2021

Asian Carp Action Plan

Asian Carp Regional Coordinating Committee

Funding Updates Incorporated on December 16, 2021

Asian Carp Action Plan for Fiscal Year 2021

March 2021

Funding updates incorporated on December 16, 2021

Asian Carp Regional Coordinating Committee

Contributing Members:

Illinois Department of Natural Resources
Illinois Environmental Protection Agency
Indiana Department of Natural Resources
Michigan Department of Natural Resources
Michigan Department of Environment, Great Lakes & Energy
Minnesota Department of Natural Resources
New York Department of Environmental Conservation
Ohio Department of Natural Resources
Pennsylvania Department of Environmental Protection
Pennsylvania Fish and Boat Commission
Wisconsin Department of Natural Resources
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Great Lakes Commission
Metropolitan Water Reclamation District of Greater Chicago
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EXECUTIVE SUMMARY

The Asian Carp Regional Coordinating Committee's (ACRCC) fiscal year (FY) 2021 Asian Carp Action Plan contains a portfolio of high-priority prevention, detection, and control projects developed to support a comprehensive science-based Asian carp management strategy. The Action Plan serves as a foundation for the work of the ACRCC partnership — a collaboration of 28 U.S. and Canadian federal, state, provincial, tribal, and local agencies — to achieve its mission to prevent the introduction and establishment of Asian carp in the Great Lakes. Projects in the 2021 Action Plan are supported by a combination of $45,397,134 in agency funding and $21,000,000* in Great Lakes Restoration Initiative (GLRI) funding provided through FY 2021 appropriations. *All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Developed annually since 2010, the Action Plan has continually evolved by incorporating advances in the most current science on Asian carp population status, life history, behavior, and ecological risk as well as advances in management practices and technologies for early detection, prevention, and long-term control. The 2021 Action Plan continues to reflect this adaptive management approach.

The 2021 Action Plan consists of a comprehensive portfolio of agency activities that control Asian carp populations in key geographic locations and that address potential pathways or vectors for Asian carp movement and range expansion into the Great Lakes. Actions for Bighead Carp, Silver Carp, Black Carp, and Grass Carp are included. The Action Plan continues to take a proactive approach by reducing Asian carp populations in the Illinois Waterway (IWW) through intensive fishing and removal to significantly reduce the threat of fish movement upstream towards the Great Lakes. The Action Plan again features extensive interagency surveillance and detection efforts, including telemetry, electrofishing and netting, and environmental deoxyribonucleic acid (eDNA) monitoring.

This Action Plan focuses on actions to control and reduce the spread of Asian carp toward the Great Lakes. The interagency contingency response plan is also in place in the unexpected event of new detections of Asian carp in the Chicago Area Waterway System (CAWS) and the Illinois and Des Plaines Rivers upstream of the Starved Rock Lock and Dam.

The ACRCC will continue to test, use, and refine new control technologies and new management approaches as part of its broader strategy to achieve its mission.

*To accommodate revised project timelines and other financial management considerations in FY 2021, $2,136,000 of FY 2021 Action Plan GLRI funding was reallocated to support FY 2022 Action Plan priorities.

SUMMARY OF FY 2021 ACTIONS

The portfolio of FY 2021 actions is summarized below under the following complementary Action Plan focus areas:

1. Prevention Actions
2. Control Measures
3. Technology Development
4. Early Detection, Monitoring, and Assessment
5. Response Actions
6. Black Carp
7. Grass Carp in Lake Erie
8. Communication/Education/Stakeholder Engagement
9. ACRCC Operations

1. PREVENTION ACTIONS

The ACRCC is undertaking several prevention actions to address existing pathways to the Great Lakes.

- **Electric Dispersal Barrier System (EDBS).** A key line of defense for preventing juvenile and adult Asian carp from entering the Great Lakes is the continued operation of the U.S. Army Corps of Engineers' (USACE) EDBS in the Chicago Sanitary and Ship Canal (CSSC). The EDBS is intended to stop the movement of juvenile and adult Asian carp towards the Great Lakes through the strategic use of electric current in the water as a deterrent barrier. The Des Plaines River Bypass Barrier and screens placed on sluice gate adjacent to the Chicago and T.J. O'Brien Locks are additional measures deployed within the CAWS to prevent carp from reaching the EDBS. In 2021, USACE will continue to operate and maintain these three different types of fish deterrent measures (bypass barrier, electric barriers, and bar screens on sluice gates).
- **Ohio & Erie Canal Aquatic Nuisance Species Barrier Project**. In 2020, the Ohio & Erie Canal project delivery team announced the completion of the Ohio & Erie Canal Aquatic Nuisance Species Barrier Project in northeast Ohio. With the barriers now in place, the threat of this potential pathway from the Mississippi River basin to the Great Lakes has been significantly reduced and only maintenance costs for the barrier are required as part of the 2021 Action Plan.
- **Stopping the Spread of Asian Carp through Human Activities.** The Illinois DNR Invasive Species Unit (ISU) consisting of Conservation Police Officers is fully dedicated to searching for illegal activities within the commercial fishing, aquaculture, transportation, bait, pet, aquarium, and live fish market industries. The ISU focuses its energies and resources on the likely pathways Asian carp could spread by human means.

- **Completion and Operation of Permanent Barrier I in the CSSC.** USACE has completed construction of an upgrade to the Demonstration Barrier I to a permanent facility. Performance verification and safety testing will be completed in the second quarter of FY 2021, which is a prerequisite for the full-time operation scheduled to occur by the end of FY 2021.
- **Design of Potential Future Actions at Brandon Road Lock and Dam.** The proposed Brandon Road project (in the vicinity of Joliet, Illinois) would implement structural and non-structural measures in the Des Plaines River that block and prevent, to the maximum extent possible, aquatic nuisance species from migrating upstream of Brandon Road Lock and Dam. In FY 2021, USACE, the State of Illinois, and the State of Michigan will initiate design to further flesh out the proposed project.
- **Closure Actions at Little Killbuck Creek Pathway.** The Great Lakes and Mississippi River Interbasin Study (GLMRIS) report identified Little Killbuck Creek as a medium risk connection for transfer of Bighead Carp, Silver Carp, and Black Carp from the Mississippi River basin to the Great Lakes. To date, Ohio DNR has completed the 25 percent design for the berm project to separate the basins and refined this design using value engineering from the USACE. Ohio DNR has secured property values for real estate negotiations which will take place in early 2021. Once the footprint for the project is secured, final design and permitting will be initiated and is expected to be completed in the spring of 2022. Construction will be initiated in the summer of 2022 and will be phased over numerous years.

2. CONTROL MEASURES

The ACRCC recognizes the need to assess the movement of Asian carp and undertakes control measures to reduce the risk of introduction and establishment of Asian carp in the Great Lakes. The following efforts will be undertaken:

- **Contract Fishing, Seining, and Netting.** In FY 2021, contracted commercial fishing will continue to be used to reduce the numbers of Asian carp in the upper Illinois River and lower Des Plaines River downstream of the EDBS. Commercial fishers will continue to be employed to harvest as many Asian carp as possible in the Starved Rock and Marseilles pools. Harvested fish will be picked up and utilized by private industry for purposes other than human consumption. As a result of efforts conducted through October 2020, over 442 tons of Asian carp were removed from the Starved Rock, Marseilles, and Dresden Island pools in support of management objectives. Efforts planned for 2021 include a removal goal of at least one million pounds of Asian carp from these waters.

- **Enhanced Contract Removal Program.** The use of targeted contract fishing in the Alton, LaGrange, and Peoria pools of the Illinois River is a key component of the ACRCC's multi-pronged control strategy. The long-term goal is removal of 20 to 50 million pounds of Asian carp annually from the IWW to progressively reduce the overall population size and the related risk of their spread into the upstream Illinois River. Through October 2020, over 2,600 tons of Asian carp were removed through this effort. The FY 2021 effort is anticipated to result in removal of approximately 5.75 million pounds of Asian carp.
- **Marketing Program.** The Mississippi River system continues to be a source of Asian carp that move into the Illinois River. To support a long-term program that will control this influx of Asian Carp, this effort also includes a marketing program to support the development of a positive brand for Asian carp, which will help product-makers and processors identify markets to utilize fish harvested from areas where populations are already established and targeted for intensive removal. Market use will support increased removal and allow for greater use of Asian carp strategically harvested in the Illinois River through State-led management and control efforts. Work to initiate a brand development process will continue in FY 2021.
- **Asian Carp Population Model and Demographics.** In FY 2021, the ACRCC will continuing to develop and refine the Spatially Explicit Asian Carp Population (SEACarP) model, a tool that provides key information on Silver Carp and Bighead Carp population dynamics in the Illinois River. The SEACarP model is currently being used to help maximize fishing harvest effectiveness with the goal of reducing numbers of adult Asian carp in targeted areas of the Illinois River. Activities in FY 2021 include development of an Illinois River specific stock-recruit relationship for Asian carp that will be incorporated into the SEACarP model, further improving the ability to simulate changes in Silver Carp and Bighead Carp population dynamics, including responses to potential control actions. In addition, U.S. Fish and Wildlife (USFWS) staff will work with experts from academia to determine how successfully statistical catch-at-age or length modeling for Asian carp could be completed based on currently available harvest data. Results from this analysis, including fishing mortality estimates, will assist the ACRCC in evaluating Asian carp population dynamics in the Illinois River and the effectiveness of targeted control efforts.

3. TECHNOLOGY DEVELOPMENT

The ACRCC will continue to develop and test the effectiveness of new Asian carp prevention and control technologies with the long-term goal of providing layered defenses and additional safety nets for Great Lakes protection. The following are summaries of the technology development measures that will be undertaken in 2021:

- **Use of Underwater Sound.** In FY 2021, the ACRCC will continue to focus on the development and testing of underwater sound-based deterrents as a potential prevention and control technology. This work is being conducted through separate but complementary initiatives. The Barkley Bio-acoustic Fish Fence (BAFF) Deployment Project, being led by USFWS, is a large-scale experimental deployment of a fish deterrent system at Barkley Dam near Grand Rivers, Kentucky. The BAFF system, installed in early 2020, includes a combination of sounds bubbles and lights, and will be evaluated through 2022. Also, the U.S. Geological Survey (USGS) will continue to lead the Lock and Dam 19 (LD19) Acoustic Deterrent System (ADS) Deployment Project, coordinating among a multi-agency science and evaluation team. A large-scale experimental pilot deployment of the ADS will begin in early 2021 at LD19, located near Keokuk, Iowa in the Upper Mississippi River. The test sites for the BAFF and LD19 ADS were selected due to their locations at "pinch point" locks actively used for navigation in river reaches currently occupied by Asian carp, thereby providing suitable opportunities for evaluating the effectiveness of the technology under real-world scenarios. Additionally, ongoing research and development related to acoustic deterrents, including engineering of new acoustic signals, and testing of signals in ponds and/or in the field on Asian carp and native fishes as well as acoustic deterrent designs, will be conducted in FY 2021.

- **Carbon Dioxide (CO_2).** CO_2 is being investigated as a potential deterrent to Asian carp. The concept is to introduce CO_2 into water to deter or immobilize Asian carp from moving upstream. State and federal partners completed several important milestones in 2019 and 2020. The USGS and USFWS previously obtained a Section 3 registration pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) from the U.S. Environmental Protection Agency (USEPA) for CO_2 as a new aquatic pesticide (Carbon-Dioxide Carp). Approved uses include: (1) as an Asian carp deterrent and (2) as a non-selective lethal control for all nuisance fishes under ice. Subsequently, an engineering feasibility study was conducted within a navigational lock in Wisconsin. Results from this study demonstrated the feasibility of the installation and operation of a large-scale CO_2 infusion system, and provided data on operational costs, fish behavior, non-target organisms, human health risk assessment, and water quality. Following this work, regulatory steps to transition from research into management were completed with registration of carbon dioxide within individual states. In FY 2021, efforts will include:

    - Data to support registration of Carbon Dioxide–Carp with individual states.
    - Development of the Carbon Dioxide–Carp online reporting system for use by management agencies.
    - FIFRA Section 3 registration of dry ice as an alternative delivery method.

  - Amendment of current registration to expand potential uses (e.g., removal of under-ice restriction for lethal applications).

- **Microparticle.** No current technology can specifically target Asian carp species for control within aquatic ecosystems. Available lethal control chemicals used in aquatic invasive species management are applied throughout the entire water column exposing both native and invasive species. The development of delivery systems that exploit the unique feeding strategies of the four Asian carp species would greatly increase the impact on the target species while minimizing potential impacts on native species. This technology has great value as part of an integrated pest management program for Asian carp and restoration of infested waters. In FY 2021, USGS will refine the oral delivery formulation (microparticle) and initiate studies to support its registration for use as a control tool.

- **Barge Entrainment.** In 2021, the ACRCC will conduct work to support the evaluation of potential technologies for addressing the risk to the Great Lakes from the inadvertent entrainment and transport of small fish by barges in the IWW. These efforts are part of a multi-year collaborative project, building on earlier findings that demonstrated the risk of small fish – including Asian carp – being carried upstream in the void spaces between commercial barge tows, including through lock structures. This effort is being proposed to assist in the development of a large-scale field study to evaluate the effectiveness of a prototype technology, the Longitudinal Bubbler Arrays (LBA), for removing entrained small fish. The LBA generates streams of bubbles, which may actively flush trapped fish. The proposed field study will utilize a mark and recapture evaluation at the Peoria Lock and Dam, a location where Asian carp are already established.

  In 2021, USACE will conduct technical modeling at the Environmental Research and Design Center (ERDC) in Vicksburg, Mississippi to inform design of the prototype LBA manifold. USFWS will assess the feasibility of capturing and raising wild-caught juvenile Asian carp for use in the upcoming barge entrainment replicate field trials, including identifying and testing propagation protocols to reduce mortality and maximize fish quality. The USGS will collect and analyze data from assessments of commercial barge movement through lock passages and approach channels to further inform the understanding of the influence of commercial barges on hydrology in and adjacent to lock structures. USGS will collect data at the Peoria Lock and Dam to inform the proposed LBA technology evaluation; analyze existing data collected at Brandon Road Lock and Dam; and collect and analyze data from a new acoustic Doppler current profiler adjacent to LD19 on the Mississippi River (to be installed in early 2021).

4. EARLY DETECTION, MONITORING AND ASSESSMENT

In FY 2021, the Action Plan again features interagency surveillance and detection efforts including telemetry, hydroacoustics, electrofishing and netting, and eDNA monitoring. An interagency Contingency Response Plan (CRP) is in place in the event of new detections of Asian carp in the CAWS and the Illinois and Des Plaines Rivers upstream of the Starved Rock Lock and Dam. The following describes the early detection, monitoring, and assessment activities being undertaken in FY 2021:

- **Monitoring Upstream of the EDBS.** Illinois DNR, USFWS, USACE, INHS, and contracted commercial fishers will conduct Seasonal Intensive Monitoring (SIM) during the spring and fall of 2021. A variety of complementary gears will be used during these intensive monitoring activities, including seines, trammel nets, and hoop nets, focused on the detection and capture of Asian carp in areas where they are not currently present or established.
- **Monitoring Downstream of the EDBS.** High priority fixed sampling sites identified by the ACRCC's Monitoring and Response Work Group (MRWG) will be sampled by MRWG agencies within Brandon Road and Lockport pools downstream of the EDBS. These fixed sites necessitate a higher frequency and greater temporal range of sampling than the randomized sampling design as a result of the proximity to the EDBS. Sampling will be conducted bi-weekly from March to December. Intensive sampling efforts at fixed and random sites and contracted netting at four fixed sites in each of the four pools below the EDBS will occur. These projects focus on the Starved Rock, Marseilles, Dresden Island, Brandon Road, Lockport, and Peoria pools utilizing electrofishing, hoop netting, and mini-fyke netting, and will include:
    - *Day Electrofishing:* Daytime pulsed Direct Current (DC) boat electrofishing to collect standardization and comparable fish catch rates within each pool.
    - *Paired Hoop Netting:* Paired deployment of a large hoop with bar mesh, and a small hoop with bar mesh net placed at each random sample site.
    - *Fyke Netting:* Fyke nets deployed in areas where water depth is sufficient to submerge the throats of the nets.
    - *Minnow Fyke Netting:* Minnow fyke nets deployed following the same criteria and exceptions as those used for fyke nets.
- **Comprehensive Interagency eDNA Monitoring Program.** The USFWS applies the science of genetics-based eDNA sampling and analysis as an early detection tool in support of the ACRCC's comprehensive monitoring approach for protecting the Great Lakes from Asian carp. In FY 2021, USFWS, in cooperation with state and tribal partners, will continue to conduct monitoring for Bighead Carp and Silver Carp eDNA in the Great Lakes basin, as well as the Upper Mississippi River and Ohio River basins. Actions include overall program coordination and oversight, field sampling, and

laboratory processing of water samples collected from priority locations for the presence of Asian carp eDNA.

- **Asian Carp Stock Assessment in the Upper Illinois River.** Hydroacoustic sampling and telemetry tracking of Asian carp in the Illinois River MRWG agencies will continue in FY 2021. Asian carp will be captured and implanted with acoustic telemetry transmitters, and an acoustic receiver array maintained for tracking in the Alton through Dresden Island pools of the Illinois River in 2021. This effort will result in the identification of high-density locations of Asian carp and inform the quantification of upstream movements and a long-term assessment of population trends. Also in 2021, Asian carp density maps will be produced every other month in the Marseilles and Dresden Island pools illustrating locations where fish densities are highest.
- **Great Lakes Monitoring.** In FY 2021, USFWS and partner agencies will continue to implement a comprehensive early detection and monitoring program. This monitoring ensures that there are no unknown populations of Asian carp in the Great Lakes or its tributaries. Sampling gears used and locations sampled are tailored each year to match conditions and agency needs, as well as to leverage new sampling technologies for aquatic invasive species (AIS) of interest. USFWS teams will be prepared to respond, as needed (in coordination with agency partners) in the event of a new detection of Asian carp in the Great Lakes.

5. RESPONSE ACTIONS

In FY 2021, the ACRCC will remain prepared to address contingency (rapid response) actions through the Monitoring and Response Work Group's (MRWG) CRP for the Upper IWW. The CRP is triggered in the event a change is detected in the status/risk of Asian carp in the Starved Rock, Marseilles, Dresden Island, Brandon Road, and Lockport pools. The ACRCC will be prepared to shift monitoring resources in the event the most current data on Asian carp location and status demonstrate the need for a tactical adjustment. As in past years, if new findings indicate an increased risk within a specific upstream location, effort will be transitioned to the involved areas, as necessary. The ACRCC will be ready to respond rapidly and shift monitoring resources to support response actions, as warranted.

6. BLACK CARP

A primary threat from Black Carp population expansion is the potential impact on native mussel and snail fauna in North American river and lake systems, with many of these species already listed as threatened or endangered. To collect critical data on Black Carp range of occurrence and biology, existing commercial fishing efforts in Midwest U.S. rivers will continue to be leveraged through a Black Carp bounty program. This program is administered by Southern Illinois University (SIU) with funds provided by Illinois DNR.

In FY 2021, USFWS will develop and lead a Structured Decision Making (SDM) process with the ACRCC's Black Carp Work Group, incorporating the most up-to-date information from current research to identify and develop near-term priorities for future work including priorities for continued research to directly inform management actions. USFWS will continue to use genetic techniques to identify potential young-of-the-year Black Carp and document any potential range expansion to inform any needed changes in management response actions. In addition, USFWS and USACE ERDC geneticists will investigate methods to improve Black Carp eDNA sampling protocols, detection sensitivity, and assay validation, and will also further develop a Standard Operating Procedure (SOP) for Black Carp eDNA monitoring. Also in FY 2021, USGS will assess Black Carp biology, early life history, habitat use, geographic range, and movement, and develop a specific bait to aggregate Black Carp to facilitate their capture and removal. Illinois DNR will continue sampling with experimental baits to assess the population of Black Carp in the lower Illinois River and the efficacy of different baits.

7. GRASS CARP IN LAKE ERIE BASIN

U.S. and Canadian resource agencies in the Lake Erie basin have identified the threat of invasive Grass Carp as a high priority requiring focused and aggressive assessment and control action. Member agencies have developed a suite of proposed actions for implementation, building on existing efforts within the Lake Erie basin. Planning is being conducted in collaboration with the Great Lakes Fishery Commission's (GLFC) Council of Great Lakes Fishery Agencies, Invasive Fishes Executive Committee, and the Lake Erie Committee (LEC).

Agencies expect to increase their Grass Carp removal through State-led activities in the Lake Erie western basin in FY 2021 with support from the GLRI funding and assistance from USFWS, USGS, and GLFC. USGS will conduct research to provide additional assistance to ongoing management activities. In FY 2021, to support state-led efforts, 10 on-the-water "strike teams" will remove Grass Carp from Lake Erie, with a goal of removing 390 fertile fish.

An additional priority for FY 2021 is the evaluation of the feasibility of a seasonal barrier to block the upstream spawning migration of Grass Carp in the Sandusky River. This project, is currently being undertaken by GLFC and Ohio DNR, has received funding for the completion of the planned work.

USGS is developing improved scientific understanding that will allow for better targeting of Grass Carp removal actions in the Lake Erie basin. Key activities by USGS include maintaining support for real-time fish telemetry receivers, conducting additional sampling for eggs in Ohio tributaries of Lake Erie, and expanding telemetry coverage to improve the overall understanding of Grass Carp movement patterns within the basin.

8. COMMUNICATION/EDUCATION/STAKEHOLDER ENGAGEMENT

In FY 2021, USFWS and Illinois DNR will continue to lead the ACRCC's coordinated communication and outreach efforts, serving as the co-chairs of the ACRCC's Communication Work Group (CWG). In FY 2021, USFWS will continue to serve as the administrator for the partnership's website, AsianCarp.us, a primary component of the ACRCC's communications strategy. As the site administrator, USFWS organizes content and leads website development efforts. New web site content will include relevant announcements provided by ACRCC member agencies, and partnership updates provided on behalf of the ACRCC co-chairs regarding field operations under COVID-19 and other developments, as needed. USFWS will grow the utility of the website in accordance with the 21st Century Integrated Digital Experience Act and continue efforts to make digital communication products compliant with Section 508 of the Rehabilitation Act (29 U.S.C. § 794d). Additionally, the CWG will amplify storytelling on AsianCarp.us to highlight ACRCC partnership work across agencies. Overall, the website continues to consistently generate traffic and attract new users interested in the Asian carp issue.

In FY 2021, targeted ACRCC communications will include:

- Ongoing coordination of partnership responses to public, congressional, and media inquiries.
- Continued refinement of the ACRCC's early detection notification protocols.
- Identifying additional communication products and strategies of value through coordination with the ACRCC and MRWG co-chairs, and all member agencies to expand our messaging and outreach to better reach underserved audiences/demographics.
- Creation of ACRCC branded communication products.

The ACRCC will continue to leverage and be informed by other Asian carp outreach and communications products and initiatives developed in the U.S. and Canada, including actions in the Mississippi River basin in support of interbasin prevention and control.

9. ACRCC PARTNERSHIP OPERATIONS

In 2021 the ACRCC will continue to collaborate with its partners to:

- Coordinate meetings and communications of the ACRCC and its subcommittees and work groups to ensure effective development and implementation of the annual Action Plan, the Monitoring and Response Plan (MRP), and other related strategic plans; and to ensure ongoing interagency information-sharing and decision-making in support of the partnership mission.
- Provide timely and substantive technical information to Congress, the public, the media, and other stakeholders on the status of the Asian carp threat, and the coordinated strategic actions undertaken by the ACRCC to address the threat.

- Collaborate with other Asian carp management efforts and partnerships outside the Great Lakes to leverage opportunities, best practices, strategies, and resources on Asian carp prevention and control across multiple basins, in support of the goals of the national *Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States* (National Plan).
- Continue to support the CAWS AIS Stakeholder Advisory Group as a platform to engage Great Lakes regional stakeholders on potential solutions to prevent Asian carp from moving through the CAWS and establishing self-sustaining populations.
- Continue working with the Technical and Policy Work Group (TPWG), a non-federal entity composed of members from stakeholder organizations, public-sector agencies, the scientific community, academia, and others.

These collaborative efforts will further support the efforts of partners to identify and leverage expertise, share data, and increase capacity to more broadly and holistically address the Asian carp challenge on a regional, multi-basin scale.

In support of the Action Plan, two appendices are included:

- Appendix A includes the FY 2021 Project Funding Matrix. *All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*
- Appendix B provides a full listing of FY 2021 Actions (agency projects), project descriptions, and intended outcomes.

1.0 INTRODUCTION

The ability of ACRCC agencies to fully conduct activities in support of the FY 2020 Asian Carp Action Plan was notably impacted due to restrictions resulting from the global COVID-19 pandemic. In compliance with U.S. and Canadian Federal, Provincial, State, local and agency-specific guidelines, certain activities were cancelled, postponed, or revised to ensure the health and safety of agency staff and the public. However, field monitoring, other critical technology development, prevention, and control actions were successfully conducted in 2020. For example, throughout the year, the USACE continued to operate the EDBS in the CSSC, serving as a primary measure for defending the Great Lakes from Asian carp. Additionally, targeted monitoring and control efforts focused on the detection and removal of Asian carp continued in the IWW, modified as needed and as conditions allowed, and while maintaining required social distancing, sanitation, and other health and safety measures. Further, progress was made on key control technology development and testing activities, as well as pathway mitigation efforts. Despite the significant challenges faced, going forward in 2021 the ACRCC remains fully committed to our mission of preventing the movement of Asian carp into the Great Lakes, while maintaining the health and safety of our staff and the citizens we serve.

1.1 ABOUT THIS STRATEGY

The ACRCC's mission is to prevent the introduction and establishment of Asian carp in the Great Lakes.

The ACRCC's 2021 Action Plan contains a portfolio of high priority detection, prevention, and control projects developed to support a comprehensive, multi-pronged, and science-based Asian carp management strategy. The Action Plan serves as a foundation for the work of the ACRCC partnership — a collaboration of 28 U.S. and Canadian federal, state, provincial, tribal, and local agencies— to achieve its mission to prevent the introduction and establishment of Asian carp in the Great Lakes.

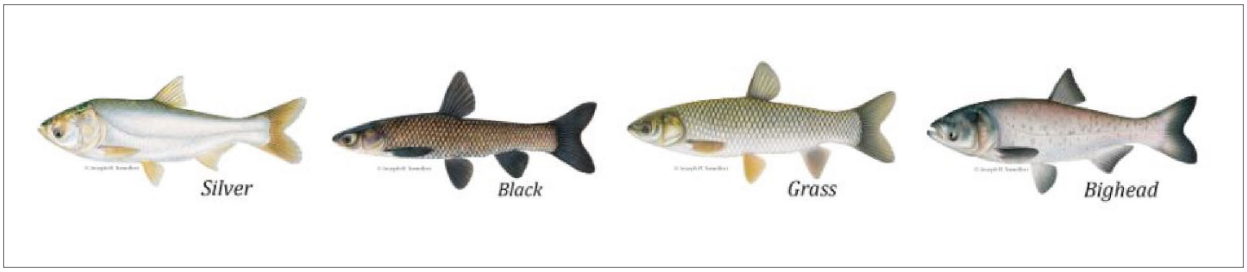
Developed annually since 2010, the Action Plan has continually evolved by incorporating advances in the most current science on Asian carp population status, life history, behavior, and risk assessment, and in management practices and technologies for early detection, prevention, and long-term control. The 2021 Action Plan continues this adaptive management approach by incorporating current science and lessons-learned for increased effectiveness at reducing the risk to the Great Lakes from Asian carp. Many individual Action Plan projects target the control or assessment of specific Asian carp life stages or behaviors, with the full portfolio of agency activities designed to be complementary to achieve the maximum collective impact to control fish population numbers and geographic range.

The 2021 Action Plan includes a goal of further reducing Asian carp populations in the IWW to more proactively address the potential threat of fish movement upstream towards the Great Lakes.

In support of the strategy, Appendices A and B of this Action Plan include a funding matrix and a description of each proposed action item. All federal funding estimates included in this Action Plan are subject to the availability of appropriations.

1.2 PURPOSE OF THIS STRATEGY

This Action Plan describes the strategies and proposed action items collaboratively developed to achieve the mission of the ACRCC and identifies the objectives and organizational structure of the binational partnership, including its work groups. While focusing heavily on efforts conducted within the CAWS (Figure 1) and IWW as the primary connection with the Great Lakes, the Action Plan also captures other key efforts within the region that further support the efforts of the ACRCC to address the threat from all four Asian carp species.



Throughout this document, the term Asian carp refers to the following four species: Silver Carp (Hypophthalmichthys molitrix), Black Carp (Mylopharyngodon piceus), Grass Carp (Ctenopharyngodon idella), and Bighead Carp (H. nobilis).

In addition, the Action Plan supports the goals, strategies, and recommendations of the national *Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the U.S.*[1] (National Plan). The Action Plan also serves to inform, though does not include, Asian carp prevention strategies being developed for other basins, such as the Upper Mississippi and Ohio River basins.

[1] Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carp in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C. 223 pp.
http://www.anstaskforce.gov/Documents/Carps_Management_Plan.pdf.
http://www.anstaskforce.gov/Documents/CO2_Management_Plan.pdf.

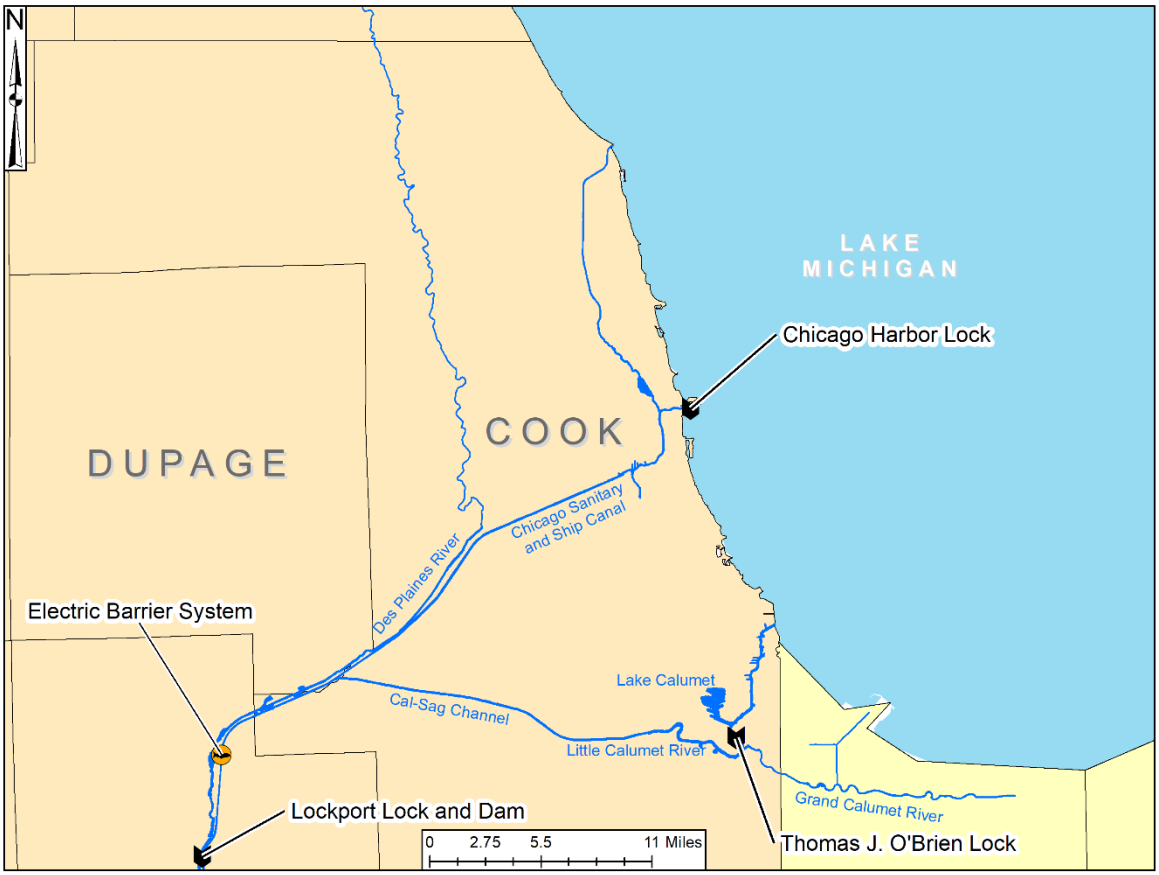


Figure 1. *Waterbodies making up the Chicago Area Waterway System.*

1.3 THE ROLE OF THE ACRCC

Through the Action Plan, the ACRCC coordinates annual interagency planning for members to strategically execute projects to achieve the mission of protecting the Great Lakes from Asian carp introduction and establishment. The ACRCC's objectives are to:

- Support efforts to prevent the introduction, establishment, and spread of Asian carp in the Great Lakes.
- Support development of technologies and methods that will result in the control and management of Asian carp and the transferability of these new tools for use in the control of other invasive species, where possible.
- Promote collection of biological information on Asian carp, including their impacts, preferred habitats, and biological and ecological requirements.
- Identify additional research, technology, and data needed to effectively inform and support Asian carp management strategies.
- Encourage the exchange of information between member agencies and stakeholders and, seek opportunities to transfer and further leverage control technologies developed as part of the Action Plan to other areas of the U.S. and Canada.

- Support the coordination and notification requirements of the U.S.-Canada Great Lakes Water Quality Agreement.
- Coordinate implementation and evaluate the effectiveness of collaborative Asian carp assessment, prevention, and control measures as described in the Action Plan.

The organizational structure of the ACRCC and its work groups is highlighted in Figure 2 below.

The ACRCC Federal Executive Committee (FEC) is charged with coordinating U.S. federal agency efforts in meeting the goals and objectives of the Action Plan. This includes working collectively on inherently U.S. federal issues related to control, response, or federal policy and legal issues associated with the Asian carp efforts to prevent the establishment of Asian carp in the Great Lakes. The FEC is co-chaired by USFWS and USEPA and includes USACE, USGS, U.S. Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Transportation (DOT).

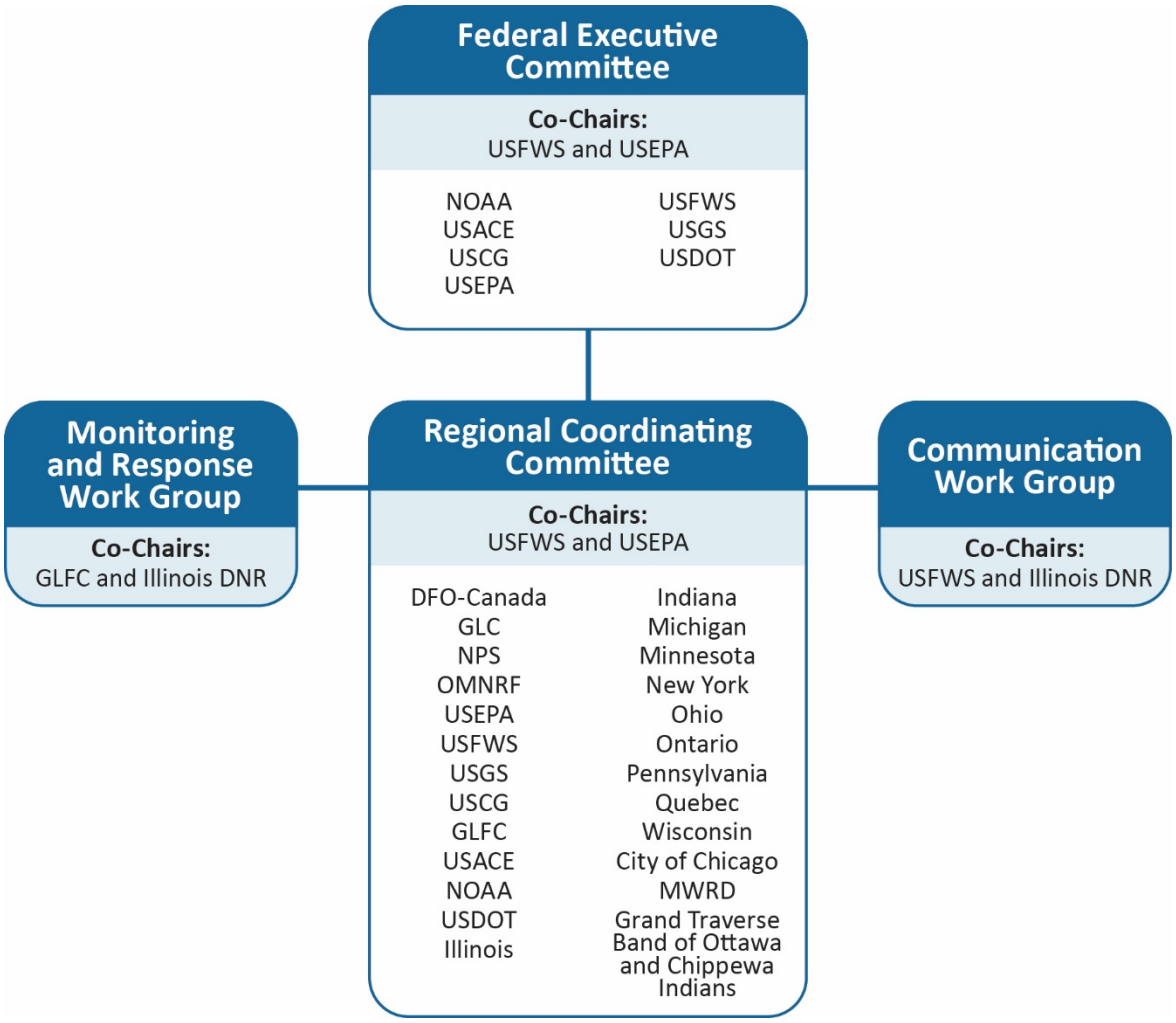


Figure 2. *ACRCC Organizational Structure.*

1.3.1 Monitoring and Response Group

The MRWG of the ACRCC, co-chaired by Illinois DNR and the GLFC, coordinates monitoring and response efforts within the Illinois River and the CAWS. The MRWG is composed of fisheries biologists and scientific experts from GLFC, Illinois DNR, Illinois EPA, Indiana DNR, USFWS, USGS, and USACE. In 2012, fisheries chiefs from all eight Great Lakes states were invited to participate in the MRWG. Since 2010, MRWG has developed an annual MRP for the Upper IWW and the CAWS. This plan is updated annually to incorporate the most current science supporting the overall goal of preventing Asian carp from establishing self-sustaining populations in the CAWS and subsequently in Lake Michigan.

Five primary objectives are specified in the MRP to accomplish the overall goal:

- Determine the distribution and abundance of Asian carp in the CAWS and use this information to inform response removal actions.
- Remove Asian carp from the CAWS.
- Identify, assess, and react to any vulnerability in the EDBS.
- Determine the leading edge of major Asian carp populations and reproductive success of those populations.
- Improve understanding of the risk for the establishment of Asian carp in the Great Lakes.

The MRWG carries out these objectives through the collective technical expertise and capacity of its member agencies. Actions include strategically planned, coordinated monitoring within the CAWS and IWW, including commercial fishing, netting, electrofishing, and remote sensing (e.g., hydroacoustics and telemetry) operations; contingency response planning and execution; and the analysis and interpretation of key Asian carp data to offer informed recommendations to the ACRCC partnership.

1.3.2 Communication Work Group

The ACRCC's CWG facilitates internal and external messaging and communication on the Asian carp prevention and control efforts of the partnership. Targeted audiences include the public, media, ACRCC member agencies, and other interested stakeholder groups outside the ACRCC.

Communication efforts support the ACRCC as it develops and executes short- and long-term strategies for preventing Asian carp movement as well as other key monitoring and control activities conducted throughout the Great Lakes basin. The CWG is not intended to supplant or supersede the agency-specific communications protocols and initiatives of the individual ACRCC members.

The CWG, currently co-chaired by USFWS and Illinois DNR, includes representatives from USFWS, USEPA, USACE, USCG, USGS, NOAA, National Park Service (NPS), Great Lakes States, the Province of Ontario, GLFC, Great Lakes Commission (GLC), and Fisheries and Oceans Canada (DFO).

The CWG co-chairs have primary responsibility for the group's management, organization, and operation, with the work activities shared among CWG members. Specific efforts of CWG include, but are not limited to, the following:

- Work in collaboration with ACRCC members to foster internal communications among ACRCC members.
- Update and maintain the website at www.AsianCarp.us and other social media.
- Distribute to appropriate agencies comments, concerns, and questions received from external audiences, including the public and key stakeholders.
- Respond to media requests.
- Provide video and photographic materials to members of the media, the ACRCC, and the public.
- Coordinate on-site or telephonic media events, including press announcements, regarding new Asian carp control efforts and new detections of Asian carp.
- Coordinate public forums and meetings.
- Provide outreach to municipal leaders, tribal leaders, and other interested parties.
- Serve in advisory capacity to the ACRCC regarding communication needs for the ACRCC's efforts.
- Develop other outreach products for public use.

1.3.3 Technical and Policy Work Group

The Technical and Policy Work Group (TPWG) is a non-federal advisory entity comprised of members from stakeholder organizations, industry, public sector agencies, the scientific community, academia, and others (see Figure 3). While the TPWG is not part of the ACRCC organization, they consult with and provide feedback to the ACRCC and other agencies on invasive species matters.

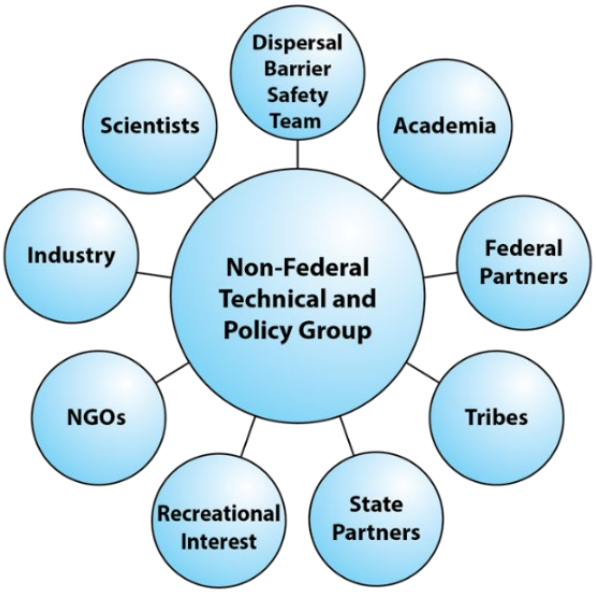


Figure 3. *Non-Federal Technical and Policy Group.*

The TPWG grew out of the Barrier Work Group (BWG), initially convened to discuss alternatives and issues regarding the development and operation of the original electrical dispersal barrier installed by the USACE in 2002. The BWG provided input into the original demonstration barrier design and operation, working on issues such as barrier alternatives, potential barrier impacts on the barge industry, safety surrounding the employment of electricity in the CAWS, impacts on local residents, businesses, and governments, and others.

1.4 Mission of the ACRCC

The ACRCC mission is to prevent the introduction and establishment of Asian carp in the Great Lakes. The ACRCC coordinates planning and execution of efforts of its members to prevent the introduction, establishment, and spread of Bighead Carp, Black Carp, Grass Carp, and Silver Carp populations in the Great Lakes. The ACRCC, a collaborative team of federal, state, provincial, tribal, and local agencies, provides oversight and coordination of multijurisdictional detection, prevention and control activities through development and implementation of an annual Asian Carp Action Plan.

THE CHALLENGE

Addressing the threat of Asian carp represents one of the greatest challenges to protecting the Great Lakes and adjacent aquatic ecosystems from AIS.

1.5 Background on Asian Carp

Asian carp – Bighead Carp, Silver Carp, Black Carp and Grass Carp – have posed a growing challenge to North America's aquatic resources, resource-dependent communities and economies, and other stakeholders since initial unintended introductions into open river systems decades ago.

Triggered by the need for coordinated action, the Aquatic Nuisance Species Task Force requested the USFWS to convene an Asian carp working group to develop a comprehensive national Asian carp management and control plan. USFWS worked with over 70 partners to develop the 'Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States' (National Plan), finalized in 2007. The National Plan identified seven goals and supporting recommendations and strategies to stop the rapid expansion and introduction of Asian carp in river and lake systems of the United States. Subsequently, in 2009, the ACRCC was formed to address the threat to the Great Lakes from the progressive upstream advance of Bighead Carp and Silver Carp in the Illinois River moving toward Lake Michigan. Further acknowledging the growing concern to the Great Lakes basin, in 2013 the Great Lakes and St. Lawrence Governors and Premiers identified all four Asian carp species as among the "least wanted" AIS that represented an imminent risk to the United States and Canada. Additionally, individual State and Provincial management plans in the basin have been developed to include a specific focus on addressing Asian carp within respective jurisdictional waters. Bi-national risk assessments focused on evaluating the potential biological and socio-economic impacts from Asian carp species to the Great Lakes basin further underscored the challenge to the region.

No Bighead Carp, Silver Carp, or Black Carp have been collected or observed in the Great Lakes basin since 2000. Historical data document two separate occasions when adult Bighead Carp were collected from the western basin of Lake Erie (1995 – one fish; 2000 – two fish). These fish remain the only documented collections of these three species in the Great Lakes. Since that

time, intensive sampling has been regularly conducted by resource agencies in the Great Lakes, yielding no additional collections of these three species. Collections of a fourth Asian carp species, Grass Carp, have been documented in the Great Lakes and other North American watersheds for decades. In addition to captures of adult fish, data demonstrate the presence of reproducing Grass Carp populations in the western basin of Lake Erie. State-led monitoring and response actions have been developed to address the Grass Carp challenge and are further described in this Action Plan.

Outside of the Great Lakes basin, the below data from Asian carp monitoring and surveillance demonstrate that new occurrences of Bighead Carp and Silver Carp continue to be documented within portions of mainstem rivers in the Mississippi River basin. Data below also illustrate the establishment of self-sustaining populations of Black Carp in the wild, initially documented in the middle Mississippi River. Monitoring, tracking, and managing multiple populations of the four species across large, complex, multi-jurisdictional watersheds underscores the challenging and evolving nature of effectively addressing the threat posed by Asian carp. Accordingly, agencies have developed strategies and approaches to further address emerging threats posed by additional species while continuing to focus on prevention of Bighead Carp and Silver Carp population expansion and introduction.

Silver Carp were first imported into the U.S. in the early 1970's to control phytoplankton blooms in sewage lagoons and as a potential addition to fish production ponds. By 1975, Silver Carp

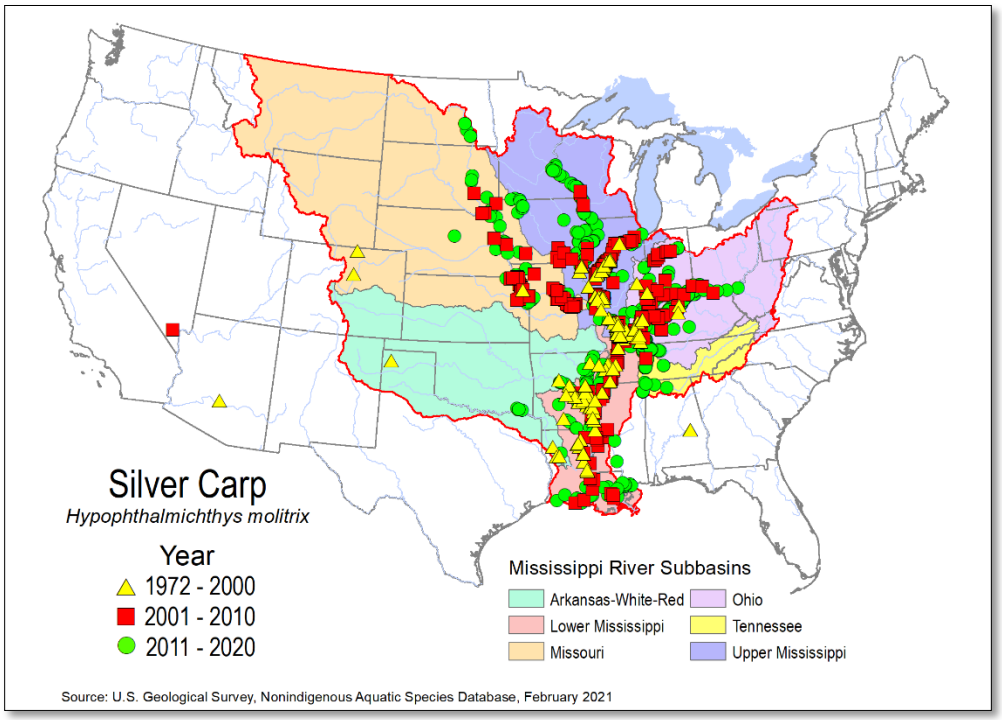


Figure 4. *Documented occurrences of Silver Carp in the U.S. waters from 1972 to 2020. Individual river sub-basins of the Mississippi River are delineated. Source: USGS NAS database.*

were collected from Bayou Meto and the White River, Arkansas, and by 1981, collected from the White, Arkansas, and Mississippi Rivers in Arkansas.

Silver Carp jump from the water when startled. Because moving boats can frighten Silver Carp, they often jump into boats, potentially injuring boaters or damaging equipment.

Silver Carp are now well established throughout much of the Mississippi River basin and are expanding in the Ohio River and other basins. In addition to concerns over ecological and related economic impacts, Silver Carp pose an additional threat to human safety, as they regularly jump out of the water when disturbed, particularly in response to outboard motors. Silver Carp was listed as Injurious under the Lacey Act in 2007, making it illegal to import live fish, gametes, viable eggs, or hybrids of the species, or to transport them between the listed jurisdictions in the shipment clause (the continental U.S., the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, and any possession of the U.S). The statute does not prohibit transport of injurious wildlife between States within the continental United States. Permits may be granted for zoological, educational, medical, or scientific purposes.

Bighead Carp were imported from eastern China to Arkansas in the 1970s to improve water quality in aquaculture ponds and sewage treatment lagoons. The fish, which can grow to 60 or more pounds, have since spread through the Mississippi River basin and have been collected as far north as Lake Pepin in Minnesota. The species was listed as Injurious under the Lacey Act in 2011. Current records indicate Bighead Carp collections from at least 27 states.

Grass Carp caught in a northwest Illinois neighborhood lake in July 2018.

Grass Carp have historically been used by resource managers as a means of combating nuisance aquatic vegetation in ponds and lakes in the U.S. Records indicate that, by the mid-1970s, this species had been stocked in at least 45 states. Although not considered widely established outside of the Mississippi River Valley (except in Texas), Grass Carp have now been documented in at least 45 states, Puerto Rico, and the Provinces of Ontario and Québec. In addition, monitoring data now provides evidence of Grass Carp natural reproduction in the Sandusky River and Maumee River, major tributaries in the western basin of Lake Erie in Ohio.

Adult Black Carp. Photo credit: www.AsianCarp.us.

Black Carp represent the fourth species of Asian carp imported into the U.S. in the early 1970s, likely in conjunction with the importation of one or more other Asian carp species. Black Carp grow to relatively large sizes and are longer lived than other species of Asian carp. As a molluscivore (feeds on mollusks and snails), its preference is to occupy benthic areas of rivers, making it suited for use as a desired biological control agent of snail populations in aquaculture ponds. Because of its known feeding ecology, its escape into the Mississippi River raised significant concern among resource managers for the long-term viability of the historical native mussel fauna in the Upper Mississippi River basin, of which over 70 percent are already imperiled or extinct. Since 2007, Black Carp have been listed as an injurious species under the Lacey Act. Current records indicate collections from at least seven states, and multiple occurrences of natural reproduction. To provide additional focus on the emerging threat from this species, the ACRCC formed an interagency Black Carp Work Group in 2017 to identify priorities and strategies for key research, monitoring and control activities supported through the annual Action Plan.

Geographically focused Asian carp management strategies are directly informed by the most current and accurate data on species distribution, establishment status and range expansion. Figure 5 on the next page illustrates the documented range of occurrence of Bighead Carp, Silver Carp, Black Carp, and Grass Carp throughout the waters of the Midwest U.S. as of October 2020. Monitoring and catch data are critical to informing the focused use of specific strategies for early detection, response, prevention, and control actions, underscoring the need for comprehensive and consistent Asian carp surveillance across the basins.

The mapping data generally illustrate the higher numbers of Asian carp historically detected in the middle Mississippi River following establishment in the wild, and increasingly in the adjacent major river reaches and tributaries, including the upper and lower Mississippi River, Ohio River, Illinois River, and Missouri River. The range of detection of each of the four species has steadily increased over time in the major river basins since initial introductions.

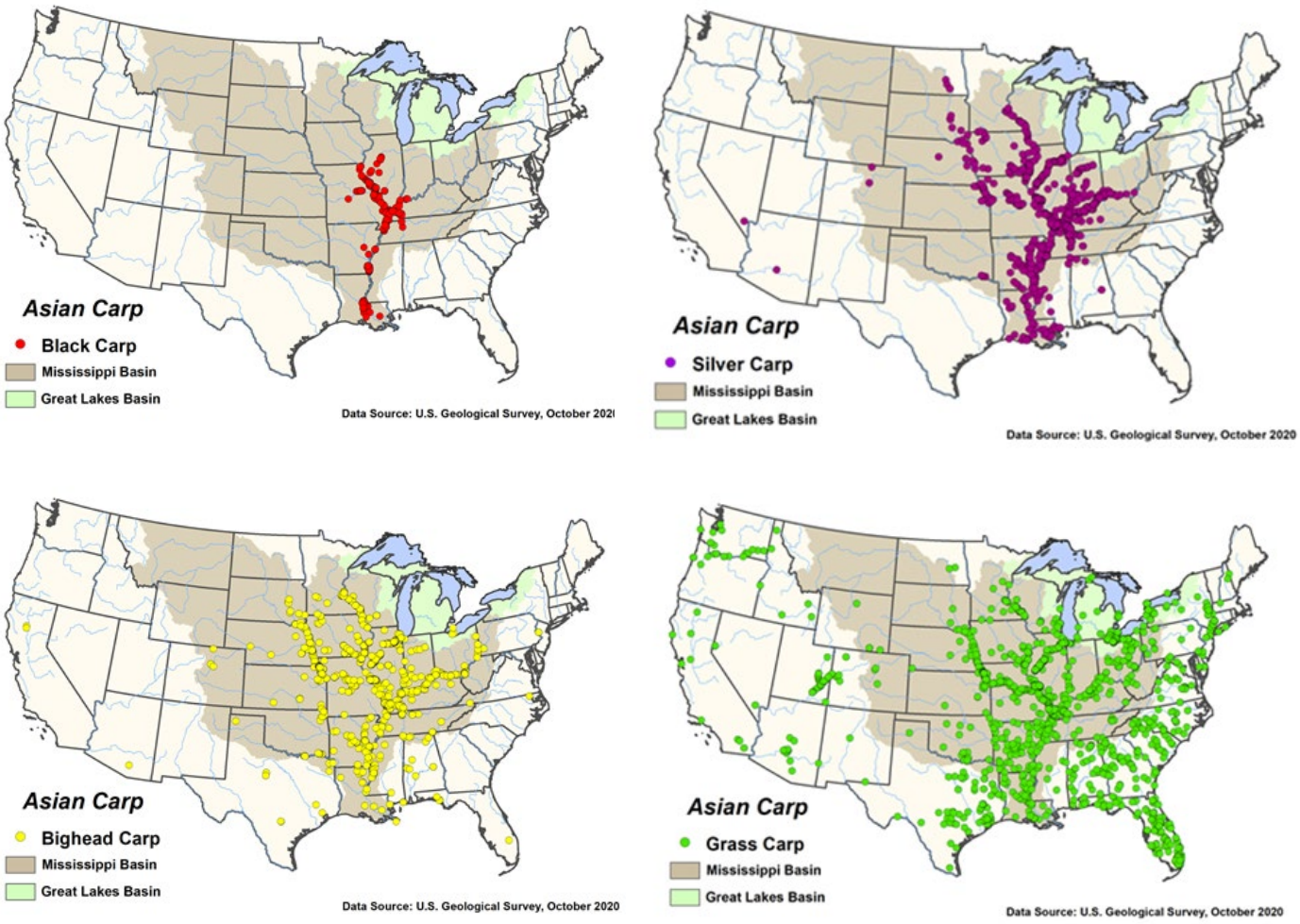


Figure 5. *Distribution maps of all four species of Asian carp in the Midwest United States. Data from the USGS NAS database, October 2020.*

Figure 6 on the next page illustrates the relative abundance and general population status of Bighead Carp and Silver Carp in Midwest U.S. river basins, showing fish densities and evidence of reproduction (including larval fish) progressively reduced toward the upstream boundaries of range of occurrence.

Accordingly, species assessments and mapping at a broader, regional scale are warranted to comprehensively evaluate the status and movement of Asian carp populations within and between basins (including identifying likely source populations) to best inform the strategic implementation of prevention and control actions by the ACRCC and other basin-wide partnerships (See Section 4.0 Collaborative Actions within the Upper Mississippi and Ohio River basins).

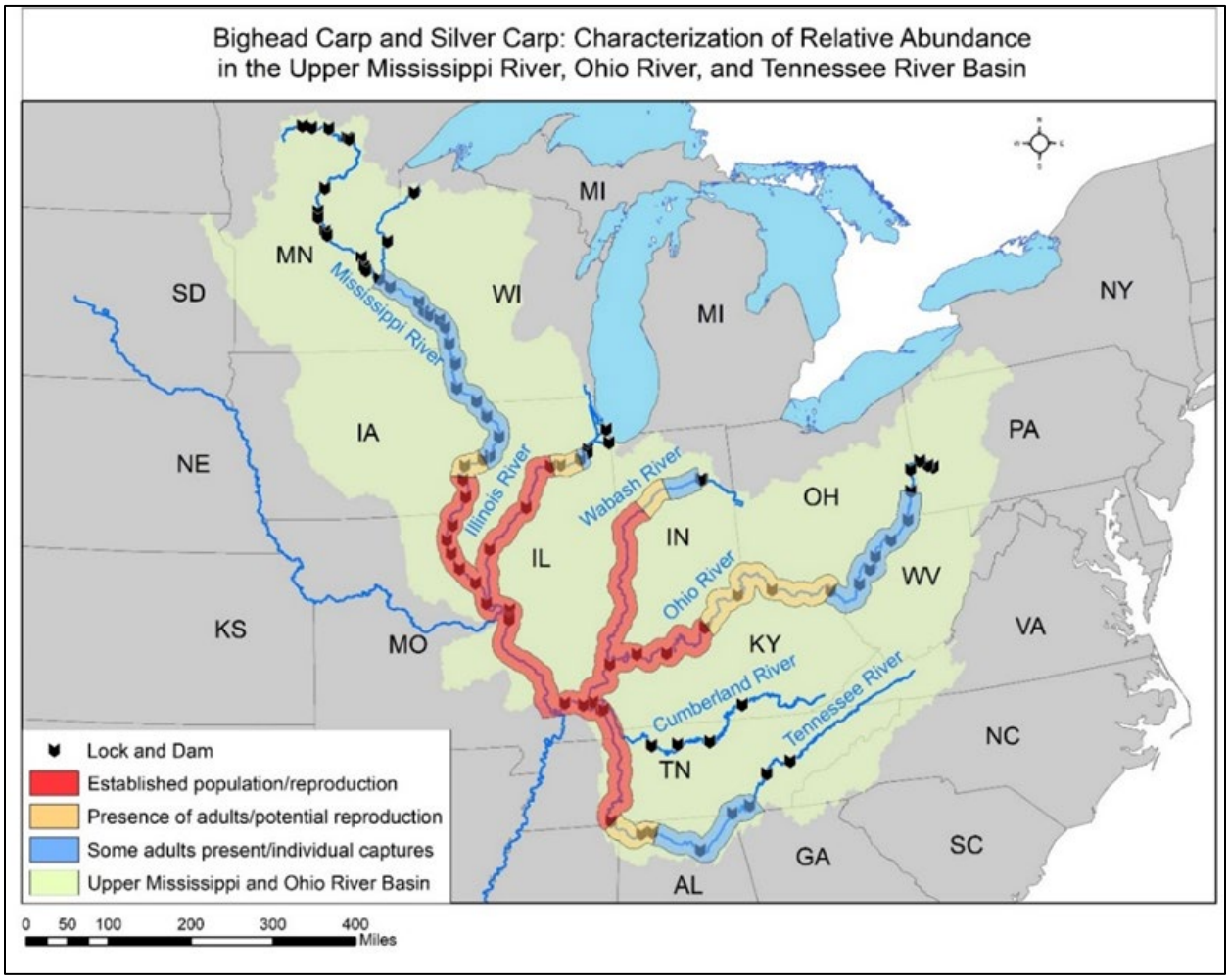


Figure 6. *Characterization of relative abundance of Bighead Carp and Silver Carp in the Upper Mississippi River Basin, Ohio River Basin, and IWW/CAWS.*

Within the Illinois River, ACRCC agencies conduct intensive ongoing monitoring for Asian carp using a combination of fishery sampling gears and techniques to ensure a comprehensive sampling approach. Traditional fishery sampling gears, including boat electrofishing and netting; remote sensing, including telemetry tracking and sonar; and eDNA sampling are conducted in targeted locations to best inform the understanding of Asian carp occurrence and population status. Due to the proximity of established populations of Bighead Carp and Silver Carp in the lower (downstream) segments of the Illinois River, intensive ongoing monitoring and control efforts have been focused on the upper IWW, including the CAWS, to lessen the risk of Asian carp migration upstream toward the Great Lakes. These actions have heavily informed the overall understanding of the dynamics and characteristics of Asian carp populations in the IWW, including surveillance actions to detect potential range expansion.

Populations of Bighead Carp and Silver Carp in the IWW are generally characterized by pool. For reference, Figure 7 below illustrates the pools in the upper IWW and the stages of invasion for Bighead Carp and Silver Carp. The MRWG has concluded that as of December 2020, the adult population front of Bighead Carp and Silver Carp in the IWW remained no closer than approximately 47 miles and two lock structures from Lake Michigan in the Dresden Island pool, unchanged for over 10 years. Additionally, notable reductions in the population density of Bighead and Silver Carp (as measured by fishery hydroacoustics surveys) have been documented along the IWW population front as compared to baseline 2012 levels, with the estimated percent reduction from 2012 levels varying by month and year.

The capture or detection of small Bighead Carp or Silver Carp (less than 6 inches in Total Length) upstream of Starved Rock Lock and Dam in Starved Rock, Marseilles or Dresden Island pools remains rare. A single early-stage larval Asian carp was detected immediately upstream of the Starved Rock Lock and Dam in 2020. The furthest upstream location where all life stages of Asian carp (eggs, larvae, juvenile, and adult fish) are consistently detected in the IWW remains in the lower three pools of Peoria, LaGrange, and Alton, also unchanged for over 10 years. The upstream boundary of these pools (Starved Rock Lock and Dam) is over 100 miles from Lake Michigan.

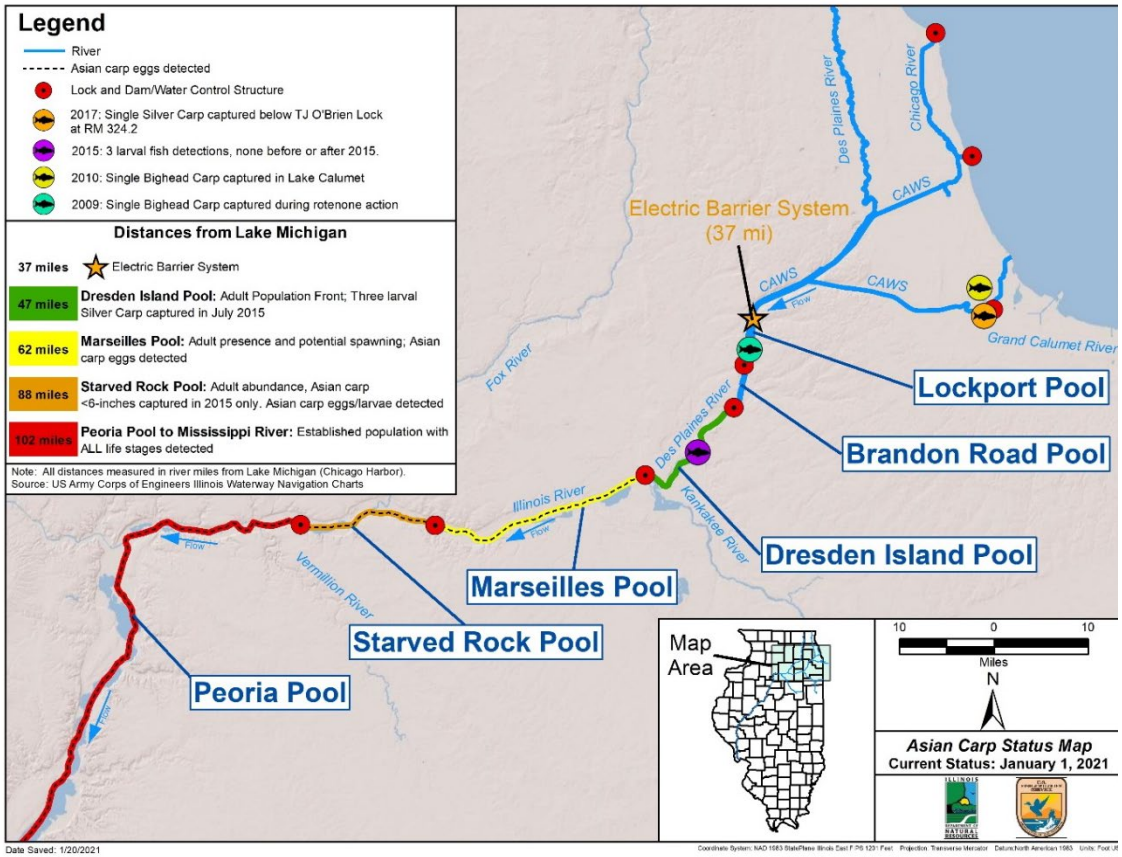


Figure 7. *Illustration of pools in the Upper Illinois River and stages of invasions for Bighead Carp and Silver Carp within the IWW.*

2.0 MONITORING AND RESPONSE WORK GROUP EFFORTS

The MRWG is tasked with planning and implementing coordinated monitoring, response, control, and management efforts in the IWW and CAWS. The MRWG MRP, developed annually, evaluates Asian carp status on a pool-by-pool basis within the Illinois River, and prescribes effort accordingly to minimize populations in each, as practicable.

In 2020, the global COVID-19 pandemic created a unique set of challenges for members of the MRWG during the field season. Guidance from the Centers for Disease Control, member agencies and public health authorities, as well as a stay-at-home order issued by the Governor of Illinois, required the cancellation of many field activities planned for March and April. Some sampling was conducted prior to these restrictions. Despite these challenges, the seasonal intensive monitoring (SIM) was completed in 2020 and no live Bighead Carp, Silver Carp, or Black Carp were found or observed immediately downstream or upstream of the EDBS. Additionally, the USACE continued to operate the EDBS in Romeoville, Illinois during 2020.

Previously, the MRWG formed discipline-specific work groups to assist in developing the annual MRPs and evaluating results to inform planning efforts. These work groups focus specific expertise for further analyses and assistance in decision-making within their functional work group area, and for generally providing the MRWG co-chairs and member agencies with insights as technical experts on a range of subjects. The work groups are listed below:

- Monitoring
- Detection
- Contingency Planning
- Removal
- Hydroacoustic Assessments
- Telemetry
- Modeling
- Behavioral Deterrent Technologies

The efforts undertaken by the MRWG are designed to address three primary objectives for preventing the spread of Asian carp to Lake Michigan. These objectives are:

- **Detection.** Determine the distribution and abundance of Asian carp to guide response and control actions.
- **Management and Control.** Prevent upstream passage of Asian carp towards Lake Michigan via use of barriers, mass removal, and understanding best methods for preventing passage.
- **Response.** Establish comprehensive procedures for responding to changes in Asian carp population status, test these procedures through exercises, and implement if necessary.

2.1 MRWG Strategic Vision

The MRWG has developed a short-term (2018-2022) and long-term (2022 and beyond) vision to strategically guide Asian carp detection, management and control, and response actions. All actions will be subject to the availability of appropriations. The goals under the vision are annually reviewed and updated, as needed, informed by the most current data on the population status in the IWW and CAWS.

2.1.1 Short-Term (5-year) MRWG Strategic Vision: 2018 – 2022

Detection

- Ensure sufficient detection effort is deployed throughout upper IWW, Des Plaines, and Kankakee rivers to inform response needs, including assessment of:
  - Adult fish, small fish, and larval/egg, where appropriate.
  - Pool-wide or regional population changes and movement metrics.

Management and Control

- Remove at least one million pounds of Asian carp annually from between Starved Rock Lock and Dam and the population front (e.g. downstream of Brandon Road Lock and Dam) to reduce upstream migratory pressure at the leading edge of the population (using observed 2015 Asian carp biomass as a baseline).
- Prevent the movement into or sustained presence of Asian carp between the Brandon Road Lock and Dam and the Lockport Lock and Dam.
- Utilize technical expertise and recommendations provided by discipline-specific work groups to determine whether algal attractants, complex sound deterrents, and use of CO_2 to herd fish can be effectively incorporated into MRWG actions.
- Evaluate the effectiveness of on-going management actions, adjust activities to improve effectiveness, as needed, and adapt management actions to future changes.
- Assist in identifying a market for the use of Asian carp harvested out of the lower three pools of the Illinois River in support of population management goals.
- Provide guidance and information to support the use established business development techniques to agency, industry, and entrepreneurs to improve ability of business establishment.

Response

- Ensure that agency response readiness is maintained and is synchronized with processes to detect changes.
- Enable rapid deployment of assets to support response actions, as needed.
- Review EDBS operations and operational changes.
- Consider annual table-top exercises and performance of existing plan to inform future planning efforts.

2.1.2 Long-Term (5+-year) MRWG Strategic Vision: 2022 and Beyond

Detection

- Implement an effective, efficient, and sustainable detection program to inform ongoing adaptive management and contingency response planning.

Management and Control

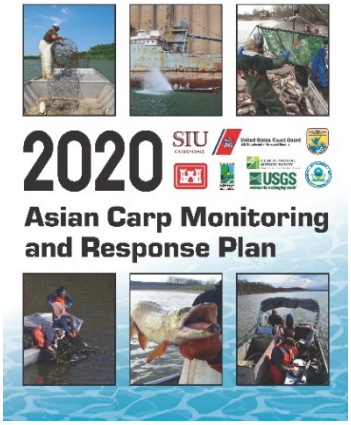
- Sustain management and control effort of Asian carp with continued population reduction using a baseline of Dresden Island pool densities as measured in 2015 as a standard for comparison.
- Provide guidance to minimize Asian carp populations in the upper IWW with no impacts on native fish or mussel populations, human health and safety, recreational use, or industrial uses of the waterway.
- Have in place a dynamic economic business strategy in the lower IWW to remove 20-50 million pounds of Asian carp annually.
- Leverage MRWG expertise and lessons-learned to support development of Asian carp management and control strategies in other river basins, as requested.

Response

- Ensure contingency response capability within 48 hours or less for any needed contingency response operation.

2.2 Monitoring and Response Plan

MRWG prepares annual workplans built on previous years' efforts. The annual MRP is a compilation of project plans for the many individual monitoring and response activities focused in the IWW and CAWS, each of which plays an important role in preventing the expansion of the ranges of Asian carp, and in furthering the understanding their location, population dynamics, behavior, and the efficacy of control and capture methods. Each individual plan outlines specific actions, including project objectives, methodology, and highlights of previous work. The MRP clearly sets pool-by-pool targets for population removal.



2020 Asian Carp Monitoring and Response Plan

This MRP uses the best available science on to help ACRCC members make the most effective management decisions in support of the Action Plan and partnership mission. Key data includes results from science-based predictive models and risk assessments that are critical for informing managers and scientists on locations at highest-risk for potential invasion, exploitation, or colonization by Asian carp.

2.3 Multiple Agency Monitoring of the Illinois River for Decision Making

A new effort in 2020, the Multiple Agency Monitoring of the Illinois River for Decision Making project will continue in 2021, supporting a robust, unbiased, and statistically powerful dataset that is comparable over time among multiple agencies and useful for leveraging fishery information across river basins as needed. A goal of this effort, which utilizes a stratified random approach to data collection in reaches of the Illinois River, is to provide unbiased estimates of Asian carp population demographics. This data can then be extrapolated to increase the understanding of population demographics under different location and scenarios, including below the EDBS, and to inform the status of the threat of possible invasion upstream the EDBS.

Agencies participating in the Multiple Agency Monitoring project include Illinois DNR and Illinois Natural History Survey (co-leads), USFWS and USACE (field support). Specifically, agencies will collaborate to sample the Lockport, Brandon Road, Dresden Island, Marseilles, Starved Rock, and Peoria pools. These MRWG efforts, coordinated with other efforts supported through the Long-Term Resource Monitoring Program and the State of Illinois, will provide for the most comprehensive dataset for management of Asian carp in the upper IWW.

The objectives of the Multiple Agency Monitoring project are:

- Monitor large and small Asian carp population demographics (i.e., presence/absence, distribution, and abundance) in pools below the EDBS with a standardized design.
- Provide for robust detection throughout the IWW, focusing on small fish from new areas or habitats, large fish above Brandon Road Lock and Dam, or other unexpected changes
- Inform other projects (i.e., Contracted Removal, Telemetry Monitoring, SEACarP model, etc.) with Asian carp demographic and fish community assemblage data necessary for making management decisions.
- Provide a robust data framework to assess potential impacts of Asian carp management decisions on native fishes.
- Detect small Asian carp presence in lower IWW pools to inform risk of upstream advancement to MRWG.
- Provide a standardized, robust, and statistically powerful monitoring approach comparable spatially and temporally throughout the entire Illinois River below the EDBS.

The Multiple Agency Monitoring project uses a proven standardized multi-gear approach that provides robust results that increase the ability to concurrently monitor Asian carp as well as native fish communities throughout pools of the Illinois River below the EDBS.

This monitoring has utilized an array of sampling techniques, including boat electrofishing, paired hoop netting, fyke netting, and minnow fyke netting to assess Asian carp population demographics and native fish assemblages spatially and temporally. Sampling will be conducted during three-time intervals in 2021 (June 15 to July 31, August 1 to September 15, and September 16 to October 31) to spread effort across the seasons and capture varying hydrological conditions. Sampling sites will be selected using a stratified random design considering all specific habitat types within each pool (i.e., main channel borders-shoreline, main channel border-open water, side channel borders, and backwater habitats). An example of the LTRM sampling configuration is provided in Figure 8 on the next page (Starved Rock Pool).

Activities conducted from 2010 through 2018, including the Fixed Site Monitoring Downstream of the EDBS and juvenile Asian carp monitoring projects have been collecting Asian carp demographic data to support MRP objectives farther upstream in the IWW. These fixed sites necessitate a higher frequency and lengthier temporal range of sampling than the randomized sampling design as a result of the proximity to the dispersal barrier and will be sampled biweekly from March to December. Fixed sites are established for monitoring in habitats where Asian carp (Bighead Carp, Black Carp, Grass Carp, and Silver Carp) have been historically found to congregate in other IWW pools (e.g., backwaters, side channel habitats, and tailwater areas below lock and dam structures). This effort will include:

- **Day Electrofishing**: Daytime pulsed DC boat electrofishing will be used to collect standardization and comparable fish catch rates within each pool.
- **Paired Hoop Netting**: Paired deployment of a large 4-foot (1.2 meter) hoop net with 1.5-inch bar mesh (3.7 centimeter), and a small 2-foot (0.6 meter) hoop net with 3/4-inch bar mesh (1.8 centimeter) at each random sample site.
- **Fyke Netting**: Fyke nets (3.0 feet [0.9 meter] x 6.0 foot [1.8 meter] frame) will be deployed in areas where water depth is sufficient to submerge the throats of the nets.
- **Minnow Fyke Netting**: Minnow fyke nets (2.0 feet [0.6 meter] x 4.0 foot [1.2 meter] frame) will be deployed following the same criteria and exceptions as those used for fyke nets.

2.4 Contingency Response Plan

Despite existing detection and management activities, it is understood that Asian carp populations may respond in unpredictable ways. Based on this realization, the MRP is designed to allow agencies to respond to unforeseen detections. The purpose of the Upper IWW CRP component of the MRP is to outline the process and procedures the MRWG and ACRCC member agencies will follow in response to the change in Asian carp conditions in any given pool of the upper IWW and how to communicate results. The three primary functions of the CRP include: (1) direct support of potential response actions, (2) work group review and updates to the CRP, and (3) continued training of action agencies and stakeholders through actual annual or tabletop exercises.

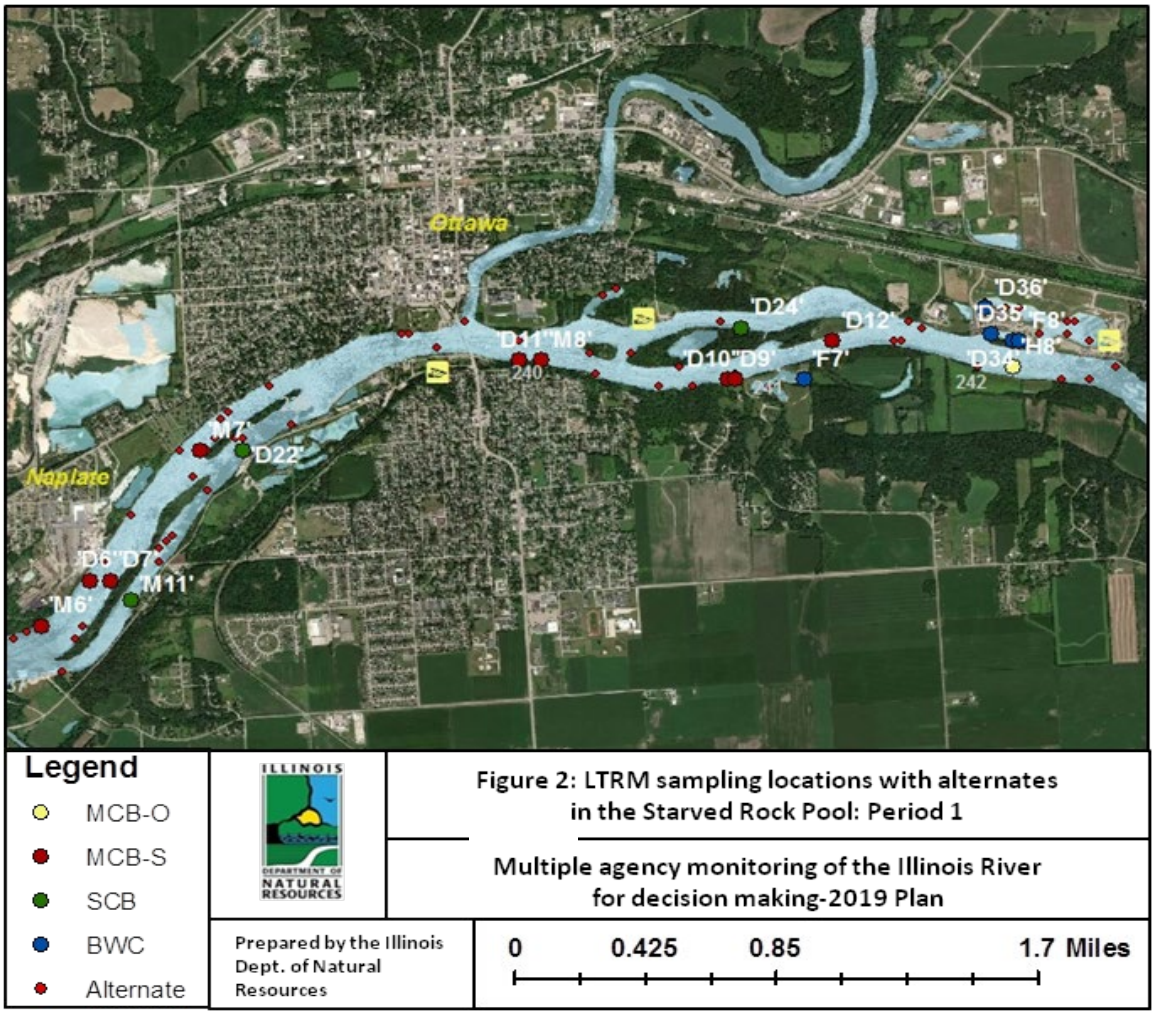


Figure 8. *Minnow fyke net ('M'), Daytime electrofishing ('D'), Paired Hoop Net ('H'), and Fyke net ('F') stratified random sampling locations: main channel border, side channel border, and backwater habitats with alternate locations in the Starved Rock pool of the Illinois River for Period 1 from river mile 242 to 237.*

The CRP describes specific options for potential response actions within the CAWS and the five navigation pools of the Upper IWW, which include the Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools. In the event a change is detected in the status of Asian carp in those pools indicating an increase in risk level, this plan will be implemented to carry out response actions. The MRWG has maintained a robust and comprehensive monitoring program in the CRP area and continues these efforts in 2021 as the foundation for early detection capability in the IWW. This approach provides MRWG with a high level of confidence in its ability to detect changes to Asian carp population status in the navigation pools in the upper IWW. The CRP and the annual interim summary reports describing these efforts, including extent of monitoring and Asian carp detection probabilities, can be found at www.AsianCarp.us.

The results of ongoing surveillance and management efforts have been used to establish the current status of Asian carp populations in each pool of the IWW, as described below:

- **Lake Michigan**: No established population.
- **CAWS**: No established population.
- **Lockport pool**: No established population.
- **Brandon Road pool**: No established population.
- **Dresden Island pool**: Adults consistently present. Larvae observed for the first time in 2015, but not observed since (source of 2015 larvae unknown).
- **Marseilles pool**: Adults consistently present. Eggs detected and spawning observed.
- **Starved Rock pool**: Adults abundant. Eggs detected and small fish (less than 6 inches total length) observed in 2015, but not observed since.
- **Peoria pool**: (downstream to confluence with Mississippi River): Established population with all life stages present.

The toolbox of potential response actions will be a primary focus area for reviews to ensure the most up-to-date information is available to the MRWG when the need for a response arises. The CRP not only provides quick guidance for agencies' actions, but also strategies for inter-agency communication, outreach and education with partners and the public.

3.0 INTERAGENCY ASIAN CARP MANAGEMENT

The coordinated interagency effort to address the risk of Asian carp establishing in Lake Michigan began in 2009 with efforts to support electric barrier maintenance within the CAWS. The formation of the ACRCC initially brought together the agencies potentially affected by the expansion of Asian carp into new waterway systems. The scope of effort has since evolved beyond a singular focus on the CAWS to now include other potential pathways for Asian carp introduction, including secondary pathways of AIS introduction as indicated in the GLMRIS report. The ACRCC's efforts are now binational and Great Lakes basin-wide in scope, encompassing 28 agencies and organizations in the U.S. and Canada. The ACRCC's efforts and mission are complementary to other interagency resource governance initiatives to address AIS threats in the Great Lakes, and the partnership strives to coordinate broadly and regularly with all entities.

Numerous key initiatives were addressed through the 2020 Asian Carp Action Plan and many will continue in 2021. ACRCC initiatives for 2021 include efforts for detection of Asian carp of various life stages using comprehensive and targeted sampling, continued development of control technologies, and identification of opportunities for their field implementation. In 2021, the ACRCC will also emphasize coordination of collaborative interagency efforts within and between basins, and program support. Accomplishments achieved in 2020 and initiatives planned for 2021 are highlighted below.

3.1. PREVENTION ACTIONS

The ACRCC is undertaking several additional prevention actions to address existing pathways to the Great Lakes. These efforts are described below.

3.1.1 Operate and Maintain Current Barrier System in the CAWS

USACE has operated electric barriers (Figure 9) in the CSSC since 2002. Over the years, several operational and procedural improvements have been implemented to improve the effectiveness and to continuously deliver an uninterrupted flow of electricity to the water to deter fish.

In 2021, the USACE will continue routine operation and maintenance of the existing barriers.

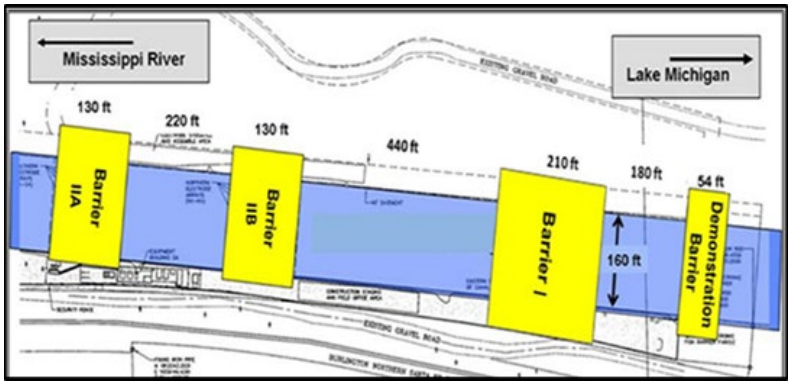


Figure 9. *USACE Electric Dispersal Barrier System.*

3.1.2 Completion and Operation of Permanent Barrier I in the CSSC

USACE has completed construction of an upgrade to the Demonstration Barrier I to a permanent facility, as authorized in the Water Resources Development Act of 2007. Performance verification and safety testing will be completed in the second quarter of FY 2021, which is a prerequisite for the full-time operation scheduled to occur by the end of FY 2021.

Permanent Barrier 1. Photo Credit: USACE

3.1.3 Design of Potential Future Actions at Brandon Road Lock and Dam

The proposed Brandon Road project would involve structural and non-structural measures in the vicinity of the Brandon Road Lock and Dam, near Joliet, Will County, Illinois. In FY 2021, USACE will, in partnership with the State of Illinois and the State of Michigan, initiate design of this proposed project, which would implement measures intended to address the upstream migration of aquatic nuisance species.

3.1.4 Closure Actions at Little Killbuck Creek Pathway

The GLMRIS Report identified Little Killbuck Creek in Ohio as a medium risk connection for the potential transfer of Bighead Carp, Silver Carp, Black Carp, Inland Silverside, and Northern Snakehead from the Mississippi River basin to the Great Lakes basin. The pathway was also identified as a medium risk connection for the potential transfer of Threespine Stickleback, Ruffe, Tubenose Goby, parasitic copepod, and Viral Hemorrhagic Septicemia (VHS) virus from the Great Lakes basin to the Mississippi River basin. Ohio DNR has completed the 25 percent design for the berm project to separate the two basins and refined this design using value engineering from the USACE. The project will continue in FY 2021 with real estate negotiations for the berm footprint, final design, permitting, and construction phased over multiple years. Ohio DNR has secured property values for real estate negotiations which will take place in early 2021. Once the footprint for the project is secured, final design and permitting will be initiated which will be completed in the spring of 2022. It is expected that the project construction will be initiated in the summer of 2022 and phased over several years.

3.1.5 Ohio & Erie Canal Pathway Project Completion

On October 15, 2020, the Ohio & Erie Canal project delivery team announced the completion of the Ohio & Erie Canal Aquatic Nuisance Species Barrier Project, providing the primary benefit of protecting the highly valuable commercial and recreational fisheries in Ohio and the Great Lakes.

Construction of physical barriers was initiated by the USACE in the spring of 2019. Close coordination of the study, design, and construction was maintained with the Ohio DNR and Summit County Metro Parks.

The GLMRIS Focus Area 2 Pathway Assessment, completed in 2014, identified the Ohio & Erie Canal as a medium risk connection for transfer of Silver Carp, Bighead Carp, Black Carp, and Northern Snakehead from the Mississippi River basin to the Great Lakes basin. The Ohio & Erie Canal project included design and construction of various structural measures to prevent or reduce the probability of AIS moving from the Tuscarawas River Watershed into the Cuyahoga River Watershed via the Ohio & Erie Canal. The closure of this potential pathway addresses two primary areas of concern: (1) the direct transfer of AIS from the Mississippi River basin to the Great Lakes basin at the Long Lake flood gates and the feeder gates to the canal that transfer water from Long Lake to the Lake Erie watershed and (2) flooding along the tow path and along sections of Long Lake that allows water to move from the Mississippi River basin to the Great Lakes basin. This closure will prevent or reduce the probability of ANS moving from the Tuscarawas River Watershed into the Cuyahoga River Watershed via the Ohio & Erie Canal. The canal towpath that forms the basin divide between Mississippi River and Great Lakes watersheds is now a trail prized for its recreational value and historical significance.

3.1.6 Alternate Pathway Surveillance in Illinois – Law Enforcement

The Illinois DNR Invasive Species Unit (ISU) was created in 2012 as a special law enforcement component to support the overall Asian carp control effort. The ISU consists of Conservation Police Officers who are fully dedicated to searching for illegal activities within the commercial fishing, aquaculture, transportation, bait, pet, aquarium, and live fish market industries. The ISU focuses on the likely pathways Asian carp could be spread by human means and has exposed the risks human activities bring by making significant arrests in almost every industry it has examined. The capabilities and knowledge of the ISU advance significantly each year.

3.2 Control Measures

The mission of the ACRCC is to prevent the introduction, establishment, and spread of Asian carp in the Great Lakes. In support of this long-term goal, an emphasis remains on scientifically assessing the movement of Asian carp and undertaking strategic, complementary control actions.

Targeted intensive harvest of Asian carp in the Illinois River is being increasingly used, informed by current fishery stock assessment data. A goal has been set of removing 15 million pounds annually by 2022 below the Starved Rock Dam. This enhanced removal is initially targeting Peoria pool (the upstream river reach). In 2021, the directed use of contract commercial fishing will continue to be increased to achieve higher annual harvest totals of adult Asian carp in the upper Illinois River in support of long-term management goals. In 2019, a project was initiated to explore potential opportunities to make greater market use of captured fish through commercial fisher removal efforts and will continue in 2021. Targeted removal efforts will be informed by agency

assessments of population status and movement within the focused geographic range, most notably characterized by the density of Asian carp at the population front within Dresden Island pool.

The following efforts described in Section 3.2 have been or will be undertaken to support these targeted removal initiatives.

3.2.1 Contract Fishing for Asian Carp Detection and Removal

Contracted commercial fishing will be used to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the EDBS. Commercial fishers will be directed to harvest as many Asian carp as possible in the Starved Rock and Marseilles pools (Figure 10). Harvested fish will be utilized by private industry for purposes other than human consumption. Efforts in 2020 (through October) removed over 442 tons (approximately 884,000 pounds) of Asian carp from Starved Rock, Marseilles, and Dresden Island pools. The 2021 efforts include a goal of removing at least 500 tons (one million pounds) of Asian carp from these sites.

By decreasing Asian carp abundance, migration pressure towards the barrier is reduced, lessening the chances of Asian carp gaining access to upstream waters in the CAWS and Lake Michigan. Monitoring for upstream expansion of Asian carp should help identify changes in their leading edge, distribution, and relative abundance in the IWW. The "leading edge" is defined as the

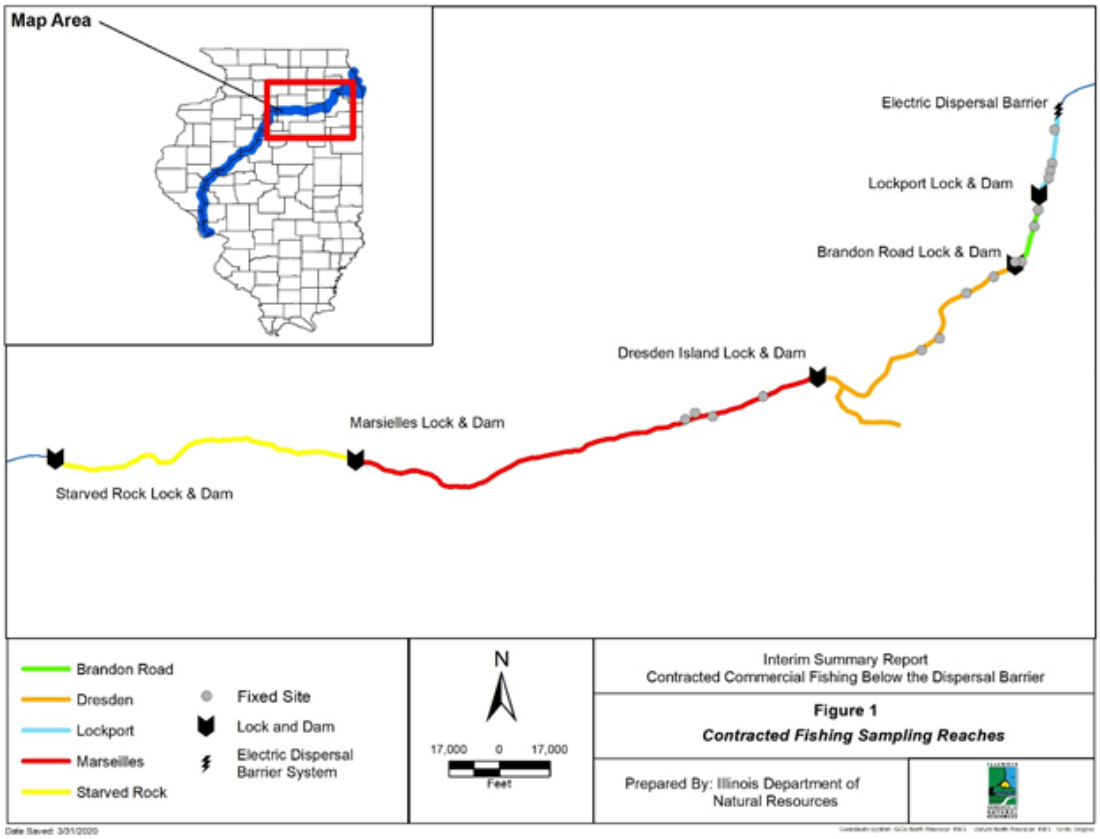
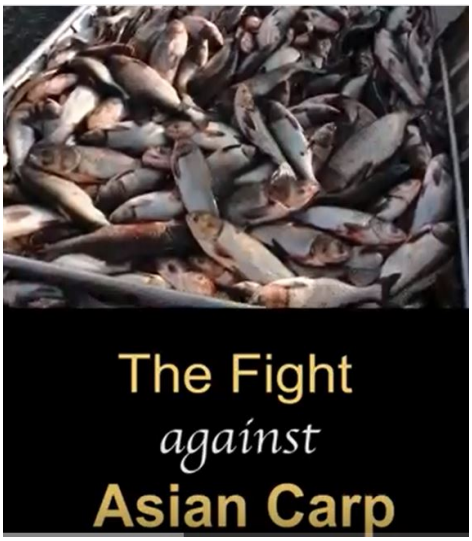


Figure 10. *Contracted commercial fishing sampling area and locations of fixed sites sampling of the contract fishing below the electric dispersal barrier project.*

furthest upstream location where multiple Bighead Carp or Silver Carp have been captured in conventional sampling gears during a single trip or where individuals of either species have been caught in repeated sampling trips to a specific site. Trends in catch data over time may also contribute to the understanding of Asian carp population abundance and movement between and among pools of the IWW.

3.2.2 Asian Carp Enhanced Contract Removal Program Development



The ACRCC and partners, including contract fishers, continue the fight against Asian carp.

The ACRCC recognizes the value of increased harvest of Asian carp in the Illinois River informed by current fishery stock assessment data. The use of targeted contract fishing in the Illinois River is a key component of the multipronged strategy. Concurrent recommendations for increased harvest are identified in a comprehensive Business Analysis Plan and corroborated by SEACarP model output. The Business Analysis Plan recommends actions to accommodate increased commercial harvest as a control option and expand alternative uses of harvested fish to increase fishing by identifying end-users. The long-term goal is removal of 20 to 50 million pounds of Asian carp annually from the IWW to progressively reduce the overall population size and the related risk of their spread into the upstream Illinois River. Through October 2020, over 2,600 tons of Asian carp were removed through this effort.

The Enhanced Contract Fishing Program will continue in 2021 in the Alton, LaGrange, and Peoria pools of the Illinois River. The goal of this effort is the significant removal of Asian carp from these areas by reducing the number of individual fish reaching the upper Illinois River. Removal effort planned for 2021 is expected to result in the removal of 5.75 million pounds of Asian carp.

This effort also includes a marketing program to support the creation of a positive brand for Asian carp that will help product-makers and processors identify and utilize markets for use of fish harvested from areas where populations are already established and targeted for intensive removal. Market engagement and increased product use will support increased intensive removal through targeted commercial harvest. Work to initiate a brand development process will continue in 2021.

3.2.3 Asian Carp Population Model and Demographics

The SEACarP model is a tool that describes our current understanding of Silver Carp and Bighead Carp population dynamics in the Illinois River. It is a simulation-based model that includes spatially explicit components (i.e., river pools) of the Illinois River system and produces probability-based predictions. SEACarP is being used to evaluate the effectiveness of different management strategy scenarios, including spatial allocation and intensity of harvest and upstream

movement deterrence between Starved Rock Lock and Dam and Brandon Road Lock and Dam. Determining ways to maximize return on investment of management actions is an area of increased emphasis. Refinement (improved the accuracy and precision), expansion, and strategic use the model continue as priorities, including a focus on informing: (1) the optimal locations and times for adult harvest in downstream navigation pools in the IWW relative to upstream navigation pools, and (2) potential locations for implementing deterrents to prevent the continuous upstream movement of Asian carp from source self-sustaining populations established farther downstream.

FY 2021 SEACarP model predictive ability will be further improved by development and incorporation of an Illinois River stock-recruit relationship for Asian carp. In addition, USFWS will collaborate with modelling experts from academia to determine how successfully statistical catch-at-age or length modeling could be completed given currently available harvest data. Results from this analysis, including fishing mortality estimates, will provide insights into the effectiveness of current control efforts. Also, preliminary development of a per capita contribution model is new for FY 2021. The goal of per capita modeling is to inform the spatial allocation of available fishing effort across individual pools of the Illinois River based on commercial catch rates.

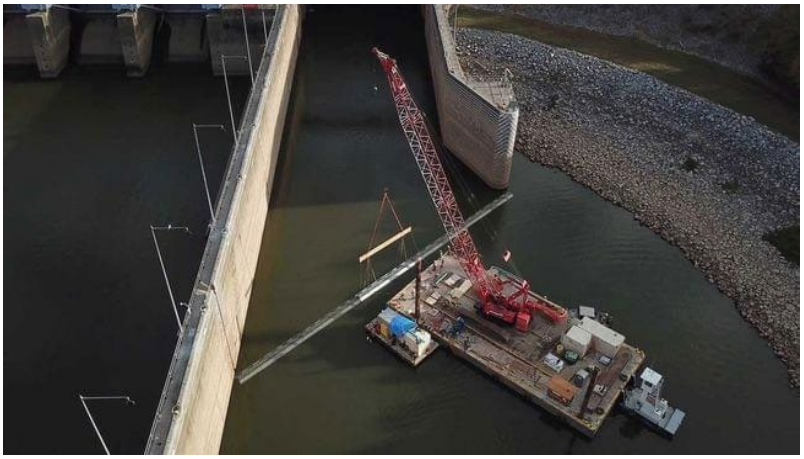
3.3 Technology Development

Currently, the primary permanent control tool for preventing the movement of Asian carp from the Mississippi watershed into the Great Lakes is the USACE EDBS located in the CAWS. Additional barriers or control technologies to augment the EDBS would improve the overall efficacy of the defense of the Great Lakes by providing redundancy and additional safety nets, ultimately offering greater confidence in their containment ability. For example, development of a chemical barrier that generates noxious water conditions might repel Asian carp, preventing them from approaching the EDBS; however, impacts on other fauna need to be assessed carefully. Some work has been done to define biological limits and potential benchmarks for candidate chemicals that may serve as a non-physical barrier to deter the movement of Asian carp.

A component of the 2021 ACRCC efforts includes the development of technologies for the control of Asian carp. In some cases, these technologies are being evaluated in areas where Asian carp populations are present in high numbers to support rigorous field assessments under realistic conditions. If these technologies prove to be effective, the goal is to eventually use them in areas where they are needed to protect the Great Lakes. One of the efforts is the use of underwater sound as a potential control technology. There are three basic components to the work being undertaken. The first component is the Barkley BAFF Deployment Project. This component is a large-scale experimental deployment of the BAFF system at Barkley Dam near Grand Rivers, Kentucky. The second component is the LD19 ADS Deployment Project near Keokuk, Iowa. The third component is the ongoing research and development related to acoustic deterrents, including engineering of new acoustic signals, and testing of signals in ponds and/or the field on Asian carp and native fishes as well as acoustic deterrent designs.

An interagency team consisting of USGS, USFWS, Illinois DNR, USACE, and other partner agencies will continue to explore options for potential implementation of new Asian carp prevention and control tools, including complex sound, CO_2, and microparticles.

3.3.1 Use of Acoustic Deterrents



Installation of the Bio-Acoustic Fish Fence at Lake Barkley, Kentucky. Photo credit: KDFWR

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of Asian carp, while allowing passage of native fish and shipping to continue. One candidate deterrent technique that has demonstrated effectiveness in laboratory and pond settings is underwater sound. Previous studies have documented both Bighead Carp and Silver Carp responding negatively to various underwater sound stimuli while many native fish species responded little to that same sound. Building on these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi basins will help in the understanding of the effectiveness of acoustic deterrents where Asian carp populations are established and will evaluate potential for the technology to be transferred and deployed in other locations to prevent upstream migration to the Great Lakes. For these large-scale pilot studies, underwater sound systems are being deployed at pinch points in river reaches where Asian carp are only able to swim upstream through a lock chamber because the head height of the dam structure prevents passage. Migration of fish is then confined to a single passage point and can be monitored with the use of telemetry and hydroacoustic equipment.

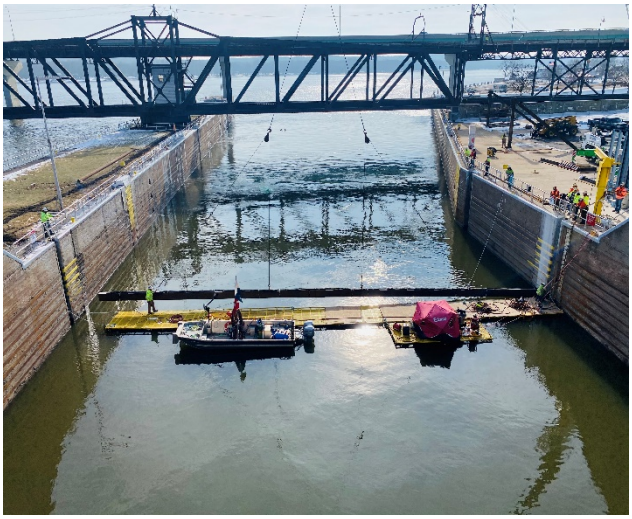
In addition to field-testing acoustic deterrent systems, research efforts in the lab will continue to refine and optimize sound frequencies, sound pressure levels, and speaker design to repel Asian carp while preventing injury to native species. Studies will also measure the efficacy of sound as a way to contain, herd, and capture Asian carp, as well as test their behavioral responses to underwater sound stimuli. Future actions will focus on refining the sound characteristics that elicit the greatest response in these species in biologically motivated states (i.e., hunger, reproduction, etc.).

In FY 2021, the multi-year large-scale field pilot studies to evaluate acoustic technologies will continue at Barkley Dam (BAFF) and LD19 (ADS).

The Barkley Dam project, led by USFWS, continues implementation of a large-scale field study of the BAFF acoustic deterrent for Asian carp, including system operations and maintenance. The test

is being conducted at Barkley Dam on the Tennessee-Cumberland River in the State of Kentucky due to the physical characteristics of the dam (high-head dam with no overflow conditions), the presence of existing fishery monitoring technology and capacity at the site (e.g., telemetry receivers), and the presence of an established population of Asian carp for evaluating response to the BAFF. Once completed in 2022-2023, the results of the study will be used to assess the overall effectiveness of the BAFF for use as an Asian carp deterrent and inform potential opportunities for the transfer of this technology to other locations to protect the Great Lakes.

At LD19 in Keokuk, Iowa (Mississippi River), development, deployment, and evaluation of an underwater ADS is underway and is led by the USGS. The effort will include a full deployment of the underwater ADS and monitoring array, evaluation of operations and fish passage, and development of underwater acoustic deterrent systems for various deployment scenarios.



Upstream Approach at Lock and Dam 19 at Keokuk, Iowa. Photo credit: USGS

In addition, ongoing research and development related to underwater acoustic deterrents will be undertaken by USACE and includes engineering of new acoustic signals and testing of signals in ponds and/or the field on Asian carp and native fishes as well as acoustic deterrent designs and components.

Results from these studies will be used to inform development of underwater sound and multi-component barrier systems as potential control alternative for Asian carp.

3.3.2 Carbon Dioxide

CO_2 is being investigated as a potential deterrent to Asian carp. The concept is to introduce CO_2 into water to immobilize or deter Asian carp from moving upstream. Several published studies at laboratory, mesocosm, and field settings have demonstrated that Asian carp and other fishes are repelled from areas with elevated CO_2 concentrations. This avoidance mechanism could be useful for management agencies to restrict movement through key pinch-points (e.g. navigation structures) and better control range expansion towards the Great Lakes and other large river basins.

State and federal partners completed several important milestones in 2019 and 2020. First, the USGS and USFWS obtained a Section 3 registration pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) from USEPA for CO_2 as a new aquatic pesticide. Approved uses include as an Asian carp deterrent and as a non-selective lethal control for all nuisance fishes. Next, an engineering feasibility study was conducted within a navigational lock in

Wisconsin. This study demonstrated the installation and operation of a large-scale CO_2 infusion system and collected data on operational costs, fish behavior, non-target organisms, human health risk assessment, and water quality. Lastly, regulatory steps to transition from research into management have been completed with registration of CO_2 within individual states.

Scientists monitored movements of Asian carp and other fish in relation to carbon dioxide in a research pond in Wisconsin. Photo credit: USGS

In 2021, efforts will include:

- Data to support registration of Carbon Dioxide–Carp with individual states.
- Development of the Carbon Dioxide–Carp online reporting system for use by management agencies.
- FIFRA Section 3 registration of dry ice as an alternative delivery method.
- Amendment of current registration to expand potential uses (e.g. removal of under-ice restriction for lethal applications).

3.3.3 Microparticles

No current technology can specifically target Asian carp species for control within aquatic ecosystems. Available lethal control chemicals used in aquatic invasive species management are applied throughout the entire water column exposing both native and invasive species. The development of delivery systems that exploit the unique feeding strategies of the four Asian carp species would greatly increase the impact on the target species while minimizing potential impacts on native species. This technology has great value as part of an integrated pest management program for Asian carp and restoration of infested waters. In 2021, USGS will refine the oral delivery formulation (microparticle) and initiate studies to support its registration for use as a control tool.

3.3.4 Barge Entrainment

In 2021, the ACRCC will conduct work to support the evaluation of potential technologies for addressing the risk to the Great Lakes from the inadvertent entrainment and transport of small fish by barges in the IWW. These efforts are part of a multi-year collaborative project, building on

earlier findings that demonstrated the risk of small fish – including Asian carp – being carried upstream in the void spaces between commercial barge tows, including through lock structures. This effort is being proposed to assist in the development of a large-scale field study to evaluate the effectiveness of a prototype technology, the LBA, for removing entrained small fish. The LBA generates streams of bubbles which may actively flush trapped fish.

The proposed field study will utilize a mark and recapture evaluation at the Peoria Lock and Dam, a location where Asian carp are already established.

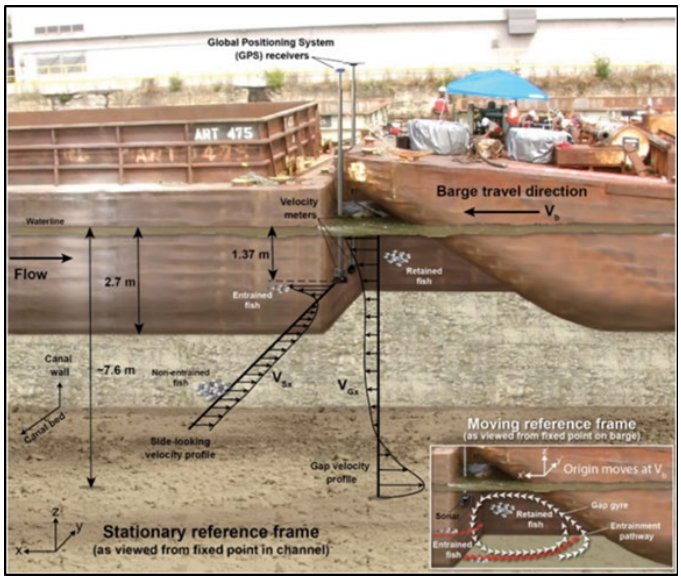


Figure 11. *Rake to box junction between barges (from Davis et al. 2016).*

In 2021, USACE will conduct technical modeling at the ERDC in Vicksburg, Mississippi to inform design of the prototype LBA manifold. USFWS will assess the feasibility of capturing and raising wild-caught juvenile Asian carp for use in the upcoming barge entrainment replicate field trials, including identifying and testing propagation protocols to reduce mortality and maximize fish quality. The USGS will collect and analyze data from assessments of commercial barge movement through lock passages and approach channels to further inform the understanding of the influence of commercial barges on hydrology in and adjacent to lock structures. USGS will collect data at the Peoria Lock and Dam to inform the proposed LBA technology evaluation; analyze existing data collected at Brandon Road Lock and Dam; and collect and analyze data from a new acoustic Doppler current profiler adjacent to LD19 on the Mississippi River (to be installed in early 2021).

3.4 Early Detection, Monitoring, and Evaluation

Continued monitoring and assessment of the population in the Upper Illinois River are critical to the ACRCC's ability to assess the threat of upstream movement and range expansion. In addition, monitoring above the EDBS is important to ensure no Asian carp have moved beyond the barrier.

3.4.1 Monitoring Upstream and Downstream of the Dispersal Barrier

SIM activities will continue in the spring and fall of 2021, utilizing targeted sampling with a variety of gears including seines, trammel nets, and hoop nets to detect, capture, and remove any Asian carp present in upstream locations.

Fixed and random site intensive efforts and contracted netting at four fixed sites in each of the four pools below the EDBS will be used for this effort. These projects focused on the Starved Rock, Marseilles, Dresden Island, Brandon Road, Lockport, and Peoria pools utilizing electrofishing, hoop netting, and mini fyke netting.

In 2021, contracted commercial netting will take place bi-weekly from March through December in the Lockport, Brandon Road, and Dresden Island pools. Contracted commercial netting in the Marseilles pool will also occur. An intense removal effort, or Barrier Defense, occurs in the Starved Rock, Marseilles, Dresden Island, Brandon Road, and Lockport pools.

The seine net is lifted to keep any fish from escaping. Photo credit: Evan Garcia /Chicago Tonight.

Transitioning to the Multiple Agency Monitoring of the Illinois River for Decision Making in 2021 will provide a robust, proven, multi-gear, standardized methodology across agencies to increase MRP effectiveness in monitoring Asian carp and native fish communities in reaches of the Illinois River below the EDBS. Additionally, these methods will allow comparisons in other river reaches outside of the program, giving additional context to observations.

A team of commercial fishers led by Illinois DNR staff and contractors will:

- Monitor for the presence of Asian carp in the five pools (Starved Rock, Marseilles, Dresden Island, Brandon Road, Lockport) below the EDBS in the IWW.
- Reduce Asian carp densities, lessening migration pressure to the EDBS, thus decreasing chances of Asian carp accessing upstream reaches (e.g., CAWS and Lake Michigan).
- Inform other projects (i.e., hydroacoustic verification and calibration, SEACarP model, small fish monitoring, telemetry master plan) with Asian carp population distribution, dynamics, and movement in the IWW downstream of the EDBS.

3.4.2 Distribution and Movement of Small Asian Carp in the IWW

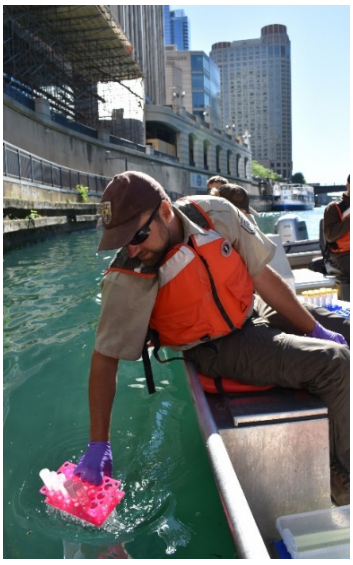
Small Silver Carp and Bighead Carp pose a unique threat of bypassing the EDBS because of the potential electrical limitations of the EDBS at immobilizing fish less than 6 inches in total length. Therefore, it is important to carry out sampling using a variety of gear at sites between the Peoria reach of the Illinois River and the EDBS throughout the year to detect upstream migrations of small and juvenile Silver Carp and Bighead Carp. Any successful capture of juvenile or small Asian carp is immediately communicated to the MRWG if it is new for the year or further upstream than prior captures.

In 2021, sites within the various pools (Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock) of the Upper IWW will be sampled using a suite of gears intended to capture juvenile Asian carp, to include fish less than 153 millimeters Total Length (6 inches). The specific objective of this effort is to detect the furthest upstream location for both small (currently believed

to be Starved Rock Pool) and large (currently believed to be Dresden Island) Silver Carp and Bighead Carp yearly.

3.4.3 Comprehensive Interagency eDNA Monitoring Program

The USFWS applies the science of eDNA as an early detection monitoring tool in support of the ACRCC strategic approach for protecting the Great Lakes from Asian carp. This work includes the continued refinement and development of state-of-the-art tools, field sampling and laboratory protocols, and expanded analytical capacity to support a robust eDNA monitoring program for efficiently sampling high-priority locations for the presence of Bighead Carp and Silver Carp. USFWS maintains program capacity to support strategic eDNA surveillance for Asian carp in the Great Lakes, Upper Mississippi, and Ohio River basins. Building upon work that has been completed for Bighead Carp and Silver Carp marker improvements, field collection and extraction protocols, USFWS will continue support for Grass Carp and Black Carp surveillance for Great Lakes protection as part of this monitoring program.



USFWS collects water for eDNA surveillance in the CAWS.

In 2021, USFWS, in cooperation with state and tribal partners, will continue to monitor for the presence of Bighead Carp and Silver Carp eDNA in the Great Lakes basin, as well as the Upper Mississippi River and Ohio River basins. Actions include program coordination and oversight, and processing collected water samples to detect the presence of Asian carp DNA in areas of concern.

3.4.4 Asian Carp Stock Assessment in the Upper Illinois River

Hydroacoustic monitoring and telemetry tracking of Asian carp in the Alton through Dresden Island pools of the Illinois River will continue in 2021. Through the telemetry project, Asian carp are implanted with acoustic transmitters, and their movement is tracked across an acoustic receiver array maintained in this section of the Illinois River. Hydroacoustic sampling will occur for multiple purposes, including whole-pool sampling in Marseilles and Dresden Island pools every other month from February through October.

In 2021, to support MRWG management, Asian carp density maps will be produced every other month for the Marseilles and Dresden Island pools, illustrating locations where densities (individuals/1000 cubic meters) are highest. Pool-wide density estimates (individuals/1000 cubic meters) from Alton to Dresden Island pools will be compared to annual estimates since 2012, and

the number of tagged Asian carp at-large in each pool, the number moving into other pools through lock and dams, and probability estimates of Asian carp moving among pools. The density heatmaps displaying spatial distributions of fish throughout the year will be provided to MRWG members to target contracted harvest to maximize harvest efficiency. Also, this effort will result in the identification of high-density locations of Asian carp long-term assessments of population trends and quantifications of upstream movements. Results will be used to direct harvest to high-density locations near the invasion front and informing decisions on current levels and locations of removal and potential deployment of deterrents to support MRWG management goals.

Hydroacoustic sampling will also take place before and after any Unified Method Asian carp removal events in spring and fall to provide density heatmaps to inform harvest actions, and to assess effectiveness of harvest at reducing densities. Finally, hydroacoustic sampling will be conducted in October at standardized locations from Alton to Dresden Island pools in order to quantify pool-wide Bighead Carp and Silver Carp densities that will be compared to long-term (since 2012) density trends.

3.4.5 Great Lakes Monitoring

The USFWS works with partner agencies to implement an ongoing early detection program for detection of AIS, including Asian carp, in the U.S. waters of the Great Lakes. Sampling strategies are tailored each year, informed by current data and emerging priorities, and incorporate new sampling technologies for AIS of interest. The USFWS continues to coordinate with federal, state, tribal, and provincial partners to annually identify priority sampling locations, further develop and refine protocols, share information, and discuss ways to coordinate agency sampling efforts. Since 2013, USFWS has worked with partners to conduct coordinated and complementary sampling efforts in the Great Lakes basin with both emerging and traditional gears. In FY 2021, USFWS will continue to lead this effort. USFWS teams will be prepared to provide support for response in the event of the detection of an Asian carp in the Great Lakes, in coordination with jurisdictional agency partners within the basin.

3.4.6 Binational Ecosystem Risk Assessments

A binational ecological risk assessment of the potential for introduction, establishment and impacts from Bighead Carp and Silver Carp in the Great Lakes was completed in 2012 to provide scientifically defensible advice for managers and decision-makers in Canada and the U.S. This risk assessment assessed the likelihood of arrival, survival, establishment, and spread of Bighead Carp and Silver Carp to obtain an overall probability of introduction. Arrival routes assessed were physical connections and human-mediated releases. The risk assessment ranked physical connections (including the CAWS) as the most likely route for arrival into the Great Lakes basin. Results of the risk assessment show that there is enough food and habitat for Bighead Carp and Silver Carp survival in the Great Lakes, especially in Lake Erie and productive embayments in the other lakes. Analyses of Canadian Great Lakes tributaries and the U.S. waters of Lake Erie indicate many suitable tributaries for Bighead Carp and Silver Carp spawning. The assessment

concluded, therefore, that should Bighead carp and Silver Carp establish in the Great Lakes, their geographic spread would not be limited, and several ecological consequences would likely occur. These consequences include increased interspecies competition from Asian carp for limited sources of planktonic food, leading to reduced growth rates, recruitment, and general abundance of planktivores, including native and commercially valuable sportfish species. Overall risk was determined to be highest for lakes Michigan, Huron, and Erie, followed by Lake Ontario then Lake Superior. To avoid the invasion process predicted in the risk assessment and prevent or minimize anticipated consequences, reducing the probability of initial introduction and establishment remains the strategic focus of the efforts of the ACRCC partnership through the Action Plan.

A binational ecological risk assessment for Grass Carp in the Great Lakes basin was released in January 2017. The document demonstrates that Grass Carp have been found in Lakes Michigan, Erie, and Ontario, and summarizes the potential ecological consequences over the next 50 years. Predicted impacts in most of the Great Lakes basin could be significant, without the implementation of strategic management actions to control their establishment and expansion. Should Grass Carp become established, wetlands in the Great Lakes basin are particularly vulnerable due to the species' direct reliance on aquatic vegetation as a primary food source. The study's findings will inform management and policy decisions with an objective of preventing the survival, establishment, and spread of Grass Carp in the Great Lakes basin on both sides of the border, as well as activities related to prevention, early detection or monitoring, response, and management. In close collaboration with subject matter experts from DFO, GLFC, and Ontario Ministry of Natural Resources and Forestry (OMNRF), Central and Arctic Region - DFO finalized a binational socio-economic risk assessment in 2018 as a companion piece to the binational Grass Carp ecological risk assessment. The study found that, in the absence of additional measures to prevent Grass Carp, starting in 2024, the present value of impact on Great Lakes commercial and recreational fishing industry in Canada would be approximately $590 million and $3.9 billion in 10 years and 40 years, respectively. The present value of impact on Great Lakes commercial and recreational fishing industry in the U.S. would be approximately $2.5 billion and $15.28 billion in 10 years and 40 years starting 2024, respectively. The study found that the presence of Grass Carp in the Great Lakes would decrease lake front use, wildlife viewing, recreational hunting opportunities and associated benefits and might benefit the recreational boating activities. Other services expected to be at risk were ecosystem services, non-use values, future use values, and subsistence, social, and cultural values.

Risk assessment and ecological impact analyses are also being completed for Black Carp focused on the Great Lakes basin. As part of development of a binational ecological Black Carp risk assessment, DFO conducted research on the potential arrival, survival, establishment, spread, and impact of Black Carp in the Great Lakes. A movement model was used to assess the predicted timeline of spread from through the Mississippi River basin (where established) to entry points near the Great Lakes. A temperature- and size-based model was developed to assess the overwinter survival of young-of-the-year Black Carp, as well as the suitability of spawning tributaries

throughout the Great Lakes basin. A population model was used to evaluate the relationship between propagule pressure and likely establishment, including the likely timeframes of spread among suitable tributaries and lake basins. The model predicted the extent of spread in the Great Lakes within 1, 5, 10, 20, 35 and 50 years using the CAWS and the Maumee River as arrival points into the Great Lakes. A series of prey layers were developed that incorporated native unionids, gastropods, and dreissenids, which were used to develop a Black Carp bioenergetics model to evaluate where Black Carp could establish populations, based on food availability. The magnitude of impact of different densities of Black Carp on the Great Lakes fish community and native unionids was assessed using a food web approach and linear inverse models. Together, this research provides key scientific information to inform the Black Carp risk assessment for the Great Lakes, anticipated to be completed in spring 2021.

3.5 Response Actions

The ACRCC will be prepared to shift monitoring resources as warranted by new information. As in past years, if new findings indicate an increased risk, resources will be available to transition to the involved areas, as necessary. Evaluations and enhanced monitoring decision tools be used to further inform contingency response planning and implementation.

In 2021, the ACRCC will be addressing any needed contingency response actions through implementation of the MRWG's CRP, using the established protocols activated in the event a change is detected in the status/risk considering all life stages of Asian carp in upstream pools in the IWW. The goal of the CRP is to provide a process to consider appropriate and specific response actions that fully consider available tools and the authorities of member agencies to implement actions. The ACRCC will be prepared to respond rapidly and redirect monitoring resources, as warranted by new information.

Initially developed in 2016, the CRP will continue to be used by the MRWG to direct response actions in the event a change is detected in the status or risk considering all life stages of Asian carp in those pools or in the event of Asian carp detection above the Brandon Road Lock and Dam. The CRP will also provide for open and transparent communication with the public and special stakeholder groups. Leadership and coordination of an Asian carp response in the IWW will be implemented under the MRWG. The Incident Command System (ICS) is a management system designed to enable effective and efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure.

3.6 Black Carp and Grass Carp Monitoring, Assessment, and Control

Illinois DNR and USFWS conduct sampling targeting all life stages of Black Carp. In addition, USFWS, USGS, Michigan DNR, Ohio DNR, OMNRF, DFO, and other partners continue to assess Grass Carp populations in Lake Erie and other locations in the Great Lakes to better understand their status, and to target capture and removal.

The Action Plan includes numerous monitoring and control activities focused on Black Carp and Grass Carp. Below are collaborative approaches undertaken by the ACRCC to address these species:

3.6.1 Addressing the Threat of Black Carp

Black carp are an invasive molluscivore in North America, originally transported to aquaculture facilities for their application as a biological control of snails in the 1980s. The greatest concern for Black Carp population expansion is the impact on native mussel and snail fauna, of which many species are already listed as threatened or endangered. Black Carp have population numbers that have been increasing in the Upper Mississippi River basin since 1994. To leverage existing ongoing commercial fishing efforts and opportunistically collect critical data on Black Carp, Southern Illinois University administers a bounty funded by Illinois DNR to encourage reporting and provide specimens for research. Reports from commercial fishers revealed that Black Carp have spread to the Illinois River (Peoria pool) and Ohio River.

Black Carp Captured, Southern Illinois University.

Recognizing the emerging threat, the ACRCC formed an interagency Black Carp Work Group (BCWG) to scientifically evaluate the status of the now-established species, identify clear management needs and objectives, and develop a strategy for implementing high-priority monitoring and control actions to abate the further expansion and establishment in U.S. waters. The BCWG is comprised of fishery scientists and managers from State and Federal agencies and academic institutions with technical expertise on Asian carp life history and management. The addition of the Black Carp Strategy within the 2017 ACRCC Asian Carp Action Plan underscored the partnership's concern for this growing threat. Through this effort, the ACRCC is identifying the data needs and highest priority management and control actions in response to the significant increases in documented occurrence and upstream range expansion in recent years.

In 2021, the USFWS will lead an SDM process with the BCWG to incorporate new information from current research and establish priorities for continued research to inform long-term options for Black Carp management actions, or specific control and containment actions on the ground in the near term. Making informed decisions will support the effective development and evaluation of tools and techniques to assess and reduce the risk of Black Carp to the Great Lakes. Use of the SDM Decisions will initially focus on:

- Effectiveness of current and likely future barriers/deterrents against Black Carp.
- Most promising Black Carp attractants to pursue.

- Most promising Black Carp control tools to pursue.
- Best methods/approaches to improve our sampling techniques.
- Risk of movement of Black Carp into new areas via non-swimming pathways.

USFWS will continue to offer technical assistance to partners for the identification of collected young-of-the-year/larval fish using genetics techniques. The identification and verification of potential Black Carp specimens will assist with documenting reproduction, range expansion and general population status, providing important baseline information for planning management actions. In addition, USFWS, consulting with USACE geneticists, will research ways to improve Black Carp eDNA sampling protocols, detection sensitivity, assay validation, and development of a standard operating procedure (SOP) for Black Carp eDNA monitoring. USFWS will also continue to conduct ploidy analysis for the assessment of collected Black Carp, providing key information on the reproductive capability and potential origins of the fish (aquaculture versus wild population).

In 2021, USGS will assess Black Carp biology and ecology, range, bait development, early life history, and habitat use and movement. Work will describe the life history and distribution of the species to support development of detection and control methods to prevent Black Carp from becoming established in the Great Lakes.

USACE ERDC will continue to test different sampling approaches to identify those that provide highest likelihood of capturing Black Carp eDNA. These tasks build on work conducted in 2018-2020. In FY 2021 eDNA samples will be taken from a locale where Black Carp eDNA detections have previously been obtained (e.g., near Greenville, Mississippi) at various time points (two to four) during the year. Sampling will focus on mainstem river habitat (e.g., in association with winged dikes) and associated sloughs and oxbows. Water and sediment samples will be tested for endemic Black Carp eDNA. Sampling correlates, such as water turbidity, depth, and temperature, will be recorded for analysis of factors influencing sampling results. In the case of examining the effects of turbidity, a subset of samples will be spiked with Black Carp eDNA materials (e.g., frozen water from commercial Black Carp ponds or synthetic DNAs) to ensure that the effects of turbidity on detection sensitivity are measurable.

Illinois DNR will continue sampling using hoop nets augmented with experimental baits to assess the population of Black Carp in the lower Illinois River while concurrently testing the efficacy of different bait options for increasing fish capture. The bait identified for use in Illinois River monitoring will be likely informed by targeted sampling of known Black Carp populations (Horseshoe Lake and Mississippi River) where bait comparisons can be evaluated during intensive sampling. In the La Grange pool of the Illinois River, Illinois DNR will expand the existing Upper Mississippi River Restoration Program's Long-Term Resource Monitoring (LTRM) standardized hoop netting efforts and make direct comparisons using experimentally baited hoop nets to target Black Carp to better detect their presence, abundance, and expansion up the lower Illinois River. While LTRM hoop netting uses a soybean-based bait, this proposed expansion will include the use

of clam-based and cottonseed-based baits deployed in approximately 100-paired hoop net sets each (approximately 200 hoops total) in main- and side-channel habitats of the La Grange pool.

3.6.2 Addressing the Threat of Grass Carp

U.S. and Canadian resource agencies in the Lake Erie basin have identified the threat of invasive Grass Carp as a high priority requiring focused and aggressive assessment and control action. Member agencies have developed a suite of proposed actions for implementation, building on existing efforts within the Lake Erie basin. Planning is conducted in collaboration with the GLFC's Council of Great Lakes Fishery Agencies, Invasive Fishes Executive Committee, and the Lake Erie Committee (LEC), to ensure strong support for the priorities of the Lake Erie fishery management agencies.

In recent years, the ACRCC has funded actions to address the threat that Grass Carp pose to the Great Lakes, broadening from the initial focus on Bighead Carp and Silver Carp. Because the spawning and early life history requirements of Grass Carp are similar to Bighead Carp and Silver Carp, USGS scientists have built on their existing knowledge base to identify two Lake Erie tributaries where Grass Carp are spawning. Investments by Michigan and Ohio, along with USGS and USFWS, have led to a better understanding of Grass Carp movements that led to improved action strategies. In 2016, Michigan DNR, collaborating with Ohio DNR, OMNRF, Fisheries and Oceans Canada, USGS, and USFWS, initiated development of an Adaptive Management Framework for Grass Carp Control in Lake Erie to inform the identification, prioritization, selection, and sequencing of key strategic actions. This information has led the binational LEC, comprised of fishery managers from Michigan, Ohio, Pennsylvania, New York, and Ontario, and supported by Canadian and U.S. federal agencies, to adopt a 5-year adaptive response strategy to reduce the threat of Grass Carp to Lake Erie through common and coordinated efforts.

Efforts to respond to Grass Carp threats support the coordinated and cooperative fishery management conducted by agencies signatory to "*A Joint Strategic Plan for Management of Great Lakes Fisheries",* and the goals and objectives of the *"Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the U.S."* These efforts are further supported by the Great Lakes AIS Early Detection program, conducted by USFWS in collaboration with State and Federal agency partners to provide targeted surveillance for non-native species (including Grass Carp) in the at-risk locations within the U.S. waters of the basin. Since 2016, a combination of research and agency removal actions has identified key areas on which to focus to best reduce the threat of Grass Carp to Lake Erie, while also increasing agency understanding that should improve future response efforts. Based on this experience and increased information about Grass Carp, the LEC recognizes that dramatically increasing the number of strike (or response) teams to target removal of adult Grass Carp and adding an additional egg sampling team to assess the risk of reproduction in other Ohio tributaries are essential elements of its 5-year adaptive response strategy.

State, provincial, and federal agencies from both Canada and the U.S. have collaborated to develop and implement Grass Carp techniques for removal of Grass Carp in Lake Erie. In 2020, seven

strike teams were available through GLRI funding, and the Congressional appropriation to the GLFC for $1 million. The LEC believes that maintaining strike teams is its highest priority as it seeks to meet its goal of removing 390 Grass Carp annually, and that funding proposed for FY 2021 can increase the total number of strike teams to 10.

A second priority, to evaluate the feasibility of a seasonal barrier in the Sandusky River, is currently underway. The third priority of the LEC is to reduce critical uncertainties to provide key data needs to comprehensively develop and evaluate Grass Carp monitoring strategies for the Lake Erie basin. Key activities that will help the LEC reduce uncertainties about where and when to target removal include maintaining support for real-time receivers, additional sampling for eggs in Ohio tributaries, and expanding telemetry coverage to improve its understanding of Grass carp movement patterns.

The increased removal effort, coupled with research into additional control strategies, is focused on increasing the ability of agencies to control the Grass Carp population in Lake Erie. Research conducted by USGS will provide additional assistance to ongoing management activities.

The following are actions that will be undertaken in FY 2021:

USGS

- **Grass Carp Spawning Event Prediction Tool**. USGS will begin development of a Decision Support Tool for resource management agencies to guide the efficient deployment of a limited number of strike teams for the collection of adult Grass Carp and Grass Carp ichthyoplankton in known spawning tributaries of Lake Erie in the State of Ohio. This project will result in the ability of management agencies to make informed decisions about when and where to deploy Grass Carp strike teams and prevent Asian Carp from becoming established in the Great Lakes by providing advanced warning of spawning events and identifying events and locations where strike teams can have the greatest impact on Grass Carp populations in Western Lake Erie.
- **Identification of Optimal River Conditions for Spawning and Recruitment of Invasive Carps in Tributaries of the Western Basin of Lake Erie.** Working with NOAA, USGS will use existing models to simulate the drift of eggs and larvae of Asian carp in tributaries to the Great Lakes, specifically the Maumee River, in 2021. This project will result in the identification of optimal river conditions for spawning and recruitment of Grass Carp in tributaries of the Western Basin of Lake Erie and prevent them from becoming established in the Great Lakes by providing information about the conditions that promote recruitment and population growth of Grass Carp in tributaries and using this information to better inform future control efforts.
- **Evaluation of Bait and Attractants to Increase Aggregation and Harvest of Grass Carp in the Lake Erie Basin.** USGS will test the usage of Grass Carp attractants and baits for enhancing removal efforts in the Sandusky River, Ohio and Plum Creek, Michigan. This project will result in increased harvest of Grass Carp and prevent them from becoming

established in the Great Lakes by reducing population size and supporting groups monitoring the leading edge of the invasion front.

- **Improve Control Efficiency through Better Understanding of Grass Carp Movements and Habitat Use.** USGS will provide information on when and where invasive Grass Carp can be most effectively targeted by fishery management control efforts in Lake Erie. This project will result in a comprehensive understanding of seasonal movements and habitat use of Grass Carp and prevent them from becoming established in the Great Lakes by better informing current control efforts.
- **Identifying Spawning Tributaries and Specific Spawning Areas of Grass Carp**. USGS will identify Great Lakes rivers in which Grass Carp spawn and specific locations within those rivers where spawning occurs in Ohio and Michigan tributaries to the Great Lakes. This project will result in an identification of tributaries in which invasive Grass Carp are spawning and locations of specific spawning areas within those tributaries and prevent Grass Carp from becoming established in the Great Lakes by providing managers with information needed to capture adult Grass Carp and initiate efforts to prevent their spawning.

USFWS

USFWS will continue to provide field crews, including strike teams and vessel support, to state, federal, and university partners working to implement Grass Carp response actions in Lake Erie. Grass Carp response priorities include:

- Provide field crews, vessel support, and laboratory assistance to project partners working to implement Grass Carp response actions in Lake Erie and connecting waters. USFWS will support research/management priorities of the LEC, identified by the Lake Erie Grass Carp Working Group, and described in the Lake Erie Grass Carp Response Strategy (2019-2023).
- Response priorities will be to: (1) deploy two field crews, (2) implement/evaluate innovative control actions for Grass Carp, (3) use real-time telemetry detections of Grass Carp to inform planning/implementation of response actions, (4) support modeling/telemetry efforts under the direction of the Lake Erie Grass Carp Working Group, (5) collect blood samples for ploidy analysis of Grass Carp captures, and (6) excise aging structures from Grass Carp and serve as a second reader to validate age estimates.
- Research priorities will be to: (1) continue to support projects identified by the Lake Erie Committee, (2) assist with implementation of USGS Grass Carp bait/attractant aggregation study, (3) assist with implementation of mobile VEMCO Positioning System array study to track fine-scale movements of Grass Carp during response actions, and (4) conduct a study aimed at evaluating alternative electrofishing settings used to induce a capture-prone response of adult Grass Carp in the Sandusky or Maumee rivers, Ohio using Smith-Root Apex boat electrofishers.

Ohio DNR

In 2021, Ohio DNR is proposing to combine previous knowledge with additional information gained to further refine when and where Grass Carp response actions can be most effective for control/eradication through the following:

- In partnership with the University of Toledo, deploy four Grass Carp Strike Teams.
- Use real-time telemetry detections to evaluate catchability and capture rates.
- Continue to support modeling efforts through University of Toledo and Michigan State University to increase collection efficiency, determine effectiveness in removal, and better estimate population size.
- Ohio DNR is undertaking a feasibility study of a Grass Carp barrier on the Sandusky River, Ohio.

Michigan DNR

Michigan DNR will support a Michigan Grass Carp response team that will implement the following actions:

- Implement and evaluate innovative control actions for Grass Carp.
- Conduct random and fixed-site monitoring to track population trends.
- Use real-time and active telemetry detections to estimate catchability and capture rates of untagged fish (i.e., "Judas fish" approach) and determine if active tracking of tagged fish can increase removal rates.

The Grass Carp response crews will collaborate with USGS partners to evaluate the use of the bait and attractants to increase Grass Carp Capture rates. A study design was developed for implementation in 2020, however the efforts were postponed until 2021 due to COVID-19 delays.

3.7 Communication/Education/Stakeholder Engagement

ACRCC communication efforts are organized by the partnership's CWG, which is co-chaired by USFWS and Illinois DNR. The CWG is comprised of communication specialists from each partner agency and serves the essential function of coordinating messaging and communications in a complex multi-agency response and management setting.

A primary component of the ACRCC's communications approach is the website, AsianCarp.us. As the site administrator, USFWS organizes content and leads website development efforts. In 2020, USFWS continued efforts to make website content compliant with Section 508 of the Rehabilitation Act (29 U.S.C. § 794d). New content included announcements provided by ACRCC partners and partnership updates on behalf of the ACRCC co-chairs regarding COVID-19. In 2021, USFWS will grow the utility of the website in accordance with the 21st Century Integrated Digital Experience Act and continue efforts to make digital communication products compliant with Section 508. Additionally, the CWG will amplify storytelling on AsianCarp.us to highlight

ACRCC partnership work across agencies. Overall, the website continues to consistently generate traffic and attract new users interested in the Asian carp issue.

Communication work will continue in 2021 to provide the ACRCC with enhanced virtual outreach support amplified in 2020 by the outbreak of COVID-19. Due to the ongoing pandemic, the ACRCC is forgoing in-person meetings and events. In their place, the ACRCC is using virtual meeting platforms to share Asian Carp Action Plan accomplishments with members of Congress, the media, partners, industry, and the public. The CWG will provide enhanced assistance and coordination in the scheduling and planning of these events.

In 2021, targeted ACRCC communications will continue with:

- Ongoing coordination of partner responses to public, congressional, and media inquiries.
- Continued refinement of the ACRCC's early detection notification protocols.
- Identifying additional communication products and strategies of value through coordination with ACRCC and MRWG co-chairs.
- Creation of ACRCC branded communication products.

Communication efforts will also continue to expand around federal and state actions in the Upper Mississippi River and Ohio River basins, as outlined in the Water Resources Reform and Development Act (2014). Overall, communications work will contribute to key audiences having a greater understanding and appreciation for the ACRCC's purpose, function, current actions, and successes.

4.0 COLLABORATIVE ACTIONS WITHIN THE GREAT LAKES AND MISSISSIPPI RIVER BASINS

The actions of the ACRCC to protect the Great Lakes basin from Asian carp reflect implementation of a broader, national approach to address the threat. The *Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States* (National Plan), finalized in 2007, provided a planning baseline for "step-down" Asian carp management strategies that were subsequently developed and are now guiding partnerships in all major sub-basins within the Mississippi River basin, in addition to the Great Lakes basin. Federal and State agencies and non-governmental partners continue to increase the network of collaboration across jurisdictional and basin watershed boundaries to address the threat on a broader, landscape-scale.

This strengthened coordination supports direction provided by Congress in the Water Resources Reform and Development Act of 2014 authorizing the Director of USFWS to coordinate with the Secretary of the Army, the Director of the NPS, and the Director of the USGS to lead a multiagency effort to address the spread of Asian carp in the Upper Mississippi River basin and Ohio River basin. The Water Resources Development Act of 2020, included within the Consolidated Appropriations Act, 2021, recently broadened the direction on the scope of the interagency coordination on Asian carp to now encompass the entire Mississippi River and tributaries, including the six sub-basins of the river.

Technical assistance, strategic planning and coordination, and other project support is provided by Federal agencies to State and local governments for conducting priority activities designed to slow, and eventually eliminate, the threat posed by Asian carp. In support of these collaborative efforts, agencies are leveraging and applying advances in detection, prevention and control technologies, and implementation strategies realized through the Great Lakes and Mississippi River basin partnerships for use across multiple basins to more cohesively address the risk of Asian carp.

Since 2015, the Mississippi Interstate Cooperative Resource Association (MICRA) has coordinated Asian carp management actions through partnerships of state, federal, and nongovernmental organizations in the Mississippi River basin. These efforts are supported, in part, by additional USFWS resources made available since 2015 to support enhanced coordination, as well as implementation of key projects to address highest-priority management needs (monitoring and assessment, containment, and control), as identified by the partnerships and in support of basin-wide strategies, as described below.

In FY 2020, USFWS continued to collaborate closely with state and federal partners in support of the management goals and objectives in the Mississippi River basin Asian carp management strategies. A focus of activities included targeted monitoring to detect the "leading edge" of advancing Asian carp populations in river systems, the strategic use of contract commercial fishing for population control (including along the "leading edge"), and the development and

testing of fish migration deterrent barrier technologies and implementation strategies. An underlying goal remains protection of the Nation's interconnected watersheds from the risk of Asian carp by detecting, containing, and controlling potential source populations established in large river systems of the Midwest. Technological developments and lessons-learned will be leveraged for use across the basins for an aggressive and coordinated management approach in support of the National Plan.

Collaborative, interagency Asian carp partnerships coordinated through MICRA and USFWS are now in place across the entire Mississippi River basin watershed, including the Upper Mississippi River sub-basin; Missouri River sub-basin; Arkansas-Red-White River sub-basin; Lower Mississippi River sub-basin; Tennessee-Cumberland River sub-basin; and Ohio River sub-basin, including in Kentucky Lake and Lake Barkley.

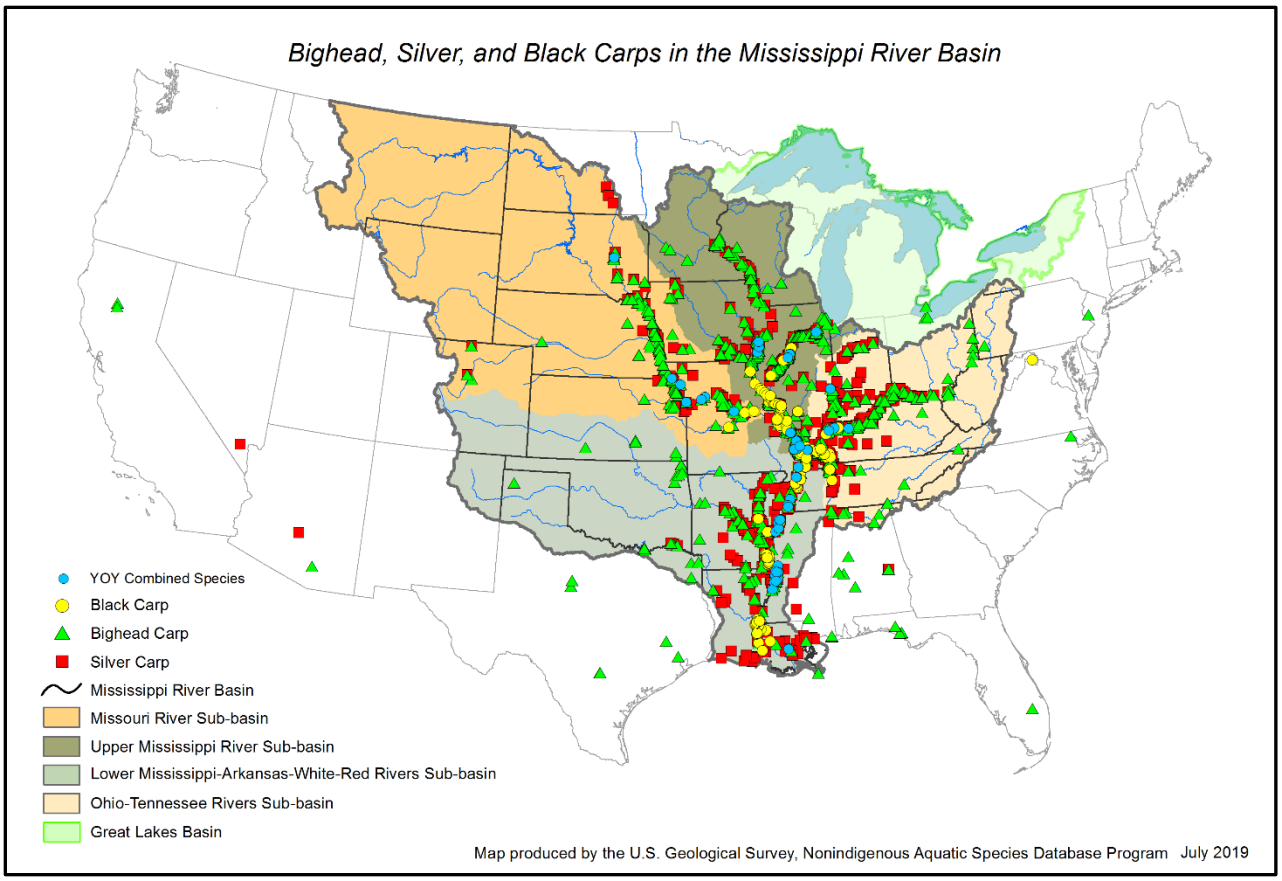


Figure 12. *Reported detections of Bighead Carp, Silver Carp and Black Carp in the Mississippi River Basin.*

Priority efforts in the Mississippi River basin include:

- Expanding collaborative interagency partnerships on Asian carp management in all sub-basins of the Mississippi River basin.
- Enhancing inter-basin collaboration between the Mississippi River basin and the Great Lakes basin.
- Defining distribution of reproduction, recruitment, juveniles, and adults of all four species – fundamental information to make informed management decisions.
- Conducting early detection surveillance and removal of Asian carp in upper reaches to prevent the establishment of reproducing populations.
- Preventing the spread of Asian carp through evaluation of deterrence technologies (e.g. complex sound, manipulation of hydrology at dams) at priority locations.
- Decreasing propagule pressure and reducing impacts of Asian carp by strategically removing them (commercial fishing, contract fishing) and evaluating removal methods.
- Improving management decisions by evaluating the impacts of harvest on Asian carp populations.

A growing number of technologies are now under development or have been proposed for use in controlling or preventing the spread of Asian carp, including Asian carp deterrent barriers that are now being rigorously tested through large-scale field trials at navigation locks in the Cumberland River and Mississippi River. Collaboration across basin boundaries supported the identification and selection of optimal sites for effectively evaluating these potential new technologies in locations where Asian carp are known to be established and migrate, providing for robust testing under "real-world" conditions. While the initial focus of new technologies developed through the Action Plan is on managing Asian carp populations that threaten the Great Lakes, advancements can potentially be leveraged and applied to partnership prevention and control strategies in other basins. Interbasin coordination of Asian carp control and management (including technology development) between the Mississippi River basin and Great Lakes partnerships supports an integrated, landscape-scale approach to addressing the threat, furthering the mission of the ACRCC and the goals of the National Plan.

For more detailed information on Asian carp project coordination and implementation in the Mississippi River basin, see the 2019 MRP for Asian Carp in the Mississippi River Basin at http://micrarivers.org/asian-carp-plans-and-reports/ or http://www.micrarivers.org/wp-content/uploads/2020/05/2019-Monitoring-and-Response-Plan-for-Asian-carp-in-the-Mississippi-River-Basin-1.pdf.

5.0 CANADIAN ASIAN CARP PREVENTION AND EARLY WARNING EFFORTS

Fisheries and Oceans Canada (DFO), the OMNRF, and the Québec Ministère des Forêts, de la Faune et des Parcs (MFFP) are key Canadian Federal and Provincial ACRCC partner agencies working to address the threat of Asian carp to the Great Lakes. Their efforts include policy, management, and scientific oversight of Asian carp actions in the Canadian waters of the Great Lakes and tributaries and represent a critical component to ensuring a basin wide approach to addressing the threat.

5.1 FISHERIES AND OCEANS CANADA

DFO has undertaken a wide variety of efforts to prevent the introduction and establishment of Asian carp (Grass Carp, Black Carp, Bighead Carp, and Silver Carp) in the Canadian waters of the Great Lakes under its Asian Carp Program, which began in 2012. Presented here is a summary of activities conducted in 2020.

5.1.1 Targeted Traditional Gear for Early Warning Surveillance

Since 2013, DFO has implemented an early detection surveillance program for the Canadian side of the Great Lakes and has continued these operations through the 2020 field season (normally May through November). Due to COVID-19, the start of field sampling was delayed until the end of June. Selection of sites was based on those identified as at-risk in Canadian tributaries in the 2011 Binational Ecological Risk Assessment for Bigheaded Carp in the Great Lakes, followed by verification. A reassessment of the sites visited in previous years resulted in the inclusion of 37 sites in total, however, for the 2020 surveillance program, 30 of those sites were surveilled. The focus of surveillance efforts was on the lower Great Lakes regions (Lake Erie and Huron-Erie Corridor) where the most immediate threat of Grass Carp exists, which included seven sites in Lake Huron, eight sites in the Huron-Erie corridor, eight sites in Lake Erie, and seven sites in Lake Ontario. The Asian Carp Program entered into an agreement again in 2020 with the Toronto and Region Conservation Authority to conduct Asian carp early detection surveillance in Toronto area Lake Ontario tributaries and wetlands.

The early warning surveillance field program uses a variety of traditional field gear, including bag seine, boat electrofishing, fyke nets, tied-down gill nets, trammel nets, 4-foot trap nets, and 5-foot and 3-foot hoop nets. New cooperative targeted sampling using gill nets or trammel nets, and electrofishing techniques was incorporated to improve sampling efficiency in blocked off areas. In 2020, the program continued egg and larval sampling using bongo nets. Field work plans extend into the 2021 season and beyond; and new gears will continue to be introduced to the program to complement those currently deployed.

The Asian Carp Program continues to conduct extensive early detection surveillance efforts each year. In 2020, sampling was reduced due to COVID-19. The field season was delayed, and a

reduced crew size was deployed in order to meet new safe work procedures related to physical distancing and other COVID-19 safety protocols. Sampling was conducted in 30 sites however, sampling data has not been entered into the DFO database, so a summary of efforts is not yet available. Bongo sampling was conducted in five tributaries in 2020: Ausable River, Grand River, Sydenham River, Thames River, and Welland River. Species identification will be completed by genetic analysis.

5.1.2 Response

The responsibility for taking action with regard to Asian carp in the Canadian waters of the Great Lakes is shared between DFO and OMNRF. Detections of a live Asian carp triggers ICS led by DFO; OMNRF may participate in the response as deemed necessary. Both agencies work co-operatively to continuously improve response activities and will continue to update protocols based on the experience gained through past responses. An Asian Carp Response Plan was developed using the ICS framework. DFO has also developed the capacity in the Asian carp laboratory for rapid ploidy testing of captured Asian carp in Canada. This capacity allows the program to better understand the level of threat posed by captured individuals and to respond quickly and accordingly. A total of 29 Grass Carp have been captured in Canadian waters of the Great Lakes since 2013. In addition to the four Grass Carp captured during DFO's early detection surveillance efforts (one in 2013, 2014, 2015, and 2020 respectively), 12 more were captured by DFO during response activities and 13 others were detected during this time by commercial fishers, recreational anglers, and other agencies. These Grass Carp captures occurred over 17 events for which response efforts were initiated; 10 of these responses involved on-water operations.

On July 2, 2020 a single Grass Carp (1.058 m in length, 16.324 kg) was captured by DFO crews conducting early detection surveillance in Jordan Harbour. A response using ICS was immediately implemented. Following confirmation that the fish was a diploid female, the ICS operations branch was activated, and continued intensive targeted sampling occurred for an additional four days. The operation ended on July 7, with no additional Grass Carp captured.

Throughout 2020, DFO was committed to respond, in conjunction with its partners, to Asian carp captures in Canadian waters. Response triggers, actions, protocols, and a response database continue to be refined as DFO's experience with responses increases. ICS and response training for DFO included intensive in-class training and on-water training exercises in April 2017 with partners in Ontario and in April-May 2018 with Québec partners. These exercises served to test DFO's Asian Carp Response Plan with partners and observers from other agencies that were present. Future exercises and other training opportunities involving other partner agencies are being explored.

5.1.3 Research Activities

DFO's Asian Carp Program focuses mainly on research related to prevention, early warning, and preparedness for response to potential Asian carp detections in Canadian waters. DFO has partnered with the University of Toronto (Scarborough) to conduct additional research activities. Such work in 2020 has included the following studies:

Native Fish Population Structure. To determine the potential for fishes to move between Lake Erie and Lake Ontario, and thereby bypass Niagara Falls, it was investigated whether populations of seven native fishes are genetically differentiated in habitats above versus below the falls. A state-of-the-art double digest restriction-site associated DNA (ddRADseq), also called ddRAD, method was used for sequencing thousands of loci (range: 6,988–29,421) from throughout the genome of each species and identified from these loci hundreds to thousands (range: 810–13,617) of single nucleotide polymorphisms. These data were used to quantify genetic distinctiveness of populations above versus below Niagara Falls and to test for the magnitude and direction of gene flow past Niagara Falls. Populations of all species (*Ameiurus nebulosus*, *Ambloplites rupestris*, *Catostomus commersonii*, *Micropterus salmoides*, *Moxostoma macrolepidotum*, *Moxostoma valenciennesi*, Perca flavescens) were significantly genomically differentiated above versus below Niagara Falls (Hudson's Fst range: 0.055 in A. nebulosus to 0.359 in *C. commersonii*). Models assuming unidirectional upstream migration past Niagara Falls were supported in all six species investigated (*A. rupestris*, *A. nebulosus*, *C. commersonii*, *M. salmoides*, *M. macrolepidotum*, and *P. flavescens*), although this support was indifferentiable from a no migration model in four species (*A. rupestris*, *C. commersonii*, *M. salmoides*, and *M. macrolepidotum*). Models in which fish migration was restricted to the last 186 years since the first navigation canal past Niagara Falls was completed were universally rejected, suggesting that all signal of gene flow past Niagara Falls is the result of still poorly understood prehistoric hydrologic connections between the Great Lakes. A manuscript reporting results of this research was submitted to the journal Molecular Ecology in February 2019 and was accepted for publication in February 2020.

Lujan NK, Weir JT, Noonan BP, Lovejoy NR, Mandrak NE. Is Niagara Falls a barrier to gene flow in riverine fishes? A test using genome-wide SNP data from seven native species. Mol Ecol. 2020;00:1–15. https:// doi.org/10.1111/mec.15406.

Metabarcoding of Fish Eggs and Larvae. Early life stages of AIS are more numerous and broadly dispersed in the environment than adults – making them ideal targets for early detection – yet precisely identifying freshwater fish eggs and larvae is often impossible using morphology-based methods and traditional molecular identification methods are slow, expensive, and labor intensive. To address these methodological shortcomings, a metabarcoding protocol was developed in which mixed species samples of fish eggs and larvae can be bulk processed with the mitochondrial DNA 'barcode' region being sequenced from all individuals in parallel. Bioinformatics processing allows the resulting DNA sequence data to be matched to a reference

alignment of all potential species in the region, and a list of species present in a given sample to be generated. In 2020, work included: the second batch of samples sequenced, raw sequencing data filtered, and improvements to the bioinformatic pipeline to filter contamination and sequencing errors. There were delays in progress due to COVID-19. Work currently underway involves sequencing samples from Asian Carp Surveillance Program. These samples are anticipated to be sequenced and analyzed by the end of 2020.

Control Technologies. Recent occurrences of Asian carp in the Great Lakes emphasize the urgent need to identify methods to prevent Asian carp establishment and spread. In 2019, field research was conducted in collaboration with the Royal Botanical Gardens to investigate the efficacy of carbon dioxide deterrents in preventing the dispersal of carp into wetland areas. This was the first study to investigate the effects of carbon dioxide on the movement of target and non-target fishes within a realistic environment. A paper was published in 2020.

Bzonek PA, Kim J, Mandrak NE (2020) Short-term behavioural response of common carp, Cyprinus carpio, to acoustic and stroboscopic stimuli. Management of Biological Invasions 11(2): 279–292, https://doi.org/10.3391/mbi.2020.11.2.07

River Modeling. A 3-D hydrodynamic model coupled with a Lagrangian Particle Tracker to simulate Asian carp egg movement in the water column was completed for the Don River. The model was calibrated and validated using the data collected in 2017. Different constant flow scenarios were run to test changes in hatching success across scenarios. Results show that hatching is possible under a wide variety of flow and temperature scenarios. The research has been published (Heer et al. 2019).

A separate model was developed on the Sandusky River in Ohio, where Grass Carp have been observed to be spawning. The model used data collected by the USGS to calibrate and validate water level and velocity throughout the river. The completed model is being validated using 2017 Grass Carp egg capture data provided by the USGS. The model successfully re-creates spawning scenarios that match the egg capture locations and developmental stage of the eggs at the time of capture. Model results indicate that some eggs may be settling in low velocity areas and becoming re-suspended in the water column, which potentially shortens the required distance for spawning and indicates that eggs could successfully hatch in the Lower Sandusky River. This research has been published (Heer et al. 2020a).

Temperature Model. The Sandusky River hydrodynamic model was linked with a temperature model able to incorporate spatial and temporal variation in water temperature, including under climate change scenarios. This model was run to test changes in hatching rates due to variations in temperature. The results of the model are currently under analysis and should be completed in 2020 (Heer et al. in prep; Heer 2020).

Heer, T., M.G. Wells, and N.E. Mandrak. 2019. Assessment of Asian carp spawning potential in tributaries to the Canadian Lake Ontario basin. Journal of Great Lakes Research. 45(6). 1332-1339. https://doi.org/10.1016/j.jglr.2019.09.019.

Heer, T. 2020. Predicting Asian Carp Spawning in Tributaries to the Great Lakes Basin. PhD Dissertation, Department of Physical and Environmental Sciences, University of Toronto, Toronto, ON.

Heer, T., M.G. Wells, N.E. Mandrak. 2020a. Asian carp spawning success: Predictions from a 3-D hydrodynamic model for a Laurentian Great Lake tributary. Journal of Great Lakes Research doi.org/10.1016/j.jglr.2020.07.007

Heer, T., M.G. Wells, P. R. Jackson, and N.E. Mandrak 2020b. Modelling Grass Carp egg transport using a 3-D hydrodynamic river model: The role of egg retention in dead zones on spawning success. Canadian Journal of Fisheries and Aquatic Sciences 2020. Modelling Grass Carp egg transport using a 3-D hydrodynamic river model: The role of egg retention in dead zones on spawning success. Can. J. Fish. Aqu. Sci. (77(8): https://doi.org/10.1139/cjfas-2019-0344

Heer, T., M.G. Wells, N.E. Mandrak (in prep). Grass Carp hatching rates from a coupled 3-D temperature and hydrodynamic model.

Spawning Suitability. A preliminary assessment of the suitability for Asian carp spawning of eight Great Lake tributaries in the Toronto area was completed in 2017. Mean daily temperature and velocity from 2009-2014 was provided by the Toronto and Region Conservation Authority (TRCA), which informed a decision tree to determine suitability. Suitability was determined based on estimates of spawning time, distance of spawning, and minimum flow spikes required for spawning. Six of the eight tributaries were found to be suitable in at least one year over the study period and two tributaries were suitable on average. This highlighted previously unexplored interannual variation in suitability and provided tributaries to further investigate using river modelling. The method can be used on other tributaries where suitable data exist. A manuscript has been prepared and was accepted and posted online. It can be found in the December 2019 issue (Volume 45, Issue 6) of the Journal of Great Lakes Research.

Heer, T., Wells, M.G., Mandrak, N.E. 2019. Assessment of Asian carp spawning potential in tributaries to the Canadian Lake Ontario basin. Journal of Great Lakes Research. https://doi.org/10.1016/j.jglr.2019.09.019

5.1.4 Ecological Risk Assessment for Grass Carp

A binational ecological risk assessment for Grass Carp in the Great Lakes basin was released in January 2017. The assessment documents that Grass Carp have been found in Lakes Michigan, Erie, and Ontario, and summarizes the potential ecological consequences over the next 50 years, which in most of the Great Lakes basin could be extreme. Should Grass Carp become established, wetlands in the Great Lakes basin are particularly vulnerable. The study's findings will inform management and policy decisions with an objective of preventing the survival,

establishment and spread of Grass Carp in the Great Lakes basin on both sides of the border, as well as activities related to prevention, early detection or monitoring, response, and management.

5.1.5 Research to Inform Ecological Risk Assessment for Black Carp

As part of the binational ecological Black Carp risk assessment, DFO conducted research on the potential arrival, survival, establishment, spread, and impact of Black Carp in the Great Lakes. A movement model was used to assess the likely timeline of spread through the Mississippi basin to entry points near the Great Lakes. A temperature- and size-based model was developed to assess the overwinter survival of young-of-the-year Black Carp, as well as the suitability of spawning tributaries throughout the basin. A population model was used to understand the relationship between propagule pressure and establishment, including the likely timeframes of spread among suitable tributaries and lake basins. The model predicted the extent of spread in the Great Lakes within 1, 5, 10, 20, 35 and 50 years using the CAWS and the Maumee River as arrival points. A series of prey layers were developed that incorporated native unionids, gastropods, and dreissenids, which were used to develop a Black Carp bioenergetics model to evaluate where Black Carp could establish populations, based on food availability. The magnitude of impact of different densities of Black Carp on the Great Lakes fish community and native unionids was assessed using a food web approach and linear inverse models. Together, this research provides scientific information to inform the Black Carp risk assessment (described below) that will be completed spring 2021.

5.1.6 Ecological Risk Assessment for Black Carp

A binational ecological risk assessment for Black Carp in the Great Lakes basin is nearing completion, with modelling and writing complete. Research and other data are being used to inform a risk assessment team composed of DFO, GLFC, USGS, and USFWS. The draft risk assessment was presented at a Canadian Science Advisory Secretariat meeting for a face-to-face peer review by a variety of invited binational experts, with a peer-review date of December 4-6, 2018. The risk assessment will also be in the U.S. federal review process within the USGS. When it is finalized, the risk assessment results and information will be presented to Great Lakes managers on both sides of the border and will form valuable science advice for prevention, early detection or monitoring, response, and management activities.

5.1.7 Outreach and Education

DFO has undertaken a variety of outreach activities to prevent the introduction and establishment of Asian carp in Canadian waters. In 2020, DFO continued engagement with Ontario's Indigenous communities that are considered to be in high risk areas along the Great Lakes. Since November 2019 (last reporting), DFO has had three in-person engagement sessions, reaching eleven First Nation communities and the Metis Nation of Ontario.

In 2020, DFO produced a short documentary-style film about the threat of Grass Carp and one vignette-style film featuring a DFO biologist and her perspective of the threat of Asian carp; these films were released in the summer of 2020 and are available at DFO's YouTube channel and posted on the asiancarp.ca website. DFO is also working on three additional vignette-style short films featuring four different perspectives of the threat of Asian carp in Canada. In addition, DFO is also working on the following outreach initiatives in 2020 and early 2021:

- Development of four presentation decks that focus on four different audiences: Indigenous communities, anglers, youth, and the general public. Completed winter 2020-21.
- Development of an image recognition model and mobile application for both IOS and Android devices to assist anglers with a suspected Asian carp capture as well as assist in the reporting of Asian carps that are identified by the model/app. Completion is anticipated to be late 2021 or early 2022.
- Installation of Asian carp signage at public and private boat launches that DFO's early detection surveillance crews use each year. This will enhance outreach to water users in and around Lakes Ontario, Erie, Huron, and the Huron-Erie corridor. Completed fall 2020.

In partnership with three non-governmental organizations, the Ontario Federation of Anglers and Hunters (OFAH), the Invasive Species Centre (ISC) and the Toronto and Region Conservation Authority (TRCA), DFO is implementing outreach and education to stakeholders and the public in Canada. Contribution Agreements between DFO and the ISC, the OFAH and the TRCA were in place throughout 2020.

In 2020, the ISC continued to manage the asiancarp.ca website as well as carpeasiatique.ca, its French language counterpart. ISC also: hosted two public information sessions, one in Windsor in March 2020 and one online (virtual session) in October 2020 for anglers; hosted two partnership meetings with the Asian Carp Canada partners (one in-person and one via teleconference); ran several social media campaigns; hosted three informational webinars; and pursued some of the recommendations of DFO's Gap Analysis, including collaborating with a social media influencer and a fishing website/mobile application.

The OFAH, despite challenges due to COVID-19, have conducted significant work on outreach and education in 2020. This includes running three separate stories on Asian carp in Ontario Out of Doors magazine digital print; participating in two public panel discussions (in-person and virtually); hiring a new outreach liaison to adapt our classroom education to a digital format where teachers can ask for pre-recorded presentations or can request live presentations. Working with partners, the OFAH produced a new Grass Carp ID factsheet that will also be translated to simplified and traditional Chinese. This factsheet was sent to approximately 47,000 OFAH members via an e-blast and resulted in a one-hour long podcast with Blue Fish Radio out of Ottawa, ON where OFAH staff discussed Grass Carp and their current status in Ontario's waters.

OFAH continued to have a strong presence on social media and have reached over 150,000 people with content related to Asian carp. OFAH have had close to 500,000 visits to www.invadingspecies.com, including approximately 9,000 visits to their Asian carp page, wherein the new Grass Carp identification factsheet has been downloaded 2,300 times since being added to the website. In addition, OFAH submitted abstracts in partnership with ISC and have subsequently presented at North American Invasive Species Management Association and Upper Midwest Invasive Species Conference in the fall of 2020. The OFAH continues to deliver the centralized reporting system in Ontario that consists of the Invading Species Hotline and the Early Detection and Distribution Mapping System (EDDMapS). As of October 29, 2020, the OFAH has received 38 reports of Asian carps, with one confirmed detection in May 2020.

The TRCA distributed 1000 printed copies of the Asian Carp information sheet to local fishing stores and made them available at TRCA-managed fishing locations. Asian Carp Education Resource kits were produced and associated with a lesson plan to use with school groups, public programs, and family audiences in the Toronto area. The kit was also used at Tommy Thompson Park through virtual education programs and summer camps and was available at the Tommy Thompson Park Nature Centre. Two pre-recorded videos focusing on Asian carp were developed and made available through their Facebook account. In addition, TRCA distributed educational information to residents through its Community Learning electronic newsletter and TRCA staff participated in the ACC Public Information Session (Windsor, Ontario in March) and the Royal Ontario Museum – Partners in Protection Program.

Since December 2015, the Biodiversity Gallery at the Royal Ontario Museum has educated the public through information provided through a display, video, and touchables (such as a rubberized Grass Carp, pharyngeal teeth, and skeletons) which are geared toward educating children on the threat of Asian carp. The Royal Ontario Museum sees 7,000 to 8,000 daily visitors.

5.1.8 Enforcement

The Canadian Federal Government's national AIS regulations came into effect in the summer of 2015. These regulations prohibit the import, transport, possession, sale, and control of high-risk AIS. These regulations complement provincial regulations and strengthen Canada's collaborative ability, along with the U.S., to protect the Canadian waters of the Great Lakes from AIS, including Asian carp. DFO continues to gather data on current live trade of Asian carp through a newly implemented joint project (Single Window Initiative) between DFO and the Canada Border Services Agency. This information will be used to provide support to enforcement agencies in both Canada and the U.S. to prevent movement of live Asian carp through trade, and potential introduction into the Great Lakes. In April 2019, new resources were provided within DFO for more on the ground enforcement of the AIS regulations.

5.2 ONTARIO

OMNRF has the lead provincial role in preventing the introduction, establishment, and spread of AIS and their negative effects on Ontario's environment, economy, and society. OMNRF's responsibilities include:

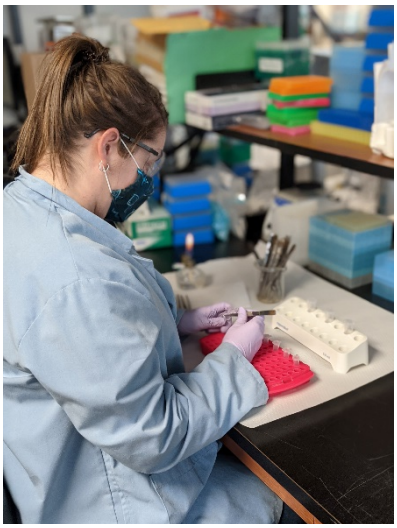
5.2.1 Surveillance and Monitoring

OMNRF continued its monitoring activities in 2020 for the Canadian waters of the Great Lakes and their tributaries. Efforts focused on monitoring and assessment on Lake Erie and its tributaries, Lake St. Clair, and southern Lake Huron. eDNA is a key technique used for monitoring in these locations. In 2020, 89 sites were sampled in the Great Lakes watershed for eDNA. The start of eDNA field sampling was delayed in 2020, therefore each location was only sampled once. Three samples were collected during each sampling event for a total of 267 water samples collected by OMNRF field staff and analyzed by the OMNRF Aquatic Genetics Laboratory, located at Trent University. There were no positive detections for any Asian carp species in 2020. Surveillance plans for 2021 are currently being developed by OMNRF.

OMNRF also conducts a variety of fisheries assessment programs throughout the Canadian waters of the Great Lakes and their tributaries. These programs are used to assess the status of sport and commercial species as well as the prey fish that these fisheries rely on. Asian carp may be encountered through the course of these activities if they are present. In addition, OMNRF has a close relationship with commercial fishers and recreational angling organizations. These stakeholders are well informed of concerns regarding Asian carp and contact OMNRF and its partner agencies when they encounter suspect fish. No Asian carp were reported through these other activities in 2020.

5.2.2 eDNA Research

OMNRF eDNA research has focused on quantifying sensitivity and specificity of eDNA assays, discriminating between detection failure and true absence, as well as testing and validating other eDNA markers and systems. Experimental eDNA trials with noninvasive species are being used to confirm taxonomic specificity and the spatial, temporal, and quantitative sensitivity of eDNA detection. OMNRF research has validated markers for all four species of Asian carp, enabling surveillance for Black Carp, Bighead Carp, Silver Carp, and Grass Carp. A 'round-robin' blind validation of Grass Carp primers and probes with Quebec and USFWS labs is assessing the repeatability and sensitivity of each group's detection assay; completion of this project has been delayed at the



Samples collected for eDNA analysis being processed at the OMNRF Aquatic Genetics Laboratory, located at Trent University (Photo credit: Naomi Leck, OMNRF)

collaborating labs. Ongoing research is assessing the sensitivity and cost-effectiveness of community eDNA metabarcoding for species detection. Several assay target regions are being tested for taxonomic breadth and sensitivity. Analysis pipelines are also being developed and validated for processing eDNA metabarcoding to facilitate rapid detection of Asian carp eDNA as well as for other aquatic invasive species.

5.2.3 Asian Carp Response Plan

OMNRF has a provincial Asian Carp Response Plan, established in partnership with DFO. The Asian Carp Response Plan outlines procedures for implementation of an agency response if Asian carp are detected in Ontario waters. The province has undertaken several simulation exercises to test the plan and improve agency-wide preparedness. In April 2016, OMNRF participated in the on-water response exercise led by DFO to test coordination between the agencies. OMNRF and DFO have also field tested the plan, in conjunction with other partners, in response to actual captures of Grass Carp in the Ontario portions of Lakes Ontario, Erie, and Huron. Based on additional field experience, new science, and continued coordination with U.S. partners, OMNRF and DFO meet annually to review, and if necessary, refine and improve this response plan.

5.2.4 Outreach Activities

The Ontario-wide Invading Species Awareness Program has been a partnership initiative of the OMNRF and OFAH since 1992. The program focuses on the promotion of public awareness and preventing the spread of invasive species. The program is also designed to track and monitor the occurrence and distribution of invasive species, including Asian carp. The program includes a toll-free hotline (1-800-563-7711) and website (www.invadingspecies.com) hosted by OFAH, as well as a web-based reporting and tracking system called EDDMapS Ontario, which also has a mobile app for Apple and Android devices. EDDMapS Ontario is designed to allow users to quickly view and report invasive species sightings. All potential reports of Asian carp received by OFAH or through EDDMapS Ontario are sent to OMNRF and DFO for identification and possible response. OFAH conducts extensive outreach with anglers and provides materials that help anglers discriminate between Asian carp and other native species.

As part of the province's cooperative efforts with commercial fishers, specific Asian carp outreach materials have been provided to commercial fishers to assist in identification and reporting. OMNRF has received several Grass Carp captured by commercial fishers the past few years as a result of this additional outreach. As well, reports of other non-native species captures have been received through this valuable partnership.

OMNRF has developed additional partnerships, including the Invasive Species Centre, to deliver various AIS programs across the province, including outreach, communications, and the development of best management practices. The Invasive Species Centre is a hub of collaboration and knowledge sharing. The mission of the Invasive Species Centre is to connect

stakeholders, knowledge, and technology to prevent and reduce the spread of invasive species. The Invasive Species Centre supports research, management, and policy for a wide range of invasive species, including invasive fishes such as Asian carp.

5.2.5 Regulations

In 2005, Ontario made it illegal to possess live Asian carp. In 2015, Ontario enacted standalone invasive species legislation, the Invasive Species Act, which came into force in November 2016. This Act regulates all four species of Asian carp. Possessing, transporting, propagating, buying, selling, leasing, trading, and bringing Asian carp into Ontario is prohibited, unless the fish are dead and eviscerated. The Act also provides a suite of provincial tools that allow Ontario to take action, while continuing to work with partners and complementing the role of the Canadian federal government, including:

- Providing a strong legislative framework to better prevent, detect, rapidly respond to, and, where feasible, eradicate invasive species.
- Promoting shared accountability for managing invasive species.
- Holding those responsible accountable for costs of control and eradication through strong penalties and cost recovery of expenses for managing invasive species.
- Using a risk-based approach that considers the full range of threats, costs, and benefits to the environment, society, and the economy.

5.2.6 Enforcement

Compliance priorities for OMNRF's Enforcement Branch are based on several factors including risk assessments and progress made towards meeting ongoing compliance goals. One of the top priorities continues to be aquatic invasive species, including Asian carp. Enforcement Branch continues to build staff, public, and market awareness of aquatic invasive species rules with a focus on the following industry pathways:

- Live baitfish
- Pet and aquarium suppliers
- Water garden suppliers
- Live food fish

In the past, OMNRF's Enforcement Branch led the development of a brochure to raise public and industry awareness of invasive species rules. As a sequel to this, in 2020, a small flyer was produced with messaging to accompany Conservation Officers checking bait buckets, boats, and live wells, as well as providing information about what people can do to help prevent the spread of invasive species. The flyer is used in certain circumstances to assist officers in communicating information. Conservation Officers will continue to inspect anglers at road check stations, boat launches, and on inland waters for compliance with rules related to the harvest, possession, transport, use, and disposal of baitfish.

Additional training is being developed for Conservation Officers on identifying aquatic invasive species and on legislation relevant to preventing the spread of invasive species. The training is planned for live delivery through an online platform in 2021.

5.3 QUÉBEC

Among its mandates, the Québec MFFP is responsible for the development and conservation of aquatic wildlife resources. It includes prevention, monitoring, and control of AIS. To fulfill these mandates, the Québec Government initiated an Asian Carp Program in April 2016. The main objectives of this provincial program are to develop an expertise on Asian carp, to create and maintain collaborative works with DFO, OMNRF, and American governmental agencies. In addition, important efforts are dedicated within the province of Québec toward surveillance, research, risk assessment, outreach, and regulation/law enforcement.

5.3.1 Asian Carp Status in Québec

In May 2016, a commercial fisherman targeting Common Carp caught a Grass Carp in the St. Lawrence River near Contrecoeur (45.8469, -73.2673) using large mesh-sized gillnets (11.5 inches stretched mesh). The Grass Carp captured was a 9-year old diploid female measuring 1.26 meters and weighting 29 kilograms. Analyses of otolith chemistry revealed that this fish was likely born in the wild and according to the strontium to calcium ratios, the fish lived its first four years of life in a relatively stable habitat before making numerous movements between water masses with contrasting chemistry. In addition, stable isotopes analyses in the otolith as well as different parts of the fish (vertebrae, muscle, liver, blood, scale) indicate the Contrecoeur Grass Carp appears to have been born and lived in the Great Lakes water mass. A second Grass Carp was captured in the Richelieu River in 2020 by an angler. Environmental DNA surveys conducted since 2015 revealed the presence of Grass Carp genetic material in 43 out of the 1360 sites sampled throughout the St. Lawrence River and some of its tributaries. No positive signals were detected for the Silver Carp and Bighead Carp. Based on the capture of two specimens and the recurrent presence of positive eDNA signals throughout the St. Lawrence, the Grass Carp is considered to be present in the system. Two main colonization routes provided by the hydrological connections are considered (1) the St. Lawrence River and the Great Lakes, and (2) the connected Richelieu River / Lake Champlain / Hudson River systems. However, since Grass Carp eDNA has been observed in a lake unconnected to the St. Lawrence River or its tributaries, other vectors of introduction are present and their importance has to be assessed.

5.3.2 Regulation

Since 2012, the possession of live individuals of the four species of Asian carp is illegal in Québec. The commerce of dead individuals or products derived from these species is still allowed. Regulation respecting aquaculture and the sale of fish (http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/C-61.1,%20r.%207) prohibit aquarium fish keeping, production, keeping in captivity, breeding, stocking, transport, sale, and purchase of all

live fish listed in the schedule IV (http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/C-61.1,%20r.%207). Grass Carp, Silver Carp, Bighead Carp and Black Carp are among the 17 fish and aquatic invertebrate species listed so far. To prevent further spread of Asian carp or other invasive species, the MFFP has recently amended the provincial baitfish regulation. Since April 2017, it is now completely forbidden to use live fish as bait throughout the province of Québec. Only dead baitfish are permitted during winter fishing in some specific regions (https://mffp.gouv.qc.ca/english/publications/online/wildlife/fishing-regulations/general-regulations/bait-fish.asp).

5.3.3 Surveillance Activities

eDNA Monitoring. Annual eDNA surveys are conducted over a 230 kilometer stretch of the St. Lawrence River, from Lake Saint Francis downstream to Lake Saint-Pierre. Surveys also target the Richelieu River, a tributary connecting the St. Lawrence River to Lake Champlain. In 2015 and 2016, a total of 110 stations were sampled, and sampling effort has increased to reach 480 stations per year in 2019. Sampling sites are determined according to the presence of potential habitats for Grass Carp, areas where positive detections occurred in previous years. In addition to the 16 positive sites for 2015-2016, Grass Carp DNA was detected at 11 sites out of 323 in 2017, 2 out of 360 in 2018, and 13 out of 483 in 2019. Analysis of samples taken in 2020 is still underway.

Traditional Gear Sampling Surveys. A dedicated survey targeting Grass Carp has been in place since May 2017. The major technique employed is herding fish in gillnets or trammel nets using one electrofishing boat (similar as in Marson et al., 2016) and using electrofishing transects. Approximately 30 days per year are dedicated to the capture of Grass Carp between May and September. No Grass Carp have been caught to date during fishing surveys; the MFFP is working to improve the fishing techniques employed as well as better selecting sampling sites and periods targeted for fishing. A part of these actions is conducted in collaboration with agencies working on Grass Carp surveillance and monitoring surveys.

Ichthyological Surveys as a Surveillance Tool. All MFFP crews working in lakes and fluvial sections of the St. Lawrence River are briefed about the possibility that they may catch Grass Carp and other Asian carp. Identification keys and standardized protocols following the capture of Asian carp species were distributed and explained to all MFFP staff. Each year since 1995, the MFFP has implemented a standardized ichthyological survey allowing monitoring of fish diversity, distribution, and abundance throughout the St. Lawrence or the Richelieu River (see Foubert et al. 2018). Field work dedicated for this survey spans over six weeks each year and fish are captured using multi-mesh gillnets and standardized seine nets.

Network for Detection of AIS by Commercial Fishermen. In addition to governmental surveys, commercial fishermen are also contributing to the surveillance of AIS through a volunteer network coordinated by the MFFP since 2003. All the members of the Network for

Detection of AIS by Commercial Fishermen annually receive protocols related to Grass Carp, identification keys and other relevant information. The utility of such a collaborative effort has been proven by the fact that the only wild specimen of Asian carp caught in Québec waters was reported by a member of this network (see Asian carp status in Québec above). Since 2019, a bounty ($200 CAD) is offered for Grass Carp captured by fishermen who are members of the network.

Citizen Collaboration. A provincial protocol to manage public sightings was created in 2017. Every public sighting follows the same standardized process of validation and, if needed, a rapid response. In 2017 and 2018, 46 and 23 observations were reported to the MFFP respectively. Citizens contacted the MFFP mostly through e-mail. The two species misidentified the most frequently as Asian carp were the Common Carp and the Fallfish (*Semotilus corporalis*). However, one valid observation which was reported resulted in the seizure of three live Grass Carp kept illegally in an establishment of Montreal (July 2017). A second, highly likely, observation led to a field operation in May 2018 in order to validate the presence of live Grass Carp in an inland lake. The response action has been realized in collaboration with DFO for the benefit of any future joint action and served as an invaluable opportunity to directly transfer expertise between both agencies in the context of a real-life event.

5.3.4 Outreach

MFFP developed outreach tools with the objective of helping to identify Asian carp and inviting citizens to report their sightings. A flyer presents the four species of Asian carp with identification criteria and facts regarding their biology. Additional species frequently misidentified as Asian carp were included: Common Carp, Fallfish, and Copper Redhorse (*Moxostoma hubbsi*). The latter species is endemic to the Province of Québec and is listed under the federal Species at Risk Act. Citizens are invited to take care to not harm or kill such fish. Flyers and stickers are available in both French and English and are distributed throughout the Province. Information about the Asian carp biology and their impact is also available on the MFFP website (https://mffp.gouv.qc.ca/english/wildlife/fishing/species/asian-carps.jsp).

The MFFP is also collaborating with the Stratégies Saint-Laurent, a local non-governmental organization conducting outreach activities in all administrative regions where Asian carp may be observed by citizens. Information and awareness campaigns are conducted targeting various audiences, with the objective of educating the public on identifying Asian carp, their biology, the ongoing North American invasion, and understanding their impacts on the ecosystems.

5.3.5 Research on Persistence and Spread of eDNA in Natural Systems

MFFP have conducted research in collaboration with Laval University (Québec) to test *in situ* the persistence and spread of eDNA in relation with water masses of St. Lawrence River: brown water from the Ottawa River and blue water from the Great Lakes are flowing side by side with little mixing. Retention cages containing Brown Trout (*Salmo trutta*) or Rainbow Trout

(*Oncorhynchus mykiss*), which are unlikely to be found in the system, are used as proxies for assessing the potential for positively detecting eDNA at various distances from cages (up to 5000 meters downstream). Results are published in Environmental DNA journal (Laporte et al. 2020, https://doi.org/10.1002/edn3.88). More experiments are ongoing or planned in the future to test the capacity to detect Asian carp eDNA under different weather conditions and timespans.

5.3.6 Analysis on Risk of Spread in Inland Waters

An analysis of potential dispersal of Asian carp from the St. Lawrence River toward Québec inland waters have been realized. Aerial photography and satellite imaging were used for the identification and mapping of existing barriers restricting upstream movements. These analyses allow the determination of tributaries at risk of invasion by Asian carp from the St. Lawrence River. The ability to pass nearly 300 potential barriers was assessed by examining the size, the geographical position, and the presence of structures favoring passage of fish (e.g., fish ladders, canals, and locks). The resulting maps cover an area extending from Ontario to the Saguenay River. In a second step, field assessment has been done on around 100 barriers identified in the first analysis in collaboration with local watershed associations. The objective was to validate barrier specifications on-site (e.g. barrier width, length, height) and other variables quantified under natural conditions. An evaluation grid has been developed to quantify the barrier potential to restrain Asian carp dispersal. This grid could be adapted for other AIS or native fishes. This study could be found in a first report (in French), published in 2019 (https://mffp.gouv.qc.ca/nos-publications/risques-de-dispersion-des-carpes-asiatiques-dans-les-tributaires-du-fleuve-saint-laurent/). This analysis will be an important management tool, helping in the planning and prioritizing of monitoring activities as well as in identifying possible sites for implementing mitigation measures such as selective or repulsive barriers.

5.3.7 Actions Planned for 2021

The following activities are planned for 2021:

- Pursuing surveillance activities, outreach, and *in situ* experiments on eDNA persistence and spread.
- Refining of the dispersal analysis using habitat data to include the likelihood for local establishment.
- Experience on the use of ichthyoplankton surveys using plankton tows and DNA metabarcoding as an additional early detection method for Asian carp and other invasive fishes.
- Assessing the legal and illegal markets where Asian carp are distributed and sold in Québec. The release of live fish is recognized as an important vector of AIS introduction and this risk is presently unknown in the Province of Québec. This work will be realized in collaboration with MFFP's Wildlife officers and investigators.

Appendix A

FY 2021 Funding Matrix

FY 2021 Asian Carp Action Plan Funding

No.	Agency	Project Title	GLRI Funding FY 2021 ($)	Agency Funding FY 2021 ($)
Prevention Actions				
P-1	USACE	Electric Dispersal Barriers	$0	$28,383,000
P-2	USCG	Electric Dispersal Barriers and Barrier Operational Risk Assessment	$10,000[1]	$5,000
P-3	USGS	Data Collection at Brandon Road Lock and Dam	$80,000	$0
P-4	USACE	Design of Brandon Road Lock and Dam Aquatic Nuisance Species Barrier	$0	$3,800,000
P-5	USCG	Aquatic Nuisance Species Control Technologies Risk Assessment	$10,000[1]	$5,000
P-6	Ohio DNR	Closure of GLMRIS Connection at Ohio & Erie Canal	$20,100	$0
P-7	Ohio DNR	Closure of GLMRIS Connection at Little Killbuck Creek	$1,596,500[2]	$0
P-8	Illinois DNR	Alternate Pathway Surveillance in Illinois – Law Enforcement	$150,000	$150,000
Control Actions				
C-1	Illinois DNR	Contract Fishing for Asian Carp Detection and Removal	$1,545,000	$0
C-2	Illinois DNR	Asian Carp Enhanced Contract Removal	$866,200	$0
C-3	Illinois DNR	Asian Carp Removal Marketing	$232,100	$0
Early Detection, Monitoring and Evaluation Actions				
M-1	USFWS	Great Lakes Early Detection, Monitoring and Evaluation	$350,000	$1,400,000
M-2	USFWS	Asian Carp Demographics	$475,000	$120,000
M-3	USFWS	Des Plaines River Overflow Monitoring	$15,000	$0
M-4	USFWS	Illinois River Monitoring and Response Team Support	$50,000	$275,000
M-5	USGS	Asian Carp Database Management and Integration Support	$195,000	$228,000
M-6	Illinois DNR	Illinois Waterway Detection, Management and Control, and Contingency Planning for Asian Carp	$3,858,000	$0
M-7	Illinois DNR	Assessment of Asian Carp Reproduction and Ecosystem Response in the Illinois Waterway	$452,000	$0
M-8	Illinois DNR	Asian Carp Stock Assessment in the Illinois River/Management Alternatives	$550,000	$0
M-9	USFWS	eDNA: USFWS Midwest Region Fisheries Program Capacity for eDNA Sampling and eDNA Sample Processing	$0	$2,400,000
M-10	USACE	Telemetry in the Upper Illinois River	$0	$200,000
M-11	USFWS	Telemetry Support for the Spatially Explicit Asian Carp Population (SEACarP) Model	$110,000	$0
M-12	USFWS	Illinois River Hydroacoustics	$125,000	$0
M-13	USGS	Real-Time Telemetry and Multi-State Modeling	$105,000	$104,000
M-14	USFWS	Early Detection of Asian Carp in the Upper Illinois Waterway	$500,000	$600,000

FY 2021 Asian Carp Action Plan Funding

No.	Agency	Project Title	GLRI Funding FY 2021 ($)	Agency Funding FY 2021 ($)
Technology Development Actions				
T-1	USACE	Acoustic Deterrents for Asian Carp	$1,531,700	$0
T-2	USFWS	Acoustic Deterrents for Asian Carp	$1,150,000	$800,000
T-3	USGS	Acoustic Deterrents for Asian Carp	$2,110,000	$472,000
T-4	USACE	Carbon Dioxide Deterrence for Asian Carp	$530,000	$0
T-5	USGS	Implementation and Planning for a Carbon Dioxide Deployment	$100,000	$0
T-6	USGS	Carbon Dioxide Deterrence for Asian Carp	$100,000	$360,000
T-7	USGS	Developing Species-Specific Control Systems for Asian Carp	$0	$890,000
T-8	USACE	Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation	$175,000	$0
T-9	USFWS	Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation	$50,000	$0
T-10	USGS	Prevention of Barge-Induced Transport of Aquatic Nuisance Species	$130,000	$0
T-11	USGS	Science Support for Control Efforts in the Illinois Waterway and Other Priority Sites	$100,000	$75,000
T-12	USFWS	Technology Registration and Environmental Review	$135,000	$15,000
T-13	USGS	Developing Techniques to Remove Large Congregations of Bigheaded Carp in Tailwaters of Strategic Dams	$0	$320,000
Decision Support Actions				
DS-1	NOAA	Modeling Potential for Asian Carp Reproduction, Population Growth, Food Web Effects and Control in Maumee River and Western Basin of Lake Erie	$110,800	$57,321
DS-2	USFWS	Asian Carp Population Modeling to Support an Adaptive Management Framework	$195,000	$100,000
DS-3	USGS	Asian Carp Population Modeling to Support an Adaptive Management Framework	$100,000	$465,000
DS-4	Illinois DNR	Asian Carp Enhanced Contract Removal, Marketing and Assessment and Management: Assessment of Enhancement Efforts	$188,600	$0
Response Action				
R-1	USFWS and USGS	ACRCC Contingency Actions in the Upper Illinois River	$0	$0
Black Carp Actions				
BC-1	USFWS	Black Carp Structured Decision Making, Sampling Improvements, and Genetics Support	$70,000	$120,000
BC-2	USGS	Black Carp Monitoring, Assessment and Control	$450,000	$95,000
BC-3	Illinois DNR	Enhanced Detection of Black Carp in the Lower Illinois River	$188,000	$0
BC-4	USACE-ERDC	eDNA Monitoring for Determining Black Carp Invasion Risk for the Great Lakes	$125,000	$0

FY 2021 Asian Carp Action Plan Funding

No.	Agency	Project Title	GLRI Funding FY 2021 ($)	Agency Funding FY 2021 ($)
Grass Carp Actions				
GC-1	USFWS	Implementation of Adaptive Management Framework for Grass Carp in Lake Erie	$350,000	$380,000
GC-2	USGS	Grass Carp Spawning Event Prediction Tool	$90,000	$0
GC-3	USGS	Identification of Optimal River Conditions for Spawning and Recruitment of Invasive Carps in Tributaries of the Western Basin of Lake Erie	$85,000	$0
GC-4	USGS	Evaluation of Bait and Attractants to Increase Aggregation and Harvest of Grass Carp in the Lake Erie Basin	$125,000	$700,000
GC-5	USGS	Developing Species-Specific Control Systems for Grass Carp	$0	$185,000
GC-6	USGS	Improved Control Efficiency through Better Understanding of Grass Carp Movements and Habitat Use	$200,000	$620,813
GC-7	USGS	Identifying Spawning Tributaries and Specific Spawning Areas of Grass Carp	$200,000	$446,000
GC-8	Ohio DNR	Adaptive Management Framework for Grass Carp in Lake Erie	$500,000[3]	$0
GC-9	Michigan DNR	Implementation of an Adaptive Management Framework for Grass Carp in Lake Erie	$325,000	$150,000
4	GLFC	Grass Carp Control in the Lake Erie Basin	$0	$1,000,000
Communication Action				
Comm-1	USFWS	ACRCC Strategic Communications	$200,000	$100,000
Partnership Operations Actions				
PO-1	USFWS	ACRCC Partnership Operations Assistance	$41,000	$41,000
PO-2	USFWS	Coordination and Facilitation for the Chicago Area Waterway System (CAWS) Aquatic Invasive Species (AIS) Stakeholder Group	$50,000	$0
PO-3	USACE	GLMRIS Program Management	$0	$335,000
TOTAL FUNDING			**$21,000,000**	**$45,397,134**
		Funding carried over into FY 2022[5]	**$2,136,000**	

[1]During the course of FY 2021, USCG determined that was funding not necessary; therefore, this funding was reallocated to support FY 2022 Action Plan priorities.

[2]During the course of FY 2021, Ohio DNR determined that was funding not necessary; therefore, this funding was reallocated to support FY 2022 Action Plan priorities.

[3]During the course of FY 2021, Ohio DNR determined that was funding not necessary; therefore, this funding was reallocated to support FY 2022 Action Plan priorities.

[4]GLFC did not provide a project description for Grass Carp Control in Lake Erie Basin.

[5]To accommodate revised project timelines and other financial management considerations in FY 2021, $2,136,000 of FY 2021 Action Plan GLRI funding was reallocated to support FY 2022 Action Plan priorities.

FY 2021 Asian Carp Action Plan Funding by Agency

Agency	GLRI Funding	Agency Funding
Illinois DNR	$8,029,900	$150,000
Michigan DNR	$325,000	$150,000
NOAA	$110,800	$57,321
Ohio DNR	$2,116,600*	$0
GLFC	$0	$1,000,000
USACE	$2,361,700	$32,718,000
USCG	$20,000*	$10,000
USFWS	$3,866,000	$6,351,000
USGS	$4,170,000	$4,960,813
TOTAL	$21,000,000	$45,397,134

**$2,136,000 was carried over into FY 2022*

Appendix B

FY 2021 Actions

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Appendix B Acronym List

Acronym	Definition
ACRCC	Asian Carp Regional Coordinating Committee
ADS	Acoustic Deterrent System
AIS	Aquatic Invasive Species
ANS	Aquatic Nuisance Species
BAFF	Bio-Acoustic Fish Fence
CAWS	Chicago Area Waterway System
CGRDC	Coast Guard Research and Development Center
CO_2	Carbon Dioxide
CO_2-Carp	Carbon Dioxide – Carp
CPO	Conservation Police Officer
CRP	Contingency Response Plan
CSSC	Chicago Sanitary and Ship Canal
DST	Decision Support Tool
EDBS	Electric Dispersal Barrier System
eDNA	Environmental Deoxyribonucleic Acid
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FY	Fiscal Year
GLATOS	Great Lakes Acoustic Telemetry Observation System
GLFC	Great Lakes Fishery Commission
GLMRIS	Great Lakes and Mississippi River Interbasin Study
GLRI	Great Lakes Restoration Initiative
IBM	Individual-Based Bioenergetics Model
Illinois DNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environmental Protection Agency
Indiana DNR	Indiana Department of Natural Resources
INHS	Illinois Natural History Survey
ISU	Invasive Species Unit
IWW	Illinois Waterway
JSP	Joint Strategic Plan for Management of Great Lakes Fisheries
KDFWR	Kentucky Department of Fish and Wildlife Resources
kHz	kiloHertz

Appendix B Acronym List (Continued)

Acronym	Definition
LBA	Longitudinal Bubbler Array
LEC	Lake Erie Committee
LTRM	Long-Term Resource Monitoring
MI EGLE	Michigan Department of Environment, Great Lakes & Energy
Michigan DNR	Michigan Department of Natural Resources
Minnesota DNR	Minnesota Department of Natural Resources
Missouri DC	Missouri Department of Conservation
MRP	Monitoring and Response Plan
MRWG	Monitoring and Response Work Group
NER	National Ecosystem Restoration
NOAA	National Oceanic Atmospheric Administration
New York DEC	New York Department of Environmental Conservation
Ohio DNR	Ohio Department of Natural Resources
OPMS	Online Program Management System
QFC	Quantitative Fisheries Center
SDM	Structured Decision Making
SEACarP	Spatially Explicit Asian Carp Population
SIM	Seasonal Intensive Monitoring
SIU	Southern Illinois University
SOP	Standard Operating Procedures
Tennessee WRA	Tennessee Wildlife Resources Agency
U.S.	United States
uADS	Underwater Acoustic Deterent System
USACE	U.S. Army Corp of Engineers
USCG	U.S. Coast Guard
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

P-1 Electric Dispersal Barriers

Lead Agency: USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$28,383,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project continues the operation of the EDBS in the CSSC. In FY 2021, funding will be used for operation of the EDBS and performance verification and safety testing of Permanent Barrier I, which is a prerequisite for the full-time operation scheduled to occur by the end of FY 2021.

Project Description:

USACE has operated electric barriers in the CSSC since 2002. Over the years, several operational and procedural improvements have been implemented to improve the effectiveness and to continuously deliver an uninterrupted flow of electricity to the water to deter fish.

In 2004, USACE initiated the construction of Barrier II. Barrier II, which is located 800 to 1,300 feet downstream of Barrier I, also uses a pulsed electric field but includes several design improvements identified during the monitoring and testing of Barrier I, including the use of 5-inch x 5-inch steel billets for the electrodes instead of cables. The steel billets were projected to have a life span of 25 years. Barrier II can generate a more powerful electric field over a larger area and was implemented in two halves, known as Barriers IIA and IIB. Barrier IIA began full-time operation in 2009. Barrier IIB became fully operational in 2011.

All construction activities for Permanent Barrier I have been completed. Performance verification and safety testing will be completed in the second quarter of FY 2021, which is a prerequisite for the full-time operation scheduled to occur by the end of FY 2021.

P-2 Electric Dispersal Barriers and Barrier Operational Risk Assessment

Lead Agency: USCG

Agency Collaborators: USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$10,000**	$5,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

***USCG determined funding not necessary; funding carried over into FY 2022.*

Project Summary:

This project will ensure all marine safety measures are in place for the operation of the electric dispersal barriers. As part of the project, a FY 2021 Safety Testing Report and a Marine Safety Risk Assessment will be developed.

Project Description:

The EDBS creates a significant electric field in the water and along the shore (an "electrified zone") that presents hazards for vessel navigation and human activity. To minimize separate USACE and USCG tests and experiments, the USCG Research and Development Center works with USACE ERDC Construction and Engineering Research Laboratory to maximize commonality in safety test development and field measurement research. This includes testing and designing field tests to determine changes in the electric field associated with the CSSC barrier system and the implicit change in marine safety risk.

When operations associated with the electric dispersal barriers, rapid response actions, research projects, or any other Asian carp activity will impact the flow of traffic on a navigable waterway, the USCG issues a safety zone and provides notice to the public and mariners to inform them of the planned activities and expected impact on navigation. If a partial or full waterway closure is required, the USCG or other agencies may need to deploy small boats, personnel, and/or obtain resources (i.e. temporary mobile command post), and/or mission support services on scene to enforce the waterway closure. For extended closures, the USCG acquires additional resources to establish a temporary vessel traffic service that tracks delayed vessels and facilitates the orderly resumption of traffic after the closure is lifted. USCG Sector Lake Michigan and Michigan State University Chicago are the primary field units of the Ninth District engaged in local Asian carp activities. They also support the management of waterway traffic in support of Asian carp control activities with industry outreach, conducting Regulated Navigational Areas and safety zone enforcements, and attending ACRCC meetings and teleconferences.

P-3 Data Collection at Brandon Road Lock and Dam

Lead Agency: USGS

Agency Collaborators: USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding *
$80,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support the operation and maintenance of a real-time, continuous water velocity and water-quality gaging station in the downstream approach channel to Brandon Road Lock in the IWW in the State of Illinois. This year's funding will produce real-time and historic water velocity and water-quality data in the downstream approach channel, which will be made available through the USGS National Water Information System.

Project Description:

This project will result in data documenting the hydrologic and water chemistry conditions in the approach channel and temporal variations associated with the river and lock and dam operations.

P-4 Design of Potential Future Actions at Brandon Road Lock and Dam

Lead Agency: USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$3,800,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This proposed project would involve structural and non-structural measures in the vicinity of Brandon Road Lock and Dam, near Joliet, Illinois is intended to address the upstream migration of ANS. In FY 2021, USACE will, in partnership with the State of Illinois and the State of Michigan, initiate design of the proposed project.

Project Description:

The proposed project involves construction of a flushing lock, an engineered channel, an acoustic fish deterrent, an electric barrier, and an air bubble curtain in addition to non-structural measures that include public education and outreach, monitoring, pest management, piscicides, manual or mechanical removal of fish, and research and development. The proposed project also includes compensatory mitigation to trap native fish downstream and transport them upstream and annual operation and maintenance costs upon completion of the project.

P-5 Aquatic Nuisance Species Control Technologies Risk Assessment

Lead Agency: USCG

Agency Collaborators: USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$10,000**	$5,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

***USCG determined funding not necessary; funding carried over into FY 2022.*

Project Summary:

This project will identify potential safety risks to vessels and mariners posed by aquatic nuisance species control technologies, including CO_2 and acoustic deterrence systems.

Project Description:

To address invasive-species control-measure changes, the USCG operational commander requested CGRDC support for research to develop scientific and technical knowledge into how species control technologies could influence possible navigation safety hazards, the extent of hazardous areas, the interaction of hazards and operational procedures, and risk mitigation alternatives associated with the control-measure changes. CGRDC research includes performing a preliminary risk assessment of new control technologies.

Research tasks for vessel-traffic density and vessel operations near anticipated barrier location under this project will include:

- Conduct in-depth data collection and analysis to determine risks for each of the different possible invasive species control measures.
- Observe and analyze vessel and vessel-crew activity in the downstream channel during and after locking through, with, and without barge cuts, before, during, and after lock-chamber draining.
- Investigate whether control measures or potential changes to present operational procedures lead to marine-safety risk scenarios that need further evaluation.
- Provide research results to USACE to develop and tabulate risk scenario matrices in coordination with USCG operational commander.

In FY 2021 the USCG operational commander seeks CGRDC assistance in the following areas:

- Early identification of safety tests that, in addition to evaluating ANS control technologies, also examine associated risks to vessels and mariners transiting Brandon

Road Lock and Dam. Technologies to include are CO_2 concentration testing and acoustic deterrence program.

- Reviewing potential ANS control technologies for use at the Brandon Road Lock and Dam to advise USCG District 9, Sector Lake Michigan, and Michigan State University Chicago on associated risks to vessels and mariners.

P-6 Closure of GLMRIS Connection at Ohio & Erie Canal

Lead Agency: Ohio DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$20,100	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will maintain the closure of the Ohio & Erie Canal GLMRIS connection in Akron, Ohio, between the Mississippi River and Lake Erie watersheds through routine maintenance of the preventative structures. This project will result in the prevention of high-risk AIS from entering Lake Erie and prevent Asian carp from becoming established in the Great Lakes by blocking their movement between these watersheds.

Project Description:

The GLMRIS determined that the Ohio & Erie Canal is a medium risk connection for transfer of Silver Carp, Bighead Carp, Black Carp, Northern Snakehead, and Skipjack Herring from the Mississippi River basin to the Great Lakes basin. The project was completed in early 2020 by raising the elevation between the two watersheds and screening structures. To ensure that the measures implemented are operating properly to prevent AIS transfer, long-term maintenance by Ohio DNR is necessary.

USACE closed the GLMRIS connection at the Ohio & Erie Canal in the spring of 2020. The State Historic Preservation Office mitigation is being implemented and the operation and maintenance manual has been completed under current funding.

P-7 Closure of GLMRIS Connection at Little Killbuck Creek

Lead Agency: Ohio DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding *
$1,596,500**	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

***Ohio will use FY 2020 funding to cover the funding needs for FY 2021 activities; funding carried over into FY 2022.*

Project Summary:

This project will close the GLMRIS connection at Little Killbuck Creek and the Black River in Lodi, Ohio. This project will result in the closure of the third GLMRIS connection behind Eagle Marsh in Ft. Wayne, Indiana; and Ohio & Erie Canal in Akron, Ohio; and prevent Asian carp from becoming established in the Great Lakes by preventing their movement across the watershed boundary. FY 2021 funding will augment current funding to secure the berm footprint and develop the final design and complete permitting for the project.

Project Description:

The GLMRIS determined that Little Killbuck Creek is a medium risk connection for transfer of Bighead Carp, Silver Carp, Black Carp, Inland Silverside, and Northern Snakehead from the Mississippi River basin to the Great Lakes basin for the transfer of Threespine Stickleback, Ruffe, Tubenose Goby, parasitic copepod, and Viral Hemorrhagic Septicemia from the Great Lakes basin to the Mississippi River basin. To date, Ohio DNR has completed the 25 percent design for the berm project to separate the basins and refined this design using value engineering from the USACE, and the project will continue in FY 2021 with real estate negotiations for the berm footprint, final design, permitting, and construction phased over multiple years.

P-8 Alternate Pathway Surveillance in Illinois – Law Enforcement

Lead Agency: Illinois DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$150,000	$150,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will prevent deliberate and unintentional introductions of Bighead Carp, Black Carp, Grass Carp, and Silver Carp in Illinois and the Great Lakes basin by increasing communication and enforcement capabilities amongst law enforcement personnel and other stakeholders. This year's funding will produce a minimum of 20 aquatic life inspections of industries linked to the Asian carp trade where the highest priority for regulatory compliance has been identified: Ten fish truck transportation inspection details, responses to all AIS law enforcement related issues, and the implementation and coordination of enforcement objectives developed by the GLFC Law Enforcement Committee. In 2021, the training of a minimum of 20 CPOs in invasive species enforcement techniques will further enhance enforcement of invasive species laws.

Project Description:

The Illinois DNR ISU was created in 2012 as a special law enforcement component to assist the overall Asian carp project and enforcement in Illinois and the region. It consists of applying specially trained CPOs who are fully dedicated to searching for illegal activities within the commercial fishing, aquaculture, transportation, bait, pet, aquarium, and live fish market industries to identify any risks of transporting or commerce of live Asian carp and other invasive species that could ultimately harm Illinois and the Great Lakes. The ISU focuses its energies and resources on the likely pathways Asian carp could spread by human means. ISU has exposed the risks human activities bring to the entire Asian carp project by making significant arrests in almost every industry it has looked at. ISU proves to be a critical piece of the puzzle among many others working diligently to protect our waterways. Activities in 2021 seek to continue priority work, cross-train up to 20 CPOs across Illinois, and coordinate with the GLFC Law Enforcement Committee in addition to other inspection activities. The capabilities and knowledge of the ISU advances significantly each year and has provided leadership and training opportunities across the basin to lower the risk of live Asian carp possession and transport.

C-1 Contract Fishing for Asian Carp Detection and Removal

Lead Agency: Illinois DNR

Agency Collaborators: INHS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$1,545,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will manage and control the Asian carp population in the upper Illinois River and the IWW, significantly reducing the risk to fish arrival at the EDBS. The contracted fishers can also be redeployed for detection in waters closest to Lake Michigan for enhanced surveillance and contingency response to emerging threats, if needed. This year's funding will remove over one million pounds of Asian carp from the upper Illinois River.

Project Description:

This project uses contracted commercial fishing from February through December to reduce Asian carp (Bighead Carp, Black Carp, Grass Carp, and Silver Carp) abundance and monitor for changes in range in the Des Plaines River and upper Illinois River, downstream of the EDBS. By decreasing Asian carp abundance, Illinois DNR anticipates reduced migration pressure towards the barrier, lessening the chances of Asian carp gaining access to upstream waters in the CAWS and Lake Michigan. Monitoring for upstream expansion of Asian carp should help identify changes in the leading edge, distribution, and relative abundance of Asian carp in the IWW. The "leading edge" is defined as the furthest upstream location where multiple Bighead Carp or Silver Carp have been captured in conventional sampling gears during a single trip or where individuals of either species have been caught in repeated sampling trips to a specific site. Trends in catch data over time may also contribute to the understanding of Asian carp population abundance and movement between and among pools of the IWW.

Commercial fishers will be employed (contracted) to harvest as many Asian carp as possible in the Starved Rock and Marseilles pools.

In the CAWS (seasonally) and from the barrier downstream through Lockport pool, Brandon Island pool, and Dresden Island pool (bi-weekly), many of the same contracted netters will work in teams of two or more to detect and remove Asian carp.

A third set of contracted fishers will fulfill a contract as rapid responders. These fishers can be called upon short notice with the widest subset of gears available, including seine, for scheduled work or in response to information that requires investigation or harvest.

C-2 Asian Carp Enhanced Contract Removal

Lead Agency: Illinois DNR

Agency Collaborators: SIU, Tetra Tech

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$866,200	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will continue the Enhanced Contract Fishing Program in Illinois in the Alton, LaGrange, and Peoria pools of the Illinois River. This project will result in significant removal of Asian carp from these areas and prevent these fish from becoming established in the Great Lakes by reducing the number of individual fish reaching the upper Illinois River. This year's funding will result in the removal of 5.75 million pounds of Asian carp.

Project Description:

SEACarP modeling suggests that the removal of Asian carp in the lower Illinois River will likely reduce the migration of fish upstream, further reducing the possibility of invasion into the Great Lakes. This project is a collaborative research effort between Illinois DNR, SIU, and Tetra Tech to develop management strategies for enhanced removal through harvest. The role of Tetra Tech is to continue the implementation of a regional-scale harvest program through contracting with commercial fishing to increase overall removal, first in the Peoria pool, then with coordination with management agencies in further downriver reaches. Tetra Tech enters into contracts on behalf of Illinois DNR to reach removal goals.

The objectives of the program are as follows:

1. Aid in reaching a target removal rate of 20 to 50-million pounds of Asian carp per year from the IWW below Starved Rock Lock and Dam.
2. Removal of Asian carp under the Enhanced Contract Fishing Program for 2019/2020 has a goal of 4.5 million pounds, while working toward a goal of removing 15 million pounds annually by 2022.
3. Coordinate fishers and processors to increase cooperation with an end goal of increasing the scale of removal operations to satisfy larger orders for harvested Asian carp.
4. Leverage other programs such as the Market Value Program to continue building increased demand for harvested Asian carp.

C-3 Asian Carp Removal Marketing

Lead Agency: Illinois DNR

Agency Collaborators: SIU

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$232,100	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

The Mississippi River system continues to be a source of Asian carp that move into the Illinois River. To support a long-term program that will control this influx of Asian carp, this project will promote the human consumption of Asian carp caught in IWW. In FY 2021, there will be a launch of a new brand for Asian carp and promotional events.

Project Description:

This project represents the culmination of a body of work to develop a new positive brand for Asian carp. It is founded on extensive analysis, surveying, and research to devise a new name and logo, as well as the creation of a marketing plan and user guide for implementation of the brand. The marketing plan consists of creation of an industry group to carry brand implementation forward; website design; a social media strategy; promotional video; creation of a national-scale launch event and supporting print; and other promotional material.

M-1 Great Lakes Early Detection, Monitoring, and Evaluation

Lead Agency: USFWS

Agency Collaborators: Michigan DNR, Illinois DNR, Indiana DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$350,000	$1,400,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will implement a comprehensive early detection surveillance for Asian carp species in the Great Lakes at high-risk locations in southern Lake Michigan (Calumet River, Burns Harbor and Ditch) and western Lake Erie. USFWS biologists will employ a wide array of traditional and novel gears to sample all potential life stages of Asian carp species to maximize detection probability. This program complements the eDNA monitoring program implemented by the USFWS and its partners.

Project Description:

USFWS will continue to implement a comprehensive early detection surveillance program for Bighead Carp, Silver Carp, Grass Carp, and Black Carp in and near the Great Lakes. This program will complement the eDNA monitoring program implemented by the USFWS and its partners. Sampling will primarily target areas of high concern in the Great Lakes (e.g., southern Lake Michigan, western Lake Erie, and areas with past positive eDNA results) and use a wide array of traditional and novel gears to sample all potential life stages of Asian carp species.

M-2 Asian Carp Demographics

Lead Agency: USFWS

Agency Collaborators: INHS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$475,000	$120,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will generate Asian carp demographic data for evaluating control efforts and exploring potential population responses to alternative management scenarios in the Illinois River. This year's funding will produce updated demographic status and trend data, building on a robust multi-year standardized dataset.

Project Description:

This project will provide reliable Asian carp demographic data for evaluating control efforts and exploring potential population responses to alternative management scenarios. Demographic data are commonly used to test for exploitation effects, such as skewed sex ratios and increased growth and condition. In addition, demographic data can be used to parameterize Asian carp population models (e.g., SEACarP model). To accomplish this goal, this project will collect demographic data, including abundance, size, age, sex structure, growth, and size at maturity. In addition, an age validation study designed to support the development of an SOP for aging Bighead Carp and Silver Carp will be completed.

There remains a need to develop SOPs and identify preferred fish skeletal structures for aging Bighead Carp and Silver Carp. New 2021 actions include the implementation of an age validation study and the development of an SOP. The accuracy and precision of using three structures for aging (i.e., postcleithra, pectoral spine, lapilli otolith) will be evaluated, and recommendations concerning standard methods and preferred aging structures for Bighead Carp and Silver Carp summarized and provided.

M-3 Des Plaines River Overflow Monitoring

Lead Agency: USFWS

Agency Collaborators: USACE, Illinois DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$15,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will continue Asian carp monitoring and early detection in the Des Plaines River, Illinois. Efforts will focus on Great Lakes protection through early detection, with the goal of preventing fish from bypassing the EDBS by moving between the Des Plaines River and the CSSC. This year's funding will produce data describing any potential Asian carp breaches as well as an annual report detailing the results of the sampling.

Project Description:

Routine early detection monitoring of the Des Plaines River increases the likelihood of detecting Asian carp in the event of their movement into the river prior to the occurrence of any overflow events, thus reducing the risk of Asian carp transfer between the Des Plaines River and the CSSC in the vicinity of the EDBS. Fixed sites will be sampled for Asian carp three times throughout the 2021 field season. Additional sampling will be scheduled if: (1) the Asian carp population status in Brandon Road Pool significantly increases, or (2) there are credible reports of Asian carp sightings in the upper Des Plaines River. Physical barrier inspections and ichthyoplankton sampling will occur when USACE personnel indicate overflow conditions are occurring.

Biologists will inspect the Des Plaines Bypass Barrier fence for areas of flow-through and potential breaches. When safe, block nets may be used to temporarily close any breaches until repairs can be made by USACE. Depending on conditions, multiple gears may be used to document fish species and sizes moving through the physical barrier.

M-4 Illinois River Monitoring and Response Team Support

Lead Agency: USFWS

Agency Collaborators: Illinois DNR, USACE, SIU

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$50,000	$275,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will provide for USFWS field support of the SIM, Unified Method, and Contingency Response efforts in the upper IWW. This year's funding will support Illinois River monitoring activities, provide summarized data to Illinois DNR for all sampling events.

Project Description:

USFWS will assist the Illinois DNR-led SIM activities during June and September 2021. SIM supports Asian carp early detection in the CAWS upstream of the EDBS, reducing the risk of Asian carp population establishment at that location. USFWS assists with the Unified Method as planned by the Illinois DNR each year. The Unified Method is used to control Asian carp population abundance in the downstream vicinity of the EDBS, reducing propagule pressure on the barrier and supporting Great Lakes protection. Additionally, USFWS will maintain readiness in the event a response action is requested by the ACRCC. Contingency response actions are aimed at minimizing imminent threats of Asian carp introduction and establishment.

M-5 Asian Carp Database Management and Integration Support

Lead Agency: USGS

Agency Collaborators: Illinois DNR, USFWS, USACE, INHS, SIU, Western Illinois University

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$195,000	$228,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will provide unified, multi-agency data management and integration support for existing datasets of Asian carp-related data throughout the Illinois River waterway system. This project will inform modeling efforts and adaptive management actions to prevent Asian carp from becoming established in the Great Lakes by providing researchers and managers with tools to integrate, analyze, visualize, and understand Asian carp data. This year's funding will provide continued data management, integration, and analysis of Asian carp data within the Illinois River waterway system via the FishTracks Telemetry Database and Illinois River Catch Database applications and associated decision support tools.

Project Description:

The overarching goal of this project is to provide data management, informational products, and decision support tools to aid and inform the management and removal of Bighead Carp and Silver Carp in the Illinois River waterway system. Integrating and transforming Asian carp-related datasets into actionable information includes the following objectives:

1. Continued maintenance of the FishTracks Telemetry Database and Illinois River Catch Database applications to facilitate Objectives 2 and 3 via data compilation, management, and summarization.
2. Furthering the understanding of Bighead Carp and Silver Carp life history and other factors that might influence the efficacy and efficiency of contract removal or other control approaches (e.g., deterrents) and facilitate risk assessment.
3. Incorporating understandings from Objective 2 into analyses, informational products, and decision support tools to inform modeling efforts and management decisions to control Bighead Carp and Silver Carp.

Specific products resulting from these objectives include:

1. Maintenance and improvement of the FishTracks Telemetry Database and Illinois River Catch Database applications, including the addition of new data and the development of

application programming interfaces to facilitate data end-user access to Asian carp telemetry, monitoring, and removal data from the Illinois River waterway system.

2. Development of a data management framework for demographics data (being collected by the partnership) to support population modeling efforts and risk assessments.
3. Decision support tools (i.e., web mapping and geoprocessing services for existing Asian carp-related data layers and tools collected and developed by the partnership) to provide an online, centralized location and user-friendly interface for Asian carp-related datasets, database applications, and analytical tools to inform risk assessment, control, removal, and other management actions in the Illinois River waterway system.

M-6 Illinois Waterway Detection, Management and Control, and Contingency Planning for Asian Carp

Lead Agency: Illinois DNR

Agency Collaborators: USACE, INHS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$3,858,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will continue to implement an active monitoring and response plan, in coordination with our partners, in the Illinois River, IWW, and CAWS. This project will prevent Asian carp from becoming established in the Great Lakes through detecting, managing, and controlling Asian carp as identified in the Asian Carp Action Plan and an updated MRP. In addition, 2021 efforts will include continued planning associated with potential contingency response efforts.

Project Description:

Administration of the grant, project supervision, proposal contributions, cooperative agreements, staff supervision, training, contract fishing observers, responders are essential to operate and manage the Asian carp projects and support for the ACRCC Action Plan. To implement the annual MRP, considerable administration and field coordination is required. Fifteen Illinois DNR staff have been identified as essential to fully implement this program and fulfill annual MRP activities with additional contracting of specific tasks. The Asian Carp MRP is prepared with significant input by Illinois DNR and released by the ACRCC.

Illinois plays an important role in preventing the expansion of the range of Asian carp and in furthering the understanding of Asian carp location, population dynamics, behavior, and the efficacy of control and capture methods. The projects undertaken by the Illinois DNR/MRWG are designed to address three primary objectives for preventing the spread of Asian carp to Lake Michigan. These objectives are:

1. **Detection:** Determine the distribution and abundance of Asian carp to guide response and control actions.
2. **Management and Control:** Prevent upstream passage of Asian carp towards Lake Michigan via use of barriers, mass removal, and understanding best methods for preventing passage.

3. **Contingency Response Planning:** Establish comprehensive procedures for responding to changes in Asian carp population status, test these procedures through exercises, and implement if necessary, but not funded through this project.

Illinois DNR SIM responsibilities in 2021 include but are not limited to sampling approximately 1,300 sites; 2,690 person-hours; 103 hours or electrofishing; 79 miles of gill/trammel netting; 1.8 miles of seine; and the use of trap nets and Great Lake fyke nets.

Multi-Agency Monitoring efforts in FY 2021 include but are not limited to monitoring adult and juvenile Asian carp population demographics (i.e., presence/absence, distribution, and abundance) in pools below the EDBS with a standardized design, including the detection of small fish above Starved Rock and adult fish above Brandon Road. This work will also inform other projects (i.e., Contracted Asian Carp Removal, Telemetry Monitoring, SEACarP model, etc.) with Asian carp demographic and fish community assemblage data necessary for making management decisions.

Illinois DNR multi-agency monitoring efforts will consist of approximately 11,815.5 person-hours expended for sampling fixed and random sites downstream the EDBS, including 187.75 hours of electrofishing; 1,177.3 hoop netting net nights; 475.8 minnow fyke netting net nights; and 113.1 fyke netting net nights.

Management and Control efforts in FY 2021 include but are not limited to: monitoring for the presence of Asian carp in the five pools (Starved Rock, Marseilles, Dresden Island, Brandon Road, Lockport) below the EDBS in the IWW. This work will reduce Asian carp densities, lessening migration pressure to the EDBS, thus decreasing chances of Asian carp accessing upstream reaches (i.e., CAWS and Lake Michigan).

Contingency Response Planning efforts in FY 2021 include but are not limited to annual table-top exercises to evaluate the CRP. It is hoped that the CRP will not need to be used, but the goal is to have the best plan at the ready if it is needed.

Asian Carp Mission Support efforts include but are not limited to:

- Developing and updating the annual Asian Carp Action Plan, MRP, Interim Summary Report, and other strategic documents on an annual basis.
- Developing and updating Asian carp response plans, including logistical planning for response.
- Supporting inter-agency coordination and planning through coordinating meetings, database development, and other tools.
- Conducting Incident Command System training at multiple levels and readiness exercises.
- Maintaining and improving MRWG website development, calendar, project map, and information repository.
- Tracking and communicating progress of agency actions to the public through quarterly meetings, regular updates to the Asian carp website, and through the development of the annual Action Plan and MRP.
- Supporting MWRG co-chairs in meeting planning, note-taking, and other coordination needs as required.

M-7 Assessment of Asian Carp Reproduction and Ecosystem Response in the Illinois Waterway

Lead Agency: Illinois DNR

Agency Collaborators: INHS, Eastern Illinois University, SGS Life Sciences Services

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$452,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will monitor for Asian carp reproduction in the IWW tributaries (Fox River, Kankakee River, Sangamon River, Mackinaw River, and Spoon River) within the state of Illinois. The project will also quantify the relationship between zooplankton abundance and Asian carp density in a subset of navigation pools in the Illinois River. This project will prevent Asian carp from becoming established in the Great Lakes by rapidly detecting Asian carp spawning in the IWW, guiding targeted responses to disrupt Asian carp reproduction, and in combination with harvest and removal efforts in the IWW, slowing expansion of the invasion front towards the Great Lakes via the IWW.

Project Description:

This project will continue to monitor Asian carp reproduction and the ecosystem response in coordination with our partners, as laid out in the Action Plan and the MRWG MRP, in Illinois, the IWW, and CAWS. Ichthyoplankton sampling is conducted to monitor for the eggs and larvae of four invasive carp species (Bighead Carp, Silver Carp, Black Carp, and Grass Carp) to assess the extent, location, and timing of invasive carp reproduction in the IWW. Sampling is conducted at weekly intervals during April through June and bi-weekly intervals from July through October, with more frequent sampling efforts during periods when temperature and flow conditions are thought to be optimal for Asian carp spawning. These data are also used as an early detection system for monitoring the upstream expansion of Bighead Carp and Silver Carp populations and potential reproduction by the newly expanding Black Carp population in Illinois. These data are also used to quantify the relationship between Asian carp stock abundance and reproductive output to assess the level of removal needed to degrade the ability of Asian carp to reproduce.

The level of spawning occurring in the upper Illinois River affects recruitment occurring downstream; therefore, quantifying the relationship between adult density and reproductive productivity will allow us to establish the levels of carp harvest in the navigation pools of the upper river that will degrade reproductive productivity sufficiently and diminish population growth rate in downstream navigation pools, ultimately reducing the number of fish moving upstream and further contributing to declines in densities in the upper Illinois River.

M-8 Asian Carp Stock Assessment in the Illinois River/ Management Alternatives

Lead Agency: Illinois DNR

Agency Collaborators: INHS, SIU, USACE, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$550,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will involve hydroacoustic sampling, implanting Asian carp with acoustic transmitters, and maintaining an acoustic receiver array in the Alton to Dresden Island pools of the Illinois River. This project will result in the identification of high-density locations of Asian carp, a long-term assessment of population trends, and quantification of upstream movements

Project Description:

This project will continue to support the broader monitoring and response plan in coordination with our partners SIU, USACE, USGS, and INHS and will use several approaches to assess the Asian carp population to aid removal and response efforts. Hydroacoustic sampling will occur in the upper Illinois River throughout the Marseilles and Dresden Island pools every other month from February to October to identify locations of high Asian carp densities. The resulting density heatmaps (illustrating locations where densities are highest) will be provided to MRWG members so that removal efforts can be targeted as fish locations within each pool change throughout the year. The same sampling approach and density heatmap generation will also occur for each Unified Method event that takes place in the upper Illinois River.

Hydroacoustic sampling will also occur in Alton to Dresden Island pools in October to quantify pool-wide Asian carp densities for comparison to long-term data collected since 2012. This will help determine whether the relative abundance of Asian carp is changing from recent years, possibly as a result of management actions, and whether relative abundances in lower river pools increased recently and warrant additional actions.

Monitoring of acoustically tagged Asian carp will continue from Alton to Dresden Island pools across an array of 70 stationary receivers. Asian carp will be implanted with acoustic transmitters in Alton (75 tags) La Grange (75 tags), Starved Rock (50 tags), and Marseilles (50 tags) pools (250 total tags) to supplement the existing number of acoustically tagged individuals at-large in these pools (Telemetry Work Group goal is to maintain at least 50 active transmitters per pool in

the upper Illinois River and 150 tags per pool in the lower Illinois River). The resulting movement data will be used to identify pool-to-pool movement rates (including dam versus lock passage routes) for inclusion into the SEACarP model and to assess potential changes in upstream movements by comparing the number of tagged fish at-large in each pool to data from past years. Maintaining a high number of tagged fish in the lower Illinois River also allows for the identification of potential upstream movements via detection on real-time receivers that could determine whether a contingency response action is necessary.

M-9 eDNA: USFWS Midwest Region Fisheries Program Capacity for eDNA Sampling and eDNA Sample Processing

Lead Agency: USFWS

Agency Collaborators: States and Tribes of Great Lakes, Upper Mississippi River, Ohio River

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$2,400,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support monitoring for the presence of Bighead Carp and Silver Carp eDNA in the Great Lakes, upper Mississippi River, and Ohio River basins. USFWS will process water samples collected in collaboration with state and tribal partners, focused on detecting the presence of Asian carp DNA in Great Lakes tributaries of concern and during annual sampling events in the CAWS of the IWW.

Project Description:

The USFWS applies the science of eDNA as an early detection monitoring tool in support of the ACRCC's strategic approach for protecting the Great Lakes from Asian carp. This work includes the continued refinement and development of state-of-the-art detection tools, field sampling and laboratory protocols, and expanded analytical capacity to support a robust eDNA monitoring program. USFWS has identified the need to maintain program capacity for Asian carp eDNA surveillance in the Great Lakes, upper Mississippi, and Ohio River basins. USFWS will build upon work previously completed for Bighead Carp and Silver Carp (including marker improvements, field collection, and extraction protocols) to support development of Grass Carp and Black Carp genomic surveillance protocols as part of this monitoring program.

M-10 Telemetry in the Upper Illinois River

Lead Agency: USACE

Agency Collaborators: USFWS, USGS, SIU, Illinois DNR, INHS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$200,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This effort is an integral part of operation of the EDBS and monitoring the movements of fish in the vicinity of the EDBS to assess the efficacy of the EDBS.

Project Description:

USACE has led telemetry efforts in the CAWS since 2010 with a primary objective of assessing the efficacy of the barriers as identified in the ACRCC MRP. By surgically implanting transmitters into fish species (both Asian carp and surrogate species), USACE has empirical data to demonstrate the barriers are effective in preventing large fish passage in the upstream direction. In FY 2021, work will be continued to assess the efficacy of Barriers IIA and IIB, and permanent Barrier I..

M-11 Telemetry Support for the Spatially Explicit Asian Carp Population (SEACarP) Model

Lead Agency: USFWS

Agency Collaborators: SIU, USACE, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$110,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will provide telemetry support for the SEACarP model that estimates the Asian carp population status and informs potential management actions in the Illinois Waterway. Data will be collected that describes the movement of telemetered Asian carp and estimates the frequency of pool-to-pool Asian carp movement, further informing and improving the accuracy of SEACarP model predictions.

Project Description:

The SEACarP model was developed as a means of assessing the Asian carp population status in the IWW. Movement is a key component of the SEACarP model and is the primary source of information about how researchers expect the population to respond to management strategies. Therefore, the model functions as an important tool for use by fishery managers to inform harvest and control of adult Silver Carp and Bighead Carp. An accurate understanding of Asian carp population status is critical for assessing invasion risk to the Great Lakes. Data gained from tagging and tracking additional Asian carp will improve the accuracy of the model.

In 2021,USFWS crews will tag an additional 150 Silver Carp and Bighead Carp in and around the Peoria and Starved Rock pool with acoustic transmitters. Tagging locations and target lengths will be informed by consultation with the MRWG Telemetry Work Group. Additional receivers will be placed in areas with reduced coverage, and the MRWG Telemetry Work Group will be consulted prior to deployment. This work is collaborative with both the MRWG Telemetry Work Group and the MRWG Modeling Work Group. All information from individual telemetered Asian carp will be shared with the working groups and uploaded to FishTracks.

USFWS project M-11 is complementary to USGS project M-13. However, M-11 supports tagging Asian carp with acoustic transmitters, while M-13 is focused on technology evaluation, data analyses, and optimizing the acoustic receiver array within the IWW.

M-12 Illinois River Hydroacoustics

Lead Agency: USFWS

Agency Collaborators: SIU, USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$125,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will provide hydroacoustic estimates of large fish abundance and distribution in the IWW in the vicinity of the EDBS. USFWS and partners will produce biweekly surveys and reports on fish abundance and distribution, as well as provide rapid communications to the ACRCC in the event of significant changes in fish community species composition or fish behavior at the EDBS.

Project Description:

The project will consist of both barrier surveys and pool surveys. The purpose of the barrier surveys is to detect fish in the vicinity of the EDBS prior to barrier operational changes or maintenance, with emphasis on ensuring that Bighead Carp or Silver Carp are not present. Side-looking split-beam hydroacoustic and side-scan sonar surveys will be conducted above and below the EDBS to assess fish abundance, density, and distribution patterns on a fine temporal scale. Surveys at the EDBS will take place on a bi-weekly basis beginning in spring 2021.

The purpose of the pool surveys is to provide early detection of an increase in the abundance of fish greater than 10 inches, which could potentially be Bighead Carp or Silver Carp. The hydroacoustic survey equipment utilized for these surveys consists of a pair of Biosonics® 200 kHz split-beam transducers, as well as a 4125 Edge Tech ultra-high-resolution side scan unit. Using both systems will allow a large portion of the water column to be assessed during each survey.

M-13 Real-Time Telemetry and Multi-State Modeling

Lead Agency: USGS

Agency Collaborators: MRWG Telemetry Work Group Agencies (Illinois DNR, GLFC, SIU, USACE, USFWS)

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$105,000	$104,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support SEACarP modeling by providing a model that estimate Asian carp movement between pools using the multi-agency network of acoustic receivers in the Illinois River and associated waterways. The project will also maintain the real-time early warning system for acoustically tagged Bighead Carp and Silver Carp.

Project Description:

USGS will work with MRWG Telemetry Work Group and Modeling Work Group in support of the SEACarP modeling by finalizing a Bayesian multi-state model for estimating transition (movement between pools) probabilities from telemetry data. The analyses will also inform the partnership on decisions regarding the level of tagging and the number of receivers needed to provide useful transition estimates. The telemetry data (2012-2019) used in the analysis is being stored in a multi-agency, centralized database (FishTracks) developed and previously maintained by the USGS as part of this project.

USGS will also work with partners via the MRWG Telemetry Work Group to inform decisions on removal and contingency actions for Bighead Carp and Silver Carp by deploying real-time acoustic receivers at strategic locations and serving that data via the internet, text messaging, and email. Specific products include (1) a real-time acoustic receiver network (nine receivers) with remote data serving and alert options and (2) finalized analysis of telemetry and catch data at key locations to correlate real-time receiver detections and actual catch rates.

M-14 Early Detection of Asian Carp in the Upper Illinois Waterway

Lead Agency: USFWS

Agency Collaborators: USACE, INHS, Illinois DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$500,000	$600,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will enhance the detection of Asian carp in the uppermost pools of the IWW by using a variety of Asian carp-focused sampling methods. This year's funding will support monitoring and produce detailed information and reports on the spatial distribution of Asian carp in the upper IWW.

Project Description:

This project aims to increase targeted early detection sampling of small and large Silver Carp and Bighead Carp in the upper IWW. Data will be used to assess whether large (greater than 153 mm Total Length) Asian carp are present above Brandon Road Lock and Dam in low numbers, or small (153 mm or less Total Length) Asian carp are present above Starved Rock Lock and Dam. The information provided by this Asian carp-focused sampling will aid ACRCC and MRWG agencies in evaluating the current invasion risk of Asian carp to the Great Lakes. The specific objective of this project is to detect the furthest upstream location for both small (currently believed to be Starved Rock pool) and large (currently believed to be Dresden Island) Silver Carp and Bighead Carp to inform the Great Lakes invasion risk assessment. As a complement to other ongoing monitoring efforts, this project will address the objective by increasing the temporal coverage and from March through November annually. Early, pre-spawn sampling will focus on targeted detection of large Asian carp, as small Asian carp are unlikely to be present in the system until spawning produces young of year individuals. Post spawn sampling will focus on targeted detection of both large and small life stages.

Sampling will be focused on detecting Bighead Carp and Silver Carp in upstream pools in the IWW currently presumed to have either no or very few individuals and will utilize a suite of gears, including electrofishing, electrified dozer trawling, and mini-fyke netting. Effort will be concentrated in the two most upstream pools, the Lockport and Brandon Road pools, with crews deployed approximately weekly. Site selection will target locations with habitat similar to what is known to support Asian carp in downstream pools. Sampling targeted towards large Asian carp will include daytime boat electrofishing and electrified dozer trawling. Sampling targeted towards small Asian carp will include electrified dozer trawling and mini-fyke netting.

T-1 USACE Acoustic Deterrents for Asian Carp

Lead Agency: USACE

Agency Collaborators: USFWS, USGS, Illinois DNR, KDFWR, Jasco Sciences, Missouri DC, Purdue University, West Kentucky University, University of Minnesota-Twin, University of Minnesota-Duluth

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$1,531,700	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will develop and test uADS for Asian carp control. This year's funding will support two large-scale evaluations of deterrent technologies at pinch-point locks and dams and provide a framework for deploying and testing deterrents at other sites (see T-2 and T-3). The project will also determine the most effective and efficient combination of sound technology that discourages upstream movement.

Project Description:

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of Bighead Carp, and Silver Carp, while allowing passage of native fish and shipping to continue. Underwater acoustic deterrent systems have demonstrated effectiveness in laboratory and pond settings. This project will build off these studies and deploy large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi River basins to help managers understand the effectiveness of acoustic deterrents where Asian carp populations are established. The project test sites are directly applicable to use for protecting the Great Lakes and have the advantage of being installed at "pinch points" in the river system where Asian carp are only able to swim upstream through a lock chamber because the head height of the dam structure is impassable.

In addition to field-testing ADS, research efforts in the lab will continue to refine and optimize acoustic playbacks (i.e., frequencies, amplitudes and patterns), and deterrent design to repel Asian carp while preventing injury to native species. Future actions will focus on refining the sound characteristics that elicit the greatest response in these species in biologically motivated states (i.e., hunger, reproduction, etc.).

This funding will support USACE efforts in three separate projects:

1. Deployment and evaluation of a BAFF Fish Guidance Systems at Barkley Lock and Dam, led by the USFWS, and includes USGS and USACE participation costs.
2. Development, deployment, and evaluation of an uADS at Lock and Dam 19 (Mississippi River), is led by the USGS and includes USACE and USFWS participation costs for FY 2021. Costs cover all equipment purchases, engineering, design, operation, electricity, sound monitoring for fish passage assessment, uADS remote monitoring development, and maintenance for the first year.
3. Ongoing research and development related to underwater acoustic deterrents. This project is led by USACE ERDC and includes engineering of new acoustic signals and testing of signals in ponds and/or the field on Asian carp and native fishes as well as acoustic deterrent designs and components.

T-2 USFWS Acoustic Deterrents for Asian Carp

Lead Agency: USFWS

Agency Collaborators: USGS, KDFWR, USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$1,150,000	$800,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support implementation of a large-scale field study of the BAFF acoustic deterrent for Asian carp, including operations and maintenance of the BAFF system. The test is being conducted at Barkley Dam on the Tennessee-Cumberland River in the State of Kentucky due to the physical characteristics of the dam (high-head dam with no overflow conditions), the presence of an existing monitoring infrastructure in place (telemetry receivers) to build upon, and the presence of an established population of Asian carp. Once completed, the results of the study will reveal the effectiveness of the BAFF so that this technology may be transferred to other locations to protect the Great Lakes from Asian carp.

Project Description:

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of Bighead Carp, and Silver Carp, while allowing passage of native fish and shipping to continue. One candidate deterrent technique that has demonstrated effectiveness in laboratory and pond settings, is underwater sound. Previous studies have documented both Bighead Carp and Silver Carp responding negatively to various underwater sound stimuli while many native fish species responded little to that same sound. Building off of these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi basins will help managers understand the effectiveness of acoustic deterrents where Asian carp populations are established and will evaluate potential for the technology to be transferred and deployed in other locations to prevent upstream migration to the Great Lakes.

For this large-scale deployment, a BAFF developed by Fish Guidance Systems will be installed at the Barkley Lock and Dam approach channel on the Cumberland River in Kentucky. The system will be evaluated by an interagency research team for a total of three years. FY 2021 is Year 2 of the study. Asian carp will be tagged and translocated each study year in the spring and the fall to track fish passage in a motivated state. Migration of fish is confined to a single passage point through the lock and will be monitored with the use of telemetry and hydroacoustic equipment around the BAFF. Funding through the Action Plan will be leveraged with USFWS Asian carp agency funding to support continued operations and maintenance of the BAFF system.

T-3 USGS Acoustic Deterrents for Asian Carp

Lead Agency: USGS

Agency Collaborators: USFWS, USACE, Illinois DNR, KDWFR, Missouri DC, University of Minnesota Duluth, Western Kentucky University, Jasco Sciences, Purdue University

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$2,110,000	$472,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will research, deploy, and evaluate acoustic deterrents in Kentucky (BAFF system in Cumberland River), Illinois/Iowa (uADS in the Upper Mississippi River), and in Illinois (testing engineered signals/playbacks in the Illinois River). This year's funding will produce quantitative measurements of fish movement at Barkley Lock and Dam in response to the BAFF; a study plan, full uADS deployment, acoustic mapping, and fish tagging at Lock and Dam 19; and, deployment and initial evaluation of a small-scale acoustic deterrent in a backwater of the Illinois River to deter motivated fish.

Project Description:

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of Bighead Carp and Silver Carp, while allowing passage of native fish and shipping to continue. One candidate deterrent technique that has demonstrated effectiveness in laboratory and pond settings, is underwater sound. Previous studies have documented both Bighead Carp and Silver Carp responding negatively to various underwater sound stimuli while many native fish species responded little to that same sound. Building off of these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi basins will help managers understand the effectiveness of acoustic deterrents where Asian carp populations are established and will evaluate potential for the technology to be transferred and deployed in other locations to prevent upstream migration to the Great Lakes. For this large-scale deployment, underwater sound equipment will be installed at "pinch points" in the river system where Asian carp are only able to swim upstream through a lock chamber because the head height of the dam structure is impassable. Migration of fish is then confined to a single passage point and can be monitored with the use of telemetry and hydroacoustic equipment.

In addition to field-testing acoustic deterrent systems, research efforts in the lab will continue to refine and optimize sound frequencies, sound pressure levels, and speaker design to repel Asian carp while preventing injury to native species. Future actions will focus on refining the sound characteristics that elicit the greatest response in these species in biologically motivated states (i.e., hunger, reproduction, etc.). The ultimate goal is to limit upstream passage, specifically in areas with access to the Great Lakes.

This funding will support USGS activities in three separate sub-projects:

1. Deployment and evaluation of a BAFF system at Barkley Lock and Dam, led by the USFWS, includes USGS participation, coordination, telemetry gear deployment, field help, and data analysis/reporting.
2. Continued deployment and assessment of an uADS at Lock and Dam 19 (Upper Mississippi River), is a sub-project led by the USGS that includes personnel, replacement equipment, maintenance, and evaluation in FY 2021.
3. Ongoing research and development related to acoustic deterrents is a sub-project led by USACE ERDC and includes engineering of new acoustic signals and testing of signals in ponds and/or the field on Asian carp and native fishes. Additional work is being completed by the USGS to test acoustic playbacks on Black Carp and Grass Carp.

T-4 USACE Carbon Dioxide Deterrence System for Asian Carp

Lead Agency: USACE

Agency Collaborators: USGS, Illinois EPA, Illinois DNR, USFWS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$530,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will design a CO_2 injection system for the CAWS EDBS. This year's funding will produce engineering designs, cost estimates, and initial model development to inform management decisions related to using this technology to clearing fish from the EDBS after maintenance shutdowns. FY 2021 deliverables will be produced from an engineering and design contract that was awarded by USGS to an independent firm in FY 2020. Specific deliverables include coordination and reviews of design submittals with state and federal partners, gas injection system construction drawings, CO_2 system specifications, construction cost estimates, and construction schedules. Additionally, USACE will lead development of a computational fluid dynamic model for 35 percent, 65 percent, and near final designs to help answer water quality questions by State partners and better refine the design at the EBDS.

Project Description:

The injection of CO_2 into the water is being evaluated as a behavioral deterrent for invasive Asian carp. In 2019, the USGS, USACE, and other partners demonstrated the temporary application of a CO_2 infusion system at a navigational lock in Wisconsin. The next step to transfer this technology from research to management is to develop more permanent systems that can be used for management actions. More specifically, management agencies need well-defined startup costs and engineering designs for CO_2 infusion systems at key management points that can be deployed to keep Asian carp from moving into new areas.

This project is focused on assessing the feasibility of CO_2 as a potential method to clear fish from the EDBS within the CAWS. The EDBS undergoes annual maintenance, which could present an opportunity for fish to move upstream towards Lake Michigan. This project will determine if CO_2 could be applied during or after maintenance to further reduce the risk of upstream expansion towards the Great Lakes. Additionally, if successful, the use of CO_2 could enhance general safety by eliminating the need to place boats within the electrified field to manually remove fish.

T-5 Implementation and Planning for a Carbon Dioxide Deployment

Lead Agency: USGS

Agency Collaborators: USACE, Illinois EPA, Illinois DNR, USFWS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$100,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will design a CO_2 injection system for the CAWS at the EDBS. This project will result in the engineering designs, estimates costs, and fluid dynamic models to assess the feasibility of CO_2 as a deterrent to prevent Asian carp from becoming established in the Great Lakes by clearing fish from the EDBS during maintenance shutdowns. FY 2021 deliverables will be produced from an engineering and design contract that was awarded by USGS to an independent firm in FY 2020. Specific deliverables include coordination and reviews of design submittals with state and federal partners, gas injection system construction drawings, CO_2 system specifications, construction cost estimates, and construction schedules. Additionally, USGS will assist the USACE development of a computational fluid dynamic model to address water quality questions on the use of CO_2 at the EDBS. This year's funding will produce engineering designs, cost estimates, and initial model development to inform management decisions related to this potential fish clearing method.

Project Description:

CO_2 injected into the water is being evaluated as a behavioral deterrent for invasive Asian carp. In 2019, the USGS, USACE, and other partners demonstrated the temporary application of a CO_2 infusion system at a navigational lock in Wisconsin. The next step to transfer this technology from research to management is to develop more permanent systems that can be utilized for management actions. More specifically, management agencies need well-defined startup costs and engineering designs for CO_2 infusion systems at key management points that can be deployed to keep Asian carp from moving into new areas.

This project is focused on assessing the feasibility of CO_2 as a potential method to clear fish from the EDBS within the CAWS. The EDBS undergoes annual maintenance, which could present an opportunity for fish to move upstream towards Lake Michigan. This project will determine if CO_2 could be applied during or after maintenance to further reduce the risk of upstream expansion towards the Great Lakes. Additionally, if successful, the use of CO_2 could enhance general safety by eliminating the need to place boats within the electrified field to manually remove fish.

T-6 USGS Carbon Dioxide Deterrent for Asian Carp

Lead Agency: USGS

Agency Collaborators: USACE, USFWS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$100,000	$360,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support the implementation of CO_2 as a management control tool for Asian carp by working with states to register CO_2 as an USEPA-approved pesticide. This year's funding will produce state registrations and efficacy data.

Project Description:

CO_2 is being investigated as a potential deterrent to Asian carp. The concept is to introduce CO_2 into the water to deter or prevent Asian carp from moving upstream. Several published studies at laboratory, mesocosm, and field settings have demonstrated that Asian carp and other fish are repelled from areas with elevated CO_2 concentrations. This avoidance mechanism could be useful for management agencies to restrict movement through key pinch-points (e.g., navigational structures) and better control range expansion towards the Great Lakes and other large river basins.

State and federal partners completed several important milestones in 2019 and 2020. First, the USGS and USFWS obtained a FIFRA Section 3 registration from USEPA for CO_2 as a new aquatic pesticide. Approved uses include an Asian carp deterrent and a non-selective lethal control for all nuisance fish. Next, an engineering feasibility study was conducted within a navigational lock in Wisconsin. This study demonstrated the installation and operation of a large-scale CO_2 infusion system and collected data on operational costs, fish behavior, non-target organisms, human health risk assessment, and water quality. Lastly, regulatory steps to transition from research into management have been completed with the registration of CO_2 within individual states.

T-7 Developing Species-Specific Control Systems for Asian Carp

Lead Agency: USGS

Agency Collaborators: USFWS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$890,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will develop species-specific delivery systems and chemical control agents for Asian carp. This year's funding will produce a final microparticle formulation selected for use as an Asian carp control tool.

Project Description:

Developing technological tools to specifically target Asian carp, like those currently used for sea lamprey, are of great interest and would minimize the risk to non-target species. By utilizing the existing biological data for Asian carp (e.g., physiology, habitat), delivery systems can be developed to exploit their unique characteristics (e.g., feeding, growth rate) in conjunction with chemical control agents to enhance species selectivity. Therefore, the following project consists of two main foci: (1) development of delivery systems and (2) identification of chemical control agents specific for Asian carp.

In silico modeling: Identification of chemical control agents using Estimated Biological Response models (https://www.usgs.gov/apps/Models_web_app/) and quantitative structure-activity relationship (QSAR), which utilize publicly available toxicity data collated by the USEPA ECOTOX Knowledgebase to link chemical structure and chemical descriptors with species-specific toxicity responses. Additionally, toxicity targets (i.e., protein molecular targets) across species will be used as a line-of-evidence to predict the likelihood of chemical susceptibility using the USEPA tool SeqAPASS.

In vitro: Development of Rainbow Trout, Lake Sturgeon, Bluegill, and Grass Carp gill cell lines, in addition to Silver Carp, Bighead Carp, Grass Carp, Rainbow Trout, and Lake Sturgeon liver cell lines to determine species-specific capacity to detoxify potential chemical control candidates. Thirteen chemical control candidates will be screened through eight species-specific gill cell lines to determine selectivity for Asian carp relative to native fish. USGS will perform range finding cytotoxicity studies with each gill cell line with four newly synthesized (Viterbo University) chemical control candidates identified by USGS. USGS will screen previously

identified Ziram® through fish gill cell lines to support *in vivo* toxicity results demonstrating Grass Carp selectivity.

In vivo: Conduct whole organism acute *in vivo* studies for the finalized chemical control candidate TC-18 with invasive (e.g., Silver Carp and Bighead Carp) and native (e.g., Rainbow Trout, Bluegill, Yellow Perch) fish species.

Oral delivery: Refine microparticle formulation to increase toxicant (e.g., Antimycin-A) bioavailability to enhance efficacy. USGS will examine new microparticle laden bait/attractant palatability in Asian carp.

Piscicide registration: Potentially establish contracts to determine terrestrial (e.g., mammalian) toxicity of Antimycin-A. USGS will perform environmental fate studies with liquid and microparticle Antimycin-A for registration. USGS will also respond to USEPA and state regulatory review of data submitted for Antimycin-A microparticle registration for use in limited open-water applications.

T-8 USACE Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation

Lead Agency: USACE

Agency Collaborators: USGS, USFWS, Illinois DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$175,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support the development and testing of mitigation technologies for preventing barge-induced upstream movement of Asian carp through navigation locks and electric barriers in the IWW. This project will result in data and other information on the use of bubbler arrays and other technologies on barges for fish clearing and prevent Asian carp from becoming established in the Great Lakes by reducing or preventing the barge-induced transport of Asian carp through locks and electric barriers. This year's funding will produce support additional model runs on the 16:1 model at ERDC to optimize the rate and flow of discharge to inform manifold design.

Project Description:

This project covers all USACE activities related to the interaction of commercial tow traffic with aquatic nuisance species such as Bighead Carp and Silver Carp. It is a continuation of previous interagency studies that investigated small fish entrainment, retainment, and upstream transport by commercial tows (Bryant and others, 2016, 2018, 2019; Davis and others, 2016, 2017; LeRoy and others, 2019). These previous studies illustrate the need for mitigating technologies that can remove entrained small fish for potential implementation as part of the GLMRIS Brandon Road project or to address known vulnerabilities at the CAWS EDBS.

In FY 2021, GLRI funding will support additional model runs on the 16:1 model at ERDC to optimize the rate and flow of discharge to inform manifold design. FY 2021 work involves extensive interagency collaboration and technical support.

This effort will prepare the agencies to plan and execute a large-scale field experiment at Peoria Lock and Dam to test whether a longitudinal bubbler array is effective at flushing live, freely-swimming fish away from barges approaching a lock. The field study would utilize a control vs. treatment study design that seeks to evaluate if the number of Asian carp recaptured from barge tow box-rake junction gaps differs between control trials (tow does not pass over longitudinal

bubble array) and treatment trials (tow passes over longitudinal bubble array). The USACE component of the work is to plan, fabricate, deploy, and operate the longitudinal bubbler manifold and coordinate activities with the ACRCC and stakeholders.

NOTE: The longitudinal bubbler evaluation study is a component of the USACE and USFWS templates titled “Experimental Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation.” The present template constitutes the USACE GLRI request for this work, though it is also noted on the USGS and USFWS templates.

T-9 USFWS Experimental Field Testing of Longitudinal Bubbler Arrays for Barge Entrainment Mitigation

Lead Agency: USFWS

Agency Collaborators: USGS, USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$50,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

In 2021, the ACRCC will conduct work to support the evaluation of potential technologies for addressing the risk to the Great Lakes from the inadvertent entrainment and transport of small fish by barges in the IWW. These efforts are part of a multi-year collaborative project, building on earlier findings that demonstrated the risk of small fish (including Asian carp) being carried upstream in the void spaces between commercial barge tows, including through lock structures. Activities proposed for FY 2021 will assist in the development of a large-scale field study to evaluate the effectiveness of a prototype technology, the LBA, for removing entrained small fish.

Project Description:

This project is a continuation of previous studies that investigated small fish entrainment, retainment, and upstream transport by commercial barge tows. The USFWS, working with partner agencies, conducted several years of barge entrainment studies that demonstrated that small fish may become entrained and retained in junction spaces between commercial barges (Davis et al. 2016, 2017). These previous studies illustrated the need for evaluating potential technologies to remove entrained small fish and reduce the risk of upstream transport in the IWW toward the Great Lakes.

USFWS, USACE and USGS are scoping a large-scale barge field study to test the efficacy of the LBA. Based on preliminary scoping, the technology field evaluation would require a minimum of 18,000 juvenile Asian carp approximately 40-50 mm Total Length to provide an adequate number of fish for barge trial replicates. Capture of the required number of wild fish needed for the barge study is not feasible; therefore, establishing appropriate captive propagation protocols is needed to ensure an adequate supply of small Asian carp for the field study.

In FY 2021, Asian carp will be collected in the Peoria pool of the IWW as larvae (8-10 mm Total Length) and transported to the Great Rivers Environmental Center where they will be raised in fish raceways until achieving a total length of approximately 40-50 mm (the size proposed for a field trial). This project will document protocols for successful capture and rearing of small Asian carp to support a large-scale evaluation of the LBA technology.

T-10 Prevention of Barge-Induced Transport of Aquatic Nuisance Species

Lead Agency: USGS

Agency Collaborators: USFWS, USACE, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$130,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support the development of mitigation technologies for preventing barge-induced upstream movement of Asian carp through navigation locks and electric barriers in the IWW. This year's funding will produce an analysis of an existing dataset of velocity measurements collected alongside a tow during lockages at Brandon Road Lock and Dam and collection of any baseline hydraulic data that is needed in anticipation of future field testing of a longitudinal bubbler array. This year's funding will also support an egg/larvae entrainment risk assessment.

Project Description:

This project covers all USGS activities related to the interaction of commercial tow traffic with aquatic nuisance species such as Bighead Carp and Silver Carp. It is a continuation of previous interagency studies that investigated small fish entrainment, retainment, and upstream transport by commercial tows (Bryant and others, 2016, 2018, 2019; Davis and others, 2016, 2017; LeRoy and others, 2019). These previous studies illustrate the need for mitigating technologies that can remove entrained small fish for potential implementation as part of the GLMRIS Brandon Road project or address known vulnerabilities at the CAWS EDBS.

In FY 2021, the USGS will engage in a "data mining" effort to analyze an existing dataset of velocity measurements collected alongside a tow during lockages at Brandon Road Lock and Dam (collected during the FY 2015/2016 entrainment study but not yet published) to characterize the flows generated by tows as they enter/exit the lock chamber. These data will be compared with velocity data from an up-looking acoustic Doppler current profiler that will be installed in the downstream approach channel of Lock and Dam 19 on the Mississippi River in early 2021 as part of on-going acoustic deterrent system trials at the site (separate template). If this data mining effort produces sufficient results, they will be published as a journal article and associated data release. Additionally, the USGS will also collect any baseline velocity data at

Peoria Lock that is needed in anticipation of potential field testing of a longitudinal bubbler array in the future. The USGS will also participate in planning for any potential future field testing.

In addition, USGS will perform an egg/larvae entrainment risk assessment. This study aims to identify if there are locations and/or periods in which there is an increased risk of tows entraining Bighead Carp and Silver Carp eggs or larvae and transporting them upstream in the IWW. The study entails a combined analysis of commercial vessel shiptrack data from the Nationwide Automatic Identification System, with results from FluEgg model runs for six spawning events in the Illinois River in 2015. In FY 2021, USGS will complete writing the publication and submit the publication to a peer-reviewed journal.

T-11 Scientific Support for Control Efforts in the Illinois Waterway and Other Priority Sites

Lead Agency: USGS

Agency Collaborators: Illinois DNR, INHS, USACE, USFWS, Tennessee Valley Authority, NOAA

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$100,000	$75,000

**All FY 2021 funding projections are based on U appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will assess the influence of river hydraulics and water-quality on the population range, movement, and spawning/recruitment success of invasive carp in the IWW. This year's funding will produce real-time and synoptic data in the IWW to support specific partner needs, an assessment of seasonal variation in invasive carp spawning locations in the IWW, and FluEgg modeling support and training for state and federal partners.

Project Description:

This project investigates the influence of habitat stimuli, such as river hydraulics and water quality, on the population range, movement, and spawning and recruitment success of Asian carp in the IWW and other priority sites identified by the ACRCC. A large part of this project is providing a wide range of scientific support to our federal and state partners on Asian carp technology development projects and control efforts.

In FY 2021, USGS will conduct continuous water-quality monitoring to support control efforts and deterrent. This project supports the operation and maintenance of two real-time, continuous water quality monitoring stations in the Marseilles pool of the IWW, one in the main channel (Illinois River at Seneca) and one in a backwater (Hanson West Pit near Morris, Illinois). Real-time data from these USGS gages provide waterway conditions used to predict fish movement and spawning activity and guide targeted commercial fishing and mass removal harvest techniques (e.g., unified method) by our state and federal partners. Acoustic deterrent system testing is scheduled for FY 2021 in the Hanson backwater, and data from these gages are needed, along with co-located real-time fish telemetry receivers to support the acoustic deterrent system testing. In addition, data from these gages (in operation since 2013) enables assessment of seasonal and yearly variation in carp response to changes in water quality, both in the main channel and in a highly-utilized backwater refuge.

USGS will perform Reverse FluEgg Simulations to Identify Spawning Locations from 2018 Ichthyoplankton Data in the IWW. This project will use the reverse-time particle tracking capabilities of FluEgg v4.1.0 to estimate the most-likely spawning locations for eggs and larvae sampled in the IWW by the INHS on June 25-26, 2018.

The estimated spawning locations determined for the 2018 samples will be compared to the spawning locations estimated for eggs and larvae collected in 2015. Results from this study will be used to evaluate the consistency of invasive carp spawning locations in the IWW across different spawning seasons. This analysis will greatly enhance the insight provided by these field ichthyoplankton collections and the feasibility of removal efforts to target annual locations of Asian carp spawning aggregations. Disruption of spawning aggregations has the potential to diminish the reproductive output and subsequent recruitment and population growth of the Asian carp populations in the IWW. In addition, the potential to incorporate FluEgg analysis as a regular component of the annual monitoring for Asian carp reproduction in the IWW would represent a major enhancement of the actionable information content provided by the ichthyoplankton surveys.

T-12 Technology Registration and Environmental Review

Lead Agency: USFWS

Agency Collaborators: USGS, USACE, USEPA, University of Wisconsin Platteville, University of Illinois, Wisconsin DNR, KDFWR, Iowa DNR, Illinois DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$135,000	$15,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support Asian carp deterrent technology projects by addressing the USEPA regulatory permitting and environmental reviews required for scale-up field deployment of CO_2 and acoustic deterrent research projects. For FY 2021, the proposed actions include developing an OPMS so state and federal partners can register to use CO_2-Carp and request a label for the specific applications approved by the USEPA. In addition, the USFWS will continue to work with project partners implementing acoustic deterrent field research to ensure compliance with all applicable federal, state, and local environmental regulations.

Project Description:

This project supports the development, registration, and use of various emerging technologies to control Asian carp, including CO_2 (now USEPA-registered CO_2-Carp) and acoustic deterrents.

For FY 2021, the proposed actions include developing an OPMS so state and federal partners can register to use CO_2-Carp and request a label for the specific applications approved by the USEPA. The USFWS and USGS will administer this system to provide and track the label to applicators, ensure state registrations and other necessary permits (for example, National Pollutant Discharge Elimination System permits) are obtained prior to receiving the label, and collect data to report back to USEPA to maintain product registration. The initial CO_2-Carp registration covered lethal under-ice application of CO_2-Carp as a piscicide, and an amended label has been submitted to the USEPA to allow the use of CO_2-Carp "to deter aquatic nuisance species or as a lethal control for aquatic nuisance species".

For acoustic deterrent research projects in progress at Barkley Lock and Dam in Kentucky and planned at Lock and Dam 19 on the Upper Mississippi River, the USFWS will continue to work with project partners to ensure compliance with all applicable federal, state, and local environmental regulations, including ESA Section 7 consultation, Migratory Bird Treaty Act compliance, and other regulatory requirements.

T-13 Developing Techniques to Remove Large Congregations of Bighead Carp and Silver Carp in Tailwaters of Strategic Dams

Lead Agency: USGS

Agency Collaborators: MRWG Agencies, KDFWR, Tennessee WRA

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$320,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will study congregations of Asian carp in tailwaters and lock approaches of strategic pinch-point dams in the Illinois River at Starved Rock Lock and Dam and in the Tennessee-Cumberland River system in Kentucky at Kentucky Dam. This project will help develop: (1) a better understanding of the environmental factors driving congregations at large and small scales and (2) techniques to remove Asian carp in these congregations. This project will prevent Asian carp from becoming established in the Great Lakes by reducing movement upstream through key pinch-point dams, thus reducing potential propagules in upstream reaches of these systems. This year's funding will be used to continue (at Kentucky Dam) and initiate (at Starved Rock Dam) sampling (hydroacoustics, flow survey, and telemetry) to better understand factors driving Bighead Carp and Silver Carp congregations at small and large scales and, begin to work with commercial fishers and management agencies in Kentucky to develop a tailwater/approach removal or deterrent techniques.

Project Description:

During part of the growing season, Bighead Carp and Silver Carp congregate in mass in lock approach areas and tailwaters of some dams that are population pinch-points for Bighead Carp and Silver Carp (pinch-point dams) on large rivers (e.g., Starved Rock Dam on the Illinois River, Barkley Dam on the Cumberland River, and Kentucky and Pickwick Dams on the Tennessee River). These congregations are often visible on the surface or at times of disturbance by flow, sampling, or boats. USGS staff hypothesize that these fish are spending significant amounts of time in these tailwaters and lock approach channels to exploit relatively concentrated food resources and/or favorable hydraulic conditions. Several factors might be contributing to concentrating food resources for Bighead Carp and Silver Carp, including an abundant source of plankton produced in the reservoirs above these dams, hydraulic conditions, like eddies that

concentrate food, and maceration of food sources, including zooplankton and fish by spillway gates, power plant turbines, or barge propellers. Bighead Carp and Silver Carp in the downstream approach channel to the lock may pose a risk for passing upstream during lock operations or interfering with lock maintenance (e.g., at Starved Rock in Fall 2020). Effectively targeting these large congregations of Bighead Carp and Silver Carp for removal at strategic dams would likely contribute to management objectives to control the spread and reduce the impacts to native fishes, as well as minimize interference of lock operations during maintenance. The objectives of this project are to identify (1) strategic dams that typically have congregations of Bighead Carp and Silver Carp where studies can be conducted, (2) large-scale environmental factors that influence when Bighead Carp and Silver Carp congregate in tailwaters and lock approaches (e.g., discharge, lift, season, temperature, and seston), and (3) small-scale hydraulic and operational factors (i.e., turbulence, eddy formations, water release from spillway gates, lock discharge, and power plant turbines) that influence the location of these congregations in tailwaters and approach channels. In parallel with the above objectives aimed at understanding factors that influence when and where large congregations occur, this project will also begin to work with KDFWR and contracted fishers (SilverFin) to develop effective removal techniques and gears for these large congregations.

DS-1 Modeling Potential for Asian Carp Reproduction, Population Growth, Food Web Effects and Control in Maumee River and Western Basin of Lake Erie

Lead Agency: NOAA

Agency Collaborators: Brenton Consulting, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$110,800	$57,321

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will develop and apply a spatially explicit multi-species, IBM of Grass Carp, Bighead Carp and Silver Carp, and native fishes and food webs in the Maumee River and western Lake Erie. This project will result in a decision support tool to inform prevention and control of Grass Carp, Bighead Carp, and Silver Carp populations and impacts, and their potential for establishment, recruitment, and food web effects. This year's funding will produce a calibrated IBM that will project Asian carp recruitment success and population growth under a range of river habitat conditions and carp spawner abundances and inform prevention efforts by projecting population response and control at varying harvest levels.

Project Description:

Bighead Carp and Silver Carp threaten to invade the Great Lakes and disrupt aquatic food webs and fisheries through their consumption of plankton and detritus in lower trophic levels. Non-reproducing triploid Grass Carp were stocked in private ponds for many years to control aquatic macrophytes, but an unknown number of diploid individuals are reproducing in the Maumee and Sandusky Rivers. At high population densities, all three Asian carp species can cause dramatic shifts in energy flow and productivity of aquatic food webs. In rivers and lakes of North America, Asia, and Europe, the introductions of Asian carp have resulted in the decline of many native fish species, with planktivorous larval, juvenile, or adult fish being particularly affected. Our previous food web model results of the potential risk of Bighead Carp and Silver Carp to Great Lakes and Illinois River habitats suggest that if the Bighead Carp and Silver Carp reach a high biomass, there could be consequences to important fishery species. Establishment and growth of Asian carp are driven by variable habitat conditions for spawning and recruitment and variation in productivity and structure of food webs, thus creating uncertainty in predicting population sizes and food web effects among and within Great Lakes habitats.

In FY 2021, NOAA will develop and apply the IBM model to simulate dynamics of Grass Carp, Bighead Carp, Silver Carp, four resident fish species (including Walleye, Yellow Perch, Gizzard Shad, and Smallmouth Bass), and multiple prey biomass groups in the Maumee River and Lake Erie's western basin. Grass Carp currently are reproducing in the Maumee River, and Bighead Carp and Silver Carp may find suitable habitat in the river for reproduction and establishment if introduced. NOAA will work with USGS and Ohio DNR to gather recent survey data on Asian carp and native fishes and their prey to help configure the IBM. NOAA will collaborate with the USGS FluEgg team to run simulations of river flow and its effects on egg and larval drift for input into the IBM and identify those habitat conditions leading to Asian carp population growth and food web effects. NOAA will also simulate a range of targeted harvests of Asian carp to help inform current management and control efforts.

This project leverages previous funding but is a new activity and extends funding received in FY 2019 to develop and test the multi-species IBM of Bighead Carp and Silver Carp in the Illinois River. In 2021, NOAA proposes to collaborate with the USGS FluEgg team to better capture recruitment dynamics, potential population growth, and food web effects of Grass Carp in the Maumee River-western Lake Erie basin and project potential for Bighead Carp and Silver Carp to establish, grow, and affect food webs.

DS-2 USFWS Asian Carp Population Modeling to Support an Adaptive Framework

Lead Agency: USFWS

Agency Collaborators: SIU, Illinois DNR, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$195,000	$100,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will further develop and implement the SEACarP quantitative fisheries population model to inform decision-making concerning Asian carp prevention and control efforts in the Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island pools of the Illinois River. Advancements to the model will improve the SEACarP decision-support tool and include the development of novel models to address emerging management questions, further supporting the use of available data and analyses. Funding in FY 2021 will support refinement of the data-driven SEACarP model, enhancing its utility for analyses of ACRCC management options, including strategically targeted intensive commercial harvest of Asian carp in select pools of the Illinois River, with the long-term goal of preventing upstream range expansion toward the Great Lakes and reducing the likelihood of fish challenging the EDBS.

Project Description:

The goal of this project is to develop objective data-driven tools in support of the adaptive management process to direct Asian carp control efforts in the Illinois River. To accomplish this goal, this project will continue ongoing efforts to further develop and implement the SEACarP model and develop novel tools to address emerging management questions.

The SEACarP model is currently being used to: (1) inform management recommendations concerning required levels and spatial allocations of mortality (e.g., when and where to focus harvest) and upstream movement deterrence to minimize the likelihood of upstream range expansion in the vicinity of the EDBS, and (2) provide management recommendations concerning needed Asian carp data collections and research in the Illinois River and guide further model development to increase model capability and reduce uncertainty.

Actions in FY 2021 will address current model limitations, including the need to enhance the Asian carp movement model within SEACarP, a key component that describes the rates at which fish move between pools. The coverage of the current movement model is limited to the Illinois

River. Consequently, the SEACarP model treats the Illinois River as a closed system, despite considerable fish movement between the Illinois River and Upper Mississippi River basins. Also, due to other limitations associated with movement estimates, model-based mortality recommendations are provided on a relatively course spatial resolution (i.e., pools above versus below Starved Rock Lock and Dam) rather than on an individual pool level. To address these limitations, project leads will coordinate with the MRWG Telemetry Work Group to deliver an updated movement model with greater spatial coverage and finer spatial resolution. The SEACarP model will be re-coded as needed to accept the updated movement model.

Additional effort will focus on continued development of an Asian carp stock-recruitment relationship to support SEACarP analyses. The stock-recruitment relationship determines how Asian carp recruitment rates respond to control-induced reductions in adult biomass. Although the SEACarP model was originally intended to include an Asian carp specific stock-recruitment relationship, there is no currently available stock-recruitment model that is compatible. Data from the MRWG Hydroacoustics Work Group as well as age-structure data from field collections will be leveraged to develop an Asian carp stock-recruitment relationship.

Further work in FY 2021 will utilize the SEACarP model to estimate the rate at which individual Asian carp in a given pool contribute to pools located above Starved Rock Lock and Dam. The goal of this contribution modeling effort is to assist managers by providing a tool that would prioritize harvest locations (i.e., pools) as a function of Asian carp densities and contracted commercial catch rates.

In addition to ongoing development of the SEACarP model, a feasibility study will be conducted to determine how successfully statistical catch-at-age or statistical catch-at-length models could be completed using currently available Illinois River data. Statistical catch at age or length modeling will provide insights into the contract commercial harvest program by estimating fishing mortality rates. A final report and manuscript based on results from the current version of the SEACarP model will also be completed.

DS-3 USGS Asian Carp Population Modeling to Support an Adaptive Management Framework

Lead Agency: USGS

Agency Collaborators: SIU, Illinois DNR, USFWS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$100,000	$465,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will develop objective data-driven models to inform decisions concerning Asian carp control efforts in the Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island pools of the Illinois River. This project will result in quantitative population models and prevent Asian carp from becoming established in the Great Lakes by identifying management recommendations that minimize the number of Asian carp challenging the electrical dispersal barriers. This year's funding will produce advancements to existing decision-support tools leading to better long-term management outcomes and develop novel models to address emerging management questions.

Project Description:

The goal of this project is to develop objective data-driven tools in support of the adaptive management process and Asian carp control efforts. To accomplish this goal, this project will continue ongoing efforts to develop and implement the SEACarP model and develop novel tools to address emerging management questions.

The SEACarP model is a simulation-based mathematical representation of Silver Carp and Bighead Carp population dynamics. The model is being used to inform management in the Illinois River in two primary ways. First, the model is being used to provide management recommendations concerning required levels and spatial allocations of mortality and upstream movement deterrence to minimize propagule pressure in the vicinity of the electrical dispersal barriers. Second, critical model assumptions and results from sensitivity analyses are being used to provide management recommendations concerning data collections and research in the Illinois River and guide ongoing model development aimed at extending model capabilities and reducing model uncertainty.

Development of the SEACarP model is ongoing. Two limitations of the SEACarP model are tied to the underlying movement model, which describes the rates at which fish move between pools. First, the coverage of the current movement model is limited to the Illinois River. Consequently, the SEACarP model treats the Illinois River as a closed system, despite considerable fish movement

between the Illinois River and Upper Mississippi River basins. Second, due to other limitations associated with movement estimates, model-based mortality recommendations are provided on a relatively course spatial resolution (i.e., pools above versus below Starved Rock Lock and Dam) rather than on an individual pool level. To address these limitations, this project will coordinate with the MRWG Telemetry Work Group to deliver an updated movement model with greater spatial coverage and finer spatial resolution. In addition, this project would recode the SEACarP model as needed to accept the updated movement model.

The development of an Asian carp stock-recruitment relationship represents a third area of ongoing model development. The stock-recruitment relationship is fundamental to the management of Asian carp in the IWW because it determines how recruitment rates will respond to control-induced reductions in adult biomass. Although the SEACarP model was originally intended to include an Asian carp specific stock-recruit relationship, there is no currently available stock-recruitment model that is compatible with the SEACarP model. In response to this knowledge gap, impacts of the stock-recruit relationship on SEACarP model predictions are assessed using sensitivity analysis. FY 2021 activities would address this limitation by leveraging data from the MRWG Hydroacoustics Work Group as well as age-structure data from field collections to develop an Asian carp stock-recruitment relationship.

A fourth area of ongoing development involves using the SEACarP model to estimate the rate at which individuals in a given pool contribute to pools located above Starved Rock Lock and Dam. The goal of this per capita contribution modeling effort is to assist managers by providing a tool that would prioritize harvest locations (i.e., pools) as a function of Asian carp densities and contracted commercial catch rates.

In addition to the ongoing development of the SEACarP model, this project will conduct a feasibility study to determine how successfully statistical catch-at-age or statistical catch-at-length models could be completed using currently available Illinois River data. Statistical catch at age or length modeling will provide insights into the contract commercial harvest program by estimating fishing mortality rates. Lastly, this project will prepare a final report and manuscript based on results from the current version of the SEACarP model.

This project is a continuation of previous efforts that included the development of data-driven decision support tools to inform Asian carp management efforts in the Illinois River. New FY 2021 activities include the development of an Illinois River Asian carp-specific stock-recruit relationship that will be incorporated into the SEACarP model, thereby improving model predictions. In addition, this project will work with experts from academia to determine how successfully statistical catch at age or length modeling could be completed given currently available harvest data. Results from this analysis, including fishing mortality estimates, would provide insights into the effectiveness of current control efforts. Lastly, preliminary development of a per capita contribution model is new for FY 2021. The goal of per capita modeling is to inform the spatial allocation of available fishing effort across individual pools of the Illinois River based on commercial catch rates.

DS-4 Asian Carp Enhanced Contract Removal, Marketing and Assessment and Management: Assessment of Enhancement Efforts

Lead Agency: Illinois DNR

Agency Collaborators: Tetra Tech, SIU

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$188,600	$0

**All FY 2021 funding projections are based on U appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will assess the success of enhanced removal efforts and aid directed harvest in the lower Illinois River of the state of Illinois. This year's funding will provide heat maps of Asian carp densities in the lower river to aid harvest and assess the effect of harvest on densities of fish.

Project Description:

Control of Asian carp via harvest is a viable technique in the upper Illinois River. The SEACarP model suggests that removal of Asian carp in the lower Illinois River may reduce the migration of fish upstream, further reducing the possibility of invasion into the Great Lakes. This proposal is a collaborative research effort between SIU and Tetra Tech to develop management strategies for enhanced removal through harvest. The role of Tetra Tech is to implement a regional-scale harvest research program through contracting with commercial fishing to increase overall removal, first in the Peoria Pool, then with coordination with management agencies in further downriver reaches. Tetra Tech will enter into contracts on behalf of Illinois DNR to reach removal goals and collect and analyze data that come from the harvested fish and contracted removal and marketing effort. SIU will integrate the contracted removal/research results from Tetra Tech with complementary sampling efforts including hydroacoustics and demographics analysis. Density hot spots will be identified and used to aid targeted removal. These efforts are required to provide detailed and comprehensive analyses about efficacy of removal, status of populations, and recommendations for future contracted removal efforts, considering spatial extent of removal as well as formulation of contracts and effort to meet management goals both in the Upper and Lower IWW.

R-1 ACRCC Contingency Actions in the Upper Illinois River

Lead Agency: USFWS, USACE, and Illinois DNR

Agency Collaborators: GLFC, USGS, USCG

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will ensure a coordinated and timely response in the event that changes are detected in Asian carp populations in the upper Illinois River, and include the continued development and refinement of the CRP through additional response planning and training. This project will result in a response-ready effort in the event the CRP indicates a response is necessary.

Project Description:

The purpose of the CRP is to outline the process and procedures the MRWG and the ACRCC member agencies will follow in response to a change in Asian carp conditions in any given pool of the upper IWW. In the event a change is detected in the status of Asian carp indicating an increase in risk level within the CRP area, this plan will be implemented to carry out appropriate response actions. The interagency MRWG has maintained a robust and comprehensive Asian carp monitoring program in the CRP area and will continue these efforts as the foundation for early detection capability in the IWW.

The MRWG continues to refine and improve the CRP through annual table-top exercises with response agencies and stakeholders. These exercises review the existing CRP and work through hypothetical scenarios that would likely trigger a response action. This allows the MRWG to elicit feedback on appropriate response actions and potential impacts.

BC-1 Black Carp Structured Decision Making, Sampling Improvements, and Genetics Support

Lead Agency: USFWS

Agency Collaborators: USACE, Black Carp Work Group, Illinois DNR, INHS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$70,000	$120,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will use SDM to prioritize Black Carp activities that are most effective for management and control, improve sampling effectiveness through testing of gears in waters where Black Carp are present, and continue coordination and collaboration on genomic and molecular sampling for Black Carp. Existing life history data be compiled and utilized in an SDM process to inform highest-priority actions to prevent Black Carp establishment in the Great Lakes.

Project Description:

- The USFWS will lead an SDM process with the Black Carp Work Group to identify and incorporate information available from current research to establish priorities for both continued research and containment actions for Black Carp. Scientifically informed decision makings will facilitate the more effective use of tools and techniques to assess and reduce the risk of Black Carp approaching and potentially entering the Great Lakes. Decisions will focus on the effectiveness of barriers and deterrents against Black Carp, potential Black Carp attractants and control tools, improvements to Black Carp sampling techniques, and analyses of potential pathways.

USFWS will continue to conduct larval fish identification in coordination with partners to track Black Carp population range and status. Additionally, USFWS will collaborate with ERDC geneticists on improvements to Black Carp eDNA sampling protocols, detection sensitivity, and assay validation; and the development of an SOP for Black Carp eDNA monitoring. Finally, USFWS MFC will continue to conduct ploidy analysis of collected Black Carp.

USFWS will collaborate with the Black Carp Work Group on the SDM process to improve the sampling effectiveness of Black Carp. The SDM process may be used to inform: (1) working with commercial fishers to learn their approach for targeting Black Carp; (2) utilizing habitat

specifications to evaluate capture techniques learned from contracted fishers; and (3) performing laboratory studies to determine Black Carp behavioral response to electrofishing.

In FY 2021, the USFWS Whitney Genetics Laboratory will develop a bioinformatics pipeline (workflow) and the use of long-read PacBio data as a genomic scaffold to anchor and guide the assembly of the previously obtained short-read sequencing data. The assembled genome will be made publicly available through National Center for Biotechnology Information's GenBank and shared with partners for use in future Asian carp biocontrol research.

BC-2 Black Carp Monitoring, Assessment, and Control

Lead Agency: USGS

Agency Collaborators: USFWS, INHS, Illinois DNR, SIU, Missouri DC, KDWFR, USACE

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$450,000	$95,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will implement the highest priority actions to monitor, assess, and control Black Carp in the Mississippi River basin, with emphasis on the Mississippi and Illinois Rivers in Illinois and Missouri. This project will result in the assessment of Black Carp biology and ecology, range, bait development, early life history, and habitat use and movement. It will also help prevent Asian carp from becoming established in the Great Lakes by describing the life history and distribution of the species for the development of detection and control methods. This year's funding will be used to complete final assessments of bait development, status, and origin of Black Carp in the wild and aspects of wild Black Carp diets. Funding will also allow for the continuation of efforts to measure habitat use and movement of Black Carp in the wild, diet composition, reproductive development, larval development, and assist state and federal collaborators with the distribution of samples and range data needed for their research.

Project Description:

Black Carp are an invasive molluscivore in North America, originally transported to aquaculture facilities for their application as biological control of snails in the 1980s. The greatest concern for Black Carp population expansion is the impact on native mussel and snail fauna, of which many species are already listed as threatened or endangered. The USFWS combined project template is a collection of several agency and academia project templates to support the coordinated monitoring, assessment, and control of Black Carp in the Midwest. Presented below are the tasks specific to the USGS portion of this template, which represents a mixture of several projects to study the species biology and ecology, habitat use and movement in the wild, early life history, and develop a species-specific toxic bait.

Biology and ecology:

- Several projects about the life history of Black Carp are facilitated by the collection of carcasses from wild-caught fish. Many of these fish are supported by a bounty paid for by the state of Illinois for removal and reporting of Black Carp captures. USGS serves as the

deposition point for nearly all wild-caught fish. The samples are processed and cataloged for diet assessment, reproductive stage, ploidy, age, growth, stable isotopes, and genetics. These samples are used to assess the status of Black Carp in the wild and potential impacts. The capture data for these fish are cataloged in the publicly available USGS Non-indigenous Aquatic Species database and are used by managers as a method to monitor changes in species range.

Habitat use and movement:

- For research to develop an understanding of Black Carp life history in their introduced range and potential impacts on ecosystems, information is needed on the habitat use and movements of the species. Our objectives are to use telemetry to (1) describe the movements and habitat use of tagged Black Carp and (2) report the occurrence of long-range movements. These results will provide preliminary data from which future research may focus a concentrated effort within habitats and seasons in which Black Carp behavior may be conducive for control or collection efforts.

Early life history:

- Early life history research defines the development of Black Carp eggs and larvae similarly to work with Bighead Carp, Silver Carp, and Grass Carp. Therefore, Black Carp can be included in improved and validated drift models like FluEgg and identification of larval Black Carp.

Bait development:

- The goal of a single-dose, species-specific piscicide bait has not been developed. USGS determined the lethal oral dose of antimycin for Black Carp. USGS developed a delivery method using glass vials attached to prey items and tested several concentrations of antimycin in solvents. Throughout FY 2021, USGS plans to work with researchers developing Grass Carp-specific baits in parallel to leverage both groups' experience in development.

BC-3 Enhanced Detection of Black Carp in the Lower Illinois River

Lead Agency: Illinois DNR

Agency Collaborators: USGS, SIU, INHS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$188,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will sample for the detection and abundance of Black Carp using baited hoop nets in the La Grange Reach of the Illinois River and other known locations of Black Carp. This project will result in increased detection of Black Carp at their upstream invasion on the Illinois River using specialized baits and prevent Asian carp from becoming established in the Great Lakes by early detection of individuals and informing managers of Black Carp bait preferences. This year's funding will produce a database of all fishes and bycatch collected including location, habitat type, bait type, abundance, total length, weight, catch per unit effort, relative weight, community structure, and size structure.

Project Description:

Exotic Black Carp have invaded the Illinois River system and have been recently captured in the Alton, La Grange, and Peoria reaches of the lower Illinois River. Currently, the invasion of Black Carp is represented by only a few reported individuals and little is known about the size of the population or potential scope of ecosystem changes that may result from the invasion. Illinois DNR has been closely monitoring the range expansion of Black Carp up the Illinois River, despite limited catches reported to date. Critical to any inferences made about the range expansion of Black Carp is better knowledge of their population levels in invaded reaches. The limited number of Black Carp reported have been from incidental commercial fishermen catches while targeting other species (e.g., Bighead Carp, Silver Carp, Common Carp, Grass Carp, Buffalo spp., Catfish spp.). These captures and associated data (e.g., length, weight, age, diet, otolith microchemistry) are valuable, but the limited number of reported individuals makes it difficult to assess their prevalence/establishment in the lower Illinois River. More robust estimates of the current population level are essential to management and potential control of Black Carp in the Illinois River.

Illinois DNR will continue sampling using hoop nets baited with experimental baits to assess the population of Black Carp in the lower Illinois River and efficacy of different baits to collect them. The bait of choice to be used in Illinois River monitoring will hopefully be guided by targeted efforts of known Black Carp populations (Horseshoe Lake and Mississippi River) where bait comparisons can be evaluated during intensive sampling. In the La Grange Reach of the Illinois River, Illinois DNR will expand upon the existing Upper Mississippi River Restoration Program's LTRM standardized hoop netting efforts and make direct comparisons using experimentally baited hoop nets to target Black Carp to better detect their presence, abundance, and expansion up the lower Illinois River. While LTRM hoop netting uses a soybean-based bait, this proposed expansion will include the use of clam-based and cottonseed-based baits deployed in about 100 paired hoop net sets each (about 200 hoops total) in main- and side-channel habitats of the La Grange reach. Expanded hoop netting efforts will be randomly fished in main- and side-channel border habitats in three time periods (Period 1, June 15-July 31; Period 2, August 1-September 15; and Period 3, September 16-October 31); similar to ongoing standardized LTRM hoop netting efforts.

BC-4 eDNA Monitoring for Determining Black Carp Invasion Risk for the Great Lakes

Lead Agency: USACE

Agency Collaborators: USFWS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$125,000	$0

**All FY 2021 funding projections are based on U appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will experiment with eDNA sampling of lower Mississippi River waters (as proxies for upper Mississippi River and Illinois River waters), with some artificial spiking of extracted water samples, to determine how different environmental factors may influence survey sensitivity and success. This project will result in the determination of best practices required for providing a sensitive, practical early detection tool for monitoring Black Carp expansion toward critical regions, particularly the Great Lakes. This year's funding will produce an actionable dataset that, in combination with FY 2018-FY 2020 study outputs, will be used to test best practices for Black Carp eDNA monitoring at the leading edges of the Black Carp invasion front in FY 2021, as well as the publication of these results in FY 2022.

Project Description:

USACE ERDC will continue to test different sampling approaches to identify those that provide the highest likelihood of capturing Black Carp eDNA. These tasks build on work conducted in 2018-2020. In FY 2021, eDNA samples will be taken from a locale where Black Carp eDNA detections have previously been obtained (e.g., near Greenville, Mississippi) at various time points during the year. Sampling will focus on mainstem river habitat (e.g., in association with winged dikes) and associated sloughs and oxbows. Water and sediment samples will be tested for endemic Black Carp eDNA. Sampling correlates, such as water turbidity, depth, and temperature, will be recorded for analysis of factors influencing sampling results. In the case of examining the effects of turbidity, a subset of samples will be spiked with Black Carp eDNA materials (e.g., frozen water from commercial Black Carp ponds or synthetic DNAs) to ensure that the effects of turbidity on detection sensitivity are measurable. Continued tests of different filter pore sizes and sediment versus filtered water versus water grabs will be incorporated, as will pre-filtering steps utilized in other studies.

This year will incorporate new sampling efforts that partly replicate efforts from prior years to make study results more robust. For the first time, ERDC will be able to investigate strategic seasonal sampling, with targeted sampling during the predicted spawning season and during low water periods (when Black Carp and their eDNA may be more concentrated). ERDC will also incorporate turbidity measurements and manipulation (reduced via water dilution combined with spiked known positive samples).

GC-1 Implementation of the Adaptive Management Framework for Grass Carp in Lake Erie

Lead Agency: USFWS

Agency Collaborators: Ohio DNR, Michigan DNR, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$350,000	$380,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will support efforts to remove adult Grass Carp in Michigan and Ohio waters of Lake Erie and targeted tributaries, while also collecting information for future adaptive response actions. This year's funding will support response efforts by two field crews at a minimum of seven high-priority locations in the western basin of Lake Erie.

Project Description:

The USFWS will provide field crews, vessel support, and laboratory assistance to project partners working to implement Grass Carp response actions in Lake Erie and connecting waters. USFWS will support research and management needs of the LEC, identified by the Lake Erie Grass Carp Working Group and described in the Lake Erie Grass Carp Response Strategy (2019-2023).

Response priorities will be to: (1) deploy two field crews, (2) implement/evaluate innovative control actions for Grass Carp, (3) use real-time telemetry detections of Grass Carp to inform planning/implementation of response actions, (4) support modeling/telemetry efforts under the direction of the Lake Erie Grass Carp Working Group, (5) collect blood samples for ploidy analysis of Grass Carp captures, (6) excise aging structures from Grass Carp and serve as a second reader to validate age estimates, and (7) provide representation at regional or national conferences/meetings.

Research priorities will be to: (1) continue to support projects identified by the LEC, (2) assist with the implementation of the USGS Grass Carp bait/attractant aggregation study, (3) assist with the implementation of the mobile telemetry Vemco Positioning System array study to track fine-scale movements of Grass Carp during response actions, and (4) conduct a study aimed at evaluating alternative electrofishing settings used to induce a capture-prone response of adult Grass Carp in the Sandusky or Maumee rivers in Ohio using Smith-Root Apex boat electrofishers.

GC-2 Grass Carp Spawning Event Prediction Tool

Lead Agency: USGS

Agency Collaborators: Ohio DNR, University of Toledo

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$90,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will develop a DST for resource management agencies to guide the efficient deployment of a limited number of strike teams for the collection of adult Grass Carp and Grass Carp ichthyoplankton in known spawning tributaries of Lake Erie in Ohio. This project will result in the ability of management agencies to make informed decisions about when and where to deploy Grass Carp strike teams to prevent Asian carp from becoming established in the Great Lakes by providing advanced warning of spawning events in Western Lake Erie. This year's funding will provide a prototype DST for the Sandusky and Maumee Rivers that will enable targeted removal of adult Grass Carp and more efficient collection of ichthyoplankton samples.

Project Description:

This project will develop a DST for resource management agencies to efficiently deploy the limited number of field crews for the collection of adult Grass Carp and Grass Carp ichthyoplankton in known spawning tributaries of Lake Erie. The collection of ichthyoplankton data (eggs and larvae) is critical to understanding reproduction, range expansion, and the potential for the establishment of invasive carp. Grass Carp spawn in response to specific environmental cues, such as a minimum water temperature threshold, water velocity, a rising hydrograph, and perhaps an increase in sediment load. Biologists use this information along with historical field observations, estimates of spawning times, areas from previous samples and model predictions, and local knowledge of river channel conditions to guide site selection and timing for egg and larval collections and targeted removal of adult Grass Carp.

The temporal and spatial variability of spawning across the geographic range of invasive carp can make field sampling difficult to coordinate. A web-accessible DST based on real-time USGS gaging station data (water level, temperature, velocity, discharge), river physiographic characteristics (drainage area, undammed river length, bedslope, etc.), known spawning times and areas, and National Weather Service river forecasts will provide managers with forecasts of high-probability spawning events up to five days in advance, enabling resource management agencies to mobilize and deploy Grass Carp strike teams effectively and efficiently.

GC-3 Identification of Optimal River Conditions for Spawning and Recruitment of Invasive Carps in Tributaries of the Western Basin of Lake Erie

Lead Agency: USGS

Agency Collaborators: NOAA, Brenton Consulting, Ohio DNR, University of Toledo

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$85,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will use existing models to simulate the drift of Asian carp eggs and larvae in tributaries to the Great Lakes, specifically the Maumee River. This project will result in the identification of optimal river conditions for spawning and recruitment of Grass Carp in tributaries of the Western Basin of Lake Erie to prevent Asian carp from becoming established in the Great Lakes by providing information about the conditions that promote recruitment and population growth of Grass Carp. This year's funding will produce a suite of FluEgg model simulations that, in addition to supporting NOAA bioenergetics modeling efforts, will be used to evaluate in-river hatching rates and larval retention rates to identify specific river conditions and spawning areas that have the greatest potential for Grass Carp reproduction.

Project Description:

The tributaries of the Western Basin of Lake Erie are the focus of intensive egg sampling efforts aimed at assessing Grass Carp recruitment risk in rivers with both confirmed and hypothesized spawning. Identifying the river conditions (flow and temperature) and spawning sites that have the greatest potential for grass carp recruitment is necessary to allow management agencies to prioritize events for response actions and allocate their limited resources effectively and efficiently. Therefore, USGS proposes to use existing hydraulic and FluEgg models and high-efficiency, batch processing capabilities to build a library of spawning simulations in the Western Basin tributaries of Lake Erie for a range of water temperatures and discharges (steady flow conditions). Work in FY 2021 will focus on the Maumee River, and outyears could involve other tributaries, such as the Sandusky River and the Cuyahoga River. The simulations will be used to evaluate in-river hatching rates and stage 38 (gas bladder inflation) larval retention rates (i.e., the percentage of larvae that are still located in the river at stage 38). Furthermore, a hindcasting approach will be used to evaluate historic ichthyoplankton data and year-class

estimates from adult captures in the context of the simulations leading to a better understanding of Grass Carp recruitment variability in the Maumee River.

The results of the simulations will also be provided to collaborators at NOAA for incorporation into a multi-species IBM that will be used to evaluate the population dynamics of Grass Carp in the Maumee River and their impacts on native species, as well as the effects of an introduction of Bighead and Silver Carp on fish populations and food web dynamics. Additional FluEgg simulations for estimating egg and larval drift for Bighead Carp, Silver Carp, and three native species will also be incorporated into the IBM. FluEgg simulations for native species will necessitate some custom modifications to the backend FluEgg code.

There will be a total of at least 540 individual FluEgg simulations that will be batch-run using custom scripts and disseminated as a USGS Data Release. In addition to facilitating the inclusion of these results into the "Grass Carp Spawning Event Prediction Tool" (see associated GLRI proposal with the same title), outyear work for this project will involve documenting the results from the Maumee River hindcasting study in an interpretive report or journal article that evaluates recruitment success for Grass Carp in the Maumee River under different temperature and flow conditions. Outyear work for this project would also include creating similar spawning simulation libraries for other Western Basin tributaries to Lake Erie, such as the Sandusky River or the Cuyahoga River.

This project prevents the establishment of Asian carp by providing resource managers with information that will inform aggregation-based (targeted) control and monitoring efforts and by contributing to an IBM that will define the conditions under which Grass Carp populations could grow and thrive. Resource managers can use this information to design targeted control strategies, assess annual catch requirements, and evaluate the impacts of spawning disruption on population growth.

GC-4 Evaluation of Bait and Attractants to Increase Aggregation and Harvest of Grass Carp in the Lake Erie Basin

Lead Agency: USGS

Agency Collaborators: Michigan DNR, Ohio DNR, USFWS, University of Toledo

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$125,000	$700,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will test the use of Grass Carp attractants and baits in harvest locations targeted by commercial fishermen and management strike teams. This project will result in an increased harvest of Grass Carp and prevent Asian carp from becoming established in the Great Lakes by enhancing removal efforts. This year's funding will test the ability of attractants and baits to concentrated fish in the Sandusky River, Ohio, and Plum Creek, Michigan.

Project Description:

This collaborative project will examine new technological control tools, such as attractants and baits, for enhanced Grass Carp removal. Different attractant classifications, like spawning-related chemicals (pheromones) and food-based attractants, aim to support resource managers using integrated management control strategies for invasive fish. Research efforts related to the project will focus on the use of baits and attractants to increase aggregation of Grass Carp, which selectively feed on aquatic vegetation, to enhance current removal efforts of Grass Carp in the Lake Erie Basin. Various taxa like Grass Carp that consume primary producers face a nutritional imbalance, which drives the consumer to select high-quality food resources. Therefore, this biological phenomenon could enable scientists to exploit Grass Carp physiology and food preferences as an invasive species control tool. Previous research has identified a suite of amino acids, high in nutritional value, that elicit an involuntary feeding response by keeping olfactory neuroreceptors open. Subsequently, the reported amino acid research has gained interest in its applicability as a food enhancer to increase the efficacy of the Grass Carp bait. The deployment of these complementary control tools (i.e., baits and attractants) is essential to establish multiple mechanisms for combating the spread of Grass Carp.

Recently, a bait formulation created from duckweed lemnoideae has been successfully used for the oral delivery of a chemical control agent to Grass Carp. Continued optimization studies with this bait have focused on increasing its selective ability in addition to incorporating a

commercially available plant-based replacement for duckweed. Further research is needed to assess the selectivity of the bait, as well as its palatability in wild fish. A method to efficiently detect and quantify bait consumption is underway and will help streamline future bait formulation development.

Once a successful bait has been designed, the addition of an attractant aims to further increase its selectivity, consumption, and efficacy for target species removal. Therefore, by exploiting the biological characteristics of Grass Carp, effective control strategies for resource managers can be developed. Further research efforts applying the approach is necessary to demonstrate the use of food attractants in addition to method development for field application strategies targeting wild Grass Carp. To monitor the effectiveness of the attractant and bait in the field, USGS will use eDNA samples and side-scan sonar to track increases in detection rates of Grass Carp. The eDNA analysis is essential to the project because it will provide an independent assessment of the efficacy of the attractant. In turn, based on previous research characterizing the palatability of these control agents, pairing appropriate chemical controls with an attractant/bait is an essential technological tool necessary for a successful application.

While the development of Grass Carp attractants and baits have been independently studied, utilization of all techniques to attract, aggregate, and successfully remove fish during extended periods have not been examined. Our goal is to determine if species-specific baits, attractants, and combinations of the two alone can increase Grass Carp harvest rates during seasonal removal operations currently employed by state management agencies in Michigan and Ohio.

GC-5 Developing Species-Specific Control Systems for Grass Carp

Lead Agency: USGS

Agency Collaborators: USFWS, Viterbo University

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$185,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will develop new methods for the control of Grass Carp in the Great Lakes basin, including Lake Erie. This year's funding will allow for the screening, selection, and field testing of new chemicals as Grass Carp-specific piscicides for resource managers within the Great Lakes basin.

Project Description:

Few tools exist to contain and prevent the spread of invasive Grass Carp in the Great Lakes. New lethal technologies are needed to establish an integrated management approach. Developing technological tools to specifically target Grass Carp, like those currently used for sea lamprey, are of great interest and would provide another strategy for fish removal. Specifically, the LEC has identified the development of Grass Carp specific piscicides as a long-term priority for the region. By exploiting the biology and ecology of Grass Carp, new lethal controls and delivery systems can be developed that are more selective that the only lethal control currently available to fishery managers for Grass Carp, rotenone. This project consists of: (1) identification and evaluation of new novel toxicants for Grass Carp and (2) development of specific delivery systems for Grass Carp for effective long-term removal strategies.

The goal of this project is to develop delivery systems and chemical control agents that specifically target Grass Carp for use by resource managers. This will be accomplished using a tiered approach by (1) using *in silico* modeling to predict candidate Grass-Carp-specific (i.e., cyprinid) toxicants; (2) screening select novel toxicants with cytotoxic assays using cell lines derived from Grass Carp (i.e., target species) and other non-target fish species (e.g., fathead minnow, rainbow trout); and (3) conducting *in vivo* laboratory toxicity studies with toxicants to examine whole organism selectivity to Grass Carp as well as effects on non-target species (fish and invertebrates) under similar water conditions found in the Lake Erie basin.

GC-6 Improved Control Efficiency through Better Understanding of Grass Carp Movements and Habitat Use

Lead Agency: USGS

Agency Collaborators: Ohio DNR, Michigan DNR, Michigan State University, New York DEC

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$200,000	$620,813

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will provide information on when and where invasive Grass Carp can be most effectively targeted by fishery management eradication efforts in Lake Erie. This project will prevent Grass Carp from becoming established in the Great Lakes by better informing current eradication efforts with a comprehensive understanding of seasonal movements and habitat use. This year's funding will produce an expanded coverage of the telemetry receiver network into currently unmonitored habitats where Grass Carp are suspected to be present.

Project Description:

The goal of this project is to address the threat of invasive Grass Carp by developing a comprehensive understanding of seasonal movements and habitat use to determine when and where eradication efforts would be most effective. The work will be accomplished with acoustic telemetry, leveraging GLATOS in a basin-wide interagency collaboration. The goal of this project directly addresses a top priority of the Council of Great Lakes Fishery Agencies. This research objective was developed through a series of SDM workshops involving USGS partners of the JSP (http://www.glfc.org/joint-strategic-plan-committees.php).

Behavioral information on Grass Carp spawning, feeding, and overwinter behavior is highly sought by managers to inform the development of control and eradication strategies. Detailed observations of the location and timing of these behaviors will also be compared to abiotic conditions to explore potential cues to these observed movement patterns. Initial telemetry results have indicated the need to expand the telemetry network into nearshore areas of Lake Erie to fill critical gaps in knowledge of Grass Carp habitat use. Our objective is to continue developing the GLATOS network in nearshore waters of Lake Erie and contribute a more robust analysis of seasonal habitats and survival for decision-makers.

This project will further develop the GLATOS network in nearshore waters of Lake Erie and contribute a more robust analysis of seasonal habitats and survival for decision-makers. USGS

will develop revised estimates of population size, survival, and behavioral models for Grass Carp. This critical component of the work combines the acoustic telemetry expertise of USGS with the modeling capabilities of the Quantitative Fisheries Center at Michigan State University (QFC). Modeling and novel spatial analyses will characterize fine-scale spawning movements in the Sandusky River, which will help identify migration "choke points" for strike teams, as well as providing supplemental information for a seasonal barrier. Telemetry information in coastal habitats not previously examined will fill some gaps in our understanding of seasonal habitat suitability for adult fish. Additionally, this work will improve survival and population size estimates relevant to informing sample size targets for tagged Grass Carp, which are periodically revised by QFC based upon new information and improved understanding of population structure and movements. In FY 2021, USGS will also begin investigating thermal and dissolved oxygen conditions to understand suitable and unsuitable habitat conditions as potential drivers of movements and cues for migration.

GC-7 Identifying Spawning Tributaries and Specific Spawning Areas of Grass Carp

Lead Agency: USGS

Agency Collaborators: Ohio DNR, Michigan DNR

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$200,000	$446,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will identify the Great Lakes rivers in which Grass Carp spawn, specifically in Ohio and Michigan tributaries of the Great Lakes. This project will result in an identification of tributaries in which invasive Grass Carp are spawning and locations of specific spawning areas within those tributaries and prevent Asian carp from becoming established in the Great Lakes by providing managers with information needed to capture adult Grass Carp and initiate efforts to prevent their spawning. This year's funding will produce an expanded number of rivers sampled (at least six), provide information on potential new spawning locations in the Great Lakes tributaries, and help verify spawning locations within those tributaries.

Project Description:

This project will sample for early life history stages (eggs and larvae) of Grass Carp in tributaries of the Great Lakes. USGS will use ichthyoplankton nets in several tributaries where Grass Carp are either known to spawn or have been identified as high risk of Grass Carp spawning during spawning season (mid-May through August). Suspected Grass Carp eggs and larvae will be examined for the developmental stage, and all collected data and developmental stages of eggs and larvae will be entered into a database. USGS uses data from eggs and larvae in models that identify specific spawning locations. This information will be provided to managers to inform their efforts to remove and eradicate Grass Carp from the Great Lakes. This project prevents the establishment of Grass Carp in two ways. First, it provides managers accurate and precise locations within rivers to target the removal of adult Grass Carp during spawning. To date, this tactic has produced high catches of adult Grass Carp. Second, it identifies new spawning rivers and locations within rivers, which increases locations where control efforts can be initiated, further reducing the overall population and risk of establishment. This goal was identified by the Great Lakes Grass Carp Advisory Committee and is a top priority of the Council of Great Lakes

Fishery Agencies, the LEC, and partners of the JSP. This template is coordinated with appropriated USGS funding under the same project title.

A new aspect of this work is expanding sampling to new tributaries in Lake Erie and Lake Huron. USGS-led research in 2019 through 2020 identified a new potential spawning river in Lake Erie. The capture of fertile Grass Carp in the Cuyahoga River, a tributary to Lake Erie, by USFWS in 2019 supported the potential for Grass Carp spawning there. The capture of a fertile female Grass Carp in the Tittabawassee River, a tributary to Lake Huron, raised the concern of spawning in that river. USGS will expand our sampling efforts to include these rivers in 2021.

GC-8 Adaptive Management Framework for Grass Carp in Lake Erie

Lead Agency: Ohio DNR

Agency Collaborators: Michigan DNR, USFWS, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$500,000**	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

***Ohio will use FY 2020 funding to cover funding needs for FY 2021 activities; funding carried over to FY 2022.*

Project Summary:

This project has a goal to remove 390 diploid Grass Carp annually from Lake Erie and determine the feasibility of a seasonal barrier on the Sandusky River to disrupt their spawning potential with the goal of eradication. This project will result in suppression/eradication of the Grass Carp population in Lake Erie and work to prevent this member of the Asian carp family from becoming established in the Great Lakes. In FY 2021, four Grass Carp Strike Teams in partnership with the University of Toledo will be deployed.

Project Description:

U.S. and Canadian resource agencies in the Lake Erie basin have identified the growing threat of invasive Grass Carp as a high priority requiring focused and aggressive monitoring and control actions targeting locations of known spawning in the Sandusky and Maumee Rivers. Member agencies have developed a suite of proposed actions for implementation, building off existing efforts within the Lake Erie basin. Planning for continued Grass Carp actions is being conducted in collaboration with the Great Lakes Fishery Commission, Council of Great Lakes Fishery Agencies Lake Erie Invasive Fishes Committee, and the Council of Lake Committees LEC.

The focus of the Lake Erie Grass Carp actions is on the Western Basin of Lake Erie, specifically in the Sandusky and Maumee Rivers. Other Lake Erie tributaries in Lake Erie will be monitored for Grass Carp and potential spawning activity. The goal of the project is to remove 390 diploid Grass Carp annually from Lake Erie to suppress their spawning potential and disrupt spawning activity through a behavioral barrier with the goal of eradication. Ohio DNR is proposing to combine previous knowledge with additional information gained to further refine when and where Grass Carp response actions can be most effective for control/eradication through the following:

1. Deploy four Grass Carp Strike Teams in partnership with University of Toledo.
2. Use real-time telemetry detections to evaluate catchability and capture rates.

3. Continue to support modeling efforts through University of Toledo and Michigan State University to increase collection efficiency, determine effectiveness in removal, and better estimate population size.
4. Continue to determine barrier feasibility on the Sandusky River using current funding.

GC-9 Implementation of Adaptive Management Framework for Grass Carp in Lake Erie

Lead Agency: Michigan DNR

Agency Collaborators: Ohio DNR, USFWS, USGS

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$325,000	$150,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will implement Grass Carp response actions in Michigan and Ohio waters of Lake Erie and connecting waters. This project will result in the removal of adult Grass Carp and prevent Asian carp from becoming established in the Great Lakes by reducing the number of spawning fish while collecting information to inform future adaptive response actions. This year's funding will support the capacity to implement response efforts at a minimum of seven high-priority locations in the Western Basin of Lake Erie.

Project Description:

Michigan DNR will implement response actions for Grass Carp in Lake Erie based on the 5-year adaptive response strategy (2019-2023) developed by the LEC and informed by an SDM process facilitated by Michigan State University in 2016-2017. The three objectives of the response strategy include: (1) improve the collective understanding of Grass Carp population dynamics, behavior, and impacts in Lake Erie to inform effective management actions, (2) implement controls to minimize population expansion by removing fish and/or blocking access to preferred habitats, and (3) minimize the likelihood of introduction and establishment of new breeding populations of Grass Carp in the tributaries and nearshore areas of Lake Erie and Lake St. Clair. This project funding will be used to support a Michigan Grass Carp response team that will implement the following actions:

- Implement and evaluate innovative control actions for Grass Carp.
- Conduct random and fixed-site monitoring to track population trends.
- Use real-time and active telemetry detections to estimate catchability and capture rates of untagged fish (i.e., "Judas fish" approach) and determine if active tracking of tagged fish can increase removal rates.
- Evaluate the use of bait and attractants to increase Grass Carp capture rates.

- Participate in the population modeling and telemetry sub-workgroups under the Lake Erie Grass Carp Working Group.
- Implement strategic response actions in Ohio waters, as requested by Ohio DNR.
- Partner with commercial fishing operations for Grass Carp removal.
- Outreach with bow-fishers to promote removal.
- Represent Michigan during regional and international invasive species meetings to communicate Grass Carp eradication efforts to interested partners and stakeholders.

The Grass Carp response crews will collaborate with USGS partners to evaluate the use of the bait and attractants to increase Grass Carp capture rates. A study design was developed for implementation in 2020; however, the efforts were postponed until 2021 due to COVID-19 delays. If the bait and attractants demonstrate increased removal effectiveness, future efforts may adopt the strategy into the basin-wide response strategy.

A feasibility study is currently underway to evaluate potential seasonal barrier for blocking Grass Carp spawning in the Sandusky River. The feasibility study is expected to be completed by January 2021. If a barrier is selected for design and/or implementation, the Michigan DNR response crew would be available to assist with any field related needs.

COMM-1 ACRCC Strategic Communications

Lead Agency: USFWS

Agency Collaborators: All ACRCC Partner Agencies

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$200,000	$100,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

The USFWS will continue to lead the implementation of targeted basin-wide ACRCC communication efforts. This work includes ongoing management of the ACRCC website, AsianCarp.us; developing targeted media outreach; coordinating partner responses to public, congressional and media inquiries; refinement of ACRCC early detection notification protocols; creating ACRCC branded communication products; organizing public listening sessions as needed; enhancing the ACRCC's image library and increasing the reach of ACRCC messaging.

Project Description:

The communications work led by the USFWS promotes transparency and accountability and supports the ACRCC's efforts to tell its own story effectively in a polished and professional manner. Strategic communication efforts contribute to key audiences' understanding and appreciation for the ACRCC's purpose, function, current actions and successes among key audiences. The partnership's ongoing work increases stakeholder engagement and directly supports the ACRCC's mission of protecting the Great Lakes from Asian carp. This year's funding will support the refinement of consistent messaging for use by the partnership, enhance storytelling efforts among targeted audiences, and support ACRCC communications capabilities during the ongoing pandemic.

PO-1 ACRCC Partnership Operations Assistance

Lead Agency: USFWS

Agency Collaborators: USEPA

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$41,000	$41,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will provide support for key coordination, communication, and outreach among the ACRCC and to other Asian carp partners. The effort increases efficiency in ACRCC strategic planning and communication and facilitates prompt and accurate deliverables on behalf of participating agencies and co-chairs.

Project Description:

The ACRCC program support provides assistance through the following primary efforts:

- Providing support to the ACRCC co-chairs on key activities of the partnership, including development of the annual Asian Carp Action Plan, general interagency coordination, and related communication and outreach.
- Supporting bi-national (U.S. and Canada) coordination through the ACRCC in the sharing of emerging Asian carp information, including relevant efforts supporting the goals of the National Plans and other Asian carp control strategies.
- Convening ACRCC calls once a month to discuss progress made on monitoring, prevention and control activities.
- Assisting ACRCC with convening full partnership meetings (in-person or virtual) to discuss agency input, as directed by the ACRCC co-chairs.
- Assisting in convening public updates with agencies and stakeholders across the Great Lakes as directed by the ACRCC co-chairs.
- Assisting in preparations for congressional and other briefings, as needed and as directed by the ACRCC co-chairs.
- Generally working with the ACRCC and other stakeholders in the Great Lakes and Mississippi River basins on relevant Asian carp issues.
- Supporting the stakeholder consensus-building process for long-term solutions to address aquatic nuisance species transfer between the Great Lakes and Mississippi River basins.
- Assisting the MRWG in the development and release of the MRP and working with the MRWG to help coordinate the extensive monitoring under the MRP for the CAWS and the Illinois River.

PO-2 Coordination and Facilitation for the Chicago Area Waterway System Aquatic Invasive Species Stakeholder Group

Lead Agency: Northwestern Indiana Regional Planning Commission

Agency Collaborators: ACRCC

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$50,000	$0

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

This project will coordinate and facilitate communication and meetings for the CAWS-AIS Stakeholder Group. This group is comprised of representatives from local governments, non-government organizations, and various waterway user groups impacted by the CAWS and/or concerned about the system's impact as an AIS pathway between basins. This project will result in further maintenance of an established and diverse group of informed stakeholders impacted by ACRCC activities. Funding in FY 2021 will produce monthly CAWS-AIS Stakeholder Group Steering Committee meetings, two to four face-to-face meetings (or virtual, depending on COVID-19 considerations), and distribution of notes and correspondence for the group.

Project Description:

The CAWS-AIS group's primary focus in 2021 will be to:

- Continue tracking the progress of the planning, engineering, and design between USACE and the State of Illinois about the planned control project at the Brandon Road Lock and Dam, as well as monitoring budgetary commitments to the project by federal and state partners.
- Continue receiving and discussing agency reports on the results of agency Asian carp surveillance and control measures.
- Continue to review and discuss the results of cost and effectiveness research into additional Asian carp control measures.
- Continue to observe progress on maintaining and updating the GLMRIS Report.
- Continue to serve as a forum for exchanging information and receiving updates from the USACE, USFWS, the State of Illinois, and other federal and state agencies.

PO-3 GLMRIS Program Management

Lead Agency: USACE

Agency Collaborators: None

FY 2021 Lead Agency Project Funding

GLRI Funding*	Agency Funding*
$0	$335,000

**All FY 2021 funding projections are based on appropriations provided by the Consolidated Appropriations Act, 2021 (Public Law number 116-260).*

Project Summary:

The proposed work includes vertical team coordination, stakeholder coordination and engagement, budget development and defense, public outreach, ACRCC and CAWS Advisory Committee related activities, and response to Congressional and media inquiries.

Project Description:

USACE completed the GLMRIS Report in January 2014, which evaluated options and technologies available to prevent the spread of aquatic nuisance species in either direction between the Great Lakes and Mississippi River basins through the CSSC, and other aquatic pathways. The Report identified multiple alternatives including alternatives at the Brandon Road Lock and Dam, which were evaluated in a separate, stand-alone feasibility study. The Brandon Road Study was completed when the Chief's Report was signed on May 23, 2019 and sent to Congress.

FY 2021 funding will be used to continue vertical team coordination, stakeholder coordination and engagement, budget development and defense, public outreach, Asian Carp Regional Coordinating Committee and Chicago Area Waterway System Advisory Committee related activities, and response to Congressional and media inquiries.