2019 ASIAN CARP ACTION PLAN

Asian Carp Regional Coordinating Committee

Asian Carp Action Plan for Fiscal Year 2019

March 2019

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 Office of the Great Lakes
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
Ontario Ministry of Natural Resources and Forestry
Québec Ministère de la Forêt, de la Faune et des Parcs
U.S Department of Commerce - National Oceanic and Atmospheric Administration
U.S. Department of Agriculture – Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Department of Transportation/Maritime Administration
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
National Park Service
Fisheries and Oceans Canada
City of Chicago
Great Lakes Fishery Commission
Great Lakes Commission
Metropolitan Water Reclamation District of Greater Chicago

TABLE OF CONTENTS

List of Figures

List of Tables

Appendices

EXECUTIVE SUMMARY

The Asian Carp Regional Coordinating Committee's (ACRCC) 2019 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 27 United States (U.S.) and Canadian federal, state, provincial, and local agencies and organizations — to achieve its mission to prevent the introduction and establishment of Asian carp in the Great Lakes.

Projects in the 2019 Action Plan are supported by a combination of $30,434,948 in Agency Funding and $21 million in Great Lakes Restoration Initiative (GLRI) funding provided through fiscal year (FY) 2019 appropriations. All proposed federal actions are subject to final Congressional appropriations. *All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

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 for Asian carp and other aquatic invasive species (AIS). The 2019 Action Plan builds upon prior efforts by applying "lessons learned" and using data and science to inform an adaptive management approach under which strategic enhancements are incorporated, when and where needed, to further reduce the risk 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 across key geographic locations. The Action Plan again includes key projects to address identified potential pathways or vectors for Asian carp movement and range expansion.

The 2019 Action Plan continues to provide an increasingly assertive approach to Asian carp control within the comprehensive strategy. This includes a goal of further reducing Asian carp populations in the Illinois Waterway (IWW) to more aggressively address the potential threat of fish movement upstream towards the Great Lakes.

The ACRCC principal line of defense is the U.S. Army Corps of Engineers' (USACE) operation of the Electrical Dispersal Barrier System (EDBS) in the Chicago Area Waterway System (CAWS). The bypass barrier and the sluice gate screens are additional measures in place to address potential issues with the efficacy of the electric barriers. The EDBS is intended to stop the movement of juvenile and adult Asian carp towards the Great Lakes. In 2019, USACE will continue to operate the fish deterrent measures in the CAWS and operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the EDBS and replacement of electrodes at the Demonstration Barrier I and Barrier IIB. In FY 2018, USACE awarded a contract for the installation of the pulse generating electric equipment at Permanent Barrier I. This work will continue in 2019.

In FY 2018, the public review period for the Brandon Road Study Tentatively Selected Plan (TSP) ended and the draft report underwent technical and policy review. Comments from these reviews were considered and incorporated into the report as feasibility level planning and engineering analysis were also completed. The final draft report will undergo State and Agency Review and a Chief's Report will be developed in FY 2019.

The ACRCC recognizes the value of increased harvest of Asian carp in the Illinois River informed by real-time fishery stock assessment data and has set a goal of removing 15 million pounds annually by 2022. In 2019, the directed use of contract commercial fishing will again be increased to achieve even greater annual harvest of adult Asian carp in key locations in the upper Illinois River to support ACRCC management goals. Also, a new pilot project will explore potential opportunities to make greater market use of adult Asian carp captured through commercial removal efforts conducted in support of the ACRCC's long-term population management goals and objectives for the Illinois River. Removal efforts will be informed by agency assessments of Asian carp population status and movement within the focused geographic range.

A key component of the 2019 ACRCC efforts includes the use of underwater sound as a potential control technology. There are three basic components of the work being undertaken. The first component is the Barkley bio-acoustic fish fence (BAFF) Deployment Project. This component will be a large-scale experimental deployment of the BAFF system at Barkley Dam near Grand Rivers, Kentucky. This will include system installation, operations and initiation of a demonstration for Barkley BAFF evaluation. The second component is the Lock and Dam 19 Acoustic Deterrent System (ADS) Deployment Project. This component will continue coordination among multi-agency science and evaluation team to determine feasibility for a large-scale experimental deployment in the Upper Mississippi River at Lock and Dam 19 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 in the field on Asian carp and native fishes as well as acoustic deterrent designs.

Increased efforts will be undertaken to field test carbon dioxide (CO_2) as a potential technology for Asian carp control. The 2019 efforts related to the development of CO_2 as a potential control technology are focused on transfer of CO_2 to management agencies through a technology demonstration at a navigational lock in the Fox River, Wisconsin. The purpose of this demonstration is to better determine the feasibility of CO_2 under real-world settings. Researchers will construct, operate, monitor, and evaluate a temporary, large-scale CO_2 injection system within a navigational lock to collect data on engineering, costs, operational parameters, water quality, air quality (human safety), fish behavior, and non-target organisms. Outcomes are expected to inform the transfer of this technology into management actions to reduce the risk of Asian carp spreading into new areas.

The ACRCC will increase focus on phasing potential control tools with demonstrated success into broader strategies, when and where possible, to achieve its mission.

In 2019, the Action Plan will again feature key baseline interagency surveillance efforts, including telemetry, electrofishing and netting, and environmental deoxyribonucleic acid

(eDNA) monitoring; and interagency contingency response plans developed specifically for potential rapid-response in the event of new detections of Asian carp of all life stages in the CAWS and the Illinois and Des Plaines Rivers upstream of the Starved Rock Lock and Dam.

The ACRCC is continuing the development and refinement of the Spatially Explicit Asian Carp Model (SEACarP) population model that will be used to maximize fishing harvest effectiveness to reduce numbers of adult Asian carp in the Illinois River by optimizing location and timing of effort on the water. The model identifies scenarios for spatially explicit components of the Illinois River system and will be expanded to: (1) recommend mortality benchmarks, or harvest quotas, and fish passage deterrent locations with efficacy requirements relative to percent of blocked passage, (2) incorporate updated Asian carp demographic rates using the most current data available, and (3) evaluate the feasibility to estimate immigration into the upper Illinois River using indirect methods from harvest information. The model will also assess potential opportunities to further manage Asian carp populations through the deployment of deterrent barriers to fish movement in strategic locations in river systems, with the goal of Great Lakes defense. In 2019 the use of the SEACarP will be expanded to assist in identifying combinations of management actions needed to achieve the maximum net impact on Asian carp population levels for specific locations in the IWW. The expanded model will incorporate key data with a focus on Asian carp control in the six lower pools in the IWW (Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island), while also providing critical information on growth and year-class strength and informing our understanding of the risk of upstream migration using the most current data.

The portfolio of initiatives in this Action Plan are described under the following complementary focus areas:

1. PREVENTION ACTIONS

The following are summaries of the prevention actions that will be undertaken in FY 2019.

- **Current Barrier System in the CAWS** – USACE will continue to operate three different types of fish deterrent measures (bypass barrier, electric barriers, and bar screens on sluice gates) in the CAWS, each designed to prevent movement of Asian carp toward the Great Lakes in a different manner.
- **Construction of a New Electric Barrier** – Construction of an upgrade to the Demonstration Barrier, authorized in the Water Resources Development Act of 2007, is being completed in stages via multiple contracts. USACE will begin the final construction phase of this barrier, known as Permanent Barrier I. Completion of Permanent Barrier I signals the completion of construction on the Chicago Sanitary and Ship Canal (CSSC) EDBS.
- **Development of Potential Future Actions at Brandon Road** –USACE studied aquatic nuisance species (ANS) control technologies that could be implemented in the vicinity of Brandon Road Lock and Dam located in Joliet, Illinois. In FY 2019, the final draft report for the Brandon Road Study will undergo State and Agency Review and a Chief's Report will be developed.

- **Closure Actions at Little Killbuck Creek Pathway** – In FY 2018, the Ohio Department of Natural Resources (DNR) worked with the local landowner and completed the 25 percent design of the proposed construction effort, determined the proposed berm alignment, developed additional hydraulic modeling to assess potential flooding, acquired easements on four parcels for the construction of the berm, and facilitated a meeting with the Potentially Affected Interests to present the project. In FY 2019, USACE will peer review Ohio DNR's findings and provide comments to that agency regarding the proposed design and/or alternative designs.
- **Closure Actions at Ohio-Erie Canal Pathway** – In FY 2018, USACE awarded the construction contract for implementation of Ohio-Erie Canal structural measures. The construction of the action to close the pathway will be completed in the fall of 2019.
- **Barge Entrainment** – Recent efforts have focused on testing techniques designed to mitigate the effects of potential barge entrainment, such as the use of water jets and increased flow rates, and the results from these studies will be published in FY 2019. U.S. Geological Survey (USGS) will collaborate with USACE to plan and execute a laboratory study on the use of sill bubble curtains (consisting of creating a wall of dense bubbles that rises continuously from the bottom of the water to the surface) to mitigate tow-induced fish transport through a lock chamber, and field measurements of the flow characteristics around existing sill bubble curtains for validation of lab experiments and preparation field trials.

2. CONTROL MEASURES

The following are summaries of the control measures that will be undertaken in 2019.

- **Contract Fishing, Seining, and Netting** – Contracted commercial fishing is used to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the EDBS. Commercial fishers harvest as many Asian carp as possible in the Starved Rock and Marseilles pools. These harvested fish are picked up and utilized by private industry for purposes other than human consumption. This process is also used to gather information on Asian carp population abundance and movement in the IWW downstream of the EDBS as a supplement to fixed site monitoring efforts. In the CAWS (seasonally) and from the barrier down downstream through Lockport, Brandon Island, and Dresden Island pools (bi-weekly), these contracted netters will work in teams of two or more to detect and remove Asian carp. Through Illinois DNR and U.S. Fish and Wildlife Service (USFWS) harvest efforts, an estimated 6.8 million pounds of Asian carp have been removed from the IWW below the EDBS since 2010. No Bighead Carp or Silver Carp were captured or observed in Lockport or Brandon Road pools during commercial netting.

  In 2019 Illinois DNR will contract with fishers to catch and remove 1 to 1.5 million pounds of Asian carp upstream of Starved Rock Lock and Dam. In addition, contracted fishers will provide expertise and support for seasonal monitoring in CAWS as well as at the EDBS. Work in Lockport and Brandon Road pools will continue at prior levels to

maintain detection ability to inform EDBS operation and contingency planning efforts. Efforts in 2019 will be increased in the Starved Rock and Marseilles pools. 2018 levels of effort will be maintained in other areas to properly inform annual Monitoring and Response Plan (MRP) and contingency planning efforts.

- **Asian Carp Enhanced Contract Removal Program Development** – This effort will continue the implementation of two key impactful recommendations identified in the Asian Carp Business Process Analysis, Final Report and Action Plan. The first recommendation is the creation of a pilot-scale contracted removal effort to spur more Asian carp removal effort in the lower Illinois River, targeting Peoria pool, then considering other lower Illinois River pools. The second recommendation is the creation of a positive brand for Asian carp, a marketing strategy, and marketing support to make use of Asian carp captured and removed through focused efforts in the Peoria pool and other targeted locations. This project will include efforts to communicate the positive qualities of Asian carp – pleasant taste, health benefits, reducing invasive species populations, low contaminant levels, and consuming fish caught from clean waterways. The positive branding will be fundamental in changing current perceptions of Asian carp. Also, a strong, positive brand that countermands negative perceptions of Asian carp, supports existing carp-related businesses, and resonates with targeted audiences could greatly affect a large number of fishers and processors. Asian carp have significant branding potential as a locally caught, fresh fish option. Marketing strategies can range from large-scale, national efforts to local, grassroots initiatives. Initial marketing efforts should occur at the regional level, with potential for expansion as fishing and processing increase. A marketing firm should be procured or added to an existing consulting contract, as permissible and desired, to undertake a short-term branding and develop a regional marketing strategy. The overall effort will reduce the numbers and influence relative abundance of Asian carp in the Peoria pool of the Illinois River, through controlled and targeted contracted fishing efforts. Reducing the relative abundance of Asian carp in the lower Illinois River will subsequently reduce the likelihood that Asian carp will expand upstream, approach, and potentially challenge the USACE EDBS. This effort will be implemented through the issuing of contracts to fishers in Peoria pool and fulfilling contractual obligations of selling, reporting, transporting, and fishing in the identified area administered with close agency oversight.
- **Asian Carp Population Model and Demographics** – In 2019, the SEACarP model will be used to inform potential combinations of management actions needed to achieve the maximum net impact on Asian carp population levels for specific locations in the IWW. The expanded model will incorporate key data with a focus on Asian carp control in the six lower pools in the IWW (Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island), while also providing critical information on growth and year-class strength and informing our understanding of the risk of upstream migration using the most current data. The model and resulting management recommendations will be annually updated and improved based on expert feedback and new information gathered

from ongoing monitoring for population changes, ultimately providing a robust tool to inform ACRCC interagency management actions.

- **Application of Improved Fishery Gears and Designs** – In 2019, this project will continue to build on successful methods for optimizing gear types for mass removal of all size classes and species of Asian carp including: an experimental surface trawl with trapping mechanism, passive weirs with live traps, light avoidance herding, beach seining, and paupier harvest methods. Concurrent work with Illinois commercial harvesters and processors conducting beach seining will enhance our ability to utilize a variety of bag designs and removal devices by capitalizing on existing harvest and removal effort.

3. TECHNOLOGY DEVELOPMENT

The ACRCC is developing control technologies to improve the overall efficacy of the defense of the Great Lakes by providing layered defenses and additional "safety nets," ultimately offering greater confidence in their containment ability. The following are summaries of the control measures that will be undertaken in 2019:

- **Use of Underwater Sound** – There are three basic components to the work being undertaken in FY 2019. The first component is the Barkley BAFF Deployment Project. This component will be a large-scale experimental deployment of the BAFF system at Barkley Dam near Grand Rivers, Kentucky. This will include system installation, operations, and initiation of a demonstration for Barkley BAFF evaluation. The second component is the Lock and Dam 19 ADS Deployment Project. This component will continue coordination among multi-agency science and evaluation teams to determine feasibility for a large-scale experimental deployment in the Upper Mississippi River at Lock and Dam 19 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. It is hoped that the results of these efforts can further inform USACE's efforts at Brandon Road through the development of underwater sound as a potential control alternative at that site.

- **Carbon Dioxide (CO_2)** –In 2019, a technology demonstration is planned at a navigational lock in the Fox River in Wisconsin to better determine the feasibility of using CO_2 as a barrier to Asian carp movement under real-world settings. Researchers will construct, operate, monitor, and evaluate a temporary, large-scale CO_2 injection system within a navigational lock to collect data on engineering, costs, operational parameters, water quality, air quality (human safety), fish behavior, and non-target organisms. Outcomes are expected to inform the transfer of this technology into management strategies to reduce the risk of Asian carp spreading into new areas.

- **Microparticle** – In 2019, USGS will undertake efforts to re-register antimycin-A, a proven fish control chemical, including development of a registration packet and meet with the U.S. Environmental Protection Agency (USEPA) for a pre-registration

evaluation to identify which studies will need to be conducted. During 2019, USGS will conduct those studies deemed necessary to support registration antimycin-A and will concurrently be working to establish a consistent supply of antimycin-A. USGS will complete *in vivo* toxicity trials with a goal of re-registering antimycin-A and preparing a registration packet for microparticle so that field trials can be resumed.

4. EARLY DETECTION, MONITORING AND ASSESSMENT

Continued monitoring and assessment of the Asian carp population in the Upper Illinois River are critical to the ACRCC's ability to assess the threat of Asian carp upstream movement and range expansion. The following describes the early detection, monitoring, and assessment activities being undertaken in 2019:

- **Monitoring Upstream of the Electric Dispersal Barrier System** – In 2019, a variety of gears will be used during seasonal intensive monitoring activities, including pulsed Direct Current (DC)-electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets and Great Lake pound nets to detect, capture and subsequently remove any Asian carp present. Additional intensive monitoring will occur in Lake Calumet (spring 2019) and the North Shore channel (fall 2019).
- **Monitoring Downstream of the Electric Dispersal Barrier System –** Fixed and random electrofishing and contracted netting has been increased since 2014 and will continue in 2019 at these elevated levels below the EDBS. The effort will include intensive electrofishing and netting at four fixed sites and will increase from four to 12 random sites in each of the four pools below the EDBS. Fixed and random site electrofishing will take place monthly from March through November. Contracted commercial netting will occur bi-weekly from March through December, except during June and September, and will include four fixed sites and 13, 13, and 24 random sites in the Lockport, Brandon Road, and Dresden Island pools, respectively. Also, 2019 sampling for young-of-year and juvenile Asian carp will take place through netting and electrofishing operations in coordination with additional projects.
- **Contracted Commercial Netting** – Contracted commercial netting will continue in the above-mentioned pools. This heightened effort remains one of the most successful tools to reduce the threat of Asian carp moving toward the Great Lakes. Through Illinois DNR and USFWS harvest efforts, an estimated 6.8 million pounds of Asian carp have been removed from the IWW below the EDBS since 2010. No Bighead Carp or Silver Carp were captured or observed in Lockport or Brandon Road pools during commercial netting. In 2019, Illinois DNR will contract with fishers to catch and remove 1 to 1.5 million pounds of Asian carp upstream of Starved Rock Lock and Dam. In addition, contracted fishers will provide expertise and support for seasonal monitoring in the CAWS as well as at the EDBS. Continued work in Lockport and Brandon Road will continue at prior levels to maintain detection ability to inform EDBS operation and contingency planning efforts. Efforts in 2019 will be increased in the Starved Rock and Marseilles pools. 2018 levels of effort will be maintained in other areas to properly inform annual MRP and contingency planning efforts.

- **Comprehensive Interagency eDNA Monitoring Program** – USFWS, in cooperation with state partners, will continue to monitor for the presence of Asian carp eDNA in the Great Lakes, Upper Mississippi River, and Ohio River basins.
- **Asian Carp Stock Assessment in the Upper Illinois River** – In 2019, annual Asian carp density estimates throughout the Illinois River (Alton – Dresden Island pools) will continue and seasonal density estimates (every other month) will extend to the Marseilles and Dresden Island pools. The acoustic telemetry array used to update movement probabilities in the SEACarP population model will be maintained. Because most Asian carp acoustic telemetry tags deployed in the lower Illinois River (Alton, La Grange) have expired, 100 additional Asian carp (50 per pool) will be tagged. An additional 50 tags will also be deployed in the Marseilles pool.
- **Great Lakes Monitoring** – In 2019, USFWS will work with partners to continue developing and adapting standard sampling protocols targeting AIS in the Great Lakes. USFWS will be prepared, and may be mobilized, to respond to any Bighead or Silver Carp detected (using either traditional gear or eDNA) in the Great Lakes. USFWS and partner agencies will fully implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS. Efforts will continue on an annual basis to detect new invasions of Asian carp.
- **Ecosystem Risk Assessments** – In 2019, the National Oceanic and Atmospheric Administration (NOAA) will complete simulations of Asian carp effects on the Illinois River food web using the Ecopath with Ecosim (EwE) model. This modeling activity will further confirm model performance and predictions of Asian carp impacts with observed impacts in the Illinois River. Moreover, modeling will provide managers further insights into how Asian carp will affect aquatic ecosystems across a productivity gradient from the productive Illinois River to the Great Lakes ecosystems.

5. RESPONSE ACTIONS

The ACRCC will be prepared to shift monitoring resources as needed informed by the most current data on Asian carp locations and status. 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 will provide additional details. In 2019, the ACRCC will address contingency actions through the Monitoring and Response Workgroup's (MRWG) Contingency Response Plan (CRP) once again in the event a change is detected in the status/risk considering all life stages of Asian carp in the Starved Rock, Marseilles, Dresden Island, Brandon Road, and Lockport pools. The ACRCC will be prepared to respond rapidly and shift monitoring resources as new information becomes available.

6. BLACK CARP

Black Carp is an invasive species that is undergoing rapid expansion in the U.S. Commercial fishers and fishery biologists have collectively reported 342 captures of Black Carp since 1994, with the majority of fish collected in the last 5 years.

In 2019, efforts to continue monitoring of Black Carp will continue with continued support of the bounty program administered by Illinois to encourage reporting of fish commonly caught in commercial gears. Additional sampling for all life stages will continue, with the evidence of natural reproduction identified for the last several years around Cape Girardeau, Missouri. Development of a species-specific bait (USGS) is underway, as well as refinement of genetic surveillance tools (eDNA), and in 2019 telemetry will be initiated to understand the habitat use and movement of this species.

7. GRASS 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.

Michigan and Ohio expect to increase their removal activity in FY 2019 with support and assistance from USFWS, USEPA, and USGS. This increased removal effort, coupled with research into additional control strategies, should increase the ability of agencies to control the Grass Carp population in the short term and allow for continued progress toward eventual eradication of Grass Carp in Lake Erie. Research conducted by USGS, which included completing spawning trials, completing an age estimation method, and research on Grass Carp reproduction, recruitment, spawning triggers, and habitat will provide additional assistance to ongoing management activities.

8. COMMUNICATION/EDUCATION/STAKEHOLDER ENGAGEMENT

Targeted ACRCC communications continue in 2019 including organizing public listening sessions; ongoing coordination of partner responses to public, congressional and media inquiries; continued refinement of the ACRCC's early detection notification protocols; creation of ACRCC branded communication products; and ultimately increasing the reach of ACRCC messaging. Communications work will contribute to key audiences having a greater understanding and appreciation for the ACRCC's purpose, function, current actions, and successes.

9. ACRCC PARTNERSHIP OPERATIONS

In 2019 the ACRCC will continue to collaborate with our 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 MRP, and other strategic plans; and to ensure ongoing interagency information-sharing and dialogue in support of the partnership mission.
- Provide timely and substantive technical information to Congress, the public, 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 outside the Great Lakes to leverage opportunities, best practices, strategies, and resources on Asian carp prevention and control from across multiple basins. This includes continuing to seek opportunities to support management efforts in the Upper Mississippi River and Ohio River basins and to

apply key developments and "lessons learned" to benefit the ACRCC mission of Great Lakes protection.

- Continue to work with the CAWS Advisory Committee and the Great Lakes and Mississippi River Interbasin Study (GLMRIS) Executive Steering Committee to engage 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. While the TPWG is not part of the ACRCC organization, it consults with the ACRCC and other agencies on invasive species matters. The current TPWG co-chairs are the Illinois Chemical Council and the Illinois Chamber of Commerce.

These collaborative efforts will further allow partners to identify expertise, share data, and increase capacity to more broadly address the threat region-wide, across multiple basins, where possible.

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

- Appendix A includes the FY 2019 Project Funding Matrix. *All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*
- Appendix B provides a full listing of FY 2019 action items, project descriptions, and intended outcomes.

1.0 INTRODUCTION

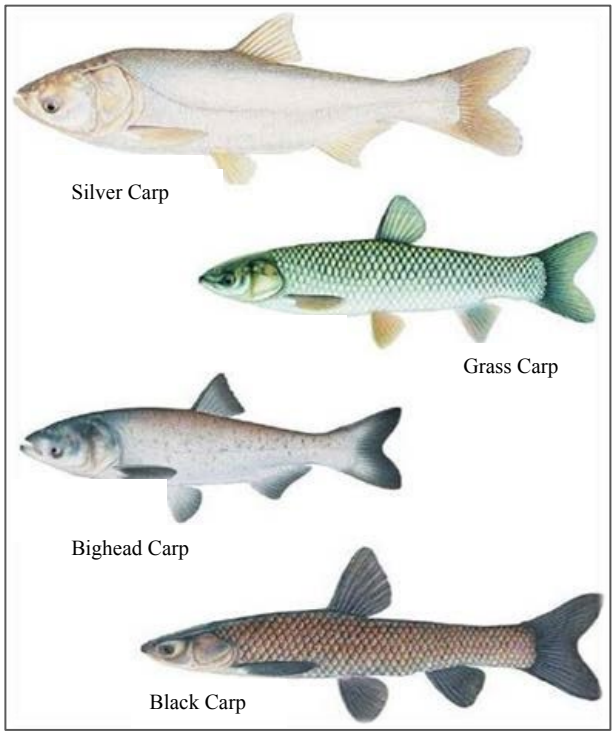
This section provides the reader with an explanation of the strategy and purpose of the Asian Carp Regional Coordinating Committee (ACRCC) Action Plan, the role and mission of the ACRCC, the ways in which this Action Plan drives efforts to reduce the threat of Asian carp, and background information to understand the threat of Asian carp.

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 2019 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 27 United States (U.S.) and Canadian federal, state, provincial, and local agencies and organizations — 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 for Asian carp and other aquatic invasive species. The 2019 Action Plan builds upon prior approaches by applying "lessons learned" using data and science to inform an adaptive management approach under which strategic enhancements are incorporated, when and where needed, for increased effectiveness at reducing the risk 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. A primary goal of a subset of 2019 Action Plan activities is to dramatically reduce Asian



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

carp populations in the Illinois River, resulting in a reduced threat of fish movement upstream towards the Great Lakes.

The 2019 Action Plan continues to provide an increasingly aggressive approach to Asian carp control. This includes a goal of further reducing Asian carp populations in the Illinois Waterway (IWW) to more aggressively address the potential threat of fish movement upstream towards the Great Lakes.

The ACRCC principal line of defense is the U.S. Army Corps of Engineers' (USACE) operation of the Electrical Dispersal Barrier System (EDBS) in the Chicago Area Waterway System (CAWS). The bypass barrier and the sluice gate screens are additional measures in place to address potential issues with the efficacy of the electric barriers. The EDBS is intended to stop the movement of juvenile and adult Asian carp towards the Great Lakes. In 2019, USACE will continue to operate the fish deterrent measures in the CAWS and operate and maintain the EDBS, including regularly scheduled maintenance and replacement of electrodes at Demonstration Barrier I and Barrier IIB. In FY 2018, USACE awarded a contract for the installation of the pulse generating electric equipment at Permanent Barrier I. This work will continue in 2019.

In Fiscal Year (FY) 2018, the public review period for the Brandon Road Study Tentatively Selected Plan (TSP) ended and the draft report underwent technical and policy review. Comments from these reviews were considered and incorporated into the report as feasibility level planning and engineering analysis were also completed. In FY 2019, the final draft report for the Brandon Road Study will undergo State and Agency Review and a Chief's Report will be developed.

The ACRCC recognizes the value of increased harvest of Asian carp in the Illinois River informed by real-time fishery stock assessment data and has set a goal of removing 15 million pounds annually by 2022. In 2019, the directed use of contract commercial fishing will again be increased to achieve even greater annual harvest of adult Asian carp in key locations in the upper Illinois River to support ACRCC management goals. Also, a new pilot project will explore potential opportunities to make greater market use of adult Asian carp captured through commercial removal efforts conducted in support of the ACRCC's long-term population management goals and objectives for the Illinois River. Removal efforts will be informed by agency assessments of Asian carp population status and movement within the focused geographic range.

A key component of the 2019 ACRCC efforts includes 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 bio-acoustic fish fence (BAFF) Deployment Project. This component will be a large-scale experimental deployment of the BAFF system at Barkley Dam near Grand Rivers, Kentucky. This will include system installation, operations and initiation of a demonstration for Barkley BAFF evaluation. The second component is the Lock and Dam 19 Acoustic Deterrent System (ADS) Deployment Project. This component will continue coordination among multi-agency science and evaluation team to determine feasibility for a large-scale experimental deployment in the Upper Mississippi River at Lock and Dam 19 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.

Additionally, increased efforts will be undertaken to field test underwater sound and carbon dioxide (CO_2) as a potential technology for Asian carp control. The ACRCC will increase focus on phasing potential control tools with demonstrated success into broader strategies, when and where possible, to achieve its mission. The 2019 efforts related to the development of CO_2 as a potential control technology are focused on transfer of CO_2 to management agencies through a technology demonstration at a navigational lock in the Fox River in Wisconsin. The purpose of this demonstration is to better determine the feasibility of CO_2 under real-world settings. Researchers will construct, operate, monitor, and evaluate a temporary, large-scale CO_2 injection system within a navigational lock to collect data on engineering, costs, operational parameters, water quality, air quality (human safety), fish behavior, and non-target organisms. Outcomes are expected to inform the transfer of this technology into management actions to reduce the risk of Asian carp spreading into new areas.

In 2019, the Action Plan will again feature key baseline interagency surveillance efforts, including telemetry, electrofishing and netting, and environmental deoxyribonucleic acid (eDNA) monitoring; and interagency contingency response plans developed specifically for potential rapid-response in the event of new detections of Asian carp of all life stages in the CAWS and the Illinois and Des Plaines Rivers, upstream of the Starved Rock Lock and Dam.

The ACRCC is continuing the development and refinement of the Spatially Explicit Asian Carp Model (SEACarP) population model that will be used to maximize fishing harvest effectiveness to reduce numbers of adult Asian carp in the Illinois River by optimizing location and timing of effort on the water. The model identifies scenarios for spatially explicit components of the Illinois River system and will be expanded to: (1) recommend mortality benchmarks, or harvest quotas, and fish passage deterrent locations with efficacy requirements relative to percent of blocked passage, (2) incorporate updated Asian carp demographic rates using the most current data available, and (3) evaluate the feasibility to estimate immigration into the upper Illinois River using indirect methods from harvest information. The model will also assess potential opportunities to further manage Asian carp populations through the deployment of deterrent barriers to fish movement in strategic locations in river systems, with the goal of Great Lakes defense. In 2019, the use of the SEACarP will be expanded to assist in identifying combinations of management actions needed to achieve the maximum net impact on Asian carp population levels for specific locations in the IWW. The expanded model will incorporate key data with a focus on Asian carp control in the six lower pools in the IWW (Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island), while also providing critical information on growth and year-class strength and informing our understanding of the risk of upstream migration using the most current data.

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 final appropriations decisions.

The 2019 Action Plan has been prepared by members of the ACRCC, including federal, state, and provincial agencies and other stakeholders, to develop and strategically implement targeted actions for preventing and controlling the movement of Asian carp. The primary focus is on preventing the introduction of Bighead and Silver Carp into the Great Lakes basin. Such actions will be strategically deployed using the most current scientific advances and technology available. Work to anticipate the migration of Black Carp and control the spread of Grass Carp continues under this Action Plan.

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. It focuses heavily on efforts taken within the CAWS and IWW, but also captures efforts outside the CAWS that indirectly assist the efforts of the ACRCC. The Action Plan primarily addresses the threat of Bighead and Silver Carp. However, the ACRCC has more recently chosen to also develop approaches and activities to begin to address the growing threat of Grass and Black Carp. This approach will be further informed by results and recommendations from binational (U.S. and Canadian) ecological risk assessments currently being conducted for Grass and Black Carp in the Great Lakes when the assessments are completed.

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]. 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.

1.3 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:

A. Support all efforts that directly lead to the prevention, introduction and/or establishment of Asian carp in the Great Lakes.

B. 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.

C. Promote collection of biological information on Asian carp, its impacts, preferred habitats, and biological and ecological requirements.

[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.

D. Identify additional research, technology, and data needed to effectively inform and support Asian carp management strategies.

E. 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. Work under this objective by the ACRCC fulfills the coordination and notification requirements of the U.S.-Canada Great Lakes Water Quality Agreement.

F. 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 1 below.

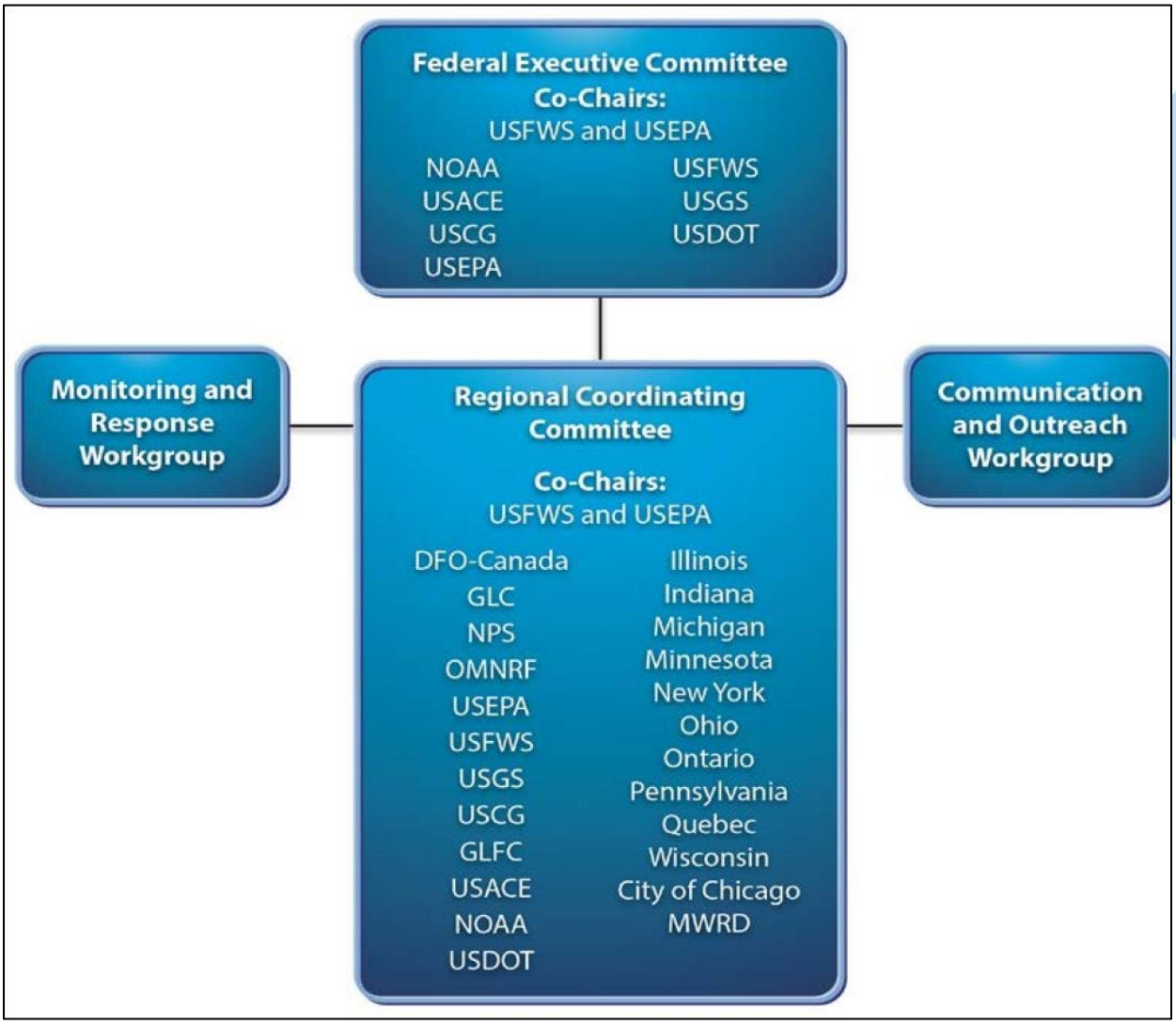


Figure 1. *ACRCC Organizational Structure.*

1.4 Mission of the ACRCC

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

While Asian carp remain a significant threat to North America's aquatic resources, no Bighead, Silver, or Black Carp have been collected or observed in the Great Lakes 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 represent the only documented collections of Bighead, Silver, or Black Carp in the Great Lakes. Since that time, intensive sampling has been regularly conducted by resource agencies in targeted locations in the Great Lakes and yielded 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. Recent data demonstrate reproducing Grass Carp populations in Lake Erie's western basin, specifically the Sandusky River, triggering focused collaborative State-led management response actions further described in this Action Plan.

Outside of the Great Lakes basin, data from Asian carp monitoring and surveillance demonstrate that new occurrences of Bighead and Silver Carp continue to be detected in progressively further upstream locations, specifically within portions of the Mississippi River and Ohio River basins. Also, data demonstrate the establishment of a self-sustaining population of Black Carp in the middle Mississippi River near St. Louis, Missouri, as well as range expansion of this species into the Ohio River basin (Kentucky), and into the Peoria pool of the IWW.

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 are developing strategies and approaches to further address emerging threats posed by additional species while continuing to focus on prevention of Bighead and Silver Carp population expansion and introduction.

Silver Carp were first imported into the U.S. in the early 1970s to control phytoplankton blooms in sewage lagoons and as a potential addition to fish production ponds. By 1975, Silver Carp 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 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 United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, and any possession of the United States). 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.

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

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 27 states.

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 mid1970s, 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 are now the most widespread species of Asian carp in North America (currently documented in 45 states and Puerto Rico, and the Provinces of Ontario and Québec).

Additionally, new information provides evidence of successful Grass Carp reproduction in the Sandusky River, a major tributary of the western basin of Lake Erie in Ohio.

Grass Carp caught in neighborhood lake in Northwest Illinois in July 2018.

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 already extinct. Black Carp remains a preferred method of snail control in states with an established aquaculture industry. Requirements governing their management, use, and intrastate transportation vary from state to state. Since 2007, they have been listed as an Injurious species under the Lacey Act. A notable rise in Black Carp captures was seen in 2017-2018, with a total of 81 captures in 2017 and 133 captures in 2018 (the highest-ever annual catch). Current records indicate Black Carp collections from seven states, and several occurrences of natural reproduction.

Currently, the Great Lakes contain more than 180 non-native aquatic species, of which many are considered invasive and causing ecological or economic damage. These invasive fish, invertebrates, viruses, bacteria, and parasites can have significant impacts on the ecological health of the watershed, as well as the quality of life of entire communities around the basin, including economic damage to the commercial, sport, and tribal fisheries of the Great Lakes. Ecological modeling has demonstrated the potential magnitude and duration of impacts that could occur in the event of an Asian carp introduction into the Great Lakes (see Rutherford et. al, National Oceanic and Atmospheric Administration [NOAA] model), further underscoring the need to ensure prevention of yet another invasive aquatic species.

Assessments of the risks posed by Asian carp and related management strategies are directly informed by the most current and accurate data on species distribution and range expansion over time. Figure 2 shows the relative abundance of Silver and Bighead Carp in distribution throughout

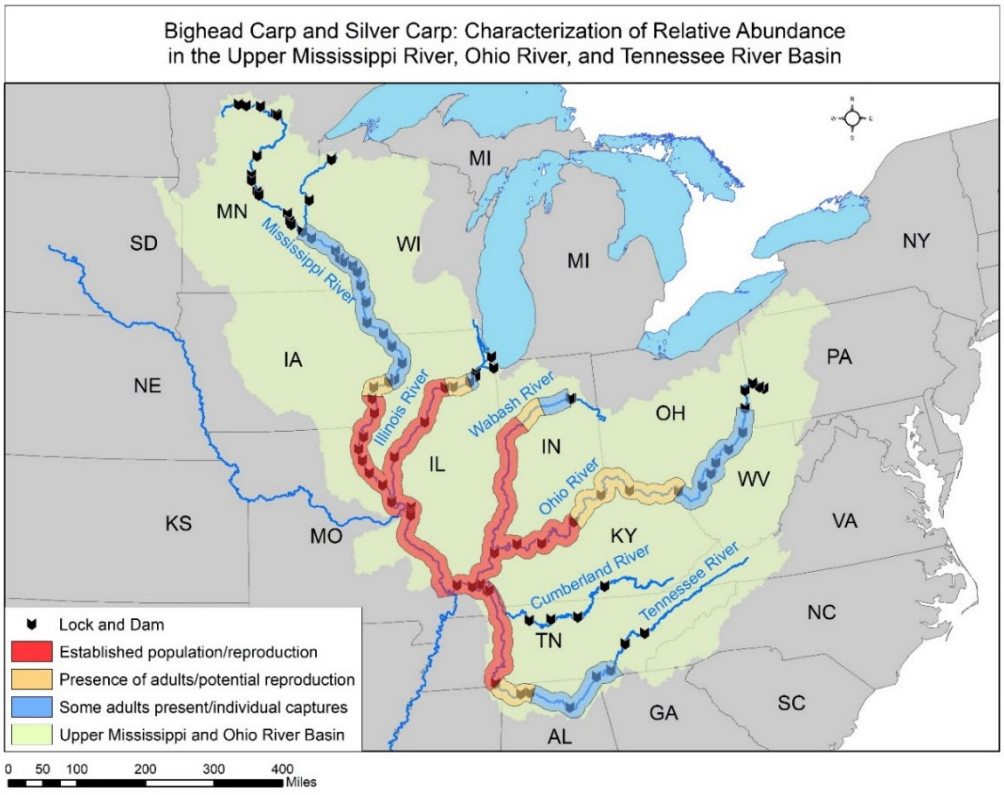


Figure 2. *Characterization of current (2017) relative abundance of Bighead Carp and Silver Carp in the Upper Mississippi River Basin, Ohio River Basin, and IWW/CAWS.*

the U.S. as of October 2016. This diagram demonstrates the dynamics of the expanding populations, with fish densities and evidence of reproduction (including larval fish) progressively reduced toward the upstream boundaries of range of occurrence. This and other monitoring information is critical to informing the most effective use of specific strategies for early detection/monitoring, as well as prevention and control.

Figure 3 (on the next page) illustrates the documented occurrences of the individual species of Asian carp within waters of the Midwest U.S. Data were collected for development of the interagency Water Resources Reform and Development Act of 2014 (WRRDA) 2017 Report to Congress on Asian Carp and was provided by state and federal agency partners. Analysis of the changes in geographic range of occurrences between reporting timeframes shows some additional range expansion over the timeframe. It is important to note that any collection of an individual Asian carp in a new location, which is defined as a range expansion, does not indicate that the species has established in that particular point in the watershed. Additional data, such as the presence of different life stages, the relative abundance of adults in the area, and spawning activity is used to assess the geographic distribution for each species within a given river basin. This report uses categories (established, abundant, and present) to define the relative abundance of Asian carp geographically. Established populations include areas where spawning has been documented. Abundant populations are areas where Asian carp are commonly captured, but spawning is not documented. Present Asian carp populations are areas where Asian carp are present, but in low abundances. This underscores the need for intensive and consistent monitoring to collect data to inform an accurate assessment of population status.

In the 2017 reporting period, range expansion was documented from a single Bighead Carp in the Upper Mississippi River basin (UMRB), 52 miles upstream in the Minnesota River. Silver Carp had a range expansion into the UMRB with the capture of one individual above the EDBS in the CAWS in June 2017, 26 miles upstream from the last known location. Additionally, Silver Carp expanded their range in the Ohio River basin (ORB) in the Tennessee River with a 44-mile range expansion upstream. Black Carp had a significant range expansion in the UMRB, with two occurrences in the Peoria pool of the IWW, representing an expansion of 145 miles upstream. Another capture in the ORB presented a 17.5-mile expansion in the Ohio River. Range expansion of Grass Carp was not detected in the 2017 reporting period.

As of fall 2017, the Monitoring and Response Workgroup (MRWG) concluded that the adult population front of Bighead and Silver Carp is approximately 47 miles and two lock structures from Lake Michigan in the Dresden Island pool. No small fish (less than 6 inches) have been detected in Dresden Island, Marseilles, or Starved Rock pools by MRWG efforts in 2018. While spawning of Asian carp and eggs have been noted in both Marseilles and Starved Rock pools, no larval fish have been detected in these pools. All life stages (eggs, larval, small Asian carp, and juvenile/adult Asian carp) have been detected in the lower three IWW pools of Peoria, LaGrange, and Alton. These pools are over 100 miles away from Lake Michigan. This information is illustrated in Figure 4 on Page 11.

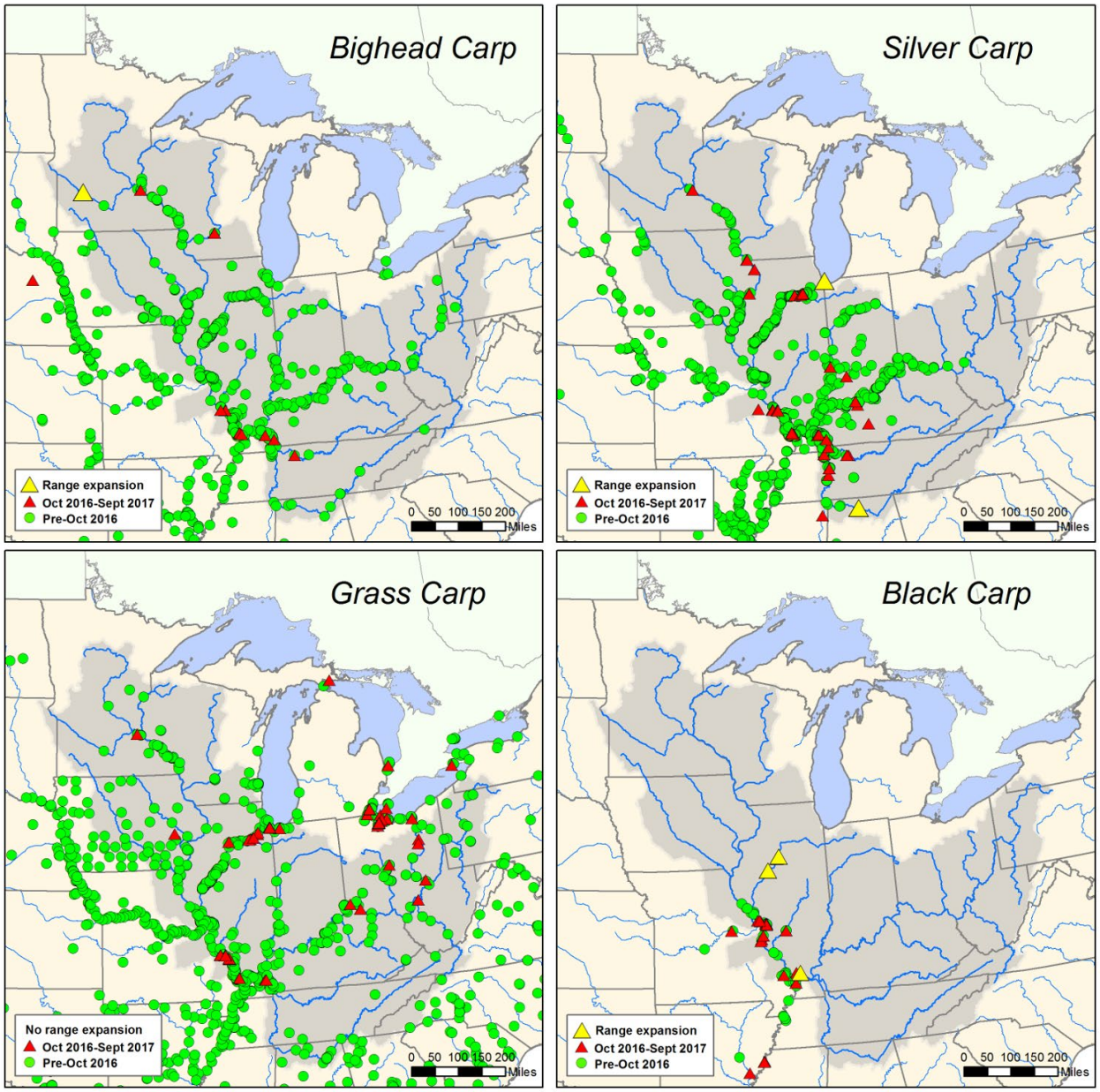


Figure 3. *Range expansion maps of all four species of Asian carp: Green circles represent the data points of occurrences before the reporting period (before October 2016); red triangles identify the new data points collected in from October 2016-September 2017; yellow triangles indicate occurrences that expanded the range of that species. Source: USGS NAS Database*

Populations of Bighead and Silver Carp in the Illinois River are generally characterized by pool. For reference, Figure 4 below illustrates the pools in the upper Illinois River, and the stages of invasion for Bighead and Silver Carp within the IWW.

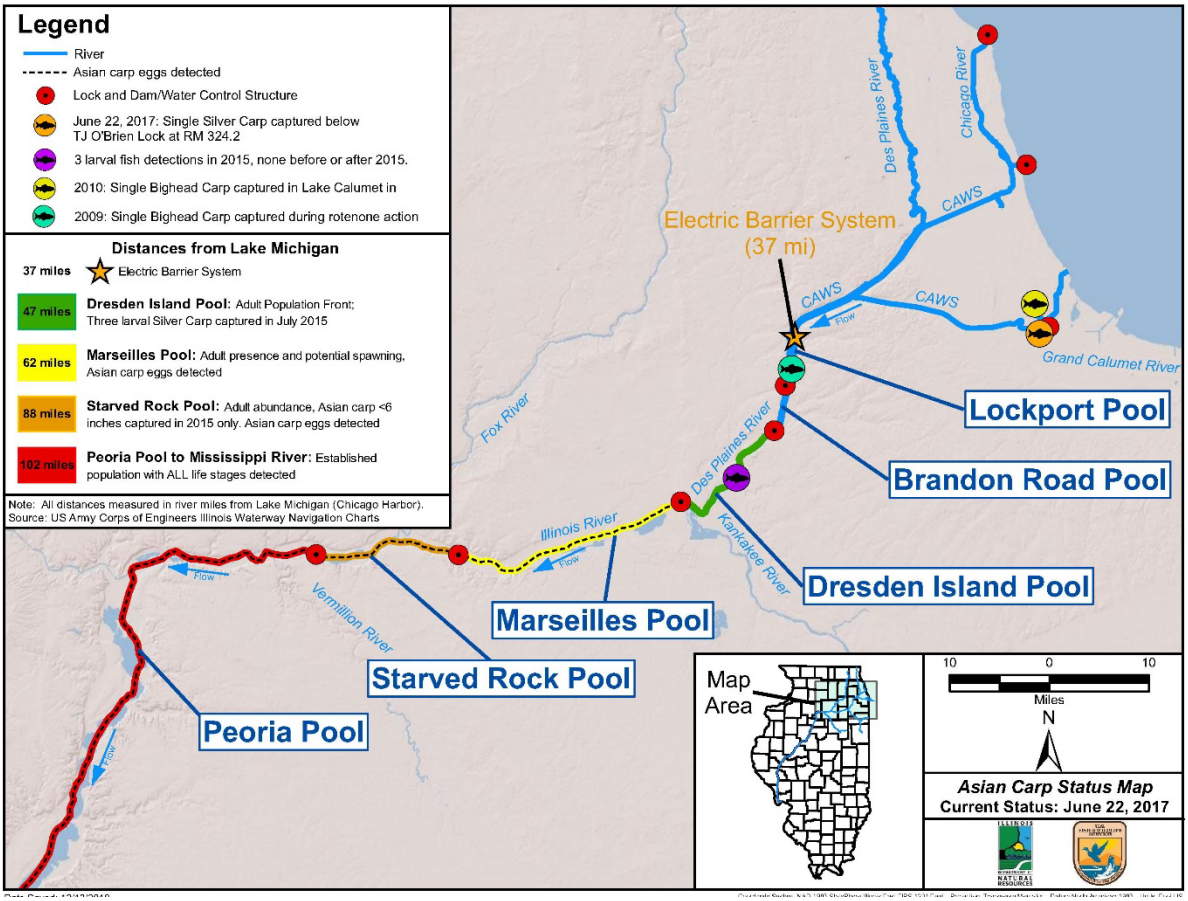


Figure 4. *Bighead and Silver Carp Status in the Upper Illinois River*

Based on the proximity of established populations of Bighead and Silver Carp in the lower (downstream) segments of the Illinois River, intensive ongoing monitoring and control efforts have been focused on the CAWS to improve the understanding of the population dynamics and lower the level of risk from fish moving upstream toward the Great Lakes.

In 2018, a standardized Silver Carp demographics protocol was initiated to quantify relative abundance, inform decision support tools, such as the SEACarP model, and evaluate management actions. Protocols were built on results of a two-year gear evaluation study indicating that the electrified dozer trawl has the ability to characterize a Silver Carp population because of the wide size ranges of fish sampled in a reasonable amount of time. The protocol was replicated in spring and fall in five pools of the Illinois River (Marseilles, Starved Rock, Peoria, LaGrange, and Alton) to determine when year class strength is set, quantify recruitment, and estimate growth of small fish. Overall, 2,804 Silver Carp measuring 1.5 to 34 inches were captured (Figure 5 on the next page). The relative abundances of the different pools were indicative of the longitudinal pattern observed in the Illinois River characterization maps (Figures 2 and 4, Pages 8 and 11, respectively).

Furthermore, 25 small Silver Carp (less than 6 inches) were captured: 22 in the LaGrange pool measured 1.5 to 5.5 inches and two in the Alton pool measured 2 to 3 inches. The 300, five-minute dozer trawl transects conducted in the Peoria, Starved Rock, and Marseilles pools associated with this study are included in Table 1 (see Page 13). Continuation of this standardized sampling strategy allows for determining population response to management actions and informs future actions.

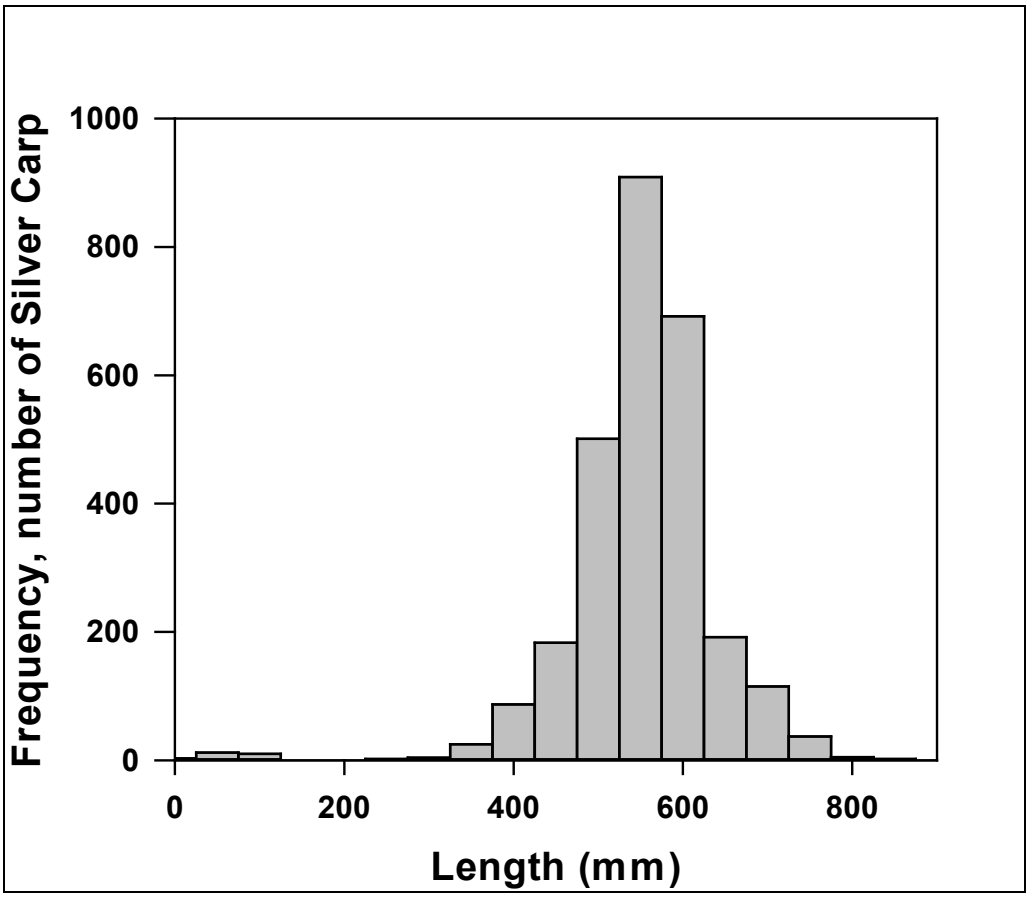


Figure 5. *Length frequency histogram of Silver Carp captured with the electrified dozer trawl as part of a demographics study in the Marseilles, Starved Rock, Peoria, LaGrange, and Alton pools of the Illinois River in Spring and Fall 2018.*

As in 2017, no Asian carp less than 6 inches were found above the Peoria pool in 2018. Based on sampling results in 2015, dedicated small Asian carp monitoring in 2018 did not detect any small fish in the Starved Rock, Marseilles, or Dresden Island pools of the Illinois River. A total of 165 electrofishing sites (39:00 hours fishing time) have been surveyed to date from the Peoria pool to Dresden Island (Table 1). The bulk of fishing effort has been from the Marseilles pool to Peoria pool based on results from prior years of sampling small Asian carp captures. Gears used have included boat electrofishing, dozer and paupier trawls, and mini-fyke nets (Table 1, next page). Electrofishing has been used to sample shorelines of all habitat types (main channel, side channels, and backwaters) due to its effectiveness in these areas. Mini-fyke nets have been used in shallow backwater areas,

especially during low water periods. Paupier and dozer trawls have been used intermittently depending on flow conditions and crew availability.

Table 1 below shows the current number of sites sampled during 2018 broken down by pool and gear type; units are the number of sites sampled.

Table 1. 2018 Site Survey Activities by Pool and Gear

Site	Electrofishing	Dozer trawl	Mini-fykes
Peoria	19	163	14
Starved Rock	45	131	31
Marseilles	74	113	13
Dresden Island	27	0	0

In 2017, three small Asian carp were captured in the Peoria pool. One individual was captured using boat electrofishing in April 2017 [Total Length (TL) = 114 millimeters (mm)] and two were captured using an electrified dozer trawl in September 2017 (TL = 109 mm and 115 mm). All three of these fish were captured in Henry, Illinois near river mile (RM) 194 in the Peoria pool.

In addition to the monitoring efforts, the U.S. Fish and Wildlife Service (USFWS) has expanded the telemetry study of juvenile Asian carp from 2017. A total 26 hydrophones have been deployed in the Peoria pool, stretching from Hennepin, Illinois downstream to Chillicothe, Illinois. Additionally, eight radio telemetry monitoring stations have been built in the Peoria pool with another 13 stations being deployed and spread from the Peoria Lock and Dam to the Starved Rock Lock and Dam, covering the entire reach. Currently, 52 fish are tagged with acoustic transmitters, with a mean size of 285 mm.

In 2014, Asian carp eggs (either Silver or Bighead Carp) were also identified from samples collected from Marseilles and Starved Rock pools of the Illinois River, as well as from downstream pools (LaGrange and Peoria). These detections are within areas that Bighead and Silver Carp have historically been captured; however, these were the first collection of larval fish upstream of Henry, Illinois (approximately 90 miles downstream on the Illinois River from this detection location in Dresden Island pool). No additional Asian carp larvae were collected in this 90-mile stretch of the Illinois River in 14 sampling visits from April 2015 to September 2015.

In a proactive response to this preliminary information, ACRCC MRWG agencies deployed electrofishing crews in the Dresden Island pool with additional and substantial effort and deployed contracted fishers using a novel tool, a 200-meter small mesh seine designed to catch gizzard shad, a small native fish species that resembles Asian carp and inhabits their same niches. Furthermore, electrofishing efforts were used to drive fish into seines, combining two effective sampling gears to maximize detections. These small meshed seine hauls were pulled in the Marseilles and Dresden

Island pools. In all the additional response efforts with these gears, no small Bighead or Silver Carp less than 6 inches were collected.

Given the concern about these findings, the 2016 Monitoring and Response Plan (MRP) included heightened efforts to detect such spawning events. Currently, the MRWG does not believe that either Asian carp species is likely established in the upper Illinois River. Monitoring efforts have also increased to help further inform managers on the location and distribution of small Asian carp (those less than 6 inches) resulting from the recent record spawns in downriver locations and their potential movement throughout the IWW.

Most recently, relative abundance of Asian carp in Dresden Island pool (the most upstream pool where they are found) has shown significant declines from 2012 to 2015 (Figure 6). This reduction is most likely attributed to contracted fish removal efforts and determined using hydro acoustic surveys of the MRWG. Most recent surveys suggest relative abundance is being maintained at the lower levels. Additional removal efforts in these pools have been programed by MRWG starting in 2016 to further reduce carp populations. Total effort by contracted fishing was increased by 50 to 100 percent in the Starved Rock, Marseilles and Dresden Island pools starting in 2016.

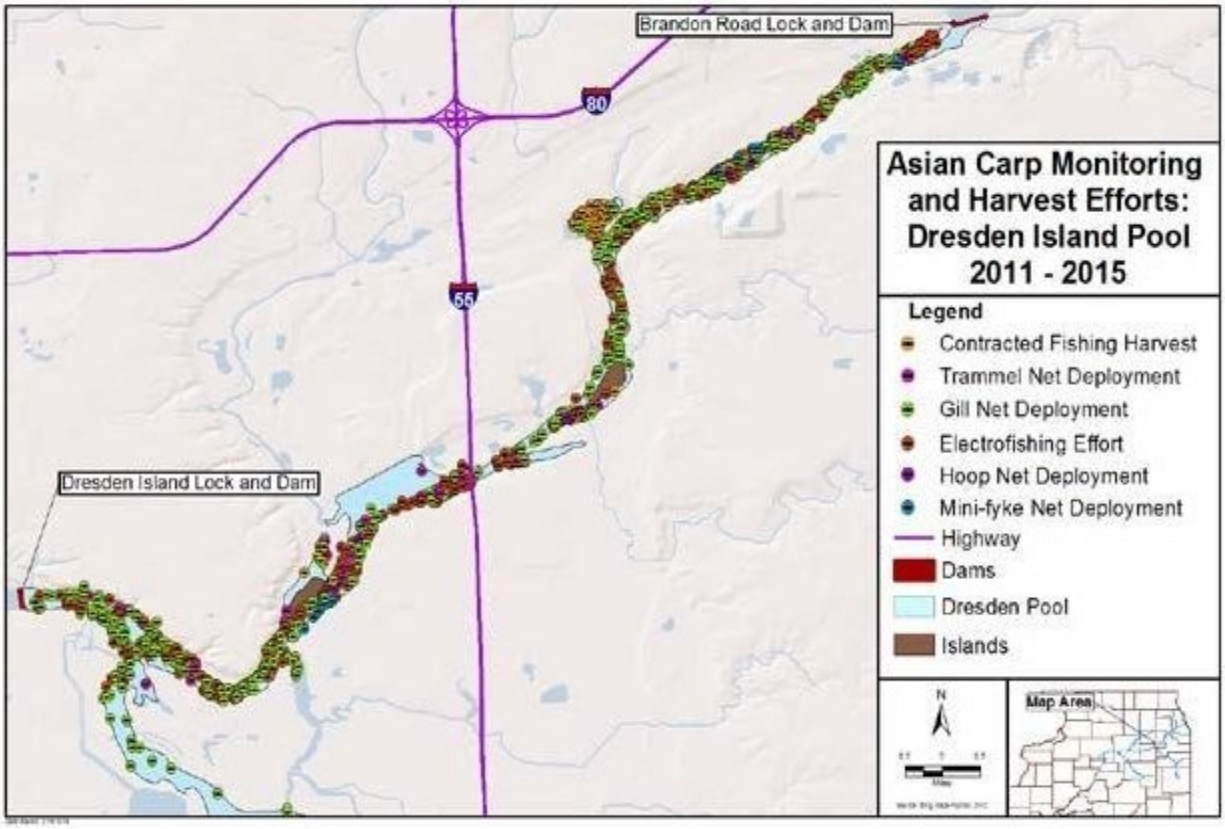


Figure 6. *Monitoring and Harvest Efforts in Dresden Island pool.*

2.0 MONITORING AND RESPONSE WORKGROUP EFFORTS

The MRWG of the ACRCC is tasked with deploying monitoring, response, control and management efforts to address the leading edge of current Asian carp boundaries. The MRP evaluates status by pool within the Illinois River, prescribing effort to minimize populations in each, as practicable.

This MRWG is generally composed of fisheries biologists and scientific experts from state and federal agencies involved in monitoring and response activities in the CAWS. In 2012, all Great Lakes states fisheries chiefs were invited to participate in the MRWG. Since 2010, MRWG has created an annual MRP for the CAWS and revises this plan annually with the overall goal of preventing Asian carp from establishing self-sustaining populations in the CAWS and subsequently in Lake Michigan.

The MRWG carries out its actions through collective efforts by member agencies. The MRWG oversees contracted fishing, netting, electrofishing, and other collection operations, and then interprets the data obtained to offer informed recommendations to the ACRCC.

The MRWG formed discipline-specific work groups to assist in developing the MRPs in the future. Workgroups are also useful to focus expertise for further evaluation, assist in decision making, or otherwise provide MRWG Co-chairs, agencies, and ACRCC with insights as technical experts on a range of subjects. The work groups are listed below.

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

The projects 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

In the 2017 MRP, the MRWG identified both a short- and long-term vision as identified below:

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

Detection

- Ensure sufficient surveillance effort is deployed throughout upper IWW, Des Plaines and Kankakee rivers to inform management and control, or response needs, including:
    - Adult fish, small fish, and larval/egg assessment.
    - Population changes and movements.

Management and Control

- Remove Asian carp from between Starved Rock Lock and Dam and Brandon Road Lock and Dam to reduce upstream migratory pressure at the leading edge of the population (biomass observed in 2015):
    - Reduce the estimated biomass of Asian carp in the Dresden Island pool by an additional 50 percent.
    - Reduce the estimated biomass of Asian carp in the Marseilles pool by an additional 25 percent.
    - Reduce the estimated biomass of Asian carp in the Starved Rock pool by an additional 25 percent.
- Prevent the movement into or sustained presence of Asian carp between the Brandon Road Lock and Dam and the Lockport Lock and Dam.
- Utilize existing and newly developed techniques to maximize removal efforts of more than 1 million pounds annually.
- Utilize technical expertise and recommendations provided by discipline-specific work groups to determine whether algal attractants, complex noise generation, and use of CO_2 to herd fish can be effectively incorporated into MRWG actions:
- Evaluate ongoing management efforts to measure the effectiveness of management actions, adjust activities to improve effectiveness, and adapt to future changes.
- Assist in developing an enhanced market for Asian carp harvested out of the lower three pools of the Illinois River by 2019.
    - Use established business development techniques to provide guidance and information to agency, industry, and entrepreneurs to improve ability of business establishment and success.
- Build upon existing commercial fishery in Illinois that can harvest as much as 6 million pounds of Asian carp annually.
- Increase harvest by expanding the commercial fishery to 8 million pounds by 2019 and 15 million pounds annually by 2022.

Response

- Ensure that response readiness is maintained and responsive to detected changes.
- Enable rapid deployment of needed assets.
- Review EDB operations and operational changes.

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

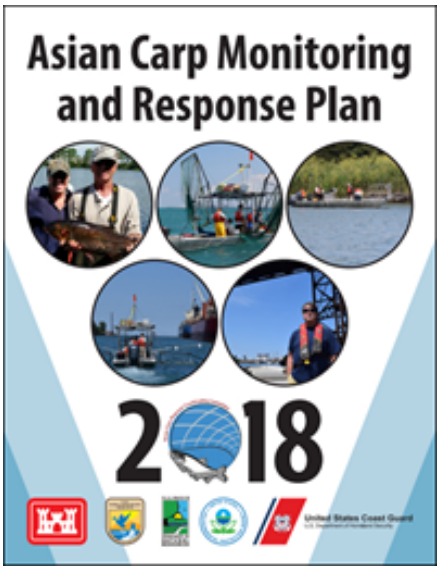
- Sustain management and control effort of Asian carp with continued population reduction as baseline 2015 levels in Dresden Island pool suggest.
- Provide guidance to minimize Asian carp populations in the upper IWW with no impacts on native fish or mussel populations, human health and safety, recreational 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.
- Support development of management and control strategies in other river basins, as requested

Response

- Provide for contingency plan and response in less than 48 hours for all contingency response measures.

2.3 Monitoring and Response Plan

MRWG prepared the 2018 Asian Carp MRP, which was released by the ACRCC. The 2019 Asian Carp MRP is currently in development. Specifically, this document is a compilation of 26 individual project plans, each of which plays an important role in preventing the expansion of the range of Asian carp, and in furthering the understanding of Asian carp location, population dynamics, behavior, and the efficacy of control and capture methods. Each individual plan outlines specific actions, including project objectives, methodology, and highlights of previous work. The MRP clearly sets pool by pool targets for population removal. ***The five-year plan and long-term plans articulate the vision for control moving downstream with private sector partnership removal at 20-50 times the current harvest level.***



2018 Asian Carp Monitoring Response Plan.

The Action Plan supports the MRP, including a recently added section on contingency actions. This MRP uses the best

science to help ACRCC members make the most effective management decisions under the Action Plan.

For example, science-based predictive models and risk assessments are critical for informing managers and scientists on locations at highest-risk for potential invasion, exploitation, or colonization by Asian carp. The following sections describe the various risk characterizations efforts and assessments that have been completed or are currently under way by the ACRCC member agencies. These efforts are evaluating the ecological risk of establishment of Asian carp in the Great Lakes and the social and financial risks associated with establishment.

2.4 CONTINGENCY RESPONSE PLAN

Despite current activities, it is understood that Asian carp populations may respond in unpredictable ways. Based on this realization, this MRP is designed to respond to unforeseen developments in Asian carp detections. The purpose of this Contingency Response Plan (CRP) 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. There are three primary functions of the upper Illinois CRP, which include: (1) direct support of potential response actions, (2) workgroup review and updates to the CRP, and (3) continued training of action agencies and stakeholders through actual annual or table top exercises.

The CRP describes specific actions within the five navigation pools of the upper IWW - 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 Asian carp monitoring program in the CRP area and will continue these efforts as the foundation for early detection capability in the IWW. Annual interim summary reports describing these efforts (including extent of monitoring and Asian carp detection probabilities) can be found at www.asiancarp.us. Based on this experience, MRWG is confident in its ability to detect changes to Asian carp status in the navigation pools in the upper IWW.

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 Asian carp population.
- **CAWS**: No established Asian carp population.
- **Lockport pool**: No established Asian carp population.
- **Brandon Road pool**: No established Asian carp population.
- **Dresden Island pool**: Adult Asian carp consistently present. Larval Asian carp observed for the first time in 2015 and have not been observed since (source unknown).
- **Marseilles pool**: Adult Asian carp consistently present, and Asian carp eggs have been detected. Spawning has been observed.

- **Starved Rock pool**: Abundance of adult Asian carp present, and Asian carp eggs have been detected. Early life-stage Asian carp (<6 inches total length) were observed in 2015 and have not been observed since.
- **Peoria pool** (downstream to confluence with Mississippi River): Established population with all life stages of Asian carp has been observed.

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 communication strategies for inter-agency communication as well as outreach and educational communications with partners and public.

2.5 BINATIONAL ECOLOGICAL RISK ASSESSMENTS

In 2017, a binational ecological risk assessment was completed for Grass Carp. The risk assessment confirmed that Grass Carp have arrived in the Great Lakes basin. The study concludes that Grass Carp have been found in Lakes Michigan, Erie and Ontario. The report - *Binational Ecological Risk Assessment of Grass Carp for the Great Lakes Basin* - concluded that the ecological consequences of Grass Carp in most areas of the Great Lakes basin could be extreme within the next 50 years. Wetlands in the Great Lakes basin are particularly vulnerable should Grass Carp become established. The scientific, peer-reviewed study was led by Fisheries and Oceans Canada (DFO), coordinated by the Great Lakes Fishery Commission (GLFC) and authored by experts from DFO, the University of Toronto Scarborough, the U.S. Geological Survey (USGS) and the USFWS. The results of the study will be used by both countries to shape decisions about Grass Carp prevention and management activities.

A Black Carp ecological risk assessment for the Great Lakes is also currently ongoing and expected to be completed in 2019. The risk assessment will evaluate the probability of introduction (assessing the likelihood of arrival, survival, establishment, and spread) as well as the magnitude of the ecological consequences for each lake, projected out for 50 years. Input into the assessments will include research and ecological modeling conducted in both Canada and the U.S. The writing team for both assessments consists of DFO, GLFC, USGS, and the USFWS.

3.0 INTERAGENCY CAWS ASIAN CARP PROGRAM

The interagency CAWS Asian Carp Program 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 aquatic invasive species (AIS) introduction as indicated in the Great Lakes and Mississippi River Interbasin Study (GLMRIS) report. The ACRCC's efforts are now binational and Great Lakes basin-wide in scope, encompassing 27 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 2018 Asian Carp Action Plan and many will continue in 2019. ACRCC initiatives for 2019 include increased 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. The ACRCC will also emphasize coordination of collaborative interagency efforts within and between basins, and program support. In addition, ACRCC continues its focus on development of control alternatives at Brandon Road Lock and Dam to further explore pathway closure opportunities. Accomplishments achieved in 2018 and initiatives planned for 2019 are highlighted below.

3.1. PREVENTION ACTIONS

The ACRCC is undertaking a number of prevention actions to address existing pathways to the Great Lakes. These efforts include:

3.1.1 Operate and Maintain Current Barrier System in the CAWS

USACE operates three different types of fish deterrent measures (bypass barrier, electric barriers, and bar screens on sluice gates) in the CAWS, each designed to prevent movement of Asian carp toward the Great Lakes in a different manner. The Bypass Barrier physically blocks known bypasses around the EDBS from the Des Plaines River and the Illinois and Michigan (I&M) Canal caused by flooding. The EDBS (see Figure 7, right) is intended to stop the movement of juvenile

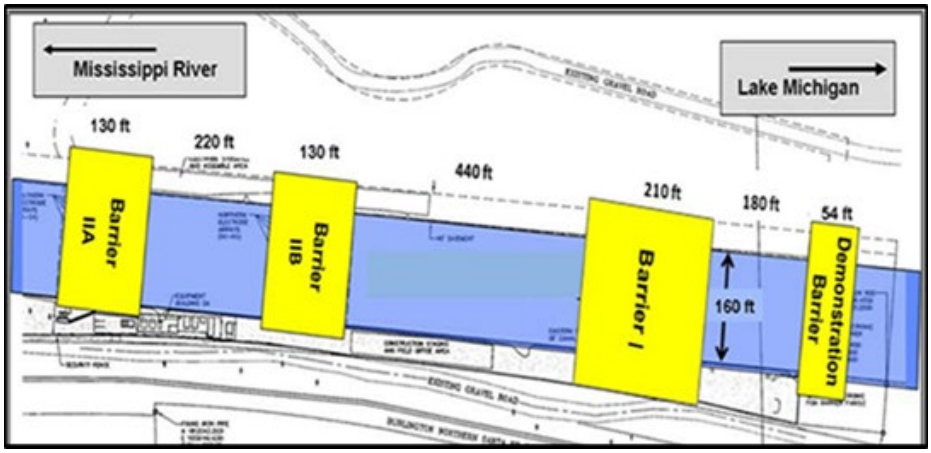


Figure 7. *USACE Electrical Dispersal Barrier System.*

and adult Asian carp during high water events by creating a waterborne pulsed direct current electric field in the Chicago Sanitary and Ship Canal (CSSC). Three electrical barriers (Demonstration I, IIA, and IIB) are currently operated by USACE. In addition, bar screens on sluice gates at Thomas J. O'Brien Lock and Dam were installed to impede entry of Asian carp to Lake Michigan. All potential impacts were considered to ensure public health and safety, and the purposes of these structures. Operation and maintenance of the barriers continued and USACE replaced the electrodes on the narrow array of Barrier IIA

Permanent Barrier I

In 2019, USACE will continue to operate three different types of fish deterrent measures (bypass barrier, electric barriers, and bar screens on sluice gates) in the CAWS, each designed to prevent movement of Asian carp toward the Great Lakes in a different manner. Operation and maintenance of the barriers will continue, including replacement of electrodes at Demonstration Barrier I and Barrier IIB.

3.1.2 Construction of a New Electric Barrier

Construction of an upgrade to the Demonstration Barrier I to a permanent facility, as authorized in the Water Resources Development Act of 2007, is being completed in stages via multiple contracts. Completion of this barrier, known as Permanent Barrier I, will signal the completion of construction on the CSSC EDBS. Site work and the installation of the new underwater components were completed in late 2014. Construction of the new control building, utility connections, and backup power systems is currently underway. A contract was awarded for the installation of the pulse generating electric equipment. Construction of Permanent Barrier I will continue in 2019 with the following proposed actions:

- Replacement of Demonstration Barrier I's cable electrodes with steel billets.
- Installation of the pulse generating electric equipment.

3.1.3 Development of Potential Future Actions at Brandon Road

USACE studied aquatic nuisance species (ANS) control technologies, as outlined by GLMRIS that could be implemented near the Brandon Road Lock and Dam located in Joliet, Illinois. Further evaluation of ANS control measures at this control point constitutes a logical next step based on the range of alternatives identified in the GLMRIS report, and input from stakeholders and the public during the public comment period for the report. In Fiscal Year 2018, the public review period for the Brandon Road Study TSP ended. The draft report also underwent technical and policy review. Comments from these reviews were considered and incorporated into the report as feasibility level planning and engineering analysis were also completed. In FY 2019, the final draft report will undergo State and Agency Review and a Chief's Report will be developed.

3.1.4 Closure Actions at Little Killbuck Creek Pathway

GLMRIS determined that Little Killbuck Creek is a medium risk connection for transfer of Asian carp from the Mississippi River Basin to the Great Lakes Basin. Ohio Department of Natural Resources (DNR) has been working with the local landowner and has accomplished the following:

- 25 percent design completion (Study and Report).
- Determined proposed berm alignment.
- Developed additional hydraulic modeling to assess potential flooding.
- Acquired easements on four parcels for the construction of the berm.
- Facilitated a meeting with the Potentially Affected Interests to present the project.

In 2019, USACE will peer review Ohio DNR's findings and provide comments to that agency on the proposed design and/or alternative designs. After the berm alignment is chosen, the berm footprint will be secured, and public input will be solicited.

3.1.5 Closure Actions at Ohio-Erie Canal Pathway

In 2018, the Ohio DNR and USACE identified 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. To date the following has been completed:

- Applicable environmental and State Historic Preservation Office (SHPO) compliance studies were completed.
- Real estate negotiations were finalized.
- Engineering plans and specifications were completed.
- Construction contract was awarded.
- Communications plan was developed.

USACE awarded a construction contract in 2018 with completion anticipated in the fall of 2019. Once the project is complete, the Ohio DNR will be responsible for the long-term maintenance of the project and require funding for monitoring and maintenance of closure measures, including personnel and equipment for maintaining the screening devise at the water control structure. Also, as part of the SHPO Memorandum of Agreement, Ohio DNR will be responsible for the development and installation of educational signage along the historic towpath.

3.1.6 Barge Entrainment

In 2018, USFWS continued to work with partner state and federal agencies and maritime industry representatives to identify and address other potential priority study needs, opportunities, and management options. USFWS and partnering agencies collaborated with maritime industry representatives to identify potential efforts to address this issue. In 2018, the study focused on barge entrainment, retention, and transport dynamics specifically regarding entrainment of juvenile Asian carp specifically locking through a lock and dam as well as distance trials.

The proposed work for 2019 builds upon previous research that has been conducted to provide management options for the mitigation of pathways for fish passage of the EDBS associated with commercial tow traffic transiting. The 2019 barge study will address any further questions or mitigation options that may stem from the work done in 2018. The 2019 study objectives are to gain further insights on barge entrainment, retention, and transport dynamics specifically regarding entrainment of juvenile Asian carp, as well as, to determine potential upper size thresholds for entrainment of juvenile Asian carp.

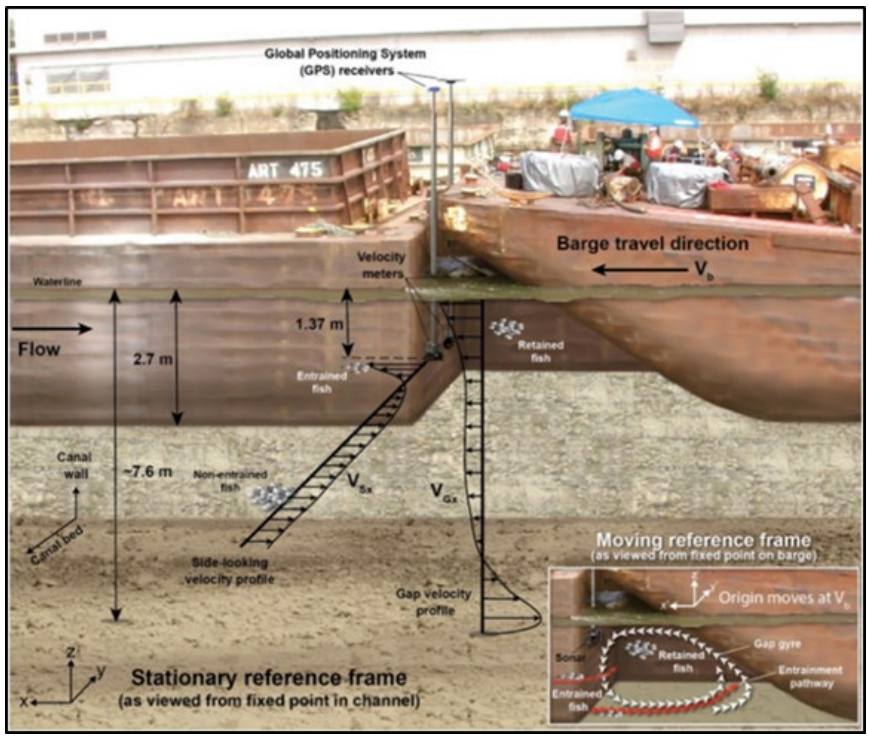


Figure 8. *Rake to box junction between barges (from Davis et al. 2016).*

Recent efforts have focused on testing techniques designed to mitigate these effects, such as the use of water jets and increased flow rates. The results from these studies will be published in FY 2019. USFWS will complete an analysis of the potential for tows to encounter eggs and larvae following spawning events in the Illinois River. USFWS will also collaborate with USACE to plan and execute a laboratory study by its Engineering and Research Development Center (ERDC) on the use of sill bubble curtains to mitigate tow-induced fish transport through a lock chamber, and field measurements of the flow characteristics around existing sill bubble curtains for validation of lab experiments and preparation field trials. USGS will provide hydraulic and hydrographic data collection as needed for these mitigation studies and will contribute to publications in collaboration with partner agencies.

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, the ACRCC recognizes the need to scientifically assess the movement of Asian carp and undertake control actions, where necessary. The following efforts have been or will be undertaken to address these potential concerns:

3.2.1 Contract Fishing for Asian Carp Detection and Removal

Contracted commercial fishing is used to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the EDBS. Commercial fishers harvest as many Asian carp as possible in the Starved Rock and Marseilles pools. These harvested fish are picked up and utilized by private industry for purposes other than human consumption. This effort is also used to gather

information on Asian carp population abundance and movement in the IWW downstream of the EDBS as a supplement to fixed site monitoring efforts. In the CAWS (seasonally) and from barrier down downstream through Lockport, Brandon Road, and Dresden Island pools (bi-weekly), these contracted netters will work in teams of two or more to detect and remove Asian carp.

Through Illinois DNR and USFWS harvest efforts, an estimated 6.8 million pounds of Asian carp have been removed from the IWW below the Electric Dispersal Barrier since 2010. Tonnage was comprised of 66,701 Bighead Carp; 722,669 Silver Carp; 5 Silver Carp and Bighead Carp hybrid; and 5,747 Grass Carp. Effort put forth to catch those fishes included 5,518 hoop net nights, 3,624 15-minute electrofishing runs, 225 Great Lakes pound net nights, 3,665 miles of gill/trammel net, and 35 miles of seine.

In 2018, contracted commercial fishers along with assisting Illinois DNR biologists set 163.63 miles of gill net at fixed and targeted sites in the Lockport, Brandon Road and Dresden Island pools (including Rock Run Rookery). Efforts collected 9,533 fish representing 27 species and 2 hybrid groups. Three hundred and twenty Bighead Carp and 752 Silver Carp were collected in Dresden Island pool, downstream of I-55. Two Bighead Carp and two Silver Carp were collected above I-55 in Dresden Island during commercial netting. No Bighead Carp or Silver Carp were captured or observed in Lockport or Brandon Road pools during commercial netting. In 2018, the results shown in Table 2 were reported for Lockport, Brandon Road and Dresden Island pools.

Table 2. Activity Results in Lockport, Brandon Road, and Dresden Island Pools

Activity	Lockport Pool			Brandon Road Pool			Dresden Island Pool		
	2016	2017	2018	2016	2017	2018	2016	2017	2018*
Yards of Net Fished	75,600	65,400	62,500	72,125	75,800	62,800	67,100	79,100	133,300
Miles of Net Fished	43.0	37.2	35.5	32,850.0	43.1	35.7	38.1	44.9	75.7
Hoop Net Nights	45.7	39.4	40.8	46.0	42.6	39.2	46.3	335.3	36.4
Mini Fyke Net Nights	22.3	21.0	20.9	22.5	23.5	18.8	24.2	26.9	19.7
Electrofishing Runs	91	104	27	91	107	24	183	167	105
Electrofishing Time (hours)	22.8	26.0	6.8	22.8	26.8	6.0	45.8	41.8	26.3
Total Asian Carp	0	0	0	0	0	0	13	27	4
Pounds of Asian Carp Harvested	0	0	0	0	0	0	270	518	906

*The increase in effort and harvest is attributable to two unified method harvest events in 2018 at the Exelon Corporation discharge into the Illinois River.

In October 2018, Illinois DNR initiated a Dresden Island Unified Fishing Method event, utilizing agency and commercial fishing crews which fished the entire navigation pool including Rock Run Rookery Lake and beginning at Brandon Road Lock and Dam tail waters and approach channel downstream to the Dresden Island Lock and Dam. Crews employed several methods of driving and capturing Asian Carp such as use of complex noise, banging, revving motors, electrofishing and

utilizing paupier and shallow water running boats. During the event crews captured and harvested 286 Asian Carp, 255 Silver Carp, and 31 Bighead Carp.

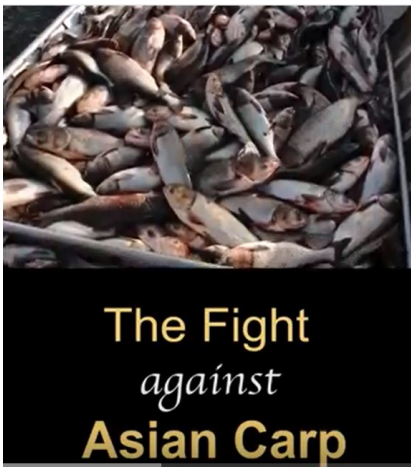
Efforts will be heightened in 2019 to prescribe more effort to maintain lower populations of Asian carp while further removing and further reducing Asian carp densities throughout the Upper IWW in several ways:

- More crew/weeks scheduled in removal efforts by increasing efforts by 30%.
- Specialty gears such as seines and trap nets will be deployed when most prudent.
- Continue adaptive netting dimensions, as carp population has changed nets will be set to optimize removal efforts. (Fishing efforts have removed the largest individuals throughout upper river therefore smaller meshed nets will be used to also optimize for the smaller fish).
- While increased surveillance efforts from the EDBS to Dresden Island pool had been modified in prior years (most recently in 2018) increased efforts in 2019 will be for removal in Starved Rock and Marseilles pools where larger densities of Asian carp exist.

In 2019, Illinois DNR will contract with fishers to catch and remove 1 to 1.5 million pounds of Asian carp upstream of Starved Rock Lock and Dam. In addition, contracted fishers will provide expertise and support for seasonal monitoring in CAWS as well as at the EDBS. Continued work in Lockport and Brandon Road pools will continue at prior levels to maintain detection ability to inform EDBS operation and contingency planning efforts. Efforts in 2019 will be increased in Starved Rock and Marseilles pools. 2018 levels of effort will be maintained in other areas to properly inform annual MRP and Contingency planning efforts.

3.2.2 Asian Carp Enhanced Contract Removal Program Development

The control strategy identified in the 2018 MRP that recognizes the value of increased harvest of adult Asian carp in the lower Illinois River, with a goal of removing 8 million pounds per year by 2019 and working toward a 5-year goal of 15 million pounds removed annually by 2022. 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 Asian Carp Business Process Analysis Report and Action Plan (Business Analysis Plan, or Report) and corroborated by SEACarP model output. The Report recommends actions to accommodate increased commercial harvest as a control option and expand alternative uses of Asian carp to increase fishing by identifying end-users for fish. The end goal is removal of 20 to 50 million pounds of Asian carp per year from the IWW to reduce the population and risk of their spread to the Great Lakes.



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

This effort will continue the implementation of two key impactful recommendations. The first recommendation is the creation of a pilot-scale contracted removal effort to spur more Asian carp removal effort in the lower Illinois River, targeting Peoria pool, then considering other lower Illinois River pools. The second recommendation is the creation of a positive brand for Asian carp, a marketing strategy, and marketing support to make use of Asian carp captured and removed through

focused efforts in the Peoria pool and other targeted locations. This strategy will include efforts to communicate the positive qualities of Asian carp – pleasant taste, health benefits, reducing invasive species populations, low contaminant levels, and consuming fish caught from clean waterways. The positive branding will be fundamental in changing current perceptions of Asian carp.

Also, a strong, positive brand that countermands negative perceptions of Asian carp, supports existing carp-related businesses, and resonates with targeted audiences could greatly affect many fishers and processors. Asian carp have significant branding potential as a locally caught, fresh fish option. Marketing strategies can range from large-scale, national efforts to local, grassroots initiatives. Initial marketing efforts should occur at the regional level, with potential for expansion as fishing and processing increase. A marketing firm should be procured or added to an existing consulting contract, as permissible and desired, to undertake a short-term branding and develop a regional marketing strategy. The overall effort will reduce the numbers and influence relative abundance of Asian carp in the Peoria pool, of the Illinois River through controlled and targeted contracted fishing efforts. Reducing the relative abundance of Asian carp in the lower Illinois River will subsequently reduce the likelihood that Asian carp will expand upstream to approach and potentially challenge USACE's EDBS. This effort will be implemented through the issuing of contracts to willing fishers in Peoria pool and fulfilling contractual obligations of selling, reporting, transporting, and fishing in the identified area administered with close agency oversight.

This overall effort will reduce the numbers and influence relative abundance of Asian carp in the Peoria pool, Illinois River through controlled and targeted contracted fishing efforts. Reducing the relative abundance of Asian carp in the lower Illinois River will subsequently reduce the likelihood that Asian carp will expand upstream and approach and potentially challenge USACE's EDBS. This effort will be implemented through the issuing of contracts to willing fishers in Peoria pool and fulfilling contractual obligations of selling, reporting, transporting, and fishing in the identified area. The project will also provide critical information on population densities of Asian carp over time in the Peoria pool as well as the remainder of the Illinois River system to guide agency management efforts. This project will also facilitate as practicable mechanisms for use of the harvested fish through private industry for a variety of purposes, including human consumption. Through a cooperative relationship of agency and fishers along with end users/markets, technical assistance and support will be provided, as necessary, to further inform fishers on the delivery of quality and quantity of fish to the end user/markets through this interaction.

This second segment will continue to promote fishing and harvest from the Peoria pool of the lower IWW. The goal is to increase harvest and not just maintain historical efforts. Agency resources combined with market development support (other template) should continue to increase harvest in upper Peoria pool and further markets acceptance to this increased catch.

3.2.3 Asian Carp Population Model and Demographics

The SEACarP model describes our current understanding of Silver 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. The model is being used to evaluate the effectiveness of different management strategies – 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 was an area of increased emphasis in 2018. Efforts were directed to the refinement (improved the accuracy and precision), expansion, and strategic use of an Asian carp population model SEACarP, including: (1) the optimal location(s) 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.

In 2019 the model will be used to determine combinations of management actions needed to achieve the maximum net impact on Asian carp population levels for specific locations in the IWW. The model identifies scenarios for spatially explicit components of the Illinois River system and will be expanded to: (1) recommend mortality benchmarks, or harvest quotas, and fish passage deterrent locations with efficacy requirements relative to percent of blocked passage, (2) incorporate updated Asian carp demographic rates using the most current data available, and (3) evaluate the feasibility to estimate immigration into the upper Illinois River using indirect methods from harvest information. The expanded model will incorporate key data with a focus on Asian carp control in the six lower pools of the IWW (Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island), while also providing critical information on growth and year-class strength and informing our understanding of the risk of upstream migration using the most current data. The model and resulting management recommendations will be annually updated and improved based on expert feedback and new information gathered from ongoing monitoring for population changes, ultimately providing a robust tool to inform ACRCC interagency management actions. In 2019 the following efforts will be addressed:

- Estimate demographic rates using the most current data available and incorporate results into the SEACarP model.
- Conduct sensitivity analyses and develop a prioritized list of data and research needs based on results thereof.
- Recommend mortality benchmarks and fish passage deterrent locations with efficacy requirements.
- Use statistical catch-at-length models to estimate vulnerability to fishing as a function of fish size, exploitation rates, and immigration into the upper Illinois River Waterway.
- Modify the length-based structure of the model; use integral projection models to define populations by a continuous variable instead of discrete length classes.

3.2.4 Mass Removal of Asian Carp

Current modeling efforts suggest that the target fishing mortality rate of 40% is likely needed to achieve population change and reduce risk of introduction into the Great Lakes. Increased handling time for smaller fish in entanglement gears and a corresponding lower price per pound for non-human flesh product may limit the ability of a commercial market to achieve a high fishing mortality rate that includes smaller fish, unless efficiency levels adjust.

In 2018, USFWS designed and deployed equipment to optimize the capture of Asian carp during mass removal efforts throughout the Illinois River and the Midwest, while concurrently providing field validation to science-based predictors of high fish concentrations. USFWS optimized mass removal netting strategies by integrating large commercial seines with a goal of increasing harvest capacity of Silver Carp to 50,000 pounds per day. In addition, USFWS identified prime "Harvest Basins" where Silver Carp can be frequently found in large concentrations and more readily harvested with a prescriptive gear and methodologies. USFWS and USGS worked collaboratively to develop the methodology to use low-cost sonar systems in conjunction with physiochemical meters to predict mechanisms for future Silver Carp aggregations.

In 2018, a new trap net called the Merwin Trap and a pound net were tested as passive gears in collaboration with the Illinois Natural History Survey in several Illinois backwaters. Also, herding techniques were further developed by testing multiple sounds and several electrofisher anode configurations. Optimal stimuli were selected and further tested in a field study evaluating four herding techniques and a control in a tributary.

Paupiers will supplement traditional fishing efforts to remove all sizes of Asian carp.

Also, in 2018, USGS, partnering with USFWS, tested and adapted the Chinese "Unified Method" of Asian carp capture to U.S. waters. In previous efforts to perform the Unified Method near Morris, Illinois, the proximity to the EDBS and the need to remove as many fish as potentially limited the ability for further scientific evaluations of different driving methods. USGS conducted a Unified Method harvest exercise at Creve Coeur Lake in eastern Missouri (near St. Louis) in January/February 2018. Evaluation of the effectiveness in removal of Asian carp in Creve Coeur Lake is being conducted by (1) acoustic telemetry, (2) hydroacoustic survey, (3) mark-recapture population estimation, (4) eDNA estimation of biomass, and (5) population assessment by paupier. New information and refinement of mass removal techniques based on this exercise will inform ACRCC efforts to contain and control Asian carp populations for Great Lakes defense. These efforts will be conducted in collaboration with Illinois DNR and contracted commercial fishers to continue Asian carp mass removal in the Illinois River.

In 2019, this project will continue to build on successful methods for optimizing gear types for mass removal of all size classes and species of Asian carp including: an experimental surface trawl with trapping mechanism, passive weirs with live traps, light avoidance herding, beach seining, and paupier harvest methods. Concurrent work with Illinois commercial harvesters and processors conducting beach seining will enhance our ability to utilize a variety of bag designs and removal devices by capitalizing on existing harvest and removal effort. In addition, the paupier has proven to be an effective tool for efficient removal of a broad size-range of Silver carp. USGS will provide a paupier boat descriptive with an integrated operator safety and

electrical efficacy training program to enable other agencies to safely and effectively use this boat to achieve harvest goals. The project will:

- In conjunction with commercial fishing operations on the Illinois River, optimize beach seining and removal methods to increase mass removal opportunities.
- Utilize weir, herding and trapping techniques to target multiple size classes and species of Asian carp.
- Utilize historically successful surface trawling technique to target Silver carp.
- Optimize paupier for future integration in Agency fleets by refining electrical gradients, writing operators handbook with Asian carp electrical target goals, and develop operator training and certification approach.

In 2019, the Merwin Trap, a pound net and three additional trap nets will be further tested in Illinois water bodies such as Starved Rock pool, Sheehan Island, and the Peoria pool where more carp removals are needed. These nets will also continue to be evaluated with and without food attractants to determine if baiting will improve catch rates. Following adequate testing of gears, the gears will be assessed for their costs and effectiveness to measure their efficiency. Herding will also be used and further evaluated in 2019 Unified Method events and as a potential supplemental harvest enhancement method to concentrate Asian carp.

In 2019, efforts will also focus on increasing the efficacy of the final collection of Asian carp once they have been concentrated, driving method efficacy, and retrieving methods for deep water unified methods from China for use in the U.S.

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.

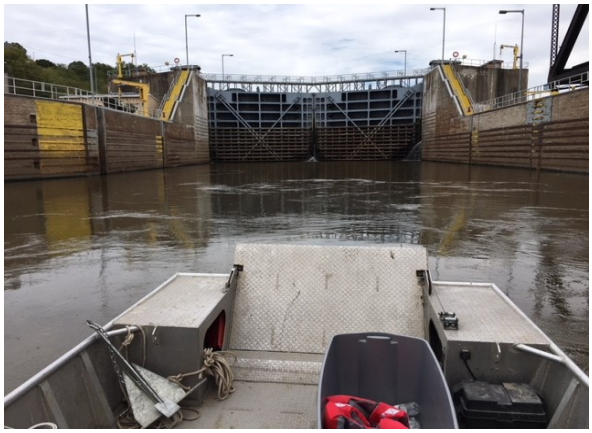
An interagency team consisting of USGS, USFWS, Illinois DNR, USACE, and other partner agencies will continue to explore options for potential implementation of new Asian carp prevention and control tools, including complex sound, CO_2, and microparticles.

3.3.1 Use of Acoustic Deterrents

Downstream approach at Barkley Lock and Dam at Grand River, Kentucky. Photo credit: USFWS

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 and Silver Carp responding negatively to various underwater sound stimuli while many native fish species responded little to that same sound. Building off 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 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 (SPLs), 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.).



Downstream Approach at Lock and Dam 19 at Keokuk, Iowa. Photo credit: USFWS

There are three basic components to the work being undertaken in FY 2019. The first component is the Barkley BAFF Deployment Project. This component will be a large-scale experimental deployment of the BAFF system at Barkley Dam near Grand Rivers, Kentucky. This will include system installation, operations and initiation of a demonstration for Barkley BAFF evaluation. The second component is the Lock and Dam 19 Acoustic Deterrent System (ADS) Deployment Project. This component will continue coordination among multi-agency science and evaluation team to determine feasibility for a large-scale experimental deployment in the Upper Mississippi River at Lock and Dam 19 near Keokuk, Iowa. Included will be:

- Collection of bathymetry, substrate, water quality, and fish passage data from desired deployment locations.
- Development of a study plan including agency roles, timelines, and deliverables, including:
    - Design plan, including engineering review, including an acoustic propagation model for the site.
    - Contract with appropriate vendors for acquisition of speaker equipment.
    - Completion of an assessment/monitoring plan.
    - Development of a long-term equipment maintenance, monitoring, and communication plan.

The third component of the projects will be research and development (lab/field testing at multiple locations). This component will include:

- Hearing tests on Grass and Black Carp to determine acoustic potential.
- Test new sounds on wild/motivated fish in the Wabash River.
- Test newly screened, high deterrent potential sounds, specifically designed to deter Asian carp and limit impacts on native fishes, in ponds.
- Initiation of 2-demensional predictive movement model of fish in response to sound using Brandon Road Lock and Dam as case study for use at other deployment sites.
- Initiation of additional deployments at targeted locations as appropriate and coordinated among the interagency planning team.

It is hoped that the results of these efforts can further inform the USACE's efforts at Brandon Road through the development of underwater sound as a potential control alternative at that site.

3.3.2 Carbon Dioxide

Carbon dioxide (CO_2) injected into water is being evaluated as a non-physical deterrent method for invasive Asian carp. Results from laboratory and mesocosm studies conducted by the USGS, USACE and University of Illinois have shown that Asian carp voluntarily avoided areas of elevated CO_2 when given the option to access other freshwater (untreated) areas. Strategic

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

implementation of CO_2 at pinch-points of rivers (i.e. inside lock chambers) could deter Asian carp passage and reduce the risk of upstream movements and range expansion.

In 2018, USFWS continued to address Section 7 Endanger Species Act consultation data requirements and other operational considerations for deployment of a CO_2 fish deterrent system focused on Asian carp prevention. In addition, USFWS worked with USGS and other partners to identify pilot opportunities for the temporary installation and operation of a CO_2 fish deterrent system for field research purposes.

In 2019, a technology demonstration is planned at a navigational lock to better determine the feasibility of CO_2 under real-world settings, in the Fox River, Wisconsin. Researchers will construct, operate, monitor, and evaluate a temporary, large-scale CO_2 injection system within a navigational lock to collect data on engineering, costs, operational parameters, water quality, air quality (human safety), fish behavior, and non-target organisms. Outcomes are expected to inform the transfer of this technology into management actions to reduce the risk of Asian carp spreading into new areas.

3.3.3 Microparticles

No current technology can specifically target Asian carp for control within aquatic ecosystems. Available control chemicals used in aquatic invasive species control programs are non-selective and are applied throughout the entire water column, resulting in equal exposures of native and invasive species alike. Developing control tools that target specific organisms like an Asian carp are highly desirable. This effort will identify and develop new control agents and technologies to target Asian carp.

During 2018, USGS conducted a large-scale field trail to control Silver Carp and Bighead Carp in pond in Iowa with antimycin-incorporated microparticle. USGS also evaluated a bait containing Ziram, a toxic chemical found to be selective to Grass Carp.

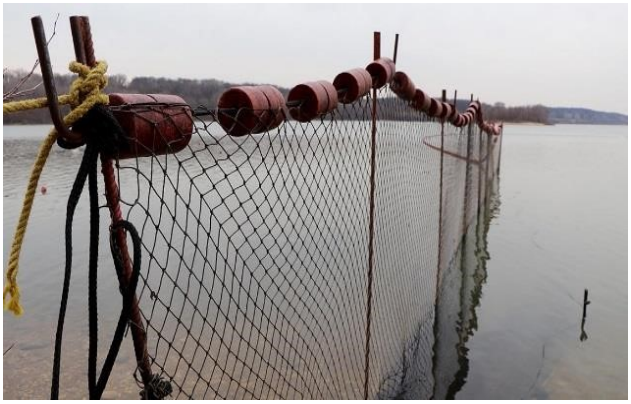
In 2019, USGS will undertake efforts to re-register antimycin-A, including development of a registration packet and meet with the U.S. Environmental Protection Agency (USEPA) for a pre-registration evaluation to identify which studies will need to be conducted. During 2019, USGS will conduct those studies deemed necessary to support registration antimycin-A. Concurrently, USGS will work to establish a consistent supply of antimycin-A. Upon request of the USEPA for registration of the microparticle, USGS will conduct tissue residue studies to determine if there will be a need for human exposure studies for the registration of the microparticle. Also, USGS will complete environmental fate studies following USEPA guidelines to determine how quickly the microparticle breakdowns in the environment. Lastly, USGS has synthesized designer chemicals that toxicity models indicated are selective to Asian carp. USGS will complete in vivo toxicity trials on these designer chemicals with a goal of re-registering antimycin-A and prepare registration packet for microparticle so that field trials can be resumed.

3.4 Early Detection, Monitoring, and Assessment

Continued monitoring and assessment of the Asian carp population in the Upper Illinois River are critical to the ACRCC's ability to assess the threat of Asian carp 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

Seasonal intensive monitoring continued in 2018. A variety of gears were used during seasonal intensive monitoring activities, including pulsed Direct Current (DC)-electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets, and Great Lakes pound nets to detect, capture, and subsequently remove any Asian carp present.



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

Fixed and random site intensive electrofishing efforts and contracted netting at four fixed sites in each of the four pools below the EDBS are used for this effort. 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 following is a summary of effort to date:

- Since 2010, 1,811 hours of electrofishing have been employed.
- From 2010-2017, contracted commercial fishers and assisting Illinois DNR biologists have deployed 2,056 miles of gill/trammel net, 20 miles of seine, 2,342 hoop nets nights, 162 Great Lakes style pound net nights.
- Seasonal intensive surveillance since 2010, only two, single fish have been collected above the EDBS (Bighead Carp 2010, Lake Calumet; Silver Carp 2017, 2 miles downstream of T.J. O'Brien Lock and Dam).
- These contracted removal and agency effort resulted in a total of 776,880 Asian carp removed weighing 6,386,020 pounds.

Fixed Site Monitoring Upstream of the Dispersal Barrier

In 2019, a variety of gears will be used during seasonal intensive monitoring activities, including pulsed DC-electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets and Great Lake pound nets to detect, capture and subsequently remove any Asian carp present. Additional intensive monitoring will occur in Lake Calumet (spring 2019) and the North Shore channel (fall 2019).

Fixed Site Monitoring Downstream of the EDBS

Fixed and random electrofishing and contracted netting has been increased since 2014 and will continue in 2019 at these elevated levels below the EBDS. The effort will include intensive electrofishing and netting at four fixed sites and will increase from four to 12 random sites in each of the four pools below the EDBS. Fixed and random site electrofishing will take place bi-weekly from March through November. Contracted commercial netting will take place bi-weekly from March through December, except during June and September, and will include four fixed sites

and 13, 13, and 24 random sites in the Lockport, Brandon Road, and Dresden Island pools, respectively. Provide monitoring of lower Kankakee River, which drains into Dresden Island pool to provide information on life stages within river. Contracted commercial netting in the Marseilles pool will occur at four fixed sites and four random sites. Effort in the Marseilles pool will remain the same.

Also, 2019 sampling for young-of-year and juvenile Asian carp will take place through netting and electrofishing operations in coordination with additional projects. The collection of small fish, in context of their relative abundance in the Upper IWW may suggest an increased risk of Asian carp movement toward Lake Michigan and this remains one of the primary foci of monitoring.

3.4.2 Distribution and Movement of Small Asian Carp in the Illinois Waterway

Small Silver and Bighead Carp pose a unique threat to invading the Great Lakes because of the potential electrical limitations of the EDBS at immobilizing fish less than 6 inches in total length. USFWS undertakes intensive sampling using a variety of fish sampling gear at both targeted and random-stratified sites in Peoria, Starved Rock, Marseilles, Dresden Island, Brandon Road, and Lockport pools of the Illinois River/CAWS throughout the year to detect upstream migrations of small and juvenile Silver and Bighead Carp. Gears used are primarily boat electrofishing, electrified and non-electrified dozer trawl, and mini-fyke nets for main-stem Illinois River areas, and backpack electrofishing, seining, or dip netting for smaller tributary or shallow areas. Two types of site selection strategies are employed: targeted, and random-stratified. Targeted sites will be selected based on the crew-leaders discretion and will be primarily areas where fish have been captured in the past or areas that closely resemble past capture locations in terms of habitat. Random-stratified sites will be computer-generated sites based on habitat characteristics areas where small Silver or Bighead Carp were previously captured, and data obtained from the Habitat Use and Movement of Juvenile Silver Carp project (telemetry).

In 2018, crews conducted sampling for juvenile Silver and Bighead Carp in Starved Rock, Marseilles, and Dresden Island pools. Gears used included electrofishing, electrified dozer trawl, and mini-fyke nets. The furthest upstream capture of a juvenile Silver Carp was in lower Starved Rock pool in 2018. Multiple juvenile Silver Carp in this age class have been captured in Peoria pool during 2018, indicating that the likely distribution front of age-0 Silver Carp is lower Starved Rock or upper Peoria pool.

In 2019, the USFWS will continue sampling activities. The collection of small fish, and their relative abundance in the Upper IWW, will continue to provide key information to inform level of risk of Asian carp movement toward Lake Michigan and remains one of the primary focus for agency monitoring efforts.

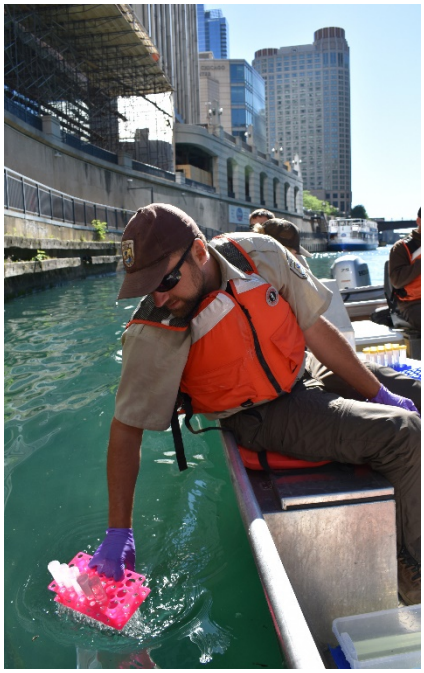
3.4.3 Comprehensive Interagency eDNA Monitoring Program

Throughout 2018, USFWS, in cooperation with agency partners, continued to monitor for the presence of Asian carp eDNA in the Great Lakes, Upper Mississippi River basin utilizing a statistically tenable sampling protocol. In addition, USFWS continued to upgrade its field

sampling infrastructure and its collection and sample processing techniques as new technologies emerged. In 2018, over 8,100 eDNA samples were collected from the Midwest Region; deploying four mobile eDNA trailers across the sampling area by USFWS.

USFWS, in cooperation with state partners, will continue to monitor for the presence of Bighead and Silver Carp eDNA in the Great Lakes, Upper Mississippi River, and Ohio River basins. USFWS will continue to process water samples collected, in collaboration with state partners, to detect the presence of Asian carp DNA in areas of concern. This will include the CAWS of the IWW and will include two sampling events in 2019. These two events will immediately precede the MRWG Seasonal Intensive Monitoring Events scheduled for the CAWS in June and September. USFWS will continue to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge.

eDNA analysis in the laboratory.



Brandon Falish (USFWS) collects water for eDNA surveillance in the CAWS..

3.4.4 Asian Carp Stock Assessment in the Upper Illinois River

Monitoring of Asian carp densities via hydroacoustic sampling throughout the Illinois River (Alton to Dresden Island pools) by Southern Illinois University (SIU) has been ongoing since 2012 and is a useful metric to evaluate long-term changes in Asian carp abundance. By monitoring densities across multiple years throughout the river, long-term trends can be identified and related to environmental conditions, reproduction, or management actions such as commercial harvest (lower Illinois River) or contracted removal (upper Illinois River) to understand the variables most strongly affecting abundance. Broad-scale density estimates also help inform management actions in the upper river near the invasion front. Annual densities, particularly in the lower Illinois River, have displayed relatively large annual fluctuations among years, necessitating the need for continued assessments of Asian carp densities throughout the river. This will identify whether lower river population size has increased from the previous year and help managers determine whether harvest or surveillance in the upper river should be altered in anticipation of increased immigration from downstream pools. It is currently unclear whether, or the extent to which, Asian carp in the Illinois River exhibit density-dependent impacts on reproduction, condition, growth, and movement. Collecting long-term data, particularly density and movement data, will help quantify these patterns which will better inform management decisions and improve models predicting population response to management actions.

While annual monitoring provides a snapshot to document long-term trends in Asian carp abundance, seasonal surveys can be used to help improve removal by identifying and directing harvest efforts to high-density sites. Dresden Island pool represents the current population front for the adult Asian carp invasion in the Illinois River, while Marseilles is the most upstream pool where young-of-year have been found. Frequent hydroacoustic surveys of Asian carp densities in these pools help identify locations where Asian carp aggregate and determine whether these seasonal high-density hotspots remain in the same location each year.

In 2019, annual Asian carp density estimates throughout the Illinois River (Alton – Dresden pools) will continue and to extend seasonal density estimates (every other month) in Marseilles and Dresden Island pools. The acoustic telemetry array will be maintained which will be used to update movement probabilities in the spatially-explicit population model. Given that most Asian carp acoustic telemetry tags deployed in the lower Illinois River (Alton, La Grange) have expired, 100 additional Asian carp (50 per pool) will be tagged and an additional 50 tags for the Marseilles pool will used.

3.4.5 Great Lakes Monitoring

USFWS continues to implement and refine, with input from agency partners, a comprehensive and complementary early detection and rapid assessment surveillance program for Bighead, Silver, Grass, and Black Carp in and near the Great Lakes.

In 2019, USFWS will work with partners to continue developing, adapting, and refining standard sampling protocols for the Great Lakes, and will continue implementing the protocol. USFWS staff/teams will be prepared, and may be mobilized, to respond to any Asian carp detected (using either traditional gear or eDNA) in the Great Lakes. USFWS and partner agencies will fully implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS. Efforts will continue annually to detect new invasions of Asian carp.

3.4.6 Ecosystem Risk Assessments

The National Oceanic and Atmospheric Administration (NOAA) is continuing to model the potential risk of Bighead and Silver Carp to Great Lakes food webs. NOAA models how Bighead, Silver carp and Grass Carp affect the food webs of the Great Lakes ecosystems. NOAA has used three types of ecosystem models to assess effects of Asian carp on Great Lakes food webs in Lake Huron, Lake Erie and Lake Michigan. The Ecopath with Ecosim (EwE) model assesses Asian carp effects on a whole lake scale, however it ignores effects of physical variables and doesn't include heterogeneity in predator prey dynamics over horizontal and vertical spatial scales. NOAA has applied this model to simulate effects of Asian carp on food webs of Lakes Erie, Huron, Michigan and Ontario. A second model is an individual-based bioenergetics model (IBM) that includes temperature as a forcing variable and tracks bioenergetic growth and metabolism in individual Asian carp and selected fish species within nearshore or offshore habitats. NOAA has applied this model to simulate Asian carp effects on nearshore communities of Lake Huron and is applying it to nearshore communities of Lake Erie and Michigan. The third model (Atlantis Ecosystem model) tracks population dynamics and predator prey interactions within heterogeneous habitats in each Great Lake and includes effects of lake physics and chemistry. NOAA applied this model to simulate effects of Asian carp on

Lake Michigan's food webs and is calibrating Atlantis models for Lake Erie and developing a model for Lake Huron.

In 2019, NOAA will complete simulations of Asian carp effects on the Illinois River food web using the EwE model. Results will be compared to the EwE model results for Great Lakes which have not been invaded by Asian carp. This modeling activity will further confirm model performance and predictions of Asian carp impacts with observed impacts in the Illinois River. Moreover, modeling will provide managers further insights into how Asian carp will affect aquatic ecosystems across a productivity gradient from the productive Illinois River to oligotrophic Great Lakes ecosystems.

3.5 Response Actions

The ACRCC will be prepared to shift monitoring resources as new information becomes available. 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 will provide additional details as warranted.

In 2019, the ACRCC will be addressing contingency actions through the MRWG's CRP once again in the event a change is detected in the status/risk considering all life stages of Asian carp in those pools. 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 shift monitoring resources as new information becomes available.

The CRP will continue to be used by the MRWG to direct response actions in the event a change is detected in the status/risk considering all life stages of Asian carp in those pools. The CRP will also provide for open and transparent communication with the public and special stakeholder groups. Command and control 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 and Grass Carp Monitoring, Assessment, and Control

The USFWS, USGS, the Michigan DNR and Ohio DNR, Ontario Ministry of Natural Resources and Forests, DFO-Canada and other partners continued to assess Grass Carp populations in Lake Erie and other locations in the Great Lakes to better understand their status. In addition, Illinois DNR and USFWS have a sampling program targeting all life stages of Black Carp.

The Action Plan includes numerous actions to address both Black and Grass Carp. For these species, an interagency collaborative effort will be needed to monitor, develop, and undertake control actions. Below are approaches the ACRCC will be taking for these species:

3.6.1 Addressing the Threat of Black Carp

Black Carp Captured, Southern Illinois University.

Black Carp, one of the four species of invasive Asian carp, have population numbers that have been increasing in the UMRB since 1994. Over 300 specimens have been collected in the U.S., with 81 records of occurrence from 2017 and 157 records from 2018 alone reported to the USGS Nonindigenous Aquatic Species (NAS) database, the highest levels recorded to date. Most of these specimens were collected by commercial fishers. To leverage existing ongoing commercial fishing efforts and opportunistically collect critical data on Black Carp, SIU administers a bounty funded by the 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. Increased captures in recent years, including a February 2018 capture of a 115-pound adult female (aged to be about 13 years old) near Cape Girardeau, Missouri, and evidence of reproduction across multiple years indicate that Black Carp are established in the Mississippi River basin and are expanding their range.

Recognizing the emerging threat, the ACRCC formed an interagency Black Carp Working 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, identified the data needs and highest priorities of actions to be taken to manage and control this species considering the significant increases in documented occurrence and upstream range expansion in recent years.

In order to effectively target Black Carp and control their spread, there is a strong need for critical data on the biology, ecology, and current population status of Black Carp. The establishment of the BCWG began to address these knowledge gaps. This interagency effort is part of a comprehensive program to coordinate research, monitoring, and development of control technologies.

The Black Carp Strategy prioritizes monitoring and surveillance of this species in its invaded range of the Mississippi River, focusing on all life stages. Development of a species-specific bait is underway, as well as refinement of genetic surveillance tools (eDNA).

The BCWG has also recommended telemetry for this species, as a tool to fill an information gap on this species movement and habitat use. Currently, all specimens are removed from waters and other demographic and biological data is gathered (sexual maturity, age, diet, ploidy), but there is little to no information on their range of or trigger for movement or habitat preference.

Therefore, in 2019 telemetry will be initiated to understand the habitat use and movement of this species.

Specific projects to monitor for Black Carp in 2019 include:

- Processing and aging current Black Carp collections for contribution into work on the status of the species, determination of timing of wild spawning, and continued identification of diet items collected.
- Development of an early life history developmental series for use in models such as FluEgg and to understand life requirements.
- Continued sampling for adults with baited nets and sampling for young of year (YOY) and juvenile life stages to determine areas of establishment.
- Refinement of genetic surveillance methods, such as using sediments to samples for eDNA identification of nursery habitats and determining number of parents required for existing populations.
- Identifying the timing and use of habitats by Black Carp with the middle Mississippi River near Mel Price Lock and Dam, the first barrier between the free-flowing and impounded reaches of the Mississippi River as target location for this research.
- Development of a telemetry plan to document habitat use and movement.
- Continue to support the Illinois DNR Black Carp bounty program.
- Work with states to identify and map locations where Black Carp are produced and housed for aquaculture.

3.6.2 Addressing the Threat of Grass Carp

In recent years, the ACRCC has supported 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.

Michigan and Ohio expect to increase their removal activity in FY 2019 with support and assistance from USFWS and USGS. This increased removal effort, coupled with research into additional control strategies, should increase the ability of agencies to control the Grass Carp population in the short term and allow for continued progress toward eventual eradication of Grass Carp in Lake Erie. Research conducted by USGS that is detailed in the 2019 project description (found in Appendix B) will provide additional assistance to ongoing management activities.

3.7 COMMUNICATION/EDUCATION/STAKEHOLDER ENGAGEMENT

ACRCC communication efforts are organized by the partnership's Communication Work Group, which is co-chaired by the USFWS and Illinois DNR. The group 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.

Illinois DNR used this bookmark to promote the consumption of Asian carp in schools.

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 2018, the website was completely overhauled. Improvements to the site included making it mobile device friendly, more intuitive navigation, improved branding in the form of a new logo, and compliance with section 508 of the U.S. Workforce Rehabilitation Act (1973). New content included emerging topics related to Asian carp, such as Grass Carp and Black Carp issues, and federal and state actions in the Upper Mississippi River and Ohio River basins, as outlined in the Water Resources Reform and Development Act (2014).

Targeted ACRCC communications continue in 2019 including organizing public listening sessions; ongoing coordination of partner responses to public, congressional and media inquiries; continued refinement of the ACRCC's early detection notification protocols; creation of ACRCC branded communication products; and ultimately increasing the reach of ACRCC messaging. Communications work will contribute to key audiences having a greater understanding and appreciation for the ACRCC's purpose, function, current actions and successes.

3.8 ACCRC PARTNERSHIP OPERATIONS

In 2019, the USFWS and other ACCRC members will continue to seek opportunities for additional collaboration with partner agencies conducting Asian carp prevention efforts in the Upper Mississippi River and Ohio River basins. These activities are outside of the purview and geographic scope of the ACRCC to leverage resources – including expertise, data, and capacity – and more broadly address the threat region-wide, across multiple basins, where possible.

4.0 COLLABORATIVE ACTIONS WITHIN THE UPPER MISSISSIPPI AND OHIO RIVER BASINS

In 2014, the President signed into law the WRRDA of 2014, Public Law 113-121, authorizing a broad array of agency actions and public projects across the WRRDA authorizes the Director of USFWS to coordinate with the Secretary of the Army, the Director of the National Park Service, 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 and tributaries. Those actions include the provisions of technical assistance, coordination, and support provided by federal agencies to state and local governments in carrying out activities designed to slow, and eventually eliminate, the threat posed by Asian carp. WRRDA also directs USFWS to lead development of an annual report to the U.S. Congress (Report) describing all activities conducted by state, federal, and non-governmental partners during the year in support of Asian carp management strategies, all related agency expenditures, any observed changes in the range of Asian carp, and measured progress made toward the goals of controlling and eliminating Asian carp in the Upper Mississippi River and Ohio River basins. The 2016 Report is available at http://www.asiancarp.us/documents/WRRDA2016.pdf or http://www.asiancarp.us/documents/WRRDA2016.pdf.

Since 2015, the Mississippi Interstate Cooperative Resource Association (MICRA) has coordinated Asian carp management actions through partnerships of state, federal and nongovernmental organizations (NGO's) in the Upper Mississippi River and Ohio River basins. 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 provided below.

In FY 2018, as per the Consolidated Appropriations Act, 2019 (PL 116-6), USFWS will receive $11 million in base appropriations in FY 2019 for Asian carp management, including an increase of $600,00 over the FY 2018 enacted level to be expended on Asian carp prevention and control efforts outside of the Great Lakes. USWS will cooperate with state and federal partners and in support of basinwide management strategies, with an emphasis on expanding and refining the use of contract fishing and fish migration deterrent barriers for deployment in strategic locations.

The increased deployment of scientifically-informed and directed contract fishing and in-water deterrent technologies will further support collaborative efforts to protect portions of the Upper Mississippi River, Ohio River, and the Great Lakes basin and other waters from the risk of Asian carp by addressing potential source populations in large river systems of the Midwest. Technological developments and lessons-learned will be leveraged for use across the basins for a more robust and coordinated approach in support of the national "*Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States*" (National Plan). The additional funds will also support enhanced management actions conducted in cooperation with state and other agency partners to address the growing threat of Grass Carp in the Great Lakes, with a focus on reducing and preventing the further spread of populations in the western basin of Lake Erie.

For more detailed information on annual Asian carp project coordination and implementation in the Upper Mississippi River and Ohio River basins, see the 2017 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin at http://micrarivers.org/asian-carp-plans-and-reports/ or http://www/asiancarp.us/documents/MRP2017MississippiRiverBasin.pdf.

Priority efforts in the Upper Mississippi River and Ohio River basins include:

- Defining distribution of reproduction, recruitment, juveniles, and adults of all four species – fundamental information to make informed management decisions.
- Early detection surveillance and removal of Asian carp in upper reaches to prevent the establishment of reproducing populations.
- Prevent the spread of Asian carp through evaluation of deterrence technologies (e.g. complex sound, manipulation of hydrology at dams) at priority locations.
- Decrease propagule pressure and reduce impacts of Asian carp by increasing removal (commercial fishing, contract fishing) and evaluating Asian carp removal methods.
- Improve management decisions by evaluating the impacts of harvest on Asian carp populations.
- Expand collaborative interagency partnerships in the Upper Mississippi River and Ohio River basins to include the Missouri River and Lower Mississippi River for Mississippi River basin wide approaches to managing the threat of Asian carp across multiple jurisdictions.
- Enhance inter-basin collaboration between the Mississippi River basin and the Great Lakes basin.

Collaborative Asian carp management projects supported with additional USFWS resources include the following:

Upper Mississippi River Basin

- **Surveillance and Evaluation** – Implementation of a comprehensive early detection program to define distribution, abundance, and movement of all life stages of Asian carp to inform control and containment efforts and subsequent evaluation of management actions.
- **Containment** – Collecting baseline fish movement data for evaluation of Asian carp deterrence technologies; as part of an integrated control strategy to prevent upstream spread while minimizing impacts to native species.
- **Control** – Expansion of contract fishing to reduce propagule pressure, reduce impacts, and characterize adult Asian carp populations. The partnership has identified an intensive management zone (between Lock and Dam 19 and Lock and Dam 14) where the majority of removal effort is focused and continually refined using up to date telemetry information.

Ohio River Basin

- **Surveillance and Evaluation** – Implementation of a comprehensive early detection program to define distribution, abundance, and movement of all life stages of Asian carp to inform control and containment efforts and subsequent evaluation of management actions.
- **Containment** – Collecting baseline movement data for evaluation of Asian carp deterrence technologies; and planning future deterrence needs as part of an integrated control strategy to prevent upstream spread while minimizing impacts to native species.

- **Control** – Deployment of contract fishing to reduce propagule pressure, reduce impacts, and characterize adult Asian carp populations. The partnership has identified priority locations in the Ohio, Tennessee and Cumberland rivers where the where the majority of removal efforts are focused and continually refined.

A growing number of technologies are now under development or have been proposed for use in controlling or preventing spread of Asian carp. While the immediate focus of many of these technologies is on managing Asian carp populations in the IWW and the CAWS to prevent establishment in the Great Lakes, advancements made can be leveraged and applied to partnership prevention and control strategies in other basins. Interbasin coordination of Asian carp control and management between the Upper Mississippi River, Ohio River and Great Lakes basins supports an integrated approach to addressing the threat. Coordinated implementation of tools and technologies in strategic locations within both the Mississippi River and Great Lakes basins will be necessary over the long-term to protect the Great Lakes and to accomplish the goals of the National Plan.

The Asian carp problem is present throughout the Mississippi River basin and additional coordination is now underway within the Missouri River and Lower Mississippi River basins. The Missouri River Asian Carp Control Strategy Framework has been completed and multi-year action plans are under development. Development of the Lower Mississippi River framework will be progressing through continued interagency collaboration in 2018.

Strong coordination within and between the Mississippi River basin and Great Lakes basin interagency partnerships is supporting more effective strategic and tactical planning and leveraging of the limited resources available for broad-scale Asian carp management efforts, working toward shared regional and national goals and objectives.

5.0 Canadian Asian Carp Control Efforts

Fisheries and Oceans Canada (DFO), the Ontario Ministry of Natural Resources and Forestry (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 basinwide approach to addressing the threat.

5.1 Fisheries and Oceans Canada

Fisheries and Oceans Canada has undertaken a wide variety of efforts to prevent the introduction and establishment of Asian carp (Grass, Black, Bighead, 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 2018.

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 2018 field season (approximately May through November). Selection of sites was based on those identified as at-risk in Canadian tributaries in the 2011 *Binational Ecological Risk Assessment for Bigheaded Carps in the Great Lakes*, followed by ground-truthing. A reassessment of the sites visited in previous years resulted in the inclusion of 34 sites for the 2017 surveillance program, with 2 sites in Lake Superior, 12 sites in Lake Huron, 7 sites in the Huron-Erie corridor, 8 sites in Lake Erie, and 7 sites in Lake Ontario.

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, trawls, 6-foot, 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. An additional vessel was added in 2018 to increase the program's sampling capacity. In 2018, the program expanded its use of bongo nets and larval light traps to sample for eggs and larval fishes. Field work plans extend into the 2019 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 2018, 984 sites have been completed (additional sampling continues). A total of 50,655 fishes have been detected, representing 86 species. Egg and Larval sampling was conducted in the Ausable River, Credit River, Grand River, and Thames River. A total of 55 bongo net hauls, and 110 light trap sets were completed, capturing 13,020 larval fishes (*species identification has not been completed).

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;

Québec Response Exercise. Photo credit Department of Fisheries and Oceans

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 28 Grass Carp have been captured in Canadian waters of the Great Lakes since 2013. In addition to the three Grass Carp captured during DFO's early detection surveillance efforts (one in 2013, 2014, and 2015, 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 16 events for which response efforts were initiated; nine of these responses involved on-water operations.

In 2018, three Grass Carp were captured in Canadian waters of the Great Lakes. Single Grass Carp were captured by commercial fishers off Point Pelee in Lake Erie in May and July 2018 and off of Point Edward in Lake Huron in July. These captures were reported to OMNRF and turned over to DFO's Asian Carp Program staff. In all three cases, ICS was implemented immediately upon confirmation of species identification (ID). Ploidy analysis revealed all three individuals to be triploid. Age estimations and other analyses are underway, and those results are expected by the end of 2018. Further analysis to better determine origin and movement in the Canadian waters of the Great Lakes for all Canadian Grass Carp specimens is on-going.

Throughout 2019, DFO will continue 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 2018 has included the following studies:

Native Fish Population Structure: To determine the potential for fish 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. In 2018, a state-of-the-art double digest restriction associated DNA (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 among individuals. Populations of all species (*Ameiurus nebulosus, Ambloplites rupestris, Catostomus commersoni, Micropterus salmoides, Moxostoma macrolepidotum, Moxostoma valenciennesi, Perca falvescens*) showed significant genomic differentiation above versus below Niagara Falls (Hudson's Fst range: 0.055 in A. nebulosus to 0.359 in C. commersoni). Migration in six species (all except *M. valenciennesi*) was examined using tests of coalescent-based demographic models. These tests rejected models assuming either no gene flow or downstream geneflow past Niagara Falls in three species (*A. nebulosus, M. salmoides, and P. flavescens*), whereas models of either upstream or bidirectional migration were supported in all three of these species plus the remaining three species examined (*A. rupestris, C. commersoni, M. macrolepidotum*). Estimated numbers of individuals migrating past Niagara Falls were low for all species, never exceeding 11 individuals per 2.5-year generation.

Metabarcoding of Fish Eggs and Larvae: Early life stages of aquatic invasive species 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 2018, work included improving upon the previously successful test of this metabarcoding pipeline by developing and testing new primers tailored more specifically to Great Lakes native, invasive, and potentially invasive fishes. The extraction of DNA from approximately 1,200 egg and larval samples received from DFO in May will be complete shortly and it is anticipated that the samples will be sequenced and identified by the end of 2018.

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 2018, previous laboratory research investigating avoidance responses of Common Carp to acoustic, strobe-light and carbon dioxide stimuli was analyzed, and is now being formatted into a manuscript. Further field and laboratory testing in collaboration with the Royal Botanical Gardens is also being

conducted to investigate the efficacy of acoustic and strobe-light barriers in preventing the dispersal of carp into wetland areas.

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 are currently being analyzed and a similar model is under development for the Rouge River.

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. Preliminary 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. The complete results of this model are currently being analyzed.

Spawning Suitability: A preliminary assessment of the suitability to 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 for submission to a peer reviewed journal.

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 document explains 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 Socio-Economic Risk Assessment for Grass Carp

In close collaboration with subject matter experts from DFO, GLFC, and OMNRF, Central and Arctic region, DFO is in the process of finalizing a bi-national socio-economic risk assessment for Grass Carp.

5.1.6 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 2019.

5.1.7 Ecological Risk Assessment for Black Carp

A binational ecological risk assessment for Black Carp in the Great Lakes basin is well underway, with modelling and the bulk of 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.

5.1.8 Outreach and Education

DFO has undertaken a variety of outreach activities in an effort to prevent the introduction and establishment of Asian carp in Canadian waters. In 2018, DFO has: updated, in both print and html formats, its 2nd most requested communications product called The Baitfish Primer; created a mobile application version of The Baitfish Primer that includes a new dichotomous key baitfish identification feature; set up an information booth at an Indigenous Community Pow Wow; participated in Asian carp public information sessions and presented at Fishing Club meetings. DFO has also contracted a company to create a short documentary-style film on the Asian Carp Program and contracted the Ontario College of Art and Design university to create infographics related to Grass Carp; both projects are expected to be complete by the end of 2018 or early 2019.

In partnership with two non-governmental organizations, Ontario Federation of Anglers and Hunters (OFAH) and the Invasive Species Centre (ISC), DFO is implementing outreach and education to stakeholders and the public in Canada. Contribution Agreements between DFO and the ISC and OFAH were in place throughout 2018 except for approximately 6-8 weeks in April and

May. The current Contribution Agreements are in place for four consecutive years to avoid yearly lapses in public outreach activities.

In 2018, the ISC continued to manage the asiancarp.ca website as well as carpeasiatique.ca, its French language counterpart, including updating webpage materials on response. ISC also: hosted two public information sessions (in Peterborough and Toronto), hosted a partnership meeting with other Asian carp Canada partners, ran social media campaigns, hosted one webinar on the Incident Command System, coordinated the launch of a new Asian Carp Exhibit at the Toronto Zoo (in February 2018), completed an Asian Carp Baseline Knowledge Survey for Manitoba, and completed a follow-up survey to the Asian Carp Baseline Knowledge Survey for Ontario.

Toronto Zoo Launch of the Asian Carp exhibit. Photo credit - Invasive Species Centre

The OFAH has conducted a significant amount of outreach and education activities on Asian carp in 2018 that includes: running a print public service announcement in three (3) issues of Ontario Out of Doors magazine and a web banner from May-August; producing one article on the topic of Asian carp; continuing their billboard campaign at four (4) locations near border crossings; attending six (6) trade shows and other key events including the Owen Sound Salmon Spectacular and Canadian National Exhibition; educating kids in the classroom by travelling to five (5) different school boards, 41 classrooms, reaching 956 students and hosting an Invasive Species Fair; and contributing regularly to their social media campaigns reaching approximately 35,000 people on Facebook, approximately 22,000 people on Twitter, and approximately 5,350 people on Instagram. OFAH also continues to run and monitor the centralized reporting system in Ontario that consists of the Invading Species Hotline and EDDMapS (Early Detection and Distribution Mapping System); OFAH received 38 reports of Asian carp in 2018.

In addition, since December 2015, the biodiversity gallery at the Royal Ontario Museum (ROM) has educated the public through information provided through a display, video and “touchables” (such as a rubberized Grass Carp, teeth, and skeletons) which is geared to children on the threat of Asian carp. The ROM sees 7,000 to 8,000 daily visitors.

5.1.9 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. Starting in April 2019, new resources will be provided within DFO for more on the ground enforcement of these regulations.

5.2 ONTARIO

OMNRF has the lead provincial role to prevent 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 2018 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, the St. Clair River, southern Lake Huron, and the St. Lawrence River. eDNA is a key technique used for monitoring in these locations. In 2018, 101 sites were sampled in the Great Lakes watershed for eDNA. Many sites were sampled on multiple dates, for a total of 188 sampling events. Over 800 water samples were collected by OMNRF field staff and analyzed by the OMNRF Aquatic Genetics Laboratory, located at Trent University. There were three positive detections for Grass Carp in 2018. These samples were collected in Big Creek, Belle River, and Lake St. Clair. In response to these detections, OMNRF staff collected additional water samples at and near these sites. There were no further eDNA detections as a result of follow up sampling. Surveillance plans for 2019 are currently being developed by the Ministry.

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 and sport fishers. These stakeholders are well informed of concerns regarding Asian carp and contact OMNRF and its partner agencies when they encounter suspect fish.

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, Bighead, Silver, and Grass Carp. Ongoing eDNA research is assessing the sensitivity and cost-effectiveness of community metabarcoding for species detection.

5.2.3 Asian Carp Response Plan

OMNRF has developed a provincial Asian Carp Response Plan 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, 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 prevention of 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.invading species.com) hosted by OFAH, as well as a web-based reporting and tracking system called Early Detection and Distribution Mapping System Ontario (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 a number of 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, the Ontario Invasive Plant Council, and others to deliver various aquatic invasive species programs across the province, including outreach, communications, and development of best management practices. OMNRF partnered with the Canadian federal government in 2009 to establish the Invasive Species Centre as 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 on November 3, 2016.

This Act regulated 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. At the same time, Ontario also regulated four other species of fishes, three aquatic invertebrates, nine plants, and one family of fishes. The Act provides a suite of provincial tools that will allow Ontario to take action, while continuing to work with partners and complement the role of the Canadian federal government. The act will:

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

5.3 QUÉBEC

Among its mandates, the MFFP of Québec 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 has 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°50'59.82"N, -73°14'57.25"O) 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 (the otolith core has a lower oxygen isotope signature than that of a specimen born in aquaculture facilities) and according to the strontium (Sr) to calcium (Ca) ratios, the fish lived its first 4 years of life in a relatively stable habitat before making numerous movements between water masses with contrasting chemistry. In addition, eDNA surveys conducted in 2015 and 2016 revealed the presence of Grass Carp genetic material in 16 out of the 110 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 one specimen 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 vector of introduction are present and their importance has to be assessed.

5.3.2 Regulation

Since 2012, the possession of live individuals from the four species composing the Asian carp species complex 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) render illegal aquarium fish-keeping, production, keeping in captivity, breeding, stocking, transport, sale and purchase all live fish listed in the schedule IV (http://legisquebec.gouv.qc.ca/en/ShowDoc/cr/C-61.1,%20r.%207). Grass, Silver, Bighead 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 approximately 325 stations per year since 2017. Sampling sites are determined according to the presence of potential habitats for Grass Carp, areas where positive detections occurred in previous years. Grass Carp DNA was detected at 11 sites out of 323 in 2017 and analysis of samples taken in 2018 is still underway.

Traditional gear sampling surveys – A dedicated survey targeting Grass Carp is 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 has been caught yet 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 aquatic invasive species through a volunteer network coordinated by the MFFP since 2003. All the members of the Network for Detection of AIS by Commercial Fishermen receive annually protocols related to Grass Carp,

identification keys and other relevant information. The utility of such a collaborative effort has been proved 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).

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 validating 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 also 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 for Asian carp were included: Common Carp, Fallfish as well as the 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 both in French and English and are distributed throughout the Province (https://mffp.gouv.qc.ca/english/wildlife/fishing/pdf/asian-carps-key-characteristics.pdf). 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 is conducting 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 distance from cages (up to 5000 meters downstream). A study assessing the performance of the various water sampling strategies has also been done: 1) 950 milliliters (mL) of surface water centrifugated, 2) 250 mL of surface water filtered with a syringe, 3) 250 mL of an integrated water column filtered with a syringe and 4) 2000 mL of an integrated water

column filtered with a drill pump. More experiments are planned over the next 3 years to test the capacity to detect Asian carp eDNA under different weather conditions and timespan.

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 is underway. Aerial photography and satellite imaging were used for the identification and mapping of existing barriers restricting upstream movements. These analyses will 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, 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. 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 2019

The following activities are planned for 2019:

- 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.
- Identifying tributaries and areas within the St. Lawrence River itself with habitat characteristics suitable for Grass Carp reproduction.
- 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 2019 Funding Matrix

FY 2019 Asian Carp Action Plan Funding

(All proposed federal actions are subject to final Congressional appropriations.)

	No.	Agency	Title	GLRI Funding FY 2019 ($)	Agency Funding FY 2019 ($)
Prevention	P-1	USACE	Electric Dispersal Barriers	$0	$18,720,000
	P-2	USACE	Evaluation of Electroshock Avoidance Behaviors in Asian Carp	$450,000	$0
	P-3	USCG	Barrier Operational Risk Assessment	$10,000	$5,000
	P-4	USGS	USGS Support of Brandon Road Study	$79,000	$0
	P-5	USACE	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	$0	$200,000
	P-6	USCG	Brandon Road Lock and Dam Operational Risk Assessment	$10,000	$10,000
	P-7	USACE	Ohio-Erie Canal ANS Barrier Project	$600,000	$0
	P-7	Ohio DNR	Ohio-Erie Canal ANS Barrier Project	$100,000	$0
	P-8	USACE	Little Killbuck Creek - USACE Peer Review	$40,000	$0
	P-9	Ohio DNR	Closure and Monitoring of the Potential Pathway at Little Killbuck Creek	$800,000	$0
	P-10	Illinois DNR	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	$200,000	$100,000
Control	C-1	USFWS	Optimization of Mass Removal Techniques	$0	$120,000
	C-2	USFWS	Asian Carp Population Suppression in the Illinois River	$295,000	$35,000
	C-3	Illinois DNR	Contract Fishing for Asian Carp Detection and Removal	$1,500,000	$0
	C-4	Illinois DNR	Enhanced Contract Removal of Asian Carp in the Peoria Pool of the Illinois River	$153,015	$100,000
	C-5	Illinois DNR	Enhanced Contract Removal, Marketing, Assessment, and Management	$550,000	$0
	C-6	USFWS	Asian Carp Population Model to Support an Adaptive Management Framework	$147,000	$0
	C-6	USGS	Asian Carp Population Model to Support an Adaptive Management Framework	$100,005	$80,000
Early Detection, Monitoring, and Evaluation	M-1	NOAA	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	$105,000	$17,250
	M-2	USFWS	Great Lakes Asian Carp Monitoring Program	$350,000	$1,150,000
	M-3	USFWS	USFWS Barge Entrainment and Asian Carp Interaction Study	$0	$300,000
	M-4	USFWS	Asian Carp Demographics - USWFS	$545,000	$70,000
	M-5	USGS	Asian Carp Demographics - USGS	$45,000	$30,000
	M-6	USFWS	Des Plaines River and Overflow Monitoring	$15,000	$0
	M-7	USFWS	Illinois River Monitoring and Response Team Support	$113,500	$275,000
	M-8	USFWS	Habitat Use and Movement of Juvenile Silver Carp in the Illinois River	$225,000	$300,000
	M-9	USFWS	Distribution and Movement of Small Asian Carp in the Illinois Waterway	$320,000	$300,000
	M-10	USGS	USGS Illinois River Monitoring and Evaluation Project	$370,000	$370,000

FY 2019 Asian Carp Action Plan Funding

(All proposed federal actions are subject to final Congressional appropriations.)

	No.	Agency	Title	GLRI Funding FY 2019 ($)	Agency Funding FY 2019 ($)
Early Detection, Monitoring, and Evaluation	M-11	Illinois DNR	Enhanced Detection Above and Below Electric Barriers	$2,950,000	$0
	M-12	Illinois DNR	Ecosystem Assessment in the Upper Illinois River	$350,000	$0
	M-13	Illinois DNR	Illinois River Stock Assessment/Management Alternatives	$450,000	$0
	M-14	USFWS	eDNA: USFWS Midwest Region Fisheries Program Capacity for eDNA Sampling and eDNA Sample Processing	$0	$2,400,000
	M-15	USGS	Advanced Molecular Tools for Tracking Asian Carp	$0	$800,000
	M-16	USACE	Telemetry in the Upper Illinois Waterway	$0	$200,000
	M-17	USFWS	Telemetry Support for the Asian Carp Population Model (SEACarP)	$140,000	$0
	M-18	USFWS	USFWS Illinois River Hydroacoustics	$135,000	$0
	M-19	USGS	USGS Telemetry Project	$449,000	$227,250
Technology Development	T-1	USACE	USACE Acoustic Deterrents for Asian Carp	$1,506,180	$0
	T-2	USFWS	USFWS Acoustic Deterrents for Asian Carp	$1,350,000	$800,000
	T-3	USGS	USGS Acoustic Deterrents for Asian Carp	$2,100,000	$300,000
	T-4	USACE	USACE Carbon Dioxide Deterrence for Asian Carp	$450,000	$0
	T-5	USGS	USGS Carbon Dioxide Deterrence for Asian Carp	$470,000	$420,000
	T-6	USGS	Developing Species-Specific Control Systems for Asian Carp	$190,000	$650,000
	T-7	USGS	Monitoring at the Electric Dispersal Barrier with Remote Sensing	$30,000	$0
	T-8	USACE	Experimental Testing of Sill Bubble Curtains for Barge Entrainment Mitigation	$440,000	$0
	T-9	USGS	Barge Entrainment/Sill Bubble Curtain Evaluation	$95,000	$0
	T-10	USGS	Development of Unified Method and Other Mass Removal Harvest Techniques	$368,000	$615,000
	T-11	USGS	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	$50,000	$59,400
	T-12	USFWS	Technology Registration and Environmental Review	$140,000	$0
	T-13	Illinois DNR	Evaluation of Gear and Novel Approaches - Modular Electric Barrier	$15,000	$0
Response	R-1	USFWS and USACE	ACRCC Contingency Actions in the Upper Illinois River	$0	$0
Black Carp	BC-1	USFWS	Black Carp Monitoring, Assessment, and Control	$175,000	$100,000
	BC-1	USGS	Black Carp Monitoring, Assessment, and Control	$377,000	$102,000
	BC-1	Illinois DNR	Black Carp Monitoring, Assessment, and Control	$175,000	$0

FY 2019 Asian Carp Action Plan Funding

(All proposed federal actions are subject to final Congressional appropriations.)

	No.	Agency	Title	GLRI Funding FY 2019 ($)	Agency Funding FY 2019 ($)
Grass Carp	GC-1	USFWS	Adaptive Grass Carp Response and Monitoring in Lake Erie	$60,000	$375,000
	GC-1	USGS	Adaptive Grass Carp Response and Monitoring in Lake Erie	$300,000	$779,048
	GC-1	Ohio DNR	Adaptive Grass Carp Response and Monitoring in Lake Erie	$300,000	$0
	GC-1	Michigan DNR	Adaptive Grass Carp Response and Monitoring in Lake Erie	$300,000	$250,000
Commu-nication	Comm-1	USFWS	ACRCC Strategic Communications	$250,000	$100,000
Partnership Operations	PO-1	USFWS	ACRCC Partnership Operations	$75,000	$75,000
	PO-2	USFWS	Administrative and Facilitation Support for the Chicago Area Waterway System Aquatic Invasive Species Stakeholder Group	$87,300	$0
	PO-3	USACE	ACRCC Monitoring and Response Team Support	$100,000	$0
TOTAL FUNDING				$21,000,000	$30,434,948

All FY 2019 Funding Projectsions are based on the Consolidated Appropriations Action 2019 (Public Law 116-6).

FY 2019 Asian Carp Action Plan Funding by Agency

(All proposed federal actions are subject to final Congressional appropriations.)

Agency	Total GLRI Funding	Total Base Funding
USACE	$3,586,180	$19,120,000
USCG	$20,000	$15,000
USFWS	$4,422,800	$6,400,000
USGS	$5,023,005	$4,432,698
NOAA	$105,000	$17,250
Illinois DNR	$6,343,015	$200,000
Michigan DNR	$300,000	$250,000
Ohio DNR	$1,200,000	$0
Total	**$21,000,000**	**$30,434,948**

All FY 2019 Funding Projectsions are based on the Consolidated Appropriations Action 2019 (Public Law 116-6).

Appendix B

2019 Asian Carp Action Plan Action Items

Contents

Contents (continued)

Action Items Page

Contents (continued)

Action Items Page

P-1 Electric Dispersal Barriers

Lead Agency: U.S. Army Corps of Engineers (USACE)

Agency Collaboration: None

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$18,720,000	$0

**All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: The electric barriers operate by creating a waterborne pulsed direct current electric field in the Chicago Sanitary and Ship Canal (CSSC). Fish penetrating the electric field are exposed to electrical stimuli which act as a deterrent. As fish swim into the field they feel increasingly uncomfortable. When the sensation is too intense, the fish is either immobilized or is deterred from progressing further into the field. Three barriers (I, IIA and IIB) are currently operated by USACE. 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 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 monitoring and testing of Barrier I, including the use of 5”x5” steel billets for the electrodes instead of cables. The steel billets were projected to have a life span of 25 years. Barrier II is able to 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.

Barrier I was constructed in 2002 as a demonstration barrier and is currently being upgraded to a permanent status. Site work for the upgraded barrier, known as Permanent Barrier I, and installation of underwater components were completed in 2014. Construction of the new control building, utility connections, and backup power systems were completed in 2018. Work on the remaining two major contracts, installation of the specialized pulse-generating system and replacement of the existing Demonstration Barrier electrodes, is underway. Permanent Barrier I is scheduled for full time operation in 2021. Once completed, the Permanent Barrier I will be capable of running at voltage levels high enough to repel smaller fish, similar to Barriers IIA and IIB, thereby providing additional protection against upward movement of Asian carp within the Chicago Area Waterway System (CAWS).

Proposed Actions for FY 2019:

- Routine operation and maintenance of existing barriers, including replacement of electrodes at Barrier IIB and Demonstration Barrier.

- Continued construction of Permanent Barrier I.

Expected Milestones:

FY 2019 Q1:

- Initiate electrode replacement.

FY 2019 Q2:

- Complete electrode replacement.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Operation and maintenance of the barriers, including regularly scheduled maintenance of the electric barriers.
- Construction of Permanent Barrier I will be completed using previously appropriated funds, with activation and full-time operation to follow.

What Is Deliverable for this Project:

- New electrodes at Barrier IIB and Demonstration Barrier; Permanent Barrier I completion.

Expected Completion Date for Project: To be determined.

Potential Hurdles:

Electrode Replacement

- Construction delays due to inclement weather or undesirable flow conditions.
- Coordination with navigation.

How will the results of this project be disseminated?

- Targeted stakeholder notifications
- USACE webpage.

P-2 Evaluation of Electroshock Avoidance Behaviors in Asian Carp

Lead Agency: U.S. Army Corps of Engineers (USACE)

Agency Collaboration:

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$450,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Fish research and development and the USACE Engineering Research and Development Center (ERDC) have been testing the efficacy of electric barriers on the immobilization of Asian carp and surrogates (e.g., gizzard shad; *Dorosoma cepedianum*) since 2010. Significant progress has been made on the operation of electric barriers to maximize effectiveness. The operating parameters currently being used in the Chicago Sanitary and Ship Canal (CSSC) were developed and tested at ERDC. Environmental operating rules have been developed for the Chicago District to conserve energy while still maintaining an effective barrier field. Comparing DC pulse electricity to AC is currently being planned and implemented under FY 2018 GLRI funding. These studies continue to evaluate and establish the most effective electrical dispersal barrier to prevent all sizes of invasive carp from entering the Great Lakes.

Proposed Actions for FY 2019: This study will evaluate efficacy of additional stimuli for increasing Asian carp spatial avoidance of areas associated with electric shock. This study addresses the *in situ* condition where some additional stimuli helps fish encountering an electroshock learn to avoid the area. Electroshock is a noxious stimulus. The additional stimuli, which in some cases can be applied as noxious stimuli, will not be noxious as applied in this study, but will serve for fish spatial awareness. Outcomes of the study will provide insight for reducing numbers of fish entering the Electric Dispersal Barrier System (EDBS) and continuing upstream to challenge the system and for development/implementation of deterrence systems to reduce numbers of invasive fish approaching vulnerable areas, such as lock chambers.

Some fish encountering an electric dispersal barrier *in situ* can learn to avoid the electric field, to leave the EDBS upon entry and return downstream rather than continuing upstream to challenge the EDBS. Prior research indicates additional stimulus can increase effectiveness of the EDBS though learned avoidance. Stewart (1990) reports that when a novel stimulus was coupled with the margin of an EDBS, fish slowed their approach and learned to avoid the electric field. Recent research has demonstrated spatial avoidance associated with electroshock was learned in goldfish (*Carassius auratus*), rainbow trout (*Oncorhyncus mykiss*), and zebrafish (*Danio rerio*). If Bighead Carp and Silver Carp exhibit learning behaviors for avoidance of electric shock is not known, but the reliable induction of spatial avoidance in these fish could drastically influence design and operation of EDBS, potentially reducing size requirements, power requirements, operating expenses.

The proposed research will test the utility of a bubble field, visual stimulus (light and color), and sound as an additional stimulus for increasing spatial avoidance of electric fields in Asian carp. The tests will be conducted on individuals and groups of fish, with testing performed in tanks and in a large circular raceway. Initial testing will be conducted on small sizes of fish and include use of goldfish as an experimental control, as prior spatial avoidance associated with potential electric shock has been demonstrated in goldfish in prior research. Sponsor input is desired regarding the inclusion of gizzard shad, as a surrogate, and larger sizes of Asian carp.

Potential Out-year Actions (Subject to Future Appropriations):

- Two years of study are required followed by one year of data analysis and final report preparation.

What Is Deliverable for this Project:

- Technical report on the use of electricity in an integrated management program to control invasive species dispersal.

Expected Completion Date for Project:

- September 2021, but progress reports and technical presentation will be provided during the study period.

Potential Hurdles:

- Application of other stimuli in a laboratory environment will require development of new experimental approaches.
- Equipment set-up is a major cost and time effort.
- Access to high numbers of test fish over a range of sizes will have to carefully planned to ensure progress in data collection.

How will the results of this project be disseminated?

- Results will be disseminated via a technical report, oral and written progress reports, followed by submission of a journal article after the study has been completed.

P-3 Barrier Operational Risk Assessment

Lead Agency: U.S. Coast Guard (USCG)

Agency Collaboration: U.S. Army Corps of Engineers (USACE)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$5,000	$10,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

To combat invasive species, particularly Asian carp, USACE installed electrified barrier systems at Romeoville, Illinois on the CSSC. These barriers create a significant electric field in the water and along the shore (an "electrified zone") that presents hazards for vessel navigation and human activity. The Coast Guard Research and Development Center (CGRDC) to work with USACE Engineering Research and Development Center (ERDC) Civil Engineering Research Lab (CERL) to maximize commonality in safety test development and field measurement research to minimize separate USACE and USCG tests and experiments. This includes field test design and conduct to determine changes in the electric field associated with the CSSC barrier system, and the implicit change in marine safety risk.

Summary of Actions to Date: Between 2002 and 2009, USACE installed a system of electrified fish barriers in the CSSC near Romeoville, Illinois. The purpose of the barriers is to limit the spread of various nuisance species, with a more-recent emphasis on preventing the "lake-ward" migration of Silver Carp and Bighead Carp, which could have a significant impact on sport and commercial fishing industries on the Great Lakes.

From the outset, USACE and the USCG were aware the actual effects of high-voltage barriers on vessel traffic and marine safety were not well known. Before getting USCG agreement that waterway navigation could safely continue during barrier operation, the ERDC/CERL conducted a series of engineering tests to determine the physical effects of vessel traffic interaction with electrified water near the barriers. USACE also funded research by the Navy Experimental Diving Unit (NEDU) to research effects the barriers would have on a person in the water. As USACE completed construction on the second and third barriers in the system, they continued engineering tests to document effects of the electrified water on vessel traffic.

In 2009, USCG field commands requested CGRDC support initially to provide an independent analysis of existing studies, to characterize knowledge gaps regarding USCG concerns, and assist in developing search and rescue policy near the barriers. At the same time, after test observation and discussion with field commands, the USCG Office of Design and Engineering Standards (CG-521) compiled a list of potential hazards, tests to investigate the potential hazards, relative degree of the hazard, and mitigation measures should the hazard exist.

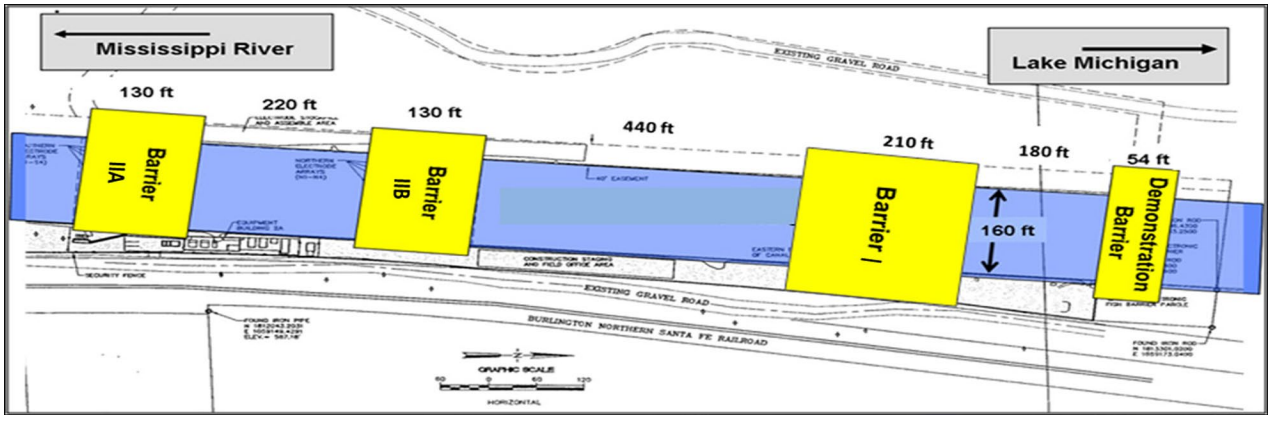
These elements all became the basis for various provisions in 33 CFR §165.923 as the rule developed. In 2010 and 2011, CGRDC conducted tests to identify the hazards associated with rescue of a person in electrified water, with operating guidance and recommendations for rescuer safety. In 2013, CGRDC completed a formal, quantitatively-based marine safety risk assessment related to operation of the barriers.

USACE has begun construction on a fourth barrier that will replace the initial demonstration barrier. The new barrier, referred to as "Barrier I," will be able to operate at higher voltages than the existing demonstration barrier it replaces, which operates at one volt per inch (V/in). Adding a new higher voltage barrier to the existing series of barriers may change the risk profile to the extent existing provisions in 33 CFR §165.923 must change to address risk to vessels and mariners in the vicinity of the barriers.

A 15-barge tow transiting in the CSSC can reach up to 1,145 feet in length. The dispersal barrier's overall length is 1,364 feet. The addition of Barrier I will reduce the length between Barrier IIA and Barrier I by 234 feet and make the overall three-barrier length 1,130 feet. Furthermore, Barrier I will operate at a stronger electric field, likely 2.3 V/in.

With the new configuration, it will be possible for a 15-barge tow to cross all three electric barriers simultaneously. The impacts of this waterway condition to mariner safety and tug/barge operations are unknown and must be examined to determine if the USCG needs to develop additional measures to mitigate the increased risk.

Marine safety and navigation is an area that needs to be incorporated in the very early stages of planning. USACE will contract a Marine Safety Specialist charged with embedding operational concerns, Marine Safety and Navigational Hazards, into the testing plan development. Once Barrier I is complete (estimated early FY 2021) USACE intends to conduct a series of engineering and safety tests to determine the physical effects of vessel traffic interaction with the electrified waters near the barrier system. The USCG RDC will engage with the USACE/Marine Safety Specialist to assist and inform the local Captain of the Port and Ninth District of the identified risks to vessels and mariners transiting the CSSC.



Proposed Actions for FY 2019

- USCG will issue and enforce a series of full and partial waterway closures as necessary to support electric fish barrier maintenance, barrier construction, barrier testing, and any other

aquatic nuisance species (ANS) control activities that may affect the safety of vessels and mariners on federally navigable waterways throughout FY 2019.

- USCG may also develop new safety zones or Regulated Navigational Areas (RNAs) to support new aquatic nuisance species initiatives.
- USCG and USACE will develop coordinated safety testing for "new" CSSC Barrier I at Romeoville, Illinois.
- With USACE ERDC CERL, develop test plan to maximize commonality in electric field test development and electric field measurement research to minimize separate USACE and USCG tests and experiments. This includes field test design and execution to advance technical knowledge about electrical field hazards and the implicit change in marine safety risk once new electrical barriers are energized.
- With USACE ERDC CERL, study electrical field measurements.
- Conduct additional test measurement research as needed.
- Develop recommendations for marine safety risk mitigation.

Potential Out-year Actions (Subject to Future Appropriations):

- USCG will issue and enforce a series of full and partial waterway closures as necessary to support electric fish barrier maintenance, barrier construction, barrier testing, and any other ANS control activities that may affect the safety of vessels and mariners on federally navigable waterways.
- USCG may also develop new safety zones or RNAs to support new aquatic nuisance species initiatives.
- USCG and USACE will also participate in EDBS Barrier I Safety Testing and perform a Marine Safety Risk Assessment.

Expected Milestones: See Proposed Actions above.

- Spring 2019: Safety testing.
- Summer 2019: Test report.
- Early 2020: Risk assessment.

What Is Deliverable for this Project:

- FY 2019 - Safety Testing Report.

Expected Completion Date for Project:

- Barrier Operational Risk Assessment: FY 2020

Potential Hurdles:

Manage Waterway Traffic in Support of Asian Carp Control Activities**:** Waterway closure requests that are provided to the USCG less than 35 days prior to the event do not provide enough time for the USCG to provide appropriate public notice. Waterway restrictions and closures should be planned and coordinated between agencies whenever possible to facilitate the regulatory process and minimize the impact to waterway users. USCG will tailor its ability to carry out short-term

Waterway Management closures/restrictions. However, any long-term closures would be extremely difficult to sustain enforcement.

Barrier Operational Risk Assessment: As part of the USACE Great Lakes and Mississippi River Interbasin Study (GLMRIS), the Commercial Cargo Navigation Team was tasked with assessing the impacts to commercial cargo navigation within the CAWS associated with the potential implementation of a GLMRIS alternative plan. This analysis is included here to quantify commercial vessel traffic within the requested study area. Note that the CAWS includes deep draft ports on Lake Michigan, and not just the CSSC. Here is a summary of their findings (See GLMRIS Section D.10).

> "Since a spike to 25 million tons in 1994, traffic on the CAWS has remained flat to declining. After achieving a five-year low in recession year 2010 at 13.2 million tons, CAWS shallow draft traffic, vessels with a draft less than fifteen feet, experienced a slight increase to 13.6 million tons. However, deep draft traffic, vessels with a draft of fifteen feet or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last ten years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage."
>
> "In 2011, the total traffic was 22.0 million tons with the three main shallow draft commodities in the CAWS being coal (33 percent), iron and steel (15 percent), and aggregates (12 percent) and the three main deep draft commodities being coal (45 percent), ores and minerals (19 percent), and all other group (13 percent)."
>
> "In 2011, approximately 73 percent of CAWS shallow draft commercial cargo traffic is traveling towards Lake Michigan. However, deep draft tonnage was almost evenly split with 56 percent traveling upbound and 44 percent moving downbound."

How will the results of this project be disseminated? To be determined.

P-4 USGS Support of Brandon Road Study

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: U.S. Army Corps of Engineers (USACE) and U.S. Coast Guard (USCG)

FY 2019 Funding Table: (USGS only)

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$79,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Work under this broad, multiagency template includes all efforts to evaluate 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 Chicago Sanitary and Ship Canal (CSSC), and other aquatic pathways. In the context of this study, USACE has interpreted the term "prevent" to mean the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. Specifically, this includes: (1) Great Lakes and Mississippi River Interbasin Study (GLMRIS) Program Management (USACE), (2) GLMRIS Brandon Road (USACE), (3) Characterization of Brandon Road Lock and Approach Channel for Barrier Implementation (USGS), and (4) Brandon Road Lock and Dam (L&D) Risk Assessment (USCG).

USACE completed and released the GLMRIS Report in January 2014. The GLMRIS Report identifies eight potential alternatives - ranging from continuing current efforts to complete separation of the watersheds - and evaluates the potential of these alternatives to control the inter-basin spread of 13 aquatic nuisance species (ANS) of concern, including Asian carp. These ANS of concern are comprised of fish, algae, virus, crustaceans and plants in all life stages with high or medium risk of adverse impacts due to their transfer through the Chicago Area Waterways (CAWS) and establishment in the newly invaded basin.

The remainder of this document focuses on only the USGS portion (Item 3) of this USACE-led project.

The Brandon Road L&D on the Des Plaines River near Joliet, Illinois, has been identified for potential implementation of ANS control measures. To provide additional information concerning the flow hydraulics and mixing characteristics of the lock and downstream approach channel, the USGS performed a detailed study of the site between December 2014 and October 2015, which included the collection and analysis of bathymetric, hydrodynamic, and dye tracer data. Synthesis of these data, combined with long-term continuous monitoring in the approach channel, allowed a characterization of the site for future use in feasibility studies of potential ANS control technologies. The results of this study were published in FY 2018 (Engel and others, 2018).

Proposed Actions for FY 2019: The FY 2019 USGS funding request covers the continued operation of velocity and water-quality gages in the downstream approach channel to Brandon Road Lock, supporting USACE GLMRIS decision making by participating in meetings and calls and specific briefings as requested, and additional hydraulic and water-quality data collection identified by partner agencies.

Expected Milestones:

FY 2019 Q1:

- Perform site visits, service gage instrumentation, calibrate sensors, and work/publish data records; attend GLMRIS meetings, calls, and respond to data requests from partner agencies.

FY 2019 Q2:

- Perform site visits, service gage instrumentation, calibrate sensors, and work/publish data records; attend GLMRIS meetings, calls, and respond to data requests from partner agencies.

FY 2019 Q3:

- Perform site visits, service gage instrumentation, calibrate sensors, and work/publish data records; attend GLMRIS meetings, calls, and respond to data requests from partner agencies.

FY 2019 Q4:

- Perform site visits, service gage instrumentation, calibrate sensors, and work/publish data records; attend GLMRIS meetings, calls, and respond to data requests from partner agencies.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continuous monitoring in support of federal and state partners is expected to continue annually as determined by GLMRIS Brandon Road project needs and the Asian Carp Regional Coordinating Committee (ACRCC) and the Monitoring Response Work Group (MRWG).
- Perform site visits, service sensors and instrumentation, and work/publish all gage data.
- Attend GLMRIS meetings, calls, and respond to related data requests from partner agencies.

What Is Deliverable for this Project:

- Real-time and historic water-quality and velocity data in the approach channel to Brandon Road Lock are received from the USGS National Water Information System (NWIS).

Expected Completion Date for Project:

- Continuous monitoring is expected to continue annually.

Potential Hurdles:

- Stream gages are subject to damage from lightning, flooding, and vandalism.
- Data collection outages may occur until repairs can be made.

How will the results of this project be disseminated?

- All publications associated with this project will be publicly accessible through the USGS Publications Warehouse (search keyword: Brandon Road) and links to articles will be posted on relevant websites (GLRI.us, AsianCarp.us). Press releases will accompany publications when appropriate.
- Data releases associated with this project including full metadata are publicly accessible on the USGS ScienceBase web portal (https://www.sciencebase.gov) (search keyword: Brandon Road).
- Real-time and historic velocity and water-quality data in the approach channel to Brandon Road Lock (USGS 05538020) and historic water-quality data just upstream of the lock chamber (USGS 05538010) are disseminatedvia USGS NWIS.

P-5 Great Lakes and Mississippi River Interbasin Study (GLMRIS) - Brandon Road

Lead Agency: U.S. Army Corps of Engineers (USACE)

Agency Collaboration: None

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$200,000**	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

** $150,000 is allocated to the Brandon Road Study, $50,000 is allocated to GLMRIS Program Management

Project Explanation

Work under this template includes the study of aquatic nuisance species (ANS) control options technologies, as outlined by the Great Lakes and Mississippi River Interbasin Study (GLMRIS), that could be implemented in the vicinity of Brandon Road Lock & Dam (L&D) located in Joliet, Illinois. Further evaluation of ANS control measures at this control point constitutes a logical next step based on the range of alternatives identified in the GLMRIS Report and input from stakeholders and the public during the public comment period for the report.

The output of this study effort will consist of a recommended plan set forth in a decision document. The decision document will evaluate options and technologies suitable for implementation in the vicinity of the Brandon Road L&D control point that will address the movement of ANS from the Mississippi River basin into the Great Lakes through the Chicago Area Waterway System (CAWS). There are three species of concern identified in the GLMRIS Report that are anticipated to pose a high or medium risk to the Great Lakes. The decision document will include sufficient planning, engineering and design to support an agency decision towards the authorization for construction of a water resources project. The completed document would include required environmental compliance analyses and support the justification of an agency decision.

Summary of Actions to Date: The Brandon Road Study was initiated in September 2014. Public Scoping Meetings were held, and a public comment period was completed in January 2015. The team worked closely with federal and state partner agencies, subject matter experts, USACE centers of expertise and stakeholders to gather data to formulate alternative solutions that address swimming, floating and hitchhiking ANS moving from the Mississippi River basin to the Great Lakes basin. The team formulated and evaluated seven alternatives and selected the Technology Alternative Complex Noise with Electric Barrier as the Tentatively Selected Plan (TSP).

The Technology Alternative Complex Noise with Electric Barrier includes nonstructural measures, engineered channel, acoustic fish deterrent, flushing lock and fish entrainment mitigation. This alternative was selected because it meets the project objective by reducing the risk of Mississippi River basin aquatic nuisance species establishment in the Great Lakes basin to the maximum extent

possible, and it provides for continued navigation and minimizes impacts to other waterway users and uses.

The TSP underwent public review and technical review from August 2017 to December of 2017. Comments from these reviews were considered and incorporated into the report as feasibility level planning and engineering analysis were also completed. The final report was provided to HQ USACE for final policy review and Senior Leader Review.

Proposed Actions for FY 2019:

- USACE will complete the Senior Leader Review Brief, Final Report and draft Chief's Report, State & Agency Review, and the final Chief's Report.

Expected Milestones:

December 2019:

- State and Agency Review.

April 2019:

- Chief's Report Milestone.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Pre-construction, Engineering and Design (PED) and implementation of the non-structural plan by others, subject to authorization and funding.

What Is Deliverable for this Project: Completed feasibility report.

Expected Completion Date for Project: April 2019 (feasibility phase).

Potential Hurdles: None.

How will the results of this project be disseminated?

- Report will be posted on the USACE website: http: www.mvr.usace.army.mil/GLMRIS-BR.
- Federal partners, state agencies, congress, stakeholders and public will be notified via Federal Register notice, email, postcard, and media advisories.

P-6 Brandon Road Lock and Dam Operational Risk Assessment

Lead Agency: U.S. Coast Guard (USCG)

Agency Collaboration: U.S. Army Corps of Engineers (USACE)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$10,000	$10,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

To address invasive species control measure changes, USCG operational commander requested Coast Guard Research and Development Center (CGRDC) support for research to develop scientific and technical knowledge into how species control technologies could influence possible navigation safety hazards, extent of hazardous areas, interaction of hazards and operational procedures, and risk mitigation alternatives associated with the control-measure changes.

CGRDC research includes how new species control technologies can influence the scope of potential risk-loss opportunities at Brandon Road Lock and Dam (L&D) before new control measure installation (preliminary risk assessment).

Research vessel-traffic density and vessel operations near anticipated barrier location.

- Conduct in-depth, data collection and analysis to determine scope of potential risk opportunities, regarding 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.
- Research results will be provided to USACE to develop and tabulate risk scenario matrices in coordination with USCG operational commander.

Summary of Actions to Date: Aquatic nuisance species (ANS) control technologies, especially electric barriers, can pose major safety risks to commercial and recreation vessels transiting the area as well as shore side personnel that come in contact with the water near ANS control measures. The risk of a person falling into the water at Brandon Road is significantly different than at the existing electric fish dispersal barrier (located 10 miles upstream of Brandon Road) because mariners must be out on deck for work in conjunction with lock operations.

The USCG operational commander requested CGRDC help in shaping USACE's formal evaluation to include associated risks to vessels and mariners, analyzing USACE results, and identifying mitigation strategies for safety risks associated with ANS controls at Brandon Road. CGRDC completed a Preliminary Marine Safety Risk Assessment for Brandon Road L&D Invasive Species

Control Measures. The report addresses control technology as far as hazardous operating environment, potentially hazardous effects on vessel operations, personnel safety, or hazardous environmental interactions near anticipated barrier location. Additionally, CGRDC developed a baseline risk matrix that identifies scenarios and potential consequences based on the interactions with the prospective control measure technologies.

Proposed Actions for FY 2019:

- Conduct in-depth research and quantification of vessel-traffic density and vessel operations near anticipated barrier location. Research will 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.
    - Frequency of operations and activities which may pose risk scenarios.
    - Tow flotilla configuration.

Timeline for Major Actions: Ongoing:

- Observation of the planning and execution of carbon dioxide (CO_2) testing at the Fox River site.
- Liaison and test attendance with USACE on acoustic deterrence.
- Participation in entrainment/non-entrainment research.

Expected Milestones: None.

What Is Deliverable for this Project: See Proposed Actions above.

Expected Completion Date for Project: On-going.

Potential Hurdles:

As part of GLMRIS, a Commercial Cargo Navigation Team was tasked with assessing the impacts to commercial cargo navigation within the Chicago Area Waterway System (CAWS) associated with the potential implementation of a GLMRIS alternative plan. This assessment is included here to quantify the commercial vessel traffic within the requested study area. Note that the CAWS includes the deep draft ports on Lake Michigan and not just the CSSC. Here is a summary of their findings (See GLMRIS Appendix D - Economic Analyses, D.10 Commercial Cargo Navigation, D.10.1.3 Key Findings).

> "Since a spike to 25 million tons in 1994, traffic on the CAWS has remained flat to declining. After achieving a five-year low in recession year 2010 at 13.2 million tons, CAWS shallow draft traffic, vessels with a draft less than fifteen feet, experienced a slight increase to 13.6 million tons. However, deep draft traffic, vessels with a draft of fifteen feet or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last ten years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage."
>
> "In 2011, the total traffic was 22.0 million tons with the three main shallow draft commodities in the CAWS being coal (33 percent), iron and steel (15 percent), and aggregates (12 percent) and the three main deep draft commodities being coal (45 percent), ores and minerals (19 percent), and all other group (13 percent)."

"In 2011, approximately 73 percent of CAWS shallow draft commercial cargo traffic is traveling towards Lake Michigan. However, deep draft tonnage was almost evenly split with 56 percent traveling upbound and 44 percent moving downbound."

How will the results of this project be disseminated? To be determined.

P-7 Ohio-Erie Canal ANS Barrier Project

Lead Agency(s): U.S. Army Corps of Engineers (USACE) and Ohio Department of Natural Resources (DNR)

Agency Collaboration: Summit County Metro Parks

FY 2019 Funding Table:

Agency Funding Expected		Asian Carp GLRI Funding Requested	
USACE	**Ohio DNR**	**USACE**	**Ohio DNR**
$0	$0	$600,000	$100,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Several actions have been completed with the goal of preventing or reducing the probability of aquatic nuisance species (*e.g.,* Asian carp) moving from the Tuscarawas River Watershed into the Cuyahoga River Watershed via the Ohio-Erie Canal. As of the end of FY 2018, USACE has completed pre-construction tasks including developing design documents, acquiring the necessary temporary real estate rights of entry, conducting outreach and stakeholder coordination, receiving all permits and approvals necessary, and soliciting and awarding a construction contract for installing numerous separate structural barriers over a few miles of basin divide in Summit County, Ohio. The construction contract was awarded on September 28, 2018.

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. At most locations, hydrologic separation of the two basins will be accomplished by raising the ground surfaces in low areas. In other places where separation isn't practical, fences or screens will be installed.

Proposed Actions for FY 2019:

USACE:

- Review contractor bonds and issue the notice to proceed, review and approve submittals, mobilize and begin field work.
- Provide all project management, engineering design and other support during construction.
- Award construction contract options
- Provide construction supervision and administration
- Monitor excavations as per terms of the mode of action (MOA).

Ohio DNR:

- Once construction is completed in the fall of 2019, Ohio DNR will be responsible for operation and maintenance (O&M) and State Historical Preservation Office (SHPO) mitigation. To accomplish this, Ohio DNR will need to purchase a piece of equipment for maintaining the screening structure and for personnel to maintain all the installed measures. SHPO mitigation will include signage that educates the public on the history of the Ohio Erie Canal.

Expected Milestones:

USACE:

FY 2019 Q1:

- Start construction.

FY 2019 Q4:

- Substantial completion.

Ohio DNR:

FY 2019 Q4:

- Complete SHPO mitigation and initiate closure.

Potential Out-year Actions (Subject to Future Appropriations)**:**

USACE:

- Prepare/review and finalize an O&M manual for Ohio DNR and close out the project.

Ohio DNR:

- Ongoing O&M.

What Is Deliverable for this Project:

USACE:

- Project turnover for O&M by Ohio DNR.

Ohio DNR:

- Complete SHPO mitigation and initiate O&M.

Expected Completion Date for Project: FY 2020 Q2

Potential Hurdles: Uncertainties at this stage that may result in hurdles include:

- Differing site conditions and possible change orders.
- Possible coordination with Ohio DNR and others on sheet pile driving/stability monitoring.
- Public/stakeholder concerns or requests for information.
- Coordination with Cargill on brine line relocation activities at Area F.
- Real estate-related requirements (i.e. Cargill staging area).

- Ensure that the tow-path measures are maintaining standards. Monitor screening structure to ensure that it is maintaining protection level necessary to prevent aquatic invasive species transfer.

How will the results of this project be disseminated? There are various possible means for disseminating information, including:

- USACE fact sheet.
- Congressional updates.
- Project completion joint USACE/Ohio DNR press release.
- GLRI.US website updates.
- Asian Carp Regional Coordinating Committee notifications.
- Facebook posts - USACE, Ohio DNR and Summit Metro Parks.
- Other social media posts.
- Dedication facilitated by Ohio DNR.

P-8 Little Killbuck Creek - USACE Peer Review

Lead Agency: U.S. Army Corps of Engineers (USACE) Buffalo District

Agency Collaboration: Ohio Department of Natural Resources (DNR)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$40,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: None.

Proposed Actions for FY 2019: Complete an independent external review of the 25 percent design report for Ohio DNR that was prepared by NTH Consultants, Ltd. The report includes two proposed layouts of an earthen berm to separate the Great Lakes and Mississippi River basins across one farm in Medina County, Ohio. This review will include, but not necessarily be limited to, geotechnical, cost engineering, biological, and civil/structural design elements. It will not, however, include a review of the Hydrologic Engineer Center River Analysis System (HEC RAS) model for hydraulics and hydrology that was developed by NTH Consultants. Review comments will be provided to Ohio DNR to be addressed/resolved and a final summary report of this independent review will be provided to both Ohio DNR and U.S. Environmental Protection Agency (USEPA).

Expected Milestones:

- USACE will complete its peer review and submit a final summary report of its review approximately three months after receipt of full funding.

Potential Out-year Actions (Subject to Future Appropriations)**:** None.

What Is Deliverable for this Project:

- Peer review report.

Expected Completion Date for Project:

- Approximately three months following receipt of full funding.

Potential Hurdles: None.

How will the results of this project be disseminated?

- Report provided to Ohio DNR and U.S. Environmental Protection Agency.

P-9 Closure and Monitoring of the Potential Pathway at Little Killbuck Creek

Lead Agency: Ohio Department of Natural Resources (DNR)

Agency Collaboration: U.S. Army Corps of Engineers (USACE)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$800,000

Project Explanation

Summary of Actions to Date: The Great Lakes Mississippi River Interbasin Study (GLMRIS) determined that Little Killbuck Creek is a medium risk connection for transfer of Silver Carp, Bighead Carp, Black Carp, and Inland Silverside (*Menidia beryllina*) from the Mississippi River basin to the Great Lakes basin for the transfer of threespine stickleback (*Gasterosteus aculeatus*) and viral hemorrhagic septicemia (VHS) from the Great Lakes basin to the Mississippi River basin. Actions to be completed with current funding includes:

- Completed 25 Percent design (Study and Report).
- Study and Report sent to USACE for peer review.
- Ohio DNR will finalize Study and Report.
- Using the finalized Study and Report, Ohio DNR will determine berm alignment.
- NTH will provide additional hydraulic modeling to assess potential flooding.
- Ohio DNR will acquire easements on four parcels for the construction of the berm.
- Ohio DNR will facilitate a meeting with the Potentially Affected Interests.

Proposed Actions for FY 2019: For construction of the berm, there is a need for borrow material. This site will also be used to mitigate for potential flooding.

Expected Milestones:

FY 2019 Q1:

- Peer review of Study and Report.

FY 2019 Q2:

- Finalize Study and Report.
- Determine berm alignment.
- Hydraulic modeling.

FY 2019 Q3:

- Berm easement acquisition.
- Outreach.

FY 2019 Q4:

- Borrow site acquisition.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Finalize project design
- Initiate construction which will likely be completed in stages over three years

What Is Deliverable for this Project:

- Acquire Borrow/Flood Mitigation Site.

Expected Completion Date for Project: FY 2023

Potential Hurdles:

- Finalizing berm alignment.
- Landowner negotiations.
- Potential for localized flooding.
- Local opposition.

How will the results of this project be disseminated?

There are various possible means for disseminating information, including:

- Congressional updates.
- Project initiation/completion press releases.
- Ohio DNR and GLRI.US website updates.
- Asian Carp Regional Coordinating Committee notifications.
- Facebook posts.
- Project completion dedication.

P-10 Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp

Lead Agency(s): Illinois Department of Natural Resources (DNR)

Agency Collaboration: None

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested*
$100,000	$200,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Note: Approximately 67% of effort will be focused on Asian carp and their pathways.

Project Explanation

While both Bighead and Silver Carp are listed under the Lacey Act as illegal to transport alive, many local communities and/or markets continue to buy and sell live Asian carp for consumption and/or release into the wild according to ethnic customs or traditions. Illinois DNR proposes to increase officer presence and enforcement activities related to Asian carp in a manner similar to the bait shops visits. This has proved successful in promoting open dialogue between store owners, the public, and enforcement officials. Community involvement would focus on fish processors, markets, and other retail food establishments where live Asian carp are (or were) likely to have been. These activities will focus on markets known for having a preference for live fish for release or food preparation as well as those that may be supplying markets.

Illinois DNR staff and Conservation Police Officers (CPOs) will perform education and outreach activities, as well as on site enforcement if necessary through informal site visits at fish processors, fish markets, and retail food establishments. In addition, import and export audits and inspections will be performed to ensure compliance with both the federal Lacey Act and Illinois Injurious Species Rule. CPOs will also be tasked with ensuring adherence to other laws and regulations by commercial fisherman.

Because unintentional contamination has been suspected in other aquatic nuisance species (ANS), fish transportation and importation for food or stocking will also be investigated. Increased officer presence, education, and communication will enhance our understanding and ability to limit these opportunities of introduction.

Summary of Actions to Date: This project is staffed by two CPOs who are trained and experienced with investigating illegal activities associated with aquatic invasive species (AIS). The Invasive Species Unit (ISU) is a specialized unit dedicated to detecting illegal activities that present a risk to the introduction or spread of AIS. The ISU conducts surveillance operations, record audits, random and targeted inspections and Internet searches. AIS complaints from any source(s) that require investigating are referred to the ISU. The ISU is responsible for training CPOs throughout the state

in AIS enforcement techniques. Illegal AIS activities often cross multiple boundaries, and the ISU is in charge of representing Illinois during multi-jurisdictional operations.

Proposed Actions for FY 2019: Surveillance and enforcement efforts will target locations throughout Illinois where live aquatic species are being caught, transported, processed, bought, sold, traded, raised or stored. Enforcement time will be prioritized and allocated based upon a risk assessment of the introduction and spread of the species and the credibility of the source(s) of information. Fish markets, bait dealers, transportation companies, pet stores, distribution centers, aquaculture facilities, and fish processing centers are all areas of interest. Joint investigations and cooperative agreements may lead to activities being conducted outside of Illinois in other jurisdictions when necessary.

Objectives of Project:

- Respond to all requests from the Monitoring Response Workgroup (MRWG) to investigate any areas of concern that arise.
- Develop enforcement strategies to detect illegal AIS activities and apprehend violators of the law.
- Train CPOs on AIS enforcement techniques.
- Seek out and complete relevant training to better equip the ISU with AIS enforcement.
- Participate and represent Illinois in multi-jurisdictional AIS operations and relevant conferences.

Expected Milestones:

- Activities will be throughout the year and adaptive to information that is shared by Illinois DNR and other partner agencies.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Maintaining high level surveillance is expected and necessary to protect Great Lakes and Illinois ecosystems.

What Is Deliverable for this Project:

- Reporting and collaboration with regional bodies will be afforded at all times for maximum protection.

Expected Completion Date for Project:

- Ongoing annually to protect ecological resources.

Potential Hurdles:

- Enforcement efforts cannot be 100 percent, but communication and education functions do thrive to educate those willing to follow the law and minimize novel introductions.

How will the results of this project be disseminated?

- Monthly summaries of activities provided to MRWG and Asian Carp Regional Coordinating Committee as prudent.
- Annual summaries provided in the Interim summary reports.
- Coordination with Communication and Outreach Workgroup.
- Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.
- Public and internal communications with appropriate agencies and jurisdictions.

C-1 Optimization of Mass Removal Techniques

Lead Agency: U.S. Fish and Wildlife Service (USFWS) - Columbia Fish and Wildlife Conservation Office

Agency Collaboration: U.S. Geological Survey (USGS) - Columbia Environmental Research Center

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$120,000	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation:

Summary of Actions to Date: This project will continue to build on successful methods and expertise for optimizing gears for mass removal of various size classes and species of invasive carps. The electrified paupier net has been validated as a gear that can fish within most habitats in Starved Rock Pool while regularly obtaining greater than 12,000 pounds/day or 1,100 fish/electro hour. USFWS conducted trials and are in the process of employing a new electrofishing configuration that will enhance the gear's ability to sample deeper habitats (>3m) in addition to surface samples, while also operating in all encountered ranges of water conductivity. This progress has been furthered by the engagement of one of our staff becoming a recognized technical instructor for electrofishing. USFWS developed modeling software and a unique electro-mapping device to describe the radiance of power in a 2D color map. USFWS worked with an electrofishing contractor (USFWS-retired) to describe and challenge existing theories of standardized power goals that will advance global understanding of electrofishing techniques. In cooperation with a net-maker, USFWS developed detachable tendering cods capable of holding ½ ton of fish, which will allow greater time spent fishing in the future.

In order to explore new methods of harvest that will reduce bycatch and allow the harvest of multiple sizes and species of carp, USFWS is conducting trials with several weir/trapping and herding methods. While traditional Great Lakes traps have been largely ineffective, USFWS sought to modify the design by observing fish behavior and areas of aversion to fyke net devices. Through consultation with a net designer, USFWS began developing several fyke devices and cod designs for three large trap nets and have shown positive results in trials conducted within small tributaries and a lake. Continued consultation with the net designer following these tests suggests quick progressive steps could be made.

Actively herding fish has been difficult, however USFWS developed and used towable high-visibility gillnets to move large schools of fish across a lake towards a capture area. The USFWS also designed and successfully implemented a visual barrier using high intensity lights and a mobile snag-proof barrier to drive fish into a trap net within a small tributary. Through progressive training with a professional net maker, our staff has received certification in net materials, design, mending and construction. This training has enabled us to quickly modify existing nets and to conceive and

build new hooded block netting that discourages fish jumping over the net. Hooded block net designs will enhance our ability to use Unified or herding methods in a wider range of water temperatures instead of only the winter season.

USFWS further developed existing surface trawl capability through on-site consultation with a net-designer. Coupled with a biologist's 17-year expertise in trawling, continued staff training and equipment infrastructure, our new surface trawl can be widely used to more efficiently sample early life stages of carp.

Proposed Actions for FY 2019: USFWS will seek to develop gears that can be used to make fishing more effective. USFWS will continue to pursue mass harvest techniques that are progressing towards an affordable gear that can be implemented for effective harvest in a wide range of water bodies. Concurrent work with Illinois commercial harvesters conducting beach seining will enhance our ability to utilize a variety of bag designs and removal devices by capitalizing on existing harvest and removal effort.

Collaborative efforts in net modification of fyke design and observation of behavioral avoidance through dual-frequency identification sonar (DIDSON) will occur. Weir/trap design will be explored with newly purchased hooded blocknets. Herding methods using high-strength gillnet will be used to compact fish in large reservoirs and night herding methods will be used in shallow backwaters and tributaries to determine its' utility.

The electrified paupier has proven to be an effective tool for efficient removal of a broad size-range of Silver Carp. USFWS will provide a paupier boat descriptive with an integrated operator safety and electrical efficacy training program to enable new agency users to safely and effectively use this boat to achieve harvest goals. USFWS will also expand the electrified paupier's use in conjunction with block netting and fish herdingto increase catch rates. USFWS will integrate removable cods to facilitate greater active fishing time versus fish removal.

Beyond mass removal, the electrified paupier has potential to inform stock assessment and serve as a harvest predictor tool utilizing low cost sonar integration, computer automation, and GIS overlays to provide a hotspot map that is informative to agencies seeking high abundance areas and an understanding of the sizes of available fish. Simple longitudinal surveys at 3mph with occasional gear deployment could provide a robust and inexpensive assessment tool that could be widely used by resource managers. Similar to NMPHS in marine systems, our agencies could provide a tool to make fishing more productive while understanding Asian carp life history and population change. Long-term monitoring as described would fully optimize this gear's application and create an inexpensive, robust and needed tool by agencies.

Expected Milestones:

FY 2019 Q1:

- Continued trials of weir/herding/trapping in lakes and tributaries.
- Continued trials of electrified paupier mass harvest in lakes and tributaries while assessing expanded correlative environmental variables as drivers for catch rate.
- Purchases of new gear will include: 3000 feet of hooded block net; adult Silver Carp surface trawl; 2000 feet Dyneema® herding net (2 depths); tapered beach seine with beach lifters and capstan engine; live car net, brail winches.

FY 2019 Q2:

- Continued gear trials, electrified paupier guidance document and preparation of training course, net design training for agency staff.

FY 2019 Q3:

- Continued seasonal gear trials, surface trawl trials and on-site consultation with experts.

FY 2019 Q4:

- Continued seasonal gear trials, report preparation, pilot study for using electrified paupier as tool for removal by agency partners.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continued trials with broader geographic implementation.

What Is Deliverable for this Project:

- An effective tool for removal of various sized carp with the training for agency personnel on methods of gear deployment and utilization.
- Infrastructure for cooperative removal events and steps toward a strategy for basin-wide deployment are primary deliverables.

Expected Completion Date for Project: 2021

Potential Hurdles:

- Timeline may be negatively influenced by unanticipated challenges, which are often associated with doing novel work.

How will the results of this project be disseminated?

- Annual summary documents and technical publications.

C-2 Asian Carp Population Suppression in the Illinois River

Lead Agency: U.S. Fish and Wildlife Service (USFWS) - Columbia Fish and Wildlife Conservation Office (Columbia FWCO)

Agency Collaboration: Illinois Department of Natural Resources (DNR), U.S. Geological Survey (USGS), Southern Illinois University (SIU), USFWS - Wilmington

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$35,000	$295,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: The Columbia FWCO has removed over 350,000 pounds (175 tons) of Asian carp since 2015 with the electrified paupier from the Starved Rock Pool in support of the Barrier Defense Asian Carp Removal Project and the removal in the Upper Illinois Waterway projects coordinated by Illinois DNR. Innovations continue to improve fish handling logistics and efficiency in terms of Asian carp biomass per labor hour. For instance, crew fatigue was reduced in 2017 by mechanical winch improvements that assisted with moving heavy loads of fish, and the addition of a tender boat freed the electrified paupier to continue fishing operations. In 2018, a processing/disposal location at the boat ramp eliminated the need to haul fish. These improvements all increased the time spent fishing and ultimately the number of fish removed in a day. Also, in 2018, telemetry, hydroacoustics, and sonar further informed our targeted removal efforts. Telemetry provided information on Silver Carp movement trends that informed us of habitats they might be using. Hydroacoustics provided maps with high densities of Asian carp identified. These "hot spot" maps informed us of new areas to fish while sonar mounted on our boats allowed us to verify the presence of schools before fishing efforts began.

In addition to mechanical and technological improvements, adjustments have been made based on our experience in and knowledge of the Starved Rock Pool to maximize our efficiency. For example, we observed Silver Carp catch rates with the electrified paupier to be highest in late summer and early fall, so removal efforts are now targeted in July through September. We also observed that certain areas had higher catch rates of non-target, native species, so those habitats are now avoided to reduce bycatch. These "lessons learned" have allowed us to refine when and where we target to remove Silver Carp. Incorporating mechanics, technology, and intimate knowledge of the area have allowed successful targeted fishing and the removal of several tons of Asian carp, further reducing the risk of Asian carp moving into the Great Lakes.

Proposed Actions for FY 2019:

- Collaborate with Illinois DNR and contracted commercial fishers to continue Asian carp mass removal downstream of the electric dispersal barrier system.

- Concentrate targeted removal efforts when catch rates are historically highest in the Starved Rock pool (i.e., July, August, and September).
- Increase harvest per labor hour, increase number of fish captured, and reduce handling of individual fish by:
    - Modifying paupier nets to improve transfer of captured fish to a tender boat.
    - Adding block nets to corral fish in high-density areas thereby increasing their vulnerability to capture.
    - Further mechanization of these processes.
    - Continuously assess and implement changes to increase efficiency.
- Use telemetry, hydroacoustics, and field visits in late spring to mid-summer to evaluate feasibility of Silver Carp targeted removal efforts in the Peoria pool and make a recommendation for out-year actions.

Expected Milestones:

FY 2019, October-December:

- Finalize data entry and preliminary analysis to draft reports and presentations for providing results to partners, collaborators and decision-makers.
- Compare FY 2018 results with expected results to refine plans for FY 2019.
- Evaluate efficiency of 2017 and 2018 Silver Carp removal efforts in collaboration with Illinois DNR to guide future removal efforts.

FY 2019, January-March:

- Submit reports and present findings to partners, collaborators and decision-makers.
- Evaluate efficiency of 2017 and 2018 Silver Carp removal efforts in collaboration with Illinois DNR to guide future removal efforts.
- Collaborate with partners to develop structure for communication and obtaining telemetry and hydroacoustics information to inform targeted removal efforts.
- Discuss with modeling workgroup how removal numbers can be incorporated into exploitation estimates and develop structure for reporting appropriate data for incorporation into models evaluating removal efforts.
- Develop plan for evaluating feasibility of Silver Carp targeted removal efforts with the paupier in the Peoria pool.

FY 2019, April-June:

- Implement plan for evaluating feasibility of Silver Carp targeted removal efforts with the paupier in the Peoria pool.
- Collaborate with partners to finalize plan and implement structure for communication and obtaining telemetry and hydroacoustics information to inform targeted removal efforts.
- Develop data workflow for removal numbers and associated data to be incorporated into exploitation estimates to evaluate removal efforts.

FY 2019, July-September:

- Implement Silver Carp targeted removal efforts in Starved Rock pool.

- Communicate with partners to obtain telemetry and hydroacoustics information to inform targeted removal efforts.
- Provide appropriate data to evaluate removal efforts.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continuously increase efficiency of mass removal efforts by increasing infrastructure, mechanization, and/or collaboration.
    - Develop and implement training program on the use of paupier for mass removal of Asian carp for partner agencies.
    - Implement operation of high capacity tender boat to service fishing efforts.
- Utilize telemetry, hydroacoustics, and past harvest data to develop a predictive model for the best times, locations, and technique for mass harvest.
- In coordination with partners and other projects, measure exploitation achieved through barrier defense efforts and the long-term impact on the Asian carp population in the Illinois River.
- Finalize data entry and preliminary analysis to draft reports and presentations for providing results to partners, collaborators, and decision-makers.
- Compare results with hypothesized and expected results to refine plans.

What Is Deliverable for this Project:

- 100,000 pounds (50 tons) of Asian carp removed from Illinois River system in July - September 2019.
- Asian carp size at capture to evaluate targeted removal capabilities.
- Annual report submitted to the Asian Carp Regional Coordinating Committee's Monitoring and Response Workgroup.
- Presentations to partners, conferences, agencies, and public.

Expected Completion Date for Project: Ongoing

Potential Hurdles:

- Collaboration with partners.
- Funding to expand the infrastructure.
- Inclement weather and flooding.
- Mechanical problems with equipment.

How will the results of this project be disseminated? Public (monthly summaries on asiancarp.us), technical audience(s).

C-3 Contract Fishing for Asian Carp Detection and Removal

Lead Agency: Illinois Department of Natural Resources (DNR)

Agency Collaboration:

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$1,500,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: This project uses contracted commercial fishing (annually and nearly continually) to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the Electric Dispersal Barrier System (EDBS). Commercial fishers will 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. Commercial fishers will gather information on Asian carp population abundance and movement in the Illinois Waterway (IWW) downstream of the EDBS as a supplement to fixed site monitoring by contracted netters. In the Chicago Area Waterway System (CAWS) (seasonally) and from barrier down 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, many of these contactors also serve as responders. This project allows for personnel services, equipment/gear and commodities for agency support, and contracts for fishing as well as any necessary contracts for fish removal.

Efforts are proposed to be heightened in 2019 to prescribe more effort to maintain lower populations of Asian carp (as observed by hydroacoustic and corroborating information) while further removing and further reducing Asian carp densities in the Upper IWW in several ways:

- More crew/weeks scheduled in removal efforts by increasing efforts by 30%.
- Specialty gears such as seines and trap nets will be deployed when most prudent.
- Continue adaptive netting dimensions, as carp population has changed nets will be set to optimize removal efforts. (Fishing efforts have removed the largest individuals in the upper river therefore smaller meshed nets will be used to also optimize for the smaller fish).
- While increased surveillance efforts from the EDBS to Dresden Island pool had been modified in prior years (most recently in 2018) increased efforts in 2019 will be for removal in Starved Rock and Marseilles pools where larger densities of Asian carp exist. Spatially Explicit Asian Carp Population (SEACarP) models suggest the removal of fish where more plentiful/dense increase ability to manage and control spread.

Fish disposal prior to 2016 was facilitated by Illinois businesses taking all of the harvested fish. Beginning in 2017 increased difficulty to find authorized business to remove fish required disposal of fish through contracted waste disposal for fish. Illinois DNR has identified increased business

willingness to remove captured fish. Use of any disposal contracts to landfills should be minimal in 2019 and only employed to facilitate removal activities in Upper IWW when necessary.

Proposed Actions for FY 2019: Illinois DNR will contract with fishers to catch and remove 1 to 1.5 million pounds of Asian carp upstream of Starved Rock Lock and Dam in 2019. In addition, contracted fishers will provide expertise and support for seasonal monitoring in CAWS as well as at the EDBS. Continued work in Lockport and Brandon Road will continue at prior levels to maintain detection ability to inform EDBS operation and contingency planning efforts.

Efforts in 2019 will be increased by 30% (contract costs) with effort increased in Starved Rock and Marseilles pools. 2018 levels of effort will be maintained in other areas to properly inform annual Monitoring and Response Plan (MRP) and Contingency planning efforts.

Expected Milestones:

- Contracted fishers have removed at least 1 million pounds of Asian carp in these efforts in prior years. It is expected that increased efforts, despite lower densities observed, would allow increased biomass removal.
- In 2019, it is expected that 1-1.5 million pounds of Asian carp will be removed.

Potential Out-year Actions (Subject to Future Appropriations)**:**

Contracted removal has accounted for some of the most encouraging reduction in risk by lowering density in the upper IWW. Continued efforts, coupled increasing with guidance from hydroacoustics and telemetry, are necessary to maintain the lower observed populations until further downstream harvest (lower IWW) can be proved to affect the upstream populations as suggested by SEACarP.

It is then hopeful (in next 5 - 10 years) that upstream contracted harvest can be minimal and reduced to a maintenance level.

What Is Deliverable for this Project:

- Monthly updates to Monitoring and Response Workgroup (MRWG) posted to www.asiancarp.us.
- Quarterly updates to management/control work with information sharing as needed to model development and others.
- Annual reporting in Interim Summary Report.
- Annually evaluate for subsequent Monitoring and Response Plan.
- Information available for contingency planning or response.
- Tool (contracted fishers) have been identified as a suitable and important response mechanisms in contingency planning for detection or removal needs.

Expected Completion Date for Project:

This project is expected to continue to provide annual evaluation and advice to the Asian Carp Regional Coordinating Committee (ACRCC) and MRWG as long as Asian carp management and control is a priority. This project could be modified on an annual basis to provide managers needed information and may be modified as new techniques or technologies inform this work. Continued

modification to fishing, e.g. Unified methods, will be identified to become more efficient. Total effort can be modified as risk is identified (more or less).

Potential Hurdles:

The working groups of the MRWG have suggested the current methodology is appropriate for management considerations for increased efficiencies or increase risk of fish movement inform these efforts. MRWG will evaluate routinely and adaptively with contracted catches, observations of population status, novel catch data. Increased downstream and enhanced contracted removal are additional to these efforts but may inform these efforts in 2019 and future years. Water levels, weather, recruitment and funding all can affect harvest rates.

How will the results of this project be disseminated?

- Monthly summaries of activities provided to MRWG.
- Annual summaries provided in the Interim summary reports.
- Coordination with Communication and Outreach Workgroup.
- When needed, and at least annually, provide a briefing to ACRCC on status of Asian carp populations and observations.
- Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.

C-4 Enhanced Contract Removal of Asian Carp in the Peoria Pool of the Illinois River

Lead Agency: Illinois Department of Natural Resources (DNR)

Agency Collaboration: Southern Illinois University (SIU)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$100,000	$153,015

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation:

The control strategy identified in the 2018 Monitoring and Response Plan (MRP) recognizes the value of increased harvest of adult Asian carp in the lower Illinois River. The goals of this MRP is removal of 8 million pounds per year by 2019 and working toward a 5-year goal of 15 million pounds removed annually by 2022. The use of targeted contract fishing in the Illinois River is a key component of the multipronged strategy to defend the Great Lakes from Asian carp range expansion and potential introduction. The strategy is supported by the success and observed reduced relative abundance in those areas generally attributed to contracted removal in the upper Illinois River. Additionally, a model has been developed that recognizes the significant management effects of increasing downstream harvest provides. Concurrent recommendations for increased harvest are identified in a comprehensive Asian Carp Business Process Analysis Report and Action Plan (Business Analysis Plan, or Report) and corroborated by the Spatially Explicit Asian Carp Population (SEACarP) model output. The Report recommends actions to accommodate increased commercial harvest as a control option and expand alternative uses of Asian carp to increase fishing by identifying end-users for fish. The end goal is removal of 20 to 50 million pounds of Asian carp per year from the Illinois Waterway (IWW) to reduce the population and risk of their spread to the Great Lakes. The Report recommends implementation of two key and most impactful recommendations: (1) creation of a pilot-scale contracted removal effort to spur more Asian carp removal effort in the lower Illinois River, targeting Peoria pool, then considering other lower Illinois River pools to meet vision goals; and, (2) creation of a positive brand for Asian carp, a marketing strategy, and marketing support. The recommendations support each other, and the project described here seeks to address the first recommendation. A second separate project is proposed to address the second recommendation

This new project will reduce the numbers and influence of the relative abundance of Asian carp in the Peoria pool, Illinois River through controlled and targeted contracted fishing efforts. Reducing the relative abundance of Asian carp in the lower Illinois River will subsequently reduce the likelihood that Asian carp will expand upstream and approach and potentially challenge U.S. Army Corps of Engineers' (USACE) electric dispersal barrier system (EDBS). This project will be implemented through the issuing of contracts to those willing to fish in Peoria pool and fulfilling contractual obligations of selling, reporting, transporting, and fishing in the identified area. This

project will also provide critical information on population densities of Asian carp over time in the Peoria pool as well as the Illinois River system to guide agency management efforts. This project will be led by Illinois DNR in coordination with the Asian Carp Regional Coordinating Committee (ACRCC) Monitoring and Response Workgroup (MRWG), and in support of the annual and long-term management goals and objectives described in the annual MRP. These targeted efforts are supported by insights from the Illinois River Asian carp population model to reduce upstream migration and relative abundances further upstream. Information including demographics, tons removed (and locations) will then further inform this model and necessary modifications and analyses. The MRWG will use the model in support of implementation of the comprehensive MRP. While initial efforts will be strictly limited to Peoria pool, it is understood that meeting Asian carp management goals and harvest objectives for the lower Illinois River may require expanding contract harvest downstream to the La Grange and Alton pools. The new project will utilize an adaptive management approach to strategically direct the location and timing of contract harvest effort informed by most-current monitoring and reporting data in maximizing harvest with intent of reducing upstream relative abundance.

Illinois DNR will contract with commercial fishers to harvest as many Asian carp as possible in the Peoria pool. This project being supported by Illinois Enhanced Contract Removal Marketing Assessment and Management in this Action Plan will also facilitate as practicable mechanisms for use of the harvested fish through private industry for a variety of purposes, including human consumption, provide necessary oversite, and coordinate through marketing and branding efforts. Through a cooperative relationship of agency and fisher along with end users/markets, technical assistance and support will be provided, as necessary, to further inform fishers on the delivery of quality and quantity of fish to the end user/markets through this interaction. This project allows for contracts for fishing from Peoria pool as the initial target.

While no funding is requested in 2019, these efforts are expected to continue with the 2018 Action Plan support and launch. This program is expected to launch in February 2019 and likely will enable the removal throughout FY 2019.

Summary of Actions to Date:

- Currently, harvest/removal of Asian carp in the lower IWW is conducted by at-large private venture commercial fishing and supported by a newly launched contracted fishing initiative, of which this is year two, resulting in approximately 3.5 million pounds of Asian carp removed annually with additional contracted fishing results yet to be captured in returns.
- Enhanced harvest efforts/contracts expected to begin February 2019.
- Conducted an Asian carp business process analysis, including a summary of findings and recommendations for action, cost estimates and implementation timelines.
- Model development by Illinois DNR, SIU, and U.S. Fish and Wildlife Service (USFWS) suggests contracted removal from Peoria pool will aid management and control.

Proposed Actions for FY 2019:

- This second segment will continue to promote fishing and harvest from Peoria pool of the lower IWW. The goal is to increase harvest and not just maintain historical efforts. Agency combined with market development support (other template) should continue to increase harvest in upper Peoria pool and further markets acceptance to this increased catch.
- Close coordination between monitoring efforts (hydroacoustic, ecological) as well as harvest records will be closely monitored supported by Illinois Enhanced Contract Removal Marketing Assessment and Management. Contracts will be enforced to maintain control of fishing activity for those contracted, but not to inhibit other fishing not subject to contracts.
- Further coordination of scientific observations and contracted efforts will be identified to assist in harvest efficiency from Peoria pool as information can enable.

Expected Milestones:

- The initial two years (2018-2019) strive to achieve up to 5 million pounds removed from Peoria pool alone.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- MRWG's best estimate is that 20 to 50 million pounds may be available in all of the Illinois River for removal. The best plan calls for a private investment of $32 million prior to privatization. These efforts are best seen as pilot as Illinois and others support evaluation of other means to support removal for ecological protection and lower overall Asian carp numbers.
- Growing contracted removal to 10 million pounds annually.

What Is Deliverable for this Project:

- This funding specifically supports removal of Asian carp.

Expected Completion Date for Project:

- Evaluation of efforts will continually under Illinois Enhanced Contract Removal Marketing Assessment and Management.
- Overall strategy of this enhanced contracted removal in lower IWW will also be evaluated after 2021. It is believed by using inference from SEACarP model output that this may be the most economical way to manage upstream populations and lower risk of spread. It does take ample data to inform on the efficacy of this strategy.

Potential Hurdles:

- Willingness of commercial fishers to take advantage of contract program.
- Ability of program to remove enough fish to make ecological difference.
- Long term funding to maintain and see effects in a highly variable ecosystem.

How will the results of this project be disseminated?

- Monthly summaries of activities provided to MRWG and ACRCC as prudent.
- Annual summaries provided in the Interim summary reports.

- Coordination with Communication and Outreach Workgroup.
- Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.

C-5 Enhanced Contract Removal, Marketing, Assessment, and Management

Lead Agency: Illinois Department of Natural Resources (DNR)

Agency Collaboration: Illinois Department of Commerce and Economic Opportunity

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$550,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

The Asian Carp Business Process Analysis Report and Action Plan (Business Analysis Plan, or Report) recommends actions to remove barriers to expand alternative uses of Asian carp as a means to increase fishing of Asian carp to minimize upstream migration. The end goal is removal of 20 to 50 million pounds of Asian carp per year from Illinois waterways to reduce population of this invasive species and risk of their spread to the Great Lakes. A wide range of recommendations is made in the Report over a 7-year period. This project will continue implementation work on the most needed and impactful recommendations:

- Support of newly created branding for Asian carp with marketing support.
- Continued support of the pilot-scale incentive to spur more fishers (enhanced contract fishing template) to pursue Asian carp, limited to the Peoria pool of the Illinois River.
- Enable evaluation and assessment of efficacy of strategy with appropriate and additional ecological data (e.g., fish community/fishery independent as well as tracking contracted harvest and compliance.

The Report included other recommendations which will necessitate cooperation among multiple state and federal agencies to realize. A steering committee will be supported to garner outside expertise.

Summary of Actions to Date:

- Launching contracting fishing winter 2018-2019, no results as of this report.

Proposed Actions for FY 2019:

- Continue contracted fishing.
- Continue support of recently developed branding from 2018 support.
- Continue steering committee for economic development (independent of project).
- Evaluate program based upon participation, harvest, and ecological impact.

Expected Milestones:

- Significantly increasing harvest from the Peoria pool.
- Increase in native species condition.

- Increase in zooplankton size.
- Overall decrease in relative abundance of Asian carp estimates (hydroacoustic sampling).

Potential Out-year Actions (Subject to Future Appropriations):

- Up to 10 million pounds removed in subsequent years.
- Decreased upstream removal is predicted per Spatially Explicit Asian Carp Population (SEACarP) model results.
- Branding developing efforts should sunset but ongoing evaluation and support of contract removal is encouraged to reach.

What Is Deliverable for this Project:

- Efficiently run program and assessment of 5 million pounds of Asian carp removed.
- Scientific guidance for future enhanced and downstream removal.
- Appropriate utilization and validation of SEACarP model results.

Expected Completion Date for Project: 2021

Potential Hurdles:

- Industry ability to take advantage of branding.
- Consumer acceptance and identification of sufficient market to take valued contracted catches (selling to market is requirement).
- Industrial support of ice and logistics may limit.

How will the results of this project be disseminated?

- Steering committee will assist with management of project.
- Monthly summaries of activities provided to Monitoring and Response Workgroup and the Asian Carp Regional Coordinating Committee as prudent.
- Annual summaries provided in the Interim summary reports.
- Coordination with Communication Workgroup.
- Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.

C-6 Asian Carp Population Model to Support an Adaptive Management Framework

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

Agency Collaboration: Southern Illinois University; Illinois Natural History Survey; Western Illinois University; Illinois Department of Natural Resources (DNR)

FY 2019 Funding Table:

Agency Funding Expected		Asian Carp GLRI Funding Requested	
USGS	**USFWS**	**USGS**	**USFWS**
$80,000	$0	$100,005	$147,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

The Spatially Explicit Asian Carp Population (SEACarP) model 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. USFWS is using the model to evaluate the effectiveness of different management strategies - spatial allocation and intensity of harvest and upstream movement deterrence. The work associated with this Monitoring and Response Plan (MRP) represents a continuation of FY 2018 efforts including model implementation and development such as sensitivity analyses and annually updated management recommendations based on contemporary data, improvements that reflect current advancements in population modeling (e.g., integral projection models), and addressing model limitations and assumptions, such as incorporating vulnerability to fishing as a function of fish size and field-based estimates of fishing mortality, growth, and upstream movement.

Summary of Actions to Date:

- Compiled Asian carp demographic data from multiple universities and state and federal agencies.
- Estimated demographic rates (e.g., growth, condition) to parameterize the SEACarP model using Bayesian hierarchical models.
- SEACarP model development and coding.
- Data analysis.
- Dissemination of results via presentations and meetings.
- Coordination meetings.

Proposed Actions for FY 2019:

- Estimate demographic rates using the most current data available and incorporate results into the SEACarP model.
- Conduct sensitivity analyses and develop a prioritized list of data and research needs based on results thereof.
- Recommend updated mortality benchmarks and fish passage deterrent locations with efficacy requirements.
- Use statistical catch-at-length models to estimate vulnerability to fishing as a function of fish size, exploitation rates, and immigration into the upper Illinois River Waterway.
- Annual coordination meeting.

Expected Milestones: Please be specific, with timelines by Fiscal Year and Quarter

FY 2019 Q1:

- Incorporate new data and update demographic statistical analyses.

FY 2019 Q2:

- Update management scenario simulations
- Prepare reports and presentations.

FY 2019 Q3:

- Start date for USGS post-doctoral researcher that will focus on sensitivity analyses and statistical catch-at-length modeling.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Sensitivity analyses.
- Implement statistical catch-at-length model.
- Incorporate integral project approach.
- Disseminate results in peer-reviewed literature.

What Is Deliverable for this Project:

- Modeling efforts will produce annually updated management strategies (mortality and deterrent benchmarks) that achieve a given management objective (*e.g.*, eliminate Asian carp in Dresden Island pool).
- Out-year deliverables include sensitivity analyses, which will be used to develop a comprehensive list of prioritized data and research needs, and statistical catch-at-length model, which will highlight differences between actual fishing mortality rates and SEACarP mortality benchmarks.
- Long-term deliverables include a multi-basin model and model validation.

Expected Completion Date for Project:

- Population modeling is an important component of the Adaptive Management framework. Consequently, efforts associated with the SEACarP model should continue until a suitable alternative is developed.

Potential Hurdles:

- Timeline may be negatively influenced by unanticipated challenges, which are often associated with doing novel work.

How will the results of this project be disseminated?

- Conferences and meetings.
- GLRI summaries and reports.
- Peer-reviewed publications.

M-1 Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes

Lead Agency: National Oceanic and Atmospheric Administration (NOAA) Great Lakes Environmental Research Lab (with co-Principle Investigator at Eureka Aquatic Research, LLC)

Agency Collaboration: U.S. Army Corps of Engineers (USACE)**,** Illinois Department of Natural Resources (DNR); U.S. Geological Survey (USGS) Great Lakes Science Center (GLSC); Southern Illinois University; Michigan DNR

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$17,250	$105,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: NOAA is continuing to model the potential risk of Asian carp to Great Lakes' food webs. NOAA will accomplish this by modeling how Bighead Carp, Silver Carp, and Grass Carp affect the food webs of the Great Lakes ecosystems. NOAA has used three types of ecosystem models to assess effects of Asian carp on Great Lakes food webs. The Ecopath with Ecosim (EwE) model assesses carp effects on a whole lake scale but ignores effects of physical variables and doesn't include heterogeneity in predator prey dynamics over horizontal and vertical spatial scales. The NOAA team has applied this model to simulate effects of Asian carp on food webs of Lakes Erie, Huron, Michigan, and is completing scenario simulations of Asian carp effects on Lake Ontario. A second model is an individual-based bioenergetics model (IBM) that includes temperature as a forcing variable and tracks bioenergetic growth and metabolism in individual carp and selected fish species within nearshore or offshore habitats. NOAA has applied this model to simulate scenarios of Asian carp establishment and their effects on nearshore communities of Lake Huron and is applying it to nearshore communities of Lake Erie and Michigan. The third model (Atlantis Ecosystem model) tracks population dynamics and predator prey interactions within heterogeneous habitats in Great Lakes and includes effects of lake physics and chemistry. The NOAA team applied this model to simulate effects of Asian carp on Lake Michigan's food webs and is calibrating Atlantis models for Lake Erie and developing a model for Lake Huron.

Proposed Actions for FY 2019: With funds in FY 2019, NOAA will complete simulations of Asian carp effects on the Illinois River food web using the EwE model. Results also will be compared to observed dynamics of Asian carp establishment, population growth, and harvest in the Illinois River, and to EwE model results for Great Lakes which have not been invaded by Asian carp. This modeling activity will further confirm model performance and predictions of Asian carp impacts with observed Asian carp impacts in the Illinois River. Moreover, modeling will provide managers further insights into how Asian carp will affect aquatic ecosystems across a productivity gradient from the productive Illinois River to oligotrophic Great Lakes ecosystems.

Expected Milestones: Below is a table of expected milestones. In 3rd Quarter 2019, the NOAA team will finish simulating Asian carp effects on the Illinois River food web (started in FY 2018) and will distribute results in 4th Quarter.

FY 2019 Q1:

- Review data to configure the Illinois River EwE food web model.

FY 2019 Q2:

- Configure and balance the Illinois River EwE model.

FY 2019 Q3:

- Complete the Illinois River EwE model simulations (started in FY 2018)

FY 2019 Q4:

- Summarize and distribute results for the Illinois River EwE model.

Potential Out-year Actions (Subject to Future Appropriations)**:** The NOAA team will use their IBM to simulate Asian carp establishment, movement and impacts on the Illinois River food web. The modeling effort will benefit from prior studies of Asian carp spawning behavior, movement and foraging in response to environmental influences (temperature, flow) that are not explicitly included in the EwE model. For both the IBM and EwE models, Asian carp population dynamics under proscribed harvest regimes will be compared to dynamics predicted by the Glover et al. population model currently used by the Monitoring and Response Workgroup (MRWG). Comparing predictions of Asian carp dynamics using these complementary models will further understanding on how such models can inform invasive species risk assessments, especially for species that have not yet invaded.

- Write a final report and manuscript on EwE model simulations of Asian carp in the Illinois River and will configure and balance the IBM carp community model for the Illinois River.
- Run IBM simulations of Asian carp in the Illinois River and will begin configuration and calibration of the Lake Michigan EwE model to simulate potential effects of Black Carp on the Lake Michigan food web.
- Finish EwE model simulations of Black Carp on the Lake Michigan food web.
- Produce report on results of the potential effects of Black Carp on the Lake Michigan food web.

What Is Deliverable for this Project:

- A manuscript summarizing model simulations of Asian carp impacts on four Great Lakes.
- A report summarizing EwE model simulations of Asian carp impacts on the Illinois River food web, with assessment of model skill.

Expected Completion Date for Project: 2020

Potential Hurdles:

- Delay in delivery of funding from U.S. Environmental Protection Agency (USEPA) to NOAA.
- Disbursement of funding from the NOAA Great Lakes Environmental Research Laboratory (GLERL) to Eureka Aquatic Research scientists to assist with food web modeling.

How will the results of this project be disseminated?

- Through presentations at regularly scheduled meetings of the Asian Carp Regional Coordinating Committee, the Illinois River Monitoring and Response Group, and to meetings of the Great Lakes science and management community (*e.g.*, International Association for Great Lakes Research[IAGLR]).
- The NOAA GLERL Information Services Branch produces a suite of science translation products targeting a general audience.
- Through a number of outlets including: social media (Twitter, Facebook, YouTube, Flickr and the GLERL Blog), fact sheets, infographics, a newsletter, educational web pages and more.
- In addition, NOAA/GLERL staff a table at community events and will give educational presentations of Asian carp impacts at a variety of public events and venues.

M-2 Great Lakes Asian Carp Monitoring Program

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

Agency Collaboration: Great Lakes States

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$1,150,000	$350,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

The Service will continue to implement and refine, with input from our partners, a comprehensive and complementary early detection and rapid assessment surveillance program for Bighead, Silver, Grass, and Black Carp in and near the Great Lakes. This program would complement the environmental deoxyribonucleic acid (eDNA) sampling and monitoring programs implemented by USFWS, U.S. Army Corps of Engineers (USACE), academia, and other partners. Sampling would primarily target areas of high concern in the Great Lakes (e.g., southern Lake Michigan, western Lake Erie, areas with past positive eDNA results), and use a diverse array of traditional and novel gears to sample all potential life stages of Asian carp species.

Summary of Actions to Date: USFWS continues to work with partners to refine a Great Lakes basin-wide early detection protocol for Asian carp and other aquatic invasive species (AIS). Sampling gears and locations sampled are tailored each year to match conditions and agency needs, as well as to leverage new sampling technologies for species of interest. USFWS continues to coordinate with federal, state, and provincial partners to annually identify sampling locations (areas of concern), further develop and refine protocols, share information, and discuss ways to coordinate agency sampling efforts. In 2013, USFWS worked with our partners to conduct coordinated and complementary sampling efforts in the Great Lakes basin with both emerging and traditional gears. In 2018, USFWS continued to expand its overall sampling efforts and collected over 4,500 eDNA water samples, electrofished, trawled, sampled ichthyoplankton, and set a variety of nets to survey for Asian carps. In 2018, no Asian carp were captured, and no positive eDNA results were obtained from Great Lakes tributary locations.

Proposed Actions for FY 2019: USFWS and partner agencies will fully implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS. USFWS staff/teams will be prepared, and may be mobilized, to respond to any Asian carp detected (using either traditional gear or eDNA) in the Great Lakes. Efforts will continue on an annual basis to detect new invasions of Asian carp.

Expected Milestones:

- Fully implement a comprehensive and coordinated Great Lakes basin-wide early detection and monitoring program for Asian carp and other AIS species in FY 2019.

- Complete early detection surveys in suspected "hot spots" for AIS, in cooperation with partner agencies, as needed.
- Continue to refine standard operating procedures for basin-wide AIS monitoring with partner agencies.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continue to implement a comprehensive and coordinated Great Lakes basin-wide early detection and monitoring program for Asian carp and other AIS species.

What Is Deliverable for this Project:

- Information regarding any new Asian carp observations/occurrences that will be provided to management agencies for potential action.
- Annual agency reports summarizing sampling efforts and findings.
- Presentations at conferences, to partner agencies, and to the public.
- A uniform, long-term data set of sampling efforts and sample collections.

Expected Completion Date for Project:

- Ongoing to maintain vigilance regarding potential new observations/occurrences of Asian carp in the Great Lakes or tributaries.

Potential Hurdles:

- Coordination among numerous agencies on a large landscape such as the Great Lakes basin.
- Attainment of agreement regarding sampling gears and sampling design among diverse partners.
- Possible issues regarding sampling site logistics.
- Inefficiency of traditional sampling gear, particularly in large, voluminous water bodies.

How will the results of this project be disseminated?

- Public (AsianCarp.us, GLRI.us, GLIN Announce) and technical audience(s).

M-3 USFWS Barge Entrainment and Asian Carp Interaction Study

Lead Agency: U.S. Fish and Wildlife Service (USFWS) Carterville Fish and Wildlife Conservation Office (FWCO)

Agency Collaboration:

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$300,000	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: This project is a continuation of a multiyear study. In 2018, the study focused on barge entrainment, retention, and transport dynamics specifically regarding entrainment of juvenile Asian carp in the gaps between barges, referred to as junction gaps, specifically when locking through a lock and dam as well as distance trials.

In 2017, biologists focused on entrainment mitigation at the Electric Dispersal Barrier System (EDBS). The U.S. Army Corps of Engineers (USACE) deployed a prototype water jet flushing system within the CSSC near the location of the EDBS. The water jet system was designed to flush entrained fish out from junction gaps in a moving tow before the tow transited the EDBS. Following deployment, a contracted commercial tow was used to test the impacts of the water jet flushing system on: (1) impacts to navigation; and, (2) effects on entrainment and retention of freely swimming fish within rake-box junction gaps. Over the two-week study segment dedicated to this research, 99 upstream transits were conducted where the tow traversed the water jet system. During all transits USACE staff conducted monitoring and interviews with the tow pilot to assess impacts to navigation. Independent observers from the U.S. Coast Guard (USCG) also observed tow transits of the water jet system to assess waterway safety. During transits USFWS stocked freely swimming Golden Shiners and passive objects into junction gap spaces. The freely swimming fish were observed via sonar and were physically sampled at different points during each trial. Additionally, acoustic Doppler velocity meters were deployed by the U.S. Geological Survey (USGS) Illinois Water Science Center at various locations on the tow and from shore to characterize the flows produced by the water jet system and the effects on water dynamics within junction gap spaces during tow transiting. Results from this portion of the study are being used to further refine the USACE water jet flushing system for full scale deployment.

During 2016, five weeks of studies continued investigations to: (1) evaluate behavior of wild fish near and in the junction gaps of barges as they traversed different sections of the Chicago Area Waterway System (CAWS); (2) determine the length of time and distance wild fish may be entrained between barges; (3) determine the size at which fish can vacate, of their own volition, the spaces between barges; (4) evaluate entrainment probabilities under different barge configurations; and, (5) determine the probability of entrainment and transport of early life stages (eggs/larval) of

Asian carp. Further details of the 2016 study results will be shared with the Asian Carp Regional Coordinating Committee member agencies, Council of Environmental Quality, Department of Justice, and the maritime industry as soon as possible.

Proposed Actions for FY 2019: No actions are currently planned for FY 2019

Expected Milestones:

- Report from 2018 studies (manuscript preparation and white paper) posted on: https://www.fws.gov/midwest/fisheries/carterville/didson-barge.html)

Potential Out-year Actions (Subject to Future Appropriations)**:**

- The USACE Rock Island District has proposed further barge studies looking at the potential use of compressed air rather than water jets, which were tested in previous studies. The focus of this research would be to: (1) test the efficacy of compressed air to disrupt fish passage via barge entrainment; and, (2) to quantify changes in flow dynamics within the hydraulic recesses during passage over a bubble curtain. This research will inform potential structural and nonstructural control measures at Brandon Road Lock and Dam. The Carterville FWCO would provide assistance as experts on barge related work.

What Is Deliverable for this Project:

- This project will provide an overarching understanding of the size specific risks for entrainment and upstream transport of Asian carp through barge entrainment pathways and identify and test mitigation options.
- Status reports covering any urgent and significant findings will be shared among partner agencies as soon as possible following the finding.
- An annual report summarizing all work conducted in 2018 will be produced and posted to the USFWS website.

Expected Completion Date for Project:

- This project will be reevaluated at the end of the study to determine if further studies are needed in 2020.

Potential Hurdles:

- Weather delays
- Small Asian carp availability.
- Staffing.
- Barge availability.
- Contracting delays.

How will the results of this project be disseminated?

- We will work with key partners to share our results and make the information publicly available through the Carterville FWCO website as well as Asian Carp.us.

M-4 Asian Carp Demographics - USFWS

Lead Agency: U.S. Fish and Wildlife Service (USFWS) Columbia Fish and Wildlife Conservation Office (FWCO)

Agency Collaboration: USFWS-Carterville FWCO, Southern Illinois University, U.S. Geological Survey (USGS) Columbia Environmental Research Center

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$70,000	$545,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: USFWS Columbia FWCO collected fisheries-independent data including age, size, sex structure, length at maturity, and relative abundance during spring (May - June) and fall (September - November) 2018 in each of the lower six pools of the Illinois River using a random design stratified by habitat type (i.e., backwaters, island side channels, main-channel borders). Consistent with previous sampling under this protocol, collection sites will be sampled by conducting 5-minute trawls at 4.8 kilometers per hour (calculated by GPS tracking) using either the electrified dozer or electrified paupier trawls. An initial sample size of 50 (5-minute trawls) per pool was selected because catch rate data from Illinois River backwaters (2014-2017 Template: Gear Evaluation for Removal and Monitoring of Juvenile Asian Carp) determined this sample size would yield a reasonable amount of accuracy and precision. Sample sizes for each pool will be adjusted based on data collected in 2018. These adjustments will help improve population assessments of Asian carp while maintaining sampling efficiency. The Asian carp demographics project will provide updated demographic data for parameterizing the Spatially Explicit Asian Carp Population (SEACarP) model and addresses data gaps identified by the modeling workgroup (i.e., stock-recruit data, growth of small fish from the lower pools).

Asian carp population size is one of the most important data types needed for making management decisions. Currently, hydroacoustics based estimates are utilized in the Illinois River. Hydroacoustics, however, are not a stand-alone gear and must be paired with physical sampling techniques to separate the overall fish community size distribution into species-specific distributions. This standardized demographic data collection effort would inform hydroacoustic sampling that has occurred within the Illinois River, providing dual benefits to Silver Carp management. It would inform hydroacoustic sampling while also gaining crucial biological data that can be used to evaluate population level changes expected from successful management implementation that are not possible with hydroacoustics (e.g., changes in growth or other demographic rates This project will help in the development of a standardized Asian carp sampling protocol that is directly transferable to other large river systems such as the Missouri and Mississippi River systems.

Proposed Actions for FY 2019:

- Collect size and sex structure, length at maturity, and relative abundance data during spring and fall in the lower five pools of the Illinois River.
- Using standard methods agreed upon from the Asian Carp Demographics 2018 age and growth workshop, generate age and growth information for the Illinois River Silver Carp at all five pools.
- Develop spawner and cohort abundance indices using summarized field data (i.e., catch rate, sex ratio, and length structure); use indices to evaluate when year class strength is set and the relationship between fall and spring spawner abundance.
- Incorporate standardized data into the SEACarP model.
- Extend demographic data collection from five pools to six pools with the addition of Dresden Island
- Pair demographic sampling with hydroacoustic supplemental physical data collection to look at the benefits and limitations of both physical sampling efforts

Expected Milestones:

- Field sampling and data entry.
- Data analysis, Annual report.
- Submit publication on consensus method(s) for aging Silver Carp.

Potential Out-year Actions (Subject to Future Appropriations):

- Continue to support management actions within the Illinois River.
- Will provide updated demographic data for parameterizing the SEACarP model and will address data gaps identified by the modeling workgroup (*i.e.*, growth of small fish from the lower pools, exploitation, etc.) for six pools in the Illinois River.
- Will provide data to evaluate the potential benefits and limitations associated with using dozer trawl results to inform hydroacoustics work relative to the capture gears currently used.
- Will help to provide a standardized Asian carp sampling protocol that is directly transferable to other large river systems such as the Missouri and Mississippi River systems.

What is Deliverable for this Project:

- An annual report and presentation summarizing sampling results will be provided to the Monitoring and Response Workgroup, agency partners, and any other interested parties.
- Project plans will be updated for annual revisions of the Monitoring and Response Plan.

Expected Completion Date for Project: Detecting changes in population status and trends through time is crucial for understanding what appropriate management actions are needed to control Asian carp in the Illinois River, Illinois.

Potential Hurdles:

- Coordination among agencies and contractors.
- Agreement regarding sampling gears and sampling design among partners.
- Sampling gear and/or site logistics.
- Environmental conditions.

- Staff availability.
- Public resistance to continued monitoring and response efforts.

How will the results of this project be disseminated?

- Conferences and meetings.
- GLRI summaries and reports.
- Peer-reviewed publications.

M-5 Asian Carp Demographics-USGS

Lead Agency: U.S. Geological Survey (USGS) Columbia Environmental Research Center (CERC)

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS) Carterville Fish and Wildlife Conservation Office (FWCO) Wilmington substation; Illinois Natural History Survey

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$30,000	$45,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: USGS collaborated with USFWS in 2018 to describe the demographics of the Asian carp population of the Illinois River. Demographic information (e.g., growth, mortality) derived from an appropriate sampling design represents the raw material for quantifying population impacts associated with management actions and for parameterizing decision support tools such as the Spatially Explicit Asian Carp Population (SEACarP) model. Opportunities exist for greater standardization and increased efficiency relative to targeted Asian carp sampling. Quality information on key demographic rates including the relationship between spawner biomass and recruitment and the relationship between length at capture and age (i.e., growth), especially for small fish <300 mm total length are exceedingly limited.

In 2018, the USGS initiated a study to evaluate different techniques for determining the age of Silver Carp to develop standardized, objective-driven, techniques to inform population demographics. The USFWS provided fish from a standardized sampling scheme on the Illinois River. USGS processed and prepared seven different hard parts (calcified anatomical structures) of 100 Silver Carp collected from five pools of the Illinois River. We convened a group of 12 experts in the fish age estimation and distributed the set of structure images for age estimation. Precision among readers by hard part and between hard parts, and reader confidence, were evaluated. A workshop was held to discuss results and make recommendations for standard procedures and preferred hard parts that minimized age estimation bias for fish from the Illinois River. Lapilli otoliths and the dorsal fin ossified ray were selected and a set of rules for evaluating these features was established. The group determined that validation of the first annulus using wild fish was desirable and possible, so young-of-year (YOY) and 1-year old fish were collected for this purpose. These hard parts will be processed and then images will be provided to the experts once again. Precision of aging will be based on data from the post-workshop aging dataset.

Proposed Actions for FY 2019:

- Process and complete preparation and age estimation from fall-collected, fishery independent, Silver Carp population samples from the Illinois River.

- Specifically target age-0 (in fall) and age-1 (in spring) Silver Carp to use to understand the first annulus formation.
- Expert readers will re-evaluate ages of the original set of 100 Silver Carp collected in Spring 2018 using new set of standard procedures and improvements in precision will be documented.
- Methods for processing and estimating age from lapilli otoliths and dorsal rays will be determined.
- Standard Operating Procedures (SOPs) will be developed for processing, preparing, and estimating age from the two selected Silver Carp hard parts.
- A manuscript will be developed based on the results of the expert aging workshop.
- Final age estimates will be provided to USFWS CFWCO for input into the SEACarP model.

Expected Milestones:

October 2019:

- Final Silver Carp hard parts for aging will be collected from Illinois River.

October-November 2019:

- Final preparation of hard parts, and age estimation.
- Expert readers re-age original set of 100 fish and data are analyzed.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Manuscript submission.

What Is Deliverable for this Project:

- SOPs for preparing and estimating age from selected structures from Silver Carp
- Recommendation on preferred aging structures.
- Manuscript.

Expected Completion Date for Project: End of FY 2019.

Potential Hurdles:

- Speed of expert agers in delivering their age estimates.
- Staff availability.

How will the results of this project be disseminated?

- Manuscript(s).
- Technical presentations at professional conferences.

M-6 Des Plaines River and Overflow Monitoring

Lead Agency: U.S. Fish and Wildlife Service (USFWS) Carterville Fish and Wildlife Conservation Office (FWCO)

Agency Collaboration: U.S. Army Corps of Engineers (USACE) Chicago District, Metropolitan Water Reclamation District of Greater Chicago, Illinois Department of Natural Resources (DNR)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$15,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: In 2010 and 2011, Asian carp environmental deoxyribonucleic acid (eDNA) was detected in the upper Des Plaines River (DPR). No Asian carp eDNA sampling has been conducted in the DPR since 2011. It is possible that Asian carp present in the upper DPR could gain access to the Chicago Sanitary and Ship Canal (CSSC) upstream of the electric dispersal barrier system (EDBS) during high water events when water flows laterally from the upper DPR into the CSSC. The construction of a physical barrier to reduce the likelihood of this movement was completed in the fall of 2010. The physical barrier was constructed by USACE and consists of concrete barriers and 0.25 inch mesh fencing built along 13.5 miles of the upper DPR where it runs adjacent to the CSSC. It is designed to stop adult and juvenile Asian carp from infiltrating the CSSC, but it will likely allow Asian carp eggs and fry in the drift to pass. Opportunites for fish to pass occurred during high discharge events in 2011 and 2013 when water breached the physical barrier. USACE reinforced these and other low lying areas to prevent scouring during future lateral water transfers. These reinforcements have withstood several high flow events. Understanding the population status of Asian carp in the DPR, monitoring for potential spawning events, and determining the effectiveness of the physical barrier are all necessary to inform management decisions and assess risk of Asian carp bypassing the EDBS.

No Bighead or Silver Carp have been collected or observed. Seven Grass Carp have been collected. Six of these were submitted for ploidy analysis and all six were determined to be triploid (sterile).

Proposed Actions for FY 2019: Fixed sites will be sampled three times throughout the field season for population monitoring. Additional sampling will be scheduled if: (1) population status in Brandon Road pool significantly increases; or, (2) there are credible reports of Asian carp sightings in the upper DPR. Physical barrier inspections and ichthoplankton sampling will occur when USACE personnel indicate overflow conditions are likely or occurring. This project consists of two different efforts, Population Monitoring and Overflow Monitoring. Population monitoring will include electrofishing and gill netting. The project will utilize pulsed-DC electrofishing. One or two dippers will attempt to dip all visible fish, with the exception of Common Carp (*Cyprinus carpio*).

Any Bighead or Silver Carp collected will be kept for further study, and the Monitoring and Response Workgroup (MRWG) will be notified. Grass Carp will be tested for ploidy.

USACE personnel will monitor water levels for potential overflow events. Carterville FWCO will be notified of potential overflow events and location. Biologists will inspect the fence for areas of flow through and potential breaches. When it is safe and practical to do so, 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.

Expected Milestones:

- Staff will conduct population monitoring in May, July and August 2019.
- Overflow monitoring will be conducted as needed
- Reports will be generated in November 2019.

Potential Out-year Actions (Subject to Future Appropriations)**:** Actions will continue.

What Is Deliverable for this Project:

- Early detection of Asian carp breach in the DPR and above the confluence with the CSSC.
- Results of each sampling event will be reported for monthly sampling summaries. Asian carp captures (excluding Grass Carp) will be reported to MRWG immediately.
- Data will be summarized for an annual interim report and presented at the annual MRWG winter meeting.

Expected Completion Date for Project: This project is expected to continue as long as Asian carp remain a threat to the upper DPR.

Potential Hurdles: Flow of river and access to fence line.

How will the results of this project be disseminated?

- Public and technical audiences.

M-7 Illinois River Monitoring and Response Team Support

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

Agency Collaboration: Carterville Fish and Wildlife Conservation Office (FWCO), Columbia FWCO, La Crosse FWCO, U.S. Army Corps of Engineers (USACE), Southern Illinois University (SIU), Illinois Department of Natural Resources (DNR)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$275,000	$113,500

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: This work encompasses all monitoring and response support provided by the USFWS in the Illinois River. This effort is led by Illinois DNR and USFWS provides support with staff and vessels during scheduled and unscheduled events. The individual projects are: (1) Fixed and Random Sites Monitoring; (2) Seasonal Intensive Monitoring (2 events per year, one in June and one in Sept); (3) Unified Method (one event per year); and, (4) Response Actions. USFWS has been assisting with these projects since 2015.

Proposed Actions for FY 2019: Fixed and Random Sites are conducted by the Carterville FWCO six times a year from April through September. Seasonal Intensive Monitoring is conducted by the Carterville and La Crosse FWCOs during two events a year, one in June and one in September. The Carterville and Columbia FWCOs assist with the Unified Method as planned by Illinois DNR each year. The Carterville and Columbia FWCOs are on call if a response action is requested by the Asian Carp Regional Coordinating Committee (ACRCC). Please see the Contingency Response Plan for further information.

Expected Milestones:

- 2019 April - September: Fixed and Random Sites (6).
- 2019 June & September: Seasonal Intensive Monitoring.
- 2019 October: Unified Method.

Potential Out-year Actions (Subject to Future Appropriations)**:** These projects will continue.

What Is Deliverable for this Project: Staff will provide requested support for Illinois DNR projects in the Illinois River. Data will be summarized and reported to Illinois DNR after each event.

Expected Completion Date for Project: Fixed and Random Site Monitoring, Seasonal Intensive Monitoring, Unified Method, and Response Support will continue as long as Asian carp remain a threat to the Great Lakes. USFWS staff will continue to provide support during these efforts as requested.

Potential Hurdles:

- Weather and equipment.

How will the results of this project be disseminated?

- Public and technical audience.

M-8 Habitat Use and Movement of Juvenile Silver Carp in the Illinois River

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

Agency Collaboration:

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$300,000	$225,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

As a supplement to the intensive sampling to determine the upstream-most location of juvenile Silver Carp, telemetry techniques are being used to determine habitat usage and movements of juvenile Silver Carp in the Peoria pool, the furthest upstream area where juvenile Silver Carp are commonly captured. These data are important in increasing the efficiency of sampling for juvenile Silver and Bighead Carp below the electric dispersal barrier due to the relative lack of knowledge of habitat use and movements of juvenile Silver Carp. Both radio and hydroacoustic telemetry tags are being used due to the wide habitat variability in the Peoria Reach and the relative limitations of each type of telemetry tag. Both types of tags are surgically implanted into each fish whenever possible to facilitate detection in both shallow water (radio) and deep water (acoustic) areas. Tags are monitored by stationary data logging equipment and active tracking throughout the year. Additionally, crews are conducting habitat attribute measurements (temperature, current velocity, dissolved oxygen, chlorophyll-A, and average depth) throughout the year in the study area. Detections of tagged fish will be analyzed for movement distances, frequency of occurrence of movements, and residence time in particular habitat types. Habitat attribute measurement data will be used to evaluate trends among tagged fish using correlation statistics. Data gathered throughout the year will be analyzed and immediately used to inform sampling efforts for small Silver Carp in upstream pools.

Summary of Actions to Date: A total of 72 juvenile Silver Carp were tagged in the Peoria pool of the Illinois River during 2017. Twelve of these fish were tagged using both acoustic V5 tags and NTQ radio tags and are still active as of October 2018. Mean total length of tagged fish was 320mm and the smallest total length of a tagged Silver Carp was 174mm. In 2018, a total of 52 juvenile Silver Carp have been tagged. Fish are tracked using 10 radio monitoring stations and 19 hydroacoustic receivers are deployed in the Peoria pool. As of October 2018, only data from 2017 have been analyzed so only those data will be reported on. Data from 2018 will be analyzed during the winter of 2019 and reported at the next Monitoring and Response Workgroup (MRWG) meeting and in a summary report. Data from 2017 and preliminary data from 2018 are already being used to inform monitoring efforts attempting to detect small Silver or Bighead Carp in upstream pools.

Juvenile Silver Carp occupied backwater habitat strata the greatest frequency of times (n = 1461 residencies) and spent the greatest mean time in these areas (10.55 hours); however, there was no significant difference between backwater areas and main channels. These results are similar to the

preliminary data analyzed from telemetry in 2016, which indicated juvenile Silver Carp were being detected in main channel habitats as often as in backwaters. Juvenile Silver Carp had average residence times of 9.65 hours in main channels and stopped near receivers 982 times (minimum of 30 minutes). When mean residence times are plotted with river discharge, a trend emerges with moderate positive correlation (0.53) between discharge and residency near a receiver. This relationship may be caused by the smaller bodied Silver Carp avoiding high river currents. There was no correlation between residence time and water temperature (-0.15).

Mean weekly movement distance (mean of 943.7 m per week) of juvenile Silver Carp fluctuated greatly throughout the field season but was generally higher between June and September. Roughly half (52%, n = 395 movements) of movements recorded were fish moving between backwater and adjacent main channel areas, repeatedly. This is similar to what was determined based on residence times, with juvenile Silver Carp stopping most frequently in backwater and main channel areas. Most other movements (42%) were fish moving up or downstream in the main channel between receivers. When movements were analyzed alongside river discharge there was no correlation (-0.28), despite current velocity being a trigger for adult Silver Carp spawning activity. When mean weekly movement distances are plotted with temperature, a weak positive correlation (.41) can be seen; as temperature decreased, the movement distances of fish decreased. This would be expected based on the physiology of fish and the general decrease in activity during winter.

To date, the results of this study indicate that juvenile Silver Carp reside in main channels nearly the same amount of time as backwater habitats. This is similar to what was seen during prior years and is different from the common thought of where to find juvenile Silver Carp because the behavior is different from adult Silver Carp. More data will be collected, and further analysis conducted to determine the mean distance juvenile Silver Carp swim upstream. Additionally, efforts will be made to sample other water quality parameters to test for correlations with movements and residencies. Results from telemetry data will be used in 2019 to generate targeted sites in upper pools for monitoring juvenile Silver Carp with the goal to increase capture efficiency.

Proposed Actions for FY 2019:

- Use telemetry methods to quantify mean movement distance, short range movement frequency, and long-range movement frequency of juvenile Silver Carp.
- Estimate macro-habitat selection based on periods of residency by juvenile Silver Carp.
- Test for correlations in movement and macro-habitat selection to a variety of river conditions both temporally and spatially, including: temperature, current velocity, dissolved oxygen, chlorophyll-A levels, and average depth in each habitat type.
- In conjunction with the Distribution and Movement of small Asian Carp project, telemetry data will be used to direct sampling efforts in future years in an attempt to increase sampling efficiency.

The projected actions for FY 2019 will be similar to what was conducted in 2018. USFWS will attempt to deploy approximately 50 more tags (in addition to the 40 during the winter of 2018) into juvenile Silver Carp to increase the numbers of active tags in the water. Two more radio monitoring stations were deployed in the winter of 2018 and some of the currently deployed equipment may be moved around. The majority of work for 2019 will be tagging fish, maintaining telemetry

equipment, downloading data, active tracking, and measuring environmental parameters. A total of 16 crew weeks is planned during 2019 to make this field work possible.

Expected Milestones:

November 2018 - December 2018

- Deployment of 2 more radio monitoring stations, tagging of 40 more juvenile Silver Carp, deployed equipment maintenance, data downloads, removal of gear that may be damaged over winter.

December 2018 - February 2019

- Data analyses, prepare report and presentation, next year field work planning, deployed equipment maintenance, data downloads, active tracking.

March - November 2019

- Fish tagging, re-deploy any equipment taken in for winter, deployed equipment maintenance, active tracking, data downloads.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- We expect to largely conclude this project unless issues arise catching fish for tagging, tag life continues on into the following year, or there is some currently unseen issue in data gathering. Currently USFWS aims to be removing equipment by the winter of 2020, analyzing all the data, and preparing a publication of the results.

What Is Deliverable for this Project:

- The results from this study will be used to inform small Silver Carp and Bighead Carp monitoring efforts throughout 2019 and for future years and fill in a critical knowledge gap about the behavior of this life stage of Silver Carp. Habitat usage and movement data is important to improving knowledge of juvenile stages of Silver Carp and subsequently will make monitoring efforts more efficient.
- Data will be analyzed, and results summarized into a MRWG summary report/presentation for the winter of 2018-2019, as well a peer-reviewed paper publication(s) and presentation(s) at the conclusion of this study.
- In addition to the data from this study, tagged fish that are between 350 mm through 500 mm or are larger than 500 mm are also utilized in support of the Spatially Explicit Asian Carp Population (SEACarP) model telemetry project. Also, adults captured during tagging efforts will be measured for demographics data to support the model.

Expected Completion Date for Project:

- This project can be expected to have concluded by the end of 2020.

Potential Hurdles:

- Weather delays, lack of suitable size fish to tag, and extreme weather/river conditions damaging equipment. In 2018 several receivers went offline due to storm damaging the solar panels maintaining the batteries in the telemetry stations. Additionally, suitable size fish for

tagging have been difficult to capture. These issues will likely arise during the next year as well, although attempts to mitigate issues are being made.

How will the results of this project be disseminated?

- Public and technical audiences.

M-9 Distribution and Movement of Small Asian Carp in the Illinois Waterway

Lead Agency: U.S. Fish and Wildlife Service (USFWS) Carterville Fish and Wildlife Conservation Office (FWCO)

Agency Collaboration:

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$300,000	$320,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Small Silver and Bighead Carp pose a unique threat to invading the Great Lakes because of the potential electrical limitations of the Electric Dispersal Barrier System (EDBS) at immobilizing fish less than 6 inches in total length. This project involves intensive sampling using a variety of fish sampling gear at both targeted and random-stratified sites between the Peoria pool of the Illinois River and the EDBS throughout the year to detect upstream migrations of small and juvenile Silver and Bighead Carp. Gears used will be primarily boat electrofishing, electrified and non-electrified dozer trawl, and mini-fyke nets for main-stem Illinois Waterway areas, and backpack electrofishing, seining, or dip netting for smaller tributary or shallow areas. An electrified paupier and surface trawl will be incorporated into targeted sampling efforts as conditions allow. Two types of site selection strategies will be employed: targeted, and random-stratified. Targeted sites will be selected based on the crew-leaders discretion and will be primarily areas where fish have been captured in the past or areas that closely resemble past capture locations in terms of habitat. Random-stratified sites will be computer generated based on habitat characteristics of areas where small Silver or Bighead Carp were previously captured, and data obtained from the Habitat Use and Movement of Juvenile Silver Carp project (telemetry). Any successful capture of juvenile or small Asian carp will be immediately communicated to the Monitoring and Response Workgroup (MRWG) if it is new for the year or further upstream than prior captures.

Summary of Actions to Date: Known populations of adult Asian carp exist in all pools of the Illinois River Waterway (IWW) downstream of Brandon Road Lock and Dam. In 2016, USFWS personnel surveyed for small Asian carp within the Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools. Three small (109 - 115 mm TL) Silver Carp were captured near Henry, IL (RM 194) in the Peoria pool during 2017. As of October 2018, the farthest upstream juvenile Asian carp (≤400 mm TL) have been recorded was in Moody Bayou (Gundy County) at Illinois River Mile 256.4. These two Silver Carp (168 and 171 mm) were collected on October 22, 2015.

During 2018, a total of 22 crew weeks have been completed sampling for juvenile Silver and Bighead carp in Starved Rock, Marseilles, Dresden Island, Brandon Road and Lockport pools. Gears used have included electrofishing, electrified dozer trawl, and mini-fyke nets. The furthest upstream

capture of a juvenile Silver Carp was in lower Starved Rock pool (TL, 222mm) on May 14th. This fish is above the 6-inch threshold; however, it is likely in the same year class as those targeted size of fish. No other juveniles in this age class were captured with this fish. Multiple juvenile Silver Carp in this age class have been captured in Peoria pool during 2018, indicating that the likely distribution front of age-0 Silver Carp is lower Starved Rock or upper Peoria pool. Sampling efforts will continue for 2018 until late November and resume as early as possible in March 2019.

Proposed Actions for FY 2019:

- The primary focus of this project is to use intensive and focused sampling to determine the upstream-most location and population density of small (less than 6 inches in total length) Silver or Bighead Carp on a yearly basis.
- A secondary goal of this project is to determine the upstream-most location and density of juvenile (less than 400mm in total length) Silver or Bighead Carp on a yearly basis to monitor recruitment.
- In conjunction with the Habitat Use and Movement of Juvenile Silver Carp project, data from captures of juvenile Silver Carp will be used to direct sampling efforts in future years.
- Sampling site selection will be conducted in two ways: stratified-random generated sites and targeted sites. Starting this year, in an effort to sample non-routinely visited areas, a series of 18 random sites will be generated for Dresden, Marseilles and Starved Rock pool, during spring, summer, and fall seasons (54 total in each pool). Six random sites will be generated in each season for each habitat strata: backwater, side channel, and main channel habitats (18 total). The ratio of sites in each habitat area is subject to change based on data gathered of habitat usage of juvenile Silver Carp studied with telemetry. These random sites will be fished using boat electrofishing for 15 minutes, similar to Long-Term Resource Monitoring (LTRM) sampling procedures, and electrified dozer trawl for 5 minutes. During targeted sampling, locations and gear will be chosen based on previous juvenile Asian carp catches, locations predicted using telemetry data for juvenile Silver Carp habitat usage, and at the crew leader's discretion based on best area to deploy gear, water quality conditions, and historically captured small Silver/Bighead Carp.
- Physical characteristics and water quality measurements are to be made at each collection site and will include: secchi depth, depth, substrate type (i.e., boulder, cobble, gravel, sand, silt, and clay), temperature, specific conductivity, and dissolved oxygen. Water quality measurements will be taken using a YSI Professional Series multi-meter. Additionally, GPS coordinates and time stamps will be recorded at the start and end of each electrofishing event, trawl run, and mini-fyke net set.
- During random site sampling all fish over 100 mm in total length will be measured for Total Length (TL) in millimeters and weighed to the nearest gram. During targeted sampling all Bighead, Silver, and Grass Carp will be measured for TL (millimeter) and weighed (grams). Any other species will be tallied and released to increase processing speed. If a small Silver Carp or Bighead Carp are captured, all fish at that site will be measured for TL (mm) and weighed (g) to provide bycatch information. Any fish not easily identified in the field will be preserved in Excel Plus or 70% ethanol for laboratory identification to the lowest possible taxonomic level. Effort will be quantified as net nights (mini-fykes) or minutes of

electrofishing (boat electrofishing, backpack electrofishing, and dozer trawl). Descriptions of individual gears for 2019 include:

- **Electrofishing:** Pulsed DC daytime boat electrofishing conducted with perpendicular passes into shore using 2 dippers for 15-minute sampling periods. Dip nets have 3/16-inch bar mesh, 1-foot deep bags, and 9-foot handles.
- **Fyke net:** Wisconsin type mini-fyke nets set overnight in both single and tandem configurations depending on site characteristics. Single nets will be set with the lead end staked against the shoreline or another obstruction to fish movement. Tandem nets (with leads attached end to end) will be fished in open water areas. All mini-fyke nets have a 24-foot lead and ⅛-inch mesh.
- **Dozer trawl:** A 35mm mesh net at the mouth reducing to 4mm mesh at the cod end tied to a 2m by 1m rigid frame mechanically raised and lowered to fish depths <1m. The net extends approximately 2.5m back as it was pulled forward. The target habitat is open water >0.6m deep. Length and duration of trawl will be dependent on-site characteristics and fish catch rate.
- **Backpack electrofishing***:* A backpack electrofisher unit and 3 dippers will be used to sample smaller tributary mouths or shallow areas not accessible by other gear types.
- **Paupier butterfly trawl:** Two, 7m nets with 35mm mesh at the mouth reducing to 4mm mesh at the cod are tied to 3.7m x1.5m rigid frames perpendicularly attached to either side of a flat-bottomed boat. Frames can be fished 0.5 to 3m depth. The system can be electrified or not. Target habitat includes open water ≥0.6m deep. Length and duration of trawl is dependent on site characteristics and fish catch rate. This may be electrified or non-electrified.
- **Surface trawl:** A 10-11m long conical trawl net with 35mm mesh in the body reducing to 4mm mesh in the cod. Towlines extend 38m to floating otter boards that spread the net to an approximate 6.5m wide. Able to fish the top 1m of the water column, target habitats include open slackwater ≥1m. Length and duration of trawl is dependent on-site characteristics and fish catch rate.

Expected Milestones:

February 2019

- Gear preparation, planning field logistics, and crew scheduling.

March - November 2019

- Fish sampling, identification, and data entry.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Actions in future years would likely be more specific site targeting based off previous years data and telemetry results on juvenile Silver Carp. The goal is to increase detection efficiency in future years by learning what sampling methods work best and locations where fish have been captured in the past.

- Complete fish identification (preserved specimens), data entry, and verification.
- Data analysis. Prepare report and presentation.

What Is Deliverable for this Project:

- Any small Asian carp captured upstream of Starved Rock pool will be reported immediately to Todd Turner (USFWS Assistant Regional Director - Fisheries) or Charlie Wooley (USFWS Acting Regional Director - Region 3) and MRWG.
- An annual MRWG report and presentation with capture location maps and data will be provided during the winter of 2019.
- In addition to data gathered for this project, measurements of all Silver and Bighead Carp are taken in order to support the Spatially Explicit Asian Carp Population (SEACarP) model. Fish measurement data is also used to assist with the hydroacoustics monitoring by Southern Illinois University.

Expected Completion Date for Project: Continuing annually.

Potential Hurdles:

- Gear, boat problems, or weather.
- Specific to this project, small Silver and Bighead Carp are hard to capture due to their size and speed limiting the effectiveness of electrofishing.
- Additionally, because we are trying to find the upstream most location, the numbers of fish that can be expected in the habitat are very low.

How will the results of this project be disseminated?

- Public and technical audiences.

M-10 USGS Illinois River Monitoring and Evaluation Project

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: Illinois Department of Natural Resources (DNR), U.S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (USACE), and Southern Illinois University (SIU)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$370,000	$370,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

The overarching goal of this project is to provide informational products and decision support tools to inform and aid the management of Asian carp in the upper Illinois River waterway system. The objectives to accomplish this goal include: (1) maintain and improve upon the Illinois River Catch Database (ILRCdb) to facilitate objectives 3 and 4 via data summary, visualization and modeling; (2) provide geospatial support (mapping and analyses) to inform the application of the Unified Method by Illinois DNR; (3) better understand Asian 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; and, (4) incorporate this better understanding from Objective 3 into informational products and decision support tools to inform management decisions to control Asian carp.

Specific products resulting from these objectives will include: (1) maintenance and improvement of the ILRCdb; (2) addition of the demographics data (being collected by the partnership in support of the Spatially Explicit Asian Carp Population [SEACarP] model) to the ILRCdb; (3) summaries, visualizations, and modeling of data from the ILRCdb and other sources to better predict Asian carp distribution at various seasons, discharges, and temperatures; (4) maps and an assessment of actions (e.g., blocking, driving, capturing) taken during the Unified Method in relation to catch and Asian carp movements derived from telemetry; (5) high resolution benthic mapping of the upper Illinois River with a focus on high priority removal areas; (6) an assessment of the sensory development of larval Asian carp and how that interacts with behavioral, habitat preference, and hydrology to influence dispersal and recruitment; and, (7) informational products and a decision support tools (e.g., web mapping service for Asian carp habitat/distribution models) that uses the information from Objectives 1-6 for informing and directing removal, other management actions, and risk assessment in the upper Illinois River waterway system.

Summary of Actions to Date: Initial development of centralized database (ILRCdb) of query-able, downloadable catch data for Illinois River that includes customized data reports has been completed. The ILRCdb provides access to monitoring and removal data from Illinois DNR to facilitate data sharing, use and analysis to aid in removal efforts for Asian carp. Example summaries and

visualizations of the ILRCdb have been developed and presented internally and externally for feedback. Geospatial support for the Unified Method was provided by preparing and visualizing data from actions (driving, blocking, and capturing) that were taken in previous Unified Method events. From this, better methods were identified to increase the completeness and resolution of collected data to improve visualizations and associated assessments. Benthic habitat mapping efforts continued in the Illinois River with further data collection and post-processing to generate usable GIS layers for incorporation into additional features of the web mapping service (see below). Initial experiments to assess sensory development of larval Asian carp were completed. Decision support tool development was initiated with the developed of a web mapping service for habitat suitability to predict distribution of Asian carp to inform decisions on removal.

Proposed Actions for FY 2019:

- Illinois River Catch Database: Incorporate new catch data collected by partner agencies; incorporate demographic data into the ILRCdb from partner sampling to obtain this data in support of the SEACarP model; add database functionality based on partner feedback; make improvements to automated quality assurance and quality control (QA/QC) and data upload functions; finalize data sharing agreements or memorandum of understandings between partners.
- Continue to add spatial/temporal visualization and summaries tools to the ILRCdb for remaining pools of the Illinois River, based on results from development of these tools on Brandon Road and Dresden Island pool data, to support removal and other management actions.
- Continue geospatial support for Unified Method assessments to help improve future applications in high priority areas identified by the Illinois DNR. Continue to improve geospatial support based on lessons learned in previous applications and new or better technologies.
- Process and serve benthic data as usable GIS layers from Dresden Island and Brandon Road pools; continue collection of benthic data on priority areas of Peoria Pool and sample at random points to validate previously collected data.
- Integrate geospatial (including processed benthic data), catch, and telemetry data to model habitat and distribution of Asian carp; expand web mapping service and removal dashboard to include outputs of improved models to support decisions on Bighead Carp removal.
- Continue larval Asian carp sensory development studies and report findings and recommendations at appropriate management and science outlets.

Expected Milestones:

2019 Q1:

- Evaluation of GPS-tracking devices on boats and equipment during implementation of Unified Method event(s) for improved data collection

2019 Q2:

- Post-process benthic data from Dresden Island and Brandon Road pools

2019 Q4:

- Add new catch data and functionality to the ILRCdb.
- Finalize agency data sharing agreements or memorandums of understanding.
- Develop spatial and temporal visualization tools for the full Illinois River catch data set.
- Collect benthic data from priority areas of Peoria pool.
- Collect samples for validation of benthic coverages at random points for Brandon Road, Dresden Island, Marseilles, and Starved Rock pools.
- Integrate processed benthic, catch and environmental data into the web mapping service for invasive carp habitat suitability).
- development of improved/enhanced visualizations of Unified Method events using data collected during events for mangers to review post-implementation.
- Completion of lab studies of larval Asian carp sensory development; report on these studies in appropriate management and science outlets.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continued maintenance of the ILRCdb; incorporate new catch data and expand database functionality as request by partners.
- Incorporate spatial/temporal analysis and visualization functionality into ILRCdb for interactive data exploration capabilities.
- Develop classification of benthic areas using National Oceanic Administration Agency (NOAA) benthic habitat classification standard and apply to collected datasets for the Illinois River.
- Integration of geospatial decision support tools (e.g., web mapping service of Asian carp distribution models) into comprehensive Asian carp decision support dashboard application.
- Continue geospatial support for planning, implementation, and visualization of Unified Method events as requested by Illinois DNR.
- Publish results from Asian carp sensory development studies.

What Is Deliverable for this Project:

- ILRCdb with customized data reports, query and visualization tools (including spatial/temporal analysis functionality), and data upload and download functionality for data sharing.
- Processed benthic GIS layers for Dresden Island and Brandon Road pools of the Illinois River; benthic data for priority areas of Peoria pool.
- Web mapping service for invasive carp habitat suitability/distribution, incorporating collected and processed benthic coverages, catch data, and environmental condition variables (e.g., water depth, classified aquatic areas, etc.).
- Framework for data collection during Unified Method events and visualization after events for further post-event assessment.
- Reports on larval Asian carp sensory development studies including implications for management actions and risk assessment.

Expected Completion Date for Project: The end of FY 2019 or beginning of FY 2020 for decision support projects. Catch database management will continue past development indefinitely at the discretion of Monitoring and Response Workgroup based on usefulness. See milestones and outyear actions for specifics.

Potential Hurdles:

- Delays in funding, purchasing and hiring.

How will the results of this project be disseminated?

- ILRCdb and associated functionality, increasing will be available online to partner agencies, through a USGS Upper Midwest Environmental Service Center-hosted server application.
- Processed benthic GIS layers for the Illinois River are available through the USGS ScienceBase Catalog.
- Study results from larval Asian carp sensory development studies will be disseminated as reports including recommendations for management and risk assessment application.

M-11 Enhanced Detection Above and Below Electric Barriers

Lead Agency(s): Illinois Department of Natural Resources (DNR)

Agency Collaboration: U.S. Army Corps of Engineers (USACE), U.S. Geological Survey (USGS), and U.S. Fish and Wildlife Service (USFWS)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$2,950,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: All the actions for Illinois DNR and its activities of this template are supported by a multi-agency Monitoring and Response Plan (MRP) in coordination with the Asian Carp Regional Coordinating Committee (ACRCC).

Annual interim summary reports and weekly/monthly activity reports from 2011-2017 contain detailed annual/monthly/weekly summary of efforts and reporting and then posted on www.asiancarp.us.

There have been no reports or captures of Bighead Carp or Silver Carp in Lake Michigan, meeting overall objectives of the Asian carp programs. Furthermore, efforts supported by this template and others suggest populations of Asian carp in the upstream Illinois Waterway (IWW) are reduced from those found in 2012.

Detection:

- A total of 1,811 hours of electrofishing and 559.5 miles of gill/trammel netting have been deployed since 2010.
- Using exhaustive and seasonal intensive surveillance since 2010, only two, single fish have been collected above the electric barrier (Bighead Carp 2010, Lake Calumet; Silver Carp 2017, 2 miles downstream of T.J. O'Brien Lock and Dam).

Management and Control:

A key component of management and control of Asian carp in the upper IWW has been removal by contracted commercial fishing. Reduced Asian carp populations in the upper IWW have been observed demonstrating lower propagule pressure and reducing the chances of Asian carp gaining access to waters near the electric dispersal barrier system (EDBS). Primary areas fished include Dresden Island, Marseilles, and Starved Rock pools.

- From 2010-2017 contracted commercial fishers and assisting Illinois DNR biologists have deployed 2,056 miles of gill/trammel net, 20 miles of seine, 2,342 hoop nets nights, 162 Great Lakes style pound net nights.

- These contracted removal and agency efforts have resulted in a total of 776,880 Asian carp removed weighing 6,386,020 pounds.
- Illinois DNR continues to work with other state and federal agencies, enabled by this project, on adaptive management strategies to further minimize risk to the Great Lakes and minimize impacts on Illinois lakes and rivers.

Contingency Response Actions as Necessary:

Contingency actions and management have recently been identified in the annual monitoring and response plan. This response allows heightened and more coordinated responses. Since 2016 a table top exercise allowed for evaluation of the new plan with edits coming in the 2017 version. During 2017, a capture of a single Silver Carp in the Little Calumet River provided for a rapid and successful deployment of this plan. In planning, is a second table top exercise to further evaluate and share the efficacy of this plan. While the hope is that this plan should not be used, it is our goal to have the best plan at the ready if indeed it is needed.

In summary, this project enables Illinois DNR to work on Asian carp detection, management and control, as well as contingency actions as necessary in the Upper IWW and Chicago Area Waterway System (CAWS).

Proposed Actions for FY 2019: Monitoring of these elevated areas will include personnel services, equipment, commodities, and contracts to accomplish Monitoring and Response Plan (MRP) as well as any contingency measures as follows:

- Conventional monitoring, such as electrofishing and netting, at designated areas in the MRP.
- Continued deployment of gears developed through prior gear development project.
- Continued support of multi-year MRPs (2010-2019) through enhanced monitoring and products to support Action Plan development.
- Continued emphasis and evaluation of zooplankton, larval, and small fish detection and evaluation in upper IWW, Des Plaines River, and CAWS to assess risk of small fish testing barrier, to inform barrier operations, and continually evaluate barrier efficacy. Evaluation will contribute to potential adaptive management strategies.
- Ongoing monitoring of evaluation/efficacy (analysis of upstream commercial removal efforts, population front, and seek independent review of efforts and identify needs).
- Based upon detection probability analysis, community analyses, and extensive monitoring, Illinois DNR can re-focus monitoring efforts downstream of electrical barrier system to maximize information gained for prevention of Asian carp challenging CAWS, barriers, and ultimately Lake Michigan.
- Focused sampling seasonally in CAWS based upon detection probabilities allows for heighted awareness directly downstream of electrical barrier system.
- Identify sampling protocols to evaluate Lake Michigan harbors and nearshore areas for
- Continue to statistically evaluate monitoring program and evaluate for efficiencies in program, gears, and coordination of efforts using Southern Illinois University (SIU) developed and USFWS supported modeling insights.

- Specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement, in part identified in the Great Lakes and Mississippi River Interbasin Study (GLMRIS) and support decision making processes in developments of alternative and/or additional measures. These efforts will include collaboration with other projects, including:
    - Telemetry efforts.
    - Floy/jaw tagging efforts.
    - Hydro-acoustic/side scan sonar efforts.
    - Traditional and contracted monitoring-removing efforts.
- Weekly coordination and summaries of scheduled activities on the waterway to facilitate communication across multiple agencies and crews.
- Monthly data summaries as available from MRP activities.
- Coordination with Monitoring and Response Workgroup (MRWG) and Communication Workgroup.
- Continue field support for removal efforts of any identified Asian carp in urban fishing ponds (a likely historical relic of fish rearing practices).
- Continue to build incident management scenarios, test contingency plan, and support contingency and response exercises, capacity, and communication to further prevent establishment of Asian carp in the Great Lakes.
- Support Asian Carp Regional Coordinating Committee (ACRCC) and MRWG (as well as contingency measures as practicable efforts, increased coordination with agencies and workgroups, outreach, reports, and communication of results to partners, public, and other interested parties.
- Lead role in development/updates of multiyear MRP based on results and findings of ongoing efforts as necessary.
- Support Communications through co-lead with USFWS regional communication staff and ACRCC Communication and Outreach Workgroup.
- Implementing Integrated Pest Management Strategies which will include implementation of the Chinese Unified techniques, adaptive and strategic harvest/removal operations, multiple gear deployments to achieve removal of all sizes of fishes observed as prudent and practicable, support aggressive contingency operations and planning.
    - Levels of agency monitoring in Brandon Road and Lockport pools will be reduced and only at monthly intervals in 2019.
    - Levels of contracted fishing will be expanded by 25% in 2019 to further remove carp in the upper IWW. These additional efforts will be focused in Starved Rock and Marseilles pools.
    - Continue to review catch data for native species and trends corresponding to Asian carp and removal efforts.

Efforts for 2019 are generally summarized in the MRP as below:

Fixed Site Monitoring Upstream of the Dispersal Barrier: A variety of gears will be used during seasonal intensive monitoring activities, including pulsed DC-electrofishing, trammel and gill nets,

deep water gill nets, a commercial seine, trap nets, hoop nets and Great Lake pound nets to detect, capture and subsequently remove any Asian carp present. To date, only two Bighead Carp has been collected (2010; 2017). Fixed and random sites throughout the CAWS above the electric barriers will be sampled seasonally (spring/fall); at these times with electrofishing and contracted netting as in past years. Additional intensive monitoring with those gears and others listed above will occur: Lake Calumet will be sampled in the spring, and the North Shore channel in the fall. Illinois DNR coordinates these efforts with USCG, USACE, USGS, and USFWS. During 2018 Illinois DNR established a Lake Michigan aquatic nuisance species/habitat position that will allow USFWS and Illinois DNR to coordinate even closer on Lake Michigan monitoring and results.

Fixed Site Monitoring Downstream of the Electric Dispersal Barrier: Fixed and random electrofishing and contracted netting has been increased since 2014 and will continue at these elevated levels in 2019 below the Electric Barrier System. The sample design includes intensive electrofishing and netting at four fixed sites and will increase from four to 12 random sites in each of the four pools below the Dispersal Barrier. Fixed and random site electrofishing will take place bi-weekly from March through November. Contracted commercial netting will take place bi-weekly from March through December, except during June and September, and will include four fixed sites and 13, 13, and 24 random sites in the Lockport, Brandon Road, and Dresden Island pools, respectively. Provide monitoring of lower Kankakee River, which drains into Dresden Island pool to provide information on life stages within river. Contracted commercial netting in the Marseilles pool will occur at four fixed sites and four random sites. Effort in the Marseilles pool will remain the same as effort since 2013.

Young-of-Year (YOY) and Juvenile Asian Carp Monitoring: As in the past, 2018 sampling for YOY and juvenile Asian carp will take place through netting and electrofishing operations in this and in coordination with additional projects. The projects included are Larval Fish and Productivity Monitoring, Fixed and Random Site Monitoring Upstream of the Dispersal Barrier, Fixed Site Monitoring Downstream of the Dispersal Barrier, Gear Efficiency and Detection Probability Study, Rapid Response Actions in the CAWS, Seasonal Intensive monitoring, Barrier Maintenance Fish Suppression Project, and the Des Plaines River and Overflow Monitoring Project. The collection of small fish, in context of their relative abundance in the Upper Illinois Waterway may suggest an increased risk of Asian carp movement toward Lake Michigan and this remains one of the primary foci of monitoring.

Response Actions in the CAWS: A decision tree is described in prior MRP's and Illinois DNR is prepared to use conventional gears, experimental gears and/or other methods to capture and remove Asian carp from the CAWS upstream of Lockport Lock and Power Station as information and remedy suggest. Each response action will be unique to location, perceived severity of the threat, and likelihood of successfully capturing, removing, or stopping Asian carp. Response actions can use Agency and contracted netters for initial responses.

Illinois DNR and other MRWG Partners are developing an updated response decision support matrix to further outline emergency response actions, as well as situational awareness and concerns throughout the agencies working as part of this Action Plan. This updated plan is to be included in

the 2016 Monitoring and Response Plan and be shared and vetted with ACRCC partners from fall 2015 - Spring 2016.

Illinois DNR contracts with a small set of commercial fishing crews as responders. These responders will fish during Seasonal Intensive Monitoring events, but also can be deployed to maximize removal efforts with any of the commercial tools, including seines up to ¾ mile long as Illinois DNR directs and is prudent and practicable (outlined in 2013 MRP and subsequent plans).

Detection and response efficiency is important for appropriate and effective invasive species control. Exercises to increase or improve upon responses in challenging, multijurisdictional areas will be identified where appropriate to facilitate future response capacities and partnerships.

Barrier Defense in Support of Contracted Removal: This project enables Illinois DNR to staff contracted commercial fishing vessels to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the Dispersal Barrier. Six Illinois DNR staff and contracted staff as necessary are necessary to observe and record data from commercial fishers under contract 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; and gather information on Asian carp population abundance and movement in the Illinois Waterway downstream of the Dispersal Barrier as a supplement to fixed site monitoring by contracted netters. In the CAWS (seasonally) and from barrier down 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, many of these contactors also serve as responders. This project allows for personnel services, equipment/gear and commodities for agency support, and contracts for fishing as well as any necessary contracts for fish removal or staff monitoring personnel.

Illinois DNR staffs the contracted fishers' boats to monitor and record data and meet MRWG goals. Illinois DNR also utilizes contracted staff to aid in this effort.

In lieu of a contracted industrial partner to utilize fish for non-human consumption Illinois DNR will dispose of Asian carp to maintain removal operations through landfill or other rendering process as available.

Barrier Maintenance Fish Suppression: Illinois DNR will work with federal and local partners to identify fish greater than12 inches long circa electric dispersal barriers and assess risk of those fish being bighead or Silver Carps prior to or during operational changes, maintenance by working closely with management agencies and partners. When risk or concern is significantly high or agreed too, agencies can respond to this risk in several ways, including additional surveys, or by collecting or driving fish into the net or from the area with mechanical technologies (surface noise, surface pulsed DC-electrofishing and surface to bottom gill nets) or, if needed, a small-scale rotenone action; and assess the success of fish clearing operations by surveying the area between Barrier 2A and 2B with remote sensing gear (split-beam hydroacoustics and side-scan sonar). Success is defined as no fish greater than 12 inches long in the between-barrier area, as determined with remote sensing gear or MRWG deems the remaining fish in the barrier as a low risk.

Additionally, guidance has been given with the wealth of monitoring data from this Action Plan and other ongoing activities. Future guidance will also be more explicit with input from an updated response matrix that will inform actions at and/or around Barrier system.

Communication and Action Plan Support: Coordination of response actions, reporting, and technical support is needed when multi-agencies are acting together. Contracted personnel will assist with facilitation of Action Plan objectives and MRP development needs that cannot be handled by any one agency directly or those items that will require facilitation or technical expertise:

- Updates program documents.
- Supplementary Document Development.
- Support Related Meetings.
- Facilitate Public Meetings.
- Incident Command System Training and Exercises.

Illinois DNR will seek to fill a communication position to further enable partner communication needs.

Contingency Planning: A table top exercise in lieu of actual need of the Contingency plan is warranted to reach to partners in conservation. Such an exercise will allow non-governmental organizations and partners not familiar with planning and implementation to be aware of how the ACRCC/MRWG will respond to captures of information that suggests increased risk of Asian carp arriving to the Great Lakes. Such communication allows for further honing of the plan, identifying additional resources, and understanding of actions to be deployed.

All these efforts include support of staff readiness, equipment, sampling gear, travel, and contracts to perform and inform needs to implement the above.

Expected Milestones:

- Evaluation of threat in CAWS both above and below the electric barrier system.
- Maintain high level of surveillance and increase efficiency and information from surveillance efforts.
- Contract commercial fishing surveillance in the CAWS both above and below the electric barrier system. Goal of 1 million pounds removed upstream of Starved Rock Lock and Dam.
- Contract commercial fishing removal in Peoria Pool, Illinois River to further protect Lake Michigan and prevent upstream movement of juvenile and adult Asian carp. Goal to increase harvest removal in Peoria Pool, Illinois River with up to 5 million pounds removed.
- Monthly reporting of monitoring results to www.asiancarp.us and informing ACRCC partners.
- MRWG meeting to share and communicate significant findings as well as identifying needs to modify or update current monitoring plans as needed. Quarterly updates via teleconference or face to face.
- Support and facilitate Action Plan development and implementation.
- Support and inform Contingency Plan as needed.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Maintain a program as identified with ACRCC partners through an adaptive process, establishing an agreed to monitoring plan each year.
- Provide for maximum protection of the Great Lakes through scientific evaluation of data and methodologies deployed.
- Seek to provide the most cost-effective program as able.

What Is Deliverable for this Project:

- Increased protection of the Great Lakes by identifying risk, reducing propagule pressure and supporting contingency measures.
- Providing oversight for safe monitoring and evaluation of Asian carp threat.
- Coordinate with other agencies on the most effective and efficient Asian carp MRP.
- Provide partners with needed information on status and risk, protecting Great Lakes and Illinois waters.

Expected Completion Date for Project: Unknown. Efforts to date have shown promise in not allowing any Asian carp into Lake Michigan nor approaching other control points. However, such efforts need constant minding and evaluation, continual harvest and population reduction even with existing or future deterrence in place. Having effective and efficient measures in place is needed. Strong advocacy to prevent future import, and subsequent release of additional species in US waters is encouraged as it would only exacerbate this issue.

Potential Hurdles:

- Unidentified pathways for expansion of Asian carp.
- Timeline of funding and prevention of timely allocation of resources.
- Very large system to find very rare fish.
- Changes in population dynamics (significant increases in abundances of Asian carp moving close to or toward the barrier; or presence of small (< 4 inch) Asian carp in the vicinity of the barrier would challenge ability of current plan to further restrict lake-ward movement of Asian carp populations (would need to implement additional or other control techniques).
- Administrative challenges to identify new communication position.

How will the results of this project be disseminated?

- Illinois DNR works closely with ACRCC and partners through the communications work group.
- Provide timely updates to ACRCC and MRWG directly to share observations and sampling results.

M-12 Ecosystem Assessment in the Upper Illinois River

Lead Agency: Illinois Department of Natural Resources (DNR)

Agency Collaboration: Illinois Natural History Survey

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$350,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Illinois DNR has posted monthly updates to www.asiancarp.us as well as lead the effort to compile annual plans and interim summary reports of all monitoring and response workgroup items and other related and associated information. These have been posted on www.asiancarp.us.

Objectives of the effort are to detect changes in ecosystem responses to corroborate other indirect population assessments, maximizing management and control efforts and further assessing and informing on risk.

The purposes of monitoring Asian carp reproduction are: (1) detection (reproductive front of Asian carp populations, including early detection of potential Black Carp reproduction in the Illinois River and its tributaries); (2) eradication (tuning of FluEgg model for application to identifying reproductive hotspots and nursery habitat); and, (3) assessment (quantifying the relationship between adult stock abundance and reproductive output to establish level of removal needed to degrade regenerative capability of Asian carp populations).

One purpose of this project is to determine if there is a positive ecosystem response to current control and removal efforts of Asian carp from the upper Illinois River. For the plankton dynamics, Illinois DNR measures function as an index for the ecosystem which should allow us to assess positive responses to the management actions more quickly than many fish-based measurements, potentially allowing for adjustments in timing or type of removal efforts.

A second purpose is to make best use of the widespread and comprehensive monitoring program conducted through a collaboration of state, federal, academic, and private entities to track changes of Bighead Carp abundances in the Chicago Area Waterway System (CAWS) through time and across space through both direct and indirect methods.

Proposed Actions for FY 2019: Asian carp egg and larval fish sampling efforts will monitor for any changes in the reproductive front of the Asian carp population of the IWW and its tributaries, and as an early detection tool to monitor for Black Carp reproduction (detection). Illinois DNR will continue to collaborate with the U.S. Geological Survey (USGS) in using our spatial sampling of carp eggs to refine the FluEgg model, with the goal of using the model to reveal reproductive hotspots and potential nursery habitats that can be targeted by removal efforts (eradication).

Information on Asian carp adult stock abundance will be combined with our egg and larvae data to quantify the relationship between stock abundance and reproductive output. This analysis will be used to assess the level of removal needed to degrade the ability of Asian carp to perpetuate themselves through reproduction (assessment). Sampling effort will be refined by reducing redundant sampling locations while maintaining appropriate spatial coverage (i.e., coverage of important environmental gradients) and early detection needs in the Illinois River. Sampling locations will include the Peoria pool, a new location targeted for Asian carp removal efforts, and potential upstream sources of Asian carp eggs and larvae dispersing into this pool.

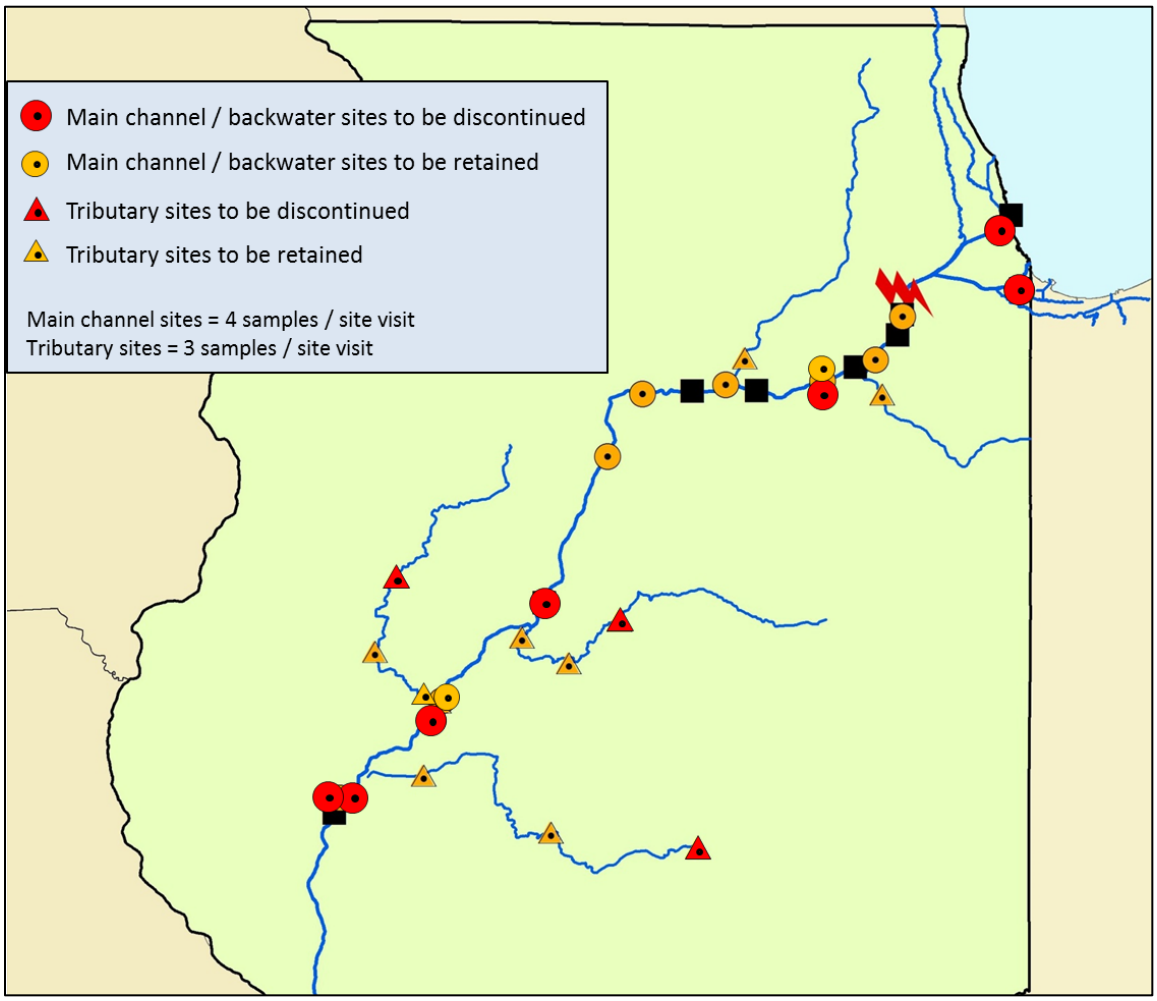
The zooplankton evaluation will use historical zooplankton data and current monitoring data for zooplankton communities in the Illinois River to develop dynamic targets for diminishing the ecological impact of Asian carp. Zooplankton are good indicators because they are known to be impacted by Asian carp, are a rapid index of ecosystem response, are distributed throughout the Illinois River, and are critical food web components for larval and adult native fishes. Zooplankton indicators are dynamic management targets because of seasonal and annual environmental variation. Assessments will be based on comparisons between field-collected data to targets derived from models developed from pre-invasion conditions. A stoplight assessment report card will be developed based on deviation of performance measures from management targets.

The 2019 efforts are a 25% reduction in our ichthyoplankton sampling effort as compared to preceding years. Reducing number of visited sites to seven main channel locations, two Upper River tributary sites (Fox River, Kankakee River), and six lower tributary sites (two each on Spoon, Mackinaw, and Sangamon Rivers; see Figure on the next page.

During 2019, Illinois DNR will maintain careful evaluation of the spatial and temporal extent of Asian carp reproduction in the IWW and its tributaries through frequent sampling with ichthyoplankton push nets and drift nets and will statistically evaluate environmental factors that contribute to successful Asian carp spawning and recruitment. This becomes even more important in lower IWW with increased enhanced contracted removal efforts. While direct or stark evidence may not be immediately prominent, a multi-layered evaluation of population densities and dynamics will be important in evaluating success. This work will be used to inform management agencies regarding Asian carp spawning events and plankton communities and densities, spawning locations, and areas of larval settlement.

FY 2019 Actions:

2019 Tasks	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Larval/egg Sampling				X	X	X	X	X	X	X		
Zooplankton Sampling					X	X	X	X	X	X		
Sample Processing					X	X	X	X	X	X	X	
Data Processing	X	X	X	X	X	X	X	X	X	X	X	X
Reporting	X			X			X			X		X



Potential Out-year Actions (Subject to Future Appropriations)**:** The regenerative process of an invasive population shapes its ability to maintain itself, spread, and increase its propagule pressure on invaded systems. Knowing that an invasive species is not only present at a location but also successfully reproducing raises the threat level of that species' presence because it didn't just disperse into that location, it is also perpetuating itself through reproduction. This may be particularly acute if find evidence is found of Black Carp reproduction in the Illinois River. Any fecundity assumptions associated with spawning stock are distorted by factors affecting survival at egg and larval stages. By combining data from our egg and larval monitoring with information on adult abundance, Illinois DNR will have the potential to reduce uncertainties associated with modelling carp population response to harvest.

An aggressive Asian carp removal program has been implemented to reduce the spread and impact of Asian carp populations. However, the extent and pace of ecosystem responses to such removals is uncertain. The stoplight report card approach will use zooplankton monitoring to establish quantitative, ecological targets for assessment of removal efforts.

Monitoring of eggs and larval stages of Asian carp is vital information for contingency planning. Currently management of Asian carps in the upper IWW is absence of observed recruitment. Changes in that fact would likely have significant changes to annual Monitoring and Response Plans (MRP) and observed risk in the waterway.

Evaluation of both plankton and egg/larval stages of frequency and location is ongoing. With increased scope of removal (enhanced contracted removal) it is necessary to maintain current efforts as to not overlook changes that could compromise or otherwise inform the annual MRP. It is likely that baselines will be established that may further allow reduction and focus on key areas instead of pool-wide evaluation. Annual evaluation and input from Management/Control and Modeling workgroups will assist in this evaluation.

Sample processing remains a significant portion of this project, working with USGS on new technological pre-screening (qPCR techniques) Illinois DNR may be able to significantly screen samples in future years, drastically decreasing the times to process. This may be most important in detection of reproductive events including any identification of Black Carp spawning which is yet described from the Illinois River. Such efforts could speed evaluation of samples to a detect/non-detect level to just one week.

What Is Deliverable for this Project:

- Monthly updates to Monitoring and Response Workgroup (MRWG) posted to www.asiancarp.us.
- Quarterly updates to management/control work with information sharing as needed to model development and others.
- Annual reporting in Interim Summary Report.
- Annually evaluate for subsequent MRPs.
- Information available for planning appropriate enhanced contracted removal and evaluation.

Expected Completion Date for Project:

- Annual evaluation is important in understanding population dynamics and densities in upper IWW.
- How effective such work is in evaluating downstream population dynamics and densities is to be determined.
- Evaluation and efficiencies will inform MRWG for future use, but it is expected that continued evaluation is necessary through 2021 (annual evaluation and modifications are likely necessary).

Potential Hurdles:

- Hydrological effects can influence plankton abundance and spawning.
- Detection of rare event or small and/or indirect changes may be difficult.
- Evaluation of larger pools in lower IWW with suitable resolution may be challenging when informing harvest strategies.

How will the results of this project be disseminated?

- Monthly summaries of activities provided to MRWG.

- Annual summaries provided in the Interim summary reports.
- Coordination with Communication and Outreach Workgroup.
- When needed, and at least annually provide a briefing to the Asian Carp Regional Coordinating Committee on the status of Asian carp populations and observations. Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.

M-13 Illinois River Stock Assessment/Management Alternatives

Lead Agency: Illinois Department of Natural Resources (DNR)

Agency Collaboration: Southern Illinois University (SIU), U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$450,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Monitoring of Asian carp densities via hydroacoustic sampling throughout the Illinois River (Alton to Dresden Island pools) by SIU has been ongoing since 2012 and is a useful metric to evaluate long-term changes in Asian carp abundance. By monitoring densities across multiple years throughout the river, long-term trends can be identified and related to environmental conditions, reproduction, or management actions such as commercial harvest (lower Illinois River) or contracted removal (upper Illinois River) to understand the variables most strongly affecting abundance. Broad-scale density estimates also help inform management actions in the upper river near the invasion front. Annual densities, particularly in the lower Illinois River, have displayed relatively large annual fluctuations among years (Coulter et al. 2016), necessitating the need for continued assessments of Asian carp densities throughout the river. This will identify whether lower river population size has increased from the previous year and help managers determine whether harvest or surveillance in the upper river should be altered in anticipation of increased immigration from downstream pools. It is currently unclear whether, or the extent to which, Asian carp in the Illinois River exhibit density-dependent impacts on reproduction, condition, growth, and movement. Collecting long-term data, particularly density and movement data, will help quantify these patterns which will better inform management decisions and improve models predicting population response to management actions.

While annual monitoring provides a snapshot to document long-term trends in Asian carp abundance, seasonal surveys can be used to help improve removal by identifying and directing harvest efforts to high-density sites. Dresden Island pool represents the current population front for the adult Asian carp invasion in the Illinois River, while Marseilles is the most upstream pool where young-of-year have been found. Frequent hydroacoustic surveys of Asian carp densities in these pools will identify locations where Asian carp aggregate and determine whether or not these seasonal high-density hotspots remain in the same location each year.

A spatially-explicit population model of Asian carp in the Illinois River was recently developed to assess how Asian carp populations respond to a variety of management actions (e.g., location and intensity of harvest; location and effectiveness of deterrent technologies). This model draws on a wide variety of data collected by different agencies including Asian carp densities and movement

data previously collected by SIU. Collaborations between the Monitoring and Response Workgroup (MRWG) modeling, telemetry, and hydroacoustic working groups have identified several additional data needs in addition to maintenance of current monitoring efforts. SIU's contribution to continued model support and development will include continued maintenance of the Illinois River stationary telemetry array to document inter-pool movements, deployment of additional acoustic telemetry tags in Asian carp (numbers set based on telemetry working group determinations), continued hydroacoustic monitoring of Asian carp densities throughout the Illinois River. Additionally, telemetry working group partners have also identified the need to better understand the meaning of telemetry data collected from surrogate fishes by comparing movements of surrogate species in relation to those of Asian carp. SIU will partner with USACE to exploit SIU's existing acoustic telemetry tags in Asian carp and stationary receiver array.

Proposed Actions for FY 2019: Funding is requested to continue annual Asian carp density estimates throughout the Illinois River (Alton - Dresden pools) in 2019 and to extend seasonal density estimates (every other month) in Marseilles and Dresden Island pools into 2019. Funding is also requested to maintain SIU's acoustic telemetry array during 2019 which will be used to update movement probabilities in the spatially-explicit population model. Given that the majority of Asian carp acoustic telemetry tags deployed in the lower Illinois River (Alton, La Grange) have expired, funds are also requested to tag 100 additional Asian carp (50 per pool) while 50 additional tags for Marseilles pool will be covered with base funds. Additional funds are requested for a graduate student and travel to examine the movement patterns of surrogate fishes and compare observed patterns to those from Asian carp.

Expected Milestones:

Goal: Document spatial and temporal variation in Asian carp densities in Marseilles and Dresden Island pools to inform harvest and control efforts.
Specific objectives are:

- Quantify Asian carp densities every other month in Dresden Island and Marseilles pools in 2019 using mobile hydroacoustic surveys to pinpoint high density areas that can be targeted during contracted removal. Surveys will also document how distributions of Asian carp change through time which can better inform targeted removal and could provide an indication of the effectiveness of harvest efforts. Data collection will occur bi-monthly as long as conditions allow, and results will be available one month after the survey.

Goal: Estimate density and biomass of Asian carp in the Illinois River.
Specific Objectives are:

- Hydroacoustic surveys will be completed in fall 2019 and Asian carp densities, biomass, and size structure in Alton – Dresden Island pools will be determined. Density, biomass, and size structure estimates will be compared across habitats, pools, and through time to compare 2019 densities to past trends. Results will be included in the final project report.
- Collect Asian via electrofishing and gill netting in fall of 2019 in the Alton, La Grange, and Peoria pools to determine species-specific densities from hydroacoustic surveys. Catch data will also help determine population characteristics including catch-per-unit effort, length-

weight relationships, and size structure of Asian carp. These data will be used to update the spatially-explicit population model and results will be included in the project's final report.

Goal: Monitor passage of Asian carp through Illinois River Lock and Dams
Specific Objectives are:

- Maintain and download SIU's extensive acoustic telemetry array currently in place in the Illinois River by replacing batteries, lost stationary receivers, and deploying additional acoustic telemetry tags. Quality check data, merge data with existing telemetry database, and supply data to the modeling working group in order to update the Spatially Explicit Asian Carp Population (SEACarP) model. Documented dam passages will be included in the final report.

Goal: Compare movement patterns of surrogate species to Asian carp to improve inferences from surrogate fish movement data near the electric barriers
Specific Objectives are:

- Compare dam passage rates and timing among surrogate species and Asian carp.
- Identify patterns and environmental correlates of the movements of surrogate species and Asian carp to improve the utility of surrogate fish movement data from near the electric barriers. Preliminary results will be included in the final report, with completed results included in the final report for 2020 work (2-year project).

Expected Results and Benefits:

- Bi-monthly surveys in Marseilles and Dresden Island pools will provide information on the locations of high Asian carp densities within one month of sampling, depending on availability of netting and electrofishing catch data. Surveys will also document seasonal changes in abundance at sampling locations. Spatial variation in Asian carp density, both within a sampling event and among sampling events, will be matched with variation in environmental variables, building on 2017 and 2018 results. This will result in recommendations to managers for the environmental characteristics indicative of areas of high Asian carp abundance which could be used to target control efforts in the future.
- Hydroacoustic and standardized sampling surveys will yield information on trends in density, biomass, and population information such as size structure, catch per unit effort (CPUE), and length-weight relationships of Asian carp in the Illinois River. Because these surveys have been ongoing since 2012, long-term temporal trends can be evaluated.
- The collection of additional telemetry and hydroacoustic data will lead to improvements and reductions in uncertainty within the SEACarP population model.
- Comparisons of surrogate fish and Asian carp will improve inferences made from surrogate fish movements regarding upstream dispersal (upstream of Brandon Road Lock and Dam) and movements through the electric dispersal barriers.

Approach:

Spatial and temporal variation in Asian carp densities in Marseilles and Dresden Island pools: relationships with environmental characteristics

- To quantify fish targets, mobile hydroacoustic surveys will be conducted in main channel, tributaries, side channels, and connected backwater lakes. Surveys will be conducted every other month in Dresden Island and Marseilles pools from March to November in 2019, given appropriate sampling conditions. In order to inform hydroacoustic data, catch from ongoing efforts (e.g., contracted removal) in the Dresden Island and Marseilles pools will be sampled throughout the year for species relative abundance and measured for length and weight.

Estimate density of Asian carp in the Illinois River

- Hydroacoustic surveys will be conducted in the fall of 2018 throughout the Illinois River, including Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island pools, following the same protocol outlined above for the bi-monthly surveys of Marseilles and Dresden Island pools. Survey sites will be the same locations sampled previously by SIU in order to add to the existing long-term (8 years as of 2018) dataset. Such data are essential to fully understand population dynamics, especially when biotic (e.g., annual variability in recruitment success) and abiotic (e.g., drought, flood years) processes fluctuate through time.
- SIU will conduct standardized gillnet and electrofishing sampling in the Alton, La Grange, and Peoria pools during late summer 2019 to provide data on species composition and size structure that will inform hydroacoustic analyses. Data from ongoing efforts (e.g., contracted removal and Illinois Natural History Survey [INHS] sampling) in the Starved Rock, Marseilles, and Dresden Island pools will provide data on the fish assemblage in the upper river.

Spatially-explicit population model movement update: continued collection of inter-pool movements and replacement of expiring acoustic telemetry tags

- The existing acoustic telemetry array of 54+ stationary receivers will be maintained and downloaded on two occasions in 2019 and up to 12 stationary receivers lost over previous years will be replaced. Stands holding the receivers and hardware will be replaced as necessary. Data from the telemetry array will provide information on numbers of tagged Asian carp moving upstream or downstream through each dam, which provides an indication of the relative numbers of individuals in the population that may be moving among pools. Additional acoustic telemetry tags will be deployed in Marseilles, La Grange and Alton pools to replace expiring tags and collect data on pool-to-pool transitions for the SEACarP model. Other telemetry collaborators (USFWS and USACE) will be replacing expiring acoustic telemetry tags in other Illinois River pools.

Surrogate fish movements: comparing the movements of surrogate fish species and Asian carps to improve inferences from surrogate fish movement data collected in the Des Planes River (above Brandon Road Lock and Dam and near electric dispersal barriers)

- In collaboration with USACE, this project will utilize an extensive array of stationary receivers (20+) around Starved Rock Lock and Dam and within Starved Rock pool as well as over 50 acoustic tags in Asian carp in Starved Rock pool to monitor the movements of Asian carp and surrogate species. In this case, Common Carp will serve as a surrogate species as this is the most common species tagged as a surrogate for Asian carp by USACE above Brandon Road Lock and Dam. Fifty Common Carp will be tagged (tags purchased by

USACE) with 25 implanted into individuals just below Starved Rock Lock and Dam and 25 implanted into individuals within Starved Rock pool.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Assessment of Asian carp populations is necessary as long as risk of populations and movement into new areas continues.
- As confidence in methodology is increased efficiencies may be identified to constrain such work further in the future. Current understanding suggests this is a necessary effort currently. MRWG workgroups on Hydroacoustics and Telemetry will advise future and suitable efforts and needs.
- It is understood that Asian carp populations and risks may change in the future. Increasing or decreasing risk may both affect future efforts and intensity. Currently it is identified that the monitoring should be consistent with current levels in future years.

What Is Deliverable for this Project:

SIU will report data collection and findings monthly to Illinois DNR and the MRWG and directly with field crews throughout the project to facilitate increased harvest and removal. While manuscripts are not expected in 2019, updates will be shared with the MRWG and with appropriate scientific peers to assure methods and results are reviewed sufficiently. All collected data will be summarized and provided for the 2019 Interim summary reports and considered in planning of future years management and control activities, detections, and contingency planning.

Expected Completion Date for Project:

This project is expected to continue to provide annual evaluation and advice to the Asian Carp Regional Coordinating Committee (ACRCC) and MRWG as long as Asian carp management and control is a priority. This project could be modified on an annual basis to provide managers needed information and may be modified as new techniques or technologies inform this work.

Potential Hurdles:

The working groups of the MRWG have suggested the current methodology is appropriate for management considerations but are developing standard operating procedures. Such procedures may require future modifications of techniques or suggest errors or oversights of current methods. Such review may provide insights or needed modifications to properly assess populations and movements.

How will the results of this project be disseminated?

- Monthly summaries of activities provided to MRWG.
- Annual summaries provided in the Interim summary reports.
- Coordination with Communication Workgroup.
- When needed, and at least annually provide a briefing to ACRCC on status of Asian carp populations and observations. Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.

M-14 eDNA: USFWS Midwest Region Fisheries Program Capacity for eDNA Sampling and eDNA Sample Processing

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

Agency Collaboration: States/tribes of Great Lakes, Ohio River, Upper Mississippi River

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$2,400,000	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: USFWS has applied the science of environmental deoxyribonucleic acid (eDNA) as an early detection monitoring tool in support the Asian Carp Regional Coordinating Committee's (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 an aggressive eDNA monitoring program for most effectively sampling high-priority locations for the presence of Bighead and Silver Carp. USFWS has identified the need to maintain program capacity for eDNA surveillance in the Great Lakes, Upper Mississippi, and Ohio River basins. Building upon work that has been completed for Bighead and Silver Carp marker improvements, field collection and extraction protocols, USFWS will continue to work to include Grass Carp and Black Carp surveillance in outyears as part of this monitoring program.

Use of eDNA as a monitoring tool for Asian carp and other aquatic invasive species (AIS) has been successfully implemented since 2013 coordinated through the Service's Midwest Fisheries Center, Whitney Genetics Lab. Improvements through research efforts within federal agencies and academic institutions has resulted in realized efficiencies in field and laboratory techniques and processes allowing for analytical capacity to expand each year. Higher throughput has been realized with modifications to current procedures and methods, all of which have been tested and validated in three labs in order to be adopted into the Quality Assurance Project Plan (QAPP). Laboratory capacity has expanded from about 2,500 to 8,500 samples per year.

Proposed Actions for FY 2019: USFWS, in cooperation with our partners, will continue to monitor for the presence of Bighead and Silver Carp eDNA in the Great Lakes, Upper Mississippi River, and Ohio River basins. USFWS will continue to process water samples collected by our FWCOs, in collaboration with our state and tribal partners, to detect the presence of Asian carp DNA in areas of concern. This will include the Chicago Area Waterway System (CAWS) of the Illinois Waterway (IWW), and will include two sampling events in 2019, immediately preceding the Monitoring and Response Workgroup (MRWG) Seasonal Intensive Monitoring Events scheduled for the CAWS. USFWS will continue to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge.

Expected Milestones:

- Continued development of capacity for implementing an eDNA sampling program at USFWS Great Lakes Fish and Wildlife Conservation Offices.
- Continued implementation and refinement of an eDNA sampling protocol for other areas of concern, with particular focus on potential hotspots for Asian carp invasions.
- Continued processing of water samples for Asian carp eDNA sampling from areas of concern.
- Continued updating of the QAPP to include any necessary updates for collection, handling, and processing of water samples.
- Increased throughput of samples processed at the Whitney Genetics Laboratory due to procedural modifications, where possible.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Ongoing monitoring at the request and in coordination of our state and tribal partners.
- Inclusion of Grass and Black Carp monitoring.

What Is Deliverable for this Project:

- Continued eDNA sampling in areas of concern by USFWS Fish and Wildlife Conservation Offices, conducted in close coordination with partners.
- Continued updating of the QAPP to include any necessary updates for collection, handling, and processing of water samples.
- USFWS eDNA sample processing and analysis; providing results to state partners within one month of when samples were received at the Whitney Genetics Laboratory.
- Posting of eDNA results on USFWS eDNA website.

Expected Completion Date for Project:

- Ongoing

Potential Hurdles:

- Limitations due to weather and difficulties accessing sites.

How will the results of this project be disseminated?

- USFWS eDNA website.

M-15 Advanced Molecular Tools for Tracking Asian Carp

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS), Purdue University, University of Illinois at Urbana-Champaign, University of Missouri - Columbia

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$800,000	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Early detection is a vital part of managing any invasive species, including the invasive Asian carp. The Asian carp consist of four species that are native to Asia and include: Black Carp, Grass Carp, Silver Carp, and Bighead Carp. All four species are currently expanding their ranges throughout the Central United States and three species, Black Carp, Silver Carp and Bighead Carp, threaten to invade the Laurentian Great Lakes. Diploid (fertile) Grass Carp have been captured in the Great Lakes, but populations are thought to be relatively low. Identification of invasion fronts and population sizes of these species is vital to their management and control. Traditional fisheries methods for capturing and monitoring a population are highly inefficient at capturing fish when at a low abundance. In addition to being inefficient, these four species are known to avoid the conventional gears used to capture native fish species. Therefore, new tools are needed for resource managers to more effectively manage these species and minimize the risk of them spreading.

One method that has garnered significant interest is in the use of environmental deoxyribonucleic acid (eDNA). This method detects the presence of nucleic acids shed from an organism in water without the need of capturing the actual organism. Environmental DNA methods have proven effective for detection of Silver Carp and Bighead Carp DNA in the field, but significant concerns about the technology and on the interpretation of a positive detection continue to exist. Improvements to eDNA technology will offer managers a "molecular toolbox" for detection and characterization of an aquatic species. Thus far, studies have indicated that potential applications of eDNA include detection of species presence, estimation of relative biomass, and detection of spawning events, fish movement, and habitat utilization. Refinements to eDNA methodology have improved detection sensitivity, minimized false negatives from polymerase chain reaction (PCR) inhibition, increased cost-effectiveness, and decreased time between sampling and results. However, applications of molecular technologies that are in need of improvements include extension of methods developed for Silver Carp and Bighead Carp to Grass Carp and Black Carp, further development of rapid detection technologies, estimation of absolute fish biomass, and methods to distinguish eDNA originating from a live fish.

Molecular biology methods (i.e., loop-mediated isothermal amplification [LAMP], high-throughput sequencing [HTS], digital PCR [dPCR], and quantitative PCR [qPCR]) are at the forefront of

technologies being developed for environmental monitoring. A portable LAMP assay has been developed for the detection of Silver Carp and Bighead Carp in baitfish tanks. This assay is now being used by several state and federal natural resource agencies to monitor the presence of Silver Carp and Bighead Carp in the baitfish trade. Also, methods to use an eDNA approach with qPCR and/or HTS to analyze DNA shed from organisms within ichthyoplankton tows have been developed and are being tested. This will significantly decrease the time between collection and identification of larval fish.

More work is needed to improve the interpretation of positive eDNA detections. In particular, single positive detections in an area that has previously tested negative are problematic because the possibility of a first detection associated with movement of an invasion front cannot currently be distinguished from eDNA originating from a carcass or transport of eDNA on a fomite. This project will aim to identify differential degradation patterns of DNA and identifying breakage 'hotspots' so that new markers can be designed that will indicate how recently the DNA was deposited. Statistical models have been developed to provide better context to managers in how to interpret eDNA results. USGS will continue to develop these models which will be used to help recognize data gaps and inform future studies.

Summary of Actions to Date: USGS has prepared 18 publications and given 30+ scientific presentations on Asian carp eDNA. USGS has optimized methods to increase sensitivity, minimize false negative and false positive results, increase cost-effectiveness, and decrease time between sampling and results. USGS has developed and validated multiple qPCR and LAMP markers for detecting Asian carp. USGS has collected a long-term set of samples in the Upper Mississippi River (UMR) that will be useful for assessing impacts of Asian carp invasion to native species, and analysis of the long term UMR samples has suggested that the invasion front may be moving up to pool 13 and above triggering additional effort to monitor those pools. USGS developed a database to disseminate eDNA data with geographic references.

USGS has developed an eDNA occupancy model and published an R package to use it. USGS has shown that seasonal trends in eDNA detection can be used to detect migration and spawning. USGS has shown that eDNA quantities can give an indication of relative biomass. USGS demonstrated that temperature does not affect eDNA shedding rates but that feeding rates do. USGS demonstrated that eDNA decays exponentially. USGS demonstrated that eDNA can arise from multiple sources such as carcasses, predator feces, or transport vectors and not only by live fish. USGS has developed simple methods for minimally trained individuals to detect Asian carp eDNA rapidly in the field and created a podcast video to demonstrate it. USGS demonstrated that eDNA can be used to assess carbon dioxide (CO_2) winterkill enhancement efficacy under the ice to inform managers if additional treatments may be required before the ice melts. USGS has shown that eDNA can be used to prioritize ichthyoplankton tow sample picking to make that type of monitoring significantly more efficient. USGS has demonstrated that dPCR can be used for eDNA work, but that it is not more sensitive than qPCR. USGS developed high-throughput sequencing methods for analyzing ichthyotow samples and transferred that technology to USFWS.

Proposed Actions for FY 2019:

- Develop LAMP assays specific for each Bighead Carp, Silver Carp, Grass Carp, and Black Carp distinct from the current assay which detects all four but cannot distinguish between them. This will allow testing of waters known to contain one or more species to determine if other species are present.
- Continue eDNA long term sampling on the UMR evaluating potentially more reliable sampling in the winter vs the summer and testing more upper pools where the invasion front may be moving into. This could potentially increase eDNA sensitivity even further, and it allows us to build the long-term data set ahead of the invasion (which is important for assessing impact to native species) and potentially get earlier warnings that may trigger additional response further upstream.
- Complete parentage analysis of Grass Carp eggs collected in the Sandusky River in 2017 using RAD-seq analysis. RAD-seq will give better estimates than the microsatellite analysis already completed and will allow potential inferences about repeat spawners contributing to multiple events. This is critical information to understanding the level of threat that is posed by spawning Grass Carp in Lake Erie tributaries.
- Conduct eDNA analysis of multiple Lake Erie tributaries that are not monitored by routine surveillance to evaluate presence of potential spawning Grass Carp. This will give quick and easy info to help identify additional streams that should be targeted for ichtyotow collection and regular surveillance. Failure to detect Grass Carp reproduction in multiple tributaries could lead to underestimation of the Lake Erie Grass Carp population and drastically inhibit effectiveness of management decisions.
- Maintain eDNA database and build visualization tools. The eDNA database is a useful tool for disseminating eDNA data and for conducting meta-analyses on data from multiple studies. In its current form, it is only useable by individuals with sophisticated database skills, and development of the visualization tools will greatly enhance its usability by a broad range of researchers. Further development will also be done to simplify data uploading and add ability to generate automatic notices for particular types of data.
- Conduct eDNA analysis of ichthyotow wash from Lake Erie and UMR samples to prioritize sample picking and egg/larvae identification for samples more likely to contain Asian carp. Cleaning and identifying these samples is extremely time-consuming, and rapid initial screens by eDNA analysis can greatly increase the efficiency of this process by focusing efforts on samples more likely to contain Asian carp eggs and larvae. This will also facilitate more rapid management response as appropriate.
- Continue development of the eDNA occupancy model to evaluate the use of multiple markers. This will help us understand if multiple marker confirmation is necessary and how using multiple markers influences confidence levels in results.
- Initiate metabarcoding studies of gut samples from wild-caught Black Carp. It is known that Black Carp prey upon bivalves as well as other invertebrates, but the degree at which they prey upon imperiled species is uncertain. Determining gut contents from wild-caught Black Carp will help understand how much of a threat they are to our native bivalves.

- Laboratory studies of the relationship between biomass and eDNA shedding rate in Black Carp will be conducted and analyzed. USGS currently has run studies assessing this relationship in juvenile Black Carp, and USGS proposes to continue this work with sub-adults. This will allow us to investigate the potential utility of using eDNA to measure relative abundance in the field.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Black Carp will also be continued and analyzed.
- Initiate eDNA analysis of habitat usage and effectiveness of a Unified Method fishing effort at Creve Coeur Lake, Missouri. Last year, USGS and partners conducted a large fishing effort to remove Bighead Carp from a lake in Missouri. USGS sampled the lake at over 50 sites multiple times before and after the removal. USGS will be analyzing those results this coming year to see if eDNA concentrations changed over the course of the removal.
- Initiate characterization of field-deployable qPCR technology for rapid assessment of Asian carp presence.
- Complete analysis and publication of estimated relative Silver Carp and Bighead Carp density in Missouri River tributaries with side-scan sonar and traditional capture methods, and simultaneous sampling for eDNA quantification to characterize habitat usage and fish movement.
- Complete validation studies on the use of dPCR as an alternate to qPCR for quantifying eDNA.
- USGS will initiate mesocosm studies of degradation of eDNA naturally shed from Bighead Carp of known biomass in order to assess whether or not degradation rates differ in natural water settings as might be the case with different physical (temperatures) and biological conditions (microbial loads). Differing decay rates will affect the temporal signal of eDNA in the field.

Expected Milestones:

- Development of single species portable eDNA detection kits to enable testing waters for Asian carp species of interest regardless of the known presence of Asian carp species of non-interest.
- Use of eDNA to help inform control technologies. (incrementally each fiscal year)
- Development of molecular monitoring protocols that extend beyond the determination of the absence/presence.
- Transfer technological and methodological advancements to monitoring programs. (incrementally each fiscal year)
- Refined parentage estimates of Grass Carp eggs collected in Sandusky in 2017.
- Development of visualization tools for eDNA database.

Potential Out-year Actions (Subject to Future Appropriations):

- Analyze UMR long-term eDNA samples for native species that may be impacted by Asian carp invasion.
- Sequence Asian carp transcriptomes, identify essential genes, and develop small interfering ribonucleic acids (RNAs) that may be used for RNA interference (RNAi) control.

- Evaluate potential differential degradation across Asian carp mitochondrial genomes to determine if using particular markers in relation to others can inform about eDNA "freshness".
- Evaluate potential inference of genetic material "freshness" by analyzing eDNA.
- Collect samples at USGS stream gage sites and potentially deploy robotic eDNA samplers to evaluate efficacy of supergage eDNA analysis for Asian carp long term monitoring or early warning notification.
- Conduct modeling and develop partnerships to understand potential synthetic biology control measures that may be used to control Asian carp.

What Is Deliverable for this Project:

- Publication of Grass Carp and Black Carp shedding rates.
- Technology transfer of portable eDNA detection kits for detecting specific species of Asian carp rapidly in the field.
- eDNA database visualization tools developed.
- Publications on the use of dPCR versus qPCR for Asian carp eDNA work.
- Assessment of Asian carp populations by multiple methods in the Missouri River.
- Publication of Black Carp diet analysis.
- Estimates of Grass Carp reproducing population sizes in the Sandusky and Maumee Rivers.

Expected Completion Date for Project:

This project involves the development and validation of rapidly evolving new technologies that will continually improve over time for the foreseeable future.

Potential Hurdles:

- Accurate inferences from eDNA data requires analysis of many samples.
- Some of our bioinformatics pipeline processes are still being refined, and delays may occur for high-throughput sequencing projects.
- Full technology transfer of portable eDNA detection kits requires commercialization by private industry partners whose willingness to cooperate can vary.
- Biomass estimates from eDNA quantity can vary in accuracy depending on the situation to which it is applied.
- Molecular control technologies require additional sequence information currently unavailable.

How will the results of this project be disseminated?

- Peer reviewed publications, scientific conference presentations, and workshops.

M-16 Telemetry in the Upper Illinois Waterway

Lead Agency: U.S. Army Corps of Engineers (USACE)

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), Southern Illinois University Carbondale (SIUC), Illinois Department of Natural Resources (DNR)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$200,000	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

USACE has led telemetry efforts in the Chicago Area Waterways (CAWS) since 2010 with a primary objective of assessing the efficacy of Barriers IIA and IIB, and Permanent Barrier I as identified in the Asian Carp Regional Coordinating Committee (ACRCC) Monitoring and Response Plan (MRP). By surgically implanting transmitters into fish species (both Asian carp and surrogate species), we have empirical data to demonstrate the barriers are effective in preventing large fish passage in the upstream direction. Future work will combine the historical acoustic telemetry monitoring with alternative monitoring systems at the barrier site such as hydroacoustics. Additionally, continual refinement of the stationary receiver network will occur which increases efficiency and coverage within the system. Further downstream, the combined receiver array established by USACE and the receiver arrays established by SIUC and USFWS, have been able to monitor long term movement of Asian carp in the entire Illinois Waterway (IWW), including localized movements through lock structures and at the area of the population's leading edge. Future downstream activities have focused on inter-pool movement across the Brandon Road Lock and Dam and finer scale movement detection of Asian carp within the Dresden Island pool.

Summary of Actions to Date: USACE researchers have successfully established an acoustic network of receivers positioned at 32 strategic locations from the Upper IWW into the CAWS. A Vemco Positioning System (VPS) was also established around Barriers IIB and IIA that was capable of providing 2D fish movements in relation to the barriers from 2011 through 2016. Transmitters have been surgically implanted into a total of 607 fishes to date. Mobile tracking and receiver downloads have occurred bi-monthly to ensure up-to-date data is provided to decision makers regarding the efficacy of the barrier system. Interim summary reports of work completed have been prepared annually and included within the MRP annual summary reports.

FY 2018 Actions:

- Winter receiver network was recovered, and full receiver network was deployed.
- Receiver downloads were completed every other month throughout FY 2018 with monthly summaries provided to the Monitoring and Response Workgroup (MRWG) for distribution.
- Participation in the Telemetry Workgroup for MRWG Support.
- Integration of USACE telemetry with USGS online telemetry networking tool.
- 2018 Interim Summary report completed.
- 2019 MRP for Telemetry developed.

Proposed Actions for FY 2019

- Continued monitoring of tagged fishes within the study area.
- Supplemental transmitter surgery implants to maintain transmitter densities in 1st quarter of FY 2019.
- Support of the Unified Fishing Method in the Dresden Island pool.
- Continued range testing and habitat mapping throughout the focus area.
- Real-time receiver monitoring above the Barriers and Brandon Road lock.
- Continued integration of USACE telemetry with USGS online telemetry networking tool.
- Work with USGS to refine receiver network in Dresden Island to reduce coverage while maintaining support to MRWG monitoring and modeling efforts.
- Commence surrogate comparison study in the Upper Illinois Waterway in cooperation with SIUC (see write up from Illinois DNR or SIUC for further details).
- Establish additional baseline fish passage rates at locks and dams in the upper Illinois River by using site fidelity to increase motivation for movement upstream and downstream.

Potential Out-year Actions (Subject to Future Appropriations):

- Continued monitoring of tagged fishes within the study area.
- Supplemental transmitter surgery implants to maintain transmitter densities.
- Refinement of telemetered and hydroacoustic monitoring at the dispersal barriers.
- Supplemental VPS established around activated Permanent Barrier I.
- Continued range testing and habitat mapping throughout the focus area.
- Continue surrogate comparison study in the Upper IWW.
- Complete the surrogate comparison study in cooperation with SIUC.

Timeline for Major Actions: The receiver network is generally deployed by early 3rd Quarter of each fiscal year and stripped to a bare-bones essential network for winter by late 1st Quarter each fiscal year. An interim summary report for the previous field season and projected plan for the upcoming field season is prepared in the 1st to 2nd Quarter each fiscal year. Monitoring specific to Permanent Barrier I will be implemented concurrent to its commissioning.

Expected Milestones:

FY 2019 Q1:

- Winter breakdown of 2018 season and final data collection.

FY 2019 Q1:

- Supplemental surgery implants of transmitters.

FY 2019 Q2:

- Annual Interim Summary Report to the MRWG.

FY 2019 Q3:

- Spring set up of 2019 season and winter downloads.

What Is Deliverable for this Project: The following deliverables can be expected each fiscal year for this continuing monitoring project:

- Real-time updates and alarms for tagged fish passage at the Electric Dispersal Barrier System (EDBS) and the Brandon Road Lock and Dam.
- Annual Interim Summary Reports.
- Monthly Summary Reports.
- Tracking reports in support of harvest efforts and special monitoring events as needed.

Expected Completion Date for Project: TBD

Potential Hurdles:

- Weather related delays to field work implementation.
- Equipment long-lead delays of custom transmitters.
- Potential technical difficulties with equipment or network arrays.
- Vandalism, theft, barge strike damage, or siltation of receivers.

How will the results of this project be disseminated?

- Public (Asiancarp.us), technical audience(s), media, etc.

M-17 Telemetry Support for the Asian Carp Population Model (SEACarP)

Lead Agency: U.S. Fish and Wildlife Service (USFWS) Carterville Fish and Wildlife Conservation Office (FWCO)

Agency Collaboration: Southern Illinois University (SIU), U.S. Army Corps of Engineers (USACE)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$140,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: In addition to the USFWS juvenile Asian carp habitat project, which is focused on tagging fish 300mm and below, staff will also tag all Asian carp collected that are 300-500mm. The Vemco V-5 tags currently used for the small fish telemetry project use 180 kHz receivers which is different than the 69 kHz array which is currently dispersed throughout the Illinois River. Work conducted in support of the SEACarP model will use Vemco tags on the 69 kHz frequency. This will give biologists a better understanding of more large-scale movement of these smaller individuals that are assumed to move at the same rates as larger, sexually mature individuals within the population model. Please see the SEACarP Model template for more information.

In 2018, staff tagged 154 Asian carp throughout the Peoria pool as was agreed upon by the Monitoring and Response Workgroup (MRWG) Telemetry Workgroup. Of the 154 fish tagged, 8 were smaller than 350mm and 146 were greater than 350mm but smaller than 500mm. Additional smaller fish were tagged as part of the USFWS Small Fish Habitat Project. All fish were also fin clipped and the sample will be sent to Western Illinois University to determine if fish were hybrids. All fish were marked with external loop tags to show that they have been tagged. All tag numbers and individual fish information were distributed to the telemetry working group and will be uploaded into Fish Tracks.

Proposed Actions for FY 2019: USFWS crews will tag an additional 150 Asian carp in and around the Peoria and Starved Rock pools. This large-scale tagging of adult and juvenile Asian carp will provide more information for the model to better estimate current levels of exploitation and to bolster estimates of large-scale pool to pool movement. Fish will be tracked using the current acoustic array within the Illinois Waterway. Additional receivers will be placed in areas with reduced coverage and the MRWG Telemetry Working Group will be consulted prior to deployment.

Expected Milestones:

- January-December: Receivers will be downloaded each month.
- February: Additional equipment will be purchased.
- July-September: Fish tagging will begin and continue until all tags are used.

- November: Data analysis.
- December: Report generation.

Potential Out-year Actions (Subject to Future Appropriations)**:** This project will continue in future years, subject to reevaluation to determine if further tagging is needed.

What Is Deliverable for this Project:

- This project will provide information as to large-scale pool to pool movement of Asian carp within the Illinois River. This data will be used to bolster the SEACarP Model and be used to direct commercial fishing in the future.

Expected Completion Date for Project: This project will be reevaluated to determine if tagging is needed in 2021.

Potential Hurdles:

- Contracting delays, weather delays, staffing, equipment.

How will the results of this project be disseminated?

- Public and technical audiences.

M-18 USFWS Illinois River Hydroacoustics

Lead Agency: U.S. Fish and Wildlife Service (USFWS) Carterville Fish and Wildlife Conservation Office (FWCO)

Agency Collaboration: Southern Illinois University (SIU), U.S. Army Corps of Engineers (USACE)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$135,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Since 2012, USFWS has utilized a wide range of technologies to collect data under this comprehensive monitoring, assessment, and barrier efficacy program. Split beam sonar, side scan sonar, and multi beam sonar imaging systems have been used extensively to monitor fish behavior and abundance near the electric dispersal barrier system (EDBS) over varying temporal and spatial scales. Initial work conducted during the 2012 and 2013 field seasons showed that fish abundance near the barrier varies throughout the year (Parker et al. 2015). During summer, large schools of small fish congregated directly below the operational barrier where fish were observed to demonstrate a "challenging" behavior. In some cases, schools of small fish penetrated the entirety of Barrier IIB which has the greatest electrical field strength (Parker and Finney 2013).

Since 2015, hydroacoustic surveys have been completed on a bi-weekly to monthly basis to gain greater temporal resolution on fish community dynamics. An additional component to this work was furthering the understanding of complexities introduced at the EDBS concurrent with passage of commercial barge traffic. Trials conducted during 2015 demonstrated that freely swimming small fish could be entrained and transported over the entire EDBS in junction gaps between barges (Davis et al. 2016). Additional trials conducted during 2016 demonstrated that small wild fish could also be transported upstream across the EDBS in return current flows associated with downstream barge transits at the EDBS (USFWS 2016). Standard operating procedures were updated and put into place at the end of 2017. During 2018, staff conducted bi-weekly scans at the barrier system and notified USACE and the Monitoring and Response Workgroup (MRWG) as to any concerns based on the scan results.

Proposed Actions for FY 2019: Side-looking split beam hydroacoustic and side scan sonar surveys will be conducted above and below the Chicago Sanitary and Ship Canal (CSSC) EDBS to assess fish abundance, density, and distribution patterns near the EDBS on a fine temporal scale. Surveys at the EDBS will take place on a bi-weekly (barrier surveys) to bi-monthly (pool surveys) beginning in January 2019. 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. The two split-beam transducers are mounted in parallel on the starboard side of the research vessel 0.15 m below the water surface on Biosonics® dual axis automatic rotators. The side scan unit is

attached to a davit and is lowered less than a meter into the water. This approach, using both systems, will allow a large portion of the water column to be ensonified by the survey vessel during each survey. These surveys will provide information on size frequency distributions of fish targets as well as spatial orientation information. Results of biweekly surveys will be communicated to partners as changes in fish abundance or behavioral status are detected. In addition, several scans will be conducted in conjunction with Southern Illinois University (SIU) throughout the summer to ensure that both agencies are collecting data in the proper manner and comparable.

Expected Milestones:

- Mobile hydroacoustic fish surveys at the EDBS: Biweekly- January 2019-December 2019.
- Mobile hydroacoustic fish surveys; Dresden Island, Brandon Road and Lockport pools: Bi-monthly May 2019-September 2019.
- Additional surveys as needed or requested based on distribution changes or barrier shutdown or maintenance.

Potential Out-year Actions (Subject to Future Appropriations)**:** Expected to continue.

What Is Deliverable for this Project:

- Biweekly report on fish density and spatial distribution near the EDBS to the Asian Carp Regional Coordinating Committee (ACRCC).
- Annual reports and presentations outlining significant findings of all program study areas.
- Rapid communications to the ACRCC on moderate or significant changes in fish community species composition or fish behavioral observations at the EDBS.

Expected Completion Date for Project: Expected to continue.

Potential Hurdles:

- Weather, barge traffic, equipment.

How will the results of this project be disseminated?

- Public and technical audience.

M-19 USGS Telemetry Project

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: Illinois Department of Natural Resources (DNR), Southern Illinois University (SIU), U.S. Army Corps of Engineers (USACE), and U.S. Fish and Wildlife Service (USFWS)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$227,250	$449,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Asian carp life history is complex with each life stage from egg through adult, and even male and female adults, potentially exhibiting season- and environmental condition-dependent habitat use and movement patterns. These variable patterns make targeting Asian carp for removal and containment challenging and costly. Acoustic telemetry and modeling to understand these complex lateral and longitudinal movements and distribution by Asian carp can be useful for (1) informing removal efforts, (2) planning contingency actions for threshold movements (e.g., past barriers), and (3) parameterizing population models for scenario planning and adaptive management.

Telemetry projects in support of removal and contingency planning: USGS will work with partners via the Monitoring and Response Workgroup (MRWG) Telemetry Workgroup to inform removal and contingency actions for Asian carp by: (1) conducting telemetry, data management, visualization and analyses to understand Asian carp distribution and movements in strategic areas to inform Illinois DNR-directed contract and agency fishing; (2) deploying real-time acoustic receivers at strategic locations, and serving that data via the internet, text messaging, and email to inform contingency planning and removal; and, (3) completing testing of new technologies (i.e., satellite tags) for real-time tracking of Asian carp. Specific products include telemetry database and visualization tools; Asian carp distribution models and visualization tools; real-time acoustic receiver network with remote data serving and alert options; assessment of existing and new telemetry and catch data to determine strategic locations to place real-time receivers to inform removal; assessment of Asian carp movement in response to the Unified Method in Dresden Island Pool; and a final assessment of satellite tags and recommendations regarding their use for tracking Asian carp in the upper Illinois River to inform removal.

Telemetry projects in support of Spatially Explicit Asian Carp Population (SEACarP) Modeling: USGS will also work with Telemetry Workgroup and other MRWG work groups in support of the SEACarP model for scenario planning and adaptive management of Asian carp by analyzing the telemetry data to (1) determine optimal receiver placement and tagging schemes and (2) model movement and survival probabilities for parameterizing SEACarP. Specific products include

geospatial models/tools to inform receiver placement and tagging schemes, and a Bayesian multi-state model for parameterizing the SEACarP model.

Summary of Actions to Date:

Telemetry in Support of Removal and Contingency Planning: Initial development of a central data repository of query-able, downloadable telemetry data that facilitates simple visualizations and sharing of data among partners (accessibility is defined by specific data sharing agreements) is complete (FishTracks) and partner accounts and data uploads were initiated (https://umesc-gisdb03.er.usgs.gov/ Fishtracks/Account/Register). Field work is complete, and analyses were initiated for modeling habitat, movement, and distribution of Asian carp in the Starved Rock pool to inform removal and further understand dam passage dynamics. USGS lead planning that resulted in deployment of 12 additional receivers (by, SIU, U.S. Army Corps of Engineers [USACE] and USGS) and tagging of > than 30 Asian carp (by USACE and U.S. Fish and Wildlife Service [USFWS]) in the Dresden Island pool to facilitate assessment of the 2018 Dresden Island Unified Method. Analysis of hydrology and fish passage at upper Illinois River Dams was completed, presented to partners (MRWG quarterly), data has been made public, and a manuscript is being developed. The real-time receiver network in the upper Illinois River waterway was modified, and additional receivers added, to facilitate removal (receivers placed in Hanson Material pits in Marseilles pool) and contingency planning (receiver placed below electrical barrier). Archiving, serving and incorporating real time data into an email/text messaging alert system and monthly summaries was continued to inform contingency planning and removal efforts. Satellite tag testing continued, with the release of 3 additional Asian carp with near-final-design satellite tags in Dresden Island pool in spring of 2018. Manual tracking of Asian carp already tagged with standard acoustic transmitters was initiated for comparison to satellite-tagged fish and to assess movements and distribution in upper Illinois River pools. Real time data from these satellite tags, along with weekly manual tracking data, was made available to agency personnel directing removal efforts.

Telemetry in Support of SEACarP Modeling: A geospatial analysis tool to assess receiver gaps and redundancies for detecting Asian carp in the Illinois River/Des Plaines longitudinal array for multi-state modeling in support of SEACarP was developed and tested on a subset of the existing telemetry data. A quantitative ecologist was hired on October 1st to develop a Bayesian, multi-state model to estimate movement and survival probabilities of Asian carp from the existing telemetry data.

Proposed Actions for FY 2019:

Telemetry in Support of Removal and Contingency Planning:

- Incorporate new telemetry and receiver data collected by partner agencies to the FishTracks Telemetry Database; add database functionality including coding to summarize movement histories applicable to the multi-state modeling and functionality based on partner feedback; further automate quality assurance and quality control (QA/QC) and data upload functionalities for new data submissions; hold workshop to demonstrate database functionality to full multi-basin telemetry partnership; finalize data sharing agreements or memorandums of understanding between partners.

- Complete modeling habitat, movement, and distribution of Asian carp in the Starved Rock pool to inform removal and further assess dam passage dynamics at upper Illinois River dams.
- Analyze the telemetry data collected by the Telemetry Workgroup in Dresden Island pool to help assess Asian carp behavior during the 2018 Dresden Island Unified Method.
- Complete and submit a manuscript, including implications for managing Asian carp, from the analysis of hydrology and fish passage at upper Illinois River dams.
- Modify and add receivers to the real-time receiver network to facilitate removal and contingency planning for Asian carp; continue to archive, serve and incorporate data from the real-time network into an email/text messaging alert system, monthly MRWG summaries, and the FishTracks database for informing contingency planning and removal efforts; in coordination with the Illinois DNR and Telemetry workgroup place additional receivers and conduct analyses with telemetry and catch data to optimize the location of real-time receivers to inform removal; conduct annual range testing and maintenance and repair on the real-time receiver network.
- Conduct final satellite tag testing by releasing 25 Asian carp with final-design tags in Dresden Island Pool in spring of 2018; implant half of these fish with standard acoustic transmitters (dual-tagged); continue manual tracking of Asian carp already tagged with standard acoustic transmitters and dual-tagged fish for comparison of information from each source (satellite-tagged vs dual tagged vs acoustic tagged only fish) to determine utility of satellite tags; real time data from these satellite tags, along with manual tracking data, will be made available to agency personnel directing removal efforts.

Telemetry in Support of SEACarP Modeling:

- Extend the implementation of telemetry receiver optimization analysis from the subset of data used for development to the entire telemetry data set; add receiver summarization functionality to FishTracks Telemetry Database; incorporate a decision support tool to generate a viewshed layer(s) for placement/removal of receivers in the longitudinal receiver network used for multi-state modeling in support of the SEACarP model.
- Develop a Bayesian, multi-state model to estimate movement and survival probabilities of Asian carp from the existing telemetry data.

Expected Milestones:

Telemetry in Support of Removal and Contingency Planning:

- Incorporate new telemetry and receiver data collected by partner agencies in 2018 to the FishTracks Telemetry Database (complete by FY 2019-Q1); finalize data sharing agreements or memorandums of understanding between partners (complete by FY 2019-Q1); further automate QA/QC and data upload functionalities for new data submissions (complete by FY 2019-Q2); hold workshop to demonstrate database functionality to full multi-basin telemetry partnership (complete by FY 2019-Q2); add database functionality including coding to summarize movement histories applicable to the multi-state modeling (complete by FY

2019-Q3), and add database functionality based on partner feedback in 2019 (initiate by FY 2019-Q4).

- Complete modeling and initial reporting (thesis) of habitat, movement, and distribution of Asian carp in the Starved Rock Pool to inform removal (complete by FY 2019-Q2); submit manuscript on this topic to peer-reviewed journal (complete by FY 2019-Q3); complete initial assessment of dam passage dynamics at Marseilles Lock and Dam using 2018 telemetry data (complete by FY 2019-Q3).
- Assemble (complete by FY 2019-Q1), analyze (complete by FY 2019-Q3) and preliminarily report on (FY 2019-Q4) the telemetry data collected by the Telemetry Workgroup in Dresden Island pool to help assess Asian carp behavior during the 2018 Dresden Island Unified Method.
- Complete and submit a manuscript, including implications for managing Asian carp, from the analysis of hydrology and fish passage at upper Illinois River dams (complete by FY 2019-Q1).
- Continue to archive, serve and incorporate data from the real-time network into an email/text messaging alert system, monthly MRWG summaries, and the FishTracks database for informing contingency planning and removal efforts (complete by FY 2019-Q4); in coordination with the Illinois DNR and Telemetry workgroup place additional receivers (complete by FY 2019-Q2) and conduct analyses (complete by FY 2019-Q3) with new and existing telemetry and catch data to optimize the location of real-time receivers to inform removal; conduct annual range testing and maintenance and repair on the real-time receiver network (complete by FY 2019-Q4); modify and add receivers to the real-time receiver network to facilitate removal and contingency planning for Asian carp (complete by FY 2019-Q4).
- Conduct final satellite tag testing by releasing 25 Asian carp with final-design tags in Dresden Island Pool in spring of 2018 and implant half of these fish with standard acoustic transmitters (dual-tagged) (complete by FY 2019-Q3); continue manual tracking of Asian carp already tagged with standard acoustic transmitters and dual-tagged fish for comparison of information from each source (satellite-tagged vs dual tagged vs acoustic tagged only fish) to determine utility of satellite tags (complete by FY 2019-Q4); real time data from these satellite tags, along with manual tracking data, will be made available to agency personnel directing removal efforts (complete by FY 2019-Q3 and Q4).

Telemetry in Support of SEACarP Modeling:

- Extend the implementation of telemetry receiver optimization analysis from the subset of data used for development to the entire telemetry data set (complete by FY 2019-Q3); add receiver summarization functionality to FishTracks Telemetry Database (complete by FY 2019-Q4).

Potential Out-year Actions (Subject to Future Appropriations)**:**

Telemetry in Support of Removal and Contingency Planning:

- Continued maintenance of the FishTracks Telemetry Database; incorporate new telemetry data and expand database functionality as requested by partners.
- Incorporate information from habitat, movement, and distribution of Asian carp in the Starved Rock Pool into decision support tool (removal dashboard); publish and present findings from dam passage analysis at Marseilles Lock and Dam using 2018 telemetry data in/at appropriate management and science venues.
- Publish findings from the telemetry data collected by the Telemetry Workgroup in Dresden Island pool to help assess Asian carp behavior during future Dresden Island Unified Method applications.
- Continue to archive, serve and incorporate data from the real-time network into an email/text messaging alert system, monthly MRWG summaries, and the FishTracks database for informing contingency planning and removal efforts; conduct annual range testing, maintenance and repair on the real-time receiver network; modify and add receivers to the real-time receiver network to facilitate removal and contingency planning for Asian carp as decided by MRWG.
- Publish findings from satellite tag testing on Asian carp in/at appropriate management and science venues.
- Apply satellite tags to Asian carp in strategic areas as determined by MRWG to assist in removal efforts.

Telemetry in Support of SEACarP Modeling*:*

- Complete and use viewshed decision support tool to inform placement/removal of receivers in the longitudinal receiver network used for multi-state modeling in support of the SEACarP model.
- Complete, publish and use the Bayesian, multi-state model to estimate movement and survival probabilities of Asian carp from the existing and future telemetry data.

What Is Deliverable for this Project: Reports, publications, presentations, models, data, databases. See milestones for specifics.

Expected Completion Date for Project: The end of FY 2019 or beginning of FY 2020 for research/modeling projects. Other management support projects (database management, and real-time telemetry network and reporting system) will continue past development indefinitely at the discretion of MRWG based on usefulness. See milestones and outyear actions for specifics.

Potential Hurdles: Delays in funding, purchasing and hiring.

How will the results of this project be disseminated? Workshops, presentation/webinars, publications, online applications. See milestones for specifics.

T-1 USACE Acoustic Deterrents for Asian Carp

Lead Agency: U.S. Army Corps of Engineers (USACE)

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), Iowa Department of Natural Resources (DNR), Illinois DNR, Indiana DNR, Kentucky Department of Fish and Wildlife (DFW), Tennessee Wildlife Resources Agency (WRA), University of Minnesota (Twin Cities & Duluth), and Purdue University (Perdue)

FY 2019 Funding Table (in alphabetical order):

Project	Agency Funding Expected	Asian Carp GLRI Funding Requested
Barkley Lock and Dam of BAFF	$0	$542,237
Lock and Dam #19 of ADS	$0	$440,387
Research & Development of ADS	$0	$523,556
Total	$0	**$1,506,180**

Project	Chicago (LRC)	Nashville (LRN)	Rock Island (MVR)	ERDC**
Barkley BAFF	$29,960	$461,091	$0	$51,186
L&D #19	$29,960	$0	$86,870	$323,557
R&D of ADS	$29,960	$0	$0	$493,596

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

**ERDC - Engineering Research and Development Center

Project Explanation

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of Bighead Carp, (*Hypophthalmichthys nobilis*), and Silver Carp (*H. molitrix*), while allowing passage of native fish and shipping to continue. Acoustic deterrent systems (ADS) have demonstrated effectiveness in laboratory and pond settings. Building off these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River (OHR) and Upper Mississippi River (UMR) 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 large-scale deployments, underwater sound systems 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.

In addition to field-testing acoustic deterrent systems, 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 template outlines the goal and objective of three separate sub-projects:

- Deployment and evaluation of a bio-acoustic fish fence (BAFF) (by Fish Guidance Systems) system at Barkley Lock and Dam, led by USFWS, and includes USGS and USACE participation costs.
- Development, implementation, assessment of an ADS at Lock and Dam 19 (Mississippi River) or surrogate location, is led by USGS and includes USFWS and USACE costs for this project for FY 2019, include all equipment purchases, engineering, design, operation, and maintenance for the first year.
- Ongoing research and development related to acoustic deterrents 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.

Summary of Actions to Date:

Prior to 2018, significant lab and pond testing was completed to assess the potential of underwater sounds to deter Bighead and Silver Carp. Pure tones (a suite of five specific tones testing independently) were found less effective than the use of a broadband 100hp boat motor acoustic stimulus. Further testing using the 100-horsepower boat motor was completed at Morris, Illinois and in ponds at USGS UMESC. Over the past year, additional actions from USGS include:

- Finish auditory evoked potentials (AEPs) and follow-up behavioral tests on Silver Carp and Bighead carp, and AEPs for Black Carp and Grass Carp to determine efficacy of sound as potential deterrents for these fishes (USGS.)
- Supported screening and selection a new set of acoustic signals and tested those at USGS Columbia Environmental Research Center (CERC) ponds with Silver Carp (USGS and ERDC.)
- Participated in multi-agency workgroup to assess implementation of a BAFF system at Barkley Lock.
- Study Plan developed for implementation of an ADS on the Wabash River. Equipment set-up and fish tagging initialized (USGS, ERDC, Purdue).
- Develop multi-agency science team for large-scale deployments in the Mississippi River basin.

Proposed Actions for FY 2019:
Below are USACE activities by sub-project.

Barkley Lock and Dam Bio-Acoustic Fish Fence (BAFF) Deployment (LEAD: USFWS)

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployment of the BAFF at Barkley Lock and Dam (Cumberland River, Kentucky).
- Completing (continuation) environmental assessment and compliance.
- Develop a science and evaluation BAFF study plan, disseminate to partner agencies and stakeholders.
- Coordination of navigation operations and support of the maintenance of the installed equipment.
- Overview of engineering design and installment.
- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
- Support multi-agency team (USFWS et al.) as needed.

Lock and Dam 19 (or alternative location) for ADS Deployment (LEAD: USGS)

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployments at Lock and Dam 19 (Mississippi River, Iowa) (multi-agency).
    - Develop 3-year study plan including agency roles, timelines, and deliverables.
    - Permitting inclusive of 408 and interagency coordination.
    - Communication.
    - ADS efficacy, fish passage.
- Collect or provide data relevant to ADS deployment:
    - Ambient acoustic monitoring.
    - Sound propagation model.
    - Lock operations by season and daily.
- Develop acoustic array design.
- Provide engineering review of construction design.

Research and Development (lab/field testing, or applicable to multiple locations; LEAD: USACE)

- Develop new engineered sounds, specifically designed to deter Asian carp and limit impacts on native fishes.
- In-pond testing of new engineered sounds on motivated Asian carp and native species.
- In-river testing of new engineered sounds on wild Asian carp and native species.
- Development of underwater acoustic deterrent systems for various deployment scenarios.
- Support multi-agency team (USGS et al.) as needed.

Expected Milestones:

Potential Out-year Actions (Subject to Future Appropriations)**:**

Barkley Lock and Dam BAFF Deployment (LEAD: USFWS)

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployment of the BAFF at Barkley Lock and Dam (Cumberland River, Kentucky).
- Support USFWS and collaborating agencies with analysis of fish movement and behavior.
- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployment of the BAFF at Barkley Lock and Dam (Cumberland River, Kentucky).
- Completing (continuation) environmental assessment and compliance.
- Develop a science and evaluation BAFF study plan, disseminate to partner agencies and stakeholders.
- Coordination of navigation operations and support of the maintenance of the installed equipment.
- Overview of engineering design and installment.
- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
- Support multi-agency team (USFWS *et al.*) as needed.
- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployment of the BAFF at Barkley Lock and Dam (Cumberland River, Kentucky).
- Coordination of navigation operations and support of the maintenance of the installed equipment.
- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
- Support multi-agency team (USFWS *et al.*) as needed.
- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployment of the BAFF at Barkley Lock and Dam (Cumberland River, Kentucky).
- Coordination of navigation operations and support of the maintenance of the installed equipment.
- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
- Support multi-agency team (USFWS *et al.*) as needed.
- Demobilization of BAFF and project closeout.

Lock and Dam 19 (or alternative location) for ADS Deployment (LEAD: USGS)

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployments at Lock and Dam 19 (Mississippi River, Iowa) (multi-agency).
- Overview of engineering design and installment.

- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
    - Analyses of ADS operational changes.
- Support multi-agency team (USGS et al.) as needed.

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployments at Lock and Dam 19 (Mississippi River, Iowa) (multi-agency).
- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
    - Analyses of ADS operational changes.
- Support multi-agency team (USGS et al.) as needed.

Research and Development (lab/field testing, or applicable to multiple locations; LEAD: USACE)

- Behavioral tests of new acoustic stimuli on Grass Carp and Black Carp.
- Assist ERDC, as needed, with development and testing of newly engineered sounds.
    - In-river testing of new engineered sounds on wild fish.
    - Finish analyses of pond work and develop publications/report.
- Initiate 2-D predictive movement model of fish in response to sound using large-scale field test location (Brandon Road Lock and Dam, Lock and Dam 19, etc.) as case study for use at other deployment sites (with ERDC).
- Development of long-term remote performance monitoring of fish and acoustics to support federal and state agencies.
- Initiate additional deployments at targeted locations as appropriate and coordinated among the interagency planning team.

- Develop new engineered sounds, specifically designed to deter AC and limit impacts on native fishes.
- In-pond testing of new engineered sounds on motivated fish.
- In-river testing of new engineered sounds on wild fish.
- Support multi-agency team (USGS et al.) as needed.

- Behavioral tests of acoustic stimuli on Grass Carp and Black Carp.
- Initiate 2-D predictive movement model of fish in response to sound using large scale field test locations (Brandon Road Lock and Dam, Lock and Dam 19) as case study for use at other deployment sites.
- Support multi-agency team (USGS et al.) as needed.

What Is Deliverable for this Project:

- Study and Project Plan for installing an ADS at Lock and Dam 19 (or surrogate location).
- Full deployment and evaluation of an ADS at Lock and Dam 19.
- Peer reviewed publication or report on fish movement and passage at sites where acoustic deterrents are deployed.
- Peer reviewed publication or report on additional testing of acoustic signal on Asian carp and native fish in a field setting.

Expected Completion Date for Project: Completion of large-scale deployments is estimated for 2023.

Potential Hurdles: Multi-agency communication, contracts for large-scale deployments, permitting timelines.

How will the results of this project be disseminated?

- Peer-reviewed reports and/or publications.
- Public Asian Carp Regional Coordinating Committee announcements and web articles as necessary.
- Webinars to partners.

T-2 USFWS Acoustic Deterrents for Asian Carp

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

Agency Collaboration: U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (USACE), Iowa Department of Natural Resources (DNR), Illinois DNR, Kentucky Department of Fish and Wildlife (DFW), University of Minnesota (UMn)

FY 2019 Funding Table:

Sub-project	Agency Funding	Asian Carp GLRI Funding Requested
Barkley Lock and Dam BAFF	$800,000	$1,275,000
Lock and Dam #19 (or Alt. Loc.) ADS	$0	$75,000
Research & Development of ADS	$0	$0
Total	**$800,000**	**$1,350,000**

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: USFWS continues to work closely with USGS and USACE to further understand how underwater sound can be successfully applied in the field as a deterrent for Asian carp. In FY 2018, a contract was awarded to Fish Guidance Systems, Ltd. (FGS) to design, build, install and operate a bio-acoustic fish fence (BAFF) at the lock approach of Barkley Lock on the Cumberland River in Kentucky. The BAFF system will be evaluated beginning in FY 2019, and state and federal agencies, along with UMn, have formed a Research Team to develop a draft Study Plan Design. Extensive collaboration with the USACE Nashville District is ongoing throughout the design, install, and operational phases of the project.

Installation of the Barkley acoustic deterrent system, slated for Feb-April 2019, will require additional support in FY 2019, as well as ongoing operational costs of running the system, and the evaluation of the technology using a combination of monitoring tools and approaches. Coordination efforts initiated in FY 2018 in the Upper Mississippi River (UMR) for acoustic deterrent system testing will continue and will also involve assisting the a UMR research group with acquiring/providing baseline data on native species and Asian carp to inform the evaluation of the Acoustic Deterrent System (ADS) at that location and the study design.

Proposed Actions for FY 2019:

Barkley BAFF Deployment Project:

- Continue to lead coordination among multi-agency science and evaluation team for large-scale experimental deployment of a BAFF at Barkley Dam (Cumberland River, Kentucky).
- Implement study design for Barkley BAFF evaluation in coordination with other agency partners applying a multi-layer approach using hydroacoustics, telemetry and sonar

technologies to track fish passage at the site and associated fish behaviors at the BAFF (Carterville, La Crosse FWCOs). The acquisition of equipment (HTI tags (200-300 fish), array, and receivers) and installation will be supported by this template, as well as data analyses and coordination among agencies throughout the evaluation.
- Support of ambient sound measurements to provide baseline model data.
- Continue to support continuing lease costs (Operating Year 1) routine maintenance, and operational needs for the BAFF system, including compressor, power and utility costs.

UMR/Lock and Dam 19 (*proposed*) ADS Deployment Project:

- Continue coordination among the multi-agency science and evaluation team to determine feasibility for large-scale experimental deployments at Lock and Dam19.
    - Coordinate with other state, federal agencies to develop study plan including agency roles, timelines, and deliverables.
- Acquire additional baseline fish population data, ARIS, native fish passage, or other determined baseline data needs (La Crosse FWCO).
- Contribute to the completion of an assessment/monitoring plan and help to develop long-term equipment maintenance, monitoring, and communication plan.

Expected Milestones:
- Continued coordination ongoing among multi-agency teams for Barkley and UMR field tests.
- October 2018: Initiate IAA with USACE and USGS for partnership coordination on acoustic testing.
- November 2018- March 2019: Finalize study design and purchase monitoring equipment (Barkley).
- January- April 2019: Barkley BAFF System Installation.
- February/March 2019: Support of baseline sound measurements to provide baseline model data.
- March/April 2019: Initiate on-the-water activities for Barkley BAFF evaluation.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Facilitate federal-state partner coordination for acoustic deterrent system planning and deployment at Upper Mississippi River Lock and Dam 19.
- Evaluate contractual agreement for continued support of OP Year 2 and/or equipment purchase - Barkley.
- Monitor and evaluate how large field-deployed acoustic deterrent systems function in areas that contain Asian carp present in high numbers.
- Monitor and evaluate the installed arrays for potential impacts to native fishes.
- Analyze project data from Barkley and utilize data to inform Spatially Explicit Asian Carp Population (SEACarP) model deterrent/harvest optimization.
- Initiate additional deployments at targeted locations as appropriate and coordinated among the interagency planning team.

What Is Deliverable for this Project: Proof-of-concept field test of a particular acoustic deterrent technology (BAFF); performance information of such system at a lock where Asian carp are established. Research outcome will be significant to continued acoustic testing.

Expected Completion Date for Project: FY 2022

Potential Hurdles:

- Technical complexity, equipment integrity and performance, and locational challenges (lock environment) that will constrain access for surveillance and maintenance.
- Discharge ports along river wall of lock will be evaluated for fish passage year 1 and may require additional acoustic deterrent equipment for testing.

How will the results of this project be disseminated?

- Public and stakeholder meetings, media, congressional communication coordinated via federal and state channels. Kentucky DFW is primary local dissemination lead.

T-3 USGS Acoustic Deterrents for Asian Carp

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: U.S. Geological Survey **(**USGS), U.S. Fish and Wildlife Service (USFWS)**,** U.S. Army Corps of Engineers (USACE); including Districts of Chicago, Nashville, Rock Island, and the US Army Engineer Research and Development Center (EDRC), Iowa Department of Natural Resources (DNR), Illinois DNR, Indiana DNR, Kentucky Department of Fish and Wildlife (DFW), Tennessee Wildlife Resources Agency (WRA), Purdue University (Perdue), University of Minnesota-Duluth (UMn-Duluth), University of Minnesota (UMn)

FY 2019 Funding Table:

Project	Agency Funding Expected	Asian Carp GLRI Funding Requested
Barkley Lock and Dam of BAFF	$0	$78,000
Lock and Dam #19 (or Alt. Loc.) of ADS	$150,000	$1,107,000
Research & Development of ADS	$150,000	$915,000
Total	**$300,000**	**$2,100,000**

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of Bighead Carp, (*Hypophthalmichthys nobilis*), and Silver Carp, (*H. molitrix*), while allowing passage of native fish and shipping to continue. Acoustic deterrents have demonstrated effectiveness in laboratory and pond settings. Building off these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River (OHR) and Upper Mississippi River (UMR) 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.

In addition to field-testing acoustic deterrent systems, research efforts in the lab will continue to refine and optimize sound frequencies, sound pressure levels (SPLs), 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.). This template outlines the goal and objective of three separate sub-projects:

- Deployment and evaluation of a bio-acoustic fish fence (BAFF) system at Barkley Lock and Dam, led by USFWS, and includes USGS participation costs.
- Development, implementation, assessment of an Acoustic Deterrent System (ADS) at Lock and Dam 19 (Mississippi River) or surrogate location, is a sub-project led by USGS includes personnel costs and projected USGS costs for this project for FY 2019 include all equipment purchases, engineering, design, operation, and maintenance for the first year.
- Ongoing Research and Development related to acoustic deterrents This sub-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.

Summary of Actions to Date:

Prior to 2018, significant lab and pond testing was completed to assess the potential of underwater sounds to deter Bighead and Silver Carp. Pure tones (a suite of five specific tones testing independently) were found less effective than the use of a broadband 100hp boat motor acoustic stimulus. Further testing using the 100-horsepower boat motor was completed at Morris, Illinois and in ponds at USGS UMESC. Over the past year, additional actions from USGS include:

- Finish auditory evoked potentials (AEPs) and follow-up behavioral tests on Silver Carp and Bighead carp, and AEPs for Black Carp and Grass Carp to determine efficacy of sound as potential deterrents for these fishes (USGS).
- Supported screening and selection a new set of acoustic signals and tested those at USGS Columbia Environmental Research Center (CERC) ponds with Silver Carp (USGS and ERDC).
- Participated in multi-agency workgroup to assess implementation of a BAFF system at Barkley Lock.
- Study Plan developed for implementation of an ADS on the Wabash River. Equipment set-up and fish tagging initialized (USGS, ERDC, Purdue).
- Develop multi-agency science team for large-scale deployments in the Mississippi River basin.

Proposed Actions for FY 2019:
Please refer to Cover Template for full project task description; below are USGS activities by sub-project.

<u>Barkley Lock and Dam BAFF Deployment (LEAD: USFWS):</u>

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployments at Barkley Dam (Cumberland River, Kentucky).
    - Participate in the science and evaluation team.
    - Develop and distribute science team study plan.
    - Conduct ARIS camera surveys (if deemed useful).
    - Assist in writing final report or peer-reviewed publication.

Lock and Dam 19 (or alternative location) for ADS Deployment (LEAD: USGS):

- Lead multi-agency effort to deploy an acoustic deterrent system at Lock and Dam 19.
    - Hold biweekly multi-agency coordination calls.
    - Lead contracting for speaker deployment, construction, or permitting (with representatives from the USACE).
    - Develop 3-year Science Study Plan (max 3 years) that includes agency roles, timelines, and deliverables.
        - 408 Permitting (USGS with USACE)
        - Communication Plan (all agencies)
        - ADS Efficacy (fish passage and native fish impacts)
        - Equipment operation and maintenance (O&M) and monitoring
- Collect or provide data relevant to ADS deployment (including, but not limited to Bathymetry, discharge/flow, or assistance to ERDC for completion of the sound propagation model).
- Summarize and communicate fish passage data with USFWS relevant to ADS deployment.
- Communicate with USACE on progress related to design plan, including engineering review.
- Contract with appropriate vendors for acquisition of acoustic equipment.

Research and Development (lab/field testing, or applicable to multiple locations; LEAD: USACE ERDC):

- Conduct hearing tests (AEP) on native fishes of concern (e.g., catfish, buffalo, sturgeon).
- Assist ERDC, as needed, with development and testing of newly engineered sounds.
    - In-pond testing of new engineered sounds on motivated fish.
    - In-river testing of new engineered sounds on wild fish (finish Wabash testing, plus additional site possible).
- Initiate additional deployments at targeted locations as appropriate and coordinated among the interagency planning team (USFWS, USGS, USACE and states).

Expected Milestones:

Potential Out-year Actions (Subject to Future Appropriations)**:**

Barkley Lock and Dam BAFF Deployment (LEAD: USFWS):

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployment of the BAFF at Barkley Lock and Dam (Cumberland River, Kentucky)
- Support USFWS and collaborating agencies with analysis of fish movement and behavior.

Lock and Dam 19 (or alternative location) for ADS Deployment (LEAD: USGS):

- Continue coordination among multi-agency team for large-scale experimental deployments at Lock and Dam19 or alternative location.
- Construction and deploying of ADS.
- Assist with Equipment Monitoring Implementation.

    - System operation changes with use, navigation, temporal variation (discharge, water quality etc.).
    - Initiate long-term ambient acoustic recording for monitoring purposes.
- Summarize and communicate fish passage data with USFWS relevant to ADS deployment.
- Equipment monitoring (system operations changes with use, navigation, and temporal variation).
- Analyses of ADS operational changes.
- Final project assessment and wrap-up meeting.
- Analyze fish passage data (USGS and USFWS) for final report.

Research and Development (lab/field testing, or applicable to multiple locations; LEAD: USACE):

- Behavioral tests of new acoustic stimuli on Grass Carp and Black Carp.
- Assist ERDC, as needed, with development and testing of newly engineered sounds.
    - In-river testing of new engineered sounds on wild fish.
    - Finish analyses of pond work and develop publications/report.
- Initiate 2-D predictive movement model of fish in response to sound using large scale field test location (Brandon Road Lock and Dam, Lock and Dam 19, etc.) as case study for use at other deployment sites (with ERDC).
- Development of long-term remote performance monitoring of fish and acoustics to support federal and state agencies.
- Initiate additional deployments at targeted locations as appropriate and coordinated among the interagency planning team.

What Is Deliverable for this Project:

- Study and Project Plan for installing an ADS at Lock and Dam 19 (or surrogate location.
- Full deployment and evaluation of an ADS at Lock and Dam 19.
- Peer reviewed publication or report on fish movement and passage at sites where acoustic deterrents are deployed.
- Peer reviewed publication or report on additional testing of acoustic signal on Asian carp and native fish in a field setting.

Expected Completion Date for Project: Completion of large-scale deployments is estimated for 2023.

Potential Hurdles: Multi-agency communication, contracts for large-scale deployments, permitting timelines.

How will the results of this project be disseminated?

- Peer-reviewed reports and/or publications.
- Public Asian Carp Regional Coordinating Committee announcements and web articles as necessary.
- Webinars to partners.

T-4 USACE Carbon Dioxide Deterrence for Asian Carp

Lead Agency: U.S. Army Corps of Engineers (USACE)

Agency Collaboration: U.S. Geological Survey (USGS), University of Illinois, University of Wisconsin Platteville

FY 2019 Funding Table:

Agency Funding Expected**	Asian Carp GLRI Funding Requested*
$0	$450,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

**$50,000 for LRC in FY 2019

Project Explanation

Summary of Actions to Date: A series of laboratory-based fish behavior studies have been completed. The work suggested that carbon dioxide has great potential to be a deterrence, but that flowing water changes the fish's response to carbon dioxide. Because carbon dioxide is a new technology for fish deterrence, feasibility of the approach in an operational setting remain. To this end, a field-scale demonstration was planned for FY 2018 at Lock and Dam 14 auxiliary lock. The field test was designed to measure cost, safety and efficacy of the barrier in a full-scale operational environment. Documents produced include:

Investigating the Mixing Efficiencies of Liquid-to-Liquid Chemical Injection Manifolds for Aquatic Invasive Species Management - Journal of Fluids Engineering (in press).

Effects of Free Carbon Dioxide on the Shoaling Behavior of Bighead Carp (*Hypopthalmichthus nobilis*) - University of California Davis/ Engineering Research and Development Center (ERDC) supported master's thesis- submitted to *Biological Invasions*.

Avoidance of carbon dioxide in flowing water by Bighead Carp - Canadian Journal of Fisheries and Aquatic Sciences (in press).

Water Quality Model of the Brandon Road Approach Channel - ERDC Technical Report (in review).

- Field Scale Demonstration Engineering Design (100%) Documents Lock and Dam 14 Auxiliary lock (USGS/USACE co leads).

Moving forward, work in FY 2019 will continue with focusing on the field demonstration at a new site on the Fox River, Wisconsin at a former USACE lock (tentative selection). A similar contracting and construction schedule is being implemented with field work commencing in June 2019 and ending around October 2019. The focus will remain on establishing cost, safety and efficacy of a carbon dioxide (CO_2) barrier.

Proposed Actions for FY 2019:

- Analyze data from FY 2019 field trail of barrier and complete report. Identify any feasibility gaps for using CO_2.
- Continue coordination on the feasibility of an operational carbon dioxide barrier at Brandon Road Lock and Dam or another site.
- Continue coordination with multi barrier teams.
- Develop a feasibility report for a field-scale permanent application of carbon dioxide at Brandon Road or other location.

Expected Milestones:

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Address feasibility gaps for carbon dioxide implementation through laboratory, field and modeling studies.
- Continue coordination among multi-agency science and evaluation team for large-scale deployment.
- Support USGS and U.S. Fish and Wildlife Service with field, laboratory and model studies.

What Is Deliverable for this Project:

- Field Trial Completion report.
- Feasibility Report for carbon dioxide in navigation environments.

Expected Completion Date for Project: FY 2021

Potential Hurdles: CO_2 is a new technology and if the field trial suggest low feasibility on either cost, safety and/or efficacy further work is unwarranted.

How will the results of this project be disseminated?

- Reports.
- Conferences.
- Monthly coordination calls.
- Peer reviewed publications.

T-5 USGS Carbon Dioxide Deterrence for Asian Carp

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), U.S. Coast Guard (USCG), Wisconsin Department of Natural Resources (DNR), University of Wisconsin Platteville, University of Illinois (UoI)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$420,000	$470,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Carbon dioxide (CO_2) injected into water is being evaluated as a non-physical deterrent method for invasive Asian carp. Results from laboratory, mesocosm and field studies conducted by USGS, USACE, and UoI have shown that Asian carp voluntarily avoided areas of elevated CO_2 when given the option to access other freshwater (untreated) areas. Strategic implementation of CO_2 at pinch-points of rivers (e.g., inside lock chambers) could deter Asian carp passage and reduce the risk of upstream movements and range expansion.

Summary of Actions to Date: Research and development of CO_2 as an Asian carp deterrent has progressed from small-to-large scales. Initial proof-of-concept research in laboratory settings determined baseline CO_2 concentrations that alter Asian carp behavior. Results from laboratory studies informed subsequent testing in outdoor ponds and flumes that evaluated fish behavior at larger spatial scales. Results from mesocosm studies then informed a field study at a water management structure along the lower Illinois River. Promising results across all spatial scales has supported continued development and evaluation of CO_2 as an Asian carp deterrent strategy and its potential utility for Asian carp control and management.

Product registration has occurred concurrent with CO_2 research and development. Currently, USGS has submitted a Section 3 registration packet to USEPA Office of Pesticides Programs with USFWS as the registrant of record for consideration as a new aquatic pesticide with uses as (1) an Asian carp behavioral deterrent and (2) as an under-ice-lethal control for nuisance fishes. Registration of CO_2 as a new Asian carp management tool could facilitate the transition of CO_2 from research and development into management practices and allow more robust field evaluations in FY 2019.

Proposed Actions for FY 2019: Current efforts are focused on transfer of CO_2 as a control tool to management agencies through a technology demonstration at a navigational lock. The purpose of this demonstration is to better determine the feasibility of CO_2 under real-world settings. Researchers will temporarily construct, operate, monitor, and evaluate a large-scale CO_2 injection system within a navigational lock to collect data on engineering, costs, operational parameters, water quality, air quality (human safety), fish behavior, and non-target organisms. Outcomes are expected to inform the

transfer of this technology into management actions to reduce the risk of Asian carp spreading into new areas.

Expected Milestones:

FY 2019 Q1:

- Architectural and engineering designs completed.

FY 2019 Q2:

- Construction contracts awarded, permits finalized.

FY 2019 Q3:

- Agency coordination, construction at test site.

FY 2019 Q4:

- Conduct study, on-site demonstrations to partners.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Data analysis, final report submission, technology transfer coordination, assist management agencies with CO_2 implementation.

What Is Deliverable for this Project:

The overall deliverable from this funding is the registration of CO_2 as a fish deterrent and as a piscicide and appropriate technology to effectively apply the material. Specific deliverables include final study reports, publications in scientific journals, on-site technology demonstrations, presentations at meetings and conferences, and inter-agency coordination to support permanent implementation.

Expected Completion Date for Project:

Completion date will depend on FY 2019 project outcomes. Management implementation of CO_2 may extend into FY 2021 and beyond.

Potential Hurdles:

- Engineering and logistical challenges with installing an Asian carp deterrence barrier within an active navigational structure.
- Potential effects of carbonic acid on control structures.
- Potential effects of CO_2 on non-target species due to non-selectivity.
- Start-up costs with permanent installations of CO_2 infusion systems.
- Regulatory permits.

How will the results of this project be disseminated?

- Several products and disseminations have occurred from research and development testing.
- Peer-reviewed publications in scientific journals are publicly available describing the efficacy, non-target impacts, alternative applications (*e.g.*, lethal control), and engineering designs for navigational locks.
- Oral disseminations have occurred at technical and scientific meetings.

- Further information transfer has occurred at inter-agency meetings (*e.g.*, Asian Carp Regional Coordinating Committee Monitoring and Response Workgroup).
- The lock demonstration project in FY 2019 will also provide an opportunity to bring research and managers together to discuss the logistics of implementing CO_2 at various management locations.

T-6 Developing Species-Specific Control Systems for Asian Carp

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS), Indiana Department of Natural Resources (DNR), Viterbo University, University of Wisconsin - La Crosse, U.S. Department of Agriculture, Iowa DNR, Iowa Department of Agriculture and Land Conservation

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$650,000	$190,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

No current technology can specifically target Asian carp for control within aquatic ecosystems. Available toxicants used in control programs of invasive or nuisance fish are generally non-selective and are often applied throughout the entire water column, resulting in equal exposures of native and invasive species alike. Developing targeted delivery systems that target feeding strategies of the targeted organism, like an Asian carp, would increase the ability of management agencies to control or limit a species like Asian carp while minimizing potential impacts on native species. This increased selectivity can be achieved by understanding the habits and physiological characteristics of the target organism and incorporating into a delivery system technology that will exploit unique feeding characteristics. Considerations such as food particle size, digestive physiology and feeding attractants/stimulants can be brought together with more selective control agents, whether chemical, biological or genetic, into a single species-specific control tool. Therefore, this project consists of two main foci: (1) development of a delivery tool; and, (2) identification of control agent that is more specific to Asian carp.

The development of an oral delivery formulation is the first step in the establishment of a species-specific control. Technologies developed for the pharmaceutical and agricultural industries can be used to encapsulate a control agent into a microparticle that can be used to increase the selectivity of non-selective control agents. A microparticle will allow for the delivery of a control agent to a select group to fishes that have similar feeding habits. This microparticle can later be combined with a new control agent that has selectivity toward the targeted species; thus, making a highly selective control tool.

Progress has been made in the past several years to identify a formulation of a spray-atomized particle that does not leach the control agent, is readily consumed by both Silver Carp (*Hypophthalmichthys molitrix*) and Bighead Carp (*H. nobilis*) (collectively referred to as bigheaded carps) and is easily scalable for commercial production. Both controlled laboratory and pond trials have been completed that demonstrate efficacy of this new delivery tool. In both laboratory and pond studies, Silver Carp and Bighead Carp died following particle consumptionwhile largemouth bass

(*Micropterus salmoides*), a native, appeared unaffected. The first field study conducted with the particle used a marker, yttrium, to determine potential non-targeted impacts. This study suggested that primarily the filter-feeding Bighead Carp and Gizzard Shad (*Dorosoma cepedianum*) would be impacted from a microparticle application and demonstrating potential increased selectivity. Then, the first deployment of a toxic microparticle was conduction in a backwater to the Wabash River near Lafayette, Indiana. During this trial, only three filter-feeding fish species were impacted from the microparticle application (*i.e*., Silver Carp, Gizzard Shad, and River Carpsucker [*Carpiodes carpio*]) even though more than 20 species were identified at the test site. This trial demonstrates that the use of microparticles can increase selectivity of a broad spectrum piscicide, which can result in decreasing impacts to many fishes of commercial and recreational importance. Results from this field study suggests improvements in the application could be made to increase impacts to Silver Carp. It is important to note that the site did not contain any Bighead Carp so further research needs to be conducted to assess potential impacts on this species. Additional field studies must be conducted to determine the best way to apply the particles as well as demonstrate specificity to Bighead Carp.

Of the currently U.S. Environmental Protection Agency (USEPA)-registered piscicides for use by aquatic resources managers to control aquatic invasive fish, two are commonly used for controlling sea lamprey and are less toxic to other fishes and the other rotenone generally impacts all fishes equally. Unfortunately, rotenone is broken down into non-toxic forms within the gastrointestinal tract which leaves antimycin as our only viable control agent for delivery with the microparticle. USGS is currently using antimycin delivered through the microparticle to test specificity of the microparticle. USGS will work toward registering the use of microparticles to deliver antimycin as a new control tool subsequent to registering antimycin A for its recently cancelled, non-microencapsulated liquid use.

Beyond just the delivery, specificity can be added through the identification of control agents that are more toxic to the targeted fishes than to non-target species. Ideally, these new control agents can easily be incorporated into the microparticle, which in turn will increase the specificity of the control tool. The identification of new control agents would provide a management option within an integrated pest management program designed to control populations of Asian carp and is essential to successful management of these nuisance species. Progress has been made in the identification of new chemical control agents. A large chemical database has been established and crude models that predict toxicity from chemical properties has been developed. These models are based solely on mortality and chemical properties, not on how the chemical causes mortality. Mortality can be caused by many different actions, including blocking cellular respiration, stimulate apoptosis, etcetera. Improvements in these models can be made by better understanding the mode-of-action (MOA) of various classes of toxicants; unfortunately this information is lacking for most chemicals. Regardless, we have been able to identify more than 30 potential new piscicides from this database. Six chemicals have passed through the initial cytotoxicity trials and two have been found to have some selectivity to cyprinids in *in vivo* toxicity tests. The initial evaluation of one of these chemicals as a piscicide is currently underway.

One promising new technology for species-specific control is the use of genetic tools. Two technologies that have garnered considerable interests in the use of clustered regularly interspaced

short palindromic repeats (CRISPR) as a gene drive system and ribonucleic acid interference (RNAi) to knock down key processes for the survival of the animal. A consideration of CRISPR is that it can generate inheritable trait(s) detrimental to the animal that may be disseminated through the population by means of natural reproduction following the introduction of a limited number of animals into the population. However once released, this trait can easily be passed from one population to another and ultimately become and "invasive" trait. Before developing CRISPR as a tool for controlling invasive species, we must determine the risk of this "invasive" trait to native populations. The other technology, RNAi, simply targets only those individuals that are exposed. A properly designed RNAi will knock down a key regulatory process within the animal and can be extremely specific. RNAi has been designed to target transcriptional control at the sub-species level in fruit flies and therefore has significant potential as a control of Asian carps. However, first a description of the transcriptome of the targeted species of Asian carp is needed so that a target gene can be identified. Once a target sequence has been identified, RNAi can be designed and purchase from a commercial provider and tested for efficacy.

The development of these new control agents is dependent upon the regulatory process. This process includes state and local permitting for applications during studies to the completion of the studies required for the registration of a new piscicide. Novel tools used to mitigate a pest must complete a rigorous registration process before they may be used within integrated pest management control programs of state and federal natural resource agencies. Specifically, the registration component of each study will (1) provide regulatory affairs support for the registration of microparticle controls and (2) develop registration-specific data to support the registration of microparticle controls for bighead carps. Results from this project will include the development of comprehensive standard operating procedures (SOPs) and institutional guidance for use of the compound as a selective piscicide by approved state or federal agencies. The SOPs will be developed based on the model of the bi-national Sea Lamprey Control Program field protocols, currently in use in the Great Lakes basin, and tailored to each specific microparticle control formulation. The detailed SOPs for the use of the compound as a piscicide will serve as core components of the registration application documentation, and include protocols on safe transport, handling, storage, and dispersal of the formulations and application equipment; treatment site selection and management (including security and environmental monitoring); employee health and safety training and monitoring; and process for approval and compliance with all requisite Federal, State and local environmental regulations (including Endangered Species Act (ESA) Section 7 consultation, National Environmental Policy Act (NEPA) and Migratory Bird Treaty Act compliance, and other regulatory requirements).

The USGS Upper Midwest Environmental Sciences Center (UMESC) will provide regulatory affairs support to the U.S. Fish and Wildlife Service (USFWS) in the development of biological and chemical pesticide controls of Bighead Carp. Regulatory affairs support will include compilation of data and reports for submission to regulatory agencies (e.g., USEPA), identification of required data to attain chemical registration, coordination of experimental use permits (EUPs), and other regulatory support as needed to attain and maintain chemical registrations of tools to control bigheaded carps. The UMESC will also develop some of the product-specific data required to attain registration of a microparticle formulation to control bigheaded carps including studies to describe

product chemistry, physical/chemical properties and USEPA Group A acute toxicity (*i.e.*, mammalian acute oral, dermal, and inhalation toxicity, eye and dermal irritation, skin sensitization).

USFWS will partner with USGS to complete the USEPA registration processes required for new active ingredients under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and lead development of the multiple SOPs for implementation of the control techniques. USFWS will provide support in preparing any needed Section 7 consultations necessary to ensure that all actions taken regarding testing and implementation of bigheaded carps control technologies are compliant with the ESA. USFWS staff will provide site specific consultations for potential field test sites and wider consultations as appropriate for planned control/chemical application areas, which could include multiple states and multiple USFWS regions.

USFWS will prepare any necessary biological opinions, if consultation processes yield a determination of "likely to adversely affect" a federally listed species, and work with USGS and partners to prepare any needed incidental take permits or exemptions, if required under the ESA to avoid/limit jeopardy. USFWS will work with USGS to compile the required health and safety information and complete procedural requirements needed for USEPA to evaluate proposed control techniques and ensure that they will not pose unreasonable risks of harm to human health and the environment. In addition, USFWS will assist with developing use manuals and labeling requirements for control technologies developed under this template, and liaise with USGS, USEPA, and other partners to fulfill other requirements of the USEPA registration process. USFWS will serve as the technical registrant for bigheaded carps control technologies developed under this template and will work with USGS to ensure that any applications, including experimental or test applications, of control technologies developed under this template are compliant with NEPA.

Summary of Actions to Date: USGS has developed an oral delivery formulation (ODF) that can stabilize and deliver antimycin-A to Silver Carp and Bighead Carp. Laboratory and highly controlled pond studies indicated that this ODF could selectively deliver antimycin-A to the two targeted species while having minimal impact on Bluegill Sunfish (*Lepomis macrochirus*) and Largemouth Bass. We then conducted the first field trail with the microparticle formulation in Indiana and followed with a second field trial in Iowa in 2018. Results for these trials indicated that the microparticle was highly selective. However, improvements in time of year for application and increase in dispersal mayincrease the efficacy of applications by reaching a larger number of target fish. This lethal particle has been incorporated into a bait to target Grass Carp (*Ctenopharyngodon idella*); unfortunately, tests conducted in 2018 indicated that the palatability of the bait to Grass Carp could be improved.

Additionally, USGS has developed a high-throughput screening tool to identify new control agents that can be used by fishery resource managers to control Asian carp. The tool uses [quantitative] structure activity relationship ([Q]SAR) analysis of a chemical to estimate toxicity to a wide variety of taxa. Once a chemical has been identified, specificity of the chemical can then be quickly assessed using cell-lines for the Asian carp and native fish. Lastly, all chemicals that demonstrate high selectivity to Asian carp can then be validated *in vivo*. USGS toxicity model has identified 13 chemicals that may be selective to Asian carp. Seven of these chemicals have been screened through cytotoxicity trials, while the remaining six still need to be tested. Three of the chemicals screened to

date demonstrate selective toxicity to Asian carp cells. These three chemicals and any others of the six yet to be tested need to be further evaluated through *in vivo* toxicity tests.

Proposed Actions for FY 2019:

- Obtain ownership of antimycin-A as a fish control agent. This includes:
    - Possession of the strain of *Streptomyces* owned by Aquabiotics Corp.
    - Possession of all data and documents to support registration of antimycin-A.
- Obtain contracts for fermentation of *Streptomyce*s strain to produce antimycin-A.
- Develop initial registration packet for antimycin-A. We will work with USFWS toward registering antimycin-A as a newactive ingredient. Following registration of the liquid antimycin formulation, we can register the various alternate formulations, which will include the aforementioned microparticles.
- Consult with USEPA to identify what data are required to be submitted or cited in support of registration.
    - USGS may need to contract with a contract research organization (CRO) lab to conduct certain types of studies like mammalian toxicity tests.
- Submit new active ingredient application for registration of antimycin-A.
- Conduct environmental fate studies for microparticle.
- Complete Product Chemistry section of registration for microparticle.
- Complete assessment of perspective chemicals that have been identified as potentially selective to Asian carp.
    - Conduct *in vivo* trails for the few chemicals that have been identified as potentially selective during cytotoxicity tests during 2018.
    - Conduct cytotoxicity tests and necessary *in vivo* assays for the remaining six perspective chemicals.
- Increase palatability of microparticle bait for Grass Carp.
- Optimize concentration of control agent in Grass Carp bait.
- Assess efficacy of oral toxicant developed by MJSTI Corp, from Overland, Kansas.
- Initiate studies to identify genetic-based controls, specifically RNAi at critical development stages for single species of Asian carp, most likely Grass Carp.

Expected Milestones: Develop initial registration packet for antimycin-A (January 2019)

- January 2019: Establish Cooperative Research and Development Agreement (CRADA) with MJSTI Corp.
- April 2019: Ownership of antimycin-A.
- July 2019: Obtain contracts for fermentation of Streptomyces strain to produce antimycin-A.
- May 2019: Assess efficacy of oral toxicant developed by MJSTI Corp, from Overland, Kansas.
- June 2019: Increase palatability of toxic bait for Grass Carp.
- June 2019: Optimize concentration of control agent in Grass Carp bait.
- July 2019: Obtain contracts to conduct studies needed for registration of antimycin-A.
- September 2019: Submit new active ingredient application for registration of antimycin-A.

- September 2019: Conduct environmental fate studies for microparticle.
- September 2019: Complete Product Chemistry section of registration for microparticle.
- September 2019: Complete assessment of prospective chemicals that have been identified as potentially selective to Asian carp.
- September 2019: Initiate studies to identify genetic-based controls, specificallyRNAi at critical development stages for Grass Carp.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Assist management agencies that plan to deploy antimycin-laden microparticles to controlAsian carp.
- Continue to screen through potential new control chemicals using cytotoxicity trials and then conduct in vivo assays with only those chemicals that demonstrate selectivity.
- Conduct studies to evaluate the use RNAi as a control for Grass Carp.
- Conduct studies to evaluate the use RNAi as a control for the other species of Asian carp.
- Continue studies for the registration of a new piscicides.
- Continue studies to support the registration of microparticles.
- Initiate and conduct studies to evaluate the use of necromones or modified pheromone antagonists to disrupt Asian carp spawning behavior.
- Initiate and conduct studies to support the registration of synthetic biology (e.g., RNAi, etc.) as a means of Asian carp control.
- Review environmental fate studies of antimycin-incorporated microparticles.
-
- Respond to USEPA or state regulatory agencies review of data submitted to register antimycin-incorporated microparticles in limited open-water application sites.
- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of the use of antimycin-incorporated microparticles in limited open-water application sites to control Bighead Carp.
- Coordinate submission of studies to complete USEPA registration of biologically derived controls incorporated into microparticles to USEPA.
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements of alternative controls for bigheaded carps.
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements of biologically-derived controls incorporated microparticles.
- USFWS will coordinate meetings with State and Federal agency partners to identify future opportunities for implementation of microparticles in support of Asian carp control strategies (for implementation following approval and registration).
- Assess registration requirements of alternative active ingredients for control of bigheaded carps.
- Respond to USEPA or state regulatory agencies review of data submitted to register microparticles containing alternative active ingredients in limited open-water application sites.

- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

What Is Deliverable for this Project:

- Stable supply of antimycin-A.
- Publication on the development and testing of the microparticle. This manuscript will include the development of the formulations, laboratory efficacy trials and the pond trials as well as the field studies.
- We will submit a manuscript on the results of the *in vivo* toxicity trials for the identification of a cyprinid-specific control.
- Submission of USEPA registration application package.
- Identification of *de novo* hemistries that could be used to minimize impacts on native fishes.

Expected Completion Date for Project:

- The development of microparticles as an oral delivery tool will likely be competed in 2020, due to the delay caused by the lapse of registration of antimycin A. However, studies on the registration of antimycin A will likely need to continue beyond 2020. Also, studies to support the future? registered use of antimycin A microparticles for the control of Asian carp by natural resource agencies may be continued beyond 2021.
- A new prospective piscicide will be identified by 2019. Once the chemical has been identified, we will initiate efforts to register the chemical as a piscicide.
- New necromone or modified pheromone antagonists are expected to be identified by 2021. Once the chemical has been identified, we will initiate registration of the chemical as a behavioral deterrent.
- Developmenta of a Grass Carp-specific toxic bait is planned for completion by 2020.
- A Grass Carp-specific RNAi is expected to be designed and tested by 2021.

Potential Hurdles:

- Obtaining access to candidate fish toxicants from private chemical libraries.
- Establishing strain and documents from Aquabiotics for antimycin-A.
- Establishment of contracts to produce antimycin-A.
- Funding available to conduct potentially expensive studies to address registration requirements.

How will the results of this project be disseminated?

- Public (GLRI.us, GLIN Announce), technical audience(s), media, *etc*.

T-7 Monitoring at the Electric Dispersal Barrier with Remote Sensing

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: U.S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (USACE)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$30,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: This multiagency project provides a range of monitoring data (biological, physical, and environmental) in and around the Electric Dispersal Barrier System (EDBS) on the Chicago Sanitary and Ship Canal (CSSC) for use by USACE in barrier efficacy evaluation and operation. USGS monitors commercial vessel traffic, flow reversals, and temperature and specific conductance in and near the EDBS. Commercial vessel traffic patterns through the EDBS are documented using a motion-activated video camera and are critical to understanding the likelihood of barrier breaches by small fish through entrainment and return flows. The frequency, duration, and magnitude of flow reversals at the EDBS are monitored using surface velocity radar (SVR), which allows the USACE to quantify the likelihood for upstream transport of invasive species across the EDBS. Temperature and specific conductance (TC) are important parameters that affect electrical barrier effectiveness. TC are reported in near real-time from USGS sensors installed just downstream of the EDBS for use by the USACE in barrier operation.

Monitoring of commercial vessel traffic and flow reversals began in January 2017 and TC in March 2017 at the EDBS. Since then, USGS monitoring data have been used by the USACE to effectively operate and evaluate the efficacy of the EDBS under highly-variable flow and water-quality conditions. Data from the TC probes have allowed the USACE to modify and optimize the EDBS settings to account for changes in water temperature and specific conductance. USACE has also been provided with summaries of reverse flow events (start time, end time, duration, and estimated maximum upstream transport distance) and commercial traffic through the EDBS (date and time of passage, configuration, loading, direction of travel, bow type) for periods of interest (*e.g.,* during the spring 2018 maintenance period). Summaries for the full 2018 water year (October 1, 2017 to September 30, 2018) will be compiled and disseminated in FY 2019 Q1.

Proposed Actions for FY 2019: This project supports continued operation and maintenance (O&M) of the commercial vessel traffic camera as well as the review, analysis, and annual summaries of commercial vessel traffic, reverse flows, and TC records at the EDBS from October 1, 2018 through September 30, 2019 (water year 2019). O&M of the SVR and TC sensors are funded separately and not included in this template.

Expected Milestones:

FY 2019 Q1:

- Perform site visits as needed to maintain equipment and download data.
- Analysis of Water Year (WY) 2018 data .
- Data processing, analysis, and summary report generation for partner-defined periods of interest (*e.g.*, Fall 2018 barrier maintenance).

FY 2019 Q2:

- Perform site visits as needed to maintain equipment and download data.
- Complete analysis of WY 2018 data.
- Data processing, analysis, and summary report generation for partner-defined periods of interest.

FY 2019 Q3:

- Perform site visits as needed to maintain equipment and download data.
- Deliver WY2018 data summaries to USACE and other partner agencies.
- Data processing, analysis, and summary report generation for partner-defined periods of interest.

FY 2019 Q4:

- Perform site visits as needed to maintain equipment and download data.
- Data processing, analysis, and summary report generation for partner-defined periods of interest.
- Prepare FY 2019 data for annual data summary (to be delivered FY 2020 Q2).

Potential Out-year Actions (Subject to Future Appropriations)**:**

-
- Continue USGS monitoring of commercial vessel traffic, flow reversals, and temperature and specific conductance in and near the EDBS to support USACE EDBS operation and ongoing efficacy evaluation.
- Deliver annual data summaries in addition to providing real-time data where possible. Modify continuous monitoring plan to meet the needs of the USACE and as directed by the Asian Carp Regional Coordinating Committee (ACRCC) and partner agencies.

What Is Deliverable for this Project:

- Annual data summaries of flow reversals and commercial vessel traffic at the EDBS.
- Data summaries of flow reversals and commercial vessel traffic at the EDBS for partner-defined periods of interest.
- Real-time flow and water-quality data at the EDBS for use by the USACE in barrier operation and optimization.

Expected Completion Date for Project:

- On-going (monitoring data are used in barrier operation and efficacy assessments).
- Continue annually as determined by the ACRCC and partner agencies.

Potential Hurdles:

- Potential for barge and lightning strikes of equipment.
- Funding for O&M of SVR and TC systems is funded separately (funding lapse may affect ability to deliver data summaries).

How will the results of this project be disseminated?

- Real-time data from the SVR and TC sensors disseminated via the USGS National Water Information System web (https://waterdata.usgs.gov/nwis/uv?site_no=05536995). This web portal also allows access to all historic USGS data at this site.
- Data summaries for partner-defined time periods will be disseminated to partner agencies through internal communications.
- Annual data summaries of commercial navigation traffic and flow reversals at the EBDS will be published as citable data releases with full metadata and made accessible on the USGS Science Base web portal (https://www.sciencebase.gov).

T-8 Experimental Testing of Sill Bubble Curtains for Barge Entrainment Mitigation

Lead Agency(s): U.S. Army Corps of Engineers (USACE) Rock Island District and Engineer Research and Development Center (ERDC)

Agency Collaboration: U.S. Geological Survey (USGS) Illinois Water Science Center

FY 219 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$440,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: U.S. Fish and Wildlife Service (USFWS) has conducted several years of barge entrainment studies that show small fish can be carried in the space between the of commercial tows (Davis et al. 2016, 2017). In 2017, clearing fish from these areas was studied with the positive findings of a physical model reinforced by a field study which showed that water jets and water jets with compressed air could achieve some level of efficacy in mitigation for entrained fishes (Bryant et al. 2016, Davis and Shanks 2017).

Preliminary results from these studies were discussed leading to a recommendation that the Great Lakes and Mississippi River Interbasin Study (GLMRIS)-Brandon Road Project Delivery Team consider using compressed air rather than water jets as a cost savings measure. It was suggested that existing sill bubble curtains at Dresden Island, Marseilles, and Starved Rock Locks and Dams could be a low-cost alternative to water jet development. Sill bubble curtains are a standard design feature of navigation locks for removing ice and debris (Tuthill and Stockstill 2005). The efficacy of compressed air to create an upwelling capable of either (1) disrupting the flow structure to assist in clearing fishes, or (2) creating bubbles acting to deter fishes from barge rake-to-box junction gaps under their own power has never been evaluated on a scale relevant for inland waterways. This document was developed to replicate earlier bio-response studies (Davis et al. 2016, Davis et al. 2017, Davis and Shanks 2017, Leroy et al. 2017[ab]).

Proposed Actions for FY 2019:

The focus of this research is to (1) test the efficacy of compressed air to disrupt vessel-induced eddies through physical removal of neutrally buoyant fish surrogates, and to (2) quantify changes in flow dynamics within the hydraulic recesses during passage over a bubble curtain. The project goal is to determine if potential exists for utilizing existing navigation structures to mitigate for small Asian carp entrainment. This study will provide information for future projects.

USACE ERDC facility in Vicksburg, Mississippi will utilize the existing Chicago Sanitation and Ship Canal (CSSC) 1:16.7 scale physical model with remote control tow and barges to evaluate the interaction between barges, fluid motions, and nearly neutral buoyant objects under a variety of

vessel speeds and barge configurations typical of a navigation lock. However, the construction of a scaled model of a lock chamber and approach channel in the existing model channel or as a separate physical model is necessary.

Objectives:

- Test efficacy of compressed air representing existing navigation lock structures and conditions to physically remove neutrally buoyant fish surrogates.
- Quantify changes in flow dynamics within the hydraulic eddies of a barge during passage over a bubble curtain.

Methods:

A sill bubble curtain will be installed on ERDC's existing CSSC physical model to evaluate the potential to remove fish surrogates in both hydraulic recesses. Neutrally buoyant particles (NPBs) will serve as floating "fish surrogates". The initial test phase will use a sill bubble curtain (SBC) to force neutrally buoyant particles trapped within hydraulic recesses away from the vessel. These experiments will determine the minimum discharge required to remove NBPs emulating existing SBC configurations within the channel cross-section at Peoria Lock and Dam.

Flow visualization will be used to track NBPs position and determine maximum displacement via a sill bubble curtain. NBPs approximating the buoyancy characteristics of Asian carp (including sinking and floating conditions) will be entrained within the hydraulic recesses to reproduce tow-induced fish transport. Once entrained, a sill bubble curtain will be used to attempt to dislodge the NBPs at various tow speeds and exposure times. The team will evaluate optimal placement for maximum removal efficiency, minimum gas volume required to dislodge fish surrogates, and the mitigation potential of existing sill bubble curtain structures for particle removal.

Particle Tracking Velocimetry (PTV) will be used to track NBPs removal and will be used to measure trajectories of simulated fishes in the hydraulic recesses. PTV will not only track particles but provide information on removal effectiveness by measuring particle speed and net displacement. PTV will be conducted in both fixed and moving reference frames. In the fixed reference frame, in-channel measurements will be collected within the field of view of the SBC for stationary and moving vessels. In the moving reference frame, images will be collected moving with the barge to quantify SBC-induced flow patterns within barge recesses and re-circulating zones.

Expected Milestones:

Task	FY Quarter	Description	Details
1	1 & 2	Model testing: setup physical model, gather additional equipment, prepare model barges, scale air entrainment bubblers with regard to discharge or momentum flux, and scale NBS.	Assemble and evaluate compressed air via lock simulations representing existing structures.
2	3	Evaluate mitigation potential: Conduct full barge experiment at standard entrance speed, then evaluate different vessel speeds and exposure time configurations.	Test compressed air efficacy for removing floating "fish surrogates". Evaluate impact of exposure time and tow speeds on effectiveness.
3	4	Analysis and report preparation.	Prepare and deliver report.

Potential Out-year Actions (Subject to Future Appropriations):

- Peoria Lock field test - Behavioral tests at Peoria Lock using live fish in the rake to box junction of a tow with USFWS. Information learned in the 2019 model tests will inform optimal design for bubblers at Peoria.
- Design of bubble curtain below Brandon Road Lock and Dam. Redesign of bubbler systems at Lockport, Dresden, Marseilles, and Peoria to minimize likelihood of small fish entrainment.

What Is Deliverable for this Project: Completion of testing and a final report documenting the findings of the physical model trials.

Expected Completion Date for Project: 2021

Potential Hurdles: None

How will the results of this project be disseminated?

A technical report will summarize results of SBC experiments with consideration of how changes in tow speeds and exposure times influence entrainment. This report will include data analysis and recommendations regarding compressed air as a mitigation tool for small Asian carp entrainment at existing navigation lock structures. The report will also provide a cost estimate of SBC operation as a mitigation strategy at Peoria Lock and Dam.

References:

Tuthill, A.M., and Stockstill, R.L. 2005. Field and laboratory validation of high-flow air bubbler mechanics. Journal of Cold Regions Engineering 19(3): 85-99. https://ascelibrary.org/doi/full/10.1061/(ASCE)0887-381X(2005)19%3A3(85)

Dugué, V., Blanckaert, K., Chen, Q. and Schleiss, A.J. 2014. Influencing Flow Patterns and Bed Morphology in Open Channels and Rivers by Means of an Air-Bubble Screen. Journal of Hydraulic Engineering 141:04014070. https://ascelibrary.org/doi/abs/10.1061/(ASCE)HY.1943-7900.0000946

Bryant, D.B., Maynord, S.T., Park, H.E., Coe, L., Smith, J., and Styles, R. 2016. Navigation Effects on Asian Carp Movement Past Electric Barrier, Chicago Sanitary and Ship Canal. US Army Engineer Research and Development Center Vicksburg United States. www.dtic.mil/dtic/tr/fulltext/u2/1002484.pdf

Davis, J.J., Jackson, P.R., Engel, F.L., LeRoy, J.Z., Neeley, R.N., Finney, S.T., and Murphy, E.A. 2016. Entrainment, retention, and transport of freely swimming fish in junction gaps between commercial barges operating on the Illinois Waterway. Journal of Great Lakes Research 42(4):837-848. https://doi.org/10.1016/j.jglr.2016.05.005

Davis, J.J., LeRoy, J.Z., Shanks, M.R., Jackson, P.R., Engel, F.L., Murphy, E.A., and Barkowski, N.A. 2017. Effects of tow transit on the efficacy of the Chicago Sanitary and Ship Canal Electric Dispersal Barrier System. Journal of Great Lakes Research 43(6):1119-1131. https://doi.org/10.1016/j.jglr.2017.08.013.

Davis J.J. and Shanks, M.R. 2017. Mitigation of tow-mediated fish passage at the Electric Fish Dispersal Barrier, Romeoville, IL - Preliminary Results, 2017 Field Trials. In press.

LeRoy, J.Z., Jackson, P.R., and Engel, F.L. 2017a. Velocity profiling at the US Army Corps of Engineers Electric Dispersal Barrier in the Chicago Sanitary and Ship Canal during passage of fully loaded commercial tows: U.S. Geological Survey data release, https://doi.org/10.5066/F7K35RTP.

LeRoy, J.Z., Jackson, P.R., Murphy, E.A., Engel, F.L. 2017b. Water velocity profiling at the U.S. Army Corps of Engineers Electric Dispersal Barrier in the Chicago Sanitary and Ship Canal during passage of fully-loaded commercial tows in August 2017: U.S. Geological Survey data release, https://dx.doi.org/10.5066/F77D2TB3.

T-9 Barge Entrainment/Sill Bubble Curtain Evaluation

Lead Agency: U.S. Army Corps of Engineers (USACE)

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

FY 219 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$95,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: During FY 2015, an interagency team from USFWS, USGS, and USACE investigated the potential for entrainment, retention, and transport of freely swimming fish within the gap space at junction points between barges (junction gaps). Results of mark and capture trials provided direct evidence that small fish can become entrained within junction gaps and transported over distances of at least 15.5 kilometers as well as through locks and through the electric dispersal barrier system (EDBS) (Davis et al. 2016).

In FY 2016, the interagency team undertook a field study at the EDBS to examine the potential for transiting tows to create non-entrainment pathways for fish passage of the barrier system. This study showed that large schools of wild juvenile fish moved upstream and crossed the high-field array of Barrier IIB concurrent with downstream-bound (downbound) loaded tows. These schools were not observed to breach the barrier system in the absence of a tow and showed no signs of incapacitation in the barrier during tow passage. Loaded tows transiting the barrier create a return flow of water between the tow and the canal wall that typically travels opposite the direction of tow movement and cause a decrease in the voltage gradient of the barrier of up to 88%. Therefore, transiting tows reduce the efficacy of the EDBS through a combination of hydrodynamic processes and their effect on the electric field (Davis et al. 2017).

In FY 2017, the interagency team began two field studies to test mitigation strategies for entrainment and non-entrainment pathways for fish passage through the EDBS during tow passage: (1) the return flow mitigation study (non-entrainment pathway); and, (2) the water jet mitigation study (entrainment pathway). A briefing report and presentation on these two mitigation studies was completed in FY 2018. Additionally, in FY 2018, hydraulic data from the return flow mitigation study was published as a USGS data release and a journal article on this study was submitted to the Journal of Great Lakes Research. FY 2018 actions also included preliminary processing of NAIS shiptrack data and initial FluEgg runs for the early life stage Asian carp entrainment risk assessment modeling study.

Proposed Actions for FY 2019: The results from the return flow mitigation study will be published in FY 2019 (see specific milestones below). Additionally, USGS will collaborate on a multiagency publication of the water jet mitigation study, to be led by USACE. The early life stage Asian carp entrainment risk assessment will be completed in FY 2019 and will include a full analysis of the potential for tows to encounter eggs and larvae following spawning events in the Illinois River. This will allow the identification of high entrainment risk locations and temporal periods. Additional FY

2019 actions will include a collaboration with the USACE to plan and execute a USACE Engineering Research and Development Center (ERDC) laboratory study on the use of sill bubble curtains to flush entrained fish from junction gaps as a tow enters a lock chamber and field measurements of the flow characteristics around existing sill bubble curtains for validation of lab experiments. Finally, FY 2019 will involve planning and preparation for field trials testing the sill bubble curtains and modifications to the EDBS in the future.

Expected Milestones:

FY 2019 Q1:

- Complete additional FluEgg runs for barge-egg interaction study and combined analysis of NAIS shiptrack data with FluEgg runs; revise and resubmit journal article on mitigation of barge-induced return flows at the EDBS; collaborate with USACE and USFWS on publication of the water jet mitigation study.

FY 2019 Q2:

- Draft publication on early life stage Asian carp entrainment risk assessment modeling study; submit publication of the water jet mitigation study (tentative; USACE lead).

FY 2019 Q3:

- Publish journal article on mitigation of barge-induced return flows at the EDBS with the Journal of Great Lakes Research; Field measurements of flow characteristics around sill bubble curtains in absence of barges for purpose of validating lab study and testing instrument performance for out-year field experiments.

FY 2019 Q4:

- Plan barge field trials with multiagency team; share results of field measurements with ERDC modelers to validate lab study; move forward with planning for sill bubbler field trials if lab trials are effective.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Actions will include additional field experiments on the mitigation of tow-induced fish transport, including potential field-scale testing of sill bubble curtains and modifications to the EDBS (e.g. effects of raising Barrier IIB electrodes to 6.5 ft off the bottom to reduce voltage sag during barge passage).
- USGS will provide hydraulic and hydrographic data collection as needed for these mitigation studies and will contribute to publications in collaboration with partner agencies.

What Is Deliverable for this Project:

- Journal article on mitigation of barge-induced return flows.
- Journal article on use of sill bubble curtains to mitigate barge entrainment.
- Journal article on early life stage Asian carp entrainment risk assessment modeling (e.g., the combined analysis of NAIS shiptrack data and FluEgg runs).
- Data releases for new data collected.

Expected Completion Date for Project:

- This project is anticipated to end in FY 2022 or as determined by partner agencies, the Monitoring and Response Workgroup and the Asian Carp Regional Coordinating Committee.

Potential Hurdles:

- Publication schedule is affected by length of time various reviewers need which is beyond the control of project personnel.
- Collaborative publications with other federal agencies subject to each agency's publication policies and internal review process.
- USGS funding for sill bubbler characterization is dependent on USACE receiving funding for laboratory experiments.

How will the results of this project be disseminated?

- All journal articles will be publicly accessible through the USGS Publication Warehouse and links to articles will be posted on relevant websites (GLRI.us, asiancarp.us). Press releases will accompany publications when appropriate.
- Data releases with full metadata and made accessible on the USGS Science Base web portal (https://www.sciencebase.gov).

T-10 Development of Unified Method and Other Mass Removal Harvest Techniques

Lead Agency(s): U.S. Geological Survey (USGS) Columbia Environmental Research Center (CERC)

Agency Collaboration: Illinois Department of Natural Resources (DNR); Illinois Natural History Survey (INHS); Kentucky Department of Fish and Wildlife Resources (FWR); Missouri Department of Conservation (MDC)

FY 2019 Funding Table:

Agency Funding Expected			Asian Carp GLRI Funding Requested		
Unified Method	Mass Harvest	**Total**	Unified Method	Mass Harvest	**Total**
$215,000	$400,000	$615,000	$84,000	$284,000	$368,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

For successful control of Asian carp populations, mass removal techniques must be applied to maximize harvest across habitat types and drainage basins. Mass harvest of Silver Carp *Hypophthalmichthys molitrix* and Bighead Carp *H. nobilis* (hereafter referred to as bigheaded carps) in particular is challenging, largely due to their strong net avoidance behaviors. Therefore, evaluation of innovative capture gears and techniques across a variety of habitat types is important to identify the most effective methods for removing large quantities of Asian carp. Models suggest that populations of Asian carp must be impacted over a large geographic area and across life-history stages to reduce the overall population to a point that limits risk of upward expansion into the Great Lakes (Phelps and Willis 2013). Collaborative work will evaluate existing and developing mass removal techniques in numerous harvest basins within the Illinois River, Missouri River, and Cumberland River systems to further evaluate the effectiveness of removal techniques and harvest gears across a range of habitat types, and to monitor repopulation of experimental harvest basins.

Specific techniques that are being evaluated include methods for increasing Asian carp densities for more efficient removal via herding and capture of Asian carp using novel trap nets of varying size. These techniques are incorporated into activities derived from methods first developed in China (the "Unified Method"), that fish a waterbody as a unit, driving the fish to a central collecting point. In shallow water bodies in China, greater than 85% of the target fish can often be harvested. Asian carp herding technique development and evaluation, previously funded under the acoustic deterrents project, is now being integrated with different harvest gears and as a part of the Unified Method. Several trap nets, including the pound net, Merwin trap, and Iruka-style trap net will continue to be evaluated as passive and, when used in conjunction with herding, active harvest gears for Asian carp. Trap nets will also be tested in conjunction with attractants to evaluate whether baiting can increase harvest efficiency.

Summary of Actions to Date: In 2016, a variety of herding techniques were deployed in the upper reaches of the Illinois River (i.e., Starved Rock and Marseilles pools) in collaboration with U.S. Fish and Wildlife Service (USFWS,) Carterville Fish and Wildlife Conservation Office (Carterville FWCO-Wilmington). Asian carp were driven using: (1) a broad-frequency sound emitted from a boat mounted speaker (i.e., boat motor recording at high RPMs); (2) boat mounted electrofishing; (3) a method employed by commercial fishermen (i.e., techniques which include revving the motor, and banging on the hull of the boat); and, (4) a control treatment without any stimulation. Preliminary results indicated that all treatments yielded higher catches compared with the control, however formal hypothesis testing was not completed.

In 2017, herding trials were conducted in the Hanson Material Services East and West pits (Illinois River backwaters; Morris, Illinois) in collaboration with the USFWS Carterville FWCO-Wilmington office and on the Spoon River (Illinois River tributary; Havana, Illinois) in collaboration with Illinois Natural History Survey (INHS). The trials in the Spoon River were intended to compare the effectiveness of sound, electrofishing, and commercial fishing herding techniques. In Morris, Illinois, trials were designed to identify the effectiveness of the various herding movement patterns that were used in 2016 trials. In 2018, herding techniques were further developed by evaluating Asian carp responses to three different sounds, and several electrofisher anode configurations. The best-performing sound and anode configuration were selected and further tested in a field study evaluating four herding techniques and a control in a tributary to the Missouri River. A new trap net called the Merwin trap, and a pound net, were tested as passive gears in collaboration with INHS in several Illinois backwaters. Preliminary evaluations of harvest by each net when baited with food attractants were also performed.

In February 2018, a test of the unified method using sound and electrofishing as drivers, and block-netting with wide exits for escape of Asian carp from the cells was completed, with excellent catch rate, without using any gill nets and very low bycatch. However, the original plan of driving the fish using a very large trap net (the Iruka net) was unsuccessful and the fish were instead captured in a seine, resulting in nearly all the fish being captured over only two days. As a part of this effort, Asian carp removal rates were tracked with a combination of methods: environmental deoxyribonucleic acid (eDNA), hydroacoustics, and mark-recapture. Dual frequency identification sonar (DIDSON) video and sidescan sonar was used to track behavior in relation to driving and block-netting efforts. Future efforts will focus on enhancing the effectiveness of the trap nets, to distribute the catch over a more manageable time period.

Proposed Actions for FY 2019:

- The Merwin trap, pound net, Iruka-style trap net and one to two additional novel trap nets will be further tested in Illinois water bodies such as Starved Rock pool, Sheehan Island, and the Peoria pool where more Asian carp removals are needed.
- Results of 2018 herding work will be applied by using the most effective herding method to drive Asian carp into trap nets for removal, so they can be evaluated as active harvest gears.
- Perform hydroacoustic surveys to estimate fish abundance and identify aggregation areas in the parts of the lake where the nets are deployed.
- Use DIDSON to observe fish behavior when encountering various parts of the nets.

- Following adequate testing of gears, the trap nets will be assessed for their costs and effectiveness to measure their efficiency.
- Herding will be used and further evaluated in 2019 Unified Method events and as a potential supplemental harvest enhancement method to concentrate Asian carp.
- Develop methods for capturing young of year silver and Asian carp in Illinois backwaters.
- Complete and submit manuscripts on: (1) description of the Unified Method as used in China, and aspects of modifying the Unified Method for the sociopolitical and habitat conditions in North America; and, (2) the Creve Coeur Unified Method case study.
- Two scientists will travel to China and receive information on use of the Unified Method in deepwater habitats.
- Tests of Iruka net, most likely at Sheehan Island (Illinois River), and compare effort/cost of the Iruka to other gears.
- Perform preliminary tests of Unified Method in Barkley Lake coves (Kentucky).

Expected Milestones:

October-December FY 2019:

- Data analysis and summary report of 2018 trap net field trials.
- Data analysis of 2018 herding study.
- Provide support to Illinois DNR during Unified Fishing Event for the Dresden Island pool and evaluating herding efficiency.
- Travel to China, report on unified method operations in the U.S., and receive information on deepwater unified method strategies and tactics.

January-March FY 2019:

- Report or manuscript preparation of 2018 herding study.
- Manuscripts on Unified Method submitted.
- Project planning for 2019 field season.
- Begin trap net evaluation field work in March.
- Perform preliminary tests of Unified Method in Barkley Lake coves.

April-June FY 2019:

- Conduct bulk of field work in Illinois evaluating trap nets as passive and active gears specifically testing the Iruka net at a prime location identified by Illinois Department of Natural Resources (DNR) (Sheehan Island).

July-September FY 2019:

- Complete trap net and gear comparison field studies.
- Compile and quality assurance and quality control (QA/QC) data.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Evaluate trap nets with and without food attractants to determine if baiting will improve catch rates.
- Perform hydroacoustic surveys to estimate fish abundance and identify aggregation areas in the parts of the lake where the nets are deployed.
- Use DIDSON to observe fish behavior when encountering various parts of the nets.
- Update simple economic analysis to more accurately evaluate costs in terms of materials and personnel compared to catch rates for each net type, with and without attractants.
- Evaluate configurations and driving methods within Unified Method operations.
- Begin tests of "deepwater" unified method operations.
- Synthesize economic analyses, size distribution and catch rate data for all nets to date and evaluate the overall effectiveness of the methods tested to provide decision support materials to managers who may be interested in these harvest techniques.

What Is Deliverable for this Project:

- Short economic analysis report for the initial deployment phase of Iruka net, pound net, Merwin Trap, and any other novel trap nets that are developed and tested.
- Draft of a report or manuscript detailing initial deployment of both novel gears and analysis of catch, abundance, and behavioral data.
- Draft of manuscript on description of the Unified Method as used in China, and aspects of modifying the Unified Method for the sociopolitical and habitat conditions in North America.
- Draft of manuscript on the Creve Coeur Lake Unified Method case study.
- Draft of a manuscript for potential publication of the experimental approaches taken to evaluate the effectiveness of attractants and herding techniques for enhancing harvest by these two gears.
- More detailed economic analysis report for all methods tested.
- Report synthesizing economic analyses, size distribution and catch rate data for all nets to date and evaluate the overall effectiveness of the methods tested to provide decision support materials to managers who may be interested in these harvest techniques.

Expected Completion Date for Project: End of FY 2021.

Potential Hurdles:

- Coordination among agencies.
- Timeline to acquire equipment.
- Staff availability.
- Flooding or drought may negatively impact the gears and delay or interrupt experiments.

How will the results of this project be disseminated?

- Dissemination in journal articles and/or USGS reports.

T-11 Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

Lead Agency: U.S. Geological Survey (USGS)

Agency Collaboration: Illinois Department of Natural Resources (DNR), U.S. Fish and Wildlife Service (USFWS), Metropolitan Water Reclamation District (MWRD), Southern Illinois University (SIU), University of Illinois at Urbana Champaign (UIUC), and U.S. Army Corps of Engineers (USACE)

FY 219 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$59,400	$50,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: 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. A deeper understanding of how Asian carp interact with the hydraulics and water quality of a river will inform efforts to control Asian carp through commercial fishing and management of habitat factors. A previous component of this project completed in 2018 (to be published in 2019), identified a correlation between the location of the stalled Asian carp population front in the Illinois Waterway (IWW) and chemicals present in the effluent-dominated water at the population front. In collaboration with the UIUC, this work was extended in FY 2018 to include sampling of tissue from Bighead Carp near the population front for comparison to tissue samples from fish further downriver. Tissue samples were analyzed for a range of chemicals identified to be correlated with the population front and known to impact the physiology of fish. The results of this work will be published in FY 2019.

Ongoing components of this project include continuous monitoring and geospatial mapping to support Asian carp control in the IWW. Along with flow data, continuous monitoring of water quality in the main channel and backwaters of IWW provides information on waterway conditions used to predict fish movement and spawning activity and guide targeted commercial fishing activities and mass removal harvest techniques. Geospatial mapping of flow, water quality, and bathymetry supports control efforts of state and federal partners and provides critical habitat information that can be used in designing control methods and modelling hydrodynamics, population dynamics, and spawning and recruitment in the IWW.

Proposed Actions for FY 2019: The FY 2019 USGS Great Lakes Restoration Initiative (GLRI) funding request for this project covers the operation and maintenance of two continuous water-quality monitoring stations on the IWW, one in the main channel and one in a backwater of the of IWW in the Marseilles pool. Flow into and out of the backwater is also continuously monitored. Real-time data from these USGS gages provides information on waterway conditions used to predict

fish movement and spawning activity and guide targeted commercial fishing activities and mass removal harvest techniques by our state and federal partners. Real-time fish telemetry receivers are co-located at these gages (funded separately) to further guide control efforts and understand relations between fish movement, flow, and water quality.

The FY 2019 USGS agency funding request for this project will support completion and publication of research into the stalled Asian carp population front in the IWW, the relation to chemicals present in the effluent-rich water from Chicago, and the analysis of tissue from fish at and downstream of the population front. Agency funding will also support geospatial mapping in response to requests from state and federal as part of ongoing efforts to control Asian carp control in the IWW.

Expected Milestones:

Quarterly:

- Perform site visits, service continuous water quality gages, and work/publish data records.
- Complete geospatial surveys on an as-needed basis (determined by partner requests).
- Publish associated data releases.

FY 2019 Q1:

- Complete and submit journal article on correlation between the location of the stalled Asian carp population front in the IWW and chemicals present in the effluent-dominated water at the population front
- Begin drafting journal article on results of tissue analysis of Bighead Carp in the population front.
- Publish data releases required for publications.

FY 2019 Q2:

- Submit journal article on results of tissue analysis of Bighead Carp in the population front

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continuous monitoring and geospatial mapping in support of state and federal partners is expected to continue annually as determined by the Asian Carp Regional Coordinating Committee (ACRCC) and Monitoring and Response Workgroup (MRWG).
- Perform site visits, service continuous water quality gages, and work/publish all gage data.
- Complete geospatial surveys on an as-needed basis (determined by partner requests).
- Publish associated data releases.

What Is Deliverable for this Project:

- Journal article on correlation between the location of the stalled Asian carp population front in the IWW and chemicals present in the effluent-dominated water at the population front (with B. Battaglin, USGS).
- Journal article on results of tissue analysis of Bighead Carp in the population front (with C. Suski, UoI).
- Real-time continuous water-quality data in the main channel and backwaters of the IWW served via USGS National Water Information System (NWIS).

- Data releases for new geospatial data.

Expected Completion Date for Project:

- Continuous monitoring and geospatial mapping in support of state and federal partners is expected to continue annually as determined by the ACRCC and MRWG.

Potential Hurdles:

- Publication schedule is affected by length of time various reviewers need which is beyond the control of project personnel.
- Stream gages are subject to damage from lightning, flooding, and vandalism. Data outages may occur until repairs can be made.

How will the results of this project be disseminated?

- All journal articles will be publicly accessible through the USGS Publications Warehouse and links to articles will be posted on relevant websites (GLRI.us, asiancarp.us). Press releases will accompany publications when appropriate.
- Data releases with full metadata will be publicly accessible on the USGS ScienceBase web portal (https://www.sciencebase.gov).
- Real-time and historic water-quality data in the main channel (USGS 05543010) and backwater (USGS 411955088280601; seasonal) of the IWW served via USGS NWIS.

T-12 Technology Registration and Environmental Review

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

Agency Collaboration: U.S. Geological Survey (USGS), U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), U.S. Coast Guard (USCG), Wisconsin Department of Natural Resources (DNR), University of Wisconsin Platteville, University of Illinois, Kentucky Department of Fish and Wildlife Resources (FWR), Iowa DNR, Illinois DNR

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$140,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: This project supports the development, registration and use of various emerging technologies to control Asian carp, including carbon dioxide (CO_2), microparticle baits and acoustic Asian carp deterrents. In the past, USFWS registration and permitting efforts for the multiple deterrent technologies in development were funded in separate USFWS projects. To date, Section 7 consultation requirements were met for a proposed CO_2 test deployment site at auxiliary Lock and Dam 14 near Bettendorf, Iowa (postponed in 2018 due to National Pollutant Discharge Elimination System [NPDES] permitting concerns) and an Intra-Service Consultation is at Barkley Dam to support the field trial of a bio-acoustic fish fence (BAFF). A comprehensive list of standard operating procedures (SOPs) has been developed for use with CO_2 deterrents and a subset of these SOPs have been written at the request of Wisconsin DNR for a test deployment proposed in FY 2019 at Kaukauna Lock in the Lower Fox River lock system in Wisconsin. A registration packet for the use of CO_2 as both a fish deterrent and as a piscicide was submitted to USEPA in September 2018.

Since the technical registrant (Aquabiotics) for antimycin A was no longer willing to support the registration of the product, the registration of the piscicide antimycin-A was cancelled. This is one of the control agents that USGS has been testing with microparticle delivery technology as a species-specific control system for Asian carp. While the cancellation of antimycin A will require USGS to first develop a consistent supply of antimycin-A before conducting any additional field trials using microparticles, USFWS will continue to move forward with evaluation of proposed field trial sites in the context of Section 7 consultation needs.

Also, in FY 2018, coordination of the acoustic deterrent project to be installed at Barkley Dam commenced. A research team was identified that includes staff from USFWS, USGS, USACE Engineering Research and Development Center (ERDC), and the University of Minnesota. The National Environmental Policy Act (NEPA) permitting process for this project was initiated in the spring of 2018. A mussel survey was conducted at the site by Tennessee Wildlife Resources Agency

staff. Survey results are being used to inform a Biological Assessment that is being prepared by USACE Nashville District staff and reviewed by the USFWS.

Proposed Actions for FY 2019:

- Coordination among the multi-agency teams involved in developing and testing sound, CO_2, and microparticle deterrent registration and regulatory permitting.
- Section 7 consultation at demonstration site(s) that are deploying deterrent field tests.
    - Barkley Dam (KY) bioacoustics fish fence.
    - Fox Locks (CO_2).
- USEPA Registration of CO_2 for use as a deterrent of Asian carp and as a piscicide.
- Facilitate Federal and State Clean Water Act standards review for deterrent field deployment sites.
- Finalize SOPs for field deployment of concentrated CO_2 at Kaukauna Lock.
- Evaluate the effects of deterrents on non-target species from microparticle trials in 2018 and CO_2 and BAFF field trials in 2019.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Continue coordination among the multi-agency teams involved in developing and testing sound, CO_2, and microparticle deterrent technologies registration and regulatory permitting.
- Evaluation of field demonstration project for CO_2 delivery system at Kaukauna Lock.
- Section 7 consultation at demonstration site(s).
    - Lock and Dam 19.
    - Microparticle field site(s) - to be determined.
- Respond to USEPA and state regulatory agency review of data submitted to register and use antimycin-incorporated microparticles.
- Continue comprehensive planning assessments for deploying CO_2 at a lock and/or approach channel to deter Asian carp movements.

Expected Milestones:

- USEPA registration of CO_2.
- Completion of Section 7 consultation(s) at Kaukauna Lock.
- Completion of Section 7 consultation at Barkley Lock and Dam.
- Completion of SOPs for a CO_2 delivery system.

What Is Deliverable for this Project:

- Section 7 consultation and other regulatory needs for registration of Asian carp deterrents (multiple sites, includes Intra-Service Consultation requirement for Barkley Dam).
- SOPs for CO_2 for USEPA registration and for State Experimental Use Permit applications.
- Review of CO_2 registration application decision and response actions.
- Safety and training programs and protocols for agency staff for implementation of control technologies in the field.
- Section 7 consultation and other regulatory needs for registration of Asian carp deterrents (multiple sites).

- Draft SOPs and guidance documents for antimycin A-incorporated microparticles.
- Antimycin-A registration application package to USEPA.
- Section 7 consultation and other regulatory needs for registration of Asian carp deterrents (multiple sites).
- Review of antimycin-A registration application decision and response actions.
- Safety and training programs and protocols for agency personnel for implementation of control technologies in the field.

Expected Completion Date for Project: Contingent on projected completion dates for development of CO_2 and species-specific Asian carp deterrents, registration of these deterrents by USEPA, and all Section 7 regulatory needs for field study sites involving CO_2, microparticles, and acoustic deterrent technologies covered by this project.

Potential Hurdles:

- Federal and State regulatory permitting issues.
- Potential impacts on non-target species, including ESA-listed species.
- Limitations to producing antimycin-A.
- Failure to meet USEPA registration requirements.
- Engineering and operational challenges associated with deploying/installing deterrents in a lock and dam environment.

How will the results of this project be disseminated?

- Public outreach (GLRI.us, GLIN Announce, Asiancarp.us)
- Presentations to technical audiences
- Partnership meetings.
- Coordination meetings.
- Media releases.
- USEPA registration notices.
- Peer reviewed publications.

T-13 Evaluation of Gear and Novel Approaches - Modular Electric Barrier

Lead Agency: Illinois Department of Natural Resources (DNR)

Agency Collaboration: Illinois Natural History Survey (INHS), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$15,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: The Monitoring and Response Workgroup (MRWG) has facilitated several meetings to discuss design and implementation of novel gear. Most notably the use of Great Lakes style pound/fyke nets benefited from this work. Additional statistical analysis and sampling was completed by INHS to evaluate cost/benefit and suitability of gear to collect Asian carp in water of the Illinois Waterway (IWW). That study identified gears that could collect Asian carp of variable sizes throughout various habitats.

The MRWG and Illinois DNR has identified that a modular and portable electric barrier system could have several uses (1) in the case of catastrophic shut down of existing barriers or for supporting maintenance of those systems and (2) have a deterrence that could be set up in temporary systems to disrupt movement and/or spawning and potentially assist in harvest and detection operations.

The modular system has been procured and tested in controlled ponds in central Illinois. Over this next year standard operational and safety procedures will be developed in cooperation with Illinois DNR, USACE, and USCG. Considerations of appropriate use in public waterways will be identified. Such implementations in public waterways can commence once standard operating procedures (SOPs) are developed and permitted by regulatory agencies. Demonstrations of this may occur in 2019.

Proposed Actions for FY 2019:

- Continuing experimental tests of the modular electric barrier system will be conducted at the INHS's Sam Parr Biological Station.
- Locations for future potential field trials will be evaluated among select locations in IWW tributaries, side channels, or backwaters.

Objectives of Project:

- Develop operational protocols, safety and transport protocols, and cost estimates for the use of a modular electric barrier system for deterring movements of Asian carp.

- Evaluate and disseminate the effectiveness of the modular electric barrier system at deterring movements of Asian carp and other fish.

In 2019, this project will establish operational protocols for the use of a modular electrical barrier system, develop safety protocols, transport procedures, and cost estimates for the use of this system, and evaluate its effectiveness at deterring movements of Asian carp and other fishes. Pond trials at the INHS's Sam Parr Biological Station will map the electric field generated by the barrier under different conditions (e.g., conductivity levels) to examine the effects of environmental variability on barrier performance. Experiments will further evaluate whether Asian carp and native fish species cross the barrier under different operational settings compared with non-operational control periods. Potential sites for field trials will be explored in consultation with Illinois DNR, USACE, and USCG.

This project will complement the Barrier Defense and Detection/Management and Control below the Barrier projects by providing a potential alternative tool to deter movements of Asian carp. This technology may eventually be useful as a system to prevent movements of Asian carp into or out of specific areas during removal operations, as a backup system for fixed barriers, or as a method to prevent passage of Asian carp through lock chambers or other strategic passage points. Such activities may assist the Mass Removal and Enhanced Contract Removal Projects.

Expected Milestones:

- By December 2019 operational procedures will be drafted and shared with MRWG and Asian Carp Regional Coordinating Committee (ACRCC) partners.

Potential Out-year Actions (Subject to Future Appropriations):

- Upon finalization of the standard operational and safety procedures this tool should be available for implementation at various locations and further study may be minimal, albeit when deployed additional data collection is likely warranted.

What Is Deliverable for this Project:

- Operational and safety protocols will be drafted to allow this to be used and implemented in various and identified locations.

Expected Completion Date for Project:

- While no additional evaluation is planned at this time, work conducted in 2019 may identify needed and future work for implementation.

Potential Hurdles:

- This gear must consider both efficacy for biological control in the field but carefully consider safety of staff and public. Close coordination of such novel uses may necessitate further work for permitting not identified at this time.

How will the results of this project be disseminated?

- Monthly summaries of activities provided to MRWG.
- Annual summaries provided in the Interim summary reports.

- Coordination with Communication and Outreach Workgroup.
- When needed, and at least annually provide a briefing to ACRCC on status of Asian carp populations and observations. Upon request will provide summaries for online content of www.asiancarp.us, www.glri.us, or other.
- Peer reviewed manuscripts will be prepared upon completion of the project and shared with partners for further dissemination.

R-1 ACRCC Contingency Actions in the Upper Illinois River

Lead Agency(s): U.S. Fish and Wildlife Service (USFWS); U.S. Army Corps of Engineers (USACE) co-lead

Agency Collaboration: Great Lakes Fishery Commission (GLFC); Illinois Department of Natural Resources (DNR); U.S. Geological Survey (USGS), U.S. Coast Guard (USCG), Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), and all other supporting Asian Carp Regional Coordinating Committee (ACRCC) stakeholders

FY 2019 Funding Table:

Agency Base Funding			Asian Carp GLRI Funding Requested		
USACE	**USFWS**	**USGS**	**USACE**	**USFWS**	**USGS**
$0	$0	$0	$0	$0	$0

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: The purpose of the Contingency Response Plan (CRP) is to outline the process and procedures the Monitoring and Response Workgroup (MRWG) and ACRCC member agencies will follow in response to the change in Asian Carp conditions in any given pool of the upper Illinois Waterway (IWW). In the event a change is detected in the status of Asian carp in the project location indicating an increase in risk level, this plan will be implemented to carry out 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 CRP was formally adopted into the Monitoring and Response Plan (MRP) in 2016 with alternative response actions identified in previous plans which only covered the Chicago Area Waterway System (CAWS) upstream of the Electric Dispersal Barrier System (EDBS). Illinois DNR and the ACRCC announced the finding of one Silver Carp in the IWW below T.J. O'Brien Lock and Dam, approximately nine miles away from Lake Michigan on June 26, 2017. The Silver Carp capture triggered two additional weeks of intense sampling in the area, as outlined in the ACRCC's 2017 CRP beginning June 26, 2017 and ending July 7, 2017. In addition to this first response action directed by the CRP, a table top exercise was executed in 2016 which brought together action resource agencies and ACRCC stakeholders. The table top exercise introduced the proposed CRP, ran through potential scenarios in which an action would be triggered, and elicited feedback to understand acceptable levels of response actions and action agency capabilities.

Proposed Actions for FY 2019: This project will continue annually in association with other MRP projects in order to maintain a standard response structure, communication plan, and management strategy for the collaboration of multiple resource agencies. This plan will evolve over time as information changes and additional tools are developed. A table top exercise is the only planned action for FY 2019 and annually thereafter. The plan outlines specific triggers that may be realized

in any given sampling season which may result in a range of response actions tailored to the relative risk identified through collaborative discussion between action resource agencies and the ACRCC. In addition to the table top exercise, the CRP will also be updated with lessons learned for the 2019 MRP and any response actions taken summarized in the 2018 Interim Summary Report.

All efforts under this project will be covered by funding form other project descriptions.

Expected Milestones:

FY 2019 Q2:

- CRP 2018 Interim Summary Report will be drafted.

FY 2019 Q3:

- Table top exercise will be completed.

Potential Out-year Actions (Subject to Future Appropriations)**:** The CRP is an annual plan to be refined using lessons learned and incorporating the most up to date information available from monitoring and management projects within the MRP. Anticipated out year actions will replicate the above outlined actions for FY 2019. This template may be used as a mechanism to distribute additional funding on an as needed basis to action agencies in the event a response action is warranted in any given year.

What Is Deliverable for this Project: Minimal funding has been identified as a requirement for those planned actions in support of the table top exercise and to develop the annual MRP and Interim Summary Reports. Request and identification of the funding in support of these activities may be accounted for through alternative action plan templates on an agency-by-agency basis.

Expected Completion Date for Project: The CRP is anticipated to be an ongoing part of the MRP until such a time as Asian carp and like invasive species are no longer a threat to the ecology and economy of the Great Lakes Region.

Potential Hurdles:

- Timely response is the key to a successful response action. Inclement weather, interference with commercial or recreational marine navigation, and/or resource distribution may present hurdles to implementing an action quickly.
- Communication between agencies and successive approval to implement actions may also restrict some immediate response actions.
- There are some developing technologies identified for potential use which also may require specific regulatory approval prior to field implementation.
- All of these hurdles may be overcome with sufficient planning and justify strong coordination through continual communication and actively engaging on these topics at the annual table top exercise.
- Additionally, efficient funding is required to ensure each individual agency is resourced correctly to take action when required. This hurdle is mitigated to some degree by allowing individual agency templates to include funding which would cover some of the response tools outlined within the CRP. However, this project also serves as an additional mechanism to distribute funding as appropriate to supplement individual agency budgets.

How will the results of this project be disseminated?

- Annual Interim Summary Reports of the MRP.
- Asiancarp.us posted updates to significant findings and subsequent response actions.
- Teleconference communication as necessary during and after response actions between action agencies (MRWG) and ACRCC members.

BC-1 Black Carp, Monitoring, Assessment, and Control

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

Agency Collaboration: U.S. Geological Survey (USGS) Columbia Environmental Research Center (CERC), U.S. Army Corps of Engineers (USACE) Engineering Research and Development Center (ERDC), Illinois Natural History Survey (INHS), Illinois Department of Natural Resources (DNR), Southern Illinois University (SIU), Missouri Department of Conservation (MDC)

FY 2019 Funding Table:

Agency Funding Expected				Asian Carp GLRI Funding Requested			
USFWS (CART/LTRM)	**USGS (CERC)**	**USACE -ERDC**	**Illinois DNR/ ILNHS**	**USFWS (CART/ WGL)**	**USGS (CERC)**	**USACE-ERDC****	**Illinois DNR/ ILNHS**
$100,000	$102,000	$0	$0	$25,000	$377,000	$150,000	$175,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

**USACE-ERDC funds to be included in USFWS costs, will be transferred via interagency agreement

Total for FY 2019 GLRI Request: $727,000

Project Explanation

To effectively target Black Carp and control their spread, there is a strong need for baseline data on the biology, ecology, and current population status of Black Carp. This combined project template is a collection of several agency and academia project templates to support the monitoring, assessment, and control of Black Carp in the Midwest. The collection of projects proposed here have been discussed by the Black Carp Working Group (BCWG). In addition to work that continues from FY 2018, in 2019 there is a telemetry project to measure unbiased habitat use and movement. For future years, tests on black carp foraging ability for zebra mussels and unionid mussels are proposed. The collaborative project templates are part of coordinated research, monitoring, and development of control technologies:

- Enhanced Detection of Black Carp in the Lower Illinois River (INHS/Illinois DNR).
- Black Carp Biology, Ecology, Early Life History, and Habitat Use (USGS CERC and USGS Great Lakes Science Center [GLSC]; with support for habitat use from USFWS).
- Black Carp Genetic Support (USFWS-Whitney Genetics Lab [WGL]).
- Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations (USACE ERDC) with samples provided by USGS CERC.

Summary of Actions to Date:

Enhanced Detection of Black Carp in the Lower Illinois River

- Monitoring for Black Carp by the Illinois DNR and INHS has been part of the comprehensive monitoring strategy already in place in the Monitoring and Response Plan (MRP), however there has been specific focus on targeting Black Carp in events such as the Horseshoe Lake Removal event in July 2018. Additionally, the Black Carp bounty program implemented by the Illinois DNR has been incredibly successful in obtaining specimens for demographic data.

Black Carp Biology, Ecology, Early Life History, Bait Development, and Habitat Use

- Black Carp bait development: CERC
    - We have tested the forage size and delivery method of a dose of antimycin A encapsulated in a glass vial attached to the exterior of a host Asian clam.
    - A draft of the preliminary work is being prepared for review.
- Black Carp biology and ecology: CERC
    - Research on the biology and ecology of Black Carp consists of processing of wild caught fish for assessment of diet, reproductive stage, ploidy, age, growth, and genetics. USGS CERC serves as the deposition point for wild caught fish. These captures are processed to remove, and catalogue necessary tissues and structures allocated to USGS and other Great Lakes Restoration Initiative (GLRI)-funded projects.
    - A manuscript on diets of wild-caught Black Carp has been submitted to journal review.
    - A manuscript of the morphometric analysis comparing Black Carp and Grass Carp has been submitted for journal review. This manuscript is in response to an identified need because grass carp and black carp are similar in outward appearance and misidentifications were occurring, in part because of the unfamiliarity of biologists and fishers with this new invader.
    - A manuscript entitled "Examination of Black Carp Capture methods in the Mississippi River Basin", based on existing reports of black carp captures and available data on those fish captures has been drafted and currently is in in-house review.
    - Aging structures of Black Carp captured 2011 - 2017 have been processed, mounted, and aging, using the Asian carp aging protocol developed in 2018, has begun.
- Black Carp early life history: CERC
    - In 2018, brood stock was not available in aquaculture and although significant efforts were made to capture wild brood stock, those efforts resulted in only two fish that survived capture and transport. Problems with brood stock survival after capture have been assessed and a plan to acquire additional brood stock with a higher survival rate has been implemented to complete this objective in spring 2019. The brood stock collection plan has been implemented and additional wild brood stock have already been acquired in early FY 2019.

Black Carp Genetic Support (USFWS-WGL)

- Collaborated with USACE to lab and field validate new environmental deoxyribonucleic acid (eDNA) markers. WGL coordinated a round-robin marker validation in three federal labs, resulting in a new assay with three eDNA markers that could be multiplexed with the internal positive control to test for reaction inhibition. This is complete. (Black Carp Strategy Priority (1) implementation of systematic monitoring).
- The lab-validated marker failed field validation three times in different areas of the Mississippi River where large fish had been captured. A fourth attempt was successful in the small agricultural ditch where the young-of-year (YOY) had been captured. While minimally successful, further work is needed to refine the field sample collection method, which is covered in the USACE portion of the template. We are assisting as needed. (Black Carp Strategy Priority (1) implementation of systematic monitoring).
- Genetic sequence validation of species identification for YOY and two of the adult fish tested for ploidy was done for partners. Genetic microsatellite analysis was done on YOY to evaluate the number of adults that may have contributed to the YOY captured in 2016. There were no YOY captured in 2017, but 30 captured in 2018 will be analyzed with 2018 funds. The data will provide estimates on the minimum number of parents contributing to the cohort. (Black Carp Strategy Priority (1) implementation of systematic monitoring).
- Whole genome data were generated, and genomes are being assembled for publication. Complications with computer access have slowed down data analysis and genome assembly, but the planned completion date is Q3 FY 2019. (Black Carp Strategy Priority (2) identification of response actions; genome data could be useful for genetic control options).
- We provided technical assistance to USACE lab to use the same microsatellite techniques to analyze all adult Black Carp captured to date. (Black Carp Strategy Priority (1) implementation of systematic monitoring).

Black Carp Field Monitoring Support (USFWS-CART)

- Collected field samples in four marker validation attempts.
- As part of a monitoring project with Southern Illinois University (SIU), MDC and the assistance of Kentucky Fish and Wildlife Resources (FWR), we sampled the Ohio River, Missouri River, and several lakes with traditional gears.
- Placed water level loggers at strategic points in Dutchtown ditch where YOY have been captured, to estimate a relationship between Mississippi River gage height and ditch connectivity to help determine where the YOY could have been spawned.
- Continued sampling of Dutchtown ditch for YOY Black Carp.
- Produced handouts to promote the Illinois DNR Black Carp bounty and encouraged reporting by the public and other agencies.
- Updated the Black Carp collection protocol and distributed collection kits to interested agencies.
- Collected hydroacoustic habitat data in Alton, Illinois and Greenville, Mississippi, where many Black Carp have been captured by commercial fishermen.

- Sampled for Black Carp in the Ohio River, Missouri River, Lake Barkley, Kentucky Lake, and several floodplain lakes as part of a larger monitoring project with SIU and MDC. Sampling effort was over double that from FY 2017 and was often assisted by Kentucky FWR.

Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations

- Determining water fraction in which Black Carp eDNA largely resides and trade-offs among filter pore sizes in water volume processed vs. % DNA captured - which pore size gives us the most Black Carp DNA (in progress, some results, complete by end of October).
- Testing sediment eDNA for a stronger Black Carp signal (sediment sampling planned for first week of Oct, complete task by 31 Oct 2018).
- Continuing microsatellite genotyping of all adult Black Carp previously and currently captured, which will allow us to potentially compare minimum number of parents between lower vs upper Mississippi River basin populations, and cohorts from different age groups (in progress; complete by Q3 FY 2019.

Proposed Actions for FY 2019:

Enhanced Detection of Black Carp in the Lower Illinois River.

- Expand the existing Upper Mississippi River Restoration Program's Long-Term Resource Monitoring (LTRM) element hoop netting efforts to target Black Carp to better detect their presence and expansion up the lower Illinois River. The primary focus areas of this effort will be in the La Grange pool of the lower Illinois River. Fish communities will be sampled in multiple strata within main channels and side channels of the La Grange Reach. Expanded hoop netting in the La Grange pool will allow for increased detection of Black Carp and better inform managers of existing populations. Expanded hoop netting will use a clam-based bait to target Black Carp and, when paired with current LTRM efforts, will allow for comparison of efficacy of different baits (LTRM beancake vs. clam-based bait). All Black Carp collected will be kept and turned over to the proper agency for further study of Black Carp life history (fish age, origin, diet, *etc.*), greatly increasing our knowledge base of the species.

Black Carp Biology, Ecology, Early Life History, Bait Development, and Habitat Use

- USGS efforts to date have included three projects: (1) biology and ecology studies using captured black carp, (2) development of a Black Carp specific toxic bait, and (3) early life history including tools for identification and staging of black carp larvae. Further work on the selective toxic bait and some aspects of research on the biology and ecology of Black Carp will be postponed. The early life history of Black Carp study began in FY 2018, and data collection and analysis for that study is scheduled for final completion in 2019. Habitat use data collected via telemetry is proposed for FY 2019. The ability of Black Carp to forage on zebra mussels is proposed to begin in future years. Habitat use research is required to understand the distribution of Black Carp within invaded ecosystems for development of control methods and understand the species potential impacts. To date, the majority of information on Black Carp captures come from commercial fisheries data which are biased

toward the gear selectivity and distribution of effort by fishers for their target species and markets.

- Black Carp biology and ecology: CERC
    - Future work will focus on processing and aging current Black Carp collections for contribution into work on the status of the species, assessment of gonad development for determination of timing of wild spawning, and continued sorting of diet items collected for identification of mollusk taxa consumed. Upcoming diet work will be limited to molluscan prey and used to better understand the types of mollusks at risk from Black Carp and to assist in identification of feeding habitats based on types of prey consumed.
- Black Carp early life history: CERC
    - Development of a developmental series, like those completed for Bighead Carp and Grass Carp so that captured Black Carp can be identified and their age determined. Behavior of Black Carp larvae, as it effects drift and colonization, will also be assessed.
- Black Carp habitat use: CERC
    - The timing and use of habitats by Black Carp is important for understanding the potential impacts of the species and how to manage them.
    - The middle Mississippi River below Mel Price Lock and Dam, the first barrier between the free-flowing and impounded reaches of the Mississippi River will be the target location for this research.
    - We researched available maps for this reach, as the availability of floodplain habitat among various river stages will determine the final distribution of implanted fish and relocation of implanted individuals. A model will be available for use under various stage conditions for this project to assist with measurement of habitat and location of tagged fish.
    - A manuscript reviewing current capture methods, habitats, and time or year will be prepared to assist with this project.
    - We will procure telemetry equipment required for this project and combined with brood stock collection effort for early life history research, begin collaboration and permitting of commercial fishers who may assist with collections.
    - A plan is being developed for implementation in 2019. No tagged Black Carp will be released in Illinois waters. Support to the habitat use project will also be provided, MDC, and USFWS.
    - Telemetry is the only surveillance method we have not employed and will give us data on movement and habitat use, which we are unable to collect from sampling and carcass collection alone, which are strongly biased by (1) gear type, (2) fishability of different habitats, and (3) the species being targeted by fishers.

<u>Black Carp Genetic Support (USFWS-WGL)</u>

- Continue to provide sequence confirmation of visual identified YOY.
- Conduct relatedness and/or parentage analysis of wild-caught Black Carp age classes. Estimate effective number of breeders or effective population size.

- Collaborate as needed with USACE as they continue to improve eDNA collection methods. Upon optimization of eDNA methods by USACE, develop specific Standard Operating Procedure for Black Carp eDNA monitoring program. Implement eDNA monitoring program.

Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations

The USACE-ERDC genetics work is comprehensive and will include the completion of work scoped in 2018 as well as two new tasks.

- Further work on eDNA sampling strategies. About 85% of FY 2019 effort.
- Continue to genotype new samples and build information database on regional and local parentage trends. About 15% of FY 2019 effort.

Task 1: Surveys for additional Black Carp nursery locations and habitat using eDNA

Controlling or eliminating adult Black Carp from large river systems will likely prove very difficult, due to relatively low concentrations of fish, high flow, complex habitat structure, etc. A potential "pinch-point" in Black Carp life history that could allow for more effective control is the juvenile stage. Juvenile Black Carp inhabit relatively shallow stream and pool habitats, where the fish are perhaps more readily discovered (when present), potentially in higher numbers, and definitely more readily accessed. Attacking invasive populations at this life stage may also significantly much greater impact future breeding and population growth, compared to control methods focused on adults. In essence, controlling Black Carp at this stage has the potential to be relatively easier and more impactful. One of the primary challenges to attacking Black Carp nursery populations is finding them. We propose to use wide-scale, but efficient eDNA surveys to attempt to locate Black Carp nursery locations and characterize Black Carp nursery habitat features. eDNA surveys of waters holding juvenile Black Carp populations have already been shown to produce positive results.

For this Task, we propose to survey the full extent of the Dutchtown Ditch (known juvenile population) near Cape Girardeau, Missouri in the late summer, along with nearby stream, ditch, and flood plain pool/lake habitats in the same region. At the same time, we propose to survey these kinds of habitat in the vicinity of Greenville, Missouri, where adult Black Carp are frequently captured. These surveys would be conducted during low water periods. Following positive eDNA detections, sites will be netted in order to verify results. These first sets of surveys would be conducted in late FY 2019. If these initial surveys prove successful (some populations of juveniles located), then a new set of surveys, guided by prior results, would be conducted upstream (to the expected leading edge of upper basin Black Carp range) and downstream of the Cape Girardeau region in order to detect any Black Carp nursery locations that feed the leading edge of the invasion and to begin to determine whether there is any current clustering of nursery populations that feed the lower and upper basin adult populations, respectively. Based on these results, additional sampling in regions of interest in the mid and upper Mississippi River basins will be conducted in future years.

Task 2: Dietary exploration of juvenile Black Carp

Understanding the impacts of juvenile Black Carp on native ecologies will require an understanding of their diet. At the same time, understanding dietary patterns in juvenile black carp may provide key factors in predicting their presence or distribution. We propose to extract digestive tracts of juvenile black carp and assay the contents for the presence of different food items using DNA metabarcoding approaches. In addition to metabarcoding of juvenile Black Carp diets, zooplankton and other potential food species collected from habitats where juvenile Black Carp are found will be sequenced in order to increase the coverage of DNA barcode data for potential dietary items. The proposed task would require that additional juvenile populations be discovered.

Potential Out-year Actions (Subject to Future Appropriations)**:**

Enhanced Detection of Black Carp in the Lower Illinois River

- This project is year 2 of Black Carp efforts in Illinois River. Monitoring is necessary until better understanding about range and risk of movement of Black Carp is better understood. If other or ongoing monitoring begins to be sufficient for our management needs this project may be sunsetted.

Black Carp Biology, Ecology, Early Life History, Bait Development, and Habitat Use

- Black Carp bait development: CERC
    - Additional oral testing will be completed at higher doses of antimycin A than prior trials delivered in a prepared bait with the goal of ingestion and absorption of piscicide through the gastrointestinal tract.
- Black Carp bait development: lab development in FY 2019, pond testing in Arkansas if successful
- Black Carp biology and ecology: continuation with variable research objectives met annually
- Black Carp early life history: Data collection and manuscripts submitted
- Black Carp habitat use (telemetry):
    - Complete most data collection.
    - Produce manuscripts and attempt to recapture any telemetered Black Carp which have not already been recaptured. Note that this effort will also inform the potential use of telemetered fish as guide fish (Judas fish) because if Black Carp co-locate with conspecifics, other Black Carp will be captured in this process.

Black Carp Genetic Support (USFWS-WGL)

- Confirmation of species ID by genetics is usually done within two weeks of receiving samples from the field.
- Microsatellite analysis is completed within two months of receiving samples from the field.
- eDNA monitoring hinges on additional work and will commence once field methods are optimized.
- Continue to provide sequence confirmation of visual identified YOY.
- Conduct relatedness and/or parentage analysis of wild-caught Black Carp age classes. Estimate effective number of breeders or effective population size.

- Implement eDNA monitoring program per states requests (will be base funded).

Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations

Task 3: Population genetic studies of Black Carp

A key to whether Black Carp control efforts in the Upper Mississippi Basin will be effective is whether or not these populations are receiving significant immigration from Lower Mississippi Basin populations. Immigration in turn is a function of how far Black Carp disperse and the distance between populations. Another key feature of Black Carp control is understanding local population growth. Trends in genetic measures of effective population size and minimum numbers of breeding pairs between different age cohorts would provide useful indices of whether or not populations are increasing in size.

Our objective will be to better understand Black Carp population connectivity/histories in the Mississippi River basin. We propose to use recently collected and incoming Black Carp samples to build on Hunter and Nico's 2007 population genetic study (2014), which included only 14 wild-caught Black Carp (all captured from 2002-2011). Currently, there at least an order of magnitude more wild-caught Black Carp available for population analyses, with more being submitted for ploidy testing on a frequent basis. We will use standard genetic analyses and a combination of microsatellite DNA and mitochondrial DNA to address a number of questions, including: What is the scale of migration and interpopulation genetic connectivity in the Mississippi River basin? Are fish emigrating from the lower to upper Mississippi River basin? Are there seeming gene flow disruption points that would indicate current limits to dispersal? Do we see trends in increasing effective population size and breeding pool from lower to upper basin populations? How many breeding pairs are likely responsible for key populations (e.g. Horseshoe Lake population)?

We would also like to explore the degree to which stable isotope analysis can provide data on the likely origins of adult fish in the upper basin.

What Is Deliverable for this Project:

Enhanced detection of Black Carp in the lower Illinois River

- Expanded hoop netting will improve detection capabilities for black carps and estimates of the current population size in the La Grange pool. Data from any collected black carp will also greatly enhance knowledge of the species' life history.

Black Carp Biology, Ecology, Early Life History, Bait Development, and Habitat Use

- Black Carp bait development: CERC
    - Results of the forage size and delivery method of a dose of antimycin A encapsulated in a glass vial attached to the exterior of a host Asian clam.
    - A manuscript of delivery methods applied.
    - Results of oral toxicity of antimycin A in a prepared bait with the goal of ingestion and absorption of piscicide through the gastrointestinal tract.
- Black Carp biology and ecology: CERC

  - Processing, archival, and distribution of wild-caught Black Carp structures to collaborators as appropriate for research on biology and ecology of Black Carp in the U.S.
  - A manuscript of the first observations of diet items by wild- Black Carp can be applied to assess the ecological impact of the species.
  - Assessment of the ability of Black Carp to feed on dreissenid mussels.
  - A manuscript of the morphometric analysis comparing large juvenile and adult Black Carp and Grass Carp can be applied to assist outreach efforts and education as biologists and commercial fishers at the edge of the species range will be able to better identify and report Black Carp captures (manuscript is in review).
  - Future work will focus on processing and aging current Black Carp collections for contribution into work on the status of the species, assessment of gonad development for determination of timing of wild spawning, and continued sorting of diet items collected for identification of mollusk taxa consumed.
- Black Carp early life history: CERC
  - Development of a developmental series, like those completed for bigheaded carps and Grass Carp for use in models such as FluEgg and to understand life requirements.
- Black Carp habitat use: CERC
  - The timing and use within habitats is important for understanding the potential impact of a species and how to target that species for collection or removal. There are two types of data that can come from a telemetry study, movement and habitat use. Both have specific requirements for data collection and provide different results that managers can apply to the control of Black Carp. There is no information available on the wild habitat use of Black Carp from unbiased telemetry studies that can be applied to help manage the species, thus application of the existing network of receiver arrays will be applied in coordination with MDC and USFWS to determine the timing and distance of long-range movements by tagged fish if observed. Active telemetry is time and labor intensive but provides data on a fish's behavior within habitats. These data are needed to know potential foraging habitat and seasonal use of the floodplain versus channel habitats.
  - A manuscript summarizing current capture methods, habitats, and time or year will assist with development of monitoring programs and targeted collection efforts such as the habitat use study.
- Black Carp Genetic Support (USFWS-WGL)
- Confirmation of identification of YOY Black Carp. This allows for further downstream analysis including population genetics and diet analysis.
- Estimates for the minimum number of parents contributing to reproduction each year.
- Early detection eDNA program specific to Black Carp. Monitoring could provide information on:
  - Identification of spawning habitats.
  - Identification of nursery habitats.
  - Further clarification on the overall size of the Black Carp population or populations.

Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations

Task 1: Key outcomes including location of juvenile populations and knowledge of juvenile population habitat features.

Task 2: Key outcomes will be determination of juvenile Black Carp diet and potential ecological impacts of these fish on local ecologies, along with optimized methodology for DNA-based analysis of juvenile fish studies.

Task 3: Key outcomes including scales of dispersal and emigration, population origins, population effective sizes, and minimum breeding pair estimates.

Expected Completion Date for Project:

Enhanced Detection of Black Carp in the Lower Illinois River

- This project is year 2 of Black Carp efforts in Illinois River. Monitoring is necessary until better understanding about range and risk of movement of Black Carp is better understood. If other or ongoing monitoring begins to be sufficient for our management needs this project may be sunsetted.

Black Carp Biology, Ecology, Early Life History, Bait Development, and Telemetry

- Black Carp bait development: FY 2020.
- Black Carp biology and ecology: continuation with variable research objectives met annually.
- Black Carp early life history: FY 2019.
- Black Carp habitat use (telemetry): FY 2022.
- Black Carp bioenergetics and forage size testing: FY 2021.

Black Carp Genetic Support (USFWS-WGL)

- When monitoring efforts by the ACRCC end and no further effort to catch Black Carp is ongoing.

Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations

- All tasks will be complete by 2022.

How will the results of this project be disseminated?

Black Carp Genetic Support (USFWS-WGL)

- Technical reports confirming species identification are provided to agencies that captured the fish.
- Technical reports on the population genetics and minimum number of parents contributing to YOY cohorts are provided to the BCWG. Eventually to be published in peer-reviewed journals.
- eDNA results will be shared with partners and ACRCC in a fashion similar to the current eDNA program for Bighead and Silver Carp.

Genetic Studies to Assist in Surveillance and Control of Invasive Black Carp Populations

- Journal articles, webinars, and workshop/conference presentations.
- Data sheets with location and habitat information.
- Databases of dietary resources, journal articles, webinars.
- Workshop/conference presentations.

Black Carp Biology, Ecology, Early Life History, Bait Development, and Telemetry

- Dissemination of project specific journal articles or USGS reports.

GC-1 Adaptive Grass Carp Response and Monitoring in Lake Erie

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

Agency Collaboration: Ohio Department of Natural Resources (DNR), Michigan DNR, Ontario Ministry of Natural Resources and Forestry (MNRF), Department of Fisheries and Oceans Canada, Great Lakes Fishery Commission, New York Department of Environmental Conservation, Pennsylvania Boat and Fish Commission, University of Toledo, Michigan State University, Bowling Green State University, University of Illinois, and Central Michigan University

FY 2019 Funding Table:

Agency Funding Expected				Asian Carp GLRI Funding Requested			
USFWS	**USGS**	**Ohio DNR**	**Michigan DNR**	**USFWS**	**USGS**	**Ohio DNR**	**Michigan DNR**
$375,000	$779,048	$0	$250,000	$60,000	$300,000	$300,000	$300,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Grass Carp is recognized as one of the four Asian carp species threatening the Great Lakes basin. Unlike Bighead Carp, Silver Carp, and Black Carp, Grass Carp has been present in the Great Lakes since the 1980s. A recent binational risk assessment, Ecological Risk Assessment of Grass Carp (*Ctenopharyngodon idella*) for the Great Lakes basin, noted that the invasion process for Grass Carp has begun in the Great Lakes, with Lake Erie being especially at risk if no further actions are taken. Grass Carp have the potential to exert their greatest ecological impacts on Great Lakes coastal wetlands, which provide essential ecosystem functions and are critical habitat areas for many life stages of native fish, waterfowl and wildlife that sustain the economic and ecological viability of this unique freshwater ecosystem.

In recent years, the Asian Carp Regional Coordinating Committee (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 lead to improved action strategies. In 2016, Michigan DNR, collaborating with Ohio DNR, Ontario MNRF, 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 Lake Erie Committee, comprised of fishery managers from Michigan, Ohio, Pennsylvania, New York, and Ontario, and supported by Canadian and U.S. federal agencies, to begin common action to reduce the threat of Grass Carp to Lake Erie as it develops a 5-year strategy to control Grass Carp. Efforts to respond to Grass Carp threats support the coordinated and

cooperative fishery management conducted by Lake Erie 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 Aquatic Invasive Species (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 highest risk locations within the basin.

During 2017 and 2018, state, provincial, and federal agencies from both Canada and the U.S. collaborated to develop and implement Grass Carp removal techniques for river systems under differing flow regimes. Michigan and Ohio expect to increase their removal activity in FY 2019 with support from this Grass Carp template and assistance from USFWS and USGS. This increased removal effort, coupled with research into additional control strategies, should increase the ability of agencies to control the Grass Carp population in the short term and allow for continued progress toward eventual eradication of Grass Carp in Lake Erie. Research conducted by USGS that is detailed in the 2019 template will provide additional assistance to ongoing management activities.

In 2018, Ohio hosted a week-long targeted removal action under the Mutual Aid Agreement for Combating Aquatic Invasive Species Threats to the Great Lakes - St. Lawrence River Basin for Grass Carp in the Sandusky River during the week of June 11. State, provincial and federal government agencies from both Canada and the U.S. participated. Agencies captured 31 Grass Carp during this event, 28 from the Sandusky River and 3 from the Maumee River.

USFWS collaborated with Michigan DNR and Michigan State University to sample Michigan waters for Grass Carp. It also conducted regular surveys for AIS, including Grass Carp, throughout U.S. waters of western Lake Erie. USFWS continued development of a Grass Carp environmental deoxyribonucleic acid (eDNA) marker in the laboratory.

In 2018, USGS undertook the following:

- Continued researching Grass Carp reproduction, recruitment, spawning triggers, and habitat.
- Worked on the Sandusky and Maumee Rivers documented four more spawning events, two in each river. Sampling on two other rivers produced no eggs.
- Validated the hydraulic models used to project spawning areas, calculate the extent of spawning events, and estimate the number of spawning individuals in the Sandusky River.
- Completed two spawning trials assessing proximal spawning cues and the second year of determining accumulated heat required for Grass Carp gonadal maturation.
- Completed development of an age estimation method.
- Improved the Sandusky River hydraulic model.
- Collected aerial imagery for all areas of U.S. waters of Lake Erie less than 6 meters in depth for use in vegetation mapping.
- Developed a weighted wind fetch model.
- Completed the third year of sampling vegetation communities in western Lake Erie.

Collectively, these accomplishments reveal that:

- Grass Carp continue to be in low abundance and widely distributed during non-spawning periods.

- Natural reproduction of Grass Carp has been documented in Lake Erie.
- Grass Carp are utilizing specific tributaries periodically for reproduction. Specific real-time movement information helps managers target their Grass Carp removal efforts. Removal techniques are improving.
- Current targeting tools (eDNA) are not particularly effective in their current state. Adult Grass Carp, during summer months, appear to exhibit broad-scale movement patterns.

Proposed Actions for FY 2019:

USFWS: USFWS will conduct priority research, early detection and response actions in support of collaborative interagency Grass Carp management strategies focused on Lake Erie and key tributaries; and the USFWS Great Lakes Early Detection and Monitoring Program (GLEDMP). Activities will include the following:

Whitney Genetics Laboratory (WGL)

- Complete genetics activities conducted in 2018, including round-robin laboratory and field validation of the Grass Carp marker; and compilation of genomic data for all four Asian carp species (to be published).
- Support egg and larval fish identification with genetic sequencing, as needed by partner agencies.

Alpena Fish and Wildlife Conservation Office (AFWCO):

- Participate in coordinated Grass Carp response activities planned by Ohio and Michigan under the "mutual aid agreement" in western Lake Erie, the Sandusky River, the Maumee River, the Detroit River, or other adjacent tributaries, as identified.
- Continue to provide a dedicated Grass Carp early detection team to support surveillance and management needs on Lake Erie.
- Continue targeted Grass Carp (juvenile/adult) sampling/removal at high priority locations in Lake Erie, in support of state agency partner efforts.
- Continue targeted icthyoplankton sampling in the Sandusky River and Maumee River in collaboration with USGS and University of Toledo to collect Grass Carp larvae after documented spawning events.
- Continue early detection research in partnership with Michigan State University Quantitative Fisheries Center and Michigan DNR targeting Grass Carp in western Lake Erie.
- Support field trials for dedicated eDNA sampling for newly developed Grass Carp eDNA marker.
- Support efforts to broaden and maintain an acoustic array for Grass Carp detections across Lake Erie.
- Conduct electrofishing pond trials using electrical impulses best suited to induce a response by Grass Carp with the goal of defining electrofishing setting necessary to efficiently sample the species using this gear.

USGS: USGS will undertake the following actions:

- Continuation of monitoring of known and potential spawning rivers for early life history stages, improving sampling methods, and developing standard protocols and index stations for sampling.
- Continuation of collection of biological data to provide population-specific parameters (e.g., growth rate, age at maturation, mortality rate) to improve population models used to assess status and control measures, and to determine heritage (wild, hatchery) and spawning locations.
- Complete estimate of number of spawning individuals in the 2017 events in the Sandusky and Maumee Rivers merging nuclear microsatellite and rad-seq genetic analyses with egg developmental stages to determine if some fish spawn repeatedly in one or both rivers, and to inform overall population size (moved from "Molecular tools…" template).
- Continuation of trials assessing proximal cues for spawning and completion of the third year of assessing thermal maturation of Grass Carp.
- Development of hydraulic models for the Maumee River for use in the FluEgg model to predict spawning locations, examine egg and larvae transport and distributions, and identify the range of flows and water temperatures in the Maumee with the greatest potential for recruitment (for targeted control efforts).
- Water-level monitoring in the Maumee River in support of model development.
- Completion of telemetry of Grass Carp in Truman Reservoir to identify aggregations and their location(s) and to assess similarity of movements of diploid and triploid fish, and continuation of support of real-time telemetry of Grass Carp in Lake Erie tributaries.
- Completion of field work for the initial 4-year assessment of aquatic vegetation communities throughout U.S. waters of Lake Erie and use USGS-developed GIS models to estimate areas with potential to have vegetation where imagery does not exist.
- Improvement of mapping of submerged aquatic vegetation using aerial imagery, and examination of using side-scan sonar in place of down-oriented sonar for intermediate-scale mapping of aquatic vegetation.
- Test the efficacy of a Grass Carp-specific bait in controlled laboratory studies, registration of chemicals used, followed by pond trials in 2019.
- Assess potential attractants for Grass Carp, including spawning-related chemicals (pheromones), food-based (e.g., products of damaged vegetation) in support of development of control strategies.

Ohio DNR: Ohio DNR will be undertaking the following actions aimed at Grass Carp population reduction/eradication:

- Continue the University of Toledo study on the application of detection probability estimates to Grass Carp population estimates and catchability.
- Refinement of Grass Carp science to improve removal efforts that will include a dedicated Grass Carp Strike Team focused on removal and comparison of removal techniques. The Strike Team will work in cooperation with staff from Michigan DNR and USFWS.
- Partner with commercial fishing operations for Grass Carp removal.

- Continue efforts to evaluate the feasibility of a temporary or permanent barrier(s) to prevent Grass Carp movement into spawning or high use areas.

Michigan DNR: Michigan DNR will be implementing response strategies that were recognized as having the greatest likelihood to result in Grass Carp population reduction in Lake Erie. The strategies were collaboratively determined by a Lake Erie Grass Carp workgroup that participated in a Structured Decision-Making process that was facilitated by Michigan State University in 2016 and finalized in 2017. The project funding will be used to hire a Grass Carp response team that will implement the following actions:

- Implement and evaluate innovative control actions.
- Implement and evaluate response actions during different times of the day (night vs. day).
- Partner with commercial fishing operations for Grass Carp removal.
- Use real-time receiver detection in Plum Creek to inform response actions.
- Outreach with bow-fishers to promote removal.
- Implement strategic response actions in Ohio waters, as requested by Ohio DNR.
- Conduct random and fixed site monitoring to track population trends.

Expected Milestones:

USFWS:

1st/2nd Quarter-FY 2019:

- Validate eDNA markers.
- Process whole genome data.
- Support implementation of Lake Erie Grass Carp management strategy and GLEDMP (ongoing through FY 2019).

3rd Quarter-FY 2019:

- Develop and submit draft of whole genome publication to peer-review journal.
- Provide genetic identification of fish eggs or larvae collected during routine monitoring.

4th Quarter-FY 2019:

- Implement use of eDNA markers for Grass Carp in the field, minimally in Lake Erie, and potentially other Great Lakes tributaries.
- Provide genetic identification of fish eggs or larvae collected during routine monitoring.

USGS:

2nd Quarter 2019:

- First genetics-based estimate of the number of spawning individuals in the Sandusky River in 2017.

3rd Quarter FY 2019:

- Verification of the model-projected spawning area for Grass Carp in the Sandusky River and validation of the methodology used.
- Validation of several functions of the 1-D FluEgg model (*e.g.*, sensitivity of egg/larvae transport and distributions to multi-dimensional flows).

4th Quarter FY 2019:

- Completion of RAS and FluEgg models for the Maumee River.

Ohio DNR:

- Develop a Grass Carp Strike Team dedicated to the removal of Grass Carp from the Sandusky and Maumee Rivers. This dedicated crew will collaborate with Ohio DNR, Michigan DNR, and USFWS for targeted removal in 2019 - 2021 with traditional gear at specified locations in the Sandusky and Maumee Rivers building on information from previous activities.
- Hire experienced contractor to conduct a barrier feasibility study to determine how and where hydrological barriers (temporary or permanent) might be used to block movements of Grass Carp and/or support population reduction actions in the Sandusky and Maumee Rivers.
- Continue to develop space and time bound predictions of adult Grass Carp spawning aggregations.
- Refine the University of Toledo's Grass Carp detection probability model using information from the Grass Carp removal actions.
-

Michigan DNR:

- Hire a Grass Carp response crew to implement response actions. This crew will collaborate with Ohio DNR, USFWS, and USGS for targeted removal in 2019 - 2021 with traditional gear at strategic locations in Michigan waters of Lake Erie. The crew will also assist, as requested by Ohio DNR, with response in the Sandusky and Maumee Rivers.
- Continue to hire response crew and implement Michigan's Lake Erie Grass Carp Response Plan.
- Use science-based approach to annually refine and adapt response actions to increase effectiveness and impact of response.
- Continue to partner with Michigan State University to coordinate collaboration meetings among Lake Erie partner agencies for Grass Carp response.

Potential Out-year Actions (Subject to Future Appropriations)**:**

USFWS:

- Conduct subsequent eDNA monitoring efforts, per state agency partner requests.
- Continue genetic-based identification of fish eggs and larvae collected during routine monitoring efforts.
- Continue support for implementation of interagency Lake Erie Grass Carp management strategy and GLEDMP.
    - Field-based detection, response, and eradication actions identified in FY 2019 will be similar to subsequent years; however, adjustments to sampling strategies will be made using the adaptive management process in collaboration with state, federal, and provincial partners.

USGS:

- Continue monitoring Great Lakes tributaries for evidence of Grass Carp spawning, including eDNA monitoring, to detect new spawning populations and to collect eggs for estimates of numbers of spawning individuals to assess population growth and effectiveness of control measures.
- Update Sandusky River models to predict Grass Carp spawning areas upstream of the site of the former Ballville Dam (relies on discovery of evidence of Grass Carp spawning upstream of the former dam).
- Analysis of the range of flows and water temperatures in the Maumee River with the greatest potential for recruitment using the hydraulic and FluEgg models developed in FY 2019.
- Continue analyses merging egg developmental stages with nuclear microsatellite and rad-seq genetics methods to estimate the number of Grass Carp that spawned in the Sandusky and Maumee Rivers in 2018 and beyond.
- Initiate field trials testing lab-identified specific spawning cues as a means to draw fish into low-success areas for spawning and potential capture.
- Begin field testing of methods related to proximal spawning cues to manipulate Grass Carp spawning.
- Begin biennial vegetation sampling and mapping to assess changes to aquatic vegetation community.
- Begin assessments of sound-based methods to deter in-migrations of Grass Carp.
- Begin field testing of adult capture methods using food- or pheromone-based attractants.
- Improve methodology for mapping vegetation at coarse scales.
- Conduct initial field testing of baits and attractant-based capture methods.

Ohio DNR:

- Refinement of Grass Carp science.
- Targeted removal of Grass Carp to suppress/eradicate population in Sandusky and Maumee Rivers.
- Determine Grass Carp detection probability and population size.
- If barrier feasibility study determines that barriers are feasibility, select the most feasible barrier option for blocking Grass Carp movement in the Sandusky and Maumee Rivers during high flows for more in-depth engineering analysis and design for construction and deployment.

Michigan DNR:

- Implementation and evaluation of response actions for Grass Carp in Lake Erie listed above will be ongoing. These actions will be multi-faceted and will take multiple years to determine the success.

What Is Deliverable for this Project:

USFWS:

- Development of assemblages of whole genomes for all four species of Asian carp.

- Development of suite of three new eDNA markers for use in monitoring programs by state and federal agencies.
- Confirmed identification of fish eggs and larvae collected during monitoring efforts.
- Enhanced understanding of effectiveness of standard electrofishing techniques for use in detecting/ removing Grass Carp under specific environmental conditions.
- Continued direct support of interagency partnership efforts to implement a comprehensive Grass Carp management strategy in Lake Erie and tributaries (includes support for rapid response and other mutual aid exercises directed at Grass Carp removal/eradication in the Great Lakes); and the GLEDMP.

USGS:

- Several research publications on validation of hydraulic and FluEgg models, genetic-estimates on numbers of spawning individuals, heritage of naturally-reproduced Grass Carp in the Great Lakes (i.e., which rivers), assessment of light traps for capturing larval Grass Carp, baseline vegetation communities and mapping methods, and potentially others.
- Maumee River hydraulic and FluEgg models in support of projecting spawning areas for Grass Carp.
- Maps of vegetated areas in Lake Erie, assessment of suitability/preference based on amount and types of vegetation present, and assessment of 3-tier system for vegetation mapping and monitoring.

Ohio DNR:

- Suppress/eradicate Grass Carp from the Sandusky and Maumee Rivers.

Michigan DNR:

- Suppress/eradicate Grass Carp from Michigan waters of Lake Erie, while providing response assistance to the Ohio DNR in the Sandusky and Maumee Rivers.

Expected Completion Date for Project:

USFWS: The following activities related to the development of genetics technologies will be completed in FY 2019:

- Validation of eDNA markers.
- Processing of whole genome data and drafting and submittal of whole genome research manuscript for publication in peer-review journal.

Activities conducted to support implementation of Lake Erie Grass Carp management strategy and GLEDMP will be ongoing through FY 2019.

USGS: There is not a firm completion date for this project.

Ohio DNR: This will be an ongoing effort to control/eradication Grass Carp populations in Lake Erie and improve long-term opportunities for eradication.

Michigan DNR: This will be an ongoing effort to control/eradication Grass Carp populations in Lake Erie and improve long-term opportunities for eradication. The response actions will be evaluated on an annual basis by the Lake Erie Grass Carp Structured Decision-Making Workgroup.

Potential Hurdles:

USFWS: None

USGS:

- Field conditions can affect what data are collected and when (e.g., high flows required for spawning and collection of hydraulic data for model creation). If field conditions are not right for the data required timelines will be delayed.

Ohio DNR:

- The largest potential hurdle for the proposed project is low sample size and episodic reproduction.
- The development of an effective control plan is dependent upon gaining information on life history characteristics, which can only be gained through collecting and analyzing enough individuals to determine if consistent spatially and temporal patterns emerge that can aid control efforts.

Michigan DNR:

- The evaluation of response actions in such a large geographic area (i.e., Lake Erie) will be the largest challenge. This is especially true considering the relatively low number of Grass Carp that have been captured to date. These challenges will be addressed using statistical methods and collaboration with other jurisdictions to increase our understanding of the impact that response actions had on the Grass Carp population.

How the results of this project be disseminated:

USFWS:

- Results summarizing genetics technology developmental activities will be made available through publication in peer-reviewed journals. Summaries may also be made available to agency partners through hosted webinar briefings and website postings.

USGS:

- Peer-reviewed publications, oral and poster presentations at meetings, media releases (where appropriate), presentations to Great Lakes Panel on Aquatic Nuisance Species; reports to the Lake Erie Committee (Forage Task Group), updates on Asiancarp.us.

Ohio DNR: Through Ohio DNR news releases and AsianCarp.us.

Michigan DNR:

- Through news releases and the Michigan DNR website as well as Asiancarp.us.
- Presentations will also be provided at professional conferences and meetings and to stakeholder groups at various meetings.

Comm - 1 ACRCC Strategic Communications

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

Agency Collaboration: All Asian Carp Regional Coordinating Committee (ACRCC) Partners

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$100,000	$250,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: USFWS has served as co-chair of the Communication and Outreach Workgroup since the inception of the ACRCC. We have successfully coordinated internal communications across the partnership, as well as external communications with key audiences. We routinely engage and help organize communication efforts related to ACRCC actions, which includes the creation of common messaging across ACRCC partner agencies.

In FY 2018, USFWS led the effort to completely overhaul and update AsianCarp.us, the partnership's primary communication platform. Improvements to the site included making it mobile device friendly, more intuitive navigation, updated content, improved branding in the form of a new logo, and compliance with section 508 of the U.S. Workforce Rehabilitation Act (1973). Finally, the value of our communication efforts has been noticed by agencies across the nation. We have received multiple invitations from organizations to share our communications model to help guide others with large-scale, multi-agency early detection and rapid response efforts.

Proposed Actions for FY 2019:

Requested funding will be used by the USFWS to lead the implementation of targeted ACRCC communication efforts. Work includes management of the ACRCC website, AsianCarp.us; organizing public listening sessions; targeted media outreach; coordinating partner responses to public, congressional and media inquiries; refinement of ACRCC early detection notification protocols; creating ACRCC branded communication products; enhancing the ACRCC's image library and ultimately increasing the reach of ACRCC messaging. Communications work will contribute to key audiences having a greater understanding and appreciation for the ACRCC's purpose, function, current actions and successes.

Expected Milestones:

Throughout the year:

- Coordination of editorial board visits and media availabilities to foster media engagement.
- Scheduling and/or coordination of outreach opportunities throughout the year with key members of Congress and their constituents including, but not limited, to Hill briefings, listening sessions, roundtables and site visits.

- Scheduling and/or coordination of ACRCC participation in targeted outreach opportunities throughout the year with key stakeholders including, but not limited to briefings, listening sessions, roundtables and site visits.
- Creation of ACRCC branded communication products and messaging
- Management and refinement of AsianCarp.us.
- Assist with sharing ACRCC communication model and lessons-learned with interested groups working on their own multi-agency early detection and rapid response efforts.
- Expansion of teacher resources available on AsianCarp.us.

FY 2019 2nd Quarter:

- Asian Carp Communications Workshop at Minnesota Valley National Wildlife Refuge, Bloomington, Minnesota. Federal, provincial, and state communications representatives will identify FY 2019 storytelling and media engagement opportunities. Review website performance and discuss potential improvements.
- Public meeting planning and scheduling.

FY 2019 3rd Quarter:

- Public meeting/listening session. Location will be determined.
- Completion and posting of Black Carp identification video.
- Organize roll out and posting of the 2019 ACRCC Action Plan, Monitoring Response Plan (MRP), and Contingency Response Plan (CRP).
- Targeted media engagement event.

FY 2019 4th Quarter:

- Completion of FY 2020 Strategic Communications Plan.

Potential Out-year Actions (Subject to Future Appropriations)**:** Communications work is ongoing and will continue to include:

- Coordination of editorial board visits and media availabilities to foster media engagement.
- Scheduling and/or coordination of outreach opportunities throughout the year with key members of Congress and their constituents including, but not limited, to Hill briefings, listening sessions, roundtables and site visits.
- Scheduling and/or coordination of ACRCC participation in targeted outreach opportunities throughout the year with key stakeholders including, but not limited to briefings, listening sessions, roundtables and site visits.
- Creation of ACRCC branded communication products and messaging.
- Management and refinement of AsianCarp.us.
- Assist with sharing crisis communications lessons-learned with interested groups working on their own multi-agency early detection and rapid response efforts.
- Expansion of teacher resources available on AsianCarp.us.

What Is Deliverable for this Project:

- Ongoing management and maintenance of AsianCarp.us, which results in a dynamic and up-to-date web-based communication platform.

- Planning and organization of a public meeting/listening session.
- Coverage of ACRCC coordinated work in local, regional, national and international media outlets.
- Outreach products include Section 508 compliant Black Carp identification video, and enhanced image library (flickr.com/ACRCC).
- Access to professional communications support and coordination for all ACRCC communication needs.
- 2020 Strategic Communications Plan document.

Expected Completion Date for Project: Communications is ongoing

Potential Hurdles: None

How will the results of this project be disseminated?

- The majority of the communications work completed under this template is public facing in nature. Work can be directly viewed on AsianCarp.us and flickr.com/ACRCC.
- Resulting ACRCC media coverage.
- ACRCC communications lessons-learned will be shared in various forums, which in the past have included an AFS state chapter meeting, National Invasive Species Council Community of Practice webinar, and panel discussions at both the Outdoor Writers Association of America and Western Governors' Association meetings.

PO-1 ACRCC Partnership Operations

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

Agency Collaboration: U.S. Environmental Protection Agency (USEPA)

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$75,000	$75,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: Asian Carp Regional Coordinating Committee (ACRCC) Partnership Operations includes contract program support staff support to the ACRCC agencies in developing reports, tracking activities; providing field support as necessary; and continued support of the ACRCC's efforts to enhance collaborations among the federal, state, and local partners.

ACRCC program support staff works closely with the Asian carp stakeholder partners and assists ACRCC activities to ensure agency collaboration activities including the following:

- Development and refinement of the Asian Carp Action Plan.
- Facilitation of meetings and outreach activities to keep the public and ACRCC member agencies aware and engaged in the control process.

Proposed Actions for FY 2019: The ACRCC program support provides assistance through the following primary efforts:

- Working with the ACRCC and other stakeholders both in the Great Lakes and in the Mississippi River basins.
- Assists USFWS in the development of the annual report identified in the Water Resources Reform and Development Act (WRRDA) of 2014.
- Assists in ensuring bi-national (U.S. and Canada) coordination in sharing of Asian carp control information, including efforts under the national Asian carp control plans.
- Development of the Asian Carp Action Plan, including interagency and intergovernmental coordination; and communication and outreach.

In FY 2019, the ACRCC program support will work with the ACRCC and interested stakeholder and be actively involved in the following:

- Provide support to the ACRCC co-chairs to support the activities of the ACRCC.
- Convening ACRCC calls once a month to discuss progress made on control activities.
- Assist in convening twice a year ACRCC face-to-face meetings to discuss agency input, as directed by the ACRCC co-chairs.
- Assist in convening Congressional briefings, as needed and as directed by the ACRCC co-chairs.

- Support the stakeholder consensus building process for long-term solutions to address aquatic nuisance species transfer between the Great Lakes and Mississippi River basins.
- Assist in convening public updates with agencies and stakeholders across the Great Lakes as directed by the ACRCC co-chairs.
- Assist the Monitoring and Response Workgroup (MRWG) in the development and release of the Monitoring and Response Plan (MRP) and work with the MRWG to help coordinate the extensive monitoring under the MRP for the Chicago Area Waterway System (CAWS) and the Illinois River.
- Attend CAWS Stakeholder Committee and Technical and Policy Work Group meetings, as directed by the ACRCC co-chairs.

The ACRCC program support will assist the USFWS in the development of the Asian carp annual WRRDA report. This may include assisting with the following:

- Soliciting and collating necessary information and data (annual expenditures, accomplishments, planned research, *etc.*).
- Compiling, editing, and drafting narrative summaries.

Additional duties to be completed by the ACRCC program support will include providing support to the USFWS on development and execution of outreach and engagement efforts on the WRRDA Report conclusions and recommendations with appropriate State and nongovernmental partners, following delivery of the WRRDA Report to the designated Congressional committees by the USFWS.

The ACRCC program support staff will assist in the efforts to share information on Asian carp control plans. This will include working with states both within Great Lakes basin and in the Mississippi River basin.

In FY 2019, the ACRCC program support staff will assist USEPA, USFWS and the ACRCC members in the identification and development of projects for the 2020 Action Plan. The ACRCC program support staff will assist in the effort to coordinate and support agencies in their efforts to work together to implement efforts that prevent invasive Asian carp from establishing in the Great Lakes.

The ACRCC program support staff will also work with the USFWS and Illinois Department of Natural Resources (DNR) to continue the coordination of Great Lakes Asian carp prevention communication effort by engaging Federal, state, and local governmental units; stakeholders in both the private and public sectors; Congressional committees, subcommittees, and staff; and media contacts. The ACRCC program support staff will also work with the Communication Work Group on the release of the Asian Carp Action Plan and will work with the MRWG on development and release of the MRP.

Expected Milestones: Milestones will be dependent on work requested by USFWS and the ACRCC.

Potential Out-year Actions (Subject to Future Appropriations)**:** Work will continue as requested by USFWS and the ACRCC.

What Is Deliverable for this Project:

- Assist in the development of the 2020 Asian Carp Action Plan, including interagency and intergovernmental coordination; and communication and outreach.
- Assist in the development of the annual WRRDA report.
- Support to the ACRCC co-chairs in support of activities of the ACRCC.
- Assist in convening twice a year ACRCC face-to-face meetings to discuss agency input, as directed by the ACRCC co-chairs.
- Assist in convening Congressional briefings, as needed and as directed by the ACRCC co-chairs.
- Support the stakeholder consensus building process for long-term solutions to address aquatic nuisance species transfer between the Great Lakes and Mississippi River basins.
- Assist in convening public updates with agencies and stakeholders across the Great Lakes, as directed by the ACRCC co-chairs.
- Attend CAWS Stakeholder Committee and Technical and Policy Work Group meetings, as directed by the ACRCC co-chairs.

Expected Completion Date for Project: September 2020

Potential Hurdles: None

How will the results of this project be disseminated? There are no direct results related to this project. However, this effort will assist other ACRCC agencies with project dissemination.

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

Lead Agency: Northwestern Indiana Regional Planning Commission (NIRPC)

Agency Collaboration: The Chicago Area Waterway System (CAWS) Aquatic Invasive Species (AIS) Stakeholder Group includes approximately 30 public and private stakeholders that benefit from and have responsibilities related to the CAWS, as well as regional stakeholder groups representing commercial, recreational, and environmental interests. The City of Chicago, Illinois Department of Natural Resources (DNR), Illinois Department of Transportation, Illinois Environmental Protection Agency (EPA), Indiana Department of Environmental Management (IDEM), Indiana Department of Transportation, Michigan DNR, U.S. Army Corps of Engineers (USACE), U.S. Department of Transportation, the Great Lakes Commission (GLC) and the Indiana Wildlife Federation are ex officio members of the committee. The committee's resource group includes U.S. and Canadian federal, state and provincial agencies, tribal authorities, and regional agencies.

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$87,300

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

Summary of Actions to Date: GLC convened the CAWS Advisory Committee in 2014 to provide a constructive forum for diverse stakeholders to build consensus on and advance progress in developing both interim control measures and a long-term solution to prevent AIS transfer through the CAWS. The committee was recently renamed the CAWS Aquatic Invasive Species Stakeholder Group, and currently includes approximately 30 public and private entities as well as regional stakeholder groups representing commercial, recreational, and environmental interests. In 2018 the group adopted new operating principles and established a new workplan.

The GLC will be transitioning out of its administrative support role for the group by the end of 2018 and this role will be assumed by the NIRPC. The GLC is assisting NIRPC in taking on this support role and will establish a contract with them to support their work from fall 2018 through June 2019. It is anticipated that a new grant from USFWS will be provided directly to NIRPC to sustain their administrative support role in 2019.

The CAWS Group has made progress over the past year in improving its operations and the members are committed to maintaining the group and continuing to focus on both near-term and long-term solutions to preventing AIS transfer through the CAWS. It is specifically focused on proposed control actions at Brandon Road and the upcoming release of the draft Chief's Report. The group is well positioned to review progress in advancing the proposed plan for Brandon Road and, where possible, support its implementation in 2019.

The CAWS group is the only stakeholder forum in place to receive reports from, and provide input to, federal and state agencies. While the group's dynamics have been challenging, it continues to play a valuable role in ensuring the transparent exchange of information and perspectives on options for preventing AIS movement through the CAWS. It has a particularly important role to play in building stakeholder support for high-profile activities, such as the proposed Brandon Road plan.

Qualifications and Capacity of the Lead Agency:

The NIRPC is the Council of Governments and Metropolitan Planning Organization for Northwest Indiana. It is charged by state statute to coordinate planning and programming in Lake, Porter, and LaPorte counties in the areas of transportation, environment, and economic development. The problems, issues, and solutions that the CAWS AIS Stakeholder Group is working to address lie at the nexus of the agency's three domains. For over 50 years NIRPC has successfully worked to facilitate regional planning, balancing the competing interests and needs of communities, industries, and environmental protection in our region in order to secure federal infrastructure funding across our three counties and 41 cities and towns.

NIRPC is responsible for the five-year Transportation Improvement Program allocating $200 - $250 million in federal surface infrastructure investments across the region. It also creates regional Long-Range Transportation Plans that address diverse topics such as congestion mitigation, air quality, and freight planning, and environmental quality. NIRPC's Finance Department directly administers $6 million in Federal Transit Administration operating and capital funds and ensuring regional transit subrecipients comply with all federal requirements.

Since 2007, NIRPC's Environmental Department has completed over $1 million in environmental grants and contracts with federal funding from U.S. Environmental Protection Agency (USEPA), U.S. Forest Service, Department of Energy, IDEM, and Indiana DNR. All work is in collaboration with elected officials, municipal staff, state and federal agencies and stakeholders. This history of close partnership with agencies such as the IDEM, Indiana DNR, Save the Dunes, The Nature Conservancy, Chicago Wilderness, the Calumet Collaborative, and the National Park Service and as well as the Northwest Indiana Forum, Indiana DOT, NIPSCO, and others has gained NIRPC staff credibility with many stakeholders across our region and in the Chicagoland area.

Staff Allocation to the Project:

Staff	FTE	Role
Chief of Staff	5%	Team Oversight, Grant Manager, Agency Liaison
Sr. Water Resources Planner	2%	Technical Point of Contact for CAWS resource agencies and working groups
Long-Range Planner	5%	Team Coordinator
Public Participation Planner	20%	General Communication and planning, stakeholder coordination
Regional Planner/Policy Analyst	5%	Website Construction
Administrative Assistant	15%	Meeting Logistics & Communication Support

Proposed Actions for FY 2019: The CAWS group's primary focus in 2019 will be on advancing the proposed plan for control actions at the Brandon Road Lock and Dam, including completion of the Chief's Report, coordinating with non-federal sponsor(s) on options for the non-federal cost share, and exploring options for long-term operations and maintenance. Identifying and promoting feasible control actions at the Brandon Road Lock and Dam has been a longstanding priority for the group, and one that it reconfirmed at its last meeting in July 2018.

The group recognizes the next 12-24 months as a critical period to complete a feasible and broadly supported proposed plan and then monitor and support key upcoming steps toward its implementation. There is significant regional and Congressional interest in the Brandon Road plan, and the CAWS group is an important forum for exchanging information and receiving updates from the USACE, USFWS, the State of Illinois, and other federal and state agencies. The recent letter from the bipartisan Senate Great Lakes Task Force to the Assistant Secretary of the Army for Civil Works supporting funding for the Brandon Road study illustrates the high level of interest in this effort and the value of keeping stakeholders informed and engaged as the project moves through critical upcoming steps.

Upcoming changes in leadership at the state level may also affect possible implementation of potential control actions at the Brandon Road Lock and Dam. The CAWS group provides a well informed and broadly representative forum for coordinating with state leaders. This will be a critical function to ensure broad understanding of state and federal perspectives, and support for the project.

Beyond potential control actions at Brandon Road, the CAWS group will continue to review and provide input on prevention and control actions being led by federal and state agencies; the work of the ACRCC; AIS lock treatment concepts; outcomes from hydrology and hydraulic investigations of impacts from AIS controls in the CAWS; cost-share options for new control actions; impacts to maritime transportation in the CAWS; and general review of the status, impacts and trends of AIS in the Great Lakes and Mississippi River basins.

Expected Milestones: The following are general milestones that would be anticipated during the project period. Exact dates for meetings may vary based on the needs of the CAWS group members and other factors.

Ongoing

- Project oversight
- Steering Committee monthly meetings
- Communications and logistical support
- Progress reports to be submitted per USFWS requirements

CWS Group and Workgroup Meetings and Webinars

- CAWS Group meeting #1 - October 2019
- Workgroup meetings to be convened as needed.
- Webinars to be convened as needed.
- Mediation of specific issues ongoing.

Potential Out-year Actions (Subject to Future Appropriations)**:** Actions will continue the group's work from previous years, likely with a focus on advancing work at Brandon Rd. This likely will also include discussion of financing and cost-share options, AIS lock treatment concepts, non-structural control actions, etc.

What Is Deliverable for this Project: The following general deliverables for this project:

- Planning and facilitation support for a minimum of three CAWS group meetings.
- Convening monthly calls with the steering committee for the CAWS group.
- Planning and facilitation of workgroup meetings and webinars, as needed.
- Coordination with relevant agencies and organizations to secure information and speakers for CAWS group meetings and webinars.
- Preparation of correspondence and statements from the CAWS group, as requested.
- Mediation of key issues with CAWS group members.
- Development of technical presentations and reports, as requested.
- Coordination and communication with the ACRCC, Technical and Policy Work Group, and other relevant groups, as needed.
- New CAWS Work Plan for 2020 reflecting changing advisory role needs for as Brandon Road project progresses and other issues evolve.

Expected Completion Date for Project: The requested funding is for administrative and facilitation support to the CAWS group for approximately one year. However, the group's functions and contributions are anticipated to continue while federal and state agencies and other stakeholders continue to review, develop and deploy measures to prevent the transfer of AIS through the CAWS, including the work of the ACRCC and USACE under the Brandon Road study and the larger Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Potential Hurdles:

- Strengthening the overall effectiveness of the group, trust and a common focus.

- Complete and timely reporting from federal agencies on relevant work (e.g., proposed actions under the Brandon Road Feasibility Study and GLMRIS).
- Transition to new state leadership, delays in state participation and focus on the issues, and transparent reporting to and engagement with the CAWS group from state agencies.

How will the results of this project be disseminated?

Project results will be disseminated primarily through the members of the CAWS group and via their membership and communications mechanisms. A website will be maintained for the CAWS group for its materials, and the administrative support organization will report out to appropriate forums, such as the ACRCC, GLC meetings, etc.

PO-3 ACRCC Monitoring and Response Team Support

Lead Agency: U.S. Army Corps of Engineers (USACE)

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

FY 2019 Funding Table:

Agency Funding Expected	Asian Carp GLRI Funding Requested
$0	$100,000

** All FY 2019 Funding Projections are based on the Consolidated Appropriations Act 2019 (Public Law 116-6).*

Project Explanation

The proposed work is to be conducted by the USACE Regional Planning & Environmental Division North (RPEDN) and the Rock Island District to support the Asian carp control efforts that have been developed by members of the Asian Carp Regional Coordinating Committee (ACRCC) by providing technical expertise to support others and facilitating the permit process for Asian Carp activities within the Rock Island District.

Summary of Actions to Date: USACE provides technical assistance to lead agencies that support the Asian Carp Action Plan developed by the ACRCC.

- Collaborated with and provided technical and field support to agencies in the implementation of the Asian Carp Action Plan and the Monitoring and Response Plan (MRP).
- Participated in interagency meetings and conference calls, including: ACRCC, Monitoring Response Workgroup (MRWG), and the Technical and Policy Workgroup.
- Collaborated with USGS in development of a system-scale analysis of Open River conditions in the Illinois and Mississippi Rivers.
- Contributed to the development of the MRP for Asian carp.
- Provided design documents and drawings to assist other agencies with Asian carp control efforts and answered numerous engineering queries on lock and dam structures in the Illinois Waterway (IWW) and their potential to slow upstream movement of Asian carp.
- Provided timely reporting of the USACE Asian carp activities through formal presentations at regional stakeholder meetings.
- Participated in routine Seasonal Intensive Monitoring in Chicago Area Waterway System (CAWS).
- Organized and facilitated a meeting with regional experts to coordinate habitat suitability information for Bighead Carp. These efforts led to submitting an USACE Engineer Research and Development Center (ERDC) Statement of Need for a Bigheaded Carp Habitat Suitability Index relevant to USACE habitat projects nationwide.
- Provided data and technical expertise to inform dam gate configuration proposal with the USFWS and Minnesota DNR.

Proposed Actions for FY 2019:

- Collaboration with and support to agencies responsible for implementation of items in the Asian Carp Action Plan and the MRP.
- Participation in interagency meetings and conference calls including: ACRCC, MRWG, and the Technical and Policy Workgroup, etc.
- Collaboration and evaluation of Asian carp control measures for use in the IWW. This includes the USFWS coordination regarding Spatially Explicit Asian Carp Population (SEACarP) modeling and may include coordinating removal efforts during scheduled 2020 IWW lock and dam maintenance at critical backwaters including Sheehan Island and Rock Run Rookery.
- Participation in Seasonal Intensive Monitoring in CAWS.
- Strategizing of Asian carp removal, i.e., water level management at previously completed and potential future HREPs in the IWW.

Expected Milestones:

- Defined annually by the ACRCC in the Asian Carp Action Plan and the MRP.

Potential Out-year Actions (Subject to Future Appropriations)**:**

- Collaboration with and technical and field support to agencies responsible for implementation of items in the Asian Carp Action Plan and the MRP.
- Participation in interagency meetings and conference calls including: ACRCC, MRWG, and the ACRCC Technical and Policy Workgroup, etc.
- Collaboration and evaluation of Asian carp control measures for use in IWW.
- Development and implementation of monitoring strategies at Brandon Road Lock and Dam.

What Is Deliverable for this Project:

- Collaboration, technical and field support on the implementation of the Asian Carp Control Strategy Framework and the MRP.
- Participation in interagency meetings and conference calls including: ACRCC, MRWG, Upper Mississippi River Asian Carp Partnership, and the Technical and Policy Workgroup, etc.
- Collaboration and evaluation of Asian carp control measures for use in the IWW.
- Development and implementation of monitoring strategies at Brandon Road Lock and Dam.

Expected Completion Date for Project: Unknown

Potential Hurdles: None.

How will the results of this project be disseminated?

- Public (GLRI.us, GLIN Announce), technical audience(s), media, etc.