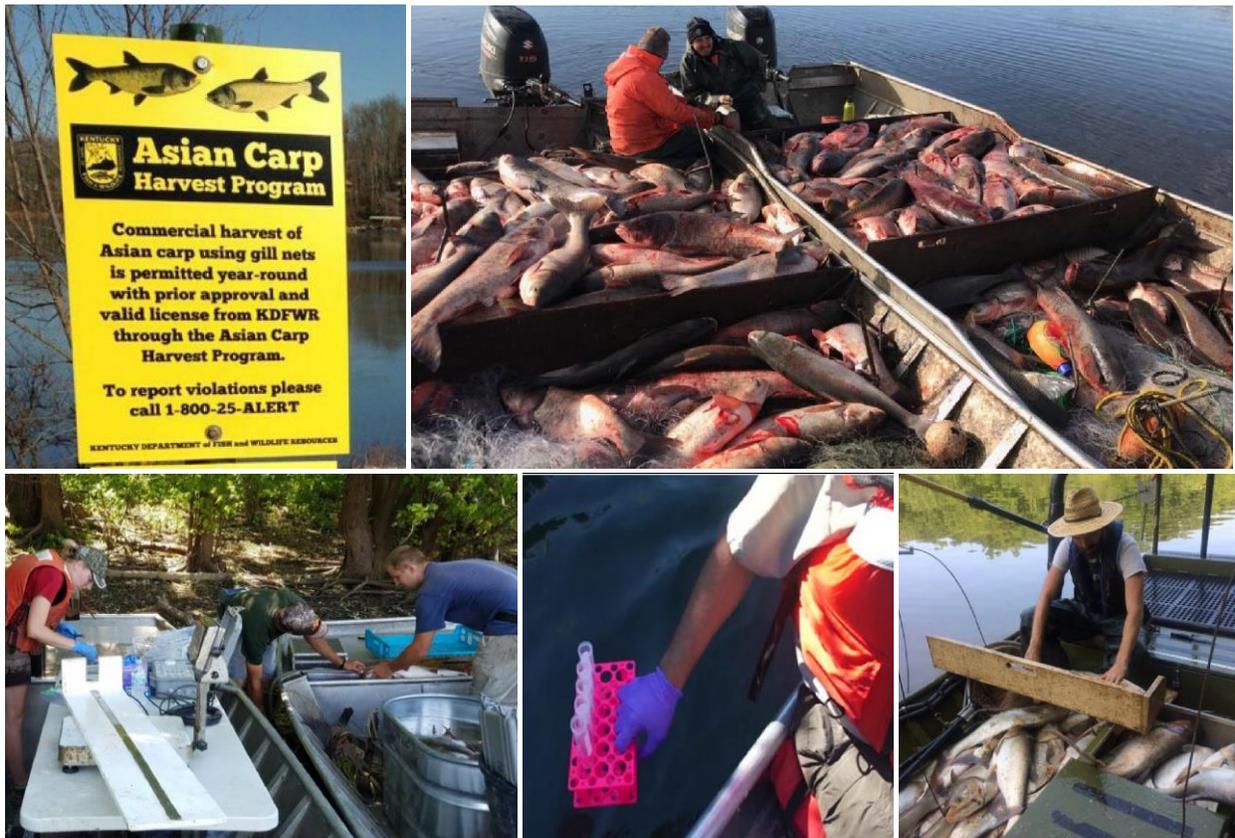




2017 Annual Report to Congress

Annual Summary of Activities and Expenditures to Manage the Threat of Asian Carp in the Upper Mississippi and Ohio River Basins

A Report to Congress Pursuant to the Water Resources Reform and Development Act of 2014 (PL 113-121)



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EXECUTIVE SUMMARY

Background

On June 10, 2014, the Water Resources Reform and Development Act of 2014 (WRRDA), Public Law 113-121 was enacted, directing an array of Federal agency actions and public projects in the United States. Section 1039 (b) of WRRDA authorizes the Director of the U.S. Fish and Wildlife Service (USFWS) to coordinate with the Secretary of the Army (through the U.S. Army Corps of Engineers, or USACE), the Director of the National Park Service (NPS), and the Director of the U.S. Geological Survey (USGS) to lead a multiagency effort to address the spread of Asian carp in the Upper Mississippi River Basin (UMRB) and the Ohio River Basin (ORB) and their tributaries. Additionally, WRRDA requires development of an annual report to the U.S. Congress (Report) summarizing strategies, expenditures, and progress in addressing the threat of Asian carp in the UMRB and ORB and their tributaries.

The Report focuses specifically on efforts to manage Bighead, Silver, Black, and Grass Carp - the four species of Asian carp addressed in the '*Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States*' (National Plan). The National Plan, developed in collaboration with Federal, State, non-governmental, and industry partners and approved by the Aquatic Nuisance Species Task Force in 2007, continues to serve as the overarching strategy providing guidance for managing Asian carp in our Nation's waters. With the National Plan as guidance, individual sub-basin partnerships (Great Lakes, Upper Mississippi River, Ohio River, Missouri River, and Lower Mississippi River) have finalized, or are in the process of developing, supplementary plans (Control Strategy Frameworks) to guide specific work in each respective basin. Finalized plans can be found at <http://asiancarp.us/PlansReports.html>.

The USFWS, working in close coordination with the USACE and other Federal and State partners, developed the 2017 Report, the fourth in the series, to summarize cooperating agency activities that were conducted for Asian carp management in the UMRB and ORB and their tributaries from October 1, 2016 to September 30, 2017. The 2017 Report includes the following information:

- Observed changes in the documented range of Asian carp in the UMRB and ORB, including locations of Asian carp within tributaries of the UMRB and ORB
- A summary of Federal agency efforts, including cooperative efforts with non-federal partners, to control the spread of Asian carp in the UMRB and ORB and their tributaries
- A summary of federally-funded research being conducted to reduce or eliminate the spread of Asian carp
- An evaluation of measures identified in the initial 2014 Report to document progress and effectiveness of Asian carp management efforts
- A cross-cut accounting of Federal and non-federal Asian carp management expenditures in the UMRB and ORB and their tributaries, as reported by individual agencies for their respective 2017 Fiscal Year (FY) reporting periods

Summaries of agency activities being conducted for the benefit of specific basins are organized into three geographically-focused sections, as follows:

1. Ohio River and key tributaries (defined as the ORB), including the Tennessee River Basin
2. Upper Mississippi River and key tributaries, excluding the Illinois Waterway (IWW) and Chicago Sanitary and Ship Canal (CSSC) (defined as the UMRB)
3. IWW and Chicago Area Waterway System (defined as the IWW/CAWS and located within the UMRB)

Reported agency activities are categorized under the following:

- Interagency Coordination (e.g. Strategy Development, Committee Participation)
- Field Monitoring and Early Detection
- Active Prevention/Control (including Physical Removal, Implementation/Operation of Barriers, and Rapid Response)
- Research and Development
- Law Enforcement/Regulatory Actions
- Outreach with Industry, Stakeholders, and the Public

The 2017 Report focuses on the Federal and State agency actions conducted within the main stem rivers and tributaries of the ORB and UMRB to protect those river basins from Asian carp. A summary of efforts in the IWW/CAWS is also included given its location within the UMRB geographic delineation, although these actions primarily support Asian carp prevention for the Great Lakes Basin (GLB). As the only permanent hydrologic connection between the Mississippi River Basin (MRB) and the GLB, the IWW/CAWS is considered the primary potential vector for the interbasin transfer of Asian carp and is therefore the geographic focus for Federal and State management efforts associated with the Asian Carp Regional Coordinating Committee (ACRCC). A general summary of the ACRCC's efforts conducted specifically in the IWW/CAWS for Great Lakes protection is included in this Report, and described in greater detail in the partnership's 2017 Asian Carp Action Plan (<http://www.asiancarp.us/documents/2017ActionPlanAmendment.pdf>) and the 2017 Monitoring and Response Plan (MRP) (<http://www.asiancarp.us/documents/MRP2017.pdf>). Activities are summarized annually in the ACRCC Monitoring and Response Work Group (MRWG) Interim Summary Reports (<http://asiancarp.us/PlansReports.html>).

Observed Changes in the Documented Range of Asian carp in the UMRB and ORB

This 2017 Report includes detailed results on the occurrence of Asian carp in U.S. waters of the UMRB and ORB, including summaries of historical and new detections and assessments of changes in the observed range of each species. This information is critical for supporting decision making on Asian carp management actions and overall strategy implementation. In the 2017 reporting period, range expansion was documented for Bighead Carp, Silver Carp, and Black Carp. No range expansion was documented for Grass Carp. All new documented detections of Asian carp were entered into the USGS Nonindigenous Aquatic Species (NAS) database and are available online at <https://nas.er.usgs.gov/taxgroup/fish/default.aspx>.

It is important to note that any collection of an individual Asian carp in a new location, which we define as a range expansion, does not indicate that the species has established in that particular point in the watershed. Additional data, such as the presence of different life stages, the relative abundance of

adults in the area, and spawning activity is used to assess the presence of the geographical boundary, or “population front”, for each species within a given river basin. This underscores the need for intensive and consistent monitoring to collect data to inform an accurate assessment of population status.

The observed changes for all four species are described in greater detail in Section 2 of this report, yet can be summarized as follows:

- Bighead Carp: UMRB, Minnesota River: range expanded 52 miles upstream
- Silver Carp: UMRB, CAWS: range expanded 26 miles upstream; ORB, Tennessee River: range expanded 44 miles upstream
- Black Carp: UMRB, Illinois River: range expanded 145 miles upstream; ORB, Ohio River: range expanded 17.5 miles upstream

Agency Prevention and Control Efforts

State and Federal agencies, universities, non-governmental organizations, and other partners are aggressively implementing key management and research actions in support of a comprehensive and strategic approach to Asian carp management within and across basins. Through ongoing and increased coordination and strategic planning, these partnerships are supporting implementation of the seven goals of the National Plan, as follows:

1. Prevent accidental and deliberate unauthorized introductions of Bighead, Black, Grass, and Silver Carp in the U.S.
2. Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the U.S.
3. Extirpate, or reduce to levels of insignificant effect, feral populations of Bighead, Black, Grass, and Silver Carp in the U.S.
4. Minimize potential adverse effects of feral Bighead, Black, Grass, and Silver Carp in the U.S.
5. Provide information to the public, commercial entities, and government agencies to improve effective management and control of Bighead, Black, Grass, and Silver Carp in the U.S.
6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of Bighead, Black, Grass, and Silver Carp in the United States
7. Effectively plan, implement, and evaluate management and control efforts for Bighead, Black, Grass, and Silver Carp in the U.S.

In addition, collaborative partnerships have been established and operationalized within the ORB, UMRB, and GLB, reflecting the specific needs and opportunities within these respective watersheds. For example, the *Ohio River Basin Asian Carp Control Strategy Framework* (ORB Framework) developed by the Ohio River Fisheries Management Team (ORFMT) outlines actions for prevention, monitoring and response, population control, research, and communications to collectively prevent further expansion, reduce populations, and better understand the environmental and socioeconomic impacts of Asian carp. Similar priorities are also included in the *Upper Mississippi River Basin Asian Carp Control Strategy Framework* (UMRB Framework) and the *ACRCC’s Action Plan and Monitoring and Response Plan for Asian Carp in the Upper Illinois River and the Chicago Area Waterway (Monitoring and Response Plan)*. All of these regional plans complement the goals within the National Plan.

As a core operating principle, basin partnerships use adaptive management to revise and update management strategies based on objective evaluation. To inform necessary revisions, the performance and effectiveness of individual projects are evaluated for their ability to meet identified goals for managing Asian carp populations.

Conducting Key Research, Transferring Technology, and Applying Lessons-Learned

The development and application of new technologies and tactics to prevent the expansion of Asian carp populations is a core component of the National Plan and the comprehensive basinwide management strategies. An evolving suite of state-of-the-art tools for Asian carp detection, deterrence, and control continues to be investigated and developed. Some tools are being tested in pilot field trials to target specific known vulnerabilities of Asian carp. The use of new prevention or control technologies, coupled with existing traditional techniques such as commercial harvest, is being scientifically evaluated under various deployment scenarios in strategic locations, with the goal of achieving maximum net impact on population numbers and reduced risk of dispersal.

The USGS continues to serve as a lead on research and development of new and emerging technologies, working closely with Federal and State partners. Additionally, the USACE's Engineer Research and Development Center (ERDC) coordinates closely with the USGS and other State and Federal agencies and universities to significantly advance the science and capacity for managing Asian carp, including the development and refinement of tools for early detection. A brief description of each agency's work is provided in this Report, with a detailed description in Appendix 2. Current Asian carp research and development projects can be described under one of the following categories:

- Early Detection and Monitoring
- Life History/Behavior
- Feeding Ecology
- Prevention
- Control
- Analysis of alternative pathways
- Risk assessment

Comprehensive interagency coordination has fostered collaboration across jurisdictional boundaries to address highest-priority research and management needs (e.g. Asian carp life history, genetics, pathway assessment, and rapid response planning) and to develop consistently used monitoring, data collection, and best-management protocols and practices.

Establishing Measures of Effectiveness for Asian Carp Prevention

The WRRDA directs the USFWS to identify measures to document progress in controlling the spread of Asian carp in the UMRB and ORB and their tributaries. The initial 2014 Report identified: (1) proposed measures and outcomes for ensuring progress toward the goals of controlling spread of Asian carp in the designated watersheds, and (2) specific critical short-term actions to continue and expand multiagency coordination to achieve common prevention-based goals. This 2017 Report continues to use the measures, with some additional modification to facilitate more efficient tracking of annual outcomes and progress toward achieving long-term goals. The use of these measures is intended to increase management efficiency and accountability for implementing Asian carp strategies in the UMRB

and ORB and their tributaries. Summaries of accomplishments achieved under each measure will be provided in this and subsequent reports.

Federal and Non-federal Expenditures

This cross-cut summary includes an overview of expenditures directly related to Asian carp activities conducted by Federal and State agencies in the UMRB, ORB, and IWW/CAWS in FY 2017. Agencies reported a total of \$57,957,420 for all basins combined, of which \$53,235,152 was used for actions in the IWW/CAWS to protect the Great Lakes from Asian carp. The total reported expenditures on activities conducted to benefit the ORB and UMRB and tributaries was \$4,722,268 (Table 1 in Section 6.0).

Agencies reported all Asian carp-related expenditures conducted during their respective FY 2017, categorized by both funding source and general type of activity. This level of breakout was not included in previous WRRDA reports. Percent of total reported expenditures was as follows: Active Prevention and Control, 56.0%; Research and Development, 21.8%; Monitoring, Early Detection, and Rapid Response, 14.7%; Interagency Coordination, 5.5%; Outreach with Stakeholders, 1.5%; and Law Enforcement/Regulatory Actions, < 0.1%. An activity category was not assigned to 0.5% of the reported expenditures.

Additional FY 2017 expenditures were reported by agencies conducting actions to prevent Asian carp movement through the temporary hydrologic connection identified by the Great Lakes and Mississippi River Interbasin Study (GLMRIS) Other Pathways. Since these pathway mitigation efforts are focused on protecting the GLB from the movement of Asian carp and are not exclusively within the delineated geographic boundaries of the ORB, related costs were excluded from the total expenditures summarized in this Report. However, this Report includes a brief summary of GLMRIS Secondary Pathway mitigation activities reported by agencies to present a complete overview of the efforts conducted to reduce the risk of potential interbasin range expansion of Asian carp from the ORB to the GLB.

Since FY 2015, additional funding has been provided to the USFWS for Asian carp prevention efforts through its annual agency base appropriations. These resources are used to support an enhanced multiagency Asian carp response in the UMRB and ORB, as directed by WRRDA, Section 1039. This response emphasizes strong coordination and collaboration between State and Federal agencies to prevent the further range expansion of Asian carp in the designated basins.

The USFWS, in coordination with the Mississippi Interstate Cooperative Resource Association (MICRA), works cooperatively with State and Federal agencies to address the highest priority implementation needs for the ORB and UMRB Frameworks that support the National Plan. The annual MRP for the MRB provides detailed information on the collaborative Asian carp projects supported with these funds. A general description of the ongoing projects funded in each basin in FY 2017 is as follows:

In the UMRB:

- **Monitoring and Assessment:**
 - Determine the status of all life stages of Asian carp populations
 - Delineate geographic boundaries of the various stages of Asian carp relative abundance above Lock and Dam 19 near Keokuk, Iowa
 - Conduct early detection surveillance monitoring at the invasion front
 - Inform containment and control/removal projects

- Containment:
 - Monitor and assess the extent of Asian carp and native species fish passage at strategic pinch points in the UMR (Lock and Dams 14, 15, 19)
 - Develop a deterrent barrier strategy
- Control/Removal:
 - Monitor and assess population abundances of Asian carp in Pools 17, 18, 19
 - Target removal of Asian carp species in Pools 14-19 using contracted commercial fishers

In the ORB:

- Monitoring and Assessment:
 - Determine the status of all life stages of Asian carp populations
 - Delineate geographic boundaries of the various stages of Asian carp relative abundance
 - Conduct surveillance monitoring and response at the invasion front
 - Inform containment and control/removal projects
 - Determine the extent of Asian carp reproduction and recruitment in the Kentucky and Barkley Reservoirs (Tennessee River)
 - Determine the status and abundance of adult Asian carp in the Kentucky and Pickwick Reservoirs (Tennessee River) and the Barkley and Cheatham Reservoirs (Cumberland River)
 - Assess Asian carp dispersal and invasion dynamics, movement through lock and dam systems
 - Identify seasonal congregations in the Tennessee River to inform future containment and control management actions
- Containment:
 - Identify opportunities to implement and evaluate the use of complex sound to deter movement of Asian carp
 - Monitor and assess Asian carp passage at Ohio River and Tennessee River locks and dams
- Control/Removal:
 - Remove Asian carp from low density areas at the leading edge of invasion of the Ohio River, above River Mile (RM) 606
 - Remove Asian carp from high density areas in the Ohio River below Markland Locks and Dam

A detailed summary of these projects is provided in the *2017 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin*. This plan provides comprehensive work plans for the ORB and UMRB projects that received funding from the USFWS in FY 2017 and is available at <http://www.asiancarp.us/documents/MRP2017MississippiRiverBasin.pdf>).

The partnerships formed to develop and refine basinwide management strategies and priorities will continue to be used to evaluate overall effectiveness of Asian carp management actions, summarize and report measurable accomplishments, and inform subsequent research and management objectives and actions.

1.0 INTRODUCTION

1.1 The Need for Interagency Management of Asian Carp in the Upper Mississippi River and Ohio River Basins – Collaboration under WRRDA 2014

The threat to natural resources within the United States from the introduction and establishment of aquatic invasive species (AIS) is well-documented and recognized as one of the primary issues facing resource policymakers and managers, resource users, and other stakeholders. AIS have resilient and adaptive characteristics that afford them competitive advantages over native species. These characteristics can include the ability to reproduce rapidly or tolerate a wider range of environmental conditions than native species, allowing them to establish self-sustaining populations in areas with few or no natural predators. In addition to widespread and longstanding ecological consequences, AIS often result in significant economic losses and cost the Nation's economy billions of dollars annually. Asian carp including Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), Grass Carp (*Ctenopharyngodon idella*), and Black Carp (*Mylopharyngodon piceus*), have the ability to quickly establish self-sustaining populations following introduction, and can significantly alter entire aquatic ecosystems, negatively impacting native species and habitats. The expansion of Asian carp populations in the ORB and the UMRB further threaten multibillion dollar industries, including recreation, tourism, and sportfishing, that are vital to local and regional economies in the Midwest.

On June 10, 2014, the WRRDA (Public Law 113-121) was enacted to provide direction on an array of agency actions and public projects in the United States. Section 1039(b) of WRRDA authorizes the Director of the USFWS to coordinate with the Secretary of the Army (through USACE) and the Directors of NPS and USGS to lead a multiagency effort to address the spread of Asian carp in the UMRB and ORB and their tributaries. Those actions include provisions for technical assistance, coordination, best practices and support to State and local governments engaged in activities to decrease the threat of Asian carp. Additionally, WRRDA directed the USFWS to develop, in coordination with the USACE, an annual report to Congress summarizing strategies, expenditures, progress, and emerging research to address the threat of Asian carp in the UMRB and ORB and their tributaries.

The direction provided in WRRDA Section 1039 complements existing Federal and State authorities that address AIS in U.S. waters, including the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), reauthorized with the passage of the National Invasive Species Act (NISA) in 1996. NANPCA established the Aquatic Nuisance Species Task Force (ANSTF) and called for the development and implementation of a comprehensive Federal program to prevent the introduction, establishment, and proliferation of aquatic nuisance species (ANS, also known as AIS). NANPCA's encouragement of a broad collaborative AIS management strategy is complemented by other Federal and State laws and regulations.

Annual Report to Congress

As stipulated in WRRDA, the USFWS coordinated with the USACE, NPS, USGS, and other Federal and State agency partners to develop the *Annual Report to Congress - Summary of Activities and Expenditures to Manage the Threat of Asian Carp in the Upper Mississippi and Ohio River Basins: October 2016 through September 2017* (2017 Report).

This 2017 Report is the fourth annual report since the enactment of WRRDA in 2014, and includes the following information:

- Observed changes in the documented range of Asian carp in the UMRB and ORB, including further delineation of the location of Asian carp within tributaries of the UMRB and ORB
- A summary of Federal agency efforts, including cooperative efforts with non-federal partners, to control the spread of Asian carp in the UMRB and ORB and their tributaries
- A summary of federally funded research being conducted to reduce or eliminate the spread of Asian carp
- An evaluation of measures identified in the initial 2014 Report to document progress and effectiveness of Asian carp management efforts
- A cross-cut accounting of Federal and non-federal Asian carp management expenditures in the UMRB and ORB and their tributaries, as reported by individual agencies for their respective 2017 Fiscal Year (FY) reporting periods

For this 2017 Report, State and Federal agencies reported all Asian carp management activities conducted in the UMRB and ORB during the reporting timeframe of October 1, 2016 through September 30, 2017. Agency activities conducted in support of the National Plan have been grouped into the following six general categories:

- Interagency Coordination (e.g. Strategy Development, Partnership Operations)
- Monitoring, Early Detection and Rapid Response
- Active Prevention/Control (e.g. Physical Removal of Asian Carp, Implementation/Operation of Barriers)
- Research and Development
- Outreach with Industry, Stakeholders, and the Public
- Law Enforcement/Regulatory Actions

This 2017 Report also identifies collaborative prevention and control projects and strategic planning efforts being funded, in whole or in part, through additional appropriated USFWS funds provided for Asian carp prevention in FY 2017. These additional funds are being used to support Asian carp activities in the UMRB, ORB, and other priority locations.

This 2017 Report will be formally transmitted to the Committee on Appropriations and the Committee on Environment and Public Works of the Senate; and the Committee on Appropriations, the Committee on Natural Resources, and the Committee on Transportation and Infrastructure of the House of Representatives. In addition, it will be made available to the public via the Internet at www.AsianCarp.us.

1.2 Basin Partnership Overviews and Accomplishments

This 2017 Report summarizes reported accomplishments and related expenditures conducted to address Asian carp in the ORB and UMRB, two sub-basins within the larger Mississippi River drainage basin (see Figure 1). To clearly describe the agency efforts conducted for the benefit of each specific sub-basin, this 2017 Report is organized into three geographically-focused sections, as follows:

1. Ohio River and tributaries (defined as the ORB), including the Tennessee River Basin
2. Upper Mississippi River and key tributaries, excluding the Illinois Waterway (IWW) and Chicago Sanitary and Ship Canal (CSSC) (defined as the UMRB)
3. IWW and Chicago Area Waterway System (defined as the IWW/CAWS and located within the UMRB)

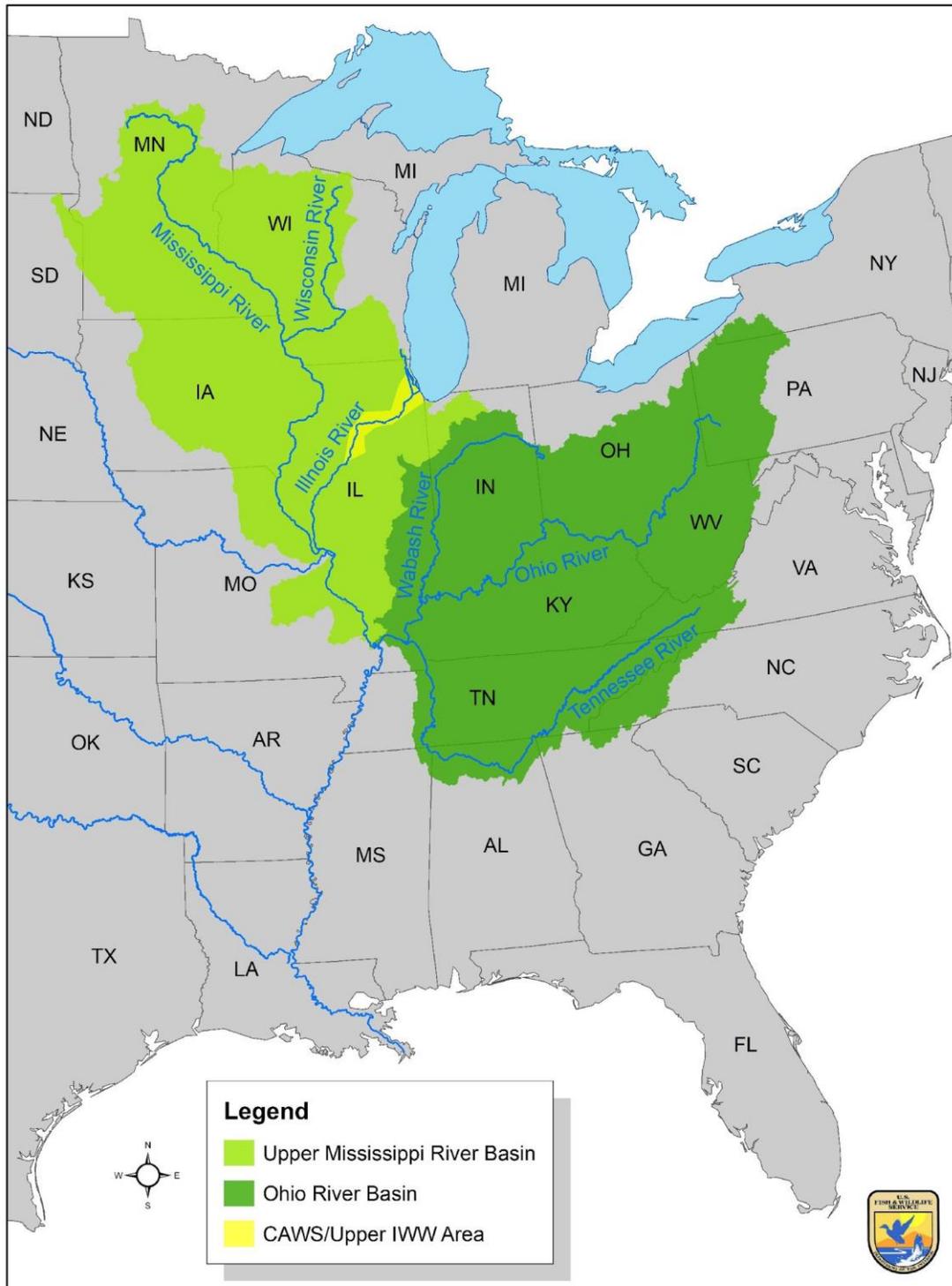


Figure 1. Upper Mississippi River (including the IWW and CAWS), Ohio River Basins as defined by the USGS Hydrologic delineations.

The Ohio River flows through or along the border of Illinois, Indiana, Kentucky, Ohio, Pennsylvania, and West Virginia. These six states collaboratively manage fisheries in the mainstem Ohio River through the Ohio River Fisheries Management Team (ORFMT), which was formed in 1990 to develop an inter-jurisdictional perspective to manage Ohio River fisheries. The six ORFMT states initiated development of the ORB Framework and requested that the remaining eight states in the ORB (Alabama, Maryland, Georgia, Mississippi, New York, North Carolina, Tennessee, and Virginia) participate in its development and implementation. Asian carp are highly abundant in the lower Tennessee River, a major tributary to the Ohio River, and are a threat to the highly valued and imperiled fish and mussel populations that inhabit these waters. Tennessee, Mississippi, and Alabama border the Tennessee River and are active participants in the ORB partnership.

The Upper Mississippi River flows through or along the border of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. These five states collaboratively manage fisheries in the mainstem Upper Mississippi River through the Upper Mississippi River Conservation Committee (UMRCC). The UMRCC was formed in 1943 for the collaborative management of interjurisdictional fishery resources in the UMR. The five UMRCC member states developed and implement the draft UMRB Framework to manage and control Asian carp populations in the UMR.

This Report focuses on the Federal and State agency actions conducted within the mainstem rivers and tributaries of the ORB and UMRB (as directed in WRRDA 2014); however, a summary of efforts conducted in the IWW/CAWS is also included. While the Illinois River is a tributary of the Upper Mississippi River, actions conducted within the IWW/CAWS (River Mile (RM) 231 to RM 333) are, for the purposes of this Report, categorized as efforts for the protection of the GLB. As the only permanent hydrologic connection between the MRB and the GLB, the IWW/CAWS is considered the primary potential vector for the interbasin transfer of Asian carp and is therefore the geographic focus for Federal and State management efforts associated with the ACRCC. Efforts conducted in the IWW/CAWS summarized within this Report are described in greater detail in the ACRCC's Asian Carp Action Plan (<http://www.asiancarp.us/documents/2017ActionPlanAmendment.pdf>) and the 2017 Monitoring and Response Plan (MRP) (<http://www.asiancarp.us/documents/MRP2017.pdf>).

1.3 The Asian Carp Challenge

During the past two decades, Asian carp have steadily increased their range through portions of the UMRB and ORB, posing a threat to the rich biodiversity and related economies of these watersheds. Bighead Carp, Silver Carp, Grass Carp, and Black Carp have the ability to quickly establish self-sustaining populations following introduction, and can significantly alter entire aquatic ecosystems, negatively impacting native species and habitats. Large portions of America's interior river systems are now occupied by one or more Asian carp species, with populations of at least one species established in 45 states. The impacts from Asian carp establishment are well-documented. For example, studies in the Illinois River demonstrated that the condition of native fish species declined significantly following the introduction and establishment of Silver Carp and Bighead Carp. Additional studies documented significant declines in the native species composition in portions of rivers and tributaries in the Midwest United States where Asian carp dominant in numbers and biomass, resulting in negative impacts to commercial and recreational fishing.

The expansion of Asian carp populations in the ORB and the UMRB threaten multibillion dollar industries, including recreation, tourism, and sportfishing, that are vital to local and regional economies in the Midwest. Such industries support thousands of jobs and provide income for communities located

on, or adjacent to, rivers and reservoirs. For example, the 2011 *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (USFWS 2011), estimated the annual economic impact from recreational fishing in the Upper Mississippi River sub-basin as approximately \$3.5 billion in retail expenditures and \$1.7 billion in job income, supporting 45,730 jobs. In the Ohio River sub-basin, the estimates were approximately \$4.4 billion in retail expenditures and approximately \$2.0 billion in job income, supporting 58,338 jobs. Although data was not reported at the individual State level in the 2016 *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, estimates of the annual impact of recreational fishing in these sub-basins are higher, reporting an increase for fishing nationwide of approximately \$1.40 billion from 2011 to 2016 (\$44.7 billion total in 2011; \$46.1 billion in 2016).

Additional impacts to resource users include compromising the safety of boaters and personal watercraft users in areas where Silver Carp have become established in high densities, as this large-bodied fish can leap out of the water when stimulated by sound and collide with passing vessels and their occupants.

Acknowledging the need for a coordinated approach to address the growing threat from Asian carp, the ANSTF requested the development of a national management plan for all four species (Bighead, Silver, Black, and Grass Carp) through its Asian Carp Working Group. The USFWS, in collaboration with over 70 State, Federal, non-governmental, and private industry partners, led the development of a National Plan. Approved and released in 2007, the National Plan is built around seven core goals that are operationalized through 48 step-down strategies and 131 recommendations to manage and control Asian carp. The National Plan continues to serve as a blueprint for Federal, State, and non-governmental partnerships on Asian carp management, and as a basis for the subsequent development of geographically-focused basinwide and State management plans (described later in this report).

Comprehensive management strategies for Asian Carp have also been, or are being developed, by State and Federal partnerships for large river sub-basins within the Mississippi River watershed. The strategies within these plans build upon the seven core goals of the National Plan, listed as follows:

1. Prevent accidental and deliberate unauthorized introductions of Bighead, Black, Grass, and Silver Carp in the U.S.
2. Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the U.S.
3. Extirpate, or reduce to levels of insignificant effect, feral populations of Bighead, Black, Grass, and Silver Carp in the U.S.
4. Minimize potential adverse effects of feral Bighead, Black, Grass, and Silver Carp in the U.S.
5. Provide information to the public, commercial entities, and government agencies to improve effective management and control of Bighead, Black, Grass, and Silver Carp in the U.S.
6. Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of Bighead, Black, Grass, and Silver Carp in the U.S.
7. Effectively plan, implement, and evaluate management and control efforts for Bighead, Black, Grass, and Silver Carp in the U.S.

Developing effective, comprehensive prevention and control strategies requires in-depth knowledge of Asian carp occurrence and population status, life history traits (e.g. feeding ecology, reproductive behavior, and preferred habitat), specific tactics for detection, prevention, and control, and potential vectors of introduction. To provide this information, comprehensive databases describing all Asian carp

life stages (eggs, larvae, juveniles, and adults) are being developed for each river basin. Collaborating Federal and State agencies are working to expand and update this body of scientific information, yet data gaps remain in key areas. Filling these gaps has been identified as a priority management need. The broad geographic scope of the watersheds with documented occurrences of Asian carp require that managers make well-informed, scientifically-based, decisions for the strategic use of available resources. To ensure that each basinwide management approach remains current and robust, partnerships utilize an adaptive management approach, which incorporates mechanisms to regularly revise and update key components of their Asian carp strategies based on objective evaluation of performance. Projects are evaluated for their ability to meet identified outcomes and goals for managing Asian carp populations, with results used to inform any necessary revisions to tactics and management strategies. As new management technologies are developed and field-tested, State and Federal agencies are actively collaborating to identify opportunities for implementation in key locations (e.g. those that afford the greatest ecosystem protection benefits and have highest likelihood of success).

Concurrent with strategic planning of projects, identifying and leveraging available resources to support both research and development, and ongoing operational actions remains critical for preventing future population expansions of Asian carp. Achieving complex long-term management goals can be achieved through annual incremental progress, but will require a sustained, coordinated effort.

1.4 Progress in FY 2017

Significant progress toward implementing a comprehensive and strategic multi-basin approach to Asian carp management continued in FY 2017. Strong State and Federal agency coordination within each basin supported ongoing collaborative strategic planning, research and development, information exchange, and the leveraging and maximizing agency resources. This section provides a general overview of progress made during the 2017 reporting period; subsequent sections provide more detailed summaries of accomplishments for each individual basin.

Progress towards accomplishing the goals of the National Plan include:

Interagency Coordination

- Progress in the development of an Action Plan for Management of Asian Carp in the Upper Mississippi River Basin, a State and Federal interagency Asian carp management plan for the UMRB.
- Expanded partnerships between State and Federal agencies and non-governmental entities within and across basins through collaborative planning, including evaluation of strategies within the National Asian Carp Management and Control strategic discussion and new issue specific work groups.

Monitoring, Early Detection and Rapid Response

- Continued implementation of key strategic actions within the 2017 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin, the Ohio River Basin Asian Carp Control Strategy Framework, the Minnesota Invasive Carp Action Plan, and the 2017 ACRC Asian Carp Action Plan.
- Development of more robust data sets for assessing the distribution and status of Asian carp populations and the Monitoring and Response Plan.
- Development and use of enhanced contingency (or “rapid response”) planning, including interagency tabletop exercises to rapidly respond if Asian carp is detected in a new location.

Active Prevention/Control

- Designation of “Intensive Management Zones” within the ORB and UMRB to provide focused control efforts and reduce populations and slow the spread of Asian carp populations.
- Development and refinement of models to assess Asian carp population dynamics to better inform the timing and placement of critical Asian carp management field actions, including intensive removal (harvest) and placement of deterrent barriers

Research and Development

- Advancements in the development and deployment of potential deterrent technologies (e.g., including electrical barriers, complex sound, carbon dioxide (CO₂), and enhanced water flow) and the identification of potential sites for pilot project implementation and related environmental planning
- Refinement of new detection tools and protocols to enhance the ability of agencies to quickly detect and respond to new occurrences of Asian carp
- Development and deployment of new tools and strategies to address the emerging threats from Black and Grass carp in the U.S.

Law Enforcement/Regulatory Actions

- Continued cooperative efforts by State and Federal law-enforcement to support applicable laws and regulations that limit the unintentional or deliberate movement of Asian carp

Additionally, since FY 2015, funding provided to the USFWS through agency base appropriations has been used to support Asian carp control efforts in the UMRB and ORB. Projects are developed cooperatively with State agencies and multijurisdictional resource organizations to address key needs that support goals of basinwide Asian carp management strategies and those of the National Plan. The collaborative projects developed and implemented through this process will augment ongoing activities conducted by State and Federal partners to address the threat of Asian carp in the UMRB, ORB, and other waters.

2.0 OBSERVED CHANGES IN THE RANGE OF ASIAN CARP IN THE UPPER MISSISSIPPI AND OHIO RIVER BASINS AND TRIBUTARIES

Range expansion was evaluated for all four species of Asian carp in the UMRB and ORB. For the purposes of this report, range expansion is defined as the difference (increase) in each species’ geographic occurrence. It is determined by comparing data collected during October 2016 to September 2017 (reporting timeframe for this 2017 Report) to the species ranges calculated for the 2016 Report. The USGS NAS database, the national repository that houses spatially referenced biogeographic accounts of introduced aquatic species across the United States, continues to serve as the primary catalogue for Asian carp occurrence data. The NAS database aids efforts to verify the presence of species and includes a number of data parameters for each collection or sighting (e.g. date, collector, location, and habitat type). It is imperative that Asian carp occurrence data collected by any verified source is reported and entered into NAS database as quickly as possible to accurately inform the extent of any potential range expansions, in particular within previously-uncolonized waters.

For this 2017 Report, range expansion since the 2016 Report was assessed by identifying the farthest known distribution points (both upstream and downstream) for each mainstream river and major tributary within the UMRB and ORB. Distribution points indicate where at least one individual fish was observed and does not infer that the species is established at that point. Data were mapped and described under two categories: “Pre-Oct 2016” (data summarized up through the 2016 Report), and “Oct 2016 – Sept 2017” (new data summarized for the 2017 Report). Observed changes in geographic distribution was assessed by comparing the farthest distance upstream or downstream an individual fish was observed in the 2017 reporting period versus the documented pre-2017 data.

As of 2017, the number of states with known occurrences of Asian carp are as follows:

- Bighead Carp, 27 states
- Silver Carp, 22 states
- Black Carp, 7 states
- Grass Carp, 45 states

Figure 2 illustrates the extent of range expansion and individual new occurrences observed for each of the four species of Asian carp from October 2016 to September 2017. These data were collected directly from the USGS NAS Database. The UMRB and ORB are represented by the grey-shaded areas on each map. Captures of adult fish are often reported by State or Federal agency monitoring crews or commercial fishers and later verified by State or Federal biologists.

The red markers indicate recent captures and not necessarily range expansions. Only when the red markers are beyond any green marker (upstream or downstream), would this be considered a range expansion, which is identified by the yellow triangles. For example, two range expansion points were observed from Black Carp in the Illinois River (UMRB) and one in the Ohio River (ORB). This was characterized as range expansion since these fish were detected at sites outside of the previous documented range.

- Observed range expansions for Bighead, Silver, and Black Carp can be summarized as: Bighead Carp: UMRB, Minnesota River: 52 miles upstream
- Silver Carp: UMRB, CAWS: 26 miles upstream; ORB, Tennessee River: 44 miles upstream
- Black Carp: UMRB, Illinois River: 145 miles upstream; ORB, Ohio River: 17.5 miles upstream

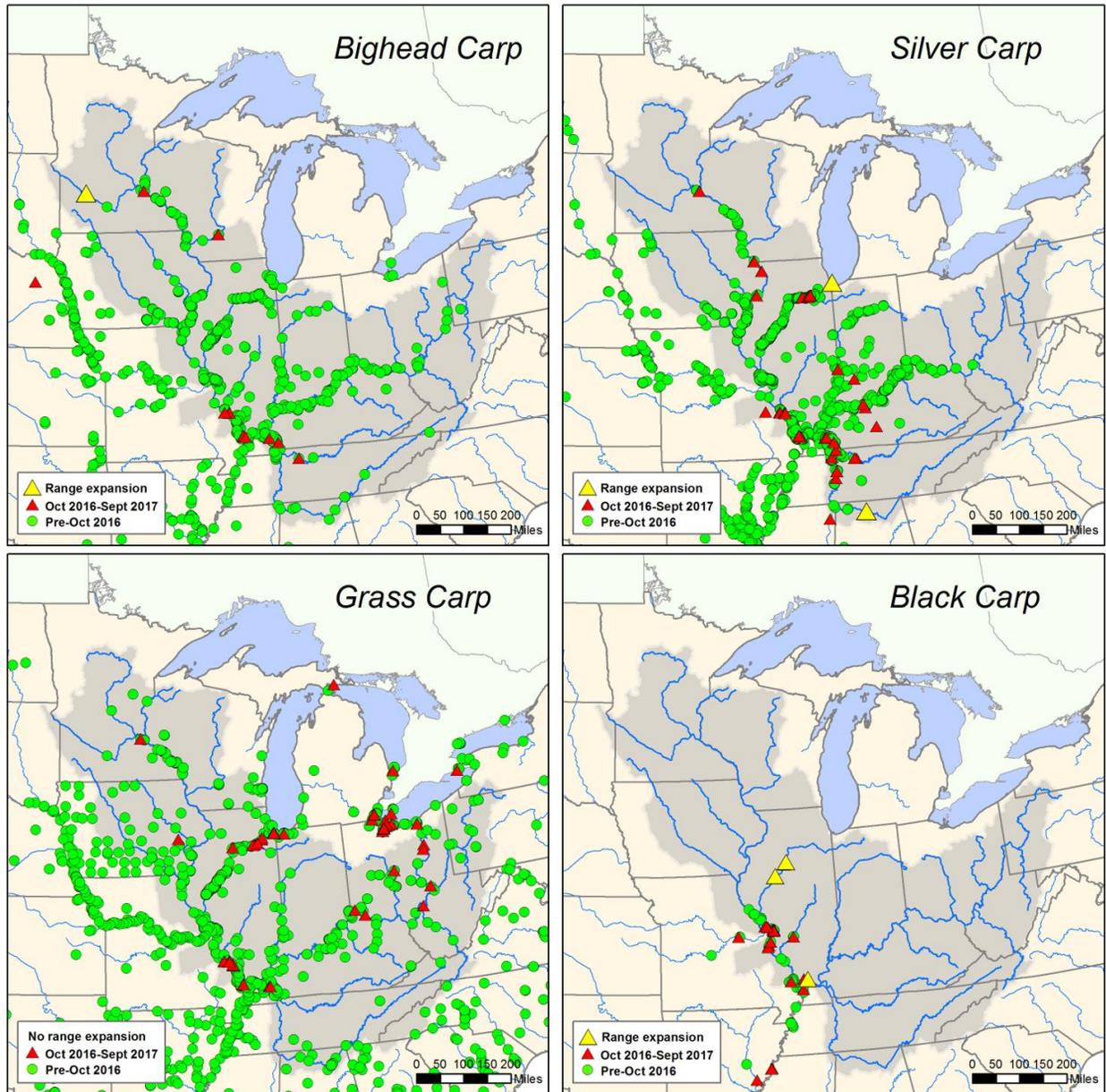


Figure 2. Range expansion maps of all four species of Asian carp: Green circles represent the data points of occurrences before the reporting period (before Oct 2016); red triangles identify the new data points collected in from Oct 2016-Sept 2017; yellow triangles indicate occurrences that expanded the range of that species. Source: USGS NAS Database.

Population Status Assessment

Individual occurrence data are important to monitor the range expansion of adult Asian carp. While the NAS occurrence data are useful in visualizing species distribution, the data provide only a partial description of the present status of each species. An accurate assessment and understanding of each species distribution and status, including all life stages, is fundamental to determine the appropriate management actions to implement at targeted locations within each basin. Acquiring this critical information requires intensive field and laboratory work and remains a high priority.

It is important to note that any collection of an individual Asian carp in a new location, which we define as a range expansion, does not indicate that the species has established in that particular point in the watershed. Additional data, such as the presence of different life stages, the relative abundance of adults in the area, and spawning activity is used to assess the geographic distribution for each species within a given river basin. This report uses categories (established, abundant, and present) to define the relative abundance of Asian carp geographically. Established populations include areas where spawning has been documented. Abundant populations are areas where Asian carp are commonly captured, but spawning is not documented. Present Asian carp populations are areas where Asian carp are present, but in low abundances. This underscores the need for intensive and consistent monitoring to collect data to inform an accurate assessment of population status.

There was a continued focused effort to monitor for eggs, larval, and juvenile stages of Asian carp in both basins. These efforts were conducted to determine the areas where Asian carp are established, abundant, or present in low abundances. Analysis of the life stages present within navigational pools of the rivers provides a qualitative measure of population status in each of the rivers. In turn, this assessment is used to inform what tools or technologies should be applied to assess the different areas.

Knowledge of each life stage for each species varies greatly. For example, the long term data set for Bighead and Silver Carp from focused long-term monitoring provides a high degree of confidence in relative abundance assessments for these species, as seen in Figure 11. Although Grass Carp are widely distributed throughout the Midwest region, there is little data on eggs, larva, or juvenile stages of these species, and therefore it is difficult to qualitatively assess the population status of this species. Black Carp, as discussed in the 2016 report, have only recently been documented as naturally reproducing in the UMRB. In 2017, the lack of early life stage data for this species continues to produce a high level of uncertainty when determining the population status for that species. Therefore, outside of the quantitative occurrence data for adults, it will be difficult to assess the relative abundance of populations of these species until more life stage data is acquired for Black and Grass Carp.

As noted above, both Bighead and Silver Carp exhibited range expansions into the UMRB, and Silver Carp expanded its range within the ORB. Details of expansion in each basin are described below.

UMRB Population Assessments

The USFWS monitored Asian carp reproduction in Pools 8-13 of the UMR and 240 samples collected in 2016 were processed in FY 2017 (Please see Figures 7 through 10 for locations of the navigation pools within the Upper Mississippi, Ohio Rivers, Tennessee, and Cumberland Rivers.) 5,242 larval and juvenile fish and 3,659 eggs were present in the 2016 samples, yet no Bighead Carp, Silver Carp, Grass Carp or Black Carp were identified. Asian carp reproduction continues to be monitored by the USFWS with weekly ichthyoplankton samples collected from pools 8-13 in the UMR from April through August 2017. Samples will be sorted and examined for presence of Asian carp eggs and larvae in the winter of 2017-2018. The collection of a single Silver Carp on June 22, 2017 in the Little Calumet River (UMRB) as part of the MRWG Seasonal Intensive Monitoring Event was significant because it was the first time a Silver Carp was captured in the CAWS above the Electric Dispersal Barrier (Figure 4). This resulted in a 26 mile range expansion for Silver Carp, and placed the fish only 9 miles from Lake Michigan. It was only the second occurrence of an Asian carp capture above the barriers since monitoring began in 2009. Using otolith microchemistry as part of an autopsy process, researchers from Southern Illinois University, the USFWS, and the USGS found that the fish originated in the Illinois/Middle Mississippi watershed. Analysis showed the 4-year-old male Silver Carp spent a quarter of its life in the Des Plaines River

watershed before being caught and removed from the Little Calumet River above the USACE's electric dispersal barriers (see Figure 20 in Section 3.4.3). Though it is not known how the fish was able to arrive above the barrier defense system, analysis show that the fish spent no more than a few weeks to a few months in the stretch of river where it was found. The live capture of this Silver Carp triggered two additional weeks of intense sampling in the area, as outlined in the MRWG CRP. The multi-agency response included electrofishing and contract netting across more than 13 miles of the Calumet River, Little Calumet River, and Calumet Harbor. More than 20,000 fish were captured, but no additional Bighead or Silver Carps were detected

Biologists from the USFWS and Western Illinois University (WIU) sampled for juvenile Asian carp in pools 14-19 of the UMR during the 2017 field season. One juvenile Silver Carp was captured near Ducky's Lagoon (RM 471.7) in Pool 16, about 1 river mile downstream from Andalusia, Illinois. Additionally, several juveniles were captured from multiple locations in Pool 17. This is the first evidence of recruitment for this species upstream from Pool 18, 38 river miles upstream from the site where juvenile Silver Carp were captured in 2016. The USFWS also detected one juvenile Bighead Carp above Lock and Dam 19 in the Bluff Harbor Marina (RM 404.5) near Burlington, Iowa, representing the furthest upstream capture of Bighead Carp in the UMR. Although sampling efforts detected an abundance of juvenile Silver Carp in pools 18 and 19 in 2016 and several in 2017, no juvenile Bighead Carp had been captured in this area prior to this single capture in 2017.

The Illinois Natural History Survey (ILNHS) has conducted monitoring for Asian carp throughout the Illinois River and the CAWS since 2010. In 2017, only Silver Carp were collected, of which 99% were from the LaGrange Pool (lower Illinois River) where an established population already exists. The remaining 1% were collected from the Peoria and Starved Rock Pools, where individual fish have also been previously documented. More details on ILNHS monitoring efforts can be found at (<http://asiancarp.us/Documents/InterimSummary2017.pdf>).

An individual Bighead Carp (Figure 3) was captured by the Minnesota Department of Natural Resources (MN DNR), in a gravel pit near the Minnesota River. In response, the USFWS's La Crosse Fish and Wildlife Conservation Office (FWCO) collected eDNA samples in the gravel pits where the fish was captured and electrofished portions of the Minnesota River adjacent to the pits. No additional Asian carp were captured and all eDNA samples were negative for Bighead Carp and Silver Carp DNA.

Black Carp numbers have been increasing in the UMRB since 1994 (Figure 5). In 2017, 75 records of occurrence were reported to the NAS database, the highest levels recorded to date. Black Carp also exhibited a significant range expansion in 2017, with 4 individuals contributing to a 145 mile range expansion in the Illinois River (Figure 6). Currently Black Carp are just over 150 miles from the entrance to Lake Michigan. Increased awareness, improved identification methods, and targeted gear are probable reasons for the increase in reporting, although it is also important to note that all fish reported are of varied size and age classes, indicating that successful reproduction has occurred in the UMRB in recent years. Although the reporting of adult Black Carp was much higher in 2017 than in previous years, a handful of juvenile fish were collected from a single location near Cape Girardeau, Missouri; also evidence of natural reproduction.

ORB Population Assessments

Silver and Bighead Carp have been present in the lower portions of the Cumberland River (below Barkley Dam) since the early 2000's, with numbers of Silver and Bighead Carp increasing steadily each year. The

status of reproduction is unknown in Lake Barkley, despite collection of juvenile Silver Carp in 2015. It is unknown if juvenile fish captured in Lake Barkley were the result of successful spawning in the lake or passage through the lock chamber. In the Cheatham Reservoir upstream of Lake Barkley, Bighead Carp are present, but in lower numbers. Above Cheatham, in Old Hickory Reservoir, infrequent targeted sampling has not resulted in the capture of Asian carp, yet there have been reports from anglers.

In 2016, Asian carp larvae and eggs were confirmed in Meldahl pool. To build upon this information, the Kentucky Department of Fish and Wildlife Resources (KYDWR) sampled the Meldahl pool in 2017 for larval and juvenile Asian carp in 2017. No juvenile fish were captured in the pool in 2017.

The collection of a Silver Carp by the Alabama Department of Conservation and Natural Resources in March 2017 documented a 44 mile range expansion of this species in the Tennessee River near Decatur, Alabama. In 2017, Black Carp were documented for the first time in the Tennessee River, a range expansion of 17.5 miles from the nearest known downstream location.



Figure 3. Bighead Carp captured on June 4, 2017, resulting in a range expansion in the UMRB, 52 miles upstream of the known location in Minnesota. Photo: Minnesota Department of Natural Resources.



Figure 4. Silver Carp captured from the Little Calumet River just below the T.J. O'Brien Lock and Dam, above the Electric Dispersal Barriers which resulted in a 26 mile range expansion for Silver Carp in the UMRB.

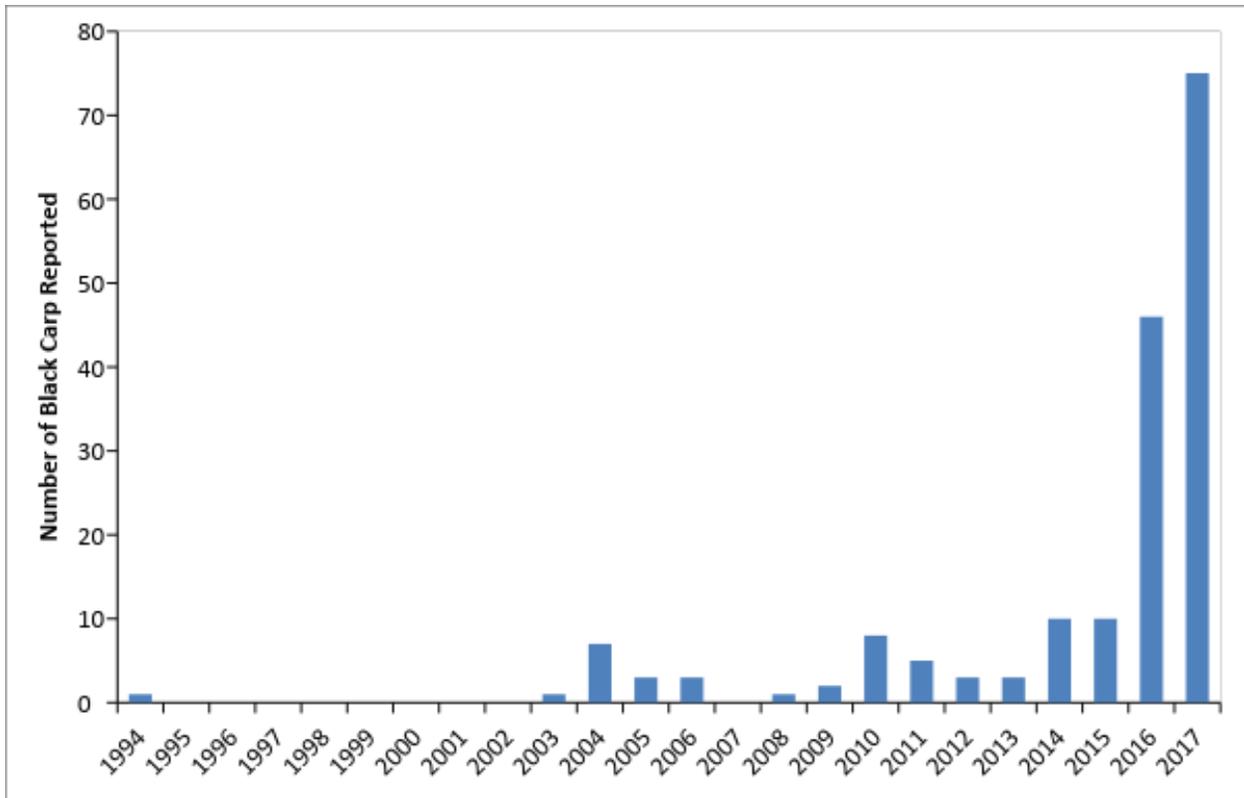


Figure 5. Number of Black Carp reported (Y axis) per year (X axis) to the USGS NAS Database. From 1994-2017 a total of 178 occurrences of Black Carp were reported; 75 of those were from 2017 alone.



Figure 6. One of the four Black Carp specimens captured from the Illinois River, resulting in a 145 mile range expansion for this species in the UMRB. Photo: Southern Illinois University.



U.S. Fish and Wildlife Service

Upper Mississippi Navigation Pools

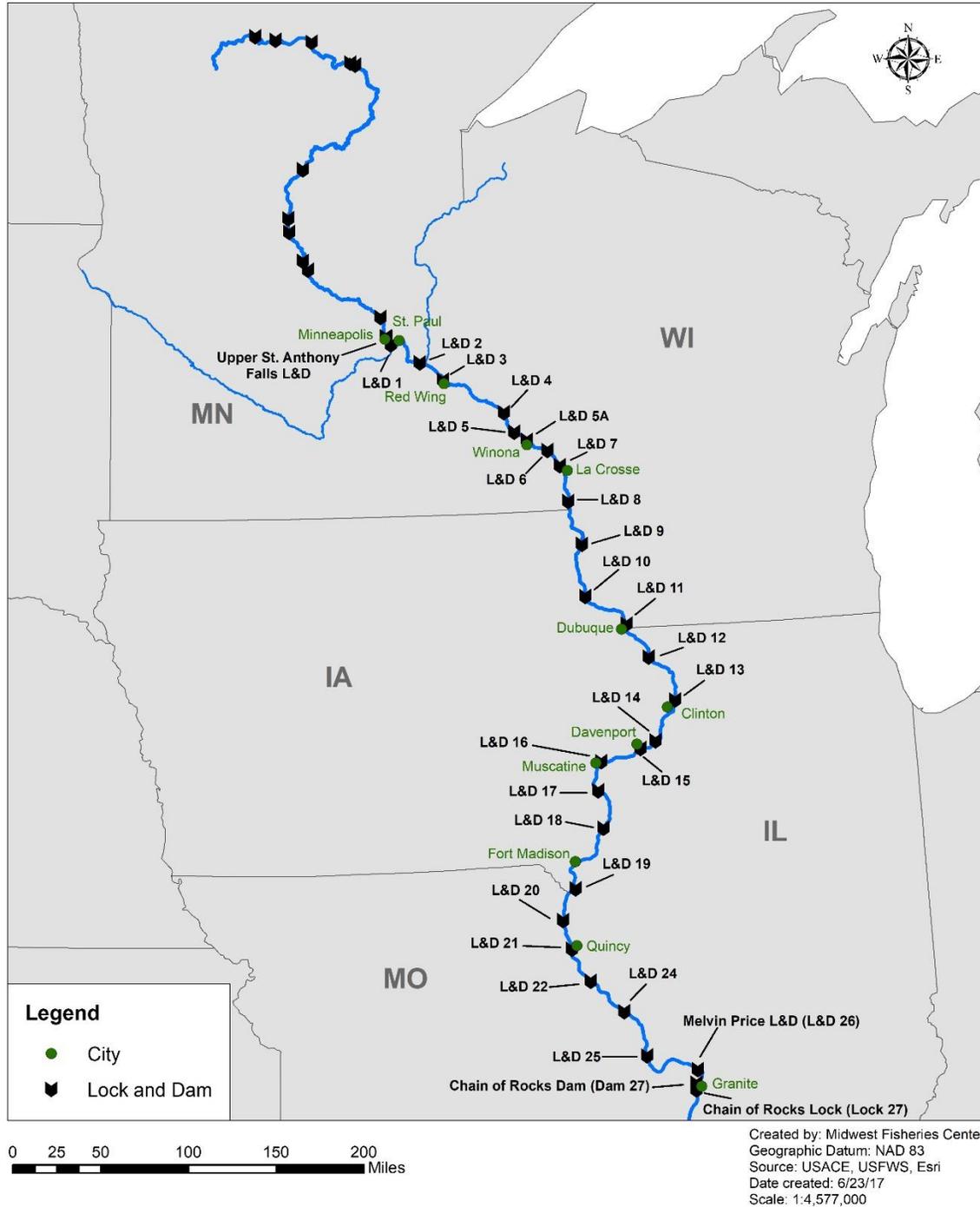


Figure 7. Map of Navigation Pools of the Upper Mississippi River



Ohio River Navigation Pools

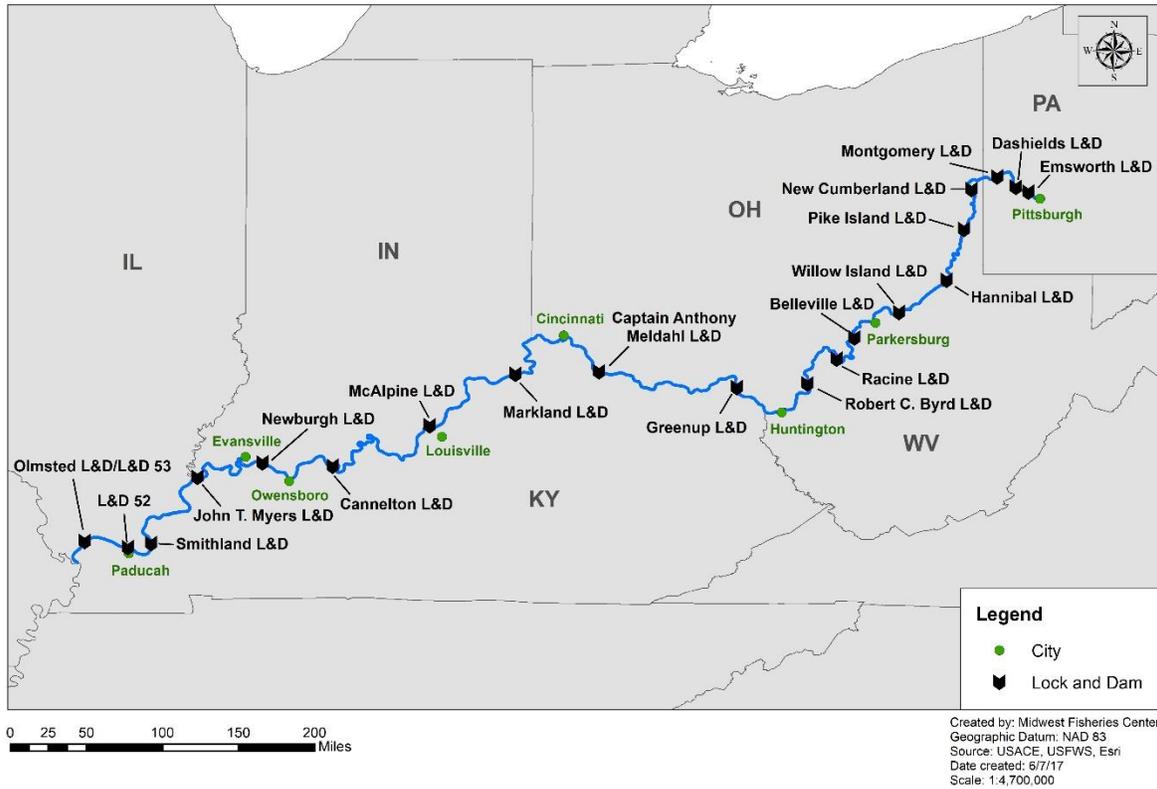


Figure 8. Map of Navigation Pools of the Ohio River



Cumberland River Navigation Pools

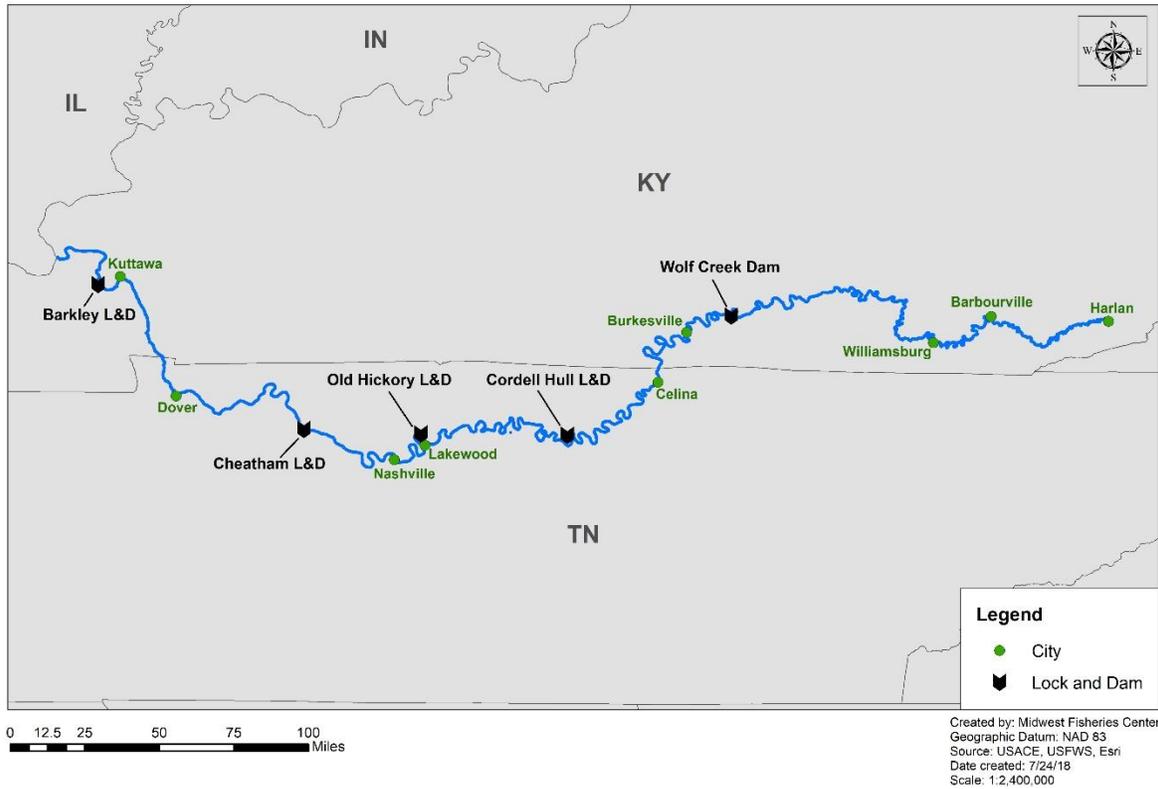


Figure 9. Map of Navigation Pools of the Cumberland River



Tennessee River Navigation Pools

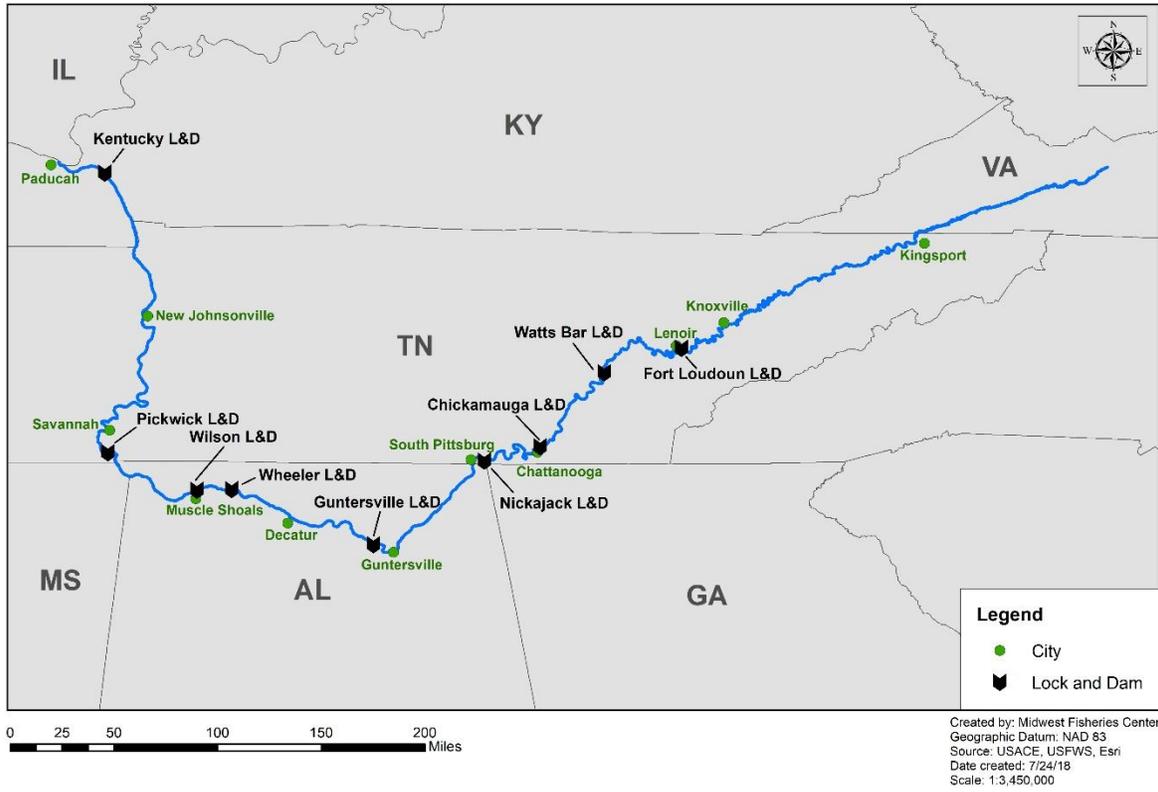


Figure 10. Map of Navigation Pools of the Tennessee River

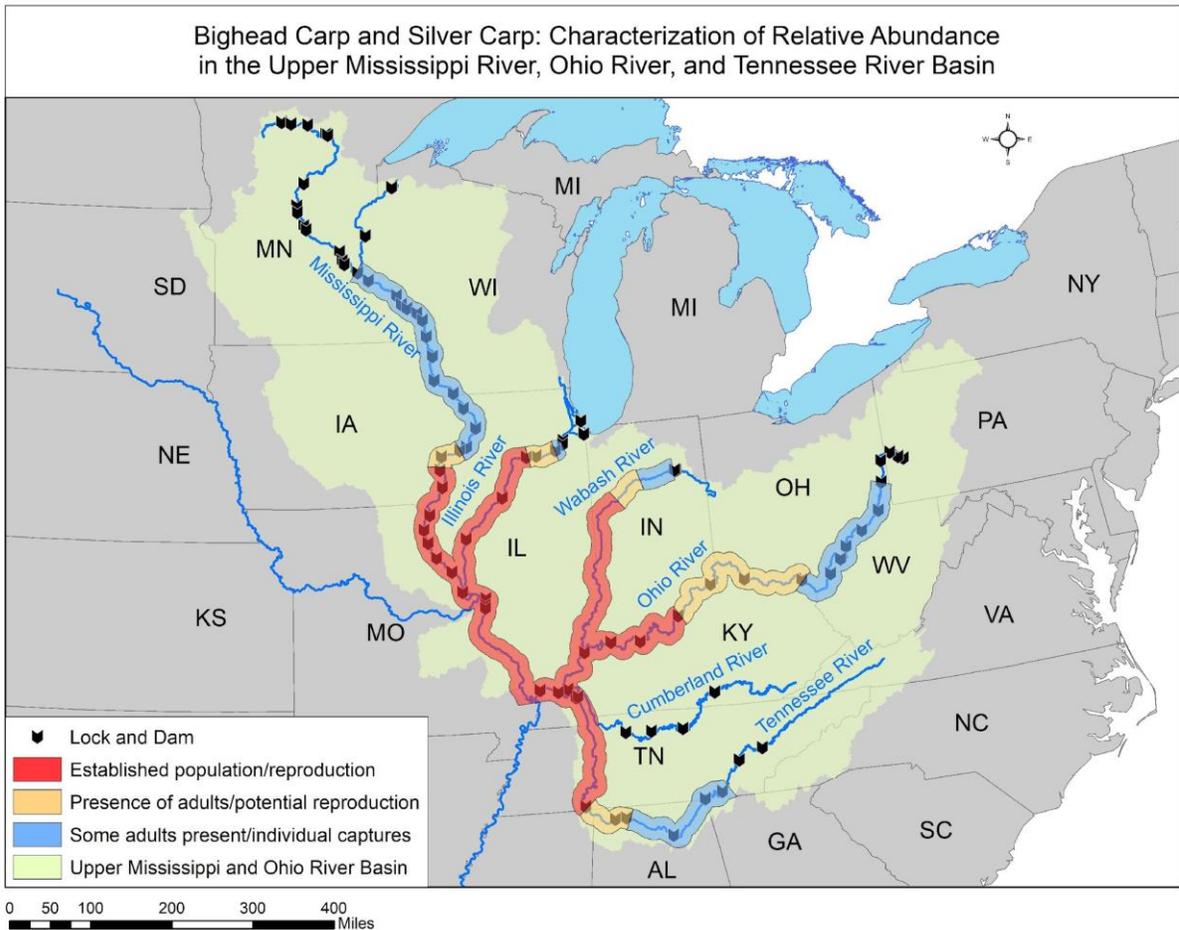


Figure 11. Characterization of current (2017) relative abundance of Bighead Carp and Silver Carp in the UMRB, ORB, and IWW/CAWS

Informing Asian Carp Management Actions

Information on Asian carp population status, including relative abundance, is used to develop partnership management strategies for each basin. Figure 11 characterizes Bighead and Silver Carp establishment and relative abundance in the UMRB and ORB, using the most-current data provided by State and Federal partners. The red-shaded area in Figure 11 indicates areas of establishment, where reproduction (spawning) has been verified by collecting taxonomically or genetically confirmed eggs, larvae, or juvenile Bighead or Silver Carp. The orange-shaded areas in Figure 11 indicate areas of adult Bighead or Silver Carp transition, where the population is stable with regular catches of adults, yet spawning has not yet been confirmed (although it may have been observed). The blue-shaded areas in Figure 11 indicate the areas where adults are occasionally captured, either through agency monitoring efforts or commercial fisher catch. The distribution of fish in the blue-shaded areas should not be considered uniform throughout those reaches.

Different management goals and actions are needed to address Bighead and Silver Carp characterized within the different color zones depicted in Figure 11. These actions are informed by the continually improved understanding of Asian carp populations and implemented by the basin partnerships.

Management actions within the established zone (red zone in Figure 11) are conducted to reduce the abundance of Bighead and Silver Carp, particularly near lock and dam complexes that act as partial barriers to upriver movement of fish. Reducing the number of fish below locks and dams (i.e., propagule pressure) reduces the numbers of fish migrating into the transitional zone (orange zone in Figure 11) where reproducing populations have not yet established. Effort is being directed to understanding the extent of fish passage, for both Asian carp and native species, at lock and dam complexes between the established and transitional zones. These locks and dams are being evaluated to determine if the use of deterrent technologies (e.g., sound or CO₂ barriers) would increase the effectiveness of these structures to serve as barriers to fish movement.

In the transitional zone, several priorities have been identified to reduce the risk that Asian carp will reach sufficient abundances to establish reproducing populations in these reaches. The first priority is to conduct intensive monitoring and assessment of all life stages to clearly define and understand where Bighead and Silver Carp are reproducing. Weather and riverine environmental conditions are highly variable each year, which may cause reproductive success to fluctuate across years. Accordingly, focused and consistent monitoring is required to detect changes in year class. This information is critical to informing the degree of establishment and range expansion.

Similar to efforts in the established zone, considerable effort is directed at removing Asian carp from the transitional zones to reduce the abundance of adults and minimize the potential for fish to successfully spawn. To inform and improve the efficiency of these efforts, studies are being conducted to understand the timing and extent of Bighead and Silver Carp movements.

Between the transitional and detected zone (blue zone in Figure 11), additional work is being conducted to evaluate the potential for additional deterrent barriers to prevent Bighead and Silver Carp from becoming established in areas where only individual fish have occasionally been collected. The primary goal and management actions within these reaches are monitoring and removal. Collection of a Bighead or Silver Carp within the detected zone may require collaborative response action, with multiple agencies intensively sampling the area to determine if more Asian carp are present.

Determination of Ploidy

Ploidy analysis is important to determine if a fish is sterile (triploid) or capable of reproducing and potentially contributing to an established population (diploid). Additionally, ploidy analysis can provide insight as to the origin of the fish (i.e. aquaculture vs. natural reproduction). Ploidy analyses is currently used for Grass and Black Carp, since they are the only two of the four Asian carp species for which triploid variations are available. At this time, no triploid Silver or Bighead Carp are produced in aquaculture. Ploidy analysis is conducted using flow cytometry techniques developed by the USGS Wetland and Aquatic Research Center, and performed by the USFWS La Crosse Fish Health Center. Ploidy results, along with collection data and images, are reported to the USGS NAS database.

A total of 54 Asian carps were analyzed for ploidy at La Crosse Fish Health Center in FY 2017. Ploidy is determined from samples collected in the field and it is not logistically feasible to test every fish captured. . The 19 Black Carp collected from the UMRB were found to be diploid. Of the 34 Grass Carp collected from the CAWS, Ohio River, and Upper Mississippi River Basins in FY 2017, 16 were diploid and 17 were triploid. The ploidy results from the one fish collected from the Tennessee River Basin could not be determined. While both the ORB and MRB had higher ratios of diploid Grass Carp collected, 3 of 5 and 12 of 20 respectively, triploid Grass Carp outnumbered diploids in the CAWS. Of the 8 Grass Carp

collected in the CAWS, 7 were triploid and 1 was diploid. The single Silver Carp captured from the CAWS in 2017 was also diploid. Although Silver Carp are not typically tested for ploidy, an exception was made since this was such a noteworthy capture above the electric barriers. Figure 12 is a map of ploidy results for the reporting period.

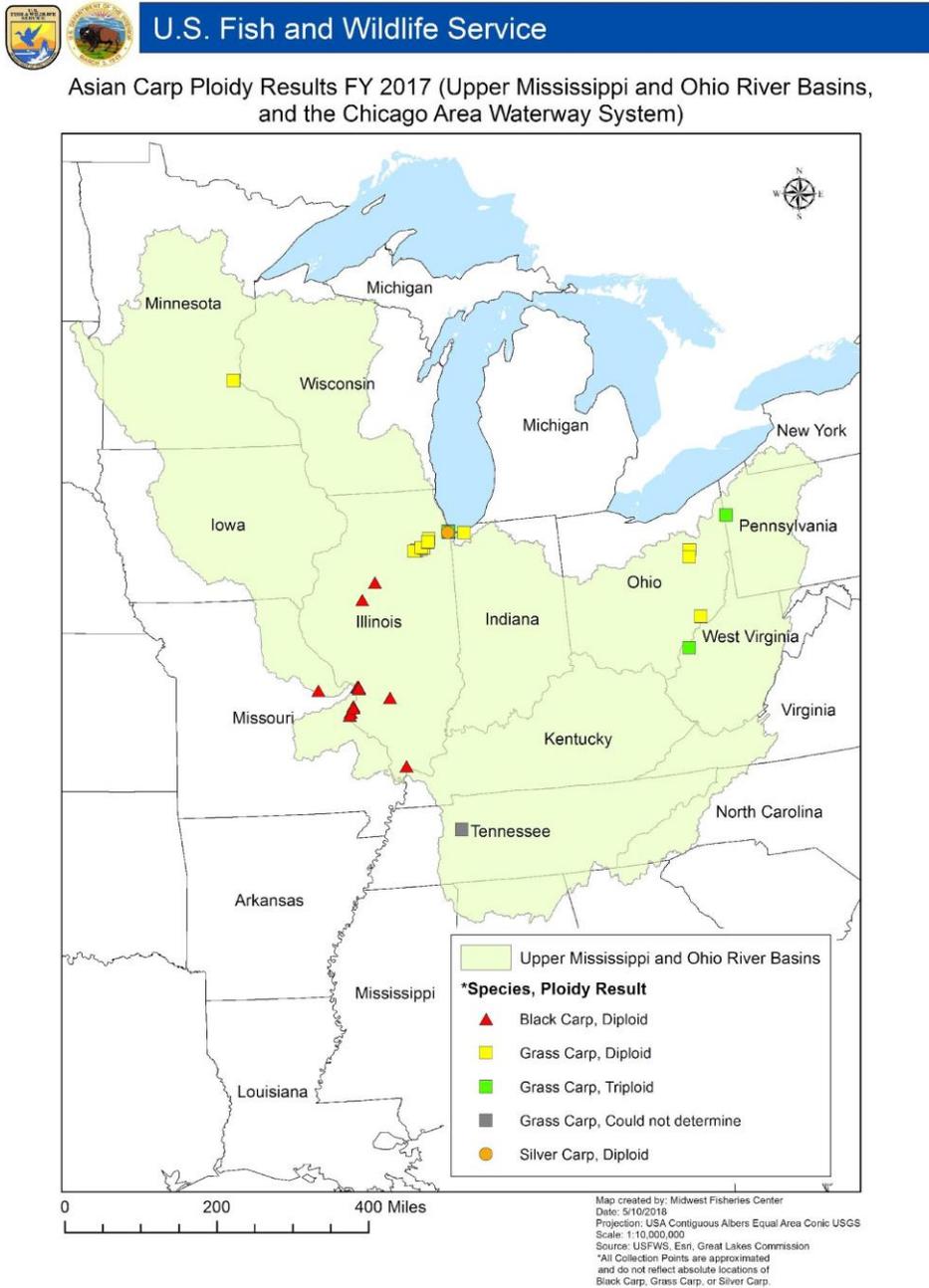


Figure 12. Map of all ploidy results (N=54) for the reporting period of this report in the UMRB and ORB
 All 19 Black Carp collected were diploid; Grass Carp specimens were both diploid (N=16) and triploid (N=17); one Grass Carp was unable to be determined. The single Silver Carp specimen was diploid.

3.0 FEDERAL AGENCY AND COOPERATIVE STATE/NON-GOVERNMENTAL PARTNER ACTIVITIES TO CONTROL SPREAD OF ASIAN CARP IN THE UPPER MISSISSIPPI AND OHIO RIVER BASINS

3.1 Basinwide Planning for Asian Carp Management

Development of long-term strategies and annual research and management work plans in each sub-basin is coordinated through multi-jurisdictional partnerships comprised of State and Federal agencies. The organizational structures for the ORB and UMRB partnerships are illustrated in Figure 13. The ACRCC partnership is focused on GLB protection through activities in the IWW/CAWS.

The MICRA (Figure 13) is a partnership of 28 state natural resources agencies organized in 1991 to improve management of interjurisdictional fish and other aquatic resources in the MRB. MICRA formed an Asian Carp Advisory Committee (ACAC) that includes State agency representatives from each of the major sub-basin partnerships that collaborate through MICRA (i.e., Upper Mississippi River, Lower Mississippi River, Ohio River, Missouri River, Tennessee/Cumberland rivers, and Arkansas/Red rivers); and representatives from several key Federal agency partners including the USFWS, USGS, USACE, NPS, and Tennessee Valley Authority. The multiple Asian carp sub-basin partnerships work together through MICRA and the ACAC to develop a unified, basin-wide perspective on Asian carp management across the MRB. MICRA works with its partnerships to identify high-priority Asian carp management needs for the MRB, which are reflected in the annual *Asian Carp Monitoring and Response Plan for the Mississippi River Basin*.

Six states collaboratively manage interjurisdictional fisheries in the mainstem Ohio River through the ORFMT. In 2014, the ORFMT formed an ORB Asian carp partnership comprised of State and Federal agency partners. Universities assisting the partnership and other non-governmental conservation organizations in the basin participate as cooperating entities. Partners in the ORB subsequently developed the ORB Framework. Implemented in 2014, the ORB Framework supplements the National Plan by providing additional strategic guidance and coordination for developing prioritized and complementary actions to support management goals and collaborative efforts to manage Asian carp in the ORB.

The UMRCC is a five-state partnership that promotes cooperation between the conservation agencies in the Upper Mississippi River sub-basin. The UMRCC engages Federal agencies and other partners through supporting technical committees to collaboratively address fishery and mussel management, recreation, wildlife, water quality, vegetation, education, and law enforcement issues. The UMRCC, through the broad membership of the Fisheries Technical Committee, implements the *Asian Carp Control Strategy Framework for the Upper Mississippi River Basin*; a step-down plan of the National Plan.

The ACRCC (Figure 14) is a partnership of 27 U.S. and Canadian Federal, State, Provincial, and local agencies and organizations working to prevent the introduction and establishment of Asian carp populations in the Great Lakes. The ACRCC coordinates the Asian carp management and research efforts of its members through an annual *Asian Carp Action Plan*. The 2017 Asian Carp Action Plan contained a comprehensive portfolio of approximately 61 projects, including early detection and monitoring, contingency response planning, prevention and control (including addressing permanent and temporary pathways), research and development of new technologies, law enforcement, and partner and stakeholder communication and outreach activities. The work of the ACRCC focuses heavily on prevention and control opportunities in the IWW/CAWS and other potential secondary pathways of risk

to the GLB, as identified in the GLMRIS report. The ACRC partnership structure includes a Federal Executive Committee (consisting of the eight U.S. Federal agency partners); the MRWG (co-chaired by the Great Lakes Fishery Commission (GLFC) and Illinois Department of Natural Resources (ILDNR)); and a Communications Work Group (co-chaired by USFWS and ILDNR). The MRWG, comprised of technical and scientific experts on Asian carp life history, prevention, and control from ACRC member agencies, develops an annual *Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System* (MRP). The MRP complements the Asian Carp Action Plan, and serves as the comprehensive tactical, on-the-the-ground annual work plan, with a primary focus on the IWW/CAWS.



Figure 13. Organizational structures of MICRA, ORB, and UMRB sub-basin partnerships

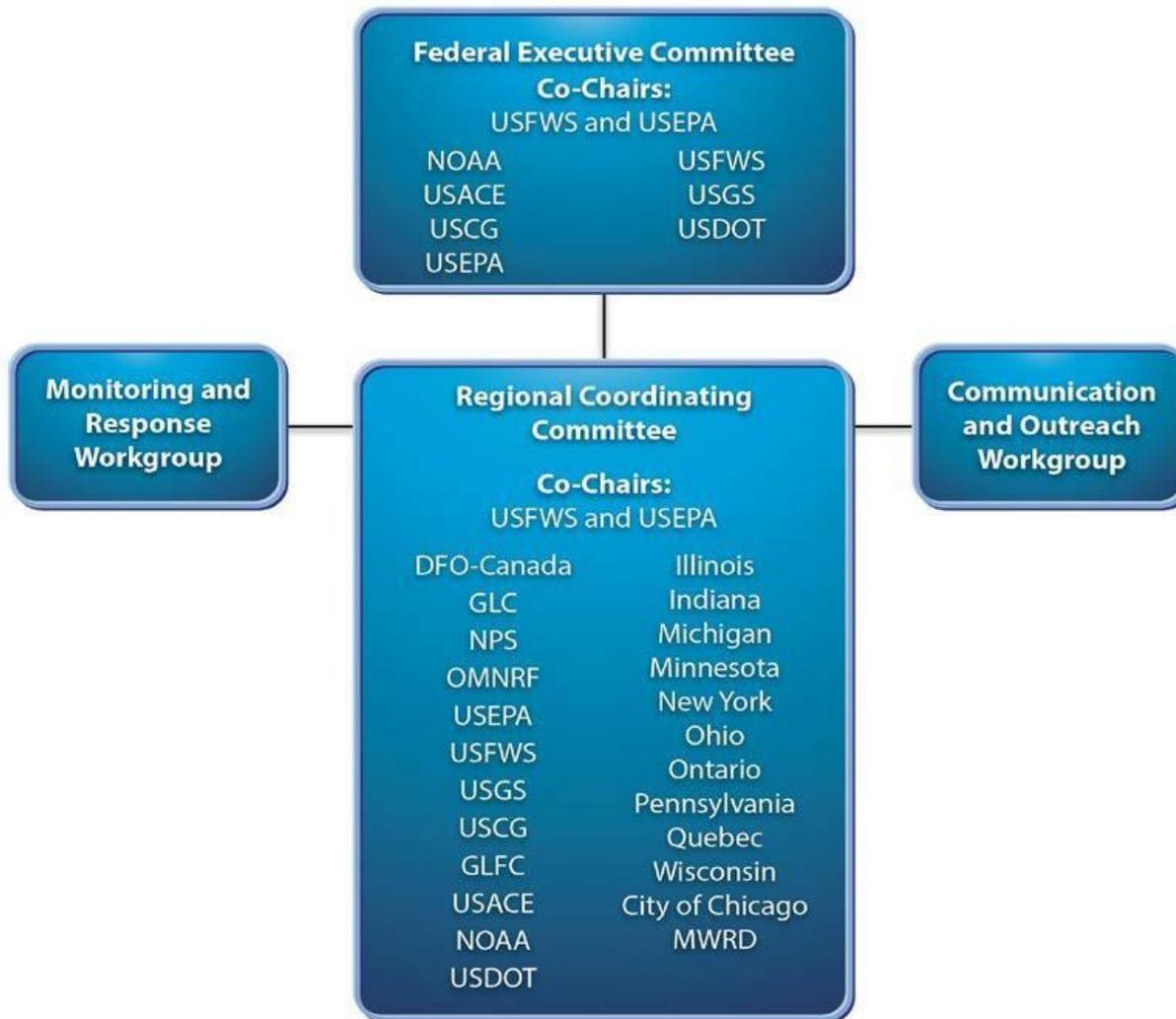


Figure 14. Organizational structure of the ACRCC partnership (includes actions in the Asian Carp Regional IWW/CAWS for Great Lakes protection)

2017 Federal, State and non-Governmental Partnership Accomplishments

The following sections provide summaries of Asian carp management activities and accomplishments achieved within each sub-basin (ORB, UMRB, and IWW/CAWS) that support partnership strategies. More comprehensive individual State and Federal agency summary reports on Asian carp management activities conducted in 2017 are available at www.AsianCarp.us. This includes the *2017 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin*, a complete compilation of work plans developed for the ORB and UMRB projects that received funding from USFWS in FY 2017.

3.2 OHIO RIVER BASIN

3.2.1 INTERAGENCY COORDINATION

- **NATIONAL PLAN GOAL: Effectively plan, implement, and evaluate management and control efforts for Bighead, Black, Grass, and Silver Carp in the United States.**

In FY 2017, State and Federal agencies continued to plan and implement strategic management actions to address the threat of Asian carp in the ORB and tributaries (including the Tennessee River) through coordinating interjurisdictional partnerships and strong collaboration focused on preventing the further spread of Asian carp. ORB partners participated in one or more levels of interagency coordination, including the MICRA Asian Carp Advisory Committee, Ohio River Sub-basin Planning Team, and Ohio River Asian Carp Technical Team. Within the sub-basin, discipline-specific workgroups, including the Tennessee River Telemetry Workgroup and ORB Communications Workgroup, continued to address priority coordination and technical needs on behalf of the broader partnerships. Priority ORB interagency coordination and Asian carp management actions to address monitoring, population containment including removal, aligned with and supported the goals of the National Plan as well as the *Ohio River Basin Asian Carp Control Strategy Framework* (ORB Framework), the ORB annual work plan, and State agency Asian carp management strategies, including the *Ohio Asian Carp Tactical Plan: 2014-2020* (Tactical Plan). The ORB Framework was developed to support other regional plans and outlines actions for prevention, monitoring and response, population control, research, and communication to collectively prevent further expansion and reduce population abundances of Asian carp. Additionally, ORB State and Federal partner agencies participated in several key inter-basin coordination efforts in FY 2017, including the Mississippi River Basin Panel on Aquatic Nuisance Species, the Lower Mississippi River Conservation Committee, ACRCC collaborative planning meetings, National Asian Carp Management and Control strategic planning discussions led by the USFWS and USGS, and a multi-basin sound deterrent coordination and planning workshop for key researchers and natural resource managers.

To further leverage the ORB partnership actions, the USFWS coordinated closely with MICRA and ORB State and Federal agency partners to identify annual ORB sub-basin priorities that may be considered for funding with available resources. Project proposals were identified and developed for early detection monitoring, monitoring and assessment, control and removal, and containment actions to prevent further distribution and establishment of Asian carp in the ORB. Full project work plans for USFWS funded projects were then developed and collaboratively implemented (see *2017 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin* - <http://www.asiancarp.us/documents/MRP2017MississippiRiverBasin.pdf>). Information on partnership efforts in the ORB can be found at www.asiancarp.us.

3.2.2 MONITORING, EARLY DETECTION AND RAPID RESPONSE

- **NATIONAL PLAN GOAL: Minimize potential adverse effects of feral Bighead, Black, Grass, and Silver Carp in the United States.**
- **NATIONAL PLAN GOAL: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**

Asian Carp Telemetry Monitoring

ORB agencies collaboratively gathered information on Asian carp largescale movements (e.g., across locks and dams) and fine-scale movements (e.g., habitat use) using acoustic telemetry, a technology that tracks the movement of fish by tagging them with transmitters that emit ultrasonic sound pulses unique to each individual. Coordination of telemetry monitoring was augmented through the Ohio River Asian Carp telemetry project and supported under the ORB Framework.

During the FY 2017 reporting period, the USFWS, Indiana Department of Natural Resources (INDNR), Ohio Department of Natural Resources (ODNR), KDFWR, and West Virginia Division of Natural Resources (WVDNR) tagged 106 Asian carp with ultrasonic transmitters. Six additional stationary receivers were deployed within the upstream lock chamber approaches of Markland, Meldahl, Greenup, Robert C. Byrd, Racine, Belleville, and Willow Island Locks and Dams. Receivers were previously deployed within the lower lock approaches at these locations during the 2016 field season; yet the additional receivers increased the ability to assess the use of active lock chambers by Asian carp as a means of bypassing dams. Results from this study are currently being reviewed and will be included in future reports.

In the ORB, an additional 52 receivers were deployed in FY 2017 to determine tributary use, bringing the total to 150 stationary receivers (Figure 15) and 506 tagged Asian carp to support the Ohio River Asian carp telemetry project. During the reporting period, 252 tagged fish were detected on the stationary receivers. The major findings of this project were: 1) The majority (80%) of Silver and Bighead Carp tagged in the Ohio River do not move much (less than 5 miles net movement upstream or down); and 2) Asian carp found in Ohio River pools use tributary habitats more than mainstem habitats. This information has guided removal efforts and sampling efforts in recent years and continues to be the baseline for decisions regarding deterrents within priority locations of the ORB.

Although the ORB stationary receivers provide useful data on the movement of Asian carp, the 150 receivers require physical download of data on a monthly basis by field personnel. As a result, there is a time lag in detecting the passage of a tagged fish at any stationary receiver location. To resolve this issue, the USGS, in collaboration with the USFWS and State partners, initiated real-time telemetry sites in FY 2016 to detect tagged Asian carp in the Ohio River at Louisville, Kentucky and Ironton, Ohio where tagged Asian carp are present. Outfitting strategic locations with real-time receivers allows instantaneous detection of Asian carp passage which can be used to fuel response efforts or assess the timing of movements related to spawning events. Data are reported through the Illinois Water Science Center Fish Tracks website (http://il.water.usgs.gov/data/Fish_Tracks_Real_Time/) and are included in

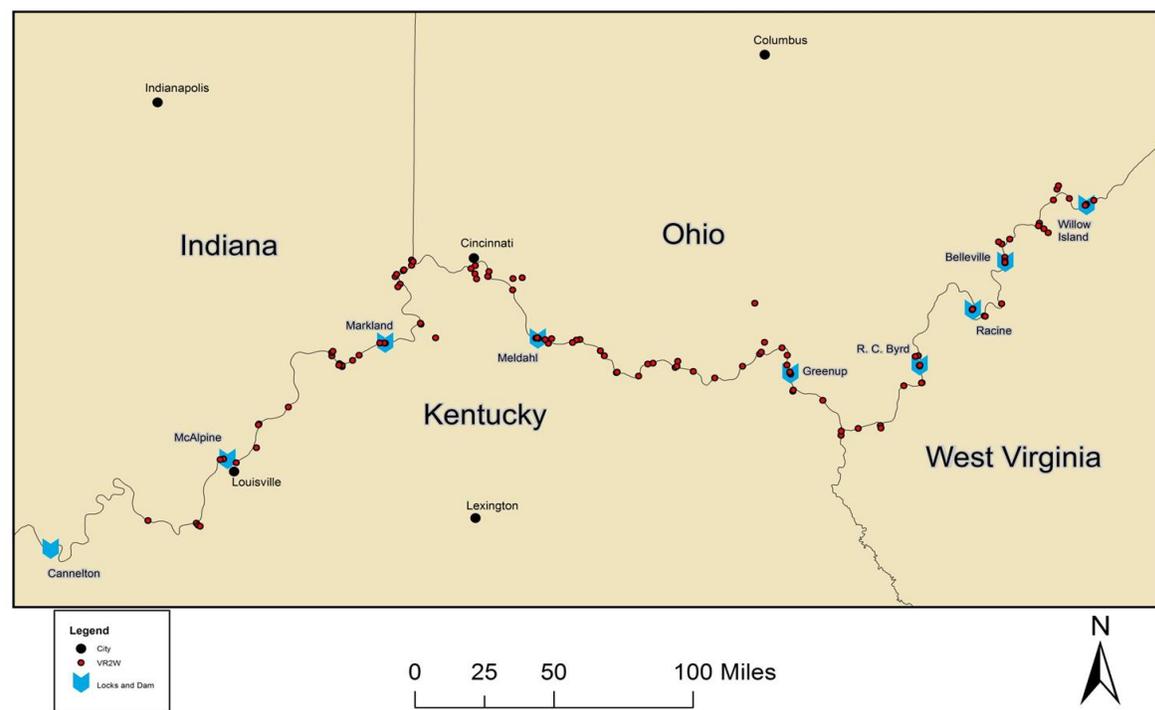


Figure 15. Location of receivers on the Ohio River

the USGS shared database and visualization tool developed for Asian carp telemetry data. This effort continued through FY 2017.

Additional efforts by the Ohio River Asian carp telemetry project in FY2017 included Asian carp mobile tracking in Ohio River navigation pools to detect Bighead Carp that were documented during the prior year's surveys. A continued emphasis on assessing Asian carp movements in ORB river systems is planned for FY 2018, focusing on factors, such as water level and temperature, that potentially influence upstream movement, range expansion, and lock and dam passage.

The Tennessee River Telemetry Work Group (TWG) was formed in 2016 to coordinate telemetry efforts throughout the Tennessee River sub-basin. The TWG created a work plan focused on increasing the number of tagged Silver Carp and developing a stationary receiver array upstream of Kentucky Lake, including locations in the Tennessee-Tombigbee waterway in Mississippi. Since 2016, telemetry has been conducted on the Tennessee River to assess movement of Asian carp through dams and inform removal efforts. Thirteen stationary receivers were deployed in Kentucky Lake, the lowermost reservoir and upstream extent of established range of Asian carp on the Tennessee River. Seventy-two Silver Carp were implanted with sonic transmitters, adding to the total number of tagged fish in the system.

eDNA Monitoring

In 2017, the USFWS and State agency partners (Pennsylvania Fish and Boat Commission (PFBC), WVDNR, KDFWR, ODNR, Alabama Department of Conservation and Natural Resources, Mississippi Department of Wildlife, Fisheries, and Parks, Tennessee Wildlife Resources Agency (TWRA)) continued eDNA sampling within the ORB for early detection of Silver and Bighead Carp. Efforts supported implementation of the Ohio River Basin Asian Carp Control Strategy Framework. Genetics-based eDNA surveillance serves as an efficient early detection surveillance tool to help inform where additional monitoring using traditional methods (e.g. netting, electrofishing) should subsequently be used in the event of a positive eDNA finding. A total of 920 samples were collected from the ORB, with one positive eDNA test result for Bighead Carp in the Montgomery Island Pool and one for Silver Carp in the Tombigbee River. These positive detections did not represent new areas of Asian Carp invasion, thus subsequent monitoring was not deployed.

Traditional Gear Sampling

ORB agencies continued coordinated sampling and stock assessment for Asian carp in the mainstem river, tributaries, and reservoirs, informed by sampling results from prior years. Monitoring focused on assessing the abundance and distribution of adults, juveniles, and larvae in targeted waters of the ORB, with an emphasis on documenting the established range and leading edge for Bighead and Silver Carp. Increased collections for Black Carp within the MRB in 2016 and 2017 warranted additional sampling for this species in downstream portions of the ORB. Added survey sites included backwater sloughs of the Ohio and Mississippi rivers to obtain information on the potential occurrence in, and use of, these habitats by Black Carp and other Asian carp species. Additional sampling was also conducted to determine the relative population densities of Asian carp in the Tennessee River and Cumberland River drainages. Further, the WVDNR collaborated with West Virginia University (WVU) to sample for larval Asian carp in the R.C. Byrd Pool, supporting the project *Abundance and Distribution of Early Life Stages of Asian Carp in the Ohio River*. Data gathered on larval fish occurrence will help inform coordinated assessments of the location and status of naturally-reproducing populations of Asian carp in the ORB.

Strategic Asian carp monitoring was augmented through the *Monitoring and Response of Asian Carp in the Ohio River Project* (MRORB), co-led by the WVDNR and KDFWR and supported under the ORB Framework. The MRORB includes targeted sampling for surveillance, early detection, distribution, and relative population density of Asian carp at multiple life stages; evaluation of the validity of consistent positive eDNA results in Ohio River pools upstream of the invasion front; compilation of all available State and Federal agency historical sampling data to establish a baseline for future comparison and analyses; and evaluation of previously established sampling protocols (2015) to determine if adjustments are warranted to increase effectiveness.

In support of the MRORB, WVDNR staff conducted electrofishing and gillnetting monitoring in the Greenup and R.C. Byrd pools. Approximately seven hours of electrofishing effort and 77.8 hours of gill netting effort were expended during the FY 2017 reporting period. Surveys yielded data from 48 species of fish, including one Bighead Carp collected in Raccoon Creek in the R.C. Byrd pool. This fish had previously been tagged with an acoustic transmitter and was, therefore, released back into the water to collect further data on movement and habitat use. Two Grass Carp were collected during this sampling effort, one from Guyan Creek in the Greenup pool and another from the Tenmile Creek in the R.C. Byrd pool.

During the FY 2017 reporting period, the KDFWR conducted over 300 hours of fishing effort, which resulted in collection of over 60 fish species from the six pools within the Asian carp monitoring project area (Cannelton through RC Byrd pools). More specifically, more than 2,000 lbs of Asian carp were captured and removed during this effort. Asian carp catch rates remained significantly higher in downriver pools (Cannelton and McAlpine) when compared to upriver locations (Markland, Meldahl, and Greenup). Sampling efforts led to the capture of one Bighead Carp in the Meldahl pool and the capture of three additional Bighead Carp above the R.C. Byrd Lock and Dam. Assessments of the gear deployment techniques used during these sampling efforts demonstrated that nets set during nocturnal hours yielded higher catches of Bighead Carp. These results are being used to inform future Asian carp sampling strategies.

The TWRA collaborated with the KDFWR, USFWS, Murray State University, Tennessee Technological University, and Mississippi Department of Wildlife Fisheries and Parks to implement the “Carp Blitz”, a focused, two-day effort for Asian carp removal, tagging, and collection of population dynamics data in the Kentucky and Barkley Lakes area.

The USFWS, KDFWR, and INDNR also conducted electrofishing surveys targeting the detection of juvenile Asian carp in lower navigation pools where they are believed to be currently established. These agencies also supported the collection of larval fish data in the Meldahl pool to build on the early-life stage information made available in 2016 by a partner consultant (EA Engineering) when Asian carp yolk-sac larvae, post yolk-sac larvae, and eggs were confirmed as far upstream as the Meldahl pool. No juvenile fish were captured in that pool during the designated follow-up sampling. Additionally, the INDNR, KDFWR, WVU, USFWS, WVDNR, and the Ohio River Valley Water Sanitation Commission (ORSANCO) collaborated on Asian carp early life stage monitoring project to investigate the key factors influencing Asian carp reproduction and recruitment within the ORB.

TWRA and its partners assessed the relative abundance of Asian carp in the Kentucky, Pickwick, Barkley and Cheatham reservoirs, including reservoir dam tailwaters, to better understand the potential risk of upstream invasion by Asian carp from the established zones and determine the leading edge of Asian carp.

In addition to agency sampling, commercial fishing continues to be a key source of information on Asian carp occurrence in the ORB. The KDFWR monitored the commercial harvest of Asian carp in Kentucky to assess the impacts of the Asian Carp Harvest Program (ACHP) on sport fish and determine Asian carp demographics in Kentucky Lake. The ACHP was initiated by KDFWR in 2013 to allow commercial anglers targeting Asian carp to fish in previously restricted areas, including Kentucky Lake and Lake Barkley. Commercial anglers are required to submit daily harvest logs and allow KDFWR staff to routinely ride-along to monitor bycatch. Analysis of the reports from the ACHP revealed that a total of 2,265,425 pounds of Silver Carp and 88,208 pounds of Bighead Carp were harvested from Kentucky waters. The KDFWR and Murray State University also monitored Silver Carp demographics in Kentucky Lake to assess the effect of continued commercial harvest on Silver Carp populations. Data demonstrate that Silver Carp in Kentucky Lake are larger in size than fish in other MRB populations, yet have similar length and weight relationships. The fish also grow very fast and exhibit variable reproduction and intermediate mortality rates. The KDFWR is currently continuing this study by analyzing 261 Silver Carp samples collected from Lake Barkley.

The KDFWR analyses of 2016 creel surveys, angler attitude surveys, and fisheries community surveys in tailwaters below Kentucky Dam (Tennessee River) and Barkley Dam (Cumberland River) was used in 2017 to assess impacts of dense Asian carp populations on popular sport fisheries. Anglers reported that Asian carp were the number one reason for dissatisfaction with the tailwater fisheries. Information was also gathered from anglers below Kentucky Dam (Tennessee River) and Barkley Dam (Cumberland River), with over 50,000 Asian carp reported by anglers in 2016-2017.

Rapid Response

After the KDFWR captured three Bighead Carp above R.C. Byrd, the USACE and other credible reporting sources in this area agreed to inform ORB partners if additional Bighead Carp were detected above the R.C. Byrd Locks and Dam. Additional Asian carp removal efforts, both above and below the site, will be included in sampling actions for the upcoming year.

In September 2017, the WVDNR Apple Grove State Hatchery staff were notified by the USACE Lock Master of R.C. Byrd Locks and Dam that several Bighead Carp were congregating upstream of the old lock chambers (no longer in use). Hatchery staff removed two large Bighead Carp (70 and 56 pounds, respectively). This information and communication channel will be used in future removal efforts.

The TWRA provided rapid response support following Asian carp sightings and mass die-off reports in Kentucky Reservoir. When credible Asian carp reports are received in new locations, TWRA investigates to the best of their ability, considering available resources. Reports of Asian carp in established zones are collected for the statewide database and reported to partner agencies and the USGS NAS Database. In spring of 2017, a die off of Silver Carp took place on Kentucky Lake, although the source of the die off was undetermined. The TWRA staff investigated reports of strange fish behavior (fish swimming onto the banks erratically) and communicated the extent of the reports to partner agencies. This investigation found that several of the Silver Carp analyzed by the USFWS Fish Health Center in LaCrosse, Wisconsin were infected with *Aeromonas hydrophila*, an environmental bacteria present in North American waterways. This bacterium is commonly present in freshwaters, but only affects stressed or injured fish. Some Silver Carp infected by the bacterium were visibly injured (e.g. cuts or abrasions), whereas other specimens had no obvious physical injuries. Following dissection, it was found that these fish had insufficient energy reserves (fat storage) and little food in their gut. Therefore, they were likely starving and stressed, which made them susceptible to this bacterium. This infection is

the likely reason Silver Carp were seen swimming erratically in shallow water and occasionally beaching themselves.

3.2.3 ACTIVE PREVENTION/CONTROL

- **NATIONAL PLAN GOAL: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**
- **NATIONAL GOAL: Extirpate, or reduce to levels of insignificant effect, feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**

Asian Carp Capture and Removal by State and Federal Agencies

ORB agencies used traditional gear to strategically detect and harvest Asian carp in the mainstem river, navigation pools, and select tributaries. For example, the KDFWR partnered with the INDNR to spend 105 days removing Asian carp from the Ohio River using electrofishing and gill netting. ORB agency Asian carp removal goals are supported by the *Containment and Suppression Project*, identified by the OHR Asian carp partnership as a priority project in 2017. Specific objectives of this project included detecting and removing Asian carp in key locations in the ORB ultimately reducing propagule pressure in the lower pools to prevent further expansion upriver.

At progressively lower Asian carp population densities, targeted detection and removal efforts with traditional gear becomes increasingly less efficient. To address this issue, ORB agencies used telemetry data, angler reports, and other agency information to identify locations Asian carp were known to inhabit. These sites were subsequently targeted for detection and removal efforts. In September 2017, the WVDNR staff conducted targeted removals in the R.C. Byrd Pool of the Ohio River. Both boat electrofishing and gill netting techniques were employed. A total of 81 hours was expended over two days of removal surveys. Areas of focus included Raccoon Creek, Crab Creek, and the area just upstream and within the upstream approach of the old lock chambers of R.C. Byrd Dam.

To more strategically halt upstream range expansion, agencies identified an Intensive Management Zone (IMZ) in the ORB that includes an area from Cannelton Lock and Dam (Owensboro, KY) to Captain Anthony Meldahl Lock and Dam (above Cincinnati, OH). The IMZ is defined by effective barriers to Asian carp passage at the upper and lower bounds, with focused intensive efforts being conducted (e.g. commercial harvest) in targeted stretches between the barriers to reduce Asian carp abundance.

Asian Carp Capture and Removal by Commercial Fishers

The KDFWR led partnership efforts for the guided use of commercial harvest for the capture and removal of Asian carp in the ORB, providing support and oversight of the commercial fishery in Kentucky waters, working with the industry to utilize intensive harvest as a key risk reduction and control strategy, and assessing existing impediments to increase harvest in select locations. In the FY 2017 reporting timeframe, Silver Carp catch accounted for 98.1% of Asian carp captured and removed. Identified barriers to commercial fishing success included lack of dedicated fishing effort correlated to fishers age demographic. The reported average age for commercial fishers was 57 years old. Thus there has been a decline in younger people choosing commercial fishing as a career. Other barriers to commercial fishing success included lack of motivated fishers, high costs of materials for net building, transportation costs to move fish to processing facilities, difficulty in maintaining fish quality during the summer months, and low price per pound for Asian carp. The low number of commercial fishers providing consistent and

reliable supply of Asian carp remains a primary challenge to commercial fish processors. The KDFWR plans to address these barriers to the Asian carp commercial industry by creating a Public-Private-Partnership (P-3) with the goal of supporting a non-governmental entity to provide the necessary industry-wide coordination, fish transportation from the reservoirs to the processors, and trained commercial fishers. This new unit's efforts will be supplemented by KDFWR research. The KDFWR also instituted a \$0.05/pound incentive for harvest of Silver and Bighead Carp in Kentucky Lake and Barkley Lake to encourage commercial harvest in these locations.

In spite of these logistical challenges, the KDFWR ACHP has harvested 3.9 million pounds of Asian carp from Kentucky waters since 2011. After 5 years of consistent increases in harvest, the commercial harvest and catch per unit effort of Asian carp stabilized between 2015 and 2016, yet increased by 0.5 million pounds between 2016 and 2017. In 2016, the KDFWR partnered with Murray State University to monitor Silver Carp demographics in Kentucky Lake and assess the effect on populations from continued commercial harvest. In partnership with industry, the KDFWR continued to utilize commercial harvest information to augment the comprehensive Asian carp distribution and biological database for the ORB. Additionally, the TWRA provided commercial fishing infrastructure support for Asian carp removal efforts in Kentucky and Barkley Reservoirs. This included contracting with counties to provide materials and supplies needed to facilitate transport of harvested Asian carp to local processors.

Pathway Closures

Ohio

The USACE provided technical support to ODNR for the GLMRIS pathway closures at Ohio Erie Canal (OEC), Little Killbuck Creek (LKC), Grand Lake St. Marys, and Mosquito Creek Lake (MCL). At the LKC connection, the ODNR and the USACE continue to work with the local landowner to identify potential closure options. In 2019, the ODNR will install a screening structure at the St. Marys State Fish Hatchery within the Grand Lake St. Marys connection to allow continued use of lake water without the risk of Asian carp transfer to the Lake Erie Basin. Finally an assessment at the MCL connection, determined that there is a low risk of transferring Asian carp, thus no further work will be done at this connection.

The ODNR and USACE continued efforts to address the highest-priority secondary (intermittent) pathways in Ohio, as identified through the GLMRIS Focus Area 2 Aquatic Pathways Assessment Summary Report. These pathways are temporary hydrologic connections that form between the ORB and GLB during episodes of high-water or seasonal flooding, allowing for the potential movement of Asian carp. The GLMRIS Aquatic Pathway Assessment Report developed for the Ohio-Erie Canal connection determined the probability of the transfer of Asian carp from the MRB to the GLB as medium for Silver, Bighead, and Black Carp. After completing conceptual design work for the Ohio-Erie Canal connection, ODNR identified some additional aquatic pathways in early 2017 that needed to be addressed by the proposed structural design measures. Accordingly, new and revised designs for the Ohio-Erie Canal connection were completed in FY 2017 to address these additional pathways. Additionally, the USACE and ODNR worked on pre-application phase permitting and initial steps for implementation of closure options (e.g., environmental compliance, real estate, cultural resources) at the Ohio-Erie Canal connection with a Phase I Environmental Site Assessment and also completed a Phase I Cultural Resource Study.

Indiana

The USGS, in collaboration with the INDNR, USACE, and local partners, maintained and operated a webcam in a spillway at the Phase 1 Eagle Marsh interbasin separation berm, a permanent barrier site near Fort Wayne, Indiana. The webcam was used to monitor flood conditions that could result in Interbasin transfer of Asian carp during episodic high flows in the Graham McCulloch Ditch (Wabash River Basin/MRB) and Junk Ditch Basin (Maumee River Basin/Lake Erie). The USGS also installed a stream gage that is providing flow and temperature data to inform USACE flow models, help determine barrier effectiveness, and verify that the barrier has no adverse impacts on area flooding.

3.2.4 RESEARCH AND DEVELOPMENT

- **NATIONAL PLAN GOAL: Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of Bighead, Black, Grass, and Silver Carp in the United States.**

Development of New Deterrent Technologies

In the UMRB, ongoing research conducted by the USGS, USACE, the University of Minnesota, and private industry investigated the effect of various underwater sounds on the behavior of Bighead and Silver Carp (responsiveness, ability to habituate, etc.), with the goal of preventing fish passage.

Building off recommendations from the first interagency Sound Deterrent Workshop Coordination and Planning Meeting held in 2016, the ORB and UMRB partner agencies conducted initial coordination and scoping to identify potential sites for the pilot deployment of acoustic (sound) deterrent technologies to prevent upstream range expansion by Asian carp in the two sub-basins. Potential strategic locations (“pinch points”) were identified in river systems where Asian carp are only able to swim upstream through a lock chamber because the height of the adjoining dam structure makes it impassable to Asian carp. These locations included Barkley Lock in Kentucky and Lock and Dam 19 on the Mississippi River in Iowa.

Asian Carp Life History and Reproduction Evaluations

The USGS continued to evaluate Asian carp spawning success in the ORB, which includes collection of water quality and flow data and the characterization of a 70-mile reach of the Ohio River from McAlpine Dam Pool at Louisville to the Markland Dam downstream from Cincinnati, Ohio. Data will be compared with computer models to evaluate Asian carp spawning success in the ORB. Data collection started in late October 2016 and ended in June 2017. Data analysis and modeling will be completed in 2018 with publication of the results in 2019. Also, building on work started in 2014, the USGS collected similar data using the Asian Carp Fluvial Egg Drift Simulator (FluEgg) model to assess the possibility of Asian carp spawning within the Muskingum River. The Muskingum River data were collected in a 50-mile reach from Coshocton (at the confluence of the Walhonding and Tuscarawas rivers) to McConnelsville. The collected field data were supplemented by a hydraulic model of the lower 60 miles for the purposes of floodplain mapping. Results from this study will be published in 2019.

Development and Testing of New Gear/Techniques

The ORB agencies developed and field tested gear focused on improving capture of Asian carp of all life stages. For example, the INDNR evaluated new sampling designs, including ichthyoplankton nets, mini-fyke nets, and surface trawls, that could be used to monitor larval and juvenile Asian carp. Also, the KDFWR partnered with the USFWS to test a boat-deployed Paupier net (specifically designed by the USFWS for capturing Asian carp) on Kentucky Lake and Lake Barkley. After three sampling cycles, the prototype gear was successful at removing 4,054 Asian carp from the two reservoirs. The KDFWR also worked with a commercial vendor, Two Rivers Fisheries, to test a net system on Lake Barkley that is currently used to capturing Asian carp in China. The gear, which was devastated by wind and wave conditions on Kentucky Lake during the study, failed to capture Asian carp. As a result, the net system will need to be redesigned to consider environmental conditions. Additional gear types are scheduled to be tested in 2018.

3.2.5 OUTREACH WITH INDUSTRY, STAKEHOLDERS AND THE PUBLIC

- **NATIONAL PLAN GOAL: Provide information to the public, commercial entities, and government agencies to improve effective management and control of Bighead, Black, Grass, and Silver Carp in the United States.**

ORB partners continued strategic communication and outreach to the public and other stakeholder groups through its Communication Work Group and implementation of the *Ohio River Asian Carp Coordination and Outreach Project*. The Communications Work Group led the development and implementation of an interagency communications effort to support partnership actions that effectively share information on the status of the Asian carp invasion, provide guidance on steps to minimize the risk of introduction and spread, and collect new occurrence information (e.g., Asian carp catch data from recreational anglers and commercial fishers). The strategy supports clear and timely communication with the public, industry, public officials, and other stakeholders to broaden awareness of and support for Asian carp management.

In addition to the communications strategy, State and Federal agencies conducted the following activities to support outreach and engagement on Asian carp management issues and opportunities:

AsianCarp.us website

The USFWS continued to support and administer the national Asian carp website (www.AsianCarp.us) as the primary platform for delivering updates on accomplishments, science, and other products related to Asian carp management. The website houses national and basinwide partnership documents on Asian carp management, including the WRRDA Reports to Congress, the National Plan, the ORB Framework, annual ACRC Action Plans and other key strategies. In 2017, the website was re-designed to include a more user-friendly interface for accessing specific content on Asian carp news and developments.

Public/Stakeholder Engagement

The ORB agencies conducted a portfolio of activities focused on outreach and education with the public, governments, industry, and other stakeholders in support of the *Ohio River Asian Carp Coordination and Outreach Project* and individual agency outreach objectives. Agencies placed signage at access points, distributed pamphlets to marinas and local businesses, sent press releases to local media outlets, and

used social media platforms to inform the public about Asian carp harvest efforts that may create conflicts with recreational anglers and boaters.

To support recent regulations in Kentucky that limit the transfer of bait fish between water bodies, the KDFWR fisheries districts purchased and distributed signs at popular boat ramps to notify the public about the potential introduction of AIS from bait bucket transfers. To further educate the public about this issue, information was included in annual fishing and boating guides and on the KDFWR website. The KDFWR further responded to requests to present Asian carp information to local angling clubs as well as TV and radio outlets. As an example, KDFWR staff presented information about ORB Asian carp projects for a webinar organized and hosted by the Indiana Wildlife Federation. The webinar increased awareness and support for Ohio River Asian carp efforts from State chapters of the National Wildlife Federation.

Additional activities by ORB States included:

- In Ohio, advertisements and signage were distributed to promote awareness of AIS issues ODNR teamed with Wildlife Forever on a “Trash Unused Bait” campaign to encourage anglers to not dump their bait buckets in lakes or rivers
- In Indiana, outreach efforts were conducted to promote the edibility of Asian carp and discourage anglers from moving bait beyond the area where the bait was collected
- In Tennessee, the TWRA sponsored Asian carp tasting events, staffed information awareness booths, and installed signage at boat ramps
- In West Virginia, Asian Carp informational signs developed by Ohio River sub-basin states are maintained at the majority of access sites along the West Virginia portion of the Ohio and Kanawha rivers

Industry Engagement

The KDFWR continued outreach with the commercial fishing industry to enhance Asian carp reporting and collection. This included meetings with commercial fishers and processors to outline changes to operation of the ACHP, identifying limiting factors to the harvest of Asian carp, developing new gear types for Asian carp capture, and conducting ongoing projects that require cooperation with commercial fishers (e.g. ACHP ride-along project and Kentucky Lake Asian carp demographics project). In 2016, the KDFWR met with prospective business people interested in investing in the commercial Asian carp industry to form relationships and discuss opportunities for partnerships. These conversations continue to progress; any results or decisions will be discussed in future reports.

3.2.6 LAW ENFORCEMENT/REGULATORY

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of Bighead, Black, Grass, and Silver Carp in the United States.**

The ORB agencies continued efforts to ensure compliance with regulations related to the production, possession, sale, and transport of Asian carp along with regulations and best-practices related to the transport and use of live bait by commercial harvesters, dealers, and anglers. For example, the ODNR Division of Wildlife Law Enforcement (DWLE) regularly monitors bait dealerships for the presence of AIS. The ODNR DWLE also conducted a two-year assessment of the Grass Carp supply chain that determined

that all tested fish were triploid (sterile) and not capable of reproduction. The results of the supply chain assessment were submitted for publication as a manuscript in a peer-reviewed scientific journal.

A Federal court ruling on the regulations governing the interstate transport of species listed under the Lacey Act resulted in the elimination of Federal restrictions on the transport of species listed as injurious across State lines within the continental United States. Other regulations continue to provide oversight on a State-by-State basis of production, possession, sale, and transport of Asian carp. For example, in West Virginia it is "...unlawful for any person to possess, sell, offer for sale, import, bring or cause to be brought or imported into this state or release into the waters of this state, in a live state, any Asian carps".

3.3 UPPER MISSISSIPPI RIVER BASIN

3.3.1 INTERAGENCY COORDINATION

- **NATIONAL PLAN GOAL: Effectively plan, implement, and evaluate management and control efforts for Bighead, Black, Grass, and Silver Carp in the United States.**

State and Federal agencies continued development and implementation of collaborative Asian carp management strategies and projects in the UMRB. As in the ORB, efforts focused on preventing the spread of Bighead and Silver Carp through coordinated monitoring and early detection, mass removal by commercial harvest, support for the development of new deterrent technologies (e.g. barriers), and outreach with industry and stakeholders. Additional effort was also placed on Black and Grass carp monitoring and analysis.

The UMRB partners participated in interagency coordination efforts at various levels, including the MICRA ACAC and the UMRCC Fisheries Technical Committee. Priority management actions support implementation of the National Plan, State agency Asian carp management strategies, and Goal 4 of the UMRCC's Upper Mississippi River Fisheries Plan (Fisheries Plan), which is to "slow or eliminate the spread or introduction of aquatic nuisance species, including pathogens, to the Upper Mississippi River." State and Federal agencies within the UMRB participated in other inter-basin coordination efforts, including the Upper Mississippi River Basin Association (UMRBA), Mississippi River Basin Panel on Aquatic Nuisance Species, the Lower Mississippi River Conservation Committee, the Missouri River 100th Meridian Work Group, the USFWS/USGS-led interbasin National Asian Carp Management and Control "strategic discussion", the GLMRIS Executive Steering Committee, ACRC planning meetings, and a multi-basin sound deterrent coordination and planning workshop.

To more strategically focus and maximize efforts to halt upstream range expansion, UMRB partners identified an IMZ in the Upper Mississippi River that includes an area from Lock and Dam 19 (Keokuk, Iowa) to Lock and Dam 14 (LeClaire, Iowa), bracketing the invasion front of Asian carp in the UMR. In concept, the IMZ is defined by effective barriers to Asian carp passage at the upper and lower bounds, with focused intensive efforts to reduce Asian carp abundance (e.g. commercial harvest) conducted in targeted stretches of the river between the barriers.

To further leverage UMRB efforts, the USFWS coordinated with MICRA and ORB State and Federal agency partners to identify annual UMRB sub-basin priorities that may be considered for funding with available resources. Project proposals were identified and developed for early detection, monitoring and assessment, control and removal, and containment actions to prevent further distribution and establishment of Asian carp in the UMR. Full project work plans for USFWS funded projects were then

developed and collaboratively implemented (see *2017 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin*; <http://www.asiancarp.us/documents/MRP2017MississippiRiverBasin.pdf>).

In Minnesota, activities were conducted to support the Minnesota Invasive Carp Action Plan (MICAP). MICAP complements both the National Plan and the Fisheries Plan as it includes specific strategies that address early detection and monitoring of susceptible waters; prevention and deterrence; response preparation; management and control; and outreach and communication.

3.3.2 MONITORING, EARLY DETECTION AND RAPID RESPONSE

- **NATIONAL PLAN GOAL: Minimize potential adverse effects of feral Bighead, Black, Grass, and Silver Carp in the United States.**
- **NATIONAL PLAN GOAL: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**

Asian Carp Telemetry Monitoring (UMRB)

Telemetry data provides key seasonal movement and location information on Asian carp populations in the UMR to enhance capture efficiency and provide critical knowledge for planning, implementing and evaluating deterrent technologies. In 2017, the USGS, USFWS, USACE, Missouri Department of Conservation (MDC), ILDNR, Western Illinois University, and Minnesota Department of Natural Resources (MNDNR) continued a collaborative Asian carp telemetry study in the UMR, that includes a telemetry array of over 225 stationary receivers that extend from above Coon Rapids, Minnesota to Cairo, Illinois; a distance of over 650 river miles. In FY 2017, the USGS and USFWS tagged an additional 38 Bighead and Silver Carp with acoustic transmitters, bringing the multi-agency total to over 400 tagged Bighead and Silver Carp. The majority of these fish are in the IMZ from Lock and Dam 19 near Keokuk, Iowa to Lock and Dam 15 near the Quad Cities area of Iowa and Illinois. During weekly tracking efforts, nearly 2,000 individual point locations of acoustically tagged Asian carp were collected in this reach and associated tributaries. In addition, millions of detections were recorded on the remote receiver array. Preliminary models developed from this data have identified seasonal aggregations and are able to predict when Asian carp move past key pinch-point dams and into tributaries. Contracted removal efforts have capitalized on this information to increase effectiveness, resulting in over 100,000 pounds of Asian carp being removed from the invasion front in the UMR during FY 2017.

In addition to the telemetry effort in and above the IMZ, the Missouri DOC maintains an extensive telemetry effort on the Mississippi River. Specifically, they conduct monthly manual tracking of Pool 20 and quarterly retrieval of stationary receivers downstream of pool 20. These data are especially critical to ongoing consideration of potential Asian carp deterrents in the UMRB.

To support the development of deterrents at key pinch-point dams and prevent upstream movement of Asian carp, scientists from the USGS Upper Midwest Environmental Sciences Center (UMESC), USFWS, WIU, and MDC collaborated on the deployment of telemetry arrays in the approaches of Lock and Dams 15 and 19. Data from these telemetry arrays provide information on movement, pathways, and behavior of acoustically tagged fish, revealing when and how these fish use the areas to pass through the dam, including using the lock as habitat or a movement corridor. The USFWS and USGS are also using the telemetry data to populate a multi-state fish movement model. This model provides the rates that Asian carp move between the navigation pools within the IMZ. Collectively, these data are being used to develop a population model that will identify optimal locations for both Asian carp removal and deterrent actions in the UMR.

In collaboration with partners, the USGS developed a multi-agency, multi-basin, telemetry database and visualization tool for Asian carp that includes fish tagged and tracked in the Upper Mississippi, Ohio and Illinois rivers. This database will facilitate fish tracking, data sharing, and understanding of Asian carp movements across river basins to better inform management of these fishes. In collaboration with partners, the USGS is also continuing to develop a multi-basin, real-time telemetry network. To date, nine real-time receivers have been installed in the Illinois, Upper Mississippi, and Ohio Rivers. Data from these real-time receivers are being used by managers to direct rapid response and removal. Correspondingly, the USGS will continue to collaborate with the telemetry workgroups in 2018 for the Upper Mississippi, Ohio, and Illinois rivers on additional Asian carp telemetry studies and the enhancement of the receiver networks (passive and real time) and telemetry database.

In Minnesota, the State Legislature granted the MNDNR the authority to use tagging as a research tool starting July 1, 2017. Legislative approval was needed because the agency is putting an invasive species back into the water after capture. The MNDNR tagged its first carp on July 28, 2017 in the St. Croix River. Fish biologists are tracking its movement using active boat tracking and the passive receiver array present in the river system. Two additional Asian carp were captured and removed in association with the recapture efforts of this fish. The State of Minnesota has a total of 88 receivers from above the Coon Rapids Dam to Lock and Dam 5 in the Mississippi River, from the Mississippi River confluence at Prescott, Wisconsin to Taylor's Falls in the St. Croix River, and from the Mississippi River confluence to the County Road 6 bridge north of Delhi, Minnesota, in the Minnesota River (RM 209).

eDNA Monitoring

The USFWS assisted the USACE-Engineer Research and Design Center (ERDC) in field-testing a genetic marker for Black Carp eDNA by collecting 450 water samples in March and 422 samples in late 2016 near Cape Girardeau, Missouri. No collected samples contained positive eDNA detections; however, the samples helped refine future collection methods and determine the sensitivity and specificity of the genetic markers. The USGS initiated laboratory evaluations of Black Carp and Grass Carp eDNA "shedding rates" to assist development of eDNA monitoring protocols and interpretation of results. The USFWS also conducted eDNA sampling for the State of Minnesota in response to a Bighead Carp capture; 66 samples were collected soon after the fish was captured but there were no positive eDNA results.

The USFWS collaborated with the USGS-UMESC to combine telemetry data with eDNA data from Pool 18 of the UMR. This study will better inform when, where, and what sample size is adequate to effectively use eDNA as an Asian carp monitoring tool in the UMR. The USFWS and USGS collaborated in a separate study to calibrate eDNA for use in surveillance of Bighead and Silver Carp DNA in the UMR. In total, 1,446 samples were collected across three events. A manuscript with details of the study and the results will be forthcoming in 2018. This information will allow for the optimization of eDNA sampling in the Upper Mississippi River both spatially and temporally. The manuscript will include recommended changes to sampling to optimize probability of detection, including timing and number of samples collected.

Traditional Gear Sampling

The UMRB agencies continued to coordinate monitoring for all Asian carp life stages using electrofishing, netting, and other capture techniques in targeted locations within the basin. For example, the USFWS continued to develop, evaluate, and integrate novel sampling techniques for the detection, monitoring and removal of Asian carp in Midwestern U.S. waters. These new gear types are being used for the

detection of larval and juvenile Asian carp at the leading edges of the population fronts in the Illinois and the UMR. From April 20 through August 25, 2017, the USFWS also monitored for Asian carp reproduction in Pools 8-13 of the UMR. Monitoring for juvenile Asian carp resulted in the captures of Age 1 juvenile Silver Carp in Pool 16, documenting the furthest upstream location of juvenile Silver Carp in the UMR. One Age 1 juvenile Bighead Carp was captured in Pool 19, representing the furthest upstream capture of Bighead Carp in the UMR. No young-of-year of either species were collected. Samples taken during this effort are scheduled to be sorted and examined for presence of Asian carp eggs and larvae in the winter of 2017-2018. Additionally, the 240 samples collected in 2016 were processed in FY 2017; 5,242 larval and juvenile fish and 3,659 eggs were analyzed with no Bighead, Silver, Grass, or Black Carp documented.

The MNDNR continued its UMRB Asian carp sampling program, initiated in 2012, using gill nets, electrofishing, trap netting, larval trawling, and targeted commercial fishing. Sampling covered approximately 55 miles of the Mississippi River from St. Anthony Falls Lock and Dam in Minneapolis, Minnesota to Polander Lake in Pool 5A near Winona, Minnesota. In the St. Croix River, standard effort was focused on a 52 mile stretch from the dam near Taylors Falls, Minnesota to the confluence with the Mississippi River near Prescott, Wisconsin. Annual reports summarizing the sampling year (January through December) are completed by MNDNR in April of each year and can be found at www.dnr.state.mn.us/invasive-carp. Agency and commercial sampling resulted in the capture of two Silver Carp, two Bighead Carp, and two Grass Carp. An additional single Bighead Carp was captured and reported by a bowfisherman.

The Iowa Department of Natural Resources (IADNR) conducted electrofishing surveys during the summer of 2017 to monitor for Bighead, Silver, and Grass Carp distribution and abundance in the Des Moines, Skunk, Iowa, and Cedar rivers and to detect presence of Asian carp in the Maquoketa River. The IADNR also provided funding to Iowa State University to evaluate adult population characteristics and dynamics of Bighead, Silver, and Grass Carp in Pools 14 -20 of the Mississippi River, to evaluate Asian carp reproduction in Pools 14 - 20 of the Mississippi River, and to evaluate reproduction in the Des Moines, Skunk, Iowa, Rock, and Wapsipicon Rivers. Larval sampling took place once every two weeks from May through August 2017 and adult sampling occurred once at each site during September and October 2017. Results from the project are being used to inform an analysis of spatiotemporal patterns of reproduction and adult population characteristics of Asian carp in Iowa waters.

Wisconsin Department of Natural Resources (WIDNR) provided additional fishery monitoring in the UMRB. Although the agency does not implement monitoring directed at Asian carp in the lower Wisconsin River, they do conduct general and specific fisheries surveys between the confluence with the Mississippi River and the first dam at Prairie du Sac, Wisconsin. In 2016-2017, seven Bighead Carp were captured in these surveys. In FY 2017, the MDC completed sampling at previously known and suspect locations for Black Carp (e.g. Dutchtown ditch; Waters Edge) and worked with commercial fishers to retrieve Black Carp collected in the basin.

Additional cooperative agency monitoring continued with a focus on maintaining key baseline datasets for both native and non-native fish species in the UMRB ecosystem. State and Federal agencies conducted research and monitoring within the Long Term Resource Monitoring (LTRM) element of the USACE Upper Mississippi River Restoration (UMRR) Program. The UMRR was the first comprehensive program for ecosystem restoration, scientific research, and monitoring on a large river system in the world. The monitoring and research activities of the LTRM are focused on identifying status and trends in critical natural resources and gaining insight into ecosystem function and the factors influencing the community structure of fishes and aquatic vegetation. Although the UMRR was not designed to

specifically address Asian carp, the long-term data (20 plus years) on fish communities, water quality, and aquatic vegetation are unique assets and provide critical pre-invasion baseline conditions within the UMRB. This information is supporting rigorous analyses to identify harmful effects of Asian carp (and other AIS) on native fauna and ecosystem processes. LTRM data and information are available at <http://www.umesc.usgs.gov/ltrmp.html>.

Key contributions from the LTRM relative to Asian carp include research on the following:

- Abundance and diversity of non-native fishes in the UMR System
- Status and Trends of fishery resources of the UMR System
- Multiyear synthesis of the fisheries data from 1993 to 2002 for the LTRM

The UMRB agencies also developed and distributed a new interagency Asian carp collection, communication, and reporting protocol to facilitate data sharing of novel captures (areas where populations are not established) for all four species of Asian carp.

Rapid Response

The capture of a Bighead Carp in a gravel pit adjacent to the Minnesota River prompted the USFWS and MNDNR to respond by collecting eDNA samples in the gravel pits where the fish was captured and electrofishing the portions of the Minnesota River adjacent to the pits. No additional Asian carp were captured and all eDNA samples were negative for Bighead Carp and Silver Carp DNA.

3.3.3 ACTIVE PREVENTION/CONTROL

- **NATIONAL PLAN GOAL: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**
- **NATIONAL PLAN GOAL: Extirpate, or reduce to levels of insignificant effect, feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**

In addition to routine monitoring of the commercial catch, the MNDNR coordinated with commercial fisherman to remove Asian carp from Minnesota waters of the UMRB. In 2017, commercial efforts included deployment of approximately 57,600 feet of gillnet over 8 days, yielding a total catch of 5 invasive carp (Silver Carp = 2, Bighead Carp = 1, and Grass Carp = 2). The MDC, through an extensive fisheries sampling program, further removed several hundred age-0 grass carp from Dutchtown Ditch and other locales. Additionally, as part of the UMRB Framework, commercial fishers were hired to capture Asian carp from Pools 16-19 of the UMR throughout the year, and the data was collected and processed by WIU (Figure 16).

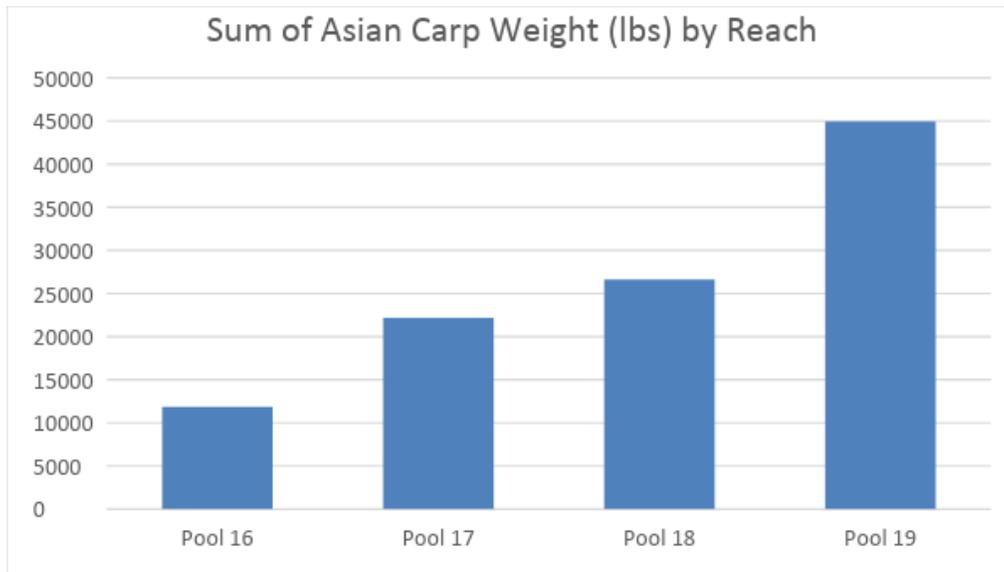


Figure 16. Asian Carp Capture and Removal (Commercial Harvest, all Asian Carp species combined), a total of 105,552 pounds were removed in 2017 from Pools 16-19 of the UMR. Source: WIU

The USGS conducted preliminary planning with the USFWS, MDC, St Louis Parks, and others to prepare for the February 2018 implementation of the unified fishing method (UFM) to capture and remove Asian carp in Creve Coeur Lake near St. Louis, Missouri, once a valuable recreational fishery before the Asian carp established. The UFM, first developed in China, utilizes techniques and equipment to facilitate the “herding” of Asian carp into a confined location for mass capture and removal in large-scale nets and traps. Agencies are planning to expand the use of this technique to other locations, including Lake Barkley and sites within the IWW.

Pathway Closures

Minnesota has identified Madison Lake and Lake Elysian as high value waterbodies where preventative actions should be taken to prevent Asian carp introductions. These lakes were chosen based on recreational value, biological importance, and risk of invasive carp expansion. Electric barriers placed in the waterbody outlet tributaries were identified as the best management option with pre-construction work beginning in 2015. While initially scheduled to be completed in 2017, obtaining easements, securing permits, and finalizing the design took longer than anticipated, extending the expected completion date into 2018.

3.3.4 RESEARCH AND DEVELOPMENT

- **NATIONAL PLAN GOAL: Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of Bighead, Black, Grass, and Silver Carp in the United States.**

Development of New Deterrent Technologies

In FY 2017, interagency coordination, project planning, and research to develop and deploy potential new Asian carp deterrent technologies increased among UMRB partners. Efforts built off

recommendations from earlier structured coordination (e.g. Sound Deterrent Workshop Coordination and Planning Meeting, National Asian Carp Management and Control strategic discussion) and focused on opportunities to rigorously evaluate the effectiveness of specific technologies (complex sound, CO₂, and water velocity manipulation) under “real world” scenarios in lock chambers, restricted river channels, or other strategic Asian carp “choke points.” Activities included developing and conducting laboratory studies needed to support larger-scale field deployment. Key research included responsiveness of Asian carp to specific deterrents under controlled settings and potential impacts on select native fish species and fish communities in the UMRB. Field research was conducted to inform potential deterrent strategies, including telemetry tracking of Asian carp to better understand their movement through specific lock structures and use of other select habitat types in the UMRB. Initial interagency discussion, planning and research scoping was conducted for possible large-scale field pilot trial sites, focused on Lock and Dam 19 in Iowa; and Lock and Dam 2, 5 and 8 in Minnesota, all identified as potential Asian carp “choke points” on the mainstem Mississippi River. Telemetry and hydroacoustics are being used to understand whether Asian carp and native fish move through lock chambers at priority locations. That data will be useful for providing a baseline for potential testing of deterrent technology at these locations.

The USFWS led an interagency team comprised of the NPS, USACE, USGS, USFWS, MNDNR, WIDNR, IADNR, ILDNR, and MDC in development of an Asian carp deterrent strategy for the UMRB. The team identified potential deterrent technologies to be considered, developed fact sheets on each feasible technology, mapped out IMZs for Silver Carp, Bighead Carp, and Grass Carp, identified suitable locations for deterrent sites, made suggestions for experimentation, and outlined next steps. The USFWS compiled this information into a report entitled “*Asian Carp Deterrent Strategy for the Upper Mississippi River Basin*” that is expected to be released in 2018 and discussed in future reports.

Sound

Agency actions focused on the scoping of potential sites and development of field study plans for evaluating the effectiveness of acoustic deterrent technologies through deployment of pilot projects at strategic lock and dam locations in the UMRB and ORB. Ongoing project planning, technical coordination, and project evaluation involved State and Federal agencies as well as academic and industry partners. The USACE coordinated a site visit to Lock and Dam 19 at Keokuk, Iowa for the USFWS, University of Minnesota, and Fish Guidance Systems, Ltd. to explore the feasibility of options for placing an acoustic fish barrier system in the tailwater approach area to prevent the upstream movement of Asian carp. Lock and Dam 19 and the adjacent non-Federal hydropower dam provide a strategic point in the river for addressing fish movements. The University of Minnesota continued to conduct lock and dam evaluation work, including tagging and tracking both common carp (as a surrogate for Asian carp) and native species to document behavioral changes at upstream passage points where underwater sound was being used as a deterrent. Studies revealed that common carp change their behavior in response to emitted sound, but due to changes in water levels and background noise from the lock opening and closing, speaker placement on lock doors was ineffective.

The MNDNR continues to collaborate with the University of Minnesota – Duluth to evaluate the feasibility of using complex sound at Mississippi River Lock and Dam 5 to deter upstream movement of invasive carps. The University of Minnesota - Duluth coordinated with the USACE and other technical subject matter experts to collect “soundscape data” (underwater ambient sound) at this location prior to installation of an acoustic deterrent system in 2019. The USFWS provided technical support by collecting sonar imagery to examine fish placement and behavior around the approach channels of

Locks 14, 15 and 19. Traditional gear and hydro-acoustic assessments were also conducted to quantify relative fish densities in these areas. Survey results indicated that Lock and Dam 19 was an optimal location to test acoustic deterrents due to the presence of an established fish population below the dam, a dam structure that prevents overflow conditions, and an existing monitoring infrastructure at the site that allows for efficient evaluation.

Water Velocity

The MNDNR and the Minnesota Aquatic Invasive Species Center (MAISC) with the University of Minnesota – Twin Cities coordinated on a study to gain additional information on flow adjustment and acoustic deterrence at Mississippi River lock and dams. The study evaluated fish movements at Lock and Dam 2 under a variety of flow conditions to understand how often fish challenge the structure, where they attempt to pass, and their success rates. MAISC is also evaluating the response of fish to acoustic speakers located in Lock 8. The USACE instituted revised dam gate operations at Lock and Dams 8 on a trial basis to make it more difficult for Asian carp to penetrate weak areas (slower velocities) in the dam flows, as recommended by MAISC. In addition, the USACE partnered with MAISC to develop flow models and conduct acoustic mapping for Locks and Dams 2, 4, 5 and 8 to assess the efficacy of acoustic barriers.

Further evaluations of the physical characteristics and available habitat in the Minnesota River were conducted by Minnesota State University - Mankato and the MNDNR to inform the potential use of invasive carp deterrents. In FY 2017, data collection was completed for the third and final year of the study; the following year a report was submitted to the MNDNR. The report describes key hydrologic and geomorphic characteristics of the river, including channel migration rates, flood plain inundation, bathymetry, and sediments. The project also examined biological data to identify habitats that are highly suitable for Asian carp. These results will be used to inform potential deterrent strategies and technologies for the Minnesota River.

Carbon Dioxide (CO₂)

The USGS, USACE, and USFWS collaborated on a field study using dye injected into a lock chamber to evaluate mixing and flow characteristics, which will inform future deterrent projects at locks, including CO₂. The dye project was conducted at Auxiliary Lock 14 near Davenport, Iowa in January 2017. The goal of the study was to understand the mixing dynamics of water within the lock chamber, to quantify the amount of leakage into and out of the lock through the gates, and to determine how quickly the dye becomes diluted downstream once released from the lock. Additional efforts included water quality and fish community sampling. Also, the UMRB partners participated in a webinar hosted by the University of Wisconsin, Platteville focused on the development of a prototype Asian carp CO₂ barrier. The webinar presented the preliminary results of experiments conducted during Summer 2017 that looked at various engineered technical configurations. Tests were conducted in large concrete test ponds at USGS-UMESC in collaboration with ERDC. Results will be used to inform engineering and technical requirements of potential future CO₂ deterrent pilot projects.

Asian Carp Biology, Life History and Reproduction Evaluations

Lack of detection or collection of larval and juvenile Black Carp serve as a critical data gap in understanding the range of establishment for this species. To address this gap and inform Asian carp prevention, monitoring, and control efforts, the UMRB agencies developed and conducted key

laboratory and field evaluations. Activities included further work to develop and refine new detection tools for Black Carp, an emerging threat to the UMRB due to expanding numbers and evidence of reproduction in the middle Mississippi River. In addition, the MDC completed sampling for “Asian Carp Reproduction Ecology in the UMR” to determine locations and timing of reproduction in the UMR and its tributaries.

The USGS, in collaboration with the USFWS, MICRA, and basin states developed a protocol for handling and conducting research on Black Carp captured in the MRB. All Black Carp captured from the wild are processed through the protocol to determine ploidy, recent reproductive status and activity, age, condition, stomach contents, and location of capture and origin. A similar protocol is in place for Grass Carp captured from portions of the MRB where they are not known to be established. The USGS began work on the development of Black Carp selective bait which could be used for population control and protection of endangered mussels. In addition, USGS scientists analyzed and catalogued stomach contents from captured wild Black Carp to obtain key information on predation of native unionid mussels and snails, zebra mussels, Asian clams and other invertebrates. A publication on the findings is in development. Additional data collected included age at capture, determination of length at sexual maturity, and time of year of maturation. USGS is collaborating with Southern Illinois University on publication of key Black Carp life history information gained from these studies, including a Black Carp population age structure for the UMRB and chemical analysis of fish otoliths (ear bones) to determine fish origin. Additionally, the USGS worked in partnership with Western Illinois University (WIU) on age and growth of Asian carp and initiated population modeling to evaluate management alternatives for removal. The USGS also continued studies with Western and Southern Illinois Universities to understand recruitment sources of the emerging population of Asian carp in the Upper Mississippi River and Ohio Rivers.

The USFWS collaborated with WIU to conduct an Asian carp age structure collection workshop at the UMRCC Fall Fish Technical Section meeting. At the workshop, technical experts demonstrated proper techniques to remove various structures (e.g., vertebrae, otoliths, pectoral girdle bones, and fin rays) that provide the best material for effectively aging individual fish. The workshop supported the consistent use of accepted methodologies by agencies for collecting key biological information used to evaluate population dynamics of Asian carp in the UMRB.

3.3.5 OUTREACH WITH INDUSTRY, STAKEHOLDERS AND THE PUBLIC

- **NATIONAL PLAN GOAL: Provide information to the public, commercial entities, and government agencies to improve effective management and control of Bighead, Black, Grass, and Silver Carp in the United States.**

AsianCarp.us website

The USFWS continued to support and administer the national Asian carp website (www.AsianCarp.us) as the primary platform for delivering updates on accomplishments, science, and other products related to Asian carp management. The UMRB agencies, in coordination with the ACRCC Communication Work Group, identified content to be developed and featured on the www.AsianCarp.us website. This information covers the sub-basin partnership’s projects and accomplishments on Asian carp management. In 2017, the website was re-designed to include a more user-friendly interface for accessing specific content on Asian carp news and developments. A prototype of the re-design is currently being reviewed and tested; deployment of the new website is scheduled for 2018.

Public/Stakeholder Engagement

In many UMR states, signs alerting the public to the presence of Asian carp are posted at fishing access sites with known populations of Bighead and Silver Carp. The signs show how to identify the species and warn that it is illegal to possess or transport live Asian carp. In addition, UMR states informed water recreationists about the threats of Asian carp using agency websites, educational brochures, identification cards and posters, billboards, and press releases. An array of materials were distributed at watercraft inspection stations, fishing clinics, state fairs, parks, nature centers, and businesses supporting aquatic based recreation.

The MNDNR regularly communicated with the “Stop-Carp-Coalition”, a collaborative comprised of non-governmental organizations concerned about Asian carp and their impacts. The UMRB partners also provided AIS information and a list of AIS-infested waters in fishing and boating regulations booklets and participated in briefings for Federal and State elected officials. Minnesota also continued its Minnesota Invasive Carp Forum series. The MNDNR, NPS, and the MAISC hosted the annual Minnesota Invasive Carp forum in March of 2017 that updated interested stakeholders and the public on Asian carp and related activities. It also provided an opportunity for attendees to ask questions, voice concerns, and offer opinions. These MNDNR outreach activities continued into 2018; outcomes of these effects will be discussed in future reports.

Industry Engagement

The USFWS, USACE, USGS, ILDNR and other cooperating agencies participated in the following organized stakeholder groups:

- The Technical and Policy Workgroup, which consists of academia and non-governmental organizations interested in technical and policy issues relating to the design and operation of the USACE EDB (electric dispersal barriers)
- The CAWS Advisory Committee, comprised of more than two dozen stakeholder organizations that have expressed an interest in preventing AIS transfer into the Great Lakes, especially Asian carp

3.3.6 LAW ENFORCEMENT/REGULATORY

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of Bighead, Black, Grass, and Silver Carp in the United States.**

A Federal court ruling on the regulations governing the interstate transport of species listed under the Lacey Act resulted in the elimination of federal restrictions on the transport of species listed as injurious across State lines within the continental United States. State regulations continue to provide oversight on a State-by-State basis of production, possession, sale, and transport of Asian carp. Federal and State agencies also continue to coordinate closely on enforcement of injurious species regulations, including the Lacey Act and other Federal and State statutes.

The Minnesota State Legislature granted the DNR Commissioner the authority to issue a permit to MNDNR divisions for tagging Bighead, Black, Grass, or Silver Carp for specific research or control purposes. Under the permit, Asian carp may be released into the water body from which it was captured. Until this authorization expires December 31, 2022, the MNDNR will collect information on habitat use and movement in State waters by telemetry tagging and tracking of Asian carp.

3.4 UPPER MISSISSIPPI RIVER BASIN-IWW/CAWS

3.4.1 INTERAGENCY COORDINATION

- **NATIONAL PLAN GOAL: Effectively plan, implement, and evaluate management and control efforts for Bighead, Black, Grass, and Silver Carp in the United States.**

Since 2009, the ACRCC has served as the primary partnership coordinating the planning and execution of Federal and State agency efforts to prevent the spread of Asian carp populations from the MRB into the GLB. The partnership and its technical and scientific sub-committee, the MRWG, provide oversight and coordination of actions conducted in the IWW/CAWS through its annual *Asian Carp Action Plan* (Action Plan) and *Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System* (MRP). The 2017 Action Plan (<http://www.asiancarp.us/documents/2017ActionPlan.pdf>) contained over 70 projects focused on monitoring and early detection, control and removal, pathway mitigation, research and development of new tools and technologies, and other strategic actions. The 2017 MRP (<http://www.asiancarp.us/documents/MRP2017.pdf>), developed by the MRWG, stepped-down and directly supported the broader partnership-wide 2017 Action Plan, providing a geographic focus and tactical approach for implementing agency actions in the IWW/ CAWS. A more detailed summary of MRP-related accomplishments and results for 2017 is included in the MRWG's annual Interim Summary Report (<http://asiancarp.us/Documents/InterimSummary2017.pdf>).

The ACRCC also participated with the ORB and UMRB partnerships in the strategic discussions led by the USFWS and USGS that focused on the National Asian Carp Management and Control Plan, as well as ongoing multi-basin sound deterrent coordination and planning coordination. In addition, the ACRCC agencies regularly engage with other coordinating bodies focused on Asian carp and multispecies AIS management, including the GLMRIS Executive Steering Committee and the Great Lakes Panel on Aquatic Nuisance Species.

3.4.2 MONITORING, EARLY DETECTION AND RAPID RESPONSE

- **NATIONAL PLAN GOAL: Minimize potential adverse effects of feral Bighead, Black, Grass, and Silver Carp in the United States.**
- **NATIONAL PLAN GOAL: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**

The ILDNR, USFWS, USACE, USGS and other ACRCC partners planned and conducted both ongoing and new monitoring activities for all life stages of Asian carp in the IWW, CAWS and adjoining waters. Strategies included the use of traditional gears (netting and electrofishing), eDNA, and remote sensing techniques, including telemetry tracking of tagged fish and hydroacoustics.

Asian Carp Telemetry Monitoring

In FY 2017, the USACE and its partners continued to implement a telemetry program in the upper IWW/CAWS using an acoustic receiver array to track the movement and behavior of individual fish tagged with coded ultrasonic transmitters. Telemetry is used to assess effectiveness of the electric dispersal barriers (EDB) by monitoring movement of fish in the immediate vicinity to determine if the fish challenge or penetrate the barriers. Additionally, telemetry is used to identify the leading edge of the Asian carp population and whether Asian carp can navigate through lock structures in the IWW system. Surrogate (non-Asian carp) species (i.e. Common Carp, buffalo spp.) were tagged at or near the

EDB in the Lockport Pool, while Asian carp were tagged in the Dresden Island and Marseilles Pools. The acoustic network (Figure 17) is composed of stationary acoustic receivers supplemented by a mobile hydrophone unit.

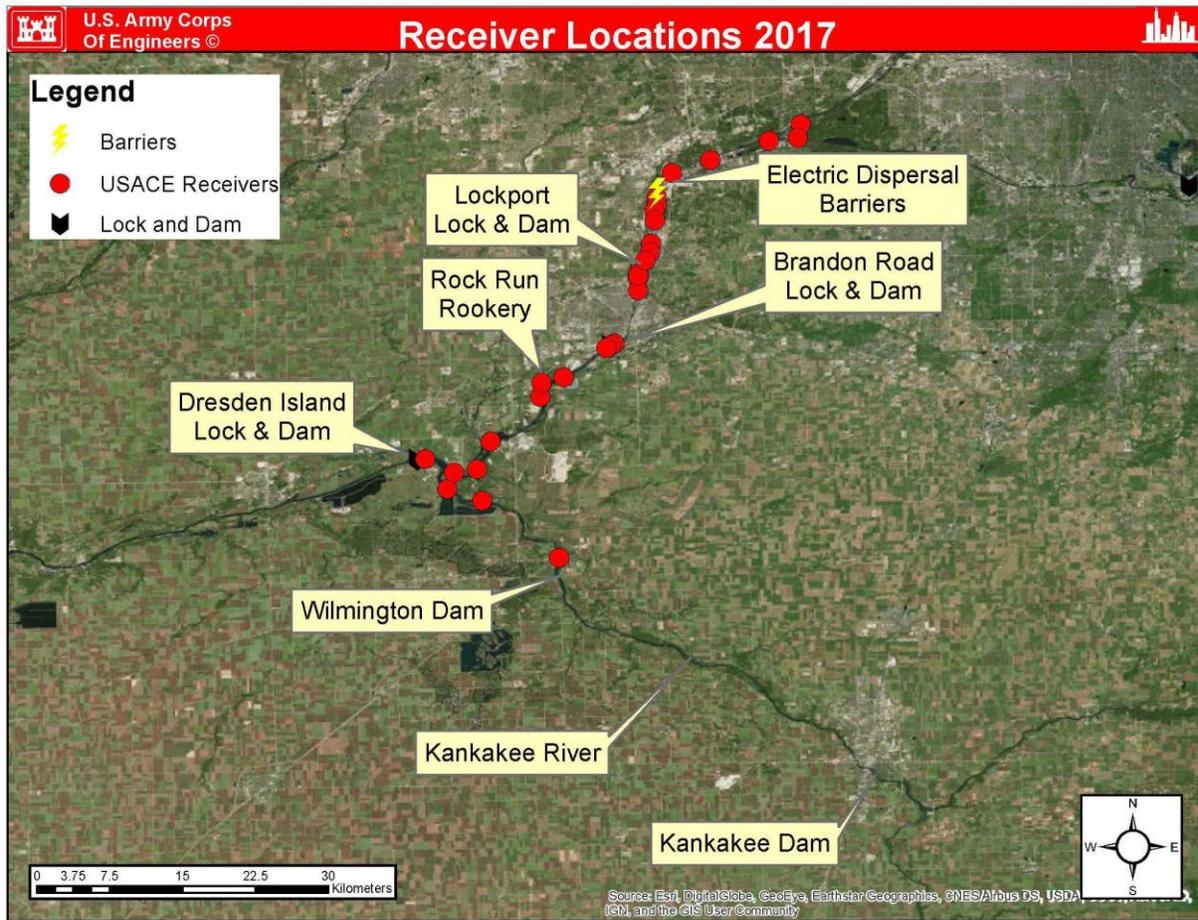


Figure 17. 2017 USACE telemetry receiver locations

The USFWS conducted a telemetry study focusing on evaluating the movements of tagged juvenile Silver Carp from their initial capture and release site. The study provided information on the general habitat categories used by tagged fish (i.e., main channel, side channel, marina, backwater, tributary, and impoundment) and the relationship of water temperature and flow to tagged fish movement. A total of 66 fish were tagged and released (9 with radio and acoustic transmitters) within the Peoria Pool during August and September 2017. The study will continue in 2018.

The USFWS also tagged Grass Carp within upstream navigation pools of the IWW with acoustic transmitters to monitor movement patterns and habitat selection. Between April and July 2017, a total of 12 Grass Carp were implanted with acoustic telemetry tags in Dresden Island, Brandon Road and Marseilles pools and released for tracking. A final report summarizing study results will be produced in 2018 and will be discussed in future reports. In addition, reports are submitted to the MRWG as part of the annual compilation of project reports, the Interim Summary Report, which is available on www.AsianCarp.us.

eDNA Monitoring

In FY 2017, the USFWS conducted eDNA monitoring in one comprehensive sampling event (240 samples taken) in the CAWS above the EDB. None of these samples were positive for either Bighead or Silver Carp eDNA. Below the EDB, eDNA sampling was conducted in May 2017 (276 samples) in the Dresden Island Pool. Of these, 8 samples were positive for Silver Carp DNA and 2 were positive for Bighead Carp DNA. All positive eDNA detections were collected from the areas of Dresden Island Pool where both species have frequently been captured (Figure 18).

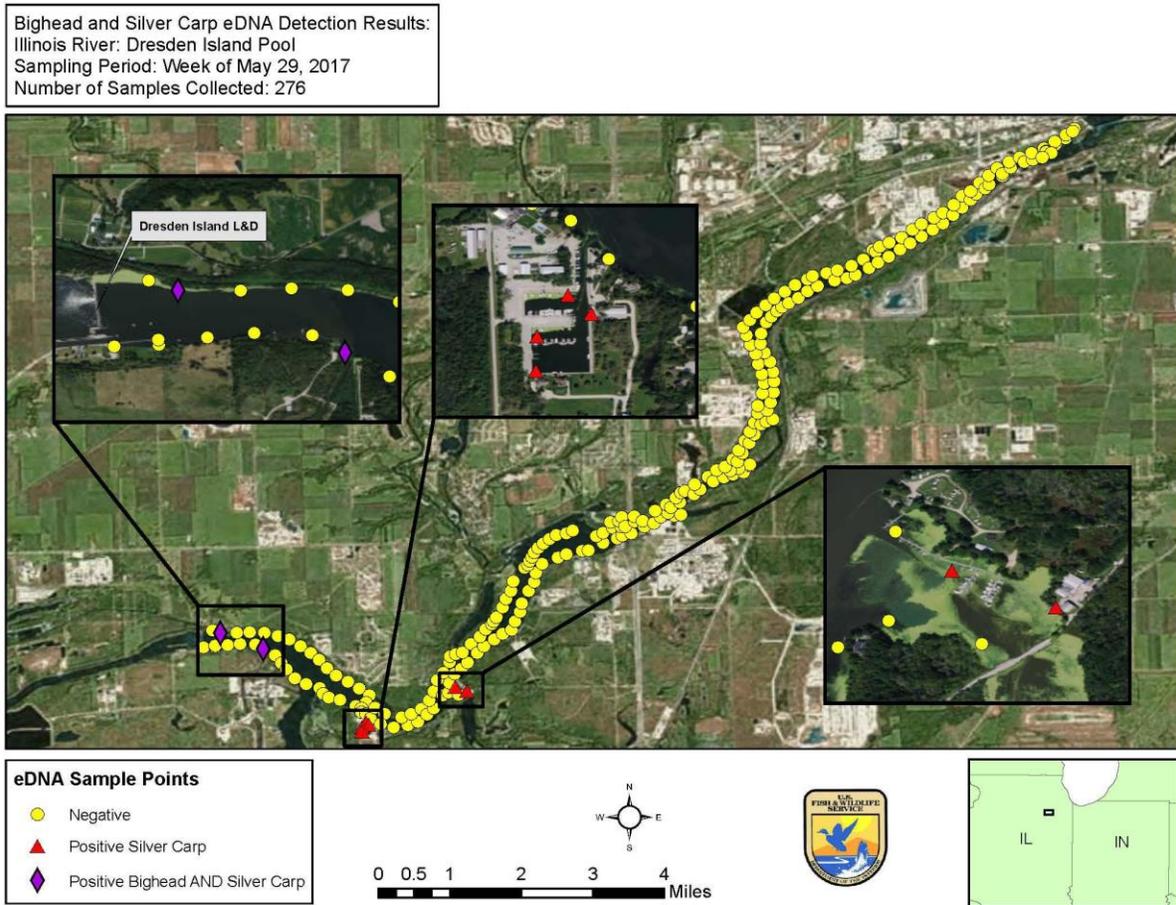


Figure 18. eDNA results for Dresden Island Pool of the IWW, with positives for both Bighead and Silver Carp in the lower end of the pool.

The USGS published results of an experimental study on the environmental factors that influence the decay of eDNA associated with Bighead Carp. Temperature had the greatest influence on decay rates, with faster decay at higher temperatures. Greater microbial loads and lower pH also increased decay rates. This information is essential for interpreting detection rates and for correlating eDNA concentrations to fish biomass in the environment.

Traditional Gear Sampling

In support of objectives in the 2017 MRP, the ACRCC partners conducted two Seasonal Intensive Monitoring (SIM) cycles in the CAWS, consisting of intensive sampling for Asian carp in the waterway

above the EDB for two consecutive weeks in spring and again in fall. SIM sampling was conducted in June 2017, focused on the Lake Calumet/Cal-Sag area of the CAWS; and in September 2017, focused on the North Shore Channel/Chicago River. The SIM program targeted areas with historic detections of Asian carp or Asian carp eDNA. A single adult Silver Carp was captured by a contracted commercial fisher during the June 2017 SIM cycle on June 22 in the Little Calumet River of the CAWS, approximately 9 miles from Lake Michigan. This capture triggered a coordinated interagency response action under the ACRCC's MRWG *Upper Illinois Waterway Contingency Response Plan* (see Rapid Response, below). No additional Asian carp were captured during the follow-up response action. The U.S. Coast Guard (USCG) assisted with notification to mariners on waterway.

Ongoing surveys continue to be conducted to target adult Asian carp in specific navigation pools and adjoining tributaries in the upper IWW, utilizing both agency and commercial fishing efforts. Monitoring was also conducted for juvenile and larval (age-0) Asian carp and eggs using gears to target earlier (smaller) life stages. The efforts included sampling at fixed-sites with gears designed to collect specific life stages and monthly standardized monitoring at locations downstream of the EDB using electrofishing gear by agencies and additional sampling by commercial fishers. Monitoring data provided key information on the location of the Asian carp adult population front, the distribution and movement of larval to age-2 Asian carp, estimated site-specific population densities, and specific habitats favored by Asian carp in the IWW.

The USFWS conducted additional monitoring in the Peoria, Starved Rock, Marseilles, Dresden Island, Brandon Road and Lockport pools, using a variety of gear types targeting smaller Asian carp life stages. USFWS personnel completed a total of 277 electrofishing sites (69.3 hours of fishing time). No small Asian carp (<153 mm) were captured by the USFWS above the Peoria Pool. Additionally, the USFWS deployed specialized gears (Paupier nets and "dozer" trawls) to target backwater sites in the Peoria Pool where concentrations of juvenile Silver Carp were captured in 2015 and suspected of serving as nursery habitat. During this effort, a total of 1,142 Silver Carp were captured. Capture included four small Asian carp in DePue Lake, a large backwater of the Peoria Pool approximately 86 miles downstream of the EDB.

The ILDNR, USFWS, and USACE coordinated on efforts to conduct electrofishing to sample five fixed locations and additional reaches in the CAWS for the presence of Asian carp and assess the local fish population. In addition to monitoring for Asian carp, these data were used to inform a fishery statistical-based model that will quantify the probability of Asian carp presence/absence and relative abundance. This effort is part of a larger CAWS monitoring program developed by the MRWG. In addition, USACE conducted monthly electrofishing surveys at the EDB, outside of the regular MRWG fixed site monitoring activities.

Hydroacoustic Sampling

The USFWS increased its efforts in 2017 on hydroacoustic fish surveys conducted directly downstream of the EDB. Acoustic sampling was conducted approximately every two weeks to measure and evaluate fish density. Results of these surveys suggested that fish density (non-Asian carp) directly downstream of the EDB was low in late winter and spring, increasing substantially in early summer and peaking in late July. This change was potentially the result of the influx of young-of-year fish (non-Asian carp) into the fish community being detected and evaluated at the study location. By mid-October fish densities declined from summer levels but were still greater than those observed during spring surveys. Data are used to inform the agencies' understanding of seasonal characteristics of fisheries adjacent to the EDB.

The USFWS also conducted direct observations of fish behavior at the EDB utilizing two dual frequency identification sonar (DIDSON) multi-beam sonar systems. The systems were deployed directly over the narrow array of Barrier IIB (area of strongest electrical field strength) concurrent with barge entrainment trials that occurred over a two-week period in August 2017. Data from the study provided key information on the actual behavior exhibited by fish when encountering the EDB under both normal operations and during the passage of barge tows. Concurrent fish sampling was conducted with traditional gears to determine the species of fish that were being observed (no Asian carp were captured or observed).

The USFWS further completed seasonal hydroacoustic fish surveys of the Lockport and Brandon Road navigation pools in the upper IWW throughout the year. The survey data provided key information on the relative abundance and densities, spatial distribution, and sizes of fish that occupy the sampled pools.

Development and Deployment of New Asian Carp Sampling Gear

The USFWS, ILDNR, USACE, USGS and other partner agencies continue to develop, evaluate, and integrate novel sampling techniques and strategies for the detection, monitoring, and removal of Asian carp in Midwestern waters. For example the USGS used a high-frequency underwater video technology to assess fish size and observe and quantify net avoidance behaviors. Knowledge of these behaviors can maximize the effectiveness of net sets and help State managers enhance fish capture. The USGS also worked alongside the ILDNR, USFWS and other partners to conduct field tests of the UFM, a Chinese Asian carp netting strategy, shown to be effective at increasing catch. Additional knowledge gained on net avoidance behaviors demonstrated by Asian carp will inform possible modifications of the UFM for future use in control strategies.

USFWS completed the final year of field work for a gear evaluation study comparing traditional electrofishing with two novel electrofishing gears and techniques (Paupier net and dozer trawl) in Illinois River backwaters. Catch rates of adult Silver Carp were significantly higher with the two novel gears as compared to traditional electrofishing during the trials. Increased capture was also demonstrated for small Asian carp. Further work focused on improvements to Asian carp capture included modifying and assessing mass removal techniques for potential integration into protocols for the detection, monitoring, and removal of Asian Carp in Midwestern river basins.

Rapid Response

The ACRCC's MRWG *Upper Illinois Waterway Contingency Response Plan* (CRP) was implemented following the capture of an adult Silver Carp on June 22, 2017 in the Little Calumet River of the CAWS, approximately 9 miles from Lake Michigan. The Silver Carp was captured by a commercial fisher during MRWG's Spring 2017 SIM sampling program. The CRP serves as the interagency rapid response protocol used in the event of the detection of Asian Carp above an established threshold in upstream locations in the CAWS, including between the EDB and Lake Michigan (<http://www.asiancarp.us/documents/2016ContingencyResponsePlan.pdf>). After the capture, the ILDNR, USFWS, USACE, and contracted commercial fishers participated in an intensive 2-week sampling effort upstream and downstream of the T.J. O'Brien Lock and Dam, as prescribed by the CRP. Four electrofishing crews, three contracted commercial fishers, and a specially outfitted netting boat were deployed daily in areas below the T.J. O'Brien Lock to Calumet Harbor. The U.S. Coast Guard assisted with notification to mariners on waterway logistics related to the response operation. The operation covered a 13-mile section of the waterway and concluded on July 7 with no additional Asian Carp

collected. Fish otoliths (ear bones) microchemistry techniques were used by Southern Illinois University to determine in which water bodies the fish was reared (natal origin) and subsequently lived. This analysis determined that the fish was an age-4 male that had originated in waters downstream below the EDB in the Illinois/Middle Mississippi watershed, subsequently occupied the Des Plaines River watershed and was caught and removed upstream in the Little Calumet River.

3.4.3 ACTIVE PREVENTION/CONTROL

- **NATIONAL PLAN GOAL: Contain and control the expansion of feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**
- **NATIONAL PLAN GOAL: Extirpate, or reduce to levels of insignificant effect, feral populations of Bighead, Black, Grass, and Silver Carp in the United States.**

Addressing Pathways

The USACE continued its execution of the GLMRIS - Brandon Road Study, including identification and release of the Tentatively Selected Plan (TSP, Figure 19). The TSP proposes multiple fish deterrent measures in the CAWS, each designed to prevent the potential upstream movement of Asian carp toward the Great Lakes through a distinct hydrologic pathway. Measures that could potentially be employed at the Brandon Road Lock and Dam were documented in a draft report. The USACE released the draft report for public review and comment and initiated an Agency Technical Review, Independent External Peer Review, Policy Review, and National Environmental Policy Act Review. The USACE further developed and employed a comprehensive public engagement strategy to ensure stakeholder awareness and communication of specific project developments and timelines on GLMRIS. For more information visit <http://glmris.anl.gov/brandon-rd/>.

BRANDON ROAD STUDY TENTATIVELY SELECTED PLAN (TSP)

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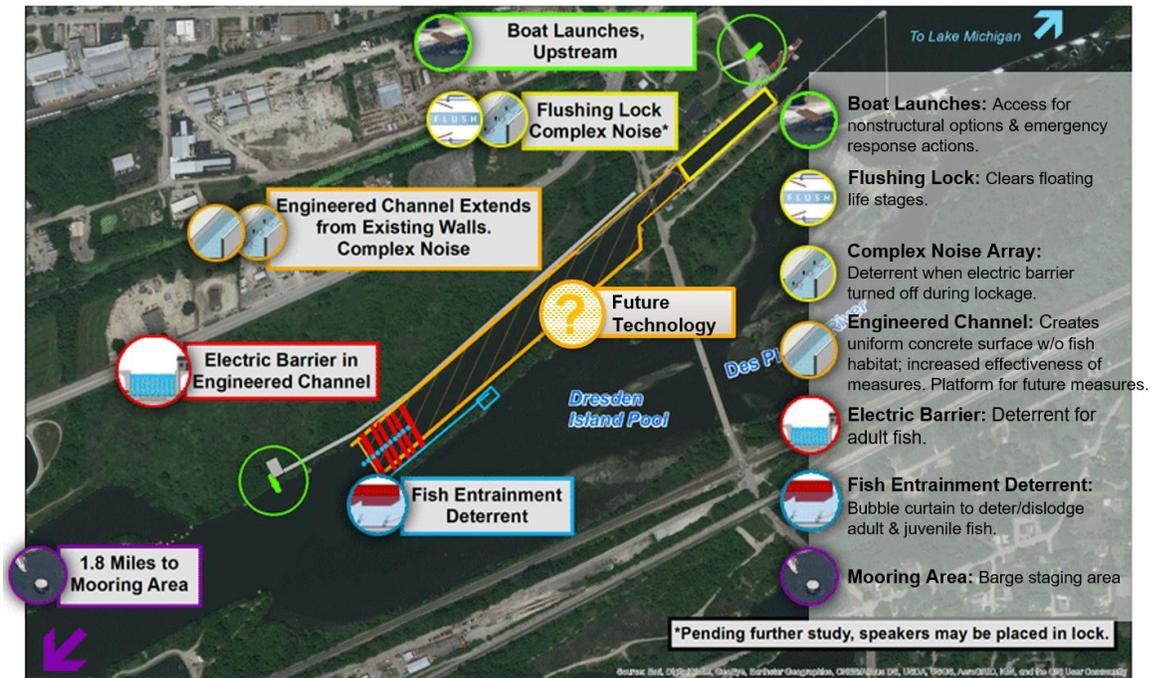


Figure 19. GLMRIS Brandon Road Tentatively Selected Plan (TSP)

The USACE continues to operate and maintain the EDB as an integral part of its strategy to prevent movement of Asian carp toward the Great Lakes. In FY 2017, the USACE continued operations of the EDB in the CSSC in Romeoville, Illinois. The EDB is designed to reduce the risk of transfer of fish between the Mississippi River to the GLB via the CSSC. The system currently consists of three barriers (Demonstration, IIA, and IIB; Figure 20) that create a waterborne, pulsed, direct current, electric field in the canal, which expose fish penetrating the electric field to electrical stimuli that act as a deterrent. Construction of an additional permanent barrier to replace the demonstration barrier will be complete in 2020.

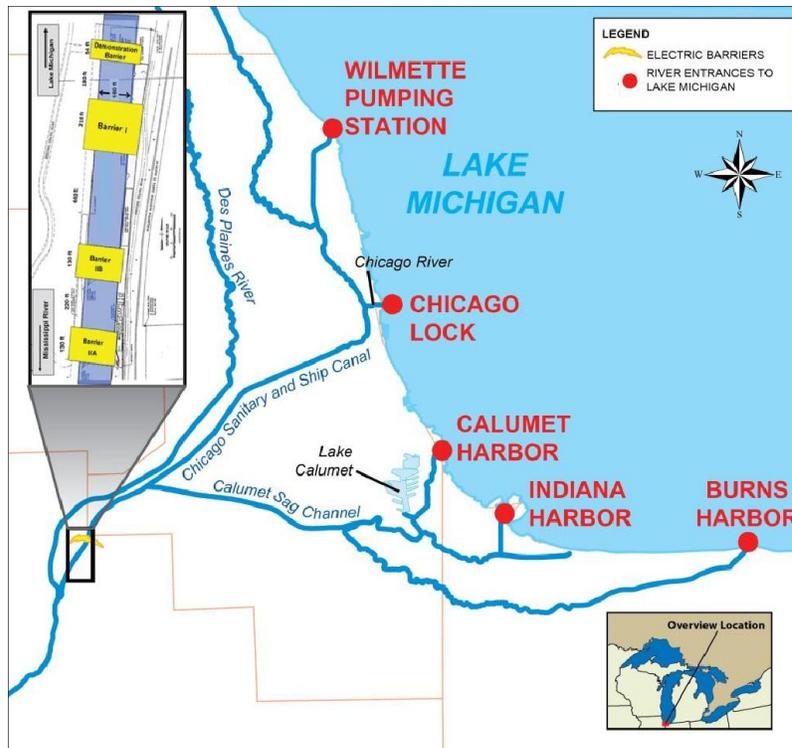


Figure 20. Electrical dispersal barrier location map

The USACE, USFWS, ILDNR, and other ACRC partners implemented a Barrier Maintenance Fish Suppression protocol for use during routine or unplanned maintenance operations at the EDB. This protocol gives the USACE the ability to safely power down barrier arrays for service without increasing the risk of Asian carp upstream passage. The protocol includes instruction for sampling downstream of the barriers prior to turning off power to determine if Asian carp are present, conducting surveillance of the barrier zone with hydroacoustics, side-scan sonar, and DIDSON during maintenance operations, and employing operations to clear fish between barriers using mechanical or chemical means.

The USACE also maintains the Des Plaines River Bypass Barrier, a 13-mile long combination fence and jersey barrier that physically blocks the movement of Asian carp through hydrologic bypasses created by flooding along the Des Plaines River and the Illinois and Michigan (I&M) Canal. The barriers placed in these locations are intended to stop upstream movement of juvenile and adult Asian carp towards the Great Lakes. The ILDNR, USFWS, USACE, and other cooperators conducted the Des Plaines River and Overflow Monitoring project, which included periodic monitoring for Asian carp presence and spawning activity in the upper Des Plaines River. In a second component, efficacy of the Des Plaines Bypass Barrier constructed between the Des Plaines River and CSSC was assessed by the USFWS during its efforts to detect Asian carp juveniles that may be transported to the CSSC via laterally flowing Des Plaines River floodwaters passing through the barrier fence.

The USGS, in collaboration with the USACE, conducted field and laboratory evaluations and trials to support development of new deterrent technologies for potential deployment at the Brandon Road Lock and Dam or other possible control points. These evaluations include studies of CO₂, hot water, and ozone for use as control technologies and include field testing and research related to the efficacy, implementation, and impacts of the use of CO₂ as a non-physical chemical barrier to deter the

movement of Asian carp. Additionally, the USGS initiated testing of the use of underwater complex sound as potential deterrent to Asian carp, considering factors such as mechanical configuration, operation, and, short- and long-term response of fish to sounds and the potential impacts to native fish and mussel species.

Barge Entrainment

The USACE, USFWS, USGS, USCG and other stakeholders partnered on barge entrainment field studies in the IWW to build on the results from prior work and address additional key informational needs, such as entrainment, retention, and transport dynamics, to inform potential entrainment mitigation options. Studies conducted in 2017 evaluated the effectiveness of water jet technology for mitigation of barge entrainment pathways and the effectiveness of canal flow manipulation for mitigation of non-entrainment pathways for fish passage at the EDB. In August 2017, the USACE also led a field study in the CAWS to determine if submerged waterjets could be used to mitigate barge entrainment of small fish by dislodging and removing entrained species from the recesses between barges and vessel-induced eddies. The study built upon prior laboratory investigations by field testing the mitigation techniques in the CSSC, just downstream of the EDB. Additional field trials were conducted by the USFWS, which utilized a commercial barge tow operating under normal conditions in the IWW. This technique was used to gain additional information on the potential for entrainment and transport of small Silver Carp within barge junction gaps under “real world” scenarios (e.g., within barges transiting active navigation channels of the IWW where Silver Carp are known to be established). Additional field trials were conducted in 2018 to evaluate passage via entrainment at locks in the lower IWW and will be discussed in future reports.

Asian Carp Capture and Removal

The ILDNR, USFWS, USACE, partner MRWG agencies, and commercial fishers conducted focused capture and removal actions in FY 2017 to reduce adult Asian carp numbers in strategic locations in the IWW to abate the advancement of adult Asian carp upstream in the CAWS and defend and support the efficacy of the EDB. Actions included the Barrier Defense Asian Carp Removal Project, a program established to reduce the numbers of Asian carp downstream of the EDB through controlled commercial fishing. The intent of the project is to reduce the propagule pressure on the EDB by reducing Asian carp populations in Dresden Island, Marseilles, and Starved Rock pools through targeted and intensive harvest of adult fish. To date, over 5 million pounds of Asian carp have been harvested and removed through this effort, with measured declines noted in the estimated density of Asian carp in navigation pools along the leading edge of established populations in the upper IWW.

Using the UFM, the ILDNR and ACRCC agency partners and commercial fishers removed over 96,000 pounds of Asian carp from a backwater lake on the upper Illinois River near Morris, Illinois in the Marseilles Pool over a two week period in June 2017. This method will continue to be deployed, where conditions are appropriate, for removal of Asian carp.

3.4.4 RESEARCH AND DEVELOPMENT

- **NATIONAL PLAN GOAL: Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of Bighead, Black, Grass, and Silver Carp in the United States.**

Development of New Deterrent Technologies

In 2017, the ACRCC agencies participated in an Asian carp acoustic deterrent workshop hosted by the USFWS in Bloomington, Minnesota. Resource managers and researchers from the USFWS, USACE, USGS, ILDNR and USACE met with representatives from academia and industry to discuss potential opportunities for field testing an acoustic deterrent system as a barrier to Asian carp movement. Issues addressed at the workshop included modeling and Asian carp surveillance data needs, potential pilot project locations, and the best available technologies for field testing where Asian carp are established.

The USACE and USGS conducted a 7-day field trial at the Brandon Road Lock to test complex noise as an Asian carp barrier. This interagency team tested equipment and developed a sound map of the lower approach area that will inform future barrier designs. A boat equipped with GPS, speakers, and hydrophones mapped the acoustics of the lower approach under a variety of scenarios (e.g., gates open/closed and vessels present/absent). Data collected in the field trial will populate models used to design the barrier.

The USACE conducted laboratory research to assess the impact of various environmental conditions on the effectiveness of the EDB and on fish behavior. Laboratory tests were conducted to confirm the optimal barrier operating parameters by examining a number of factors including water temperature and dissolved oxygen levels. The USACE also conducted tests that expose fish to the electrical field for longer durations of time to determine if the fish become less affected over time along with tests to better understand the swimming capabilities of Bighead and Silver Carp.

The USGS continued to develop and refine the microparticle piscicide (fish toxicant) that has demonstrated high toxicity and selectivity toward Asian carp. Additional work was conducted to integrate the use of fish feeding attractants with microparticle delivery to increase the amount of consumption of the microparticles by Asian carp. Research conducted by the USGS and their partners for Asian carp management is described in detail in Section 4.0: Research and Technologies Potentially Useful for Controlling the Spread of Asian Carp.

Asian Carp Biology, Life History and Reproduction Evaluations

The USFWS, USGS, and their partners completed the second year of an analysis of feral Grass Carp in the CAWS and Upper IWW, with the overall goal of better understanding Grass Carp population dynamics in these locations. Between April and July of 2017, 13 Grass Carp were captured, including 2 near the TJ O'Brien Lock and Dam, and were processed for life history traits, including ploidy, age, microchemistry (used to determine fish geographic origin and subsequent locations), and reproductive capacity. Grass Carp captured within Marseilles, Dresden Island, and Brandon Road pools were implanted with acoustic transmitters to monitor movement patterns and habitat selection; an additional 12 Grass Carp were implanted with acoustic telemetry tags in Dresden Island, Brandon Road and Marseilles pools and released for tracking. A final report summarizing study results will be produced in 2018.

3.4.5 OUTREACH WITH INDUSTRY, STAKEHOLDERS AND THE PUBLIC

- **NATIONAL PLAN GOAL: Provide information to the public, commercial entities, and government agencies to improve effective management and control of Bighead, Black, Grass, and Silver Carp in the United States.**

AsianCarp.us Website

The USFWS continued to support and administer the national Asian carp website (www.AsianCarp.us) as the primary platform for delivering updates on accomplishments, science, and other products related to Asian carp management. The website houses the current interagency documents on Asian carp management, including all iterations of the WRRDA Report to Congress, ACRCC Action Plans and related strategies, and the National Asian Carp Management Plan. The USFWS initiated a re-design of the website to include specific content on Asian carp news and developments. Additional content to share ACRCC findings and updates is being developed by the multi-agency Communication Workgroup. In 2017, a complementary web site, www.asiancarp.ca, was developed by the Invasive Species Centre and Canadian ACRCC partners to provide a Canadian perspective on the Asian carp issue.

Public/Stakeholder Engagement

The ACRCC member agencies provided periodic briefings to Congress and others on key issues related to Asian carp management in the IWW/CAWS. The USACE employed a comprehensive public engagement strategy for AIS recommendations and actions related to the GLMRIS Report. This strategy consisted of focused briefings, stakeholder conference calls, media events, social media, and project websites.

Industry Engagement

The USFWS, USACE, USGS, ILDNR and other cooperating agencies participated in the following organized stakeholder groups:

- The Technical and Policy Workgroup, which consists of academia and non-governmental organizations interested in technical and policy issues relating to the design and operation of the USACE EDB
- The CAWS Advisory Committee, comprised of more than two dozen stakeholder organizations that have expressed an interest in preventing AIS transfer into the Great Lakes, especially Asian carp
- The Barrier Navigation Task Force, which is composed of representatives from the navigation industry interested in research on the efficacy of the electric barriers

3.4.6 LAW ENFORCEMENT/REGULATORY

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of Bighead, Black, Grass, and Silver Carp in the United States.**

Federal and State agencies continued to coordinate closely on enforcement of the Lacey Act and other Federal and State statutes. Additionally, the ILDNR Office of Law Enforcement conducted an alternative pathway surveillance program intended to increase education and enforcement activities at bait shops, bait and sport fish production and distribution facilities, fish processors, fish markets, and establishments known to have a preference for live fish for release or food preparation.

4.0 RESEARCH AND TECHNOLOGIES POTENTIALLY USEFUL FOR CONTROLLING THE SPREAD OF ASIAN CARP

Agency and non-governmental partners are conducting critical research to support the development and implementation of potential new technologies for use in Asian carp management strategies in the

UMRB and ORB. Federal efforts are led primarily by the USGS, with additional research conducted by the USACE and USFWS. State and Provincial agencies and universities are also conducting key research, adding to the scope of complementary projects currently underway. Research and development efforts are being conducted on the following areas:

- Early Detection and Monitoring
- Life History and Behavior
- Feeding Ecology
- Prevention
- Control
- Pathway Analysis
- Risk assessment

Research currently being conducted, and highlighted below, has been developed to target potential control opportunities based on known Asian carp life-history vulnerabilities and unique behavioral characteristics. Individual projects being conducted by the USGS for Asian carp management are described in further detail in Appendix 1. Additional research conducted by other Federal and State agencies is described in the ORB, UMRB, and IWW/CAWS sections of this Report.

As potential new tools are investigated and developed for Asian carp control, research must also consider potential negative impacts to non-target aquatic species, in particular depleted or imperiled State or Federally-listed fish and mussels. As a result, several control tools currently being developed are highly-specific to Asian carp species (primarily Bighead and Silver Carp) to avoid impacts to non-target native aquatic species. Prevention actions that are more general and not selective for Asian carp (e.g. sound, CO₂, or bubble barriers to fish movement) are designed to be deployed in a manner to deter fish movement while not being lethal. Research includes the following:

- Underwater Sound Technology to alter behavior of Asian carp: the USGS and USACE conducted sound field trials at Brandon Road Lock and Dam to test the engineering feasibility of sound as a deterrent and obtain additional data, build a sound propagation model, and optimize design of future deterrent systems. The USGS also collaborated with the USFWS and commercial fishermen to test the use of underwater sound to herd fish using circular and linear boat patterns and other techniques to enhance fish capture. Scientists are also testing different sound broadcasting configurations to achieve the most focused, targeted application.
- Portable hand-held eDNA detection device: The USGS validated a loop-mediated isothermal amplification (LAMP), a genetic assay method for detection of Asian carp as well as other invasive species and pathogens. This new portable detection assay was tested in pond studies and appears to be more sensitive than current detection kit assays. Work was also conducted to meet State requests to extend the use of the tool beyond baitfish tanks to open water applications. Commercial availability of this new kit is being investigated with two companies. The USGS delivered kits to the NPS and agencies within Minnesota, Wisconsin, and Kentucky and trained staff in use of the device.
- Fluvial Egg Drift Simulator (FluEgg): Prior to 2010, information on spawning requirements for Asian carp was primarily based on observations that spawning in rivers occurred during high-flow events and that eggs must remain in suspension in the water column until hatching to survive. Recent studies on Asian carp spawning requirements have used the FluEgg model, to predict likely Asian carp spawning locations and conditions that would allow eggs and larval fish

to survive until they can find nursery habitat. The model demonstrated that spawning may occur in much lower velocities than previously observed. Moreover, the recent discovery that Asian carp larvae begin to swim vertically immediately after hatching suggests that the minimum velocity criteria is only applicable to the egg stage, further broadening the range of potential spawning rivers. This information can be used to inform potential targeted control efforts and provides insight into spawning site characteristics. In FY 2017, USGS in collaboration with the University of Toledo, expanded the FluEgg model to include Grass Carp and combined it with the USACE's Hydrologic Engineering Center's River Analysis System (HEC-RAS) simulation model to estimate spawning and hatch locations of previously captured Grass Carp eggs. Results indicate that hatching may have occurred in the mouth of the Sandusky River, Ohio, rather than in flowing water. Scientists have begun further expansion of the model to include Black Carp egg and larval data.

- Carbon Dioxide (CO₂) as a barrier: Field evaluations of CO₂ as a deterrent were completed at a water control structure at Emiquon Preserve (Illinois) including identification of minimum and maximum target CO₂ concentrations under different water flow rates and ranges of temperatures. Preliminary work was conducted in preparation for a 2018 field test in a lock structure on the Illinois River. Studies on potential effects of CO₂ on non-target native mussels were completed and acute and chronic exposure limits were determined to meet requirements for registration of its use. An effective concentration of CO₂ as a non-selective toxicant was determined for winter application under-ice for Bighead and Silver Carp control. Scientists also began evaluating CO₂ and fish behavior in outdoor ponds using acoustic telemetry and evaluation of gradients to identify effective concentrations.
- Targeted Chemical Controls: An initial field test was conducted in Missouri using non-toxic microparticles to refine methods and gain insight into best practices and areas for use. The first lethal microparticle field trials were conducted in 2017 and 2018; results are currently being analyzed with expected publication in 2019. Registration activities with USEPA as well as coordination activities with the USFWS are ongoing to estimate the potential non-target effects on native aquatic organisms. Microparticle use is also being adapted for other toxicants, bioactive compounds, and other invasive species. A selective toxic bait is under development which could be deployed to remove Black Carp from locations where they may harm endangered or threatened organisms such as native mussels.
- Hydraulic data and analysis support: The USGS completed four weeks of data collection, hydrodynamic analysis, and other hydraulic support on the Illinois River to support the USFWS assessment of the ability of barges to entrap and move small Asian carp. The USGS also worked on installation and testing of water jets as a mitigation strategy for this pathway. Analysis of water quality and chemical components was completed for waters where Asian carp movement is currently stalled. Results were presented to the ACRCC and indicate that certain chemical constituents could be affecting Asian carp movement and warrant additional study.
- Food Attractants to optimize capture or control applications: Algal attractants were released daily over several days during field trials on the Missouri River in the UMR to monitor the magnitude and duration of fish response, identify the minimum number of days to achieve a desired level of response, and identify how environmental variables and habitat type affect fish response. Samples of eDNA were also taken to measure changes in biomass when the attractant was applied in areas where Asian carp densities are low, such as an invasion front. Results are currently under review and are expected to be available in 2019.

- Genetic control testing: Research was published on the release of YY-male Grass Carp as a genetic control. Unlike normal XY-male Grass Carp, YY-males have two Y chromosomes and when they spawn with normal females only normal XY-males are produced. Releasing enough YY-males could cause a population to crash by strongly biasing the sex ratio, over time, toward males. A population model was developed to explore this method of control for Lake Erie, but it was determined that it would take too many YY-males to make it feasible for use. It could be used to control smaller Grass Carp populations in geographically constrained areas or other species with different life history strategies.

Appendix 1 provides a summary of completed or ongoing research being undertaken in 2017 by the USGS with the assistance of other Federal, State, and research institutions that focus on Asian carp management in U.S. waters.

5.0 METRICS AND METHODOLOGIES FOR EVALUATING SUCCESS OF ACTIONS TO CONTROL THE SPREAD OF ASIAN CARP

The WRRDA directs the USFWS to identify measures to document progress in controlling the spread of Asian carp in the UMRB and ORB and their tributaries. The initial 2014 Report identified: (1) proposed measures and outcomes for ensuring progress toward the goals of controlling spread of Asian carp in the designated watersheds, and (2) specific critical short-term actions to continue and expand multiagency coordination to achieve common prevention-based goals. This 2017 Report continues to use these measures, with some modification, to facilitate more efficient tracking of annual outcomes and progress toward achieving long-term goals. The use of these measures is intended to increase management efficiency and accountability for implementing Asian carp strategies in the UMRB and ORB and their tributaries. Summaries of accomplishments achieved under each measure will be provided in subsequent WRRDA reports.

5.1 Actions to Address the Need for Interagency Coordination

The following measures of progress are identified to evaluate progress in strengthening coordination better State and Federal agencies to cohesively manage Asian carp.

- 1) Development of interagency UMRB, ORB, IWW/CAWS, and other basin-specific Asian carp control strategies that complement the National Plan while addressing the management needs of each basin. Integrating the individual basin efforts into a cohesive national strategy is desirable to promote efficacy and efficiency of management actions, support information sharing on best-practices and lessons-learned, and prevent duplication of effort. Incorporating basin-specific Asian carp control strategies into a national approach will also help identify gaps in science and data in Asian carp management and provide a foundation for collectively developing priority initiatives to benefit multiple basin-wide partnerships.

Accomplishments in the UMRB

- The UMRB partners continued to develop and refine the draft (UMRB Framework). A final version was completed in late 2017. (<http://asiancarp.us/Documents/MRP2017MississippiRiverBasin.pdf>)
- The MNDNR, through the University of Minnesota, completed the *Minnesota Bigheaded Carps Risk Assessment*. The findings from this assessment revealed that the potential adverse effects and risks posed by Bighead and Silver Carps vary across watersheds. The Minnesota River-

Mankato watershed was estimated to have the highest probability of establishment (70%), followed by the Lower St. Croix River (45%) and Nemadji River watersheds (38%).

Accomplishments in the ORB:

- The ORFMT continued to implement the ORB Framework, originally released in 2014. This Framework outlines actions for prevention, monitoring and response, population control, understanding impacts, and communication to prevent further expansion, reduce populations, and better understand the impacts of Asian carp. Implementing the Framework is intended to minimize the social, ecological, and economic impacts of these invasive fishes.

Accomplishments in the IWW/CAWS:

- The ACRCC's MRWG developed the MRP for Asian carp in the IWW/CAWS. This interagency strategy, updated annually by the MRWG, directs the strategic development and implementation of key early detection, response, control and prevention projects in the upper IWW and CAWS in support of the ACRCC's mission of Great Lakes protection from Asian carp. Primary agencies include the ILDNR, USFWS, USACE, USGS, USEPA, ILNHS, and the GLFC. The 2017 MRP was prepared by the MRWG and released by the ACRCC. Specifically, this document is a compilation of 26 individual project plans, each of which plays an important role in preventing the expansion of the range of Asian carp, and in furthering the understanding of Asian carp location, population dynamics, behavior, and the efficacy of control and capture methods. Each individual plan outlines specific actions, including project objectives, methodology, and highlights of previous work. The MRP sets pool-by-pool targets for population removal and includes short-term and long-term plans that articulate the vision for control, including downstream commercial removal at 20 to 50 times the current harvest level.
 - The MRWG also formed discipline-specific work groups to assist future development of the MRP. The work groups use technical experts to assist with decision making or otherwise provide the MRWG co-chairs, agencies, and ACRCC with insights on a range of subjects. The work groups include:
 - Contingency Planning
 - Removal
 - Hydroacoustic Assessments
 - Telemetry
 - Modeling
 - Behavioral Deterrent Technologies
 - The MRWG compiles annual summary reports that detail the results of the MRP projects, each playing an important role in preventing the expansion of the range of Asian carp and in furthering the understanding of Asian carp location, population dynamics, behavior, and the efficacy of control and capture methods. Each summary report outlines the results that were realized for the given year and provides recommendations for next steps for each project.
- 2) Identification of Federal and State resources potentially available for implementing control strategies and actions.



Accomplishments:

- The USFWS worked extensively with the UMRB and ORB States and other Federal agencies to identify potential resources to implement highest-priority prevention and control actions in support of partnership Asian carp management strategies. Through cyclical (annual) development of strategic priorities and step-down agency work plans, key projects and related budgets were developed for the federal Fiscal Year. Federal agency annual budgets were leveraged with State resources, where possible. Limitations in State agency budgets have not allowed some States to significantly supplement Federal funding; however, States that received additional funding from the USFWS for Asian carp projects in conjunction with their ANSTF-approved State ANS management plans provided at least a 25% match for these funds. Numerous States are also evaluating the need for increased funding and are considering increasing fees and other innovative methods to leverage funding.
- 3) Development of ORB/UMRB formal institutional arrangements, using a collaborative model similar to the ACRCC, to facilitate interagency coordination, collaboration, and plan implementation.

Accomplishments:

- Utilizing MICRA, the ORFMT and UMRCC adopted an agency coordination model to provide recommendations for the highest priority Asian carp project needs in the ORB and UMRB, with the USFWS making final funding decisions. State representatives from both sub-basins recommended that the USFWS work through MICRA for executive-level Asian carp coordination and multistate project planning and implementation in the MRB. The sub-basin partnerships identified potential interagency management structures for coordinated planning and reporting, development of funding strategies, implementation of actionable plans, and identification of roles and responsibilities for all participating agencies.
 - Under the ORFMT, project specific working groups were created to address routine coordination needs including the TWG and ORB Communications Work Group.
- 4) Development of an annual project plan with management structure and appropriate funding.

Accomplishments:

- Each year, the Ohio River and Upper Mississippi River Basin Asian carp partnerships plan and implement priority projects identified in the Monitoring and Response Plan for Asian Carp in the Mississippi River Basin (<http://asiancarp.us/Documents/MRP2017MississippiRiverBasin.pdf>). Deliverables for the projects outlined in the Monitoring and Response Plan are provided in annual interim technical reports for each project (<http://asiancarp.us/Documents/MRP2017MississippiRiverBasin.pdf>) representing detailed findings as well as future recommendations for respective projects.
- 5) Development of a process to ensure actions are strategically prioritized and properly sequenced.

Accomplishments:

- The USFWS has worked extensively with the UMRB and ORB States, MICRA, and other Federal agencies to ensure that individual activities proposed for Asian carp management are strategically prioritized and properly sequenced. This action will continue annually.
- The OHRB and UMRB partnerships work through a specific process to develop projects that meet the strategies and objectives laid out in their basin control strategy frameworks. That begins with a consideration of the findings from the previous year presented by lead investigators in March. That is followed by coordination meetings where projects are revised

to address any needed changes and new ideas are considered for funding. Each agency then ranks project priorities by objectives and a list of priority projects is proposed for funding approval by the Asian Carp Advisory Committee and the USFWS. Individual project leads develop sequencing for projects as annual project plans are developed to provide expected outcomes and anticipated need for funding in future years. Those project plans are available in the Monitoring and Response Plans for Asian Carp in the Mississippi River Basin.

- 6) Preparation of an annual report summarizing accomplishments and strategies for management of Asian carp, as prescribed in WRRDA 2014, Section 1039.

Accomplishments:

- The USFWS develops an annual report to measure progress and to identify successes and strategies for moving forward. The USFWS will continue to provide leadership in coordinating this effort on behalf of the Federal agencies with assistance from other State and Federal agencies, non-governmental organizations, and local entities.

5.2 Quantitative Measures of Progress

The following quantitative measures of progress are identified to evaluate progress in controlling Asian carp.

- 1) Physical removal of Asian carp through the use of focused contracted commercial harvest in the UMRB, ORB and the Upper Illinois River.

Accomplishments:

- A number of State agencies are actively involved in the physical removal of Asian carp within river basins, focusing on reducing population numbers along the “leading edge.” The agencies are providing support and oversight to both the contract efforts and the commercial fishing industry. They are also assessing barriers and operational needs as well as the effects of harvest on Asian carp population dynamics to increase strategic use of commercial harvest in support of Asian carp management goals.
- The KDFWR ACHP has facilitated the harvest of 3.9 million pounds of Asian carp from Kentucky waters since 2011. KDFWR and Murray State University monitored Silver Carp demographics in Kentucky Lake to assess the effect of continued commercial harvest. The KDFWR identified that the most significant challenge to fish processors is the low number of commercial fishers providing consistent and reliable supply of Asian carp. To assess this challenge, the KDFWR worked with the commercial fishing industry and determined that the low number of commercial fishers may be attributed to 1) lack of dedicated fishing effort correlated to fishermen age demographics (average 57 years old), 2) lack of inspired fishermen, 3) high costs of webbing for net building, 4) transportation costs to move fish to processing facilities, 5) difficulty in maintaining fish quality during the summer months, and 6) low price per pound for Asian carp.
- The ILDNR continued contract fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines Rivers downstream of the EDB. Through this effort, over 850,000 pounds of Asian carp are removed from upper IWW annually, thereby maintaining or further reducing the estimated Asian carp populations.
- Commercial harvest efforts in 2017 removed 105,552 pounds of Asian carp from Pools 16-19 of the UMR.

- 2) Verify changes in movement in the current adult Asian carp population front in the UMRB and ORB and their tributaries.

Accomplishments:

- The range expansion for Bighead Carp was verified in the UMRB, with the capture of an adult in the Minnesota River, 52 miles upstream from the last downstream location. For Silver Carp, range expansion was documented in both basins; in the ORB there was a detection in the Tennessee River 44 miles upstream from the last downstream location, and in the UMRB an individual Silver Carp was captured above the EDB in the CAWS, 26 miles upstream from the last location downstream in the Illinois River and only 9 miles from Lake Michigan. Black Carp exhibited several new occurrences in 2017, and a range expansion of 145 miles in the Illinois River (UMRB) as well as a 17.5 mile range expansion in the ORB. No range expansion was observed for Grass Carp.

- 3) Document changes in eDNA positive findings within areas upstream of the known adult Asian carp population fronts.

Accomplishments:

- In 2017, 6,252 water samples were collected and processed for the presence of Bighead and Silver Carp eDNA as part of the USFWS-led eDNA Surveillance Program. 5,332 samples were also collected from Great Lakes tributaries, 520 for the CAWS, 1,920 from Ohio and Tennessee Rivers, and 66 samples from the Minnesota River gravel pit where the Bighead Carp was collected documenting a range expansion for this species in 2017. An additional 1,446 samples were collected from the UMR, but were not reported through the standard reporting process as they were part of an optimization modeling investigation. The only positive detections for Bighead and Silver Carp eDNA were in the Ohio and Tennessee Rivers. Figure 21 depicts the map of all early detection samples collected in 2017.

**Bighead and Silver Carp eDNA Early Detection Results:
 All 2017 eDNA Results
 Number of Samples Collected: 6252
 Number of eDNA Positives: Silver Carp 1; Bighead Carp 1**

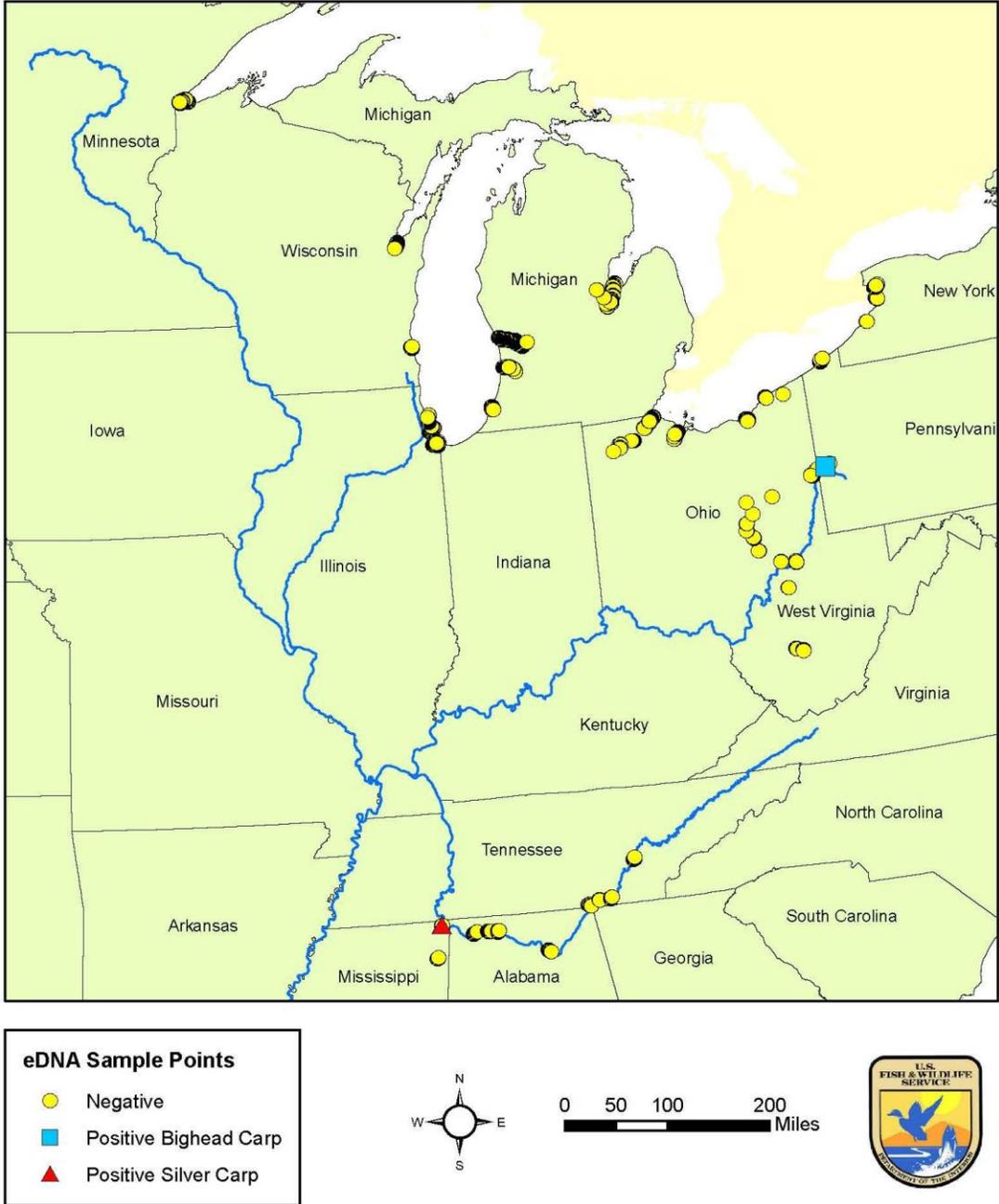


Figure 21. Overview of all 2017 eDNA sampling sites and results

- 4) Increase number of River miles (RM) excluded or protected from Asian carp movement.

Accomplishments:

- The CAWS (RM 296-RM 333) is currently protected from Asian carp dispersal via the EBR near Romeoville, Illinois. Although one Silver Carp was detected above the barrier in 2018, the entire CAWS above the barrier is protected from species dispersal by the electric barrier. In addition, the increase of harvest below the barrier adds additional miles to protection from reducing propagule pressure against the barrier. Additionally, new deterrent projects at the Lake Barkley site in the Ohio River basin will increase miles of protection from dispersal in that basin.

- 5) Increase the number of control technologies proven to control or eradicate Asian carp that are ready for in-the-field use.

Accomplishments:

- Partnerships within the UMRB, ORB, and IWW/CAWS are working collaboratively to evaluate, implement, and increase the number of new control technologies for field use. The following technologies are being evaluated for potential pilot deployment in the field or already underway as control tools:

- **Underwater Sound Technology to alter behavior of Asian carp:** In laboratory and pond tests, scientists found that Bighead and Silver Carp reacted strongly to complex noises transmitted underwater. Initial observations of fish behavior in response to specific projected sounds demonstrated the potential for deploying underwater acoustic technology as a barrier to prevent Asian carp movement through restricted channels, such as lock chambers. Initial field trials were conducted to inform study designs and pilot project implementation. The USGS co-led a multi-basin workshop on the state-of-the-science and the steps needed to use complex sound as a deterrent in lock approaches at lock and dams in the UMRB and ORB. Field trials began in 2016 and continued into 2017 in the ORB and UMRB to use sound to herd Asian carp as part of removal efforts.

Numerous Federal and State agencies participated in an Asian carp acoustic deterrent workshop hosted by the USFWS. Resource managers and researchers from State DNR's, the USACE, ILNHS, USFWS, USGS, academia, and Fish Guidance Systems, Ltd. met to discuss the USFWS' acoustic deterrent field testing in 2018. The group discussed the available modeling and surveillance data and the best available technologies for field testing where Asian carp are established.

The University of Minnesota – Duluth began evaluating the feasibility of using complex noise at Mississippi River Lock and Dam 5 to deter upstream movement of Asian carp. The USACE led a site visit of Lock and Dam 19 at Keokuk, Iowa for personnel from the USFWS, University of Minnesota, and Fish Guidance Systems, Ltd. Feasibility options for placing an acoustic fish barrier system in the tailwater approach area to prevent the upstream movement of Asian carp were discussed. Lock 19 and the adjacent non-Federal hydropower dam provide a strategic point in the river for addressing fish movements.

The USACE and USGS conducted a 7-day field trial at the Brandon Road Lock to test complex noise as an Asian carp barrier. This interagency team tested equipment and developed a sound map of the lower approach area that will inform future barrier designs. A boat equipped with global positioning system (GPS), speakers and hydrophones mapped the acoustics of the lower approach under a variety of scenarios (e.g., gates open/closed and

vessels present/absent). Data collected in the field trial will populate models used for purposes of designing future barriers.

- **FluEgg:** The FluEgg model is used to predict likely Asian carp spawning locations as well as conditions that would allow eggs and larval fish to survive until they can find suitable nursery habitat. The FluEgg can assess individual locations specifically using the unique hydraulic data at each site throughout the river and can help determine how far eggs and larval fish drift before they are detected in gears. FluEgg could also be used to assess risk of establishment of new spawning populations and evaluate possible control measures. The FluEgg model was used in 2017 to determine the drift and swimming behavior of eggs and larvae as well as their interaction with bottom material in flowing water. This information was used to simulate the hydraulic conditions of the 2015 spawning season in the IWW in order to hindcast spawning locations for Bighead and Silver Carp. The results showed that spawning locations are present below the Starved Rock, Marseilles, and Dresden Island Lock and Dams.

- **Carbon dioxide (CO₂) as a barrier:** Fish species, including Asian carp, are known to exhibit a negative response to increased levels of CO₂ in the water, and will avoid areas with increased concentrations. To explore the potential for use as a barrier to Asian carp movement, large-scale field trials were completed in 2015 to evaluate the application of CO₂ into waters in navigation approach channels or other navigation structures (e.g. locks) as a non-physical barrier chemical. Large-scale field trials were completed in 2015 to evaluate the application of CO₂ into waters in navigation approach channels or other navigation structures (e.g. locks) as a non-physical barrier chemical to deter the movement of Asian carp. Initial results indicate that Asian carp did not cross a carbon dioxide barrier at peak concentrations. The USGS is evaluating how fish interact with a CO₂ gradient to determine optimal exposure conditions (minimum levels required for Asian carp dispersal) and, are working with partners to determine better methods to deliver CO₂. Laboratory research by the USACE is currently on-going to determine the efficacy, implementation processes, and impacts of the use of CO₂ on USACE infrastructures. Also, as a deterrent, CO₂ must be evaluated for its environmental impacts on species of concern to help meet the requirements of the Endangered Species Act (ESA) (Section 7 consultation). CO₂ as a lethal control tool must undergo a rigorous registration process before it may be used within IPM control programs of Federal or State natural resource agencies. Currently, the USFWS and USGS are working to provide regulatory affairs support for the use of CO₂ as a deterrent to control Asian carp and acquire data to support the registration of CO₂ as a lethal pesticide control. In addition, the USGS, with State and Federal partners, is developing comprehensive planning assessments for deploying CO₂ at a lock or approach channel to deter Asian carp movement and will be conducting field studies to demonstrate potential management applications, such as:
 - Application of CO₂ to block Asian carp access to backwater areas of the Illinois River
 - Application of CO₂ to enhance Asian carp removal efforts
 - Application of CO₂ as lethal control of Asian carp under-ice in backwaters of large rivers

In addition, multiple State and Federal agencies worked with the USGS to develop a CO₂ demonstration project at Lock and Dam 14. Researchers from the USACE-ERDC, USGS, and USFWS conducted studies (dye study, water quality, and fish sampling) at Auxiliary Lock 14.

The USACE hosted a decisional briefing and granted the USGS permission to use the Auxiliary Lock 14 for CO₂ fish barrier testing in the summer of 2018.

- **Electric Barrier Efficacy Research:** Laboratory research to assess the impact of various environmental conditions on barrier effectiveness and fish behavior were conducted to confirm optimal operating parameters by examining a number of factors including how variations in canal water temperature and dissolved oxygen levels impact the effectiveness of the barrier. The USACE also conducted tests that expose fish to the electrical field for longer durations of time to determine if the fish become less affected over time and tests to better understand the swimming capabilities of Bighead and Silver Carp.
- **Barge Entrainment Mitigation:** Following laboratory investigation of mitigation techniques to minimize barge entrainment of fish, the USACE conducted a field demonstration to determine if submerged waterjets could be used to dislodge species from the recesses between barges and vessel-induced eddies. The demonstration was performed in the CSSC, just downstream of the electric barriers. In-field testing also investigated effectiveness of barrier with passing barges and mitigative measures for reverse-flow phenomena. Field trials were also conducted downstream with Asian carp species to determine if they were entrained in lower reaches of the river. Notable results from the barge studies concluded that small, non-Asian Carp fish can be transported upstream via entrainment in barges up to 10 miles and through lock and dam structures. Also, reverse flow was documented at the electric barriers which could be problematic if fish are nearby the barriers when this phenomenon occurs with the downstream passage of a barge. All results for barge studies can be found at: <https://www.fws.gov/midwest/fisheries/carterville/didson-barge.html>.

- 6) Increase the number of agencies with model regulations or ordinances that focus on Asian carp prevention.

Accomplishments:

- Agency regulations and ordinances are discussed in Section 5.3 below.

5.3 Qualitative Measures of Progress

The following qualitative measures of progress are identified to evaluate progress in controlling Asian carp.

- 1) Monitoring and assessment of Asian carp - Establishment of a long-term, comprehensive, cooperative monitoring and assessment program within each basin.

Accomplishments:

- The MNDNR, in partnership with the ILDNR, and IADNR, and WIU, is leading an effort to develop and implement a comprehensive surveillance program to define presence, invasion, and established fronts in UMR.
- In the ORB, the USFWS is partnering with KDFWR, WVDNR, Purdue University, ODNR, and the ORSANCO to assess the distribution, movement, and lock and dam passage of Asian carp through the use of telemetry. The Kentucky Department of Natural Resources (KYDNR), PFBC, ILDNR, INDNR, ODNR, and New York State Department of Environmental Conservation (NYDEC) will be working with WVDNR on this effort.

- In the upper Illinois River and CAWS, the multiagency MRWG annually develops and implements its MRP that includes monitoring of Asian carp populations (determining status of adult population front and presence of all life stages).
- 2) Preventing the introduction and movement of Asian carp via identified pathways – Establishment of strategies to manage pathways for accidental or deliberate unauthorized introductions of Asian carp.

Accomplishments:

- To protect the Great Lakes, the USACE continues to apply two different types of fish deterrent measures throughout the CAWS. Each is designed to prevent a distinct pathway of Asian carp toward the Great Lakes.
 - The EDB, located on the CSSC in Romeoville, Illinois, is designed to reduce the risk of transfer of fish between the MRB and GLB via the CSSC. The system currently consists of three barriers (Demonstration, IIA, and IIB) that create a waterborne, pulsed, direct current, electric field in the canal. These fields expose approaching fish to electrical stimuli that act as a deterrent to further upstream movement. Although the barriers were placed into service prior to the reporting period, the USACE continues to operate and maintain them as an integral part of its strategy to prevent movement of Asian carp toward the Great Lakes.
 - The Des Plaines River Bypass Barrier is a 13-mile long combination of fence material and jersey barriers that physically block known bypasses around the electric barriers that occur during periods of flooding from the Des Plaines River and I&M Canal, thereby halting possible fish movement through this area. The barriers are designed to stop the movement of both juvenile and adult Asian carp.
 - Pathway closures were evaluated at OEC, LKC, and Grand Lake St. Marys. The USACE will complete the final design for closing the OEC connection. The ODNR is in the process of completing the design for closing the LKC connection. Modifications have been made at St. Marys State Fish Hatchery to allow continued use of lake water without the risk of Asian carp transfer to the Lake Erie Basin.
 - The USACE continued the GLMRIS–Brandon Road Study during the reporting period, to include identification and release of the TSP. The TSP was documented in a draft report released for public review and comment. As part of the public comment period, the USACE conducted three public meetings. In addition to this public review, the USACE initiated an Agency Technical Review, Independent External Peer Review, Policy Review and National Environmental Policy Act Review of the draft report.
 - In the UMRB, the ILDNR, Western Illinois University, MDC, and IADNR will be undertaking contract fishing to reduce propagule pressure in Pool 20; reduce populations in Pools 17-19; and to characterize adult Asian carp catches in Pools 13-16.
 - In the ORB, the KDFWR and WVDNR will also be undertaking efforts to control and remove Asian carp.
 - In Illinois, the ILDNR conservation police officers employ surveillance to prevent the intentional or unintentional movement of AIS and work collaboratively with Federal and regional State agencies.
- 3) Rapid response planning –Development of rapid response plans available to prevent range expansions and eradicate new introductions in both basins.

Accomplishments:

- Each State develops response actions or plans as deemed necessary, such as the CRP developed by the MRWG.

4) Collaborative research –Develop and validate tools to ensure complete control of Asian carp.

Accomplishments:

- Federal and State agencies are working collaboratively to develop and validate potential control technologies, with the goal of field trial implementation and, where feasible, long-term installation. In addition, many States are working with local universities to address research needs in the UMRB and ORB. For example, Ball State University is evaluating the impact of Asian carp on native fishes in the Wabash River.
- The USGS is working collaboratively with other agencies to identify additional barrier types, technologies, and deterrents and evaluate their effectiveness in the UMRB and the ORB.
- The MRWG is also working collaboratively with both UMRB and ORB states to evaluate and implement new monitoring technologies. In addition to advances in technical research and development, interagency meetings were convened to address site selection for potential implementation as well as environmental regulations and permitting requirements for field implementation of specific control techniques. Work is being conducted to address these requirements concurrent to ongoing research to refine and complete necessary research in advance of deployment.
- The INDNR began exploring new sampling designs and gears that could be used to improve monitoring efficiency for larval and juvenile Asian carp. Gears included ichthyoplankton nets, mini-fyke nets, and surface trawls. Gears that show the most promise will be used to target larval and juvenile sampling in future years.
- The Department of Commerce’s National Oceanic and Atmospheric Administration (NOAA) performed calibrations of the Asian carp biophysical model (Atlantis Ecosystem model) for Lakes Michigan and Erie. The model tracks Silver and Bighead carp population dynamics and predator-prey interactions, and provides key data on the potential impacts to native aquatic species in the event of Asian carp introduction and establishment within each lake basin. The preliminary results are consistent with what NOAA found for Lake Erie using a food web model. Availability of the models provides more robust technology for better informing fishery management decisions under various scenarios within the lake basin. Develop strategies to minimize adverse effects – Establishment of collaborative strategies to eradicate or minimize potential adverse effects.

Accomplishments:

- In the URB and ORB, State/Federal agency partnership developed the Monitoring and Response Plan for the Mississippi River Basin. The UMRB and ORB partnerships have identified “intensive management zones” for strategically targeting specific control actions (e.g. harvest) to abate the upstream migration of self-sustaining populations established further downstream. The focused use of expanded commercial harvest for control, coupled with the strategic placement of potential barriers (deterrent technologies) is being evaluated. Planning includes the identification and development of potential new control technologies, and placement at strategic control points. In the UMRB, the MNDNR, MDC, and IADNR initiated evaluation of Asian carp and native fish passage at Lock and Dam 8 and Lock and Dam 19. In the ORB, the

KDFWR, USACE, USGS, and USFWS initiated scoping for efforts to evaluate the use of sound, bubble, and light deterrents at possible sites on the Cumberland River, including Barkley Dam and Kentucky Dam.

- In the IWW, partner agencies developed an annual: 1) Asian Carp Action Plan, and 2) Monitoring and Response Plan to direct the development and implementation of key priority projects, including timing and location of strategic detection, prevention, and control field activities. The plans incorporate the use of data-driven intensive harvest for control of Asian carp adults, focused on abating advance of the upstream boundary of established populations in the Illinois River. Further, potential deterrent technologies are being evaluated, focused on Great Lakes protection.
- 5) Information and education – Establishment of strategies to provide information to the public, commercial entities, and government agencies to improve effective management and control of Asian carp in the ORB and the UMRB.

Accomplishments:

- In the ORB, Kentucky has taken the lead on an Asian carp communication, coordination, and outreach efforts. The PFBC, ILDNR, INDNR, ODNR, WVDNR, and NYDEC will be assisting with this effort. In addition, many States have developed informational signs at boat ramps to help anglers identify Asian carp and avoid accidental transport and introduction to new waters. Furthermore, bait shop minnow information campaigns encourage anglers to be vigilant for Asian carp minnows.
 - INDNR biologists collected Asian carp and processed approximately 60 pounds of boneless fillets. These fillets were served at Hoosier Outdoor Experience and the Indiana State Fair in an effort to promote the edibility of Asian carp.
 - State and Federal biologists regularly communicate current information regarding Asian carp to the public and actions that the agencies are taking to research and control these species.
 - The USFWS, through the *AsianCarp.us* website increased the Asian carp communication efforts by covering emerging topics related to Asian carp such as Grass Carp and Black Carp issues and Federal and State actions in the UMR and ORB.
- 6) Effective regulations and laws – Development of an effective system of compatible laws and regulation, both at the Federal and State levels, for the UMRB and the ORB.

Accomplishments:

- Close coordination continued between Federal and State agencies in support of enforcement of the Lacey Act and other laws and authorities regulating Asian carp. No new Federal regulations or laws for Asian carp regulation or management were promulgated or enacted during the reporting timeframe.
- The MICRA had previously completed a review of commercial Grass Carp production, certification, shipping, stocking and regulation in the U.S. The final report contains eight recommendations from MICRA to improve Grass Carp regulation, with the goal of preventing the illegal or unintentional release of Grass Carps into the Great Lakes and other U.S. waters. Through the reporting timeframe, the report was used to inform subsequent discussions on the need for consistent State Grass Carp regulations, and a broader comprehensive policy strategy to effectively minimize the risks of additional fertile and sterile Grass Carp introductions in the Great Lakes.

- To support regulations that limit the transfer of bait fish between water bodies, Indiana is pursuing an administrative rule to eliminate baitfish collections for 500 yards below any dam, except for the Ohio River.
 - The KDFWR has purchased and distributed signs at popular boat ramps to notify the public of the harm in bait bucket transfers. New sections were also created in the annual fishing and boating guide and for the KDFWR website to the same effect.
 - The ODNR Division of Wildlife Law Enforcement conducted a two-year assessment of the Grass Carp supply chain that determined that all tested fish were triploid (sterile). The results of the supply chain assessment will be submitted for publication as a manuscript in a peer-reviewed scientific journal.
 - The Minnesota Legislature granted the MNDNR the authority to use tagging as a research tool. Legislative approval was needed because during the study the agency would be returning an invasive species back into the water before it is recaptured.
- 7) Ensuring sufficient resources are available – Secure sufficient financial resources for Federal, State, and local agencies to address the long-term issue of controlling and reducing risk from Asian carp in the UMRB and ORB.

Accomplishments:

- The USFWS has received additional agency funding for efforts outside of the Great Lakes, including the UMRB and the ORB. These resources, along with other State and Federal resources are being leveraged to support current activities.

6.0 CROSS-CUT SUMMARY OF FEDERAL AND NON-FEDERAL EXPENDITURES IN THE UPPER MISSISSIPPI AND OHIO RIVER BASINS

This cross-cut summary includes an overview of FY 2017 expenditures directly related to Asian carp activities conducted by Federal and State agencies in the UMRB, ORB, and IWW/CAWS. Agencies reported a total of \$57,957,420 for all basins combined, of which \$53,235,152 was used for actions in the IWW/CAWS to protect the Great Lakes from Asian carp. The total reported expenditures on activities conducted to benefit the ORB and UMRB and tributaries was \$4,722,268 (Table 1 in Section 6.0). . For comparison, in FY 2016, agencies reported a total of \$58,954,512, of which \$55,203,807 was used for actions in the IWW/CAWS to protect the Great Lakes from Asian carp, and \$3,750,705 to benefit the ORB and UMRB. An additional \$3,340,791 was reported for work to address GLMRIS Secondary Pathways.

Agencies were queried for an accounting of all Asian carp-related expenditures during their respective FY 2017, categorized by both funding source and general type of activity conducted. The level of breakout was not included in previous WRRDA reports. Activities were categorized as follows:

- Interagency Coordination (e.g. Strategy Development, Partnership Operations)
- Monitoring, Early Detection and Rapid Response
- Active Prevention and Control (e.g. Physical Removal of Asian Carp, Implementation/Operation of Barriers)
- Research and Development
- Outreach with Industry, Stakeholders, and the Public
- Law Enforcement/Regulatory Actions

The percent of total reported expenditures is as follows: Active Prevention and Control, 56.0%; Research and Development, 21.8%; Monitoring, Early Detection, and Rapid Response, 14.7%; Interagency Coordination, 5.5%; Outreach with Stakeholders, 1.5%; and Law Enforcement/Regulatory Actions, < 0.1%. An activity category was not assigned to 0.5% of the reported expenditures.

Additional FY 2017 expenditures were reported by agencies conducting actions to address the GLMRIS Secondary Pathways. Since these pathway mitigation efforts are focused on protecting the GLB from the movement of Asian carp and are not exclusively within the delineated geographic boundaries of the ORB, related costs were excluded from the total expenditures summarized in this Report. However, this Report includes a brief summary of GLMRIS Secondary Pathway mitigation activities reported by agencies to present a more complete overview of the scope of efforts conducted to reduce the risk of potential interbasin range expansion of Asian carp from the ORB to the GLB.

Table 1 provides a summary of all expenditures reported by individual agencies: Columns in the table are identified as follows:

- Total Agency Great Lakes Restoration Initiative (GLRI) Expenditures - Total reported expenditures of GLRI funds for activities that support Asian carp management in the IWW/CAWS
- Total Agency Base Expenditures - Total reported expenditures of agency base funds for activities that support Asian carp management in the UMRB, ORB, and IWW/CAWS
- Total Reported Expenditures - Total reported expenditures of agency base, GLRI, or other funds for activities that support Asian carp management in the UMRB, ORB, and IWW/CAWS

- Total UMRB/ORB (without IWW/CAWS) Expenditures - Total Reported Expenditures (see above), for only UMRB and ORB Asian carp management (excludes all IWW/CAWS activity expenditures)

Note that funds provided by granting agencies (e.g. the USEPA and USFWS) to financially support activities conducted by a partner agency is only reported once by the recipient, as they expend funds and conduct the actual activity. Agency expenditures under \$10,000 were not reported or included for the purposes of this Report, except where it is specifically known that no money was spent by an agency for Asian carp management.

Table 1. Total FY 2017 Expenditures for Asian Carp Activities

Agency	Total Agency GLRI Expenditures¹	Total Agency Base Expenditures	Total Other Expenditures	Total Reported Expenditures²	Total UMRB/ORB (w/o IWW/CAWS) Expenditures³
USACE	\$2,627,014	\$31,075,147	\$0	\$33,702,161	\$0
USGS	\$4,228,497	\$5,006,875	\$261,390	\$9,496,762	\$200,000
NOAA	\$0	\$206,782	\$0	\$206,782	\$0
USFWS	\$3,552,500	\$3,076,362	\$0	\$6,628,862	\$1,920,000
USCG	\$120,340	\$36,559	\$0	\$156,899	\$0
National Park Service	\$0	\$7,926	\$0	\$7,926	\$7,926
Georgia	\$0	\$0	\$0	\$0	\$0
Indiana	\$0	\$0	\$20,707	\$20,707	\$20,707
Iowa	\$0	\$126,000	\$0	\$126,000	\$126,000
Kentucky	\$0	\$465,000	\$342,000	\$807,000	\$807,000
Illinois	\$4,844,949	\$0	\$318,737	\$5,163,686	\$0
Minnesota	\$0	\$114,396	\$912,034	\$1,026,430	\$1,026,430
Mississippi	\$0	\$0	\$0	\$0	\$0
Missouri	\$0	\$28,350	\$31,500	\$59,850	\$59,850
New York	\$0	\$0	\$0	\$0	\$0
North Carolina	\$0	\$0	\$0	\$0	\$0
Ohio	\$0	\$65,011	\$195,033	\$260,044	\$260,044
Pennsylvania	\$0	\$26,656	\$10,730	\$37,386	\$37,386
Tennessee	\$0	\$203,025	\$0	\$203,025	\$203,025
West Virginia	\$0	\$16,400	\$29,100	\$45,500	\$45,500
Wisconsin	\$0	\$8,400	\$0	\$8,400	\$8,400
Total	\$15,373,300	\$40,462,889	\$2,121,231	\$57,957,420	\$4,722,268

- 1 Actions for GLB protection that are conducted within the IWW/CAWS are included in this Report based on its hydrologic delineation within the UMRB, and to provide a more complete picture of scope of Asian carp activities carried out within the designated sub-basin. These activities, as well as others focused on Great Lakes protection and conducted through the ACRC, are further described in the FY 2017 Asian Carp Action Plan.
- 2 Total Report Expenditures includes any other outside funding sources reported by agencies. (e.g., Minnesota expenditures include funding from the Minnesota Environment and Natural Resource Trust Fund and the Minnesota Outdoor Heritage Fund).
- 3 Total UMRB/ORB (excluding IWW/CAWS) represents all reported expenditures for actions to address Asian carp in the ORB and UMRB, excluding projects conducted in the IWW/CAWS for Great Lakes protection.
- 4 Note that funds provided by granting agencies (e.g. the USEPA and USFWS) to financially support activities conducted by a partner agency are only reported by the recipient as they expend funds and conduct the actual activity.

APPENDIX 1

RESEARCH (USGS FY 2017 UPDATES)

1.1 Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp

Carbon dioxide (CO₂) injected into water is being evaluated as a non-physical deterrent method for invasive Asian carp. Studies have shown that Asian carp voluntarily avoided areas of elevated CO₂ when given the option to access untreated areas. In 2017, a field evaluation of CO₂ as an Asian carp deterrent was completed near a water management structure at Emiquon Preserve near Havana, Illinois. Engineering designs and other evaluations of systems to deliver and disperse CO₂ within lock chambers were completed, and a dye study was conducted to characterize water mixing and flow in the Lock and Dam 14 auxiliary lock to inform FY18 CO₂ field trials. Pond experiments were also completed to assess CO₂ sensitivity to Silver Carp and Bighead Carp. A journal article was published describing the effectiveness of CO₂ as an under-ice lethal control for non-native Grass Carp, Common Carp, Silver Carp and Bighead Carp (Cupp *et al.* 2017, Biological Invasions)

1.2 Developing Targeted Micro-Particle Control Systems for Asian Carp

The USGS is developing oral delivery formulations that can stabilize and deliver a control agent that targets Asian carp while minimizing potential impacts on native species. In 2017, two field assessments of microparticles were conducted that included population assessments during pre- and post-exposure. One study determined the potential impacts of microparticle application on fish using non-toxic microparticles, and the second tested the application of toxic antimycin microparticles. Data and results are under analysis. A new bait formulation was developed to selectively target the delivery of antimycin to Grass Carp. The USGS also identified methods for producing antimycin that will increase production and efficiencies. Discussions were initiated with Joliet Junior College on potential development of a bait formulation that, when used with specific attractants, will elicit an involuntary feeding response in Asian carp.

1.3 Registration of Asian Carp Control Technologies (Carbon Dioxide as a Barrier and Microparticles)

Specific registration processes must be followed to obtain approval for the use of CO₂ and toxic microparticles as control agents in the environment. The USGS is providing support for these activities to the USFWS through the compilation of data and reports for submission to the USEPA or other regulatory agencies. The USGS is continuing development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO₂ for control of Asian carp. The USFWS continued to work with USGS to coordinate submission of studies to address EPA and Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles with USGS.

1.4 Use of Complex Sound to Alter Behavior of Asian Carp

Scientists are testing the use of complex sound technology by determining the optimal sound frequencies and sound pressure level to optimize deterrence of Asian carp while preventing injury to native species, and its effectiveness for containing, herding or capturing Asian carp. In 2017, the USGS began refining the sound characteristics (i.e., frequency and decibels; SC) used to deter Silver and Bighead Carp based on the results from high range hearing tests for Asian carp, and further investigated potential for Asian carp to acclimate to complex boat motor sounds. In the field, work continued to test

the effectiveness of acoustics to deter Silver and Bighead Carp and drive them to target locations for removal using boat motor sound at Emiquon Preserve and completed trials in the Spoon River to herd Asian carp. Trials were also conducted in the Illinois River to determine efficacy of sound and electrofishing to increase fish catch in nets. The USGS deployed a seven-day acoustic field trial in the approach channels to Brandon Road Lock and Dam in June 2017; USACE analyzed data collected to develop a quantitative sound propagation model of the study area to inform designs at other locks.

1.5 Field Evaluation of Chemical Attractants to Control Asian carp and Development of Protocols for Field Verification of Response

Laboratory and field studies, including underwater video, conducted by the USGS and independent researchers have consistently confirmed that an algal food stimulus is highly attractive to Asian carp. In 2017, a 6-week field study was conducted during which liquid algae was applied to four sites on the Missouri River to determine whether these habitats are suitable for using algae to concentrate fish. Preliminary observations suggest that the selected sites are too hydrologically variable. A feeding station was deployed in Mallard Lake near St. Louis, Missouri, which has high densities of Silver Carp, to determine whether carp could be concentrated in a region of the lake for more efficient removal. A large scale field application combining the algal food attractant and antimycin microparticle was conducted to evaluate potential impacts to native species and inform potential management actions for microparticle use. A potential collaboration with Joliet Junior College was initiated for potential development of a bait formulation that will elicit an involuntary feeding response in Asian carp.

1.6 Integrated Pest Management (IPM)

IPM is a decision support system that integrates new information and tools with existing information and tools to enhance monitoring, surveillance, control and containment for Asian carp in the upper Illinois River and other rivers while minimizing harm to human health and the environment. This work is developed through collaborative multi-partner efforts that address the field evaluation component of the various control tools and technologies, through technology and information workshops, and development of databases and decision support tools. In 2017, real time telemetry, and a telemetry database and visualization tools were placed in strategic locations to inform Asian carp removal (e.g. contract fishing) and potential rapid response efforts. Scientists also continued the development of a decision support tool to inform mitigation measures to minimize the entrainment of Asian carp eggs and larvae by barge traffic.

1.7 Assessing Life History Traits of Asian Carp in Established and Emerging Populations to Identify and Characterize Vulnerabilities that can be Exploited for Control

A better understanding of life history traits and population dynamics of Asian carp in areas with established (e.g., Illinois River) and emerging populations is necessary to identify vulnerabilities that could be exploited for control strategies using an IPM approach. In 2017, field studies on the capabilities of native predators to consume young-of-year carp were completed in collaboration with WIU. FluEgg model work in 2017 included lab experiments in a flume to determine the drift and swimming behavior of eggs and larvae, respectively, and their interaction with bottom material in flowing water and creation of an operational hydraulic model of the Illinois waterway to generate input for the FluEgg model so it may be used in real time predictions. The field portion of a light trapping study in Missouri River tributaries to assess movement rates and habitat selection of Bighead Carp and Grass Carp larvae was completed. High resolution benthic mapping data has been collected on the main navigation channel of the Illinois River in Starved Rock and Marseilles, Illinois to inform ongoing management

actions and Bighead Carp habitat modeling using fish hydroacoustic and environmental data collected by Southern Illinois University. An article on factors affecting reproduction in an emerging population have been published (Larson *et al.* 2017).

1.8 Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish

Early detection is a vital part of managing any invasive species, including invasive Asian carp. Genetic methods are being used to detect Bighead and Silver Carp at low abundances and identify their invasion front using molecular signals such as eDNA in water samples. In 2017, the USGS validated the use of the portable eDNA detection kit for Asian carp in open water applications and, following successful training efforts, transferred 10 kits to law enforcement officers in Ohio, Michigan and Illinois. This portable device detects eDNA of Bighead and Silver Carp in water samples, can be processed rapidly, and can be used to look for Asian carp in bait tanks at bait shops. A new LAMP assay for the portable kits was also developed that detects all four species of Asian carp. Other USGS progress includes initiation of controlled eDNA degradation studies in natural river water; continued evaluation of the utility of eDNA for assessing the effects of management actions; and investigating genetic markers useful for tracking live fish. Several studies were conducted focusing on application of eDNA technologies to Black Carp and Grass Carp detection based on knowledge and data from work on Bighead and Silver Carp.

1.10 Use of Acoustic Video and Side-scan Technology to Determine Behavior of Asian Carp, especially Net Avoidance Behavior

Asian carp are believed to have highly developed net avoidance behavior, which inhibits control methods based on harvest. To assess this, USGS scientists performed extensive study on the avoidance behavior of Silver Carp to nets, using dual frequency identification sonar (DIDSON) underwater technology. A special net is under construction and scheduled to be completed in early 2018. The first deployment of this net will be in Creve Coeur Lake, to capture Bighead Carp during the upcoming unified method event.

1.11 Hydraulic and Water Quality Evaluation of Asian Carp Habitat in the Upper Illinois River and their Impacts on Asian Carp movement

This project investigates the influence of habitat stimuli, such as river hydraulics and water-quality, on the population range, movement, and spawning and recruitment success of Asian carp. In 2017, the USGS, in coordination with ILDNR and other agencies, continued velocity mapping of selected river reaches in support of IPM and spawning documentation activities () and published the resulting data releases. Analyses of water quality samples for detailed chemical analysis were completed (e.g., pharmaceuticals and hormones) for evaluation of potential effects on the Bighead Carp and Silver Carp populations. Results were presented at the Emerging Contaminants in the Aquatic Environment conference in May 2017. Spawning and recruitment work included simulation of the hydraulic conditions in the Illinois River during the spawning season of 2015 to determine spawning locations. An operational hydraulic model of Illinois Waterway was also created to generate input for the FluEgg model so it may be used in real time predictions.

1.12 Grass Carp Reproduction and Population Dynamics

The USGS research on Grass Carp focuses primarily on understanding biology and hydrologic factors related to biology. In 2017, Grass Carp eggs were collected during several spawning events in the

Sandusky River and Maumee River for analysis. Collaborative sampling with Michigan DNR, USFWS, and DFO was initiated to increase spatial scale of sampling for larvae following collection of confirmed Grass Carp eggs. Twenty thermographs to measure temperature were deployed at 10 stations along the Sandusky River to determine spawning locations and model probability of successful hatch. Egg densities were calculated in the Sandusky River from 2015 and 2017 and samples were used to compare magnitudes of each of the spawning events. The FluEgg model was used to project spawning and hatching locations for Grass Carp in the Sandusky River and water chemistry was sampled in several Great Lakes tributaries to establish a library for estimating potential spawning locations. Age estimation methods for Grass Carp were developed and verified to ensure accuracy. For western Lake Erie, first-generation maps of aquatic vegetation and data analysis of aquatic vegetation collections were completed providing baseline information for assessing potential Grass Carp impacts. Collaborators on Grass Carp activities include Ohio DNR, Michigan DNR, University of Toledo, Bowling Green State University, University of Illinois, USFWS, and Department of Fisheries and Oceans Canada.

1.13 Interim barrier - Brandon Road Lock and Dam

Newer barrier technologies to Asian carp movement, such as complex sound or injecting CO₂ to drive fish away have been proposed for use at the Brandon Road Lock and Dam on the Illinois River to help prevent the movement of Asian carp from the MRB to the GLB. Implementing new technologies requires a better understanding of hydrologic conditions and water chemistry to assess the impacts these technologies may have on lock structures and to inform barrier deployment strategies. In 2017, the USGS barrier support included collection, analysis, and publication of hydrodynamic and water-quality data in the lock and downstream to define flow velocity distributions under representative lock operations. The USGS also continued to operate real-time velocity and water-quality gages that provided critical data and information to inform USACE models for decision making.

1.14 Wabash/Maumee Hydrologic Support to Prevent Interbasin Transfer of Asian Carp

In 2016, the construction of a permanent barrier at Eagle Marsh in Fort Wayne, Indiana between the GLB and MRB eliminated the pathway for Asian carp migration from the Wabash River, where adult Bighead Carp are found, to Lake Erie. As part of the project, the USGS operated streamflow, temperature, and water level gauges as well as a webcam at the site to monitor flow conditions that may lead to flooding and to obtain the stream data that was used to help determine the location for the newly constructed permanent barrier. The USGS continued this support in 2017.

1.15 Lock Treatment Options to Prevent Aquatic Invasive Species Movement

Scientists conducted studies to identify methods or tools to prevent two-way movement of AIS through the CAWS from Lake Michigan, as well as from the Illinois River with minimal impact to navigation. This project is evaluating the potential to use chemicals to effect control of AIS that might be associated with vessels during locking activities. In 2017 the USGS completed toxicity tests with chlorine (sodium hypochlorite) and hot water-chlorine combinations, held discussions with USEPA to determine best course of action for registration of vessel treatment technologies during lock operation, and prepared a summary report on test results.

1.16 Multi-agency Telemetry Database and Visualization Tool

The USGS is coordinating a telemetry database to inform management and removal efforts and contingency actions with ILDNR, USACE, and other partners. This tool will allow for quick transformation

of this massive amount of data into usable information to control Asian carp. In 2017, USGS monitored, maintained, and downloaded data from real time receivers and provided timely summaries to removal crews and installed three additional real time receivers in the Illinois River. An automated alert system was established for detections of tagged Asian carp in strategic locations for input into contingency actions. The telemetry database and beta visualization tools were further developed. Data updates were provided as needed to inform Asian carp removal crews and other partners.

1.17 Black Carp Detection and Risk Assessment

Black Carp captures in the Illinois and Middle Mississippi rivers have increased substantially in recent years, and almost all the captured fish have been diploid (fertile). The USGS has been working for four years with the USFWS and Southern Illinois University to process Black Carp captured by recreational or commercial fishers and by state agencies to generate age, growth, diet, fertility, and source information. In 2017, reports (with numbers and locations) were provided to the Mississippi River Basin Panel, Indiana DNR, Upper Mississippi River Asian carp working group, Midwest Fish and Wildlife Conference, American Fisheries Society, Missouri Aquaculture Association, and writers group for the Binational Black Carp Risk Assessment for Black Carp in the Great Lakes. In 2017, the USGS continued development of the Black Carp bait, a hollow glass bead that would be filled with a registered toxicant that would cause mortality when eaten by Black Carp. The USGS determined the optimal size of the bait based on Black Carp food size preferences. Black Carp eat mussels and snails by crushing the shells with their strong jaws, so scientists tested prototype vials of the bait that contained a toxic solution and attached them to clams. In that test, most vials were broken but no fish were killed. Further testing of the glass beads will continue in 2017. A genetic marker has also been developed and validated for Black Carp that could aid early detection efforts.

List of Acronyms

- 2017 Monitoring and Response Plan (MRP)
- Asian Carp Advisory Committee (ACAC)
- Asian Carp Harvest Program (ACHP)
- Asian Carp Regional Coordinating Committee (ACRCC)
- Great Lakes and Mississippi River Interbasin Study (GLMRIS)
- Great Lakes Fishery Commission (GLFC)
- Illinois Department of Natural Resources (ILDNR)
- Illinois Natural History Survey (ILNHS)
- Indiana Department of Natural Resources (INDNR)
- Intensive Management Zone (IMZ)
- Kentucky Department of Fish and Wildlife Resources - KDFWR
- Kentucky Department of Natural Resources (KYDNR)
- Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States' (National Plan)
- Minnesota Department of Natural Resources (MNDNR)
- Minnesota Invasive Carp Action Plan (MICAP)
- Missouri Department of Conservation (MDC)
- Monitoring and Response of Asian Carp in the Ohio River Project (MRORB)
- Monitoring and Response Work Group (MRWG)
- New York State Department of Environmental Conservation (NYDEC)
- Ohio Asian Carp Tactical Plan: 2014-2020 (Tactical Plan)

- Ohio Department of Natural Resources (ODNR),
- Ohio River Basin Asian Carp Control Strategy Framework (ORB Framework)
- Ohio River Fisheries Management Team (ORFMT)
- Ohio River Valley Water Sanitation Commission (ORSANCO)
- Pennsylvania Fish and Boat Commission (PFBC)
- Tennessee River Telemetry Work Group (TWG)
- Tennessee Wildlife Resources Agency (TWRA)
- UMRCC's Upper Mississippi River Fisheries Plan (Fisheries Plan)
- United States Coast Guard (USCG)
- Upper Mississippi River Basin Asian Carp Control Strategy Framework (UMRB Framework)
- Upper Mississippi River Basin Association (UMRBA)
- Upper Mississippi River Conservation Committee (UMRCC)
- Upper Mississippi River Conservation Committee (UMRCC)
- USGS Columbia Environmental Research Center (CERC)
- USGS Upper Midwest Environmental Sciences Center (UMESC)
- West Virginia Division of Natural Resources (WVDNR)
- Western Illinois University (WIU)