Report to Congress

Biennial Summary of Activities and Expenditures to Manage the Threat of Invasive Carp in the Mississippi River Basin—FY 2019 and FY 2020

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EXECUTIVE SUMMARY

Background

The Water Resources Reform and Development Act of 2014 (WRRDA 2014), Public Law 113–121, authorized 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 invasive carp in the Upper Mississippi River Basin (UMRB) and the Ohio River Basin (ORB) and their tributaries. Required coordination included the development of an annual report to the U.S. Congress summarizing actions, strategies, expenditures, and progress in addressing the threat of invasive carp in the UMRB and ORB and their tributaries. The Water Resources Development Act of 2020 (WRDA 2020), included in the Consolidated Appropriations Act, 2021, broadened the scope of the authorized interagency coordination and reporting on invasive carp to encompass the entire Mississippi River and tributaries, including the six subbasins of the river. Further, the required reporting period was revised from annually to biennially, with the first report to summarize Fiscal Years (FY) 2019 and 2020.

The *2019–2020 Report to Congress on Invasive Carp in the Mississippi River Basin* (Report) summarizes actions conducted during that 2-year timeframe in the Mississippi River basin (MRB). Major river subbasins in the MRB include the ORB; the Tennessee River and Cumberland River subbasin (TNCRB); the UMRB; the Missouri River subbasin (MORB); the Lower Mississippi River subbasin (LMRB); and the Arkansas-Red-White River subbasin (ARWRB). The Illinois Waterway and Chicago Area Waterway System (IWW/CAWS) are included as an additional sub-category in the Report due to their delineation within the MRB.

For the purposes of this report, the term *invasive carp* refers to bighead carp (*Hypophthalmichthys nobilis*), silver carp (*H. molitrix*), black carp (*Mylopharyngodon piceus*), and grass carp (*Ctenopharyngodon idella*).

As required, the Report includes the following information:

- Observed changes in the documented range of invasive carp in the MRB, including locations of invasive carp within major tributaries.
- A summary of Federal agency efforts, including cooperative efforts with non-Federal partners, to control the spread of invasive carp in the MRB.
- A summary of federally funded research being conducted to reduce or eliminate the spread of invasive carp.

- An evaluation of accomplishments using qualitative and quantitative measures to document the progress and effectiveness of invasive carp management efforts.
- A cross-cut accounting of Federal and non-Federal invasive carp management expenditures in the MRB, as reported by individual agencies for their respective FY 2019 and 2020 reporting periods.

The accomplishments summarized in the Report describe efforts to manage the four species of invasive 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, nongovernmental, 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 invasive carp in our Nation's waters. Federal and State interagency partnerships have since developed step-down management plans to guide monitoring, prevention, and control actions in each subbasin of the MRB. In addition, a partnership strategy was previously developed for protection of the Great Lakes basin (GLB) from invasive carp, focusing heavily on the IWW/CAWS (http://invasivecarp.us/PlansReports.html).

The USFWS coordinated closely with Federal and State partners to develop the 2019–2020 Report, which summarizes activities conducted from October 1, 2018, through September 30, 2020. Activities and expenditures for invasive carp management are organized by individual MRB subbasin and reporting year. Accomplishments are further categorized within each subbasin summary by type of activity and corresponding National Plan goal. The 2019–2020 Report focuses on the Federal and State agency actions conducted within the mainstem rivers and tributaries of the MRB to protect those river basins from invasive 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 invasive carp prevention for 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 invasive carp and is, therefore, the geographic focus for Federal and State management efforts associated with the Invasive Carp Regional Coordinating Committee (ICRCC). A general summary of the ICRCC's efforts conducted specifically in the IWW/CAWS (within the MRB delineation) for Great Lakes protection is included in this report and described in greater detail in the partnership's 2019 and 2020 Invasive Carp Action Plans and Interim Summary Reports.

Observed Changes in the Documented Range of Invasive Carp in the MRB

This 2019–2020 Report includes detailed results for the documented occurrence of invasive carp in the MRB, including summaries of historical and new detections and assessments of changes in the observed range of each species.

Bighead Carp

During the 2019 and 2020 reporting period, no increase in the range of occurrence was documented for bighead carp in any of the MRB subbasins during either year.

Silver Carp

Increases in the documented range of occurrence of silver carp in 2019 included the following:

- Increase of 11 miles within the Red River subbasin (upstream in the Kiamichi River, a major tributary of the Red River)
- Increase of 13 miles upstream in the St. Croix River

Increases in the documented range of occurrence of silver carp in 2020 included the following:

- Increase of 6 miles upstream in the St. Croix River
- New detections of silver carp in the North Loup River, a tributary of the Platte River

Black Carp

Increases in the documented range of occurrence of black carp in 2019 included the following:

- Increase of 34 miles upstream in the Mississippi River (Upper Mississippi River ~ River Mile (RM) 344; Lewis County, MO/Adams County, IL)
- Increase of 146 miles upstream in the Ohio River (Ohio River ~ RM 778; Warrick County, IN/Henderson County, KY)
- Increase of 61 miles upstream in the Tennessee River (Tennessee River ~ RM 100; Benton County, TN/Humphreys County, TN)

Increases in the documented range of occurrence of black carp in 2020 included the following:

- Increase of 13 miles upstream in the Mississippi River (Upper Mississippi River ~ RM 364; Hancock County, IL/Lee County, IA)

Grass Carp

While new detections were reported during 2019 and 2020, no notable increases in the range of occurrence for grass carp were documented in the mainstem Mississippi River during the reporting period. Grass carp had been historically documented in a total of 45 states as of September 2020, unchanged since the previous 2018 reporting period.

New documented detections of invasive carp during 2019 and 2020 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 although the collection of an individual invasive carp in a new location may be defined as range expansion in this report, it does not indicate that the species has become established at that particular point in the watershed. Additional data, such as evidence of spawning activity, the presence of various life stages of invasive carp (e.g., eggs, larvae, and juveniles), and the relative abundance of adults, are used to holistically assess and better define the geographic boundary, or "population front," for self-sustaining populations of each species within a given river basin. This underscores the need for ongoing monitoring to collect

data to inform an accurate assessment of population status. As of September 30, 2020, invasive carp were documented within the United States as follows: grass carp = 45 States; bighead carp = 27 States; silver carp = 22 States; and black carp = 8 States (per USGS NAS database).

Agency Prevention and Control Efforts

This report summarizes the many activities conducted by invasive carp partnerships under each of the seven goals of the National Plan:

1. Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.
2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carp in the United States.
3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carp in the United States.
4. Minimize potential adverse effects of feral bighead, black, grass, and silver carp in the United States.
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 United States.
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 United States.

Stepping down the National Plan, the Federal and State agency partnerships described in this report have developed and are now implementing comprehensive invasive carp management plans for each subbasin, ensuring strong ongoing interagency coordination and supporting their specific detection, prevention, and control priorities. These plans include the following:

- *Ohio River Basin Asian Carp Control Strategy Framework* (ORB Framework; includes TNCRB activities), developed by the Ohio River Fisheries Management Team (ORFMT)
- *Upper Mississippi River Basin Asian Carp Control Strategy Framework* (UMRB Framework), developed by the Upper Mississippi River Asian Carp Partnership
- *Lower Mississippi River Basin Asian Carp Control Strategy Framework* (LMRB Framework; includes ARWRB activities), developed by the Asian Carp Team of the Lower Mississippi River Basin
- *Missouri River Basin Asian Carp Control Strategy Framework* (MIRB Framework), developed by the Missouri River Natural Resource Committee's Asian Carp Technical Committee
- *Invasive Carp Action Plan* (Action Plan) and *Asian Carp Monitoring and Response Plan (*MRP*)*, developed by the Invasive Carp Regional Coordinating Committee (ICRCC) for the Upper Illinois River and the Chicago Area Waterway
    - 2019 Action Plan and 2019 MRP: https://invasivecarp.us/Documents/2019-Action-Plan-Amended.pdf; https://invasivecarp.us/Documents/Monitoring-Response-Plan-2019.pdf

- 2020 Action Plan and 2020 MRP
  https://invasivecarp.us/Documents/2020%20Action%20Plan%20Amended.pdf;
  https://invasivecarp.us/Documents/Monitoring-Response-Plan-2020.pdf

The Frameworks for the MRB partnerships are further stepped down to describe specific priority projects targeted for implementation in the respective subbasins in the *Monitoring and Response Plan for Asian Carp in the Mississippi River Basin* (MRPMRB), developed by the Mississippi Interstate Cooperative Resource Association Asian Carp Advisory Committee (MICRA ACAC). The 2019 MRPMRB provide detailed information on the projects supported with FY 2019 and FY 2020 USFWS invasive carp funds directed to the MRB subbasins. A general description of the types of projects includes targeted and coordinated monitoring, assessment, and early detection for invasive carp; prevention and control actions, including development and evaluation of potential invasive carp deterrent barrier technologies; and strategic population containment and reduction, including targeted contract fishing to prevent further range expansion and establishment.

The organizational structure and strategic planning processes for the subbasin partnerships are further described in Section 3.0 of this report.

Conducting Key Research, Transferring Technology, and Applying Lessons Learned

This report summarizes developments in key research and technology conducted by the MRB partnerships related to invasive carp detection and control. The USGS continues to serve as a lead Federal agency on research and development of new and emerging technologies, working closely with Federal and State partners. In addition, USACE's Engineer Research and Development Center (ERDC) coordinates closely with the USGS and other State and Federal agencies and universities to advance the science and technical capacity for managing invasive carp. The breadth of invasive carp research supports comprehensive management strategies by addressing key science and technology needs. Areas of focus include invasive carp early detection and monitoring, life history and behavior, feeding ecology, prevention and control technology development and testing, and ecological risk assessment and analyses of potential pathways of introduction.

Interagency coordination on the identification, planning, and implementation of key research is a priority within each MRB subbasin partnership and directly supports National Plan Goals 6 and 7, with benefits for multiple detection, prevention, and control recommendations in the Plan. Close collaboration among technical subject matter experts is fostered to identify highest-priority invasive carp research needs; develop and implement best management practices for state-of-the-art monitoring and data collection activities; and identify opportunities to leverage other relevant existing aquatic invasive species (AIS) prevention and control research and technology that could be applied toward invasive carp management. Research activities conducted in 2019 and 2020 are described in Section 3.0 of this report.

Establishing Measures of Effectiveness for Invasive Carp Prevention

The WRRDA directed the USFWS to develop measures to document progress in controlling the spread of invasive carp. Appendix 2 of this report provides a roll-up of agency accomplishments achieved in 2019 and 2020 under specific quantitative or qualitative measures to track outcomes achieved during the reporting period and general progress toward addressing the longer-term management goals in support of the National Plan.

Federal and Non-Federal Expenditures

This report includes a summary of expenditures directly related to invasive carp activities conducted by Federal and State agencies in the MRB in FY 2019 and FY 2020, respectively. The total reported expenditures on activities conducted to benefit the MRB (excluding the IWW/CAWS) was $7,869,025 in FY 2019 and $16,006,775 in FY 2020 (Tables 6-1 and 6-2, Section 6). All total reported expenditures, including actions conducted in the IWW/CAWS to protect the Great Lakes from invasive carp, were $51,454,903 in FY 2019 and $55,925,360 in FY 2020.

Individual agencies reported all invasive carp-related expenditures conducted during their respective fiscal years, categorized by funding source and general type of activity. For FY 2019 and FY 2020, the percentage of total reported expenditures by category was as follows: Active Prevention and Control: FY 2019—48.9 percent, FY 2020—47.3 percent; Research and Development: FY 2019—31.5 percent, FY 2020—31.3 percent; Monitoring, Early Detection, and Rapid Response: FY 2019—16.7 percent , FY 2020—18.1 percent; Interagency Coordination: FY 2019—1.5 percent, FY 2020—2.7 percent; Outreach with Industry, Stakeholders, and the Public: FY 2019—1.4 percent, FY 2020—0.6 percent; and Law Enforcement/Regulatory Actions: FY 2019—<0.1 percent, FY 2020—<0.1 percent. An activity category was not assigned by the agencies to < 0.1 percent of the reported expenditures.

Additional FY 2019 and FY 2020 expenditures were reported by agencies conducting actions to prevent invasive carp movement though the temporary hydrologic connection identified by the Great Lakes and Mississippi River Interbasin Study (GLMRIS) Other Pathways assessment. Because these pathway mitigation efforts are focused on protecting the Great Lakes basin (GLB) from the movement of invasive carp and are not exclusively within the delineated geographic boundaries of the MRB (primarily the ORB), related costs were excluded from the total expenditures summarized in this report. However, a brief summary of GLMRIS Secondary Pathway mitigation activities reported by agencies is included to present a complete overview of the efforts conducted to reduce the risk of potential interbasin range expansion of invasive carp from the ORB to the GLB.

1.0 INTRODUCTION

1.1 Interagency Management of Invasive Carp in the Mississippi River Basin—Collaboration Under WRDA 2020

Recognizing the growing threat from the introduction of invasive carp populations into major river basins of the United States, State and Federal agencies have developed collaborative partnerships and management strategies focused on implementing a comprehensive approach to abate further range expansion. The establishment and spread of invasive carp threaten multibillion dollar industries vital to local and regional economies in the Mississippi River Basin (MRB), including sportfishing, recreational boating, and tourism.

The Water Resources Reform and Development Act of 2014 (WRRDA; Public Law 113–121,) Section 1039(b), and amended as the Water Resources Development Act of 2020 (WRDA 2020), included in the Consolidated Appropriations Act, 2021, supports these efforts by authorizing 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 [USACE]) and the Directors of the National Park Service (NPS) and U.S. Geological Survey (USGS) to lead a multiagency effort to address the spread of invasive carp in the MRB. Additionally, the USFWS is directed to develop, in coordination with USACE, an annual (now biennial) report to Congress summarizing strategies, expenditures, progress, and emerging research to address the threat of invasive carp. The geographic scope of both the interagency coordination and reporting initially specified only the Upper Mississippi River Basin (UMRB) and the Ohio River Basin (ORB) subbasins in WRRDA 2014 but was subsequently broadened to include all subbasins of the MRB in WRDA 2020.

Since 2014, the USFWS has coordinated with USACE, NPS, USGS, and other Federal and State agency partners to develop an annual report, as previously required. This version of the Report is the first biennial version to include all MRB subbasins, as directed in WRDA 2020.

This 2019–2020 Report includes the following information:

- Observed changes in the documented range of invasive carp in the MRB, including further delineation of the location of invasive carp within tributaries of the MRB.
- A summary of Federal agency efforts, including cooperative efforts with non-Federal partners, to control the spread of invasive carp in the MRB and its tributaries.
- A summary of federally funded research being conducted to reduce or eliminate the spread of invasive carp.
- An evaluation of accomplishments using qualitative and quantitative measures to document the progress and effectiveness of invasive carp management efforts.
- A cross-cut accounting of Federal and non-Federal invasive carp management expenditures in the MRB and its tributaries, as reported by individual agencies for their respective FY 2019 and FY 2020 reporting periods.

USFWS requested that State and Federal agencies report all invasive carp management activities conducted in the MRB during the reporting timeframe of October 1, 2018 through September 30, 2020. In the Report, agency activities were summarized under the relevant overarching National Plan goal and one of the following descriptive categories:

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

As directed, the 2019–2020 Report is 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, the Report is made available to the public via the Internet at www.invasivecarp.us.

1.2 Geographic Scope of Accomplishment Reporting by MRB Subbasin Partnership

Accomplishments included in this report are summarized by individual MRB invasive carp subbasin partnership geographic delineation (ORB, including the Tennessee River and Cumberland River subbasin [TNCRB]; UMRB; Lower Mississippi River subbasin [LMRB], including the Arkansas-Red-White River subbasin [ARWRB]; Missouri River subbasin [MORB]; and Illinois Waterway and Chicago Area Waterway System [IWW/CAWS]).

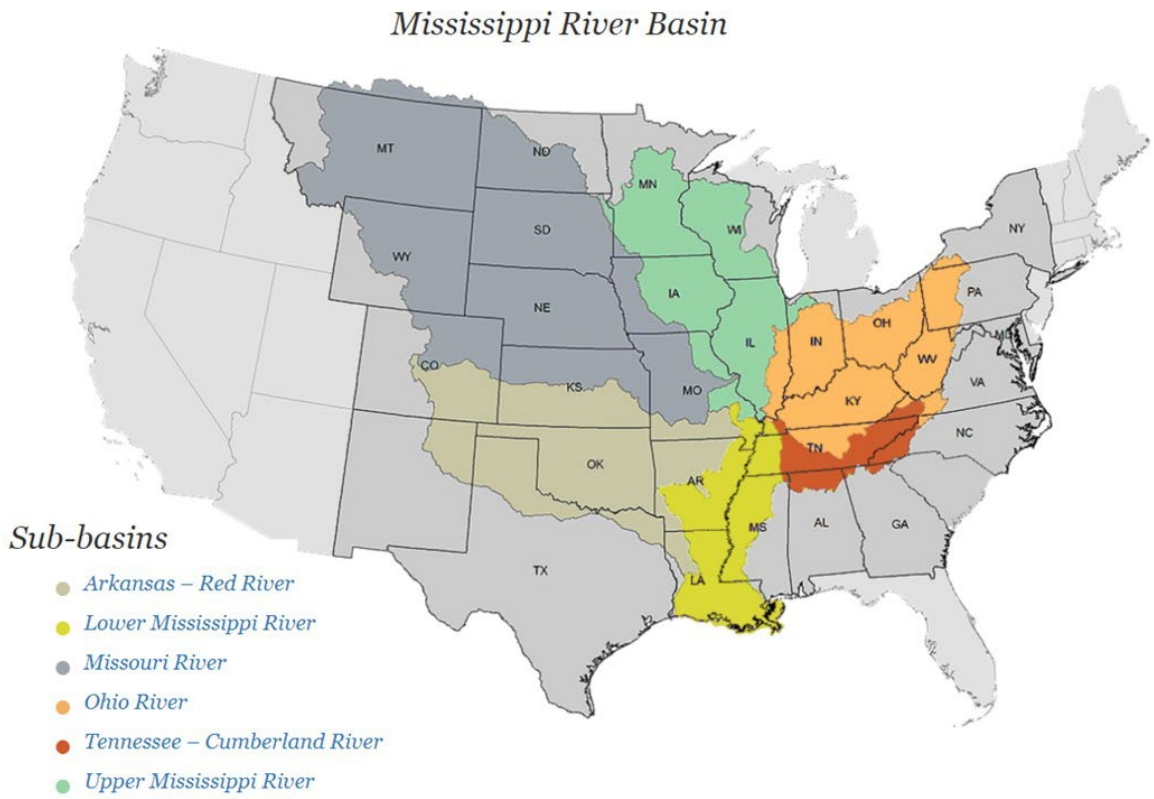
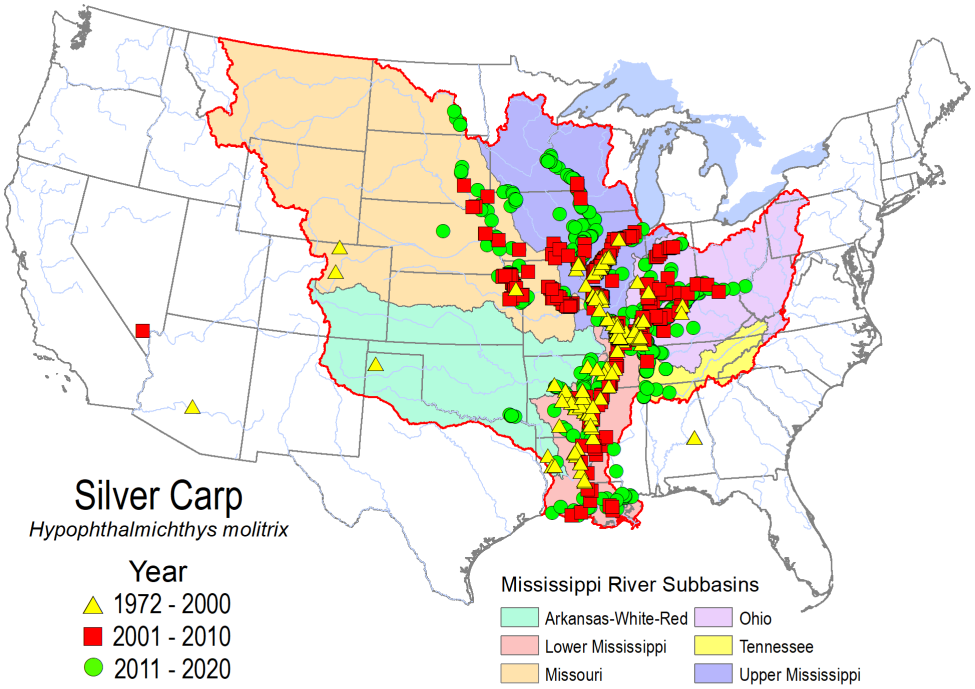


Figure 1. Mississippi River Basin, with Major Subbasins Indicated

This Report focuses on the myriad Federal and State agency actions conducted in the mainstem rivers and tributaries of the MRB, as directed in WRDA 2020. A summary of efforts conducted in the IWW/CAWS for protection of the GLB from invasive carp is also included because this location is technically within the MRB hydrologic delineation. Activities conducted in the IWW/CAWS (River Mile [RM] 231 to RM 333) are, for this report, categorized as efforts conducted within the MRB but for the protection of the GLB. Federal and State management efforts in the IWW/CAWS are primarily conducted through the Invasive Carp Regional Coordinating Committee (ICRCC) and are described in greater detail in the ICRCC's 2019 and 2020 Invasive Carp Action Plans (https://invasivecarp.us/Documents/2019-Action-Plan-Amended.pdf; https://invasivecarp.us/Documents/2020%20Action%20Plan%20Amended.pdf) and corresponding 2019 and 2020 Monitoring and Response Plans (https://invasivecarp.us/Documents/Monitoring-Response-Plan-2019.pdf; https://invasivecarp.us/Documents/Monitoring-Response-Plan-2020.pdf).

1.3 Addressing the Invasive Carp Challenge

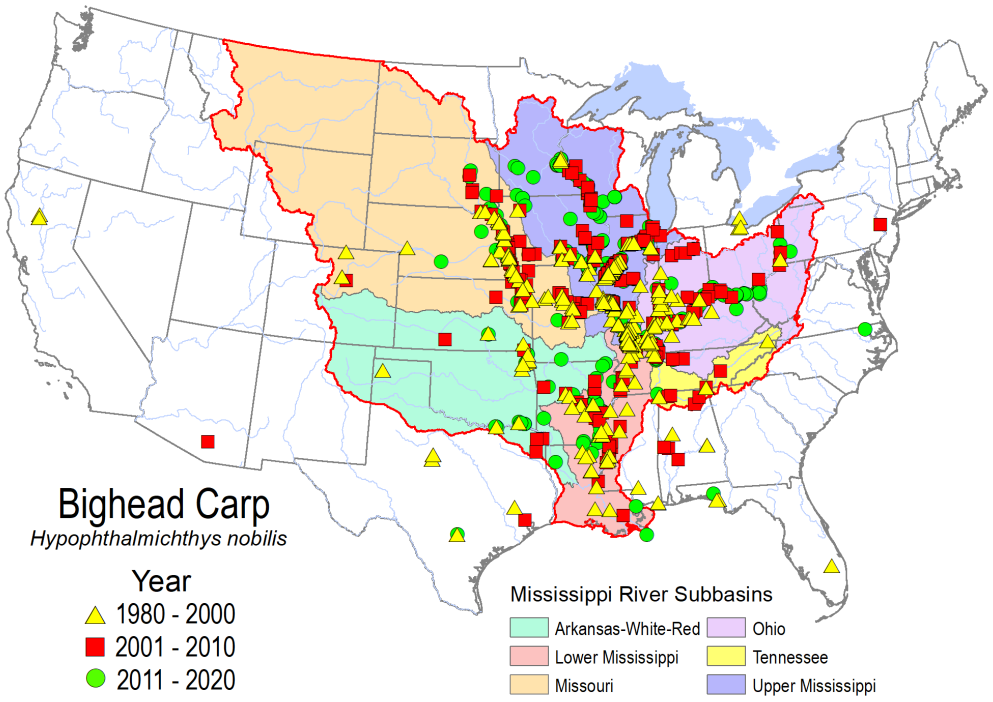
The threat to the Nation's aquatic resources from the establishment and expansion of invasive carp populations has steadily increased since initial inadvertent introductions into open and interconnected river and reservoir systems in the Midwest United States several decades ago. Figure 2 illustrates the increase in the range of occurrence for silver carp over time in the MRB since initial detection in 1972.



Source: U.S. Geological Survey, Nonindigenous Aquatic Species Database, February 2021

Figure 2. Captures of Silver Carp Documented in the USGS Nonindigenous Aquatic Species Database, 1972 Through 2020

Similar trends are demonstrated for bighead carp in Figure 3, with the range of occurrence expanding progressively over time across the MRB since the first documented reported capture in 1980.



Source: U.S. Geological Survey, Nonindigenous Aquatic Species Database, February 2021

Figure 3. Captures of Bighead Carp Documented in the USGS Nonindigenous Aquatic Species Database, 1980 Through 2020

The numerous actions and strategies described in this report reflect the coordinated and comprehensive approach that is now being implemented across jurisdictions and watershed boundaries to address key detection, prevention, containment, and control needs. The planning and coordination of the strategic actions conducted in 2019 and 2020 support the *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* (National Plan), the national management framework for all four species (bighead, silver, black, and grass carp), developed at the request of the Aquatic Nuisance Species Task Force (ANSTF) in 2007. To address the growing threat, the ANSTF requested the development of a national management plan through its Asian Carp Working Group. The USFWS led this effort, in collaboration with more than 70 Federal, State, industry, and nongovernmental partners. The National Plan identifies the following seven core goals, with supporting step-down strategies and recommendations:

1. Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.
2. Contain and control the expansion of feral populations of bighead, black, grass, and silver carp in the United States.
3. Extirpate, or reduce to levels of insignificant effect, feral populations of bighead, black, grass, and silver carp in the United States.
4. Minimize potential adverse effects of feral bighead, black, grass, and silver carp in the United States.

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 United States.
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 United States.

Since the completion of the National Plan in 2007, comprehensive "step-down" management strategies have been developed to protect the natural resources and economies of the Mississippi River and Great Lakes basins from invasive carp, building on the initial blueprint developed at the ANSTF's request. Interagency partnerships in the ORB, UMRB, LMRB, MORB, and IWW/CAWS have each developed a comprehensive management strategy ("Asian Carp Control Strategy Frameworks," or "Action Plans"), building off the overarching model of the National Plan but tailored to direct the specific high-priority monitoring, prevention, and control actions in their respective subbasin waters.

For this report, reported agency accomplishments are described under specific descriptive categories, each supporting specific goals of the National Plan, as follows:

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.*

Monitoring, Early Detection, and Rapid Response: Includes subcategories Invasive Carp Telemetry Monitoring; eDNA Monitoring; Traditional Gear Sampling; 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.*

Active Prevention and Control: Includes subcategories Invasive Carp Capture and Removal by State and Federal Agencies; Invasive Carp Capture and Removal by Commercial Fishers; Pathway Mitigation

- 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.*

Research and Development: Includes subcategories Development of New Deterrent Technologies; Development of New Control Technologies; Invasive Carp Biology, Life History, and Reproduction Evaluations; Development and Testing of New Gear/Techniques

- 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.*

Outreach with Industry, Stakeholders, and the Public: Includes subcategories Public/Stakeholder Engagement; Industry Engagement

- 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.*

Law Enforcement and Regulatory Actions

- National Plan Goal: *Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.*

1.4 Progress in Fiscal Years 2019 and 2020

This section provides a general overview of progress made toward accomplishing the overarching goals of the National Plan during the reporting period. Subsequent sections provide more detailed summaries of accomplishments for each individual basin.

Interagency Coordination

- Geographically broadened and enhanced coordination between Federal and State agencies and nongovernmental partners to implement comprehensive invasive carp management strategies for all subbasins of the Mississippi River basin, including provision of additional resources to support these efforts.
- Continued coordination and alignment of detection, prevention, and control actions to support the National Plan.

Monitoring, Early Detection, and Rapid Response

- Implementation of high-priority, targeted monitoring actions identified in invasive carp subbasin management strategies, building on information gained and lessons learned from prior and existing efforts.
- Continued development and refinement of comprehensive datasets for assessing the distribution and status of invasive carp populations within and across subbasins.
- Expanded development, refinement, and use of contingency (or "rapid response") plans, including use of the Incident Command System structure and interagency exercises, to ensure responder readiness.

Active Prevention and Control

- Designation of "Intensive Management Zones" within the ORB and UMRB to provide focused control efforts, reduce populations, and slow the spread of invasive carp populations.

- Refinement and use of models to assess invasive carp population dynamics to better inform the timing and placement of critical invasive carp management field actions, including intensive removal (harvest) and placement of deterrent barriers.
- Expanded use of contract commercial fishers to reduce invasive carp populations, targeting areas where currently established to prevent emigration and upstream range expansion.

Research and Development

- Implementation of large-scale field trials to evaluate the effectiveness of new potential deterrent technologies, including complex underwater sound and carbon dioxide barriers.
- Refinement of new detection tools and protocols to enhance the ability of agencies to quickly detect and respond to new occurrences of invasive carp.
- Evaluation and refinement of new tools and strategies to address the emerging threats of black carp and grass carp.

Outreach with Industry, Stakeholders, and the Public

- Refinement and expansion of stakeholder engagement strategy on priority invasive carp topics, including development and posting of new web-based identification and reporting guidance and best practices.

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 invasive carp

2.0 OBSERVED CHANGES IN THE RANGE OF INVASIVE CARP IN THE MISSISSIPPI RIVER BASIN

Range expansion was evaluated for all four species of invasive carp in the MRB. For this report, *range expansion* is defined as the difference (increase) in each species' geographic occurrence, documented using data collected from October 2018 through September 2020. The new range for each species is compared with the prior range assessments conducted for the 2018 Report, as well as for 2019 and 2020, to determine upstream or downstream expansion from year to year. The USGS Nonindigenous Aquatic Species (NAS) database, the national repository housing spatially referenced biogeographic accounts of introduced aquatic species across the United States, continues to serve as the primary catalog for invasive carp occurrence data. The NAS database aids efforts to verify the presence of species and includes specific data parameters for each collection or sighting (e.g., date, collector, location, and habitat type).

Expansion of the invasive carp range of occurrence documented since the 2018 Report was assessed per species by identifying the farthest known distribution points (both upstream and downstream) within each mainstream river and major tributary of the MRB. Distribution points indicate where at least one individual fish was observed but does not necessarily infer that the species is established at that point. Data were mapped and described under three categories: "Pre-Oct 2018" (data summarized up through the 2018 Report), "Oct 2018–Sept 2019", and "Oct 2019–Sept 2020" (new data summarized for the 2019–2020 Report). Observed year-to-year changes in geographic distribution were assessed by comparing changes in the farthest distance upstream or downstream one or more fish were observed between the three reporting periods (Figures 4, 5, 6, and 7). These range maps represent data archived in the USGS NAS database for each invasive carp species (https://nas.er.usgs.gov/).

Captures of invasive carp along population leading edges, including those that designate new range expansions, primarily result from State or Federal agency monitoring or from commercial or recreational fishing activities. Individual invasive carp species and other key information for these reported captures is verified by a State or Federal agency biologist and documented in the database. It is important to note that new fishery monitoring efforts initiated in previously unsampled waters can potentially yield initial invasive carp captures in upstream locations, which could imply a sudden increase in the documented range of occurrence. Establishing these baseline data within mainstem river stretches and major tributaries is needed to allow for subsequent year-to-year assessments of changes in invasive carp range.

Red markers on the maps indicate new invasive carp captures made within the 2019 reporting period (October 1, 2018 through September 30, 2019) and reported to the USGS NAS database. Yellow markers on the maps indicate new captures made within the 2020 reporting period (October 1, 2019 through September 30, 2020) and reported to the USGS NAS database. Range expansion is indicated only when

red or yellow markers are located beyond previously documented data points (upstream or downstream). These data represent only reported captures of the various invasive carp species.

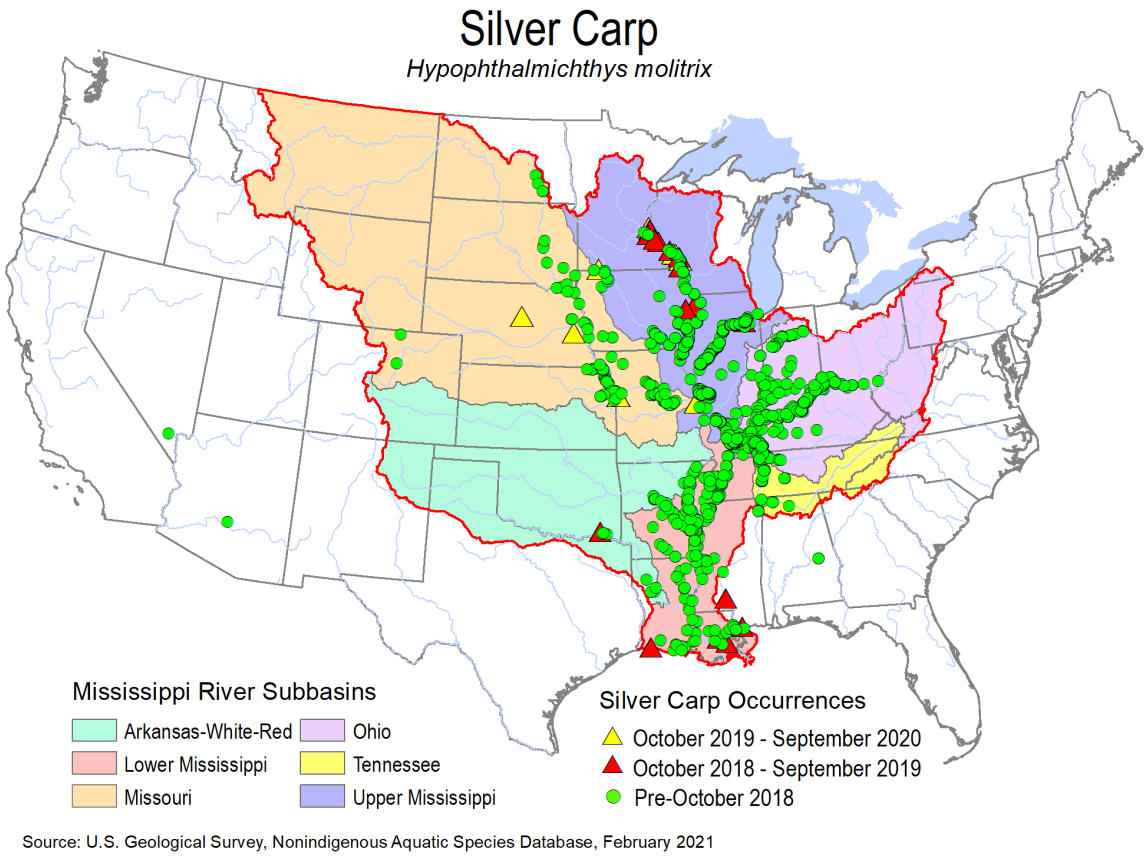


Figure 4. Documented Change in Range of Occurrence for Silver Carp in the MRB Through September 2020 (U.S. Geological Survey Nonindigenous Aquatic Species Database, Gainesville, FL, https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=549)

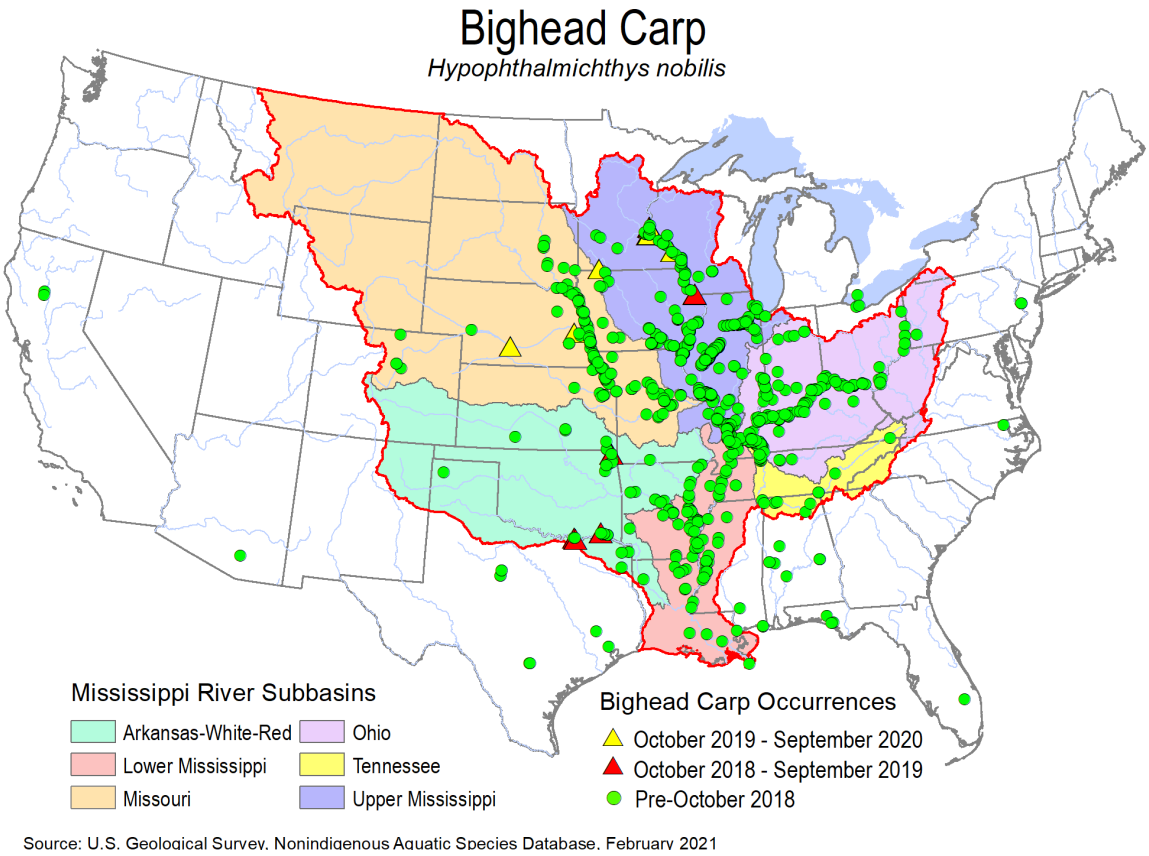


Figure 5. Documented Change in Range of Occurrence for Bighead Carp in the MRB Through September 2020 (U.S. Geological Survey Nonindigenous Aquatic Species Database, Gainesville, FL, https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=551)

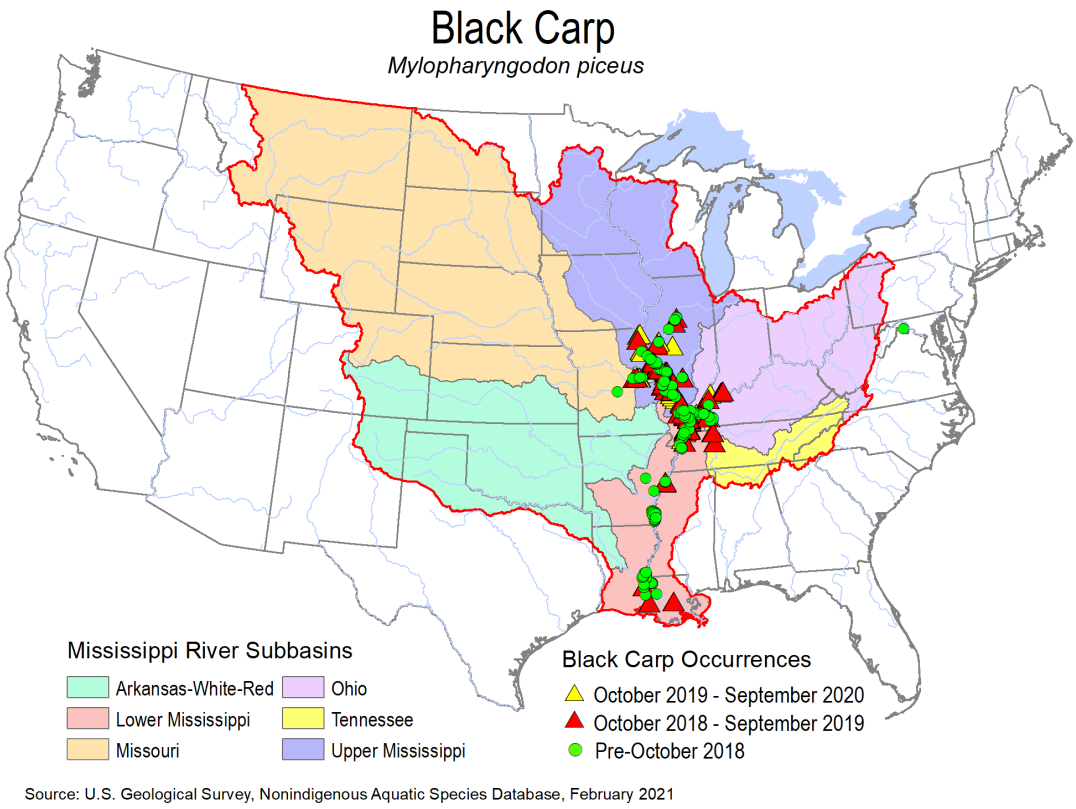


Figure 6. Documented Change in Range of Occurrence for Black Carp in the MRB through September 2020 (U.S. Geological Survey Nonindigenous Aquatic Species Database, Gainesville, FL, https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=573)

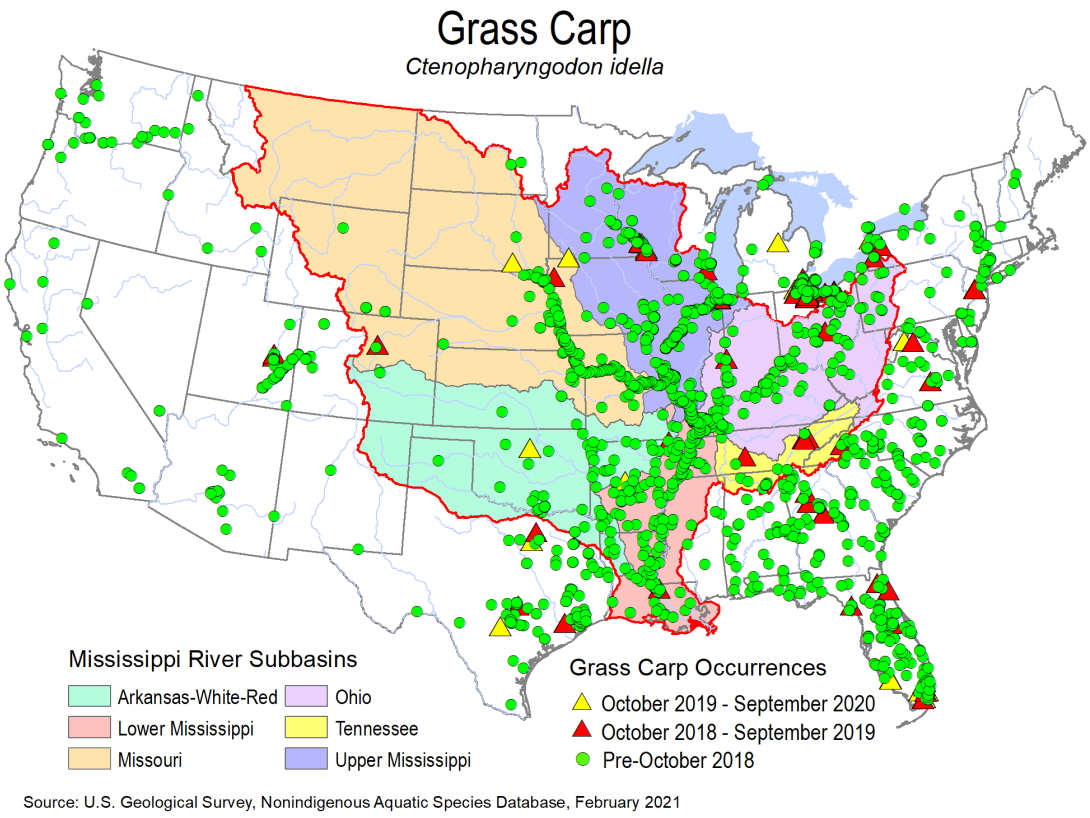


Figure 7. Documented Change in Range of Occurrence for Grass Carp in the MRB Through September 2020 (U.S. Geological Survey Nonindigenous Aquatic Species Database, Gainesville, FL, https://nas.er.usgs.gov/viewer/omap.aspx?SpeciesID=514)

The 2019–2020 Report includes information describing changes in the documented occurrence of invasive carp in the MRB during the reporting period. Assessments for this report provide analyses of new versus historical detections, including quantified changes in the observed range of each species.

Bighead Carp

During the 2019 and 2020 reporting period, no range expansion was documented for bighead carp in any of the MRB subbasins during either year.

Silver Carp

Increases in the documented range of occurrence of silver carp in 2019 included—

- Increase of 11 miles within the Red River subbasin (upstream in the Kiamichi River, a major tributary of the Red River)
- Increase of 13 miles upstream in the St. Croix River

Increases in the documented range of occurrence of silver carp in 2020 included—

- Increase of 6 miles upstream in the St. Croix River
- New detections of silver carp in the North Loup River, a tributary of the Platte River

Black Carp

Increases in the documented range of occurrence of black carp in 2019 included—

- Increase of 34 miles upstream in the Mississippi River (Upper Mississippi River ~ RM 344; Lewis County, MO/Adams County, IL)
- Increase of 146 miles upstream in the Ohio River (Ohio River ~ RM 778; Warrick County, IN/Henderson County, KY)
- Increase of 61 miles upstream in the Tennessee River (Tennessee River ~ RM 100; Benton County, TN/Humphreys County, TN)

Increases in the documented range of occurrence of black carp in 2020 included—

- Increase of 13 miles upstream in the Mississippi River (Upper Mississippi River ~ RM 364); Hancock County, IL/Lee County, IA)
- Bighead Carp

Grass Carp

While new detections were reported during 2019 and 2020, no notable increases in the range of occurrence for grass carp were documented in the mainstem Mississippi River during the reporting period. Grass carp had been historically documented in a total of 45 states as of September 2020, unchanged since the previous 2018 reporting period.

New documented detections of invasive carp during 2019 and 2020 were entered into the USGS Nonindigenous Aquatic Species (NAS) database and can be viewed online at https://nas.er.usgs.gov/taxgroup/fish/default.aspx. It is important to note that although the collection of an individual invasive carp in a new location may be defined as range expansion in this report, it does not indicate that the species has become established at that particular point in the watershed. Additional data, such as evidence of spawning activity, the presence of various life stages of invasive carp (e.g., eggs, larvae, and juveniles), and the relative abundance of adults, are used to holistically assess and better define the geographic boundary, or "population front," for self-sustaining populations of each species within a given river basin. This fact underscores the need for ongoing monitoring to collect data to inform an accurate assessment of population status. Further, as the overall agency invasive carp monitoring effort increases within the various MRB subbasins, new fishery sampling actions are likely being conducted for the first time or more frequently in certain waterbodies and river reaches, especially upstream areas and key tributaries, which may or may not have historically contained low numbers of invasive carp. These locations may lack robust historical data on invasive carp occurrence due to a lack of earlier sampling; therefore, these new sampling efforts may provide important initial invasive carp detection information. Although these invasive carp occurrence data in new waters may imply a range expansion, it is important to note that in the absence of prior presence/absence data, historical comparison to prior years (to determine actual upstream expansion from year to year) is challenging due to the lack of earlier targeted survey efforts.

As of September 30, 2020, invasive carp were documented in the United States as follows: grass carp = 45 States; bighead carp = 27 States, silver carp = 22 States, and black carp = 8 States (per USGS NAS database).

2.1 Determination of Invasive Carp Reproductive Status

Additional key data describing invasive carp population status in the MRB are collected through the laboratory analysis of fish captured during agency monitoring, commercial fishing, or other activities. *Ploidy* determination is a genetic analysis of the reproductive capabilities of captured grass and black carp using flow cytometry. Analysis of captured grass or black carp determines if the fish are sterile triploids (e.g., escaped from intentional stockings for aquatic weed or snail control) or are naturally reproducing diploids and may establish invasive populations. Results are used by partner agencies to inform on the risk of new population establishment or range expansion and to focus the implementation of potential response and control actions on areas of need where diploid fish threaten to establish reproductive populations. Ploidy results, along with collection data and images, are reported to the USGS Nonindigenous Aquatic Species (NAS) Database: https://nas.er.usgs.gov/. Figure 8 describes capture locations and ploidy results for all black and grass carp reported in the USGS NAS database for

2019 and 2020, with the Mississippi River and Great Lakes basins delineated.

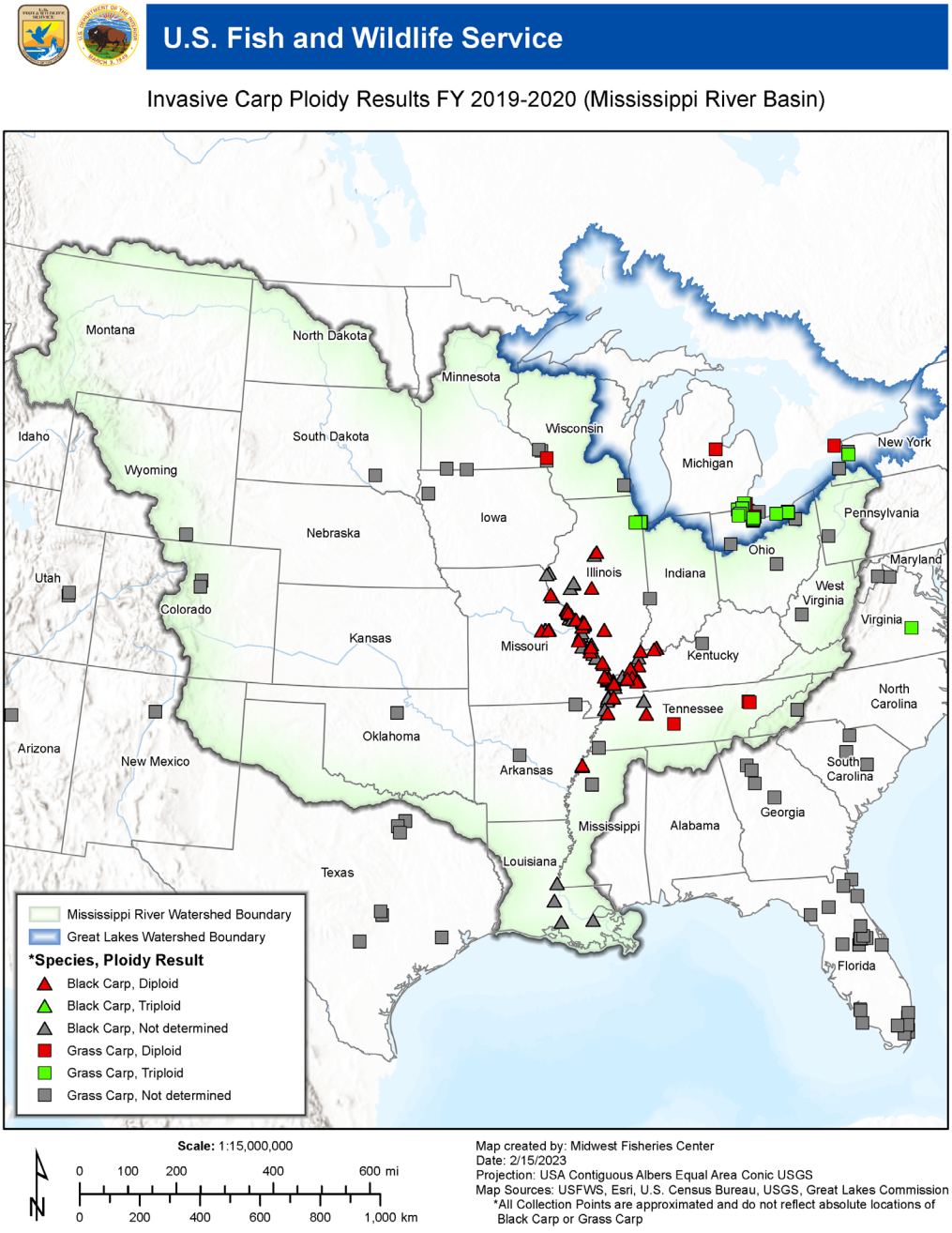


Figure 8. Capture Locations and Ploidy Results for all Black Carp and Grass Carp Reported in the USGS NAS Database for 2019 and 2020 (Mississippi River and Great Lakes Basins Delineated)

Figure 9 describes the total number and ploidy of all black carp reported in the USGS NAS database by year from 2004 through 2020.

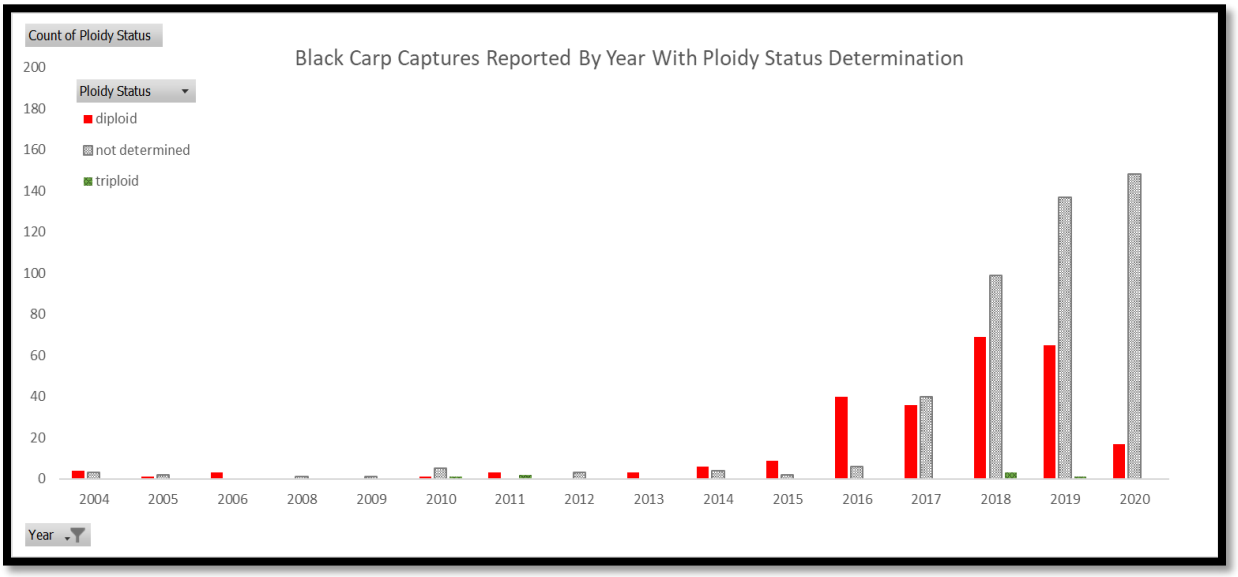


Figure 9. All Reported Black Carp Captures Reported by Year, 2004–2020 (categorized within year by reported ploidy results) (Nonindigenous Aquatic Species Database, Gainesville, FL, https://nas.er.usgs.gov/queries/CollectionInfo.aspx?SpeciesID=573)

2.2 Population Status Assessment

A comprehensive understanding of invasive carp population dynamics and status requires the collection and assessment of data for all life stages, including eggs, larvae, juveniles, and adults. This information provides a more complete description of the degree of establishment and threat of advance for a given population and can be used to inform the implementation of strategically targeted management actions within a given subbasin. The intensive field sampling and laboratory analyses to support the acquisition of key invasive carp data remained a high priority of MRB agencies in 2019 and 2020.

Figure 10 characterizes the bighead carp and silver carp stage of establishment and relative abundance in the mainstem rivers of the MRB as of September 2020, using data provided by State and Federal partners. These data described the presence of different life stages of invasive carp, the relative abundance of adults in the area, and the presence of spawning activity. Three general categories were used to describe establishment status and relative abundance of invasive carp within river reaches, and are indicated with red, orange, or blue shaded zones on the map. Red shading indicates areas of established bighead carp and/or silver carp populations in which reproduction (spawning) has been verified by collecting and taxonomically or genetically confirming eggs, larvae, or juvenile fish. This area is also referred to as the “established front”. Orange shading indicates areas of adult population transition, defined as locations where the population is stable with regular catches of adults, but spawning has not yet been confirmed (although it may have been observed). This area is also referred to as the “invasion front”. Blue shading indicates areas where adult fish are occasionally, but not

consistently, captured. The distribution of fish in the blue-shaded areas should not be considered uniform throughout those reaches. This area is also referred to as the “presence front”.

Figure 10. Characterization of Relative Abundance of Bighead and Silver Carp in the MRB (as of September 2020)

A detailed summary of invasive carp monitoring and assessment activities conducted by partner agencies within the MRB in 2019 and 2020 is provided in Section 3.0 (*Federal Agency and Cooperative State/Nongovernmental Partner Activities to Control the Spread of Invasive Carp in the Mississippi River Basin*).

2.3 Informing Invasive Carp Management Actions

Information on invasive carp population status is used to support project planning and decision making in partnership management strategies. Specific projects are developed to address bighead and silver carp populations most effectively, as characterized at differing levels of invasion and establishment within the three different color zones depicted in Figure 10.

Management actions conducted within river reaches with established populations (red zones in Figure 10) focus on reducing the abundance of adult bighead and silver carp through physical capture

and removal, including from areas near lock and dam complexes that may act as partial barriers to the movement of fish. For example, reducing the number of fish below locks and dams (i.e., propagule pressure) lowers the numbers of fish likely to migrate upstream into the transitional zone (orange zone in Figure 10), where reproducing populations have not yet fully established. Additional effort is being directed to quantitatively evaluate the extent of fish passage, including invasive carp and native species, at lock and dam structures between the established and transitional zones. Further, pilot studies are being conducted to evaluate the potential effectiveness of deterrent technologies (e.g., acoustic barriers) deployed at lock and dam structures to serve as barriers to fish movement.

Within the transitional zone, priority actions focus on reducing the risk that invasive carp will reach sufficient abundance to establish reproducing populations. Those actions include conducting intensive monitoring and assessment of all life stages—to clearly define and understand when and where bighead and silver carp are reproducing—and focused capture and removal efforts. Because annual variability in environmental conditions and other factors can strongly influence invasive carp reproductive success across years, understanding the geographic boundary and extent of invasive carp establishment requires ongoing focused monitoring. Similar to efforts in the established zone, considerable effort is directed at removing invasive carp from the transitional zones to reduce the abundance of adults and minimize the potential for fish to successfully spawn and subsequently increase upstream range. 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 zones in Figure 10), 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 surveillance, monitoring, and removal. Collection of a bighead or silver carp within the detected zone may result in collaborative response action, with multiple agencies intensively sampling the area to determine if additional invasive carp are present.

3.0 FEDERAL AGENCY AND COOPERATIVE STATE/NONGOVERNMENTAL PARTNER ACTIVITIES TO CONTROL SPREAD OF INVASIVE CARP IN THE MISSISSIPPI RIVER BASIN

3.1 Basinwide Planning for Invasive Carp Management

Development of long-term strategies and annual research and management workplans in each MRB subbasin is coordinated under the Mississippi Interstate Cooperative Resource Association (MICRA) through multijurisdictional partnerships comprising State and Federal agencies. Planning and activities focused on GLB protection from invasive carp are coordinated through the ICRCC, but many of its activities are conducted in the IWW/CAWS, the upstream boundary of the UMR, and are therefore included in this report.

MICRA (Figure 11) is a partnership of 28 State natural resources agencies organized in 1991 to improve the management of interjurisdictional fish and other aquatic resources in the MRB. In 2015, MICRA formed an Asian Carp Advisory Committee (ACAC) that includes State agency representatives from each of the major subbasin partnerships that collaborate through MICRA. The ACAC also includes representatives from key Federal agency partners, including the USFWS, USGS, USACE, NPS, and Tennessee Valley Authority. The multiple invasive carp subbasin partnerships work together through MICRA and the ACAC to develop a unified, basinwide perspective on invasive carp management across the MRB. Through this process, high-priority invasive carp management needs are identified; those needs are reflected in the annual *Asian Carp Monitoring and Response Plan for the Mississippi River Basin*.

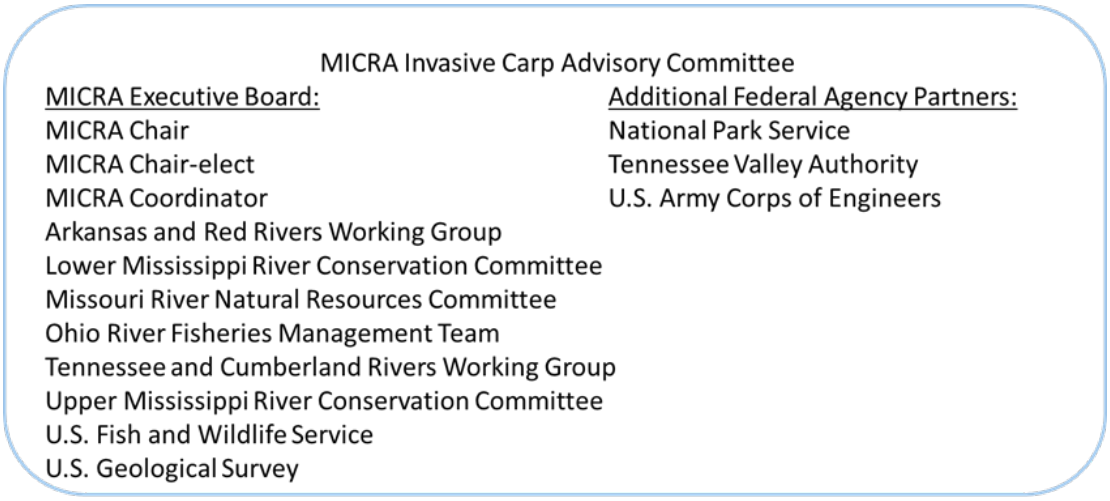


Figure 11. Organizational Structure of MICRA Asian Carp Advisory Committee

The ICRCC (Figure 12) is a partnership of U.S. and Canadian Federal, State, Provincial, Tribal, and local agencies and organizations working to prevent the introduction and establishment of invasive carp populations in the Great Lakes. The ICRCC develops an annual *Invasive Carp Action Plan,* a

comprehensive portfolio of projects including early detection and monitoring, contingency response planning, prevention and control (including addressing permanent and temporary pathways), new technology development, law enforcement, and partner and stakeholder communication and outreach. The work of the ICRCC focuses primarily 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. In addition, the ICRCC's Monitoring and Response Work Group (MRWG) 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 Invasive Carp Action Plan and serves as the comprehensive tactical, on the-ground annual work plan, with a primary focus on monitoring, prevention, and control of invasive carp in the IWW/CAWS.

Figure 12. Organizational Structure of the Invasive Carp Regional Coordinating Committee

3.2 Subbasin Partnerships in the MRB

Interagency partnerships to address the threat of invasive carp are now operational in all major river subbasins of the MRB, providing coordination across the watershed. The MRB subbasin invasive carp partnerships provide coordinated development and implementation of regional frameworks and supporting annual invasive carp projects. Each partnership is supported through strong Federal and State collaboration, leveraging the expertise and capacity of each member agency. Agency membership of the individual subbasin partnerships is shown in Figure 13.

Figure 13. Organizational Structures of the MRB Subbasin Invasive Carp Partnerships

Each MRB subbasin partnership has developed a Framework strategy to provide overarching goals and recommendations to inform development of the MRP and annual planning within their respective geographic boundaries. The individual Frameworks and links to the documents are as follows:

ORB Framework (includes Tennessee River and Cumberland River subbasin):

- *Ohio River Basin Asian Carp Control Strategy Framework* (ORB Framework), developed by the Ohio River Fisheries Management Team (ORFMT)

UMRB Framework:

- *Upper Mississippi River Basin Asian Carp Control Strategy Framework* (UMRB Framework), developed by the Upper Mississippi River Asian Carp Partnership

LMRB Framework (includes Arkansas River, Red River, and White River sub-basin):

- *Lower Mississippi River Basin Asian Carp Control Strategy Framework* (LMRB Framework), developed by the Asian Carp Team of the Lower Mississippi River Basin

MORB Framework:

- *Missouri River Basin Asian Carp Control Strategy Framework* (MORB Framework), developed by the Missouri River Natural Resource Committee's Asian Carp Technical Committee

3.3 Enhanced Support for Subbasin Partnership Priorities

Funding to support the activities described in this report for each subbasin partnership was provided primarily through annual Federal and State agency budgets for invasive carp management in FY 2019 and FY 2020. Of note, since FY 2015, increased funding has been provided to the USFWS for collaborative invasive carp prevention efforts through its annual agency base appropriations to support an enhanced multiagency invasive carp response in the MRB, as called for in WRRDA 2014. The USFWS, in coordination with the Mississippi Interstate Cooperative Resource Association (MICRA), works directly with State and Federal agencies to address the highest priority implementation needs for the MRB frameworks and in support of National Plan goals.

In FY 2019, the USFWS allocated $2,790,000 to support collaborative invasive carp monitoring, prevention, and control actions conducted in the UMRB and ORB under the MRB Framework. In FY 2020, USFWS funding allocated to support MRB Framework implementation increased to $13,919,996 and expanded to include all six MRB subbasins.

Fiscal Year	ORB	UMRB	TNCRB	ARWRB	LMRB	MORB
FY 2019	$1,735,000	$1,055,000	$0	$0	$0	$0
FY 2020	$8,019,996	$1,500,000	$1,000,000	$1,000,000	$1,300,000	$1,100,000
Total	**$9,754,996**	**$2,555,000**	**$1,000,000**	**$1,000,000**	**$1,300,000**	**$1,100,000**

Table 1. USFWS Funding Allocated for Invasive Carp Projects in the MRB Subbasins in FY 2019 and FY 2020

With this support, the USFWS continued to facilitate coordination with MICRA and the State and Federal agency partners to identify subbasin needs and priority projects for funding consideration in 2019 and 2020, based on available resources. Projects were identified and developed for early detection monitoring, monitoring and assessment, control and removal, and containment actions in the 2019 and 2020 MRPs.

Specific MRB subbasin partnership projects funded through this process in 2019 and 2020 included the following:

Upper Mississippi River Subbasin

- Early Detection of Invasive Carp on the Invasion Front in the Upper Mississippi River (2019)
- Detection of Invasive Carp in the Presence Front and at the Invasion Front in the Upper Mississippi River (2020)
- Evaluation of Controls, Impacts, and Behaviors of Asian Carp in the Lower Upper Mississippi River (2019)
- Evaluation of Controls on Density and Behaviors of Invasive Carp in the Lower UMR (2020)

- Contract Fishing for Asian Carp Detection and Removal in the Upper Mississippi River (2019 and 2020)
- Evaluation of Fish Passage for Assessment of Bigheaded Carp Deterrents at Locks in the Upper Mississippi River (2019 and 2020)

Ohio River Subbasin

- Early Detection and Evaluation of Asian Carp Removal in the Ohio River (2019 and 2020)
- Abundance and Distribution of Early Life Stages of Asian Carp in the Ohio River (2019 and 2020)
- Control and Containment of Asian Carp in the Ohio River Basin (2019 and 2020)
- Quantifying Lock and Dam Passage, Habitat Use, and Survival Rates of Asian Carp in the Ohio River Basin (2019 and 2020)

Tennessee-Cumberland Rivers Subbasin

- Relative Population Densities and Movement of Asian Carp in the Tennessee River and Cumberland River, Tributaries of the Ohio River (2019 and 2020)
- Deterrent Strategy Planning for Asian Carp in the Ohio River Basin (2019 and 2020)
- Evaluation and Removal of Asian Carp in the Tennessee and Cumberland Basins (2019 and 2020)

Missouri River Subbasin

- Define the Spatial Distribution and Population Demographics of Asian Carp Populations and the Associated Fish Community in the Missouri River Basin (2020)
- Asian Carp Movement and Habitat Use in the Missouri River Basin to Inform Containment and Control Management Actions (2020)
- Control and Containment of Invasive Carp in the Missouri River Basin (2020)
- Kansas River Bowersock Dam Barrier Feasibility Study (2020)

Lower Mississippi River Subbasin

- Asian Carp Movement and Assessment to Inform Management and Removal Efforts in the Lower Mississippi River Basin (2020)
- Control of Asian Carp in the Lower Mississippi River Basin (2020)
- Abundance and Distribution of Early Life Stages of Asian Carp in the Lower Mississippi River Basin (2020)

Arkansas-Red-White River Subbasin

- Distribution and Population Demographics of Asian Carp in the Lower Red River Basin (2020)
- Distribution and Population Demographics of Bighead Carp in the Neosho River-Grand Lake System to Inform Removal (2020)
- Control of Asian Carp in the Arkansas-Red-White River Basin (2020)
- Movement of Asian Carp in the Arkansas River to Inform Management (2020)
- Abundance and Distribution of Early Life Stages of Asian Carp in the Red River Basin (2020)

In addition to the projects listed, numerous other priority detection, prevention, and control efforts, including technology development and stakeholder outreach and communications, were supported through Federal and State agency resources in support of the subbasin partnership and National Plan strategy goals and objectives. These activities and their related expenditures are included in this report.

3.4 2019 and 2020 Federal, State, and Nongovernmental Subbasin Partnership Accomplishments

The Report provides a general summary of the numerous invasive carp management activities and accomplishments achieved within each MRB subbasin in 2019 and 2020. Additional detailed technical reports summarizing activities conducted in the MRB and GLB during the reporting timeframe are available at www.micrarivers.org and www.invasivecarp.us.

The *Monitoring and Response Plan for Asian Carp in the Mississippi River Basin* includes a compilation of work plans developed for MRB projects that received funding from the USFWS in FY 2019 and FY 2020.

The *Asian Carp Monitoring and Response Plan Interim Summary Report* provides a summary of work conducted by the ICRCC's MRWG in the IWW/CAWS Reports summarizing 2019 and 2020 efforts, which are available at 2019 Asian Carp Monitoring and Response Plan (invasivecarp.us) and 2020 Asian Carp Monitoring and Response Plan (invasivecarp.us).

3.5 Ohio River Basin (including Tennessee River and Cumberland River watersheds)

3.5.1 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 2019 and 2020, interagency coordination on invasive carp actions in the ORB were supported through the Ohio River Sub-basin Planning Team, the Ohio River Asian Carp Technical Team, and the MICRA Asian Carp Advisory Committee. Additional focused coordination in the Tennessee and Cumberland Rivers was provided through interagency technical committees and planning work groups comprising ORB agencies and academic partners. Collaborating State and Federal agencies in the ORB are shown in Figure 13 (*Organizational Structures of the MRB Subbasin Invasive Carp Partnerships*).

Partnering agencies include the Alabama Department of Conservation & Natural Resources (ADCNR), Georgia Department of Natural Resources (GDNR), Illinois Department of Natural Resources (ILDNR), Indiana Department of Natural Resources (IDNR), Kentucky Department of Fish and Wildlife Resources (KDFWR), Maryland Department of Natural Resources (MDNR), Mississippi Department of Fish and Wildlife Resources (MDFWR), New York Department of Environmental Conservation (NYSDEC), North Carolina Wildlife Resources Commission (NCWRC), Ohio Department of Natural Resources (ODNR), Pennsylvania Fish and Boat Commission (PFBC), Tennessee Wildlife Resources Agency (TWRA), Virginia Department of Wildlife Resources (VDWR), West Virginia Division of Natural Resources (WVDNR), USACE, U.S. Coast Guard, USFWS, USGS, and Tennessee Valley Authority (TVA).

Agencies collaboratively identified and developed projects for funding consideration to address highest-priority management and research needs using available resources. These priority actions were identified in the 2019 and 2020 MRPs for the MRB. Invasive carp management actions conducted in the ORB supported the overarching goals of the National Plan and the priorities of the *Ohio River Basin Asian Carp Control Strategy Framework* (ORB Framework and *the* Ohio *Asian Carp Tactical Plan: 2014–2020* (Tactical Plan).

3.5.2 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.**

Invasive Carp Telemetry Monitoring

In 2019 and 2020, ORB partner agencies expanded their capacity for using acoustic telemetry to assess the distribution, movement, and lock and dam passage of invasive carp in the mainstem Ohio, Tennessee, and Cumberland Rivers and key tributaries. Acoustic telemetry is a technology that tracks the movements of fish by tagging them with transmitters that emit ultrasonic sound pulses unique to

each individual fish. Data from the transmitters can be detected and recorded by receivers installed at specific locations within a river or reservoir. In the ORB, agencies continued to assess invasive carp upstream movement and migration patterns, behaviors within specific river habitats, potential range expansion, and passage through locks. Information from telemetry monitoring was used to inform preliminary planning for invasive carp deterrent strategies in the ORB. Collaborative ORB projects directly informed by telemetry monitoring in 2019 and 2020 included *Quantifying Lock and Dam Passage, Habitat Use, and Survival Rates of Asian Carp in the Ohio River,* focused on the mainstem Ohio River, and *Deterrent Strategy Planning for Asian Carp in the Ohio River Basin,* focused on the Tennessee and Cumberland Rivers.

In the mainstem Ohio River, agencies continued to support the Ohio River Asian Carp Telemetry Project (ORACTP), a tracking array and data collection effort spanning more than 500 miles of the river. Efforts included ensuring that adequate numbers of fish were tagged with active transmitters in the McAlpine and Meldahl Pools, key upstream study locations for understanding potential range expansion. In 2019, 13 invasive carp were tagged with ultrasonic transmitters in the Ohio River, of which 11 were in Meldahl Pool. In 2020, an additional 40 invasive carp were tagged, all captured and released in the McAlpine Pool. As of September 2020, the ORACTP included 130 stationary receivers and 435 tagged invasive carp. From October 2018 through September 2019, 174 individual fish were detected, accounting for more than 4 million detections. From October 2019 through September 2020, 164 individual fish were detected, accounting for more than 3 million detections. As of September 2020, the telemetry study's database included approximately 29.3 million tag detections for invasive carp movement in total within the ORB. A large proportion of the active telemetry tags (more than 100 tags) were set to expire in 2021; therefore, the tagging effort was planned to accommodate replacement of the expiring tags during the 2021 field season.

Within the greater ORB, the Tennessee and Cumberland River telemetry working group coordinated telemetry efforts throughout the Tennessee River and Cumberland River subbasin. Telemetry capacity was expanded in 2019 and 2020 to provide more comprehensive data on invasive carp population dynamics within the subbasin. A stationary receiver array maintained in the Tennessee River includes all locks and dams on the mainstem river and some major tributaries. As of September 2020, the array consisted of 45 receivers. The stationary receiver array deployed in the Cumberland River was expanded to 25 receivers in 2019 and to 30 receivers in 2020. The number of silver carp tagged with acoustic transmitters in the Tennessee and Cumberland River systems was increased to 450 in 2019 and subsequently to 542 as of September 2020. The data obtained through these arrays are being used to better understand the ability of invasive carp to utilize lock and dam structures for upstream and downstream passage on the Tennessee and Cumberland River systems, including Barkley Lock and Dam and Kentucky Lock and Dam. Barkley Lock and Dam is the last structure on the Cumberland River before its confluence with the Ohio River, serving as the first major obstruction to upstream movement of invasive carp in the Cumberland River and a strategic "pinch point" for the potential deployment of fish deterrent technologies. Kentucky Lock and Dam is the last structure on the Tennessee River before its confluence with the Ohio River and serves as the first major obstruction to upstream movement of

invasive carp. To inform potential fishery deterrent deployments in the future, the movement (passage) of tagged fish through Barkley Lock and Dam and the Kentucky Lock and Dam was assessed during 2019 and 2020. Passages of tagged fish through both lock structures were noted during the reporting period. This evaluation is ongoing.

Telemetry tracking was also used to evaluate the potential for the interbasin movement of invasive carp from the Tennessee River basin to the Mobile River basin via the Tennessee-Tombigbee Waterway (TTW). The TTW is a 234-mile man-made navigation canal with a series of 10 lock-and-dam impoundments that connects the Tennessee River at Pickwick Lake to the Black Warrior/Tombigbee River system in Alabama, eventually leading to Mobile Bay. The TTW is considered a major tributary of the Tennessee River. The Mississippi Department of Fish and Wildlife Resources (MDFWR) collected and analyzed invasive carp movement data from telemetry receivers on the TTW and Pickwick Lake and relocated or replaced receivers within the array as needed. In 2019, MDWFP fisheries biologists implanted acoustic tags in 45 invasive carp and installed five Vemco receivers in Pickwick Lake and the TTW. Tracking data were retrieved on a monthly basis and uploaded to the multistate tracking database. In 2020, additional fish were tagged with telemetry transmitters to support the TTW study. Telemetry tracking through this effort is expected to provide key data on invasive carp occurrence and movement in the TTW and Pickwick Lake.

During 2019, Eastern Illinois University and Southern Illinois University became active partners on the invasive carp telemetry effort in the ORB, adding monitoring capacity to the Wabash River drainage. These universities, in collaboration with the existing partnership, are establishing an additional stationary array to include telemetry receivers in tributaries and downstream pools of the Ohio River and the Wabash River. This added capacity supports the detection of any tagged invasive carp from the confluence of the Ohio River and Mississippi River near Cairo, IL, upstream to Willow Island Lock and Dam, covering more than 800 mainstem river miles in addition to numerous major tributaries.

USGS continued to maintain real-time telemetry sites to detect tagged invasive carp in the Ohio River at Louisville, KY, and Ironton, OH, allowing for the instantaneous detection of invasive carp passage at specific locations. This information can be used to assess the timing of movements related to spawning events and inform potential management actions.

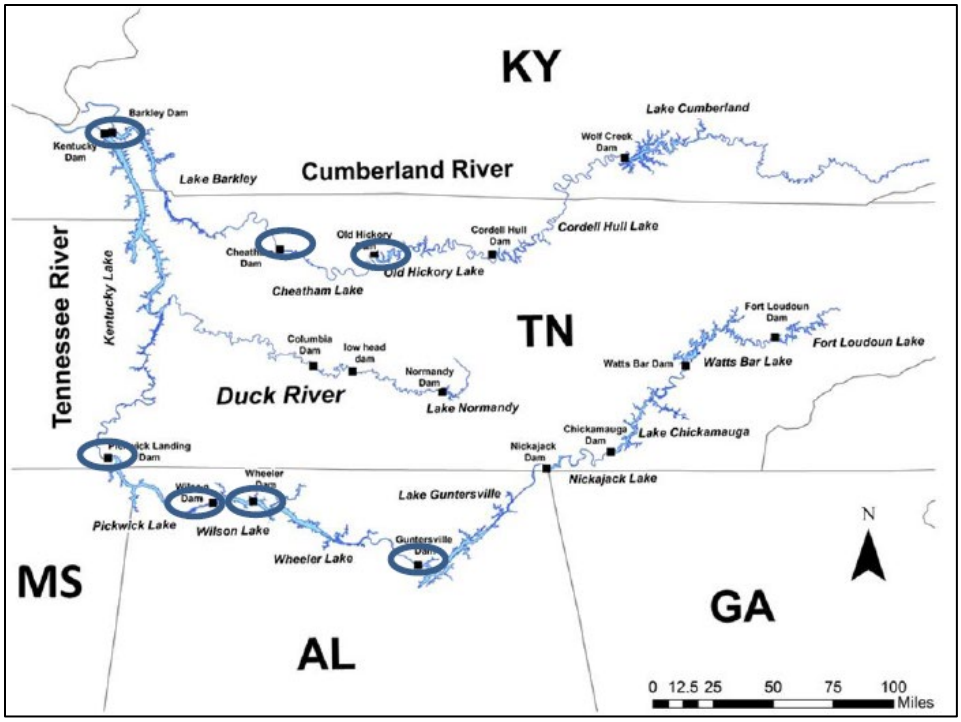


Figure 14. Tennessee River and Cumberland River Locks and Dams (Circled) That Are Monitored Using Acoustic Telemetry Receivers to Measure Invasive Carp Upstream Invasion

Hydroacoustics

USFWS conducted fishery hydroacoustic surveys to assess invasive carp populations in the mainstem Ohio River in November 2019. Surveys were planned for October 2020 in the Cannelton and McAlpine pools but were postponed due to health and safety considerations under COVID-19 protocols. Additional efforts by USFWS in 2020 included refinement and improvement of hydroacoustic sampling protocols for future invasive carp population assessments. A sampling rotation for the pools of the ORB was developed for use in future surveys, with more effort to be focused on the lower pools in which invasive carp populations are larger and ongoing management actions being focused. Refinements to the hydroacoustic survey protocols, in concert with fish data collection, are anticipated to produce more robust invasive carp population estimates.

eDNA Monitoring

Genetics-based eDNA surveillance serves as an efficient early detection monitoring tool to help identify specific locations where additional targeted sampling or rapid response actions focused on invasive carp capture and removal may be warranted. In the event of a preliminary positive finding of invasive carp genetic material, traditional fishery sampling gears and methods such as gill netting, trap netting, and electrofishing may be deployed.

No eDNA sampling was conducted by USFWS and agency partners in the ORB between October 1, 2018, and September 30, 2020. Further details on the agency eDNA monitoring efforts in the ORB and other

basins can be found at
https://fws.maps.arcgis.com/apps/dashboards/52b22abe9c4d4575adfe851a946f444d.

Traditional Gear Sampling

During 2019 and 2020, ORB agencies continued invasive carp monitoring activities using traditional fishery sampling gears to assess the abundance, distribution, and habitat use of larval, juvenile, and adult invasive carp. Sampling efforts utilized electrofishing, netting, and trapping to detect the upstream extent of reproducing populations of invasive carp and included sampling for early life stages (e.g., eggs and larval fish). Multiagency monitoring efforts supported the priorities of the 2019 and 2020 MRB MRPs, including the Early Detection and Evaluation of Asian Carp Removal in the Ohio River (EDEAC) and Abundance and Distribution of Early Life Stages of Asian Carp in the Ohio River (ADELSAC) projects. The EDEAC included baseline monitoring to evaluate potential invasive carp management actions by measuring changes in distribution and relative density through targeted sampling, potential indirect impacts on native fish communities in response to actions, and invasive carp presence in upstream areas. Surveys were designed to provide data on the relative abundance of invasive carp within each pool and the overall range of occurrence within the ORB. Sampling was stratified (further subdivided) by habitat type and includes multiple tributaries of the Ohio River. Additional actions conducted in support of the EDEAC during the reporting period included evaluations of Hovey Lake in Indiana, a backwater complex that supports invasive carp recruitment. The primary objective of this new effort is to understand factors that may influence invasive carp recruitment dynamics at that location.

During the reporting period, KDFWR led the EDEAC within the mainstem Ohio River (including navigation pools), coordinating with USFWS, PFBC, WVDNR, IDNR, ILDNR, and Southern Illinois University (SIU). In 2019 and 2020, targeted sampling for invasive carp continued in the six pools in the middle Ohio River upstream of the Cannelton Lock and Dam complex (Cannelton, McAlpine, Markland, Meldahl, Greenup, and R.C. Byrd Pools) using a variety of gear. In 2019, agency surveys detected silver carp upstream in the Ohio River into the Markland Pool, bighead carp into the Cannelton and McAlpine Pools, and grass carp into the McAlpine and Markland Pools. Data continued to demonstrate that invasive carp catch rates remained significantly higher in downstream pools (Cannelton and McAlpine) compared with upstream locations (Markland and Meldahl), an expected trend based on initial introduction and establishment from downstream sources in the Ohio River. Within the Greenup and R.C. Byrd Pools, gillnetting and electrofishing conducted in 2019 resulted in the capture and removal of one bighead carp (Fivemile Creek/Kanawha River) and two grass carp from R.C. Byrd Pool. Monitoring efforts in 2019 demonstrated that the Markland Pool was the farthest upriver location where silver carp or bighead carp were documented. However, removal efforts and previous historical data suggest the silver carp range extending into R.C. Byrd Pool and the bighead carp range extending well upriver to the New Cumberland Pool, indicating a need for increased targeted and monitoring efforts to provide better resolution when considering invasion ranges in lower density pools, upriver of the establishment front. In 2019, bighead carp, silver carp, and grass carp accounted for approximately 3.0 percent of the total catch from all KDFWR fishery monitoring activities conducted in this portion of the Ohio River, with silver carp being the most abundant invasive species encountered between Cannelton and Meldahl Locks and Dam.

Figure 15. KDFWR Biologist with Silver Carp in Sinking Creek, a Tributary of the Cannelton Pool of the Ohio River, in 2021. Photo Credit: Andrew Stumpf, KDFWR

Results from agency surveys in 2020 indicated that the Cannelton and McAlpine Pools continued to have much higher densities of bighead and silver carp compared with pools further upstream. Data suggested that the geographic line of silver carp establishment in the mainstem Ohio River as of 2020 likely fell within the Cannelton Pool. Data from the Cannelton Pool, a key assessment point in the mainstem Ohio River, demonstrated an increase in average catch rates for silver carp from 2016 through 2019. In 2020, electrofishing catch rates for silver carp in the Cannelton Pool were the highest levels recorded since the start of the EDEAC project (2015; project formerly known as Monitoring and Response). In 2020, invasive carp accounted for approximately 0.2 percent of the total catch from all KDFWR fishery monitoring activities conducted within the McAlpine and Markland Pools. Bighead carp were routinely captured during monitoring efforts, although in lower numbers relative to silver carp, resulting in a less robust dataset for the species, making analysis of the extent of their establishment in the mainstem Ohio River challenging. Additional sampling efforts were planned for 2020 to provide additional data and increase the ability to detect annual changes in invasive carp population status. Abundances upstream of the Cannelton Pool remained at a level too low for the current monitoring effort to detect annual variation. Agency sampling for invasive carp was hindered in the spring of 2020 due to operational restrictions in place due to the COVID-19 pandemic. Fishery monitoring in 2019 and 2020 provided additional data on the overall fish community composition within the silver and bighead carp invasion range in the Ohio River. Surveys documented the total number of fish species present over five pools (48 species in 2019; 60 species in 2020). In 2019, bighead, silver, and grass carp accounted for approximately 3.0 percent of the total catch from all KDFWR monitoring activities, with silver carp being

the most abundant invasive species encountered between Cannelton and Meldahl Locks and Dam. In 2020, invasive carp accounted for approximately 0.2 percent of the total catch from all KDFWR monitoring activities within the McAlpine and Markland Pools.

In 2019 and 2020, agencies continued efforts to detect and collect invasive carp eggs and larvae in the ORB to assess and document reproduction status and degree of establishment. Partners conducted traditional ichthyofaunal surveys targeting larval fish through several coordinated projects in support of the ORB MRP, including Early Detection and Evaluation of Asian Carp Removal in the Ohio River. Assessments of invasive carp reproduction dynamics conducted in the ORB in 2019 and 2020 supported the priorities of the ADELSAC project. Objectives included determining the extent of bighead and silver carp spawning activity in the Ohio River upstream of the Markland Dam, identifying tributaries in which spawning occurs, determining the geographic extent and locations of invasive carp recruitment in the Ohio River, identifying characteristics of potential invasive carp nursery areas, and determining the propagule source of invasive carp in the Ohio River. During the reporting period, IDNR led the ADELSAC, in coordination with USFWS, KDFWR, WVDNR, West Virginia University (WVU), SIU, and Ball State University (BSU). Agency activities included extensive ichthyoplankton (fish eggs and larvae) sampling and analyses. In 2020, agencies conducted more than 40 larval tows in the McAlpine and Markland Pools. Despite reported signs of spawning activity, only one possible invasive carp egg was collected from all sampling efforts, and no invasive carp larvae were collected. Silver carp bearing physical signs of spawning behavior (spawning patches) were detected as early as May 2020, and spawning efforts were observed and first reported through the 2020 contract fishing program in the Cannelton Pool.

In 2019 and 2020, State agencies continued targeted sampling for invasive carp in the Tennessee and Cumberland River systems within the greater ORB. KDFWR conducted standardized sampling with gillnets in the Kentucky Lake and Lake Barkley Reservoirs in 2019 and 2020. Demographics information obtained through targeted sampling indicated that silver carp in Lake Barkley grew faster and larger on average than in Kentucky Lake, although the populations were similar in age distribution. In addition, KDFWR conducted fish community surveys in the tailwaters below Kentucky Dam (Tennessee River) and Barkley Dam (Cumberland River) to monitor the impacts of dense invasive carp populations on popular sport fisheries. Further information was gathered through angler creel surveys conducted by KDFWR at those locations. A creel survey conducted in the tailwaters of Kentucky Dam and Barkley Dam from February through November 2019 indicated that the total catch of silver and bighead carp decreased slightly in both tailwaters from the previous survey in 2017 and that most anglers surveyed said they were satisfied with the tailwaters' fisheries.

Also in 2019 and 2020, TWRA assessed invasive carp populations in the Tennessee and Cumberland River systems in Kentucky, Pickwick, Barkley, and Cheatham Reservoirs. Activities focused on determining population characteristics, spatial and seasonal variation, and relative abundance of bighead and silver carp. TWRA also continued development of indices of invasive carp abundance in the dam tailwaters of these reservoirs. Data from those efforts provide key information on invasive carp populations that serve as potential source populations of further upstream range expansions. TWRA also conducted targeted field sampling to evaluate invasive carp reproductive success in Kentucky Lake

and Lake Barkley by deploying larval fish light traps for the capture of age-0 (larval) bighead and silver carp.

In 2019 and 2020, the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP) fisheries biologists conducted invasive carp sampling on Pickwick Lake using gillnets and electrofishing gear (five sampling events in 2019 and four in 2020). In 2020, MDWFP coordinated with Mississippi State University (MSU) on a project entitled Development of Management Strategy for Surveillance and Containment of Invading Asian Carp in Waters Connected to the Tennessee River. MSU conducted invasive carp sampling in the Mississippi waters of Pickwick Lake and Bay Springs Lake using electrofishing and gillnetting. No invasive carp were captured or observed. Additional sampling was conducted in Pickwick Lake and Bay Springs Lake using gillnetting; however, sampling was hindered due to heavy barge and boat traffic and other logistics. No bighead or silver carp were captured during the additional sampling in Pickwick Lake. Two silver carp were captured during gillnet sampling in Bay Springs Lake. Also, MSU conducted an analysis of trends in the fish species assemblages based on agency fishery sampling data from Pickwick Lake (1992–2017) and Bay Springs Lake (1986–2017). Results of electrofishing data did not demonstrate any major shifts in the fish assemblages that could be attributed to the introduction of bighead and silver carp in these waters. Those results were expected as invasive carp abundance at both reservoirs was nil or very low during most of the period analyzed. MSU conducted a similar analysis using gillnetting and electrofishing data collected by TVA in Kentucky Lake and Wheeler Lake, reservoirs in the Tennessee River above and below Pickwick Lake, respectively. The TVA dataset spanned 1990–2017. Bighead carp were first reported in the Tennessee River in 2004 and as of 2017 had not reached Wheeler Lake (the control lake). Results indicated that gizzard shad began decreasing in density in both reservoirs well before the introduction of bighead carp and that the decrease continued after 2004. The MDFWP analysis identified no detectable effect of bighead carp on the trends in gizzard shad densities already underway before 2004.

In 2020, the Alabama Department of Conservation and Natural Resources (ADCNR) conducted monitoring for invasive carp in the four Tennessee River impoundments in Alabama (Pickwick, Wilson, Wheeler, and Guntersville Reservoirs). ADCNR collected initial survey data to assess nine potential gillnet sample locations using bottom sonar and subsequently conducted standardized gillnet sampling (six sites) and electrofishing (four surveys) on Pickwick and Wheeler Reservoirs. Invasive carp collections were limited during the 2020 field sampling. All invasive carp were captured in Pickwick Reservoir (five silver carp; one grass carp) and were removed from the system.

Rapid Response

Agencies continued the development of a contingency response plan for the ORB to guide response efforts in the event that changes in the distribution of invasive carp are detected above a threshold level within specific locations in the ORB. WVDNR and KDFWR continued to lead this effort. A final plan was anticipated by October 2022.

In November 2018, PFBC biologists conducted gillnet sampling in the Montgomery Slough portion of the Montgomery Island Pool (PA) on the basis of eDNA results from 2017 that included one positive result for bighead carp at this location. No invasive carp were captured during targeted gillnetting. Additional gillnetting was conducted near the mouth of Mahoning Creek on the Allegheny River (Ohio River tributary), with no invasive carp captured.

In 2020, the Georgia Department of Natural Resources (GADNR) developed a framework for implementing strategic rapid response actions in the event of an invasive carp introduction in Georgia waters. The document also informs the planning of education and prevention efforts that will minimize the risk of potential introductions. The framework identified partners needed during development and implementation of a response; treatment options to consider based upon the circumstances of the introduction; education and outreach efforts to consider; and post-treatment management of an introduction.

3.5.3 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.**

Invasive Carp Capture and Removal

ORB agencies continued the targeted capture and removal of invasive carp using State-directed commercial fishing and agency fishery sampling capacity during 2019 and 2020. Fishing effort was focused in the mainstem sections, pools, and reservoirs of the Ohio, Tennessee, and Cumberland Rivers. Removal actions focused on reducing propagule pressure (or the likelihood of population growth and dispersal) in downstream pools to prevent further expansion upriver, supporting the detection and removal goals of the ORB MRP project Control and Containment of Asian Carp in the Ohio River. ORB invasive carp removal efforts used agency internal capacity and licensed commercial fishers. Removal strategies were directly informed by up-to-date information on invasive carp populations in the ORB, including fish movement patterns within specific pools during varying river conditions. In addition, anecdotal reports from fishing tournaments, marina operators, and anglers to agencies provided further information on specific locations in tributaries and embayments in pools where high densities of invasive carp were observed.

Agency removal efforts in pools of the Ohio River spanned 2019 and 2020. In 2019, WVDNR, KDFWR, USFWS, and West Virginia University (WVU) partnered to conduct a large-scale removal effort in the R.C. Byrd Pool using boat electrofishing and gillnetting. The effort focused on habitats where invasive carp were more likely to be present (e.g., tributaries, lock approaches). Eight bighead carp were removed, all from Raccoon Creek, a tributary of the R.C. Byrd Pool. WVDNR continued targeted removal efforts in the R.C. Byrd Pool through multiple sampling events in 2019 and 2020. In 2019 and 2020, KDFWR crews

conducted targeted removal actions in the Cannelton, McAlpine, and R.C. Byrd Pools. KDFWR and partners conducted assessments of the efficacy of unconventional gear types for capturing invasive carp during the monitoring and removal activities. In 2020, KDFWR agency staff focused removal efforts primarily above Cannelton Pool, where invasive carp numbers are much lower. KDFWR removed 5,430 silver carp, lower than anticipated due to decreased field time during peak sampling periods as a result of COVID-19 restrictions. In 2020, IDNR conducted seven targeted invasive carp removal efforts in the ORB, resulting in the capture and removal of 2,230 invasive carp totaling 19,180 pounds.

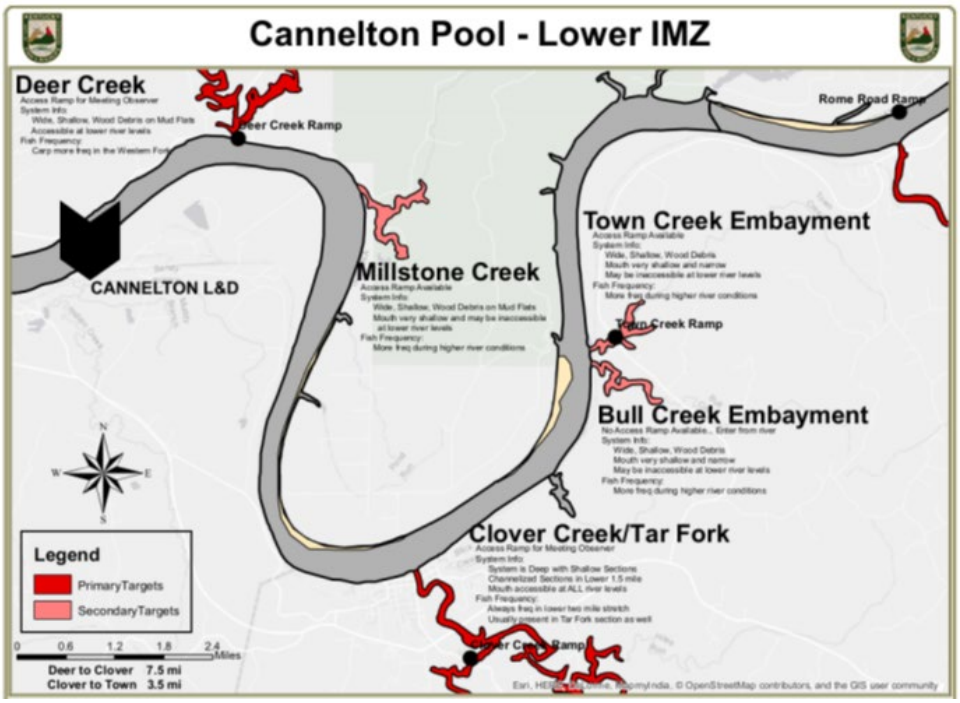


Figure 16. Map Developed to Inform Planning for Targeted Invasive Carp Removal in the Lower Cannelton Pool. Note: This is one of a series developed using monitoring and removal data collected during the previous four years. Source: Map developed by Andrew Stumpf, KDFWR

In the Tennessee and Cumberland River systems, KDFWR conducted 36 targeted invasive carp removal surveys in 2019, resulting in the removal of 50,561 pounds of invasive carp. In 2020, 39 targeted invasive carp removal surveys by KDFWR resulted in the removal of 53,696 pounds of invasive carp from this subbasin.

Removal of invasive carp by commercial fishers from ORB waters increased during 2019 and 2020. State agencies continued to provide coordination and oversight of commercial harvest, strategically directing the effort to locations where it could most effectively reduce invasive carp population numbers and abate upstream range expansion. In 2020, contracted commercial fishers increased harvest of invasive carp in the middle Ohio River by more than 200 percent above 2019 levels. Harvest effort by contract fishers was greatest during the fall-through-spring months, when water levels were relatively high. Contracted anglers were the first to report sightings of invasive carp spawning activity during the spring of 2020.

In 2019 and 2020, KDFWR expanded its collaboration with commercial fishers to support invasive carp removal, establishing an agreement with 13 experienced commercial fishers to fish Cannelton Pool to decrease carp population numbers and discourage density-dependent dispersal in the Ohio River. Efforts targeting removal of invasive carp through this agreement began in July 2019.

From its inception in 2013 through 2020, the KDFWR Asian Carp Harvest Program (ACHP) supported the harvest of more than 20 million pounds of invasive carp from Kentucky waters. The ACHP was initiated by KDFWR to allow commercial fishing targeting invasive carp in previously restricted areas of Lake Barkley, Kentucky Lake, and their respective tailwaters. Commercial fishers are required to submit daily harvest logs and allow KDFWR staff to routinely accompany them to monitor bycatch, providing an additional source of valuable data on invasive carp population status and demographics. KDFWR incentivizes the harvest of invasive carp from Lake Barkley, Kentucky Lake, and their tailwaters by administering a $0.05/pound subsidy through the ACHP to commercial fishers harvesting invasive carp in those waters. KDFWR paid $157,670 to commercial fishers in 2019 and approximately $350,000 in 2020 through the subsidy program, leading to the removal of 7,716,770 pounds of silver carp, 113,551 pounds of bighead carp, and 207,534 pounds of grass carp, for a total of 8,037,855 pounds for all three species combined from January 2019 through September 2020.

In addition, KDFWR monitored silver carp demographics in Lake Barkley to assess the effect of continued commercial harvest on populations. After analyzing and collecting the biological information, KDFWR determined that the level of commercial harvest of silver carp in Kentucky Lake and Lake Barkley was not adequate to provide a sufficient level of control without additional measures.

Commercial fishers also supported the acquisition of key data from incidental captures of black carp, which are present in relatively low numbers in the ORB and are therefore harder to collect. In 2019, KDFWR retrieved 18 black carp captured by commercial fishers in the Ohio River and two captured in Kentucky Lake. In 2020, KDFWR retrieved 11 black carp captured in the Ohio River and one captured in Lake Barkley, which were assessed following standard USGS protocol and samples sent to the appropriate entities for further analysis.

In 2019 and 2020, Tennessee Wildlife Resources Agency (TWRA) provided oversight and support for the targeted use of commercial fishers for invasive carp removal in the Tennessee waters of Kentucky Lake and Lake Barkley. TWRA continued to administer the State's Asian Carp Harvest Incentive Program (ACHIP), a subsidy initiative to promote the targeted harvest and market use of invasive carp by commercial fishers and wholesale fish dealers. More than 2.1 million pounds of invasive carp was harvested through the ACHIP between October 2018 and September 2019, and more than 2.9 million pounds was harvested between October 2019 and September 2020, for a total of more than 5 million pounds during the reporting period. In addition, TWRA provided netting to commercial fishers for use in sampling for and harvesting invasive carp in Lake Barkley and Kentucky Lake.

In Mississippi, MDWFP conducted outreach to local commercial fishers in the Pickwick Lake area to inquire about their potential interest in being contracted by the agency for invasive carp removal from the lake. MDWFP communicated with all licensed resident and non-resident commercial fishers and

those who contacted MDWFP expressing interest in harvesting invasive carp, informing them of the State's contract fishing program. The program proposed to pay at least $10.00 per hour to participants. The proposed contract fishing program was subsequently terminated due to lack of interest from potential participant fishers. Plans were made to develop an invasive carp processor reimbursement program in 2021 to support harvest and removal efforts. TWRA proposed a similar reimbursement program to support invasive carp harvest and removal efforts at Pickwick Lake in 2021. MDFWP and TWRA are coordinating on this effort regarding the appropriate reimbursement price per pound and what price per pound invasive carp processors should pay to fishers to seek the agency reimbursement price. The goal is to have both MDWFP and TWRA use the same prices to discourage fishers from moving between the States to seek a higher reimbursement price.

Actions to Address Pathways

During 2019 and 2020, ORB agencies continued efforts to identify, evaluate, and mitigate potential pathways facilitating the interbasin movement of invasive carp. In 2019 and 2020, the Mississippi Department of Wildlife, Fisheries and Parks evaluated the potential for the interbasin transfer of invasive carp from the Tennessee River basin to the Mobile River basin via the Tennessee-Tombigbee Waterway (TTW). Completed in the early 1980s, the TTW is a 234-mile man-made navigation canal with a series of 10 lock-and-dam impoundments that connect the Tennessee River at Pickwick Lake to the Black Warrior/Tombigbee River system in Alabama, eventually leading to Mobile Bay. The TTW is considered a major tributary of the Tennessee River. All MDWFP activities were within the greater Ohio River subbasin.

The ODNR and USACE continued activities to address the highest-priority secondary hydrologic interbasin pathways between the MRB and GLB, identified through the GLMRIS Focus Area 2 Aquatic Pathways Assessment Summary Report (GLMRIS 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 dispersal of invasive carp and other aquatic species. The GLMRIS Aquatic Pathway Assessment Reports identified several intermittent pathways in Ohio as having a medium probability of transfer of invasive carp and other aquatic invasive species (AIS) from the MRB (via the ORB) to the GLB. Work conducted in Ohio during the reporting period addressed the Ohio-Erie Canal and Little Killbuck Creek pathways, both categorized as medium risk. Also, the Indiana DNR continued a collaboration with the Little River Wetlands Project (https://www.lrwp.org/eaglemarsh) to maintain and upgrade, as needed, the earthen berm constructed in 2015 to address the medium-risk interbasin pathway at Eagle Marsh in northeast Indiana.

In addition, IDNR collaborated with KDFWR and local property managers to determine the feasibility of future lake drain structure modifications to limit invasive carp recruitment occurring in Hovey Lake, a small lake in Indiana adjacent to the Ohio River.

3.5.4 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

Agencies conducted collaborative research to assess technologies and inform the potential implementation and operation of invasive carp barriers, with a focus on deployment at locks and dam structures as strategic "pinch points" in the ORB. Actions included implementation of large-scale field pilot studies; scoping of potential opportunities to support deterrent deployment in subbasins; assessment of the distribution, movement, and lock and dam passage of invasive carp in the Ohio River through acoustic telemetry; and evaluation of movement and lock and dam passage of invasive carp in the Tennessee River.

Acoustic Deterrent Barriers

In 2019 and 2020, the USFWS, USACE, USGS, and KDFWR, in collaboration with the University of Minnesota and Fish Guidance Systems, Ltd. (FGS), initiated a multiyear pilot project to evaluate the effectiveness of a Bio-Acoustic Fish Fence (BAFF) deterrent system to slow the upstream migration of invasive carp at Barkley Lock and Dam (BLD) on the Cumberland River in Kentucky. The BLD site was chosen for testing the technology due to the presence of an established and migratory population of invasive carp both upstream and downstream of the lock and dam complex. The BAFF system was designed by FGS for deployment at the entrance of lock approach channels. It generates a combination of sound, bubbles, and lights as a behavioral deterrent to fish movement. Installation began in July 2019, and the system became operational in October 2019. The pilot evaluation was initiated and continued through the 2020 reporting period. The pilot study is evaluating the effectiveness of the BAFF against invasive carp under varying conditions and over the course of multiple seasons and years. The majority of fish tagged for the study are silver carp, the most abundant species of invasive carp found in this reach of the Cumberland River. The study is evaluating effectiveness against both translocated and nontranslocated fish. Translocated fish are individuals that were captured upstream of the study site (upstream of the BLD and the BAFF deployment site) and are then transported downstream, acoustically tagged, and released. The addition of translocated fish ensures the inclusion in the study of invasive carp further motivated to migrate back upstream to their site of origin, potentially providing a more aggressive test of the BAFF's effectiveness as a deterrent. Additional activities included to support the multiyear study include tagging invasive carp and native species with acoustic transmitters, operation of a fish telemetry receiver array to support the study, and enforcing fishing restrictions in the area. The study is scheduled to conclude in September 2023. This project is further referenced in Section 3.9.4.

In 2020, ORB agencies—including USGS, USFWS, TVA, USACE, KDFWR, TWRA, Mississippi Department of Wildlife, Fisheries, and Parks (MDFWP and Alabama Department of Conservation and Natural Resources (ADCNR)—convened the Tennessee River Asian Carp Deterrent Workshop, a series of joint working

meetings between fisheries resource managers and other technical subject matter experts. The workshop led to the development of a structured process for comprehensive and robust analysis to rank and prioritize both fish barrier technologies and specific locations with the goal of optimizing focused actions for the control of invasive carp within the Tennessee River system. Multiple fish deterrent technologies were evaluated for barrier efficacy, cost, safety, and other factors; the current distribution of invasive carp within the Tennessee River was used as a primary factor to inform decision making on strategic placement of fish barriers to achieve maximum impact in slowing range expansion. Recommendations of the workshop participants were subsequently used to inform TVA's process to finalize scientifically defensible alternatives that were included in their Asian Carp Mitigation Draft Programmatic Environmental Assessment (PEA) (The PEA includes an assessment of the potential environmental and economic impacts of invasive carp range expansion throughout the Tennessee River watershed.

In addition, TWRA conducted freshwater mussel surveys below six lock and dam sites on the Tennessee River to inform the barrier installation PEA being led by TVA.

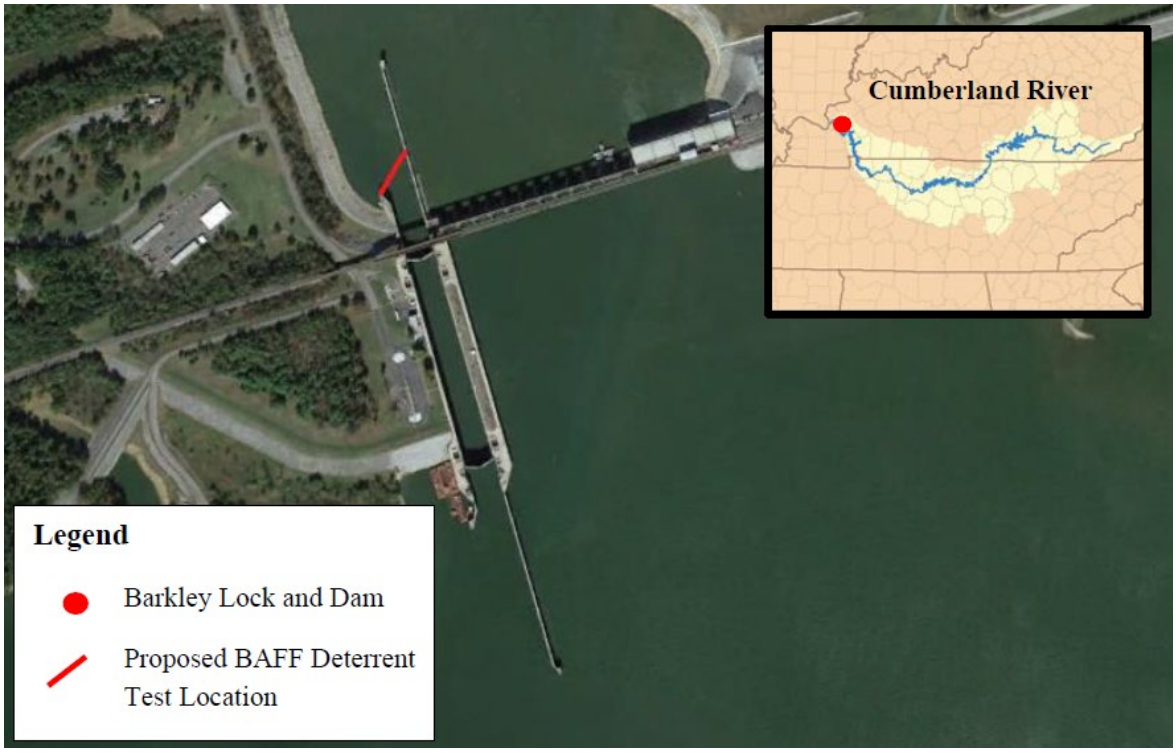


Figure 17. Location of Bio-Acoustic Fish Fence (BAFF) Deterrent System Pilot Test at Barkley Lock and Dam on the Cumberland River in Kentucky

Development and Testing of New Capture Gears and Techniques

ORB agencies continued development and testing of fishery gears and techniques focused on improving the ability to detect and capture invasive carp of all life stages in various habitats. USGS, KDFWR, and USFWS collaborated on implementation of a Modified Unified Method (MUM) invasive carp sampling

strategy for use in select embayments of Kentucky Lake. The MUM technique was developed for capturing invasive carp in lake or reservoir embayments using directional fish “herding” with boat electrofishing and sound to drive invasive carp into entrapment gears (e.g., large nets) for capture and removal. Planning and advance coordination occurred in 2019. An initial MUM sampling event conducted during February 2020 in Kentucky Lake, resulting in the capture and removal of approximately 69,000 pounds of invasive carp. A second MUM event was conducted in Kentucky Lake between December 2020 and March 2021, again led by USGS, in collaboration with KDFWR and USFWS. The goals of those initial sampling events were to evaluate the overall effectiveness of the MUM as a localized control strategy, the response of tagged fish to net deployment and herding techniques, and the effectiveness of acoustic methods for measuring fish abundance in the embayments. Approximately 38,000 pounds of invasive carp were captured and removed through the second MUM sampling event.

In 2019, KDWR and USFWS deployed a Paupier net designed to capture invasive carp on Kentucky Lake and Lake Barkley. Sampling resulted in the capture and removal of 7,935 pounds of invasive carp from the two reservoirs. The agencies conducted additional sampling in Kentucky Lake in fall 2019 using both the Paupier net and an electrified dozer trawl to assess the relative abundance and length frequency of silver carp. Those sampling efforts allowed the agencies to assess the potential for either gear type to be used for standardized sampling and estimating the relative abundance of invasive carp in large reservoirs. An evaluation of the data showed the Paupier net was more effective at capturing silver carp less than 22 inches in total length compared with the electrified dozer trawl and provided additional information on the condition and demographics of silver carp in Kentucky Lake.

In 2020, USGS initiated a field study to assess bighead and silver carp behavior in the tailwaters of the Kentucky Dam on the Tennessee River. The study is evaluating factors that influence when silver and bighead carp congregate in tailwaters to inform potential removal efforts. Fish survey and river flow data were collected at Kentucky Dam using hydroacoustics. Also, an acoustic telemetry array was established, and bighead and silver carp were tagged in this tailwater in 2020. Informed by this work, USGS is partnering with KDFWR to develop techniques and gear for targeted removal of large congregations of invasive carp at tailwater locations.

KDFWR collaborated with Two Rivers Fisheries to test a netting system originally used in China for harvesting invasive carp in U.S. waters. The system was fished for one week in Lake Barkley, resulting in the capture and removal of 341 pounds of invasive carp. In addition, KDFWR developed a master agreement contract designed to assess potential invasive carp harvest methods and technologies.

Indiana DNR (IDNR) tested fishery trawling gear designed for deployment higher in the water column for its ability to target and capture juvenile (smaller sized) invasive carp. The gear was used by agencies to capture juvenile silver and bighead carp during summer months, providing important data for identifying recruitment areas.

Invasive Carp Life History and Reproduction Evaluations

USGS conducted evaluations of invasive carp spawning success in the ORB, which included collection of water quality and flow data and use of the Fluvial Egg Drift Simulator (FluEgg), a biological particle transport model for predicting the transport of invasive carp eggs and larvae in rivers. Work in 2019 and 2020 focused on predicting bighead carp early life-cycle conditions in the Ohio River, with a goal of providing information on where eggs could be expected to settle or be transported through the Markland-McAlpine reach of the river.

3.5.5 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 partner agencies continued targeted communication and outreach to the public, industry, and other stakeholder groups on key invasive carp topics. Agencies developed and implemented communications strategies to support collaborative partnership missions by sharing information on the status of invasive carp, providing guidance on steps to minimize the risk of introduction and spread, and collecting new occurrence information (e.g., invasive carp catch data from recreational anglers and commercial fishers).

Invasive Carp Partnership Websites

Key planning documents and reports for 2019 and 2020 relevant to the MRB subbasin partnerships were made available to the public on MICRA's general website under "Invasive Carp Management and Control". Content is regularly updated as new plans and reports become available. Also, USFWS is regularly updated as new plans and reports become available. Also, USFWS continued to support and administer the invasivecarp.us website (formerly asiancarp.us) as a primary platform for delivering general updates on accomplishments, science, and other products related to invasive carp management, with a focus on activities of the ICRCC.

Public/Stakeholder Engagement

Through the reporting period, ORB partners supported activities focused on invasive carp outreach and education with the public, governments, industry, and other stakeholders. Agencies developed and placed educational signage at fishing and boating access points, distributed pamphlets to marinas and local businesses, provided press releases to local media outlets, and used social media platforms and podcasts to inform the public about invasive carp harvest efforts. Postings included messaging to inform local anglers and boaters of commercial fishing activities in specific areas to minimize potential impacts to recreational resource users. Agencies regularly provided informational updates to local angling clubs and media outlets on the status of invasive carp and opportunities for early detection and prevention.

State agency staff also coordinated with commercial fishers to ensure that deployed nets were properly marked for recreational fisher and boater awareness.

Informational materials also included messaging to discourage anglers from moving bait beyond the area where collected, information on how to identify invasive carp species, and what to do if a fish is captured or observed. Further efforts included activities to promote the appeal and edibility of invasive carp products to the public.

ORB agencies coordinated informational briefings and panel presentations for Federal and State elected officials, their staff, and the media in 2019 and 2020. A stakeholder roundtable and field briefing on invasive carp was hosted by Senator McConnell in western Kentucky in May 2019. In November 2019, agencies coordinated and hosted a deployment ceremony to highlight the installation of the BAFF at Lake Barkley in Kentucky. Support for the BAFF deployment event included development of a webpage, social media content, messaging, and frequently asked questions. An additional congressional field briefing was held in February 2020 associated with the MUM sampling event on Kentucky Lake. The event was attended by elected officials from Kentucky, including Senator McConnell, Congressman Comer, and Governor Beshear.

Also, the ODNR continued an aquatic invasive species outreach campaign with Wildlife Forever (https://www.wildlifeforever.org/) to minimize the movement of bait by anglers using targeted messaging on billboards, print media, and items for distribution at events with the slogan "Trash Unused Bait." Products and messaging from the outreach campaign were used to support the prevention of invasive carp and other AIS in waters of the State of Ohio.

Industry Engagement

The KDFWR continued outreach with the commercial fishing industry to enhance invasive carp reporting and collection. Outreach included meetings with commercial fishers and processors outlining changes to operation of the ACHP, identifying limiting factors to the harvest of invasive carp, and planning projects to develop new gear types for invasive carp capture. Additional coordination with commercial fishers included planning related to the ACHP ride-along project and the Kentucky Lake invasive carp demographics project. The KDFWR continued outreach with prospective businesses potentially interested in participation in processing and marketing opportunities for invasive carp, including coordination with consultants to identify potential markets for harvested fish.

3.5.6 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 state resource management agencies continued to enforce regulations providing oversight on AIS within their respective jurisdictions, including invasive carp. Enforcement focused on compliance with regulations related to the production, possession, sale, and transport of invasive carp along with

regulations and best practices related to the transport and use of live bait by commercial harvesters, dealers, and anglers. In 2017, the U.S. Court of Appeals for the District of Columbia Circuit held that section 42(a)(1) of title 18 of the Lacey Act does not "prohibit shipments of injurious species between the continental States" (*United States Ass'n of Reptile Keepers, Inc.* v. *Zinke,* 852 F.3d 1131, 1142; D.C. Cir. 2017). Individual States, however, continued to regulate production, possession, sale, and transport of invasive carp.

Although regulations are in place on a State-by-State basis, grass carp are not listed injurious under the Lacey Act. In 2015, MICRA submitted a report to USFWS proposing eight recommendations to establish a consistent national policy strategy for grass carp to minimize the risk of unintentional and illegal introductions of diploid and triploid grass carp. State agencies continued to conduct actions to provide oversight of grass carp within their respective jurisdictions. Through the Aquatic Nuisance Species Task Force Great Lakes Panel, the ODNR sent a letter to the remaining States in the MRB that allow use of diploid (fertile) grass carp recommending a transition to triploid (sterile) fish. In addition, ODNR continued to assess the grass carp supply chain to ensure that all tested fish were triploid (sterile) and conducted surveillance of Ohio's bait supply chain to determine if AIS, including bighead and silver carp, were being transported through this pathway.

State agencies implemented or amended existing regulations and guidance to support general AIS and invasive carp prevention and control within their respective jurisdictions. KDFWR amended existing regulations to restrict fishing in the mouth of the Barkley Lock chamber to support the BAFF pilot study throughout its testing period; include a commercial fishing license fee waiver for commercial fishermen who harvest only invasive carp; allow commercial fishing for invasive carp in restricted waters on weekends and holidays throughout the year; and allow the sale of invasive carp harvested by any legal fishing method whether the harvester possesses a commercial or sport fishing license.

KDFWR continued to enforce regulations regarding mesh size of gillnets to reduce bycatch. Gillnets are the primary invasive carp harvest method used by the commercial industry in Kentucky waters.

3.6 Upper Mississippi River Basin

3.6.1 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.**

Federal and State agencies in the UMRB continued collaboration on invasive carp management strategies and projects in 2019 and 2020 through the MICRA Asian Carp Advisory Committee and the UMRCC Fisheries Technical Section Ad Hoc Asian Carp Team. Priority management actions support implementation of the National Plan, State agency invasive carp management strategies, and the UMRCC's Upper Mississippi River Fisheries Plan. Additional coordination occurred through the Upper Mississippi River Basin Association (UMRBA), MRBP, the Lower Mississippi River Conservation Committee, the Missouri River 100th Meridian Work Group, and ICRCC planning meetings.

Partnering agencies include the Illinois Department of Natural Resources (ILDNR), Illinois Natural History Survey (INHS), Iowa Department of Natural Resources (IADNR), Minnesota Department of Natural Resources (MNDNR), Missouri Department of Conservation (MDC), Wisconsin Department of Natural Resources (WDNR), USACE, USCG, USFWS, USGS, and NPS.

USFWS coordinated with Federal and State agency partners to identify annual UMRB subbasin priorities. Projects were identified and developed for early detection, monitoring, and control to prevent further distribution and establishment of invasive carp in the UMRB.

3.6.2 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.

Invasive Carp Telemetry Monitoring

The UMRB agency partners continued to maintain a comprehensive telemetry monitoring network in the main stem Mississippi River and major tributaries during 2019 and 2020. Telemetry tracking of invasive carp in the UMRB started in 2008. The telemetry monitoring effort has since expanded and continues to provide critical data describing the movement and location of invasive carp populations across seasons and under varying environmental conditions. Data are used to inform targeted invasive carp harvest actions conducted in collaboration with commercial fishers and deterrent technology evaluations being planned or already underway within the UMR. Telemetry activities in 2019 and 2020 supported two projects described in the Monitoring and Response Plan for Asian Carp in the Mississippi River Basin *(Evaluation of Controls, Impacts and Behaviors of Asian Carp in the Lower UMR* and *Evaluation of Fish Passage for Assessment of Asian Carp Deterrents at Multiple Locks in the Upper Mississippi River).*

In 2019 and 2020, USGS, USFWS, USACE, MDC, INHS, and MNDNR continued a collaborative telemetry study that tracked acoustically tagged invasive carp through a telemetry array of more than 250 stationary receivers, extending from above Coon Rapids, Minnesota, to Cairo, Illinois, a distance of more than 650 river miles (Figure 18). Nearly 900 acoustic tags have been implanted in invasive carp and native fish by USFWS, USGS, and INHS from 2013–2020. Additional capacity was added to the UMRB telemetry array with the installation of two new telemetry real-time receivers in Pool 16 and Pool 17 during 2019, supplementing existing real-time receivers in Boston Bay (Pool 18) and Cleveland Slough (Pool 17) (Figure 19). Telemetry data were used to inform planning of four targeted invasive carp capture efforts, during which more than 126,000 pounds of invasive carp were removed from the river.

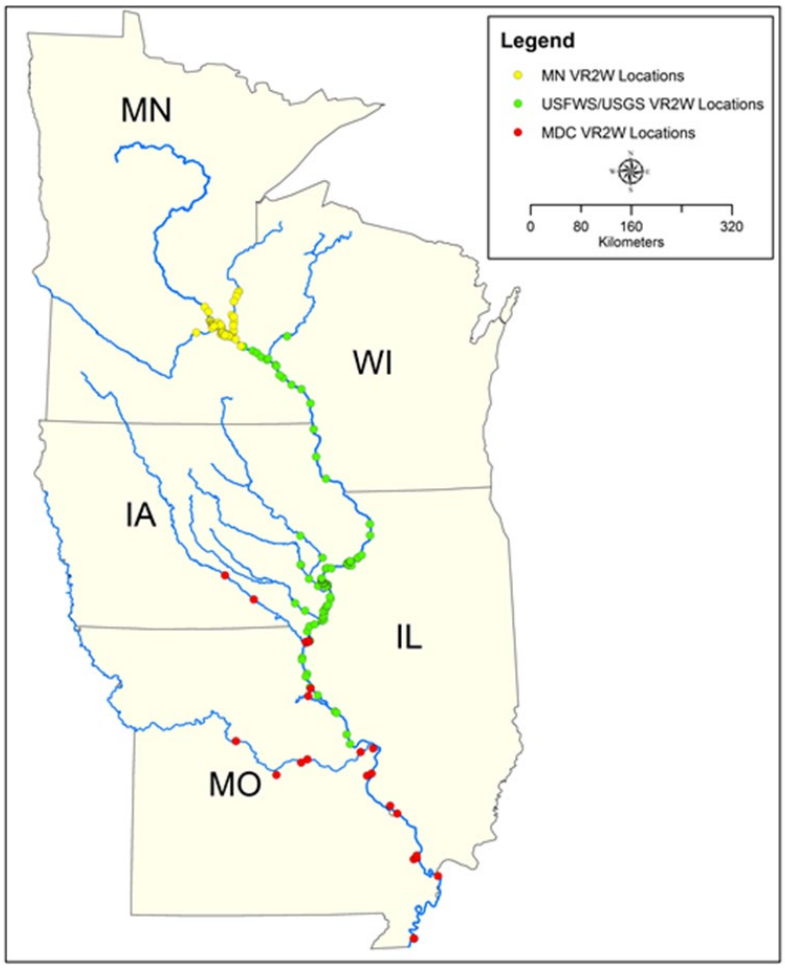


Figure 18. Map of Telemetry Receivers Deployed by UMRB Agency Partners to Monitor the Movements of Invasive Carp and Sympatric Native Species Note: The location and number of receivers attributed to each agency is approximate because the actual number and position of some of these units changes each year. Map Credit: J. Koenig, USFWS

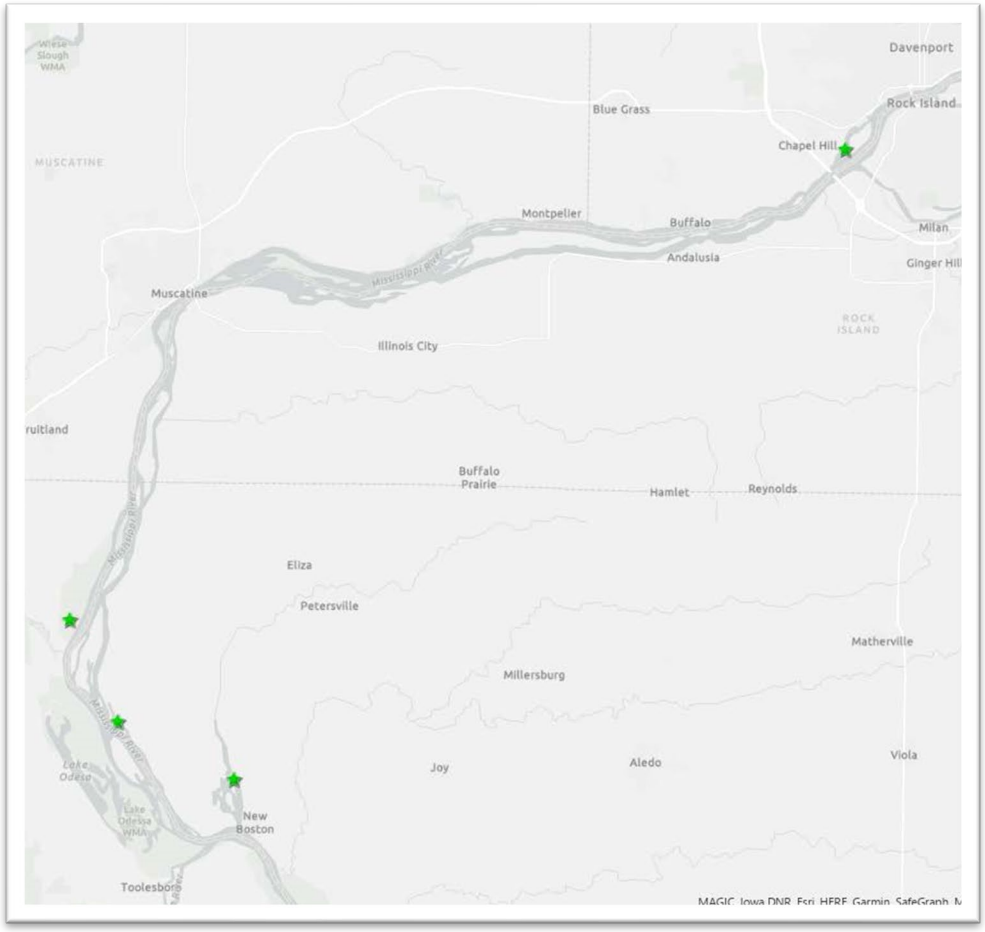


Figure 19. Map of Real-Time Telemetry Unit Locations Deployed and Operated by USFWS and USGS. Note: Green star symbols indicate the location of individual telemetry units in Pools 16-18 of the UMR. Map Credit: Mark Fritts, USFWS

During 2019 and 2020, INHS and USFWS tagged additional silver and bighead carp for invasive carp telemetry tracking in Pools 14 through 16 of the upper Mississippi River (n=18, November 2019; n=132, June 2020). During 2020, the design of the UMR telemetry array was modified to better accommodate reduced agency field operations due to health and safety requirements in place as a result of the COVID-19 pandemic. For example, the density of receivers in Pool 5A through Pool 10 was increased and a smaller "skeleton" of receivers was deployed in downstream locations where overnight travel is typically required to complete the routine field activities. Despite the limited extent of the 2020 array, receivers deployed by USFWS and INHS recorded detections from 27 bighead carp, 57 silver carp, 5 hybrid carp, 50 bigmouth buffalo, 46 paddlefish, and 1 lake sturgeon in eight pools of the UMR. Most invasive carp residency events were concentrated in Pools 16 through 19, where the highest densities of tagged invasive carp occur.

Within the Upper Mississippi, Ohio, and Illinois Rivers, USGS continued collaboration with USFWS and other partners to develop and operate a multibasin, real-time telemetry network and a telemetry

database and visualization tool that includes data from fish tagged and tracked in those rivers. The database facilitates real-time fish tracking and data sharing between agencies, supporting a greater understanding of invasive carp movements within and across river basins.

Further upriver, USFWS collaborated with MNDNR and WIDNR in 2020 to surgically implant acoustic telemetry tags into five silver carp captured during contracted commercial fishing efforts in Pool 8 of the Mississippi River near La Crosse, Wisconsin, for active tracking. Similar to tracking and planning efforts in other pools, data collected from these tagged fish were used to inform targeted harvest by contracted commercial fishers working with MNDNR to remove silver and bighead carp near the uppermost extent of their invasion range in the UMR.

In the St. Croix River, MNDNR continued monitoring tagged bighead carp using active boat tracking and a passive telemetry receiver array in 2019 and 2020, providing information on daily and seasonal fish movement, including overwintering habitats. Tagged fish exhibited similar movement patterns as those observed in previous years. MNDNR used data from the fish tracking project to inform invasive carp removal efforts in the St. Croix River.

Telemetry tracking was also used to collect key baseline information on black carp in the UMR in 2019 and 2020. USGS collected data from acoustic- and radio-tagged adult fish to support an evaluation of black carp habitat use and movement and to assess the location, method, and timing of black carp captures. Monitoring of the long-range movement of black carp continued through 2020 with the existing acoustic receiver array managed by UMRB partners.

Hydroacoustics

During the fall of 2019, USFWS conducted hydroacoustic surveys in more than 315 miles of main channel, side channel, and backwater habitats of Pools 16 through 19 in the UMR. The surveys were conducted to inform development of an invasive carp stock assessment. In total, more than 36.6 million cubic meters of water were sampled with hydroacoustics, and 5,559 fish greater than 10 inches (254 mm) in total length (TL) were detected. Surveys provided data on the general distribution of fish by size class within the various habitat types and observed differences in fish densities between pools. Future surveys will require more robust fishery-independent sampling data (e.g., data from targeted agency fishery surveys for invasive carp and other species using traditional sampling gear) to inform the development of species-specific hydroacoustic estimates. In addition, USFWS conducted hydroacoustic surveys in Pool 8 of the UMR to search for possible congregations of invasive carp and to identify suitable locations to conduct and evaluate targeted contracted commercial fishing and use of the MUM.

eDNA Monitoring

USFWS conducted eDNA monitoring for invasive carp in priority locations in the UMRB in 2019 and 2020 in coordination with State agency partners. Monitoring for bighead and silver carp eDNA was conducted by USFWS during the weeks of October 28 and November 14, 2019, focused on the mainstem Mississippi River and select backwaters (Figures 20 and 21). A total of 88 samples were collected in Pool

13, near Bellevue, Iowa, and Hanover, Illinois. A single sample was positive for invasive carp eDNA (bighead and silver carp eDNA detected). Of the 528 samples collected from Pool 14 at four sites between Clinton, Iowa, and Rapid City, Illinois, 7 were positive for silver carp eDNA. Collection of samples was targeted toward backwater habitats in priority UMRB locations, identified in coordination with State partners**.** Additional sampling planned for the spring of 2019 in Pools 13 and 14 of the Upper Mississippi River was canceled due to prolonged flooding. Sampling planned for the spring of 2020 in Pools 13, 14, and 16 of the Upper Mississippi River was canceled due to health and safety restrictions resulting from the COVID-19 pandemic. Further details on the agency eDNA monitoring efforts in the UMRB and other basins can be found at https://fws.maps.arcgis.com/apps/dashboards/52b22abe9c4d4575adfe851a946f444d.

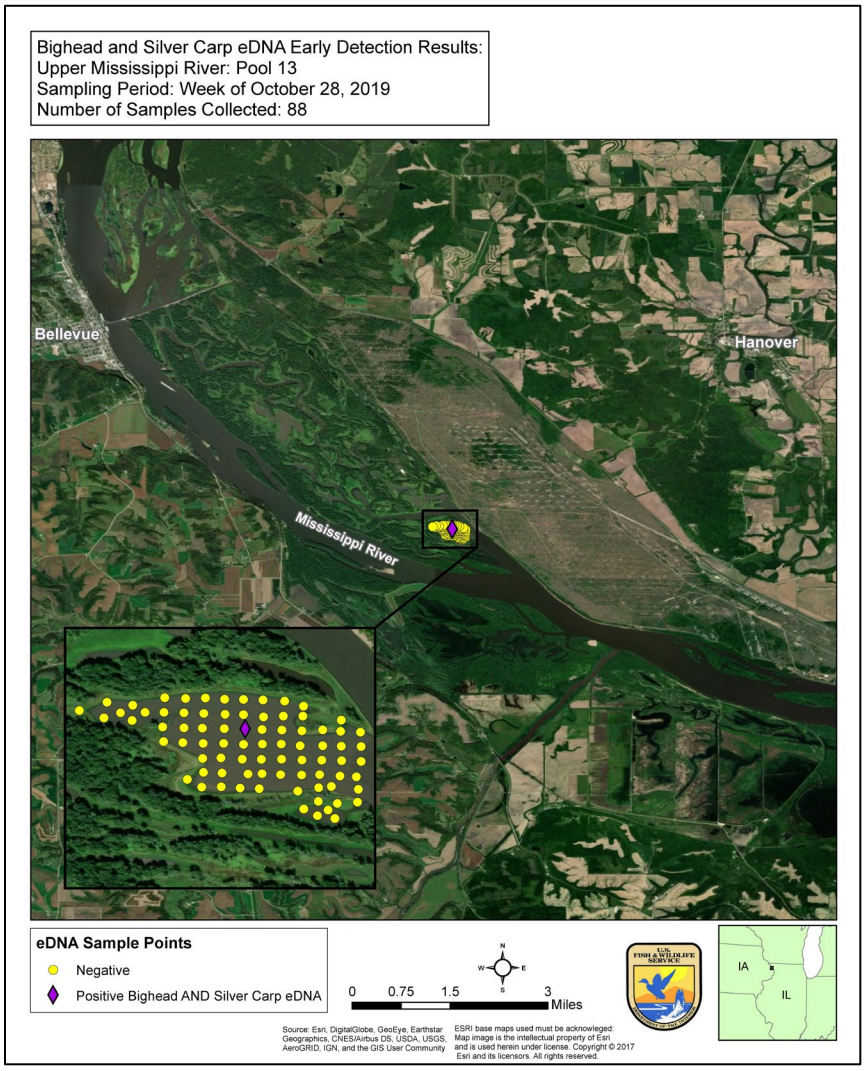


Figure 20. Sample Locations and Results for Invasive Carp eDNA Monitoring in Pool 13 of the Mississippi River, October 2019

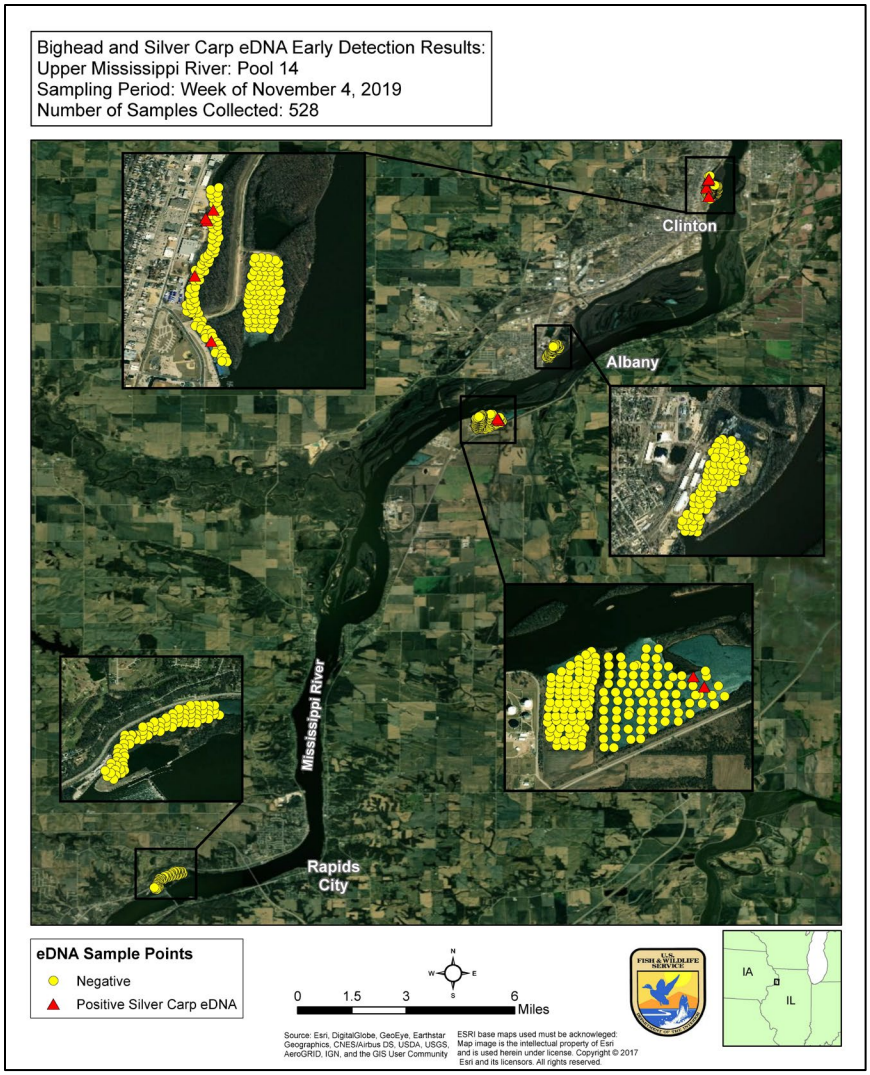


Figure 21. Sample Locations and Results for Invasive Carp eDNA Monitoring in Pool 14 of the Mississippi River, November 2019

USGS continued the development of new technologies and processes for effectively using eDNA as an early detection tool for invasive carp. Actions included developing and validating the use of a portable eDNA detection kit for silver, bighead, grass, and black carp in open water applications. In addition, USGS developed occupancy models to identify the number of samples needed to minimize the risk of "false negatives" and protocols to inform when and where to collect water samples for eDNA analysis to maximize the chances of detection of silver and bighead carp. A false negative occurs when eDNA is present at the sampling site but not collected in the eDNA sample or eDNA is present in the collected sample but not detected with the genetic assay.

Traditional Gear Sampling

The UMRB agencies conducted comprehensive monitoring for all life stages of invasive carp using electrofishing, netting, and other standard fishery gear and capture techniques in targeted pools, river

reaches, and tributaries in the basin. In 2019 and 2020, efforts continued to focus on detection of the leading upstream edges of bighead and silver carp populations in the mainstem upper Mississippi River and select tributaries, detection of new occurrences beyond the documented range of establishment, and identification of key locations and habitats for spawning and reproduction.

In 2019 and 2020, the MNDNR conducted targeted monitoring for invasive carp in Minnesota waters of the UMRB through its sampling program, initiated in 2012. The sampling was conducted by a dedicated team and included gillnets, electrofishing, trap netting, and larval trawling and monitoring of commercial fishing operations, contracted commercial fishing, and public reports. The MNDNR received 11 reports of invasive carp from the public in 2020. All reports were investigated in person, by phone, or via e-mail. Two reports were confirmed as invasive carp. One report was confirmed not to be invasive carp on the basis of photographs, and five reports were unlikely to be invasive carp on the basis of discussions. The MNDNR conducted followup sampling in response to three of the public reports of invasive carp occurrence, leading to the capture of two additional invasive carp. MNDNR annual reports summarizing invasive carp captures in Minnesota waters can be found at www.dnr.state.mn.us/invasive-carp.

The IADNR conducted electrofishing surveys during the summer months to monitor bighead, silver, and grass carp distribution and abundance in the Des Moines [Iowa] and Cedar Rivers. Additional information was provided by anglers, who reported first occurrences for silver carp in the Maquoketa River (North Fork) and Wapsipinicon River in Iowa.

Targeted sampling was conducted to assess the status of invasive carp reproduction in the UMR, including evaluations of the densities of eggs, larvae, and juvenile fish. In 2019, USFWS biologists assessed samples previously collected during the summer of 2018 through the Upper Mississippi River Invasive Carps, Egg, and Larval Fish Monitoring Program. Only one bighead carp larva was observed in 161 samples from 2018. The ILDNR conducted larval fish sampling in backwater habitats of Pools 17, 18, and 19 of the Mississippi River during June through September 2019. The total of 202 samples collected was lower than in previous years due to cooler water temperatures, flooding conditions, and inclement weather throughout the season. No invasive carp were collected in the 2019 samples. In 2020, ILDNR conducted sampling for larval fish on a weekly basis from June through September. A total of 129 samples were collected using larval light traps deployed in stream tributaries of Pool 19, targeting potential preferred habitat in Chaney Creek, Larry Creek, Waggoner Creek, and Lamalees Creek. No bighead carp were detected in the 2020 larval light trap samples.

In 2019, the ILDNR Invasive Species Unit (ISU) evaluated invasive carp reproduction in and adjacent to Pools 14 through 20. The ISU project assessed the contribution of major tributaries—including the Wapsipinicon, Rock, Iowa, Skunk, and Des Moines Rivers—to invasive carp reproduction (egg and age-0 fish densities). In 2019, no age-0 invasive carp were collected during sampling for this project. However, major flooding occurred during April, May, and June, preventing sampling during those months and potentially affecting the results. Given that age-0 invasive carp have been detected in the UMR every

year from 2014 through 2018, undetected successful invasive carp spawning events could have potentially occurred during the flooding period.

Rapid Response

The Upper Mississippi River Basin Asian Carp Control Strategy Framework includes goals and strategies that recognize the importance of expedited coordinated action in response to detections of invasive carp in new locations. Actions are intended to contain expansion of invasive carp in the UMR while minimizing impacts to native species. No rapid response actions were triggered or conducted during the 2019 and 2020 reporting period in the UMR.

3.6.3 Active Prevention and 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.**

Invasive Carp Capture and Removal

In 2019, persistent high-water levels on the Mississippi River in southern Minnesota, Iowa, and Illinois created prolonged "open river" conditions during which fish could move upstream unimpeded by locks and dams. Those conditions are believed to have led to higher numbers of invasive carp being detected and captured during monitoring and commercial fishing efforts in pools above the Intensive Management Zone (IMZ). Conditions in 2020 were more suitable for monitoring and commercial fishing efforts, although agency and contractor efforts were reduced due to health and safety restrictions resulting from the COVID-19 pandemic.

In 2019 and 2020, Western Illinois University (WIU), INHS, ILDNR, USGS, and USFWS collaborated on an effort to capture and remove invasive carp from Pools 14, 15, 16, 17, and 18 of the UMR. The project goals include the targeted removal of 400,000 to 500,000 pounds of invasive carp from those pools using commercial fishing and intensive netting protocols and collecting additional data to determine population abundance, reproduction, and movement. Commercial fishers removed 170,698 pounds of invasive carp during 2019. Use of multiple crews (more than one fisher) tended to increase catch-per-unit effort, specifically in Pools 18 and 19. Invasive carp were previously tagged with acoustic transmitters in these pools to provide data for informing targeted removal actions. The majority of acoustically tagged fish that were caught during removal efforts were released to provide additional data for future population evaluation and management efforts. In 2020, commercial fishers removed 171,299 pounds of invasive carp (through calendar year 2020). Since the project started, in 2015, 715,695 pounds of invasive carp were removed through 2020. The majority of invasive carp were captured in pools furthest downstream (Pools 18 and 19), an expected trend based on historic pattern of establishment and upstream expansion in the UMR.

Targeted fishing efforts continued in upstream waters of the UMR, where invasive carp establishment status and relative abundance levels are much lower than in downstream pools. Capture and removal of invasive carp from Minnesota waters increased to 83 fish in 2020, the highest annual number as of that date. This high number resulted primarily from the capture of 51 fish in Mississippi River Pool 8 by a commercial fisher during one fishing event in early March. Due to the elevated capture number, MNDNR responded by deploying its contracted commercial fisher in Pool 8 and nearby pools. The MNDNR temporarily suspended contract commercial fishing, targeted netting, targeted electrofishing, and work with partner agencies on all Minnesota waters, including Pool 8, following issuance of a State Emergency Executive Order to allow for health and safety considerations during the COVID-19 pandemic. Those activities were brought back online as appropriate safety measures and guidance were developed. MNDNR netting activities and electrofishing were brought back in a limited capacity beginning in May 2020, with contract commercial fishing resuming in October 2020.

Actions to Address Pathways

MNDNR previously identified priority aquatic resources for protection from invasive carp introduction in the Minnesota River watershed, a major tributary of the Mississippi River. Two sites were chosen in the Le Sueur River subwatershed of the Minnesota River for implementation of measures to protect lake systems. At Mayhew Creek, an open-ditch waterbody, an electrical grid was installed to protect Elysian and Buffalo Lakes. The second site consisted of an unnamed creek in which a culvert electrical array was installed to protect Madison and Eagle Lakes. Both sites were commissioned and operational in December 2018.

3.6.4 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 2019 and 2020, UMRB agencies and academic partners continued collaboration to develop and evaluate invasive carp deterrent and control technologies. Coordination, project planning, and research focused on advancing the development and testing of prototype control tools, including underwater sound and carbon dioxide.

Underwater Acoustic Deterrents

USGS, USFWS, USACE-Engineer Research and Development Center (USACE-ERDC), INHS, and academic and industry partners continued to collaboratively assess the feasibility of deploying a prototype underwater acoustic deterrent system (uADS) at an active navigation lock on the Mississippi River. Mississippi River Lock and Dam 19 (L19) at Keokuk, Iowa, was previously identified as a suitable site to evaluate this technology because it includes a high-head dam that fish cannot pass and serves as an

invasive carp pinch point. Because the spillway gates at L19 do not open, the adjoining lock chamber is the only means by which fish can migrate upstream. Objectives of this ongoing study are to evaluate changes in invasive carp and native fish behavior and lock passage in response to underwater acoustic signals and to assess the engineering, maintenance, and logistical considerations associated with long-term operation of a uADS in an active navigation channel. In 2019, USGS translocated invasive carp that were captured upstream of L19 and released downstream into Pool 20. Initial data collected from those fish demonstrated a higher rate of upstream passage relative to invasive carp collected and tagged in Pool 20 and are providing insight on how fish passages relate to lock operation and river traffic. Results from the fish movement study and the bathymetry and acoustic data are being used to inform the design, installation, and evaluation of the uADS at L19. Installation of the uADS in the downstream lock approach of L19 is planned for February 2021 and the project will continue through 2023. This project is referenced in Section 3.9.4 (IWW/CAWS, Research and Development, Development of New Deterrent Technologies—Acoustic Deterrent Barriers).

In 2020, USGS scientists continued testing the use of underwater acoustic deterrents by investigating the optimal sound characteristics (e.g., sound pressure levels, frequencies, and particle velocities) that deter invasive carp while minimizing impacts to native species and the effectiveness of sound for containing, herding, or capturing invasive carp. USGS completed studies with the University of Minnesota—Duluth comparing the hearing sensitivity of native fishes in the UMR to that of invasive carp. Data analysis from pond studies to test new acoustic stimuli (playbacks developed by USACE-ERDC) continued in 2020. The study design, permitting, and initial fish tagging (acoustic telemetry) for a field study to test new engineered playbacks in the field were initiated in December 2019 but delayed until 2021 due to health and safety restrictions resulting from the COVID-19 pandemic.

The MNDNR, USFWS, USACE, Minnesota Aquatic Invasive Species Research Center (MAISRC), University of Minnesota—Twin Cities (UMTC), and University of Minnesota-Duluth (UMD) continued to evaluate the potential use of acoustic deterrents for invasive carp at lock and dam locations in Minnesota waters. Evaluations focused on lock and dam complexes on the UMR and the Minnesota River, including Lock and Dam (LD) 5 and LD 8. Initial scoping of these projects used technical expert input focused on determining acoustic system feasibility while considering specific engineering, biological, and physical landscape factors. Activities in 2019 and 2020 were informed by initial deterrents studies conducted by collaborating agency and university partners. The MAISRC conducted research to evaluate fish movement in the proximity of LD 2 and to evaluate the effectiveness of an acoustic system previously installed at LD 8 in 2014. Results from the study of fish passage at LD2 were summarized in a publication *Monitoring Upstream Fish Passage Through a Mississippi River Lock and Dam Reveals Species Differences in Lock Chamber Usage and Supports a Fish Passage Model Which Describes Velocity-Dependent Passage Through Spillway Gates*, made available in August 2019 at https://onlinelibrary.wiley.com/doi/10.1002/rra.3530. The UMD concluded a study in 2018 that evaluated the feasibility of using underwater sound as a deterrent to the upstream movement of invasive carp at LD 5. The study findings were provided in the final technical report *Feasibility Study: Using Acoustic Deterrents to Prevent Invasive Bigheaded Carp at Lock and Dam 5*, released in 2019.

Additionally, the UMD published results in a publication *Acoustic Deterrents to Manage Fish Populations,* made available at https://link.springer.com/article/10.1007/s11160-019-09583-x.

USFWS assisted UMTC with the LD 8 evaluation by conducting acoustic telemetry and tagging of common carp, a surrogate to invasive carp, to assess fish response to the acoustic deterrent system. Results from the LD 8 study indicated that the initial acoustic system as constructed was ineffective at blocking common carp. That system was subsequently updated to incorporate technology that may be more effective at deterring fish movement. The MAISRC continued to evaluate the effectiveness of the updated system in 2020.

INHS, MDC, USGS, USFWS, and USACE conducted research to assess fish passage rates at lock and dam structures in the invasive carp IMZ on the UMR. The designated IMZ (spanning from LD 15 to LD 19) brackets the invasion front of invasive carp in the UMR, the upstream location with known invasive carp natural reproduction, and is intended to more strategically focus efforts to halt upstream range expansion. A collaborative fish passage study *(Evaluation of Fish Passage for Assessment of Bigheaded Carp Deterrents at Locks in the Upper Mississippi River)* was geographically focused on Pools 14 through 20, with an emphasis on LD 15 and LD 19. Fish movement data were analyzed to evaluate approach channel use, lock use, and dam passage by invasive carp and select native species over seasons and years and under varying environmental conditions, including water temperature and river stage (depth and flow). Results further demonstrated the ability of invasive carp to migrate upstream through lock and dam complexes in the UMR. From 2017 through 2019, USGS and partners documented 27 instances when tagged invasive carp were detected in the downstream lock approach, then detected in the lock chamber and subsequently upstream of LD 19 (in Pool 19). Related field evaluations in the IMZ and adjacent tributaries in 2019 and 2020 provided data on habitat use and fish passage. The INHS, USFWS, USGS, and MDC conducted research to assess habitat use and passage by bighead and silver carp, as well as bigmouth buffalo and paddlefish (native fish species), over major movement pinch points in the UMR. The study provided key data on fish passage at LD 14 and LD 15 and demonstrated that invasive carp are capable of having predictable yearly and seasonal movements through pinch point dams.

Development of New Targeted Control Technologies

USGS continued efforts to develop new formulations to orally deliver control agents (piscicides) that target invasive carp while minimizing impacts on native species. In 2019, USGS conducted two field assessments of microparticles (encapsulated piscicides) in collaboration with Iowa DNR. Studies evaluated the impacts of applying microparticles to target silver and bighead carp using toxic microparticles in an effluent pond at the Rathbun Fish Hatchery in Iowa. A second trial assessed the efficiency of alternative application technique using a nontoxic microparticle at that same effluent pond. Also, USGS identified a new bait formulation that attracts grass carp in controlled trials. The bait is formulated to readily deliver lethal controls. USGS also purchased the strain used to produce antimycin and initiated reestablishment of the registration of Fintrol as a fish toxicant for use by resource managers.

3.6.5 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.**

Invasive Carp Partnership Websites

Key invasive carp documents for the MRB partnerships (including Control Strategy Frameworks, Monitoring and Response Plans, Annual Summary Reports, Annual Reports to Congress, and the National Asian Carp Management and Control Plan) were made available to the public on MICRA's general website under "Invasive Carp Management and Control". Content is updated as new plans and reports become available (see Resources/Documents/Invasive Carp Plans and Reports). Also, USFWS continued to support and administer the www.InvasiveCarp.us website (formerly www.AsianCarp.us) as a primary platform for delivering general updates on accomplishments, science, and other products related to invasive carp management, with a focus on activities of the ICRCC.

Public/Stakeholder Engagement

UMRB agencies presented information on interagency invasive carp planning and implementation activities in the subbasin to multiple stakeholder groups and members of the public during 2019 and 2020. Presentations highlighted interagency invasive carp partnership collaborative planning, priority management and research efforts, assessments of invasive carp population dynamics, and other topics.

In UMRB states, signs alerting the public to the presence of invasive carp continued to be posted and maintained at fishing access sites with known populations of bighead and silver carp. In addition, State agencies informed water recreationists about the threats of invasive carp using agency websites, educational brochures, identification cards, posters, billboards, and press releases. Outreach materials were distributed at watercraft inspection stations, fishing clinics, State fairs, parks, nature centers, and businesses supporting aquatic-based recreation. Also, MNDNR continued collaboration with the Stop-the-Carp Coalition to support regular communications and outreach on invasive carp-related issues. The coalition is composed of partner nongovernmental organizations concerned about invasive carp and their impacts.

Industry Engagement

3.6.6 Law Enforcement/Regulatory

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.**

No activities were reported by agencies under this category for the 2019-2020 reporting period.

3.7 Lower Mississippi River Basin (includes Arkansas River, Red River, and White River watersheds)

3.7.1 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.**

During 2019 and 2020, strategic planning and coordination on invasive carp actions in the LMRB was supported through the Lower Mississippi River Sub-Basin Asian Carp Partnership (LMRB Partnership). This collaboration comprises representatives from the 11 State agencies, universities, and nongovernmental organizations from within the LMRB, as well as USFWS and USGS. A key achievement In 2019 was development of the first *Lower Mississippi River Basin Asian Carp Control Strategy Framework* (LMRB Framework). The LMRB Framework stepped down the National Plan, providing a blueprint for annual interagency strategic planning and project development within the subbasin. The LMRB Framework identifies seven goals and associated potential strategies to prevent further expansion, reduce population abundance, and better understand the impacts of invasive carp through a comprehensive approach. The seven goals of the LMRB Framework include (1) Prevention, (2) Monitoring and Population Status, (3) Population Control and Agency Response, (4) Understanding Impacts and Research, (5) Agency Communication, (6) Public Outreach and Education, and (7) Funding and Financial Support.

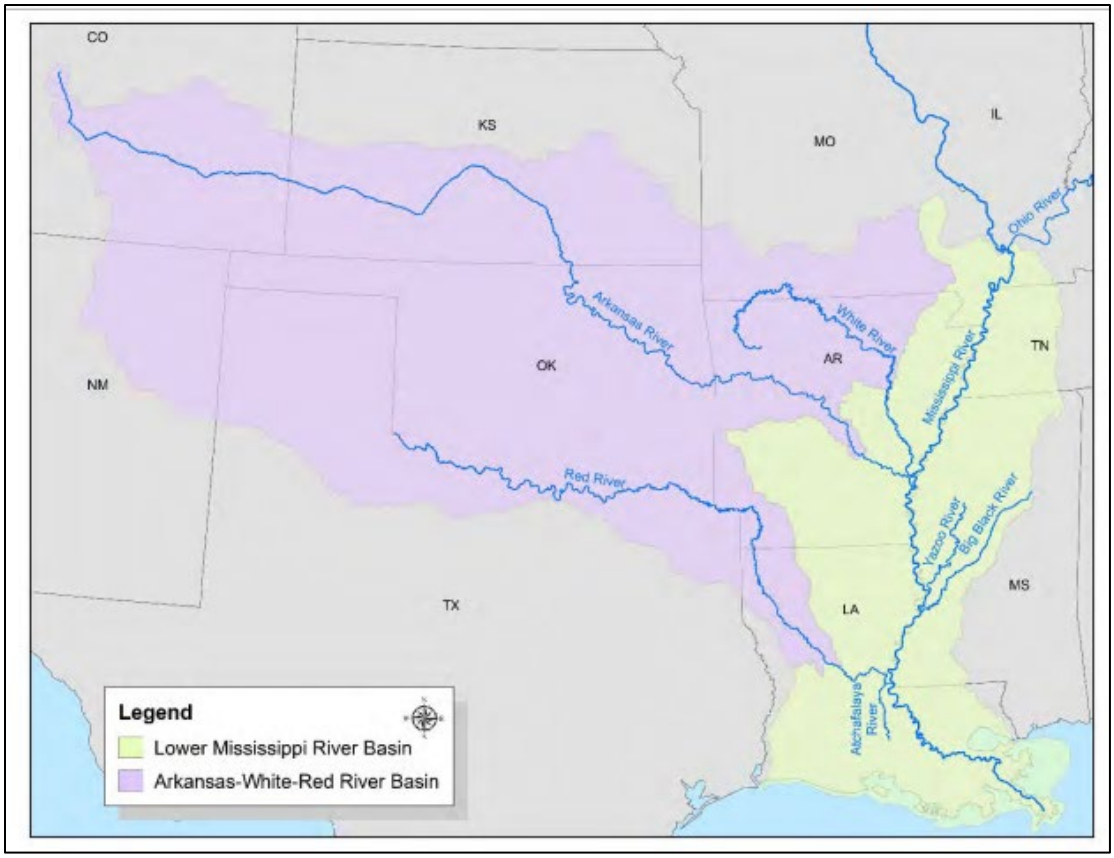


Figure 22. Map of Lower Mississippi River and Arkansas-White-Red River Subbasins

Throughout the reporting period, the LMRB Partnership coordinated closely to identify and address high-priority invasive carp research and management needs for the entire subbasin, which included activities in the Arkansas, Red, White, St. Francis, Yazoo, Obion, Big Black and Hatchie Rivers and their tributaries. Implementation of on-the-ground projects primarily fell to the State resource agencies, with technical, funding, and planning support provided by Federal agency partners. In general, LMRB Partnership actions are intended to minimize the social, ecological, and economic impacts from invasive carp to the region's millions of resource users and stakeholders.

USFWS provided initial funding to implement projects in the LMRB, including the ARWRB, in FY 2020. Activities funded in FY 2020 supported key work to assess the reproduction dynamics and movement of invasive carp in the subbasin and inform potential management options, including control and removal actions.

Activities conducted during the 2019–2020 reporting period addressed the LMRB Framework goals. Collaborative projects supported telemetry efforts in the Arkansas River system, larval invasive carp monitoring and collection in the lower Red River system, assessment of population demographics in the upper Red River system below Denison Dam, and fish sampling in the Neosho River–Grand Lake system. Further, the LRMB Partnership collaborated on invasive carp strategy development, monitoring and implementation, invasive carp removal through contract fishing, and the "Modified Unified Method and

contributed to further development of technologies for the prevention of range expansion (e.g., acoustic or other deterrent barriers).

Projects initiated in 2020 include the following:

Lower Mississippi River Subbasin

- Abundance and Distribution of Early Life Stages of Asian Carp in the Lower Mississippi River Basin
- Asian Carp Movement and Assessment to Inform Management and Removal Efforts in the Lower Mississippi River Basin
- Control of Asian Carp in the Lower Mississippi River Basin

Arkansas-Red-White River Subbasin

- Abundance and Distribution of Early Life Stages of Asian Carp in the Red River Basin
- Control of Asian Carp in the Arkansas-Red-White River Basin
- Distribution and Population Demographics of Asian Carp in the Lower Red River Basin
- Distribution and Population Demographics of Bighead Carp in the Neosho–Grand Lake System to Inform Removal
- Movement of Asian Carp in the Arkansas River to Inform Management

Summaries of those activities will be provided in the subsequent version of this report, and project-specific reports and results will be made available on MICRA's general website under "Invasive Carp Management and Control".

In 2020, forward-looking operational planning for 2021 invasive carp activities was conducted through the LMRB Partnership, with recommendations included in the 2020 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin (MRB MRP). Projects identified for future implementation in 2021 through the FY 2020 MRB MRP address key baseline data and management needs. Priority projects build on 2020 efforts and include assessments of invasive carp distribution and demographics in the Red River Basin and the Neosho River–Grand Lake system; use of contracted commercial fishing in the Arkansas-Red-White River basin to reduce invasive carp population abundance; assessments of invasive carp movement among lock and dam complexes in the Arkansas River; monitoring of early life stages of invasive carp to determine the extent of spawning in the Red River basin; evaluations of interbasin movement of invasive carp to inform deterrent and control strategies; assessments of invasive carp spawning activity in the Atchafalaya River, Ouachita River, and Tensas River Basins in Louisiana; and support for invasive carp removal programs in the LMRB using commercial fishing.

Additional coordination on invasive carp and other priority AIS issues in the LMRB occurred through the Mississippi River Basin Panel of the Aquatic Nuisance Species Task Force, the Gulf and South Atlantic Regional Panel on Aquatic Invasive Species (GSARP), and other interagency collaborations.

3.7.2 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.**

Invasive Carp Telemetry Monitoring

USFWS, the Arkansas Game and Fish Commission, and the University of Arkansas Pine Bluff collaborated on the planning and deployment of acoustic telemetry receivers at lock and dam complexes in the Arkansas River between Pine Bluff, Arkansas, and the Arkansas/Oklahoma border at Pool 13, including receiver installation and monthly data retrieval. The added receivers will supplement tracking and data collection for evaluating the movement of bighead and silver carp through the lock and dam complexes. Planning for future invasive carp telemetry tracking efforts to support LMRB priorities included scoping of the potential deployment of additional receivers on the Red River.

Hydroacoustics

No hydroacoustics monitoring for invasive carp in the LMRB was reported for 2019 and 2020.

eDNA Monitoring

No eDNA monitoring for invasive carp was conducted in the LMRB during 2019 and 2020.

Traditional Gear Sampling

LMRB agencies developed and implemented select monitoring projects targeting larval and adult invasive carp in support of the goals of the LRM Framework. However, the ability of agencies to conduct monitoring activities during the reporting period was notably affected by the COVID-19 pandemic and necessary health and safety restrictions. Despite the pandemic and operational restrictions, project planning and coordination continued through virtual platforms. Planning concentrated on researching and procuring equipment, renewing and expanding the capacities of laboratories, continuing communication with partners, and addressing project logistics (e.g., pre-planning, including identifying access sites and obtaining permission for use in support of future invasive carp monitoring activities).

In 2019, the Louisiana Department of Wildlife and Fisheries (LDWF) conducted ichthyoplankton sampling that targeted larval invasive carp in rivers throughout Louisiana. Samples were analyzed and data were reviewed using quality assurance and quality control protocols, with positive findings of invasive carp reported for entry into the USGS Nonindigenous Aquatic Species database**.**

In 2020, USFWS, Auburn University, and Texas Tech University coordinated future invasive carp sampling in the Red River and Sulphur River drainages to determine the most effective traditional gear sampling techniques and describe the distribution and population demographics of invasive carp in those systems.

Assessments of the spawning and recruitment of invasive carp were initially planned by USFWS for May through August 2020, to include ichthyoplankton tows and light trapping for larval fish in the Red River mainstem and tributaries (the Kiamichi River, Choctaw Creek, and Muddy Boggy Creek). The 2020 field assessments were canceled due to health and safety restrictions resulting from the COVID-19 pandemic. However, agencies continued regular collaboration on refinement of sampling methodologies, focused on assessing invasive carp recruitment and demographics, including standardization to ensure data comparability and utility across subbasins.

Rapid Response

No invasive carp rapid response activities were conducted in the LMRB during 2019 and 2020.

3.7.3 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.**

Invasive Carp Capture and Removal

USFWS harvested and assessed all adult invasive carp captured as bycatch during ongoing paddlefish bloodstock surveys in the Red River and Kiamichi River in 2019 and 2020. Captured invasive carp were measured and weighed, fish sex was determined, and otoliths were removed to supplement data describing invasive carp populations in these river basins.

Actions to Address Pathways

No activities to address invasive carp pathways in the LMRB were reported for 2019 and 2020.

3.7.4 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

No activities to develop new invasive carp deterrent technologies in the LMRB were reported for 2019 and 2020.

Invasive Carp Life History and Reproduction Evaluations

No activities to evaluate invasive carp life history or reproduction in the LMRB were reported for 2019 and 2020.

3.7.5 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.**

Public/Stakeholder Engagement

In 2019 and 2020, LMRB agencies routinely responded to requests for information, delivered in-person presentations to constituents, and produced and provided outreach materials (e.g., identification brochures, displays) to locations and partners. KDWPT used a professional marketing firm to conduct a comprehensive education and outreach campaign. Through this effort, information on invasive carp and other AIS was strategically disseminated through radio and internet advertisements, social media, and convenience store point-of-sale messaging. In addition, USFWS biologists contacted and communicated with private landowners to obtain permission for staff access at strategic locations to conduct invasive carp monitoring projects along the Red River in Oklahoma and Texas.

Industry Engagement

In 2020, LDWF planned research to assess the feasibility of invasive carp protein to be used as fish feed and plant fertilizer. Planning efforts included engagement with industry partners (e.g., Nobilis Aqua LLC, Fort Collins, CO) and local fishers and producers. In addition, LDWF planned to survey fishers and producers about incentives for invasive carp harvest and production.

3.7.6 Law Enforcement/Regulatory

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.**

No activities to address law enforcement or regulatory actions related to invasive carp in the LMRB were reported for 2019 and 2020.

3.8 Missouri River Basin

3.8.1 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 2019 and 2020, State and Federal partner agencies in the Missouri River Basin (MORB) used the *Missouri River Basin Asian Carp Control Strategy Framework* (MORB Framework) as a foundation for strategic planning, project development, and implementation to address the threat of invasive carp. The MORB Framework was finalized in 2018 by the Missouri River Natural Resource Committee Asian Carp Technical Committee (MRNRC Committee), with input from the 100th Meridian Missouri River Basin Team. The geographic scope of the MORB Framework comprises the entire Missouri River watershed,

including all or parts of 10 states and covering approximately one-sixth of the continental United States. The MORB Framework contains six goals and associated strategies that support the National Plan and other regional plans. Implementation is primarily the responsibility of the MORB State agencies, including Missouri, Kansas, Iowa, Nebraska, South Dakota, and North Dakota, with support from Federal agency partners. Ongoing coordination is conducted through the Asian Carp Technical Committee (Committee) of the Missouri River Natural Resources Committee (MRNRC).

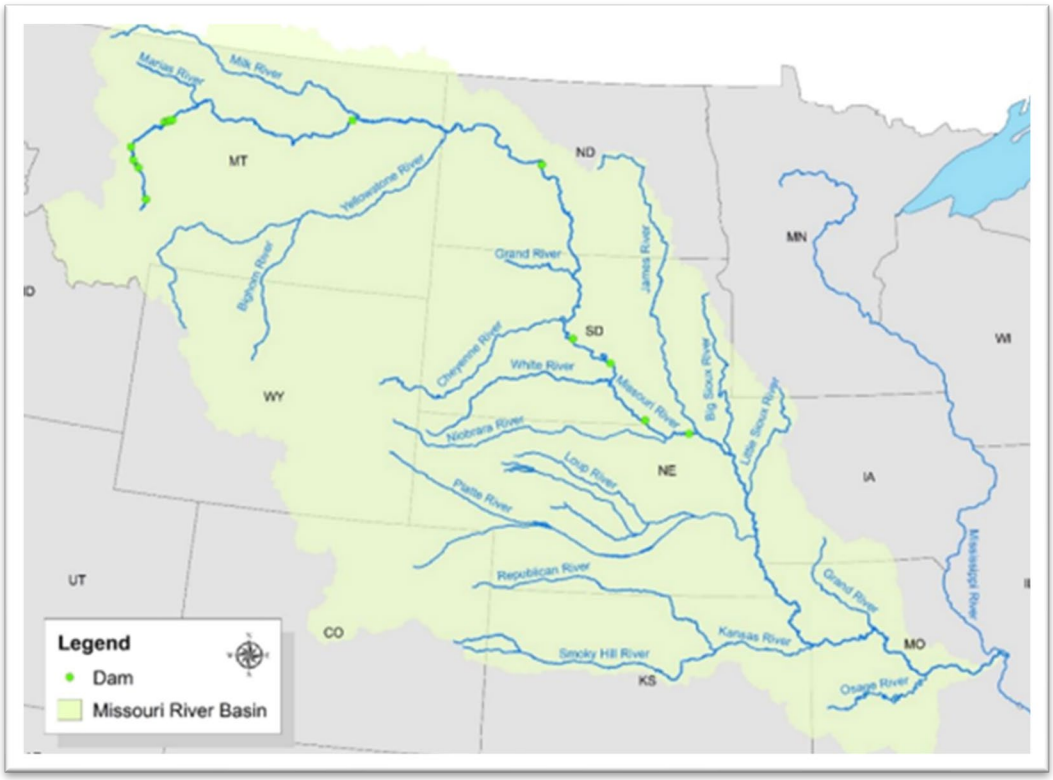


Figure 23. Map of the Missouri River Subbasin, with Major Tributaries Identified

Coordination in 2019 and 2020 resulted in the development and implementation of workplans and specific projects to address detection, prevention, and control priorities, which are further described in this section. Additional coordination on invasive carp and other AIS topics was conducted through the Mississippi River Basin Panel on Aquatic Nuisance Species.

FY 2020 was the initial year of implementing invasive carp management and control activities in the MORB with USFWS funding as part of National Plan implementation. Projects selected for funding addressed the highest priorities of the partnership, including defining the geographic extent and population demographics of invasive carp populations in the MORB subbasin; understanding bighead carp movements and habitat use in tributaries; and investigating management actions to contain and reduce populations.

FY 2020 funding was allocated to support the four State-led projects in the MORB described below:

1. **Define the Spatial Distribution and Population Demographics of Asian Carp Populations and the Associated Fish Community in the Missouri River Basin**

   Objectives:

   - Determine the geographic extent (presence/absence) of bighead, silver, and (potentially) black carp throughout the Missouri River Basin to evaluate current barriers, prevent further range expansion, and identify potential control/removal opportunities.
   - Characterize spatial (tributaries longitudinally distributed in the Lower Missouri River) and temporal (seasonal and annual) patterns in the silver and bighead carp population demographics (e.g., size structure and relative abundance) while developing standard operating procedures that are specific for the lower Missouri River Basin to prescribe and assess population control measures.
   - Characterize the historic and current fish community in the inter-reservoir reach and the Lower Missouri River to assess the impacts to the fish community pre- and post-invasion as well as provide baseline data for comparison to prescribe and assess future management actions.
   - Develop a computer-based application based on previous bighead and silver carp research and monitoring in the Upper Mississippi River for expeditious laboratory identification of fish eggs collected during ichthyoplankton sampling as part of an early detection protocol for bighead, silver, grass, or black carp.

2. **Asian Carp Movement and Habitat Use in the Missouri River Basin to Inform Containment and Control Management Actions**

   Objectives:

   - Determine silver and bighead carp residence time and movement in the Missouri River and its tributaries in association with season, environmental conditions, and barriers to inform containment and control management actions.

3. **Control and Containment of Invasive Carp in the Missouri River Basin**

   Objectives:

   - Remove Asian carp to provide a buffer against upstream range expansion should Bowersock Dam be inundated during a high-flow event.
   - Determine the feasibility and exploitation of various removal techniques on adult and juvenile bighead and silver carp and the effects on other fish species in the Lower Missouri River to inform control actions.

4. **Kansas River Bowersock Dam Barrier Feasibility Study**

   Objectives:

   - Conduct a feasibility study to determine the options and approximate costs for an Asian carp barrier at Bowersock Dam during high-flow events.

The implementation of the majority of the field activities supporting these four projects was scheduled to start in FY 2021; therefore, those accomplishments and findings resulting from the projects will be summarized in the FY 2021–2022 version of this report.

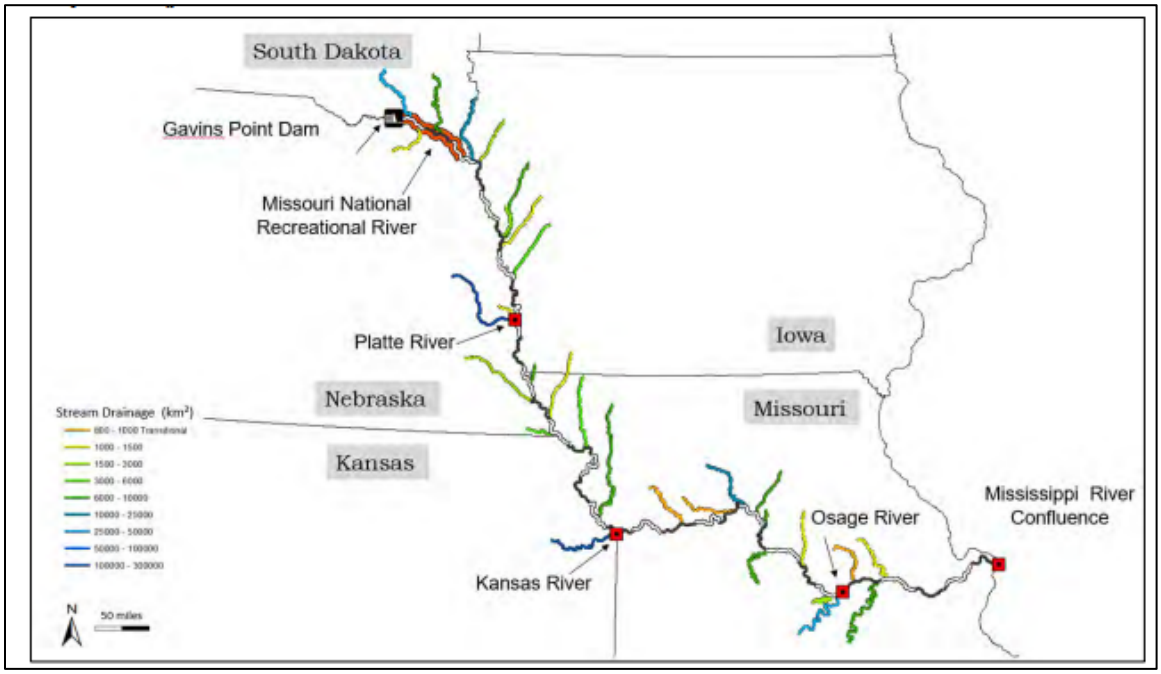


Figure 24. Missouri River from Confluence with Mississippi River to Gavins Point Dam (River Mile 811)

Note: Tributaries are color-coded by cumulative drainage area. The non-channelized portion of the Missouri River is highlighted in orange and labeled as the Missouri National Recreational River. Select tributary confluences are highlighted with red boxes.

3.8.2 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.**

Invasive Carp Telemetry Monitoring

USGS continued research during the winter season in Truman Reservoir, Missouri, to evaluate winter habitat selection and the efficacy of telemetry tracking to inform potential grass carp capture and removal efforts in large reservoirs. A total of 86 grass carp were tagged with acoustic transmitters and tracked to evaluate winter habitat selection and to determine the effectiveness of using tagged fish to locate and remove wild fish. Harvest at locations of tagged fish was compared with harvest at control sites that were previously identified as suitable grass carp habitat. Results from this study suggested that grass carp did not usually form large winter aggregations, and although targeting locations with tagged fish slightly increased harvest success compared with efforts without them, attempts to reduce

populations of grass carp via harvest may be difficult in large reservoir systems when fish are widely dispersed.

Hydroacoustics

In December 2019, USFWS conducted a hydroacoustic feasibility study on the lower Missouri River near Columbia, Missouri. The purpose of this field effort was to determine if hydroacoustic techniques for estimating invasive carp abundance that were originally developed for use in large river navigation pools could be adapted to other conditions found in the MORB. Preliminary data indicated that existing hydroacoustic protocols were suitable for sampling Missouri River tributaries and Missouri River main-channel habitat; however, sampling behind dikes, which are common in the Missouri River, would require protocol modifications to produce robust invasive carp abundance estimates.

Numerous agency field monitoring activities were limited in 2020 to accommodate health and safety restrictions due to the COVID-19 pandemic. Agencies continued project coordination, logistical planning, and preparation, including the acquisition of telemetry gear to track carp in the Vermillion and Big Sioux Rivers, and modification of sampling vessels, nets, and hydroacoustics gear.

eDNA Monitoring

The USFWS Bozeman Fish Health Center and Midwest Fisheries Center—Whitney Genetics Laboratory conducted initial planning focused on expanding eDNA analytical capacity to accommodate future field collection and analyses for invasive carp early-detection monitoring in the MORB. Preplanning included the identification of priority sites for sampling in MORB tributaries in North Dakota and South Dakota.

The Kansas Department of Wildlife and Parks (KDWP) collaborated with the University of Nebraska on a multicomponent study to evaluate the demographics, distribution, and natal origin of invasive carp in the Kansas River. One objective of the project was to determine if bighead and silver carp are present upstream of Bowersock Dam and if black carp are present in the lower Kansas River. This assessment included monitoring using eDNA conducted in the summers of 2018 and 2019 on three sections of the Kansas River. No silver or bighead carp were detected upstream of the second barrier below Bowersock Dam (approximately River Mile 52) on the Kansas River with eDNA or physical sampling. However, black carp were detected near the confluence with the Missouri River with the eDNA analysis but not with physical sampling. Additional accomplishments reported under this multicomponent assessment project for 2019 and 2020 are included below under “Invasive Carp Biology, Life History, and Reproduction Evaluations.”

Traditional Gear Sampling

Agencies conducted targeted monitoring in 2019 and 2020 using traditional fishery sampling techniques and gears to collect key baseline data on the geographic distribution and population status of invasive carp in the MORB.

The Nebraska Game and Parks Commission (NGPC), working with the University of Nebraska—Lincoln School of Natural Resources (UNLSNR), conducted activities to inform awareness of the geographic extent of invasive carp throughout Nebraska interior rivers and streams; characterize the population demographics; determine impacts to native fish species; and assess to what extent Gavins Point Dam continues to serve as a barrier to upstream range expansion by invasive carp. In 2019 and 2020, KDWPT and UNLSNR collaborated to identify the presence and upstream extent of bighead, silver, and black carp in the Kansas River Basin. Traditional fishery sampling gear (electrofishing and netting) and eDNA methods were used. No evidence of these three species of invasive carp was found upstream of the Bowersock Dam in Lawrence, Kansas.

The North Dakota Department of Fish and Game (NDDFG) detected a female bighead carp and one male suspected hybrid silver/bighead carp during fishery sampling in June 2019 below LaMoure Dam on the James River in North Dakota. This finding marked the first bighead carp capture documented in North Dakota. Following agency sample events in June and July 2019, reports of additional invasive carp (primarily silver carp) were provided by anglers. Videos taken at Ypsilanti Dam on the James River documented large numbers and multiple size classes of silver carp. Sustained high water in the James River in 2019 potentially allowed invasive carp to move upstream from known populations further downstream in the James River in South Dakota. As of the reporting period, bighead carp have only been documented up to the LaMoure Dam, and silver carp have been documented up to the Jamestown and Pipestem Reservoir dams.

Rapid Response

No rapid response actions were conducted during the 2019–2020 reporting period. However, the MORB Framework recognizes the importance of early detection as a strategy for preventing further range expansion of invasive carp. Effective rapid response actions rely upon the timely and coordinated reporting of data documenting captures in new waters. As part of early detection efforts, MORB agency personnel are encouraged to report new sightings of invasive carp where these species are not known to be established to the USGS Nonindigenous Aquatic Species (NAS) database (https://nas.er.usgs.gov/) and partner agencies. In addition, agencies have created outreach materials to encourage stakeholders to report new sightings of invasive carp to agency staff for local verification of invasive carp and subsequent reporting to the NAS database.

3.8.3 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.**

Invasive Carp Capture and Removal

In 2020, the Missouri River Unit of the Missouri Department of Conservation (MDC) developed two proposals focused on (1) assessing population demographics of invasive carps in four tributaries, their

associated Missouri River bends, and possibly two oxbow lakes; and (2) assessing removal methods and exploitation feasibility. Pilot work on the population demographic study provided preliminary demographic and abundance data to identify potential locations for a removal effort. Length frequency, weight, and abundance data were used to inform a target removal area to conceptualize what a removal effort in the state of Missouri may look like and the feasibility and exploitation.

Pathway Mitigation

During the 2019–2020 reporting period, MORB partner agencies, led by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT), identified the opportunity to implement fish passage control actions at the Bowersock Dam at Lawrence, Kansas, on the Kansas River as a potential management priority for further evaluation and scoping through its 2020 MRB MRP. The concept of a barrier to the upstream movement of fish that functions during high-flow events is focused on reducing the threat of invasive carp passage and establishment in a portion of the Kansas River Basin above Bowersock Dam that represents one of the few large, nonimpounded reaches of midwestern prairie rivers currently unaffected by invasive carp. Relatively few bighead carp have been documented upstream of this barrier (KDWPT, unpublished data), and these fish are believed to have passed over the dam during extreme flooding in 1993.The Bowersock Dam was previously identified as a barrier that serves as a "choke point" to the upstream movement of invasive carp and other fish except during periods of exceptionally high flows. To further evaluate the potential for a control action, KDWPT and UNLSNR collaborated to evaluate the flows required for invasive carp to successfully pass upstream over the dam, with results indicating that successful passage is likely to occur at flows at or above approximately 120,000 cubic feet per second. Further work to assess the feasibility of a barrier at the Bowersock Dam site is planned for 2021.

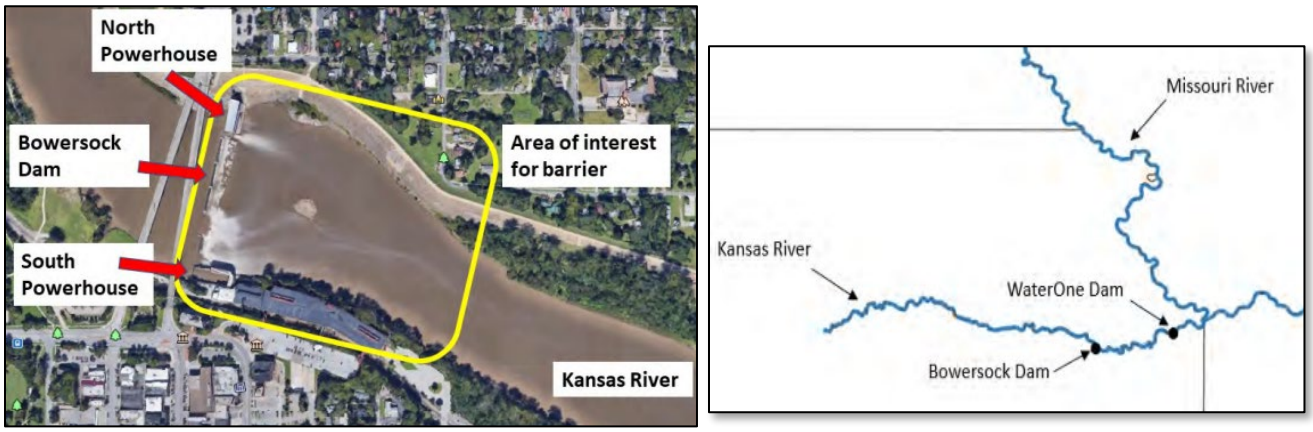


Figure 25. Study Location for Potential Fish Passage Control Project at Bowersock Dam on the Kansas River

3.8.4 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

The MDC worked with USACE—St. Louis District to conduct a Creve Coeur Lake fish barrier study. Creve Coeur Lake is a high-use recreational floodplain lake in St. Louis County, MO. St. Louis County Parks manages the park surrounding the lake, and MDC manages the lake fishery. The degree of the invasive carp problem in Creve Coeur Lake was highlighted when a video of the Washington University rowing team was uploaded and widely viewed on social media and was broadcast on national newscasts (https://www.cnn.com/videos/us/2015/04/12/vo-flying-fish-ireport-asian-carp.cnn; https://www.studlife.com/sports/club-sports-sports/2015/04/16/fish-are-friends-not-projectiles-crew-team-bombarded-by-asian-carp/).

In the early winter of 2018, USGS, MDC, and USFWS implemented a 3-week removal effort resulting in approximately 47,000 invasive carp weighing almost 240,000 pounds removed from the lake. Following that extensive effort, MDC worked with USACE—St. Louis District to develop and analyze structural and nonstructural alternatives, determining feasibility and associated costs to prevent the movement of invasive carp from the Missouri River to Creve Coeur Park Lake. By analyzing local hydrology and Missouri River backwater influence, the team identified six pinch points and assessed them for deterrent placement. Seven deterrent measures were evaluated for impacts to Creve Coeur Lake water surface elevation, barrier-to-invasive carp jumping height, effectiveness in range of storm events, power requirements, operations and maintenance, cleaning, and overall costs.

Invasive Carp Biology, Life History, and Reproduction Evaluations

Agencies noted that during 2019, the MORB had sustained high water levels, and young-of-year invasive carp were detected in many tributaries of the Lower Missouri River. Silver carp length-frequency histograms provided evidence of multiple spawning events during the year. Catch data supported the likelihood that silver carp were capable of large spawning events during flood pulses, with high mortality of early life stage, and multiple spawning bouts in the same year.

The Kansas Department of Wildlife, Parks and Tourism (KDWPT) and UNLSNR collaborated on a multi-objective study conducted in 2019 and 2020 to assess the population characteristics of invasive carp in the Kansas River. The study investigated population demographics, distribution using eDNA surveillance, and environmental history using otolith microchemistry of invasive carp in the lower Kansas River. Differences were noted in the physical characteristics of silver carp populations upstream versus downstream (e.g., individuals captured above the lowermost barrier had longer lengths-at-age, longer total lengths, and occurred at lower relative abundances than below the barrier). Otolith microchemistry results indicated that the population of silver carp in the Kansas River comprises primarily individual resident fish, with few invasive carp originating from the Missouri River. Results also indicated that

movements by fish from the Kansas River into the Missouri River are generally brief. In addition, the study determined that, within the Kansas River, very few young-of-year silver carp were found above the WaterOne Dam at Edwardsville, KS (river mile 14.8), indicating that reproduction is likely occurring in the lowest stretch of the river but is very limited above this dam. Silver carp of multiple year classes (multiple ages) were captured during the study. No relationship between climatic or hydrological variables and silver carp recruitment in the Kansas River was detected. Results of all study components were published in a graduate student thesis in 2020 and will be used to inform potential management actions for invasive carp control in the Kansas River and other areas within the MORB ("Population Demographics, Distribution, and Environmental History of Asian Carp in a Great Plains River," J. Werner, https://digitalcommons.unl.edu/natresdiss/327/).

To further support invasive carp identification at early stages of development, researchers at Iowa State University developed a computer application to identify invasive carp eggs. The app, titled WhoseEgg, is a tool for classifying fish eggs without the need to obtain genetic identification. A future goal is to expand upon initial app development by including profiles of invasive carp eggs from other rivers throughout the United States to support a more robust identification tool. The WhoseEgg app is available online at no cost to users at https://whoseegg.stat.iastate.edu/ and is accessible from any device with a browser.

Development and Testing of New Detection or Capture Gear and Techniques

No activities to develop and test new detection or capture gear and techniques in the MORB were reported for 2019 and 2020.

3.8.5 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.**

Public/Stakeholder Engagement

MORB agencies routinely responded to requests for information, delivered in-person presentations to constituents, and produced and provided outreach materials (e.g., identification brochures, displays) to locations and partners.

Throughout 2019 and 2020, KDWPT used a professional marketing firm to conduct a comprehensive education and outreach campaign throughout the State. Through this effort, information on invasive carp and other AISs were strategically disseminated through radio and internet advertisements, social media, and convenience store point-of-sale messaging. In the fall of 2019, KDWPT hosted an invasive carp public outreach event for Senator Jerry Moran's 2019 "Conservation Tour." The event was held at Kaw Point Park at the confluence of the Kansas and Missouri Rivers. Participants were provided an overview of AIS issues and a field demonstration of sampling for invasive carp using boat electrofishing.

The stakeholder outreach event was covered by local media outlets. In addition, USFWS collected young-of-year invasive carp to provide samples to be photographed for use in public outreach materials, including species identification products.

Figure 26. KDWPT-Hosted Invasive Carp Public Outreach Event Conducted in Cooperation with Senator Jerry Moran's 2019 "Conservation Tour". Photo Credit: Office of Senator Jerry Moran, Kansas.

Industry Engagement

No activities related to industry engagement on invasive carp in the MORB were reported for 2019 and 2020.

3.8.6 Law Enforcement/Regulatory

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.**

No activities related to invasive carp law enforcement or regulatory actions in the MORB were reported for 2019 and 2020.

3.9 Upper Mississippi River Basin—IWW/CAWS

3.9.1 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 2010, the ICRCC has served as the primary partnership coordinating Federal and State agency efforts to prevent the spread of invasive carp populations from the MRB into the GLB. In 2019 and 2020, ICRCC agencies regularly participated in internal planning and coordination discussions addressing invasive carp monitoring and management within the Illinois River, the Illinois Waterway (IWW), and the

Chicago Area Waterway System (CAWS). Coordination included development of annual strategies, operational plans, and activities; technical discussion of invasive carp population and risk status; opportunities for emerging prevention or control technologies; and other priority topics. Additional collaboration included contingency response (emergency or rapid response) planning to ensure general preparedness in the event a multiagency response is warranted.

Invasive carp management actions conducted in the IWW/CAWS were identified and funded primarily through the ICRCC's annual Invasive Carp Action Plan (Action Plan) and implemented through the Response Plan for Invasive Carp in the Upper Illinois River and Chicago Area Waterway System (MRP). The MRP is the annual operational work plan developed by the ICRCC's Monitoring and Response Work Group (MRWG) that guides many of the projects in the Action Plan and conducted within the IWW/CAWS.

In the IWW/CAWS, the ICRCC and MRWG implemented projects focused on the overall goal of preventing the establishment of self-sustaining populations in the CAWS and Lake Michigan through the following objectives:

- Determination of the distribution and abundance of any invasive carp in the CAWS, and use of that information to inform response and removal actions;
- Removal of any invasive carp found in the CAWS to the maximum extent practicable;
- Identification, assessment, and reaction to any vulnerability in the current system of barriers to prevent invasive carp from moving into the CAWS;
- Determination of the leading edge of major invasive carp populations in the Illinois River and the reproductive successes of those populations; and
- Improvement of the understanding of factors behind the likelihood that invasive carp could become established in the Great Lakes.

In total, the 2019 Action Plan (https://invasivecarp.us/Documents/2019-Action-Plan-Amended.pdf) contained 43 projects and the 2020 Action Plan (https://invasivecarp.us/Documents/2020%20Action%20Plan%20Amended.pdf) contained 55 focused on monitoring and early detection; control and removal; pathway mitigation, research, and development of new tools and technologies; stakeholder communications; and other strategic actions focused on Great Lakes protection. The 2019 MRP (https://invasivecarp.us/Documents/Monitoring-Response-Plan-2019.pdf) and 2020 MRP (https://invasivecarp.us/Documents/Monitoring-Response-Plan-2020.pdf) served as the field operational plans for Action Plan projects geographically focused in the IWW/CAWS during that timeframe. A more detailed summary of 2019 and 2020 MRP-related accomplishments and results is included in the respective annul Interim Summary Reports (https://invasivecarp.us/Documents/Interim-Summary-Report-2019.pdf; https://invasivecarp.us/Documents/Interim-Summary-Report-2020.pdf).

This section provides a general overview of actions accomplished to address invasive carp in the IWW/CAWS in 2019 and 2020. More detailed summaries of accomplishments are provided in the 2019 and 2020 Action Plans and MRPs described above.

3.9.2 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.**

In 2019 and 2020, State and Federal agencies continued comprehensive monitoring for all life stages of invasive carp in the IWW using multiple fishery sampling gears and techniques. In downstream pools of the IWW where bighead carp and silver carp are established or typically present, activities focused on assessing the population status, reproduction dynamics, and movement patterns (including pool-to-pool migration) of these species. Monitoring in upstream IWW locations focused on detecting potential range expansion or advance in the invasive carp "population front," determined by the MRWG to be approximately 47 miles from Lake Michigan (~ river mile 281, within the Dresden Island Pool) as of 2020 and unchanged for more than 10 years.

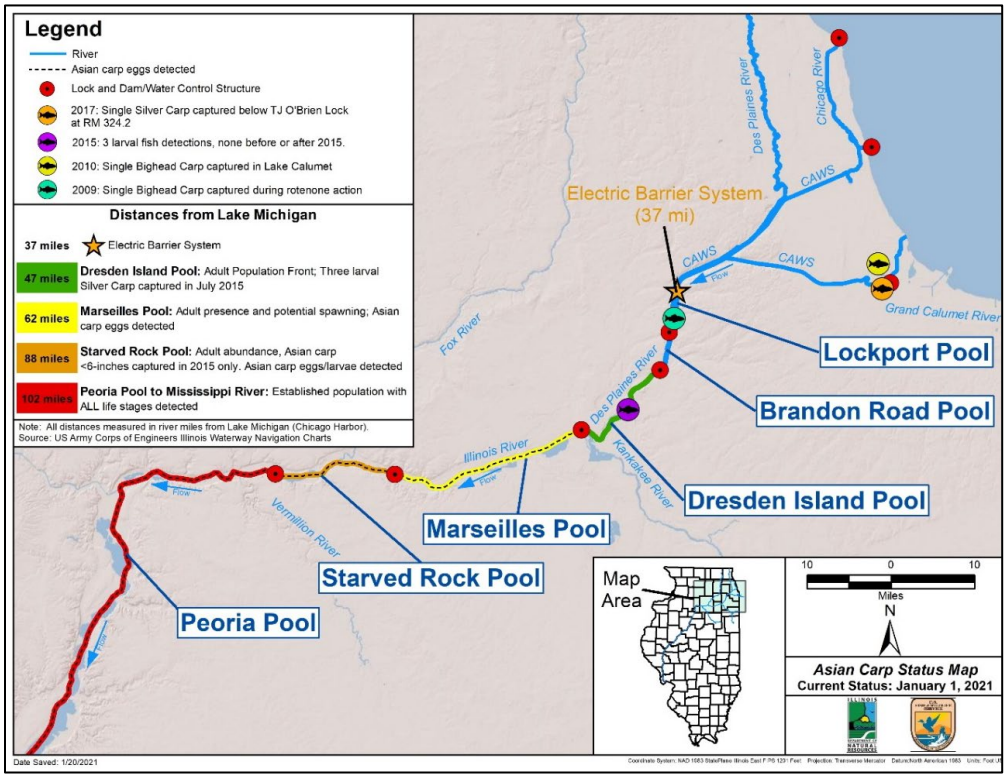


Figure 27. Status of Bighead and Silver Carp in the Upper Illinois Waterway

Invasive Carp Telemetry Monitoring

In 2019 and 2020, agencies continued efforts to use telemetry monitoring of invasive carp and surrogate fish (noninvasive carp) tagged with coded ultrasonic transmitters to collect information on fish movement, behavior, and habitat use within the IWW.

USACE continued collaboration with USFWS, Southern Illinois University at Carbondale (SIUC), ILDNR, USGS, and Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) to deploy and use telemetry technology to assess the effectiveness of the Electric Dispersal Barrier System (EDBS) as a deterrent on tagged fish in the Chicago Sanitary and Ship Canal (CSSC) and to assess general behavior and movement of fish in the CSSC and IWW. Surrogate fish species (i.e., common carp (*Cyprinus carpio*) and select native species) were tagged at and near the EDBS in the Lockport Pool, and invasive carp were tagged in the Dresden Island and Marseilles Pools. Through 2020, USACE had acquired approximately 35 million detections from 686 ultrasonically tagged fish through this effort. No live tagged fish have crossed the EDBS in the upstream (toward Lake Michigan) direction. In 2019, 7 upstream and 11 downstream passages of tagged common carp (surrogate noninvasive carp) occurred between the Brandon Road and Lockport Pools. The monitoring effort in 2020 was affected due to the pandemic. A relatively high percentage of tagged surrogate fish (noninvasive carp) in the Lockport Pool of the IWW continued to be detected near the EDBS during 2019 and 2020. Tagged invasive carp continued to be detected throughout the Dresden Island Pool, with the majority of fish detected in the proximity of the Dresden Island Lock and the confluence with the Kankakee River.

Additional telemetry monitoring was conducted by USFWS to assess general movement patterns of juvenile silver carp (≤300 mm total length, including potential migration through lock structures. The evaluation tracked the movements of tagged fish from their initial capture and release site, providing 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 37 fish were tagged and released (35 with radio and acoustic transmitters) in the Peoria Pool during October 2019. USFWS tagged an additional 161 invasive carp in the Peoria Pool in support of data collection to inform the Spatially Explicit Invasive Carp Population (SEICarP) Model. In addition, fin clips were taken of every tagged fish to assist in determining hybridization rates in the Peoria Pool.

USGS continued efforts to (1) conduct real-time telemetry in support of contingency response actions and removal, (2) develop and maintain an online invasive carp telemetry database, and (3) model telemetry data collected by partners to determine the transition rates of invasive carp between river reaches and evaluate potential invasive carp management actions. USGS deployed, maintained, and range-tested nine real-time receivers in the upper IWW system in 2019 and deployed seven receivers in 2020. Location information of tagged silver and bighead carp from real-time detections were made available online through the FishTracks telemetry database to biologists directing day-to-day fish removal efforts and as email alerts to managers responsible for executing potential monitoring and contingency actions. USGS initiated analyses of receiver detections and catch data from contract fish removal efforts to evaluate the effectiveness of real-time receivers to inform decisions on those efforts. In addition, USGS maintained a system previously established in 2017 to alert key MRWG personnel of detections of bighead carp in areas of concern.

eDNA Monitoring

In 2019 and 2020, USFWS collected and processed a total of 1,126 water samples from the CAWS, including sites within the CSSC; the Mainstem, South, and North Branches of the Chicago River; the Calumet River and Little Calumet River; and Lake Calumet (Figures 28 and 29). All samples were processed at the USFWS Whitney Genetics Lab—Midwest Fisheries Center. All sample collection, handling, and processing was conducted following the protocols established and outlined in the USFWS Quality Assurance Project Plan: eDNA Monitoring of Bighead and Silver Carps (QAPP) (https://www.fws.gov/media/2023-quality-assurance-project-plan).

Monitoring for invasive carp eDNA was conducted in the CAWS upstream of the EDBS during October 2018 (311 samples; 2 positive for silver carp and 1 positive for bighead and silver carp DNA), April 2019 (401 samples; 1 positive for bighead carp, 1 positive for silver carp, and 2 positive for bighead and silver carp DNA), and October 2019 (414 samples; 49 positive for silver carp and 27 for bighead carp DNA). Additional eDNA samples were not collected in Chicago in April 2020 due to COVID-19 restrictions.

During October 2019, an unusually high number of positive samples were detected, with the majority collected in or adjacent to Bubbly Creek within the CAWS. On the basis of the high number of positive findings, USFWS conducted additional follow-up sampling later in October 2019 in and around Bubbly Creek, with results yielding a similarly high number of positive eDNA detections. USFWS worked with the Metropolitan Water Reclamation District of Greater Chicago (MWRD) to design the additional sampling event targeting the sewer system in the area surrounding Bubbly Creek. The results indicated that the high number of positive eDNA detections in Bubbly Creek likely came from the discharge of sewer water, containing invasive carp DNA from human consumption and fish markets, around the time of a stormwater pumping event. The ILDNR and other partner agencies were notified of all results following the established interagency communication protocols after sample processing was complete. The 2019 eDNA results were followed by 2 weeks of intensive monitoring in the Bubbly Creek area completed by the Illinois Department of Natural Resources and Invasive Carp Regional Coordinating Committee partners using traditional fish sampling gears, including nets and electrofishing. During that time, biologists found no evidence of invasive carp in the area. eDNA sampling protocols were amended to extend waiting periods following large precipitation and active water control events. Further details on the agency eDNA monitoring efforts in the CAWS and other basins can be found at https://fws.maps.arcgis.com/apps/dashboards/52b22abe9c4d4575adfe851a946f444d.

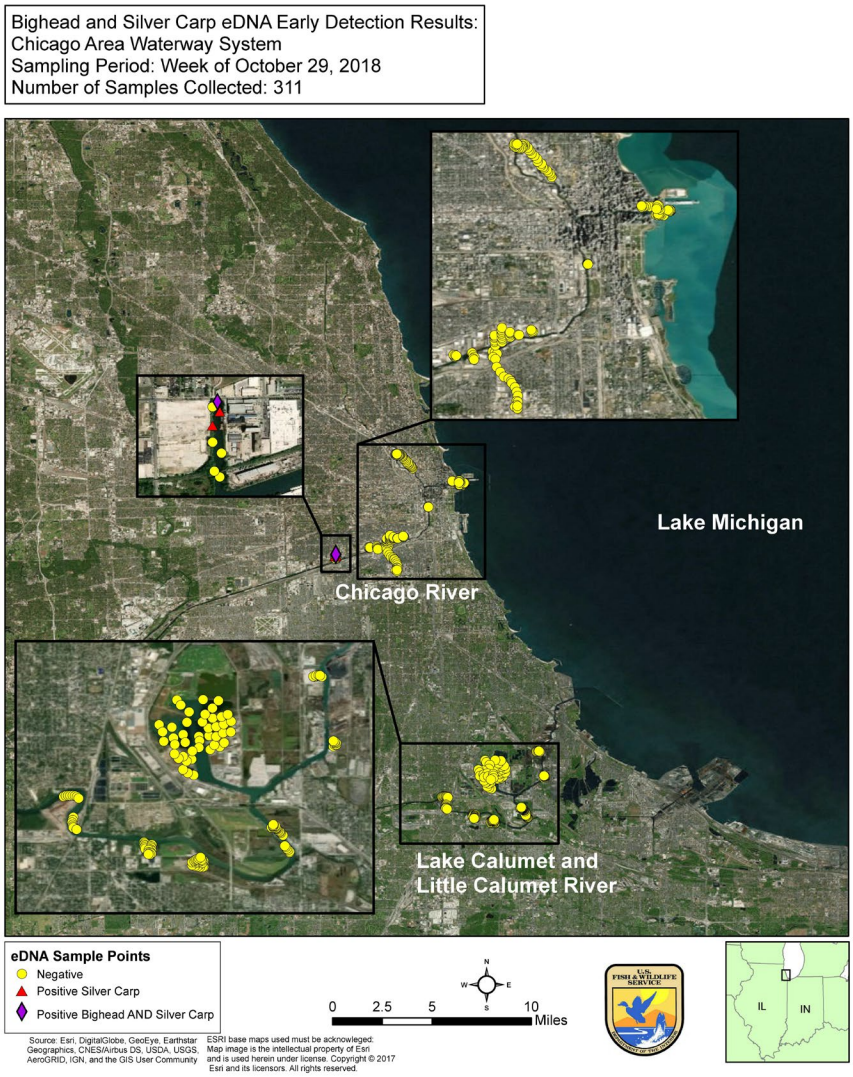


Figure 28. Results of eDNA Sampling for Bighead and Silver Carp in the CAWS, Week of October 29, 2018

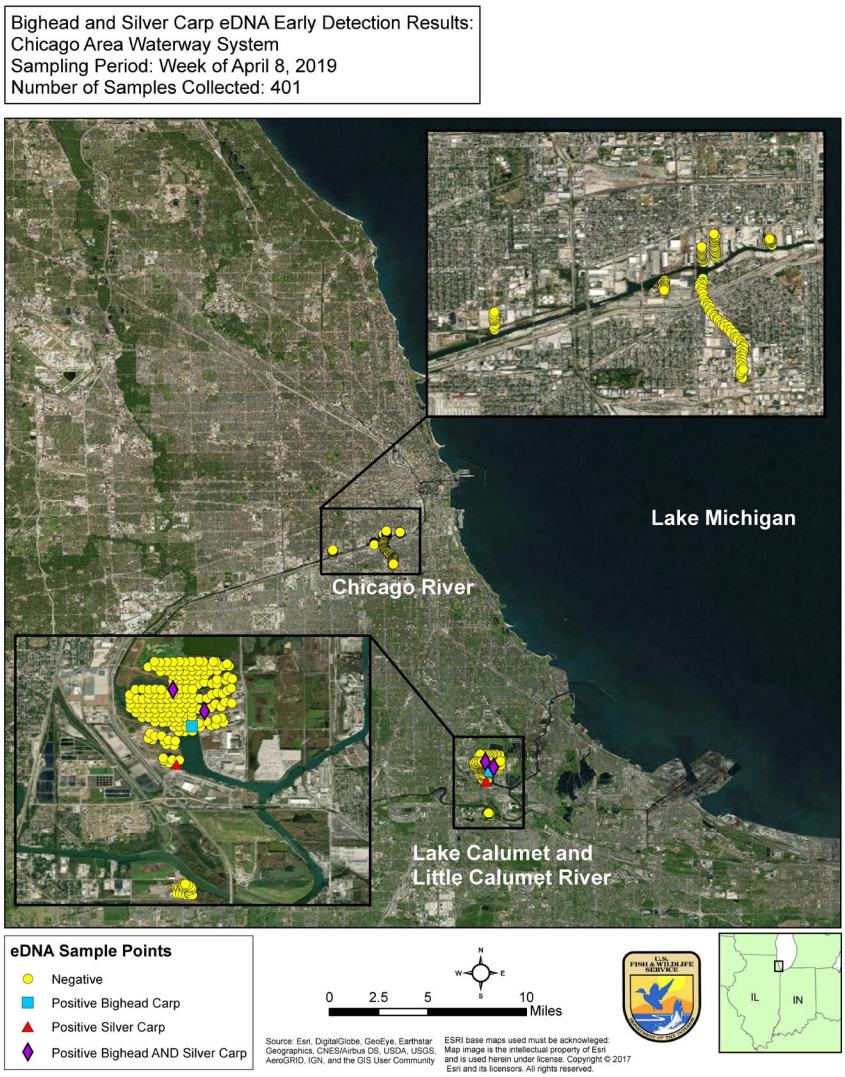


Figure 29. Results of eDNA Sampling for Bighead and Silver Carp in the CAWS, Week of April 8, 2019

Traditional Gear Sampling

In 2019 and 2020, ICRCC agencies, working through the MRWG, conducted comprehensive sampling for all life stages of invasive carp targeting key locations of the IWW/CAWS through a variety of complementary monitoring efforts.

The ILDNR, USACE, USFWS, USGS, SIU, and contract commercial fishers conducted coordinated multigear sampling in targeted locations in the CAWS upstream of the EDBS through the Seasonal Intensive Monitoring (SIM) program in 2019 and 2020. SIM sampling is an ongoing activity conducted two times per year (every spring and fall) in support of early detection and monitoring objectives described in the annual MRP. In 2019 and 2020, SIM monitoring was completed for 2 consecutive weeks during late spring and early fall, with some modification to planned sampling operations in 2020 to

ensure compliance with COVID-19 health and safety protocols. Comprehensive sampling during the SIM events included targeted electrofishing, gillnetting, and commercial seining.

In 2019, SIM monitoring events were conducted during June and September (two consecutive weeks of sampling during each month). A total of 27,326 fish were sampled across all locations and gears, representing 53 species and 3 hybrid groups. In 2020, SIM monitoring events (two consecutive weeks of sampling) were again conducted during June and September. A total of 10,087 fish were sampled, representing 44 species and 2 hybrid groups in 2020. No silver, bighead, or black carp were captured or observed during SIM monitoring in 2019 and 2020.

In 2019 and 2020, ILDNR, INHS, and USACE conducted systematic fishery monitoring in the IWW in pools downstream of the EDBS using a standardized fishery sampling methodology. This approach used daytime boat pulsed DC electrofishing, fyke netting, minnow fyke netting, and paired large and small hoop netting in a stratified random approach to sample for multiple species. Data are being used to evaluate fish community status in these pools, including potential upstream movement of invasive carp, and to inform assessments of the impacts of management actions (e.g., contracted removal) and enhance decision-support tools, such as the SEICarP model. In 2019, a total of 150,171 fish representing 108 species and 16 hybrid groups were captured through this effort. A total of 252,911 fish representing 107 species and 13 hybrid groups were captured in 2020. No invasive carp were captured in the Lockport or Brandon Road Pools in 2019 or 2020 through this sampling effort. Small silver and bighead carp (< 6 inches/152.4 mm TL) were captured in the Peoria Pool (river mile 216; ~108 miles from Lake Michigan) in 2020, 14 miles further upriver than in 2019.

During the reporting period, USFWS conducted additional sampling specifically targeting small silver and bighead carp less than 6 inches in TL using boat electrofishing and dozer trawling. The goal of the evaluation was to detect where young invasive carp (age 0 to 2) occur in the IWW. This age group was targeted because smaller invasive carp pose additional concerns to managers, as higher voltages at the EDBS are required to deter their movement compared with larger adult fish, and they pose a potential risk of entrainment and transport in transiting barges due to their small size and reduced swimming ability. In 2019, effort was focused in the Peoria and Lockport Pools. A total of 101 silver carp less than 153 mm TL were captured in Peoria Pool, with the furthest upstream collection at Hennepin, IL (river mile 207.8, 88 miles from EDBS). No silver carp less than 153 mm were captured upstream of the Starved Rock Lock and Dam. Sampling was affected in 2020 during the COVID-19 pandemic. In 2020, 51 sites in three Illinois River pools (Starved Rock, Marseilles, and Dresden) were sampled for small invasive carp; none were captured during this sampling.

In 2019 and 2020, agencies continued sampling for invasive carp eggs and larvae in the IWW to provide information on the status and location of breeding populations and the location of the current population front. In 2019, sampling was also conducted in tributaries, including the Kankakee, Fox, Mackinaw, Spoon, and Sangamon Rivers. During sampling, 1,430 invasive carp eggs and more than 80,000 larval fish were collected, including 3,595 invasive carp larvae. Invasive carp eggs and larvae were collected only in the LaGrange and Peoria Pools of the IWW during 2019. No invasive carp eggs or larvae

were collected in the Kankakee or Fox Rivers, but larvae were observed in all other tributaries and eggs were collected in the Spoon and Sangamon Rivers.

In 2020, 404 ichthyoplankton samples were collected at seven sites from the Brandon Road Pool to the LaGrange Pool during May through September. Sampling was again conducted in select Illinois River tributaries during 2020. Sampling resulted in the collection of 1,947 invasive carp larvae and 465 invasive carp eggs. Eggs were collected as far upstream as the Marseilles Pool, and three invasive carp larvae were collected from the Starved Rock Pool during 2020. Overall, numbers of invasive carp eggs and larvae observed during 2020 were very low compared with previous study years. No evidence of invasive carp reproduction was observed in the Kankakee, Fox, or Mackinaw Rivers. A single invasive carp larvae was collected from the Spoon River, and invasive carp eggs were collected from the Sangamon River. Invasive carp eggs or larvae were present during late May through June, and a late spawning event was observed at the beginning of October. Analyses indicated that invasive carp egg production was highest during years with warmer spring to early-summer water temperatures and higher flow rates, and production increased with adult density.

USFWS continued to support overflow monitoring of the Des Plaines River by conducting surveillance for potential invasive carp presence and spawning activity in the upper Des Plaines River. Efficacy of the USACE Des Plaines Bypass Barrier constructed between the Des Plaines River and CSSC is assessed by USFWS during its efforts to monitor for juvenile invasive carp that may potentially be transported to the CSSC via laterally flowing Des Plaines River floodwaters passing through the barrier fence. Four "overtopping" (overflow) events have occurred since 2011, resulting in improvements to the barrier fence by USACE. One overtopping event occurred in 2020. During 2019 and 2020, sampling was conducted in the upper Des Plaines River from Romeoville to Willow Springs, IL, using boat electrofishing and gillnet sets. No bighead or silver carp were captured or observed through all years of sampling during this project (2011–2020). Ten grass carp have been collected since 2011 (through September 2020).

Hydroacoustic Sampling

In 2019 and 2020, USFWS, in coordination with USACE and ILDNR, conducted hydroacoustic surveys to assess the abundance and spatial distribution of large fish (≥305 mm, or 12" TL) within and directly downstream of the EDBS and in the Lockport, Brandon Road, and Dresden Island Pools of the IWW. At the EDBS, surveys were conducted using split-beam hydroacoustic technology on a biweekly to monthly basis throughout 2019. Information is used to help inform operational and maintenance decisions related to the EDBS and potential risk of fish activity (e.g., potential for fish to challenge the EDBS). Results showed that fish density (noninvasive carp) within the EDBS was consistently low throughout 2019, with an annual mean of 1.8 large fish detected per survey. Fish abundances measured directly downstream of the EDBS were also low, with an annual mean of 3.6 large fish detected per survey. Hydroacoustic surveys were also conducted in the Lockport, Brandon Road, and Dresden Island navigation pools during the summer and fall of 2019. Fish density was greater in Dresden Island Pool

during the summer surveys relative to the densities in Brandon Road and Lockport Pools. Overall fish density was similar among the three pools during the fall surveys.

In 2020, USFWS conducted four surveys within and directly downstream of the EDBS between January and March. Results in 2020 showed that fish abundances were again relatively low and similar across surveys. The hydroacoustic survey effort was limited after March due to the COVID-19 pandemic health and safety restrictions. Fish densities measured within the EDBS were low, with a mean of 0.75 large fish detected per survey. Abundances measured directly downstream of the EDBS were also low, with a mean of 1.8 large fish detected per survey. In the absence of additional hydroacoustic sampling at the EDBS after March 2020, fishery monitoring with conventional gears in the Lockport Pool was used to assess risk. During 2020, hydroacoustic sampling in the Lockport, Brandon Road, and Dresden Island Pools was only conducted in March due to operational restrictions resulting from the COVID-19 pandemic. Large fish density was greatest in Dresden Island Pool (1.1 fish per 100,000 m^3) and similar in Brandon Road and Lockport Pools (0.4 fish per 100,000 m^3). Densities across all three pools were relatively low and similar to fall 2019 survey results.

In 2019 and 2020, SIUC, in coordination with ILDNR, USFWS, USACE, USGS, and INHS, conducted hydroacoustic surveys downstream of the EDBS in the IWW in the Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria, LaGrange, and Alton Pools to assess the spatial distributions of bighead and silver carp on a seasonal and annual basis. Results for those surveys are used to direct efforts by contracted commercial fishers to high-density locations to maximize invasive carp removal efficiency. SIUC has conducted hydroacoustic monitoring of bighead carp and silver carp in the Dresden Island through Alton Pools since 2012, providing a metric for evaluating spatial and temporal changes in invasive carp abundance. In 2019, surveys in Dresden Island and Marseilles Pools identified areas of high invasive carp density and how those locations changed through time. Bighead carp densities in Alton and Peoria Pools during the fall of 2019 were lower than in previous monitoring years, which coincided with flooding and historically high river discharge during the time of sampling. Low observed densities may have been caused by fish moving out of high-flow main channel areas and into shallow, low-flow habitats that were not sampled. In 2020, surveys in Dresden Island and Marseilles Pools again identified areas of high invasive carp density and were used to inform contracted removal efforts. Bighead and silver carp densities in Starved Rock, Marseilles, and Dresden Island Pools were not completed due to COVID-19 related delays in processing capture data. Densities in Alton Pool during the fall of 2020 were similar to previous years. La Grange and Peoria Pool densities in fall 2020 were slightly lower than in previous years, excluding 2019, which was a flood year. Continued hydroacoustic surveys were planned for 2021.

In 2020, USFWS developed and implemented monitoring protocols informed by data from a 2-year evaluation of the use of electrified “frame trawls” (e.g., dozer trawls) for comprehensively sampling a wide range of size classes of silver carp within a specific population. In addition, during 2018 through 2020, a standardized silver carp demographics protocol was implemented to quantify relative abundance and collect data to inform the SEICarP model and other decision-support tools. In 2020, USFWS collected data describing pool-specific relative abundance and individual age, sex, length, and

weight of invasive carp. The data are being used to inform evaluations of potential responses (e.g., compensatory growth, recruitment) for management actions.

During 2019, ILDNR, USFWS, and USACE coordinated efforts to sample five fixed locations and additional reaches in the CAWS for the presence of invasive and noninvasive carp species. Data from those surveys are being used to inform a fishery statistical-based model that will quantify the potential of invasive carp presence/absence and relative abundance. In addition, during 2019 and 2020, USACE conducted monthly boat electrofishing surveys at the EDBS. No invasive carp were captured or observed during those additional surveys.

Rapid Response

During 2019 and 2020, ICRCC MRWG agencies maintained preparedness for coordinated response in the event that a change in the status of invasive carp was detected in the upper IWW. The MRWG maintains and updates, as needed, the Contingency Response Plan (CRP) for the CAWS and the upper IWW, which describes specific actions to be taken within the five navigation pools of the upper IWW pools (Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock) and the CAWS in the event that a change is detected in the status of invasive carp, indicating an increase in risk level. Further emphasis is on the upstream waters from the EDBS to Lake Michigan. In addition, the CRP provides recommendations for conducting fish assessment, clearing, and suppression in the proximity of the EDBS in the event that construction or maintenance requires a change in the operational status of one or more of the arrays. As part of the CRP, barrier maintenance fish suppression is conducted to support USACE during maintenance operations at the EDBS. This process includes sampling to detect invasive carp downstream of the barriers before turning off power, surveillance of the barrier zone with hydroacoustics, side-scan sonar, and DIDSON sonar during maintenance operations and operations to clear fish from between barriers using mechanical or chemical means, if needed. In 2019, two 15-minute electrofishing runs were completed between Barriers 2A and 2B to supplement existing data in support of the MRWG clearing decision. Split-beam hydroacoustics and side-scan sonar assessed the risk of large fish presence between the barriers on a biweekly basis, both below and within the EDBS, indicating the presence of fish over 300 mm but in low abundance. In addition, USGS installed an acoustic deterrent system approximately 0.75 mile downstream of the EDBS between November 2018 and April 2019 in support of annual maintenance operations conducted by USACE. No invasive carp were captured or observed during fish suppression operations. The MRWG agency representatives convened virtually and discussed the risk level of invasive carp presence at the EDBS for each event involving a primary barrier loss of power to the water and potential need for subsequent assessment or clearing activities. In October 2019, regularly scheduled eDNA sampling conducted by USFWS in the CAWS yielded an unusually high number of positive results for invasive carp eDNA near Bubbly Creek (Chicago, IL). Out of an abundance of caution, ILDNR coordinated with other ICRCC agencies to lead an intensive 2-week sampling effort of the waters surrounding the eDNA detections in Bubbly Creek. The multiagency response used the Incident Command System with guidelines prescribed in the 2019 MRP Upper Illinois River Contingency Response Plan (CRP). No bighead or silver carp were captured or observed during the

2-week response operation (Follow-up eDNA results announced for Bubbly Creek | AsianCarp.us (invasivecarp.us).

3.9.3 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.**

Invasive Carp Capture and Removal

In 2019 and 2020, the use of State-directed commercial fishing continued to be a key strategy for the control of invasive carp populations in the IWW. Complementing the existing program that uses contracted commercial fishing crews to harvest invasive carp from pools downstream of the EDBS (Dresden Island, Marseilles, and Starved Rock Pools), the effort was expanded during the reporting period to promote the control of established, self-sustaining source populations farther upstream in the Peoria Pool. The two-pronged approach was intended to prevent the further upstream advance of the documented invasive carp population front, thereby reducing the risk of fish advancing toward and potentially challenging the EDBS, and to reduce the ongoing emigration of additional fish from the Peoria Pool, the most upstream navigation pool where all life stages of bighead and silver carp are consistently present. ILDNR—in collaboration with USFWS, USGS, USACE, and other MRWG partners—provides oversight and direction for the implementation of the coordinated harvest strategy.

In the upper IWW, the focus of removal actions continued to be in the Dresden Island, Marseilles, and Starved Rock Pools, where bighead and silver carp are regularly present. A variety of capture gears were used by commercial fishers, including gillnets, trammel nets, commercial seines, Great Lakes pound nets, and hoop nets. Between 2010 (the start of the program) and 2020, a total of 101,579 bighead carp, 1,157,698 silver carp, and 10,461 grass carp were removed by contracted fishers. The total estimated biomass of invasive carp removed is approximately 10,295,000 pounds. No invasive carp have been collected in the Lockport Pool or Brandon Road Pool since the start of this effort in 2010. Declines have been detected in the estimated density of invasive carp in navigation pools along the leading edge of established populations in the upper IWW since the start of State-directed contract commercial fishing in these pools.

In 2019, additional commercial fishing efforts were promoted to support the intensive harvest of invasive carp from the Peoria Pool. Analyses conducted through the MRWG supported an additional focus for removal at this location to reduce the likelihood of upstream migration by invasive carp. In 2019, approximately 518,000 pounds of invasive carp had been removed from the Peoria Pool through this effort, with harvest increasing to more than 3.3 million pounds in 2020. To ensure capacity, ILDNR entered into contracts with Illinois-licensed commercial fishers targeting the Peoria Pool (19 contracts in 2019; 31 contracts in 2020). Additional activities included development of a prototype branding and

marketing strategy to use the invasive carp harvested from waters where already established in support of collaborative prevention and control efforts.

Agencies continued to further develop and refine an invasive carp fishery population model (SEICarP) to inform invasive carp management options in the IWW. The SEICarP model uses comprehensive and current datasets of invasive carp demographics (e.g., growth, natural mortality, length, weight) and movement to support evaluations of optimal locations and times for the harvest of adult fish and potential locations for implementing deterrents to fish movement. This effort is a collaboration between USFWS, USGS, ILDNR, SIUC, INHS, Western Illinois University, and other partners. Through 2020, the demographic parameters in SEICarP for silver and bighead carp across the Illinois River were updated with data from an additional 13,000 fish from 2018 and 2019. In addition, input was solicited from quantitative fishery experts on SEICarP, including feedback on model assumptions, design, and analysis to promote model-based tool development and improvements. Expert input was used to improve existing model tools and support development of a manuscript for publication in a peer reviewed journal. Simulations generated by the SEIcarP model indicated that additional mortality (removal) of invasive carp was a more effective long-term control strategy in the lower pools of the IWW than in the upper pools. Also, model simulations of deterrents to the upstream movement of invasive carp demonstrated the value of implementing reduced passage immediately upstream of source populations versus sites located farther upstream. Model simulations provided evidence that the most effective long-term strategy to manage silver carp is by using a combination of control methods (e.g., removal and deterrents). USFWS, USGS, and partners conducted additional work to build on the SEICarP approach for development of a multibasin population model that accounts for effects associated with fish movement among the Illinois, Mississippi, Missouri, and Ohio river subbasins. The SEICarP model was further informed by additional telemetry monitoring data collected in 2019 and 2020. That effort included the collection of key data describing pool-to-pool movement of invasive carp in the IWW. In 2019, 161 adult silver carp were captured in Peoria Pool and implanted with acoustic transmitters. Data from the five acoustic receivers were collected, processed, and used by the MRWG for further analysis and planning. In 2020, due to safety concerns surrounding the COVID-19 pandemic, USFWS did not implant acoustic transmitters in invasive carp. Data from the five acoustic receivers were collected, processed, and provided to the MRWG Telemetry Work Group for use in the modeling efforts.

USGS continued to incorporate all data from invasive carp removal and monitoring efforts in the IWW into a centralized database, facilitating data standardization, accessibility, sharing, and analysis to aid in invasive carp removal efforts, evaluations of management actions, and population modeling. Work completed during the 2019 and 2020 reporting period included validation of hydroacoustic survey data (e.g., multibeam and side-scan sonar), creation of animated visualization overviews of Unified Method fishing events for several Dresden Island Unified Method events from tracking and activity data from boats and gear deployments, and development of an online, interactive mapping tool for existing invasive carp-related data layers. Equipment requirements, deployment techniques, and a methodology for collecting data from boats and gear deployments during Unified Method events were developed. This methodology was used during the Dresden Island Pool in the fall of 2019 Unified Method event, implementing improvements to data collection issues that were revealed from gaps in data collection

during the Dresden Island Pool in the fall of 2018 event. Geospatial data collected during a Unified Method event conducted in the Dresden Island Pool in the fall of 2018 were processed and used to reduce the time required to clear the same area during subsequent events (e.g., covering Dresden Island Pool with 4 days of coordinated fishing effort instead of 5 days).

Pathway Mitigation

During the reporting period, agencies conducted numerous activities to address primary and secondary interbasin pathways of potential AIS introduction, with a focus on preventing the movement of invasive carp. In 2019 and 2020, USACE continued to support multiple fish deterrent measures in the CAWS, each designed to prevent the potential upstream movement of invasive carp toward the Great Lakes. USACE continued maintenance, operations, and enhancements to the EDB in the CSSC in Romeoville, IL. The EDBS is designed to reduce the risk of transfer of fish from the Mississippi River to the GLB via the CSSC and consists of multiple barriers that create a pulsed, waterborne electrical field in the canal that acts as a deterrent to fish movement (Demonstration Barrier—2002, Barrier IIA—2009, and Barrier IIB—2011). In 2020, USACE completed major construction at the site to upgrade the Demonstration Barrier to the more robust Permanent Barrier I, as authorized in the Water Resources Development Act of 2007. Performance verification and safety testing of the Demonstration Barrier was scheduled for 2021, a prerequisite for full-time operation. USGS continued to support USACE operation and assessment of the EDBS by providing monitoring data (biological, physical, and environmental) collected from within and around the site. USGS provided data on commercial vessel traffic, flow reversals, water temperature and specific conductance, and in-water voltage gradients.

USACE continued to maintain the Des Plaines River Bypass Barrier (DPRBB), a 13-mile-long combination fence and jersey barrier that physically blocks known hydrologic bypasses around the EDB that can occur during periods of flooding from the Des Plaines River and the Illinois and Michigan (I&M) Canal. The DPRBB is designed to prevent the movement of juvenile and adult invasive carp during periods of high water. The ILDNR, USFWS, USACE, and other cooperating agencies conducted the Des Plaines River and Overflow Monitoring project to monitor for invasive carp presence and spawning activity in the upper Des Plaines River. No bighead or silver carp were captured or observed during monitoring under this project in 2019 and 2020. USACE continued to operate bar screens on sluice gates at Thomas J. O'Brien Lock and Dam on the Calumet River in Chicago. The screens were previously installed by USACE to impede the potential entry of invasive carp into Lake Michigan in the event that fish were present at that location.

During 2019 and 2020, USACE continued work on the feasibility study for the Brandon Road Interbasin Project, a large-scale AIS control project designed to address the potential interbasin movement of invasive carp and other species from the Mississippi River to the Great Lakes Basin. During May 2019, the USACE Chief's Report recommending a National Ecosystem Restoration (NER) Plan was signed by the Department of the Army's Chief of Engineers and sent to Congress. The NER Plan is a Federal risk management plan that provides a layered system of structural controls and nonstructural measures, including managing the waterway below Brandon Road as a "population reduction zone," where monitoring and overfishing would occur. Through 2020, USACE continued to coordinate closely with the

State of Illinois as the project's non-Federal sponsor on negotiations for the design agreement, the State of Michigan, and other Great Lakes agencies and organizations to ensure stakeholder input and project outreach. USGS continued to support Brandon Road Interbasin Project planning efforts through the continued operation and maintenance of a USGS streamflow gaging station in the downstream approach channel to the Brandon Road Lock and Dam (BRLD) station established in 2015. Monitoring data were quality assured and published on the USGS National Water Information System website (https://waterdata.usgs.gov/nwis). Operation of this gage provides USACE and partners with critical data to inform models and feasibility studies and for use in the preconstruction engineering and design at BRLD.

Agencies continued activities to address GLMRIS secondary (intermittent) interbasin hydrologic pathways in Indiana and Ohio. Indiana DNR (IDNR) continued maintenance of the Eagle Marsh (IN) project, previously completed in 2016 to create a permanent barrier near Fort Wayne, IN. The Eagle Marsh project eliminated the potential pathway for invasive carp migration from the Wabash River into the Lake Erie Basin. Continuing through 2020, IDNR, in partnership with the Little River Wetlands Project, conducted maintenance onsite to ensure the structural integrity of the Eagle Marsh berm and at wetland sites associated with the pathway mitigation project. In 2020, the crest of the Eagle Marsh berm was further reinforced and stabilized. In addition, USGS operated streamflow gages (Eagle Marsh East Near Fort Wayne, IN—USGS Water Data for the Nation) and a webcam at the project site to provide data to evaluate changes in water levels in response to regional rainfall and to simulate barrier integrity and flooding relative to seasonal high flow conditions.

In 2019 and 2020, USACE, in partnership with Ohio DNR, completed the hydrologic separation for pathway mitigation at the Ohio-Erie Canal in Summit County, OH. Construction was conducted onsite to raise the ground surfaces in low areas and prevent intermittent hydrologic interbasin connectivity during high-water events. In other locations, where complete hydrologic separation was not feasible, fences or screens were installed. The project will prevent or reduce the probability of the movement of invasive carp and other AIS from the Tuscarawas River watershed (MRB) into the Cuyahoga River watershed (GLB) via the Ohio-Erie Canal.

Figure 30. U.S. Army Corps of Engineers Buffalo District Contractors Install a Check Valve at Wolf Creek as Part of the Ohio-Erie Canal Aquatic Nuisance Species Project in Akron, Ohio

USACE and Ohio DNR continued efforts on closure of the Little Killbuck Creek pathway in northern Ohio, in collaboration with local landowners. This pathway consists of a surface water connection between the Ohio River watershed and the Lake Erie watershed in Medina County, OH. Previous work included initial design of needed construction effort, including berm alignment; additional hydraulic modeling to assess potential flooding; and acquisition of easements on four parcels for the construction of the berm. In 2019, USACE completed a peer review of a 25 percent design report completed for Ohio DNR by an engineering consultant and recommended alternative designs for the project. Ohio DNR selected an alternative design and conducted appraisals to support the acquisition of easements for the properties needed for berm construction. In 2020, Ohio DNR continued collaboration with local landowners and efforts to complete the 100 percent design for construction of the berm.

Barge Entrainment

Previous studies investigated the potential inadvertent entrainment and upstream transport of small fish by commercial barges transiting in the IWW and other factors that have the potential to facilitate fish movement under certain conditions (e.g., temporary localized alterations to lock hydrology and effectiveness of the voltage gradient of the EDBS caused by commercial barge traffic). A peer-reviewed article published in the Journal of Great Lakes Research in 2019 summarized study findings (https://pubs.usgs.gov/publication/70205250), with results indicating that preventing upstream return currents may reduce but does not prevent commercial tow-mediated upstream fish passages because tows may also cause a temporary reduction in the streamwise voltage gradient at the EDB.

In 2019 and 2020, USACE and partners conducted evaluations to determine if existing compressed air systems in lock structures on the Illinois River, specifically sill bubble curtains designed for ice removal,

have the potential to mitigate for small invasive carp entrainment. USACE developed a physical model of the CSSC with remote control tow and barges to (1) test the efficacy of compressed air bubble curtains to remove entrained neutrally buoyant fish surrogates from tows, and (2) quantify changes in flow dynamics within the hydraulic recesses during passage over a bubble curtain. USGS conducted surveys of the lower sill bubble curtain at Peoria Lock and Dam in September 2019. The surveys included hydroacoustic (acoustic Doppler) water velocity measurements, video recordings, and acoustic imaging of the bubble curtain in the water column. Data are being used to validate results from the physical model and to inform planned field trials. USGS also conducted additional modeling and data analyses for the Illinois River to assess the risk of entrainment of early life stage invasive carp in transiting commercial barges. In 2020, USACE used a scale model of the Peoria Lock to evaluate the interaction between barges, fluid motions, and nearly neutral buoyant objects under a variety of vessel speeds and barge configurations typical of IWW navigation locks. This effort focused on evaluating several bubble array configurations as a potential mitigation measure to remove small fish entrained in the junction gaps of the model barge tow. Data will be used to inform further evaluation and development of this potential fish entrainment mitigation technology.

3.9.4 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

Federal, State, and nongovernmental partners conducted activities in 2019 and 2020 to develop and evaluate invasive carp deterrent technologies. The ICRCC's 2019 and 2020 Invasive Carp Action Plans continued support for the development of emerging invasive carp deterrent technologies. Activities conducted during the reporting period were supported through strong collaboration between Federal and State agency partners across the IWW/CAWS, UMRB, and ORB.

Acoustic Deterrent Barriers

USFWS, USGS, USACE, and other Federal, State, and nongovernmental partners continued collaborative development and evaluation of underwater acoustic technology as a potential fish deterrent tool. Efforts in 2019 and 2020 included large-scale field evaluations of the efficacy of acoustic deterrent systems conducted in locations within river systems with active navigation locks where populations of bighead or silver carp or both were previously established. Coordination of the acoustic deterrent evaluations continued through interagency science and evaluation teams guiding the large-scale experimental deployment of the Bio-Acoustic Fish Fence (BAFF) at Barkley Lock and Dam in Kentucky and the Acoustic Deterrent System at Lock and Dam 19 in Iowa and Illinois. The initial installation of the BAFF at Barkley Lock and Dam on the Cumberland River in Kentucky was completed in 2019. Evaluation of the BAFF effectiveness was initiated and will continue until conclusion of the study in 2023. A second large-scale field trial was initiated in 2019 when a study plan was developed for deployment and

evaluation of an underwater Acoustic Deterrent System (uADS) at Lock and Dam 19 on the Upper Mississippi River. System deployment was scheduled for winter of 2020/2021 with system operation planned for up to 3 years. These projects are further described in Sections 3.5.4 and 3.6.4.

Agencies conducted further research to evaluate the effectiveness of specific sounds for use as deterrents to invasive carp while minimizing impacts to native species. USGS and USACE conducted evaluations to screen and select a new set of underwater acoustic signals. Studies to test fish response to the signals were developed by USACE ERDC and conducted at the Columbia Environmental Research Center (CERC) in Columbia, MO, using silver carp. A subsequent field study was initiated in 2020 at Morris, IL (concluding in 2021). In addition, fieldwork continued to test the effectiveness of sounds generated from boat motors for driving (herding) bighead and silver carp to predetermined locations for removal in the Illinois River. Also, in 2019, USGS completed studies with the University of Minnesota—Duluth and Western Kentucky University to test the impacts of long-term exposure of sound in silver and bighead carp. The fish displayed temporary hearing loss, but no long-term hearing loss was evident (Nissen et al. 2019).

USGS, USACE (ERDC), and Purdue University developed a study plan for implementation of an acoustic deterrent system focused on invasive carp control on the Wabash River. Actions completed in 2019 and 2020 included equipment setup and fish tagging to support the evaluation of fish behavior and system effectiveness.

Carbon Dioxide Barriers

USGS and partner agencies completed a large-scale pilot project to evaluate the use of CO_2 injected into water as a potential nonphysical deterrent barrier to invasive carp and other AIS. The feasibility study was conducted within a navigational lock on the Fox River near Kaukauna, WI. In 2019, USGS and partners from USACE, USFWS, U.S. Coast Guard, Wisconsin DNR, University of Illinois, and University of Wisconsin—Platteville conducted an engineering feasibility study at Lock #2 on the Fox River. The study evaluated the engineering, costs, water quality, human safety, fish behavior, and nontarget impacts associated with the operation of a CO_2 deterrent at navigational locks to control invasive fish movements. Data from the study were processed, with results and final reports completed in 2020. This project is further described in Section 3.6.4 (UMRB—Research and Development, Development of New Deterrent Technologies).

Development of New Targeted Control Technologies

USGS continued development of oral formulations (microparticles) that can deliver control agents, including piscicides, in a targeted manner to silver, bighead, grass, and black carp while minimizing potential impacts on native species. In late 2018 and September 2019, USGS conducted two field assessments of microparticles evaluating the effectiveness of targeting silver and bighead carp using toxic microparticles in an effluent pond at the Rathbun Fish Hatchery in Iowa.

USGS and USFWS coordinated on actions required to complete the registration processes with regulatory agencies and develop standard operating procedures for the use of CO_2 and toxic microparticles as invasive carp control agents in the environment. In April 2019, USGS registered CO_2 (on behalf of USFWS) as a deterrent for invasive carp and an under-ice lethal control for aquatic nuisance species. Also, USGS purchased all rights to antimycin-A in—and completed actions required for registration for use as—a piscicide (on behalf of USFWS). A potential producer has been identified for this formulation (to be known as "Piscamycin"). USGS will subsequently expand the registration to include microparticle use. Additional coordination by USFWS and USGS addressed EPA and Section 7 ESA-consultation data requirements of antimycin-A-incorporated microparticles. USGS also began the process to reestablish registration of Fintrol as a fish toxicant for use by resource managers.

Development and Testing of New Gear and Techniques

USFWS, ILDNR, USACE, and USGS continued to develop new sampling techniques and gear for invasive carp detection and removal in various habitat types. Agencies evaluated capture methods and sampling gear to better target invasive carp in tributaries, large reservoirs, and backwater lakes. USGS evaluated the Unified Method, a fishing strategy used for intensive and geographically focused harvest of invasive carp from reservoirs or embayment. Manuscripts summarizing the results from evaluations of the Unified Method conducted in Creve Coeur Lake, MO, in 2018 were published. In April 2019, a harvest workshop was conducted in Kentucky, which included presentations and training on use of the Unified Method and various invasive carp netting techniques. USGS coordinated with partners to conduct a Unified Method fishing effort for invasive carp in December 2019 in Morris, IL. USGS also collaborated with INHS and ILDNR to assess the effectiveness of herding invasive carp for capture in multiple capture gear types in an enclosed backwater of the Starved Rock Pool in the Illinois River. The project assessed the capture and behavioral responses of bighead and silver carp among three different trap-gear types. These techniques were also used in a Unified Method assessment in Morris, IL. Preliminary results show that the acoustic stimulus combined with electroshock is the most effective technique for pushing (or "herding") fish to areas for removal at distances up to 2 miles.

In 2020, USFWS published the results from an evaluation of factors influencing silver carp catch rates with boats outfitted with electrified Paupier nets deployed in lake or reservoir habitats. The publication also provided guidelines for using this method for invasive carp capture and removal.

Invasive Carp Biology, Life History, and Reproduction Evaluations

In 2019 and 2020, agencies collected information on invasive carp reproduction dynamics, growth, feeding behavior, and other parameters to inform monitoring and management strategies. NOAA further developed a food web model for bighead and silver carp in the Illinois River and the CAWS. The model was used to inform simulations of invasive carp population growth, food web effects, and impacts of control through harvest removals. In addition, NOAA initiated development of an individual-based bioenergetics model to track daily consumption, growth, survival, reproduction, and movement of silver and bighead carp individuals in response to temperature, prey resources, and interactions with four other fish species in the Illinois River. The model will also simulate the effects of harvest on size

composition of individuals. USGS collected high-resolution bathymetry data from priority areas of the Illinois River (Brandon Road, Dresden Island, Marseilles, Starved Rock, and Peoria reaches) to inform potential management action.

Development of a validated, benthic habitat classification for the Illinois River continued. Data layers were incorporated into an online web mapping service with other environmental data and habitat suitability models to help inform invasive carp removal efforts, including assessments for areas with similar habitat and environmental characteristics. USGS continued refinement and use of the FluEgg model, a tool used to assess potential invasive carp spawning and predict the survival of eggs and larvae under simulated environmental and physical conditions. In 2019, an updated version of the FluEgg model was published to improve accessibility and functionality and was applied to several priority rivers to assess invasive carp spawning suitability (egg and larval transport capability) or spawning area identification. Progress continued in 2019 on an interactive web application for daily predictions of egg and larval plumes on the IWW during spawning season using FluEgg. This web application was made public in 2020 as part of the U.S. Government's GeoPlatform portal (www.geoplatform.gov).

In 2019, USGS and the University of Illinois continued to investigate the influence of water quality and river hydraulics on the range, movement, spawning, and recruitment success of invasive carp in the IWW. Previously, in 2015, USGS had analyzed water samples collected at multiple sites along the IWW for chemicals, identifying several specific compounds that may be contributing to the stalled invasive carp population front in the IWW. In a related study conducted by the University of Illinois, analyses of tissue from silver carp captured by commercial netting in 2016 near and downstream of the population front showed that silver carp at the population front demonstrated specific physiological differences observed in fish (Jeffrey et al. 2019). In 2019, the University of Illinois conducted an analysis of additional fish tissue samples collected in 2018 from silver carp caught by commercial fishers near the population front in the IWW.

In 2020, USFWS processed aging structures collected from 200 individual invasive carp. Collections included smaller size (younger) fish, which are captured less frequently than adult invasive carp; information will be used to inform IWW-focused invasive carp demographics and population assessments.

During the reporting period, the USFWS also coordinated the interagency Black Carp Work Group (BCWG), collaborating with USGS, ILDNR, USACE, and other partners. The BCWG was previously formed to identify priority actions and data needs for addressing the growing threat of black carp to river systems of the Midwest United States. In 2019 and 2020, USGS and partners assessed wild-caught black carp to collect key information on diet, reproductive status and ploidy, age, growth, and genetics. Black carp specimens were captured primarily by cooperating commercial fishers and provided to USGS for analysis. USGS CERC served as the repository for wild-caught fish. Research conducted by USGS demonstrated a greater reliance upon mollusks as a source of prey by black carp than previously believed, underscoring the potential risk to threatened and endangered mussel species in North American waters. Results from those studies were published in peer-reviewed manuscripts. Additional

USGS activities to address black carp included development of a black carp-specific bait to augment capture and removal efforts, assessment of wild black carp habitat use and movement by telemetry tracking of tagged fish, and collaboration on development of a binational risk assessment of black carp for the Great Lakes.

3.9.5 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.**

Invasive Carp Partnership Websites

USFWS continued to support and administer the national invasive carp website (www.invasivecarp.us) as the primary platform for delivering updates on accomplishments, science, and other products related to invasive carp management. The website houses documents related to invasive carp management, including collaborative strategies and summary reports. USFWS initiated a redesign of the website to include specific content on invasive carp news and developments. Additional content to share ICRCC findings and updates is being developed by the multiagency Communication Work Group. In collaboration with Canadian ICRCC partners, The Invasive Species Centre developed a complementary website (https://www.asiancarp.ca/), which provides a Canadian perspective on the invasive carp issue.

Public/Stakeholder Engagement

During 2019 and 2020, USACE employed a comprehensive public engagement strategy for GLMRIS during the reporting period consisting of focused briefings, stakeholder conference calls, media events, social media posts, and project websites.

Industry Engagement

During 2019 and 2020, USACE conducted outreach with members of the navigation industry in advance of and during significant EDBS maintenance activities that affected navigation traffic in the CSSC.

3.9.6 Law Enforcement/Regulatory

- **NATIONAL PLAN GOAL: Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carp in the United States.**

The ILDNR Invasive Species Unit (ILDNR ISU) continued to support comprehensive invasive carp management through various law enforcement actions in 2019 and 2020. The ILDNR ISU was created in 2012 as a special law enforcement component to the overall invasive carp project, focusing on the surveillance of alternate pathways of concern for the introduction of AIS in the State of Illinois.

In 2019, an out-of-state pond-stocking company investigated by the ISU was criminally charged and pled guilty to unlawfully importing viral hemorrhagic septicemia (VHS)-susceptible species into Illinois without permits. The court ordered restitution to the ILDNR in the amount of $11,494.00. The investigation revealed the company imported, sold, and stocked live gizzard shad, fathead minnows, bluegill, red ear sunfish, and largemouth bass without a nonresident aquatic life dealer's license and often without VHS import permits. Also, 39 businesses within the Great Lakes region selling live red swamp crayfish on the internet and shipping them to customers through mail delivery services were identified and sent official notification letters containing jurisdictional regulations and agency AIS personnel contact information. The effort signified a proactive approach to protecting resources while simultaneously providing those within the industry easy access to regulatory information and personnel.

During 2020, through the actions of ILDNR ISU, the owner of a Missouri fish farm previously charged with selling and shipping live tilapia to Illinois customers (a violation of fish importation regulations) entered into a deferred prosecution agreement with the Illinois Attorney General's Office and was ordered to pay $8,000 in restitution to the State of Illinois. In addition, ILDNR ISU investigated an anonymous complaint of a bait shop illegally selling frozen shad and invasive carp parts as bait. The investigation revealed that the shad were illegally harvested from a prohibited area, and the invasive carp bait violated VHS regulations. The business was brought into compliance with all regulations.

ILDNR continued its actions to conduct alternative pathway surveillance and urban pond monitoring in Illinois waters. This project focuses on sampling and removing invasive carp from urban fishing ponds in the Chicago area to prevent the potential incidental or intentional transport of fish from these ponds to the CAWS or Lake Michigan. From 2011 through 2020, 44 bighead carp and one silver carp were removed from 10 ponds. Sampling has been conducted using electrofishing, trammel nets, and gillnets since 2011. Three of the captured fish were provided to the Shedd Aquarium in Chicago for display to support public outreach on invasive carp. As of 2020, 18 of the 21 ILDNR Chicago Urban Fishing Program ponds have been sampled for invasive carp with nets and electrofishing.

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

Agency and nongovernmental partners conduct critical research to support the development and implementation of potential new technologies and tools for use in invasive carp management strategies. In 2019 and 2020, Federal agency efforts were led primarily by USGS, USACE and USFWS, with State agencies and universities conducting additional key research. Research and technology development activities addressed priority needs under the following categories:

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

Potential new invasive carp control technologies are designed to exploit known species-specific life-history vulnerabilities and unique behavioral characteristics to achieve optimal population management impact. As potential new tools are investigated and developed, supporting research must also consider potential negative impacts to nontarget aquatic species, especially depleted or imperiled State- or Federally listed fish and mussels. As a result, several control tools currently being developed are highly specific to invasive carp species to avoid impacts to nontarget native aquatic species. Prevention actions that are more general and not selective for invasive carp, including sound, CO_2, or bubble barriers, are designed to be deployed in a manner to deter fish movement while not being lethal. Information on invasive carp life history, including habitat use and migration patterns, is integral for informing and directing the strategic timing and placement of potential control technologies and understanding the risk posed by potential movement through various pathways.

Key invasive carp research and technology projects conducted by Federal and State agencies and partners in 2019 and 2020 are further described in Section 3.0 of this report in the individual subbasin "Research and Development" summaries.

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

The WRRDA directs USFWS to identify measures to document progress in controlling the spread of invasive carp in the MRB. The initial 2014 Report identified (1) proposed measures and outcomes for ensuring progress toward the goals of controlling spread of invasive carp in the designated watersheds, and (2) specific critical short-term actions to continue and expand multiagency coordination to achieve common prevention-based goals. The use of these measures is intended to promote ongoing evaluation, reporting, and accountability in support of the National Plan and the invasive carp strategies now in place in the multiple subbasins. The identified measures of progress include specific actions to support comprehensive and sustained interagency coordination and both qualitative and quantitative measures of progress identified to describe progress in strategically implementing comprehensive invasive carp detection, prevention, and control actions.

A detailed summary of accomplishments achieved in FY 2019 and FY 2020 and described in this report by each measure is provided in Appendix A.

6.0 CROSS-CUT SUMMARY OF FEDERAL AND NON-FEDERAL EXPENDITURES IN THE MISSISSIPPI RIVER BASIN

Agencies were queried for a summary of all invasive carp-related expenditures incurred during their respective 2019 and 2020 fiscal years, categorized by both funding source and general type of activity conducted. This cross-cut summary includes an overview of FY 2019 and FY 2020 expenditures directly related to invasive carp activities conducted by Federal and State agencies in the MRB, including the IWW/CAWS. The summary includes all agency respondents that incurred invasive carp-related expenditures during the reporting period.

For FY 2019, agencies reported a total of $51,454,903 in expenditures, of which $7,869,025 was expended on activities conducted to address invasive carp in the MRB and tributaries. A total of $43,585,878 in reported expenditures supported activities in the IWW/CAWS to protect the Great Lakes from invasive carp.

For FY 2020, agencies reported a total of $55,925,360 in expenditures, of which $16,006,775 was expended on activities conducted to address invasive carp in the MRB and tributaries. A total of $39,918,585 in reported expenditures supported activities in the IWW/CAWS to protect the Great Lakes from invasive carp.

For FY 2019 and FY 2020 combined, the total reported expenditures on activities conducted to benefit the MRB and tributaries was $23,875,800 (Tables 6a and 6b).

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 Invasive Carp, Implementation/Operation of Barriers)
- Research and Development
- Outreach with Industry, Stakeholders, and the Public
- Law Enforcement/Regulatory Actions

For FY 2019 and FY 2020, the percent of total reported expenditures by category was as follows:

Active Prevention and Control: FY 2019 - 48.9 percent, FY 2020 - 47.3 percent; Research and Development: FY 2019 - 31.5 percent, FY 2020 - 31.3 percent; Monitoring, Early Detection and Rapid Response: FY 2019 - 16.7 percent, FY 2020 - 18.1%; Interagency Coordination: FY 2019 - 1.5 percent, FY 2020 - 2.7 percent; Outreach with Industry, Stakeholders, and the Public: FY 2019 - 1.4 percent, FY 2020 - 0.6 percent; and Law Enforcement/Regulatory Actions: FY 2019 - <0.1 percent, FY 2020 - <0.1 percent. An activity category was not assigned by the agencies to < 0.1 percent of the reported expenditures.

Additional FY 2019 and FY 2020 expenditures were reported by agencies conducting actions to address the Great Lakes and Mississippi River Interbasin Study (GLMRIS) Secondary Pathways. Since these pathway mitigation efforts are focused on protecting the GLB from the movement of invasive carp and are not exclusively within the delineated geographic boundaries of the MRB (ORB sub-basin), 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 invasive carp from the MRB (ORB sub-basin) to the GLB. Tables 6.1 and 6.2 provide a summary of all expenditures reported by individual agencies by year. 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 invasive carp management in the IWW/CAWS.
- Total Agency Base Expenditures—Total reported expenditures of agency base funds for activities that support invasive carp management in the MRB, including the IWW/CAWS.
- Total Other Expenditures—Includes additional expenditures not supported by GLRI or agency base funds.
- Total Reported Expenditures—Total reported expenditures of agency base, GLRI, or other funds for activities that support invasive carp management in the MRB, including the IWW/CAWS.
- Total MRB (without IWW/CAWS) Expenditures—Total Reported Expenditures (see above) for only MRB invasive carp management (excludes all IWW/CAWS activity expenditures).

Note that funds provided by granting agencies (e.g., EPA and USFWS) to financially support activities conducted by a partner agency are reported only once, by the recipient, as they expend funds and conduct the actual activity.

Table 2. FY 2019 Expenditures by Agency and Funding Source

Agency	Total Agency GLRI Expenditures[1]	Total Agency Base Expenditures	Total Other Expenditures	Total Reported Expenditures[2]	Total MRB (w/o IWW/CAWS) Expenditures[3]
USACE	$3,887,480	$19,094,404	$0	$22,981,884	$0
USGS	$5,968,955	$7,005,560	$228,259	$13,202,774	$831,159
NOAA	$105,781	$97,635	$0	$203,416	$0
USFWS	$3,800,300	$3,165,892	$0	$6,966,192	$2,592,800
USCG	$581	$19,046	$0	$19,627	$19,627
Illinois	$3,843,870	$0	$382,463	$4,226,333	$367,346
Indiana	$25,914	$7,335	$22,004	$55,253	$55,253
Iowa	$0	$47,000	$0	$47,000	$47,000
Kansas	$0	$95,859	$0	$95,859	$95,859
Kentucky	$0	$1,326,501	$379,039	$1,705,540	$1,705,540
Louisiana	$0	$7,425	$22,500	$29,925	$29,925

Minnesota	$0	$263,055	$442,914	$705,969	$705,969
Mississippi	$0	$15,763	$0	$15,763	$15,763
Ohio	$493,479	$15,031	$45,093	$553,603	$553,603
Pennsylvania	$0	$40,930	$0	$40,930	$40,930
Tennessee	$0	$248,000	$311,100	$559,100	$559,100
West Virginia	$0	$34,301	$11,433	$45,734	$45,734
Total	**$18,126,360**	**$31,483,738**	**$1,844,805**	**$51,454,903**	**$7,869,025**

Table 3. FY 2020 Expenditures by Agency and Funding Source

Agency	Total Agency GLRI Expenditures[1]	Total Agency Base Expenditures	Total Other Expenditures	Total Reported Expenditures[2]	Total MRB (w/o IWW/CAWS) Expenditures[3]
USACE	$2,985,270	$22,974,235	$0	$25,959,505	$0
USGS	$5,835,588	$6,252,212	$218,659	$12,306,459	$6,470,871
USFWS	$3,012,800	$6,848,745	$0	$9,861,545	$4,693,650
USCG	$0	$1,820	$0	$1,820	$1,820
Georgia	$0	$1,400	$0	$1,420	$1,420
Illinois	$2,908,882	$0	$423,942	$3,332,824	$377,227
Indiana	$240,000	$32,154	$99,154	$371,308	$371,308
Iowa	$0	$70,000	$0	$70,000	$70,000
Kentucky	$0	$1,282,063	$969,113	$2,251,176	$2,251,176
Kansas	$0	$73,250	$0	$73,250	$73,250
Minnesota	$0	$256,460	$185,163	$441,623	$441,623
Mississippi	$0	$27,839	$36,232	$64,071	$64,071
Nebraska	$0	$15,000	$0	$15,000	$15,000
Ohio	$0	$18,327	$54,982	$73,310	$73,310
Pennsylvania	$0	$35,794	$0	$35,794	$35,794
Tennessee	$0	$641,702	$204,265	$845,967	$845,967
West Virginia	$0	$34,101	$11,367	$45,468	$45,468
Total	**$ 14,982,540**	**$ 38,739,942**	**$ 2,202,877**	**$ 55,925,360**	**$ 16,006,775**

1 Actions for GLB protection that are conducted within the IWW/CAWS are included in this report based on its hydrologic delineation within the MRB and to provide a more complete picture of the scope of invasive carp activities carried out within the designated subbasins. These activities, and others focused on Great Lakes protection and conducted through the ICRCC, are further described in the FY 2019 and FY 2020 Invasive Carp Action Plans.

2 Total Reported Expenditures include 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 MRB Expenditures (excluding IWW/CAWS) represent all reported expenditures for actions to address invasive carp in the MRB, excluding projects conducted in the IWW/CAWS for Great Lakes protection.

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APPENDICES

- Appendix A: Maps of Navigation Pools and Lock and Dam Structures in the Upper Mississippi River Basin and Ohio River Basin
- Appendix B: Summary of 2019–2020 Accomplishments Described by Qualitative/Quantitative Metric
- Appendix C: List of Abbreviations Used in this Report

APPENDIX A: MAPS OF NAVIGATION POOLS AND LOCK AND DAM STRUCTURES IN THE UPPER MISSISSIPPI RIVER BASIN AND OHIO RIVER BASIN

Figure 31. Map of Lock and Dam Structures and Navigation Pools on the Upper Mississippi River

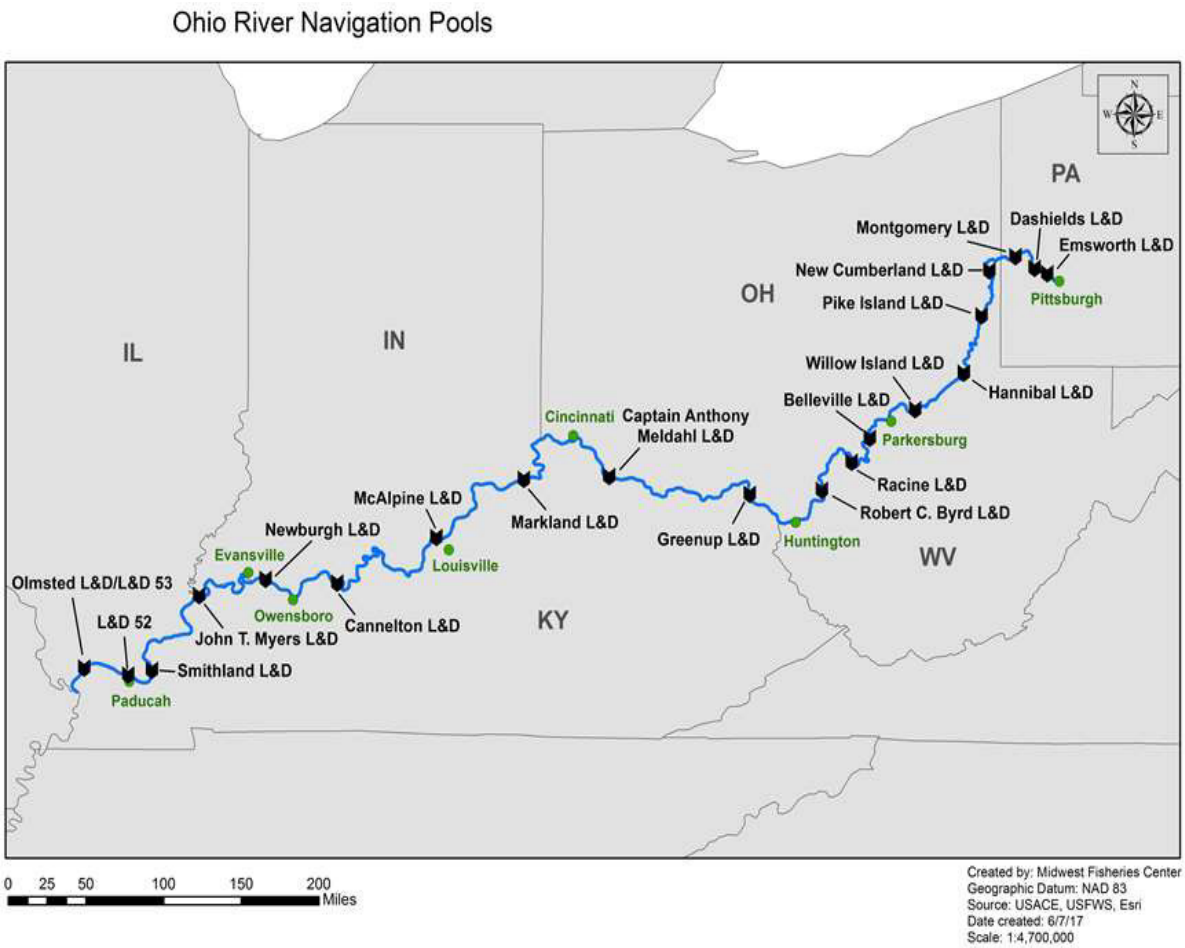

Figure 32. Map of Lock and Dam Structures and Navigation Pools on the Ohio River

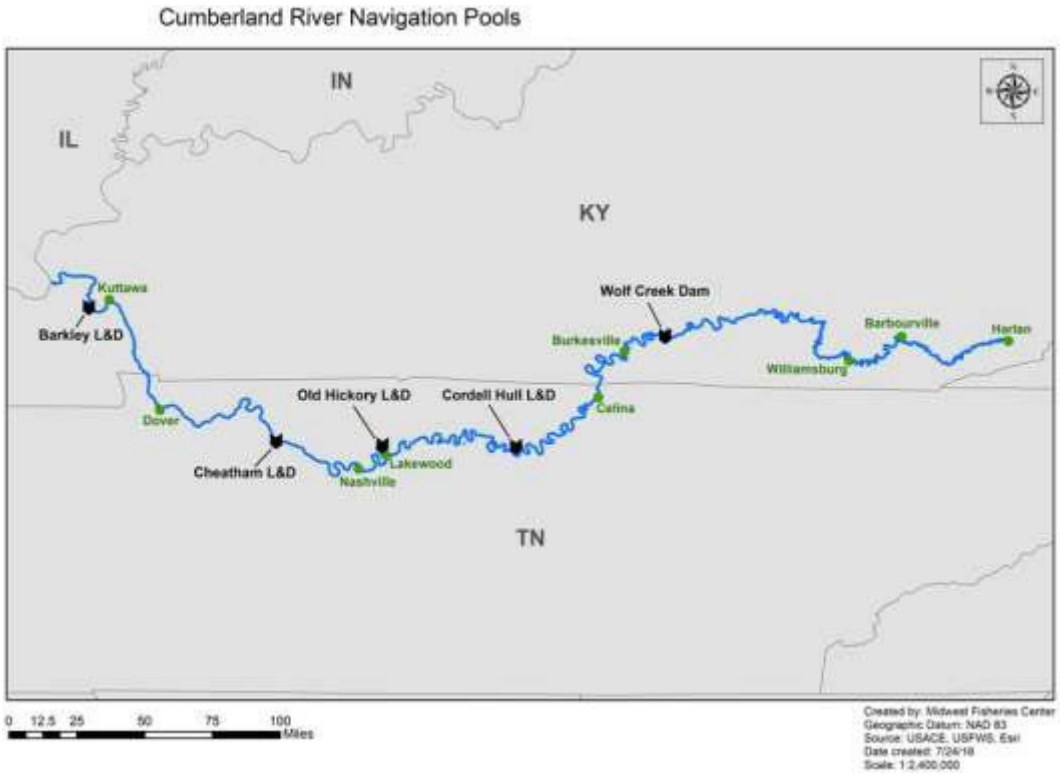

Figure 33. Map of Lock and Dam Structures and Navigation Pools on the Cumberland River

Figure 34. Map of Lock and Dam Structures and Navigation Pools on the Tennessee River

APPENDIX B: SUMMARY OF 2019 AND 2020 ACCOMPLISHMENTS DESCRIBED BY QUALITATIVE/QUANTITATIVE METRIC

The Water Resources Reform and Development Act of 2014 (WRRDA 2014) directed the U.S. Fish and Wildlife Service (USFWS) to identify measures documenting progress to control the spread of invasive carp in the Upper Mississippi River Basin (UMRB) and the Ohio River Basin (ORB) and their tributaries for inclusion in the Annual Report. The initial 2014 Report identified the following: (1) proposed measures and outcomes for ensuring progress toward the goals of controlling the spread of invasive carp in the designated watersheds, and (2) specific critical short-term actions to continue and expand multiagency coordination to achieve common prevention-based goals. Those measures have been updated accordingly to reflect the broadened geographic scope of the reporting prescribed in WRDA 2020. The identified metrics include qualitative and quantitative measures identified to describe progress in strategically implementing comprehensive invasive carp detection, prevention, and control actions.

The individual actions included under each qualitative or quantitative measure in this appendix have been previously described within the appropriate MRB subbasin in Section 3 of this report.

Actions to Address the Need for Interagency Coordination

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

1. ***Development of interagency MRB basin-specific invasive 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 invasive carp control strategies into a national approach will also help identify gaps in science and data in invasive carp management and provide a foundation for collectively developing priority initiatives to benefit multiple basinwide partnerships.*

   Accomplishments in the MRB

   - In 2019 and 2020, the annual Monitoring and Response Plan for Asian Carp in the Mississippi River Basin was developed and implemented to deliver priority projects in support of the goals and recommendations of the MRB subbasin Frameworks (see #4 below).
   - Invasive carp management frameworks and annual workplans were developed and implemented in all MRB subbasin partnerships during the reporting period.
   - The Invasive Carp Regional Coordinating Committee (ICRCC) developed and implemented its annual Invasive Carp Action Plan during 2019 and 2020. The action plan supported implementation of the ICRCC's tactical 2019 and 2020 Monitoring and Response Plans (MRPs) and the goals and recommendations of the National Plan. In 2019 and 2020, priority control technology development projects were conducted in cooperation with Federal and State partners in other subbasins, including the ORB and UMRB. Results and lessons learned are shared across the multiple river subbasins conducting invasive carp management actions.
   - The ICRCC Monitoring and Response Work Group (MRWG) developed its 2019 and 2020 MRPs for directing the implementation of early detection, response, control, and prevention projects in the upper Illinois Waterway (IWW) and Chicago Area Waterway System (CAWS) to support

protection of the Great Lakes from invasive carp. The 2019 and 2020 MRPs are available at 2019 Asian Carp Monitoring and Response Plan (invasivecarp.us) and 2020 Asian Carp Monitoring and Response Plan (invasivecarp.us).

2. ***Identification of Federal and State resources potentially available for implementing control strategies and actions.***

Accomplishments

- USFWS continued to coordinate with other Federal agency partners and MRB State agencies to identify resources to implement highest-priority detection and control actions and leverage those resources where feasible. States received funding from USFWS for invasive carp projects in addition to awards supporting implementation of Aquatic Nuisance Species Task Force (ANSTF)-approved State ANS management plans. Numerous States also evaluated the need for increased State resources, exploring options including increasing fees and other innovative methods to leverage funding.

3. ***Development of MRB formal institutional arrangements, using a collaborative model similar to the ICRCC, to facilitate interagency coordination, collaboration, and plan implementation.***

Accomplishments

- USFWS continued to work through the Mississippi Interstate Cooperative Resource Association (MICRA) for annual and longer-term invasive carp coordination and multistate project planning and implementation in the MRB. The subbasin partnerships previously identified interagency organizational structures and processes for coordinated planning and reporting, development of funding strategies, implementation of actionable plans, and identification of roles and responsibilities for all participating agencies. During 2019 and 2020, interagency invasive carp partnerships were further developed in the Missouri River and Lower Mississippi River subbasins, following the existing USFWS-coordinated MICRA subbasin partnership collaborative model.
- Continuing in 2019 and 2020, priority projects were proposed for funding approval by the MICRA Invasive Carp Advisory Committee and USFWS. This previously established coordination model ensured that annual projects were vetted through USFWS and the MICRA Invasive Carp Advisory Committee and that funded projects support the management priorities of the respective subbasin strategies and the National Plan. This process directly supported implementation of the respective MRB invasive carp Frameworks.

4. ***Development of an annual project plan with management structure and appropriate funding.***

Accomplishments

In 2019 and 2020, the MICRA and USFWS coordinated with the MRB subbasin partnership planning teams to develop the annual comprehensive work plans incorporating priority USFWS-funded projects for FY 2019 and FY 2020. The annual Invasive Carp Monitoring and Response Plan for the Mississippi River Basin (MRPMRB) developed for each year (2019 and 2020) outlined collaborative efforts to manage and control invasive carp populations within the respective MRB subbasins. The MRPMRB is adaptive and updated annually, informed by current data and priorities, in support of the MRB Frameworks and the National Plan. The 2019 and 2020 MRPMRBs are available on the MICRA partnership website.

- Deliverables outlined in the MRPMRB are provided in annual technical reports for each project

conducted in the MRB and include detailed findings and future recommendations for respective projects.

5. Development of a process to ensure that actions are strategically prioritized and properly sequenced.

Accomplishments

- The USFWS worked extensively with MICRA, other Federal agencies, and individual MRB States within each subbasin to ensure that individual activities proposed for invasive carp management and funding were strategically prioritized and properly sequenced and supported the goals and recommendations of the National Plan and subbasin Frameworks. This process continued in 2019 and 2020, building upon the existing interagency coordination mechanisms previously established within the respective subbasins. Efforts in 2019 and 2020 leveraged the enhanced funding received by USFWS in its annual agency invasive carp appropriation to support collaborative State-led detection, prevention, and control projects. Further, technical work groups established within the various subbasin partnerships developed, implemented, and evaluated annual comprehensive work plans and informed needed changes for outyears on the basis of results and recommendations.

6. Preparation of a biennial report summarizing accomplishments and strategies for management of invasive carp, as prescribed in WRDA 2020, Section 506.

Accomplishments

- USFWS developed the 2019–2020 biennial Report to Congress (Report), summarizing accomplishments and expenditure for invasive carp prevention and control efforts in the MRB. The 2019–2020 Report represents the first biennial, MRB-wide iteration since the updated direction from Congress provided in WRDA 2020, Section 506 (revising WRRDA 2014, Section 1039). USFWS continued to provide leadership in coordinating the Report on behalf of the identified Federal agencies, with assistance from partner State agencies conducting activities to address invasive carp in the MRB. As required, the Report includes a summary of agency accomplishments and related expenditures for invasive carp activities, status of the distribution of invasive carp (including any observed changes in range), and an overview of key research to support prevention and control measures.

<u>Quantitative Measures of Progress</u>

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

1. Physical removal of invasive carp through the use of focused contracted commercial harvest in the MRB.

Accomplishments

- In 2019 and 2020, agencies in the MRB continued to actively use the physical removal of invasive carp within targeted locations in river basins, with a focus on reducing densities of fish along the upstream “leading edges” of established populations. State resource management agencies provided oversight for contract and commercial fishing activities given their designated

management authority for their respective jurisdictional waters. Removal efforts were informed by fishery surveys and population and harvest modeling analyses. Models were further refined to enhance their effectiveness. During 2020, demographic parameters in SEICarP for silver and bighead carp populations across the Illinois River were updated with data from an additional 13,000 fish collected during 2018 and 2019. Additional assessments included modeling the cumulative effects of the potential placement of fish migration barriers in conjunction with commercial harvest and quantitatively evaluating the effects of intensive harvest on invasive carp population dynamics in support of invasive carp management goals. State agencies evaluated further opportunities to expand the targeted use of commercial fishing capacity to support invasive carp removal goals in support of management strategies.

- The Kentucky Department of Fish and Wildlife Resources (KDFWR) continued to support the Asian Carp Harvest Program (ACHP), focused on intensive removal of adult invasive carp from Lake Barkley, Kentucky Lake, and their respective tailwaters. From its inception in 2013 through 2020, the KDFWR ACHP supported the harvest of more than 20 million pounds of invasive carp from Kentucky waters. Supported by the KDFWR ACHP, commercial fishers removed 7,716,770 pounds of silver carp, 113,551 pounds of bighead carp, and 207,534 pounds of grass carp, for a total of 8,037,855 pounds for all three species combined from Kentucky waters, from January 2019 through September 2020.
- In 2019 and 2020, KDFWR expanded its collaboration with commercial fishers to support invasive carp removal, establishing an agreement with 13 experienced commercial fishers to fish Cannelton Pool, with the goal of decreasing carp population numbers and discouraging density-dependent dispersal in the Ohio River.
- In 2019 and 2020, TWRA's Asian Carp Harvest Incentive Program (ACHIP) supported the targeted harvest and removal of more than 2.1 million pounds of invasive carp between October 2018 and September 2019 and more than 2.9 million pounds between October 2019 and September 2020, for a total of more than 5 million pounds during the reporting period. The ACHIP supports the commercial harvest of invasive carp in the Tennessee waters of Kentucky Lake and Lake Barkley.
- In support of invasive carp removal goals under the UMRB Framework, the deployment of contracted commercial fishers in Pools 14–18 within the Intensive Management Zone of the UMR resulted in the removal of 170,698 pounds of invasive carp during 2019 and 171,299 pounds of invasive carp in 2020. Invasive carp previously tagged with acoustic transmitters in these pools provided data to inform targeted removal actions. From the time the project started, in 2015, through 2020, a total of 715,695 pounds of invasive carp were removed.
- The ILDNR continued contract fishing to reduce the numbers of invasive carp in the Upper Illinois Waterway and lower Des Plaines Rivers, downstream of the Electric Dispersal Barrier System (EDBS). Between 2010 (the start of the program) and 2020, a total of 101,579 bighead carp, 1,157,698 silver carp, and 10,461 grass carp was removed by contracted fishers. The total estimated biomass of invasive carp removed through 2020 was approximately 10,295,000 pounds.
- In 2019 and 2020, an additional commercial fishing effort was directed by ILDNR to remove invasive carp from the Peoria Pool in the IWW. In 2019, approximately 518,000 pounds of invasive carp was removed through this effort, with harvest increasing to more than 3.3 million pounds in 2020. To ensure capacity, ILDNR entered into contracts with Illinois-licensed commercial fishers targeting the Peoria Pool (19 contracts in 2019; 31 contracts in 2020).

2. Verify changes in movement of the current adult invasive carp population fronts in the MRB subbasins.

Accomplishments

- Agencies continued targeted fishery monitoring to assess the geographic extent of invasive carp populations within the MRB, with a focus on verifying current population fronts of the respective species. Continuing in 2019 and 2020, documented captures of bighead, silver, black, and grass carp were reported to the USGS Nonindigenous Aquatic Species database (https://nas.er.usgs.gov/), and analyses were conducted to evaluate the extent of range expansion for each species.
- Species-specific invasive carp ranges of occurrence documented for 2019 and 2020 in the MRB are described in Section 2 of this report.

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

Accomplishments

- USFWS continued eDNA sampling in multiple MRB subbasins for the early detection of silver and bighead carp. Samples were processed at the USFWS Whitney Genetics Lab—Midwest Fisheries Center. All sample collection, handling, and processing was conducted following the protocols established and outlined in the FWS Quality Assurance Project Plan eDNA Monitoring of Bighead and Silver Carps (QAPP).
- No eDNA sampling was conducted by USFWS and agency partners in the ORB between October 1, 2018, and September 30, 2020.
- In the UMRB, USFWS conducted eDNA sampling for bighead and silver carp during 2019, focused in the mainstem Mississippi River and select backwaters. During October and November 2019, a total of 88 samples were collected in Pool 13, near Bellevue, IA, and Hanover, IL. A single sample was positive for invasive carp eDNA (both bighead carp and silver carp eDNA detected). In addition, 528 samples were collected from Pool 14 at four sites between Clinton, IA, and Rapid City, IL. Seven samples were positive for silver carp. Sampling planned for the spring of 2019 in Pools 13 and 14 of the Upper Mississippi River was canceled due to prolonged flooding. Sampling planned for the spring of 2020 in Pools 13, 14, and 16 of the Upper Mississippi River was canceled due to health and safety restrictions resulting from the COVID-19 pandemic.
- In the IWW/CAWS, USFWS monitoring for invasive carp eDNA was conducted upstream of the EDBS during October 2018 (311 samples; 2 positive for silver carp and 1 positive for bighead and silver carp DNA), April 2019 (401 samples; 1 positive for bighead carp, 1 positive for silver carp, and 2 positive for bighead and silver carp DNA), and October 2019 (414 samples; 49 positive for silver carp and 27 for bighead carp DNA). Additional eDNA samples were not collected in Chicago in April 2020 due to COVID-19 restrictions. The unusually high number of positive samples from the CAWS-Bubbly Creek site during October 2019 prompted USFWS to conduct additional followup sampling for eDNA at that location. USFWS worked with the MWRD to design the additional sampling event targeting the sewer system in the area surrounding Bubbly Creek and determined that the high number of positive eDNA detections came from the discharge of sewer water containing invasive carp DNA from human consumption and fish markets into Bubbly Creek. The 2019 eDNA results were followed by 2 weeks of intensive monitoring in the Bubbly Creek area completed by the ILDNR and ICRCC partners using traditional fish sampling gear, including nets and electrofishing. During that time, biologists found no evidence of invasive carp in the area.
- Results from all eDNA sampling and analyses conducted through the USFWS eDNA program are

available at FWS Midwest Region 3 FAC Bighead and Silver Carp eDNA Monitoring Dashboard (arcgis.com).

4. Increase the number of river miles (RM) excluded or protected from invasive carp movement.

Accomplishments

- The CAWS (RM 296–RM 333) is currently protected from invasive carp dispersal via the USACE EDB. This area represents the most upstream portion of the CAWS between Romeoville, IL, and Lake Michigan. The USACE continued to update and enhance the fish deterrent capacity of the existing EDB during 2019 and 2020.
- The navigation lock on the Mississippi River at Upper St. Anthony Falls in Minneapolis, MN, was permanently closed in June 2015. The lock closure by the USACE was supported by the MNDNR to serve as a barrier against the upstream spread of invasive carp in the Mississippi River watershed.

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

Accomplishments

- Partnerships within the MRB continued efforts to advance the development and testing of new prototype control technologies or identify appropriate opportunities to use existing technologies. The technologies summarized below are being evaluated for potential pilot deployment in the field or are already being implemented as control tools.
- Notable progress was made in laboratory and field testing of potential invasive carp deterrent technologies during 2019 and 2020 (previously described in Section 3 of this report). Two large-scale, multiyear fish deterrent technology field trials were initiated to test their effectiveness at impeding invasive carp upriver passage. USGS and partners deployed an underwater acoustic deterrent system (uADS) on the Mississippi River at Lock and Dam 19 in Keokuk, IA, and USFWS and partners deployed a BioAcoustic Fish Fence (BAFF) at the Barkley Lock and Dam on the Cumberland River in Kentucky.
- State and Federal ORB agencies convened the Tennessee River Asian Carp Deterrent Workshop to objectively rank fish barrier technologies and potential deployment locations to optimize opportunities for control of invasive carp within the Tennessee River system. Multiple fish deterrent technologies were evaluated for barrier efficacy and other factors, and invasive carp distribution and movement data were used to inform decision making on strategic placement of fish barriers to achieve the maximum impact at slowing range expansion in the Tennessee River. Recommendations of the workshop were used to inform the Tennessee Valley Authority's process to finalize alternatives included in their "Asian Carp Mitigation Draft Programmatic Environmental Assessment".
- Federal and State agency partners previously completed an invasive carp deterrent assessment and strategy for the UMRB, identifying potential suitable deterrent technologies and locations for deployment and providing recommendations for experimentation and next steps. The assessment, led by USFWS, is summarized in the report entitled "Asian Carp Deterrent Strategy for the Upper Mississippi River Basin".
- USGS and partner agencies completed a large-scale pilot project to evaluate the use of CO_2 injected into water as a potential nonphysical deterrent barrier to invasive carp and other AIS. The feasibility study was conducted within a navigational lock on the Fox River near Kaukauna,

WI. In 2019, USGS and partners conducted an engineering feasibility study at Lock #2 on the Fox River. The study evaluated the engineering, costs, water quality, human safety, fish behavior, and nontarget impacts. Data were processed, with results and final reports completed in 2020 (this project is further described in Section 3 of this report).

- USGS continued efforts to develop and test new formulations to orally deliver invasive carp control agents (piscicides). In 2019, USGS conducted two field assessments of microparticles (encapsulated piscicides) to potentially target silver and bighead carp. Studies were conducted in collaboration with the Iowa DNR at the Rathbun Fish Hatchery in Iowa. USGS also purchased the strain used to produce antimycin and initiated reestablishment of the registration of Fintrol as a fish toxicant for use by resource managers.
- USGS and USFWS conducted work to complete the registration processes with regulatory agencies and develop standard operating procedures for the use of CO_2 and toxic microparticles as invasive carp control agents. In 2019, USGS registered CO_2 (on behalf of USFWS) as a deterrent for invasive carp and an under-ice lethal control for aquatic nuisance species. Also, USGS purchased all rights to antimycin-A in—and completed actions required for registration for use as—a piscicide (on behalf of USFWS). A potential producer has been identified for this formulation (to be known as "Piscamycin"). USGS will subsequently expand the registration to include microparticle use.
- Additional coordination by USFWS and USGS addressed EPA and Section 7 ESA-consultation data requirements of antimycin-A-incorporated microparticles.

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

- The State resource management agencies continued to enforce and, as needed, amend existing regulations providing oversight on AIS, including invasive carp, within their respective jurisdictions. Enforcement focused on compliance with regulations related to the production, possession, sale, and transport of invasive carp along with regulations and best practices related to the transport and use of live bait by commercial harvesters, dealers, and anglers.
- KDFWR amended existing regulations to restrict fishing in the mouth of the Barkley Lock chamber to support the BAFF pilot study throughout its testing period; to include a commercial fishing license fee waiver for commercial fishermen who harvest only invasive carp; to allow commercial fishing for invasive carp in restricted waters on weekends and holidays throughout the year; and to allow the sale of invasive carp harvested by any legal fishing method whether the harvester possesses a commercial or sport fishing license.

Qualitative Measures of Progress

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

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

Accomplishments

- Agencies in the MRB are collaboratively implementing ongoing coordinated actions for monitoring invasive carp populations within the subbasins, including evaluating the degree of reproduction and establishment (presence of various life stages), determination of the invasion leading edge, and detection of potential range expansion.

- Individual projects addressed these data needs and supported priorities of the 2019 and 2020 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin. Monitoring efforts will continue in outyears, informed and refined on the basis of results from assessments completed in previous years. In the MRB subbasins, targeted monitoring and assessment projects were collaboratively developed to address key data needs and goals of the respective partnership Frameworks. Actions conducted in 2019 and 2020 are previously described within the subbasin summaries in Section 3 of the Report.
- In the IWW and CAWS, the multiagency MRWG of the ICRCC annually develops and implements focused monitoring of invasive carp populations coordinated through the annual Monitoring and Response Plan and supported under the Invasive Carp Action Plan. Agency and cooperator monitoring and surveillance include traditional fishery gear, contract fishers, eDNA, and remote sensing (telemetry, hydroacoustics, and other techniques). These monitoring efforts inform the status of the adult population front and the presence of all life stages in the Upper IWW and CAWS.
- USFWS and USGS conducted research to improve the effectiveness of eDNA as an early-detection tool for invasive carp, including genetic marker refinement and validation.
- USFWS and partners continued to implement the Quality Assurance Project Plan for eDNA Monitoring of Bighead and Silver Carps (QAPP) as guidance for ensuring that all eDNA sample collection, handling, and processing is conducted following established protocols (https://www.fws.gov/media/2023-quality-assurance-project-plan).
- The USGS previously developed and validated the use of a portable eDNA detection kit for silver, bighead, and grass carp for use in the field in open water applications.

2. Preventing the introduction and movement of invasive carp via identified pathways—Establishment of strategies to manage pathways for accidental or deliberate unauthorized introductions of invasive carp.

Accomplishments

- Interagency subbasin partnerships were previously developed, and agencies are implementing comprehensive, multipronged Framework strategies to address various potential pathways of invasive carp movement and introduction.
- Within the MRB subbasins, collaborating Federal and State agencies conduct comprehensive stakeholder outreach (with both the public and industry) and education to reduce the risk of the inadvertent or deliberate use and transport of invasive carp, focusing on identification, best practices, and regulations on prohibited species.
- Within the MRB subbasins, early detection monitoring of potential pathways includes targeted surveillance in locations along population "leading edges" and other higher-risk locations incorporating eDNA monitoring and remote sensing for invasive carp presence and movement. USFWS conducts eDNA monitoring in coordination with the jurisdictional state resource agency targeted for sampling.
- State and Federal agencies provide regulatory oversight of bait and aquaculture industries, with enforcement based on applicable Federal and State laws and authorities, and coordinated response plans in the event of a detection in a new waterbody or location.
- Key strategies to manage invasive carp introductions include early detection monitoring and rapid response and the development and testing of pathway-specific deterrent barrier technologies and implementation plans.
- Federal and State agencies enforce regulations on the collection, sale, and use of bait for

recreational fishing to prevent the inadvertent capture and movement of small invasive carp between waterbodies and the transport of invasive carp between State waters and between individual State jurisdictions.

- In 2019 and 2020, ILDNR employed surveillance to prevent the intentional or unintentional movement of AIS, including invasive carp, and worked collaboratively with Federal and regional State agencies. Through the Alternative Pathway Surveillance in Illinois project in the 2019 and 2020 MRPs, the ILDNR strengthened the enforcement component of the State's invasive species program by increasing education and enforcement activities at bait shops, bait and sport fish production and distribution facilities, fish processors, and fish markets and food establishments known to have a preference for live fish for release or food preparation. Inspection and surveillance efforts focused on the Chicago Metropolitan Area.
- USACE continues to operate and maintain the EDB to prevent the migration of invasive carp toward the Great Lakes.
- In 2019 and 2020, USACE, USGS, and partners collaborated on evaluations to determine if existing compressed air systems in lock structures on the Illinois River (sill bubble curtains designed for ice removal) have the potential to mitigate for small invasive carp entrainment. Those efforts evaluated several bubble array configurations as a potential mitigation measure to remove small fish entrained in the junction gaps of commercial barge tows. Data are being used to inform further evaluation and development of this potential fish entrainment mitigation technology, including deployment at lock and dam locations.
- During 2019 and 2020, USACE continued work on the feasibility study for the Brandon Road Interbasin Project (BRIP) to address the potential interbasin movement of invasive carp and other species from the MRB to the GLB. In 2019, the USACE Chief's Report recommending a National Ecosystem Restoration (NER) Plan was signed by the Department of the Army's Chief of Engineers and sent to Congress. Through 2020, USACE continued to coordinate closely with the State of Illinois as the project's non-Federal sponsor on negotiations for the design agreement, the State of Michigan, and other Great Lakes agencies and organizations to ensure stakeholder input and project outreach. USGS continued to support BRIP planning efforts through operation of its streamflow gaging station in the downstream approach channel to BRLD, providing USACE with critical data to inform models and feasibility studies and for use in the preconstruction engineering and design
- USACE continues to maintain the Des Plaines River Bypass Barrier, a 13-mile-long combination of fence material and jersey barrier that physically blocks known bypasses around the EDB that occur during periods of flooding from the Des Plaines River and the I&M Canal. The barrier prevents the possible migration of juvenile and adult invasive carp.
- In 2019 and 2020, USACE, in partnership with the Ohio DNR, completed the hydrologic separation for pathway mitigation at the Ohio-Erie Canal in Summit County, OH. Construction was conducted onsite to raise the ground surfaces in low areas and prevent intermittent hydrologic interbasin connectivity during high-water events. The project will prevent or reduce the probability of the movement of invasive carp and other AIS from the Tuscarawas River watershed (MRB) into the Cuyahoga River watershed (GLB) via the Ohio-Erie Canal.
- In 2019 and 2020, USACE and the Ohio DNR advanced work on the closure of the Little Killbuck Creek pathway in northern Ohio, in collaboration with local landowners in Medina County, OH. USACE completed a peer review of a 25 percent design report for the Ohio DNR and recommended alternative designs. The Ohio DNR selected an alternative design and conducted appraisals to support acquisition of easements for the properties needed for berm construction. In 2020, the Ohio DNR continued collaboration with local landowners and efforts to complete the

100 percent design for the construction of the berm.

3. Rapid response planning—Development of rapid response plans available to prevent range expansions and eradicate new introductions in both basins.

Accomplishments

- In the ORB, previous interagency efforts to address early detection and rapid response needs were coordinated through the Early Detection and Evaluation of Asian Carp Removal in the Ohio River project (EDEAC). In 2019 and 2020, WVDNR and KDFWR continued to lead development of a contingency response plan for the ORB to guide response efforts in the event that changes in the distribution of invasive carp are detected above a threshold level within specific locations. A final plan was anticipated by October 2022.
- In the IWW/CAWS, interagency early detection and rapid response actions are coordinated through the Upper Illinois Waterway Contingency Response Plan, a component of the annual MRP. Cooperating Federal and State agencies conduct annual scenario-based tabletop contingency response planning and preparedness exercises. MRWG agencies have implemented the plan to address detections of invasive carp above the EDB in the CAWS.
- Individual State agencies develop response plans for AIS, including invasive carp, within their respective jurisdictions as deemed necessary.
- Rapid response coordination and implementation actions conducted in 2019 and 2020 are further described in Section 3 of this report.

4. Collaborative research—Develop and validate tools to ensure control of invasive carp.

Accomplishments

- Within the MRB subbasins, Federal and State agency partners collaborated closely on the development and field testing of select invasive carp control technologies and on methodologies to inform and evaluate focused population control actions.
- Prototype control technologies that were further developed and tested in 2019 and 2020 are further described above under Quantitative Measures of Progress 5 (*Increase the number of control technologies…*).
- Within the MRB subbasin partnerships, agencies and universities collaborated to develop and evaluate new invasive carp monitoring and control fishery detection and capture gear and strategies. Further, Federal and State agencies developed and evaluated new sampling strategies and detection gear to ensure monitoring for all life stages of invasive carp, including eggs and larvae.

5. Develop strategies to minimize adverse effects—Establishment of collaborative strategies to eradicate or minimize potential adverse effects.

Accomplishments

- In 2019 and 2020, MRB Federal and State agency partners routinely collaborated to develop comprehensive prevention and control priorities, strategies, and on-the-water work plans. The work was informed by the most current data on invasive carp distribution and population dynamics, with emphasis on strategic opportunities to prevent further range expansion and, where feasible, reduce local population levels toward short-term management goals.
- The MRB partnerships, working through the Mississippi Interstate Cooperative Resource

Association, developed comprehensive collaborative strategies and workplans to guide actions focused on minimizing potential adverse effects from invasive carp. Those strategies include the *Ohio River Basin Asian Carp Control Strategy Framework*, *Upper Mississippi River Basin Asian Carp Control Strategy Framework, Lower Mississippi River Basin Asian Carp Control Strategy Framework,* and *Missouri River Basin Asian Carp Control Strategy Framework* and the 2019 and 2020 versions of the *Monitoring and Response Plan for Asian Carp in the Mississippi River Basin*. Individual collaborative projects supported with USFWS funds are described in detail in Section 3 of this report.

- Interagency meetings were convened to identify opportunities for abating and subsequently reducing the range of invasive carp in MRB subbasins by combining control actions (e.g., harvest) with deterrent technologies, including selection of potential project sites, environmental regulation considerations, and permitting requirements for field implementation of specific control techniques. For example, in 2020, ORB agencies convened the Tennessee River Asian Carp Deterrent Workshop to develop a structured process to rank and prioritize individual fish barrier technologies and specific locations, with the goal of optimizing focused actions for the control of invasive carp within the Tennessee River system. Recommendations of the workshop informed TVA's process to finalize scientifically defensible alternatives that were included in their *Asian Carp Mitigation Draft Programmatic Environmental Assessment (PEA)*. The PEA includes an assessment of the potential environmental and economic impacts of invasive carp range expansion throughout the Tennessee River watershed.
- The ICRCC's 2019 and 2020 MRPs incorporated the use of monitoring, surveillance, and decision-support tools to increase the defense of the EDB and enhance the impact of targeted invasive carp removal through agency and contract harvest capture efforts in the IWW. The annual collaborative actions further minimize the risk of invasive carp upstream range expansion in the IWW and the threat of introduction into the Great Lakes.

6. ***Information and education—Establishment of strategies to provide information to the public, commercial entities, and Government agencies to improve effective management and control of invasive carp in the MRB.***

Accomplishments

- MICRA established an invasive carp issues and resources web portal under the broader MICRA organizational website houses all MRB invasive carp documents, including partnership Frameworks, Monitoring and Response Plans, Annual Work Plans, Annual Summary Reports, and Annual Reports to Congress.
- USFWS continued to manage the invasivecarp.us website, supporting invasive carp communication efforts focused on the IWW/CAWS. Content included emerging topics such as grass and black carp issues and Federal and State actions conducted through the ACRCC.
- Through MICRA and the ICRCC, Federal and State agencies provided informational briefings for Members of Congress and their staff on annual invasive carp partnership work plans, accomplishments, and key biological findings.
- Federal and State biologists regularly communicated current information regarding invasive carp to the public and actions the agencies are taking to research and control these species.
- In the MRB subbasins, State resource agencies conducted comprehensive outreach with commercial fishers and recreational resource users to enhance awareness of the four invasive carp species and support proper identification and reporting of invasive carp captures.

7. Effective regulations and laws—Development of an effective system of compatible Federal and State laws and regulations for the UMRB and the ORB.

Accomplishments

- In 2019 and 2020, close coordination continued between Federal and State agencies in the MRB subbasins to support enforcement of regulations providing oversight on AIS, including invasive carp, within their respective jurisdictions. Enforcement focused on compliance with regulations related to the production, possession, sale, and transport of invasive carp along with regulations and best practices related to the transport and use of live bait by commercial harvesters, dealers, and anglers.
- Previously, in 2017, the U.S. Court of Appeals for the District of Columbia Circuit Court held that section 42(a)(1) of title 18 of the Lacey Act does not "prohibit shipments of injurious species between the continental States." *United States Ass'n of Reptile Keepers, Inc.* v. *Zinke,* 852 F.3d 1131, 1142 (D.C. Cir. 2017). Individual States, however, continued to regulate the production, possession, sale, and transport of invasive carp within their respective jurisdictions.
- In 2015, MICRA submitted a report to USFWS proposing eight recommendations to establish a consistent national policy strategy for grass carp for minimizing the risk of unintentional and illegal introductions of diploid and triploid grass carp. MICRA had previously completed a review of commercial grass carp production, certification, shipping, stocking, and regulation in the United States. The fundamental recommendation provided in the report to achieve a consistent national policy is for all States to prohibit the production, shipment, and stocking of diploid grass carp. Regulations are in place on a state-by-state basis for grass carp in most States throughout the Continental United States.

8. Ensuring that sufficient resources are available—Identify sufficient resources for Federal, State, and local agencies to address the long-term issue of controlling and reducing risk from invasive carp in the MRB.

Accomplishments

- In 2019 and 2020, Federal and State agencies continued to receive funding to support invasive carp detection, prevention, and control activities—primarily through annual budgeting and agency appropriations processes—in support of implementation of the National Plan and step-down subbasin partnership strategies.
- USFWS, USGS, USACE, USEPA, and State agency partners provided informational briefings for Members of Congress and their staff and the White House Office of Management and Budget. The briefings covered annual invasive carp partnership strategies and work plans, recent accomplishments, and key biological findings.
- In FY 2019 and FY 2020, USFWS received additional agency funding for invasive carp management efforts outside the Great Lakes, including the MRB subbasins. Those resources, along with other Federal and State resources, were leveraged to support high-priority activities in support of the goals and recommendations of the National Plan and subbasin Frameworks and Action Plans.

APPENDIX C: LIST OF ABBREVIATIONS USED IN THIS REPORT

- Aquatic Nuisance Species Task Force (ANSTF)
- Asian Carp Harvest Program (ACHP)
- 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)
- Invasive Carp Advisory Committee (ICAC)
- Invasive Carp Regional Coordinating Committee (ICRCC)
- Kentucky Department of Fish and Wildlife Resources (KDFWR)
- Kentucky Department of Natural Resources (KYDNR)
- Metropolitan Water Reclamation District of Greater Chicago (MWRD)
- 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 Plan (MRP)
- 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)
- Upper Mississippi River Basin Asian Carp Control Strategy Framework (UMRB Framework)
- Upper Mississippi River Basin Association (UMRBA)
- 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)
- Wisconsin Department of Natural Resource (WIDNR)