

Asian Carp Action Plan

May 2018

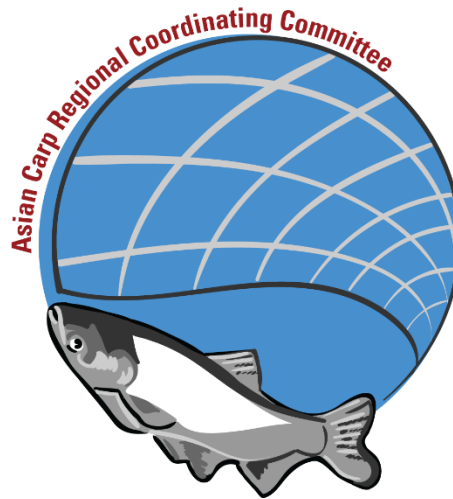


Asian Carp Regional
Coordinating Committee

Asian Carp Action Plan for Fiscal Year 2018

May 2018

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
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City of Chicago
Great Lakes Fishery Commission
Great Lakes Commission
Metropolitan Water Reclamation District of
Greater Chicago

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EXECUTIVE SUMMARY

The Asian Carp Regional Coordinating Committee's (ACRCC) 2018 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 2018 Action Plan are supported by a combination of \$28,922,810 agency funding and \$21.1 million Great Lakes Restoration Initiative funding provided through fiscal year (FY) 2018 appropriations. *All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

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 2018 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.

For development of the 2018 Action Plan, even greater interagency coordination was facilitated by developing broader “themed” templates within which groupings of related, more specific priority projects were embedded. While this resulted in numerically fewer general templates compared to the 2017 Action Plan and prior years, the overall number and type of specific detection, prevention, control, emerging technology, and communications initiatives remained comparable. The end result was significantly increased interagency dialogue and coordination during the early stages of Action Plan development, setting a path for more effective implementation of the ACRCC's strategy in the coming year.

The 2018 Action Plan provides an increasingly aggressive approach to Asian carp control within the comprehensive strategy. This includes a goal of further reducing Asian carp populations in the Illinois Waterway to more aggressively address the potential threat of fish movement upstream towards the Great Lakes. Accordingly, 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 by 2022. In 2018, the directed use of contract commercial fishing will be increased to achieve even greater annual harvest of adult in 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.

Additionally, increased efforts will be undertaken to field test underwater sound and water jets as potential technology for Asian carp control. The ACRCC will increase focus on phasing potential control tools into broader strategies, when and where possible, to achieve its mission.

The ACRCC is further developing and refining a 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 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 2018, 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 Chicago Area Waterways (CAWS) and the Illinois and Des Plaines Rivers upstream of the Starved Rock Lock and Dam.

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

1. PREVENTION ACTIONS

The following are summaries of the prevention actions that will be undertaken in 2018.

- **Current Barrier System in the CAWS** – U.S. Army Corps of Engineers (USACE) continues to operate three different types of fish deterrent measures (bypass barrier, electric barriers, and bar screens on sluice gates) throughout the CAWS, each designed to prevent movement of Asian carp toward the Great Lakes in a different manner.
- **Construction of a New Electric Barrier** – USACE is currently upgrading the demonstration barrier (now Barrier 1) to a permanent facility.
- **Development of Potential Future Actions at Brandon Road** – USACE will recommend a path forward to complete the feasibility study.
- **Closure Actions at Little Killbuck Creek Pathway** – Ohio Department of Natural Resources (DNR) will complete the design plans, finalize permitting for construction and acquire easements on parcels for the construction of the berm.
- **Closure Actions at Ohio-Erie Canal Pathway** – USACE will complete 100 percent design and will obtain necessary environmental compliance approvals, execute real estate

agreements, and award the construction contract for implementation of Ohio-Erie Canal structural measures.

- **Barge Entrainment/Water Jets** – The proposed work for FY 2018 builds upon previous research that has been conducted to provide management options for the mitigation of pathways for fish passage at the electric dispersal barrier system (EDBS), and potential entrainment and transport of fish through locks associated with transiting commercial tow traffic.

2. CONTROL MEASURES

The following are summaries of the control measures that will be undertaken in 2018.

- **Contract Fishing, Seining, and Netting** – Illinois DNR will continue contract fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines Rivers downstream of the electrical barrier. Through this effort, over 850,000 pounds of Asian carp are removed from upper Illinois Waterway (IWW) annually, thereby maintaining or further reducing the estimated Asian carp populations.
- **Asian Carp Enhanced Contract Removal Program Development** – This project recognizes the value of increased harvest of Asian carp in the lower Illinois River by removing a goal of 8 million pounds by 2019 and a short-term (five-year) vision to achieve 15 million pounds removed by 2022. This new program will reduce the numbers of Asian carp in the Illinois River in the Peoria Pool through controlled and contracted fishing efforts. This program 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 management efforts. This project will also identify and use mechanisms for use of the harvested fish through private industry for purposes including human consumption. Through a cooperative relationship of agency and fisher along with end users/markets, advice 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.
- **Asian Carp Population Model and Demographics** – Determining ways to maximize return on investment of management actions will be an area of increased emphasis in 2018. These efforts will be guided through the refinement, expansion, and strategic use of an Asian carp population model developed to inform key management decisions for Asian carp control, 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. 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.

- **Apply Improved Fishery Gears and Designs** – U.S. Fish and Wildlife Service (USFWS) will complete final analysis of the gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl, and in coordination with partners compile results from multiple gear evaluation projects to develop standard protocols to detect, monitor, and remove populations of Asian carp in the Illinois River.

3. **TECHNOLOGY DEVELOPMENT**

The ACRC is developing control technologies to 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. The following are summaries of the control measures that will be undertaken in 2018:

- **Use of Underwater Sound** – Underwater sound technology is one candidate deterrent that may be integral to the prevention of Asian carp, which demonstrated effectiveness in laboratory and pond settings. Previous studies have indicated that both Bighead and Silver Carp react negatively to sound. These studies have documented that Asian carp repeatedly respond to various underwater sound stimuli while many native fish species responded little to that same sound. Acoustic deterrent technology will be further evaluated and field tested for potential deployment at strategic locations within river systems, ideally sites where Asian carp can only move upstream through defined “choke points” such as lock chambers.
- **Carbon Dioxide (CO₂)** – The U.S. Geological Survey (USGS) and USFWS will complete studies as needed to support the USEPA national registration of CO₂ as a fisheries control chemical for both deterrents and piscitidal uses. The agencies will further complete studies as needed to address USFWS Section 7 ESA requirements for CO₂ as a fisheries control chemical. Data will be collected on water quality, air quality (operator safety), and fish behavior during simulated lock operating conditions to help determine the feasibility of CO₂ as an Asian carp control tool. Additionally, outcomes from the engineering, architectural designs, and construction process are expected to result in conceptual procedures for implementing large-scale CO₂ injection systems at navigational locks.
- **Microparticle** – USGS scientists have finalized the formulation of a targeted toxin (antimycin) delivery system in the form of a coated micro-particle with high specificity for Bighead and Silver Carp. USGS and USFWS will conduct multiple field trials and will complete registration review with U.S. Environmental Protection Agency (USEPA).
- **Development of Grass Carp Control Technologies** – Understanding the extent of the invasion and whether the Grass Carp population is self-sustaining or expanding is critical to guiding effective management actions focused on Grass Carp control in the Great Lakes and large river systems. USGS, USFWS, Ohio DNR and Michigan DNR will assess movement of Grass Carp, test the efficacy of a Grass Carp-specific bait and further develop planned response activities.

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 2018:

- **Monitoring Upstream of the Electric Dispersal Barrier** – Seasonal intensive monitoring (June and September) and targeted and fixed site monitoring will continue with a variety of gears being used, 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.
- **Monitoring Downstream of the Electric Dispersal Barrier** – Fixed and random site electrofishing efforts and contracted netting will continue below the electric barrier system with activities that include intensive electrofishing and netting in each of the four pools (Lockport, Brandon Road, Dresden Island and Marseilles) below the electrical barrier system.
- **Contracted Commercial Netting** – Contracted commercial netting will continue in the above-mentioned pools. These heightened efforts remain one of the most successful tools to reduce the threat of Asian carp moving toward the Great Lakes.
- **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** – The ACRCC will continue to better understand population dynamics of Asian carp that would give insight into the ability of directed harvest and other control measures to reduce overall Asian carp populations and reduce their movement upstream toward the CAWS.
- **Great Lakes Monitoring** – USFWS and partner agencies will continue to implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS.
- **Ecosystem Risk Assessments** – The National Oceanic and Atmospheric Administration (NOAA) will develop a food web model of the Illinois River and simulate effects of Asian carp on the Illinois River's fish communities and lower trophic levels.

5. **RESPONSE ACTIONS**

In June 2017, the Illinois DNR and the ACRCC announced the finding of one Silver Carp in the Illinois Waterway below T.J. O'Brien Lock and Dam, approximately nine miles away from Lake Michigan. The Silver Carp finding triggered two-weeks of intensive monitoring as outlined in the ACRCC's Contingency Response Plan. In 2018, the ACRCC will be addressing contingency actions through the plan 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 contingency plan 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.

6. BLACK AND GRASS 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 use in 2018 regarding Black Carp:

- Support the Illinois DNR Black Carp bounty program.
- Sample eDNA to facilitate marker development and testing.
- Contract commercial fisher(s) to capture Black Carp and provide data on captures.
- Use the Fluvial Egg Drift Simulator (FluEgg)¹ model to estimate Black Carp spawning locations.

U.S. and Canadian resource management and research agencies in the Lake Erie basin have identified the growing threat of invasive Grass Carp as a high priority requiring focused and aggressive monitoring and control action in 2018. The ACRCC state and federal member agencies have developed a suite of proposed actions for implementation, building off existing efforts within the Lake Erie basin. In 2018 the following Grass Carp efforts will be undertaken:

- Develop and implement an expanded planned action to use traditional gear at specified locations in the Sandusky River.
- Analyze all Grass Carp removed from Lake Erie for ploidy status, natal origin, estimated age, growth rates, and maturity status.
- Create new eDNA markers for Grass Carp.
- Complete FluEgg simulations for past high-flow events on the Sandusky River (and potentially Maumee River) to assess past successful spawning events and validate FluEgg performance.
- Test the efficacy of a Grass Carp-specific bait in controlled laboratory studies, followed by pond trials, and assess potential attractants for Grass Carp, including spawning-related chemicals (pheromones).

7. COMMUNICATION/EDUCATION/STAKEHOLDER ENGAGEMENT

The key method of communication for the ACRCC is the *AsianCarp.us* website hosted by USFWS since 2011. In addition, the ACRCC, through the Communications Work Group, continues to provide Congressional and public briefings, webinars and other communication initiatives. Also, USFWS increased the Asian Carp communication efforts by covering emerging topics related to Asian carp such as Grass Carp and Black Carp issues and federal and state

¹ FluEgg Model is a three-dimensional Lagrangian model that simulates the movement and development of Asian carp eggs until hatching based on the physical characteristics of the flow field and the physical biological characteristics of the eggs. <https://pubs.er.usgs.gov/publication/70146633>

actions in the Upper Mississippi River and Ohio River basins. In 2018, the ACRCC will continue these efforts through:

- Using and improving the *AsianCarp.us* website.
- Providing Congressional and public briefings, webinars, and other communication initiatives.
- Encouraging information flow between ACRCC partner agencies and other stakeholders.
- Providing proactive engagement with media and the public.
- Implementing the ACRCC's Communication Strategic Plan.

Also, the National Parks Service (NPS) will work to connect teachers and educators throughout the Great Lakes region to new resource materials on Asian carp including lesson plans and high-quality exhibit materials on Asian carp, such as free-standing pull up exhibits and banners.

The ACRCC communication efforts are strategically coordinated with our Canadian partner's efforts to ensure a binational approach.

8. ACRCC PARTNERSHIP OPERATIONS

In 2018, the ACRCC will 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 Monitoring and Response Plan, 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 to engage stakeholders on potential solutions to prevent Asian carp from moving through the CAWS and establishing self-sustaining populations.

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 a funding matrix. *All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*
- Appendix B provides a full listing of FY 2018 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.

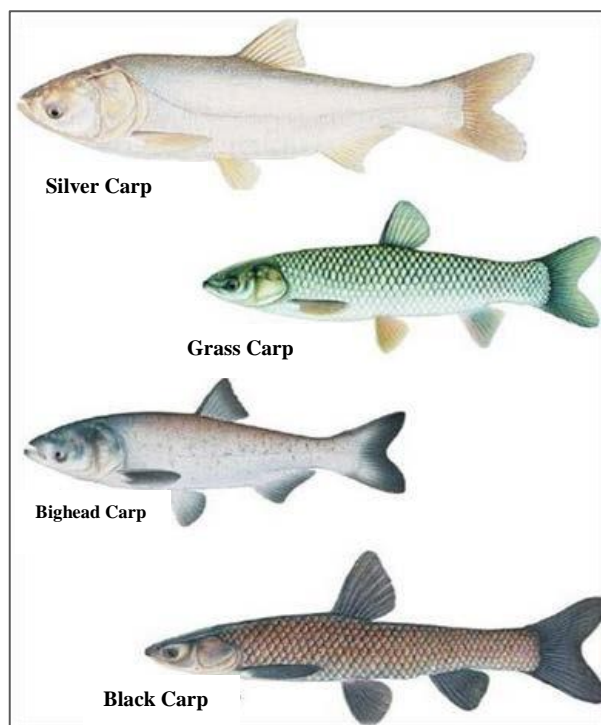
1.1 ABOUT THIS STRATEGY



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

The ACRCC 2018 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 2018 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 2018 Action Plan activities is to dramatically reduce Asian carp populations at locations in the proximity of the electric dispersal barrier (EDBS) in the



*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*).*

Chicago Area Waterway System (CAWS) near Chicago, resulting in a reduced threat of fish movement upstream towards the Great Lakes.

For development of the 2018 Action Plan, even greater interagency coordination was facilitated by developing broader “themed” templates within which groupings of related, more specific priority projects were embedded. While this resulted in numerically fewer general templates compared to the 2017 Action Plan and prior years, the overall number and type of specific detection, prevention, control, emerging technology and communications initiatives remained comparable. The end result was significantly increased interagency dialogue and coordination during the early stages of Action Plan development, setting the path for more effective implementation of the ACRCC’s strategy in the coming year.

The ACRCC’s strategic approach in 2018 includes interagency contingency response plans developed specifically for potential responding rapidly 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.

Also, in 2018, increased efforts will be undertaken to field test acoustic deterrents. In addition, the ACRCC is developing a population model that will maximize fishing harvest effectiveness for reducing Asian carp in the upper Illinois River waterway, particularly in combination with other tools such as deterrent barriers.

The ACRCC recognizes the value of increased harvest of Asian carp in the lower Illinois River by setting a goal to remove 15 million pounds by 2022. Reducing the Asian carp population by assisting local commercial efforts is the focus of a new pilot project. The ACRCC will also be working to better understand and develop actions that will remove barriers to expanding alternative uses of Asian carp to reduce the Asian carp population.

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. The fiscal year (FY) 2018 funding projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141). All funding numbers included in this Action Plan are subject to final appropriations decisions.

The 2018 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 THE 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 Illinois Waterway (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 members have 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 United States¹. 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. Promote collection of biological information on Asian carp, its impacts, preferred habitats, and biological and ecological requirements.
- B. Identify additional research, technology, and data needed to effectively inform and support Asian carp management strategies.
- C. 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.
- D. 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 United States and Canada. Work under this objective by the ACRCC fulfills the coordination and notification requirements of the United States-Canada Great Lakes Water Quality Agreement.
- E. 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 on the next page.

¹ Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carp in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C. 223 pp.

http://www.anstaskforce.gov/Documents/Carps_Management_Plan.pdf.
http://www.anstaskforce.gov/Documents/CO2_Management_Plan.pdf.

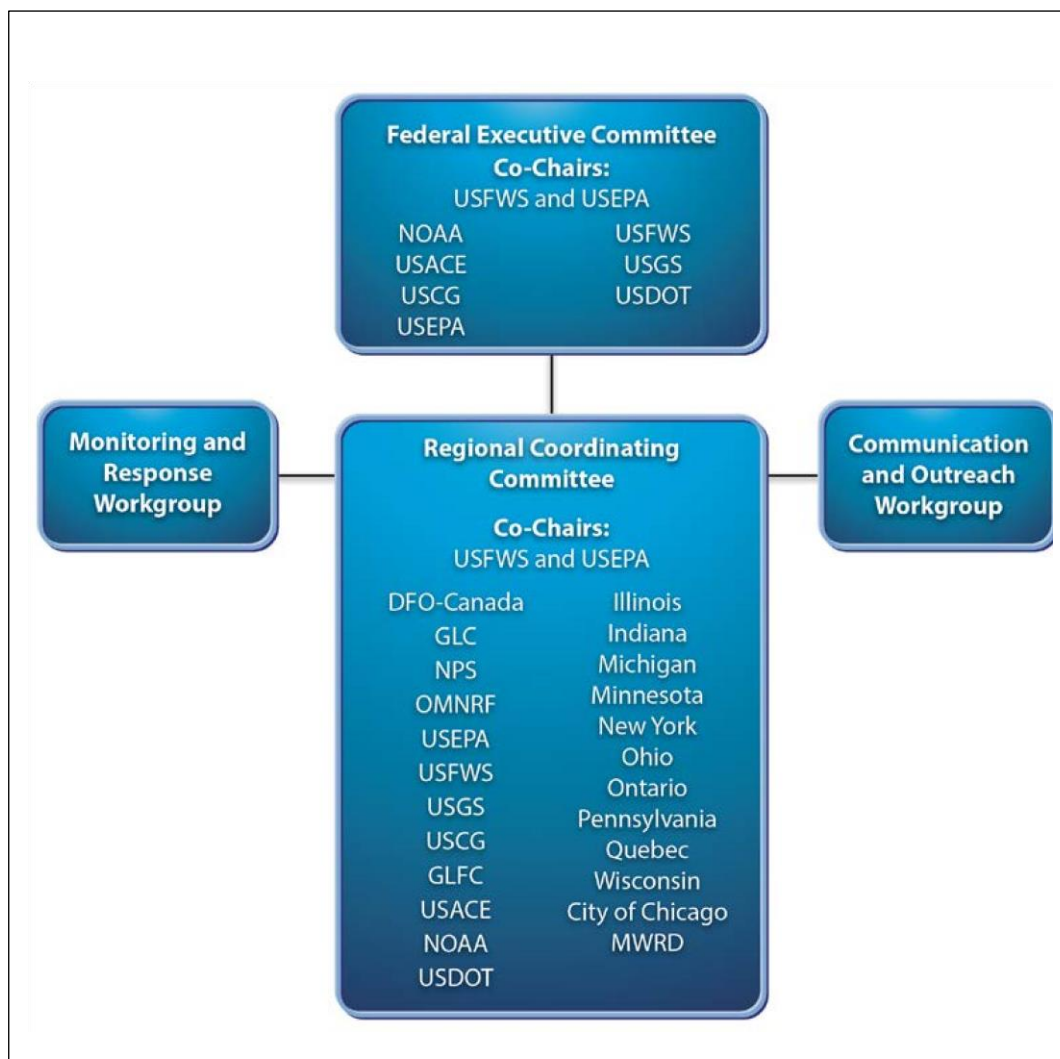


Figure 1. ACRCC Organizational Structure.

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.

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

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.

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 United States 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 or to transport live fish, including viable eggs or hybrids of the species, across state lines, except by permit for zoological, educational, medical, or scientific purposes. Current records indicate Silver Carp collections from 21 states.



Silver Carp jump from the water when frightened. 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 United States. Records indicate that, by the mid-1970s, this species had been stocked in at least 45 states. Although not considered widely established outside of the Mississippi River Valley (except in Texas), Grass Carp 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 Quebec). 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.

Black Carp represent the fourth species of Asian carp imported into the United States 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 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, with a total of 66 captures in 2017 (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, 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 the United States 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.

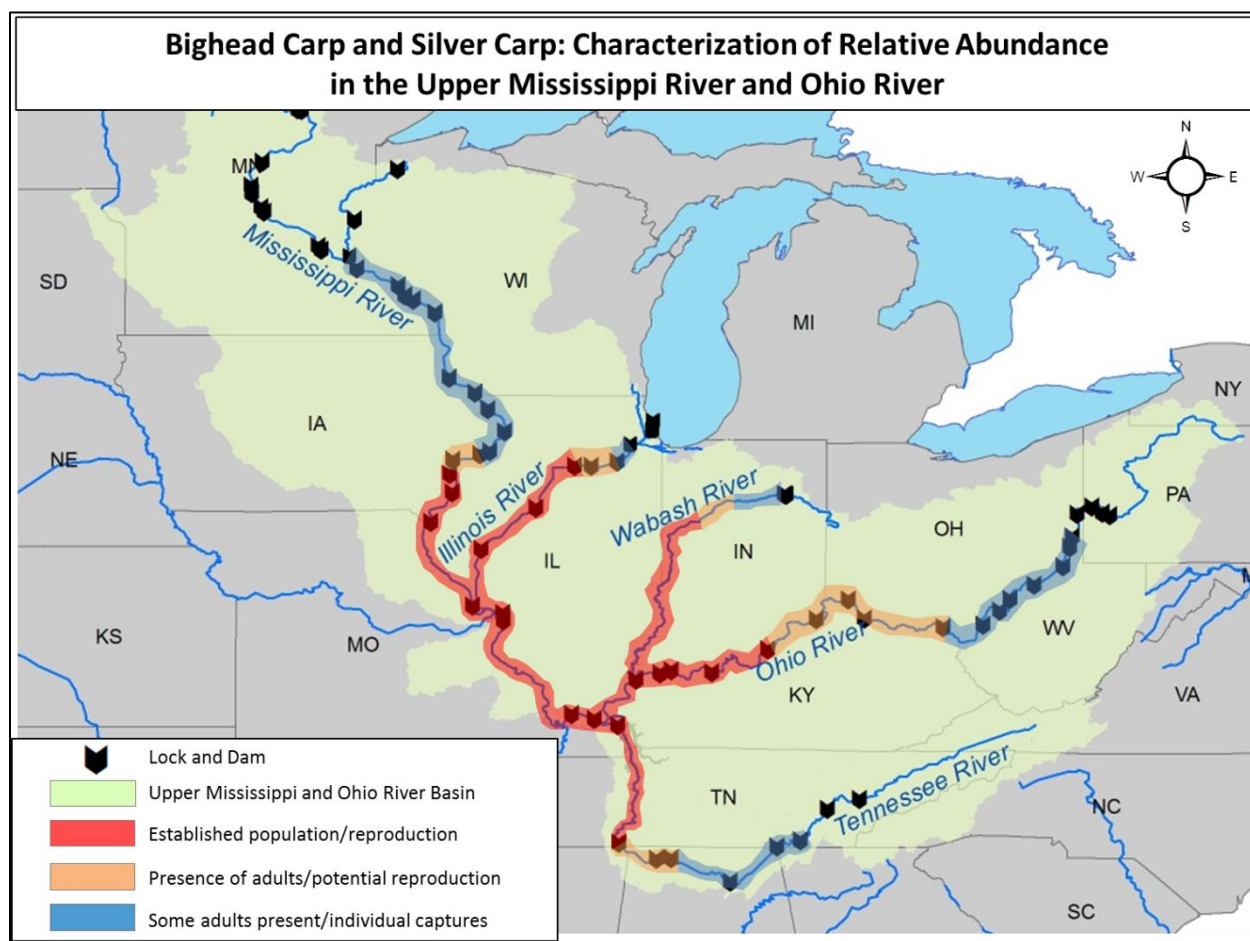


Figure 2. Bighead and Silver Carp Relative Abundance in the Upper Mississippi River and Ohio River.

Figure 3 (on the next page) illustrates the documented occurrences of the individual species of Asian carp waters of the Midwest United States. Data were collected for development of the interagency Water Resources Reform and Development Act of 2014 (WRRDA) 2016 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. In the 2016 reporting period, range expansion was documented from a single adult Silver Carp collected at river mile (RM) 280 of the Ohio River, approximately 64 miles upriver from a prior collection near Wheelersburg, Ohio. There was also a range expansion of Bighead Carp and Grass Carp into the Minnesota River, 103 miles from previous capture locations in the Upper Mississippi River. Range expansion of Black Carp was not detected in the 2016 reporting period.

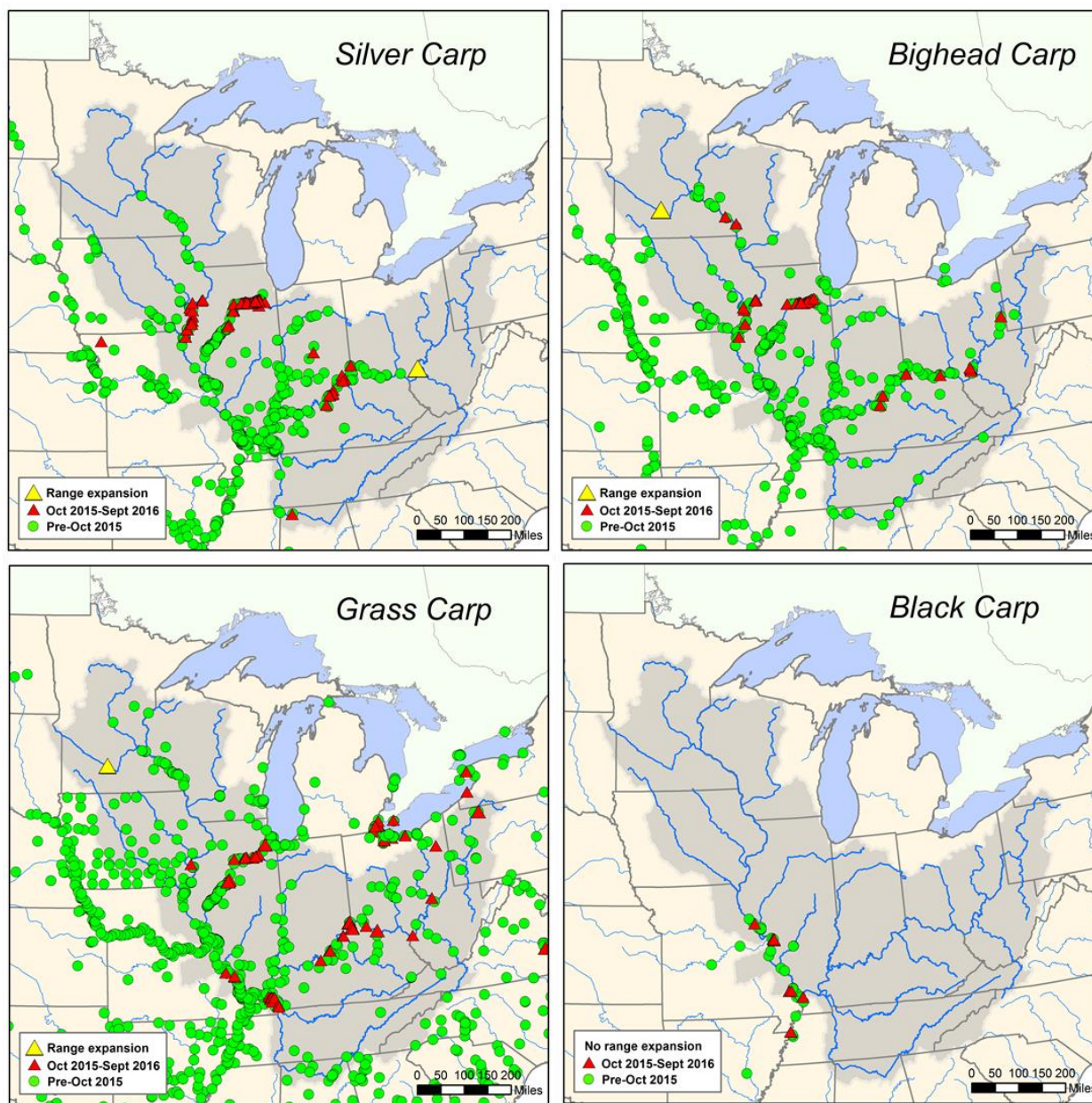


Figure 3. Recorded Occurrences of Silver, Bighead, Black, and Grass Carp before October 2015 and from October 2015 to September 2016.

As of fall 2017, the Monitoring and Response Work Group (MRWG) concluded that the adult population front of Bighead and Silver Carp is approximately 47 miles and two lock structures from Lake Michigan in 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 2017. 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 Illinois Waterway (IWW) pools

of Peoria, LaGrange, and Alton. These pools are over 100 miles away from Lake Michigan. This information is illustrated in Figure 4.

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

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 upper IWW and the CAWS to improve the understanding of the population dynamics and lower the level of risk from fish moving upstream toward the Great Lakes.

As in 2016, no Asian carp less than 6 inches were found above the Peoria Pool in 2017. Based on sampling results in 2015, dedicated small Asian carp monitoring in 2017 did not detect any small fish in the Starved Rock, Marseilles, or Dresden Island Pools of the Illinois River, despite historically high sampling rates in Starved Rock Pool. A total of 277 electrofishing sites (69.25 hours fishing time) have been conducted to date from the Peoria reach to Lockport (Table 1). The bulk of fishing effort has been from Marseilles reach to Peoria 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). 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 fykes 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 on the next page shows the current number of sites sampled during 2017 broken down by river reach and gear type; units are: number of sites sampled. Note: Effort includes electrofishing (n = 17 runs) and dozer trawls (n = 30 runs) in Peoria targeting fish for telemetry.

From April to September of 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

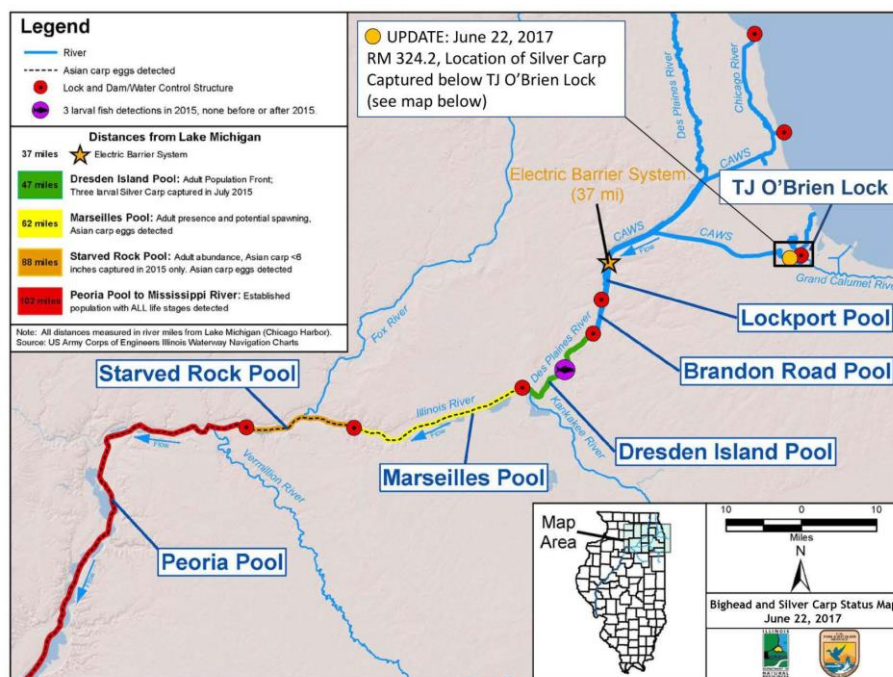


Figure 4. Bighead and Silver Carp Status in the Upper Illinois River

(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. Additionally, 12 juveniles less than 300 mm total length and 59 individuals between 300 mm and 400 mm have been captured in the Peoria reach as a result of telemetry tagging efforts.

Table 1

Site	Electrofishing	Dozer trawl	Paupier	Mini-fykes
Peoria	37	44	3	12
Starved Rock	86	40	11	50
Marseilles	104	17	10	6
Dresden Island	29	20	3	0
Brandon Road	14	13	0	0
Lockport	7	8	0	0

In addition to the monitoring efforts, the U.S. Fish and Wildlife Service (USFWS) has expanded the telemetry study of juvenile Asian carp from 2016. A total 26 hydrophones have been deployed in the Peoria reach, stretching from Hennepin, Illinois downstream to Chillicothe, Illinois. Additionally, five radio telemetry monitoring stations have been built in the Peoria reach 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, 57 fish are tagged with acoustic transmitters, with a mean size of 320 mm; 9 fish have been tagged in the 300 mm to 400 mm size class using both radio and acoustic transmitters.

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 of 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 5). 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 5. Monitoring and Harvest Efforts in Dresden Island Pool.

2.0 MONITORING AND RESPONSE WORKGROUP EFFORTS

The MRWG of the ACRCC is tasked with monitoring and response efforts within the CAWS and at the leading edge of current Asian carp boundaries. 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 of the 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 commercial 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. Work groups 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.
- **Manage 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 Monitoring and Response Plan 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.

Manage 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 technical expertise and recommendations provided by discipline-specific work groups to determine whether algal attractants, complex noise generation, and use of CO₂ 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 in 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.

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.

Manage and Control

- Sustain management and control efforts with continued population reduction.
- 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.

- Put in place a dynamic economic business strategy for the Lower IWW to remove 20-50 million pounds of Asian carp annually.
- Support development of management and control strategies in other river basins.

Response

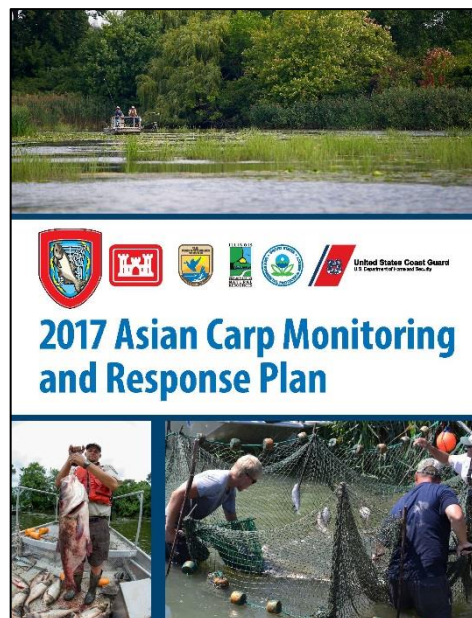
- Provide for contingency plan and response in less than 48 hours for all contingency response measures.

2.2 MONITORING & RESPONSE PLAN

The 2017 Asian Carp MRP was prepared by the MRWG and released by the ACRCC. Specifically, this document is a compilation of 24 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.*

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. Figure 6 (on the next page) identifies the current invasion of Bighead and Silver Carp in the IWW.

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.



The 2017 Asian Carp Monitoring Response Plan.

2.3 CONTINGENCY 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 carp detections. 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 annual table top exercises. Finally, the MRWG will continue to evaluate and update the CRP through periodic reviews and revise accordingly.

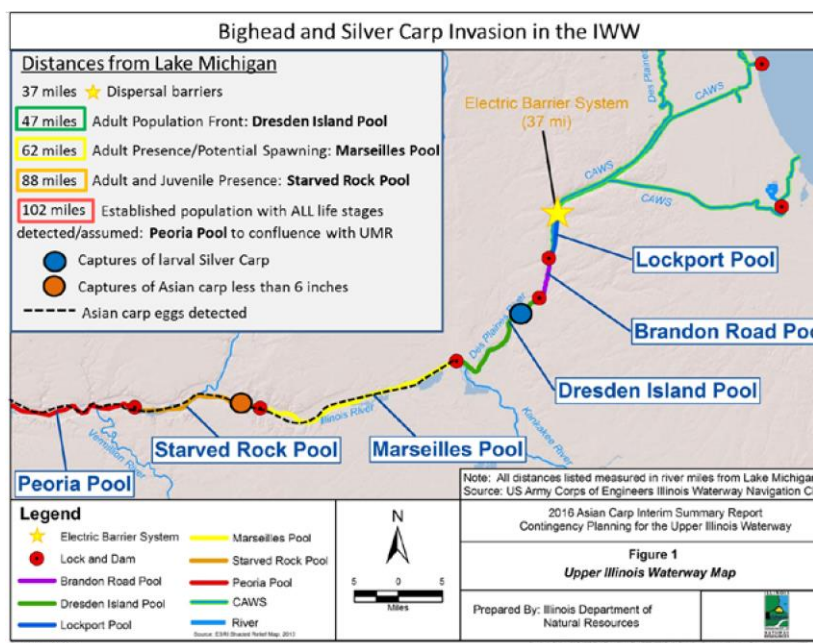


Figure 6. Bighead and Silver Carp in the IWW.

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 prescribes aggressive actions in response to findings contrary to the baseline (2015) presence of Asian carp in the Upper IWW. MRWG has selected 2015 as an appropriate baseline for comparisons in future years as noted above. 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.

2.3.1 Operation Silver Bullet

On June 23, 2017, the Illinois Department of Natural Resources (DNR) and the ACRCC announced the preliminary finding of one Silver Carp in the IWW below T.J. O'Brien Lock and Dam, approximately nine miles away from Lake Michigan. The fish was captured with a gill net by a contracted commercial fisher, as part of the ACRCC MRWG's seasonal intensive monitoring event. The Silver Carp was 28 inches in length and weighed approximately 8 pounds. The Silver Carp finding triggered two additional weeks of intense sampling in the area, as outlined in the ACRCC's CRP. During the two additional weeks of intensive monitoring no Silver or Bighead Carp were seen or caught.

Crews from the USFWS, U.S. Army Corps of Engineers (USACE), Illinois DNR, Illinois Natural History Survey and contracted commercial fishers conducted the monitoring operation. The U.S. Coast Guard (USCG) provided notice to mariners of increased activity in the areas above and below the T.J. O'Brien Lock and Dam. The field portion of the operation exceeded 1,950 person-hours. In addition, commercial fishers working with Illinois DNR biologists set

more than 43 miles of gill net, while crews with Illinois DNR, USACE, and USFWS conducted 365 electro-fishing runs for a total of more than 91 hours of effort.

An autopsy of the Silver Carp captured found that the fish originated in the Illinois/Middle Mississippi watershed. Analysis showed the 4-year-old male Silver Carp spent a quarter of its life in the Des Plaines River watershed before being caught and removed from the Little Calumet River above the USACE electric dispersal barrier system (EDBS). Though it is not known how the fish was able to arrive above the barrier defense system, analysis showed that the fish spent no more than a few weeks to a few months in the stretch of river where it was found.

It is important to note that this preliminary finding did not confirm that a reproducing population of Asian carp currently exists above the EDBS or within the Great Lakes. In eight consecutive years of intensive monitoring and fish sampling in the CAWS, this was the second time a Bighead or Silver Carp had been found above the EDBS. A Bighead Carp was found in Lake Calumet in 2010.



This Silver Carp was captured in the Illinois Waterway below T.J. O'Brien Lock and Dam on June 22, 2017. Photo courtesy of Illinois DNR.

2.4 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 2018. 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 barrier maintenance within the CAWS. The formation of the ACRCC initially brought together the agencies potentially affected by the expansion of Asian carp into new waterway systems. The scope of effort has since evolved beyond a singular focus on the CAWS to now include other potential pathways for Asian carp introduction, including secondary pathways of AIS introduction as indicated in the 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.

Key Efforts Completed or Underway

Numerous key initiatives were addressed through the 2017 Asian Carp Action Plan and many will continue in 2018. ACRCC initiatives focused on development and refinement of detection and control technologies, coordination, and program support. In addition, the ACRCC focused on the GLMRIS alternatives to further advance control opportunities.

ACRCC initiatives for 2018 will fall under eight focus areas and 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.

Accomplished achieved in 2017 and initiatives planned for 2018 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

2017 Accomplishments

USACE operates three different types of fish deterrent measures (bypass barrier, EBDS and bar screens on sluice gates) throughout 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 EBDS from the Des Plaines River and the Illinois and Michigan (I&M) Canal caused by flooding. The EBDS is intended to stop the movement of juvenile and adult Asian carp during high-water events. The EBDS operates 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, including regularly scheduled maintenance of the EDBS. Construction of the main Permanent Barrier I building and the Control Gear/Backup Power building also continued. The development of the Permanent Barrier I control system was completed. In January 2017, a USACE dive team conducted a visual inspection of the electrodes, examining their condition at 5-foot intervals. Results of the inspection indicate the electrodes are corroding faster than expected and require replacement. USACE developed plans and specifications for the replacement electrodes for Barrier IIA's narrow (high field) array.

2018 Actions

USACE continues to operate three different types of fish deterrent measures (bypass barrier, EDBS and bar screens on sluice gates) throughout 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 regularly scheduled maintenance of the EDBS. Construction of the main Permanent Barrier I building and the Control Gear/Backup Power building will also continue.

3.1.2 Construction of a New Electric Barrier

2017 Accomplishments

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. Completion of this barrier, known as Permanent Barrier 1 (PB1), will signal the completion of construction on the CSSC



Aerial view of electric barriers project. Photo courtesy of USACE.

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 and will be completed in 2018.

2018 Actions

Construction of the EBDS will continue in 2018 with the following proposed actions:

- Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the EBDS, such as:
- Replacement of Demonstration Barrier's cable electrodes with steel billets.
- Replacement of Barrier IIA's narrow array (high field) electrodes.
- Continued work on Permanent Barrier I.

3.1.3 Development of Potential Future Actions at Brandon Road

2017 Accomplishments

The USACE studied aquatic nuisance species (ANS) control technologies, as outlined by GLMRIS that could be implemented in the vicinity of Brandon Road Lock & 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. The USACE identified the Tentatively Selected Plan (TSP), released the TSP draft report for public review, conducted four public meetings to allow for public comment on the TSP, and initiated Agency Technical Review (ATR), Independent External Peer Review (IEPR), Policy Review, and National Environmental Protection Act (NEPA) review.

2018 Actions

The USACE will complete the ATR, IEPR, Policy, and NEPA reviews, analyze public comments received during the public review period, develop a recommended path forward to complete the feasibility study based on comments received and what is needed to complete the study, and present a path forward at Agency Decision Milestone.

3.1.4 Closure Actions at Little Killbuck Creek Pathway

2017 Accomplishments

Ohio DNR facilitated numerous meetings with the Medina Soil and Water Conservation District, U.S. Department of Agriculture Natural Resources Conservation Service, and the primary landowner. A consultant completed a preliminary investigation of closure options at the Little Killbuck Creek connection site. This study refined the closure options so that a final engineering study can be completed. The consultant for the final design was selected and the final engineering design completed. During this period, Ohio DNR met with the primary landowner and other potentially affected parties to evaluate and identify the preferred alternative for closure. In 2018, Ohio DNR will complete the design plans, finalize permitting for construction and acquire easements on parcels for the construction of the berm.

2018 Actions

Ohio DNR will complete the design plans and finalize permitting for construction and acquiring easements on four parcels for the construction of the berm.

3.1.5 Closure Actions at Ohio-Erie Canal Pathway

2017 Accomplishments

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. USACE completed a preliminary closure assessment in 2014 with an array of potential options presented in the “Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures”. USACE assisted Ohio DNR in completing all necessary environmental compliance, coordination requirements in preparation for construction.

2018 Actions

In 2018, USACE will complete 100 percent design in consultation with Ohio DNR and Summit County Metroparks. Additionally, USACE will obtain necessary environmental compliance approvals, execute real estate agreements, coordinate public outreach and award the construction contract for implementation of Ohio-Erie Canal structural measures.

3.1.6 Barge Entrainment/Water Jets

2017 Accomplishments

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. Also, in 2017, USACE created a physical scaled model to develop and test methodologies to remove fish from the void spaces between barges. Methodologies shown to be effective based on the model will be field tested. The USFWS and partnering agencies collaborated with maritime industry representatives to identify potential efforts to address this issue. 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 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 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.

Studies conducted during FY2017 provided preliminary evaluations of potential mitigation management strategies and technologies. The results from that work will be built upon and refined through additional testing of waterjet flushing systems and canal flow management strategies.

2018 Actions

The proposed work for FY2018 builds upon previous research that has been conducted to provide management options for the mitigation of pathways for fish passage of the EDDBS associated with commercial tow traffic transiting. Pilot testing of water jet technologies within the CSSC was conducted during FY2017. This testing was designed to evaluate the water jet technologies under real world conditions at the pilot field scale within the Chicago Sanitary and Ship Canal. Field scale testing included a fully equipped pump station and adequate piping, manifold, and water jet nozzles to produce the required velocities at the canal surface; however, the project was limited in the number of water jets that could be implemented. An interagency study team will follow up previous year's actions to build confidence in a final design for implementation.

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

2017 Accomplishments

Contract fishing, seining, and netting reduced the numbers of Asian carp below the EDDBS through controlled and contracted fishing efforts. Through these efforts, over 850,000 pounds of Asian carp are removed from the upper IWW annually, thereby maintaining or further reducing the estimated Asian carp populations. Reducing the number of Asian carp below the EDDBS reduces the opportunity for Asian carp to test the barrier and therefore decrease the possibility of Asian carp moving across the barrier and gaining access to waters upstream of the barrier. This effort also allowed for monitoring population densities of Asian carp over time in the CAWS down to Starved Rock Pool. Illinois DNR posts monthly updates to the *AsianCarp.us* website as well as lead the effort to compile annual and interim summary reports of all monitoring and response associated information.

2018 Actions

Illinois DNR will continue to use contracted commercial fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines Rivers downstream of the EDDBS. Nine 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. Also, in 2018, the Unified Fishing Methods will be used in new areas with at least one unified fishing method being performed in each of 2018-2019.

3.2.2 Asian Carp Enhanced Contract Removal Program Development

New in 2018

This project will begin implementation and support the strategy identified in the 2017 MRP that recognizes the value of increased harvest of Asian carp in the lower Illinois River by removing a goal of 8 million pounds by 2019 and a short term (five-year) vision to achieve 15 million pounds removed by 2022. This new program will reduce the numbers of Asian carp in the Illinois River in the Peoria Pool through controlled and contracted fishing efforts. Reducing the number of Asian carp in the Illinois River will reduce the opportunity for Asian carp to approach the electric dispersal barrier. This program 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 management efforts. While initial efforts are strictly limited to Peoria Pool, it is understood that to meet harvest needs, consideration of expanding harvest to La Grange and Alton Pools of the Illinois River may be necessary. This project will also identify and use mechanisms for use of the harvested fish through private industry for purposes including human consumption. Through a cooperative relationship of agency and fisher along with end users/markets, advice 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.



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

3.2.3 Asian Carp Population Model and Demographics

New in 2018

Increasing the ability to effectively remove and/or prevent the upstream migration of adult Asian carp in the IWW ultimately reduces the risk of the progressive expansion of the established population front toward upstream navigation pools, the EDBS, and the Great Lakes. Determining ways to maximize return on investment of management actions will be an area of increased emphasis in 2018. These efforts will be guided through the refinement (improved the accuracy and precision), expansion, and strategic use of an Asian carp population model (Spatially Explicit Asian carp Population model [SEAcP]) developed to inform key management decisions for Asian carp control, 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. 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. The expanded model will incorporate key data with a focus on Asian carp control in the six lower pools in the IWW, 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.

3.2.4 Mass Removal of Asian Carp

New in 2018

In 2018, USFWS will design and deploy 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 will optimize 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 will identify prime “Harvest Basins” where Silver Carp can be frequently found in large concentrations and more readily harvested with a prescriptive gear and methodologies. USFWS will work collaboratively with USGS to develop the methodology to use low-cost sonar systems in conjunction with physiochemical meters to predict mechanisms for future Silver Carp aggregations.

Since 2015, the USFWS has contributed to monthly mass removal of Asian carp in the Starved Rock and Marseilles pools of the Upper Illinois River, previously referred to as Barrier Defense. This effort was established to reduce Asian carp pressure downstream of the EDBS through targeted and contracted commercial fishing. In 2018, USFWS will supplement traditional fishing efforts using a paupier (a tool to remove large amounts of Asian carp) to remove all sizes of Asian carp from a variety of habitat types.



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

In 2018, USGS, partnering with USFWS, will test and adapt 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) environmental deoxyribonucleic acid (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 below the EDBS.

3.2.5 Apply Improved Fishery Gears and Designs at Brandon Road

2017 Accomplishments

USFWS continued to work with partners to develop, adapt, and refine standard protocols for construction and use of small-mesh, lightweight, purse-type seines in the CAWS to target concentrations of juvenile Asian carp for removal. Deploying these purse-type nets may be a better method for removing large numbers of small fish, potentially halting the advance of juvenile Asian carp toward the Great Lakes.

Sampling techniques that have a high probability to detect Asian carp and the ability to quickly and accurately assess the population are crucial for management and control. In 2016 and 2017, USFWS conducted a gear evaluation study comparing traditional electrofishing and two novel electrotrawling techniques, the paupier and dozer trawl, in their ability to assess Silver Carp populations in backwaters of the Illinois River. The final analysis of the gear evaluation study comparing traditional electrofishing, paupier, and dozer trawls will be completed. In addition, the results of multiple gear evaluation/capture projects will be evaluated to determine the most effective ways to capture all sizes of Asian carp in a variety of habitats at varying densities. This synthesis will be used to subsequently develop standard protocols in support of Asian carp management strategies.

2018 Actions

USFWS will complete final analysis of results from gear evaluation studies conducted with partners to compare traditional electrofishing, paupier, and dozer trawls; and compile results from additional multiple gear evaluation projects to develop standard protocols to detect, monitor, and remove populations of Asian carp in the Illinois River.

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 single 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 generated 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, CO₂, and microparticles.

3.3.1 Use of Underwater Sound

One candidate deterrent technology that may be integral to the prevention of Asian carp, and that has demonstrated effectiveness in laboratory and pond settings, is underwater sound. Previous studies have indicated that both Bighead and Silver Carp react negatively to sound. These studies have documented that Asian carp repeatedly respond to various underwater sound stimuli while many native fish species responded little to that same sound.

Acoustic technology can be used as an effective deterrent for Asian carp only by determining the optimal sound frequencies, sound pressure levels, and speaker design to repel Asian carp while preventing injury to native species. The technology is transportable and can also be applied to contain, herd, and remove Asian carp from the river system. The application of underwater sound to broader management goals needs to be informed by large-scale field testing of an experimental system at a location where Asian carp are present in the system and motivated to migrate. This scale of testing has not yet been implemented until now.

2017 Accomplishments

USGS tested the effectiveness of acoustic stimuli for excluding Bighead and Silver Carp from preferred habitats and for driving them to target locations for increased removal. In addition, USGS initiated regulatory permit applications for federal and state permits that may be required to allow agencies to deploy a sound deterrent. USACE worked towards installing initial speakers and monitoring sound field produced for approximately seven days to provide the modelers with information on how sound travels through the channel.



Field testing the use of complex sound to move Asian carp.

2018 Actions

Acoustic technology will be deployed at strategic locations, or “pinch points” in the river system, where Asian carp can only move upstream through a lock chamber. This allows observation and monitoring of all fish passage upstream through a restricted area. Barkley Lock and Dam on the Cumberland River in Kentucky presents an optimal location to test underwater sound and its

deterrence against Asian carp and planning for initial implementation is currently underway. Federal, state, and academic partners are working collaboratively to deploy these experimental systems so that they may be evaluated for use at other key locations to prevent the range expansion of Asian carp and entry into the Great Lakes. Additional tools will be developed that allow for movement predictions based on lock and dam operations, array designs for new deployments, and long-term remote monitoring of fish and acoustic deterrent systems.

3.3.2 Carbon Dioxide (CO₂)

2017 Accomplishments

CO₂ injected into water is being evaluated as a non-physical deterrent method for invasive Asian carp. Results from laboratory and mesocosm studies have shown that Asian carp voluntarily avoid areas of elevated CO₂ when given the option to access other freshwater (untreated) areas. Strategic implementation of CO₂ 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 2017, the USGS, USACE, and other partners developed comprehensive planning assessments for deploying CO₂ at a lock and/or approach channel to deter Asian carp movement. USGS and partners also conducted applied field studies to demonstrate potential management applications such as use for blocking Asian carp access to backwater areas of the Illinois River or to enhance Asian carp removal efforts.



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

2018 Actions

USFWS will continue studies to address Section 7 ESA consultation data requirements and other operational considerations for deployment of a CO₂ fish deterrent system focused on Asian carp prevention. In addition, USFWS will work with USGS and other partners to identify pilot opportunities for the temporary installation and operation of a CO₂ fish deterrent system for field research purposes.

3.3.3 Microparticles

2017 Accomplishments

USGS scientists have finalized the formulation of a targeted toxin (antimycin) delivery system in the form of a coated microparticle with high specificity for Bighead and Silver Carp to control or

limit Asian carp while minimizing potential impacts on native species. Scientists conducted a large-scale field assessment of particles that included a population assessment of invertebrates and vertebrates pre- and post-exposure to identify which species are likely to be impacted by the use of particle during a management action.

2018 Actions

USGS and USFWS will: (1) conduct multiple field trials with toxic particles at a location with

Laboratory testing of microparticle effects on Asian carp.

Asian carp to verify specificity to Asian carp, (2) initiate the application of microparticles as part of a management action, and (3) complete registration review with USEPA to determine registration data requirements of antimycin incorporated microparticles in limited open-water application sites.



3.3.4 Development of Grass Carp Control Technologies

2017 Accomplishments

Understanding the extent of the invasion and whether the Grass Carp population is self-sustaining or expanding is critical to guiding effective management actions focused on their control in the Great Lakes and large river systems. USGS research on Grass Carp is diverse, focusing primarily on understanding biology and hydrologic factors related to biology.

In 2016 scientists collected egg and larval samples for grass carp presence and the FluEgg simulation model was used to estimate spawning and hatching locations of Grass Carp eggs in the Sandusky River. Remote sensing imagery was used to detect and map where submerged aquatic vegetation (SAV – preferred food of Grass Carp) does/does not occur and generated maps for western Lake Erie. This work continued in 2017, including completing maps of SAV for the eastern half of Lake Erie. A USGS stream gage was installed near the mouth of the Sandusky River that provides essential hydraulic data including observations of velocity magnitude and direction which will be used to assess the performance of a hydraulic model that provides critical input to the FluEgg simulation model.

2018 Actions

Many ACRCC partner agencies will work to further their Grass Carp programs and develop control technologies. See below for some agency-specific activities.

USGS will focus on the following activities:

- Perform second-generation light trap experiments to test effects of light intensity independent of color through two experiments.
- Assess movements of both diploid and triploid Grass Carp during spring and summer.
- Determine if triploid Grass Carp participate in spawning movements like those of diploid fish to assess the potential for triploid fish to fully serve as Judas fish.

- Complete FluEgg simulations for past high-flow events on the Sandusky River.
- Test the efficacy of a Grass Carp-specific bait in controlled laboratory studies, followed by pond trials.
- Assess potential attractants for Grass Carp, including spawning-related chemicals (pheromones) and food-based (e.g., products of damaged vegetation) products.

Ohio DNR will be further developing Ohio's planned response activities, including:

- Analyzing all Grass Carp removed for determination of ploidy status and natal origin.
- Estimating age, growth rates, and maturity status of all Grass Carp removed from Lake Erie.
- Developing and implementing an expanded planned action using traditional gear at specified locations in the Sandusky River.

Michigan DNR proposed actions are all directly linked to preventing the introduction of Grass Carp into Lake Erie waters through:

- Monitoring for the presence and expansion of Grass Carp in Lake Erie and connecting waters by employing commercial fishers, traditional fisheries monitoring techniques (e.g., electrofishing, gillnetting, etc.), emerging genetic techniques (i.e., environmental DNA), and acoustic telemetry.
- Implementing a control strategy that is linked with current knowledge of distribution and habitat use of Grass Carp in Lake Erie.

USFWS proposed actions include:

- Assembly and publication of whole genomes for each of the four species.
- Tissue collection for additional mitochondrial genome data generation and assembly.
- Creation of new eDNA markers that have been validated and ready for use.

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 EDDB is important to ensure no Asian carp have moved beyond the barrier.

3.4.1 Monitoring Upstream of the Dispersal Barrier

2017 Accomplishments

Seasonal intensive monitoring continued in 2017. 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.*

2018 Actions

Seasonal intensive monitoring (as identified in the 2017 MRP) will continue in 2018. 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 Lakes pound nets to detect, capture, and subsequently remove any Asian carp present. Sampling design has been and will continue to be evaluated for both community composition and detection probability to assure appropriate detection of rare specimens, or potential Asian carp species in these efforts.

3.4.2 Monitoring Downstream of the EDBS

2017 Accomplishments

Fixed- and random-site electrofishing efforts and contracted netting has been increased starting in 2014 and further elevated in 2017. These heightened efforts remain one of the most successful tools to reduce threat of Asian carp moving toward the Great Lakes.

2018 Actions

Fixed and random site electrofishing efforts and contracted netting will be further elevated in 2018 below the EDBS. These activities will include intensive electrofishing and netting at four fixed sites in each of the four pools below the EDBS. 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 Starved Rock and Marseilles Pools and in Dresden Island, Brandon Road, and Lockport Pools.

3.4.3 Young-of-Year and Juvenile Asian Carp Monitoring

2017 Accomplishments

USFWS continued to conduct sampling for larval and juvenile Asian carp using netting and electrofishing operations.

2018 Actions

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.

3.4.4 Comprehensive Interagency eDNA Monitoring Program

2017 Accomplishments

Throughout 2017, USFWS, in cooperation with our 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. The USFWS continued to upgrade its field sampling infrastructure and its collection and sample processing



Collecting eDNA samples.

techniques as new technologies emerged. In 2017, 8,592 eDNA samples were collected from the Midwest Region; deploying four mobile eDNA trailers across the sampling area by USFWS.

2018 Actions

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 our partners, to detect the presence of Asian carp DNA in areas of concern. This will include the CAWS of the Illinois Waterway, and will include two sampling events in 2018. 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.

3.4.5 Asian Carp Stock Assessment in the Upper Illinois River

2017 Accomplishments

In 2017, stock assessments in the Upper Illinois River were undertaken to better understand population dynamics of Asian carp that would give insight into ability of directed harvest and other control measures to reduce overall populations within waters connecting to the Great Lakes and to reduce movement of Asian carp upstream toward the CAWS. This effort encompasses multiple studies with the goal of determining estimates of Asian carp abundance, biomass, size structure, with insights into demographics (e.g., growth and mortality), and natal origin in the Alton, LaGrange, Peoria, Starved Rock, Marseilles, Dresden Island, and Brandon Road pools of the Illinois and Des Plaines rivers.

2018 Actions

The ACRCC will continue to better understand population dynamics of Asian carp to give insight into ability of directed harvest and other control measures to reduce overall populations. This effort will gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to assist in the development of strategies to prevent upstream movement, and support decision making processes in development and location of control measures.

3.4.6 Great Lakes Monitoring

2017 Accomplishments

The USFWS 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.

2018 Actions

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 on an annual basis to detect new invasions of Asian carp.

3.4.7 Ecosystem Risk Assessments

2017 Accomplishments

The National Oceanic and Atmospheric Administration (NOAA) is applying a model to simulate effects of Asian carp on the Lake Ontario food web. NOAA also completed model simulations of Asian carp effects on Lake Michigan, Lake Huron (Saginaw Bay and Main basin) and Lake Erie.

2018 Actions

NOAA will develop an Ecopath with Ecosim food web model of the Illinois River, and simulate effects of Asian carp on the Illinois River's fish communities and lower trophic levels. In addition, NOAA will complete the Lake Ontario food web modeling.

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.

2017 Accomplishments

In June 2017, Illinois DNR and the ACRCC announced the finding of one Silver Carp in the Illinois Waterway below T.J. O'Brien Lock and Dam, approximately nine miles away from Lake Michigan. The Silver Carp finding triggered two-weeks of intensive monitoring as outlined in the ACRCC's Contingency Response Plan.

2018 Actions

In 2018, the ACRCC will be addressing contingency actions through the plan 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 contingency plan 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

The USFWS, USGS, the Michigan DNR and Ohio DNR, Ontario Ministry of Natural Resources and Forests, and 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 is an invasive species that is undergoing rapid expansion in the United States. Commercial fishers and fishery biologists have collectively reported over 150 captures of Black Carp, with the majority of fish collected in the last 5 years. To leverage existing ongoing commercial fishing efforts and opportunistically collect critical data on Black Carp (physical specimens and life history information), Southern Illinois University (SIU) administers a bounty funded by the Illinois DNR to encourage reporting and provide specimens for research. Reports from commercial fishers in 2017 revealed that Black Carp have spread to the Illinois River (Peoria pool) and Ohio River. The first evidence of reproduction in the wild was reported in 2016, when researchers from the Missouri Department of Conservation (MDC) and the USFWS captured young-of-year (YOY) Black Carp in an agricultural ditch near Cape Girardeau, Missouri. In 2017, two additional Black Carp YOY were captured in the same agricultural ditch during agency sampling. The increased captures in recent



Black Carp Captured, Southern Illinois University.

years, including a February 2018 capture of a 115-pound adult 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. The 115-pound fish that was recently captured was female with eggs, and is the largest specimen of this species ever captured in North America.

Recognizing the emerging threat, an interagency Black Carp Working Group (BCWG) was formed in 2016 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 in light of 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.

USGS efforts are a combination of four efforts, three which have been on-going and cover research on early life history, biology, and ecology of these fish including assessment of diet, reproductive analysis, birthplace origin, ploidy, age, growth, and genetics. USGS has been researching development of baits to aid in control efforts. The Black Carp Working Group 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 we have little to no information on their range of or trigger for movement or habitat preference.

USFWS efforts focus on monitoring and field collection of specimens, focused in the areas of new range expansion, using new methodology (hydroacoustics) as well as working with commercial fishers to identify and refine traditional methods (hoop and gill netting). USFWS will also collaborate with the USACE to continue work on eDNA marker refinement and field detection.

2018 Actions

In 2018, the following efforts will be undertaken:

- Support the Illinois DNR Black Carp bounty through advertising, improved data collection, and financial support if available.
- eDNA samples as needed to facilitate marker development and testing.
- Contract commercial fisher(s) to capture Black Carp and provide data on captures.
- Provide field support for the FluEgg model to estimate Black Carp spawning locations.

- Finalize genome assembly for Black Carp, publish and make available to collaborators to develop new tools for monitoring or control of Black Carp.
- Assess Black Carp swimming behavior similarly to previous assessments of Bighead, Silver, and Grass Carp.

3.6.2 Addressing the Threat of Grass Carp

Grass Carp are recognized as one of the four Asian carp species threatening the Great Lakes basin. Great Lakes coastal wetlands provide essential ecosystem functions and are critical habitat areas for many life stages of native fish, waterfowl and wildlife. Grass Carp have the potential to impact these important wetland habitats through habitat loss by direct consumption of aquatic macrophytes.

In recent years, the ACRCC has provided funding to address Grass Carp-related efforts, broadening from the initial focus on Bighead Carp and Silver Carp. Understanding the extent of the invasion within the Great Lakes and other areas of the U.S. and whether the Grass Carp populations are self-sustaining and expanding is critical to providing managers information they need to address control of this species. The presence of Grass Carp, while undesirable, offers an opportunity to study their reproduction and population dynamics and apply those insights at an early stage to prevent establishment in the Great Lakes. Although behavior and physiology of adult Grass Carp differs from Bighead Carp and Silver Carp, their spawning and early life history requirements are quite similar. USGS scientists have already begun to identify Grass Carp spawning habitat and investigate egg survival concurrently with studies on Bighead Carp and Silver Carp. Grass Carp often spawn with Silver Carp, their eggs and larvae drift similarly, and their young are often captured together in the same type of habitat. Wherever Grass Carp can successfully spawn and recruit, it is likely that Bighead Carp and Silver Carp also would be successful. Thus, what is learned studying and implementing actions for Grass Carp may be transferable to Bighead Carp and Silver Carp and be useful for managers in planning response and control methods for those fish should they invade the Great Lakes.

U.S. and Canadian resource management and research agencies in the Lake Erie basin have identified the growing threat of invasive Grass Carp as a high priority requiring focused and aggressive monitoring and control action in 2018. The binational study, *Ecological Risk Assessment of Grass Carp (Ctenopharyngodon idella) for the Great Lakes Basin*, identified the potential susceptibility of Lake Erie to Grass Carp introduction and establishment, further underscoring the need for management action. Based on available physical habitat, temperature profile, high biological productivity, and other factors, Lake Erie was identified as potentially highly susceptible to Grass Carp establishment relative to other Great Lakes. To address the threat, in 2016, Michigan DNR, collaborating with Ohio DNR, 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. Lake Erie management and research agencies are now utilizing this structured decision making model to serve as a baseline process to inform development of new actions including: gathering key data on Grass Carp population status and life history (e.g. address data gaps and address critical questions on Grass Carp population dynamics); developing new, state-of-the-art detection tools;

quantify and map potential habitat available for Grass Carp within the basin; and developing effective control options for potential use within a comprehensive control strategy.

Additionally, other key research is being conducted to address data gaps and critical questions on Grass Carp population dynamics within the basin.

2018 Actions

ACRCC state and federal member agencies have developed a suite of proposed actions for implementation in 2018, building off existing efforts within the Lake Erie basin. Planning is being conducted in collaboration with the Council of Great Lakes Fishery Agencies Lake Erie Invasive Fishes Committee, which has identified addressing the Grass Carp threat as a high priority for strategic action among its agency membership with jurisdictional management authority. Efforts to manage Grass Carp support the coordinated and cooperative fishery management conducted by Lake Erie agencies signatory to the *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 Carps in the United States*. These efforts are further supported by the Great Lakes AIS Early Detection program, conducted by USFWS in collaboration with State and Federal agency partners to provide targeted surveillance for non-native species (including Grass Carp) in high-priority (highest risk) locations within the basin.

In 2018 the following Grass Carp efforts will be undertaken:

- Develop and implement an expanded planned action using traditional gear at specified locations in the Sandusky River.
- Implement and evaluate innovative solutions for controlling Grass Carp, as science becomes available (e.g., bait attractants, behavioral deterrents, etc.).
- Continue and supplement ongoing early life history sampling for Grass Carp in the Sandusky River to measure potential reproductive response of action.
- Analyze all Grass Carp removed from Lake Erie for ploidy status, natal origin, estimated age, growth rates, and maturity status.
- Create new eDNA markers for Grass Carp.
- Develop permanent monitoring/index stations for Grass Carp eggs in the Sandusky and Maumee Rivers and sample the rivers several other Lake Erie tributaries during high-flow events.
- Complete FluEgg simulations for past high-flow events on the Sandusky River (and potentially Maumee River) to assess past successful spawning events and validate FluEgg performance.
- Test the efficacy of a Grass-Carp-specific bait in controlled laboratory studies, followed by pond trials and assess potential attractants for Grass Carp, including spawning-related chemicals (pheromones).

3.7 COMMUNICATION/EDUCATION/STAKEHOLDER ENGAGEMENT

2017 Accomplishments

The *AsianCarp.us* website continued to be the ACRCC's central platform for public outreach and education. As the site administrator, USFWS maintained and further developed the website,

working toward a goal of increased visits from the public and stakeholders. In 2017, the website continued to be expanded to encompass 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 WRRDA. Also, the National Park Service (NPS) worked with partners and teachers and began a new project to develop Asian carp specific education materials, Asian carp “traveling trunks,” and consolidated relevant education materials on the *AsianCarp.us* website. The creation of a new strategic communications plan will also serve to extend the reach of ACRCC messaging and help key audiences develop a greater understanding and appreciation for the ACRCC’s purpose, function, current actions, and successes.

2018 Actions

USFWS has hosted and administered the *AsianCarp.us* website since 2011. In 2018, USFWS will continue to grow the ACRCC’s image library offering high resolution downloads of Asian carp and Asian carp management



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

images to the public and the media. USFWS will also expand the current website to encompass 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. In FY2018, the NPS will continue its efforts to work with the ACRCC partners and teachers on developing Asian carp education materials such as traveling trunks for educators and Asian Carp lesson plan for middle and high school educators.

The ACRCC will also continue to work with the CAWS Advisory Committee to engage stakeholders on potential solutions to prevent Asian carp from establishing populations or moving through the CAWS. The CAWS Advisory Committee includes diverse stakeholders working to build consensus and advance development of both interim control measures and a long-term solution to prevent the transfer of Asian carp and other AIS through Chicago-area waterways while maintaining current uses of the system. The Advisory Committee’s products are available on line at <http://glc.org/projects/invasive/chicago-waterway/>.

3.8 ACCRC PARTNERSHIP OPERATIONS

In 2018, 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 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 U.S. 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>.

Since 2015, the Mississippi Interstate Cooperative Resource Association (MICRA) has coordinated Asian carp management actions through partnerships of state, federal and non-governmental 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 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 (a summary is provided below).

In FY2018, as per the Consolidated Appropriations Act of 2018, USFWS is expected to receive an additional \$2,000,000 in base appropriations for controlling Asian carp populations in the Great Lakes, Mississippi River and Ohio River basins, in cooperation 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 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://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 for managing the threat of Asian carp across multiple jurisdictions.
- Enhance inter-basin collaboration between the UMRB and ORB 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; and 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 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.

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, and 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 Quebec 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.

Since 2012, 26 Grass Carp have been captured in Canadian waters: 16 of these fish were caught in Lake Erie, eight in Lake Ontario, one in Lake Huron, and one in the St. Lawrence River (Quebec). No Bighead, Silver or Black Carp have been found in Canadian waters since 2012. The efforts of the Canadian agencies are identified in this section.

5.1 FISHERIES AND OCEANS CANADA

DFO 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 2017.

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 2017 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, 13 sites in Lake Huron, 5 sites in the Lake St. Clair basin, 9 sites in Lake Erie, and 5 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 2016 to increase the program's sampling capacity. In 2017, 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 2018 season and beyond; and new gears will continue to be introduced to the program to complement those currently deployed.

The Asian Carp Program has increased its early detection surveillance efforts each year. In 2013, 291 sites were sampled, detecting 21,510 fishes representing 83 species, including 1 Grass Carp (Grand River). In 2014, 743 sites were sampled, 43,840 fishes detected, 93 species represented, including one Grass Carp (Grand River). In 2015, 1,056 were sampled in 2015, detecting 64,552 fishes representing 98 species, including one Grass Carp (Jordan Harbour). In 2016, 1,334 sites were sampled, 85,633 fishes detected, representing 99 species. So far in 2017, 1,013 sites have

been sampled, detecting 43,584 fishes, representing 85 species (*note: this does not include results from larval work). Asian carp surrogate species (Buffalo spp. and Common Carp) were targeted as proxies for successful capture of Asian carp. In 2017, a total of 695 Buffalo spp. and 1,871 Common Carp were captured.

5.1.2 Response

DFO works with OMNRF to lead Asian carp responses in the Canadian waters of the Great Lakes. An Asian Carp Response Plan was developed using the Incident Command System (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. In addition to the three Grass Carp captured during DFO's early detection surveillance efforts (one in 2013, 2014, and 2015, respectively), 22 Grass Carp were also detected during this time by commercial fishers, recreational anglers, and other agencies. These captures resulted in 11 official responses.

In July 2017, a commercial fisher captured a live Grass Carp in Lake Huron in a trap net near Sarnia, ON. This specimen was reported to OMNRF and turned over to DFO's Asian Carp Program staff. ICS was initiated with operations on standby. Ploidy analysis and full dissection determined this to be a triploid male. ICS was then called off. The following week, a citizen spotted a dead Grass Carp on a Lake Erie beach near Port Maitland, ON, and reported the specimen to the Invading Species Awareness Program. Asian Carp Program staff collected the specimen and completed a dissection. Ploidy testing was not possible due to the state of decomposition. The Lake Huron fish was 5 years old, and the age estimation is still pending for the Lake Erie fish. Oxygen isotope analysis indicates aquaculture origin for both individuals. Further analysis to better determine origin and movement in the Canadian waters of the Great Lakes for all 2015, 2016, and 2017 Grass Carp specimens is on-going.

Throughout 2018, 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 an on-water training exercise in April 2017. This exercise served to test DFO's Asian Carp Response Plan with partners from OMNRF, and observers from other partner agencies present. Plans for future exercises and other training opportunities involving other partner agencies are underway.

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 2017 has included:

- **Native Fish Population Structure** – To determine the potential for fish to move from Lake Erie to Lake Ontario via the Niagara River and Niagara Falls, thereby bypassing the Welland Canal, we investigated whether populations of seven native fishes are genetically differentiated in habitats above versus below the falls. We used a state-of-the-art ddRAD method for sequencing thousands of loci (range: 3,334–7,005) from throughout the genome of each species and identified from these loci hundreds to thousands (range: 474–2,770) of single nucleotide polymorphisms among individuals. Four species (*Ambloplites rupestris*, *Catostomus commersoni*, *Micropterus salmoides*, *Moxostoma lepidotum*) showed no genomic evidence of population structure above versus below Niagara Falls, whereas three species (*Ameiurus nebulosus*, *Moxostoma valenciennesi*, *Perca falvescens*) showed modest levels of differentiation. Preliminary demographic models have been unable to determine whether gene-flow in any of these species is directional, likely due to overall genetic similarity within species. These results suggest that Niagara Falls is not an effective barrier to gene-flow in fishes and/or that it has only begun to function as a barrier to gene-flow in some species very recently.
- **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, we developed a metabarcoding protocol 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. A preliminary trial revealed that the overall pipeline – from DNA extraction to species identification – works well, but that some aspects (e.g., barcode primer design) should be more specifically tailored to Great Lakes fish taxa. These refinements are ongoing as are plans to scale up the method to approximately 350 samples collected from southern Ontario during summer 2017.

5.1.4 Control Technologies

In 2017, movement data collected on fishes exposed to non-physical behavioral barrier control technologies continued to be analyzed. Analysis techniques new to the field of behavioral barrier research were used to interpret fine-scale movement responses to adverse strobe-light and acoustic stimuli. Laboratory experiments were also conducted to investigate the behavioral and physiological responses of Common Carp to carbon dioxide as well as stroboscopic and acoustic stimuli. This work has helped to inform how multiple behavioral barrier technologies will interact with each other. Additionally, this work has aided in explaining how behavioral variation in response to barrier technologies may be structured within a population. Finally, new experiments have also been initiated to investigate the impact of turbidity on Common Carp avoidance responses to stroboscopic stimuli.

5.1.5 River Modeling

A method for using a 3-dimensional river model to predict Asian Carp egg movement is under development for the Don and Rouge rivers. Acoustic Doppler surveys were conducted in May and June 2017 on both rivers to obtain necessary bathymetry and velocity profiles. The data have been converted into a 3-D grid and are being inserted into a commercial hydrodynamic model (EE Explorer). A Lagrangian Particle Tracker will be used to track egg movement at each time step to determine if eggs will be suspended in the water column at the time of hatching. The model is nearing completion for the Don River and should be running by the end of 2017. Once completed, different flow and temperature scenarios will be undertaken to provide distributions of egg hatching success in different scenarios.

5.1.6 Spawning Suitability

A preliminary assessment of the suitability to Asian carp spawning of eight Great Lake tributaries in the Toronto area was completed. 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.

5.1.7 Risk Assessment (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 the majority 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. Additionally, a binational socio-economic assessment for Grass Carp has been drafted and is currently out for review.

5.1.8 Research to Inform Risk Assessment (Black Carp)

As part of the binational 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 2018.

5.1.9 Risk Assessment (Black Carp)

A binational ecological risk assessment for Black Carp in the Great Lakes basin is well underway, with a writing meeting in early December 2017. Research and other data are being used to inform a risk assessment team of DFO, GLFC, USGS, and USFWS. The draft risk assessment will be presented at a Canadian Science Advisory Secretariat meeting for a face-to-face peer review by a variety of invited binational experts, with a target peer-review date of May 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.

5.1.10 Outreach and Education

In partnership with two non-governmental organizations, Ontario Federation of Anglers and Hunters (OFAH) and the Invasive Species Centre (ISC) in Ontario, DFO is implementing outreach and education to stakeholders and the public in Canada. No contribution agreements were in place between DFO and their partners between April and November 2017, so work in 2017 has been limited. Despite this, the ISC still managed to run the *asiancarp.ca* website (approximately 40 visitors per day in 2017) as well as *carpeasiatique.ca*, its French language counterpart (approximately 11 visits per day in 2017), host two public information nights, train DFO and OMNRF on their equipment database, host a partnership meeting with other Asian Carp Canada partners, run two social media campaigns, host three webinars, and conduct ongoing coordination of an upcoming Asian Carp exhibit at the Toronto Zoo. The OFAH has also done quite a bit of outreach work on Asian carp in 2017 that includes: running a print public service announcement in three issues of Ontario Out of Doors magazine, producing two news articles on the topic of Asian carp, continuing their billboard campaign, attending five trade shows, and contributing regularly to their social media campaigns (reaching approximately 36,000 people on Facebook and approximately 21,000 on Twitter in 2017). OFAH has also received 54 reports of AIS so far in 2017. Contribution agreements with both organizations were finalized in November 2017, and outreach activities are set to continue until March 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.

5.1.11 Enforcement

The Canadian Federal Government's national AIS regulations came into effect in summer 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 United States, 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 United States to prevent movement of live Asian carp through trade, and potential introduction into the Great Lakes.

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

The OMNRF continued its monitoring activities in 2017 for the Canadian waters of the Great Lakes and their tributaries. Efforts focused on monitoring and assessment on Lake Erie, Lake St. Clair, the Detroit River, the St. Clair River, and southern Lake Huron. eDNA is a key technique used for monitoring in these locations. Surveillance plans for 2018 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.

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 emergency 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 and to prepare for the summer field season. 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. In 2017, the province continued its efforts to improve the plan based on additional field experience, new science, and continued coordination with U.S. partners.

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 also partners with the Invasive Species Centre and the Ontario Invasive Plant Council to deliver various aquatic invasive species programs across the province, including outreach, communications, and development of best management practices.

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 QUEBEC

Efforts to control Asian carp outside the Great Lakes basin are not within the scope of the ACRCC and therefore were not discussed within the action items of the present Action Plan. However, they are equally important for controlling Asian carp population dispersal throughout American and Canadian water bodies. The Québec Government is responsible for the conservation of wildlife and wildlife habitats, in a manner consistent with sustainable development and supported by up-to-date knowledge. It also promotes wealth creation through the development of wildlife resources. In Quebec, the mission of the Ministère des Forêts, de la Faune et des Parcs (MFFP, Ministry of Forests, Wildlife and Parks of Quebec) is to promote knowledge acquisition and to ensure the development and optimal use of forestry, wildlife, and parks in Québec from a sustainable development perspective, for the benefit of the entire population. More specifically, MFFP is also responsible for the conservation and protection of the integrity and health of the biodiversity of aquatic and terrestrial wildlife and for managing fishing activities for both freshwater and anadromous fishes. MFFP collaborates with other ministries, agencies, governments, jurisdictions, stakeholders, and partners to protect, restore, and sustain wildlife habitats and biodiversity. MFFP fulfills its objectives through planning, regulation, enforcement, scientific study, stocking, stewardships, and outreach. The MFFP is the provincial leader in preventing the introduction, establishment, and spread of aquatic invasive animal species, to reduce the negative impacts on Quebec's aquatic ecosystems, economy, and society. MFFP's responsibilities include:

5.3.1 Surveillance and Monitoring

Since 1995, an annual provincial standardized Fish Monitoring Network (FMN) was established by the MFFP. This network monitors fish abundance, biodiversity, and fishes community composition throughout the St. Lawrence. Because of the sheer size of the St. Lawrence, the annual survey focuses each year on a different region of the river; the whole St. Lawrence is covered in 4 to 5 years. Although AIS monitoring is not the primary goal of the FMN, every capture of exotic species is recorded. Thus, the establishment and spread of round gobies, tench, and common rudd is monitored over the years. FMN data can be viewed on the St. Lawrence Global Observatory Website: <http://ogsl.ca/en/>.

A dedicated AIS early detection network was implemented in 2007. This network is composed of 40 volunteer commercial anglers who work in collaboration with the MFFP. This network operates as sentinels for AIS detection. Volunteers report any exotic, unknown, or suspicious fish caught. The network covers over a 600-kilometer (km) stretch of the St. Lawrence River. The suspicious fishes caught are sent to the Ministry's experts for further identification when required. Fishermen have been informed and trained to identify Asian carp. Given the fact that fishermen are aware of the risks and threats these species represent, they would immediately communicate with the Ministry if a specimen were caught. The one and only Asian carp (Grass Carp) ever reported in the St. Lawrence River, about 70 km downstream of Montreal, on May 27, 2016, was reported by one of the volunteers of the AIS early detection network.

In 2016, the MFFP evaluated both the FMN and AIS early detection networks. From these assessments, a new ministerial AIS Early detection network will be implemented to better address Asian carp issues and increase detection efficiency. The new measures were implemented in 2017.

5.3.2 eDNA Research

eDNA sampling and analysis protocols have been field-tested since 2013 to be implemented within the ministerial AIS early detection and monitoring network. The eDNA is also currently used to detect endangered and rare aquatic species within the St. Lawrence. Grass, Silver, and Bighead Carp eDNA primers have been developed and tested over the years. In 2016, eDNA sampling and analysis were restricted to the St. Lawrence River nearby Montreal. This area is the main focus of field activities, as it is believed risks of Asian carp introduction is locally high through human activities in the Greater Montreal area and through natural colonization from migrating individuals from the upstream Great Lakes.

The capture of the first Grass Carp in the St. Lawrence River at the end of May 2016 makes eDNA sampling a critical tool for conducting further reconnaissance in the area where the fish was captured. Water samples were collected in the vicinity of the site of capture and from a greater region of the St. Lawrence covering the Richelieu River mouth (this river is connected to Lake Champlain) downstream to Lake St. Pierre. A second eDNA sampling operation was conducted in fall.

5.3.3 Quebec's Asian Carps Program

In 2015, the Quebec government officially adopted its new Maritime Strategy. It presents a perspective out to 2030 and sets out an action plan for the 2015 to 2020 period. One of the three orientations presented in the Maritime Strategy focuses on the protection of biodiversity and aquatic ecosystems. One of the actions listed is to structure an approach aimed at affording Québec adequate response capability to counteract threats posed by aquatic invasive species, in particular, the Asian carp from the Great Lakes. The approach includes prevention, early detection, and control and eradication measures.

To achieve this goal, a Quebec Asian Carps Program was officially launched during summer of 2016. The first phase of the program will span the next 3 years, from 2016 to 2019. Specifically, the objectives of the Quebec Asian Carps Program — Phase I are:

1. Develop a local expertise on Asian carp.
2. Establish collaborations to tighten partnerships; more specifically with (1) other Quebec's Ministries concerned by the Asian carp problem, (2) the Canadian government (including DFO), the OMNRF, and (3) the American jurisdictions adjacent to the province and the Great Lakes.
3. Revise an early detection network targeting Asian carp.
4. Conduct a risk analysis for the province's water bodies, identifying intervention options as well as possible mitigation measures.
5. Develop a concerted Asian Carp Action Plan.

Phase II of the program will consist of the identification of a coordinator in the Quebec government and of implementation of the Action Plan developed in Phase I.

The Québec Maritime Strategy may be found at:

<https://strategiemaritime.gouv.qc.ca/pp/uploads/2015/06/maritime-strategy-unabridged2.pdf>.

Appendix A

2018 Funding Matrix

FY2018 Asian Carp Action Plan Funding

	No.	Title	GLRI Funding FY 2018 (\$)	Base Funding FY 2018 (\$)
Prevention	1	Electric Dispersal Barriers and Barrier Operational Risk Assessment	\$ 1,050,000.00	\$ 16,505,000.00
		USACE	\$ 1,000,000.00	\$ 16,500,000.00
		USCG	\$ 50,000.00	\$ 5,000.00
	2	Great Lakes Mississippi River Interbasin Study (GLMRIS)	\$ 70,000.00	\$ 1,850,000.00
		USGS	\$ 70,000.00	
		USACE		\$ 1,850,000.00
	3	Closure and Monitoring of Other Pathways for Asian Carp to Enter the Great Lakes (Little Killbuck Creek, Ohio-Erie Canal and Eagle Marsh)	\$ 1,110,000.00	\$ 6,000.00
		Ohio DNR - Little Killbuck Creek	\$ 840,000.00	
		USACE - Little Killbuck Creek	\$ 40,000.00	
		USACE - Ohio-Erie Canal	\$ 200,000.00	
	USGS - Eagle Marsh	\$ 30,000.00	\$ 6,000.00	
4	Community Awareness, Surveillance, and Enforcement	\$ 300,000.00		
	Illinois DNR	\$ 300,000.00		
Control	5	Optimization of Mass Removal Harvest Techniques	\$ 330,000.00	\$ 335,000.00
		USFWS	\$ 105,000.00	\$ 50,000.00
		USGS	\$ 225,000.00	\$ 285,000.00
	6	Barrier Defense Using Novel Gear	\$ 290,000.00	\$ 35,000.00
		USFWS	\$ 290,000.00	\$ 35,000.00
	7	Contract Fishing for Asian Carp Detection and Removal	\$ 1,150,000.00	
		Illinois DNR	\$ 1,150,000.00	
	8	Asian Carp Enhanced Contract Removal Program Development	\$ 730,000.00	
		Illinois DNR	\$ 730,000.00	
	9	Asian Carp removal Support through Branding, Marketing Strategy Development and Implementation	\$ 170,000.00	
	Illinois DNR	\$ 170,000.00		
10	Asian Carp Population Model and Demographics to Support an Adaptive Management Framework	\$ 548,680.00	\$ 135,560.00	

FY2018 Asian Carp Action Plan Funding

	No.	Title	GLRI Funding FY 2018 (\$)	Base Funding FY 2018 (\$)
Early Detection, Monitoring, and Evaluation		USFWS	\$ 452,000.00	\$ 70,000.00
		USGS	\$ 96,680.00	\$ 65,560.00
	11	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	\$ 203,100.00	
		NOAA	\$ 203,100.00	
	12	FlueEgg Model to Assess Risk of Spawning, Egg/Larvae Survival and Enhance Predictive Capabilities	\$148,000.00	\$214,000.00
		USGS	\$ 148,000.00	\$ 214,000.00
Early Detection, Monitoring, and Evaluation	13	Great Lakes Asian Carp Monitoring Program	\$ 350,000.00	\$ 1,150,000.00
		USFWS	\$ 350,000.00	\$ 1,150,000.00
	14	Illinois River Monitoring and Evaluation	\$ 4,486,000.00	\$ 1,075,000.00
		USACE	\$ 150,000.00	
		USFWS	\$ 570,000.00	\$ 875,000.00
		USGS	\$ 294,000.00	\$ 200,000.00
		Illinois DNR	\$ 3,472,000.00	
	15	Detection Using Novel Gear	\$ 100,000.00	
		USFWS	\$ 90,000.00	
		Illinois DNR	\$ 10,000.00	
	16	eDNA: USFWS Program Capacity for eDNA Sampling and eDNA Sample Processing, and Advanced Molecular Tools for Tracking Asian Carp	\$ 110,000.00	\$ 3,200,000.00
		USFWS		\$ 2,400,000.00
		USGS	\$ 110,000.00	\$ 800,000.00
17	Telemetry and Telemetry Database	\$ 666,000.00	\$ 397,250.00	
	USACE		\$ 200,000.00	
	USFWS	\$ 200,000.00		
	USGS	\$ 466,000.00	\$ 197,250.00	
Early Detection, Monitoring, and Evaluation	18	Monitoring at the Electric Dispersal Barriers with Remote Sensing	\$ 170,000.00	\$ -
		USFWS	\$ 140,000.00	
		USGS	\$ 30,000.00	
	19	Acoustic Deterrents for Asian Carp	\$ 3,100,000.00	\$ 715,000.00

FY2018 Asian Carp Action Plan Funding

	No.	Title	GLRI Funding FY 2018 (\$)	Base Funding FY 2018 (\$)
Technology Development		USACE	\$ 525,000.00	
		USFWS	\$ 2,000,000.00	\$ 300,000.00
		USGS	\$ 575,000.00	\$ 415,000.00
	20	Carbon Dioxide	\$ 920,000.00	\$ 370,000.00
		USACE	\$ 450,000.00	
		USFWS	\$ 70,000.00	
		USGS	\$ 400,000.00	\$ 370,000.00
	21	Developing Species-Specific Control Systems for Asian Carp	\$ 670,000.00	\$ 780,000.00
		USFWS	\$ 70,000.00	
		USGS	\$ 600,000.00	\$ 780,000.00
	22	Barge Entrainment	\$ 700,000.00	\$ 300,000.00
		USACE	\$ 100,000.00	
		USFWS	\$ 500,000.00	\$ 300,000.00
		USGS	\$ 100,000.00	
	23	Testing and Adaptation of Chinese “Unified Method” of Carp Capture to U.S. Waters	\$ 163,000.00	\$ 285,000.00
		USFWS	\$ 38,000.00	\$ 70,000.00
		USGS	\$ 125,000.00	\$ 215,000.00
24	Electric Field-Based Aquatic Nuisance Species Dispersal Barrier			
	(No funding needed in 2018)			
25	Chemical Attractant Investigations to Increase Aggregation and Harvest for Asian Carp Control	\$ 300,000.00	\$ 230,000.00	
	USGS	\$ 300,000.00	\$ 230,000.00	
26	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	\$ 144,000.00	\$ 145,000.00	
	USGS	\$ 144,000.00	\$ 145,000.00	
Response	27	ACRCC Contingency Actions in the Upper Illinois River	\$ 220,000.00	
		USFWS	\$ 45,000.00	
		USGS	\$ 175,000.00	

FY2018 Asian Carp Action Plan Funding

	No.	Title	GLRI Funding FY 2018 (\$)	Base Funding FY 2018 (\$)
Black Carp	28	Black Carp Monitoring and Control	\$ 1,160,000.00	\$ 170,000.00
		USFWS	\$ 467,000.00	\$ 100,000.00
		USGS	\$ 493,000.00	\$ 70,000.00
		Illinois DNR	\$ 200,000.00	
Grass Carp	29	Grass Carp Monitoring, Research, and Response Actions	\$ 920,000.00	\$ 850,000.00
		USFWS	\$ 60,000.00	\$ 75,000.00
		USGS	\$ 325,000.00	\$ 425,000.00
		Ohio DNR	\$ 210,000.00	
		Michigan DNR	\$ 325,000.00	\$ 350,000.00
Communications	30	ACRCC Strategic Communications and Education Implementation	\$ 325,000.00	\$ 100,000.00
		USFWS	\$ 250,000.00	\$ 100,000.00
		NPS	\$ 75,000.00	
ACRCC Partnerships	31	ACRCC Partnership Operations	\$ 496,220.00	\$ 75,000.00
		USFWS	\$ 75,000.00	\$ 75,000.00
		USEPA	\$ 421,220.00	
TOTAL FUNDING			\$ 21,100,000.00	\$ 28,922,810.00

Note: FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

FY2018 Asian Carp Action Plan Funding by Agency

Agency	Total GLRI Funding	Total Base Funding
USACE	\$2,465,000	\$18,550,000
USCG	\$50,000	\$5,000
USEPA	\$421,220	\$0
USFWS	\$5,772,000	\$5,600,000
USGS	\$4,706,680	\$4,417,810
NOAA	\$203,100	\$0
NPS	\$75,000	\$0
Illinois DNR	\$6,032,000	\$0
Michigan DNR	\$325,000	\$350,000
Ohio DNR	\$1,050,000	\$0
Total	\$21,100,000	\$28,922,810

Appendix B

2018 Asian Carp Action Plan Action Items

All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141). All out-year activities are projections and will be subject to appropriations.

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1. Electric Dispersal Barriers and Barrier Operational Risk Assessment

Lead Agency: USACE

Agency Collaboration: USCG

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USACE	USCG	USACE	USCG
FY2018	\$16,500,000	\$5,000	\$1,000,000	\$50,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

Electric Dispersal Barriers (USACE)

The electric dispersal barriers (EDB) are located in the Chicago Sanitary and Ship Canal (CSSC), which is a man-made waterway creating the only continuous connection between Lake Michigan and the Mississippi River basin. The dispersal barrier system was developed to prevent the spread of invasive fish species between these watersheds.

Operation of the first barrier (Barrier I or Demonstration Barrier) by USACE began in April 2002, demonstrating a new technology for preventing the spread of aquatic nuisance species.

Barrier I, which is located at river mile 296.5 in Romeoville, Illinois, is formed of steel cables that are secured to the bottom of the canal. A low-voltage, pulsing DC current is sent through the cables, creating an electric field in the water. The electric field is uncomfortable for fish and they do not swim across it.

Barrier II was constructed with the ability to maintain a higher voltage level in the water in order to more effectively deter fish. It has two components, Barrier IIA and Barrier IIB. Barrier IIA was activated in 2009 and Barrier IIB was activated in 2011. The Water Resources Development Act (WRDA) of 2007 authorized USACE to upgrade the demonstration project of 2002 to a permanent status. Once completed, the permanent barrier (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).

Managing Waterway Traffic in Support of Asian Carp Control Activities (USCG)

When operations associated with the electric fish barrier, rapid response actions, research projects, or any other Asian carp activity will impact the flow of traffic on a navigable waterway, the USCG issues a Regulated Navigational Area (RNA) or safety zone and provides notice to the public and mariners to inform them of the planned activities and expected impact on navigation. If a partial or full waterway closure is required, the U.S. Coast Guard (USCG) may need to deploy small boats, personnel and/or obtain resources (i.e. temporary mobile command post) and/or mission support services on scene to enforce the waterway closure. For extended closures, the USCG acquires additional resources to establish a temporary vessel traffic service that tracks delayed vessels and facilitates the orderly resumption of traffic after the closure is lifted. Sector

Lake Michigan and Marine Safety Unit (MSU) Chicago are the primary field units of the Ninth District engaged in local Asian carp activities. Sector Lake Michigan and MSU Chicago support the management of waterway traffic in support of Asian carp control activities with industry outreach, conducting RNA and safety zone enforcements and attending Asian Carp Regional Coordinating Committee (ACRCC) meetings and teleconferences.

Barrier Operational Risk Assessment

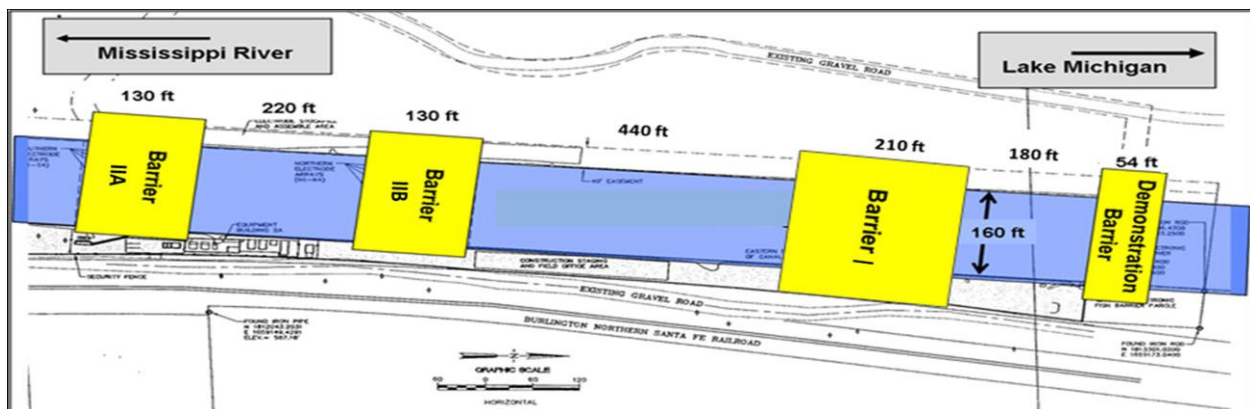
To prevent the spread of invasive species, these barriers create a significant electric field in the water and along the shore (an “electrified zone”) that presents hazards for vessel navigation and human activity.

Adding a new higher voltage barrier to the existing series of barriers, with the upgrade of Barrier I, 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 CG needs to develop additional measures to mitigate the increased risk.

Once Barrier I is complete, the 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 USACE Engineering Research and Development Center (ERDC) and the Coast Guard Research and Development Center (CGRDC) Construction Engineering Research Lab (CERL) will maximize commonality in safety test development and field measurement research and minimize separate USACE and CG tests and experiments. This includes field test design to conduct and 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

Electric Dispersal Barriers

In 2002, USACE began operating the first electric barrier (Barrier I or Demonstration Barrier). 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 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.

The Des Plaines River Bypass Barrier was erected in 2010 to physically block known bypasses around the electric barriers from the Des Plaines River and the Illinois and Michigan (I&M) Canal caused by flooding. The barriers placed in these locations are intended to stop juvenile and adult Asian carp. Portions of the barrier were damaged during the record flood of April 2013. Subsequently, the fence fabric was reinforced through the placement of riprap at the base of the structure, and later through the construction of a berm comprised of overburden material from the McCook Reservoir.

Site work and installation of new underwater components for the upgraded barrier, known as Permanent Barrier I, were completed in 2014. Construction of the new control building, utility connections, and backup power systems is currently underway and will be completed in Fiscal Year 2018.

During FY2015, the barriers underwent significant repairs including the installation of new switches.

Barrier IIA was outfitted with an uninterrupted power supply (UPS) to ensure continuous delivery of power in the event of a utility power outage in FY 2016. Additionally, efforts are underway to improve the cooling system of Barrier IIA.

Manage Waterway Traffic in Support of Asian Carp Control Activities

- In 2010, the USCG put in place a Temporary Interim Rule (33 CFR 165.930) that established a 77-mile-long safety zone from Brandon Road Lock to Lake Michigan in Chicago, Illinois, including segments of the navigable waters of the Des Plaines River, the CSSC, branches of the Chicago River, and the Calumet-Saganashkee Channel. The purpose of the safety zone was to provide the USCG Captain of the Port with the ability to take targeted and quick action to protect vessels and persons from the hazards associated with any federal and state efforts to control aquatic nuisance species. The USCG also put in place a Temporary Interim Rule that established a RNA (33 CFR 165.923) on the waters located adjacent to, and over, the electric fish barrier. The RNA prescribes requirements for vessels passing over the barrier to protect them from hazards associated with the barrier. This Temporary Interim Rule also established a safety zone that restricts vessels from transporting non-potable water across the barrier with the intention of discharging the water on the other side.

- In 2011, the USCG put in a place a Final Rule that established a permanent safety zone covering the same 77 miles of waterways covered by the Temporary Interim Rule issued in 2010 (33 CFR 165.930) and issued a Final Rule to make the safety zone and RNA, created under the Temporary Interim Rule issued in December 2010, permanent (33 CFR 165.923).
- In 2013, the USCG issued an Interim Rule amending the RNA (33 CFR 165.923) to restrict vessels 20 feet or less in length, and personal or human-powered watercraft of any kind, from crossing the electric fish barrier. Also, in 2013, the USCG RDC delivered a report titled “Chicago Sanitary and Ship Canal (CSSC) Marine Safety Risk Assessment.” This report categorized risks to mariners and shore personnel in the vicinity of the CSSC electrified barriers near Romeoville, Illinois.
- The draft Notice of Proposed Rulemaking (NPRM), which is still under review by the USCG District Prevention and Investigations Branch and the District Legal Branch, will update the current restrictions listed under 33CFR 165.923. In particular, the proposed NPRM removes current requirements that have been deemed unnecessary or ineffective from the RNA. They also clarify discrepancies between Sections .923 and .930, harmonizing the boundary limits for the safety zone and RNA to alleviate boundary confusion. These changes reflect information collected from field units, industry, and the USCG Research and Development marine safety risk assessment in 2013. Selected items included in the proposed NPRM to be listed under Section .923 instead of the safety zone are:
 - Removing bow boat requirements for flammable liquid cargoes. Facility handling such cargoes ceased operations in 2012.
 - Reclassifying the restrictions on “non-potable” water discharge under Section .923 with the RNA.
 - Potential removal of wire rope to prevent electrical arcing and considering other means of maintaining electrical connectivity between tows.
 - Establishing a no wake zone to all vessels in RNA.

Barrier Operational Risk Assessment

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, U.S. Army Engineer 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.

FY2017 Actions

Electric Dispersal Barriers

Operation and maintenance of the barriers continued, including regularly scheduled maintenance of the electric barriers. Continued construction of the main Permanent Barrier I building and the Control Gear/Backup Power building. Completed development of the Permanent Barrier I control system. In January 2017, a USACE dive team conducted a visual inspection of the electrodes, examining their condition at 5-foot intervals. Results of the inspection indicate the electrodes are corroding faster than expected and require replacement. USACE developed plans and specifications for the replacement electrodes for Barrier IIA's narrow (high field) array.

Proposed Actions for FY2018

Electric Dispersal Barriers

Operation and maintenance (O&M) of the barriers will continue, including regularly scheduled maintenance of the electric barriers, such as:

- Replacement of Demonstration Barrier's cable electrodes with steel billets.
- Replacement of Barrier IIA's narrow array (high field) electrodes.
- Continued work on Permanent Barrier I.

The 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 throughout FY 2018. The USCG may also develop new safety zones or RNAs to support new aquatic nuisance species initiatives.

Barrier Operational Risk Assessment

Develop coordinated USCG and USACE safety testing for Permanent Barrier I at Romeoville, Illinois.

- 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.
- 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)

Electric Dispersal Barriers

O&M of the barriers will continue, including regularly scheduled maintenance of the electric barriers.

The 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. The USCG may also develop new safety zones or RNAs to support new aquatic nuisance species initiatives.

Barrier Operational Risk Assessment

Participation in electric dispersal barrier system (EDBS) Barrier 1 Safety Testing, Perform Marine Safety Risk Assessment.

Timeline for Major Actions

Electric Dispersal Barriers:

- January/February 2018: annual maintenance
- Quarterly: other routine maintenance

Expected Milestones

Electrode Replacement:

- First Quarter 2018 – Awarded construction contract

What Is Deliverable for this Funding

Electrode Replacement: 2018 - Contract award for electrode replacement, new electrodes at Barrier IIA and the Demonstration Barrier.

Barrier Operational Risk Assessment:

- Safety Testing Report
- Marine Safety Risk Assessment

Expected Completion Date for Project

Electrode Replacement: Barrier IIA – April 2018; Demonstration Barrier – December 2018

Potential Hurdles

Electrode Replacement:

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

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. The 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

None

2. Great Lakes Mississippi River Interbasin Study (GLMRIS)

Lead Agency(s): USACE

Agency Collaboration: USGS, USCG

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested		
	USACE	USGS	USCG	USACE	USGS	USCG
FY2018	\$1,850,000	-	-	-	\$70,000	-

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

Work under this 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, 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) GLMRIS Program Management (USACE), (2) GLMRIS Brandon Road (USACE), (3) Characterization of Brandon Road Lock for Barrier Implementation (USGS), and (4) Brandon Road Lock and Dam (L&D) Risk Assessment (USCG).

GLRMIS Program Management

Efforts include vertical team coordination, coordination among and support to project elements within the geographical boundaries of the GLMRIS program, budget development and defense, public outreach, Asian Carp Regional Coordinating Committee and Chicago Area Waterway System Advisory Committee related activities, stakeholder engagement, and response to Congressional and media inquiries.

GLMRIS Brandon Road

Work under this template includes the study of aquatic nuisance species (ANS) control technologies, as outlined by the January 2014 GLMRIS Report, that could be implemented in the vicinity of Brandon Road 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 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.

Characterization of Brandon Road Lock for Barrier Implementation

USGS has collected, analyzed and published hydrodynamic and water-quality data in the Brandon Road lock and downstream. This effort provides information to define flow velocity distributions under representative lock operations. USGS has also operated real-time velocity and water-quality gages.

Brandon Road L&D Operational Risk Assessment

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) since mariners must be out on deck for work in conjunction with lock operations.

To address invasive-species control-measure changes, USCG operational commander requested CGRDC support for research to develop scientific and technical knowledge into how species control technologies could influence possible navigation safety hazards, 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 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

USACE completed and released the GLMRIS Report in January 2014. The GLMRIS Report identified multiple alternatives; three alternatives identified the Brandon Road Lock and Dam as a location to establish controls that would create a buffer zone to address upstream transfer of Mississippi River species through all Chicago Area Waterway System (CAWS) pathways. 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 CAWS and establishment in the newly invaded basin.

GLMRIS Program Management

Continues USACE-wide coordination, coordination among and support to project elements within the geographical boundaries of the GLMRIS program, budget development and defense, public

outreach, Asian Carp Regional Coordinating Committee and CAWS Advisory Committee related activities, stakeholder engagement, and response to Congressional and media inquiries.

GLRMIS Brandon Road

Based on the evaluations presented in the GLMRIS Report and in response to stakeholder input, the Assistant Secretary of the Army (Civil Works) directed USACE to proceed with a formal evaluation of potential control technologies to be applied in the vicinity of the Brandon Road L&D. USACE hosted three public meetings as part of the scoping process. To date, the Project Delivery Team (PDT) has achieved the first two major milestones of the feasibility phase by developing a focused array of alternatives to be considered, by completing the Alternatives Milestone in June 2015, and development of the Tentatively Selected Plan in January 2017. In August 2017, USACE released the draft report for public review. USACE hosted four public meetings during the 120 day public comment period. Additional data gathering and research completed on multiple ANS control measures conducted by other agencies, expert elicitation of the multiple control measures to determine effectiveness has been completed.

Characterization of Brandon Road Lock for Barrier Implementation

- Collection, analysis and publication of hydrodynamic and water-quality data in the lock and downstream to define flow velocity distributions under representative lock operations. (USGS)
- Operation of real-time velocity and water-quality gages. (USGS)

Brandon Road L&D Operational Risk Assessment

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. CGRDT 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.

FY2017 Actions

GLMRIS Program Management

Continued vertical team coordination, coordination among and support to project elements within the geographical boundaries of the GLMRIS program, budget development and defense, public outreach, ACRCC and CAWS Advisory Committee related activities, stakeholder engagement, and response to Congressional and media inquiries.

GLMRIS Brandon Road

Identified the Tentatively Selected Plan (TSP), released the TSP draft report for public review, conducted four public meetings to allow for public comment on the TSP, and initiated Agency Technical Review (ATR), Independent External Peer Review (IEPR), Policy Review and National Environmental Policy Act (NEPA) review.

Proposed Actions for FY2018

GLMRIS Program Management

Continue vertical team coordination, coordination among and support to project elements within

the geographical boundaries of the GLMRIS program, budget development and defense, public outreach, ACRCC and CAWS Advisory Committee related activities, stakeholder engagement, and response to Congressional and media inquiries.

GLMRIS Brandon Road

Complete ATR, IEPR, Policy and NEPA reviews, analyze public comments received during the public review period, develop a recommended path forward to complete the final feasibility phase of the study based on comments received and what is needed to complete the study, present a path forward at Agency Decision Milestone. This is the fourth phase of the USACE Specific Measurable Attainable, Risk Informed Timely (SMART) Feasibility Study Process. It consists of Senior Leader Review Panel and state and agency review.

Characterization of Brandon Road Lock for Barrier Implementation

- Support USACE GLMRIS decision making by participating in meetings and calls and specific briefings as requested.
- Publish USGS Scientific Investigations Report (SIR) on velocity and dye study data and analysis.
- Publish USGS SIR on water-quality data and analysis, with an emphasis on the carbon dioxide in the system.
- Continue operation of velocity and water-quality gages to provide continuous data.
- Publish journal article on collection and analysis of continuous carbon dioxide data.
- Additional hydraulic and water-quality data collection as partners identify.

Brandon Road L&D Operational Risk Assessment

The USCG operational commander seeks CGRDC assistance in the following areas:

- Early identification of USACE and safety tests that, in addition to evaluating ANS control technologies, also examine associated risks to vessels and mariners transiting Brandon Road L&D. Technologies to include: carbon dioxide (CO₂) concentration testing, water-jet and reverse-flow reduction testing, and acoustic deterrence program.
- Reviewing USACE evaluation of potential ANS control technologies for Brandon Road L&D to advise D9, Sector Lake Michigan, and MSU Chicago on associated risks to vessels and mariners.

Potential Out-year Actions (Subject to Future Appropriations)

GLMRIS Program Management

Continue vertical team coordination, coordination among and support to project elements within the geographical boundaries of the GLMRIS program, budget development and defense, public outreach, ACRCC and CAWS Advisory Committee related activities, stakeholder engagement, and response to Congressional and media inquiries.

GLMRIS Brandon Road

Complete feasibility phase analysis, prepare final feasibility report, initiate and complete state and agency and public review of the final report, assemble a Chief's Report with a signed Record of Decision, and submit Chief's Report.

Characterization of Brandon Road Lock for Barrier Implementation

- Support USACE GLMRIS decision making by participating in meetings and calls and specific briefings as requested.

- Continue operation of velocity and water-quality gages to provide continuous data
- Additional hydraulic and water-quality data collection as partners identify.

Brandon Road L&D Operational Risk Assessment

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

GLMRIS Program Management

Operates on a yearly basis supporting the other efforts.

Brandon Road L&D Operational Risk Assessment

- Participation in planning and execution of CO₂ testing at L&D 14 on the Upper Mississippi River.
- Liaison and test attendance with USACE on acoustic deterrence.
- Participation in entrainment/non-entrainment research.

Expected Milestones

GLMRIS Program Management: None

GLRMIS Brandon Road:

- Agency Decision Milestone June 2018

Characterization of Brandon Road Lock for Barrier Implementation: None

Brandon Road L&D Operational Risk Assessment: None

What Is Deliverable for this Funding

GLMRIS Program Management

Continues vertical team coordination, coordination among and support to project elements within the geographical boundaries of the GLMRIS program, budget development and defense, public outreach, ACRC and CAWS Advisory Committee related activities, stakeholder engagement, and response to Congressional and media inquiries.

GLRMIS Brandon Road

- FY2018: Completion of public review and Agency Decision Milestone. This is the fourth phase of the USACE SMART Feasibility Study Process. It consists of Senior Leader Review Panel and state and agency review.

Characterization of Brandon Road Lock for Barrier Implementation

- USGS SIR on velocity and dye study results.
- USGS SIR on water-quality data analysis.

Expected Completion Date for Project**GLMRIS Program Management:** TBD**Characterization of Brandon Road Lock for Barrier Implementation:** TBD**Brandon Road L&D Operational Risk Assessment:** TBD**Potential Hurdles**

Brandon Road L&D Operational Risk Assessment: As part of GLMRIS, a 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.

At this time, beyond a preliminary risk assessment, there are too many variables and uncertainties to accurately quantify risk. Each of the variables associated with the proposed control measures need individualized examinations before combining them into an assessment that evaluates them as a system.

3. Closure and Monitoring of Other Pathway for Asian Carp to Enter the Great Lakes (Little Killbuck Creek, Ohio-Erie Canal and Eagle Marsh)

Lead Agency: U.S. Environmental Protection Agency

Agency Collaboration: Ohio DNR, USACE – Buffalo District, USGS, Maumee River Basin Commission, City of Fort Wayne, Aqua America, Inc., ORSANCO

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested					Other Funding
		USACE – Ohio Erie Canal	Ohio DNR Little Killbuck Creek	USACE Little Killbuck Creek	USACE Eagle Marsh Phase 2	USGS Eagle Marsh H&H	
FY2018	\$6,000	\$200,000	\$840,000*	\$40,000	0	\$30,000	\$21,150**

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

*Funding request for this project increased significantly after a 50% design review meeting with the consultant. ** Eagle Marsh Hydrologic and Hydraulic (H&H) - USGS Cooperative Water Program: \$6,000; Cooperator funds: Maumee River Basin Commission \$3,100, City of Fort Wayne \$6,500; Aqua America, Inc./ ORSANCO: \$10,900

Project Explanation

As part of the GLMRIS, USACE assessed the Great Lakes and Mississippi River watershed divide to determine if there were viable surface water pathways for the transfer of ANS between basins. The GLMRIS Aquatic Pathway Assessment Report developed for Ohio Erie Canal determined it was a medium risk connection and that there was a risk for transfer of AIS from the Mississippi River basin to the Great Lakes basin for Silver Carp, Bighead Carp, Black Carp, northern snakehead, and skipjack herring. The GLMRIS Aquatic Pathway Assessment Report developed for the Little Killbuck Creek determined it was a medium risk connection and that there was a risk for transfer of aquatic invasive species (AIS) from the Mississippi River basin to the Great Lakes basin for Silver Carp, Bighead Carp, Black Carp, and inland silverside and from the Great Lakes basin to the Mississippi River basin for threespine stickleback and VHS.

The USACE and Eagle Marsh local, state and federal partner agencies determined that additional USGS streamflow data are needed on Graham-McCulloch Ditch upstream from the Phase 1 aquatic nuisance species separation berm at Eagle Marsh (at South Bend Drive) to calibrate simulations of flow and flooding needed to finally close the Asian carp berm-barrier. The Phase 1 closure berm is 1.7 miles long and an average 7.5 feet high that restricts Asian carp passage into the Great Lakes basin except at a small notch (350 feet long) that was built to the

approximate 10-year flood elevation. A mesh screen at the notch extends to the top of the berm and has a screen opening that will block Asian carp at elevations up to the 100-year, 1 percent chance flood event. A USGS webcam permits remote monitoring in the event of flooding conditions at the Phase 1 notch and mesh screen. Phase 2 final closure of the berm will remove the Phase 1 barrier screen and close a 10-year, 10 percent floodway notch and an upstream gap to achieve basin separation at a 100-year, 1-percent chance flood event. Final berm closure cannot be completed until the Corps indicates through their calibrated computer simulations that flood risk in the area is not increased by final berm closure. The Phase 1 berm was completed by U.S. Department of Agriculture, Natural Resource Conservation Service (NRCS), Indiana DNR and the Little River Wetland Project using computer flow simulations from the USACE calibrated with USGS streamflow data. The berm restricts Asian carp entry into the Great Lakes.

Summary of Actions to Date

USACE – Ohio Erie Canal

- February 2013: Ohio DNR met with the City of Akron to discuss the Aquatic Pathway Assessment Report for Ohio Erie Canal. The Ohio DNR and the USACE discussed the two primary areas of concern at the time:
 - Direct transfer of water from the Mississippi River basin to the Great Lakes basin at feeder gates that transfer water from Long Lake to the Ohio Erie Canal.
 - Flooding along the Ohio Erie Canal tow path that allows water to move from the Mississippi River basin to the Great Lakes basin.
- October 2013: Ohio DNR facilitated Asian Carp Framework funding for the USACE to conduct a preliminary assessment of closure options at Ohio Erie Canal.
- September 2014: USACE completed a preliminary closure assessment in September 2014 and identified six connection points at the Ohio Erie Canal as presented in the “Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures” report dated September 30, 2014. Included 50% design level designs.
- September 2014 – August 2015: Further design efforts progressed toward the 100% design stage, including checking of areas downstream in the Tuscarawas River that may be more appropriate, simpler, and efficient for stopping the northward movement of aquatic invasive species.
- September 2016: The USACE completed 100% Design Document Report for the Ohio Erie Canal Aquatic Nuisance Species Control Project.
- October 2016 – February 2017: Ohio DNR informed USACE of additional potential aquatic pathways along the Canal and initial H&H investigation.

Ohio DNR - Little Killbuck Creek

- November 2012: Ohio DNR met with the Medina Soil and Water Conservation District (SWCD) and the local NRCS representative to discuss the GLMRIS study.
- September 2013: Ohio DNR, Medina SWCD, and NRCS met with the primary landowner (Dewey Hall) to discuss the GLMRIS study and the alternatives for closure (other land uses, non-structural alternatives, and structural alternatives).
- November 2013: Ohio DNR met with the Medina SWCD, the local NRCS representative, and representatives from the NRCS central office staff. A decision was made to have NRCS provide design assistance for structural alternatives.

- February 2014: NRCS developed preliminary alternatives for structural closure. These alternatives were discussed in March 2014. The two alternatives are to improve the current dike system or construction of a new dike along the historical watershed boundary.
- April 2014: Ohio DNR, Medina SWCD, and NRCS met with the primary landowner to discuss the closure alternatives. Discussions included the preferred alternative, how this alternative will impact the landowners farming operation, and mitigation that can be implemented to ensure the landowners continued operation.
- October 2014: Kabil Associates was selected to conduct a preliminary investigation of closure options at Little Killbuck Creek. This study will be used to narrow down the closure options so that a final engineering study can be completed.
- September 2015: Kabil Associates completed the preliminary design for closing the connection.
- January 2016: Met with the primary landowner to discuss the preliminary design. The landowner was supportive of moving ahead with the final design.
- September 2016: The consulting firm, NTH Consultants, Ltd (NTH) was selected to develop final designs for closing the connection.
- September 2015: Kabil Associates completed the preliminary design for closing the Little Killbuck Creek connection.
- January 2016: Ohio DNR met with the primary landowner to evaluate and determine the preferred alternative for closure. This alternative is based on cost and potential impacts to local landowners.
- September 2016: Ohio DNR contracted with NTH to develop 90% design plans for closure, including mitigation of impacts to the local landowners.
- September 2016 – October 2017: NTH conducted cultural resource, wetland/stream, geotechnical, and hydrological assessments. They also developed preliminary design plans and initiated project permitting.

USACE - Little Killbuck Creek

- The USACE completed the “GLMRIS Focus Area 2 Aquatic Pathway Assessment Report, Little Killbuck Creek, Ohio” in 2013. This report consolidated the available information about this location such as the ANS of concern, habitat, water quality, hydrology, and land use and it assessed the probability of such ANS being able to use this pathway to move from one basin to the other. Since completion of this report, Ohio DNR has progressed development of preliminary designs for structural separation of the basins at this location and there has been no USACE involvement.

USGS H&H Technical Support for Eagle Marsh Phase II Basin Separation – see above.

FY2017 Actions

USACE – Ohio Erie Canal

- USACE updated conceptual designs to address the early 2017 emergence of new potential pathways along the Canal, which caused the deferment of the construction contract award until calendar year 2018.

- USACE and Ohio DNR worked on pre-application phase of permitting and initial steps for implementation of closure options (e.g., environmental compliance, real estate, cultural resources).
- Completed Phase I Environmental Site Assessment and Phase I Cultural Resource Study.

Ohio DNR - Little Killbuck Creek

- October 2017: Ohio DNR met with NTH to discuss the 50% design plans for the closure and discussed next steps.
- December 2017: Ohio DNR will facilitate a meeting with the Potentially Affected Interests to present the connection closure alternative(s) and the preferred path forward for closing the connection.
- March 2018: Ohio DNR will initiate discussions with the primary landowners on compensation for land purchase or easements for the berm and flood storage components for the project.
- May 2018: Complete 90% design plans.

USACE - Little Killbuck Creek

- No actions taken by USACE in FY2017.

USGS H&H Technical Support for Eagle Marsh Phase II Basin

- Operated webcam at the site of a spillway in the permanent aquatic nuisance control (ANSC) barrier along Graham-McCulloch Ditch in Eagle Marsh to validate operation of Phase 1 fence and barrier.
- Procured, installed and began collection of streamflow data from a site on Graham-McCulloch Ditch above Eagle Marsh (South Bend Drive) to provide data to the Corps of Engineers to assess calibration of their flow simulations. The streamflow data are being collected in 2017-early 2019 to support and validate USACE modeling efforts to verify that the final ANSC barrier has no adverse impact on area flooding.
- Collected and report streamflow data from two sites along streams that drain either side of the Eagle Marsh (Graham-McCulloch Ditch at Ellison Road) to the Little and Wabash Rivers and (one site on Junk Ditch) to the St. Mary's and Maumee Rivers as part of local observations to demonstrate that Phase 1 separation of the Wabash and Maumee basins is effective to prevent migration of ANS (Asian carp). These two have been transitioned to funding by local partners and USGS Cooperative Water Program funds to support other interests and are not supported by Great Lakes Restoration Initiative (GLRI) funds.

Proposed Actions for FY2018**USACE – Ohio Erie Canal**

- USACE will complete 100% design in consultation with Ohio DNR and Summit County Metroparks. Additionally, USACE will obtain necessary environmental compliance approvals, execute real estate agreements, and award the construction contract for implementation of Ohio Erie Canal structural measures.

Ohio DNR - Little Killbuck Creek

- Complete 100% design plans and finalize permitting for construction.

- Acquire easements on four parcels for the construction of the berm.

USACE - Little Killbuck Creek

- Complete an independent external review of the approximately 90 percent designs for Ohio DNR that were prepared by NTH. 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 HEC RAS model for hydraulics and hydrology that was developed by NTH. 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 USEPA.

USGS H&H Technical Support for Eagle Marsh Phase II Basin

Stakeholders are analyzing how an improved and expanded ANSC barrier (levee-grade berm along the eastern and southern banks of Graham-McCulloch Ditch to separate the Wabash and Maumee basins to the 1-percent flood frequency) affects flooding on either side of the barrier. USGS 2018 project actions include the following:

- Final year to operate a webcam at the site of a spillway in the permanent ANSC barrier along G-M ditch in Eagle Marsh. Transition webcam operation and maintenance to local stakeholders.
- Continue collecting streamflow and temperature data from a site on Graham-McCulloch Ditch above Eagle Marsh (South Bend Drive) to provide data to the Corps of Engineers to assess calibration of their flow simulations. Provisional streamflow data will be provided to the Corps after one year of operation to support and validate USACE modeling efforts.
- Collect and report streamflow and temperature data from two sites along streams that drain either side of the Eagle Marsh (Graham-McCulloch Ditch at Ellison Road) to the Little and Wabash Rivers and (one site on Junk Ditch) to the St. Mary's and Maumee Rivers to demonstrate phase 1 separation. The two sites are funded by local partners and USGS Cooperative Water Program funds and not by GLRI funds.

Potential Out-year Actions (Subject to Future Appropriations)

USACE – Ohio Erie Canal

- Monitoring of recently completed construction and coordination with stakeholders. Completion of project construction.

Ohio DNR - Little Killbuck Creek

- Acquire four parcels for the construction stormwater retention basins.
- Initiate construction of berm and retention basins.
- Complete construction of the project.

USACE - Little Killbuck Creek

- Remain available to Ohio DNR and USEPA for consulting, as needed.

USGS H&H Technical Support for Eagle Marsh Phase II Basin

- Collect streamflow data for Graham-McCulloch Ditch at Ellison Road and Junk Ditch sites funded by local partners and USGS Cooperative Water Program funds.

Timeline for Major Actions**USACE – Ohio Erie Canal**

- September 2018: Construction contract award.

Ohio DNR - Little Killbuck Creek

- May 2018: Complete 90% design plans.
- September 2018: Complete 100% design plans and finalize permitting for construction
- September 2018: All properties for project acquired.

USACE - Little Killbuck Creek

- N/A

Expected Milestones**USACE – Ohio Erie Canal**

- September 2018: Construction contract award.

Ohio DNR - Little Killbuck Creek

- May 2018: Complete 90% design plans.
- September 2018: Complete 100% design plans
- September 2018: Acquire easements for the construction of the berm

USACE - Little Killbuck Creek

- Complete independent external review of 90% design drawings in 2018.

USGS H&H Technical Support for Eagle Marsh Phase II Basin

- Report streamflow data from site installed in 2017 on Graham-McCulloch Ditch above Eagle Marsh (South Bend Drive).
- Provide data to Corps of Engineers modeling team to understand whether separation of the Wabash and Maumee basins is effective to prevent migration of ANS (Asian carp) and has no adverse impact on area flooding.
- Operate webcam at the Phase 1 spillway and Asian carp fence to monitor flood conditions when the Wabash and Maumee basins permit cross basin communication of ANS during flooding that exceeds the 10-percent flood frequency.

What Is Deliverable for this Funding**USACE – Ohio Erie Canal**

- Construction contract award.
- Supervision and administrative of construction, project management, and fiscal closeout.

Ohio DNR - Little Killbuck Creek

- 100% design plans and permits complete. Secure land for berm.

USACE - Little Killbuck Creek

- Completion of an independent external review of the approximately 90 percent designs for Ohio DNR that were prepared by NTH Consultants, Ltd. 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 USEPA.

USGS H&H Technical Support for Eagle Marsh Phase II Basin

- Streamflow and water temperature data from this project assist with demonstrating that separation of the Wabash and Maumee basins is effective to prevent migration of ANS (Asian carp) and verification whether the final implemented barrier has no adverse impact on area flooding.
- Webcam operation informs modeling team and agency responders when flooding permits communication of ANS during flooding that exceeds the 10-percent flood frequency.
- USGS involvement at Eagle Marsh furthers the national goal to develop and implement measures to prevent movement of invasive species, in this case Asian carp, into the Great Lakes. USGS hydrologic and remote data observation capabilities provide necessary elements to the successful Federal-State-local partnership that maintain and will complete the Eagle Marsh berm.

Expected Completion Date for Project

- Ohio Erie Canal: July 2019
- Little Killbuck Creek: September 2022

Potential Hurdles**USACE – Ohio Erie Canal**

- Development and agreement between USACE, Ohio DNR, Summit County Metroparks, and other landowners on temporary and permanent real estate easements and long-term responsibilities may result in some contract award delays
- Securing Clean Water Act Section 404 permit in light of potential cultural resource issues along the historic Ohio-Erie Canal. For example, the Ohio State Historic Preservation Office may seek to require implementation of mitigation measures (e.g., interpretive signage via Memorandum of Agreement [MOAs]) if the project's permit area could affect part of the Canal if it is determined eligible for listing on the National Register of Historic Places. The need for such an MOA could delay construction schedule.

Ohio DNR - Little Killbuck Creek

- The ability to develop a separation option that prevents the movement of aquatic invasive species (AIS) across the basin divide while allowing for landowner-desired continued agriculture operation and provides for minimization of flooding to surrounding properties.

USACE - Little Killbuck Creek

- None

USGS H&H Technical Support for Eagle Marsh Phase II Basin

- None. Local governments continue to cooperate with providing permission to operate two of the three streamflow gages.

4. Community Awareness, Surveillance, and Enforcement

Lead Agency(s): USEPA

Agency Collaboration: Illinois DNR, USFWS, state and federal law enforcement agencies, DFO/Canadian enforcement as necessary, Illinois Natural History Survey-Illinois/Indiana SeaGrant

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
		Illinois DNR
FY2018	-	\$300,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

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 friendly 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 ANS, fish transportation and importation for food or stocking will also be investigated. Increased officer presence, education, and communication will enhance our understanding of this.

Summary of Actions to Date

Illinois DNR will post monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

Proposed Actions for FY2018

- In 2018 Illinois DNR will continue with the efforts started in 2012 in working throughout the greater Chicago area and expand the program to statewide site visits and surveillance,

working with multijurisdictional teams when appropriate. Additional areas where live Asian carp may be moving within the state intentionally or unintentionally will be identified.

- To expand these efforts, Illinois DNR will coordinate efforts with the USFWS along with local and regional (specifically Great Lake) jurisdictions.

Expected Milestones

- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Establish consistent enforcement and understanding in Illinois and train surrounding states in same consistent enforcement techniques.
- Increase coordination with City of Chicago, and USFWS in these issues.
- Consider signatory enforcement compact with other Great Lakes States/Provinces.

What Is Deliverable for this Funding

Outcomes/Outputs

- Continued enforcement and establish expectations regarding live fish sales in Illinois.
- Continued coordination with multijurisdictional and regional fish hauling and movement of fish.
- Increased awareness and education and then built upon to ensure compliance.
- Decrease or eliminate any illicit transportation of Asian carp within or across Illinois.
- Educate law enforcement that is not regularly involved with resource conservation in the Asian carp issues and further increase ability to stop illicit AIS movement and enforce regulations.
- Contribute to pet surrender days to reach out to public wanting to get rid of unwanted AIS.

Potential Hurdles

- Difficult to inspect non-registered locations, or black-market dealers.
- Activity in other states/jurisdictions may affect Illinois commerce and activity.

5. Optimization of Mass Removal Harvest Techniques

Lead Agency(s): USGS and USFWS

Agency Collaboration: Missouri Department of Conservation (MDC); Kentucky Department of Fish and Wildlife Resources (KDFWR); Illinois Natural History Survey (INHS)

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USFWS	USGS	USFWS	USGS
FY2018	\$50,000	\$285,000	\$105,000	\$225,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

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 Asian carp) 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 to 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”.

Mass harvest fishing methodologies exist throughout the world for a variety of species and these methods can be adapted to harvesting Asian carp from Midwestern U.S. waters. Mass harvest technique development incorporates global expertise in net design, existing technology for mass removals, innovative boat construction, and other methods. Experimental approaches can be used to test the effectiveness of these gears to identify the most efficient mass-removal strategies for reducing Asian carp populations. To date, preliminary evaluations of several capture methods, particularly the paupier boat, have been conducted by the Columbia Fish and Wildlife Conservation Office. This capture technique has been tested in a variety of habitats including smaller tributaries, larger rivers, and backwaters. Ongoing efforts will further test promising capture methods across a range of habitat types. In addition to field evaluations of current methodologies, new gears and techniques will be developed. One such need for mass removal of Asian carp is a large, commercial fishing vessel. If such a vessel were available to managers, more harvest techniques would be available and more biomass could be removed.

Two new gears that will undergo initial testing by USGS and collaborating state agencies in 2018 include the large “Iruka” net, and the Merwin Trap (Figures 1, 2). Lakes and backwaters

are particularly challenging to managers trying to control their Asian carp populations, and large trap nets may be an effective complement to existing harvest methods. In Lake Barkley for example, electrofishing is ineffective and removal efforts are primarily conducted by commercial fishermen alone. Although commercial fishermen have removed approximately 2 million pounds per year of Asian carp in Lake Barkley, only fish larger than 750mm are targeted. Not only is the commercial fishing technique labor intensive, gill netting results in high bycatch mortality and the size bias limits availability of population demographic information in the lake. To increase capture efficiency of these novel harvest gears, researchers at CERC and other institutions have been testing the use of food attractants to evaluate whether Asian carp can be concentrated into an area where the attractant is applied. Laboratory and field studies suggest that an algal food stimulus is attractive to Asian carp and can increase the abundance of these species in areas where the stimulus is applied. This potential aggregation stimulus will be tested on both the Iruka and Merwin Trap nets as part of a robust experiment. Ultimately, we will evaluate the methods of capture tested to recommend the most economical supplemental capture technique(s).

To assist with deciding when and where to concentrate effort to maximize harvest, we will begin to compile data on behavior, biology, habitat use, and environmental drivers of carp concentrations to create predictive models. Developing an understanding of when and where Asian carp populations will be concentrated will facilitate efficient mass-removal efforts. This effort will be led by the USFWS Columbia Fish and Wildlife Conservation Office and will be ongoing through 2019, until enough data have been collected to inform the models for targeted regions.

Additional studies linked to this template, yet funded through the sound template, include the evaluation of sound as a herding technique. There is evidence that acoustic stimuli can be used to either attract or repel Asian carp. Herding studies conducted by USGS and USWFS Wilmington Field Station suggest that the use of complex acoustic stimuli can enhance harvest of Asian carp. The use of sound to enhance harvest of different capture gears will continue to be investigated. The use of biologically relevant, attractive, acoustic stimuli to aggregate carp will continue to be investigated as well.

Resulting information from the actions described will include at a minimum, summaries of harvestable water bodies with high carp densities, discussion of harvest gears most effective for certain habitat types, and predictive models to identify when and where mass removal efforts should be directed. These information products will assist managers with deciding which harvest methods are optimal for effectively controlling carp populations within their respective regions.

Additional long-term objectives of the template include: (1) optimizing mass removal netting strategies by integrating large commercial seines with a new fishing vessel to increase harvest capacity of Silver Carp to 50,000 pounds per day; (2) identifying prime “harvest basins” where Silver Carp can be frequently found in large concentrations and easily harvested with a prescriptive gear and methodology; and (3) working collaboratively to develop a methodology to use low-cost sonar systems in conjunction with physiochemical meters to provide correlative data that would predict causal mechanisms for future Silver Carp aggregations.

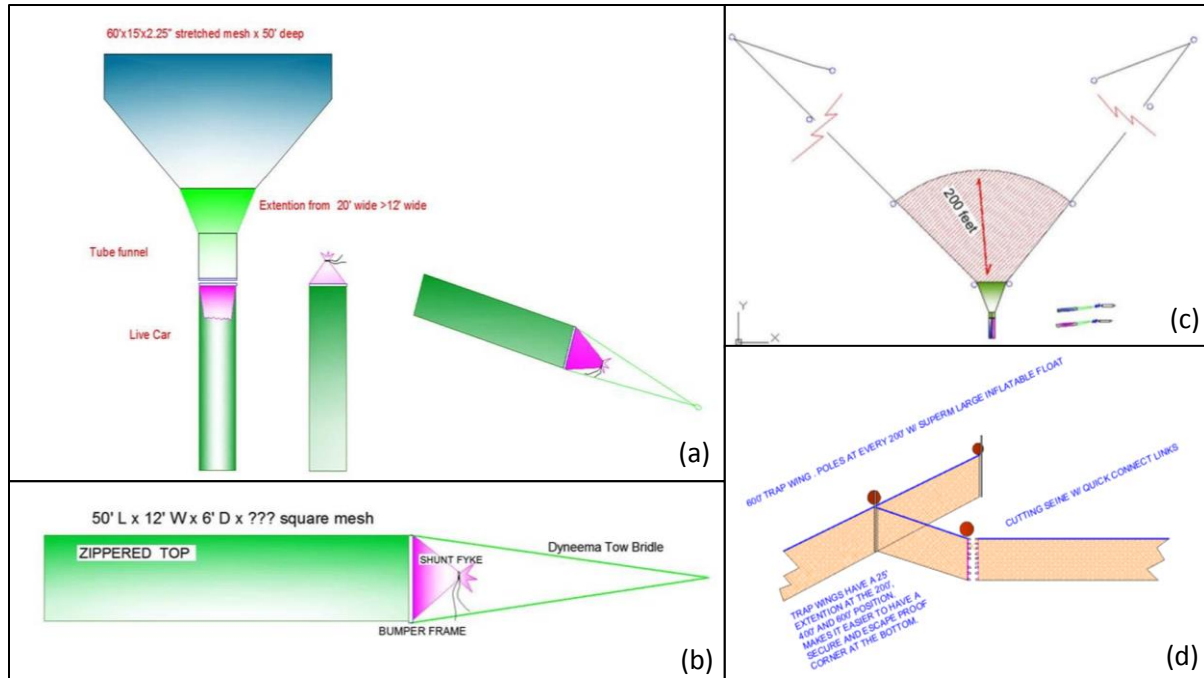


Figure 1. Diagrams depicting the Iruka net described in the text. Schematic of cod capture area (a) and removable live car (a and b), broad view of Iruka net, long wings, and cutting seines used to congregate fish toward trap area (c), and detail of cutting seines and connectors (d). Drawings provided by G. Faulkner.

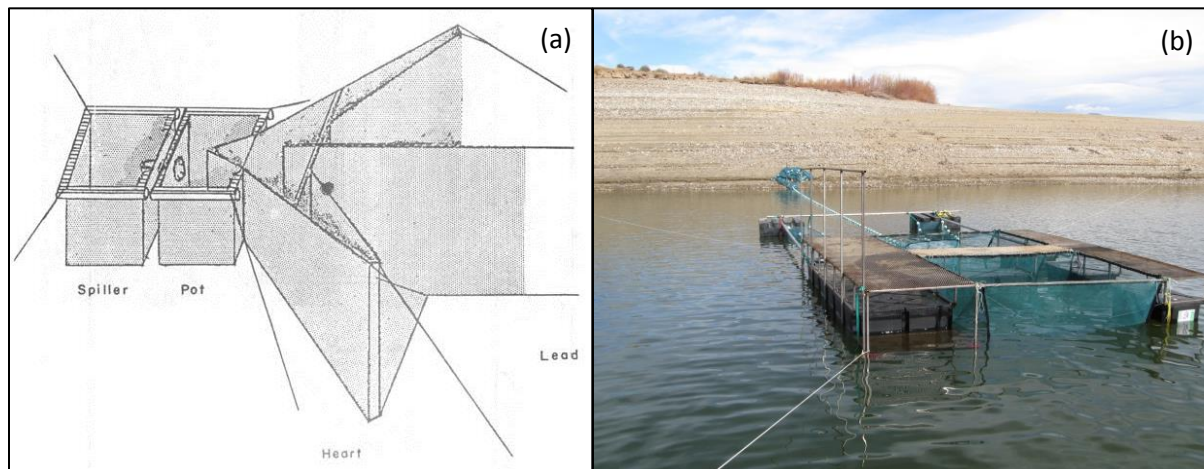


Figure 2. Merwin Trap illustration (a) taken from Hamilton et al. (1970), and photo of Merwin Trap field deployment (b) by Colorado Parks and Wildlife.

Summary of Actions to Date

USFWS

- Prototype boats and nets have been designed and built.
- New hydraulic mechanisms have been incorporated into seine boats to assist deployment and harvest.
- Twin trawl boats have been rigged with electricity components to herd fish into shocking trawl.
- Paupier can harvest 1,000 pounds in five minutes of electrofishing in high Silver Carp concentrations and mechanical systems can pass harvest to a tender boat.
- Behavioral study of DIDSON video showed high avoidance to funnel of trap net during day and night suggesting a minimum of 12 feet was needed for fish to enter trap. Acoustic and electrofishing herding efforts showed minimal effect as most fish stayed behind the driving apparatus. Results suggest that fish will need to be physically herded into a trap net or other unidirectional sound effects need to be explored for effective herding.
- Low-cost sonar (Humminbird 360) was used to assess the size of a Silver Carp population at Creve Coure Lake while simultaneously using the paupier to mark/recapture Silver Carp. Estimates were within 20,000 fish between the two methods and occurred in two days' time. Results showed that low cost sonar can be used for general population size description (high/medium/low) and the paupier is an effective tool for discrete short-term mark/recapture population estimates.

USGS

- Studies evaluating the attraction of Asian carp into pound nets show that food attractants could increase harvest, however response was non-significant. The study area however is intensively harvested and therefore a region with greater carp densities may provide more conclusive evidence. *(This action is linked with the Chemical Attractant template, Action Item 25.)*
- Evidence of attraction to algal stimulus solutions was observed in a mesocosm experiment using pit-tagged juvenile Asian carp. Fish began to move from the attraction area as the algal stimulus dissipated as a result of consumption by the carp and dilution. The response was highly consistent among the 12 trials conducted and ambient native algal blooms did not diminish the response to the algal stimulus. *(This action is linked with the Chemical Attractant template, Action Item 25.)*
- Performed extensive study on the avoidance behavior of Silver Carp to nets, using DIDSON, publication draft to be completed in calendar 2017.
- First Iruka net is under construction and scheduled to be completed in early 2018. The first deployment of this net will be in Creve Coeur Lake, to capture Asian carp during the upcoming unified method event. *(This action is linked with the Unified Method template, Action Item 23.)*
- Constructed an olfactory/chemosensory apparatus to perform electro-olfactograms to screen for physiological response in Asian Carp to various food stimuli. This new capability will allow rapid screening to help identify additional potential attractants. *(This action is linked with the Chemical Attractant template, Action Item 25.)*

- Completed a study in Mallard Lake, upstream of Creve Coeur Lake, where automated feeding platforms applied algae for one month to concentrate Asian carp into a portion of the lake from which they can be more easily removed. Sonar data were collected twice weekly and will be analyzed to evaluate the net gain in the feeding area. Preliminary observations suggest there was a substantial increase in the number of fish over the course of the month-long application period. (*This action is linked with the Chemical Attractant template, Action Item 25.*)

Proposed Actions for FY2018:

Collaborative

- Identify experimental harvest basins using summary of existing data prepared by USGS and validate if/when concentrations of Asian carp exist within “harvest basins” to maximize harvest efficiency.
- Identify site appropriate mass removal gears (Lampara Seine, tributary Iruka Trap, Paupier, Purse Seine, effluent trap) and refine prototype gear to minimize limitations and maximize efficiency.
- Use a variety of techniques including the paupier boat, purse seine, pound nets, Iruka net, and herding techniques to maximize harvest of Asian carp in a two-week event in Creve Coeur Lake. (*This action is linked to Unified Method template, Action Item 23.*)
- Begin method development of low-cost sonar population surveys in conjunction with water quality predictive parameters. Validate species and size range of fish with paupier.
- Herd fish within a tributary using new scare curtain tactic, block nets and mini-iruka trap net. Provide sonar population survey validation through the effort.
- Observe fish behavior with DIDSON technology.

USFWS

- Continue to refine the use and efficiency of the paupier boat by incorporating removable cods, determining opportune times to sample, and compressing fish with blocking nets prior to sampling.
- Deploy Lampara and Danish seines for mass removal efforts within, Creve Coeur Lake, Missouri; Alton, Illinois pools; Material Services Pits, Illinois; and Kentucky and Barkley Lakes, Kentucky using newly modified hydraulic net wheel on jet trawler.
- Acquire holding cods for fish driving attempts.
- Employ proven Chinese methods as described in publications using fish weir traps in backwaters and tributaries.
- Describe the use of low tech sonar in predicting, targeting, removing, and validating removal within harvest basins.
- Build and incorporate scare curtain capable of herding fish without getting snagged for tributary mass removal efforts.
- Further develop, test and describe use of electrified twin trawlers (200ft guide nets pulled by trawl boats funneled to electrified cod or paupier) in reservoirs, backwaters and tributaries.
- Modify our current net material along with timing and methods of deployment to reduce bi-catch of native species and increase Asian carp capture.
- Write protocols for mass removal gear deployment.

- Report results of mass removal efforts.

USGS

- Summarize existing data on spatial distribution and density of Asian carp populations to aid in the identification of discrete “harvest basins”.
- Examine sites in the Illinois and Cumberland River Basins to identify suitable locations for deploying large trap nets.
- Deploy one Iruka net and one Merwin Trap for 2 weeks at a time in suitable locations in accordance with experimental design to test catch rates of both nets when baited and unbaited with attractants. (*This action is linked with the Chemical Attractant template, Action Item 25.*)
- 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.
- Perform a simple economic analysis to evaluate costs in terms of materials and personnel compared to catch rates for each net type.
- Compile data for commercial fishing effort and catch in study areas to compare with Iruka and Merwin net performances.
- Identify potential modifications and areas for improvement in terms of net design and deployment.
- Further evaluate the use of sound to herd Asian carp into capture gears in local tributaries such as the Lamine River and Perche Creek, Missouri (*This action is linked to the Sound template, Action Item 19.*)
- Submit publication on gear avoidance behavior of Silver Carp.

Potential Out-year Actions (Subject to Future Appropriations)

Collaborative

- Refine harvest basin sonar/water chemistry predictive tool.
- Develop strategy for Asian carp reduction within tributaries.
- Deploy appropriate harvest gear coupled with novel concentration/herding approaches.
- Evaluate success of gear deployments.

USFWS

- Assist other agencies and contractors in the development of mass removal techniques.
- Assess effectiveness of mass harvest events using hydroacoustics, mark-recapture methods and sonars.
- Develop a predictive model to inform when removal events should occur in “harvest basins” relative to seasonal and hydrologic variables.
- Acquire a large fishing vessel for deploying mass removal gear.
- Assist other agencies and contractors in the development of mass removal techniques.
- Further refine new mass removal gears and describe limitations of those gears.
- Use infrastructure assets for collaborative sampling events.
- Identify “harvest basins” and optimal sampling times for population reduction in the Illinois River

- Provide economic valuation of Asian carp harvest potential within tributaries of Missouri and Illinois.
- Strengthen model parameters needed for accurate predictions of the Asian carp population model.

USGS

- Continue to test Iruka net and Merwin Trap at suitable locations to experimentally evaluate whether the application of attractants to the nets enhances catch rates of Asian carp. (*This proposed action is linked with the Chemical Attractant template, Action Item 25.*)
- 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 progress and make any necessary modifications to improve catch rates.
- 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.

Timeline for Major Actions

USFWS

- November 2017-January 2018: Gear preparation, field trials for gear function and prototype modifications.
- February 2018-July 2018: identify and validate potential harvest basins, conduct field sampling, sonar sampling.
- August 2018: Data entry/analysis.
- September-December 2018: Field Sampling.
- December 2017-January 2018: Annual Report generation.

USGS

- October-December 2018: Iruka net under construction, collaboration with KDFWR established, design Merwin Trap.
- January-February 2018: First deployment of Iruka net in Creve Coeur Lake, contract the construction of Merwin Trap, begin summary of carp population densities and distributions.
- March-April 2018: Discussion and potential site visit to identify deployment sites in Lake Barkley and or/Kentucky Lake, begin field work evaluating sound herding in local tributaries.
- May-July 2018: Iruka net and Merwin Trap deployments in suitable locations, hydroacoustic and DIDSON surveys, identify and visit potential harvest basins.
- August-September 2018: Data entry and processing begin, initial economic analysis of net deployment(s) and comparison with commercial fishing, complete herding field work and summarize results.

Expected Milestones**Collaborative**

- Identification and validation of harvest basins for experimental evaluation of harvest gears. (end of FY2018)
- Description of tributary harvest methodology.

USFWS

- Identify and describe method for using low-tech sonar for AC population assessment
- Identify AC aggregations with correlations to environmental variables.
- Collect 50,000 pounds of fish per day with multiple techniques.
- Employ a fishing vessel within the basin that can aid agencies with deployment of large gear and harvest of large catches (e.g. Unified Method).
- Optimize efficiency of mass removal tools that have the ability to impact AC populations on a system-wide scale.

USGS

- Initial deployment and evaluation of both gear types completed.

What Is Deliverable for this Funding**FY2018**

- Manuscript describing results of Creve Coeur Unified Method (USGS, *linked to Unified Method template, Action Item 23.*)
- Short economic analysis report for the initial deployment phase of Iruka net and Merwin Trap (USGS).
- Document synthesizing existing data on Asian carp population density and distributions (USGS).
- Protocol and report describing utility and success of prototype mass removal gears.

Expected Completion Date for Project**Collaborative**

- Initial evaluations of removal methods in identified “harvest basins” is expected to be complete in FY2019.
- Assessments of mass removal effectiveness using hydroacoustics, mark-recapture methods, and sonars will commence and continue as needed.
- Correlative and causal physicochemical cues to AC concentrations will be assessed in FY2018.

USFWS

- Deployment of the Lampara, Danish, Electrified twin trawl, Chinese weir, Scare Curtain and paupier (with block netting) will occur throughout FY2018 within five geographic locations.

USGS

- Initial deployment of both the Iruka net and Merwin Trap is expected to be completed by December of 2018.

Potential Hurdles

- Coordination among agencies.
- Timeline to acquire equipment.
- Staff availability.
- Flooding or drought may negatively impact the gears and delay or interrupt experiments.

6. Barrier Defense Using Novel Gear

Lead Agency: USFWS

Agency Collaboration: Illinois DNR, Southern Illinois University, USGS-UMESC

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
FY2018	\$35,000	\$290,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

Since 2015, the USFWS has contributed to monthly mass removal of Asian carp in the Starved Rock and Marseilles pools of the Upper Illinois River. This project, referred to as barrier defense, was established to reduce Asian carp pressure downstream of the EDB through targeted and contracted commercial fishing. This is consistent with predictions from the Spatially Explicit Asian carp Population (SEAcP) model, which suggests that exploitation in the upper Illinois River reduces abundance of invasive Asian carp near the vicinity of the electric dispersal barrier relative to the “no fishing” scenario. For barrier defense, the USFWS supplements traditional fishing efforts using a paupier, a novel electrotrawling method, to remove all sizes of Asian carp from a variety of habitat types. The efficiency of the paupier as a tool to remove large amounts of Asian carp has improved year to year. Collaboration with partners and pooling resources can reduce the Asian carp population in the Upper Illinois River thereby decreasing risk to the Great Lakes.

FY2017 Actions

In 2017, the addition of a tender boat, mechanical winches, and other improvements enabled the removal of 43 tons of Asian carp (mostly Silver Carp) in eight days of effort with the paupier. Targeting fishing efforts in areas with high densities of Silver Carp and low bycatch allowed paupier catch rates in the Starved Rock Pool to triple in 2017 compared to 2016 (2,100 Silver Carp/electrotrawling hour and 700 Silver Carp/electrotrawling hour, respectively). To quantify increases in harvest efficiency, we expressed our data in terms of biomass per labor hour. In 2017 approximately 500 pounds of Asian carp was harvested per labor hour, which is double what it was in 2016.

Times spent on the various components of the fishing operation were tracked to identify where improvements were needed. This information was continuously incorporated into operations and informs future planning.

Proposed Actions for FY2018

1. Collaborate with Illinois DNR and contracted commercial fishers to continue Asian carp mass removal below the EDBS.
2. Concentrate effort when paupier catch rates are historically highest (i.e., July, August, and September).

3. Reduce Asian carp handling to further increase efficiency.
4. Track time spent on daily operations, continuously assess, and implement changes to increase efficiency.
5. In coordination with partners and other projects, develop method to relate removal efforts to the SEAcP model.

Potential Out-year Actions (Subject to Future Appropriations)

- Utilize telemetry, hydroacoustics, and past harvest data to develop a predictive model for the best times and locations for mass harvest.
- Expand mass removal efforts to pools in the lower Illinois River as suggested by the SEAcP model.
- Continuously increase efficiency of mass removal efforts by increasing infrastructure, mechanization, and/or collaboration
- Implement operation of high capacity tender boat to service fishing efforts
- Collaborate with economics and marketing professionals to connect removed fish with market.
- 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.

Timeline for Major Actions and Expected Milestones

FY2018:

- In collaboration with Illinois DNR, reduce logistics and improve efficiency of removing mass quantities of Asian carp from the Marseilles and Starved Rock pools.
- Assess feasibility of mass removal efforts with the paupier in lower pools of the Illinois River.

What Is Deliverable for this Funding

- 40 plus tons of Asian carp removed from Illinois River system.
- Improved infrastructure to assist partners with logistics of removing mass quantities of Asian carp.
- Annual report submitted to ACRCC Monitoring and Response Workgroup (MRWG).
- Presentations to partners, conferences, agencies, and public.
- Asian carp size at capture to estimate population parameters.

Expected Completion Date for Project

Ongoing.

Potential Hurdles

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

7. Contract Fishing for Asian Carp Detection and Removal

Lead Agency(s): USEPA

Agency Collaboration: USFWS, Illinois DNR, USGS

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
		Illinois DNR
FY2018	-	\$1,150,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

This program was established to reduce the numbers of Asian carp below the Electric Barrier System through controlled and contracted fishing efforts. Reducing the number of Asian carp below the Electric Barrier System will reduce the opportunity for carp to test the barrier and therefore decrease the possibility of Asian carp moving across the barrier and gaining access to waters upstream of the Barrier. Refocus of efforts in 2014 can further remove more fish from the Illinois River from the most populated reaches. This program also allows for monitoring population densities of Asian carp over time in the CAWS down to Starved Rock Pool.

This project uses contracted commercial fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the EDB. Nine 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; and gather information on Asian carp population abundance and movement in the Illinois Waterway (IWW) downstream of the EDB 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

Summary of Actions to Date

Illinois DNR will post monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

Efforts were heightened in 2017 to remove more Asian carp in several ways:

- More crew/weeks scheduled in removal efforts.
- Scheduling more consistent use of seine to further increase removal efforts.

- 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).
- Seining will be increased to maximize removal, increase smaller fish removal, and adding shad seines will also then begin to monitor for, and enable the removal of the smallest fish by our contracted fishers.
- Increased surveillance from the barrier to Dresden Island Pool by scheduling more crews in a given month to increase annual crew/weeks.

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 will continue to reach out to appropriate companies to receive fish but recognize the need to support waste management as necessary to reach goal of fish removed annually.

FY2017 Actions

Illinois DNR continued the efforts identified in 2016. Illinois DNR posted monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

Proposed Actions for FY2018

This project will continue to use contracted commercial fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the EDB. Nine 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; and gather information on Asian carp population abundance and movement in the IWW downstream of the EDB 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.

Sampling will continue to consider the following, but anticipates 2016 levels of efforts, perhaps assigned in new areas as data and fish populations suggest:

- Continue with crew/weeks scheduled in removal efforts approximating effort expended in 2017.
- Scheduling more consistent use of seine/hoopnets to further increase removal efforts.
- 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).
- Seining/hoopnetting will be increased to maximize removal, increase smaller fish removal, and adding shad seines will also then begin to monitor for, and enable the removal of the smallest fish by our contracted fishers.

- Increased surveillance from the barrier to Dresden Island Pool by scheduling more crews in a given month to increase annual crew/weeks.
- Make available this highly skilled resource to other Actions with state and federal partners needs as requested/approved for such.

Expected Milestones

- Annual observance of reduction of biomass of Asian carp detected in river reaches below the Electric Barrier System thus reducing the threat of challenges to Electric Barrier System and lower threat to Great Lakes.
- A minimum of 400 tons of Asian carp removed from upper IWW annually.
- Deploy seines/hoopnets to maximize removal up to 10 times (weeks) annually.
- Maintain or further reduce estimated Asian carp populations in Dresden Island Pool using hydro-acoustic efforts and inter-agency communication to aid in this assessment.
- Further develop orchestrated removals e.g. Unified Fishing Methods in new areas. At least one unified fishing method will be performed in FY2018.

Outcomes/Outputs

- Ability to assess these populations and adjust efforts to optimize impacts.
- Population reduction.
- Reduce opportunities for Asian carp to challenge electric barrier.
- Apply multiple control and detection techniques to maximize control on an invasive species.
- Monitor leading front of Asian carp length and weight and general biological condition.
- Have significant resources contracted for implementation over a short response time for rapid responses.
- Significant personnel/crews with experience fishing multiple gears in riverine conditions to respond rapidly for early detection and rapid responses.
- Assessment of efficacy of removal efforts by reference to added telemetry data (other projects) is expected to indicate success of removal efforts on a pool by pool basis and thus success in prohibiting upstream movement of Asian carp.
- Additional removal using contracted netting (both seining and gill/trammel netting) possible with efficient deployment of fishers as informed by telemetry and remote sensing (concurrent projects with results communicated to fishers should improve removal rates).
- Heightened ability to respond with sufficient and suitable expertise

Expected Completion Date for Project

Ongoing.

Potential Hurdles

- Increased immigration from out-populations could outpace removal efforts (being investigated by stock assessment, population estimates, and comparing catch rates).
- Removal efforts can be affected by weather and river levels. Effort will be scheduled to minimize these factors or rescheduled in case efforts need to be canceled for safety concerns.

- Without sufficient immigration and/or recruitment, removal efforts could drive population down without immigration (as designed) which could preclude removal of 400 tons annually. In this case removal efforts can be optimized at new levels.
- Observance of smaller Asian carp in Upper Illinois River could complicate fishing by increased bi-catch or decreased efficiency.

8. Asian Carp Enhanced Contract Removal Program Development

Lead Agency: USEPA

Agency Collaboration: Illinois DNR, USFWS

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
		Illinois DNR
FY2018	\$0	\$730,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

This project will be led by Illinois DNR and begin implementation and support the control strategy identified in the 2017 Monitoring and Response Plan (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 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 draft 2017 Asian Carp Business Process Analysis Report and Action Plan (Business Analysis Plan, or Report). This 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 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 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 EDB. 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 ACRC 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 will also identify 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 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 personnel services, equipment/gear and commodities for agency support, and contracts for fishing as well as any necessary contracts for fish removal/transportation or staff monitoring personnel.

Summary of Actions to Date

- Currently, harvest/removal of Asian carp in the lower IWW is conducted by at-large private venture commercial fishing resulting in approximately 3.5 million pounds of Asian carp removed annually.
- Conducted an Asian carp business process analysis, including a summary of findings and recommendations for action, cost estimates and implementation timelines.

Proposed Actions for FY2018

Pilot Contracted Fishing

Creation and implementation of a pilot contracted fishing effort to increase the removal of Asian carp from the lower Illinois River (Peoria Pool) and thereby increasing the overall removal of Asian carp from Illinois' waterways in support of management (population control) goals. Support for this effort will involve development of a detailed contract structure and function document, implementation outline, detailed schedule, forms, policies and procedures, on-line and electronic program administration documents, web content, and training and program educational materials. Please see the chart below for budget breakout of these items. It is recognized as contracted efforts progress it may be necessary to expand to lower Illinois River pools and such decisions will be based upon relative abundance data, catch trends/contracting rates, or catch rates.

Coordination with other Agencies

To expand these efforts, Illinois DNR will coordinate efforts with the USFWS and other interested parties along with local and regional (specifically Great Lakes, and Ohio and Mississippi Rivers) jurisdictions to assist regional Asian management goals.

The table below identifies the budget breakout of the items above.

PROPOSED BUDGET	
Create Pilot Contract Fishing Program	
Funding for Contracted Fishing Effort (Illinois DNR)	\$450,000
Management and Administration (Illinois DNR)	\$80,000
Development of contracted fishing administration, operating procedures and forms, disbursements, accounting and record keeping, staff training (Illinois DNR)	\$200,000
Project Total	\$830,000

Expected Milestones

- Increased harvest of Asian carp realized in the Peoria Pool.
- Decrease relative abundance in the Peoria Pool.
- Increased efficacy and reduced abundance in all upstream Illinois River areas.
- Promote appropriate management strategy by partnering with local commercial entities.

Outcomes/Outputs

- A goal of 8 million pounds per year of Asian carp removed from the Illinois River, with reduced risk/increased depopulation upstream. This includes the management - contracted removal target of 4 million pounds from the Peoria Pool.
- Support for key component of the MRWG's MRP goals and objectives for population control.
- Key improvements realized in communication/facilitation role via steering committee, fishers, processors, and markets including local/regional considerations
- Increased understanding of harvest role to increased mortality of IWW populations.
- Decrease/eliminate upstream movement of Asian carp.
- Further inform of Asian carp population density and movement model to improve management decisions.
- Serve as a model for industry/regions to build from to support Asian carp management strategies in other locations/rivers.
- Illinois DNR will post updates as well as lead the effort to compile appropriate information and summary reports relative to these actions. This will be reported with monthly MRP activities on www.AsianCarp.us.

Potential Hurdles

- Increased market volume for Asian carp products is hard to predict.
- Concern of increased fishing activity to reduce catchability in confined areas.
- Ability to enforce fishing areas.
- Ability to assess relative abundances and fishing mortality/effects in large river pools.

9. Asian Carp Removal Support through Branding, Marketing Strategy Development and Implementation

Lead Agency: USEPA

Agency Collaboration: Illinois DNR, USFWS

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
		Illinois DNR
FY2018	\$0	\$170,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

The purpose of conducting the Asian Carp Business Process Analysis was to identify how Illinois DNR can support growth and establishment of businesses that use Asian carp, as vehicles for increasing the amount of carp fished from Illinois' waterways. Such a goal (increased carp removal) is key to reaching management goals to prevent spread and lower impacts where currently abundant. The study's main goal was to identify and address barriers to growth and establishment of Asian carp businesses. Key recommendations in the study were to develop a more positive brand for Asian carp to support local processors and their products and, provide marketing support as a way to bolster the marketing efforts of multiple Illinois processors and fishers to encourage their business growth. This growth increases demand for Asian carp, increased fishing of the invasive species, and thus its removal from Illinois waterways and support of invasive species management goals. The project will include three primary activities: (1) selection of a marketing company knowledgeable in aquacultural branding and marketing, (2) development of a brand and marketing strategy for Asian carp that will support a wide range of carp processors and users, and (3) marketing implementation funding. These items are discussed further below.

A strong, positive brand that countermands negative perceptions of Asian carp, supports existing carp-related businesses, and resonates with targeted audiences can greatly benefit a large number of fishers and processors. Asian carp have significant branding potential as a locally-caught, fresh, sustainable fish option. The fish meat is tender and mild, healthful with beneficial fatty acids, and compares well with other popular fish in terms of purity and low levels of contaminants.

A branding exercise will develop a new "image" for the fish to distance it from commonly-held consumer misconceptions. It will be overarching in nature, crafted for wide use by many businesses and will resonate with a range of product customers. It is intended to be a "meta" brand, not to focus on a single product. It can take the form of a state-level brand such as "Illinois Made," broad-reaching concept such as "Wild Caught" or "Fresh Caught", re-naming such as "Silver Fin", or other broad concept.

Selection of Marketing Firm: Work on branding and a marketing strategy for Asian carp will begin with creation of a scope of work, selection criteria, and identification of a group of qualified marketing companies knowledgeable in aquacultural branding and marketing. The Steering Committee created for the Asian Carp Business Process Analysis will be employed to provide input into the scope and criteria and, assist in identifying marketing firms. Once a satisfactory list has been compiled, these companies will be provided the scope and criteria, and asked for a proposal and cost estimate. Again, the Steering Committee will be employed to assist in evaluating marketing firm submittals and selection of the firm to perform the work. The selected firm will be hired as a sub-consultant to existing consulting firm, Tetra Tech, currently under contract with Illinois DNR.

Brand and Marketing Plan: The marketing firm will lead Illinois DNR and regional stakeholders through the process of developing a positive brand for Asian carp that will support a wide range of carp processors and users. This work will likely begin with market research and information gathering on the benefits and detractors from Asian carp. Then one or more groups of stakeholders who will benefit from a better brand for the fish will be identified and convened and, brought through a brainstorming and brand development exercise. From this work, several brand options will be presented to the Steering Committee and a decision made on one. A report for use of the brand, color scheme, size, scaling, and the like will be written. This report also will contain a budget-sensitive marketing plan for employment of the brand. Finally, the firm will support the creation of a media event to announce the new brand.

Marketing Plan Implementation: Based on the recommendations made in the marketing strategy.

Summary of Actions to Date

- Conducted an Asian carp business process analysis, including a summary of findings and recommendations for action, cost estimates and implementation timelines.

Proposed Actions for FY2018

- Selection of marketing firm.
- Creation of positive brand for Asian carp and a marketing strategy to implement the brand.
- Implementation of marketing strategy.

The table below identifies the budget breakout of the items above.

GLRI PROPOSED BUDGET	
CREATE PILOT CONTRACT FISHING PROGRAM FOR PEORIA POOL	
Brand and Marketing Strategy Creation (Illinois DNR)	\$50,000
Management and Administration (Illinois DNR)	\$20,000
Marketing Implementation (Illinois DNR)	\$100,000
Project Total	\$170,000

Expected Milestones

- Creation of scope, and list of eligible firms.
- Firm selection.
- A total of six Steering Committee meetings: to consider branding/marketing strategy scope and firm generation (one meeting), firm selection (one meeting), and participation in branding exercise and announcement event (four meetings).

Outcomes/Outputs

- Brand creation.
- Marketing strategy.
- One or more marketing assets.

Potential Hurdles

- Resistance to or slowness to adopt the new brand name.

10. Asian Carp Population Model and Demographics to Support an Adaptive Management Framework

Lead Agency(s): USFWS

Agency Collaboration: USGS; Southern Illinois University; Illinois Natural History Survey; Western Illinois University; Illinois DNR

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USFWS	USGS	USFWS	USGS
FY2018	\$70,000	\$65,560	\$452,000	\$96,680

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

There is strong interest in maximizing harvest effectiveness for reducing Asian carp in the upper Illinois River waterway, particularly in combination with other tools such as deterrent barriers. Consequently, a population model that includes spatially explicit components of the Illinois River system was developed to inform management decisions concerning the locations for harvest and locations for upstream movement deterrents (i.e., Spatially Explicit Asian Carp Population model; SEAcP). Funding associated with this template will support actions designed to improve the accuracy and precision of the SEAcP model predictions and hence better inform management decisions regarding invasive Asian carp. There are two projects covered under this template:

- Asian carp population model to support an adaptive management framework
- Asian carp demographics

Asian carp population model to support an adaptive management framework will focus on model implementation and development including annually updated management recommendations and improving model design based on expert feedback.

Asian carp demographics work was coordinated with partner agencies to prevent duplication of efforts and will focus on addressing existing data gaps, including determining when year class strength is set, quantifying recruitment, and estimating growth of small fish – current data are uninformative on the growth of small fish. In addition, the Asian carp demographic project will develop a standard operating procedure for quantifying age and growth of invasive Asian carp. Implementation of a standard operating procedure will mitigate aging errors, which contribute a substantial amount of uncertainty to model predictions.

Summary of Actions to Date**Asian carp population model:**

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

Asian carp demographics:

- Completed gear evaluation study to determine sample size needed to assess Asian carp populations
- Assembled a collection of aging structures for the age and growth workshop including structures from known-age fish and structures collected from different basins (Missouri, Upper-Mississippi, Illinois).

FY2017 Actions**Asian carp population model:**

- During FY2017 we focused on updating parameter estimates and disseminating models results.

Asian carp demographics:

- This is a new project designed to address data gaps identified by the SEAcP and develop a standardized protocol for estimating age and growth of invasive Asian carp Asian carp demographics:

Proposed Actions for FY2018**Asian carp population model:**

- Recommend mortality benchmarks and fish passage deterrent locations with efficacy requirements
- Conduct sensitivity analyses and develop a prioritized list of data and research needs based on results thereof
- Incorporate updated demographic rates using the most current data available
- Evaluate the feasibility of statistical catch at length models to estimate immigration into the upper Illinois River and compare with estimates derived from the existing movement model (MRWG 2017)
- Modify the length-based structure of the model; use integral projection models to define populations by a continuous variable instead of discrete length classes
- Coordination meeting

Asian carp demographics:

- Collect Asian carp from the lower five pools of the Illinois River (i.e., Alton, La Grange, Peoria, Starved Rock, Marseilles pools) during spring and fall.
- Poll stakeholders as to preferred methods for otolith preparation for Asian carp and, prepare lapilli and asterisci otoliths of known-age fish according to preferred methods.
- Extract the following structures from all field caught fish: scales, pectoral spines, vertebrae, postcleithra, lapilli, dorsal spine, and asterisci otoliths.
- From at least 100 fish, chosen to cover a variety of sizes and locations within the Illinois River, within the pool of provided fish, prepare and digitally image all those structures
- Host age and growth workshop during August 2018.
- Reduce uncertainty in the spatially explicit Asian carp population model predictions by minimizing variation in the statistical growth model - develop a standard operating procedure for aging invasive Asian carp using an expert led aging workshop.
- Quantify demographic rates of invasive Asian carp collected from the lower five pools of the Illinois River.
- The USFWS Carterville FWCO will work with the Illinois DNR commercial fishermen during a two-week intensive data collection effort.
 - Staff will collect length, weight, sex, as well as some aging structures.
- Quantify year class strength annually.

Potential Out-year Actions (Subject to Future Appropriations)**Asian carp population model:**

- Incorporate updated demographic rates annually.
- Develop a multi-basin population model that incorporates dynamics such as inter-basin movement among multiple population sources.
- Inform future data collections and research efforts using prioritized list of data and research needs.
- Implement TRACE (“TRAnsparent and Comprehensive model Evaluation”; Schmolke et al. 2010; Grimm et al. 2014; Augusiak et al. 2014) model documentation
- Disseminate results annually.
- Incorporate updates to the underlying movement model (MRWG 2017).

Asian carp demographics:

- Transition to a single season sampling design (i.e., spring or fall) based on determinations of when year class strength is set.
- Collect individual Asian carp from the field for demographic analysis, process laboratory samples, and update demographic parameter estimates annually.
- Combine year class strength measurements with spawning stock biomass estimates (e.g., hydroacoustics) to fit a stock-recruitment relationship for invasive Asian carp.
- Assess management actions by tracking demographic responses to changes in control strategies (e.g., increased harvest).
- Disseminate results annually.
- Prepare a report or manuscript describing the results from the age and growth workshop.
- Prepare a report or manuscript characterizing spatial and temporal age and growth patterns of Asian carp.

Timeline for Major Actions**Asian carp population model:**

- Complete sensitivity analyses.
- Implement integral projection modeling.

Expected Milestones**Asian carp population model:**

- Develop a comprehensive list of data and research needs.
- Provide updated management recommendations (i.e., mortality and deterrent benchmarks) generated using the most current demographics data available and the integral projections modeling framework.

Asian carp demographics:

- April-May 2018: Collect individual Bighead Carp from the lower five pools of the Illinois River and transfer aging structures and other pertinent data (e.g., size at capture) to USGS for analysis.
- By mid-July 2018: Distribute digital images to age and growth workshop participants
- August 2018: Host age and growth workshop
- December 2018: Complete laboratory processing of all fish captured during spring 2018 and disseminate results to USFWS.
- September-October 2018: Collect individual Asian carp from the lower five pools of the Illinois River for demographic analysis.

What Is Deliverable for this Funding**Asian carp population model**

- Modeling efforts will produce updated management recommendations (mortality and deterrent benchmarks) annually.
- Deliverables completed during FY2018 will include sensitivity analyses which will be used to develop a comprehensive list of prioritized data and research needs.
- Documenting model development using the TRACE framework will begin during FY2018 and will be ongoing.

Asian carp demographics

- The Asian carp demographics project will provide updated demographic rates for the five lower pools of the Illinois River and stock-recruit data during each fiscal year, which represent two important data gaps identified by the SEAcP model.
- In addition, a workshop will be conducted during FY2018, which will yield a standard operating procedure for quantifying age and growth of Asian carp.

Expected Completion Date for Project**Asian carp population model**

Population modeling will be a continuing project to manage the ongoing Illinois River Asian carp problem.

Asian carp demographics

Asian carp demographics will be an ongoing project used to describe the status of Asian carp populations in the Illinois River waterway and for making predictions via the SEAcP model about how the population will respond to different management actions, such as increased harvest mortality.

Potential Hurdles**Asian carp population model**

- Inter-agency coordination across multiple geographic locations.
- Timeline may be negatively influenced by unanticipated challenges, which are often associated with doing novel work.

Asian carp demographics

- Coordination among agencies.
- Issues regarding sampling gear, sample size, and logistics.
- Environmental conditions.
- Staff availability.

11. Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes

Lead Agency: NOAA GLERL

Agency Collaboration: USACE; University of Michigan CIGLR; Illinois DNR, USGS, Southern Illinois University, Michigan DNR

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
FY2018	-	\$203,100

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

NOAA is continuing to model the potential risk of Asian carp (Bighead, Silver, Black, and Grass) on Great Lakes food webs and fisheries. NOAA has accomplished this using several different modeling approaches (Ecopath with Ecosim, Individual-based model, and Atlantis Ecosystem Model) across three of the Great Lakes. The Ecopath with Ecosim (EwE) model assesses Asian 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. NOAA has applied this model to simulate effects of Asian carp on food webs of Lakes Erie, Huron, Michigan and Ontario. The individual-based bioenergetics model (IBM) includes temperature as a forcing variable and tracks the bioenergetics growth and metabolism in individual Asian carp and selected fish species within nearshore or offshore habitats. NOAA has applied this model to simulate Bighead and Silver Carp effects on nearshore communities of Lake Huron and, is applying it to nearshore communities of Lake Erie and Michigan. The Atlantis Ecosystem model tracks population dynamics and predator-prey interactions within heterogeneous habitats and, includes effects of lake physics and chemistry. NOAA applied this model to simulate effects of Asian carp on Lake Michigan's food web and, is calibrating an Atlantis model for Lake Erie and developing a model for Lake Huron.

NOAA will develop an Ecopath with Ecosim model to simulate Asian carp effects on the Illinois River food web. Our modeling efforts will benefit from prior agency and university studies and ongoing control efforts organized by the Asian Carp MRWG led by Illinois DNR. This modeling activity will further confirm model performance and predictions of Asian carp impacts with observed/realized Asian carp impacts in the Illinois River. Moreover, this modeling effort will provide managers further insights into how Asian carp will affect aquatic ecosystems across a productivity gradient from the productive Illinois River to the oligotrophic Great Lakes.

Summary of Actions to Date**FY2017 Actions**

NOAA is applying an EwE model to simulate effects of Asian carp on the Lake Ontario food web. NOAA has completed EwE model simulations of Asian carp effects on Lake Michigan, Lake Huron (Saginaw Bay and Main Basin) and Lake Erie and, is writing up results of that analysis. NOAA completed Atlantis model simulations of Asian carp effects on the Lake Michigan ecosystem, and is writing up results for a journal paper. NOAA finished configuring the Atlantis model for Lake Erie and is now in the calibration phase. Further, NOAA is beginning configuration of the model for Lake Huron. NOAA is writing up the IBM model simulations of Asian carp effects on a nearshore fish community in Saginaw Bay, and is configuring the IBM model for nearshore habitats in Lake Erie and Lake Michigan.

Proposed Actions for FY2018 Actions

- NOAA will develop an Ecopath with Ecosim food web model of the Illinois River, and simulate effects of Asian carp on the Illinois River's fish communities and lower trophic levels.
- NOAA will write up model results from simulating Asian carp effects on the Lake Ontario food web.

Potential Out-year Actions (Subject to Future Appropriations)

- NOAA will write up results from simulating Asian carp effects on Illinois River food web from FY2018.
- NOAA will apply the EwE model to simulate Grass Carp effects on the Lake St. Clair food web.

What Is Deliverable for this Funding

- Food web model for Illinois River.
- Effects of Asian carp on the fish community and food web of Illinois River.
- Baseline comparison of Illinois River food web with Great Lakes food web models.

Expected Completion Date for Project

September 2019

12. FluEgg Model to Assess Risk of Spawning, Egg/Larvae Survival and Enhance Predictive Capabilities

Lead Agency: USGS

Agency Collaboration: University of Illinois

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
FY2018	\$214,000	\$148,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

The FluEgg model simulates egg and larvae transport from spawning grounds. Model results can help in determining reach length required for successful egg hatching or the location of nursery habitat. For successful recruitment, egg hatching needs to occur in close proximity to larval habitat, so FluEgg results can be linked with habitat data for a more complete picture of likely population growth in a river. The model can also be used in “reverse-time” mode to estimate spawning location from the location of sampled eggs.

The model has gone through multiple updates to increase capabilities: adding Grass Carp egg development, extending the development series simulated to gas bladder inflation, increasing data input capabilities to include more temporal flow data. The next updates include incorporation of juvenile swim speed and 2-dimensional flow.

In addition to model improvements, this project will fund applications of the model to provide better predictions of egg and larval dispersal in rivers. The IWW is identified as a high priority for spawning response activities, and a hydraulic model to generate input for FluEgg improves the capability to identify spawning locations and quickly predict where eggs and larvae will be located after a spawning event. Simulations will be also run for the Ohio River, especially focused on potential tributary spawning locations. Enhanced predictive capabilities will contribute to larger scale control efforts, targeted sampling/removal, and the application of new control technologies.

Summary of Actions to Date

FY2017 Actions

- Laboratory experiments in a flume to determine the drift and swimming behavior of eggs and larvae, respectively, and their interaction with bottom material in flowing water.
- Simulated the hydraulic conditions in the IWW during the spawning season of 2015 to hindcast spawning locations.
- Created an operational hydraulic model of IWW to generate input for the FluEgg model so it may be used in real time predictions.
- Collected hydraulic and water-quality data in Ohio River with funding from the USGS Midwest Region.

Proposed Actions for FY2018

- Complete a USGS software release of FluEgg executable and source code, including a user's manual.
- Present a webinar targeted toward managers to explain FluEgg capabilities.
- Analyze data from the first phase of flume experiments, draft a journal article with findings.
- Second phase of laboratory experiments in a flume to characterize swim speeds and mortality in flowing water (includes culture and maintenance of brood stock, spawning fish at least twice, transportation of live eggs to Illinois and performing the research on-site, plus analysis and writeup). A different species of Asian carp will be used in 2018.
- Publish results of the hindcasting of Asian carp eggs to estimate spawning locations in the Illinois River during the 2015 spawning season.
- Complete the IWW real-time predictive hydraulic model to drive FluEgg simulations.
- Work with MRWG to use the IWW forecasted hydraulic conditions and the FluEgg model to predict where eggs and larvae will be after spawning.
- Simulate a range of hydraulic and temperature conditions in the FluEgg model to determine which combinations lead to recruitment success in the IWW.
- Simulate a range of hydraulic and temperature conditions in the FluEgg model to determine which combinations lead to recruitment success in the Markland to McAlpin reach of the Ohio River. Potential spawning locations to be selected in consultation with USFWS and the Kentucky Department of Fish and Wildlife Resources.

Potential Out-year Actions (Subject to Future Appropriations)

- Incorporate Black Carp early life history information into the FluEgg model (pending funding in FY2018 from the Black Carp template for laboratory work).
- Analyze data from the second phase of flume experiments and draft a journal article with findings.
- Implement new functionality in FluEgg egg and larval drift model with data from the flume experiments.
- Use of the Illinois River hydraulic model to drive predictive FluEgg simulations in real time during spawning season and dissemination of simulated egg and larvae plume locations to managers.
- Publication of Ohio River FluEgg analysis.
- On-demand FluEgg simulations to predict locations of eggs and larvae following spawning events for management response.

What Is Deliverable for this Funding

- Current version of FluEgg software released through USGS (previous version released as University of Illinois product).
- Webinar targeted toward managers to explain FluEgg capabilities.
- Publication of FluEgg user's manual.
- Conference presentation of flume experiment results.
- Journal article, with INHS co-authors, on results of hindcasting eggs to estimate spawning locations in the Illinois River.

Outcomes/Outputs

- Expanding capabilities of Decision Support for the Illinois River through the Illinois River hydraulic model to drive FluEgg simulations in near real time.
- Provide a first level of assessment for locations of hatching and gas bladder inflation in a potential spawning reach of the Ohio River.

Expected Completion Date for Project

FY2019

Potential Hurdles

- Publication schedule is affected by length of time various reviewers need which is beyond the control of project personnel.

13. Great Lakes Asian Carp Monitoring Program

Lead Agency: USFWS

Agency Collaboration: Great Lakes States, USGS, USACE, academic institutions

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
FY2018	\$1,150,000	\$350,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

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 DNA (eDNA) sampling and monitoring programs implemented by the USFWS, 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 basinwide early detection protocol for Asian carp and other AIS. Sampling gears used and locations sampled are tailored each year to match conditions and agency needs, as well as to leverage new sampling technologies for 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. From May-November 2013, USFWS collected 2,240 eDNA water samples, electrofished, and set nets to assess presence or absence of Asian carp. In 2013, no Asian carp were captured, but positive eDNA results were obtained from USFWS sampling in 3 locations. In 2014, USFWS expanded its overall sampling efforts and collected over 4,000 eDNA water samples, electrofished, trawled, sampled ichthyoplankton, and set nets to survey for Asian carp. In 2014, no Asian carp were captured, but positive eDNA results were obtained from USFWS sampling in 3 locations. In 2015, 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 carp. In 2015, no Asian carp were captured, and no positive eDNA results were obtained from Great Lakes tributary locations. In 2016, the sampling in the Great Lakes basin expanded yet again to over 4,800 eDNA samples, returning only one sample that was positive for both Bighead and Silver Carp eDNA from the CAWS. Electrofishing, trawling, ichthyoplankton sampling, and a variety of netting continued to survey for all life stages of Asian carp in all of the Great Lakes, with no observation or capture of Bighead or Silver Carp.

FY2017 Actions

- USFWS continued to expand its overall sampling efforts and collected over 5,332 eDNA water samples, electrofished, trawled, sampled ichthyoplankton, and set a variety of nets to survey for Asian carp.
- No Asian carp were captured, and no positive or Bighead or Silver Carp eDNA results were obtained from Great Lakes tributary locations by USFWS crews.

Proposed Actions for 2018

- 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 on an annual basis to detect new invasions of Asian carp.

Potential Out-year Actions (Subject to Future Appropriations)

- 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.

Timeline for Major Actions

Annually, April through November.

Expected Milestones

- Fully implement a comprehensive and coordinated Great Lakes basinwide early detection and monitoring program for Asian carp and other AIS species.
- Complete early detection surveys in suspected “hot spots” for AIS, in cooperation with partner agencies, as needed.
- Continue to refine standard operating procedures (SOP) for basinwide AIS monitoring with partner agencies.

What Is Deliverable for this Funding

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.

14. Illinois River Monitoring and Evaluation

Lead Agency: USFWS

Agency Collaboration: USFWS, USACE, Illinois DNR, INHS, Southern Illinois University (SIU), Western Illinois University (WIU)

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested			
	USGS ¹	USFWS ^{2,3,4}	USACE	USGS ¹	USFWS ^{2,3,4}	USACE ⁹	Illinois DNR ^{5,6,7,8}
FY2018	\$200,000	\$875,000	\$0	\$294,000	\$570,000	\$150,000	\$3,472,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

¹Asian Carp Life History (USGS) - \$200,000 agency funding, \$294,000 GLRI funding

²Illinois River Monitoring and Response Team Support (USFWS) - \$300,000 agency funding, \$195,000 GLRI funding

³Des Plaines River and Overflow Monitoring (USFWS and USACE) – USFWS: \$85,000 agency funding, \$55,000 GLRI funding.

⁴Distribution and Movement of Small Asian Carp in the IWW (USFWS) - \$490,000 agency funding, \$320,000 GLRI funding

⁵Enhanced Detection Above and Below Electric Barriers (Illinois DNR) - \$0 agency funding, \$2,550,000 GLRI funding

⁶Illinois River Stock Assessment/Management Alternatives (Illinois DNR) – \$0 agency funding, \$440,000 GLRI funding

⁷Evaluation of Gear and Novel approaches (Illinois DNR)- \$0 agency funding, \$45,000 GLRI funding

⁸Ecosystem assessment – Eggs, Larvae, Plankton for risk and population assessment (Illinois DNR) - \$0 agency funding, \$437,000 GLRI funding

⁹USACE Monitoring and Response Team Support

Project Explanation

This template encompasses all effort within the Illinois River related to the Monitoring and Evaluation of Asian carp. The projects covered by this template include and are described separately below:

- SubProject 1 - Asian Carp Life History (USGS)
- SubProject 2 - Illinois River Monitoring and Response Team Support (USFWS)
 - Fixed and Random Site Monitoring
 - Seasonal Intensive Monitoring
 - Unified Method Support
 - Response Action Support
- SubProject 3 - Des Plaines River and Overflow Monitoring (USFWS)
- SubProject 4 - Distribution and Movement of Small Asian Carp in the IWW (USFWS)
- SubProject 5 - Enhanced Detection Above and Below Electric Barriers (Illinois DNR)

- SubProject 6 - Illinois River Stock Assessment/Management Alternatives (Illinois DNR)
- SubProject 7 - Evaluation of Gear and Novel approaches (Illinois DNR)
- SubProject 8 - Ecosystem assessment – Eggs, Larvae, Plankton for risk and population
- SubProject 9 – USACE Monitoring and Response Team Support

The projects identified above are identified in the 2017 Asian Carp MRP was prepared by the MRWG and, released by the ACRCC. Specifically, this compilation of project plans 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 project identifies anticipated actions that will take place in 2018, including project objectives, methodology, and highlights of previous work.

The projects identified above are designed to address three primary objectives for preventing the spread of Asian carp to Lake Michigan. These objectives are:

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

The projects build upon considerable work completed during past years.

SubProject 1: Asian Carp Life History

Lead Agency(s): USGS

Agency Collaboration: USFWS, USACE, Illinois DNR, INHS, SIU, WIU

Project Explanation

The goal of this project is to better understand Asian carp life history to improve the efficacy and efficiency of existing control and containment methods, or devise new methods, without doing significant harm to social, economic and ecological systems. This better understanding will be incorporated into informational products and decision support tools to inform management decisions to control Asian carp. Past field and laboratory studies on recruitment, native predators, light trapping larval stages and development of triploid Bighead Carp are concluding with final reporting planned in 2018. Moving forward this project will focus on better understanding habitat use and selection by adult, juvenile and larval Asian carp under various environmental conditions (e.g., season and discharge) to (1) inform the removal efforts by state and federal agencies, and private entities (i.e., contract and standard commercial fishing) and (2) help devise other potential control methods as supported by the Glover-Kallis Population model and managers.

MRWG database: As part of this effort a MRWG database containing standard monitoring and removal data collected since 2010 will be assembled from the existing Illinois DNR, USFWS, and USACE data. Field data collection and upload/download applications will be developed as part of this effort. The database produced through this study will be documented with standard metadata descriptions. The database will be made public in accordance with standard federal

practice after partner approvals. This database will be incorporated into various decision support tools including the removal dashboard described below.

Asian carp habitat mapping, modeling and removal dashboard: One approach that USGS will take to better understand habitat use and selection by Asian carp at various life stages includes using previously collected data from ongoing monitoring and removal programs to plot heat maps of catch and model habitat of Asian carp by season and discharge/stage in the Illinois River. Additional environmental data from high resolution bathymetry and current velocity profilers will also be collected and mapped for use in Asian carp habitat modeling. The Glover-Kallis population model has suggested that removal of Asian carp in upstream (above Starved Rock Lock and Dam) and downstream reaches of the Illinois River could be effective at minimizing pressure on the electrical barrier. Heat maps of 1) Asian carp catch and 2) habitat suitability in these reaches will be included as part of an online removal dashboard, a GIS visualization and decision support tool, made available to agency and private entities to help determine where, and with what gears, removal efforts might be most effective and efficient given the expected environmental conditions (e.g., season, discharge, stage and aquatic area). Heat maps from Asian carp catch and habitat modeling derived from lateral telemetry studies (see telemetry template) conducted in collaboration with Southern and WIU and USFWS will also be incorporated into the removal dashboard in out years.

Sensory development of larval Asian carp: A new effort to better understand larval habitat needs will focus on their sensory development. Habitat selection and preferences of early life history staged Asian carp are largely unknown. Asian carp juveniles and larvae past stage 40 in development are primarily found in tributaries, floodplains, backwaters, and other low velocity habitat, though little is known about what cues are used to select this habitat. Previous work (notably historical literature from Russia) has assumed that larvae are swept into these habitats by chance, with little or no active selection. However, current understanding of larval dispersal shows that larvae are far from passive particles transported by flows, and instead show complex behaviors and interactions with their environment. It is likely that all forms of sensory input contribute to these behaviors and, understanding the ontogeny of sensory systems and preferences of carp larvae at settlement stage will contribute to understanding what drives settlement behavior and how and where that can be used to more effectively implement control methods directed at early life history stages.

Phototactic, chemotactic, and rheotactic behaviors have all been investigated in previous projects, and inferences from these behaviors (especially rheotaxis) can be incorporated into drift models such as FluEgg. Other stimuli, such as auditory, magnetic, or temperature stimuli have not been tested in regards to Asian carp larvae. Emerging research on coral reef fish suggests that sensory input to coral reef fish larvae is considered to have a large effect on navigation and orientation capacities exhibited by these fish with regards to settlement. While the relative importance of different types of stimuli will differ for turbid river larvae, sensory inputs and their detection will remain an important factor in early life behavior.

Light trapping protocols have been developed around carp larvae based on previous observations of behavioral responses to light stimuli. These protocols have been demonstrably successful in multiple aquatic systems for capturing early life history stages of Asian carp. The extent of visual acuity and the stages at which it becomes relevant for navigation and orientation have yet to be determined. Similarly, there is very little description available for ontogeny of any sensory capacity of larval Asian carp. El-Fiky (2003) describes some of the early development of sensory

organs in Grass Carp from a toxicological perspective, including some scanning electron microscope (SEM) images of early developmental stages. Ecologically relevant development and behavioral capabilities have not yet been described.

By combining data based on structural ontogeny, behavioral experiments, preference testing, and dispersal patterns, USGS should be able to improve dispersal models and recruitment predictions, as well as informing control efforts for early life history stages.

Summary of Actions to Date

Concluding life history studies on reproduction, predation, light trapping, and triploidy

- Articles on sampling and identification methods to detect reproduction of Asian carp and factors affecting reproduction in an emerging population have been published.
- Field studies on the capabilities of native predators to consume young-of-year (YOY) carp have been completed in collaboration with WIU. One thesis on predation of YOY Asian carp by native predators in the Illinois River has been completed (Anderson 2016) and an associated manuscript for publication in a peer-reviewed journal is being prepared. A second thesis and manuscript is being prepared on predation of YOY Asian carp by native predators in an emerging population of Asian carp.
- Completed field portion of light trapping study in Missouri River tributaries to assess movement rates and habitat selection of Asian carp and Grass Carp larvae, processed samples, and most of larval fish identification and staging of Asian carp and Grass Carp is complete.
- Completed second year of pond studies and predator-prey interactions to inform effectiveness of different native predators for control of juvenile Asian carp and of habitat selection (to inform surveillance) of juvenile Asian carp in presence and absence of predators using PIT-tag technology. Summarized survival of 2015 and spring-summer of 2016 portions of the study. This included 9 two-week experiments with 12 replicates each.
- Performed study on gut evacuation rates of Asian carp predators to assist in pond and field studies and to aid in interpretation of field gut content data.
- Tested triploid Bighead Carp for maturity and sterility as part of Judas fish project. Neither triploid nor diploid Asian carp from same cohort were yet mature. Male triploid and diploid Bighead Carp were anticipated to be mature in 2017 but, were not due to slow growth rates in culture ponds. To resolve this problem, grow-out of the fish was contracted to a commercial aquaculturist.

MRWG Database

- The beta MRWG Microsoft Access database was transferred to UMESC and upgraded to more sustainable relational database for online serving.
- A data upload and quality control portal was developed.

Asian carp mapping, modeling and removal dashboard

- High resolution benthic mapping data has been collected on the main navigation channel in Starved Rock and Marseilles, for informing ongoing management actions and Asian carp habitat modeling using fish hydroacoustic and environmental data collected by SIU.
- Data framework for Asian carp habitat modeling was developed that has all of the currently available UMRR_LTRM fish and environmental data for the La Grange reach of the Illinois River.

Sensory development of larval Asian carp

- Study on chemotactic responses to different olfactory stimuli by settlement sized larval Asian carp (Grass, Silver, Bighead), showing no preference for any tested stimulus.
- Studies showing phototactic response beginning at gas bladder emergence by all species of Asian carp.
- Studies on swimming speed (Grass, Bighead, Silver Carp) and response to flow by Grass Carp larvae through gas bladder inflation (*data analysis ongoing, covered under FluEgg template, Action Item 12*).
- Light color preference of Grass Carp larvae in light traps (*covered under Grass Carp template, Action Item 29*).

Proposed Actions for FY2018

Concluding life history studies on predation, light trapping, and triploidy

- Complete analyses and writing on thesis and manuscripts for predation of YOY Asian carp by native predators in emerging and established populations.
- Finish staging of larval carp captured in light traps in Missouri River tributaries, perform analysis of rate of lateral dispersal from the Missouri River, produce manuscript.
- Complete analysis of pond studies of predation on Bighead, Silver, and Grass Carp and gizzard shad, and produce manuscript.
- Test triploid and diploid Asian carp for maturity, determine if triploid Bighead Carp produce gametes.

MRWG Database

- Internally release version 1.0 of database to partners for usability and functionality testing
- Work with partners to identify issues that arise during initial deployment
- Establish partner login functionality
- Create data sharing agreements for partners

Asian carp mapping, modeling and removal dashboard

- Collect high resolution bathymetry in off channel areas of Starved Rock and Marseilles Pools, including Morris pits.
- Collect high resolution bathymetry data in Dresden Island and Brandon Roads pools.
- Process and serve high resolution bathymetry data as usable GIS layers for use in management action planning and Asian carp habitat modeling with fish hydroacoustic data from SIU.
- Work with SIU to initiate modeling of Asian carp habitat using fish hydroacoustic data and environmental data including high resolution bathymetry in upper Illinois River.
- Meet with Illinois DNR and USFWS removal crew leads to build a conceptual model of what a Asian carp removal dashboard (i.e., GIS visualization and decision support tool)

for displaying heat maps of previous catch data from monitoring programs and Asian carp habitat models to inform decisions regarding where, and what gears, to fish to maximize Asian carp removal given anticipated environmental conditions (e.g., discharge, stage, season).

- Summarize existing MRWG catch data for use in Asian carp habitat modeling and removal dashboard.
- Develop an integrated dataset and geospatial regression tools that combine catch and environmental data to model likely Asian carp locations (habitat) for inclusion in the online removal dashboard.

Sensory development of larval Asian carp

- Conduct preliminary investigations of audiotaxis and thermotaxis.
- Collect, prepare and analyze larvae Asian carp at different stages to determine structural development, likely utilizing scanning electron microscopes.
- Continue studies on rheotaxis using hydraulic flumes.

Potential Out-year Actions (Subject to Future Appropriations)

MRWG Database

- Add functionality based on partner feedback.
- Add new data collected by partners.
- Continue to improve automated data QC and upload functionality of database.
- Update digital data input tool as needed by partners.
- Continue maintenance of database and associated applications to meet usability and security standards.
- Add partner requested functionality.

Asian carp mapping, modeling and removal dashboard

- Complete work on examples for removal of dashboard and present to MRWG for feedback.
- Hold workshop for partner agencies on initial removal dashboard and refine the dashboard based on workshop feedback to meet partner needs for determining where to target removal efforts for maximum effect in upper and lower reaches of the Illinois River given environmental conditions.
- Work with SIU to complete Asian carp habitat models using fish hydroacoustic and environmental data including high resolution bathymetry in upper Illinois River.
- Hold workshop on and develop classification of benthic areas using NOAA Benthic habitat classification standard.
- Collect and serve high resolution bathymetry for priority areas of lower Illinois River Pools (i.e., Peoria, LaGrange, Alton).
- Work with SIU to complete Asian carp habitat models using fish hydroacoustic data and high-resolution bathymetry in the lower Illinois River. Incorporate outputs into the removal dashboard.
- Work with partners conducting telemetry to understand lateral habitat use by Asian carp in upper and lower reaches of the Illinois River to build habitat models. Incorporate model outputs into the removal dashboard.

- Hold final workshop for partner agencies on removal dashboard for determining where to target removal efforts for maximum effect in upper and lower reaches of the Illinois River given environmental conditions.

Sensory development of larval Asian carp

- Continue studies on audiotaxis, and other sensory inputs.
- Synthesize data on development and behavior to better understand “settling” behavior of larval Asian carp in selection of nursery habitat.
- Prepare models and manuscripts with recommendations on using this information on development and behavior to devise controls targeting early life stages of Asian carp.

Timeline for Major Actions/Expected Milestones/Deliverables

Concluding life history studies on predation, light trapping, and triploidy

- By the end of FY2018: Manuscripts submitted to peer-reviewed journals on predation, light trapping and triploidy with associated management recommendations regarding monitoring and control of Asian carp.

MRWG Database

- By mid FY2018: Beta version of MRWG database with QA/QC and upload/download applications.

Asian carp mapping, modeling and removal dashboard

By the end of FY2018:

- High resolution bathymetry data from upper Pools in Illinois River as GIS layers for use in management action planning and Asian carp habitat modeling
- Initial removal dashboard (GIS visualization and decision support tool) for displaying heat maps with MRWG data in the upper Illinois River to inform removal efforts.
- Asian carp habitat model from LTRM data in La Grange Pool of the Illinois River

Expected Completion Date for Project

This project is highly integrated but contains many smaller projects. Portions of this template have been completed during 2017, while others will be completed in FY2018-FY2022.

Potential Hurdles

- Hiring and procurement for all projects.
- Spawning difficulties for sensory work.
- Availability of SEM for sensory work.

SubProject 2: Illinois River Monitoring and Response Team Support

Lead Agency(s): USFWS

Agency Collaboration: USFWS Carterville, Columbia, and Lacrosse, USACE

Project Explanation

This template encompasses all monitoring and response support provided by the USFWS throughout the Illinois River. This effort is led by the Illinois DNR and the USFWS provides support with staff and vessels during these scheduled and unscheduled events. Below are summaries of the individual projects.

Fixed and Random Site Monitoring

This project began in 2010 and is still ongoing. Fixed site events occur once monthly from April through November and samples are collected at four fixed sites in each of the four upper pools as well as randomized sampling sites. This effort will allow biologists the opportunity to better assess Asian carp abundances and distributions downstream of the electric dispersal barrier System (EDBS). Seasonal Intensive Monitoring (SIM) events are a supplement to this effort and are conducted above the EDBS. Standardized sampling for these events consists of DC electrofishing, hoop and mini-fyke netting, and contracted commercial netting to monitor for the presence of Asian carp in the four pools below the EDBS. The goal is to determine the relative abundance of Asian carp in locations and habitats where they are likely to congregate as well as to supplement Asian carp distribution data obtained through other projects (such as the Asian Carp Barrier Defense Project). This is also an opportunity to obtain information on the non-target fish community to help verify sampling success, guide modifications to sample locations, and assist with detection probability modeling and gear evaluation studies.

SIM

The objectives of the SIM events are to remove Asian carp from the CAWS upstream of the EBDS when warranted and to determine Asian carp population abundance through intense targeted sampling efforts at locations deemed likely to hold fish. These SIM events are a modified continuation of the Fixed and Random Site Monitoring Upstream of the Electric Dispersal Barrier System. These events are conducted twice a year in June and in September each comprising two weeks of effort.

Unified Method

As part of the Asian Carp MRP, commercial fishing is being used to reduce the number of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the EBDS. By decreasing Asian carp numbers, a decrease in migration pressure towards the barrier as well as a reduced chance of carp gaining access to upstream waters in the CAWS and Lake Michigan is possible.

The Unified Fishing Method (UFM) was developed by Chinese fisherman to harvest the maximum amount of fish in backwater lakes. In large Chinese backwater lakes (> 10,000 acres) this method is successfully used to harvest over 90% of fish. The UFM utilizes the Asian carp schooling instincts, a series of block nets and non-aggressive herding techniques to ultimately move Asian carp into a final catch and removal area.

Response Support

The ACRCC has developed a Contingency Response Plan which outlines 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. Contingency actions include those direct actions taken in response to a trigger, which include proper coordination and communication of those actions as it relates to response efforts. Response actions vary depending on the size, number and location of a captured Asian carp. Please see the Contingency Actions template for more information.

Summary of Actions to Date

FY2017 Actions

Fixed and Random Site Monitoring

In 2017, USFWS completed six Fixed Site events within the upper pools of the Illinois River. Each event is one week in duration and data is given to the Illinois DNR for compilation at the end of the week. USACE biologists completed 12 weeks of Fixed Site events within the lower Lockport and Brandon Road Pools. A total of 4 fixed sites and 8 random sites in each pool were completed bi-weekly from March through November. Data was reported to Illinois DNR for compilation with partner agency data at the end of each event and a monthly summary of catch data was also submitted.

SIM

SIM was conducted during June and September in 2017. Each event consists of two weeks of random and fixed site sampling. The Carterville office supplied one electrofishing boat for the first week and two the second week of each event as well as the staff to man the boats.

Unified Method

During 2017, two Unified Method Events were completed. The first event took place in March within the Hanson Material Services West Pit and the second event which occurred in October was focused within the Dresden Island Pool of the Illinois River.

Labor and equipment support for each event by agency are detailed below.

- Unified Method – March 2017
 - USFWS provided two electrofishing boats to assist with efforts involved in driving fish out of block-netted sections of the West Pit with electrofishing boats.
 - USFWS used the paupier boat to clear Asian carp from within the sectioned off areas.
- Unified Method – October 2017
 - USFWS provided one electrofishing boat as well as an additional sound boat.
 - USFWS used the paupier boat to harvest Asian carp within Dresden Island Pool in support of the herding efforts.
 - USACE provided two boats and four staff during the week of the event. Two staff members conducted electrofishing support on one vessel while the remaining to staff conducted telemetry tracking support from the second vessel. Additionally, a full telemetry system download was completed the previous week and data was shared with the UFM team to optimize harvest effort.

Response Support

On June 22, 2017, the 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 as part of the Monitoring Response Work Group's SIM event. The Silver Carp was 28 inches in length and weighed approximately 8 pounds. This Silver Carp find triggered two additional weeks of intense sampling in the area, as outlined in the ACRCC's Contingency Response Plan.

In response to this finding, USFWS provided support during what was later called Operation Silver Bullet. Each office supplied one boat for the first week of the two-week event.

Proposed Actions for FY2018

Fixed and Random Site Monitoring

In 2018, USFWS will complete six Fixed Site events within the upper pools of the Illinois River. Each event is one week in duration and data is given to the Illinois DNR for compilation at the end of the week.

SIM

SIM will once again be conducted during June and September in 2018. Each event consists of two weeks of random and fixed site sampling. The Carterville office will supply one electrofishing boat for the first week and two the second week of each event as well as the staff to man the boats.

Unified Method

In 2018, USFWS is anticipating at least one Unified Method Event. The USFWS will once again provide support as detailed below.

During each event, USFWS will provide support with staff and boats.

- Provide two electrofishing boats to assist with efforts involved in driving fish out of block-netted sections.
- Use the paupier boat to clear Asian carp from within the sectioned off areas.

Response Support

Although there are no scheduled response events it is always a possibility. USFWS staff will be on call to assist with response efforts if the need arises. Staff will remain in contact with the Illinois DNR and the ACRCC to determine what our support efforts will entail. During past response efforts, USFWS provided support for Operation Silver Bullet with each office supplying one boat for the first week of the two-week event.

Potential Out-year Actions (Subject to Future Appropriations)

Fixed and Random Site Monitoring, SIM, Unified Method, and Response Support will continue as long as Asian carp remain a threat to the Great Lakes. Monitoring and Response actions will be revised on an annual basis in response to previous year's findings. Efforts will be tailored appropriately to assess and react to the threat of Asian carp as populations dynamics shift longitudinally along the IWW. USFWS staff will continue to provide support during these efforts as requested.

Expected Milestones

All actions will be completed in a timely manner and data will be transferred to the Illinois DNR at the end of each event.

What Is Deliverable for this Funding

USFWS crews will continue to support the Fixed Sites and SIM events as in the past and will participate in other events as requested.

Expected Completion Date for Project

As long as Asian carp remain a threat to the Great Lakes these projects will continue and will be supported by the USFWS.

Potential Hurdles

Weather, staff, time, boat availability, duration of effort.

SubProject 3: Des Plaines River and Overflow Monitoring

Lead Agency(s): USFWS

Agency Collaboration: Metropolitan Water Reclamation District of Greater Chicago, USACE, and Illinois DNR

Project Explanation

The upper Des Plaines River rises in Southeast Wisconsin and joins the CSSC in the Brandon Road Pool immediately below the Lockport Lock and Dam. Asian carp have been observed in this pool up to the confluence and have free access to enter the upper Des Plaines River. In 2010 and 2011, Asian carp eDNA was detected in the upper Des Plaines River (no samples were taken in 2012-2016). It is possible that Asian carp present in the upper Des Plaines River could gain access to the CSSC upstream of the EDB during high water events when water flows laterally from the upper Des Plaines River 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 the USACE and consists of concrete barriers and 0.25-inch mesh fencing built along 13.5 miles of the upper Des Plaines River where it runs adjacent to the CSSC. It is designed to stop adult and juvenile Asian carp from infiltrating the CSSC, but it will not block drift of Asian carp eggs and fry. Opportunities for fish to pass occurred during high discharge events in 2011 and 2013 when water overtopped the river banks and scoured breaches in the barrier. USACE reinforced these and other low-lying areas to prevent future scouring and overtopping by burying chicken wire in gravel and/or cement at the foot of the barrier fence. It is important to understand the Asian carp population status, monitor for any potential spawning events, and determine the effectiveness of the physical barrier to inform management decisions and help assess risk of Asian carp bypassing the Dispersal Barrier.

Summary of Actions to Date

This project began in 2011 and is ongoing. Between 2011-2016, 9,696 fish have been collected via electrofishing (51.19 hours) and gill netting (134 sets; 17,584 yards). No Bighead or Silver Carp have been collected or observed. Seven Grass Carp have been collected. Six of these were submitted for ploidy analysis. All were determined to be triploid (sterile). The dispersal barrier

fence is routinely monitored for damage or potential weak points by USACE staff throughout the year. Turtle gates have been installed along the fence line to allow migration of amphibians and reptiles during their respective spawning and nursery seasons. The turtle gates must be manually opened or closed before and after potential overtopping events to prevent the passage of fishes. Repair work to the fence has been made on several occasions in response to vandalism or vehicle accidents as well.

FY2017 Actions

Fixed sites were sampled in the Des Plaines once during spawn and twice during post-spawn time frames. Reports of water overtopping the Des Plaines and going into the CSSC occurred twice and were investigated. No Asian carp were sighted or captured during any of the events.

Proposed Actions for FY2018

Fixed sites will be sampled once each during spawn and post-spawn time frames. 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 Des Plaines River.

USACE personnel will monitor water levels for potential overtopping events. USFWS will be notified of potential overtopping events and location. When it is safe and practical to do so, block nets may be used to temporarily close any breeches. Similarly, small mesh seines and ichthyoplankton trawls will be fished on the floodplain on both sides of the barrier fence near areas where water is flowing through the fence or where breeches have occurred, provided it can be done safely.

Monitoring and repair work will continue along the full length of fence. In addition, close coordination with USFWS will occur to both respond to flood events and effectively manage the turtle gates.

Potential Out-year Actions (Subject to Future Appropriations)

This project is perpetual by nature, however changes (i.e. additions) in barriers downstream or shifts in the Asian carp population in the area may be cause for this project to be altered in the future. Regular monitoring of the Des Plaines for the presence of Asian carp will be necessary to ensure they are not becoming established, and to assess the threat they may pose to invade the CSSC during high rain/over topping events.

Timeline for Major Actions

Sampling timeframes should be similar for the fixed site sampling. Overtopping response sampling will continue to be done on an as needed basis.

Expected Milestones

Ongoing project with an annual report.

What Is Deliverable for this Funding

Results of each sampling event will be reported for monthly sampling summaries. Captures of Bighead or Silver Carp will be reported to MRWG immediately. Data will be summarized for an annual interim report and presented at the annual MRWG winter meeting. USACE will provide notifications to USFWS when overtopping events are forecasted along with an after-action report following overtopping events to describe the location, magnitude, and duration for each event.

Expected Completion Date for Project

Indefinite. Annual ongoing monitoring project.

Potential Hurdles

Potential hurdles are the ability to deploy staff safely and in a timely manner during over topping events, and conditions in the Des Plaines being right to complete fixed site sampling.

SubProject 4: Distribution and Movement of Small Asian Carp in the IWW

Lead Agency: USFWS

Project Explanation

The primary purpose of this study is to determine the location and density of young (age 0 to age 2) Asian carp in the IWW using intensive, directed fish sampling targeting this life stage. For the purposes of this project, Asian carp specimens less than 350mm total length will be considered a size of interest based on previous research of age-one and age-two Bighead and Silver Carp. Specimens less than 153mm total length (6mm) will be called, “small Asian carp,” and are of special concern based on the electrical limitations of the EDBS and the potential threat of fish in this size class breaching it. Fishing gears used include: pulsed-DC boat electrofishing, paupier trawl, electrified dozer trawl, surface trawl, otter trawl, push trawl, mini-fyke nets, and large-frame fyke nets (fykes). Secondary to this goal, USFWS will attempt to determine the primary habitat area usage and movement distances of young Asian carp using acoustic and radio telemetry. For telemetry efforts USFWS will employ both acoustic and radio equipment based on the characteristics of the Peoria reach, where this study is occurring.

Summary of Actions to Date

Monitoring for juvenile Asian carp began in 2012 and has been ongoing. Efforts were increased in 2015 with use of novel trawling gear. Prior to that year, only boat electrofishing, push trawls, mini-fyke nets, and large frame fyke nets were used. From 2015 to present, more emphasis has been placed on sampling using: boat electrofishing, mini-fykes, paupier, and dozer trawl.

During 2012, one small Silver Carp was captured at River Mile (RM) 194, near Henry, Illinois. This fish represented the furthest upstream documentation of post-larval juvenile Asian carp. A total of 4 individuals less than 153mm in total length were captured that year. No small Asian carp captures occurred during 2013 or 2014, indicating a potential failure of recruitment of new Asian carp cohorts. During 2015, the largest number of small Asian carp to date was captured from the IWW. Two of these fish were caught in the lower end of Marseilles pool, representing the new upstream bound for this size class of Asian carp. The remainder of the small fish were caught in Starved Rock and Peoria reaches. Sampling results of 2016 resulted in zero small Asian carp captured upstream of the Peoria reach. Four Silver Carp from the Peoria reach represent the only small fish captured by the USFWS during 2016 however, nine juvenile Silver Carp were captured in Starved Rock during 2016. Similar results have been found during 2017, with three small fish captured in Peoria reach and zero to date caught in upstream pools.

FY2017 Actions

Sampling to monitor for the presence of small Asian carp has been ongoing for 2017. A total of 277 electrofishing sites have been conducted to date from the Peoria reach to Lockport. The bulk of fishing effort has been from Marseilles reach to Peoria 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. 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 fykes 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.

To date, three small Asian carp have been captured during 2017. One individual was captured using boat electrofishing in April 2017 and two were captured using an electrified dozer trawl in September 2017. All three of these fish were captured from Henry, Illinois near RM 194 in the Peoria Pool. Additionally, 12 juveniles less than 300mm TL and 59 individuals between 300mm and 400mm have been captured in the Peoria reach as a result of tagging efforts.

In addition to the monitoring efforts, USFWS has expanded the telemetry study of juvenile Asian carp from 2016. USFWS has deployed a total of 26 hydrophones in the Peoria reach since April, stretching from Hennepin, Illinois downstream to Chilicothe, Illinois. Additionally, USFWS has set up five radio telemetry monitoring stations in the Peoria reach with the goal of 13 stations deployed and spread from the Peoria Lock and Dam to the Starved Rock Lock and Dam, covering the whole reach. Currently, 57 fish are tagged with acoustic transmitters, with a mean size of 320mm. Additionally, nine fish have been tagged in the 300mm to 400mm size class using both radio and acoustic transmitters.

Efforts for the remainder of 2017 will focus on tagging the smaller size class of fish (120mm to 300mm), using both radio and acoustic transmitters when possible, and deploying the remaining radio telemetry stations. Acoustic telemetry data will be analyzed each year with the goal of using it to begin designating potential small Asian carp, “hot spots,” and fishing locations within other pools as an effort to improve monitoring. The data gathered over the next year will aid in this effort.

Proposed Actions for FY2018

Monitoring efforts continue in a similar manner as 2017. Primary fishing efforts will center on Marseilles and Starved Rock reaches unless small Asian carp are captured there. In that case, effort will shift upstream to Dresden Island and Marseilles or further, in order to keep tracking the population front. Total crew weeks monitoring will be similar to 2017 (around 24 weeks total). Additional effort will occur as a result of fish tagging efforts in Peoria, assisting the Illinois DNR with projects, and conducting other projects within our office.

Similar fishing gears will be used next year that are currently employed. Electrofishing remains one of the best tools due to the capability of fishing all shorelines less than two meters deep, in and around woody debris and other structure. Additionally, the Wilmington office has two electrofishing boats equipped with shallow drive motors that are capable of entering areas that aren't possible with normal boats. Mini-fyke nets will continue to be used as a supplement in fishable areas (<1m deep) due to their effectiveness for catching very small young of year fish. In some areas mini-fyke nets are the only gear which is usable based on water depth. The paupier

and dozer trawls will be used as much as river conditions allow in the areas they work well. The paupier is primarily used in larger backwater lakes and slow-moving side channels to sample more pelagic habitat than traditional electrofishing or other gears.

One change from past years is that telemetry data will be used to designate potential small Asian carp, “hot spots,” based on the habitat usage data in Peoria pool. These areas will have random sites generated in them that USFWS will sample periodically within the 2018 field season. Random sites will be stratified by habitat area, water depth (gear specific), and typical flow conditions, to maximize the ability of each gear type to be usable (i.e. backwater and channel borders <1m depth at base flow for mini fykes, backwaters >2m depth at base flow for paupier trawl, etc.). Random site locations will be generated for 3 sampling periods of the year and will total between 75-100 sites (25 to 32 per sampling period) for each gear. Sampling of random sites will result in data which can be used to develop a detection probability estimate for small Asian carp in the future. This type of analysis can aid in management plans by estimating how much sampling effort is needed to detect rare fish such as small Asian carp.

The plan is to continue telemetry of small Asian carp for 2018 as an effort to gather more data on habitat usage and movement to improve monitoring upstream of Peoria reach. Acoustic receivers must be removed from the river for winter due to ice conditions; however, radio monitoring equipment will remain year-round. The acoustic receivers will be re-deployed immediately following ice melt on the river. Tagging efforts will be conducted periodically throughout the 2018 field season in the Peoria reach.

Potential Out-year Actions (Subject to Future Appropriations)

This project is expected to continue for the foreseeable future based on limitations of the EDB and the danger of small Asian carp to breaching it. Similar amounts of effort will be spent on directed intensive sampling in the future years. As more data is gathered from telemetry and monitoring actions, it is the goal to aim as becoming more efficient at detecting these small fish by targeting the hot spots regularly. Gears used will remain similar to present due to the nature of the reaches being monitored and the previously discussed strengths of the strategies currently employed.

As of now, the telemetry aspect of this project can be expected to be completed near the close of FY2019 unless additional data is necessary to inform fishing efforts. USFWS expects to begin using the data as soon as 2018 so the additional data would only make fishing strategy predictions more accurate. Data gathered from this telemetry projects will also be used in other projects such as the Asian carp population model. Data needs to inform small Asian carp monitoring will continue to be assessed on a yearly basis.

Expected Milestones

Sampling efforts to determine the recruitment front of small Asian carp will begin during the month of March each year and can be expected to return preliminary results by second quarter. Monitoring will still be taking place up until late November since there is possibility of fish moving upstream or a new cohort as a result of spawning activity upstream. Monthly summaries of efforts including number and locations of small Asian carp captured will included in the MWRG monthly reports. At the close of each year, sampling data will be analyzed and presented at the MWRG meeting in January. Total captures of fish, distribution data, and catch per unit effort of small Asian carp and bycatch will be included.

Acoustic telemetry data collected in 2017 will be analyzed at the close of the 2017 field season. This data will be used to plan the random site locations and potential hot spots for small Asian carp monitoring in 2018. Radio gear will be at least 75% deployed by December 2017, including 25 to 50 fish tagged and 10 monitoring stations set up. Beginning in March 2018, the remaining gear will be deployed based on movements of tagged fish over winter. Fish tagging will also resume and acoustic telemetry gear will be re-deployed. The goal is to have 50 to 100 more fish tagged with acoustic and/or radio tags by July 2018.

What Is Deliverable for this Funding

At the close of each year, distribution and density data for young Asian carp will be analyzed and presented to MWRG in the form of maps and tables illustrating the data. As detections of small Asian carp occur, this information will be immediately relayed to other agencies, including the MRWG, involved in monitoring and removal efforts of Asian carp in the IWW. At the close of each year, the monitoring plan for the next year will be developed and presented to MWRG prior to implementation. This will include the random site maps and projected hot spots to target for the next sampling year.

Telemetry data will be analyzed following the 2017 field season and the 2018 field season. A plan for any telemetry effort in 2019 will be created following the 2018 analysis. Due to the nature of these fish tags lasting up to 1 year, this plan for 2019 will most likely be developed in a fluid manner during the 2018 field season as data is gathered and patterns observed.

Expected Completion Date for Project

While the telemetry portion of this project can be expected to be completed by 2019 or 2020, it is imperative that monitoring efforts continue within this area of the IWW. Small sizes of Asian carp remain one of the biggest threats to passing the EDBS due to the ineffectiveness of electrical fields on small bodied fish, thus monitoring should continue until there is no risk of these fish going through the barrier. Sampling efforts should continue from Lockport pool to the Peoria reach, centering on finding the recruitment front every year.

Potential Hurdles

Possible hurdles for this project are mainly environmental related; dangerous weather or river conditions can prevent monitoring of small Asian carp for weeks at a time. Sampling efforts for small Asian carp will be conducted during flood events due to the possibility for fish passage through dams and the spawning conditions favored by Asian carp. However, field team safety will remain the number one priority. Extreme cold conditions on the river will also halt routine monitoring for the year due to danger for field crews, especially when ice is forming. A final problem that can hamper monitoring efforts is field equipment malfunctions or breakdowns. Every effort is made to repair gear quickly and maintain extra equipment. However, this is always a possible issue with field work.

The telemetry aspect of this project has similar environmental hurdles as monitoring. High flow conditions can result in equipment damage, poor fish detections, prevent data acquisition, and prevent field efforts. Similarly, high winds or extreme weather can damage radio telemetry equipment. Another potential problem with telemetry equipment is gear being stolen, vandalized, or tampered with. As of now there have been only a few issues, but this is always a concern. Lastly, the failure to catch or locate suitable sizes of fish to implant with tags has occurred in the past and can interfere with field efforts in the future. These issues are handled by communicating

with other agencies working in the area to inform field efforts, inputting more fishing effort, or changing fishing locations.

SubProject 5: Enhanced Detection Above and Below Electric Barriers

Lead Agency: Illinois DNR

Agency Collaboration: USACE, and USFWS

Project Explanation

Work will include a continuation of extensive monitoring efforts in elevated risk areas to detect the presence of Asian carp and remove them, as necessary. These areas are those previously identified through waterway characterization as preferable Asian carp habitat, extensive sampling, or where previous eDNA sampling indicated the presence and persistence of Asian carp DNA in the area at the time of sample collection. Monitoring of these elevated areas will include personnel services, equipment, commodities, and contracts to meet accomplish MRP as well as any contingency measures as follows:

- Evaluation and updates to enhanced eDNA testing and monitoring in the CAWS as needed.
- Conventional monitoring, such as electrofishing and netting, at designated areas.
- Continued deployment of gears developed through prior gear development project.
- Continued support of multi-year Monitoring and Response Plan (2016-2017) through enhanced monitoring and products to support Action Plan development.
- Continued emphasis on 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.
- 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 heightened 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 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 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 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 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. *Additional measures may necessitate additional funding needs to accomplish.
- 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 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.
- Continue to review catch data for native species and trends corresponding to Asian carp and removal efforts.

Summary of Actions to Date

Illinois DNR will post monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

Proposed Actions for FY2018

Fixed Site Monitoring Upstream of the Dispersal Barrier

These activities will continue in 2018 at the same level in past two years. SIM is a modified continuation of Fixed and Random Site Monitoring Upstream of the Dispersal Barrier and Planned Intensive Surveillance in the CAWS. A variety of gears will be used during SIM 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 one Bighead Carp has been collected (in 2010) the very first day contracted fishers were deployed in this area. Sampling will occur both in Spring (June) and Fall (September) when Asian carp catches in other areas are notably higher. Fixed and random sites throughout the CAWS above the electric barriers will be sampled 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.

Fixed Site Monitoring Downstream of the Electric Dispersal Barrier

Fixed and random electrofishing and contracted netting has been increased in 2014 and will continue at these elevated levels in 2018 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 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 in 2013.

Young-of-Year 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 (see USFWS and INHS small fish projects in 2017 Monitoring and Response Plan. These 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 IWW 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 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 MRP 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 SIM events, but also can be deployed to maximize removal efforts with any of the commercial tools, including seines up to $\frac{3}{4}$ 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. 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 IWW 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. Efforts were heightened in 2016 to remove more Asian carp through additional crew/weeks scheduled in removal efforts.

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

Fish disposal prior to 2016 was facilitated by Illinois businesses taking all of the harvested fish.

Barrier Maintenance Fish Suppression

The Illinois DNR will work with federal and local partners to remove fish greater than 12 inches long between Barrier 2A and 2B before maintenance operations are initiated 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 hydro-acoustics and side-scan sonar). Success is defined as no fish larger 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 Monitoring and Response Plan 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.

Additional Proposed Actions for FY2018

- Establishment of Lake Michigan and Communication ANS positions to provide local expertise for near shore Lake Michigan needs and further integration of efforts with ongoing GLRI and Lake Committees as well as supporting Illinois-ACRCC communication needs.
- Updating communication strategy and materials using contracted and agency personnel in coordination with other ACRCC and MRWG partners to best share information and updates.
- Re-establish synthesis of zooplankton-carp relationships to further understand recovery and relationships of removal efforts.
- Seek additional locations for Chinese Unified fishing method as a highly successful removal strategy.

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.
- Application of new gear into surveillance as warranted.
- 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.

Outcomes/Outputs

- Prevention of Asian carp establishment in CAWS through an active and adaptive monitoring and management program.
- Coordination and summary of sampling and response efforts.
- Share expertise and lessons learned with other agencies and programs wanting to remove/control aquatic nuisance species.

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 (less than 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 Lake Michigan and Communication position.

SubProject 6. Illinois River Stock Assessment/Management Alternatives**Lead Agency:** Illinois DNR**Agency Collaboration:** SIU, Feeding Illinois**Project Explanation**

Illinois DNR will advance its work monitoring and developing insights into the strategies for addressing Asian carp in the Illinois River. The primary objective is to understand population dynamics of Asian carp that would give insight into ability of directed harvest and other control measures to reduce overall populations within waters connecting to the Great Lakes and, reduce movement of Asian carp upstream toward the CAWS. Population-level effects and capabilities of harvest as a control strategy are outlined in the Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States. Using best science and understanding the harvest and stock/recruitment variables in the upper Illinois River, Illinois DNR is further developing dynamic models to forecast and predict effects of harvest, other control efforts, and breadth of Asian carp populations. This will provide science-based direction for harvest and control strategies and regional regulatory oversight to achieve goals for (1) prevention of spread toward the CAWS and (2) further reduction of Asian carp populations. Through 2017, these efforts have documented significant decrease in the population of Asian carp through the contracted fisher removal program. Most significantly, Dresden Island Pool Asian carp population has declined to 2014 levels that are just 32% of levels found in 2012 as a result of the carp removal. These lower population levels are being maintained currently

This project encompasses multiple studies with the goal of determining estimates of Asian carp abundance, biomass, size structure, with insights into demographics (e.g., growth and mortality), natal origin in the Alton, LaGrange, Peoria, Starved Rock, Marseilles, Dresden Island, and Brandon Road pools of the Illinois and Des Plaines rivers.

As with other projects, beginning in 2018 the project will specifically gather information around several known bottlenecks (Brandon Road, and Starved Rock lock and dams) to understand when and how to prevent or slow upstream movement as noted in prior year's work, and in part identified in the GLMRIS and support decision making processes in developments of alternative and/or additional measures. Data suggest in years with low discharge that immigration from downstream is lower, thus mortality/capture rates in upstream pools is high while in years with increased discharge also increases the opportunity of upstream migration. There remain additional needs to support model input parameters. Ongoing efforts also suggest where concentrations of fish are located which can quickly be relayed to contracted removal efforts. Such communication in the past has increased fishing efficiency. The 2018 funding of an additional \$40,000 would enable the tagging and replacing of 100 Asian carp in Alton and La Grange pools. The data is needed from these fish to further inform the spatial model developed.

Summary of Actions to Date

Illinois DNR will post monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

Proposed Actions for 2018

- Gather and share (communicate) basic information regarding ongoing market driven economy, industry developments, and carp populations to decision makers and managers to understand existing effort to prevent upstream migration and to facilitate information of ongoing efforts to public sector.
- Data analysis is ongoing but Asian carp abundance appears to be holding at a low level as in 2012-2014, and decreasing in the most upstream reaches. Record recruitment suggests many smaller and juvenile fish may have the opportunity to migrate upstream and challenge our ability to remove/harvest within Upper Illinois River. Evaluation of this data throughout 2016-2017 will highlight areas in need of further or even modified targeted efforts to further goal of contracting population of fish away from sensitive areas or pathways toward Lake Michigan.
- 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 GLMRIS and support decision making processes in developments of alternative and/or additional measures. These efforts will include:
 - Telemetry efforts.
 - Hydro-acoustic/side scan sonar efforts.
 - Traditional and contracted monitoring efforts.
 - Mark-recapture studies.
 - Collating dam operation guidelines to facilitate operational control (if practicable).
 - Provide rapid response and emergency hydro-acoustic efforts if necessary.
 - Real time water quality monitoring along with hydroacoustics may allow for correlation of habitat and fish biomass that can further enhance removal and modeling efforts.

Information from these efforts can inform harvest strategies and inform managers on potential for infrastructure modification, operations, or design at or near lock chambers or other locations where fish may by-pass bottlenecks.

- Provide insights from recently developed spatially explicit movement model and provide review results, with suggestions on how to 1) validate model 2) inform harvest strategy to maximize results.
- Tag additional 100 Asian carp in lower IWW to replace expiring tags and further inform spatial modeling.
- Data from tags will be unilaterally shared through a telemetry and model development working group.
- Real time water quality monitoring along with hydroacoustics surveys may allow for correlation of habitat and fish biomass that can further enhance removal and modeling efforts coordinated with USGS.

Expected Milestones

- Annual, relative population estimates for all Illinois populations of Asian carp for use by program to maximize efficiency in reducing numbers and retracting range of Asian carp.
- Dynamic movement and multi pool models for entire Illinois River that can prescribe efficient and optimal harvest strategies to keep Asian carp from the electric barrier system and Brandon Road Lock and Dam. This work will be coordinated closely with USFWS.
- Further identify areas of control.
- Identify areas and times to restrict fish passage.

Outcomes/Outputs

- Ability to transfer knowledge, management actions, and control technologies obtained from Asian carp activities to national or international levels.
- Conveyance of information to the ACRCC regarding control efforts to reduce the density of Asian carp approaching the Great Lakes.
- Prediction of effects of harvest and other control efforts on movement of Asian carp populations toward the Great Lakes.
- Determination of potential impact of Asian carp on native fish and other ecosystem parameters if the carp invades the Great Lakes.
- Reduced upstream passage of Asian carp.
- Overall reduced populations of Asian carp in upper IWW.
- Reduced risk of Asian carp at or near electric barrier system.

Potential Hurdles

- Variation in feral carp populations due to reproduction and or movements may exceed ability to detect changes due to harvest/control efforts.
- Hydrological effects on removal efforts and implementation of surveillance.
- Funding cycle could delay implanting fish in 2018 but would be as soon as allowed.

SubProject 7: Evaluation of Gear and Novel approaches

Lead Agency: Illinois DNR

Agency Collaboration: None

Project Explanation

Three efforts will be led by Illinois DNR in collaboration with INHS:

1. Evaluation of Juvenile Gear Efficiency and Asian Carp Detectability

Objectives: During 2018, Illinois DNR will compare the size selectivity and relative catch rates of juvenile Asian carp among traditional and alternative sampling gears, including mini-fyke nets, beach seines, pulsed-DC boat electrofishing, and hydroacoustic systems through opportunistic sampling at multiple sites in the IWW. Data from gears targeting nearshore habitats will be used to assess their complementarity with innovative pelagic gears being tested by collaborating agencies (paupier nets, surface trawls, dozer trawls). These efforts as well as

juvenile Asian carp sampling conducted by collaborating agencies will be used to describe the distribution of juvenile Asian carp throughout the IWW. Illinois DNR will also refine estimates of the probability of detecting Asian carp and other fishes with different gear types among different pools of the IWW. This work will be used to inform management agencies regarding optimal sampling gear selection for different life stages of Asian carp, juvenile Asian carp distributions, and appropriate levels of sampling effort through weekly updates, monthly summaries, annual reports, and annual updates to the MRWG's Interim Summary Report.

2. New Gear Development

Objectives: During 2018, Illinois DNR will evaluate the size selectivity and relative catch rates of Asian carp among various configurations of pound nets to enhance capture of Asian carp. Pound nets will also be used to assist other agencies with various research, monitoring, and control objectives. This work will be used to inform management agencies on the optimal use of pound nets through weekly updates, monthly summaries, annual reports, and annual updates to the MRWG's Interim Summary Report.

3. Modular Deterrent Barrier Evaluation

Objectives: During 2018, Illinois DNR will evaluate the effectiveness of a modular electric deterrent barrier, map the electric field generated by the barrier, develop operational protocols, and identify operational costs and constraints. To determine barrier effectiveness, Asian carp and native fishes will be tagged with passive integrated transponder (PIT) tags, and fish movements will be monitored via radio-frequency identification (RFID) antennas in controlled pond settings to determine whether fishes challenge and cross the electrified deterrent barrier. Differences between waveforms (pulsed vs. gated burst waveform) will also be assessed. The experience gained from these trials will be used to develop recommended operational settings, safety and transport protocols, and cost scenarios. This work will be used to inform management agencies on the optimal use of the modular electric barrier through weekly updates, monthly summaries, annual reports, and annual updates to the MRWG's Interim Summary Report.

Summary of Actions to Date

Illinois DNR will post monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

Proposed Actions for FY2018

- Fish pound nets in new locations e.g. Peoria Lake and possibly unified fishing method under new configurations.
- Further testing novel gears (Mamou and Paupier nets) in IWW in collaboration with USFWS. Areas of interest will continue to move upstream to find novel information. Compare efficacy with other experimental gears.
- Evaluate hydro-acoustic data to compare efficacy of catch vs standing stock.
- Continue small fish detection work in response to immigration from downstream to further inform on abundance source.
- Continue to evaluate newly procured mobile (Spring 2016), electric barrier and deploy to evaluate efficacy and uses.

- Deployment of a mobile, electric barrier system depends upon initial deployments and findings in 2017-2018.
- Evaluation of mobile, electric barrier system efficacy on human safety, and fish efficacy. This will enable Increased emphasis on fish detection at Brandon Road Lock and Dam and lower Kankakee River to enlighten Monitoring Plan on these locations and gear efficiencies as practicable.

Expected Milestones

- Demonstrate gears and unique deployments to use in lower IWW where fish abundance is high to further enhance removal.
- Construct total list of gears, specifications, and sources to share with partner agencies.
- Gain necessary insight to demonstrate mobile electric barrier in IWW.

Outcomes/Output

- Further development of new gears and fine tuning of existing ones to maximize detection and removal of Asian carp.
- Additional tools for detecting, stopping, and eliminating Asian carp from the waterway and elsewhere.
- Additional tools to be utilized wherever Asian carp exist to increase likelihood of capture.
- Additional tools for rapid responses which can be deployed to maximize chances of capturing rare fish in deep channels or Great Lakes habitats.
- Additional tools to fish habitats that are hard to sample with more conventional gears.
- Further develop plausible explanations for lack of migrations further upstream.
- Develop tools that will be able to fish water more effectively and cost effective while minimizing mortality to native species.

Potential Hurdles

- Cost of applying new technology may not have cost savings over existing methods.
- New technologies may not improve upon sampling efficiencies when actually deployed.
- New gears may be more expensive and require additional equipment to deploy as compared to traditional fisheries gear.
- Gears may catch fish where they are abundant but may not increase ability to catch fish significantly where they are very rare.
- Gears may not be safe to deploy in various habitats.

SubProject 8: Ecosystem Assessment – Eggs, Larvae, Plankton for Risk and Population Assessment

Lead Agency: Illinois DNR

Agency Collaboration: USFWS, state and federal law enforcement agencies, DFO/Canadian enforcement as necessary, Illinois Natural History Survey-Illinois/Indiana SeaGrant

Project Explanation

1. Larval Fish Monitoring in the IWW

Objectives: During 2018, Illinois DNR will identify 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 work will be used to inform management agencies regarding Asian carp spawning events, spawning locations, and areas of larval settlement through weekly updates, monthly summaries, annual reports, and annual updates to the MRWG’s Interim Summary Report.

2. Detect Changes in Ecosystem Response to Corroborate Other Indirect Population Assessments

Objectives: 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 Asian carp abundances in the CAWS through time and across space through both direct and indirect methods.

Summary of Actions to Date

Illinois DNR will post monthly updates to www.AsianCarp.us as well as lead the effort to compile annual and interim summary reports of all monitoring and response workgroup items and other related and associated information. These additional reports will also be posted on www.AsianCarp.us.

2018Actions:

		2018											
		J	F	M	A	M	J	J	A	S	O	N	D
1.	Larval Fish Monitoring												
	Field Sampling				X	X	X	X	X	X	X		
	Sample Processing					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
2.	Gear Evaluation												
	Field Sampling						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
3.	New Gear Development												
	Field Sampling				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
4.	Modular Deterrent Barrier Evaluation												
	Field Sampling					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
5.	Zooplankton												
	Sampling					X	X	X	X	X	X		

Expected Milestones

- Annual pool-wide assessments of plankton abundance.
- Waterway assessment of spawning activity.
- Waterway assessment of potential recruitment.
- Relationship established between harvest and ecological impacts.
- Identify areas where plankton abundance indicates more fish than other tools predict.

Outcomes/Outputs

- Multiple lines of evidence for the best understanding of Asian carp demographics.
- Estimates of spawning populations to assure no new populations are spawning in new locations.
- Corroborating pool-wide and hydroacoustic estimates.
- Estimating pool-wide contributions to production and recruitment.
- Providing model parameters and/or predicting ecological bottlenecks.
- Increased inference to potential ecological risk.

Potential Hurdles

- Hydrological effects can influence plankton abundance and spawning.
- Detection of rare events.

Subproject 9 - USACE Monitoring and Response Team Support

Project Explanation

The proposed work is to be conducted by the Corps of Engineers' (USACE) Regional Planning & Environmental Division North and the Rock Island District to support the Asian carp control efforts that has been developed by members of the ACRCC by providing technical expertise to the lead agencies as support-for-others.

Summary of Actions to Date

The USACE provides technical assistance to lead agencies that support the Asian Carp Action Plan developed by the ACRCC.

FY2017 Actions

- Collaboration with, and technical and field support to agencies responsible for implementation of items in the Asian Carp Action Plan and the Monitoring and Response Plan.
- 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.
- Development of monitoring strategies and a project implementation plan at Brandon Road Lock and Dam.
- Collaboration with USGS in development of a system scale analysis of Open River conditions on the Illinois River.
- Collaboration with USFWS and States in the application of research and management strategies to limit the abundance of Asian carp in the Upper Mississippi River (UMR) and contributed to the development of the Monitoring and Response Plan for Asian Carp in the Mississippi River basin.
- Coordination of telemetry and ARIS work at locks and dams within the Rock Island District, assisted with the permitting process for testing barrier technologies at Locks and Dams 14 and 19.
- Provided design documents and drawings to assist Asian carp control efforts of other agencies and answered numerous engineering queries on lock and dam structures on the IWW and UMR and how they could be used to slow upstream movement of Asian carp.
- Provided timely coordination on USACE Asian carp activities through formal presentations at regional stakeholder meetings including the UMR Basin Association, Strategic Discussion of National Asian Carp Management and Control, Technical and Policy Workgroup, and the Fish and Wildlife Interagency Committee meetings.

Proposed Actions for FY2018

- Collaboration, technical and field support for lead agencies with ACRCC agencies on the implementation of the Asian Carp Control Strategy Framework and the Monitoring and Response Plan.
- Participation in interagency meetings and conference calls including: ACRCC, MRWG, Brandon Road Work Group, and the Technical and Policy Workgroup, etc.
- Collaboration and evaluation of Asian carp control measures for use in the IWW and development of monitoring strategies and a project implementation plan at Brandon Road Lock and Dam.
- Internal USACE coordination of ACRCC activities.
- Biological, engineering, and navigation technical expertise.

Potential Out-year Actions (Subject to Future Appropriations)

- Collaboration, technical and field support for lead agencies with ACRCC agencies on the implementation of the Asian Carp Control Strategy Framework and the Monitoring and Response Plan.
- Participation in interagency meetings and conference calls including: ACRCC, MRWG, Brandon Road Work Group, and the ACRCC Technical and Policy Workgroup, etc.
- Collaboration and evaluation of Asian carp control measures for use in the IWW and development of monitoring strategies and a project implementation plan at Brandon Road Lock and Dam.
- Internal USACE coordination of ACRCC activities.
- Biological, engineering, and navigation technical expertise.

Timeline for Major Actions

Ongoing through FY2018.

Expected Milestones

Defined annually by the ACRCC in the Asian Carp Action Plan and the MRP.

What Is Deliverable for this Funding

Includes yearly support through:

- Collaboration, technical and field support for lead agencies with ACRCC agencies on the implementation of the Asian Carp Control Strategy Framework and the Monitoring and Response Plan.
- Participation in interagency meetings and conference calls including: ACRCC, MRWG, Brandon Road Work Group, and the Technical and Policy Workgroup, etc.
- Collaboration and evaluation of Asian carp control measures for use in the IWW and development of monitoring strategies and a project implementation plan at Brandon Road Lock and Dam.
- Internal USACE coordination of ACRCC activities.
- Biological, engineering, and navigation technical expertise.

Expected Completion Date for Project

Unknown.

Potential Hurdles

None

15. Detection Using Novel Gear

Lead Agency(s): USFWS and Illinois DNR

Agency Collaboration: Illinois Natural History Survey (INHS)

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USFWS	Illinois DNR (INHS)	USFWS	Illinois DNR (INHS)
FY2018	\$0	-	\$90,000	\$10,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

Sampling techniques that have a high probability to detect Asian carp and the ability to quickly and accurately assess the population are crucial to manage and control these invasive species. In 2016 and 2017, The USFWS conducted a gear evaluation study comparing traditional electrofishing and two novel electrotrawling techniques, the paupier and dozer trawl, in their ability to assess Silver Carp populations in backwaters of the Illinois River. Several other projects have also evaluated techniques used to capture Asian carp in the Illinois River, including: Barrier Defense Using Novel Gear; Evaluation of Gear Efficiency and Asian Carp Detectability; Unconventional Gear Development; and Monitoring Asian Carp Using Netting with Supplemental Capture Techniques. In addition to completing the final analysis of the gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl, the results of multiple projects will be compiled to determine the most effective ways to capture all sizes of Asian carp in a variety of habitats at varying densities. This synthesis will be used to develop standard protocols to answer management questions.

Objectives:

- Complete final analysis of gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl.
- In coordination with partners, synthesize multiple gear evaluation projects to develop protocols to detect, monitor, and remove populations of Asian carp in the Illinois River, Illinois.

Summary of Actions to Date

- Mass Removal and Monitoring of Juvenile Asian Carp (USFWS).
- Barrier Defense Using Novel Gear (USFWS).
- Evaluation of Gear Efficiency and Asian Carp Detectability (INHS) .
- Unconventional Gear Development (INHS).
- Monitoring Asian Carp Using Netting with Supplemental Capture Techniques (USFWS).
- Detection and monitoring of small Asian carp (USFWS).

FY2017 Actions

- Second and final year of field work for gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl in their ability to assess Silver Carp populations in the Illinois River. This was under the previous project title of Mass Removal and Monitoring of Juvenile Asian carp by USFWS.
- Collaboration between USFWS and INHS to coordinate spatial and temporal sampling for gear evaluation projects.
- Collaboration between USFWS– Wilmington to detect small Asian carp at the leading edge of the population front to assess risk to the Great Lakes.
- Laboratory study on Silver Carp behavioral response to electrofishing settings.

Proposed Actions for FY2018

- Complete final analysis of gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl.
- In coordination with partners, compile results from multiple gear evaluation projects to develop standard protocols to detect, monitor, and remove populations of Asian carp in the Illinois River.

Potential Out-year Actions (Subject to Future Appropriations)

- Inter-agency workshops for development and implementation of protocols into an adaptive management framework addressing Asian carp management on the Illinois River. For example:
 - Detecting the leading edge of Asian carp populations
 - Assessing Asian carp populations pre- and post-management actions to evaluate the impacts
 - Detecting Asian carp recruitment
- Interagency data management
- Expand protocols to assess populations at a large spatial and temporal scale

Timeline for Major Actions and Expected Milestones

- January - April 2018: Final analysis and write-up of gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl. Compile results from previous projects (listed above) performing Asian carp gear evaluations.
- September 2018: Publish results of gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl.

What Is Deliverable for this Funding

- Final analysis and publication of gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl.
- Compilation and synthesis of previous projects (listed above) performing Asian carp gear evaluations.

Expected Completion Date for Project

- Short term (2018): Publication of the gear evaluation study comparing traditional electrofishing, paupier, and dozer trawl in their ability to assess Silver Carp populations in backwaters of the Illinois River.

Potential Hurdles

- Coordination among agencies.
- Staff availability.

16. eDNA: USFWS Program Capacity for eDNA Sampling and eDNA Sample Processing, and Advanced Molecular Tools for Tracking Asian Carp

Lead Agency: USFWS

Agency Collaboration: USGS, Great Lakes States, USACE, Purdue University, University of Illinois at Urbana-Champaign, University of Missouri - Columbia

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USGS	USFWS	USGS	USFWS
FY2018	\$800,000	\$2,400,000	\$110,000	\$0

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

The USFWS and USGS are working collaboratively to apply the science of eDNA as an early detection monitoring tool in support the ACRCC’s strategic approach for protecting the Great Lakes from Asian carp. This work includes the continued refinement and development of state-of-the-art 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. These agencies have identified the need to maintain program capacity for eDNA surveillance in the Great Lakes, Upper Mississippi, and Ohio River basins. Building upon previous work that has refined the technology to improve detection sensitivity and efficiencies, applications of molecular technologies are needed to extend improvements for Grass Carp and Black Carp markers, as well as estimation of biomass and methods to distinguish eDNA originating from a live fish.

Use of eDNA as a monitoring tool for Asian carp and other 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 to be adopted into the QAPP. Lab capacity has expanded from about 2,500 to 8,500 samples per year.

Summary of Actions to Date

The USFWS continues to work with partners to refine a Great Lakes basinwide early detection protocol for Asian carp, and potentially other AIS species, using eDNA. USFWS continues to coordinate with federal, state, and provincial partners to annually identify sampling locations (areas of concern), share information, and discuss ways to coordinate eDNA sampling efforts within affected jurisdictions. In 2013 and 2014, USFWS worked with our partners to conduct coordinated and complementary sampling efforts in the Great Lakes basin with both emerging

and traditional gears. From May-November 2013, USFWS collected 2,240 eDNA water samples. In 2014, the Whitney Genetics Lab processed over 5,000 eDNA water samples collected by Service offices. In 2015-2017, USFWS expanded the scope of its overall sampling efforts and collected over 7,500 eDNA water samples from the Midwest Region each year.

FY2017 Actions

Throughout 2017, USFWS, in cooperation with our 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. The USFWS continued to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge. In 2017, 8,592 eDNA samples were collected from the Midwest Region; deploying 4 mobile eDNA trailers across the sampling area by staff of our Fish and Wildlife Conservation (FWCO) offices: Carterville/Wilmington, Alpena, Ashland, La Crosse, and Green Bay. USFWS also partnered with staff from the Lower Great Lakes FWCO and deployed a trailer in that region as well. Additionally, all data was collected using the newly and specifically designed Collector App on iPads provided to each station with a mobile eDNA trailer. This efficiency in collecting data electronically and immediately uploading to our ArcGIS server saved the government \$130,000 and is expected to provide that return on investment in every year going forward.

Additionally, the efficiencies in our lab allowed us to increase capacity for processing without an increase in costs. In 2017, 2,340 samples were collected from areas that were not reported publicly – either to refine the science as research samples, or at the request of a partner. The remaining 6,252 samples were collected as part of our eDNA Early Detection Surveillance Program, throughout tributaries of the Great Lakes, Upper Mississippi basin (including the CAWS), and the Ohio River basin. One positive eDNA result for Bighead Carp was found in the Montgomery Island Pool of the Ohio River, and one positive result for Silver Carp was found in Pickwick Lake, also in the Ohio River basin. All eDNA results can be found here:

www.fws.gov/midwest/fisheries/eDNA.html.

Proposed Actions for FY2018

USFWS, in cooperation with our partners, will continue to monitor for the presence of Asian 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 partners, to detect the presence of Asian carp DNA in areas of concern. This will include the CAWS of the IWW and, will include four sampling events in 2018: May, June, September, and October. Two of these events will immediately precede the MRWG Seasonal Intensive Monitoring Events scheduled for the CAWS. In the May event, the upper portion of Dresden Island pool (above I-55 bridge) will also be sampled due to the planned decrease in barrier operations over the winter of 2017. USFWS will continue to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge.

Potential Out-year Actions (Subject to Future Appropriations)

USFWS, in cooperation with our partners, will continue to monitor for the presence of Asian carp eDNA in the Great Lakes Upper Mississippi River and Ohio River basins. 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 Quality Assurance Project Plan (QAPP) to include any necessary updates for collection, handling, and processing of water samples.
- Increased throughput of samples processed at the Whitney Genetics Lab due to procedural modifications, where possible.

Outcomes/Outputs

- 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 Lab.

Potential Hurdles

- Limitations due to weather and difficulties accessing sites

Advanced Molecular Tools for Tracking Asian Carp (USGS Lead)

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. 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 DNA (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 PCR inhibition, increased cost-effectiveness, and decreased time between sampling and results. However, applications of molecular technologies that need 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 methods used in medicine (i.e. loop-mediated isothermal amplification [LAMP], high-throughput sequencing [HTS], digital polymerase chain reaction [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. 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 are being developed and 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. USFWS will also validate the use of unique gut microbial markers that could be used to complement eDNA, and assays of water samples for species-specific metabolites (i.e. pheromone, hormones, etc.). Using existing data, models will be developed that will identify the probability of a detection coming from a live fish or some other vector or fomite. These models will be used to help recognize data gaps and inform future studies.

Summary of Actions to Date

Characterization of eDNA from Silver Carp and Bighead Carp in the Field

- Developed an eDNA occupancy model and published R package and three papers using the model.
- Dorazio, RM and Erickson RA. (2017) eDNA occupancy: an R package for multi-scale occupancy modeling of environmental DNA data. *Molecular Ecology Resources*. In Press. <http://dx.doi.org/10.1111/1755-0998.12735>.
- Erickson RA, Merkes CM, Jackson CA, Goforth RR, Amberg JJ. (2017) Seasonal trends in eDNA detection and occupancy of bigheaded carps. *Journal of Great Lakes Research*. 43(4): 762-770.
- Erickson RA, Rees CB, Coulter AA, Merkes CM, McCalla SG, Touzinsky KF, Walleser L, Goforth RR, Amberg JJ. 2016. Detecting the movement and spawning activity of bigheaded carps with environmental DNA. *Mol Ecol Resour* 16:957-965.
- Identified significant spike in Silver Carp and Bighead Carp eDNA correlated with migration and spawning event in the Wabash River and Missouri River.

- Richter CA, Hayer CA, Klymus KE, Thompson N, Paukert C, and Chapman DC. In preparation. Quantification of environmental DNA (eDNA) shedding rate to detect spawning and estimate biomass of invasive Silver Carp (*Hypophthalmichthys molitrix*) Manag Biol Invasion
- Completed eDNA sampling in pools of the Upper Mississippi River behind and ahead of the invasion front.
- Estimated relative Silver Carp and Bighead Carp density in Missouri River tributaries with side-scan sonar and traditional capture methods, and conducted simultaneous sampling for eDNA quantification to characterize habitat usage and fish movement.
- Conducted comparisons of water sampling methods during field and pond studies, to optimize water sampling methods for eDNA detection and quantification.
- Initiated the evaluation of Silver Carp and Bighead Carp distribution and land-use practices by using eDNA.

Characterization of eDNA from Silver Carp and Bighead Carp in the Laboratory

- Described a linear relationship over four orders of magnitude between Silver Carp and Bighead Carp biomass and eDNA shedding rate.
- Showed that temperature does not alter eDNA shedding rates.
- Demonstrated that feeding increases eDNA shedding by about 10-fold.
- Klymus KE, Richter CA, Chapman DC, Paukert C. 2015. Quantification of eDNA shedding rates from invasive bighead Carp *Hypophthalmichthys nobilis* and Silver Carp *Hypophthalmichthys molitrix*. Biol Conserv 183:77-84.
- Klymus KE, Richter CA, Chapman DC, Paukert C. 2015. A reply to Iversen et al.'s comment "Monitoring of animal abundance by environmental DNA — An increasingly obscure perspective". Biol Conserv 192:481-482.
- Described degradation curve of eDNA from Silver Carp and Bighead Carp sperm under controlled laboratory conditions, showing a good fit to exponential decay with a half-life of about 8 hours.
- Lance RF, Klymus KE, Richter CA, Guan X, Farrington HL, Carr MR, Thompson N, Chapman DC, Baerwaldt KL. 2017. Experimental observations on the decay of environmental DNA from Bighead and Silver Carp. Manag Biol Invasion 8:343-359.
- Completed studies to determine the degradation of DNA under controlled conditions
- Merkes CM, McCalla SG, Jensen NR, Gaikowski MP, Amberg JJ. 2014. Persistence of DNA in carcasses, slime and avian feces may affect interpretation of environmental DNA data. PLoS ONE 9:e113346.
- Completed mesocosm studies of eDNA shedding rates from larval Bighead Carp.

Development of Molecular Markers for Asian Carp

- Validated new qPCR markers through a multi-lab round robin blinded study for Silver Carp and Bighead Carp mitochondrial DNA to allow incorporation into USFWS eDNA monitoring program.
- Initiated validation of Silver Carp and Bighead Carp-specific microbial communities to detect these fish.
- Initiated mitochondrial sequencing of select native cyprinids whose mitochondrial DNA sequences are underrepresented in GenBank.

- Continued to sequence mitochondrial DNA of fishes' native to Upper Mississippi River whose mitochondrial DNA sequences are underrepresented in GenBank.
- Identified enteric microbial populations from more than 150 individuals, comprising more than 15 different native species of fish, from the Illinois River.
- Designed microbial marker to identify SVC in water samples.
- Initiated validation of microbial markers for detecting SVC.
- Validated internal positive controls for incorporation into USFWS eDNA monitoring program to prevent false negatives from PCR inhibition.
- Applied "stair-step" markers to eDNA samples, detecting sequences of greater than 800 base pairs that indicate freshly shed eDNA from live fish.

Development of Emerging Technologies for Asian Carp Detection and Control

- Developed and validated the portable eDNA detection kit for detection of Bighead and Silver Carp in bait tanks.
- Developed and validated pan-Asian carp LAMP assay for detecting all 4 species of Asian carp with the portable eDNA detection kit.
- Developed methods for using the portable eDNA detection kit in open water applications.
- Merkes CM, Caucutt, M, Hines RK. (2017) Environmental DNA detection in the field. U.S. Geological Survey Podcast. Available at: <https://www.youtube.com/watch?v=L9f1A4jgcrU>.
- Initiated studies to evaluate the use of RNA as an alternative to eDNA.
- USGS identified a method using next-generation sequencing protocols to analyze composite water samples, plankton tows, and ichthyoplankton tows for detection of Asian carp.
- Initiated validation studies on the use of dPCR as an alternative to qPCR for quantifying eDNA.

FY2017 Actions

Characterization of eDNA from Silver Carp and Bighead Carp in the Field

- USGS integrated eDNA sampling and HTS with long-term monitoring.
- USGS continued to assess land-use practices with fish movement and eDNA.
- Studies that evaluate the utility of eDNA for assessing the effects of management actions were continued.
- USFWS validated the use of the portable eDNA detection kit for Asian carp in open water applications.

Characterization of eDNA from Silver Carp and Bighead Carp in the Lab

- Initiated controlled studies of degradation of eDNA in natural river water.

Development of Molecular Markers for Asian Carp

- USGS initiated studies to design, test and validate qPCR assays from the Silver Carp and Bighead Carp mitochondrial DNA genome to span multiple rapidly degraded sites to develop markers useful for tracking live fish.
- Microbial source markers were investigated for potential inclusion into surveillance program in an effort to track live fish.
- Mitochondrial DNA of fishes native to Upper Mississippi River whose mitochondrial DNA sequences are underrepresented in GenBank continued to be sequenced.

- USGS developed a new pan-Asian carp LAMP assay that detects all 4 species of Asian carp for the portable eDNA detection kits.

Development of Emerging Technologies for Asian Carp Detection and Control

- Studies evaluating eRNA as an alternative signal for tracking live fish were continued.
- USGS evaluated data from the use of the portable detection device by law enforcement.
- USGS continued to develop next-generation sequencing protocols to analyze composite water samples, plankton tows, and ichthyoplankton tows for species composition/richness determination, Silver Carp and Bighead Carp biomass, spawning events/locations, etc.
- A probabilistic model was investigated for eDNA to inform of live fish.

Application of eDNA Technologies to Black Carp Detection

- USGS initiated development of a LAMP assay for Black Carp.
- USGS initiated development of a sampling protocol for Black Carp.
- USGS initiated genome and transcriptome sequencing of Black Carp.
- Laboratory studies of the relationship between biomass and eDNA shedding rate in Black Carp were initiated.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Black Carp were initiated.

Application of eDNA Technologies to Grass Carp Detection

- USGS initiated development of a LAMP assay for Grass Carp.
- USGS initiated development of a sampling protocol for Grass Carp.
- USGS initiated genome and transcriptome sequencing of Grass Carp.
- Laboratory studies of the relationship between biomass and eDNA shedding rate in Grass Carp were initiated.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Grass Carp were initiated.

Proposed Actions for FY2018

Development of Emerging Technologies for Asian Carp Detection and Control

- Technology will be transferred for the use of HTS protocols to USFWS or other management agencies in analyzing individual or composite water samples, plankton tows, or ichthyoplankton tows to correlate with species composition/abundance.
- USGS will conduct preliminary work required for the development of RNAi controls in a feed bait for Grass Carp in collaboration with other work covered by the microparticle template.
- Continue validation studies on the use of dPCR as an alternative to qPCR for quantifying eDNA.
- Initiate characterization of field-deployable qPCR technology for rapid assessment of Asian carp presence.

Development of Molecular Markers for Asian Carp

- USGS will begin to transition the use of species-specific microbial communities as a complement to eDNA to monitoring programs.

Characterization of eDNA from Silver Carp and Bighead Carp in the Field

- USGS will repeat sampling of upper Mississippi sites with a gradient of known relative population densities of Silver Carp and Bighead Carp, in collaboration with the Long-Term Resource Monitoring Program or in areas with commercial catch data, in order to characterize any changes in populations over time and evaluate impacts to native species.
- Analysis of land-use practices and carp population density and eDNA data will be completed.
- Initiate eDNA analysis of habitat usage and effectiveness of a Unified Method fishing effort at Creve Coeur Lake, Missouri.
- Initiate eDNA analysis to evaluate effectiveness of a microparticle field trial.
- USGS will initiate mesocosm studies of degradation of eDNA naturally shed from Bighead Carp of known biomass.
- Complete data analysis and publication of study comparing eDNA quantification with estimates of relative density in Missouri River tributaries and wetlands from side-scan sonar and traditional capture methods, to characterize habitat usage and fish movement.

Application of eDNA technologies to Black Carp Detection

- USGS will continue development of a LAMP assay for Black Carp.
- USGS will test and validate a sampling protocol for Black Carp.
- USGS will continue genome and transcriptome sequencing of Black Carp.
- Laboratory studies of the relationship between biomass and eDNA shedding rate in Black Carp will be analyzed.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Black Carp will be analyzed.
- Initiate method development for metabarcoding studies of Black Carp diet.

Application of eDNA technologies to Grass Carp Detection

- USGS will continue development of a LAMP assay for Grass Carp.
- USGS will test and validate a sampling protocol for Grass Carp.
- USGS will continue genome and transcriptome sequencing of Grass Carp.
- Additional laboratory studies of the relationship between biomass and eDNA shedding rate in Grass Carp over a greater range of biomass will be conducted.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Grass Carp will be analyzed.
- Parentage analysis on Grass Carp eggs captured in the Sandusky and Maumee Rivers. (requesting \$40,000 in addition to using \$40,000 from base to add this work)

Environmental DNA Database Work:

- Build eDNA database with functionality to upload data and link to other geographic data sets.

Potential Out-year Actions (Subject to Future Appropriations)

Development of Emerging Technologies for Asian Carp Detection and Control

- USGS will continue to assess the potential for RNA Interference technology to be developed for control of Asian carp.

- Synthetic biology may offer novel routes to effective and selective Asian carp control tools. USGS will work to remain abreast of developments in this field and evaluate opportunities as they arise.
- Publish studies on the use of dPCR as an alternative to qPCR for quantifying eDNA.
- Continue characterization of field-deployable qPCR technology for rapid assessment of Asian carp presence.
- Conduct testing of automated eDNA samplers for remote monitoring in real time at streamgages.
- The development of eRNA or nuclear markers and evaluate usefulness in captive tank or field samples known to contain presence recently introduced live fish will be completed.
- Evaluate use of attractants to enhance the sensitivity of eDNA detection in areas where Asian carp are rare.

Development of Molecular Markers for Asian Carp

- USGS will continue to transition the use of species-specific microbial communities as a complement to eDNA to monitoring programs.
- Quantitative PCR assays for rapidly degraded sites on the mitochondrial DNA genome will be validated.
- Further optimization of high-throughput sequencing methods for eDNA surveillance and rapid detection in ichthyoplankton tow samples.
- The development of qPCR assays from Silver Carp and Bighead Carp DNA that span multiple restriction site regions of interest in an effort to develop markers useful for tracking live fish will be completed.
- Quantitative PCR assays for rapidly degraded sites on the mitochondrial DNA genome will be designed and validated.

Characterization of eDNA from Silver Carp and Bighead Carp in the Field

- USGS will continue sampling of upper Mississippi sites with a gradient of known relative population densities of Silver Carp and Bighead Carp, in collaboration with the Long-Term Resource Monitoring Program or in areas with commercial catch data, in order to characterize any changes in populations over time.
- Analyze eDNA data on habitat usage and effectiveness of a Unified Method fishing effort at Creve Coeur Lake, Missouri.
- Analyze eDNA data on effectiveness of a microparticle field trial.
- Analyze mesocosm studies of degradation of eDNA naturally shed from Bighead Carp of known biomass.

Application of eDNA technologies to Black Carp Detection

- USGS will continue development of a LAMP assay for Black Carp.
- USGS will continue genome and transcriptome sequencing of Black Carp.
- USGS will support efforts to develop Black Carp baits and potential molecular control measures compatible with baits, including RNAi.
- Laboratory studies of the relationship between biomass and eDNA shedding rate in Black Carp will be published.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Black Carp will be published.
- Continue metabarcoding studies of Black Carp diet.

- Mesocosm studies of eDNA shedding rates in Black Carp will be initiated.

Application of eDNA technologies to Grass Carp Detection

- USGS will continue development of a LAMP assay for Grass Carp.
- USGS will continue genome and transcriptome sequencing of Grass Carp.
- Additional laboratory studies of the relationship between biomass and eDNA shedding rate in Grass Carp over a greater range of biomass will be analyzed and published.
- Laboratory studies of the relationship between food type and eDNA shedding rate in Grass Carp will be published.
- Mesocosm studies of eDNA shedding rates in Grass Carp will be initiated.

Environmental DNA Database Work

- Maintain eDNA database.
- Optimize database queries, add additional queries as needed.
- Automate pipeline for loading sequenced data into database.
- Create geographic visualization tool of sample/species occurrences.
- Generate automatic reports to flag occurrences of specific sequence occurrences.
- Create graphic visualization of species data, combine with flow and volume data if possible.

Expected Milestones

- Establishment of HTS protocols to assist in answering management questions above and beyond the presence of eDNA that hinge on fish movement, spawning events, fish abundance, etc.
- Expansion of the species detected with use of the portable eDNA detection kit.
- Use of eDNA to help inform control technologies. (incrementally each fiscal year)
- Transfer technological and methodological advancements to monitoring programs. (incrementally each fiscal year)

What Is Deliverable for this Funding

- Technology transfer to rapidly evaluate ichthyoplankton tows using high-throughput sequencing.
- Technology transfer of microbial source tracking methods for Asian carp.
- Publication of Grass Carp and Black Carp shedding rates.
- Technology transfer of portable eDNA detection kits for detecting Asian carp rapidly in the field.
- eDNA database developed.

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.

17. Telemetry and Telemetry Database

Lead Agency(s): USFWS and USGS

Agency Collaboration: USACE, Illinois DNR, Southern Illinois University-Carbondale (SIUC) and Illinois DNR

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested*		
	USGS	USACE	USFWS	USACE	USGS	USFWS
FY2018	\$197,250²	\$200,000¹	-	-	\$466,000²	\$200,000³

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

¹USACE Telemetry Monitoring Plan

²USGS Telemetry Monitoring Plan

³USFWS Telemetry Monitoring Plan

*Illinois DNR costs included in another project template.

Project Explanation

This template incorporates efforts within the Illinois River for FY2018 and beyond being completed by USFWS, USACE, USGS, Illinois DNR, SIUC, and Illinois DNR.

The following projects are included in this template:

- Subproject 1. USACE Telemetry Monitoring Plan
- SubProject 2: USGS Telemetry Monitoring Plan
- SubProject 3: USFWS Telemetry Monitoring Plan

USACE will continue the work in assessing the efficacy of Barriers IIA and IIB, and permanent Barrier I. New efforts will combine the historical acoustic telemetry monitoring with alternative monitoring systems at the barrier site such as hydroacoustics. Downstream activities will focus on inter-pool movement across the Brandon Road Lock and Dam and finer scale movement detection of Asian carp within the Dresden Island Pool. Also, combining the existing USACE receiver array with the new receiver arrays established by SIUC and USFWS will allow monitoring the long-term movement of Asian carp in the entire IWW, including localized movements through lock structures and at the area of the population’s leading edge.

USGS will deploy and maintain existing and planned main stem focused arrays. USGS and its partners will also deploy off-channel area focused arrays (including real time and passive receivers) and, conduct active tracking of Asian carp to better understand lateral movements and habitat use in the Illinois River system, and to incorporate this understanding into a decision support system for managers and commercial fishers. In 2018 USGS will:

- Install additional real-time receivers in the upper Illinois River at key removal areas and bring them online for use by Illinois DNR removal crews

- Tag additional fish, redeploy and maintain receivers in Starved Rock Pool
- Deploy 10 geotags on Asian carp in Dresden Island Pool to monitor movements and habitat use
- Conduct manual tracking of Asian carp in the Starved Rock and Dresden Island reach of the upper Illinois River.

USFWS will continuation efforts looking at the habitat use and movement of juvenile Asian carp and related to the Glover-Kallis model. Continued telemetry of small Asian carp will continue in 2018, as an effort to gather more data on habitat usage and movement to improve monitoring upstream of Peoria reach with the aim to have 100 to 150 tagged fish throughout the year. In addition, Asian carp collected that measure 300-500mm will be tagged. USFWS will also tag up to 150 adult and juvenile Asian carp centered in and around the Starved Rock Pool.

Illinois DNR will undertake telemetry efforts to gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams). Illinois DNR will deploy 100 tags into Alton and La Grange reaches. To continue to improve movement probability estimates among the river reaches, tagged Asian carp are needed in all reaches. Most of the tags that had been in Alton and La Grange reaches expired this year or will expire early next year. Therefore, this project will replace these expiring tags and allow continued data collection on passages through the two most downstream Illinois River dams. The project will also provide data that could be used in the future when movement among river basins is estimated. In 2018, Illinois DNR will share data through a telemetry and model development working group. In addition, Illinois DNR will be assisting other partners. Details of this effort are included in other templates.

This collective effort will give biologists a better understanding of more large-scale movement of large and small Asian carp.

Below are the individual agencies project descriptions.

Subproject 1. USACE Telemetry Monitoring Plan

Lead Agency: USACE

Agency Collaboration: USFWS, USGS, SIUC, Illinois DNR

Project Explanation

USACE has led telemetry efforts in the CAWS since 2010 with a primary objective of assessing the efficacy of the barriers as identified in the ACRC Monitoring and Response Plan. 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 fish passage in the upstream direction. This funding request is to continue the work in assessing the efficacy of Barriers IIA and IIB, and permanent Barrier I. 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, combining the existing receiver array established by USACE with the new receiver arrays established by SIUC and USFWS will also be able to monitor long term movement of Asian carp in the entire IWW,

including localized movements through lock structures and at the area of the population's leading edge. Future downstream activities will focus 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

Since 2010, USACE researchers have successfully established an acoustic network of receivers positioned at a minimum of 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 barrier fields from 2011 through 2016. Transmitters have been surgically implanted into 607 fishes which were released throughout the system. Mobile tracking and receiver downloads have occurred 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 Monitoring and Response Plan annual summary report.

FY2017 Actions

- Winter receiver network was recovered and full receiver network was deployed.
- Receiver downloads were completed every other month throughout FY2017 with monthly summaries provided to the MRWG for distribution.
- Transmitter surgeries were successfully completed 3rd Quarter FY2016 and 1st Quarter FY2017 in surrogate species (Common Carp) within the Lockport and Brandon Road Pools and Asian carp (Bighead and Silver Carp) within the Dresden Island Pool.
- Coordination occurred between USACE, USFWS and SIUC in deployment of receivers to integrate the three telemetry networks.
- Real-time receivers implemented above the Barriers and within Brandon Road Pool.
- Participation in the Telemetry Workgroup for MRWG Support.
- Support of the Unified Fishing Method in the Dresden Island Pool.
- 2017 Interim Summary report completed.
- 2018 Monitoring and Response Plan for Telemetry developed.

Proposed Actions for FY2018

- Continued monitoring of tagged fishes within the study area.
- Supplemental transmitter surgery implants to maintain transmitter densities.
- Integration of hydroacoustic monitoring at the dispersal barriers.
- Continued range testing and habitat mapping throughout the focus area.
- Real-time receiver monitoring above the Barriers and Brandon Road lock.
- 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 IWW in cooperation with SIUC.

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.
- Continued range testing and habitat mapping throughout the focus area.
- Include year two of surrogate comparison study in the Upper IWW.
- Conclude 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 2nd Quarter each fiscal year. Monitoring specific to PB1 will be implemented concurrent to its commissioning.

Expected Milestones

- FY2018 Q1 – Winter breakdown of 2018 season and final data collection.
- FY2018 Q1 – Supplemental surgery implants of transmitters.
- FY2018 Q2 – Annual Interim Summary Report to the MRWG.
- FY2018 Q3 – Spring set up of 2019 season and winter downloads.
- FY2018 Q4 – Establish Vemco Positioning System Surrounding PB1.

What Is Deliverable for this Funding

- Real-time updates and alarms for tagged fish passage at the Electric Dispersal Barriers 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

Monitoring at the Electric Dispersal Barriers and at the Brandon Road Lock and Dam will be required for the length of the projects or until such a time as Asian carp and other high risk invasive species are no longer a threat to the Great Lakes.

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.

SubProject 2: USGS Telemetry Monitoring Plan

Lead Agency: USGS

Agency Collaboration: USFWS, Western Illinois University, Southern Illinois University,
USACE

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. This complexity also makes it difficult to discern population and meta-population dynamics at appropriate scales to conduct population modeling necessary for decision support (e.g., with the Glover-Kallis Model). Acoustic telemetry to understand these complex lateral and longitudinal movements and habitat use by Asian carp can be useful for informing removal efforts, parameterizing population models for decision support, and even planning contingency actions for threshold movements (e.g., past barriers).

Existing and planned longitudinal (main stem focused) arrays will be deployed and maintained by SIU and USFWS, respectively, for the purpose of parametrizing the Glover-Kallis population model. USGS and its partners propose to deploy and maintain lateral (off-channel area focused) arrays (including real time and passive receivers) and conduct active tracking of standard acoustic- (VEMCO) and geo-tagged Asian carp to better understand lateral movements and habitat use in the Illinois River system, and to incorporate this understanding into a decision support system for removal. Better understanding lateral movement and habitat use including the environmental factors that influence these, will allow managers and commercial fishers to target appropriate areas in both upper and lower reaches of the Illinois River at appropriate times given the environmental conditions (e.g., flow, season, temperature) to maximize removal. This understanding of lateral movements and habitat use can come from real time telemetry, as can be obtained from geotags and strategically placed real time receivers for standard acoustic tags.

As well, active tracking and passive acoustic telemetry arrays designed to assess lateral movements and habitat use can further contribute to our understanding of these complex behaviors and inform removal. Real time and passive-array telemetry to assess lateral movements and habitats will also complement existing (SIU) and planned (USFWS) longitudinal (i.e., main channel-focused) arrays in the Illinois River to parametrize the Glover-Kallis population model for decision support. Because Asian carp likely spend as much time in lateral (off-channel) habitats as longitudinal habitats, and lateral habitats may be more conducive to acoustic signal detection at times, supplementing longitudinal arrays with lateral receiver placements will likely improve detection probabilities and thus more robustly discern important population model parameters (i.e., pool-to-pool transition and mortality estimates) as compared to longitudinal, mainstem-focused arrays alone.

USGS will also maintain an online database and visualization tool for all of the Asian carp-related acoustic telemetry data in the Illinois River collected by ACRCC partners in accordance with federal regulations concerning data collected using federal dollars. USGS in collaboration with partners will also summarize and analyze data from the telemetry database (from longitudinal and lateral arrays) to discern state-based movement histories, detection probabilities, pool-to-pool transition probabilities and survival estimates (i.e., conduct multi-state modeling)

needed to parameterize the Glover-Kallis population model. Finally, USGS will conduct analyses on existing and planned longitudinal telemetry array and fish tagging data to optimize these arrays for detections to improve population model parameters and control and containment efforts.

Summary of Actions to Date

- Real time telemetry in Illinois River to inform contingency actions and removal (USGS, Illinois DNR, USACE, other sub-basin partners).
 - Installed three real time receivers in the Illinois River in 2016.
 - Installed one real time receiver in the Sandusky River (Ohio) in 2016.
 - Developed online application to view data from real time receivers 2016.
- Telemetry database and visualization (USGS, Illinois DNR, USFWS, USACE, other sub-basin partners).
 - Released alpha and beta online database and visualization tools for input from partners in 2016.
 - Initiated partner discussions on data sharing agreements.
- Lateral movements and habitat (USGS-WIU-SIU).
 - In Starved Rock Pool to inform removal (USGS-SIU).
 - Tagged Bighead and Silver Carp in Starved Rock Pool in fall 2016.
 - In upper Pools in the Illinois River (Starved Rock-Dresden Island Pools) with geotags and manual tracking to inform removal (USGS-WIU).
 - Tested prototype geotags (v1.0) without satellite capabilities in ponds and in the Dresden Island pool in 2015.
 - Began manual tracking of previously tagged Asian carp in the upper Pools to inform control and compare with geotagged Asian carp in 2016.
- Longitudinal movements to inform controls and population modeling in the Illinois River (USGS, SIU, USACE, USFWS).
 - In 2016, compiled hydrological data for navigation dams (LG to BR) on the Illinois River to be used in analysis to evaluate Asian carp dam passage.

FY2017 Actions

- Real time telemetry in Illinois River to inform contingency actions and removal (USGS, Illinois DNR, USACE, other sub-basin partners).
 - Installed three additional real-time receivers in the Illinois River and brought them online.
 - Established automated alert system for detections of tagged Asian carp in strategic locations for input into contingency actions.
 - Monitored, maintained and downloaded data from real time receivers and provided timely summaries to removal crews and other partners.
 - Conducted range testing of receivers under high and low water conditions to establish detection capabilities and limitations.
- Telemetry database and visualization (USGS, Illinois DNR, USFWS, USACE, other sub-basin partners).
 - Transferred beta database and programing to UMESC.
 - Further developed beta visualization tools and data upload/download functions.
- Lateral movements and habitat use to inform removal.

- Lateral habitat in Starved Rock Pool to inform removal (USGS-SIU).
 - Tagged additional fish, deployed receivers, sampled environmental variables weekly, presented preliminary results at AFS.
- Lateral habitat in upper Pools (Starved Rock and Dresden Island) in the Illinois River with geotags and manual tracking to inform removal (USGS-WIU).
 - Tested five prototype geotags (v1.1) with satellite capabilities in the Dresden Island pool.
 - Conducted manual tracking of Asian carp in the Starved Rock and Dresden Island reach of the upper Illinois River to inform removal efforts and compare to geotagged fish behavior.
 - Provided updates to removal crews and other partners.
- Longitudinal movements to inform controls and population modeling in the Illinois River (USGS, SIU, USACE, USFWS).
 - Analyzed hydrological data to determine historical open river conditions on Illinois River dams (Starved Rock and Brandon Road) .
 - Initiated analysis on longitudinal movements of telemetered Asian carp in relation to hydrological conditions.

Proposed Actions for FY2018

- Real time telemetry in Illinois River to inform contingency actions and removal (USGS, Illinois DNR, USACE, other sub-basin partners).
 - Install three additional real-time receivers in the upper Illinois River at key removal areas and bring them online for use by Illinois DNR removal crews.
 - Monitor, maintain, test and download data from real time receivers and provide timely summaries and alerts to removal crews and key decision makers.
- Telemetry database and visualization (USGS, Illinois DNR, USFWS, USACE, other sub-basin partners).
 - Debug issues identified in beta version.
 - Establish function for online data uploads/downloads by partners to UMESC server.
 - Release Version 1.0 of database to partners.
 - Present database functionality to MRWG telemetry working group.
 - Develop final data sharing agreements with partners.
 - Develop code to extract individual Asian carp state-based movement histories from the telemetry database for parameterizing Glover-Kallis population model.
- Lateral movements and habitat use to inform removal.
 - Lateral habitat in Starved Rock Pool to inform removal (USGS-SIU).
 - Tag additional fish, redeploy and maintain receivers as needed, sample environmental conditions weekly, report out preliminary findings to removal crews and other partners.
 - Lateral habitat in upper Pools (Starved Rock and Dresden Island) in the Illinois River with geotags and manual tracking to inform removal (USGS-WIU).
 - Deploy 10 geotags (v1.2) on Asian carp in Dresden Island Pool to monitor movements and habitat use.
 - Share geotag phone application for Asian carp locations with Illinois DNR fish crews to inform removal.

- Conduct manual tracking of Asian carp in the Starved Rock and Dresden Island reach of the upper Illinois River to inform removal efforts and compare to geotagged fish behavior.
- Longitudinal movements to inform controls and population modeling in the Illinois River (USGS, SIU, USACE, USFWS).
 - Complete analysis and writing for study of longitudinal movements of telemetered Asian carp in relation to hydrological conditions in the Illinois River.
 - Conduct analyses on available Asian carp telemetry data to optimize receiver placement and tag numbers for the longitudinal array used to parametrize the Glover-Kallis population model.
 - Initiate the development of a multi-state model that incorporates state-based movement histories derived from the telemetry database (above) for parameterizing Glover-Kallis population model.

Potential Out-year Actions (Subject to Future Appropriations)

- Real time telemetry in Illinois River to inform contingency actions and removal (USGS, Illinois DNR, USACE, other sub-basin partners).
 - Install additional, or redeploy existing, real time receivers in the Illinois River at key removal areas and bring them online for use by Illinois DNR removal crews.
 - Monitor, maintain, test and download data from real time receivers and provide timely summaries and alerts to removal crews and key decision makers.
- Telemetry database and visualization (USGS, Illinois DNR, USFWS, USACE, other sub-basin partners).
 - Add functionality based on partner feedback, add new data collected by receivers, continue to improve automated data Quality Control and upload functionality, conduct workshop to demo database and tools to full partnership
 - Continue maintenance of database to meet usability and security standards and add partner requested functionality as requested.
- Lateral movements and habitat use to inform removal.
 - Lateral habitat in Starved Rock Pool to inform removal (USGS-SIU).
 - Incorporate into Asian carp removal decision support system that displays model outputs of likely locations of Asian carp at given discharge, temperature and season (see Monitoring and Evaluation Template subsection on Life History and Decision Support).
 - Lateral habitat in upper Pools (Starved Rock and Dresden Island) in the Illinois River with geotags and manual tracking to inform removal (USGS-WIU).
 - Incorporate into Asian carp removal decision support system that displays model outputs of likely locations of Asian carp at given discharge, temperature and season (see Monitoring and Evaluation Template subsection on Life History and Decision Support).
 - Initiate and complete assessment of lateral movements and habitat use by adult Asian carp in the lower Pools of the Illinois River. Incorporate this information into Asian carp removal decision support system that displays model outputs of likely locations of Asian carp at given discharge, temperature and season.
- Longitudinal movements to inform controls and population modeling in the Illinois River (USGS, SIU, USACE, USFWS).

- Complete reporting and make recommendations on analyses to optimize receiver placement and numbers of tagged fish for the longitudinal array used to parametrize the Glover-Kallis population model.
- Complete the development of a multi-state model that incorporates state-based movement histories derived from the telemetry database for parameterizing Glover-Kallis population model.

Expected Milestones

- Real time telemetry.
 - A functional, but adaptable, real time telemetry network in the upper Illinois River to inform contingency actions and removal.
 - Additional receivers to compliment the current real-time telemetry network.
- Telemetry database and visualization tool.
 - A fully functional telemetry database and visualization system for archiving Asian carp telemetry by end of FY2018.
 - A fully functional telemetry database and visualization system that informs removal efforts and outputs state-based movement histories of individual fish that can be incorporated into a multi-state model to parameterize (i.e., detection probabilities, transition probabilities, and survival estimates) the Glover-Kallis population model.
- Lateral movements and habitat.
 - Peer reviewed manuscripts from individual lateral movement and habitat studies, and a decision support system on lateral movements and habitat use to inform removal in the upper pools (Starved Rock and Dresden Island) of the Illinois River.
 - Protocols and peer reviewed manuscript for using real time geotags to inform lateral and longitudinal movements, habitat use, and removal of adult Asian carp.
 - Peer reviewed manuscripts and decision support system on lateral movements and habitat use to inform removal in the lower pools (Alton to Peoria) of the Illinois River.
- Longitudinal movements.
 - Recommendations and peer reviewed manuscripts on optimal receiver placement within the longitudinal array and number of tagged Asian carp to robustly parametrize the Glover-Kallis population model in the Illinois River.
 - A multi-state model that incorporates state-based movement histories derived annually from the telemetry database to parameterize the Glover-Kallis population model.

Potential Hurdles

- Hiring.
- Procurement.
- Environmental conditions.

SubProject 3: USFWS Telemetry Monitoring Plan

Lead Agency: USFWS

Project Explanation

USFWS will have two projects related to telemetry in 2018. The first project is a continuation from FY2017 looking at the habitat use and movement of juvenile Asian carp and the second project will be related to the Glover-Kallis model.

Habitat Use and Movement of Juvenile Asian Carp in the Illinois River

The purpose of this study is to attempt to determine the movement range and preferred habitat characteristics of juvenile Asian carp using acoustic and radio telemetry in an effort to improve monitoring of juvenile Asian carp in the upper Illinois River. Current sampling strategies in the upper pools (Starved Rock to Lockport) focus mainly on backwaters and marinas in an effort to detect small Asian carp; however, there is little knowledge about the preferred habitat of juvenile Asian carp (less than 300mm TL) and preliminary results from 2016 indicate main channel usage by small fish. Telemetry will aid monitoring by knowing the quantity of time spent in each habitat area (residence time) during different seasonal river conditions. The movement characteristics and distances will also be calculated and will help to determine the danger of upstream migration of juvenile Asian carp. Temporally changing river conditions will be monitored and studied alongside juvenile Asian carp residence time and movement to see if trends exist. Following data collection and analysis of this telemetry study, sampling efforts to monitor the recruitment front of juvenile Asian carp can be tailored to focus more on areas similar to those where telemetered fish inhabit most frequently during particular river conditions. *(This project is further explained in the Illinois River Monitoring and Evaluation template, Action Item 14).*

Glover-Kallis Modeling Support

In addition to the juvenile Asian carp habitat project which is focused on tagging fish 300mm and below, USFWS will now 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. The additional work in support of the model will use Vemco V-9 tags which are 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.

Beginning in FY2018, crews will tag an additional 150 Asian carp in and around the Starved Rock Pool using Vemco V-16 tags. 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.

For more information on the Glover-Kallis model please refer to the Asian Carp Population Modeling template.

Summary of Actions to Date

During 2016, a total of 75 juvenile Asian carp were tagged in the Peoria reach using acoustic transmitters. Telemetered fish were monitored using 10 stationary hydrophone receivers deployed from Henry to Chillicothe, Illinois. Poor detection ability, high flow conditions, and too few receivers negatively affected the quantity of data collected. Only 40 of the 75 fish were

detected on the receivers following tagging. Still, 50% of the detections occurred in main channel habitats which was not expected based off of previous sampling efforts targeting small Asian carp.

FY2017 Actions

The telemetry study of juvenile Asian carp has been expanded from 2016. A total of 26 hydrophones have been in the Peoria reach since April, stretching from Hennepin downstream to Chilicothe, Illinois. Additionally, 10 radio telemetry monitoring stations have been set up in the Peoria reach, with the eventual goal of 13 stations deployed and spread from the Peoria Lock and Dam to the Starved Rock Lock and Dam, covering key points throughout the reach. Currently, 57 fish are tagged with acoustic transmitters, with a mean size of 320mm. Additionally, 14 fish have been tagged in the 300mm to 400mm size class using both radio and acoustic transmitters.

Efforts for the remainder of 2017 will focus on tagging the smaller size class of fish (120mm to 300mm), using both radio and acoustic transmitters when possible, and deploying the remaining radio telemetry stations. Acoustic telemetry data will be analyzed each year with the goal of using it to begin designating potential small Asian carp, “hot spots,” and fishing locations within other pools for different river conditions to improve effectiveness of monitoring in Starved Rock to Lockport reaches.

Proposed Actions for FY2018

Continued telemetry of small Asian carp will continue in 2018, as an effort to gather more data on habitat usage and movement to improve monitoring upstream of Peoria reach. Acoustic receivers must be removed from the river for winter due to ice conditions; however, radio monitoring equipment will remain year-round. The acoustic receivers will be re-deployed immediately following ice melt on the river. Tagging efforts will be conducted periodically throughout the 2018 field season in the Peoria reach with the aim to have 100 to 150 tagged fish throughout the year. In addition, Asian carp collected that measure 300-500mm will be tagged in support of the Glover-Kallis model in conjunction with this project.

USFWS will also tag up to 150 adult and juvenile Asian carp in support of the Glover-Kallis model in addition to the small Asian carp mentioned above. This effort will be centered in and around the Starved Rock Pool.

Potential Out-year Actions (Subject to Future Appropriations)

The small Asian carp (<300mm) telemetry aspect of this project can be expected to be completed near the close of FY2019 unless additional data is necessary to inform fishing efforts. The data will begin being used as soon as 2018, so additional data would only make fishing strategy predictions more accurate. Data gathered from this telemetry projects will also be used in other projects such as the Asian carp population model. Data needs to inform small Asian carp monitoring will continue to be assessed on a yearly basis.

Tagging of small Asian carp (less than 300-500mm) as well as juvenile and adult fish will continue through 2022. Up to 200 tags will be added each year to ensure that the level of tagged fish remains high.

Expected Milestones

- Acoustic telemetry data collected this year (2017) will be analyzed at the close of the 2017 field season. This data will be used to plan the random site locations and potential hot spots for small Asian carp monitoring in 2018.
- Radio gear will be at least 75% deployed by December 2017, including 25 to 50 fish tagged and 10 monitoring stations set up.
- Beginning in March 2018, the remaining gear will be deployed based on movements of tagged fish over winter.
- Fish tagging will also resume and acoustic telemetry gear will be re-deployed. The goal is to have 50 to 100 more fish tagged with acoustic and/or radio tags by July 2018.
- For information regarding what the additional tagged fish will be used for please refer to the Glover-Kallis Model template.

What Is Deliverable for this Funding

- Telemetry data will be analyzed following the 2017 field season and the 2018 field season and will be used to generate targeted sites for fishing the Starved Rock, Marseilles, and Dresden Island pools. This plan will be updated as more data is collected at the close of each field season. Telemetry results will be written up in a MWRG report and potentially a publication following the study.
- A plan for any telemetry effort in 2019 will be created following the 2018 analysis. Due to the nature of these fish tags lasting up to one year, this plan for 2019 will most likely be developed in a fluid manner during the 2018 field season as data is gathered and patterns are observed.
- At the end of every field season a final summary and report will be written, and the results presented at the annual MRWG meeting.

Expected Completion Date for Project

The small fish (less than 300mm) project is expected to be completed by the close of FY2019. This could change based on field work success and data needs. Following the 2018 field season and data analysis, the need for another field season will be assessed.

Tagging being completed in support of the Glover-Kallis model is scheduled to continue and will be reassessed at the end of every fiscal year to ensure that the project is providing the information desired and is still relevant.

Potential Hurdles

- The telemetry aspect of this project has similar environmental hurdles as monitoring.
- High flow conditions can result in equipment damage, poor fish detections, prevention of data acquisition, and prevention of field efforts.
- Similarly, high winds or extreme weather can damage radio telemetry equipment.
- Another potential problem with telemetry equipment is gear being stolen, vandalized, or tampered with. As of now there have been only a few issues, but this is always a concern.
- Lastly, the failure to catch or locate suitable sizes of fish to implant with tags has occurred in the past and can interfere with field efforts in the future. These issues are handled by communicating with other agencies working in the area to inform field efforts, inputting more fishing effort, or changing fishing locations.

18. Monitoring at the Electric Dispersal Barrier with Remote Sensing

Lead Agency: USFWS

Agency Collaboration: USACE, USGS

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested		
	USFWS	USACE	USGS	USFWS	USACE	USGS
FY2018	-	-	-	\$140,000	-	\$30,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

This project provides both a continuation of ongoing work and an extension in scope to investigations designed to assess the effectiveness of the Electric Dispersal Barrier System (EDBS). Previous and ongoing studies have monitored physical phenomena and observed fish behavior at the barrier system on many scales. Fish behavioral studies using DIDSON sonar technology, community wide fish density monitoring using mobile hydroacoustic surveys, and monitoring of various physical variables have been conducted during previous years. This project will consolidate these ongoing EDBS studies to provide management agencies with the most up to date information possible in a consolidated format. The USFWS will continue to conduct bi-weekly mobile hydroacoustic surveys at the EDBS throughout the year, DIDSON fish behavioral studies will be conducted by the USFWS if warranted due to barrier operational changes, and the USGS will continue monitoring of physical variables and commercial traffic patterns. Additionally, this project will support the pilot deployment of a stationary hydroacoustic fish monitoring system at the EDBS. This portion of the project will be conducted jointly by the USFWS and the USACE with the goal of providing real time information on fish presence/density to the barrier management team and the ACRC.

Summary of Actions to Date

- Monthly to bi-weekly hydroacoustic surveys have been conducted at the EDBS since 2013. These surveys serve to monitor the density and locations of large fish targets and inform the Asian Carp Monitoring and Response Work Group on the potential need for barrier clearing or fish removal actions.
- Seasonal hydroacoustic scans of the upper Illinois River pools have been conducted since 2015. The purpose of these surveys is to attempt to detect an increase in large bodied fish which could potentially be Asian carp as a complement to traditional sampling methods such as electrofishing and gill netting. Using these scans, biologists can determine the densities by season and can compare this information over multiple years.
- Shore based DIDSON sonar deployments, which provide data similar to an “acoustic camera”, have also been used since 2013 to understand how fish interact with the electric field under varying field conditions. For more info see: <https://www.fws.gov/midwest/fisheries/carterville/documents/DIDSON.pdf>

- During barge studies completed from 2015-2017, the USFWS deployed a prototype version of a fixed station hydroacoustic system at the EDBS over a two week period during the study. The data collected from that deployment will be used to refine the longer duration 2018 deployment.
- USACE/USGS have installed a surface velocity radar at the EDBS to assist in tracking canal flow velocities at the surface of the water column. This project seeks to quantify the risk for reverse flow events across the canal toward Lake Michigan at the EDBS directly.
- USACE/USGS have installed temperature and conductivity meters near the EDBS just downstream of the Romeoville Road Bridge. These meters provide a near real-time tracking system for important physical water parameters that may affect barrier effectiveness.

FY2017 Actions

- Mobile hydroacoustic barrier scans took place on a monthly to bi-weekly schedule throughout the year. Pool scans were conducted seasonally throughout the year.
- USFWS deployed a prototype version of a fixed station hydroacoustic system at the EDBS over a two-week period during August. The data collected from that deployment will be used to refine the longer duration 2018 deployment.
- In April 2017, the USGS installed a Hikvision day/night surveillance camera with motion detection on the west bank of the Chicago Sanitary and Ship Canal at the Electric Dispersal Barrier System near barrier IIB. The camera is triggered by vessels moving through the EDBS and records 30 seconds of video for each motion trigger.

Proposed Actions for FY2018

Mobile Hydroacoustic Surveys at the EDBS

Bi-weekly mobile hydroacoustic barrier surveys will continue to be conducted throughout the year. Surveys will also be conducted at the request of the Asian Carp MRWG. The results of these surveys will be communicated to the ACRCC in monthly reports on fish abundance and density at and near the EDBS.

Mobile Hydroacoustic Surveys Within the Upper Pools of the IWW

Bi-monthly mobile hydroacoustic surveys will continue to be conducted throughout the year. Surveys will be conducted in conjunction with SIU which will be scanning the lower pools of the Illinois River on the same schedule. The results of these surveys will be communicated to the ACRCC in monthly reports on fish abundance and density within each pool scanned by the USFWS.

Stationary Hydroacoustic Deployment at the EDBS

A stationary hydroacoustic monitoring system will be deployed at the EDBS from May 1 thru October 30, 2018. This system will collect data on the size, density, and locations of fish targets near the barrier constantly during the deployment period. The goals of this pilot deployment are to refine data collection and summarization techniques, address special challenges associated with deployment near the EDBS, and provide real time updates on the status of fish near the barrier to management agencies and the ACRCC.

Analysis of Commercial Traffic Patterns at the EDBS

In April 2017, the USGS installed a Hikvision day/night surveillance camera with motion detection on the west bank of the CSSC at the EDBS near barrier IIB. The camera is triggered by

vessels moving through the EDBS and records 30 seconds of video for each motion trigger. Manual review and analysis of these videos can provide the time and approximate duration of barge passages, the configuration and loading of the tows, and the direction of travel of the tows. Documentation and analysis of the commercial vessel traffic through the EDBS is critical to understanding the effectiveness of the EDBS and potential risk of barrier breaches by small fish through entrainment and return flows. Requested funding will support the continued operation and maintenance of the camera, video review, data compilation, and analysis of commercial vessel traffic at the EDBS from October 1, 2017 through September 30, 2018.

Operation and Maintenance of Physical Water Quality/Flow Sensors

Operation and maintenance of the surface velocity radar, temperature, and conductivity meters will continue through FY2018. Annual review of this data will be completed to provide yearly summaries for record. Additionally, any pertinent fluctuations in the data that may affect barrier effectiveness shall be communicated to the ACRCC/MRWG and barrier management agencies. Funding for this work is tracked through the Barrier O&M Template and a description is included here as it pairs well with the additional remote sensing gears deployed.

Potential Out-year Actions (Subject to Future Appropriations)

Continue monitoring and assessment of barrier effectiveness issues as they arise and as directed by the ACRCC.

Expected Milestones

FY2018 Q1: Project scoping and planning meetings completed. Define study objectives. Conduct mobile acoustic surveys.

FY2018 Q2: Complete deployment of the stationary hydroacoustic monitoring system. Analyze traffic data. Conduct mobile acoustic surveys.

FY2018 Q3: Field study operations. Conduct mobile acoustic surveys.

FY2018 Q4: Data Analysis, report generation, and conduct mobile acoustic surveys.

What Is Deliverable for this Funding

- Annual report describing project results.
- Monthly preliminary reports to update ACRCC on fish abundance and density changes.

Expected Completion Date for Project

FY2018 Q4

Potential Hurdles

- Logistics for stationary deployment.
- Potential for barge strikes to equipment.

19. Acoustic Deterrents for Asian Carp

Lead Agency(s): USFWS

Agency Collaboration: USGS, USACE

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested		
	USGS	USFWS	USACE	USGS	USFWS	USACE
FY2018	\$415,000	\$300,000	-	\$575,000	\$2,000,000	\$525,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

Currently, prevention of the movement of both Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*H. molitrix*), from the Illinois River into southern Lake Michigan relies on an EDDBS in the CSSC of the CAWS. Due to the electrical and mechanical properties of the EDDBS, its effectiveness is dependent on water quality and size of fish (i.e., small fish are less effected by the barrier); thus, supplemental deterrent systems are needed to increase the efficacy of the EDDBS and also to serve as stand-alone systems at strategic locations where Asian carp can move upstream through a lock chamber. In many areas, locks and dams act as structural deterrents to carp passage, but these structures also provide locations where additional deterrent measures can be established. To that end, increasing the number of deterrents would also create a “buffer zone”, where Asian carp are absent or in low numbers, thus providing greater confidence in their containment.

Significant work has been done to identify potential biological and physical deterrent techniques that discourage the movement of bighead carp and silver carp while allowing passage of native fish and shipping to continue. One candidate deterrent technique that has demonstrated effectiveness in laboratory and pond settings, is underwater sound. Previous studies have indicated that both Bighead and Silver Carp react negatively to sound. These studies have documented that Asian carp repeatedly respond to various underwater sound stimuli while many native fish species responded little to that same sound.

Building off of these studies and deploying large-scale experimental acoustic structures at critical passage points in the Ohio River and Upper Mississippi River basins will help managers understand the effectiveness of acoustic deterrents where Asian carp populations are established and will evaluate potential for the technology to be transferred and deployed in other locations to prevent upstream migration to the Great Lakes. For this large-scale deployment, underwater sound equipment will be installed at “pinch points” in the river system where Asian carp are only able to swim upstream through a lock chamber because the head height of the dam structure is impassable. Migration of fish is then confined to a single passage point and can be monitored with the use of telemetry and hydroacoustic equipment.

With the ultimate goal of developing long-term acoustic deterrents to prevent the upstream migration of Asian carp to the Great Lakes, the objectives here are multifaceted. First, we intend to use this technology as a deterrent by determining the optimal sound frequencies, sound pressure levels, and speaker design to repel Asian carp while preventing injury to native species. Second, we want to determine the efficacy of complex sound to contain, herd, and capture Asian carp. For both approaches, an ideal evaluation should assess these acoustic techniques in the field on motivated fish (spawning, feeding, etc.). Third, we need to critically evaluate the efficacy of this technology when deployed on a large scale where Asian carp are present, reevaluate the deterrent (both acoustically and biologically), and re-deploy/re-evaluate, as necessary. Finally, we will develop tools that allow for movement predictions based on L&D operations, array designs for new deployments, and long-term remote monitoring of fish and acoustic deterrent systems. 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.).

Summary of Actions to Date

Prior to 2015, experiments in labs and ponds were conducted on bighead carp using pure tones and 100hp boat motor recordings (historically referred to as “complex sound”) at USGS UMESC. Asian carp habituated to single pure tones quickly, but they continued to respond to a 100hp boat motor recording.

- In 2015, field-testing of underwater boat motor sound was completed at Morris, Illinois (IPM template, USGS) on Bighead and Silver Carp. Fish behavior was modified, but there was no significant difference between fish crossings with and without sound playing.
- Pond experiments using the underwater boat motor sound were conducted at USGS UMESC, using a sound pressure gradient to limit fish movement through a constructed channel.
- Additional habituation trials were conducted using the 100-horsepower boat motor sound at USGS CERC.
- In 2016, USGS and USACE identified sound as a control technology that is ready for larger-scale field-testing.
- In September 2016, a kick-off meeting was held at USACE Chicago office (LRC) with USGS, USACE, USFWS, USCG, USEPA, and Illinois DNR invited to participate in the planning of an acoustic field trial at Brandon Road lock and dam.

FY2017 Actions

Ponds/Lab Tests

- USGS completed tests of Asian carp hearing (auditory evoked potentials; AEPs) to determine high range hearing capabilities.
- USGS began refining the sound characteristics (i.e., frequency and decibels; SC) used to deter Silver and Bighead Carp based on the results from high range hearing tests for Asian carp.
- Conducted trials to determine the SC combination that will cause hair cell death, and possibly hearing damage to Bighead Carp.

- USGS implemented pond studies to further investigate the potential for Asian carp to habituate or acclimate to complex boat motor sounds, and to evaluate the effects of the 100-horsepower boat motor sound on native/resident fishes.
- USGS conducted trials to determine thresholds for hair cell death, and possibly hearing damage to Bighead Carp.

Field Tests

- USGS continued to test the effectiveness of acoustic stimuli for excluding Silver and Bighead Carp from preferred habitats and driving them to target locations for removal using boat motor sound by testing 100 horsepower boat motor sound at Emiquon Preserve.
- USGS performance tested small underwater speakers when exposed to various environmental conditions.
- USGS completed trials in the Spoon River to herd Asian carp.
- USGS and USFWS conducted trials in the Illinois River to determine efficacy of sound and electrofishing to increase catch in gill/trammel nets.

Acoustic Propagation Modeling for a Lock Approach

- USGS and USACE held a site visit and scoping meeting November 2016 at the Brandon Road Lock Approach (USACE/USGS). Study plan finalized May 2017.
- Bathymetry and depth-to-bedrock data was collected in the Brandon Road approach channel February 2017.
- Completed all permitting and/or regulatory requirements for deployment at Brandon Road lock approach March 2017.
- USACE and USGS deployed seven-day acoustic field trial at Brandon Road lock June 2017 by suspending speakers from research vessels in the Brandon Road approach channel and monitoring sound field produced.
- USACE analyzed acoustic, biological, and environmental data collected during field trial to develop quantitative sound propagation model of the study area. The model will inform designs at other locks.
- Project scoping meeting for Brandon Road Lock and Dam acoustic design in September 2017 at USACE Chicago office with USGS, USACE, USFWS, USCG, USEPA, and Illinois DNR invited to participate. FY2018 scope includes defining sound characteristics that deter Asian carp to refine the acoustic model for the design of acoustic deterrent arrays.

Proposed Actions for FY2018

Ponds/Lab

- Conduct auditory evoked potentials (AEPs) and follow-up behavioral tests on Black Carp and Grass Carp to determine efficacy of sound as potential deterrents for these fishes (USGS).
- Rapid screening of new sounds on Bighead and Silver Carp in the lab (USACE/USGS December-January 2018).
- Test newly screened, high deterrent potential sounds, specifically designed to deter Asian carp and limit impacts on native fishes, in ponds (USGS/USACE April-July 2018).

- Initiate development of planning and analyses tools for response of fish to acoustic fields (USACE/USGS).

Acoustic Propagation Modeling

- Finalize acoustic propagation model and report (USACE/USGS).
- Initiate 2-D predictive movement model of fish in response to sound using Brandon Road Lock and Dam as case study for use at other deployment sites (USACE/USGS).
- Host a workshop for lock and dam managers to brief them on acoustics and use of propagation model for their lock and dams (USACE January 2018).

Field (Multi-agency)

- Select a set of non-proprietary sounds to be used in the field to deter Asian carp (based on pond trials [see above]) and project in a field setting (USACE/USGS; June 2018).
- Test new sounds on wild/motivated fish in the Wabash River (USGS/USACE; June 2018).
- Parameterize sound propagation model (Brandon Road lock approach) with new sounds (USACE; June-September 2018).
- Collect necessary field parameters at locations desirable for large-scale field applications of acoustic deterrent arrays to reparameterize Brandon Road model for other locations (USGS/USACE).
- Compare the effectiveness of several different sounds to herd fish in tributaries with high densities of Asian carp (USGS).
- Compare the effectiveness of different herding techniques in tributaries by testing different capture gears, driving patterns, and stimuli (USGS).
- Support Illinois DNR contract efforts with herding tools when reasonable as requested, to further science, and facilitate the desired technology transfer to management agencies (USGS/USACE).

Large-scale Field Deployment Test

- Continue coordination among multi-agency science and evaluation team for large-scale experimental deployments at Barkley Dam (Cumberland River, Kentucky) (multi-agency) and other high priority site(s).
- Support second year of operational costs, agency coordination capacity, and equipment rental of acoustic deterrent system components at Barkley Dam. Proposed: Bio Acoustic Fish Fence (BAFF) technology speaker(s) for side discharge culvert.
- Initiate preliminary data and logistical information collection for additional high priority site(s). Some or all of the below tasks will be accomplished (multi-agency):
 - Collect bathymetry, substrate, water quality, and fish passage data from desired deployment locations (USGS, USACE).
 - Develop acoustic propagation model for site (USGS, USACE).
 - Develop design plan, including engineering review (USGS, USACE, USFWS).
 - Contract with appropriate vendors for acquisition of speaker equipment (USFWS, USGS).
 - Complete an assessment/monitoring plan (USFWS, USGS).
 - Develop long-term equipment maintenance, monitoring, and communication plan (USFWS, USGS).

Potential Out-year Actions (Subject to Future Appropriations)

- Engineer and install acoustic array at selected high priority site(s) (USGS, USACE, USFWS).
- Monitor and evaluate how large field-deployed acoustic deterrent systems function in areas that contain Asian carp present in high numbers (USFWS, USGS).
- Monitor and evaluate the installed arrays for potential impacts to native fishes (USFWS, USGS).
- Assess equipment/sound array ability over time (does the equipment function as desired?) (USFWS/USGS/USACE)
- Continue to evaluate the effects of newly recommended sounds (e.g., characteristics) on native fishes (USACE/USGS).
- Evaluate refined operating parameters for deterring Asian carp in a riverine environment (USACE/USGS).
- Model for predicting fish movement based on site specifications, array design, and local species (USACE/USGS).
- Evaluate the efficacy of sound propagation as a deterrent at field locations.
- Assess equipment/sound array ability over time (does the equipment function as desired?) (USFWS/USGS/USACE)
- Development of long-term remote performance monitoring of fish and acoustics to support federal and state agencies (USACE/USGS).
- Compare the effectiveness of several different sounds to herd fish in tributaries with high densities of Asian carp.
- Compare the effectiveness of different herding techniques in tributaries by testing different capture gears, driving patterns, and stimuli.
- Continue testing the best use of sound and other techniques for herding and capturing carp in tributaries (USGS, USFWS).
- Development of data portal that integrates acoustics (designs and SCs), fish, environment with operations for federal and state efforts (USACE/USGS).
- Initiate additional deployments at targeted locations as appropriate and coordinated among the interagency planning team (USFWS, USGS).

Acoustic Propagation Modeling

- USACE will provide a final acoustic propagation model for lock and dam approach channels report, including an acoustic deterrent array recommendation for Brandon Road Lock and Dam and guidance for designing acoustic deterrent systems using the sound propagation model and optimal deterrent sound(s) in other lock and navigation channels (USACE).
- USGS will provide a biological findings report informing the movement of fish in response to sounds tested in the field (USGS).
- USACE will provide an after-action report documenting the engineering feasibility and operating considerations needed to incorporate this technology into future USACE control actions (USACE).
- USACE and USGS will communicate results and information needed to transfer technology toward other acoustic implementations (USGS/USACE).

- Based on results of the effort, additional acoustic deterrent trials may be proposed at Brandon Road Lock and Dam or other locations to further test design and assess engineering and navigation feasibility (USACE/USGS.)

Expected Milestones

- Large-scale Field Deployment Test(s) Plan of Study (USFWS, USGS, USACE).
- Multi-agency completion of environmental compliance and permitting procedures for large field-test deployment of acoustic arrays.
- Acquisition of acoustic deterrent systems/arrays (USFWS, USGS – Spring/Summer 2018).
- Targeted installation of deterrent array(s) and initiation of evaluation protocols for large field-test deployments.
- Completion of field-testing with new deterrent sounds (August 2018).
- Update acoustic propagation model with new SC and biological results (September 2018).
- USACE acoustic propagation model for lock and dam approach channels report, including acoustic deterrent design guidance for lock and dam approach channels.
- USGS biological findings report or publication informing the movement of fish in response to sounds tested.
- USACE after action report documenting the engineering feasibility and operating considerations needed to incorporate this technology into future control actions.

What is Deliverable for this Funding FY2018

- Final Plan of Study for the Large-scale Field Deployment Test(s) (USFWS, USGS, USACE).
- Draft acoustic propagation model for lock and dam approach channels report December 2017, including preliminary acoustic deterrent array design, for Brandon Road lock approach using the acoustic model under current conditions (USACE).
- Complete full work plan for laboratory and other field testing (USACE, USGS).
- Additional sounds identified and tested for deterring Asian carp (USACE, USGS).
- Refined sound propagation model for designing acoustic deterrent systems in locks and navigation channels (USACE, USGS).
- Report and presentation outlining SCs that will cause hair cell death and possibly hearing damage to Bighead Carp (USACE, USGS).
- Report or publication on the potential for habituation to 100 horsepower boat motor sound in Bighead Carp (USACE, USGS).
- Report or publication detailing the effectiveness of herding strategies in tributaries with high densities of Bighead Carp (USACE, USGS).

Expected Completion Date for Project

Acoustic Propagation Modeling in Lock Approach (Brandon Road):

Lab and Field Studies: This is a highly integrated multi-agency and multi-discipline project. It is likely that aspects of this project will continue for many years as operating parameters for the

use of complex sound are continuously refined. As this technology moves to new locations, the effects of additional fish species will need to be examined to ensure minimal disturbance to native fishes. However, the majority of this project will move to the field setting by FY2019, with further evaluations of sound and model development for predicting effects will occur and integrated into the user community (i.e., deployment deterrent systems, if appropriate, will be upgraded with new knowledge and tools). As these systems become permanent structures, efforts will need to be undertaken to make them efficient to manage and remotely monitor biological activity.

Potential Hurdles

- Timeliness of speaker or telemetry procurement.
- Multi-agency communication and collaboration.
- Scaling of evaluated technologies to use in field trials.

20. Carbon Dioxide (CO₂)

Lead Agency: USGS

Agency Collaboration: USACE, USFWS, USEPA, USCG, Iowa DNR, Illinois DNR, University of Illinois, University of Wisconsin-Platteville

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested		
	USGS	USFWS	USACE	USGS	USFWS	USACE
FY2018	\$370,000	\$0	\$0	\$400,000	\$70,000	\$450,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

Carbon dioxide (CO₂) injected into water is being evaluated as a non-physical deterrent method for invasive Asian carps. Results from laboratory and mesocosm studies conducted by the USGS, USACE and University of Illinois have shown that Asian carps voluntarily avoided areas of elevated CO₂ when given the option to access other freshwater (untreated) areas. Strategic implementation of CO₂ at pinch-points of rivers (i.e. inside lock chambers) could deter Asian carps passage and reduce the risk of upstream movements and range expansion. Findings from previous research have been disseminated in several peer-reviewed publications in scientific journals.

FY2017 Actions

- Completed field evaluation of CO₂ to deter Asian carps near a water management structure at The Nature Conservancy's Emiquon Preserve near Havana, Illinois.
- Completed acoustic telemetry studies to identify the optimal CO₂ concentrations that deter Asian carps (Silver Carp and Grass Carp) in large outdoor ponds.
- Completed engineering designs and computational/physical evaluations of piping systems to deliver and disperse CO₂ and other control chemicals within lock chambers.
- Completed pond experiments to quantify CO₂ toxicity to Asian carps (Silver Carp and Bighead Carp).
- Completed dye study to characterize the mixing and flow characteristics of the auxiliary lock of Lock and Dam 14 to inform FY2018 field trials.
- Completed evaluations of behavioral switching between negative chemotaxis (CO₂ avoidance) and positive rheotaxis (upstream orientation and swimming).
- Obtained permissions from the USACE Rock Island District to conduct a field demonstration in FY2018 of a CO₂ fish deterrent system within the auxiliary lock of Lock and Dam 14 near Bettendorf, Iowa.
- USEPA Registration Division confirmed CO₂ field demonstration at the auxiliary lock of Lock and Dam 14 falls under the threshold requirement for an Experimental Use Permit (no EUP required).

- Published a journal article describing the effectiveness of CO₂ as an under-ice lethal control for non-native Grass Carp, common carp, Silver Carp and Bighead Carp (Cupp et al. 2017, Biological Invasions).
- Continue development of protocols, standard operating procedures, and supporting documentation in advance of registration and field allocation of CO₂ for control of Asian carp.

Proposed Actions for FY2018

- Complete registration of CO₂ as a lethal control or as a non-lethal fish deterrent with USEPA.
- Complete studies as needed to support the USEPA National Registration of CO₂ as a fisheries control chemical (deterrent and piscicide).
- Complete studies as needed to support USFWS Section 7 ESA requirements for CO₂ as a fisheries control chemical.
- Complete a water quality and hydrological model of CO₂ within USACE locks.
- Publish a journal article characterizing the effects of water temperature on Asian carp behavior in response to elevated CO₂.
- Publish a journal article characterizing the behavioral responses of Asian carps to a CO₂ gradient in outdoor ponds.
- Publish a journal article characterizing the toxicity of CO₂ to Asian carp.
- Publish a journal article describing CO₂ injection devices and piping designs for navigational locks.
- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of the use of CO₂ as a deterrent or the use of a CO₂ as a control agent in limited open-water application sites to control Asian carp.
- Continue development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO₂ for control of Asian carp.

Potential Out-year Actions (Subject to Future Appropriations)

- Temporarily install and operate a CO₂ fish deterrent system for research purposes at a site to be determined at a later date.
 - Obtain all necessary state and federal permits.
 - Operate CO₂ infusion system under simulated navigation scenarios.
 - Evaluate air quality, water quality, fish responses and various system operating parameters during system operation.
 - Evaluate the effects of CO₂ infusion on non-target species.
- Deliver a final study report describing the engineering, installation, costs, air quality, water quality and fish behavior associated with the implementation of a CO₂ fish deterrent system within a navigational lock.
- Assist management agencies with the deployment of CO₂ as an Asian carp deterrent
- Finalize development of protocols, standard operating procedures, and supporting documentation in advance of registration and field allocation of CO₂ for control of Asian carp.
- Develop and initiate safety and training programs and protocols for agency staff for implementation of control technologies in the field.

- Coordinate additional meetings with state and federal agency partners to identify opportunities for implementation of CO₂ as a control agent and, identify related requirements.
- Respond to USEPA or state regulatory agencies regarding the use of CO₂ as a deterrent or to register CO₂ as a control agent in limited open-water application sites.
- Complete field evaluation of CO₂ as a piscicide for Asian carp (work in this area tabled in FY2018 to devote all funding resources towards field deployment of CO₂ as a fish deterrent).
- Complete additional deterrent field trials focusing on lessons learned in FY2018 focusing on fish behavior.
- Deliver a final study report describing the field efficacy of CO₂ as an Asian carp lethal control.
- Initiate long-term barrier performance monitoring of fish and CO₂ at USACE lock using remote technology.
- Develop a strategy for management of multi-barrier interference to inform permanent barrier installation.

Timeline for Major Actions

- Field demonstration of a CO₂ fish deterrent system within a navigational lock.
- Develop CO₂ water quality model to assist with barrier performance analysis and receiving water body impacts. Model will use data collected by USGS to quantify operational aspects of CO₂ barriers related to efficacy, safety and economics.

Expected Milestones

- Field demonstration of a CO₂ injection systems at USACE infrastructure.

What Is Deliverable for this Funding

- Demonstration of technology at USACE infrastructure to deter the upstream movements of Asian carp.
- Report characterizing the effects of water temperature on Asian carp behavior in response to elevated CO₂.
- Report characterizing the behavioral responses of Asian carps to a CO₂ gradient in outdoor ponds.
- Report characterizing the toxicity of CO₂ to Asian carp.
- Report describing CO₂ injection devices and piping designs for navigational locks.
- Draft Standard Operating Protocols.
- Section 7-ESA consultation for demonstration site.

Expected Completion Date for Project

Completion date depends on management agency needs after completion of field demonstrations of CO₂ as an Asian carp deterrent

Potential Hurdles

- Engineering and operations challenges with installing an Asian carp deterrence barrier in an active navigational structure.

- Potential effects of carbon acid on control structures.
- Potential effects of CO₂ on non-target species due to non-selectivity.
- Start-up costs with permanent installations of CO₂ infusion systems.
- Identifications of CO₂ vendor to support registration as fisheries control chemical.
- Regulatory permitting.

21. Developing Species-Specific Control Systems for Asian Carp

Lead Agency: USGS

Agency Collaboration: USFWS, Indiana DNR, Missouri Department of Conservation, Purdue University, Viterbo University, Aquabiotics, University of Wisconsin – La Crosse, United States Department of Agriculture, University of Illinois, Southern Illinois University

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USGS	USFWS	USGS	USFWS
FY2018	\$780,000	-	\$600,000	\$70,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

No current technology can specifically target Asian carp for control within aquatic ecosystems. Available toxicants 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 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 currently available to natural resource managers. 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 and Bighead Carp 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 lab and pond studies, Silver Carp and Bighead Carp died following particle exposure while largemouth bass, 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 Asian carp and Gizzard Shad would be impacted from a microparticle application and demonstrating potential increased selectivity. Then, the first deployment of a toxic microparticle was conducted 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 (Silver Carp, Gizzard Shad, and River Carpsucker) 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 Bighead Carp. 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 four currently 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 the bony fishes and the other two, rotenone and antimycin, are piscicides that generally impact 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. We are currently using antimycin delivered through the microparticle to test specificity of the microparticle. We will work toward registering the use of microparticles to deliver antimycin as a new control tool.

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 has been identified 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 RNA interference (RNAi) to knock-down key processes for the survival of the animal. One advantage of CRISPR is that one can generate an inheritable trait that detrimental to the animal is rapidly spread via natural reproduction through a population using only a few animals. One can then use this trait to eradicate all animals of that population. However once released, this trait can easily be passed

from one population to another and ultimately become an “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 carp. 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 purchased 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 registration of a new piscicide. Novel tools used to mitigate a pest must complete a rigorous registration process before it may be used within integrated pest management control programs of state and federal natural resource agencies. Specifically, the registration component of this 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 Asian carp. Results from this project will include the development of comprehensive Standard Operating Procedures (SOPs) and institutional guidance for use by approved state or federal agencies when implementing the control agents in prevention actions. 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 control SOPs will serve as core components of the registration application documentation, and include protocols on safe transport, handling, storage, and dispersal of control agents and 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, NEPA and Migratory Bird Treaty Act compliance, and other regulatory requirements).

The USGS’s UMESC will provide regulatory affairs support to the USFWS in the development of biological and chemical pesticide controls of Asian 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 and other regulatory support as needed to attain and maintain chemical registrations of tools to control Asian carp. The UMESC will also develop specific data required to attain registration of microparticles to control Asian carp including studies to describe product chemistry, physical/chemical properties and USEPA Group A acute toxicity (acute oral, dermal, and inhalation toxicity, eye and dermal irritation, skin sensitization).

The USFWS will partner with USGS to complete the USEPA registration processes required for new toxicants under the Federal Insecticide, Fungicide, and Rodenticide Act, and lead development of the multiple SOPs for implementation of the control techniques. The USFWS will provide support in preparing any needed Section 7 consultations necessary to ensure that all actions taken regarding testing and implementation of Asian carp 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. The USFWS will prepare any necessary biological opinions, if consultation processes yield a finding of “likely to adversely affect” a listed species, and work with USGS and partners to prepare any needed incidental take permits or exemptions, if required under the ESA. The 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, the 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. The USFWS will serve as eventual registrant of Asian carp 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

Develop an Oral Delivery Formulation that Can Stabilize and Deliver a Control Agent to a Targeted Group of Fishes, Specifically Silver Carp, Bighead Carp, Grass Carp, and Black Carp

- A prototype to manufacture microparticles has been designed.
- A final formulation of a microparticle that contains antimycin-A was identified that: 1) holds the control agent (antimycin A); 2) is of the appropriate size (50-100 μm); and 3) is readily consumed by both Silver Carp and Bighead Carp.
- We found that Silver Carp and Bighead Carp have higher levels of the protease trypsin and higher levels of phosphatases than that in Gizzard Shad or Bigmouth Buffalo. These enzymes could be used as a potential release mechanism for the control agent.
- Silver Carp were found to actively feed earlier in the year when native fishes are not feeding. This may be a time of the year for application of a microparticle to increase specificity for Silver Carp and Bighead Carp.
- USGS staff were able to kill both Silver Carp and Bighead Carp with microparticle, while having minimal mortality in Largemouth Bass and Bluegill in controlled laboratory studies.
- USGS staff were able to kill both Silver Carp and Bighead Carp with microparticle without killing any Largemouth Bass in pond studies.
- Completed laboratory exposure to determine the dosage and ingestion rate of microparticles to deliver antimycin to Asian carp using an yttrium laden particle as an indicator. This test provided data on the best application rate of microparticles and the quantity that needs to be ingested to induce mortality. The food attractant was used in order to ensure ingestion of the microparticle.
- Continued to conduct pond studies integrating the use of a feeding ring with food attractants and microparticle treatments to inform field applications for Asian carp.
- A manuscript describing the digestive enzymes in Silver Carp and Bighead Carp has been accepted with revisions in Ichthyological Research.
- Methods have been developed to use metagenomics to assess blue-green algae consumption by Silver Carp and Bighead Carp.
- Conducted the first field assessment of microparticles at Arrow Rock National Wildlife Refuge using inert microparticle. This study was conducted to determine potential

impacts of antimycin-latent microparticles. Results suggest that microparticles will selectively deliver antimycin to Bighead Carp, Silver Carp, and Gizzard Shad. (This action is linked to the Chemical Attractant template)

- Conducted first field trial with antimycin-latent microparticle in backwater to the Wabash River near Lafayette, Indiana. Silver Carp, Gizzard Shad, and River Carpsucker were found to consume the microparticle and die. None of the other 20 or more species found in the study area were impacted from the microparticles. (This action is linked to the Chemical Attractant template)

Identification of a New Control Agent with Specificity Toward Cyprinids, Especially Silver Carp, Bighead Carp, Grass Carp and Black Carp

- Cell lines for Silver Carp and Bighead Carp have been established.
- Cytotoxicity protocols for new piscicides have been identified.
- We developed and published a chemical database of potential piscicides.
- Structure Relationship Models (SARs) have been developed to identify new chemicals that may be highly toxic to fish and chemicals that may have selective toxicity toward cyprinids.
- Two chemicals have been identified to be more toxic to cyprinids.
- A metabolomic study was conducted and has been published in *Chemosphere*. This type of study helps to identify the mode-of-action (MOA) of toxic chemicals and improve SARs models to predict toxicity.
- Largemouth Bass Virus is more virulent to both Silver Carp and Bighead Carp cells than Bluegill cells.

FY2017 Actions

Develop an Oral Delivery Formulation that Can Stabilize and Deliver a Control Agent to a Targeted Group of Fishes, Specifically Silver Carp, Bighead Carp, Grass Carp, and Black Carp

- Two field assessments of microparticles were conducted. This included population assessments pre- and post-exposure. One study determined the potential impacts of microparticle application and the second to actually test the application antimycin-latent microparticles with feral fish. (*This action is linked to the Chemical Attractant template, Action Item 25.*)
- Determined that Silver Carp are much more active feeders at night.
- Discussion have been initiated on the potential deployment of antimycin-latent microparticles at Hansen Lake 2 near Omaha Nebraska.
- Consulted with USFWS, USEPA and state regulatory agencies (particularly Indiana DNR and the Office of Indiana State Chemist) to conduct field studies with antimycin-latent microparticle.
- Developed a bait formulation to selectively target the delivery of antimycin to Grass Carp.
- Identified *Streptomyces* strains and production methods for the production of antimycin. Improvements in production and efficiency are needed prior to mass production. Material Transfer agreements have been established so the UMESC can work with the strain that has produced the global supply of antimycin.

- Discussion has been initiated with Dr. Patrick Mills (Joliet Junior College) on the potential development of a bait formulation that will elicit an involuntary feeding response in Asian carp. (*This action is linked to the Chemical Attractant template, Action Item 25.*)

Identification of a New Control Agent with Specificity Toward Cyprinids, Especially Silver Carp, Bighead Carp, Grass Carp and Black Carp

- Screened through potential new control chemicals using cytotoxicity trials and then conduct *in vivo* assays with only those chemicals that demonstrate selectivity.
- Continued to conduct metabolomic studies to identify the MOA for various classes of chemicals so we can refine our models to identify new piscicides.
- Initiate studies to identify genetic-based controls, specifically RNA interference (RNAi) at critical development stages for Grass Carp.
- Collected tissues for RNASeq analysis for Grass Carp so that targets for RNAi can be designed and tested.

Proposed Actions for FY2018

Develop an Oral Delivery Formulation that Can Stabilize and Deliver a Control Agent to a Targeted Group of Fishes, Specifically Silver Carp, Bighead Carp, Grass Carp, and Black Carp

- USGS will publish results from laboratory, pond and field trials for microparticles as a control for Asian carp.
- USGS will conduct multiple field trials with toxic particles at a location with Bighead Carp to verify specificity to Asian carp since they were not present at the location along the Wabash River where the first field assessment of microparticles was conducted.
- USGS will conduct multiple field trials to initiate the Standard Operating Procedure (SOP) required for registration of the microparticle.
- USGS will refine the production of antimycin.
- USGS will conduct a webinar on the development and status of the microparticles and other species-specific control tools.
- USGS will initiate the application of microparticles as part of a management action.
- USGS will initiate the registration of microparticles as a delivery tool for antimycin.
- USGS will conduct laboratory and pond trials to assess efficacy of the Grass Carp-specific bait.
- USGS will determine the effective range of the algal attractant, which will allow us to develop a protocol that maximizes the efficiency of microparticle delivery.
- USGS will assess the use of bait to improve capture efficiency.
- USFWS will coordinate submission of studies to address Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles with USGS.
- USFWS will complete registration review with USEPA to determine registration data requirements of antimycin incorporated microparticles in limited open-water application sites in conjunction with USGS.
- USFWS, in partnership with USGS, will develop and initiate safety and training programs and protocols for agency staff for implementation of control technologies in the field.

- USFWS will initiate acquisition of materials and equipment needed for field implementation of microparticles at select site(s) that are yet to be determined.
- USFWS will work with USGS to prepare and submit required documentation to serve as the agency registrant for the microparticles.
- USFWS will coordinate meetings with state and federal agency partners to identify future opportunities for implementation of microparticles in support of Asian carp prevention strategies (for implementation following approval and registration).
- USFWS and USGS will respond to USEPA and state regulatory agencies for review of data submitted to register antimycin-incorporated microparticles.
- Both USFWS and USGS will respond to USFWS review of data submitted to address Section 7 ESA-consultation of antimycin-incorporated microparticles.

Identification of a New Control Agent with Specificity Toward Cyprinids, Especially Silver Carp, Bighead Carp, Grass Carp and Black Carp

- Screen potential new control chemicals.
- USGS will continue to conduct metabolomic studies to identify the MOA for various classes of chemicals so we can refine our models to identify new piscicides.
- USGS will initiate studies for the registration of at least one new piscicide.

Potential Out-year Actions (Subject to Future Appropriations)

- Assist management agencies that plan to deploy antimycin-latent microparticles to control Asian 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 control tool.
- Review environmental fate studies of antimycin-incorporated microparticles.
- Assess registration requirements of biologically-derived controls of Asian carp.
- 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 Asian 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 Asian carp.
- 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 prevention strategies (for implementation following approval and registration).
- Assess registration requirements of alternative active ingredients for control of Asian carp.
- 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.

Expected 2018 Milestones

- Webinar on the status of species-specific control will be conducted by the end of January.
- First field trial will be conducted in early spring, Subsequent field trials will be conducted at sites throughout the year.
- Contracts of registration studies will be awarded by January.
- Initial studies for the registration of antimycin-latent microparticle will be completed by September.
- Submit 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.
- Determination of USEPA registration and Section 7 ESA-consultation data requirements for antimycin-incorporated microparticle registration (June).
- Acquisition of Experimental Use Permits to allow experimental use of antimycin-incorporated microparticles in limited open-water application sites to control Asian carp (September).

What Is Deliverable for this Funding

- Webinar on the status of species-specific control will be conducted.
- Protocol for the mass production of antimycin.
- Submit 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.
- Draft Standard Operating Protocols and guidance documents.
- Section 7-ESA consultation for proposed application site(s).
- Submission of USEPA registration application package (Section 18 Permit).

Expected Completion Date for Project

- The development of microparticles as an oral delivery tool will be completed in 2018. However, studies on the registration of the control agent will likely need to continue.
- A new piscicide will be identified by 2019. Once the chemical has been identified, we will initiate registration of the chemical as a piscicide.
- New necromone or modified pheromone antagonists will be identified by 2019. Once the chemical has been identified, we will initiate registration of the chemical as a behavioral deterrent.

Potential Hurdles

- Obtaining access to candidate fish toxicants from private chemical libraries.
- Establishing contracts to produce the quantity of antimycin-A.
- Potential impacts of antimycin on non-target species due to non-selectivity.
- Regulatory permitting.

22. Barge Entrainment

Lead Agency: USFWS

Agency Collaboration: USGS, USACE, USCG

Funding Table:

Funding	Agency Funding			Asian Carp GLRI Funding to be Requested		
	USFWS	USGS	USACE	USFWS	USGS	USACE
FY2018	\$300,000	-	-	\$500,000	\$100,000	\$100,000

*\$100,000 early request for funding.

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

This project allows for final further work regarding the behavior of Asian carp in barge junction gap spaces and also assesses potential distances Asian carp may be transported within barge junction gaps, as well as, the investigations and reporting of barge entrainment and fish interaction studies conducted during 2017. This study, and similar efforts in 2015 and 2016, showed that freely swimming small fish could become entrained within barge junction gap spaces and subsequently transported upstream. Surrogate fish were transported upstream through the EDDBS, through upstream lockage operations, and over long distances (9.6 river miles). The proposed work for FY2018 aims to complete analyses of and reporting on the 2017 mitigation studies for both entrainment and non-entrainment pathways for fish passage of the EDDBS associated with transiting of commercial barge tow traffic. Additional work entails risk assessment modeling of Asian carp egg and larval stage entrainment in the lower IWW building upon the existing FluEgg model, historical ship tracking data, and lessons learned from 2017 field trials of Silver Carp entrainment. The only field trials to be completed in 2018 are based on additional work with small Silver Carp entrainment in the lower pools of the Illinois River.

Summary of Actions to Date

2015 Barge Entrainment Studies

During 2015, an interdisciplinary team from USFWS, the USGS, and the USACE investigated the potential for entrainment, retention, and transport of freely swimming fish within large gaps (50 meters³) created at junction points between barges. Modified mark and capture trials were employed to assess fish entrainment, retention, and transport by barge tows. A multi-beam sonar system enabled estimation of fish abundance within barge junction gaps. Barges were also instrumented with acoustic Doppler velocity meters to map the velocity distribution in the water surrounding the barge and, in the gap formed at the junction of two barges. Results indicate that the water inside the gap can move upstream with a barge tow at speeds near the barge tow travel speed. Water within one meter to the side of the barge junction gaps was observed to move upstream with the barge tow. Observed transverse and vertical water velocities suggest pathways by which fish may potentially be entrained into barge junction gaps. Results of mark and capture trials provide direct evidence that small fish can become

entrained by barges, retained within junction gaps, and transported over distances of at least 15.5 kilometer. Fish entrained within the barge junction gap were retained in that space as the barge tow transited through locks and the EDBS, which would be expected to impede fish movement upstream (Davis et al. 2016).

More information on 2015 barge entrainment studies can be found at:

<https://www.fws.gov/midwest/fisheries/carterville/documents/2015-barge.pdf>

<https://doi.org/10.1016/j.jglr.2016.05.005>

2016 Efficacy Studies at the Electric Dispersal Barrier System During Tow Transit: Non-Entrainment Pathways

In August 2016, the USFWS, USGS, and USACE undertook another field study at the EDBS to examine the potential for transiting tows to create non-entrainment related pathways for fish passage of the barrier system. This novel study examined the influence of tow transit on the efficacy of the EDBS in preventing the passage of wild juvenile fish (total length < 100 mm). Dual-frequency identification sonar data showed that large schools of wild juvenile fish (mean school size of 120 fish; n = 19) moved upstream and crossed the electric field of an array in the EDBS concurrent with downstream-bound (downbound) loaded tows in 89.5% of trials. Smaller schools of wild juvenile fish (mean school size of 98 fish; n = 15) moved downstream and crossed the electric field of an array in the EDBS concurrent with upstream-bound (upbound) loaded tows in 73.3% of trials. Observed wild fish passages through the barrier system were always opposite to the direction of tow movement, and not associated with propeller wash. 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 current of water flowing 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%. Return currents and decreases in voltage gradients induced by tow passage likely contributed to the observed fish passage through the barrier. The efficacy of the EDBS in preventing the passage of small, wild fish is compromised while tows are moving across the barrier system. In particular, downbound tows moving through the barrier create a pathway for the upstream movement of small fish, and therefore may increase the risk of transfer of invasive fishes from the Mississippi River Basin to the Great Lakes Basin (Davis et al. 2017).

More information on 2016 Efficacy studies at the Electric Dispersal Barrier during tow transit: Non-entrainment pathways can be found at:

<http://www.AsianCarp.us/documents/BargeTrafficStudy-InPress.pdf>

FY2017 Actions

Barge Entrainment Mitigation - Water Jet Field Testing

Objective: Evaluate the efficacy and implementation feasibility of USACE waterjets for flushing junction gap spaces of entrained fish under real world field conditions within the canal near the EDBS.

During 2017, 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 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 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.

Non-entrainment Pathway Mitigation

Objective: Identify and test strategies for mitigation of non-entrainment pathways for fish passage at the EDBS induced by the passage of commercial vessels.

Additional experimental trials focusing on mitigation of non-entrainment pathways for fish passage at the EDBS were conducted over a two-week period during 2017. Increased velocity of water flow within the navigation channel at the EDBS has the ability to counteract reverse flows created by tows transiting the barrier in a downstream direction. During this portion of the study a matrix of canal discharge levels and tow speeds were tested during the course of 132 tow transits over the barriers to determine the effects of discharge alteration on flow dynamics within the canal and fish behavioral responses. The Metropolitan Water Reclamation District of Greater Chicago altered flows within the canal to meet study objectives. The USCG placed observers on the contracted tow to assess impacts to navigation and vessel safety concerns. The USGS Illinois Water Science Center quantified flow dynamics within the canal. Concurrently, shore based DIDSON and split beam sonar deployments were used by the USFWS to document fish behavior at the EDBS during transiting trials. Results from this portion of the 2017 trials will be used to inform potential emergency management actions.

Entrainment Dynamics of Juvenile Silver Carp

Objectives: Determine if juvenile Silver Carp (30-300 mm) can become entrained and transported in a manner similar to that observed with Golden Shiners used during previous studies. Determine the size threshold at which Silver Carp swimming ability is strong enough to avoid retention within rake junction gaps if they are retained and transported similarly to Golden Shiners. Document any entrainment of wild Asian carp that may occur during standard transiting of the Alton and Lagrange reaches of the IWW.

Juvenile Silver Carp (mean size 39mm) were captured from the wild in the La Grange reach of the Illinois River during early August 2017. These individuals were transported to the INHS National Great Rivers Research and Education Center in Alton, Illinois. They were held in raceways fed with recirculated river water until needed for the study in mid-September. These fish were then removed from the raceways and transported to the tow at the beginning of each study week with a mean size of 51 mm. Juvenile Silver Carp were marked (fin clips) and stocked into the rake-box junction gap during upstream tow transits. The location and behavior of stocked fish was monitored with ARIS sonar. Periodically during upstream transits, a net was

used to sample the population present within the gap to confirm the identity of fish observed with the sonar system. Additionally, acoustic transmitters were implanted into larger (131-325mm n=6) Silver Carp to monitor their entrainment status. Sampling of wild fish observed via sonar was conducted opportunistically throughout the study.

Results and data from 2017 field studies are currently undergoing analysis and consolidation.

FluEgg Modeling

In 2017, HecRAS outputs were run for the Illinois River and input into FluEgg. Scenarios for different flows, water temperatures, and potential spawning locations have been run.

Proposed Actions for FY2018

Small Asian Carp Entrainment Within the Lower Illinois River

Additional studies will be conducted in the field regarding the behavior of Asian carp in barge junction gap spaces and potential distances Asian carp may be transported within barge junction gaps. A modified mark recapture study utilizing juvenile Asian carp of varying sizes will be performed in a downstream location with hyper-abundant Asian carp populations. Nets will be used to physically recapture marked study specimens and document entrainment transport distances. Additionally, multi-beam sonar systems and video cameras will be deployed around the barge tow. The images from the DIDSON or underwater cameras will be used to view and count fish in barge junctions over time and distance traveled. Additional data on temperature, flow, speed of the barges, and distances traveled by the barges will also be collected and compared to the sonar data.

Barge Entrainment Mitigation 2017 Field Testing Final Reports

Final work up and analyses of data collected during the 2017 field season will be completed for both direct entrainment, water jet and non-entrainment, canal discharge management mitigation testing. Preliminary results have been developed for initial briefings of the field trials and a deep dive full analysis is pending. Final reports will be generated through individual agency internal reporting systems and an interagency peer reviewed publication will be compiled as a combined effort. Final reporting will also include briefing of the results to the ACRCC membership and discussion with the State of Illinois and the Federal Executive Committee to prioritize further development of these mitigation techniques in relation to other ongoing research and development projects. A plan for future development of the technologies involved and the required field testing to verify efficacy will be coordinated as appropriate.

Early Life Stage Asian Carp Entrainment Risk Assessment Modeling

Historical Asian carp spawning events and commercial ship track data on the Illinois River will be analyzed to determine if there were periods and/or reaches where entrainment and upstream transport of Asian carp eggs and/or larvae were possible. The analysis will be based on visualizing plumes of eggs and larvae after documented spawning events by using the FluEgg model along with historical commercial ship track data. This will allow the identification of high entrainment risk locations and temporal periods. Early life stages (eggs and larvae) of Asian carp passively drift downstream during the period before inflation of the gas bladder. If early life stages occupy the same time and space as northbound commercial traffic, there is a risk of entrainment and upstream transport. Hydrologic data from periods corresponding with historical spawning events (up to 6 events) occurring between 2012-2016 (river stage, discharge, etc.) will be used as input to the FluEgg model. This particle tracking model, developed especially for Asian carp eggs, will then be used to simulate historical spawning events at likely spawning

locations within the IWW. This will provide spatially explicit Asian carp egg density estimates within the IWW during simulated spawning events. Ship track data from the National Automated Identification System (NAIS), used to track commercial vessels, will then be overlaid on egg location density data in a Geographic Information System (GIS). These products will allow the identification of locations where egg density is likely to be high and the incidence of spatial overlap with commercial traffic is also likely to occur. These potential zones of high entrainment risk are likely localized, only occur at specific discharge levels, and only occur for short windows of time after a spawning event occurs. Identification of these risk windows has the potential to offer opportunities for management and avoidance actions.

In 2018, biologists will finalize scenario runs and create an online visualization library. The visualization tool will also be finalized and user tested once complete. A report will be written on the use of the tool for the purpose of modeling barge entrainment scenarios.

Potential Out-year Actions (Subject to Future Appropriations)

Entrainment Mitigation Technology Refinement

Pending an interagency leadership and ACRCC decision to move forward with promising entrainment mitigation technology refinement, the proposed work for out years may build 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. Pilot testing of water jet technologies within the CSSC was conducted during FY2017. This testing was designed to evaluate the water jet technologies under real world conditions at the field scale within the CSSC. Field scale testing included a fully equipped pump station and adequate piping, manifold, and water jet nozzles to produce the required velocities at the canal surface; however, the project was limited in the number of water jets that could be implemented. Pilot testing in the canal allowed researchers to better understand some of the complexities of deploying the technology in situ. Complexities included a diverse and quickly changing flow regime, interaction with live fish, and logistics of operating the system. While the pilot testing provided invaluable data and insight into the efficacy of the technology to mitigate for direct barge entrainment of fishes, there are several follow up actions that should be undertaken to build confidence in a final design for implementation.

1. Additional manifold and water jet nozzles will be added to the three-jet pilot test design. Laboratory testing included 18 water jet nozzles allowing for an extended exposure period as the scale model tow transited over the system. A minimum of six additional water jet nozzles are proposed for future in situ testing. This would increase the field scale system up to a total of nine water jets. This will increase the exposure time and is expected to improve efficacy of the technology to clear entrained fish from wider and faster tows.
2. During some portions of the 2017 field testing, air was entrained in the water pumped through the jets to aerate the water column near the surface of the canal while maintaining the exit velocity of water at the jet nozzle. The purpose of the air entrainment was to introduce a behavioral stimulant to the live fishes. This concept can be further refined and developed through additional testing.
3. During the course of the 2017 testing, researchers noted several design considerations that would need to be addressed for a permanent installation of the technology. An important design consideration includes the uncertainty of individual tows traversing over

the water jet array in the same location. To reduce the uncertainty of variation in approach angle, vessel speed, and misalignment with water jets, a park and flush methodology is proposed for further research. This method would include testing a moored barge with side angled jets to flush the barge voids of entrained fishes.

Study design, logistical planning, and permitting/coordination with regulatory agencies would begin as early as possible once final reporting and interagency evaluations have been completed for 2017 field testing. These actions would likely require approximately one fiscal year to complete.

The final study design and all permits would be completed early the following fiscal year and the interagency study team will be designated along with roles and responsibilities. Manufacturing of the water jet manifolds, completed contracts for pump stations and dive/lift teams, and a field logistics schedule will be prepared through the winter of that fiscal year and into the spring of the following calendar year. Field trials will be completed during the late summer and initial summaries of actions taken will be compiled. The data management, analyses, final report write up, and publication of results will continue into the following fiscal year. Proposed out year actions will be designed to consider input from the interagency team and the maritime industry regarding mitigation of barge entrainment and non-entrainment pathways for fish passage at EDBS and Asian carp entrainment and transport dynamics in the IWW.

Expected Milestones

FY2018 Q3: Continued analyses of full data sets from 2017 field testing of entrainment and non-entrainment pathway mitigation techniques.

Contract awarded for additional work in the lower Illinois River.

FY2018 Q4: Additional small Asian carp entrainment field work in the lower Illinois River will be completed.

FY2018 Q4: Final reports completed for 2017 field testing.

Potential Future Milestones for Entrainment Mitigation Technology Development

FY2018 Q3: Begin project scoping and planning meetings. Define study objectives.

FY2018 Q4: Complete project scoping and study objectives. Begin detailed study design.

What Is Deliverable for this Funding

- Final report on pilot testing of mitigation techniques for entrainment and non-entrainment pathways at the CSSC Dispersal Barriers.
- Preliminary data regarding additional field work completed in the lower Illinois River will be compiled and a report will be generated.
- Interagency and ACRCC decision on path forward for further development of technologies utilized in mitigating entrainment and non-entrainment pathways.
- Model output identifying locations and periods of high entrainment risk for early life stages of Asian carp.
- Online visualization tool and FluEgg report.

Expected Completion Date for Project

Q4 2018: Early life stage Asian carp entrainment risk assessment modeling.

Q4 2018: Pilot testing of mitigation techniques for entrainment and non-entrainment pathways

Q4 2018: Small Asian carp entrainment work in the lower Illinois River

Potential Hurdles

- Continuing work in the lower Illinois River will require a new contract with a commercial tow as well as concerns regarding the collection, stocking and potential upstream movement of Asian carp used during experimental trials.
- Additional technology refinement and field implementation logistics is warranted for the identified mitigation techniques of entrainment and non-entrainment bypass pathways at the CSSC Dispersal Barriers.
- Final results and collaborative interagency discussions are needed to determine the priority of this work in relation to alternative projects proposed for GLRI funding.
- Should further refinement of the required technologies be ranked as a high priority and funded, there are several areas of risk that will affect field implementation including contracting of a commercial tow charter, waterway closures, and logistics concerns.

23. Testing and Adaptation of Chinese “Unified Method” of Carp Capture to U.S. Waters

Lead Agency(s): USGS

Agency Collaboration: USFWS, Missouri Department of Conservation, Illinois Department of Natural Resources, and Saint Louis County Parks

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested		Other Funding
	USGS	USFWS	USGS	USFWS	
FY2018	\$215,000 (\$200,000 CERC and \$15,000 UMESC)	\$70,000	\$125,000 (\$85,000 CERC and \$40,000 UMESC)	\$38,000	In kind funding from Illinois DNR, Missouri Dept. of Conservation and Saint Louis County Parks

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

Capture and removal of adult Bighead Carp is an obvious answer to their overabundance and undesirable effects. In addition, commercial capture of Bighead Carp provides a financial incentive for removal of the carp through the sale of the fish. However, this could be improved by increasing the ratio of fish captured to expense or effort. Furthermore, traditional methods of commercial fishing generally entails fishing concentrations of fish, and these methods do not remove most of the fish from any body of water in a given year.

The Chinese Unified Method consists of using a variety of net types and methods of driving fish, to drive most of the target fish in a given water body to a central collection point, usually an extremely large trap net known as a “stow net”. The fish are then harvested from the stow net and transported live to market. Using the shallow water version of the Unified Method, Chinese fishing companies are often able to remove up to 85% of the target fish from shallow water Yangtze floodplain lakes measuring thousands of hectares each. Unified Method operations on these large water bodies in China can take more than a month to accomplish.

Some fish in the Unified Method are captured in entanglement nets such as gill or trammel nets, but the goal is to capture most of the fish in the stow net, because that gear requires less effort for harvest and also results in less damage to the fish. This has potential advantages in the United States as well. Bigheaded carps are more easily driven than many North American native fish, which limits bycatch. Many of the native fish which are more easily driven (for example, buffalos) may also often be legally harvested commercially. In addition, because most fish are

captured in a large live trap, most of the non-target fish so captured should survive capture and release.

The central idea of the Unified Method consists of using block nets to encompass small compartments of the body of water to be fished, driving the fish out of the compartment, and sealing off the exit so that the fish cannot re-enter it. This is repeated many times until the fish are concentrated at the final collection point. The stow net can be harvested as necessary during this process to remove fish from the collection point to prevent the amassing of so many fish that compartments cannot be cleared. Other methods can be used as well to harvest the concentration of target fish.

The central advantage of the Unified Method is that a body of water is fished as a unit, instead of fishing small parts of the water body where concentrations of easily captured fish exist. In so doing, all parts of the water body are fished, and the number of fish in a water body can be substantially reduced, rather than just pushing the fish around within the water body.

The Unified Method has disadvantages in that (1) it works best when the water is very cold, because Silver Carp jump over block nets more when the water is warm; (2) it requires a tremendous amount of netting; (3) nets in the water may be problematic for other users of the waterbody, or other users may damage nets; (4) it requires a substantial amount of labor and a very large degree of organization, and the use of several boats may be required; (5) it can result in the production of an extremely large amount of fish all at once, which can create logistic problems; (6) the Unified Method would not currently be legal in most jurisdictions for private commercial fishers; and (7) the Unified Method as practiced by the Chinese would not work in all locations. There is a “deep water” unified method, used in deep reservoirs, but it is not as successful as the shallow water method in removing fish. The Unified Method is not typically used in China under flowing water conditions and, is best performed in locations with limited amounts of large woody debris and in locations of even, shallow, bathymetry.

In previous efforts to perform the Unified Method in the US, near Morris, Illinois, the proximity to the electric barrier and the need to remove as many fish as possible limited the scientific evaluation of different driving methods. In early calendar 2018, USGS plans to perform a Unified Method harvest at Creve Coeur Lake in eastern Missouri. USGWS is working with Missouri Department of Conservation and St. Louis County, and the USFWS on this project, and Illinois DNR has offered to share block netting purchased for Unified Method work near Morris for this project. Creve Coeur Lake is a good candidate for this work because of its shallow and flat bathymetry, allowing existing block nets to reach the bottom over nearly all of its area, because of limited large woody debris, a reasonable size, and because it is only intermittently connected to the river, during high flood years. Additionally, collaborating agencies have a strong desire to control Silver Carp in this lake because of their effect on a previously high value crappie fishery, and because the lake has long been an important location for rowing (“crew”) races and for training for such races. The jumping Silver Carp have famously created problems for those races in this location.

Economic and cultural differences between the US and China require that US efforts be somewhat less labor intensive and, rely as much as possible on more automated methods rather than human force. USGS proposes to test and evaluate different methods of driving fish and clearing methods in a statistically defensible approach, using acoustic methods (DIDSON, side scan sonar) to evaluate the success of clearing compartments. Methods to be tested include at

least the following: no action beyond the laying the net, driving with electrofishing boats, sound boats, and driving with motorboats. Compartments tested will be substantially smaller than the compartments used in the Morris effort.

Evaluation of success in removal of the fish in the lake will be done by (1) acoustic telemetry of Silver Carp, (2) hydroacoustic survey to be performed by USFWS, (3) mark-recapture population estimation (performed by USFWS and USGS in conjunction), (4) eDNA estimation of biomass (funded under the eDNA template), and (5) Silver Carp population assessment by paupier.

In addition, an assessment of native gamefish in Creve Coeur has been taken and gamefish populations will be assessed for at least two years after the removal, unless the Missouri River rises and refloods the lake, allowing repopulation by Asian carp.

Depending on the success of the operation and, depending on need and presence of carp in the system an additional operation might be conducted in 2019, or if not needed at Creve Coeur, a different site would be chosen to perform additional tests and improvement of the method.

Summary of Actions to Date

- Representatives for USGS and Illinois DNR traveled to China for training in the method and to observe equipment and sites in China.
- Illinois DNR performed two trials of the unified method in a backwater at Morris, IL, using a seine as the final collection method, rather than a stow net. This provided a relatively high degree of success, with acoustic methods indicating a capture of approximately 60% of the resident fish. Illinois DNR also performed another driving exercise similar to the Unified Method in Dresden Island Pool.
- Illinois DNR purchased a large quantity of block nets and pound nets which will be loaned to USGS for use in this removal.
- USGS contracted construction of stow (Iruka) net and an additional very large trap net and a brailer net for removal of fish from the stow net. Contracted for training for deployment and harvest of the stow net. MDC arranged for large excavator to prep site for the stow net and to be used as the arm for deploying the brailer net.
- USFWS performed acoustic fish survey and bathymetry of Creve Coeur Lake.
- USFWS completed the pre-assessment of the Silver Carp population with the paupier.
- With MDC and USFWS, planned January or February Unified Method actions and preparatory activities. Using Incident Command structure for planning the operation.
- USGS and MDC performed removal of Asian carp in Mallard Lake upstream of Creve Coeur Lake in early FY2018.
- Collected eDNA from both Mallard and Creve Coeur Lake to assess biomass
- USGS and FWS tagged approximately 1,500 Silver Carp with jaw tags, 120 of which were placed in ponds to assess tagging mortality.
- USGS has deployed 29 HTI receivers in Creve Coeur Lake to plot movements of the carp and, implanted and released 31 Silver Carp with transmitters.
- Missouri Department of Conservation arranged for disposal of the harvested carp.
- USGS performed pre-assessment of centrarchid gamefish catch, age, size, and growth.

Proposed Actions for FY2018

- Deploy HTI receivers in Creve Coeur Lake to plot movements of the carp, and implant 30 Silver Carp with transmitters.
- Perform a minimum of two post-assessments of the Silver Carp population with the paupier. Assessments will include comparing pre- and post-event relative abundance, age, and growth.
- Tag up to additional 3,000 Silver Carp with jaw tags and continue to assess tagging mortality.
- Collect additional eDNA samples monthly before and after the removal operation (funded under eDNA template).
- Perform Unified Method in Creve Coeur Lake in January or February 2018.
- Perform additional acoustic survey to assess number of large fish in lake after the removal effort.
- Perform assessment of population and growth of gamefish in Creve Coeur Lake after the removal operation.
- Draft manuscript on the results of the Creve Coeur effort and submit by the end of the fourth quarter of 2018, including a description of the Unified Method and its potential uses in the US and its uses in China.

Potential Out-year Actions (Subject to Future Appropriations)

In the same or in a different body of water in Missouri or Illinois, perform another Unified Method operation, adaptively modifying techniques and measuring success.

What Is Deliverable for this Funding

- Perform Unified Method at Creve Coeur Lake, evaluate overall success using a variety of methods including response of native gamefishes. Evaluate different driving method success by comparison of different cell success.
- Prepare manuscript describing results by end of fourth quarter of FY2018.
- Provide presentation at the American Fisheries Society annual meeting describing the effort and its success and hurdles yet to be passed.

Expected Completion Date for Project

FY2020

Potential Hurdles

- Weather – this project is best performed during cold periods but relies on minimal ice and temperatures not too far below freezing during the day. Therefore, unexpected changes in weather can cause problems, or an extremely cold year could cause delays.
- In addition, flooding could cause problems. Floods are rare in the winter, but Creve Coeur Lake does flood on average at least once a decade. Flooding, and reinvasion of carp during the spring could negate any effects of the removal on native fish by reintroducing large numbers of carp. Late fall flooding could reintroduce carp and negate our estimates of abundance via mark recapture and hydroacoustics.

24. Electric Field-Based Aquatic Nuisance Species Dispersal Barrier: Development and Implementation of an Alternating Current Electric Dispersal Barrier to Block Passage of Small Sizes of Bighead Carp and Silver Carp

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
FY2018	0	.*

*No funding needed in 2018

Project Description

Background: Electric dispersal barriers are being considered as a means of blocking upstream passage of Asian carp into Lake Michigan. Bighead Carp and Silver Carp are nuisance invaders of the Mississippi River System, with established reproducing populations in the system. The invasion front has recently moved upstream, increasing risk for invasion of the Great Lakes. EDB's can be an efficient method for preventing upstream movement of fish. Edward and Higgins (1972) and Bird and Cowx (1992) reported that maximum susceptibility to pulsed direct current (PDC) may occur at different PDC frequencies among species and that fish of different sizes can exhibit their greatest susceptibility at different pulse frequencies. Typically, smaller fish require greater pulse frequencies and/or greater pulse amplitudes to induce passage-preventing behaviors. Use of higher PDC pulse frequencies and/or amplitudes may lead to increased concern for human safety, greater rates of anode destruction, and greater rates of corrosion of surrounding structures.

The effectiveness of EDBs on very small Bighead Carp and Silver Carp is of particular concern. Recent research related to EDBs operating on the CSSC indicates the effectiveness for blocking passage of fish with PDC to be strongly influenced by fish size (Holliman 2011; Holliman 2014 A; Holliman 2014 B) with electric field parameters demonstrated effective on large fish shown to be less effective on small fish. Recent research also indicates seasonal environmental conditions, specifically water temperature, to strongly influence effectiveness of EDBs on the CSSC, with electric field parameters demonstrated effective on Bighead Carp at lower water temperatures shown to be less effective at summer season (warmer) temperatures. Alternating current (AC) can be used for EDBs and could be as, or more, effective than pulsed direct current. AC also has the potential benefit of reducing concerns over corrosion and anode destruction. Moreover, AC can be manipulated to conserve electrical energy, to have characteristics of PDC but with constant reversals of electrode polarity, which would also prevent galvanotaxis (forced-swimming by fish) to the anode or in some cases the cathode. An AC EDB may have the distinct advantage, over PDC, in simplification of circuitry requiring less specialization in design and maintenance personnel.

Purpose: The purpose of this project is to design an Alternating Current Electric Dispersal Barrier (AC EDB) and determine its efficacy. The project is broken into four broad Tasks, each with a specific objective. Task One will develop scaled models and conduct Simulations of

Intrusion with small sizes of live Bighead Carp to determine spatial and temporal characteristics for the waterborne electric field that needs to be produced by the AC EDB. Task Two will conceptualize the primary components of the AC EDB (power supply, monitoring and control systems, and electrode systems) necessary to produce the electric field tested in Task One. Task Three, a follow-on Task for Task One, proposes additional laboratory testing under varying Seasonal/Environmental conditions. Task Four, a follow-on Task for Task Two, proposes to provide cost estimates for the design and construction the AC EDB components conceptualized in Task Two.

AC EDB can be designed to be central in a multiple-technology deterrence system or as an accessory technology. The incorporation of alternative deterrence technologies can be included in the Conceptualization. The AC EDB can be operated to function as a physiologic barrier, where fish of the targeted size and larger are rendered incapable of swimming through the electrified zone, or as a behavioral barrier. When being operated as a physiologic barrier, the output of the AC EDB can also be turned down from levels that target small fish to output levels safer for humans. The output of the AC EDB can be changed depending on the circumstance [e.g., barge present, switch on alternative technology (increase water velocity, or turn on complex sound) decrease output of AC EDB to safer levels and, increase AC EDB output to higher levels after barge has cleared area). This type of flexibility can be designed into the system. If multiple deterrence technologies are being applied, a monitoring and control system will need to be developed to interface with each of them. It may be possible that the AC EDB monitoring and control system could be developed so alternative technologies (e.g., complex sound) can be integrated into the system.

Proposed Actions for FY2018

Task One: Specification of Electric Field Parameters for an Alternating Current Electric Dispersal Barrier: Evaluation of Alternating Current for Blocking Passage of Very Small Asian Carp (Funded)

Objective: To determine sets of AC electric field parameters for EDB that achieve a reliability (probability) of 95% for inducing passage preventing behaviors in very small sizes of Bighead Carp at a 95% confidence level.

Background: Specification of electrical stimulus that will be effective on the targeted fish sizes and species is a first step in the process of conceptualization, design, development, purchase, and implementation of an EDB system. We have developed research equipment, methods, modeling and simulation approaches, and scaled models for EBD, in support of the operation and optimization of EBD employed by the US Army Corps of Engineers on the Chicago Sanitary Ship Canal, which can be employed for specification of effective electrical stimulus for EDB in other locations.

Approach: A scaled-model approach will be employed, where a Brett Swim Tunnel or similar flume will be modified so the field strength at the water surface of an EDB will be simulated under controlled conditions. The field strength applied in the simulations will be determined by modeling EBD electric fields, assuming a water depth of 15 feet and bottom-mounted electrodes (e.g., Holliman et al. 2015). Simulations of Intrusion into the EDBs will be conducted with live Bighead Carp (or Silver Carp) of 1 to 2 inches total length. The scaled-model of the EDB will be characterized by AC electrical parameters under consideration (e.g., 60 Hz AC).

- Pilot testing will be conducted with candidate sets of electric field parameters and reliability demonstration testing will be conducted on promising sets of electric field parameters. Water temperature will be at ambient conditions (20 °C) and water conductivity will be selected after conferring with sponsors.
- Videography will be employed to record fish behavior during the electrical exposures, with automated and manual video review to determine onset of targeted behavioral endpoints and metrics of fish performance during electrical exposures (e.g., loss of posture, tetany, swim velocity, distance traveled by fish during exposure).
- Reliability demonstration testing will be conducted with an appropriate number of fish, with a 95/95 reliability standard for induction immobility/tetany specified (95% probability at a 95% confidence level). Depth of intrusion (i.e., distance into the EDB) at onset of immobility/tetany will be estimated and reported.

Deliverable: A report will be prepared summarizing the results of the testing and potential application of results. Specifically, the descriptions of the electric field parameters evaluated, the estimated reliability for the sets of electric field parameters evaluated for induction of immobility/tetany, the estimated depths of intrusion (penetration) into the electric field, and fish size and species, will be provided.

Task One Time: Testing will occur in Year 1 at the Aquatic and Wetland Ecosystems Research and Development Center, Environmental Laboratory, ERDC, which is an approved facility under the Environmental Laboratory Institutional Animal Care and Use Committee and, accredited by the Association for Assessment and Accreditation of Laboratory Animal Care. Bighead and Silver Carp are currently being maintained in the facility. However, additional fish may be necessary to complete all testing. A draft final report will be submitted 6 months after testing begins.

Task Two: Conceptualization of an AC EDB system

Objective: This task will conceptualize an alternating current (AC) Electric Dispersal Barrier system (AC EDB) power supply, including monitoring and control systems, and electrode system. Electric Dispersal Barriers (EDB) are composed of three primary systems, the physical structures, the power supply (including control and monitoring systems), and the electrode arrays.

Approach: The USACE Chicago District will be queried for information and documents related to construction, operation, and maintenance of the power supplies, monitoring and control systems, and electrode systems of the EDB operating on the Chicago Sanitary Ship Canal (CSSC). This information on EDB on the CSSC is not required for the conceptualization and design of the AC EDB to proceed, but may prove useful to compare and contrast existing ACOE PDC EDB with the conceptual AC EDB or for conceptualization of PDC EDB.

A customized power system will be conceptualized for the AC EDB (or PDC EDB). Outcomes of experimentation and testing on targeted sizes and species of fish in Task One (this project Title) can be used to inform specifications for the power supply and electrode system. These specifications, and, if possible, continued testing with the targeted species and sizes of fish (Task 3), will inform power supply conceptualization and requirements for output and preliminary cost

estimates for design, construction, and installation, of the AC EDB power supply and electrode system. Input from the sponsors will be used to refine features and requirements for the EDB power supply, monitoring and control systems, and electrode systems. The potential for integration and interfacing electric field monitoring technologies, with fish monitoring-detection technologies, and other deterrence technologies is also a consideration.

Deliverables: The conceptualization of the AC EDB will include a brief report, concept drawings/sketches, basic descriptions of the AC EDB capabilities, features, components, hardware, software, operation, and maintenance; input electrical energy requirements; basic descriptions of infrastructure requirements; preliminary cost estimates for design, construction, and testing of the AC EDB (or PDC EDB) power supply, monitoring and control system, and electrode system.

Potential for integration with other deterrence technologies will be addressed, depending on information on other deterrence technologies being available. This task will identify high risk technological challenges to development of an AC EDB (or PDC EDB).

Task Two Time: Estimated time frame is 18 months. The first year will focus on basic descriptions of the AC EDB capabilities and components; the second year will complete the deliverables. Completion of the task is influenced by timing and availability of information related to the EDB operating characteristics if the sponsor prefers this information to be considered in the conceptualization of the AC EDB (or PDC EDB).

Potential Out-year Actions (Subject to Future Appropriations)

Task Three: Laboratory testing will be continued with the scaled model developed in Task One to evaluate efficacy of an AC EDB on immobilizing small Asian carp and to compare sets of AC and PDC electric field parameters of interest under various seasonal/environmental conditions (water temperature, conductivity).

Deliverable: Report containing recommendations for environmental operating rules and outcomes of comparative testing between the conceptual AC EDB and PDC EDB to aid decision making.

Task Three Time: Research scheduled for Year 2. Research preparation and equipment setup and testing will take 21 days. Data collection, evaluation and analysis will take 34 days and report generation will take an additional 14 days. A final draft report will be submitted 6 months after receipt of funding.

Task Four: After specification of output (Tasks One and Three) and conceptualization of the EDB System (Task Two) and receiving sponsor input we will submit cost estimates, timelines, and benchmarks for design, construction, testing, and installation of the EDB power supply (AC or PDC), monitoring and control system, and electrode system.

Deliverable: Conceptual Design Review, Critical Design Review (includes Mechanical Drawings, Detailed Engineering Drawings, Architectural Drawings, Software Specifications, Hardware Specifications, Breadboard Demonstrations, Material Cost Estimates), Final Design Review (includes evaluation of prototype, if necessary, verification of performance, final costs, final materials list), Final Design Report.

Expected Milestones

- Task 1: Development of the Computer Model for the AC EDB - Lab Application

Outcomes

Development of effective new aquatic invasive species deterrence technology and systems.

Potential Hurdles

- Availability of small sizes of Bighead Carp.
- Development of new aquatic invasive species deterrence technology while keeping costs down.
- Efficacy of alternative technologies for deterrence of small sizes of aquatic invasive species.

25. Chemical Attractant Investigations to Increase Aggregation and Harvest for Asian Carp Control

Lead Agency: USGS

Agency Collaboration: USFWS, Illinois DNR, Illinois Natural History Survey (INHS), Kentucky Department of Fish and Wildlife Resources (KDFWR), USACE ERDC

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding Requested
FY2018	\$230,000	\$300,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

Chemical attractants have been used by fishermen in many parts of the world to increase harvest efficiency. Attractants used by fishermen range from strong odorants such as anise to more natural baits or pheromones. Food-related attractants are typically used; however, pheromones and even live fish have been used to attract conspecifics. The effectiveness of certain chemical attractants likely varies by species; therefore, research is needed to identify attractants that will concentrate each of the invasive Asian carp species. The main objectives of our attractant studies are to identify techniques that will (1) increase harvest of carp by resource management agencies, and (2) enhance early detection probabilities.

Laboratory studies conducted at CERC and by independent researchers have consistently confirmed that an algal food stimulus is attractive to filter-feeding Asian carp. Past success in the laboratory and ponds using *Chlorella* and *Spirulina* algae as attractants warrants further investigation, therefore field applications will be conducted. Laboratory work will continue to identify additional attractants for larval, juvenile and adult Asian carp species (Bighead and Silver Carp, Grass Carp and Black Carp) using an electro-olfactogram (EOG). Attractants that elicit a strong electric response will be further tested in mesocosms to identify behavioral responses.

Acoustic stimuli have also been used to attract many species of fish, however fast habituation to a sound stimulus when no food is presented has been documented. Combining a sound stimulus with a food attractant may enhance attraction over greater distances. A variety of sound stimuli have been used to enhance fishing efforts such as rattles for sharks and catfishes, or croakwood for the South European sheat-fishery. Such stimuli are likely biologically relevant in that they mimic sounds and vibrations made by prey items. For schooling fish like Asian carp, sounds of conspecifics feeding may be attractive, particularly when used in conjunction with a food stimulus.

The combination of the feeding attractant with electrofishing, eDNA monitoring, and side-scan survey methods may provide early detection. This application will allow researchers to understand the abundance of Asian carp in an area and when paired with telemetry technology provide information on Asian carp movement within a tributary. This approach could be very effective in monitoring fish movement at an invasion front in order to develop a control strategy.

This project will serve as the main foundation for all chemical attractant investigations; however, some objectives will link up with other projects to begin the integration and implementation of various control strategies with current management actions.

Summary of Actions to Date

- Completed video analyses of lab studies confirming Asian carp attraction to the algal stimulus solution.
- Completed mesocosm study with juvenile Silver and Bighead Carp where a pit tag array was used to confirm attraction to the algal stimulus. A consistent response was observed among the 12 trials conducted and ambient native algal blooms did not diminish the positive response to the algal stimulus.
- Tests confirmed that Bighead and Silver Carp aggregate to feeding stations and that such strong attraction can potentially be used to facilitate their capture.
- Studies determined that wild carp abundance increased at feeding stations at sites of varying complexity relative to width, depth, flow and cover along the Missouri River and the Illinois River. Apparatus and procedures were developed for applying the algal stimulus each day. Initial observations using DIDSON imagery indicated the attraction for fish including carp to this feeding. Preliminary data indicate the abundance of fish catch increased when feeding stations were positioned at the mouth of pound nets.
- Completed laboratory trials where juvenile Silver Carp were conditioned to a pure tone auditory stimulus when combined with a food attractant. Observations also indicate the food attractant has to be present in order to elicit a full robust response.
- Completed a field study where a pure tone auditory stimulus, combined with an algal feeding station was applied in a backwater tributary of the Illinois River near Havana, Illinois. Initial observations indicated the auditory stimulus had a negative impact on the feeding behavior and decreased pound net catch rates of both Silver and Bighead Carp in a natural habitat.
- Conducted laboratory trials to test alternative foods and potential attractant chemicals on both Silver and Grass Carp to characterize initial behavioral response to the stimuli. (*This action can be linked to the Grass Carp project, Action Item 29*)
- Completed laboratory exposure to determine the dosage and ingestion rate of microparticles to deliver antimycin to Asian carp using an yttrium laden particle as an indicator. This test provided data on the best application rate of microparticles and the quantity that needs to be ingested to induce mortality. The food attractant was used in order to ensure ingestion of the microparticle. (*This action can be linked to the Microparticle project, Action Item 21*)
- Continued to conduct pond studies integrating the use of a feeding ring with food attractants and microparticle treatments to inform field applications for Asian carp. (*This action can be linked to the Microparticle project, Action Item 21*)
- Conducted a field reconnaissance trip to assess potential sites along the Ohio River to setup feeding stations for use in early detection application coupled with eDNA samples and monitoring tagged fish.
- Constructed an olfactory/chemosensory apparatus to perform electro-olfactograms to screen for physiological response in Asian carp to various food stimuli. This new capability will allow rapid screening to help identify potential attractants and/or deterrents.

FY2017 Actions

- Recorded sounds of Silver Carp and Bighead Carp feeding in ponds on both algae and small pelleted feed. (*This action can be linked with the Sound project, Action Item 19.*)
- Conducted a six-week field study where liquid algae was applied to four sites on the Missouri River to determine whether these habitats are suitable for using algae to concentrate fish. Preliminary observations suggest that the selected sites are too hydrologically variable and that stochastic events are stronger drivers of fish abundance than the food attractant.
- Deployed a feeding station in Mallard Lake near St. Louis, Missouri, which has high densities of Silver Carp, to determine whether carp could be concentrated in a region of the lake for more efficient removal.
- Continued to develop and use 360 and side-scan sonars to monitor fish abundances during our field studies.
- Conducted a large-scale field application combining the algal food attractant and antimycin microparticle to evaluate potential impacts to native species in order to determine the best management action for use. (*This work is supported through the microparticle project, Action Item 21.*)
- Initiated potential collaboration with Joliet Junior College on the potential development of a bait formulation that will elicit an involuntary feeding response in Asian carp.
- Completed a large-scale field assessment of antimycin microparticles.

Proposed FY2018 Actions

- Screen alternative foods and chemicals using the electro-olfactogram to identify those that elicit a strong physiological response in Asian carp. (*This work can be linked to the Grass Carp project, Action Item 29.*)
- Further test alternative foods and chemical that elicit strong physiological responses in Asian carp in mesocosms to identify behavioral responses. (*This work can be linked to the Grass Carp project, Action Item 29.*)
- Continue field testing of algal attractant to identify (1) habitat types where Asian carp can be effectively concentrated and (2) length of time algae must be applied before a robust response is observed.
- Evaluate performance of harvesting gears for removing Asian carp in habitats where the fish were successfully concentrated. (*This work can be linked to the Mass Harvest project, Action Item 5.*)
- Test whether an auditory stimulus when paired with a food attractant can increase responsiveness to the feeding station to increase densities of Asian carp.
- Conduct a field study in an area where Asian carp densities are low, to identify whether a chemical attractant might enhance early detection probabilities. This study will be part of a combined study where eDNA and enhanced harvest using sound as detection methods will be evaluated pre-and post-algae application.
- Continue to develop and expand protocol for the use of side-scan sonar technology to estimate fish abundance in an area. There is a demand for such techniques by state agencies tasked with the monitoring and control of invasive species such as Asian carp.

- Continue to work with management agencies to develop the best application method for using antimycin laden microparticles to control Asian carp. (*This work is supported through the microparticle project, Action Item 21.*)
- Initiate studies to test a bait formulation that will elicit an involuntary feeding response to determine and characterize the behavioral response and the duration of the response.

Potential Out-year Actions (Subject to Future Appropriations)

- Continue to provide updated information to federal and state resource managers regarding techniques that seem effective for carp control management activities using chemical attractants.
- Continue laboratory and mesocosm studies to characterize Asian carp (all four species) responses to alternative chemical attractants identified through olfactory screening. (*This work can be linked to the Black Carp and Grass Carp project, Action Items 28 and 29, respectively*)
- Conduct chemical analyses of attractants that elicit both a physiological and behavioral response to identify component compounds that trigger the response in Asian carp (all four species). (*This work can be linked to the Black Carp and Grass Carp project, Action Items 28 and 29, respectively.*)
- Further evaluate use attractants in combination with eDNA sampling to concentrate and locate Asian carp in low density areas and monitor fish behavior.
- Continue to work with management agencies to develop the best application method for using antimycin laden microparticles to control Asian carp. (*This work will be supported through the microparticle project, Action Item 21.*)
- Begin development of methods for using chemical attractants to concentrate larval Asian carp for removal.
- Conduct field tests of attractants that elicited robust behavioral responses in mesocosm experiments.
- Continue to test a bait formulation that elicits an involuntary feeding response in Asian carp and determine the best method of application for a management strategy.

What Is Deliverable for this Funding

- A report will be drafted detailing the results of development and field testing of a feeding station at Mallard Lake near St. Louis, Missouri to concentrate Asian carp to a localized area.
- A report will be drafted, detailing the results of the six-week Missouri River field study where algae was applied every day at four sites which were also monitored daily for fish abundance and habitat parameters.
- A publication will be submitted on the results for the development and testing of the microparticle. This manuscript will include the development of the formulations, laboratory efficacy trials and the pond trials. (*This work will be supported through the microparticle project, Action Item 21.*)
- New potential food and/or chemical attractants will be identified for use with Asian carp control strategies
- A manuscript for potential publication characterizing Asian carp behavior in response to auditory stimuli when paired with the food attractant will be drafted. (*This work is linked to the Sound project, Action Item 19.*)

- A report will be drafted with results of alternative chemical attractant testing using the electro-olfactogram, and any completed behavior tests on those that elicited physiological responses.

Expected Completion Date for Project

- Studies supporting the use of food attractants within an integrated management approach for controlling Asian carp are expected to continue beyond 2020.
- The development of microparticles as an oral delivery tool will be completed in 2018. Studies to support the use of microparticles by natural resource agencies are expected to be continued beyond 2019.
- New attractant chemicals for potential use are expected to be identified by 2020.

Expected Milestones

- Complete preliminary field effectiveness trials using feeding station locations to determine if the feeding station increases harvest abundance.
- Protocols and methods for the use of an algal attractant in combination with eDNA sampling and telemetry will be completed in 2018.

Outcomes/Outputs

- Create expanded protocol for the application of chemical attractants incorporating auditory stimuli.
- Integrate chemical lure with micro-particle technologies to ensure ingestion of fish toxins.
- Merge chemical attractant and harvesting methodologies.
- Merge chemical attractant and early detection methodologies.
- Report on feasibility of the use of chemical attractants and repellants in the capture and harvest of Asian carp.
- Apply current methodologies to Grass and Black Carp as well as other aquatic invasive species.
- Transfer of technology to state agencies.

Potential Hurdles

- Flooding and severe weather events can cause high river stages that hinder research due to unsafe conditions and can delay fieldwork.
- Low water can also negatively impact our ability to access sites.
- Equipment malfunctions and boat repairs can lead to delays.
- Personnel turnover and shortages could lead to scheduling issues and conflicts.

26. Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

Lead Agency: USGS

Agency Collaboration: Illinois DNR, USFWS, MWRD, SIU, University of Illinois Natural History Survey, and USACE

Funding Table:

Funding	Agency Funding Expected	Asian Carp GLRI Funding to be Requested
FY2018	\$145,000	\$144,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

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 Bighead 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.

Intensive sampling by Illinois DNR has shown that the leading edge of the Bighead Carp population front has been stalled in the Dresden Island Pool of the IWW since at least 2008. In 2015, this study established baseline water chemistry conditions in the IWW with four rounds of water quality sampling that identified trends in anthropogenic bioactive compounds (ABCs) that correlate with the stalled population front. Along with ongoing continuous water quality monitoring at Seneca, Illinois and Morris, Illinois, discrete samples were collected at seven locations along the river to analyze for over 650 constituents not previously assessed, such as pesticides, metals, volatile organic compounds, hormones, pharmaceuticals, and other wastewater indicator chemicals. Initial analysis of these water-quality samples indicate that the concentrations of ABCs are higher in the Dresden Island Pool than in the Marseilles Pool whereas pesticide concentrations are higher in the Marseilles Pool than upstream in the Dresden Island Pool. Existing data, including long-term water-quality sampling by the Metropolitan Water Reclamation District (MWRD) of Greater Chicago, were reviewed for the analyses.

In 2018-19, this study will evaluate ABCs that correlate with the stalled population front. An initial round of metabolomic analyses of fish tissue samples collected by the University of Illinois at multiple locations in the IWW in 2015 will be completed. The results of the 2015 metabolomic analyses will be compared to the 2015 water chemistry results to target specific ABCs. In 2018, commercial fishers will collect fish from Rock Run Rookery (population front) for analysis of specific ABCs in tissue. This fish tissue analysis will help define if environmental ABCs are contributing to the stalled movement of the leading edge of carp populations and how to use the information to control the population front.

Summary of Actions to Date**FY2017 Actions**

- Published 2016 water year water quality data for Illinois River main channel and backwater sites.
- Continued velocity mapping of selected river reaches and spawning documentation activities in coordination with Illinois DNR and other agencies and published ScienceBase data releases containing the data.
- Completed analyses of water quality samples for detailed chemical analysis of anthropogenic bioactive compounds (including lab schedules for pharmaceuticals and hormones) for evaluation of potential effects on the Bighead Carp population.
- Presented water quality sampling results at Emerging Contaminants in the Aquatic Environment conference (May 2017) and hosted USGS web-ex presentation (October 2017).

Proposed Actions for FY2018

- Publish continuous 2017 water year water quality data for Illinois River main channel and backwater sites.
- Continue velocity and bathymetry mapping of selected river reaches and spawning documentation activities in coordination with Illinois DNR and other agencies and publish all water quality and velocity data collected in FY2017.
- Analyze 2015 fish tissue for ABCs. Collaboration with U. of Illinois.
- Review historic INHS data for fish tissue analyses.
- Coordinate fish tissue sampling with Illinois DNR and commercial fishers.
- Fish tissue analyses.
- Draft a USGS SIR or journal article relating the Asian carp movement data and water-quality data.

Potential Out-year Actions (Subject to Future Appropriations)

- Publish 2018 water year water quality data for Illinois River main channel and backwater sites
- Continue velocity and bathymetry mapping of selected river reaches and spawning documentation activities in coordination with Illinois DNR and other agencies and publish data collected in FY2017.
- Publish an SIR or journal article relating the Asian carp movement data and water-quality data.
- Publish water year water quality data for Illinois River main channel and backwater sites
- Continue velocity and bathymetry mapping of selected river reaches and spawning documentation activities in coordination with Illinois DNR and other agencies and publish data collected.

What Is Deliverable for this Funding

- Information on Illinois River conditions used to predict movement and spawning activity and target commercial fishing activities
- Analysis of relation between water-quality and Asian carp population front in the IWW.

Outcomes/Outputs

- Greater understanding of habitat selection for Bighead Carp with regards to hydraulic and water-quality characteristics.
- Development of hypotheses to define how environmental variables and ABCs may be deterring the spread of Bighead Carp.
- Insight into how habitat may be altered to deter Bighead Carp from spreading into new areas.

Potential Hurdles

- The project has a large field data collection component which is subject to weather delays during the year.
- Publication schedule is affected by length of time various reviewers need which is beyond the control of project personnel.

27. ACRCC Contingency Actions in the Upper Illinois River

Lead Agency(s): USACE

Agency Collaboration: USEPA, USFWS, USGS, Illinois DNR, USCG

Funding Table:

Funding	Agency Funding Expected				Asian Carp GLRI Funding to be Requested			
	USACE	USFWS	USGS	Illinois DNR	USACE	USFWS	USGS	Illinois DNR
FY2018	-	-	-	-	-	\$45,000	\$175,000	*

*USACE and Illinois DNR funding included in other collaborative or supporting projects.

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

The purpose of the Contingency Response Plan (CRP) is to outline the process and procedures the MRWG and the ACRCC member agencies will follow in response to the change in Asian carp conditions in any given pool of the upper IWW. Contingency actions include those direct actions taken in response to a trigger, which include coordination and communication of those actions, annual review and updates to the CRP, and periodic training of action agencies as it relates to response efforts. This project has been submitted to help facilitate interagency cooperation and ensure the MRWG and action agencies have dedicated funding to cover recurring annual costs in support of response plan maintenance, action agency preparedness, and any scheduled contingency response actions for the upcoming fiscal year.

Summary of Actions to Date

Previous operations have been successfully conducted by ACRCC cooperating agencies in order to reduce risk of fish passing the electric barrier or otherwise finding their way into Lake Michigan. A response was conducted in 2009 to reduce risk of fish passage upstream of the EDBS during scheduled maintenance in which five miles of the CSSC was treated with a piscicide. A similar action was taken in 2010 with a response in the Little Calumet River where piscicide was applied to over two miles of waterway. In 2016, an enhanced CRP was developed that expanded the geographic scope of existing contingency planning efforts, as well as, the scope of potential tools to be utilized in such an event. The CRP also considers barrier operations and status and is complementary and additive to the existing response plan in the MRP.

FY2017 Actions

The CRP was developed through an interagency collaboration in the fourth quarter of FY2016 and the first quarter of FY2017 culminating in a fully developed plan integrated into the 2017 MRP. The CRP took shape through a series of facilitated group discussions and involved input from members of the MRWG, Federal Executive Committee, and ACRCC.

Once a draft plan had been fully vetted with the appropriate action agencies and stakeholders, a tabletop exercise was led by the ACRCC's MRWG to test the process. The tabletop exercise was completed on September 19 and 20, 2016 and consisted of three modules of increasing complexity. Each module was designed to test the capability and capacity of the ACRCC action agencies to respond to various simulations of response triggers.

The CRP was implemented in 2017 following the capture of a Silver Carp within the Calumet River below the T.J. O'Brien Lock and Dam on June 22, 2017. A coordinated and intensive monitoring response was initiated immediately following the initial capture and concluded on July 7, 2017. Multiple agencies responded as directed by the CRP process following rapid communication and planning calls within and between ACRCC action agencies. No further Asian carp were detected and monitoring actions resumed according to the 2017 MRP.

An interagency team was developed by the third quarter of FY2017 composed of experts from USFWS, USGS, USEPA, USACE, and Illinois DNR to form a Contingency Response Plan Workgroup (CRPWG). The purpose of the workgroup is to assist MRWG co-chairs with understanding issues related to response actions and the CRP as well as provide feedback and recommendations on decision points related to a potential response action.

Proposed Actions for FY2018

There are three primary functions of the Contingency Action project which include (1) direct support of planned response actions, (2) workgroup review and updates to the CRP, and (3) continued training of action agencies and stakeholders through annual table top exercises. This project will support recurring annual costs in support of maintaining the CRP and tabletop exercise. Additional funding is included for FY2018 barrier maintenance support actions. The 2018 barrier maintenance support actions include electrofishing, contracted commercial netting, an acoustic deterrent barrier, and hydroacoustic surveys. While these actions are not specifically being taken in response to an established response trigger as outlined in the CRP, the MRWG and ACRCC agreed that the contingency response plan was the most appropriate tool to facilitate the barrier maintenance support efforts.

An annual table top exercise is scheduled for FY2018. Table top exercises include simulating scenarios identified in the contingency plan that would trigger a response. The exercise includes ACRCC stakeholders and action agencies of the MRWG to discuss what actions would be taken appropriate to the specific scenario and how they would be communicated. This allows the full group to maintain awareness and readiness even if there are years between actual emergency response actions.

Finally, the CRPWG will continue to evaluate and update the CRP through periodic reviews and revise accordingly. 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 workgroup will also work toward developing coordination plans for specific reaches of the IWW that may include identifying appropriate action agencies and pool specific logistics.

Potential Out-year Actions (Subject to Future Appropriations)

The CRP is a living document that must be regularly maintained and revised as conditions change over time and technologies are more fully developed. The FY2018 actions are good

indicators for what will be needed in out years and can be quickly summarized by the three primary functions of this project:

1. Direct support for planned support or response actions.
2. Annual review of CRP toolbox and update plan as necessary.
3. Annual tabletop exercise for action agencies and stakeholders.

The primary funding supports the recurring annual costs associated with items 2 and 3 above. Supplemental funding is expected to be included with this project on an as needed basis for known activities in item 1 above. Additionally, funding requests for the Illinois DNR in support of contingency response planning or actions will be covered through other projects funding requests. This project will continue to track Illinois DNR's integral role in contingency response planning on an annual basis.

Timeline for Major Actions

The CRPWG will meet periodically throughout the year to review the CRP and the toolbox of response actions. The CRP will be revised on an annual timeline in conjunction with the larger MRP. An annual tabletop exercise will be held during the second quarter of each fiscal year (January to March) when monitoring and harvest activities are on hold and as we prepare for the next field season to begin. Response actions may arise at any time throughout the year but are most likely to occur during the spring, summer, and fall seasons.

Expected Milestones

The following are expected milestones by quarter. These milestones will be consistent from year to year and are repeatable:

- CRP toolbox reviewed/revised quarterly.
- CRP updated annually for inclusion with the MRP by 2nd quarter.
- Tabletop exercise coordinated and planned 1st quarter.
- Tabletop exercise completed 2nd quarter.

What Is Deliverable for this Funding

This project will help maintain an updated and relevant CRP for each fiscal year that streamlines response actions and builds confidence with stakeholders. Annual action items will ensure that current technologies and the most up-to-date knowledge is being applied to the toolbox of potential response actions. Tabletop exercises maintain a strong working relationship between action agencies and stakeholders. These exercises also ensure all participating agencies are well prepared for a contingency response action when the need arises. The CRPWG will continue to remain vigilant and may add value to the CRP with supplemental tools and references as they become available.

Expected Completion Date for Project

This is an ongoing project geared specifically at unexpected contingencies throughout the Upper IWW and should be maintained as long as a risk for Asian carp breaching the Great Lakes exists. The CRP should be modified as necessary to maintain relevance to the leading edge of the invasion front and current environmental, ecological, and technological conditions.

Potential Hurdles

- Coordination with many agencies is the largest hurdle for this work. The CRP seeks to maximize protection and prevention efforts as much as practicable and recognizes existing agency authorities, listed in the CRP, to achieve these goals.
- Requested funding covers known contingency response planning or actions in any given fiscal year.
- Planning includes annual review of the CRP and tabletop exercises.
- Actions are only funded if they are known to the MRWG/ACRCC prior to the development of the current year's project.

28. Black Carp Monitoring and Control

Lead Agency: USFWS

Agency Collaboration: USGS, Southern Illinois University, USACE, MDC, KDFWR, Illinois DNR

Funding Table:

Funding	Agency Funding Expected				Asian Carp GLRI Funding to be Requested			
	USFWS	USGS	USACE	Illinois DNR	USFWS	USGS	USACE	Illinois DNR
FY2018	\$100,000	\$70,000	-	-	\$467,000	\$493,000	-	\$200,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Funding by individual project template:

Black Carp Templates	Agency Funding Expected				Asian Carp GLRI Funding to be Requested			
	USGS	USACE	Illinois DNR	USFWS	USGS	USACE	Illinois DNR	USFWS
Assessment in the Mississippi Basin: diet, reproductive analysis, birthplace origins, ploidy, age, growth, and genetics.	\$30,000				\$62,000			
Year 2, Advancing eDNA Sampling and Other Genetic Tools								\$267,000
Early Life History					\$131,000			
Telemetry					\$250,000			
Monitoring and control				\$100,000				\$200,000
Bait project	\$40,000				\$50,000			
Monitoring population front in IWW and Middle Mississippi River							\$200,000	
TOTAL	\$70,000			\$100,000	\$493,000		\$200,000	\$467,000

Project Explanation

Black Carp (*Mylopharyngodon piceus*) is an invasive species that is undergoing rapid expansion in the United States. Commercial fishers and fishery biologists have collectively reported over 150 captures of Black Carp, with the majority of fish collected in the last five years (Nico and Neilson 2017). To leverage existing ongoing commercial fishing efforts and opportunistically collect critical data on Black Carp (physical specimens and life history information), SIU administers a bounty funded by the Illinois DNR. Reports from commercial fishers in 2017 revealed that Black Carp have spread to the Illinois River (Peoria pool) and Ohio River. The first evidence of reproduction in the wild was reported in 2016, when researchers from the Missouri Department of Conservation (MDC) and the U.S. Fish and Wildlife Service (USFWS) captured 63 YOY Black Carp in an agricultural ditch near Cape Girardeau, Missouri. In 2017, two additional YOY were captured in the same agricultural ditch during agency sampling. The increased captures in recent years and evidence of reproduction indicate that Black Carp are established in the Mississippi River basin and are expanding their range.

Recognizing the emerging threat, an interagency Black Carp Working Group (BCWG) was formed in 2016 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 ACRC Asian Carp Action Plan underscored the partnership’s concern for this growing threat and, identified the data needs and highest priorities of actions to be taken to manage and control this species in light of the significant increases in documented occurrence and upstream range expansion in recent years. Most notably, 2017 captures from the Peoria Pool of the Illinois River now place Black carp just over 150 miles from Lake Michigan, an advance in the known range of this species of over 160 miles (Figure 1).

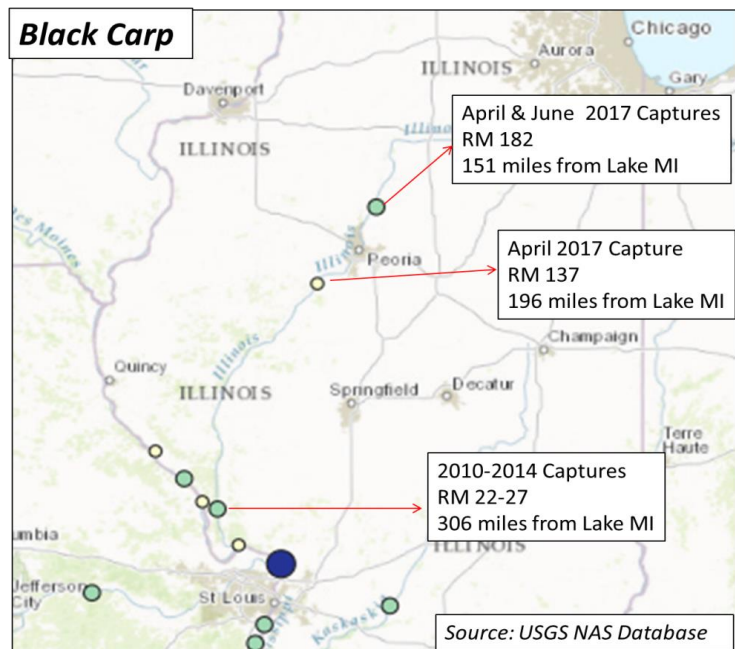


Figure 1

In order 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. The establishment of the BCWG (led by USFWS with participation from SIU, USGS, USACE, MDC, KDFWR, and Illinois DNR) began to address these knowledge gaps. This interagency template includes projects from collaborators as part of a coordinated research, monitoring, and development of control technologies for a comprehensive program in FY2018; and beyond and recommended implementation of a monitoring and removal program in 2019 and beyond, both identified as high-priorities by the BCWG.

USFWS efforts focus on monitoring and field collection of specimens, focused in the areas of new range expansion, using new methodology (hydroacoustics as well as working with commercial fishers to identify and refine traditional methods (hoop and gill netting). We will also collaborate with the USACE to continue work on eDNA marker refinement and field detection, as well as genetic estimation of spawning population sizes.

USGS efforts are a combination of four projects, three which have been on-going and cover research on early life history and biology and ecology of these fish including assessment of diet, reproductive analysis, birthplace origin, ploidy, age growth and genetics. USGS has been researching development of baits to aid in control efforts. Telemetry is a new project and is recommended by the BCWG to fill an information gap on this species movement.

USACE efforts focus on advancing eDNA sampling and other genetic tools for the monitoring and detection of Black Carp in surface waters. USACE efforts will be funded through USFWS via an interagency agreement.

Illinois DNR efforts focus on continuing their intense monitoring and surveillance program in the lower Illinois and middle Mississippi Rivers, including an increase in funding for the bounty program.

Summary of Actions to Date

USFWS

Carterville FWCO:

- Collected field samples in four marker validation attempts.
- Established and coordinated the Black Carp Working Group in 2016.
- As part of a monitoring project with SIU, MDC and the assistance of KDFWR, we sampled the Ohio River with several traditional gears.
- Placed water level loggers at strategic points in the agricultural ditch, where YOY were captured, to estimate a relationship between Mississippi River gage height and ditch connectivity to help determine where the YOY could have been spawned.
- Produced handouts to promote the bounty and encourage reporting by the public and other agencies.
- Updated the Black Carp collection protocol and distributed collection kits to interested agencies.

WGL:

- Collaborated with USACE to lab and field validate new 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.

- 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 YOY had been captured.
- Genetic work was also carried out in support of field work to validate species identification of YOY, and to evaluate the number of adults that may have contributed to the YOY captured in 2016. Whole genome data was generated for use by collaborators in research or development of control or other monitoring methods.

USGS:**Life History:**

- Assessed availability of Black Carp brood stock.
- Acquired permit from the state for holding Black Carp at USGS facilities.
- Planned and designed biosecure facility capable of spawning Black Carp without escapement of larvae. Facility is scheduled to be available by midsummer 2018.

Biology and Ecology:

- CERC (with USFWS and SIU) has been working for four years to process Black Carp to generate age, growth, diet information, ploidy, source, maturity and gonad histology, and to archive samples for potential future genetic work.

Bait Development:

- Initiated creation and testing bait for Black Carp. Hatchery raised Black Carp were first trained to feed on Asian clams.
- Tested dose response of antimycin and evaluated delivery methods for the toxic bait.

Telemetry:

- Obtained quotes for telemetry and archival tags.
- Discussed support for telemetry work with stakeholders.

USACE:

- Developed highly sensitive and selective qPCR markers for Black Carp eDNA detection.
- Laboratory validated (with USFWS and USGS) three qPCR markers that can be analyzed in single reactions with an internal positive control to check for inhibition.
- Assisted in field validation of eDNA markers with USFWS.

Illinois DNR:

- Developed intense monitoring program using expertise from river ecologists, fishery biologists, contracted commercial fishers, which has resulted in the large increase of detections in the Illinois and Mississippi Rivers. Management has consisted of removal of each detected fish and use of the whole fish to inform biology and ecology.
- The bounty program is managed separately and is the basis for detecting Black Carp in these rivers.

FY2017 Actions**USFWS:****Cartersville FWCO:**

- Established BCWG.
- Updated Black Carp collection protocol.
- Made Black Carp identification handout and handout on what to do when you capture a Black Carp.
- Sampled for Black Carp in the Ohio River as part of a larger monitoring project with SIU and MDC.
- Installed data loggers in the agricultural ditch where young-of-year were found
- Seined in the agricultural ditch.
- Contacted commercial fishers to gauge interest in contracting for FY2018.
- Planned for FY2018 post-hoc sampling of USGS-NAS Black Carp capture sites, in collaboration with SIU.

WGL:

- Used traditional sequencing techniques to confirm species identification done visually in the field for age 0 or small fish that may be difficult to identify. All fish captured by MDC were sequence confirmed, 63 of the 78 fish provided were confirmed as Black Carp, in addition to two fish from November 2015. Reported to Q. Phelps 17 March 2017.
- Tested, optimized and collected data on multi-locus microsatellite markers from the literature to determine relatedness or parentage of the YOY fish. Completed, 18 variable loci were amplified for all of the YOY fish. Final analyses are being finalized and will be included in MDC reports.
- Used Next Generation sequencing techniques to generate whole genome sequences for Black Carp in US waters. Whole genome raw data has been collected and is in the process of being assembled.

USGS:**Biology and Ecology:**

- Continued to work with collaborators on commercially-captured Black Carp, to provide aging and diet information from captured fish, to inform directions of diet selectivity research.
- Provided reports on findings (age and growth, cohort strength, age at maturation, and collection numbers and locations) to the Mississippi River Basin Panel, Indiana DNR, Upper Mississippi River Asian carp working group, Midwest Fish and Wildlife Conference, American Fisheries Society, Missouri Aquaculture Association, and writers group for the Binational Black Carp Risk Assessment for Black Carp in the Great Lakes.
- Kept database on Black Carp captures and provided information as needed and to the USGS NAS.
- Performed morphometric analysis of Black Carp and Grass Carp juveniles and adults to improve field identification characteristics.
- Performed gonad histology on captured Black Carp large enough to be potentially mature; to determine age at maturation and time of year that fish are spawning. Inadequate numbers of mature fish have so far been captured at the critical times of year

to fully describe maturation parameters, but gonadosomatic indices indicate that male Black Carp are maturing at approximately 750 mm and females at approximately 1 m total length.

- Began diet analysis from Black Carp gut samples. At this time, approximately 40 fish of widely varying sizes with substantial gut contents have been captured and the gut contents picked, separated and prepared for final identification and quantification, which has just begun. An additional 10 fish with gut contents have been captured which will be included in the first analysis and publication, but which are still in the preparation for identification process. Part of this analysis will include parasitic flukes found in the gut of Black Carp which have life cycles that also use native mollusks. These flukes are specific to clades of mussels and thus the fluke species can be used to identify diet organisms that may not be present in the gut of the fish at the time of capture.

Bait Development:

- Determined bait size selectivity of approximately 550 mm Black Carp using readily available *Corbicula sp.* Asian clams, including largest particles eaten readily compared to target size Black Carp (important because larger baits will exclude more non-target fish, and simplify attachment of toxic bead).
- Determined isomers of antimycin present in purchased antimycin, for determination of relative toxicity of the bait.
- Tested prototype vials for delivery of toxicant. Determined the propensity of hollow vials of different types to be broken when attached to bait and eaten by Black Carp. Assessed different attachment methods and determine method most likely to result in a vial broken by the pharyngeal teeth of a Black Carp
- Tested oral toxicity of small buccal doses of concentrated antimycin A solution to Black Carp.
- Performed first test of toxicity to Black Carp of vials containing antimycin A solution, attached to clams. In that test, most vials were broken but no fish were killed. Assessed behavior of Black Carp that consumed the vials.
- Purchased and retrieved additional Black Carp to replace those used in toxicity testing trials.

Telemetry:

- Obtained quotes for telemetry and archival tags.
- Discussed support for telemetry work with stakeholders.

USACE:

- Development and validation of new eDNA markers.

Illinois DNR:

- Monitoring and bounty programs have resulted in the increased level of detections discussed in the introduction.

Proposed Actions for FY2018**USFWS:****Cartersville FWCO:**

- Continue coordinating the Black Carp Working Group, improving reporting, and supporting members' projects as needs arise.
- Support Black Carp bounty through advertising, creating a standardized protocol for collecting data on the habitat where the capture occurred and, the gear used.
- Collect eDNA samples as needed by the USFWS Whitney Genetics Lab and USACE as they develop and test new sampling methods.
- Assist USGS in tagging and tracking Black Carp.
- Use base funds to hire commercial fishers to capture Black Carp, while a USFWS biologist collects data on the methods used and habitats sampled. Commercial fishers are more likely to be able to capture Black Carp than agencies, due to their high sampling volume and local knowledge. Follow up on past Black Carp captures that were reported to USGS-NAS to collect data post-hoc on the habitat and conditions in which they were captured.
- Hydroacoustics, sediment grabs, visual observation, and other sampling methods will be used to determine potentially unique characteristics about the habitats at which Black Carp are being captured. Weather and river conditions from NOAA and USGS databases could also be utilized.
- Continue to monitor the agricultural ditch with MDC. We propose kayaking the length of the ditch to map its depth and locate potential nursery or spawning habitats.
- Continue to monitor water level and temperature using loggers. Seining, electrofishing, and netting may be used to sample for Black Carp.
- Provide field support for a partner who will run the FluEgg program to improve the estimates of where the young-of-year were spawned.
- Use the data gathered from previous years to inform a monitoring and removal program (may include eDNA, netting, electrofishing, contracted fishing, or other techniques). Implementation of this program is subject to the results from USFWS and others in FY2018, as monitoring and removal approaches will need to be developed and adapted as needed. We anticipate that the monitoring and removal programs would continue as long as there is a need to do so.

WGL:

- Continue to provide sequence confirmation of visual Identification of YOY and genotype all viable YOY Black Carp samples available.
- Finalize genome assembly for Black Carp.
- Assist USACE with development of field sampling method that will successfully detect Black Carp DNA in large rivers.

USGS:**Life History:**

- Purchase or collect Black Carp brood stock.
- Spawn Black Carp and prepare developmental series similar to those published for Bighead, Silver, and Grass Carp.
- Retain adequate voucher specimens from all developmental stages for sharing with collaborators.

- Develop temperature based developmental rate model for Black Carp.
- Measure egg sinking rates for Black Carp.
- Assess directionality and swimming speeds of Black Carp larvae.
- Assess Black Carp swimming behavior similarly to previous assessments of Bighead, Silver, and Grass Carp.

Biology and Ecology:

- Publish results of morphometric analysis to assist in field identification of Black Carp.
- Provide eyes, genetic material, otoliths, and capture data to collaborating agencies as appropriate.
- Continue to collect and process gut samples, but complete final identification and quantification of samples collected in prior to the end of FY2017 by January 2018.
- Complete first draft publication on Black Carp diets in the U.S. and submit for journal publication.
- Participate in the Binational Risk Assessment, which should be completed and released in FY2018.
- Complete aging of Black Carp collected through FY2017. Publish a document including age structure of Black Carp population by mid-FY2018. This will likely be co-authored with SIU and USFWS and contain information on ploidy and natal origins (hatchery or wild birth).
- Continue to work with collaborators on commercially-captured Black Carp, to provide aging and diet information from captured fish, to inform directions of diet selectivity research. Perform gonad histology on captured Black Carp large enough to be potentially mature; if possible determine age at maturation and time of year that fish are spawning.
- Continue to reach out to commercial fishers, fish processors, and recreational fishers to insure and increase the supply of research organisms.

Bait Development:

- Perform additional trials of the oral toxicity of antimycin to Black Carp, using the vial and bait design, using higher doses of antimycin than in the first trial. Assess behavior of carp that consume piscicide-bearing vial. Determine minimum dosage required to result in mortality of most Black Carp that consume and break the bead.
- Perform an analysis of prey selectivity of selected prey types that are available, including unionid mussels with morphology similar to threatened or endangered species
- Design and test trays for the efficacy in retention of model baits under simulated lentic and lotic conditions.
- Test toxicity of antimycin formulations via bioassay at regular intervals for 1 year to determine degradation rate of antimycin and solvent under simulated field conditions.

Telemetry:

- Purchase required tags, receivers, and hydrophones. Transmitters and archival tags for up to 30 fish will be purchased, and with sufficient CART tags to double tag 15 fish. NOTE: fish will not be tagged or released in Illinois waters, per the request of Illinois DNR.
- Hire technicians for telemetry work.
- Inform/work with proprietors of existing telemetry receiver network to inform them of the presence of telemetered Black Carp.
- Contract commercial fishers to collect live Black Carp for implantation.

- In late FY2018, begin capture and implantation of Black Carp.

USACE:

- Following up on size fraction results with maximum volume-selective filtration sampling of aquatic systems known to house Black Carp. Include comparative sampling with standard approaches. Focus on minimum of three classes of sampling location: large river, backwater sloughs (or similar structures), and smaller creeks or irrigation ditches.
- Following up on identification of habitat-selective sampling and sediment/near sediment sampling for Black Carp. Include comparative sampling with standard approaches. Focus on minimum of three classes of sampling location: native mussel beds, sites with high Dreissenid mussel densities, select “baseline” locales.

Illinois DNR:

- This project uses large river ecologists, contracted commercial fishing, and proven and possibly experimental gear to increase capture of Black Carp. Efforts to further identify food resources in these captured fish will be heightened. Coordinated through INHS, the use of ecologists and fishers will concentrate within the leading edge of the population to heighten ability to predict population trends, beginning just above and below Lock and Dam 26.
- 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.
- Efforts were heightened through a bounty program and those efforts will continue with Illinois DNR funds.

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

- Support the Illinois DNR Black Carp bounty through advertising, improved data collection, and financial support if available.
- Take eDNA samples as needed to facilitate marker development and testing.
- Contract commercial fisher(s) to capture Black Carp and provide data on captures.
- Work with SIU to conduct post-hoc sampling of habitat at Black Carp capture sites.
- Continue to monitor water level loggers in the agricultural ditch.
- Continue to sample for Black Carp in the agricultural ditch.
- Travel the length of the agricultural ditch to map habitat.
- Provide field support for the FluEgg model to estimate Black Carp spawning locations.
- Improve reporting in the Black Carp Working Group.
- Continue FY2018 actions.
- Implement eDNA surveys to locate Black Carp if sampling technique is ready.
- Recommend removal of Black Carp based on FY2017 and FY2018 data.

WGL:

- Continue to provide sequence confirmation of visual identified YOY Black Carp.
- Conduct relatedness and/or parentage analysis of wild-caught Black Carp age classes. Estimate effective number of breeders or effective population size if genotype data is robust enough for analysis methods.
- Finalize genome assembly for Black Carp, make available to collaborators to develop new tools for monitoring or control of Black Carp, publish results in peer-reviewed journal.
- Develop specific Standard Operating Procedure for Black Carp eDNA monitoring program. Implement eDNA monitoring program if new sampling methods are developed.

USGS:**Life History:**

- Purchase or collect Black Carp brood stock.
- Spawn Black Carp and prepare developmental series similar to those published for Bighead, Silver, and Grass Carp.
- Retain adequate voucher specimens from all developmental stages for sharing with collaborators.
- Develop temperature based developmental rate model for Black Carp.
- Measure egg sinking rates for Black Carp.
- Assess directionality and swimming speeds of Black Carp larvae.
- Assess Black Carp swimming behavior similarly to previous assessments of Bighead, Silver, and Grass Carp.
- Create pictorial developmental series for Black Carp.
- Validate or develop key to distinguish Black Carp from other Asian carps at all possible developmental stages.
- Develop temperature dependent developmental model for all Black Carp developmental stages.
- Publish the above in the peer reviewed literature.
- Incorporation of Black Carp data into FluEgg model.

Biology and Ecology:

- Publish results of morphometric analysis to assist in field identification of Black Carp.
- Provide eyes, genetic material, otoliths, and capture data to collaborating agencies as appropriate.
- Continue to collect and process gut samples, but complete final identification and quantification of samples collected in prior to the end of FY2017 by January 2018.
- Complete first draft publication on Black Carp diets in the U.S. and submit for journal publication.
- Participate in the Binational Risk Assessment, which should be completed and released in FY2018.
- Complete aging of Black Carp collected through FY2017. Publish a document including age structure of Black Carp population by mid-FY2018. This will likely be co-authored with SIU and USFWS and contain information on ploidy and natal origins (hatchery or wild birth).

- Continue to work with collaborators on commercially-captured Black Carp, to provide aging and diet information from captured fish, to inform directions of diet selectivity research. Perform gonad histology on captured Black Carp large enough to be potentially mature; if possible determine age at maturation and time of year that fish are spawning.
- Continue to reach out to commercial fishers, fish processors, and recreational fishers to insure and increase the supply of research organisms.

Bait Development:

- Perform additional trials of the oral toxicity of antimycin to Black Carp, using the vial and bait design, using higher doses of antimycin than in the first trial. Assess behavior of carp that consume piscicide-bearing vial. Determine minimum dosage required to result in mortality of most Black Carp that consume and break the bead.
- Perform an analysis of prey selectivity of selected prey types that are available, including unionid mussels with morphology similar to threatened or endangered species.
- Design and test trays for the efficacy in retention of model baits under simulated lentic and lotic conditions.
- Test toxicity of antimycin formulations via bioassay at regular intervals for 1 year to determine degradation rate of antimycin A and solvent under simulated field conditions.
- In Arkansas aquaculture ponds or ponds in China, test trays for efficacy in retention of bait and acceptability as feeding stations to naïve Black Carp.
- Initiate pond tests with toxic baits.
- Submit publications on food particle size selection and oral toxicity of piscicides to Black Carp.
- In laboratory, assess non-target mortality in other fishes which might consume the bait (catfishes, common carp, freshwater drum).
- Finish toxicity testing for the shelf life of antimycin A and begin preparation of publication.

Telemetry:

- Purchase required tags, receivers, and hydrophones. Transmitters and archival tags for up to 30 fish will be purchased, and with sufficient CART tags to double tag 15 fish.
- Hire technicians for telemetry work.
- Inform/work with proprietors of existing telemetry receiver network to inform them of the presence of telemetered Black Carp.
- Contract commercial fishers to collect live Black Carp for implantation.
- In late FY2018, begin capture and implantation of Black Carp.
- Continue tagging fish until all tags are deployed.
- Track fish at least 8 boat-days per month for first year. When a fish is located during warm months, attempt to locate multiple times over a 24-hour period to assess daily movements, for at least one fish per month. In following years, the amount of active tracking will be based on success of first year and data needs.
- Acquire telemetry results from tagged Black Carp on receiver array.
- Plot movements of Black Carp using GIS/tracking software.
- Beginning after 1 year of deployment, attempt to recapture any Black Carp found in a location where recapture is likely to be successful, to download archival tag data. If Black Carp are recaptured, download tag and re-implant in the same or a different Black Carp.

- Provide interim reports to USFWS, MRBP, Asian carp river basin working groups, and at scientific meetings, as appropriate.

USACE:

- Collect samples, complete lab tests, and determine outcomes for larger-volume water samples and sediment samples to determine the best sample collection method for eDNA monitoring.
- Complete reports on best eDNA collection methods.

Illinois DNR:

- This project uses large river ecologists, contracted commercial fishing, and proven and possibly experimental gear to increase capture of Black Carp. Efforts to further identify food resources in these captured fish will be heightened. Coordinated through INHS, the use of ecologists and fishers will concentrate within the leading edge of the population to heighten ability to predict population trends, beginning just above and below Lock and Dam 26.
- 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.
- Efforts were heightened through a bounty program and those efforts will continue with Illinois DNR funds.
- Continue monitoring and bounty program efforts.

What Is Deliverable for this Funding**USFWS:****FY2017**

- **FWCO:** Updated Black Carp collection protocol, Black Carp identification handout, “Keep, Cool, Call: What to do if you capture a Black Carp” handout, data from sampling in Ohio River, data from water level loggers
- **WGL:** Confirmation of identification of YOY Black Carp in Mississippi River waters, optimized multi-locus data or determines that different microsatellites. Raw genome sequence data generated.

FY2018

- **FWCO:** Report on connectivity of the agricultural ditch, report on post-hoc sampling of Black Carp captures and contracted commercial fishing captures detailing habitat characteristics of these locations, report by BCWG of overall plans and progress.
- **WGL:** Confirmation of identification of YOY Black Carp captured by partners as part of any of the carp monitoring programs, results of relatedness/parentage analysis. The final assembly of full Black Carp genome will be published and made available to public and partners.

USGS:**Life History:**

- FY2018: Acquire brood stock, spawn Black Carp and collect data.

Expected Completion Date for Project**Biology and Ecology:**

- Complete analyses of gut contents, aging, and ploidy on samples collected through FY2017 band draft several publications.
- Continue to collaborate to catalogue age, diet, origin of birth, and building upon information in the publications.

Bait Development:

- Submit note on oral toxicity of antimycin formulations to Black Carp.
- Submit publication on food particle size and preference for different shaped mollusks

Telemetry:

- Acquire tags, begin tagging and tracking fish (dependent on arrival of funding and delivery of transmitters and archival tags).
- Tag and track fish, provide interim reports on results to USFWS, stakeholder groups, and to a scientific meeting.
- Collect samples and data to determine a new eDNA sample collection method for detecting Black carp eDNA in large river systems. Aggregate Black Carp sequence data and create RADseq markers.

Outcomes/Outputs**USFWS**

- This work will continue to advance the knowledge of Black Carp biology, ecology, and status, and then implement a monitoring and removal program based on that information.

USGS**Life History**

- Black Carp will be able to be modeled in FluEgg to allow for inference of nursery habitats and predict dispersal of this species to better inform future monitoring and control efforts.

Biology and Ecology

- Understanding on the diets, genetics, age structure, and reproductive status of invasive populations will benefit control efforts taken in the future.

Bait Development

- The expected product would be bait which can be deployed as a protection against predation of endangered mussels, or as a rapid response in the case of an introduction Black Carp to a new location.

Telemetry

- A better understanding of the long-distance dispersal and movement of rare fish in very large river systems.

USACE:

- New and better technical capabilities for obtaining eDNA detections for Black Carp (and, potentially, other species) that include a better understanding of where and when to sample for Black Carp eDNA (and similar species), better capability for tracking changes in spread of Black Carp towards Great Lakes region. A technical report providing guidelines for Black Carp eDNA monitoring.

Illinois DNR:

- Annual observance of and capture of wild caught Black Carp will increase. Maximize biological information by expediting collection and dissection of specimens working with USGS, USFWS, and SIU to identify ploidy, environmental history, age, growth rates, and diet.

Potential Hurdles**USFWS:**

- Availability of funds.
- Development of a method for using the Black Carp eDNA marker in the field.
- Continued solvency of the Illinois DNR bounty as captures increase.
- Coordination among a diverse group of partners.
- Ability to capture Black Carp given their rarity.

USGS:**Life History**

- Availability of broodstock could be limited from the aquaculture industry. As a back-up plan, the Louisiana Department of Natural Resources has indicated that they will help collect Black Carp brood stock from the Atchafalaya basin if Black Carp cannot be purchased. Black Carp are considered to be most abundant in that location but successful collection of wild brood stock cannot be 100% assured.
- Spawning difficulties (must achieve a minimum number of spawning events with adequate number of brood stock and with high quality eggs and larvae).

Biology and Ecology

- Sample sizes can be low, due to the rarity of this species, but increased efforts in areas with more fish to the south and increased communications with commercial fishes have resulted in collection of more individuals over time.

Bait Development

- Efficacy of the delivery vehicle and delivering enough antimycin in one oral dose to kill a Black Carp.
- Regulatory hurdles in deployment of the developed bait.
- Unknown difficulties in development of artificial baits that are attractive to Black Carp or finding alternative live baits that will not themselves become invasive.

Telemetry

- Black Carp are rare and it may be difficult to capture fish for this project.
- Mortality of fish is possible, but Black Carp are similar to Grass Carp in morphology, and we have been successful in tagging and tracking Grass Carp.
- There is a substantial possibility that most of the fish will not be detected by active tracking, or not detected often. For this reason, individual detections of fish will be used

heavily, and fish will be followed for a time to get the most potential data out of a detection, and to determine if fish move to different locations at night or different times of day.

USACE

- Black Carp eDNA may be so rare at low population densities that only infeasible volumes of water would be required for detection.
- Existing information on Black Carp spawning is inadequate for predictive purposes or does not apply well to North American populations.

Illinois DNR

- Increased immigration from out-populations could outpace removal efforts (being investigated by stock assessment, population estimates, and comparing catch rates).
- Removal efforts can be affected by weather and river levels. Effort will be scheduled to minimize these factors or rescheduled in case efforts need to be canceled for safety concerns.
- Without sufficient immigration and/or recruitment, removal efforts could drive population down without immigration (as designed) which could preclude removal of 400 tons annually. In this case removal efforts can be optimized at new levels.
- Black Carp may occupy habitats of the river that may be hard to sample, even with focused efforts.

29. Grass Carp Monitoring, Research, and Response Actions

Lead Agency: USFWS

Agency Collaboration: Michigan DNR, Ohio DNR, USGS, Ontario Ministry of Natural Resources and Forestry, DFO-Canada, Great Lakes Fishery Commission, New York Department of Environmental Conservation, Pennsylvania Boat and Fish Commission, Michigan State University, University of Toledo, Bowling Green State University, University of Illinois, and Central Michigan University

Funding Table:

Funding	Agency Funding Expected			Asian Carp GLRI Funding to be Requested			
	Michigan DNR	USGS	USFWS	Ohio DNR	Michigan DNR	USGS	USFWS
FY2018	\$350,000	\$425,000	\$75,000	\$210,000	\$325,000	\$325,000	\$60,000

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Introduction

U.S. and Canadian resource management and research agencies in the Lake Erie basin have identified the growing threat of invasive Grass Carp as a high priority requiring focused and aggressive monitoring and control action in 2018. Grass Carp have historically been documented within the Great Lakes basin for decades, with records of captures of individual adult specimens going back to the 1980's (USGS NAS Database). Captures have included both triploid (reproductively sterile) and diploid (reproductively viable) adult Grass Carp, with the greatest total numbers found in Lake Erie.

More recently, agency monitoring has yielded strong evidence of expanding natural reproduction by Grass Carp in the western basin of Lake Erie, primarily in the Sandusky River and, to a lesser extent, the Maumee River. Additionally, the binational study, *Ecological Risk Assessment of Grass Carp (Ctenopharyngodon idella) for the Great Lakes Basin*, identified the potential susceptibility of Lake Erie to Grass Carp introduction and establishment, further underscoring the need for management action. Based on available physical habitat, temperature profile, high biological productivity and other factors, Lake Erie was identified as potentially highly susceptible to Grass Carp establishment relative to other Great Lakes. To address the threat, in 2016, Michigan DNR, collaborating with Michigan State University, Ohio DNR, USGS, USFWS, Ontario Ministry of Natural Resources and Forestry, Department of Fisheries and Oceans Canada, Pennsylvania Fish and Boat Commission, New York Department of Environmental Conservation, Illinois DNR, University of Toledo, and Central Michigan University 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. Lake Erie management and research agencies are now utilizing this structured decision making model to serve as a baseline process to inform development of new actions including: gathering key data on Grass Carp population status and life history (e.g. address data gaps and address critical questions on Grass Carp population dynamics); develop new, state-of-

the-art detection tools; quantify and map potential habitat available for Grass Carp within the basin; and develop effective control options for potential use within a comprehensive control strategy. Additionally, other key research is being conducted to address data gaps and critical questions on Grass Carp population dynamics that would benefit control actions within the basin.

ACRCC state and federal member agencies have developed a suite of proposed actions for implementation in 2018, building off existing efforts within the Lake Erie basin. Planning is being conducted in collaboration with the Council of Great Lakes Fishery Agencies Lake Erie Invasive Fishes Committee and the Council of Lake Committees Lake Erie Committee (LEC), which has identified addressing the Grass Carp threat as a high priority for strategic action among its agency membership with jurisdictional management authority. Efforts to manage Grass Carp support the coordinated and cooperative fishery management conducted by Lake Erie agencies signatory to the *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 Carps in the United States*. These efforts are further supported by the Great Lakes AIS Early Detection program, conducted by USFWS in collaboration with State and Federal agency partners to provide targeted surveillance for non-native species (including Grass Carp) in high-priority (highest risk) locations within the basin.

Project Explanation

Grass Carp have been detected in low frequencies in Lake Erie proper for nearly three decades, with the first documented occurrence in 1984. Recently, documented reports of Grass Carp have increased in the Lake Erie system in all jurisdictions. Since 2011, Michigan DNR and Ohio DNR staff-initiated activities to address knowledge gaps associated with Grass Carp in the Lake Erie system, and to understand capacity to impact Grass Carp abundance in the system. These projects have included collaborative projects with Michigan DNR, USGS, and USFWS to determine ploidy status of all Grass Carp collected in western Lake Erie, using otolith microchemistry, determining natal origins of Grass Carp collected in Lake Erie, assessment of production from specific tributaries in Lake Erie (Sandusky River), and developing an understanding of movement patterns, habitat use, and aggregation of Grass Carp. Additionally, as a part of a multi-jurisdictional Asian carp response, Ohio DNR and Michigan DNR developed and implemented an assessment/response exercise to develop readiness for a multi-jurisdictional AIS response, gather demographic, abundance, and distribution information on Grass Carp, and test the efficacy of eDNA (and other information) for targeting sampling activities to affect Grass Carp control or eradication activities.

The presence of Grass Carp in the Great Lakes, while undesirable, offers an opportunity to study their reproduction and population dynamics at an early stage of establishment. Although behavior and physiology of adult Grass Carp differs from Bighead Carp and Silver Carp, their spawning and early life history requirements are quite similar. Grass Carp often spawn with Silver Carp, their eggs and larvae drift similarly, and their young are often captured together in the same type of habitat. Wherever Grass Carp can successfully spawn and recruit, it is likely that Bighead Carp and Silver Carp also would be successful. Thus, what is learned studying Grass Carp will be transferable to Bighead Carp and Silver Carp and be useful for managers in planning rapid response and control methods for those fishes should they invade the Great Lakes. Outcomes will also be applicable elsewhere in the United States where there is concern about the expansion of Asian carp.

In autumn 2012, six 1-year-old, diploid Grass Carp were captured in the Sandusky River, a major tributary to western Lake Erie. USGS researchers from GLSC and CERC, collaborating with colleagues from Bowling Green State University, concluded using otolith microchemistry that these fish were probably spawned in the Sandusky River. This was the first inferred evidence of spawning of Grass Carp in a Great Lakes tributary. Since 2012, more evidence has been assembled of spawning of Grass Carp and the spatial scale of the population. Several diploid fish have been captured in Lakes Erie and Michigan since 2012, and various lines of evidence suggest many were naturally reproduced. In 2015, the University of Toledo collected the first genetically-confirmed Grass Carp eggs in the Sandusky River on five different sampling dates during three separate high-flow events. Several diploid fish were also captured in Lake Ontario and Lake Michigan. In 2016, Grass Carp were captured as far east as Dunkirk Harbor in Lake Erie. In 2017 more than 7,800 Grass Carp eggs were sampled over 4 days during two spawning events in the Sandusky River, demonstrating a probable increase in size of the spawning population. Also, the first developing eggs were captured in the Maumee River, demonstrating a second spawning tributary (and possible population). These research results increased interest in developing a strategic research plan focusing on Grass Carp biology and reproduction in the Great Lakes.

The six spawning events in the Sandusky (2015, 3 events; 2017, 2 events) and Maumee (2017, 1 event) Rivers provided opportunities to model hatching and spawning locations of Grass Carp. Hatching locations permit refinement of risk analysis (i.e., how probable is recruitment from a spawning event?) and potentially control measures, and spawning locations inform where and when control measures that interfere with spawning might be deployed. Modeling of the 2015 events identified spawning locations in the Sandusky River within a range of ~1.5 river km near Fremont, Ohio. Steady-state and unsteady-state hydraulic models suggest a wider range of potential hatch locations. A new USGS-gaging station installed in the mid-reaches of the Sandusky River in 2017 will provide data to further refine hydraulic models, which will further refine projections of hatching and spawning locations. An existing hydraulic model for the Maumee River has been identified and will be evaluated for utility.

New information, as a part of collaborative research outlined above suggests that:

- Grass Carp continue to be in low abundance and widely distributed during non-spawning periods (LEC/USFWS surveillance).
- Some natural reproduction for Grass Carp is occurring in Lake Erie (USGS/Michigan DNR otolith microchemistry)
- Grass Carp are utilizing specific tributaries periodically for reproduction (USGS/UT Sandusky River egg sample collections).
- 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 (Michigan DNR/Ohio DNR acoustic telemetry).

Ohio DNR Actions

For this project, Ohio DNR is proposing to combine previous knowledge with additional information gained through our proposed work, in an attempt to further refine when and where Grass Carp (or other Asian carp) response actions can be most effective for control/eradication. This project will combine knowledge gained from egg/larval collections in the Sandusky River, coupled with egg stage information and FLUEGG/HEC-RAS hydraulic model outputs to estimate probable locations of fertilization for Grass Carp eggs collected in the Sandusky River system in 2015. In addition to this information, hydraulic condition estimates, thermal, and reproductive life-history characteristics will be summarized for Grass Carp, and time and space bound estimates of probable Grass Carp reproductive locations will be established in the Sandusky River. Ultimately, collaborators will assist in implementing an intense, traditional gear sampling strategy at limited locations (and times) in the Sandusky River in an attempt to validate spawning location information as predicted from the above, ongoing research. Lastly, as a part of this project, post-response action of larval and egg collections will continue to help inform frequency of reproductive activity, and effectiveness of actions. Ultimately, this project will help inform Ohio's response strategies, as identified in the Asian Carp Tactical Plan, and should guide future AIS responses in Ohio.

Michigan DNR Actions

Michigan DNR will work to implement a response action for Grass Carp in Lake Erie by conducting actions within Michigan's waters, work collaboratively with other states as requested, and continue to serve as a coordinator for lakewide projects. Michigan DNR will develop a dedicated Grass Carp response crew to respond timely to findings and congregations of Grass Carp as well as assist other jurisdictions and regional partners (e.g. Ohio, USFWS). There will be a continued partnership and reimbursement program with Michigan commercial fishers for retention and handling of Grass Carp for scientific purposes to continue to collect information for contribution to the response effort. While no additional fish will be tagged, staff will continue monitoring tagged fish for behavior and location observations. Additionally, enhanced acoustic telemetry equipment will be acquired and placed to address knowledge gaps related to where and when to effectively implement response actions and increase Grass Carp monitoring to evaluate range expansion and search for potential locations for removal efforts. Michigan will continue to dedicate resources to continue to build on regional partnerships to gain information on the life history of Grass Carp in Lake Erie that will then inform control and monitoring efforts.

To enhance regional collaboration and scientifically driven response actions, Michigan will contract with Michigan State University (MSU) on behalf of the Lake Erie jurisdictions to coordinate and host workshops with all partners for the Structured Decision Making working group to work towards attaining regionally desired outcomes that consist of implementing an adaptive management approach.

USFWS Actions

Sequencing the entire genome of all four species of Asian carp from specimens collected in U.S. waters is advantageous, because it provides detailed information on the species that is useful in multiple applications, from designing new eDNA markers for detection programs, to developing potential molecular or genetic control mechanisms. It is important to use wild-caught fish from U.S. waters so that future work can be reasonably expected to be effective on the invasive population in the U.S. and, avoid including confounding genetic variation from the native range

that is likely to be present in data from public data bases such as GenBank. Including genetic diversity from the native range would make eDNA markers or genetic control efforts less effective in the invasive range, where there is much less genetic variation present. WGL has collected raw data from Bighead, Grass, Silver, and Black Carp from a minimum of 4 wild-caught specimens of each species. This raw data must be processed so that genomes can be assembled, which is a computationally time intensive effort, and the computational needs are available for WGL staff at USGS UMESC.

Grass Carp genome assembly will be prioritized so that new eDNA markers can be developed and tested over the winter months. The goal will be to have several lab-validated markers ready for field validation in early spring, and fully validated markers ready for implementation in the 2018 eDNA season, particularly in Lake Erie waters. Work with data generated in FY2017 has indicated a large amount of variation in the 4 Grass Carp specimens that were collected and, creates concern that we may not have captured the genetic diversity present in US waters, which could lead to less effective eDNA markers or control measures for this species. Thus, we intend to obtain samples from the ploidy program data base to ensure that we capture genetic diversity present in US waters. These samples will have to be processed so that raw data can be generated and included in the Grass Carp marker development portion of this work. Raw genomic data for these new specimens can be collected by December 2018, and the data worked into the pipeline of genome assembly that has been established by working on the other three species.

USGS Actions

USGS research on Grass Carp is diverse, merging biology and hydrology to better understand spawning, recruitment, seasonal and spawning-related movements, proximal cues for spawning, and behaviors that might be used in control efforts. Results of this research program form the base of knowledge for managers to formulate potential control and management strategies and tactics under an Integrated Pest Management (IPM) framework following outcomes of the Structured Decision-Making workshops to identify management alternatives.

There is no evidence to date on whether Grass Carp form aggregations. Location of winter aggregations would be most easily accomplished through the use of “Judas” fish. The use of telemetered sterile fish has potential applications in the study of habits of Grass Carp. There have never been any investigations directly comparing the movements and habits of triploid and diploid fish. Knowing if there are differences will help to inform telemetry efforts underway in Lake Erie, where fish captured by either agencies or commercial fishermen in Ohio and Michigan waters are tagged with acoustic tags and released to be tracked.

Truman Reservoir in Warsaw, Missouri offers an ideal location to answer these key questions. Grass Carp are currently present in Truman Reservoir and have been found to spawn in at least four of its tributaries. Because of an ongoing study on Paddlefish, Truman Reservoir is already outfitted with stationary telemetry receivers, and University partners are present on the lake tracking the fish from boats during some seasons. Truman Reservoir is located in a zone cold enough to induce winter behaviors, but the central part of the reservoir rarely if ever freezes, which would allow physical tracking and other work during the winter months.

In addition to knowing Grass Carp spawning areas in the Sandusky and Maumee Rivers, knowledge of the specific proximal spawning cues related to high flow events will also inform management options. Evidence to date strongly corroborates that high-flow events are necessary for successful spawning, but the specific cues to which Grass Carp react are not known. Ponds at

USGS Columbia Environmental Research Center (CERC) have been engineered to create a circular, flowing environment (the Round River) provide an environment suitable to studies of effects of increased velocity, increased turbidity, and decreased temperature using diploid fish in a controlled environment. First efforts in 2017 induced spawning, proving concept for using the ponds to test proximal cues.

Although the Sandusky and Maumee Rivers are presently the only known spawning tributaries, spawning in other potential tributaries can't be ruled out. Complete knowledge of all spawning tributaries is necessary if control measures are to be attempted and successful. High-probability tributaries (based on current knowledge) can be sampled or when direct sampling is not possible, otolith microchemistry can be used to infer where fish have been, provided water chemistry is known. New water chemistry data will be collected in unsampled streams and at unsampled flow levels in all streams to build a library that can be used to assess where Grass Carp may have been given their otolith microchemistry. In 2016, USGS worked in collaboration with Bowling Green State University (BGSU) on a pilot project to determine uptake of Strontium (Sr) in Grass Carp otoliths (strontium to calcium ratios are a diagnostic metric). BGSU began a follow-up study in 2017 to build on results of the pilot study.

Ongoing research at the USGS CERC lab, in which adults are raised to maturity in ponds and then spawned to produce fry for experimentation, can be augmented to assess thermal thresholds in a controlled environment. Knowing thresholds will further refine understanding of when spawning can be expected in natural waters. Fully understanding and predicting recruitment events, which will be critical information for control efforts, requires sampling of fry to link to specific spawning events. Experiments were successfully conducted in 2017 to test the effect of light color and other relevant factors (e.g., turbidity). That study will be published in 2018, and a second-generation validation study might be conducted in 2018.

The directly observed 2015 and 2017, suspected 2013, and demonstrated 2011 spawning events, increasing numbers of diploid Grass Carp captured throughout the Great Lakes, and observations of subtle shifts in vegetation communities in western Lake Erie has USGS researchers concerned about the potential for Grass Carp to have already begun to alter vegetation communities in western Lake Erie. Broad-scale surveys of vegetation using remote sensing and GIS mapping, coupled with on-the-ground samples in key locations in the lower Sandusky River and upper Sandusky Bay will permit assessment of what, if any, effect Grass Carp may have already had on aquatic vegetation communities and establish baseline conditions for assessing future effects. The two different remote sensing methods at different scales can be validated with on-the-water sampling.

Summary of Actions to Date

Ohio DNR

Since 2011, Ohio DNR and other agencies have collaborated on Grass Carp sampling and messaging to inform current knowledge gaps and ensure consistent messaging associated with this invasive species in western Lake Erie. The critical knowledge gaps include basic life history characteristics, such as population size, reproductive capacity, and seasonal habitat use, which are needed to inform and implement effective control measures. In the past two years Michigan and Ohio have been proactive in providing resources for sampling efforts and research projects to address these information gaps that have been the limiting factor in developing a scientifically based Grass Carp control plan. Sampling efforts have included leading a multijurisdictional

Grass Carp response exercise in western Lake Erie in 2014, partnering with commercial fishing operations to remove Grass Carp, and conducting early life history sampling to detect potential locations of reproduction. To date, information gained through on-going work has provided insight on the current risk, distribution, and life history of Grass Carp in western Lake Erie, but because of low samples sizes many of the knowledge gaps persist, thus jeopardizes the effectiveness of control measures. Michigan and Ohio have actively participated in developing the study design and have assisted with sample collection. The two agencies played a critical role as liaisons between the commercial fishermen and university investigators. The ultimate goal of these research projects was to gain additional information to develop more effective control/eradicate response plans for Grass Carp.

The specific actions undertaken in FY2016 and FY2017 included:

- Continued to supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River.
- Further developed and analyzed hydraulic models and coupled with egg stage development information.
- Analyzed all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry, in partnership with Central Michigan University and USGS.
- Estimated age, growth rates, and maturity status of all Grass Carp removed from the Great Lakes, in partnership with USGS.
- Developed and implemented a planned action with multiple organizations using traditional gear at specified locations in the Sandusky River. A total of eight Grass Carp were collected and all these individuals were triploid.

Michigan DNR

In FY2017, Michigan initiated a Structured Decision-Making process that was used to strategically address regional concerns and knowledge gaps. Michigan DNR partnered with Michigan State University's Quantitative Fisheries Center, partner agencies (e.g., Lake Erie Committee and Department of Fisheries and Oceans Canada), and subject matter experts to determine a regional and science-based approach for eradicating Grass Carp in Lake Erie. This proposed Lake Erie Grass Carp response plan is based on recommended outcomes from the SDM process that link directly with implementation of an adaptive management framework for the eradication of Grass Carp in Lake Erie. The proposed response plan will utilize existing state funding and leverage state funds to compete for multiple federal funding opportunities to optimize the plan's implementation and likelihood for success. In addition, partner agencies will be utilized to the fullest extent and incorporated into these planning efforts. The Grass Carp response plan is designed for 5-years at which point it will be re-assessed and future management direction will be determined.

USFWS

In 2017 USFWS accomplished the following:

- Tissue samples from all four species were obtained and raw data generated.
- Grass Carp mitochondrial genomes (smaller than whole genomes) were assembled and preliminary work on eDNA marker creation was started. Results indicate we need additional specimens to capture genetic diversity in US waters to increase marker performance.

- Data analysis methods were researched and small test analysis runs were completed.
- Only the mitochondrial genomes of Grass Carp have been assembled and preliminary eDNA marker development has been started to test methods so that once additional data are collected, work can proceed quickly.

USGS

In 2017 USGS accomplished the following:

- Collected Grass Carp eggs during several spawning events in the Sandusky River and Maumee River.
- Deployed 20 thermographs at 10 stations along approximately 15km of the Sandusky River to determine spawning locations and to model probability of successful hatch.
- Used the FluEgg model and a multiple-simulation approach to project spawning and hatching locations for Grass Carp in the Sandusky River.
- Calculated egg densities in the Sandusky River from 2015 and 2017 egg sampling to make a first-level comparison of magnitudes of the spawning events.
- Initiated collaborative sampling with Michigan DNR, USFWS, and DFO to increase spatial scale of sampling for larvae following collection of confirmed Grass Carp eggs.
- Continued to collect otolith core oxygen isotope and transect microchemistry and isotopes to determine spawning locations and basin-wide movements.
- Sampled water chemistry of dozens of Great Lakes tributaries to establish library of water chemistry for estimating potential spawning tributaries.
- Continued work on first-generation probabilistic models of risk of spawning using hydrologic and meteorologic variables.
- Developed and verified age estimation methods for Grass Carp.
- Aged Grass Carp and collected GSI and gonad histology to determine age of maturation in the Great Lakes basin.
- Validated otolith core oxygen isotope ratio method for identification of aquaculture fish through measurement of isotopes of triploid and diploid fish from aquaculturists that produce Grass Carp for stocking. Continued to perform otolith core measurements of oxygen isotopes of Grass Carp collected from the Great Lakes basin to establish extent of escapement of illegally-stocked diploid fish as a contribution to the Great Lakes Grass Carp population versus natural reproduction within the basin.
- Began the development of a FluEgg module to simulate the entire hydrograph (un-steady flow), rather than using just the peak flow to improve simulation realism on egg transport.
- Installed an acoustic Doppler velocity meter (ADVM) to measure velocity and water-surface elevation at Wightman Cove in the Sandusky River near the mouth (Fall, 2016), which will be used to refine and validate the hydraulic model.
- Installed five pressure transducers to measure continuous water-surface elevation and water temperature data at five locations along the Lower Sandusky River.
- Developed a 2D HEC-RAS model encompassing the Sandusky and Muddy Creek Bays and, connected to the 1D Sandusky RAS model.
- Used FluEgg to simulate transport of eggs in the lower Sandusky River for seven successful egg-sampling events in 2015.

- Monitored bowfishing tournaments in order to retrieve any tags captured by bowfishers and to distribute information on the need to return tags (one tagged fish was captured by a bowfisher, but the tag was damaged by the arrow).
- Conducted three experimental trials to evaluate proximal cues for Grass Carp spawning in experimental mesocosms evaluating variables including water velocity, turbidity, and temperature. Spawning behaviors and successful fertilization of eggs were observed in one trial.
- Completed analysis of gonad histology of Grass Carp collected from the Great Lakes from 2015-2017 for determination of age at maturation and time of year of maturation.
- Completed first-generation maps of aquatic vegetation for western Lake Erie, and using results of gap analysis from 2016, identified high-priority areas for vegetation inventory and monitoring using both remote sensing and on-the-ground validation sampling.
- Completed data analysis of aquatic vegetation collections throughout western Lake Erie, including species composition and relative abundance, distributions, presence of non-native species and identification of areas with abundant vegetation and validate remote sensing and hydroacoustics for assessment of presence of aquatic vegetation. Several poster presentations are planned for 2018.
- Developed a model for areas of western Lake Erie with inadequate imagery for mapping vegetation.
- Provided recommendations on simple practices to enhance egg/larvae sampling campaigns for capturing the main mass of drifting eggs using FluEgg simulation results from historical recruitment events (2017).

Proposed Actions for FY2018

Ohio DNR

Ohio's goal is to process information and further develop Ohio's planned response activities and, incorporate into Ohio's Asian Carp Tactical Plan. The specific actions for FY2018 include:

- Continue and supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River to measure potential reproductive response of action,
- Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry in partnership with CMU and USGS,
- Estimate age, growth rates, and maturity status of all Grass Carp removed from Lake Erie, in partnership with USGS,
- Building on the efforts in 2017, develop and implement an expanded planned action using traditional gear at specified locations in the Sandusky River.

Michigan DNR

Michigan DNR proposed actions are all directly linked to achieving the following objectives that are within the Michigan DNR's Grass Carp response plan for Lake Erie. The objectives and specific actions are described below.

- Prevent the introduction of Grass Carp into Lake Erie waters: Law Enforcement and Fisheries Divisions will act to ensure enforcement of Grass Carp regulations, increase awareness to bait harvesters and retailers, bow-fishers, and commercial fishers.
- Monitor for the presence and expansion of Grass Carp in Lake Erie and connecting waters by employing commercial fishers, traditional fisheries monitoring techniques (e.g., electrofishing, gillnetting, etc.), emerging genetic techniques (i.e., eDNA), and

acoustic telemetry and use the data to estimate abundance, determine preferred habitats, and inform changes to existing knowledge of Grass Carp distribution in Lake Erie and connecting waters.

- Maximize life history information gained to refine spatially explicit Grass Carp population model consisting of collecting life history information to inform critical population model parameters, such as survival, age structure, recruitment potential, and movement patterns. Partner with MSU's QFC to update population model parameters to refine expected outcomes for various response actions. Also partner with Great Lakes Fishery Commission (GLFC) and MSU to host coordination workshops to ensure collaboration and information sharing between regional partners.
- Implement control strategy that is linked with current knowledge of distribution and habitat use of Grass Carp in Lake Erie by (1) using otolith microchemistry and acoustic telemetry with passive and real-time receivers to inform the location and timing of agency removal efforts; (2) increase use of acoustic tag and receiver technology (including real-time receivers) to determine finer resolution of Grass Carp movements to help guide removal and monitoring efforts; (3) using established partnerships with other state and federal agencies to maximize removal efforts and implement the Mutual Aid Agree for AIS response in the Great Lakes, as appropriate; (4) build upon existing relationships with commercial fishers to contract and implement effective control actions; and (5) implement and evaluate innovative solutions for controlling Grass Carp, as science becomes available (e.g., bait attractants, behavioral deterrents, etc.).

USFWS

- Assembly and publication of whole genomes for each of the four species.
- Tissue collection of more Grass Carp for additional mitochondrial genome data generation and assembly.
- Creation of new eDNA markers for Grass Carp that have been fully validated and ready for use in the 2018 eDNA season.

USGS

- Develop permanent monitoring/index stations for Grass Carp eggs in the Sandusky and Maumee Rivers.
- Sample the Sandusky and Maumee Rivers and several other Lake Erie tributaries for Grass Carp eggs during high-flow events.
- Continue to refine sampling methods to ensure adequate characterization of spawning duration, magnitude, and conditions.
- If there is an event on the Sandusky River, focus on intense sampling of a single location to characterize dynamics of egg pulses.
- Identify spawning and hatching locations of Grass Carp in the Maumee River (contingent upon suitable HEC-RAS model; may be postponed to 2019 if the existing model is not sufficient).
- Update projections of potentially suitable Great Lakes tributaries for spawning of Grass Carp.
- Perform second-generation light trap experiments to test effects of light intensity independent of color through two experiments: (1) same intensity but different color and (2) different intensities of same color (probably with LEDs).

- Continue to track Grass Carp in Truman Reservoir. Assess size of any schools present with side scan sonar and/or split beam sonar in winter months, attempt to recapture fish with appropriate gear (e.g., trammel nets or trawls) and determine whether Grass Carp are overwintering in single-species or multi-species aggregations.
- Assess movements of both diploid and triploid Grass Carp during spring and summer. Determine if triploid Grass Carp participate in spawning movements like those of diploid fish to assess the potential for triploid fish to fully serve as Judas fish.
- Attempt to try to recapture Grass Carp for retrieval of archival tags. Tags will be re-deployed after data retrieval in the same or different fish.
- Continue to monitor bowfishing tournaments for tagged fish and distribute outreach materials to bowfishers to increase probability of retrieving tags.
- Begin to synthesize 2017 and 2018 Truman Reservoir data.
- Complete gonad histology of Grass Carp collected from Great Lakes, for determination of age at maturation and time of year of maturation.
- Continue operation of water-surface elevation, water-temperature, and streamflow gaging in the Sandusky River.
- Monitor the progress of Ballville Dam demolition project for any changes to channel geometry. Modify the RAS model if required.
- Examine suitability of an existing RAS model for the Maumee River for use in FluEgg to assess spawning and hatching locations; develop a plan for refinement if necessary.
- Complete FluEgg simulations for past high-flow events on the Sandusky River (and potentially Maumee if the existing HEC-RAS model suffices) to assess past successful spawning events and validate FluEgg performance using results from an Ohio DNR-funded dye study and USGS-collected egg data on the Sandusky River concurrent with the dye study.
- Continue work on decision support and visualization tools for Grass Carp data.
- Complete maps of aquatic vegetation for all of Lake Erie (U.S. side) and model vegetation for areas of Eastern Lake Erie with inadequate imagery for mapping.
- Collect second season of maturation status of Grass Carp coupled with thermal data to validate minimum thermal requirements for reproductive maturation.
- Conduct additional research trials in the Round River at CERC to evaluate proximal cues for Grass Carp spawning.
- Assess parentage of thousands of Grass Carp eggs captured in the Sandusky River to estimate the number of spawning adults.
- Test the efficacy of a Grass-Carp-specific bait in controlled laboratory studies, followed by pond trials in 2018 (supported by the “Developing Species-Specific Control Systems for Asian Carp” template).
- 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 (supported by the “Microparticle” template).
- Screen several potential foods and other chemical attractants, conduct focused studies on those that pass screening, and test merging olfactory and auditory stimuli on Grass Carp.

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

- Continue and supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River to measure potential reproductive response of action
- Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry in partnership with CMU and USGS
- Estimate age, growth rates, and maturity status of all Grass Carp removed from Lake Erie, in partnership with USGS
- Building on the efforts in 2018, develop and implement an expanded planned action using traditional gear at specified locations in the Sandusky River.

Michigan DNR

The proposed actions are part of a five-year response plan developed by the Michigan DNR and as such the actions in out-years will be the same as proposed in FY2018. The actions in out-years, however, will also be flexible to incorporate additional knowledge gained in FY2018 to ensure that the implementation of response actions is achieving the highest level of success at working towards to the goal of Grass Carp eradication.

USFWS - None

USGS

- Assess whether removal of the Ballville Dam has resulted in spawning of Grass Carp upstream of the former dam site (contingent upon capturing eggs or larvae from the next spawning event and extension of the FluEgg model upstream of the Ballville Dam site).
- Begin to identify potential control measures to prevent or disrupt Grass Carp spawning.
- Sample for aggregated Grass Carp in Truman Reservoir during winter using a variety of methods.
- Complete synthesis of 2017 and 2018 Truman Reservoir data.
- Complete synthesis of experimental mesocosm results on proximal spawning cues, and use results to support development of potential control measures for disrupting spawning or proper development of eggs.
- Continue operation of streamflow gage during spawning season to provide continuous hydraulic data to support assessment of Grass Carp reproduction in the Sandusky River.
- Complete decision support and visualization tools for Grass Carp data.
- Develop high resolution bathymetry and/or habitat mapping using hydroacoustics of "hot spot" areas in western Lake Erie: Sandusky River mouth, Muddy Creek Bay, North Maumee Bay.
- Complete report on the mapping of aquatic vegetation in Lake Erie for Grass Carp risk assessment.

Timeline for Major Actions**Ohio DNR**

- Continue to refine Grass Carp science.
- Complete large scale planned actions for Grass Carp in the Sandusky River.
- Initiate research project with the University of Toledo to assess probability Grass Carp catchability and apply this to actions in the Sandusky River.

Michigan DNR

- Order and procure equipment.
- Develop tactical implementation approaches.
- Communicate with partners on collaborations.

USFWS

- First and second quarter FY2018:
 - Collect additional Grass Carp specimens from ploidy data base, generate raw data, assemble mitochondrial genomes
 - While additional data are collected, work with current Grass Carp mitochondrial genomes and develop candidate markers for lab testing, which will include:
 - Sensitivity tests to ensure species specificity
 - Multiplexing tests so that detection and confirmation of positive samples can be handled in one reaction to save time and cost for the monitoring program.
 - Repeatability of performance when tested in multiple laboratories.
- Third quarter FY2018:
 - Draft of whole genome publication and submission to peer-review journal
 - Field validation of new eDNA markers for Grass Carp.
- Fourth quarter FY2018:
 - Use of eDNA markers for Grass Carp in the field, minimally in Lake Erie, potentially other Great Lakes tributaries.

USGS

- Establishment of ‘permanent’ index stations for monitoring Grass Carp reproduction in the Maumee and Sandusky Rivers after next major spawning events.
- Determine the existing RAS suffices for modeling Grass Carp egg flow in the Sandusky River or that refinements are required (2018).
- First estimate of size of spawning population of Grass Carp in the Sandusky River from genetic analyses (2018).
- Completion of a more comprehensive water quality database for Great Lakes tributaries (all lakes except Superior) for use in assessing spawning tributaries used by Grass Carp (first generation 2018).

Expected Milestones**Ohio DNR**

- Develop space and time bound predictions of adult Grass Carp spawning aggregations.
- Implement large scale targeted traditional gear planned action using information from previous activities at specified locations in the Sandusky River.
- Complete University of Toledo study on Grass Carp detection probability.

Michigan DNR

- Convene the Structured Decision Making (SDM) working group to coordinate annual implementation of control actions and monitoring for Grass Carp in Lake Erie.
- Finalize the initial Grass Carp telemetry manuscript and initiate project to further refine movements to inform control action, which includes deployment of multiple real-time acoustic telemetry receivers.
- Increase capacity and implementation of control actions in western Lake Erie with response crew and contracts with commercial fishers, including participation in any response exercise hosted by other jurisdictions.
 - Continue to gain information on population demographics to inform the Grass Carp control model developed during initial SDM process.

USFWS

- First quarter FY2018:
 - Complete Grass Carp data collection and mitochondrial genome assembly
 - Set of at least 50 eDNA markers for lab testing
- Second quarter FY2018:
 - Completion of lab validation of a minimum of three new eDNA markers for Grass Carp.
- Third quarter FY2018:
 - Draft of whole genome publication and submission to peer-review journal. Final genomes will be available to any partners prior to publication.
 - Field validation of new eDNA markers for Grass Carp.
- Fourth quarter FY2018:
 - Use of eDNA markers for Grass Carp in the field, minimally in Lake Erie, potentially other Great Lakes tributaries.

USGS

- Collect continuous water depth-data at different locations along the lower Sandusky River (2017-2018).
- Develop hydrodynamic model of Sandusky River and Muddy Creek Bay predicting natural seiche effects (2017-2018).
- Modify hydraulic model accounting for the removal of the Ballville Dam (2018).
- Complete models projecting spawning locations and spawning risk (2017-2018).
- Complete assessment of recruitment success or failure of Grass Carp in the Sandusky River (2018).
- Determine differences on patterns in thermal and flow conditions that were likely conducive to recruitment.

What Is Deliverable for this Funding**Ohio DNR**

- Refinement of Grass Carp science, implementation of planned actions, and initiation of Grass Carp catchability study.

Michigan DNR

- Reduction of Grass Carp in Lake Erie.

- Refinement and understanding of the abundance and distribution of Grass Carp in Lake Erie and a population model to support that understanding.
- Reduced risk of spread of Grass Carp throughout Lake Erie.
- Increased protection for aquatic habitat from damage due to Grass Carp.
- Final assessment and report on control actions.
- Recommendations for future control actions.

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.

USGS

- Reports, publications, and presentations on research:
 - Genetic-based estimate of spawning population using the Sandusky River (supported by the molecular template).
 - Spawning and hatching locations for the Maumee River (contingent on Maumee RAS, which may have to be develop).
 - Thermal maturation thresholds for Grass Carp.
 - Joint USGS-USFWS light trap protocol for sampling Grass Carp larvae.
 - Vegetation maps for historical reference.
 - Assessment of 3-tiered vegetation mapping and validation for monitoring changes in vegetation communities.
 - Distributions of vegetation and assessment of Grass Carp habitats and potential effect on them.
 - Assessment of spawning locations and movements of Grass Carp in Lakes Erie and Michigan based on otolith microchemistry.
 - Comparison of 1D vs 2D HEC-RAS models for assessing Grass Carp spawning locations.
 - Hindcasting of past recruitment events in the Sandusky River to assess recruitment potential.
 - Spawning movements and aggregations of Grass Carp in Truman Reservoir.
- Identification of likely proximal spawning cues for Grass Carp.
- Identification of a suite of potential attractants for Grass Carp (supported by the microparticle and Optimization of Mass Removal template).
- Menu of potential control actions targeting spawning, recruitment, and capture of aggregations of Grass Carp supported by research (merges outcomes of several templates).
- Streamgage installed and maintained in the lower Sandusky River near the mouth.
- Continuous water depth-data at different locations along the lower Sandusky River, data would be published through Ohio WSC.
- Hydraulic data to account for the removal of the Ballville Dam, data would be published through Ohio WSC.
- Hydraulic and FluEgg models archived, including model input and output data (ongoing).

Expected Completion Date for Project

- Ohio DNR - 2019

- Michigan DNR - 2019
- USFWS - September 2018 for genomic deliverables; additional work dependent on partner needs
- USGS - 2018 through 2019 (varies based on project component); additional work dependent on partner needs

Potential Hurdles

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

No potential hurdles to implementing these actions is foreseen.

USFWS

Possible uncertainty genome assembly that could delay final genome products and unexpected difficulty in field validation of new eDNA markers.

USGS

- All work related to spawning of Grass Carp requires additional spawning events. For the past 6 years the pattern has been alternating wet-dry years, with odd years producing spawning events. If that continues all milestones and deliverables related to spawning or products of spawning (e.g., continued analyses of population size) will be delayed.
- Bowfishers may kill or damage tagged fish in Truman Reservoir, causing loss of research organisms.
- Field crew personnel necessary to complete project may be limited.
- Adverse environmental conditions (e.g., floods, droughts) might prevent access or delay data collection.
- Loss of field equipment (receivers, temperature loggers, light traps, bongo nets). Long-term deployed equipment carries the risk of lost and irrecoverable data. Loss of short-term equipment might delay, but not otherwise adversely effect, data collection.
- The inability to induce Grass Carp to spawn in experimental mesocosms without the aid of hormone injections may hinder the ability to fully discern the effect of proximal cues on Grass Carp reproduction.
- Turnover of project personnel; loss of institutional knowledge impedes progress.

30. ACRCC Strategic Communications and Education Implementation

Lead Agency(s): USFWS

Agency Collaboration: National Park Service (NPS) and ACRCC member agencies

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested	
	USFWS	NPS	USFWS	NPS
FY2018	\$100,000	\$0	\$250,000	\$75,000

** All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).*

Project Explanation

USFWS Strategic Communications

USFWS has served as co-chair of the Communication Work Group since the inception of the ACRCC. Through our work with ACRCC member agencies we have coordinated common messaging and media roll-outs, as well as fostered inter-agency collaboration through the management of www.AsianCarp.us the ACRCC’s primary outreach platform. FY2018 requested funding will be used to continue the work started in FY2017 to better target communication efforts to priority audiences, as well as complete the redesign of www.AsianCarp.us.

NPS Educational Activities

Beginning in May 2017, NPS staff at Indiana Dunes National Lakeshore hired three GS-04 Park Guide Pathways interns to initiate an Asian Carp Education team. These three park guides worked on three primary goals:

- Research the Asian carp education status of our region by visiting collaborating partners, meeting with scientists, reviewing a variety of literature and websites, and asking park visitors what they know about Asian carp. The goal was to assess needs and gain a better understanding of the resources available currently about this complex issue.
- Develop updated educational activities and resources for the general public and students.
- Participate in a variety of outreach events throughout the region with a variety of audiences and provide updated information and education about Asian carp to these audiences.

FY2017 Actions

USFWS Strategic Communications

- Enhanced communication support for ACRCC partners for both routine announcements, as well as high profile announcements (e.g. live fish find on June 22, 2017 and subsequent communication coordination, follow-up and messaging).
- Through greater targeted work with the media the Asian carp response actions of the ACRCC were featured in major media outlets including AP, Detroit Free Press, Chicago Tribune, NPR and Reuters, in addition to numerous other local media outlets.
- Worked to update key members of Congress on ACRCC efforts through direct notification and support for Hill briefings.

- Supported ACRCC participation in targeted outreach opportunities with nongovernmental organizations through events like the ACRCC's Chicago public listening session and coordination of requests for ACRCC speakers (e.g. U.S. Power Squadron Presentation).
- Managed and updated www.AsianCarp.us, as well as initiated re-design of www.AsianCarp.us website to improve functionality and better target key audiences.
- Completed ACRCC stakeholder analysis to inform the partnership's strategic communications plan.
- Completed ACRCC partner survey to inform www.AsianCarp.us redesign efforts.

NPS Educational Activities

There were three main outcomes for FY2017 funding:

- Design Asian Carp Traveling Trunks for educators.
- Compilation of educational resources on www.AsianCarp.us website.
- Draft Asian Carp Lesson Plan for middle and high school educators.

Between May and October 2017, the NPS Asian carp team contacted 3,166 people in a wide variety of programs and events. During a three-week period in October, the team engaged 4,500 students and approximately 26 teachers to learn about the importance of Great Lakes ecosystems, including keeping Asian carp out of our waterways. The NPS Asian Carp team engaged students of all grades, conducted activities at three different county fairs in Indiana, did informal interpretation at local waterways with boaters and anglers, participated in local festivals and outreach events. At all of these events, they conducted fun, interactive games and educational programs to teach about Asian carp and their effects in waterways. The NPS Asian Carp team also gathered most of the supplies and activities for the Asian carp travelling trunk that will be used by educators across the region. In addition, exhibits were developed in the park's visitor center about Asian carp to engage visitors. The NPS Asian Carp team has compiled and created a suite of activities for a variety of audiences.

Proposed Actions for FY2018

USFWS Strategic Communications:

- Complete redesign of www.AsianCarp.us.
- Continue to update, refine and implement ACRCC strategic communications plan
- Improve targeted messaging.
- 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 environmental non-profits including, but not limited to briefings, listening sessions, roundtables and site visits.
- Creation of ACRCC branded communication products.
- Management of www.AsianCarp.us.
- Enhanced communication support for ACRCC partners for both routine announcements, as well as high profile announcements.

NPS Educational Activities

In FY2017, the NPS Asian Carp team was able to gain valuable insight into what visitors know and don't know about Asian carp. The NPS Asian Carp team was able to compile a variety of educational materials and activities that can be used by others at programs and events. The NPS Asian Carp team drafted outline for a travelling trunk for teachers. Based on this work, the staff at INDU proposes to focus the 2018 funds on educational programs and teacher workshops on Asian carp of the Great Lakes by hiring a term GS-07 Educator position who can work independently and lead school programs, develop activities, and train teachers on using resources developed. This person will finalize the travelling trunk and market it to teachers throughout the Great Lakes. He or she will work closely with collaborating partners to be involved in a variety of projects and programs throughout the Great Lakes, including Chicago. This person will also work closely with the ACRCC Communications Group. In addition to the term position, INDU would hire visual communication technician who can assist the educator to create visual media around the Asian carp story. This person would make the lesson plans usable and publish on the park's website as well as the larger Asian carp website maintained by ACRCC. He or she will create high quality exhibit materials on Asian carp such as free-standing pull up exhibits and banners.

Potential Out-year Actions (Subject to Future Appropriations)**USFWS Strategic Communications**

- Continue to update, refine and implement ACRCC strategic communications plan
- Improve targeted messaging.
- 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 environmental non-profits including, but not limited to briefings, listening sessions, roundtables and site visits.
- Creation of ACRCC branded communication products.
- Management of www.AsianCarp.us.
- Enhanced communication support for ACRCC partners for both routine announcements, as well as high profile announcements.

NPS Educational Activities

To be determined

Timeline for Major Actions**USFWS Strategic Communications**

- Spring/early summer of 2018 - launch redesigned www.AsianCarp.us website.
- Summer 2018 - finalize strategic communications plan.
- Summer 2018/early fall of 2018 - initiate first targeted outreach campaign with the media that leverages new/updated content of www.AsianCarp.us.

NPS Educational Activities:

- Hire term education specialist position with NPS. (Winter 2017-18)

- Contact stakeholders in the Great Lakes region who work on this issue to assess approaches and possible collaboration. (Winter 2018)
- Finalize and market Asian Carp Traveling Trunks for educators. (By spring 2018)
- Create Asian Carp Lesson Plan for middle and high school educators. (Spring 2018)
 - Research and focus groups to understand need and appropriate target audience.
 - Develop a pilot lesson(s).
 - Test the pilot by teaching the lesson several times. Work with teacher(s) to test and provide feedback.
 - Revise as necessary and create final lesson plan(s).
 - Make the lesson plan(s) widely available by posting online.
 - Host a one-day teachers workshop (ideally with credit) to teach the content, lesson, and provide the materials necessary for teachers to implement in their own classrooms. Workshops could be done in multiple locations. (Summer and Fall 2018)
- Explore Citizen Science engagement approaches. (Winter 2018-Summer 2018)
 - Develop and begin implementation of a detailed lesson plans that primarily are aimed at prevention and early detection information and deliver these lesson plans via web-based systems.
 - Further develop Citizen Science engagement through these lesson plans.
 - Develop a social media strategy specifically targeted at Teachers and students. The strategy will include best practices, content, and messages for communicating with these audiences over platforms that favor visuals and concise, consistent messages.
- Visual communication technician will be hired Spring 2018 to assist Educator and develop visual media for programs, websites and exhibits.

Expected Milestones

USFWS Strategic Communications: FY2018 (note, website redesign actions were started in FY2017 and are currently ongoing in the first and second quarter of FY2018)

- February - finalize www.AsianCarp.us navigation and page designs.
- March - complete content development, including partner review, for www.AsianCarp.us.
- April/May - completed website is shared for partner review, functionality testing.
- June/July - official launch of new website. Begin coordination of targeted outreach campaign for the media that leverages new website content.
- August - review website analytics to track what pages are being accessed and to make sure that website is functioning as intended. Identify and resolve any issues with content or navigation. Implement targeted media campaign.

NPS Educational Activities

- Contact stakeholders in the Great Lakes region who work on this issue discuss project and get input by March 2018.
- Market Asian Carp Traveling Trunks for educators by June 2018.
- Conduct three teacher workshops by October 2018.
- Publish Asian Carp Lesson Plan for middle and high school educators by October 2018.

What Is Deliverable for this Funding**USFWS Strategic Communications**

- Completed redesign of www.AsianCarp.us.
- Updated strategic communications plan paired with a timeline for implementation.
- Creation of key messages that will resonate with selected key audiences (e.g. members of Congress, the media and non-profits).
- Scheduling and coordination of two or more outreach ACRCC opportunities with members of Congress and/or their constituents.
- Scheduling and coordination of two or more ACRCC outreach opportunities with members of the media.
- Scheduling and coordination of two or more ACRCC outreach opportunities with environmental non-profits.
- Creation of ACRCC branded communication products as needed/requested.
- Coordination of posts and content placed on www.AsianCarp.us.

NPS Educational Activities

- Implementation of the Asian Carp Traveling Trunks for educators.
- Compilation of educational resources on www.AsianCarp.us website and NPS website.
- Deliver Asian Carp Lesson Plans for middle and high school educators to at least 45 teachers educated on Asian carp and aquatic invasive species.
- Develop high quality table top/portable exhibit on Asian carp and provide the exhibit plans on the ACRCC website.

Expected Completion Date for Project

USFWS Strategic Communications: NA - Communications work is ongoing.

NPS Educational Activities: 2019

Potential Hurdles

USFWS Strategic Communications: None

NPS Educational Activities

- Coordination of a large number of perspectives to build lessons around those messages.
- Staffing issues.
- Marketing of workshops.

31. ACRCC Partnership Operations

Lead Agency(s): USEPA

Agency Collaboration: Great Lakes Commission, USFWS, Illinois DNR

Funding Table:

Funding	Agency Funding Expected		Asian Carp GLRI Funding to be Requested			Other Funding
	CAWS Advisory Committee	USFWS Program Support	CAWS Advisory Committee	ACRCC Program Support	ACRCC Contract Support	
FY2018	\$0	\$75,000	\$150,000	\$75,000*	\$196,220	Joyce Foundation funding anticipated for CAWS Advisory Committee

*Program Support: ACRCC Program Support - \$75,000 (USFWS), ACRCC Contract Support - \$196,220 (Illinois DNR)

* All FY 2018 Funding Projections are based on the Consolidated Appropriations Act 2018 (Public Law 115-141).

Project Explanation

This project has two components:

- Support for the CAWS Advisory Committee
- ACRCC Program and contractual support for USFWS, Illinois DNR and USEPA.

The threat of Asian carp introduction into the Great Lakes directly affects the Great Lakes Program support includes emergency funding to support rapid response against Asian carp introductions; separation of newly discovered potential pathways of migration and fish suppression activities if new populations are found in the Great Lakes basin; staff and contractor support to the ACRCC agencies in developing reports, tracking activities; providing field support as necessary; development and deployment of training and exercises throughout the basin to enhance agencies' rapid response capabilities; and continued support of the ACRCC's efforts to enhance collaborations among the federal, state, local, and tribal agency partners.

Summary of Actions to Date

CAWS Advisory Committee

The CAWS Advisory Committee provides 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 aims to resolve issues and find common ground; review and provide input on both interim and long-term control alternatives; build consensus on the best path forward; secure leadership from key implementation partners; develop funding alternatives and recommendations for specific actions; and showcase opportunities to improve benefits from the CAWS while preventing AIS transfer.

The Great Lakes Commission provides staff support to the committee through the organization and coordination of regular committee meetings, webinars, conference calls and related activities.

Since 2014 the CAWS Advisory Committee has released a series of consensus recommendations related to GLMRIS and a framework for a long-term solution to prevent AIS transfer through the CAWS while maintaining current uses of the system. With support from a technical consultant, HDR Inc., it prepared a comprehensive summary of technical evaluations assessing the risk of AIS transfer and impacts to navigation from potential ANS control measures and implications for associated issues. It sponsored a case study of the Fargo-Moorhead Flood Diversion Project that illustrated how multiple jurisdictions organized a cost-share partnership for a large water management project. Finally, it developed a detailed outline of hydrologic, hydraulic, and water quality investigations needed to evaluate the conceptual elements for a long-term solution that it recommended for further study. More broadly, the committee provides a credible forum for reporting and receiving input on actions to prevent AIS transfer through the CAWS, including the work of the ACRCC, the USACE GLMRIS, USGS, and others.

ACRCC Program Support

ACRCC Program Support staff have continued to work closely with the Asian carp stakeholder partners. With GLRI funding, ACRCC Program Support has assisted ACRCC activities to ensure agency collaboration and program support for Asian carp-related 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.

ACRCC Contract Support

With GLRI funding, USEPA and Illinois DNR has supported ACRCC contract activities to ensure agency collaboration and program support for Asian carp-related activities, including the following:

- Development and refinement of the Asian Carp Action Plan since 2010.
- Development and delivery of rapid-response training courses and exercises for increased agency capability.
- Contractor support to provide technical expertise and services.
- Facilitation of meetings and outreach activities to keep the public and ACRCC member agencies aware and engaged in the control process.
- Expansion of the monitoring and response support program to allow for increased capacity and for response activities by USFWS, Great Lakes' States, USGS, and other ACRCC partners.

FY2017 Actions

CAWS Advisory Committee

In FY2017, the committee continued to review and provide input on prevention and control actions developed by federal and state agencies. This included a major focus on the USACE's feasibility analysis for the proposed plan for Brandon Road; overall work conducted by the ACRCC; AIS lock treatment concepts; outcomes from hydrology and hydraulic investigations of impacts from AIS controls in the CAWS; cost share options for construction of controls at

Brandon Road; 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.

The Great Lakes Commission hired a new facilitation team to provide neutral facilitation of the committee. Since August 2017 the new team has met or spoken with most of the committee members, attended the USACE's two public meetings on the Brandon Road report, convened two meetings with the CAWS Advisory Committee's steering committee (which works with the facilitation team to plan committee work), and acquainted themselves with the issues, stakeholders, and associated perspectives.

ACRCC Contract Support

Funding will be used for Asian carp efforts to include the following:

- Response Actions, if determined necessary.
- Contract support for USEPA.
- Contract support for ACRCC.

ACRCC Program Support

The ACRCC Program Support provided assistance through the following primary efforts:

- Working with the ACRCC and other stakeholders both in the Great Lakes and in the Mississippi River basins.
- Assist the USFWS in the development of the annual report identified in Water Resources Reform and Development Act of 2014 (WRRDA 2014).
- Ensure bi-national (U.S. and Canada) coordination in sharing of Asian carp control effort information, including efforts under the national Asian carp control plan titled 'Management and Control Plan for Bighead, Black, Grass, and Silver Carp in the United States' and dated November 2007, and the document prepared by the ACRCC entitled '2017 Asian Carp Action Plan'.
- Development of the 2018 Asian Carp Action Plan, including interagency and intergovernmental coordination; and communication and outreach.
- Working with the ACRCC and other stakeholders both in the Great Lakes and in the Mississippi River basins.

Proposed Actions for FY2018

CAWS Advisory Committee

The facilitation team is working with a steering committee to develop new operating principles and decision-making procedures to guide the Advisory Committee's work moving forward. Many committee members are frustrated with the current principles, which require complete consensus of all members for the committee to make statements or recommendations. The facilitators and steering committee will also consider opportunities to strengthen participation and representation of stakeholder groups on the committee. While the feasibility of one-way control measures for Asian carp at Brandon Road are of significant interest to the committee, there is also interest in reinvigorating progress on developing long-term solutions to prevent two-way AIS movement through the CAWS, consistent with the authorized purpose of the GLMRIS study. Toward this end, the committee is considering a new statement building on its January 2016 letter outlining framework for a long-term solution.

The CAWS Advisory Committee is at a point of transition and there is some uncertainty about its structure and operations moving forward. However, despite frustration among some members,

most have expressed support for maintaining the committee—in some form—to continue to explore and advance solutions that enjoy broad support. The Brandon Road TSP likely will be the committee’s primary focus over the coming year, including consideration of the pros and cons of its proposed elements and the level of support that exists for them. Important discussions are taking place that may reveal opportunities for consensus on some elements of the TSP. The facilitation team is engaged in “behind the scenes” conversations that will set the stage for further discussion and negotiation with the full committee. The facilitators have made a concerted effort to consult with industry/navigation stakeholders to understand their concerns and opportunities for compromise. This is revealing more flexibility and less uniformity in views among these groups, which may provide a path forward to achieving consensus on control actions to deploy at Brandon Road, along with measures to mitigate impacts on commercial navigation.

Thus, while there are uncertainties moving forward, the CAWS Advisory Committee has significant potential to outline a proposed approach for control actions at Brandon Road that can attract broad-base support and to provide a powerful voice to advance that plan with both the federal government and regional jurisdictions and stakeholders. Collectively, new operating principles, strong facilitation, and creative thinking among key groups offers promise for making progress over the coming year. This will be a pivotal time as the Corps moves forward in finalizing the Brandon Road plan and options are advanced for funding and non-federal sponsors.

Beyond potential control actions at Brandon Road., the committee will continue to review and provide input on: prevention and control actions developed 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.

ACRCC Contract Support

Funding will be used for Asian carp efforts to include the following:

- Response Actions, if determined necessary.
- Contract support for ACRCC.
- Contract support for USFWS.

ACRCC Program Support

The ACRCC Program Support will provide assistance through the following primary efforts:

1. Working with the ACRCC and other stakeholders both in the Great Lakes and in the Mississippi River basins.
2. Assist the USFWS in the development of the annual report identified in WRRDA 2014;
3. Ensure bi-national (U.S. and Canada) coordination in sharing of Asian carp control effort information, including efforts under the national Asian carp control plans.
4. Development of the 2019 Asian Carp Action Plan, including interagency and intergovernmental coordination; and communication and outreach.
5. Working with the ACRCC and other stakeholders both in the Great Lakes and in the Mississippi River basins.

In FY2018, 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.
- Assist in convening twice a year ACRCC face-to-face meetings to discuss agency input, as directed by the ACRCC co-chairs.
- Convene Congressional briefings twice a year (early March and October), or as needed, 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, by invitation of the host state, as directed by the ACRCC co-chairs.
- Represent the ACRCC on the CAWS Advisory Committee, as directed by the ACRCC co-chairs.

The ACRCC Program Support will assist the Service in the development of the Asian carp annual WRRDA report. This may include assisting with the following:

- Establishing a network of state agency and non-governmental organizational points-of-contact for the WRRDA Report development process.
- Convening regular communications (teleconferences, webinars, in-person meetings), as needed.
- 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 an outreach and engagement strategy on the WRRDA Report conclusions and recommendations with appropriate State and non-governmental partners, following delivery of the WRRDA Report to the designated Congressional committees by the Service.

The ACRCC Program Support 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.

The Asian Carp Action Plan is updated annually and includes a series of other actions, including the research and development of long-term biological controls. Efforts of the ACRCC Program Support will include:

- Convening bi-national ACRCC face-to-face meetings twice a year to discuss progress made on control activities, as directed by the ACRCC co-chairs.
- Convening ACRCC calls once a month to discuss progress made on control activities.
- Convening public updates with agency/stakeholder meetings across the Great Lakes, by invitation of the host state to discuss progress made on control activities, as directed by the ACRCC co-chairs.
- Working with the MRWG on the extensive monitoring under the 2017 MRP for the CAWS and the Illinois River and development and release of the 2018 MRP.

In FY2018, the ACRCC Program Support will assist USEPA, USFWS and the ACRCC members in the identification and development of projects for the 2019 Action Plan. The

ACRCC Program Support will also coordinate the activities of the ACRCC which plans and executes efforts to prevent the unintentional transfer of Asian carp between the Mississippi River and Great Lakes basins. The ACRCC Program Support 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. ACRCC Program Support will coordinate quarterly meetings of the ACRCC and regular teleconferences to ensure a bi-national effort to ensure coordinated and collaborative response to controlling Asian carp. The ACRCC Program Support will also coordinate quarterly (as needed) meetings with ACRCC members.

The ACRCC Program Support will also work with the USFWS and Illinois 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 will also work with the Communication Work Group on the release of the 2018 Action Plan and will work with the MRWG on development and release of the 2018 MRP.

Potential Out-year Actions (Subject to Future Appropriations)

CAWS Advisory Committee

The Committee will continue work from previous years, likely with a focus on advancing work at Brandon Road, should that be the consensus of the committee. This likely will also include discussion of financing and cost-share options, AIS lock treatment concepts, non-structural control actions, etc.

ACRCC Program Support and ACRCC Contract Support

Funding will continue to be used for Asian carp efforts including; Response Actions, if determined necessary; contract support for support of the ACRCC. Direct support for USFWS.

Timeline for Major Actions

CAWS Advisory Committee: The timeline for this project is approximately one year.

ACRCC Program Support and ACRCC Contract Support: The timeline for this project is approximately one year.

ACRCC Program Support and ACRCC Contract Support

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 Advisory Committee members.

- Development of 2019 Action Plan – Fall 2018.
- Development of monthly ACRCC calls.
- ACRCC meetings – twice a year.
- Assistance to MRWG in development of the MRP.

What Is Deliverable for this Funding

CAWS Advisory Committee

The following general deliverables would apply to each Fiscal Year:

- Planning and facilitation support for a minimum of three Advisory Committee meetings.
- Convening calls with the steering committee for the Advisory Committee.
- Planning and facilitation of workgroup meetings and webinars, as needed.

- Coordination with relevant agencies and organizations to secure information and speakers for Advisory Committee meetings and webinars.
- Preparation of correspondence and statements from the Advisory Committee, as requested.
- Mediation of key issues with Advisory Committee members.
- Development of technical presentations and reports, as requested.
- Coordination and communication with the ACRCC, Technical and Policy Work Group, and other relevant groups.

ACRCC Contract Support

- Development of 2019 Action Plan.
- ACRCC meetings – twice a year.

ACRCC Program Support

- Working with the ACRCC and other stakeholders – ongoing.
- Assist development of the annual WRRDA report.
- Development of the 2019 Asian Carp Action Plan.

Expected Completion Date for Project

CAWS Advisory Committee: The requested funding is for facilitation support to the CAWS Advisory Committee for approximately one year. However, the committee'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 the USACE under GLMRIS.

ACRCC Program Support and ACRCC Contract Support: September 2018

Potential Hurdles**CAWS Advisory Committee**

- Resolution of concerns among committee members about the operating principles and decision-making guidelines, and strengthening the overall effectiveness of the committee.
- Continued funding for technical and administrative support to the committee (currently provided separately through foundation support).
- Complete and timely reporting from federal agencies on relevant work (e.g., proposed actions under GLMRIS).

ACRCC Program Support and ACRCC Contract Support: None