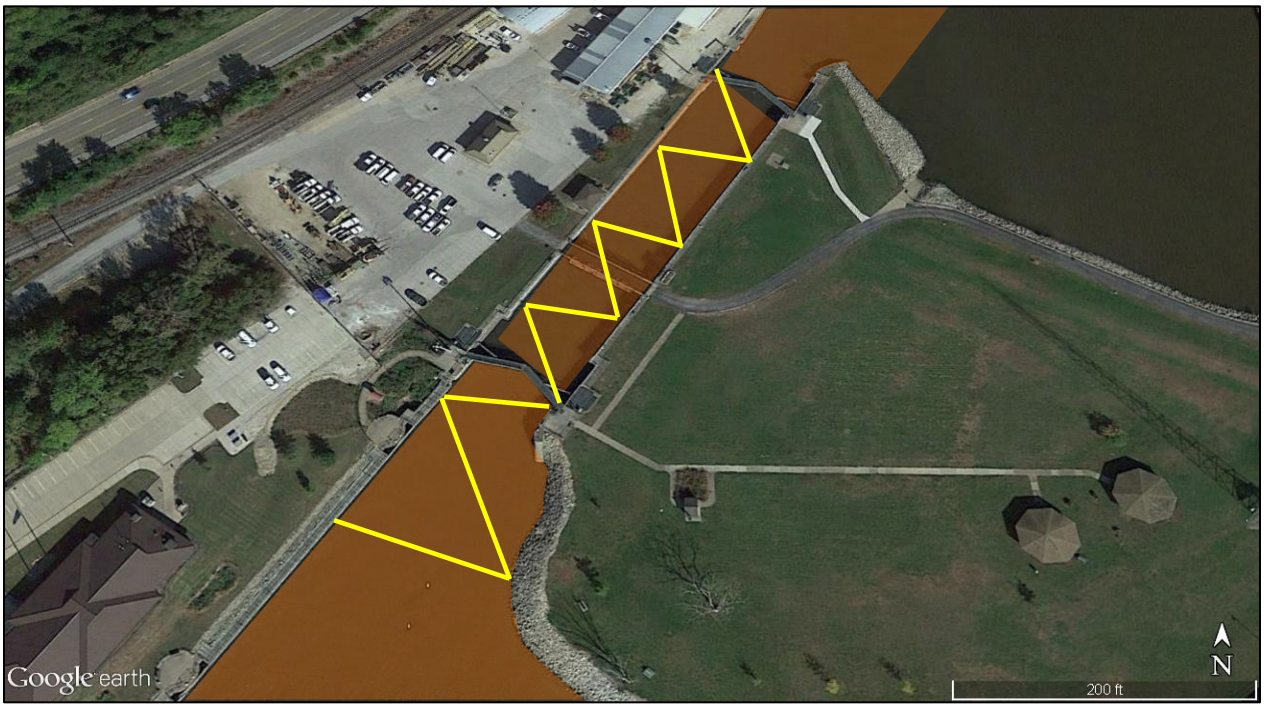


Figure 4. Areas where pulsed DC electrofishing and hydroacoustic surveys (orange) will be conducted, and gill nets (yellow) will be set at the auxiliary chamber of Lock 14.

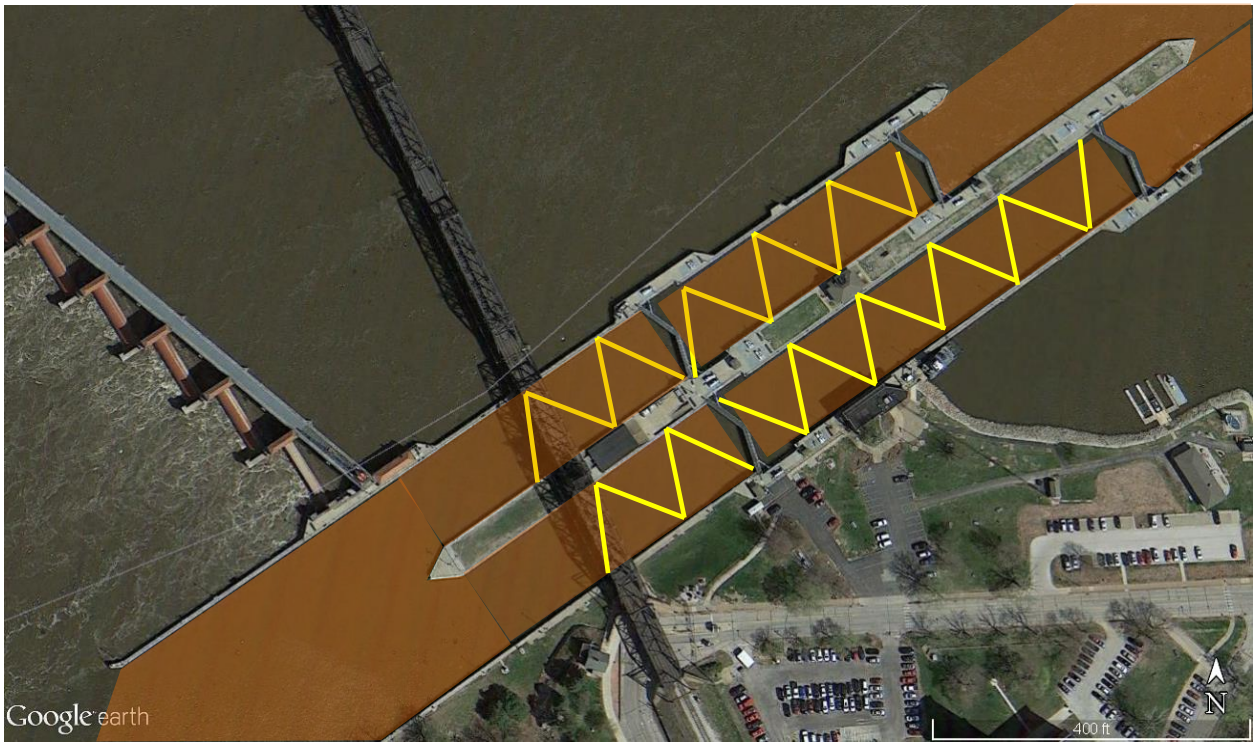


Figure 5. Areas where pulsed DC electrofishing and hydroacoustic surveys (orange) will be conducted, and gill nets (yellow) will be set at the main and auxiliary chambers of Lock 15.

Literature Cited:

Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. Long term resource monitoring program procedures: fish monitoring. National Biological Service, Environmental Management Technical Center, LTRMP 95-P002-1, Onalaska, Wisconsin.

Wilcox, D. B. 1999. Fish passage through dams of the Upper Mississippi River. Project status report, 99-05. Upper Mississippi River Long Term Resource Monitoring Program, United States Geological Survey, La Crosse, Wisconsin.

Wilcox, D. B., E. L. Stefanik, D. E. Kelner, M. A. Cornish, D. J. Johnson, I. J. Hodgins, S. J. Zigler, and B. L. Johnson. 2004. Improving fish passage through navigation dams on the Upper Mississippi River System. Upper Mississippi River- Illinois Waterway System Navigation Study ENV 54.

U.S. Fish and Wildlife Service, Midwest Region. 2016. Annual Report to Congress: Summary of Activities and Expenditures to Manage the Threat of Asian Carp in the Upper Mississippi and Ohio River Basins (*Draft*).

Appendix B.

Best Management Practices to Prevent the Spread of Aquatic Nuisance Species during Asian Carp Monitoring and Response Field Activities

Implementation of the project plans described in the Monitoring and Response Plan pose a risk of transporting and introducing aquatic nuisance species (ANS), including fish, plants, invertebrates, and pathogens. These best management practices (BMPs) are designed to be effective, easy to implement, and realistic; their use should reduce or potentially eliminate the threat of ANS spread by Monitoring and Response Plan activities. Further, BMPs combined with diligent record keeping can benefit the organizations participating in Monitoring and Response Plan activities by demonstrating that they are taking effective actions to prevent the spread of AIS.

For the purposes of these BMPs, all gear utilized in the process of field work that comes in contact with the water, including but not limited to those in the list below will be referred to as "sampling gear."

boats	eDNA collection gear	cast/beach/purse seines	hoop nets
trailers	personal gear	trammel nets	pound nets
electrofishing gear	ichthyoplankton nets	fyke nets	gill nets
hydroacoustic gear	cast nets	trawl nets	fish collection tubs

Field activities that have location-specific gear may need to do less to ensure that they are not transporting ANS or their genetic material. Examples might include boats, electrofishing gear, nets, or personal gear that are only used to sample one location. If potentially contaminated gear does not travel, the possibility of that equipment transporting ANS is reduced or eliminated. Maintaining duplicate gear for use in contaminated vs. non-contaminated locations or sampling all non-contaminated locations before moving on to contaminated locations may also reduce or eliminate the possibility of ANS spread.

Before traveling to a sampling location:

- ❒ ***Check*** gear and determine if it was previously cleaned. Accurate record-keeping can eliminate the need for inspecting or re-cleaning prior to equipment use. If you do not know if the sampling gear was cleaned after its last use, inspect and remove any plant fragments, animals, mud, and debris, and drain any standing water. If necessary, follow the appropriate "Clean" step(s) listed below.

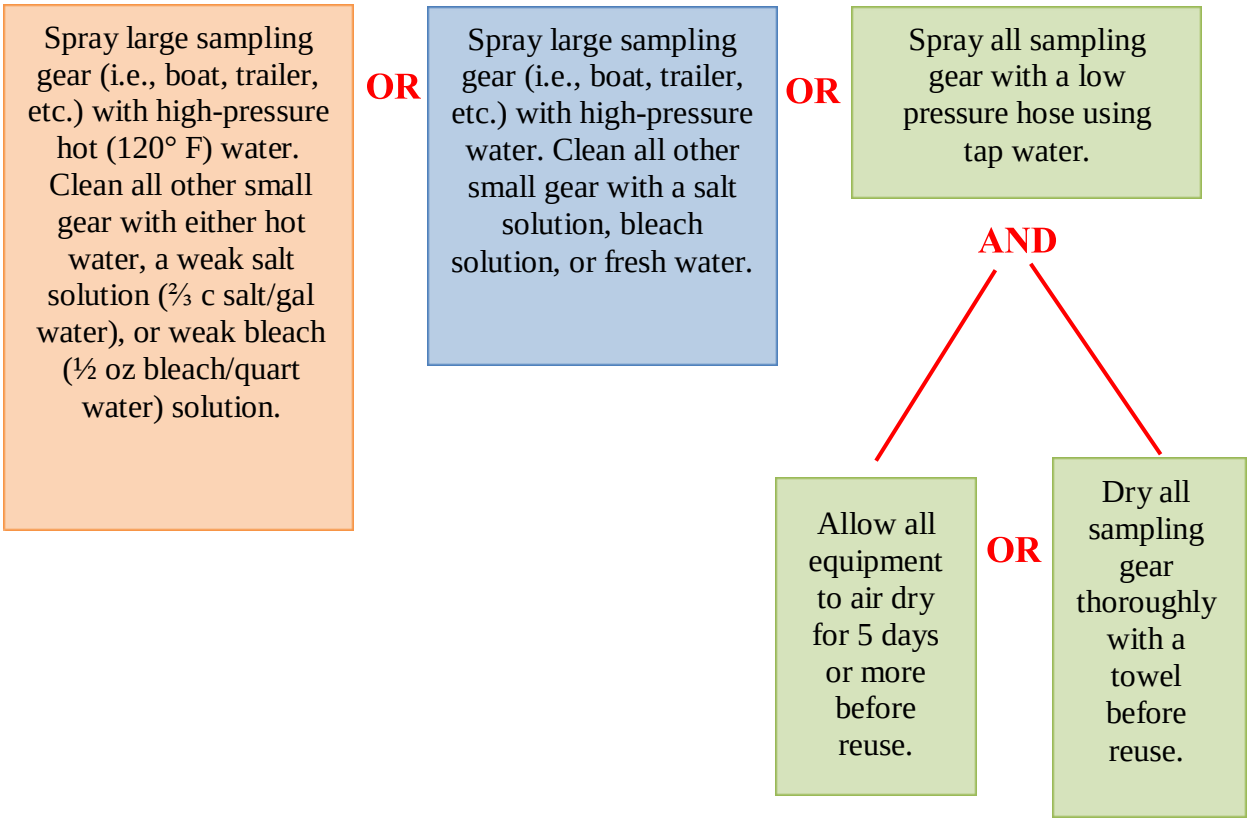
After each sampling event, *before leaving waterbody*:
The following steps should occur before gear is transported away from the waterbody to prevent transport of aquatic plants and animals by boats, trailers, and vehicles.

- ❒ ***Remove*** plants, animals, and mud from all sampling gear.
- ❒ ***Drain*** all water from boat and sampling gear.

After each sampling event, *before using gear at another location*:
The following cleaning/decontamination steps may occur either at the water access point

(preferred, if possible) or may be completed at the gear storage location.

- ❒ ***Clean*** all sampling gear. Select an option below based on the available equipment (i.e., high-pressure hot washer, pressure washer, and low-pressure hose). In general, pressure wash removes organisms while high temperatures will kill organisms. A three-minute pressure wash is effective at removing zebra mussel larvae and other microscopic organisms. Keep nozzle at a 90 degree angle to the boat and at least 12 inches away from the boat to prevent removing decals.



Keep Records:
Develop a Standard Operating Procedure (SOP) or checklist for cleaning equipment to make ANS prevention steps easy to follow and documentable. Complete the checklist for each sampling event with date, location, the recorder‘s name and what was done. These records over time demonstrate a solid commitment to AIS prevention, will help build a standard cleaning protocol, and will eliminating wasted time spent re-checking or re-cleaning equipment.

(Adapted by Illinois-Indiana Sea Grant from BMPs created by the Great Lakes Sea Grant Network.)

Appendix C.

Upper Mississippi River Collection Protocol For Bighead, Silver, Black, and Grass Carp

UMRCC Asian Carp Ad-hoc
August 2017

Table of Contents

Introduction

Asian carp (Silver, Bighead, Black, and Grass Carp) specimens and structures from those specimens can provide valuable data needed for managing Asian carp in the Upper Mississippi River (UMR) basin. Natal origin of the fish can sometimes be determined with microchemistry analysis of otoliths, and age data from collected structures and gonad analysis is vital for understanding population dynamics.

This document contains three simple steps for general Asian carp capture reports from novel areas that may be received by resource agency personnel; an inter-agency communication protocol for note-worthy captures of Asian carp in the UMR basin; and for reference, detailed instructions for collection of structures from individual Asian carp.

Species of Interest and their Novel Locations

This protocol should be followed for all four species of Asian carp (Bighead, Silver, Grass, and Black) collected in the UMR basin if the individual was captured from a novel area for that species as defined below (current as of August 2017):

Adult Silver and Bighead Carp – Pool 15 and upstream including all tributaries
YOY and juvenile Silver and Bighead Carp (< 250 mm) – Pool 19 and upstream including all tributaries
Black Carp – any location in the UMR basin
Grass Carp – Pool 12 and upstream including all tributaries

What to do if Someone Reports an Asian Carp

Collect, Cool, Call

1. **Collect/Cool** Collect information on date, location, name and contact information of person that captured/recovered the fish, and a photograph of the fish if possible. If the fish is delivered to you, put it on ice immediately, do not freeze the fish.

2. **Call** Follow the **Interagency Communication Protocol** and contact the appropriate **State Agency Asian Carp Authority** (listed below) to get direction and approval for collection, communication, and disposition of the fish. If you already have the fish, you should also call one of the **UMR Asian Carp Contacts** listed below and they will arrange to get the fish from you.

3. **Collect/Cool** Upon approval from the appropriate **State Agency Asian Carp Authority**, acquire the fish and put it on ice - **DO NOT FREEZE**– but if the fish is already frozen, it is still a valuable sample. If the fish is available but you are not able to pick it up, please contact one of the **UMR Asian Carp Contacts** or **Designated Collectors** listed below and they will make arrangements to do so and/or they will pick up the fish from you.

State Agency Asian Carp Authorities

Minnesota: Nick Frohnauer office: (651)259-5670; cell (218)464-3554
Wisconsin: Jordan Weeks office: (608) 785-9002 **OR** Jeff Janvrin office: (608)785-9005; cell: (608)386-0341
Iowa: Kim Bogenschutz office: (515)432-2823 x103 **OR** Scott Gritters office: (563)872-4976; cell: (563)880-8781
Illinois: Kevin Iron office: (217)557-0719; cell: (217)685-3103 **OR** Illinois ANS office dnr.ans@illinois.gov or (217)785.8772
Missouri: Sara Tripp office: (573)243-2659 x1041

UMR Asian Carp Contacts

Byron Karns, NPS, St. Croix Falls, WI cell: (651)315-0307
Nick Frohnauer, MN DNR, St. Paul, MN office: (651)259-5670; cell: (218)464-3554
John Waters, MN DNR, St. Paul, MN cell: (651)587-2781.
Jordan Weeks, WI DNR, La Crosse, WI office: (608) 785-9002
Jeff Janvrin, WI DNR La Crosse, WI, office: (608)785-9005; cell: (608)386-0341
Brent Knights, USGS, La Crosse, WI office: (608)781-6332
Ann Runstrom, USFWS La Crosse, WI office: (608)783-8433; cell: (608)769-7481
Scott Gritters, IA DNR Bellevue, IA office: (563)872-4976; cell: (563)380-8781
Kim Bogenschutz, IA DNR Boone, IA office: (515)432-2823 x103
Michael Weber, ISU, Ames, IA office: (515)294-7344
Mark Cornish, ACOE, Rock Island, IL office: (309)794-5385; cell: (309)912-3024
Kevin Irons, IL DNR, Springfield, IL office: (217)557-0719; cell: (217)685-3103
Matt O'Hara, IL DNR, Springfield, IL office: (217)785-9742; cell: (217)685-3143
Jim Lamer, WIU, Warsaw, IL office: (217)256-4519; cell: (217)357-5106
Sara Tripp, MDC, Jackson, MO office: (573)243-2659 x1041
Duane Chapman, USGS, Columbia, MO office: (573)355-0257; cell: (573)876-1866
Greg Whitledge, SIU, Carbondale, IL office: (618)453-6089
Grace Loppnow, USFWS, Marion, IL office: (618)997-6869 x115

Designated Collectors

John Waters, MN DNR, St. Paul, MN cell: (651)587-2781
Brent Knights, USGS UMESC, La Crosse, WI office: (608)781-6332
Ann Runstrom, FWS FWCO, La Crosse, WI office: (608)783-8433; cell: (608)769-7481
Kim Bogenschutz, IA DNR, Boone, IA office: (515)432-2823 x103
Jim Lamer WIU, Warsaw, IL office: (217)256-4519; cell: (217)357-5106
Sara Tripp, MDC, Jackson, MO office: (573)243-2659 x1041
Patrick Kroboth, USGS CERC, Columbia, MO office: (573)875-5399 x1548
Greg Whitledge, SIU, Carbondale, IL office: (618)453-6089

Interagency Communication Protocol

Designated collectors or other biologists able to follow this collection protocol must contact the **State Agency Asian Carp Authority** from the state in which the fish was collected to get direction and approval for collection, communication, and disposition of the fish and structures. The collector and **State Asian Carp Authority** should discuss and assign responsibility for reporting the capture to the USGS Nonindigenous Aquatic Species searchable database: http://nas.er.usgs.gov/ Please contact Amy Benson (abenson@usgs.gov) for questions regarding collection data. For particularly noteworthy captures, State Authorities should notify UMR partners by contacting the other **State Agency Asian Carp Authorities** and **UMR Asian Carp Contacts**, or they may contact La Crosse FWCO (Ann Runstrom, office: (608)783-8433; cell (608)769-7481 who will then notify those representatives.

Collection Protocol for Silver and Bighead Carp

1. Record date and time of capture, location captured (GPS coordinates) and local names/descriptors, species, mode of collection, who collected it and their contact information.
2. Record total length (Do not pinch the caudal fin together, bend the lower lobe of the caudal fin so it makes a straight line with the body of the fish, maximizing length), fork length, weight, girth (at point just in front of dorsal) measurements.
3. Refer to these examples and take photos of the following:

Figure 1. Lateral view of entire left side of a two Silver Carp.

Figure 2. Ventral view of a hybrid carp showing the length of the keel**.**

Figure 3. Photo showing gill rakers for species identification. Left to right, gill rakers of Bighead, hybrid, and Silver Carp. Collection protocol does not require gill raker removal, photo of gill raker may be taken with fish intact.

Figure 4. Photo showing an abraded pelvic fin area, or "spawn patch". Take pictures of this area and note if red abraded area or scale loss (spawn patch) is observable.

4. Record any notes you have on the fish regarding appearance, including presence/absence of peritoneal fat, lesions from parasites, appearance of gonads, etc.
5. Take 3 small fin clips (about thumbnail size). With a pencil, label a tube/vial with species, date, and location and put it in the vial or label the outside of tube. For long term-storage, preserve with 95% non-denatured ethanol. If 95% non-denatured ethanol is unavailable ≥ 70% isopropanol (rubbing alcohol) can be used and the sample can be transferred to 95% ethanol later. If no alcohol is available, place a small fin clip or several scales in an envelope (e.g., scale envelope) and allow to dry thoroughly.
6. Examine gonads and determine sex and developmental condition. Examine photos in Appendix B for reference. Avoid disturbing the ventral surface between the pelvic and pectoral fins (area of spawn patch) while examining/removing gonad samples. To find the gonads, tease the viscera either left or right to expose the "crease" between the gas bladder and the cavity wall (Figure B-7). Expect to find the gonads in the crease. If the fish is mature, remove both branches of the gonads. Remove any excess fat attached to gonads. Fat tissue is smooth and yellow to white in color, ovaries are grainy and lattice-like, and testes are smooth and almost white in color. Take pictures and weigh whole gonads. If branches are not mirror images, samples should be taken from both branches along the extent of the branch from anterior to posterior end. If they are mirror images, samples can be taken from one side or the other. Place 5 eraser-sized gonad samples in a histology cassette. Place cassette in provided vial with 10% buffered formalin. The ratio of 10% buffered formalin to sample volume should be approximately 9 to 1. Label cassette with species, collection date, collection location, sex, total length (mm), weight (kg), and total weight of the gonad (g). When packing this sample, wrap the bottle to insulate it so it does not freeze if placed next to the frozen carcass.
7. If shipping the whole carcass, freeze it (after collecting gonad samples) and then proceed to shipping procedures in the following section. If sending structures only, continue to the next step.

8. Remove aging structures: scales, postcleithra, pectoral spine, dorsal spine, and vertebrae anterior to dorsal fin, and all 3 otoliths (Appendix A) if possible.
9. Remove and freeze the spawn patch area from females (Figure 4). Be sure not to cut between pelvic fins when excising the area. Leave the pelvic fins on the sample, cutting right behind the pectoral fins and as wide as possible without cutting the ribs.
10. Take a fin clip, thoroughly dry and place in a scale envelope for stable isotope studies.
11. Make a copy of completed collection form and keep the copy as a backup should shipment get misplaced.
12. Proceed to sample preparation for overnight shipment and shipping procedures.

UMR Bighead and Silver Carp Collection Form

Waterbody: _____ Species: _____

Pool:_____ River Mile:_____

Capture Location Description including nearest municipality:_____

_____

_____

GPS Location: N:_____W:_____Datum_____

Date of Capture: _____Water Temp (or estimate):_____ °F or °C(circle one)

Entity that Captured fish (Circle one):

Angler, Commercial Fisher,

Contracted Commercial Fisher

Agency:_____

Other:_____

Gear (Circle one):

Gill Net, Bow, Seine, Trap Net,

Electrofishing – Boat or Backpack,

Other:_____

Capture Entity's Contact Information (Name, phone #, email):_____

_____

Collector: _____Agency: _____

Agency Point of Contact:_____

Phone: _____ Email: _____

Total Length (mm):_____ Fork Length (mm): _____ Girth (mm): _____

Total Weight (g): _____

Sex (Circle one): Male Female Unknown

Total gonad sample weight (g): _____

Gonad branches mirror images? Yes No

Comments:_____

_____

_____

Date shipped: _____ Carrier: _____

Tracking Number_____

Sample Preparation for Overnight Shipment of Bighead and Silver Carp:

a) Pack entire frozen specimen or structures in an insulated container with plenty of ice packs, frozen water bottles, or ice to keep cool. Do ***NOT*** use dry ice for shipping.
b) Include collection data sheet, printed on waterproof paper, and placed in double ziplock bag in container with samples.
c) Seal container thoroughly to contain potential leaks. If using a styrofoam cooler within a box, make sure the lid is taped and sealed securely.
d) Ship immediately or keep frozen until ***First Overnight*** shipping arrangements are made.

Shipping Procedures for Bighead and Silver Carp:

a) Contact Columbia Environmental Research Center personnel (below) to make ***First Overnight*** (for morning delivery) shipping arrangements for the collection samples.
b) Do ***NOT*** ship samples until arrangements have been made for receipt of package.
c) Ship specimen and data sheet in sealed, insulated container (see sample preparation instructions below).
    a. FedEx First Overnight to the attention of Duane Chapman or Joe Deters.
    b. Send via FedEx government rate.
d) Email confirmation of shipment, tracking numbers, scanned copy of completed collection form, and digital images to dchapman@usgs.gov.

Contact Information:

Duane Chapman
573-875-5399
573-289-0625 (mobile)
dchapman@usgs.gov

Joe Deters
573-875-5399
573-239-9646 (mobile)
jdeters@usgs.gov

Shipping Address:

Duane Chapman or Joe Deters
Columbia Environmental Research Center
U.S. Geological Survey
4200 New Haven Road
Columbia, MO 65201

Black Carp Watch and Bounty

Black Carp are molluscivores, meaning they eat freshwater mussels and snails. Freshwater mussels are the most endangered fauna in the world, and Black Carp pose a significant threat to existing populations. Black Carp are reproducing in the Mississippi Basin and catches have increased in frequency.

Illinois DNR offers a $100 bounty to members of the public for any wild captured Black Carp from the Upper Mississippi River basin. If you suspect you have a Black Carp, keep the fish cold **(DO NOT FREEZE)** and take a good photograph. Contact the appropriate **State Agency Asian Carp Authorities** listed below. For information on the $100 bounty contact one of **Black Carp Bounty Contacts** and send them the photograph of the fish to verify species identification.

State Agency Asian Carp Authorities

Minnesota: Nick Frohnauer office: (651)259-5670; cell (218)464-3554
Wisconsin: Jordan Weeks office: (608) 785-9002 **OR** Jeff Janvrin office: (608)785-9005; cell: (608)386-0341
Iowa: Kim Bogenschutz office: (515)432-2823 x103 **OR** Scott Gritters office: (563)872-4976; cell: (563)880-8781
Illinois: Kevin Irons office:(217)557-0719; cell: (217)685-3103 **OR** Illinois ANS office dnr.ans@illinois.gov (217)785.8772
Missouri: Sara Tripp office: (573)243-2659 x1041

Black Carp Bounty Contacts

Kevin Irons, Illinois DNR, office: (217)557-0719; cell: (217)685-3103
Matt O'Hara, Illinois DNR, office: (217)785-9742; cell (217)685-3143
Duane Chapman, USGS, Columbia, MO office: (573)355-0257; cell: (573)876-1866
Greg Whitledge, Southern Illinois University, Carbondale, IL office: (618)453-6089

Black and Grass Carp Identification

Black and Grass Carp are very similar in appearance and it is very difficult to tell them apart based on external characteristics. These photos and general characteristics might help. Good photographs sent to the right person can sometimes determine the correct identification.

Black Carp

Grass Carp

Figure 5. Lateral views of the head of Black and Grass Carp. The adult Black Carp mouth is more subterminal and the operculum is longer than in Grass Carp. The Black Carp head is generally narrower and more cone-shaped, whereas the Grass Carp head tends to be more round and blunt. However, the difference can be subtle.

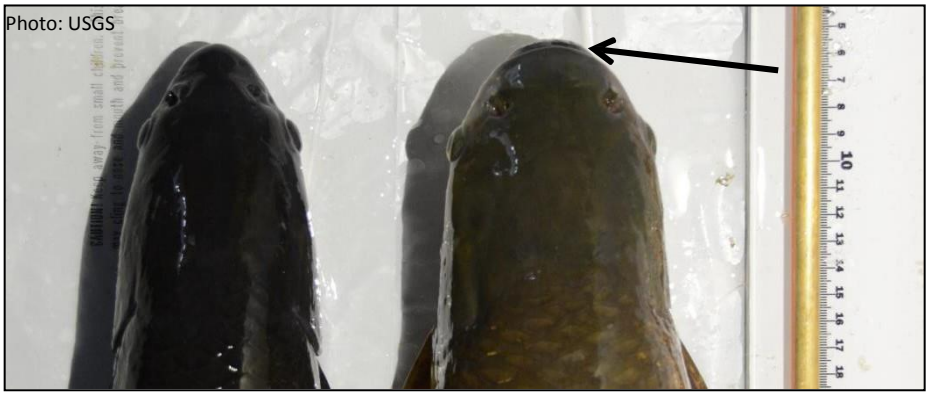


Figure 6. The subtle difference in the lips of adult Black and Grass Carps viewed from directly above the head with mouths fully closed. The upper lip of a Grass Carp is visible from above but that of a Black Carp is generally not when the mouth is fully closed. The upper lip of young Black Carp may also be visible from above, so this comparison is only useful in adults.

Figure 7. The angle of the lateral line in Black and Grass Carps. If the carcass is in good condition, "the lateral line of a Black Carp remains relatively straight moving posteriorly from the operculum, with a slight dip around the dorsal fin. The lateral line on Grass Carp takes an initial ventral dip (about 10°) for the first 6-8 scales" (Patrick Kroboth, USGS).

Black Carp

Grass Carp

Figure 8. Multiple images comparing the general appearance of Black Carp vs. Grass Carp. Black Carp tend to have longer pectoral fins. The coloration of Black Carp is described as, "Black, blue gray, or dark brown and the fins in particular are darkly pigmented. In contrast, coloration of Grass Carp is often described as olivaceous, silvery white, or as olive- brown above and silvery below and most fins are dusky. Nevertheless, color may not always be reliable" (Nico et al. 2005).

Collection Protocol for Black and Grass Carp

This information was copied from the April 2017 draft of the document "Shipping, Handling, and Data Protocols for Wild Captured Black Carp and Grass Carp"

Any suspect Black Carp collected in the wild in the United States and Grass Carp collected in the novel locations in the UMR (see p. 1) or other novel areas in the U.S., should be immediately reported to the appropriate resource management agency in the state where the fish was collected (see **State Agency Asian Carp Authorities** p. 1 or p. 9). These protocols are ***not*** intended for Grass Carp collected from established populations in the Middle and Lower Mississippi River Basin or authorized stocking locations. Do ***not*** release any suspect Black or Grass Carp collected in the Upper Mississippi River or Great Lakes Basin, unless required by state laws or instructed to do so by the appropriate resource management agency.

Differentiating Black Carp from Grass Carp using diagnostic external characteristics can be very challenging, especially when the two species are not being compared side-by-side. Careful attention should be given in waters where Grass Carp are known to occur to confirm that captured individuals are indeed Grass Carp and not Black Carp. If you are not positive of the species identification you should take a good photograph and report the collection to the appropriate resource management agency to get assistance and further instructions.

Collection information, basic biological data, and digital images should be collected for any suspect Black or Grass Carp as soon as possible after capture. In addition to collection and basic biological data, we are interested in collecting multiple structures and organs from each fish for management and research purposes. Protocols are provided for 1) collection information, basic biological data, and digital images; removal, preparation, and shipment of eyes for ploidy analysis; and 3) preparation and shipment of Black and Grass Carp carcasses.

These protocols are intended to provide resource management agencies, or authorized personnel, with complete instructions for the proper collection, preparation, and shipping of data, samples, and carcasses for the collection of as much biological information as possible. It is important that all collections of Black and Grass Carp (from the identified locations above) are immediately reported to the appropriate resource management agency in the state where the fish was collected. Ploidy results and field collection data from wild-caught Asian carps will be incorporated into the USGS Nonindigenous Aquatic Species searchable database: http://nas.er.usgs.gov/. Please contact Amy Benson (abenson@usgs.gov) for questions regarding collection data.

Data Collection for Black and Grass Carp

1. Fill out Data Collection Form (Attached).
2. Record GPS Location (if available, otherwise a description of collection location);
3. Record date of capture, method of capture, and collecting individual or agency. Record fish weight, girth (Figure 9), total and fork lengths, and species (number samples if necessary);
4. Take high resolution digital pictures:
   a. Lateral view of fish's entire left side (Figure 9)
   b. Close-up lateral view of head (Figure 10)
   c. Dorsal view of head with mouth ***fully*** closed taken from directly above the fish's head (Figure 11)
   d. Ventral view of the head with the mouth closed (Figure 12)
5. Record name, telephone number, and/or email address for point of contact;
6. E-mail data and digital images to Jennifer Bailey at jennifer_bailey@fws.gov;
7. Proceed to **Eyeball Removal of Black and Grass Carp and Sample Preparation for Overnight Shipment.**

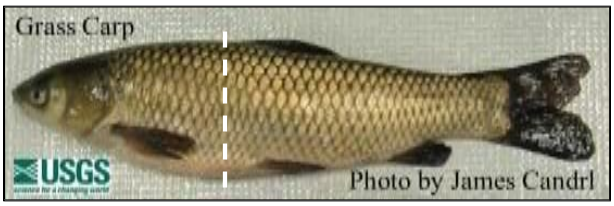


Figure 9. Example of step 4.a: Lateral view of fish's entire left side. Dashed white line indicates location for girth measurement.

Figure 10. Example of step 4.b: Close-up lateral view of head.

Figure 11. Example of step 4.c: Dorsal view of head with mouth fully closed.

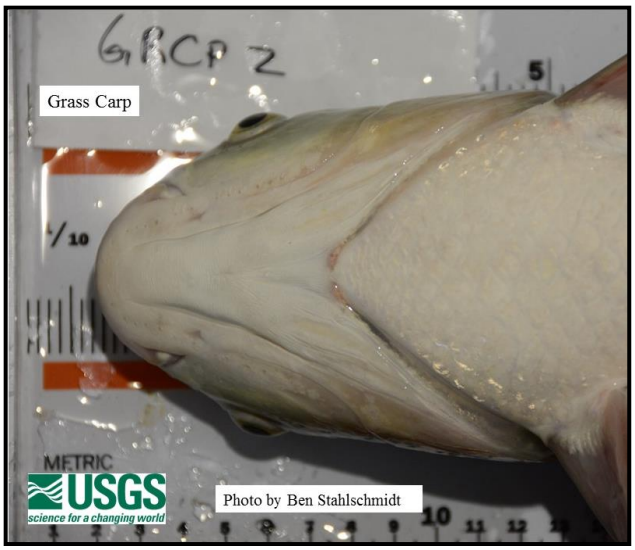


Figure 12: Example of step 4.d: Ventral view of the head with mouth closed.

Data Collection Form for Black and Grass Carp

Include with Shipment of Eyeballs and Gonads: Do Not Freeze

GPS Location: N:_____ W: _____

Date of Capture: _____ Water Temp (or estimate): _____

Collector:_____ Agency: _____

Species:_____ Capture Method: _____

Weight (g):_____ Girth (mm):_____ Sex: _____

Total Length (mm):_____ Fork Length (mm): _____ Gonad wt. (g) _____

Are gonad branches mirror images? (y/n): _____ Total Gonad sample wt. (g) _____

Point of Contact: _____

Phone:_____ email: _____

Black and Grass Carp Eyeball and Gonad Contact Information

Jennifer Bailey 608-518-0128, jennifer_bailey@fws.gov
Sara Erickson 608-783-8418, sara_erickson@fws.gov

Shipping Address:
La Crosse Fish Health Center
US Fish and Wildlife Service 555 Lester Ave
Onalaska, WI, 54650
608-783-8444

Supplies for Eyeball Removal of Black and Grass Carp

Materials:

- Forceps; scalpel; blunt or curved scissors
- Permanent marking pen
- 50-100 ml plastic containers with leak-proof screw top cap
- Sealable plastic bags to fit several 50-100 ml containers
- Contact lens solution or saline (0.8-1.0% NaCl in DI water)(1 g NaCl per 100 ml of DI water)
- MS-222 or other means of euthanasia
- Cooler or insulated container with ice packs, packing tape to seal cooler

NOTE: Contact the La Crosse Fish Health Center if you have questions regarding the materials needed or to request assistance with preparing a kit for sample preparation and shipment.

Eyeball Removal of Black and Grass Carp and Sample Preparation for Overnight Shipment

*Do not collect eyeball samples from fish captured in the Lower Mississippi River.

Do Not Freeze!

1. Euthanize fish with an overdose of tricaine methanesulfonate (MS-222) or sharp blow to head.
2. Label a small, plastic container with collection date, species, and sample number (e.g. 25MAR13, Black Carp, #12).
3. Use forceps to hold the eyeball steady. Taking care not to puncture the eyeball, insert scalpel blade between the eyeball and socket wall with the blade pointed outward toward the socket wall. Cut around the circumference of the eyeball until the eyeball moves freely in the socket.
4. Use the blunt or curved scissors to reach behind the eyeball and cut the optic nerve. Once the optic nerve is cut, you should be able remove the eyeball and trim off any excess tissue.
5. Remove the other eyeball and place both eyeballs in the labeled container.
6. Pour contact lens solution or saline into the labeled container until full. Both eyeballs should be completely immersed. Close lid tightly. Maintain at 4 to 8°C. **Do Not Freeze.**

Contact Jen Baily or Sara Erickson at USFWS La Crosse Fish Health Center on day of collection or as soon as possible to make Overnight Shipping arrangements. If fish are collected live, blood samples may be collected 1:1 in Acid Citrate Dextrose (ACD) as an alternative to eyes. Keep samples on ice and ship overnight.

1. Pack samples in a Ziploc bag to prevent leakage and then enclose in a sealed, insulated cooler with ice packs to maintain 4 to 8°C. **Include collection data form with package**. Tape lid securely.
2. Ship priority overnight to La Crosse Fish Health Center (address on data collection form).
3. Email confirmation of shipment and tracking numbers to jennifer_bailey@fws.gov; include digital images and GPS sampling location with this email.

Black and Grass Carp Gonad Removal and Sample Preparation

If the fish is less than 450mm (18") long, it is "obviously immature" and gonads need not be collected. If the fish is small enough to ship whole or with the tail section removed, and it is logistically possible to ship or deliver the fish without freezing, it is not necessary to remove the gonads. The whole fish may be shipped, refrigerated, not frozen, to one of the recipients listed for the carcass delivery below. If the fish is too large to be shipped easily or the fish cannot be shipped immediately, follow the following protocol to provide the gonad samples, which cannot be frozen.

Instructions for Gonad Histology Sampling – Do Not Freeze:

1. Remove complete Gonad from body cavity.
2. Lay out on dissection area. Asses the tissue to identify gonad tissue from fat. Carefully remove excess fat (The fat tissue is smooth and yellow to white in color, the ovaries will be grainy, eggy or lattice-like, and the testes will be smooth and almost white in color and will usually will have been closest to where the gonad was adhered to the inside of the body cavity.)
3. Weigh the whole gonad. Record gonad weight on bottle and on data sheet. (Note: do not enclose in the same sample bottle with the eyes).
   Is total weight of the gonad more than 20 g?
   YES: Proceed to #4 below.
   NO: Place entire gonad in sample bottle, skip to #5 below.
4. Assess the whole gonad to determine if the 2 branches are mirror images.
   YES: gonad branches are mirror images: From the left gonad, take 5 samples along the gonad, at least 2 g each. Weigh the 5 samples (one measurement of their total weight) and record on data sheet and bottle label. `
   NO: gonad branches are not mirror images: Make note of the difference; weigh the halves and record weights. Take 5 samples at least 2 g each along the "normal" side of the gonad, weigh and record data as above. Take 2 samples from the abnormal section of the gonad, weigh, and record data. Store in a separate bottle, and label appropriately.
5. Fill sample bottles with saline or contact solution. Maintain at 4 to 8°C. **Do Not Freeze.**
6. Ship sample bottles to La Crosse Fish Health Center, following shipping instructions for the eyeballs.

Black and Grass Carp Carcass and Digestive Tract Preparation

Several external and internal samples will be analyzed from both Black Carp and Grass Carp collections, including the contents of the digestive tract, otoliths, fin rays, vertebrae, and genetics. Fish should be shipped whole to the USGS lab for processing, however for large specimens it is only necessary to ship the anterior 1/3(Figure 13). The entire digestive tract from all Black Carp should accompany head shipments. When removing the digestive tract, first squeeze both ends roughly 2 cm near the esophagus and anus to condense contents away from your cut. Clamp or tie off the ends of the tract near the esophagus and the anus and cut exterior of the ties, leaving roughly a centimeter on either end of the tie to ensure the tract will remain closed during shipping. Place the whole digestive tract in a double ziplock bag or whirlpack, and refrigerate until shipped. **Do not freeze the digestive tract.** This can damage diet items rendering them unidentifiable. The anterior 1/3 of the carcass should be frozen and shipped along with the digestive tract on ice packs. Consider adding packaging materials to the shipment to cushion during shipping

Note: The USGS CERC lab may be contacted to discuss shipping options, instructions for the collection of gut or gonad samples, and payment of shipping fees as needed.

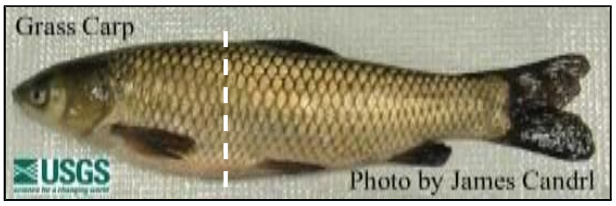


Figure 13. Approximate location for removing the anterior 1/3 from large specimens (dashed white line). Cut should be made far enough behind the head to include several vertebrae and first dorsal fin ray.

Black and Grass Carp Carcass Sample Preparation for Overnight Shipment:

If possible, *ship samples on ice or with ice packs within 36 hours of catch*. Otherwise, freeze the carcass alone (after gonad and digestive tract removal) before shipping.

1. First wrap the entire carcass or anterior 1/3 in a plastic trash bag to keep the package from leaking.
2. Pack entire specimen (with eyes extracted) in an insulated container with plenty of ice packs, frozen water bottles (soda bottles work well), or ice. Do ***NOT*** use dry ice for shipping. Include collection data (and sample number if necessary) in double ziplock bag in container.
3. Seal container to contain leaks. If using a styrofoam cooler within a box, make sure the interior lid is taped and sealed securely.
4. Ship immediately or keep frozen until Overnight Priority shipping arrangements are made.

Black and Grass Carp Carcass Shipping Procedures:

1. Contact Columbia Environmental Research Center personnel to make Overnight Priority (for morning delivery) shipping arrangements (contact information below). Do ***NOT*** ship samples until arrangements have been made for receipt of package.
2. Ship specimen in sealed, insulated container (see sample preparation instructions above) priority overnight to the attention of the recipients listed below
3. Email confirmation of shipment and tracking numbers to recipients.

Mississippi River Fish Contact Information:
Duane Chapman, 573-875-5399, 573-289-0625 (cell), dchapman@usgs.gov
Patrick Kroboth, 573-875-5399, 703-595-6405 (cell), pkroboth@usgs.gov

Shipping Address for Mississippi River Fish:
U.S. Geological Survey
Columbia Environmental Research Center
4200 New Haven Road
Columbia, MO 65201

Instructions for Removing Structures from Bighead and Silver Carp

Figures provided with permission for use by Joe Deters, USGS Columbia Environmental Research Center.

Scales: Remove ~10 scales from fish above the lateral line in the region below the dorsal fin. Wash using water and gently rub any excess debris, blood, and slime off. Allow to dry flat and after drying, place in a scale envelope.
Pectoral fin spines: Remove first 2 fin spines from fin down to the knuckle from both pectoral fins. Place in a zip-lock bag and freeze.
Dorsal fin spines: Remove first 2 fin spines from fin down to the knuckle from dorsal fin. Place in a zip-lock bag and freeze.
Postcleithra: Remove postcleithra from both sides of fish by puncturing the fish in the depression behind pectoral fin, cut along the cleithra up to the opercula with a knife. Use care such that the postcleithra is not broken during removal. Place the postcleithra in a zip-lock bag and freeze.

Figure A-1. Photo showing the location for the initial cut for postcleithra removal. The location is directly into the depression behind the pectoral fin and ventrally to the terminus of the postcleithrum.

Figure A-2. Photo showing the second cut when removing the postcleithra. This cut is posterior to the first, meets it at the ventral terminus, and extends dorsally to where the pelvic girdle interferes with the knife's progression.

Figure A-3. Photo showing how to expose the postcleithra for removal. Pull the cut end of the postcleithra outward and dorsally. This will invert the postcleithrum and expose the dorsal tip (circled in red) which will be devoid of flesh.

Figure A-4. Remove the exposed postcleithra with a pliers. Grasp the exposed tip of the postcleithrum with a pair of pliers and pull the bone away from the fish. This should leave the bone mostly free of flesh.

Figure A-5. Photo demonstrating the trimming and removal of excess tissue.

Figure A-6. Photo showing the freshly removed postcleithrum, (Circled in red). The spine (right) is from the same fish.

Vertebrae: Vertebrae should be taken from the section of the spine starting at the back of the skull back to the dorsal fin rays. Cut from the top of the fish following the ribs on both sides similar to filleting. Remove vertebral processes and separate this section from the rest of the vertebrae. Remove as much excess processes and flesh as possible. Place in a zip-lock bag and freeze. **Lapillus otoliths**: Use a pruning shears to cut the top of the skull from the nares back to behind the eyes in a square shape. Carefully pry the top of the skull off. The lapillus otoliths can be found by locating the lobes of the brain and they are located just below the lobes on each side. Figure A-7 shows photographs of all three otoliths.

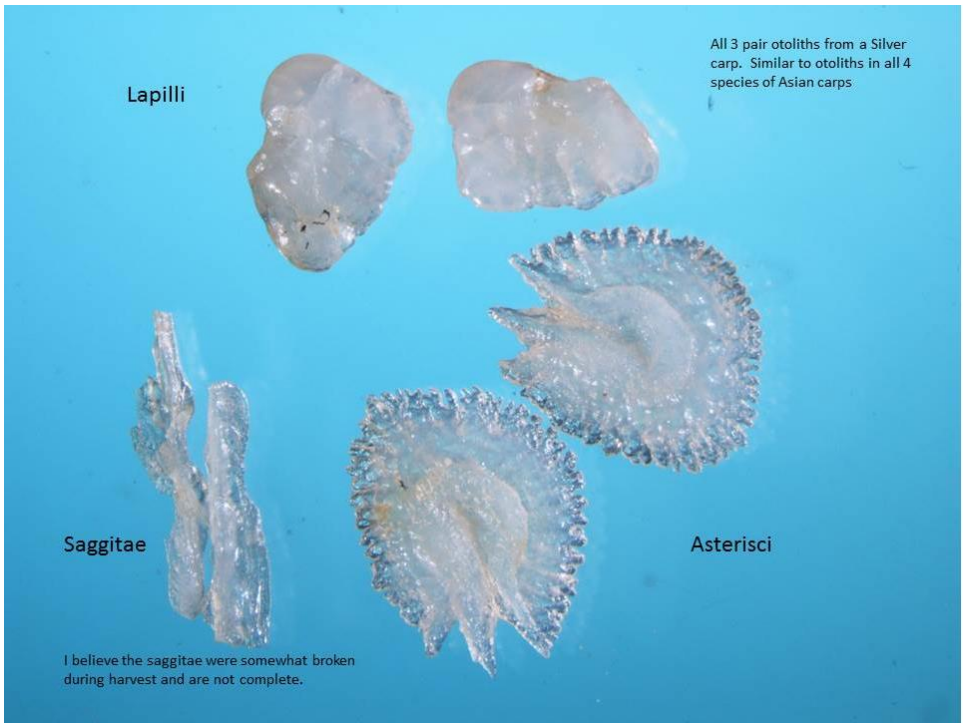


Figure A-7. The lapilli, sagitae and asterisci otoliths from a Silver Carp.

Sagittal otoliths: After the lapillus otoliths are removed, clean out the remaining brain matter using a low pressure water source like a squirt or spray bottle. Once clean, locate 2 small ports at the back of the skull. The sagittal otoliths are extremely small and brittle and are located within these ports. Use a fine-tipped tweezer to enter the ports and carefully remove them.

Asteriscus otoliths: After the sagittal otoliths are removed, use a small chisel to lift up the ports the sagittal otoliths were in. This usually requires a bit of pressure to press into the ports and then pry upward. Once lifted, the asteriscus otoliths can be found to the far left and right in a small pouch under the skull plate in which the port and sagittal otoliths were found. The asteriscus otoliths are relatively robust and circular in shape.

Description and Images of Condition/Stage of Asian Carp Gonads

Figures are provided with permission for use by Jim Lamer, Western Illinois University and Duane Chapman, USGS Columbia Environmental Research Center.

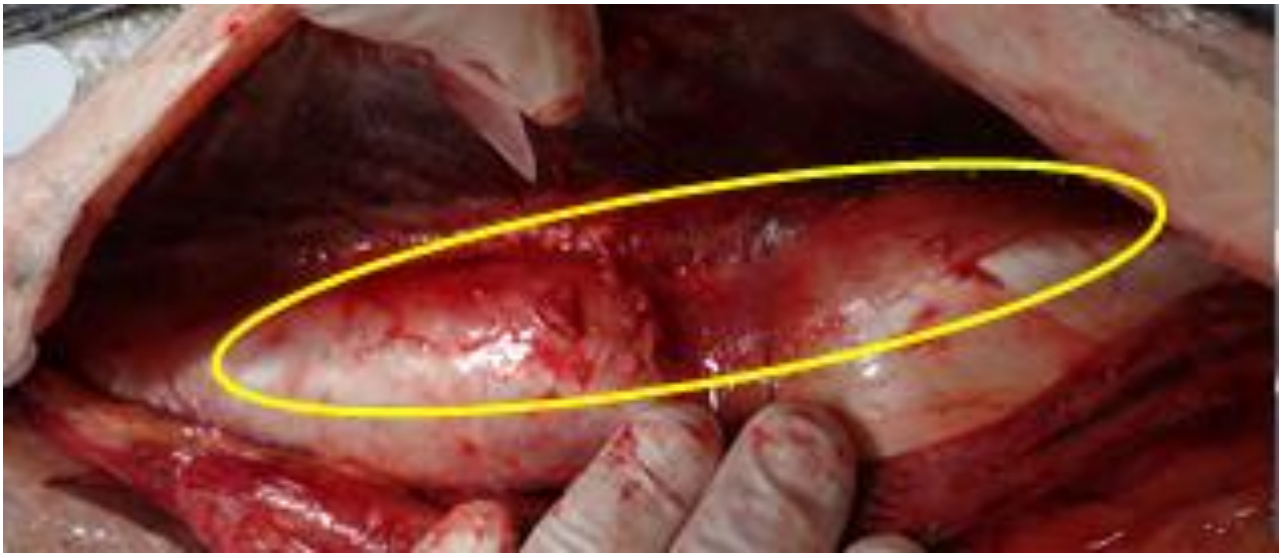


Figure B-1. Location of gonads relative to the gas bladder in an immature female Asian carp.

Figure B-2. The immature ovary is band-like and less “tubular” than immature testes.

Figure B-3. Early egg development (stage 2) in a female Asian carp.


Figure B-4. Developing ovary (stage 3) in a female Asian carp.

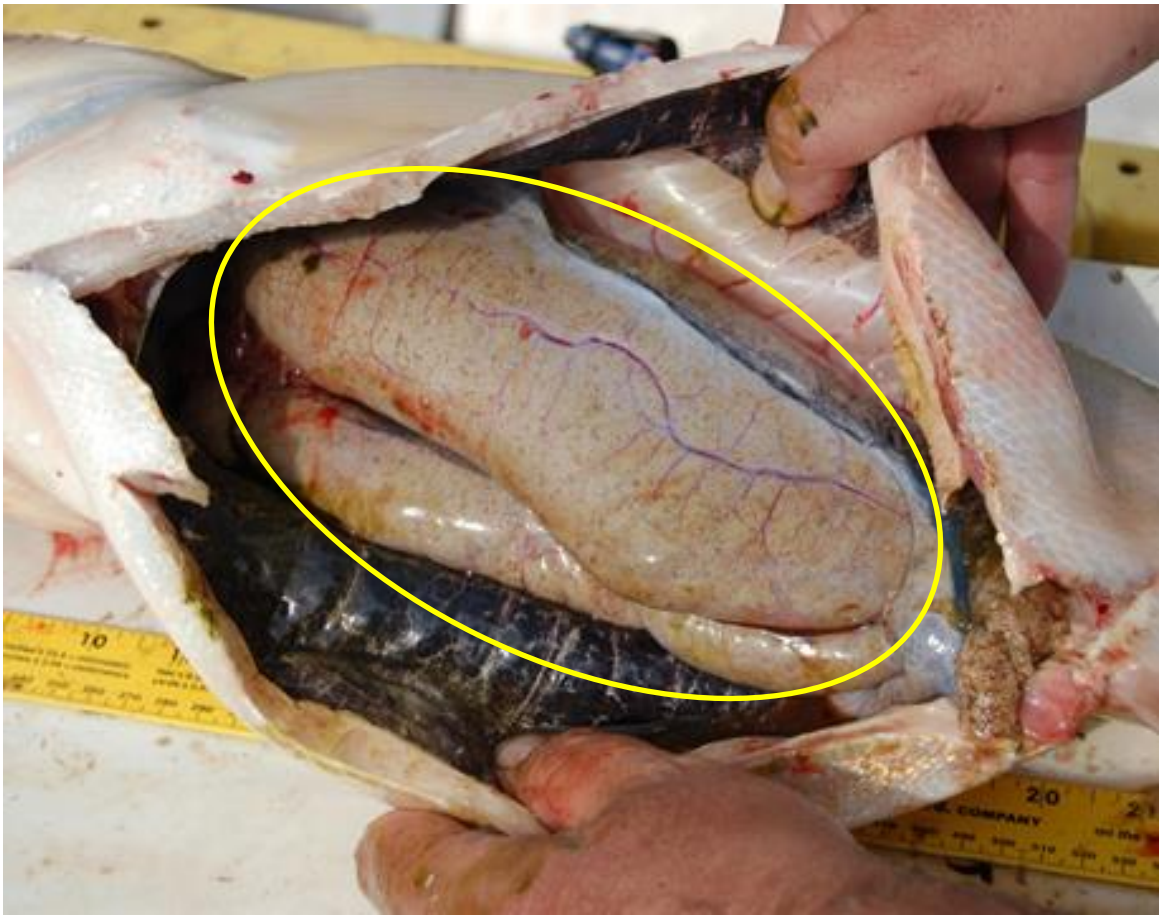


Figure B-5. Mature eggs (stage 4) in a female Asian carp.

Figure B-6. Mature post-spawn female Asian carp.

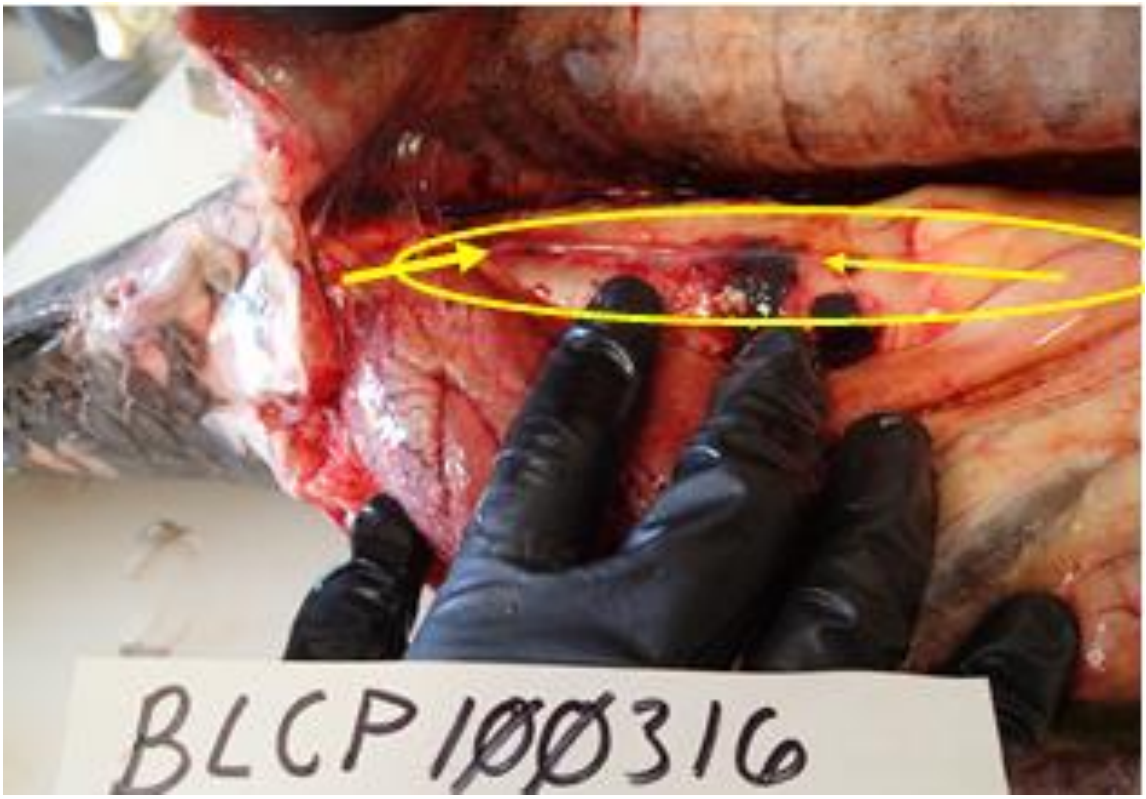


Figure B-7. Immature male testes are difficult to find and are narrow and ribbonlike.

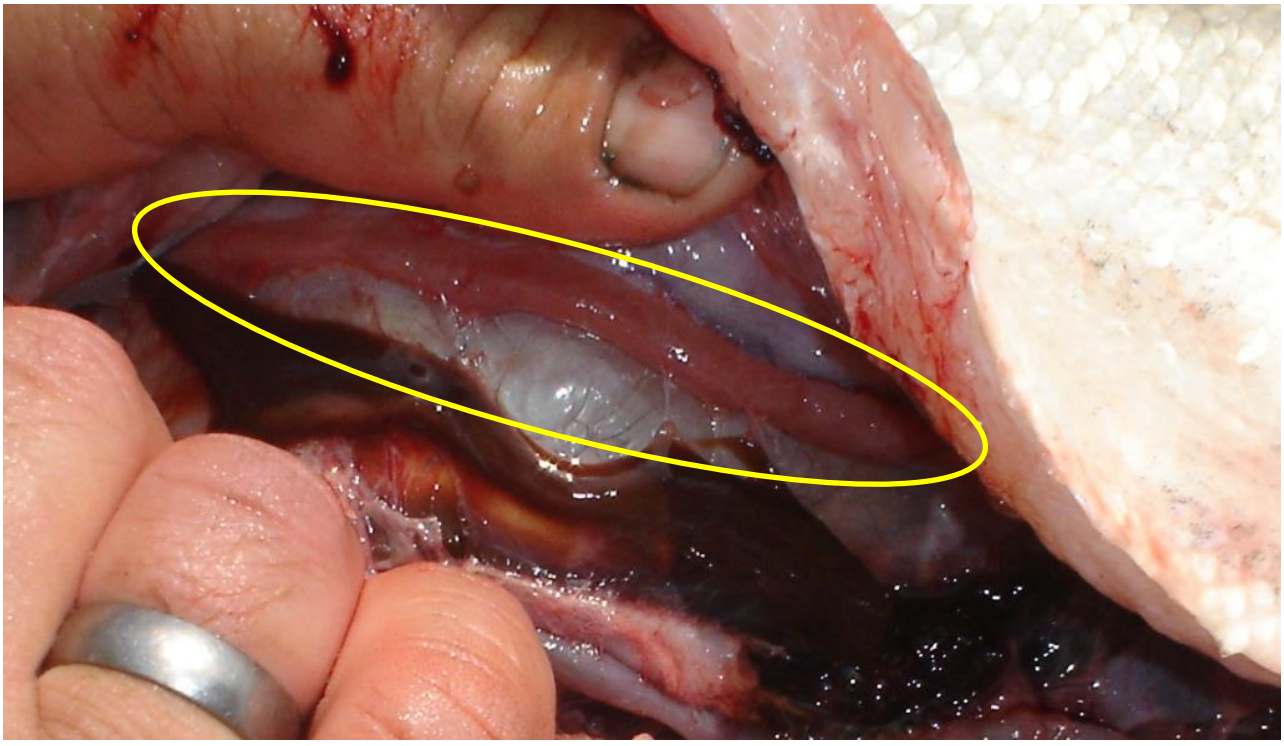


Figure B-8. Testes of a male Asian carp.

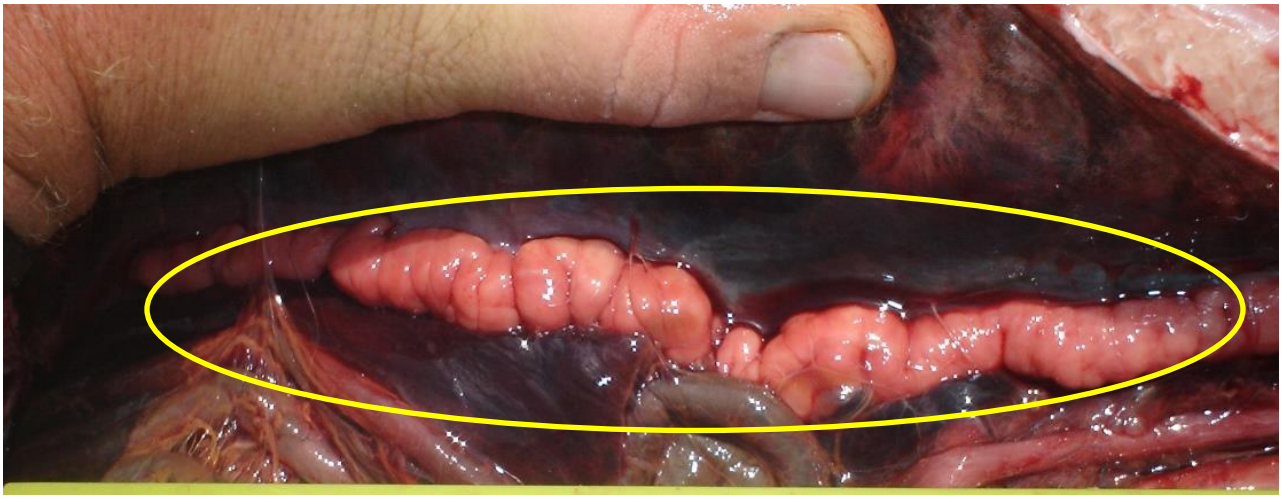


Figure B-9.Testes of a mature male Asian carp.

Figure B-10. Mature male Silver Carp in spawning condition.