

2016 Asian Carp Action Plan

Asian Carp Regional Coordinating Committee



April 2016

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Contributing Members:

Illinois Department of Natural Resources
Illinois Environmental Protection Agency
Indiana Department of Natural Resources
Michigan Department of Natural Resources
Michigan Office of the Great Lakes
Minnesota Department of Natural Resources
New York Department of Environmental Conservation
Ohio Department of Natural Resources
Pennsylvania Department of Environmental Protection
Pennsylvania Fish and Boat Commission
Wisconsin Department of Natural Resources
Ontario Ministry of Natural Resources
Quebec Ministère de la Forêt, de la Faune et des Parcs
U.S. Department of Commerce - National Oceanic and Atmospheric Administration
U.S. Department of Agriculture – Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Department of Transportation/Maritime Administration
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
Fisheries and Oceans Canada
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 Action Plan, formerly the Asian Carp Control Strategy Framework, communicates collaborative efforts among federal, state, provincial and other agencies to achieve the Asian Carp Regional Coordination Committee's (ACRCC) purpose: to prevent the introduction, establishment, and spread of Asian carp into the Great Lakes.

To more clearly communicate the scope of the annual effort the title of the document has been changed from Asian Carp Control Strategy Framework to Asian Carp Action Plan. The new title of this document is intended to provide a better understanding of its purpose – to summarize the portfolio of strategic actions being undertaken by the agencies as a coordinated response to the Asian carp threat to the Great Lakes in 2016. The Action Plan continues to embody components of the previous Frameworks, but includes enhancements for more effective interagency planning and coordination. In addition, in Appendix C, this Action Plan includes a long-term planning horizon that can be used to inform future actions. This document is not a commitment to future funding. All out-year actions beyond fiscal year (FY) 2016 may be adjusted annually based on appropriations and allocations.

Many new or continuing initiatives in this Action Plan fall under three "focus areas".

1. PREVENTION

Pathway Closures & Control Measures

- Construction of a new electric barrier to increase capability to stop fish passage in the Chicago Sanitary and Ship Canal.
- Evaluation of control measures and development of a recommended plan to address upstream transfer of aquatic nuisance species, including Asian carp, at Brandon Road Lock and Dam.
- Closure of Eagle Marsh pathway through construction of a new earthen berm across the floodway at Eagle Marsh in Indiana that prevents the interbasin passage of Asian carp into Lake Erie from the Wabash River.
- Development of closure options at Little Killbuck Creek Pathway and Ohio-Erie Canal pathways.
- Evaluation of Asian carp behavior near barges and in void spaces of barge tows to minimize potential inadvertent fish entrainment through the electric barrier and through locks.

2. DETECTION, MANAGEMENT AND CONTROL

Fishery Management

- Contract fishing to reduce the numbers of Silver and Bighead Carp in the upper Illinois and lower Des Plaines rivers downstream of the electric barrier will be increased by 50 percent.
- An updated response decision support tool will be developed to further outline response actions, as well as situational awareness and concerns throughout the Asian Carp Regional Coordinating Committee (ACRCC).
- Increasing use of small mesh purse type nets will be deployed to target juvenile Asian carp to remove them from waterways before they can breed and to evaluate effectiveness in decreasing juvenile Asian carp densities.
- The Ohio Department of Natural Resources (DNR) and Michigan DNR will be developing an adaptive management framework for Grass Carp capture in Lake Erie and Sandusky Bay.

Development of New Control Technologies and Strategies

- Evaluations on the effectiveness of carbon dioxide (CO₂) as a tool for deterring or controlling Asian carp will continue.
- Development of a microparticle that would demonstrate high toxicity and selectivity for Asian carp will be continued.
- Expanded studies of fish attractants will be undertaken with federal and state agencies, and commercial fishermen.
- The effectiveness of acoustic stimuli for excluding Asian carp will be evaluated.
- Sampling will continue in the Sandusky River and River Raisin to document evidence of Grass Carp spawning and identify potential control technologies.
- Toxicity tests will be conducted on hot water and ozone, singly and in combination, against a broad range of taxa and life stages to determine effectiveness.

Monitoring and Assessment

- Fixed-site monitoring upstream of the electrical dispersal barrier and Seasonal Intensive Monitoring (as identified in the 2016 Monitoring and Response Plan) will continue in 2016.
- Continuing fixed-site monitoring downstream of the electric dispersal barrier and random electrofishing and contracted netting will continue at elevated levels.
- Continued sampling for young-of-year and juvenile Asian carp will take place through netting and electrofishing operations.
- Additional work will be undertaken to better understand population dynamics (stock assessment) of Asian carp in the upper Illinois River.
- A comprehensive and complementary early detection and rapid assessment surveillance program for Bighead, Silver, Grass, and Black Carp in and near the Great Lakes will continue.
- Black and Grass Carp populations in the Chicago Area Waterway System (CAWS) will be analyzed to better understand their risk of invasion to the Great Lakes.

3. MANAGEMENT

Communication and Outreach

- Monitoring and response updates are reported regularly on the asiancarp.us website. The asiancarp.us website will be expanded to include Grass Carp in priority basins.
- Continued efforts to communicate and develop additional mechanisms to share information and engage partners, stakeholders, and the public will be undertaken.

Interbasin Collaboration

- Coordination and communication of lessons learned within and between the partnerships are being facilitated, enhanced, and more formally codified.
- USFWS will continue its increased leadership activities and provide funding to states for high-priority prevention projects for interagency efforts outside the Great Lakes Basin, focusing on the Ohio River and Upper Mississippi River basins.
- Support for interbasin coordination between the ACRCC and other multijurisdictional basinwide partnerships in other parts of the nation to leverage available resources and to maximize conservation benefits will continue.

A full listing of 2016 action items, project descriptions, and intended outcomes is provided in Appendix B of the Action Plan.

1.0 INTRODUCTION

1.1 ABOUT THIS STRATEGY

To more clearly communicate the scope of the annual effort the title of the document has been changed from Asian Carp Control Strategy Framework to Asian Carp Action Plan. The new title of this document is intended to provide a better understanding of its purpose – to summarize the portfolio of strategic actions being undertaken by the agencies as a coordinated response to the Asian carp threat to the Great Lakes in 2016. The Action Plan continues to embody components of the previous Frameworks, but includes enhancements for more effective interagency planning and coordination. In addition, in Appendix C, this Action Plan includes a long term planning horizon that can be used to inform future actions. This document is not a commitment to future funding. All out-year actions beyond fiscal year (FY) 2016 may be adjusted annually based on appropriations and allocations.

1.2 THE CHALLENGE

Addressing the threat of Asian carp represents one of the greatest challenges to protecting the Great Lakes and adjacent aquatic ecosystems from aquatic invasive species (AIS). Throughout this document, Asian carp refers to the following four species: Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), Black Carp (*Mylopharyngodon piceus*), and Grass Carp (*Ctenopharyngodon idella*).

The 2016 Action Plan has been prepared by members of the Asian Carp Regional Coordinating Committee (ACRCC), including state, provincial, and federal 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.

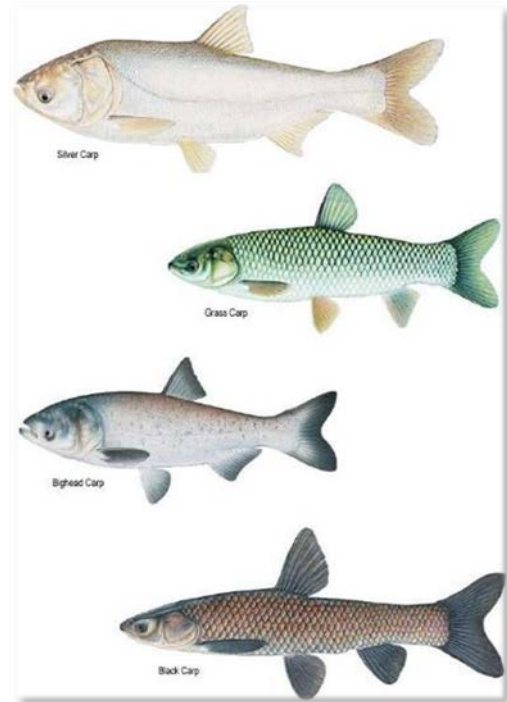
1.3 MISSION OF THE ACRCC

The ACRCC coordinates the 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.

1.4 PURPOSE

This Action Plan describes the strategies and proposed action items to achieve the mission of the ACRCC. This Action Plan identifies the objectives and organizational structure of the ACRCC, including work groups. It focuses on efforts taken within the Chicago Area Waterway System (CAWS) and captures efforts outside the CAWS that indirectly assist the efforts of the ACRCC. The Action Plan specifically addresses the threat of Bighead and Silver Carp; however, the ACRCC members have chosen to also address the threat of Grass and Black Carp. This approach may change in future years as the binational ecological risk assessments for Grass and Black Carp are completed.

In addition, the Action Plan provides a direct link to the 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.

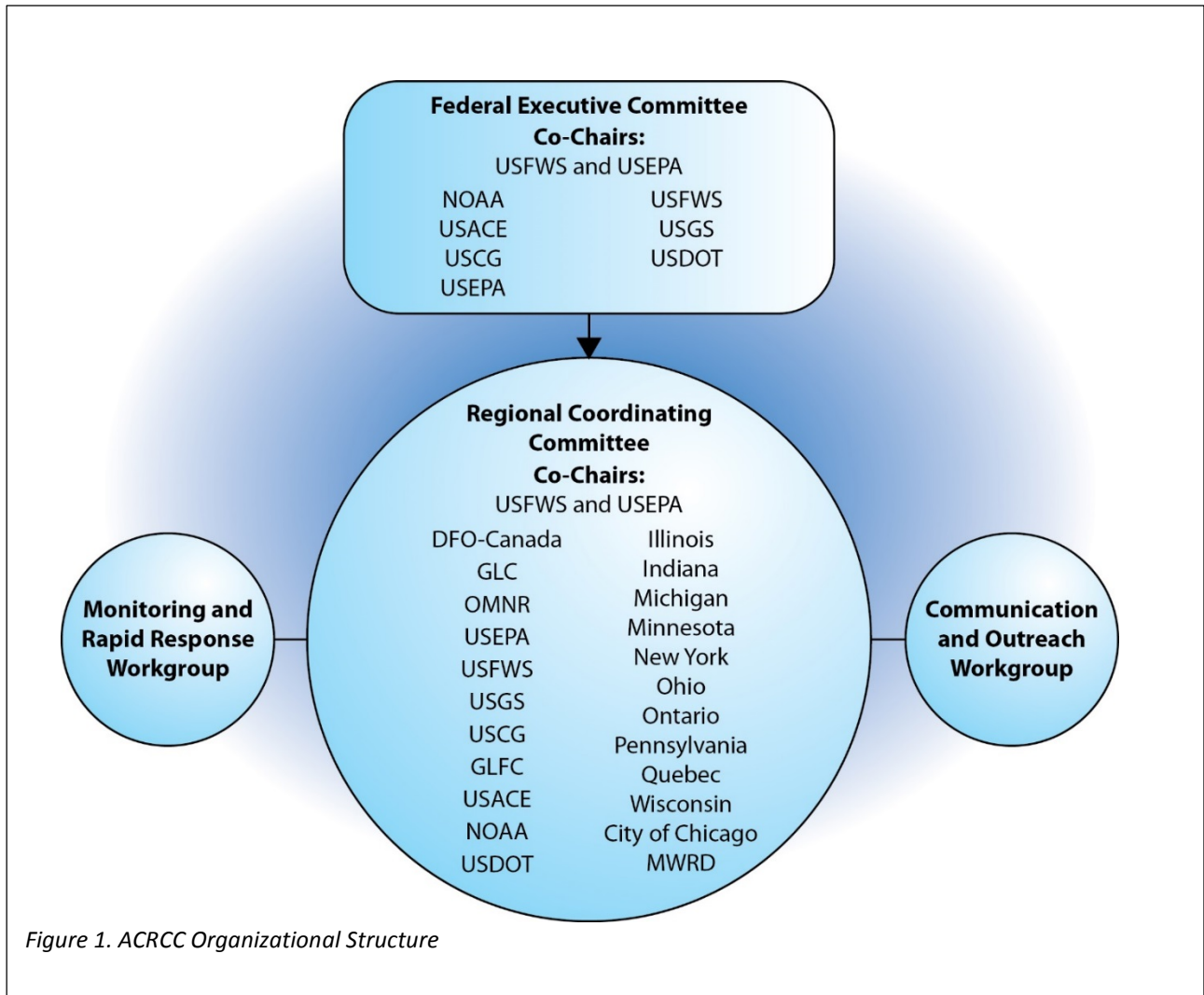


Through the Action Plan, the ACRCC coordinates planning for members to execute projects to achieve the ACRCC's mission. To achieve its mission, the ACRCC's objectives are to:

- A. Promote the collection of biological information on Asian carp, their 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 the 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.

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/CO2_Management_Plan.pdf.

The organizational structure of the ACRCC and its work groups is highlighted in Figure 1 below.



1.5 BACKGROUND ON ASIAN CARP

Recent data indicate that the geographic ranges of Bighead and Silver Carp are expanding in the Mississippi River and Ohio River Basins, threatening invasion into the Great Lakes and other waterways. Additionally, evidence shows the increasing dispersal of Black Carp upstream in rivers of the Midwest United States, including the Mississippi and Illinois Rivers.

The threats from introduced species to our native aquatic ecosystems have existed for many decades. Since the beginning of the 19th century, many non-native species have been introduced into the Great Lakes. Currently, more than 180 of these non-native species are considered invasive, causing ecological or economic damage and threatening human health. These invasive fish, invertebrates, viruses, bacteria, and parasites can devastate native communities and cause great economic damage to the commercial, sport, and tribal fisheries of the Great Lakes. The potential invasion of Bighead and Silver Carp is a serious invasive species threat facing the Great Lakes today. Figure 2 shows the relative abundance of Silver and Bighead Carp in distribution throughout the United States.

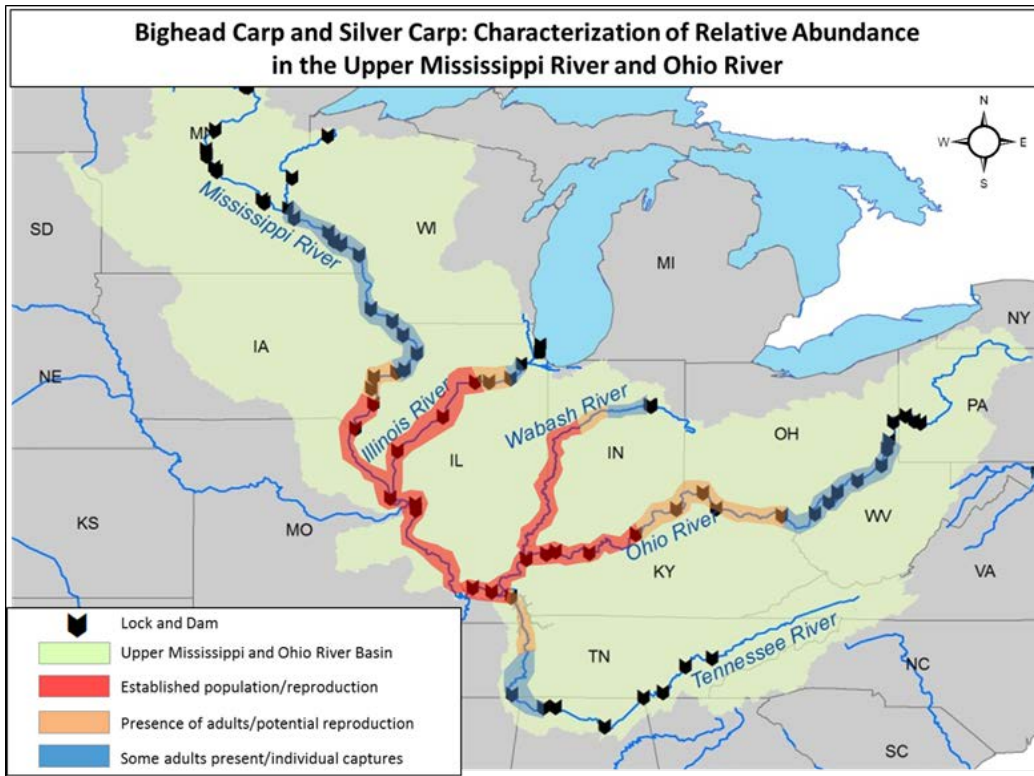


Figure 2. Bighead and Silver Carp Relative Abundance in the Upper Mississippi River and Ohio River

Figures 3 and 4 (on the next page) demonstrate the relative abundance and extent of range expansion and individual new occurrences observed for Grass and Black Carp.

Historically, Grass Carp have been intentionally 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 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).

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



Figure 4. Black Carp recorded occurrences.

longer life span. Recent discoveries of likely reproduction in the Mississippi River suggests this threat could be increasing. Furthermore, their reproduction may increase opportunities for them to cause more damages within invaded areas.

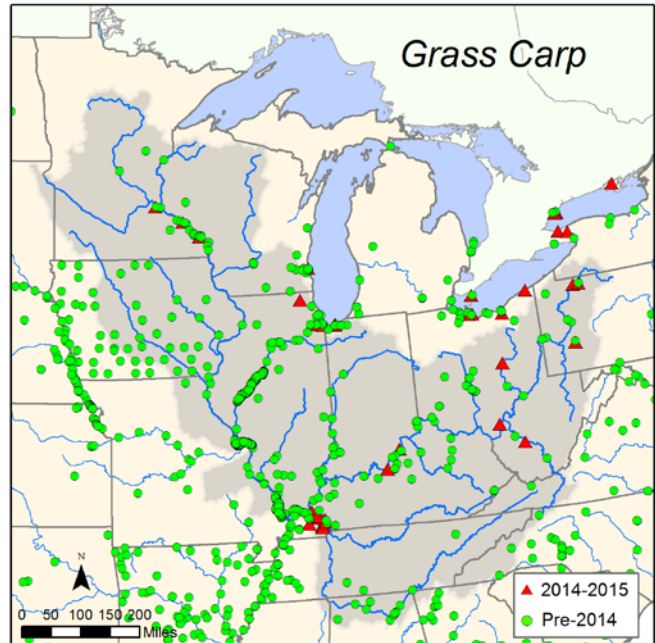


Figure 3. Grass Carp Recorded Occurrences

Act, prohibiting their live interstate movement.

The ecological and economic damage experienced in the Mississippi River Basin after the Bighead and Silver Carp invasion is a forewarning of potential impacts from these species to other watersheds, including the Great Lakes. The continued increases in population size and upstream range observed in the Mississippi River watershed for both Bighead and Silver Carp ultimately inspired extensive mobilization of local, state, and federal agencies and the creation of the ACRCC as a unified interagency team responsible for coordinating and conducting prevention and control activities for the protection of the Great Lakes. Though not as widely distributed as the Silver and Bighead species, Black Carp remain a threat based on their diet, their potential ability to outcompete native species for food, and their

A food web simulation model was used by the National Oceanic and Atmospheric Administration (NOAA) to forecast the potential effects of Bighead and Silver Carp on the Lake Erie food web given varying scenarios of carp diet composition². The model results indicated that Bighead and Silver Carp would reach equilibrium abundance within 20 years and comprise approximately 30 percent of total fish weight in Lake Erie. Most native fishes in Lake Erie were predicted to decline as a result of the invasion. Planktivorous fishes such as Rainbow Smelt, Gizzard Shad, and Emerald Shiner were predicted to decline in biomass from 13 to 37 percent, owing to competition for plankton. Adult walleye were predicted to decline by 8 to 12 percent, owing to declines in biomass of their planktivore fish prey base. Smallmouth Bass would increase by 13 to 16 percent, because of the increases in prey fish biomass provided by young Bighead and Silver Carp. Adult Yellow Perch would increase by <5 percent because of declines in perch larvae mortality resulting from declines in White Perch, a predator of fish larvae. The model forecasts generally were consistent with earlier predictions made by regional experts in Asian carp biology or Great Lakes fish ecology.

Establishment of Bighead, Silver, or Black Carp populations in the Great Lakes could have long-lasting negative effects on lakeshore communities and other stakeholders. Impacts would likely be multifaceted, potentially affecting the ecology, biology, and economic and social function of the Great Lakes region. Each potential impact is interrelated with the others, with complex relationships, necessitating development of an active, multi-disciplinary approach to understanding, addressing, and preventing the introduction of these species into the Great Lakes.

1.6 BIGHEAD AND SILVER CARP POPULATION STATUS IN THE CAWS

Populations of Bighead and Silver Carp in the Illinois River are generally characterized by pool. For reference, Figure 5 illustrates the pools in the upper Illinois River.

Based on the proximity of established populations of Bighead and Silver Carp in the lower (downstream) segments of the Illinois River, intensive ongoing monitoring and control

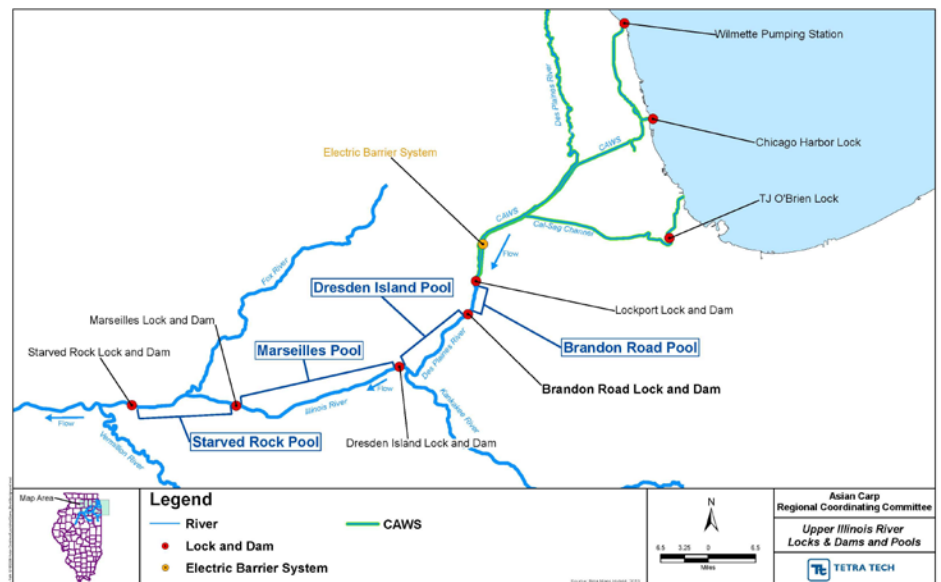


Figure 5. Map of Upper Illinois River Pools

² Zhang, H., E.S. Rutherford, D.M. Mason, M.E. Wittmann, R.M. Cooke, D.M. Lodge, J.D. Rothlisberger, X. Zhu, and T.B. Johnson. 2016. Forecasting the Impacts of Silver and Bighead Carp on the Lake Erie Food Web. Transactions of the American Fisheries Society. Transactions of the American Fisheries Society. 145:1

efforts have been focused on the upper Illinois Waterway (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. Figures 6 and 7 illustrates Chicago-area locations for individual captures of Silver and Bighead Carp.

As part of a comprehensive monitoring plan for assessing location and populations of Asian carp in the IWW, in April 2015, crews detected Silver Carp less than 6 inches in length in the Starved Rock Pool of the Illinois River, just a few miles downstream from Marseilles Lock and Dam near Ottawa, Illinois. Asian Carp less than 6 inches were found as far upstream as Peru, Illinois. These fish were likely spawned in 2014. Focused monitoring through June 2015 did not detect any additional small fish in the Starved Rock, Marseilles, or Dresden Island Pools of the Illinois River, despite historically high sampling rates. From July 2015 to early September (September 7, 2015), 99 Silver Carp less than 6 inches were collected, all within the Starved Rock Pool. In October 2015, two juvenile Silver Carp were captured in the Marseilles Pool, approximately 40 miles downstream of the electric dispersal barriers. Although these fish were just over 6 inches in length, they were aged and determined to be Young-of-Year are the smallest size of Asian carp to be found upstream of Marseilles Lock and Dam. Additionally, three Silver Carp larvae were collected approximately 1.5 miles upstream of the I-55 Bridge (Channahon, Illinois), in the Dresden Island Pool of the Des Plaines River (River Mile (RM) 279.3). These samples were collected in June 2015, but results on processing were released in November 2015 when they were identified to be Silver Carp. These individuals ranged from 8.5 – 10.0 mm (0.33-0.39 inches) total length. Asian carp eggs (either Silver or Bighead Carp) were also identified from

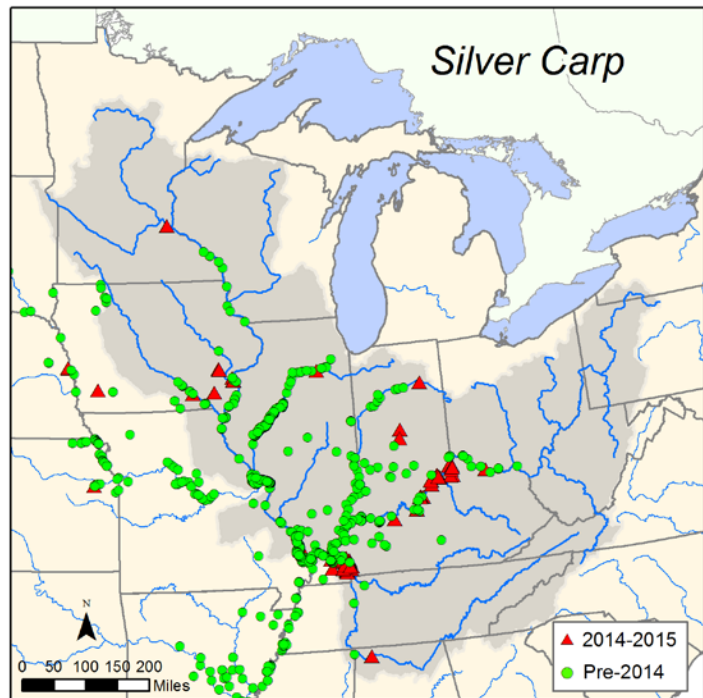


Figure 6. Silver Carp Recorded Occurrences

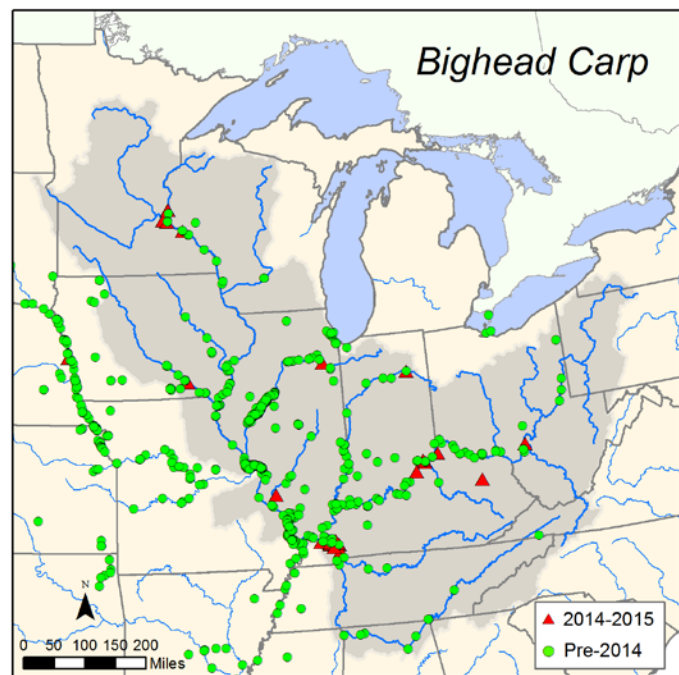


Figure 7. Bighead Carp Recorded Occurrences

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. The Asian carp monitoring and harvest effort in Dresden Island Pool are illustrated in Figure 8 below.

In a proactive response to this preliminary information, ACRCC Monitoring and Response Work Group (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.

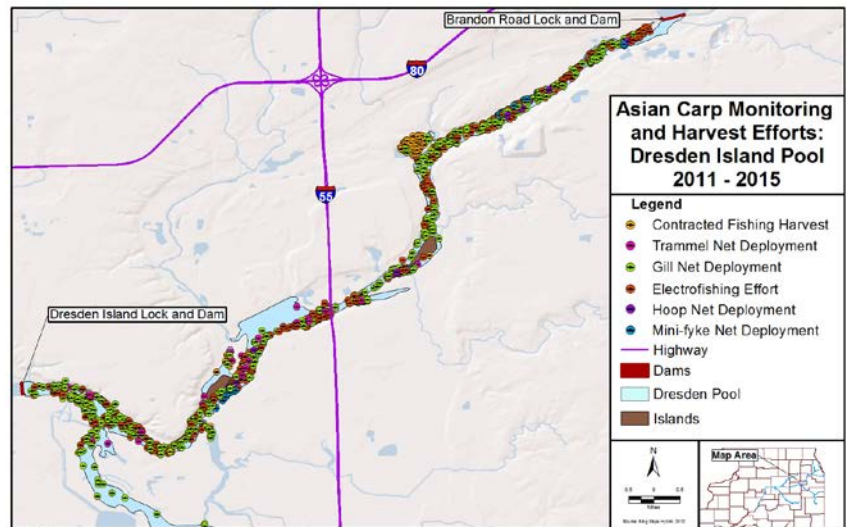


Figure 8. Monitoring and Harvest Efforts in Dresden Island Pool

Given the concern about these findings, the 2016 Monitoring and Response Plan will include 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 will also increase to 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.

Asian carp abundance in the most upstream pool in which they are found (Dresden Island), have shown significant declines in abundance (68 percent) from 2012 to 2014. This reduction is most likely attributed to contracted fish removal efforts. Recommendations to increase fish sampling efforts by 50 percent-100 percent in these river pools are being developed.

In 2015, MRWG concluded that the adult population front of Bighead and Silver Carp is approximately 47 miles and two lock structures from Lake Michigan. The presence of adult and potential spawning locations, including the collection of eggs, of Bighead and Silver Carp, has been determined to be approximately 62 miles from Lake Michigan and includes the Starved Rock and Marseilles pools. The established front of the Asian carp population, verified by successful spawning and presence of all life stages of Bighead and Silver Carp, is more than 100 miles away from the entrance to Lake Michigan, below Starved Rock Lock and Dam within Peoria Pool of the Illinois River. This information is illustrated in Figure 9 on the next page.

Monitoring & Response Plan

The Action Plan is based on the Monitoring and Response Plan (MRP), which uses the best science to help ACRCC members make the most effective management decisions under the Action Plan.

For example, science-based predictive models and risk-assessments are critical for informing managers and scientists on locations at highest-risk for potential invasion, exploitation, or colonization by Asian carp. The following sections describe the various risk characterizations efforts and assessments that have been completed or are currently under way by the ACRCC member agencies. These efforts are evaluating the ecological risk of establishment of Asian carp in the Great Lakes and the social and financial risks associated with establishment. In 2016, the binational ecological risk assessments are expected to be completed for both Black and Grass Carp. The risk assessments will evaluate the probability of introduction (assessing the likelihood of arrival, survival, establishment, and spread) as well as the magnitude of the ecological consequences. Input into the assessments will include research and ecological modeling conducted in both Canada and the United States. Both risk assessments will undergo extensive peer review. The writing team for both assessments consists of Department of Fisheries and Oceans–Canada (DFO), Great Lakes Fishery Commission (GLFC), U.S. Geological Survey (USGS), and the U.S. Fish and Wildlife Service (USFWS).

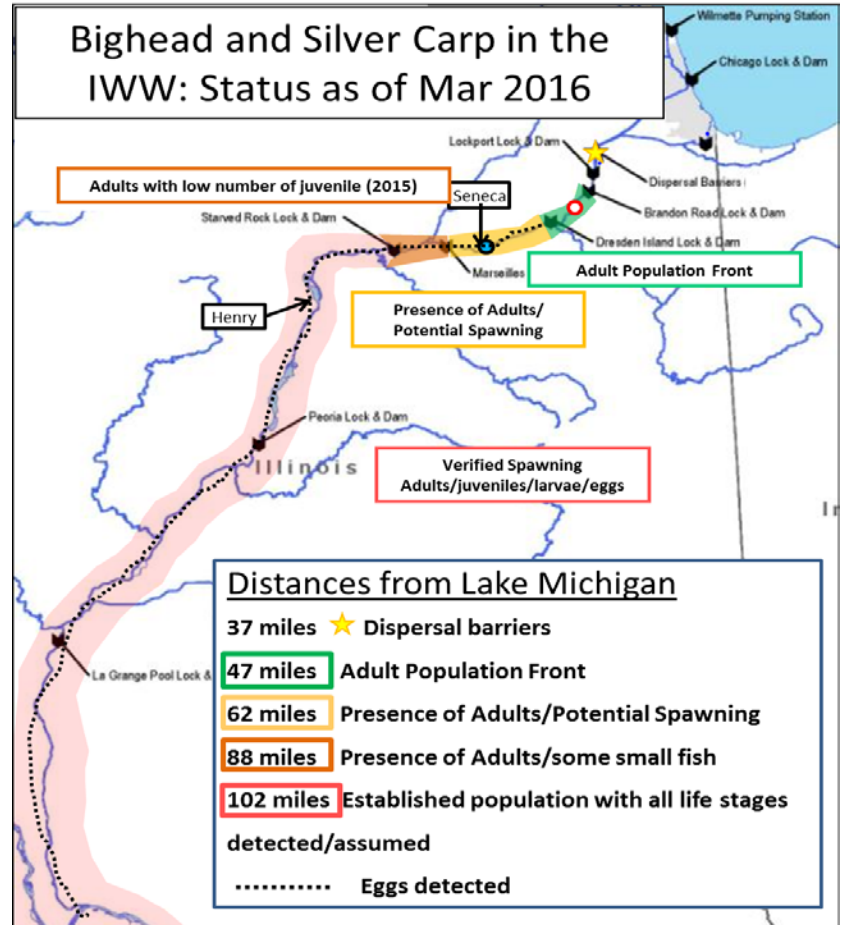


Figure 9. Bighead and Silver Carp in the IWW.

2.0 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 efforts has since been expanded beyond the CAWS to include the Great Lakes basin, as well as 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 efforts of the ACRCC now are binational in scope and encompass 22 agencies and organizations in the United States and Canada.

2.1 2015 KEY EFFORTS COMPLETED OR UNDERWAY

Numerous key initiatives were addressed through the 2015 Framework. 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. Several of these initiatives are highlighted below:

Brandon Road Lock and Dam – As a continuation of the GLMRIS efforts, led by the U.S. Army Corps of Engineers (USACE), several multi-agency efforts further delineated the feasibility of potential control technologies at the Brandon Road Lock and Dam.

Integrated Pest Management – Building on accomplishments and ongoing research efforts from 2014 and earlier, the USGS lead this effort to combine the tools, knowledge, and information needed to holistically detect, remove, control, and exclude Asian carp.

Carbon Dioxide – The USGS, USACE, and the University of Illinois at Urbana-Champaign, and other agencies collaborated to examine carbon dioxide (CO₂) effects on fish behavior in open-water. Efforts were initiated by USGS and USFWS on the registration process for the use of CO₂ as both a potential deterrent and a piscicide for Asian carp control with the U.S. Environmental Protection Agency (USEPA), including addressing Endangered Species Act Section 7 consultation, National Environmental Policy Act (NEPA), and all other regulatory requirements.

Microparticle Technology Development – USGS continued to refine the use of microparticles as a toxicant delivery system targeted for Asian carp.

Electric Barriers – USACE continued construction of a third permanent electric barrier in the CAWS upstream of the existing Barrier IIA and Barrier IIB with increased capability to stop fish passage. The construction will continue in 2016 with completion scheduled in 2017.

Barge Entrainment – In 2015, USFWS completed a study of the entrainment of small fish (native Golden Shiner) by barges through the IWW and CAWS. This work was conducted in collaboration with USGS and assessed the potential for small fish to be entrained and carried by barges moving through the navigation system, including thorough lock structures and over the USACE electric barrier system at Romeoville, Illinois. Results indicated small fish can be moved along with barges through the waterway. If and to what degree Asian carp can be entrained will be a topic of research in 2016.

Young-of-Year and Juvenile Asian Carp Monitoring – In 2015, sampling for Young-of-Year (YOY) and juvenile Asian carp increased through netting and electrofishing operations specifically noting changes in these small fish (less than 6 inches) was noted. Enhanced sampling of this life stage is scheduled in 2016 efforts.

Eagle Marsh Separation Project – The Eagle Marsh project was under way in 2015 and is expected to be complete in 2016. The project, when completed, will create an earthen berm across the floodway. The project will be built in two phases to quickly maximize prevention of interbasin spread of AIS while also preventing potential induced flood damages to properties currently in and adjacent to the floodplain between the basins.

Develop and Deploy New and Novel Gears – In 2015, ACRCC partners worked to develop and deploy new and novel gears for more effectively sampling Asian carp of various life stages, with an emphasis on improving detection of small fish (larval and juveniles) and eggs to better determine areas of reproduction and further describe population characteristics. Efforts were focused primarily on the upper IWW and

were adapted over the course of the sampling season based on most current capture data to add additional effort where needed, and gain new information on Asian carp in locations progressively upstream in the IWW.

Enhanced Monitoring in the IWW and CAWS – In 2015, the ACRCC partners conducted enhanced Asian carp monitoring in the IWW and CAWS in support of defense of the USACE electric barrier. Additional monitoring effort was warranted given the extreme environmental conditions experienced in spring 2015 (e.g. extremely high conductivity levels in the CAWS), which challenged the ability to consistently operate the barrier array at optimal parameters, and subsequent barrier maintenance needs in spring/summer 2015.

eDNA Monitoring – In 2015, USFWS continued to lead collaborative interagency efforts to implement a comprehensive eDNA monitoring program, focused on supporting early detection of Bighead and Silver Carp, in concert with traditional gear sampling in the CAWS, IWW, and other priority waters.

National Asian Carp Control – USFWS increased its leadership activities, as directed under the Water Resources Reform and Development Act of 2014 (WRRDA), and provided increased funding for efforts outside the Great Lakes Basin. The USFWS funded projects from agency base appropriations for Asian carp management in both the Upper Mississippi River and Ohio River basins in 2015, with the goal of preventing upstream spread. This effort will continue in 2016.

Canadian Comprehensive Asian Carp Control Actions – Canadian partners are developing Asian carp control technologies and are undertaking monitoring and assessment efforts in the Canadian waters of the Great Lakes. In addition, they are working to improve science on control technologies and to assess the risk of Asian carp invasion, specifically Grass and Bighead Carp.

Asian Carp Web Sites – The ACRCC web site, www.asiancarp.us, expanded its content to include information and actions dealing with Asian carp across the United States, with a particular added emphasis on the Upper Mississippi River and Ohio River basins. In addition, the Invasive Species Centre developed a Canadian web site— www.asiancarp.ca — that focuses on a Canadian perspective on the Asian carp issue and with largely Canadian content.

2.2 2016 KEY INITIATIVES

ACRCC initiatives for 2016 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, ACRCC coordination of collaborative interagency efforts within and between basins, and program support. In addition, the ACRCC is continuing its focus on development of control alternatives at Brandon Road Lock and Dam area to further advance pathway closure opportunities. These key initiatives are highlighted below:

2.2.1 Pathway Closures & Control Measures

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

Improve and maintain current barrier system in the CAWS – USACE operates three different types of fish deterrent measures 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 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 the movement of juvenile and adult Asian carp during high-water events. The electric barriers operate by creating a waterborne pulsed direct current electric field in the Chicago Sanitary and Ship Canal (CSSC). Fish penetrating the electric field are exposed to electrical stimuli which act as a deterrent. As fish swim into the field, they feel increasingly uncomfortable. When the sensation is too intense, the fish is either immobilized or is deterred from progressing further into the field. Three barriers (Demonstration, IIA, and IIB) are currently operated by USACE. Also, 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 must be maintained as authorized by law.

USACE has operated electric barriers in the CSSC since 2002. Over the years, several operational and procedural improvements have been implemented to improve the effectiveness and to continuously deliver an uninterrupted flow of electricity to the water to deter fish. During 2015 the barriers underwent significant repairs, including the installation of new switches. Additionally, installation of a counterpoise system to reduce impacts to an adjacent railroad began in 2015. In 2016, operation and maintenance of the barriers by USACE will continue, including regularly scheduled maintenance of the electric barriers.

Fencing of the CAWS – an important deterrent was construction and continued maintenance and monitoring of the fence between the canal and Des Plaines River. Although carp are not detected in the river, this fence remains an important safeguard.

Construction of a new electric barrier – Since USACE began operation of the first electric barrier in the CSSC as a demonstration project in 2002, efforts to create a more effective and reliable fish deterrent technology have resulted in the development of a redundant system of electric barriers with increased capacity. The system currently consists of three barriers: the demonstration barrier, Barrier IIA, and Barrier IIB. Construction of an additional barrier is currently under way. This action will effectively upgrade the demonstration barrier to a permanent facility, as authorized in the Water Resources Development Act of 2007. Completion of this additional barrier, known as Barrier I, will signal the completion of construction on the CSSC electric barriers. In potential future year actions, the USACE focus will shift from design and construction to operation and maintenance of the electric barriers in the CSSC. In addition to regular operation and maintenance, monitoring efforts such as the telemetry program are expected to continue, along with research to improve the efficacy of the barriers.

Development of potential future actions at Brandon Road – Currently, the USACE is studying 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 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 Lock and Dam 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 (Scud, Bighead Carp, Silver Carp) 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.

Based on the evaluations presented in the GLMRIS Report and in response to stakeholder input, USACE has been directed by the Assistant Secretary of the Army (Civil Works) to proceed with a formal evaluation of potential control technologies to be applied in the vicinity of the Brandon Road Lock and Dam. A public comment period on the proposed GLMRIS-Brandon Road effort closed on January 31, 2015. USACE hosted three public meetings as part of the scoping process. The Project Development Team has made progress on the planning document by developing a focused array of alternatives to be considered, completing the Alternatives Milestone in June 2015, and initiated development of the Tentatively Selected Plan. In 2016, the USACE will continue development of the Tentatively Selected Plan, gathering data and information including the data and research completed on multiple ANS control measures conducted by other agencies, conduct expert elicitation of the multiple control measures to determine effectiveness and feasibility of such measures, and initiate evaluation and analysis of alternatives. In 2017, the USACE will identify the Tentatively Selected Plan, submit the Tentatively Selected Plan document for policy review, complete analysis and conceptual design, and conduct Agency Technical Review (ATR), Independent External Peer Review (IEPR), Policy Review, and NEPA review. In 2018, the USACE plans to continue the process by submitting an Agency Decision Milestone document, conduct more detailed engineering analysis of the Agency Decision Milestone Plan, complete feasibility level report, and submit a Civil Works Review Board document for review. A Chief's Report is expected in January 2019.

ANS control technologies, especially electric barriers, can pose major safety risks to commercial and recreational vessels transiting the area, as well as to shore-side personnel that come in contact with the water near ANS control measures. As part of this effort for the Brandon Road area, USCG will be assisting USACE in evaluating ANS control technologies by examining associated risks to vessels and mariners transiting or in the vicinity of Brandon Road Lock and Dam, and will conduct additional safety testing if necessary.

Also, USGS will be developing designs and plans for deployment of complex noise, carbon dioxide, and possibly other technology barriers of up to 30 days in the approach channel at the Brandon Road Lock and Dam. This effort will include development of a plan to begin the technology transfer of these technologies from USGS to partner agencies.

Closure of Eagle Marsh Pathway — Eagle Marsh is a United States Department of Agriculture (USDA) – Natural Resources Conservation Service (NRCS) Wetland Reserve Program (WRP) wetland site near Fort Wayne, Indiana, owned jointly by Little Rivers Wetland Project and the Indiana DNR. The owners have been actively maintaining a temporary fence constructed in the marsh, as well as the Graham-McCulloch berm to prevent movement of Asian carp from the Wabash River watershed into the Maumee River watershed during flooding. Through ongoing efforts at Eagle Marsh, the USDA-NRCS has worked with the USACE and other federal, state, and local agencies to identify options for designing a berm to permanently restrict Asian carp from entering the Great Lakes via Eagle Marsh. The NRCS holds a WRP easement on the site. To implement the closure, WRP funding was used for changes within the area of the easement, and GLRI funding was expended to tie the berm in at the ends of the project, off the WRP property; to cover mitigation and maintenance costs; and for NRCS design, engineering and technical assistance.

The Eagle Marsh project creates an earthen berm across the floodway to prevent mixing the watersheds above the 100-year flood level. It will be built in two phases to quickly maximize prevention of interbasin spread of AIS while also preventing potential induced flood damages to properties currently in and adjacent to the floodplain between the basins.

The first phase was completed in December 2015 and consisted of 9,080 linear feet of berm averaging 8.0 feet high, as well as two notches (total 350 feet) that were built to the approximate 50-year flood elevation. Chain link fence was installed along the length of the notches to prevent alteration of the flood crests while blocking AIS transfer at elevations that exceed the 100-year flood event. The second phase will remove the screen and fill in the notch, but cannot be completed until all flood risk in the area has been mitigated.

Closure actions at Little Killbuck Creek Pathway – The GLMRIS Aquatic Pathway Assessment Report developed by the USACE for the Little Killbuck Creek connection assessed the risk for transfer of AIS between the Mississippi River and the Great Lakes Basins. This connection was rated a medium risk for the transfer of Silver Carp, Bighead Carp, Black Carp, Inland Silverside, and Northern Snakehead, and a low risk for the transfer of Skipjack Herring between the Mississippi River and the Great Lakes basins. This connection was rated a medium risk for the transfer of Three Spine Stickleback, Ruffe, Tubenose Goby, parasitic copepod, and Viral Hemorrhagic Septicemia, and a low risk for the transfer of European Fingernail Clam and European Stream Valvata between the Great Lakes and the Mississippi River Basins. The Ohio Department of Natural Resources (DNR) has facilitated numerous meetings with the Medina Soil and Water Conservation District, USDA-NRCS, and the primary landowner. A consultant has been selected to conduct a preliminary investigation of closure options at the Little Killbuck Creek connection site. This study will be used to refine the closure options so that a final engineering study can be completed. The consultant will develop a preliminary assessment of the closure options by September 2015. Ohio DNR will then meet with the primary landowner and other potentially affected parties to evaluate and identify the preferred alternative for closure. This alternative will be based on cost and potential impacts to local landowners.

Closure actions at Ohio-Erie Canal Pathway - The GLMRIS Aquatic Pathway Assessment Report developed for the Ohio-Erie Canal OEC connection calculated the risk for the transfer of AIS from the Mississippi River Basin to the Great Lakes Basin as a medium risk for transfer of Silver Carp, Bighead Carp, Black Carp, and Northern Snakehead, and low for Skipjack Herring. There is no risk from transfer of AIS in the opposite direction. The Ohio DNR and the USACE discussed the two primary areas of concern:

- The direct transfer of water from the Mississippi River Basin to the Great Lakes Basin at the feeder gates to the Canal that transfer water from Long Lake to the Lake Erie watershed;
- Flooding at the tow path that allows water to move from the Mississippi River Basin to the Great Lakes Basin.

The USACE completed a preliminary closure assessment in September 2014 with an array of potential options presented in the “Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures.” Preliminary designs were initially developed and presented for all potential options. At the request of USEPA and Ohio DNR, the USACE is now completing fully developed designs for these measures and expects completion by September 2016. USACE expects to assist Ohio DNR in completing all necessary environmental compliance and coordination requirements in preparation for construction in 2018. USACE will be the implementing agency for construction.

Addressing potential barge entrainment - This past year, the USFWS conducted studies to test whether small fish could become trapped in the underwater spaces between commercial barges and inadvertently transported over various distances, through lockages, and across electric barriers. Research used Golden Shiners as a surrogate species to examine the impact of commercial barge traffic on small fish entrainment to better understand the potential risk of small Asian carp passing through the electric fish

dispersal barriers in the Chicago Sanitary and Ship Canal. Preliminary results of this research indicate that small fish can become entrained between barges and subsequently transported measurable distances (up to 9.9 miles), through a lock and dam system, and across electric barriers. Since this study exclusively used Golden Shiners, it is unknown if juvenile Asian carp would respond in the same manner. However, we believe that Golden Shiners are a reasonable surrogate for Asian carp. More testing is needed to confirm this assumption. There is no evidence that Asian carp have ever crossed the electrical barriers in this way. However, this study indicates that there is the potential risk that commercial barge traffic could inadvertently facilitate the movement of small fish, including Asian carp, by entraining and transporting them upstream through locks and across the electrical barriers.

In 2016, USFWS will work with partner state and federal agencies and maritime industry representatives to identify and address additional potential study needs and management options going forward building off of results from the 2015 barge entrainment and other relevant studies. Activities in 2016 may include the investigation of potential tools and options for vessel operations for reducing the likelihood of small fish entrainment between barges.

Also, in 2016, USGS will be initiating simulation studies to assess the potential of barge entrainment and movement of eggs and larvae. USGS will also initiate laboratory studies to assess the time to response of Silver and Bighead Carp to CO₂ to determine the time and concentration of CO₂ needed to potentially clear carp from the void spaces of barges. As part of the effort, USGS will initiate laboratory studies (and potentially field studies) to assess the response of Silver and Bighead Carp to complex sound to determine whether complex sound is capable of clearing carp from the void spaces of barge tows and assess the potential for hydraulic flushing of void spaces of barge tows.

USACE will use 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 ACRCC will be collaborating with maritime industry representative to identify potential collaborative efforts to address this issue.

2.2.2 Undertaking Responses

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 will be undertaken to address these potential concerns:

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. Up to nine fishers with commercial fishing expertise will be employed to harvest as many Asian carp as possible in the Starved Rock and Marseilles Pools. Efforts in 2016 will be heightened to remove more Asian carp in several ways:

- More crew/weeks scheduled in removal efforts, with a goal to remove a minimum of 400 tons of Asian carp;
- Consistent and increased use of seines to further increase total removal efforts, including increased efforts to remove small Asian carp;
- As Asian carp population abundance changes, nets configurations will be set to optimize removal efforts;

- Increased surveillance below the barrier, with 100 percent increased efforts within Dresden Island Pool.

Applying improved fishery gears and designs at Brandon Road – A team of fishery biologists, Great Lakes and riverine commercial fishers, net manufacturers, and hydroacoustic and pheromone experts is continuing to develop new gear types to use in the CAWS and IWW focused on capture of Asian carp of various life stages (sizes). Deep panel gill nets, large hoop nets (6 feet), and Great Lakes-style pound nets are currently being evaluated as appropriate gears that increase our ability to detect Asian carp in the CAWS and upper IWW. Additional locations and gears, as well as combinations of gears and fine-tuning of deployment efforts, is ongoing to further increase detection rates of Asian carp. Pheromone research by cooperating agencies has identified some baits and lures that also may aid in capture of Asian carp. These tools may be implemented as available. In particular, the area downstream of Brandon Road Lock and Dam has been identified as a location where increased efforts should be focused. This project will assist in further customizing gears for this specific area, as well as other areas, to fully implement gears with highest efficiency throughout MRP areas and activities as appropriate.

Additional emphasis on small fish detection will occur in 2016, based on the increased detection rates of small fish (less than 6 inches in length) in the upper IWW during 2015. Illinois Natural History Survey crews will increase surveillance efforts at the mouth of Kankakee River with multiple gears and increased frequency in 2016. Efforts will be coordinated with USFWS small fish sampling crews to facilitate comparisons of efforts to maximize our ability to detect and characterize this life stage.

Small Asian Carp removal – In 2015 in the CAWS, juvenile Silver Carp were captured more than 50 miles closer to the electric dispersal barriers than in previous years. These captures may indicate an increase in abundance of juvenile Silver Carp, a change in distribution of juvenile Silver Carp, increased agency efforts to catch juvenile Silver Carp, or may be the result of deploying more efficient gears to capture juvenile fishes, as many of the juveniles sampled in 2015 were captured with a newly developed electrified butterfly trawl (Paupier Net).

In 2016, the USFWS will attempt to deploy two small-mesh, lightweight purse-type and Paupier nets to target concentrations of juvenile Asian carp, and evaluate this gear's effectiveness and utility at capturing and decreasing juvenile Asian carp densities in large navigable rivers. Juvenile Asian carp are largely not vulnerable to the trammel nets used by commercial fisherman because of the relatively large mesh size of the commercial gear and the relatively small size of juvenile Asian carp. Deploying these purse-type nets may better target small fish for removal, while potentially halting the advance of juvenile Asian carp toward the Great Lakes. USFWS will work with appropriate partners to develop, adapt, and refine standard protocols for construction and sampling use of "Lampara" and "Danish" style purse seine nets in the CAWS. Emphasis will be placed on developing these gears for use by a standard river vessel and crew to target concentrations of juvenile carp as part of ongoing monitoring and removal efforts for Asian carp. If effective, efforts will continue with these gears on an annual basis to detect and potentially remove new concentrations of juvenile Asian carp.

Updated Response Decision Support Tool – In prior Monitoring and Response Plans, a response plan has been in place for areas upstream of Brandon Road including the CAWS both above and below the electric barrier. Illinois DNR and other Monitoring and Response Workgroup partners are developing an updated and enhanced decision support tool to further identify and outline response actions when serious changes in Asian Carp presence is detected on a pool by pool basis from Starved Rock Pool lakeward through the CAWS. This tool will provide more details in response, agency responsibility, and allow for

clear authority when implementing any potential response effort. This updated plan is to be included in the 2016 Monitoring and Response Plan.

Grass Carp Efforts – Since 2012, Michigan DNR and Ohio DNR 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 2 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 science based Grass carp control plan. In 2016, the Ohio DNR and Michigan DNR will be developing an adaptive management framework for Grass Carp eradication in Western Lake Erie.

Also, Ohio DNR and Michigan DNR will be developing capabilities and response methodologies to effectively respond to detections of Grass Carp in Ohio. Grass Carp have been detected in low frequencies in Lake Erie proper for nearly three decades, with the first documented occurrence in 1984. In 2016, Ohio DNR will further develop information from Grass Carp egg collections in the Sandusky River to predict reproductive locations for Grass Carp. This effort will assist in developing strategies for Grass Carp control in Lake Erie and other areas.

In addition, USFWS will evaluate existing information on grass carp presence in upper IWW and provide additional monitoring of this population through telemetry and field monitoring.

2.2.3 Development of New Control Technologies and Strategies

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 electric barrier system located in the CAWS. Additional barriers or control technologies to augment the electric barrier system 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 electric barrier; 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. In 2016, 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 CO₂ microparticles, and complex sound, as identified below:

Carbon Dioxide (CO₂) – One candidate barrier chemical that has received a great deal of attention and shown promise based on preliminary results is CO₂. In 2016, the USGS and partners will initiate laboratory studies to assess the potential for habituation/acclimation by Asian carp to elevated CO₂ levels. Working with industry, USGS will assess the efficacy of different CO₂ delivery systems through a combination of laboratory and field studies and assess the time to response of Silver and Bighead Carp to CO₂ to establish the time and concentration of CO₂ needed to clear carp from the void spaces of barges. USGS has been working with USFWS to initiate regulatory applications for FIFRA Section 18 exemption and other required federal and state permits to allow agencies to implement a CO₂ barrier or to allow use of CO₂ in the void spaces of barges (if effective).

Microparticle – No current technology can specifically target Bighead or Silver Carp for control within aquatic ecosystems. Available toxicants used in AIS 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 with high specificity for Bighead and Silver Carp would increase the ability of management agencies to control or limit Asian carp while minimizing potential impacts on native species. In 2016, USGS will continue efforts to develop a microparticle that would demonstrate high toxicity and selectivity for Asian carp. In addition, potential field sites along the Illinois River will be identified for field trials to begin to assess populations of fishes and invertebrates in field sites where microparticles will be tested. Also, USGS will work with USFWS and USEPA to initiate studies to complete USEPA registration of antimycin-incorporated microparticles and obtain required experimental use permits, and to address USFWS Section 7 Endangered Species Act-consultation data requirements of antimycin-incorporated microparticles.

Chemical Attractant Investigations to Increase Harvest and Control – Laboratory and field studies conducted have consistently confirmed that an algal food stimulus is highly attractive to Asian carp and may increase the abundance of fish in areas where Asian Carp have been conditioned to the food. Such attractions are sufficiently persistent to enhance capture and also to ensure the ingestion of microparticle poison bait. In 2016, expanded studies with the USFWS, state agencies, and commercial fishermen will be undertaken. An important facet of this effort will be in optimizing the fishing effort relative to the time of year, habitat characteristics, gear selection, and appropriate conditioning to the feeding station to facilitate use of an attractant for microparticle poison bait.

Use of Complex Sound to Alter Behavior of Asian Carp – One candidate barrier technology that has received a great deal of attention has been complex sound. Previous studies have indicated that both Bighead and Silver Carp react negatively to sound. These studies have indicated that the Asian carp will repeatedly respond to complex sound while many native fish respond little to that same sound, but some basic questions still must be answered. In 2016, USGS will test the effectiveness of acoustic stimuli for excluding Bighead and Silver Carp from preferred habitats and for driving them to target locations for increased removal, and conduct trials to assess the synergistic or compensatory effects of CO₂ and sound used in tandem. In addition, USGS will initiate regulatory permit applications for federal and state permits that may be required to allow agencies to deploy a sound deterrent.

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 their control in the Great Lakes and large river systems. In 2016, USGS will continue to sample the Sandusky River and River Raisin for evidence of spawning of Grass Carp and project spawning locations for known spawning events. In addition, USGS will work with other ACRCC members to use information gained from this effort predicting potential areas for successful reproduction, recruitment, and establishment. These data can then be helpful in management plans for prevention, control, and removal in the Great Lakes and other emerging and established Grass Carp populations.

Using Hot Water, Ozone, and other Chemicals for Lock Treatment – ACRCC members, conservation organizations, and other stakeholders share a strong interest in solutions for addressing the two-way movement of AIS through the CAWS from Lake Michigan, as well as from the Illinois River. One option under consideration is to develop a lock treatment process that stops AIS from entering (and moving through) the CAWS, while at the same time not unduly impeding the movement of barges and other boat traffic between Lake Michigan and the Mississippi River. Treatment of locks or approach channels to locks is one option that could be implemented in a relatively short time. Initial discussions have favored the idea of establishing measures centered around the locks at the upper (T.J. O'Brien) and lower (Brandon Road) end of the CAWS to create one-way barriers that together would prevent movement of organisms into and through the canal system. USGS will be evaluating the potential to use chemicals to

effect control of aquatic invasive organisms that might be associated with vessels during locking activities. Based on available data concerning effectiveness, environmental impacts, human safety, availability, impacts to vessels and structure, and regulatory issues, the initial screen suggested that hot water and ozone are the options most likely to meet objectives. In 2016, USGS will be conducting toxicity tests on hot water and ozone, singly and in combination, against a broad range of taxa and life stages to evaluate their effectiveness. In addition, USGS will assist with transfer of technology for development of engineering designs and provide regulatory affairs support for registration of potential lock treatment technologies.

2.2.4 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 electrical barrier system is important to ensure no Asian carp have moved beyond the barrier. The following describes the monitoring and assessment activities being undertaken:

Randomized, Targeted, and Fixed Site Monitoring Upstream of the Dispersal Barrier – Seasonal intensive monitoring (as identified in the 2016 Monitoring and Response Plan) will continue in 2016. A variety of gears will be used during seasonal intensive monitoring activities, including pulsed DC-electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets, and Great Lake pound nets to detect, capture, and subsequently remove any Asian carp present. To date, only one Bighead Carp has been collected (in 2010) above the electrical barriers, on the very first day contracted fishers were deployed in this area. 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.

Randomized, Targeted, and Fixed Site Monitoring Downstream of the Electric Dispersal Barrier – Fixed and random site electrofishing efforts and contracted netting has been increased starting in 2014 and will be further elevated in 2016 below the electric barrier system. These activities will include intensive electrofishing and netting at four fixed sites, and will increase from four to 12 random sites in each of the four pools below the electrical barrier system. Contracted commercial netting will take place bi-weekly from March through December at four fixed sites and random sites in the Lockport, Brandon Road, and Dresden Island pools. Contracted commercial netting in the Marseilles Pool will occur at four fixed sites and at four random sites. An intense removal effort, or Barrier Defense, occurs in Starved Rock and Marseilles pools with 6 contracted fishers/week and in Dresden Island, Brandon Road, and Lockport pools with three contract fishers/week. These efforts have removed 4 million pounds of Asian carp from Starved Rock, Marseilles, and Dresden Island. These heightened efforts in 2016 remain one of the most successful tools to reduce threat of Asian carp moving toward the Great Lakes.

Young-of-Year and Juvenile Asian Carp Monitoring – Continued sampling for YOY and juvenile Asian carp will take place in 2016 through netting and electrofishing operations. The collection of small fish, and their relative abundance in the Upper IWW, would suggest an increased risk of Asian carp movement toward Lake Michigan, and remains one of the primary focus for agency monitoring efforts.

Comprehensive Interagency eDNA Monitoring Program – In 2016, USFWS will continue to lead the comprehensive interagency eDNA monitoring program in support of actions identified in the ACRCC's 2016 Monitoring and Response Plan and in conjunction with standard gear sampling conducted in priority areas. These efforts will build upon eDNA sampling results from 2015 and prior years. Also, analysis of samples collected from the IWW, CAWS, and other priority waters in 2016 will include additional

analysis for the detection of Black Carp, after the development of a new eDNA marker for this species has been completed. This work was deemed a priority new project in 2016 with collection of new data showing the presence of Black Carp farther upstream in the watershed.

Barrier Maintenance Fish Suppression – MRWG will work with federal and local partners to evaluate fish around the USACE electric barrier system. The need for any additional work/surveillance varies by season, operational parameters, as well as current MRWG efforts at and around the barrier.

Stock Assessment in the Upper Illinois River – In 2016, the ACRCC will continue to develop insights into strategies for addressing Asian carp in the Illinois River. It is critical 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. This effort will continue to develop estimates of Asian Carp abundance, biomass, size structure, demographics (such as growth and mortality), natal origin, and rates of hybridization in the Alton, LaGrange, Peoria, Starved Rock, Marseilles, Dresden Island, and Brandon Road pools of the Illinois and Des Plaines Rivers. Specifically, 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.

Great Lakes Monitoring - The USFWS will continue to implement and refine, with input from other ACRCC members, 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 complements the eDNA sampling and monitoring programs implemented by the USFWS, USACE, academia, and other partners. Sampling will primarily target areas of high concern in the Great Lakes, and use a diverse array of traditional and novel gears to sample all potential life stages of Asian carp species. In 2015, USFWS continued to expand its overall sampling efforts and collected more than 4,500 eDNA water samples, electrofished, trawled, sampled ichthyoplankton, and set a variety of nets to survey for Asian carp. In 2016, 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.

Deploying monitoring resources based on on-going risk assessment activities – 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 impacted areas, as necessary. Evaluations and enhanced monitoring decision tool will provide additional and more details as warranted.

Black and Grass Carp monitoring – The USFWS and its partners will be analyzing Grass Carp populations in the CAWS and IWW to better understand their risk of invasion to the Great Lakes. This effort will include determining their relative abundance, concentration areas, ploidy, age/growth, otoliths, and movements (telemetry). The USFWS, working with its partners, will be developing a new qPCR marker for application in 2016, following a validation trial in independent laboratories. An incentive program (\$100 reward per fish) was established to encourage commercial fishermen to report and donate all wild-caught Black Carp for research, currently only 24 Black Carp have been reported from the wild as agencies have not captured these fish. This incentive/bounty helps get information from the few fish

that fisherman may otherwise just send to the market. In 2016, a sampling program targeting all life stages of Black Carp will complement and expand upon ongoing Black Carp research, addressing limitations of reliance on commercial fish collections as the sole source of information on Black Carp.

Seek Opportunities for Additional Collaboration – In 2016, the USFWS and other ACRCC 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 – to more broadly address the threat region-wide, across multiple basins, where possible.

2.2.5 Communication and Outreach

The USFWS has hosted and administered the asiancarp.us website since 2011. In 2015, asiancarp.us continued to be the ACRCC's central platform for public outreach and education. As the site administrator, USFWS maintained and developed the website, working toward a goal of increased visitation from the public and stakeholders. Since first launched in 2011, the site has reached more than 200,000 unique visitors from around the world. Website highlights from the last year include creating space on the website to share information on the work now being done with state partners in the Upper Mississippi River and Ohio River basins. Work also included growing the ACRCC's image library that offers high resolution downloads of Asian carp and Asian carp management images to the public and the media. In 2016, the website will continue to be expanded to encompass emerging topics related to Asian carp, including Grass Carp issues; and federal and state actions in the Upper Mississippi River and Ohio River basins, as outlined in the Water Resources Reform and Development Act (WRRDA) of 2014. The website may be expanded to include preliminary information on Black Carp, based on emerging data and science on the species, as well as to broaden usefulness of sight by developing content, organization to inform managers, public, and policy makers.

2.2.6 Interbasin Collaboration

Coordination between agencies and organizations working to address Asian carp prevention at the watershed scale continues to increase both within and between basinwide partnerships. WRRDA, signed into law in June 2014, called for enhanced interagency collaboration within the Ohio River and Upper Mississippi River basins for the purposes of preventing the continued range expansion of Asian carp in these basins, and has led to the development of stronger interagency partnerships guided by sound management strategies and collaborative decision-making. Collaboration between basinwide partnerships in the Upper Mississippi River and Ohio River basins and the ACRCC is notably increasing, guided by the common goal of Asian carp prevention and control, and beginning the process for a more region-wide approach to Asian carp management. Strategies used by the various basinwide partnerships share many common goals and objectives (for example, development and implementation of new control tools; collection and use of current population monitoring data, etc.), thereby offering opportunities for greater leveraging of resources, new knowledge/technology and lessons-learned on Asian carp management. In general, overall coordination and collaboration between federal and state agencies and other organizations has increased in both frequency and scope. Within basin partnerships, recent coordination efforts have yielded expanded monitoring and surveillance efforts for Asian carp, further development and field testing of detection and control tools, priority research to identify and investigate potential new technologies, and development of communication strategies and mechanisms to share information and engage partners, stakeholders, and the public. Expanding this dialogue and coordination between basins will continue in 2016 and outyears, including convening workshops and meetings for interbasin dialogue and further leveraging of accomplishments and science for more effective implementation of key

management actions on a regionwide scale. This work will include identifying and addressing vulnerabilities or critical pathways with the potential for transfer or introduction of Asian carp populations between basins. Coordination will include member agencies and organizations, including the ACRCC, MICRA, UMRCC, and other interagency collaboratives currently engaged on Asian carp prevention.

3.0 CANADIAN ASIAN CARP CONTROL EFFORTS

Fisheries and Oceans Canada, the Ontario Ministry of Natural Resources and Forestry (OMNRF), and the Quebec Ministère des Forêts, de la Faune et des Parcs 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.

In 2015, nine Grass Carp were caught on the Canadian side of the Great Lakes. Seven of the Grass Carp were found in Lake Ontario, one in Lake Erie, and one in the lower Niagara River. On September 17, 2015, a 23-pound grass carp was caught near Point Pelee in Lake Erie. In Lake Ontario, Grass Carp were caught near Toronto, St. Catherines, and the Bay of Quinte earlier in the summer. The fish ranged in size up to 40 pounds. No Bighead, Silver, or Black Carp have been found in Canadian waters.

The efforts of the Canadian agencies are identified in this section.

3.1 FISHERIES AND OCEANS CANADA

DFO has undertaken a wide variety of efforts to prevent the introduction and establishment of Asian carps (Grass, Bighead, Silver, and Black carp) in the Canadian waters of the Great Lakes under its Asian Carp Program. Presented here is a summary of activities conducted in 2015 and plans for 2016.

Targeted Traditional Gear Surveillance – Since 2013, DFO has implemented an early detection surveillance program for the Canadian side of the Great Lakes and will continue these operations through the 2016 field season (approximately May through November). Determination of sites were based on those identified as at risk in Canadian tributaries were identified in the “2011 Binational Ecological Risk Assessment for Asian Carps in the Great Lakes,” followed by ground-truthing. In 2015, 31 early detection sites were visited, along with ground-truthing of two additional sites in eastern Lake Ontario (Duffin’s Creek and Rouge River) and one in the Huron-Erie Corridor (Sydenham River). A reassessment of the sites in 2014 resulted in the selection of 34 sites for the 2015 surveillance program, with two sites in Lake Superior, 13 sites in Lake Huron, five sites in the Lake St. Clair basin, nine sites in Lake Erie, and five sites in Lake Ontario.

In 2015, a variety of traditional field gear were deployed in 1047 field sampling sites, including bag seine, boat electrofishing, fyke nets, tied-down gillnets, trammel nets, 4-foot trap nets, trawls, 6-foot and 3-foot hoop nets. New cooperative targeted sampling using gill nets, trammel nets, and electrofishing techniques was incorporated to improve sampling efficiency in blocked off areas. Asian carp surrogate species (Buffalo sp. and Common Carp) were targeted as proxies for successful capture of Bigheaded Carp, Silver Carp and Grass Carp. A total of 771 Buffalo sp. and 3142 Common Carp were captured. Also, one Grass Carp was captured during early detection surveillance in Jordan Harbour, Lake Ontario. (Note: additional Grass Carp were also found outside early detection surveillance activities; see Response section.) The 2015 field work resulted in a capture total of 67,221 fishes representing 97 species.

An additional vessel will be deployed for continuation of surveillance at the established early detection sites, and it is anticipated that sampling effort will increase slightly from 2015 levels, with a continued focus on at-risk locations. Ground-truthing will continue in the 2016 sampling season for high risk sites identified in eastern Lake Ontario for their suitability to be added to our early detection sites. Additional gear will continue to be introduced to the program to complement those currently deployed, including the use of Bongo nets and light traps to begin sampling for eggs and larval fishes.

Field work plans do not currently extend to the 2017 field season and beyond as 2016/2017 (March 2017) is the final year of the 5-year funded Asian Carp Program in DFO.

Response - DFO works with the Province of Ontario to lead Asian carp responses in the Canadian waters of the Great Lakes. DFO has developed the capacity in DFO's Asian Carp Laboratory for rapid ploidy testing of captured Asian carp in Canada.

In 2015, nine Grass Carp were found in the Canadian waters of the Great Lakes, and DFO participated in six separate responses using an Incident Command System (ICS) model. In July, the Toronto and Region Conservation Authority (TRCA) captured a Grass Carp in an enclosed pond in Tommy Thompson Park near Toronto during fish removal activities using a boat electrofisher prior to the construction of wetland within the pond. The pond had previously been connected to Lake Ontario in spring 2015. When DFO was notified of the capture, response protocols — involving intensive netting and boat electrofishing efforts by DFO, TRCA and Ontario Ministry of Natural Resources and Forestry (OMNRF) — were immediately invoked. Response activities resulted in the capture of a second Grass Carp in the pond. Ploidy and laboratory testing revealed both fish were diploid males; the first records of diploid Grass Carp in Canadian waters. The fish were 13 and 14 years old and oxygen isotope analyses indicate origin from aquaculture facilities.

In August 2015, DFO staff captured a single Grass Carp in Jordan Harbour, Lake Ontario, in a trammel net during regular early detection surveillance. Response protocols involving intensive netting and boat electrofishing efforts by DFO were invoked. Response activities suggested no additional specimens were present. The specimen was a diploid male, 16 years old, and oxygen isotope analyses indicate origin from aquaculture facilities.

In September 2015, TRCA captured two Grass Carp in the bays of the Toronto Islands, Lake Ontario, during routine fish monitoring using boat electrofishing. DFO was immediately notified of the captures and response protocols — involving intensive netting and boat electrofishing efforts by DFO, TRCA and OMNRF — were immediately invoked. Response activities resulted in the capture of a third Grass Carp in the same location as the first two. Ploidy and laboratory testing revealed all three fish were diploid, two were male and one was female. The fish were 9, 11, and 13 years old and oxygen isotope analysis indicates origin from aquaculture facilities.

Farther into September 2015, three additional Grass Carp were caught. One triploid Grass Carp was caught in a trap net by a commercial fisher in the Bay of Quinte, Lake Ontario, and, a few days later, another triploid Grass Carp was caught in a trap net by a commercial fisher off Point Pelee, Lake Erie. Response protocols involving intensive netting and boat electrofishing efforts were invoked for these two captures until ploidy status was determined. The response activities suggested no additional specimens were present. One decomposing Grass Carp of undeterminable ploidy was found later the same week by an angler on the shore of the lower Niagara River. (No response activity was undertaken.) The fish were 13, 8, and 10 years old, and oxygen isotope analysis indicate origin from aquaculture facilities.

Further analyses to better determine origin and movement in the Canadian waters of the Great Lakes for all 2015 Grass Carp specimens is under way.

For 2016, DFO will continue to respond, in conjunction with its partners, to Asian carp captures in Canadian waters. Response triggers and actions are being refined as DFO's experience with responses increases. ICS and response training for DFO has begun and intensive in-class training will occur in winter 2016 with a goal of conducting on-water training later in the year. Internal response protocols and an equipment database are under development and will be completed in 2016. Response planning does not currently extend to the 2017 field season and beyond, as 2016/2017 (March 2017) is the final year of the 5-year funded Asian Carp Program in DFO.

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.

The risk of direct movement of freshwater fishes through the Welland Canal and St. Marys River is being assessed using telemetry studies that began in 2012 and continued until 2015. As the Welland Canal and St. Marys River are direct pathways connecting Lake Ontario and Erie, and Lake Superior and Huron, this research will assess the likelihood of Asian carp movement through the connecting channels and identify the location and timing of early detection and control activities. To date, 331 large-bodied fishes (16 species) were tagged and released in the Welland Canal and St. Marys River. In 2012-2015, tracking of these fishes resulted more than 1.3 million detections. Seven of 179 tagged fishes moved out of Welland Canal into either lakes Ontario or Erie, while eight of 152 tagged fishes were detected moving from Lake Huron to Lake Superior. Additional analyses are currently under way that will help identify to management species with key ecological characteristics, areas, and timing windows for early detection or control.

Control Technologies – DFO's Asian Carp Program is evaluating several non-permanent barrier control technologies in deterring fish movement under field and laboratory settings. These studies have been conducted in a semi-enclosed large boat slip that mimics the structure of a canal. It is an intermediate site size that complements the small and large-scale work being conducted in the United States by USGS.

In 2015, 147 large-bodied fishes (eight species) were tagged and tracked in response to bubbles, underwater speakers, underwater lights, and electricity. Data from these studies are currently being analyzed for completion of results by spring of 2016. In 2016, researchers will study the use of carbon dioxide as a barrier mechanism, as well as evaluate the combined ability of all studied mechanisms (pulse pressure [water gun], low-frequency sonar, bubbles, underwater speakers, alarm cue, underwater lights, electricity and carbon dioxide) to work together toward an integrated pest management (IPM) system. Evaluation of these non-permanent barrier technologies in managing fish movement will provide management options in preventing the spread and reducing the recruitment of Asian carp.

Research to Inform Risk Assessment – As part of the binational Grass Carp risk assessment, DFO conducted research on the potential survival, establishment, spread and impacts of Grass Carp in the Great Lakes. A temperature and size-based model was developed to assess the overwinter survival of young-of-the-year Grass Carp. An area-restricted random walk model was used to model movement dispersal of Grass Carp in the Great Lakes. The model predicted the extent of spread in the Great Lakes within 1, 5, 10, 20, 35 and 50 years using the Chicago Area Waterway System and the Maumee River as arrival points. A laker transport model predicted the potential for spread of early life stages in ballast water between lake ports. A broad-scale Great Lakes submerged aquatic vegetation inventory and biomass model were used in conjunction with a Grass Carp bioenergetics model to evaluate where Grass Carp could establish populations, based on food availability, and the magnitude of impact different

densities of Grass Carp would have on vegetation biomass. Published data on dependence and usage of vegetated habitat were compiled to assess which portions of the native fish and aquatic bird communities could be most impacted by Grass Carp establishment. Together, this research provided scientific information to inform the Grass Carp risk assessment (described below).

Risk Assessment – A binational ecological risk assessment for Grass Carp in the Great Lakes basin is nearing completion. Research (as described above) and other data were used to inform a risk assessment team of DFO, Great Lakes Fishery Commission, USGS, and USFWS. The draft risk assessment was presented at a Canadian Science Advisory Secretariat meeting for a face-to-face peer review by a variety of invited binational experts. The risk assessment is also in the U.S. federal review process within the USGS. When it is finalized (plan for spring 2016), 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. A binational socio-economic assessment for Grass Carp is being scoped out and may include a broader assessment of aquatic invasive species. As the work is still being organized, a timeline is not yet available. A binational ecological risk assessment for Black Carp in the Great Lakes has been scoped out, but a new timeline for milestone and completion has not yet been determined for 2016/2017.

Outreach and Education – In partnership with two non-governmental organizations (Ontario Federation of Anglers and Hunters and the Invasive Species Centre) in Ontario, DFO is implementing outreach and education to stakeholders and the public in Canada. “Asian Carp Canada” has been branded, and its use on Twitter and Facebook began in 2013. The Asian Carp Canada website, www.asiancarp.ca, a counterpart to www.asiancarp.us, was launched in January 2015. The website currently receives an average of 40 daily visitors, an increase from the 20 average daily visitors seen earlier in the year. Outreach materials, enforcement and education billboards, presence at trade shows, community-based workshops and events, and webinars were developed in 2015, and this work will continue into 2016 to March 2017. In December 2015, augmentation of the Royal Ontario Museum’s biodiversity gallery included information (display, video and ‘touchables’ [such as a rubberized Grass Carp, teeth, skeletons] geared to children) on the threat of Asian carp to educate the 7,000 to 8,000 daily museum visitors. In March 2016, the Invasive Species Centre will host an Innovative Solutions Competition at the University of Toronto at Scarborough that will challenge post-secondary students to devise technological or other solutions for the prevention and control of Asian carp in the Great Lakes.

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. The first charge and conviction under these new AIS regulations occurred this fall for an Ontario AIS bait-related offense. The convicted was fined \$8,000. In 2016, DFO plans 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 continue to provide support through to March 2017 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.

3.2 ASIAN CARP CONTROL EFFORTS IN CANADA: 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:

Surveillance and Monitoring: The OMNRF increased its monitoring activities in Canadian waters of the Great Lakes and its tributaries. Efforts focus on monitoring and assessing Lake Erie, Lake St. Clair, the Detroit River, the St. Clair River, southern Lake Huron, and Lake Ontario. eDNA is a key technique used for monitoring in these locations. OMNRF also conducts electrofishing in these locations, both to monitor for Asian Carp presence and to better understand the composition of fish species currently present. In addition, OMNRF collects samples from commercial fishing harvests within Lake Erie and has instituted a trawling program in the eastern and western basins of Lake Erie to monitor for Asian carp. A seining program has also been instituted in Lake St. Clair to monitor for Asian carp.

eDNA Research: eDNA research focuses on discriminating between detection failure and true absence, as well as testing and validating other eDNA markers and systems. Experimental eDNA trials with non-invasive species are being used to confirm taxonomic specificity and the spatial, temporal, and quantitative sensitivity of eDNA detection. In-year development and validation for Black Carp eDNA markers enabled surveillance for Black Carp as well as Bighead, Silver, and Grass Carp.

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 2016, the province continued its efforts to improve the plan based on new science and improved coordination with U.S. partners.

Outreach Activities: The Ontario-wide Invading Species Awareness Program has been a joint partnership initiative of the OMNRF and OFAH since 1992. The program focuses on 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 a website (www.invading-species.com) hosted by OFAH. Recently, a web-based reporting and tracking system has been introduced called Early Detection and Distribution Maps Ontario, which also has a mobile app for Apple and Android devices. It is designed to allow users to quickly view and report invasive species sightings. 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.

Regulations: In 2005, Ontario made it illegal to possess live Asian carp. In 2015, Ontario passed invasive species legislation, the Invasive Species Act. 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; and
- Use a risk-based approach that considers the full range of threats, costs, and benefits to the environment, society, and the economy.

3.3 ASIAN CARP CONTROL EFFORTS IN QUEBEC

Efforts to control Asian carp outside of the Great Lakes Basin are not within the scope of the ACRCC and therefore not discussed within the action items of this Action Plan. However, they are equally critical to controlling the Asian carp population throughout the United States and Canada and can ultimately affect the efforts taken within the basin. Some of the many efforts being undertaken at the federal and state level are discussed below. In Quebec, the Ministère des Forêts, de la Faune et des Parcs (MFFP) is responsible of the conservation and protection of the integrity and health of the biodiversity of aquatic and terrestrial Wildlife. MFFP is also responsible of managing sport fishing of freshwater and anadromous fish species. MFFP works in collaboration with other ministries, agencies, governments, jurisdictions, stakeholders, and partners to protect, restore, and sustain wildlife habitats and biodiversity. MFFP fulfills these mandates through planning, regulation, enforcement, scientific study, stocking, stewardships, and outreach.

eDNA sampling and analysis protocols have been tested since 2013 as a future Ministerial tool for early detection of invasive exotic and endangered animal species in aquatic habitats. For 2016, focus will be made on sampling urban areas, like the portion of the St. Lawrence River and fluvial lakes that encompass the greater Montreal. This area is considered as very sensitive for Asian carp introduction considering the importance of a great number of aquatic activities, the importance and diversity of the population, as well as the proximity of the Ontario and United-States borders.

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 period 2015-2020. One of the 82 actions presented in the action plan concerns the protection of biodiversity and aquatic ecosystems. It will structure an approach aimed at affording Quebec adequate response capability to counteract threats posed by aquatic invasive species, in particular Asian carp from the Great Lakes. The approach includes prevention, early detection, and control and eradication measures. The strategy may be found at:

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

4.0 CONTROL ACTIONS WITHIN THE UPPER MISSISSIPPI AND OHIO RIVER BASINS

In 2014, the President signed into law the WRRDA, Public Law 113-121, authorizing a broad array of agency actions and public projects across the United States. 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 and Ohio River basins and tributaries. Those actions include the provision of technical assistance, coordination, best practices, and support to state and local governments engaged in Asian carp prevention and control; and development of an annual report to the United States Congress summarizing strategies, expenditures, and progress in addressing the threat of Asian carp in the Upper Mississippi River and Ohio River basins and their tributaries.

In 2015, federal and state agencies significantly increased overall coordination efforts on Asian carp prevention planning within the Upper Mississippi River and Ohio River basins. Additional Service USFWS resources were available to support enhanced coordination, as well as the development and implementation of key projects to address highest-priority management needs (monitoring, prevention, and control), as identified by the partnerships and in support of basinwide strategies.

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

In the Upper Mississippi River Basin:

- Monitoring – Comprehensive surveillance program to define presence, invasion, and established fronts in Upper Mississippi River Basin.
- Control – Contract fishing to reduce propagule pressure and to characterize adult Asian carp populations.
- Research – Evaluation of Asian carp and native fish passage at Lock and Dam 8 and 19.

In the Ohio River Basin:

- Monitoring – Distribution, movement, and lock and dam passage of Asian carp through telemetry.
- Control – Control and removal of Asian carp in the Ohio River Basin.
- Research – Limiting Asian carp dispersal at lock and dams.
- Research – Impact of Asian carp on native fishes in the Wabash River.
- Communication – Ohio River Basin Asian carp coordination and outreach.

Key initiatives being undertaken in the Upper Mississippi River and Ohio River basins include:

- Continued refinement and expansion of a standardized, near-real time Asian carp early detection monitoring program using methods (both traditional gears and eDNA sampling).
- Continued refinement and development of potential new tools and technologies for the early detection and control of Asian carp.
- Further progress on the analysis of potential AIS control alternatives for deployment in or adjacent to lock and dam structures to allow for navigation.
- Closure of St. Anthony Lock in Minneapolis, Minnesota, as authorized under WRRDA, to prevent further upstream movement of Asian carp in the Mississippi River.
- Development of new or refinement of existing basinwide or statewide Asian carp prevention strategies.
- Further development and population of standardized datasets for tracking the status of Asian carp populations in waters of the United States, focusing on the Upper Mississippi River and Ohio River basins.
- Expanded collaborative interagency partnerships in the Upper Mississippi River Basin and Ohio River Basin for managing the threat of Asian carp across multiple jurisdictions.

- Enhanced interbasin collaboration between the Upper Mississippi River and Ohio River basins, and Great Lakes basin.

The enhanced interbasin interagency coordination offers tangible opportunities for more effectively leveraging the limited resources available for broad-scale Asian carp management efforts. A growing number of technologies are currently under development or have been proposed for use in controlling or preventing spread of Asian carp. While the immediate focus of many of these activities has been on the challenge of managing Asian carp populations in the IWW and the CAWS to prevent establishment in the Great Lakes, many tools may hold promise for use in other waterways (including the Ohio River and Upper Mississippi River basins) threatened by AIS. Working closely with federal and state partners, USGS is the primary federal agency spearheading research and development of new and emerging technologies in the United States. Additionally, the USACE, Engineer Research and Development Center (ERDC), the USGS and other federal agencies, state agencies and universities have contributed significant advancements to the science and capacity for managing Asian carp, including development and refinement of tools for early detection.

Appendix A

2016 Asian Carp Action Plan: Funding Matrix

FY 2016 - 2017 GLRI Project Funding ^{*}

	#	Title	FY 2016	FY 2017* (\$)	TOTAL Request (2016-2017)
USACE	1	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	500,000	TBD	\$500,000
	2	Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment	\$971,000	\$300,000	\$1,271,000
	3	Operation and Maintenance of Barriers	\$0	\$0	\$0
	4	Barrier I Constuction	\$0	\$0	\$0
	5	Telemetry - Barrier Efficacy Evaluation	\$0	\$0	\$0
	7	Monitoring and Response Team Support	\$200,000	\$200,000	\$400,000
	39	Ohio-Erie Canal Pathway Closure Assessment	\$258,000	\$1,050,000	\$1,308,000
	44	Laboratory Analysis of Mitigation Measures to Address Barge Entrainment of Fish and Floating Species	\$0	\$0	\$0
	45	Field Deployment of Barriers at Brandon Road Lock	\$450,000	\$380,800	\$830,800
	46	Asian Carp Swim Speed Study	\$200,000	\$0	\$200,000
	47	H & H Support for Eagle Marsh II	\$15,000	\$50,000	\$65,000
		Subtotal	\$2,594,000	\$1,980,800	\$4,574,800

USFWS	6	Great Lakes Asian Carp Monitoring Program	\$350,000	\$350,000	\$700,000
	7	Monitoring and Response Team Support	\$820,000	\$820,000	\$1,640,000
	8	Barge Entrainment and Interaction Study	\$750,000	\$750,000	\$1,500,000
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	\$160,000	\$160,000	\$320,000
	10	Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters	\$0	\$0	\$0
	11	Program Capacity for eDNA Sampling	\$0	\$0	\$0
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	\$0	\$0	\$0
	13	Illegal Transport of Injurious Wildlife Enforcement	\$0	\$0	\$0
	14	Asian Carp Website Operation and Maintenance	\$50,000	\$50,000	\$100,000
	15	Use of Novel Gear: Video Outreach	\$0	\$0	\$0
	16	Registration of Microparticle Technologies	\$125,000	\$225,000	\$350,000
	17	Registration of Carbon Dioxide Technologies	\$125,000	\$125,000	\$250,000
	43	Program Support for Asian Carp Activities	\$0	\$0	\$0
	48	Black Carp eDNA Marker Development	\$300,000	\$0	\$300,000
	49	Analysis of Grass Carp in the CAWS	\$200,000	\$200,000	\$400,000
	50	Black Carp Assessment: CAWS and UMRB	\$200,000	\$200,000	\$400,000
	51	Mass Removal and Monitoring of Juvenile Asian Carp	\$100,000	\$100,000	\$200,000
	52	Barrier Defense Using Novel Gear	\$80,000	\$80,000	\$160,000
		Subtotal	\$3,260,000	\$3,060,000	\$6,320,000

FY 2016 - 2017 GLRI Project Funding ^{*}

	#	Title	FY 2016	FY 2017* (\$)	TOTAL Request (2016-2017)
USGS	16	Registration of Microparticle Technologies	\$300,000	\$650,000	\$950,000
	17	Registration of Carbon Dioxide Technologies	\$175,000	\$175,000	\$350,000
	18	Development of Grass Carp Control Technologies	\$325,000	\$325,000	\$650,000
	19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	\$315,000	\$315,000	\$630,000
	20	Characterization of Brandon Road Lock for Barrier Implementation	\$450,000	\$300,000	\$750,000
	21	Use of Seismic Technology to Divert and Eradicate Asian Carp	\$50,000	\$0	\$50,000
	22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	\$500,000	\$400,000	\$900,000
	23	Developing Targeted (Microparticle and Piscicide) Control Systems	\$600,000	\$400,000	\$1,000,000
	24	Chemical Attractant Investigations to Increase Harvest and Control	\$0	\$0	\$0
	25	Use of Acoustic Technology to Determine Behavior	\$0	\$0	\$0
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	\$110,000	\$110,000	\$220,000
	27	Integrated Pest Management Program	\$1,000,000	\$850,000	\$1,850,000
	28	Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp	\$200,000	\$200,000	\$400,000
	29	Assessing Techniques to Enhance Barrier Characteristics of High-Head Navigation Dams on the Upper Illinois River	\$75,000	\$75,000	\$150,000
	45	Field Deployment of Barriers at Brandon Road Lock	\$450,000	\$900,000	\$1,350,000
	53	Use of Complex Sound to Alter Behavior of Asian Carp	\$200,000	\$0	\$200,000
	54	Hot Water and Ozone Use for Lock Treatment	\$300,000	\$100,000	\$400,000
	55	Other Program Support	\$40,000	\$0	\$40,000
56	Black Carp Control, Bait, and Attractant Use	\$150,000	\$150,000	\$300,000	
		Subtotal	\$5,240,000	\$4,950,000	\$10,190,000
USFWS-IL DNR	30	Enhanced Monitoring Above and Below Electric Barriers	\$1,350,000	\$1,950,000	\$3,300,000
	31	Illinois River Stock Assessment/Management Alternatives	\$300,000	\$300,000	\$600,000
	32	Contract Fishing for Asian Carp Detection and Removal	\$1,400,000	\$1,200,000	\$2,600,000
	33	Interim and Long-Term Strategy and Tactics Development at Starved Rock	\$0	\$0	\$0
	34	Reducing the Risk of Asian Carp Upstream Movement: Applying Improved Fishery Gears and Designs at Brandon Road	\$0	\$0	\$0
	35	Use of Improved Gear and Novel Designs at Brandon Road	\$350,000	\$150,000	\$500,000
	36	Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System	\$0	\$0	\$0
	37	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	\$300,000	\$300,000	\$600,000
		Subtotal	\$3,700,000	\$3,900,000	\$7,600,000

FY 2016 - 2017 GLRI Project Funding ^{*}

	#	Title	FY 2016	FY 2017* (\$)	TOTAL Request (2016-2017)
ODNR	38	Killbuck Creek Pathway Closure Assessment	\$150,000	\$1,000,000	\$1,150,000
	39	Ohio-Erie Canal Pathway Closure Assessment	\$292,000	\$0	\$292,000
	59	Development of Grass Carp Response Capabilities in Ohio	\$180,000	\$100,000	\$280,000
	Subtotal		\$622,000	\$1,000,000	\$1,622,000
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control Activities	\$5,000	\$105,000	\$110,000
	41	Brandon Road Lock and Dam Risk Assessment	\$100,000	\$600,000	\$700,000
	42	Electric Barrier Construction and Operation Risk Assessment	\$4,000	\$400,000	\$404,000
	63	Asian Carp Barge Entrainment Mitigation Risk Assessment	\$100,000	\$200,000	\$300,000
	Subtotal		\$209,000	\$1,305,000	\$1,514,000
NOAA	61	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	\$0	\$184,590	\$184,590
	Subtotal		\$0	\$184,590	\$184,590
MID NR	60	Grass Carp Eradication in Western Lake Erie	\$200,000	\$150,000	\$350,000
	Subtotal		\$200,000	\$150,000	\$350,000
USEPA	43	Program Support for Asian Carp Activities	\$1,713,000	\$969,610	\$2,682,610
	Subtotal		\$1,713,000	\$969,610	\$2,682,610
Totals			\$17,538,000	\$17,500,000	\$35,038,000

* Note that this Action Plan is not a commitment to future funding and that all out-year actions are subject to the availability of future appropriations and allocation decisions.

Note: Fiscal Year 2016 USEPA Support: [Response Actions (\$1,173,000, Transportation Study (\$290,000), CAWS Advisory Committee (\$75,000), Contract Support (\$100,000), ACRCC Support (\$75,000)].

Agency Funding by Agency

	#	Title	FY 2016 (\$)	FY 2017* (\$)	TOTAL Base (FY2016-2017)
USACE	1	Great Lakes Mississippi River Interbasin Study (GLMRIS) - Brandon Road	\$1,000,000	\$2,600,000	\$3,600,000
	2	Lab Experimentation and Modeling to Quantify Response to CO2 in a Flowing Environment	\$0	\$0	\$0
	3	Operation and Maintenance of Barriers	\$11,750,000	\$11,800,000	\$23,550,000
	4	Barrier I Constuction	\$16,000,000	\$0	\$16,000,000
	5	Telemetry - Barrier Efficacy Evaluation	\$250,000	\$200,000	\$450,000
	7	Monitoring and Response Team Support	\$0	\$0	\$0
	39	Ohio-Erie Canal Pathway Closure Assessment	\$0	\$0	\$0
	44	Laboratory Analysis of Mitigation Measures to Address Barge Entrainment of Fish and Floating Species	\$0	\$0	\$0
	45	Field Deployment of Barriers at Brandon Road Lock	\$0	\$0	\$0
	46	Asian Carp Swim Speed Study	\$0	\$0	\$0
	47	H & H Support for Eagle Marsh II	\$0	\$0	\$0
		Subtotal	\$29,000,000	\$14,600,000	\$43,600,000

USFWS	6	Great Lakes Asian Carp Monitoring Program	\$1,150,000	\$1,097,088	\$2,247,088
	7	Monitoring and Response Team Support	\$1,015,000	\$300,000	\$1,315,000
	8	Barge Entrainment and Interaction Study	\$200,000	\$0	\$200,000
	9	Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	\$160,000	\$0	\$160,000
	10	Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters	\$0	\$0	\$0
	11	Program Capacity for eDNA Sampling	\$1,100,000	\$1,050,000	\$2,150,000
	12	Fisheries Capacity for eDNA Processing and Technology Refinement	\$1,300,000	\$1,300,000	\$2,600,000
	13	Illegal Transport of Injurious Wildlife Enforcement	\$0	\$0	\$0
	14	Asian Carp Website Operation and Maintenance	\$100,000	\$100,000	\$200,000
	15	Use of Novel Gear: Video Outreach	\$0	\$0	\$0
	16	Registration of Microparticle Technologies	\$0	\$0	\$0
	17	Registration of Carbon Dioxide Technologies	\$0	\$0	\$0
	43	Program Support for Asian Carp Activities	\$75,000	\$0	\$75,000
	48	Black Carp eDNA Marker Development	\$0	\$0	\$0
	49	Analysis of Grass Carp in the CAWS	\$0	\$0	\$0
	50	Black Carp Assessment: CAWS and UMRB	\$0	\$0	\$0
	51	Mass Removal and Monitoring of Juvenile Asian Carp	\$100,000	\$0	\$100,000
	52	Barrier Defense Using Novel Gear	\$100,000	\$0	\$100,000
		Subtotal	\$5,300,000	\$3,847,088	\$9,147,088

Agency Funding by Agency

	#	Title	FY 2016 (\$)	FY 2017* (\$)	TOTAL Base (FY2016-2017)
USGS	16	Registration of Microparticle Technologies	\$100,000	\$100,000	\$200,000
	17	Registration of Carbon Dioxide Technologies	\$50,000	\$25,000	\$75,000
	18	Development of Grass Carp Control Technologies	\$325,000	\$325,000	\$650,000
	19	Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options	\$625,000	\$610,000	\$1,235,000
	20	Characterization of Brandon Road Lock for Barrier Implementation	\$0	\$0	\$0
	21	Use of Seismic Technology to Divert and Eradicate Asian Carp	\$50,000	\$20,000	\$70,000
	22	Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp	\$300,000	\$300,000	\$600,000
	23	Developing Targeted (Microparticle and Piscicide) Control Systems	\$630,000	\$830,000	\$1,460,000
	24	Chemical Attractant Investigations to Increase Harvest and Control	\$274,000	\$274,000	\$548,000
	25	Use of Acoustic Technology to Determine Behavior	\$144,000	\$50,000	\$194,000
	26	Improving Molecular Techniques for Monitoring, Biomass Estimation, and Correlation with Live Fish	\$800,000	\$800,000	\$1,600,000
	27	Integrated Pest Management Program	\$1,750,000	\$1,750,000	\$3,500,000
	28	Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp	\$100,000	\$100,000	\$200,000
	29	Assessing Techniques to Enhance Barrier Characteristics of High-Head Navigation Dams on the Upper Illinois River	\$0	\$0	\$0
	45	Field Deployment of Barriers at Brandon Road Lock	\$0	\$0	\$0
	53	Use of Complex Sound to Alter Behavior of Asian Carp	\$0	\$0	\$0
	54	Hot Water and Ozone Use for Lock Treatment	\$70,000	\$25,000	\$95,000
55	Other Program Support	\$10,000	\$10,000	\$20,000	
56	Black Carp Control, Bait, and Attractant Use	\$0	\$0	\$0	
		Subtotal	\$5,228,000	\$5,219,000	\$10,447,000

	30	Enhanced Monitoring Above and Below Electric Barriers	\$0	\$0	\$0
	31	Illinois River Stock Assessment/Management Alternatives	\$0	\$0	\$0
	32	Contract Fishing for Asian Carp Detection and Removal	\$0	\$0	\$0
	33	Interim and Long-Term Strategy and Tactics Development at Starved Rock	\$0	\$0	\$0
	34	Reducing the Risk of Asian Carp Upstream Movement: Applying Improved Fishery Gears and Designs at Brandon Road	\$0	\$0	\$0
	35	Use of Improved Gear and Novel Designs at Brandon Road	\$0	\$0	\$0

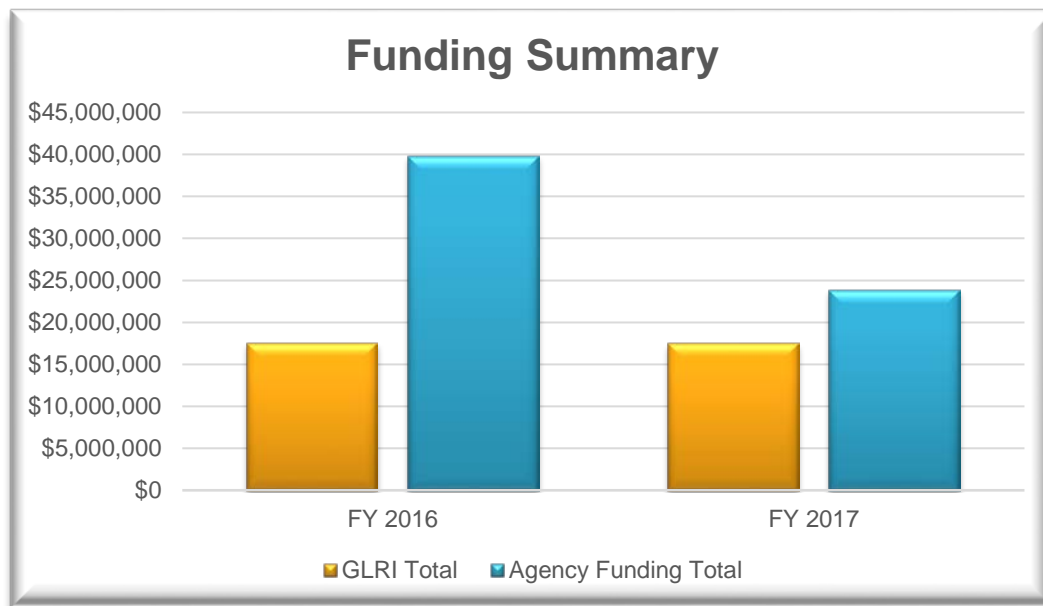
Agency Funding by Agency

	#	Title	FY 2016 (\$)	FY 2017* (\$)	TOTAL Base (FY2016-2017)
USFWS-IL DNR	36	Assessing the Distribution of Apocorophium Lacustre in the Chicago Area Waterway System	\$0	\$0	\$0
	37	Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp	\$0	\$0	\$0
	Subtotal		\$0	\$0	\$0
ODNR	38	Killbuck Creek Pathway Closure Assessment	\$0	\$0	\$0
	39	Ohio-Erie Canal Pathway Closure Assessment	\$0	\$0	\$0
	59	Development of Grass Carp Response Capabilities in Ohio	\$0	\$0	\$0
Subtotal		\$0	\$0	\$0	
USCG	40	Manage Waterway Traffic in Support of Asian Carp Control Activities	\$1,600	\$1,600	\$3,200
	41	Brandon Road Lock and Dam Risk Assessment	\$2,000	\$2,000	\$4,000
	42	Electric Barrier Construction and Operation Risk Assessment	\$2,000	\$2,000	
	63	Asian Carp Barge Entrainment Mitigation Risk Assessment	\$2,000	\$2,000	\$4,000
Subtotal		\$7,600	\$7,600	\$15,200	
NOAA	61	Food Web Modeling to Support Risk Assessment of Asian Carp in the Great Lakes	\$152,128	\$0	\$152,128
Subtotal		\$152,128	\$0	\$152,128	
MID NR	60	Grass Carp Eradication in Western Lake Erie	\$150,000	\$150,000	\$300,000
Subtotal		\$150,000	\$150,000	\$300,000	
Base Funding Total			\$39,837,728	\$23,823,688	\$63,661,416

* FY 2016 and FY2017 are estimated requests based on 2015 actions and intended outcomes.

Funding Summary

	FY 2016	FY 2017
USACE GLRI Total	\$2,594,000	\$1,980,800
USACE Agency Total	\$29,000,000	\$14,600,000
USEPA GLRI Total	\$1,713,000	\$969,610
USEPA Agency Total	\$0	\$0
USCG GLRI Total	\$209,000	\$1,305,000
USCG Agency Total	\$7,600	\$7,600
USFWS GLRI Total	\$3,260,000	\$3,060,000
USFWS Agency Total	\$5,300,000	\$3,847,088
USGS GLRI Total	\$5,240,000	\$4,950,000
USGS Agency Total	\$5,228,000	\$5,219,000
USFWS - ILDNR	\$3,700,000	\$3,900,000
USFWS - ILDNR Agency Total	\$0	\$0
USFWS - ODNR GLRI Total	\$622,000	\$1,000,000
USFWS - ODNR Agency Total	\$0	\$0
USFWS - MIDNR GLRI Total	\$200,000	\$150,000
USFWS - MIDNR Agency Total	\$150,000	\$150,000
NOAA GLRI Total	\$0	\$184,590
NOAA Agency Total	\$152,128	\$0
GLRI Total	\$17,538,000	\$17,500,000
Agency Funding Total	\$39,837,728	\$23,823,688



Appendix B

2016 Asian Carp Action Plan: Action Items

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1. Great Lakes and Mississippi River Interbasin Study (GLMRIS) – Brandon Road

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,000,000	\$500,000
FY 2017	\$2,600,000	TBD

Project Explanation: Work under this template includes the study of aquatic nuisance species (ANS) control technologies, as outlined by the Great Lakes and Mississippi River Interbasin Study (GLMRIS), that could be implemented in the vicinity of Brandon Road Lock & Dam 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 Lock and Dam control point that will address the movement of ANS from the Mississippi River Basin into the Great Lakes through the Chicago Area Waterway System (CAWS). There are three species of concern identified in the GLMRIS Report that are anticipated to pose a high or medium risk to the Great Lakes. The decision document will include sufficient planning, engineering and design to support an agency decision toward the authorization for construction of a water resources project. The completed document would include required environmental compliance analyses and support the justification of an agency decision.

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

Based on the evaluations presented in the GLMRIS Report and in response to stakeholder input, USACE has been directed by the Assistant Secretary of the Army (Civil Works) to proceed with a formal evaluation of potential control technologies to be applied in the vicinity of the Brandon Road Lock and Dam, located near Joliet, IL. A public comment period on the proposed GLMRIS-Brandon Road effort closed on January 31, 2015. USACE hosted three public meetings as part of the scoping process. The PDT has made progress on the planning document by developing a focused array of alternatives to be considered completing the Alternatives Milestone in June of 2015 and initiated development of the Tentatively Selected Plan.

2. Lab Experimentation and Modeling to Quantify Response to CO₂ in a Flowing Environment

Lead Agency: USACE

Agency Collaboration: University of Illinois Urbana-Champaign, USGS, Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$971,000
FY 2017	\$0	\$300,000

*Assume flat line funding for Agency funding.

Project Explanation: This project includes research related to the efficacy, implementation, and impacts of the use of Carbon Dioxide gas (CO₂) as a non-physical barrier chemical to deter the movement of Asian carp associated with USACE infrastructure. Adding CO₂ to water has two main effects: (1) a reduction in pH due to the formation of carbonic acid (a weak acid), and (2) elevation of dissolved CO₂ (hypercarbia). Lower pH concerns the USACE as it may damage concrete structures. Also, lower pH may violate water quality standards and impact aquatic life. To help address these concerns, concrete effects studies and water quality modeling studies are planned. Dissolved CO₂ in water influences fish movement in laboratory and field studies but no studies exist on how advective systems will change CO₂ effectiveness as a barrier technology. To address this gap, studies of fish response to CO₂ in flowing systems are being conducted. In addition, water quality models will be used to characterize how CO₂ is mixed in flowing systems and identify potential limitations of the approach so that effective mitigation can be designed. Additional studies focused on implementation of this technology and barrier assessment may occur.

The work is focused at Brandon Road Lock and Dam but other locations may be considered.

Summary of Actions to Date: The laboratory construction is complete and the first experiment to assess fish behavior to CO₂ in flowing systems is under development. A preliminary hydraulic model for Brandon Road Lock and Dam with a one-year run is complete. Kinetics have been incorporated into the CO₂ plume model and runs are underway. The report on water quality/effects of operation of a CO₂ barrier is under development. Initial engineering estimates for the volume of CO₂ needed at Brandon Road under lock emptying and lock closed conditions have been computed.

Proposed Actions:

FY 2016 Actions:

- Complete initial behavior testing of fish in advective environments; identify new information needs and path to integrate into field data and modeling simulations. This includes integrated studies with UIUC.
- Provide information on downstream impacts of CO₂ on receiving environment, focused on pH and CO₂ concentrations.
- Complete hydraulic and water quality CO₂ transport study at the local (Brandon Road approach channel) and reach (Brandon Road to Dresden Lock and Dam).
- Initiate concrete effects study using various samples possibly including concrete from Brandon Road Lock and Dam.

- USACE conduct coordination efforts between ERDC, USGS, USEPA, FWS, and various other involved or interested parties.
- Continue behavior testing of fish in advective environments; identify new information needs and path to integrate into field data and modeling simulations. This includes integrated studies with UIUC.
 - Examination of CO₂ acclimated fish to freshwater plume.
 - Long-term response of fishes to CO₂-infused, flowing water.
- Assist USGS with implementation issues, field deployment, and coordination.
- Continue hydraulic and water quality modeling studies as needed to estimate receiving body water quality impacts and concentrations of CO₂.
- Coordinate efforts between ERDC, USGS, USEPA, USFWS, and various other involved or interested parties.

FY2017 Actions:

- Complete the concrete effects study and issue draft report.
- Continue behavior testing of fish in advective environments.
- Continue to support USGS field implementation activities.
- Coordinate efforts between ERDC, USGS, USEPA, USFWS, and various other involved or interested parties.

Expected Milestones:

- | | |
|--|------------|
| • Brandon Road large scale water quality and hydro modeling report | Sept 2016 |
| • Brandon Road fine scale water quality and hydro modeling report | Sept 2016 |
| • Interim concrete effects report – year 1 | Sept 2016 |
| • Fish behavior report | March 2016 |
| • Concrete effects report – year 2 | Sept 2017 |

Outcomes/Outputs:

- Define extent and duration of a CO₂ plume in the receiving body of water.
- Estimate of the impacts to USACE infrastructure from elevated CO₂ concentrations. This information will help determine if the barrier can be deployed in close proximity to USACE concrete structures.
- Define likely outcomes of different barrier operation scenarios.
- Develop predicative relationships between carp movement in response to changing concentrations of CO₂ in a flowing environment.
- Support USGS and other agencies in development and deployment of an operational barrier.
- Tool to estimate near and far scale CO₂ concentrations under the influence of flowing water and project operations including various possible scenarios.
- Tool to estimate fish response to hydraulic and CO₂ concentration gradients under the influence of flowing water and project operations including various possible scenarios. Fish response will

include behavior as single fish, groups of fish, under multiple barrier influences and temperature at a minimum.

Potential Hurdles: Changing priorities for barrier location complicates development of the proposed tools and information.

3. Operation and Maintenance of Barriers

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$11,750,000	\$0
FY 2017	\$11,800,000	\$0

Project Explanation: USACE operates three different types of fish deterrent measures throughout the CAWS. Each is designed to prevent movement of Asian carp toward the Great Lakes in a different manner.

- The Bypass Barrier physically blocks 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.
- The Electric Barriers operate by creating a waterborne pulsed direct current electric field in the Chicago Sanitary and Ship Canal. Fish penetrating the electric field are exposed to electrical stimuli, which act as a deterrent. As fish swim into the field, they feel increasingly uncomfortable. When the sensation is too intense, the fish is either immobilized or is deterred from progressing further into the field. Three barriers (Demo, IIA and IIB) are currently operated by USACE.
- 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 must be maintained as authorized by law.

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

The Des Plaines River Bypass Barrier was erected in 2010. 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.

During FY 2015, the barriers underwent significant repairs including the installation of new switches. Additionally, installation of a counterpoise system to reduce impacts to an adjacent railroad began in FY 2015.

Proposed Actions:

FY 2016 Actions: Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the electric barriers.

FY 2017 Actions: Operation and maintenance of the barriers will continue, including regularly scheduled maintenance of the electric barriers. Operation of Barrier I begins in FY 2017.

Expected Milestones:

- Annual maintenance May/June
- Other routine maintenance Quarterly

Outcomes/Outputs: The barriers will perform as designed, thereby minimizing the risk of Asian carp movement toward Lake Michigan through the CAWS.

Potential Hurdles: None

4. Barrier I Construction

Lead Agency: USACE

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$16,000,000	\$0
FY 2017	\$0	\$0

Project Explanation: Congress authorized USACE to upgrade the demonstration barrier to a public facility in the Water Resources Development Act of 2007. Once completed, the permanent barrier 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 CAWS.

Summary of Actions to Date: Site work was completed in 2014. Contracts were awarded for fabrication and placement of the in-water structures, acquisition of the new barrier's electrical equipment, construction of the building to house the equipment, and installation of mechanical and backup power systems.

Proposed Actions:

FY 2016 Actions: Main building construction is scheduled for completion in 2016. Also, installation of the electrical equipment and mechanical components are scheduled to occur in 2016.

FY 2017 Actions: Remaining construction items will be completed in Fiscal Year 2017. Performance and safety testing will also be conducted prior to final activation of the barrier during the 3rd quarter.

Expected Milestones:

- Award equipment installation contract 1st Quarter 2016
- Complete major construction activities/
initiate performance and safety testing 2nd Quarter 2017
- Commission Barrier I 3rd Quarter 2017

Outcomes/Outputs: Once completed, Barrier I is expected to be capable of delivering power necessary to deter fish with sufficient redundancy to significantly reduce the potential for system outages.

Potential Hurdles: None

5. Telemetry-Barrier Efficiency Evaluation

Lead Agency: USACE

Agency Collaboration: USFWS, Southern Illinois University - Carbondale, Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$250,000	\$0
FY 2017	\$200,000	\$0

Project Explanation: USACE has led telemetry efforts in the Illinois Waterway (IWW) and CAWS since 2010 with a primary objective of assessing the efficacy of the electric barriers in the Chicago Sanitary and Ship Canal as identified in the ACRCC's Monitoring and Response Plan. By surgically implanting transmitters into fish species (both Asian carp and surrogate species), empirical data are compiled to demonstrate the barriers are effective in preventing passage of adult large bodied surrogate fishes in the upstream direction. This project continues the work in assessing the efficacy of Barriers IIA and IIB, as well as adding an array at the site of the new permanent Barrier I. Additionally, the projects include procurement of depth sensor transmitters this year to provide further insight into barrier challenges by surrogate species as well as how tagged fishes react to passing barge traffic. Further refinement of the stationary receiver network is an ongoing activity within the project which increases efficiency and coverage within the system. By combining the array established by USACE with the new arrays previously established by Southern Illinois University - Carbondale and USFWS, these organizations are also 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 over 30 strategic locations from the Upper IWW into the CAWS. A Vemco Positioning System (VPS) was also established around Barriers IIB and IIA that is capable of providing 2D fish movements in relation to the barrier fields. Transmitters have been surgically implanted into 432 fishes, which were released throughout the system. Mobile tracking and receiver downloads have occurred monthly to ensure up-to-date data are provided to decision makers regarding the efficacy of the barrier system. Some of the interim studies of the project have provided results on small fish and fish-barge interactions. These results have informed USACE management decisions and have also been shared with partner agencies in support of external study development. Additional work in FY 2015 included the implantation of depth sensor tags into surrogate species at the barriers, further work with USFWS on fish-barge interaction trials and expanding the network receiver coverage at the leading edge of the Asian carp range expansion. This expanded network focuses specifically on the Brandon Road Lock and the Kankakee River. Interim summary reports of work completed are prepared annually and included within the Monitoring and Response Plan annual summary report.

FY 2016 Actions:

- Implant depth sensor tags into surrogate species within the Brandon Road Lock.
- Establish Barrier I Vemco Positioning System with most efficient receiver network available.

- Maintain levels of transmitter density per pool.
- Adjust/increase receiver locations as needed.
- Bi-monthly downloads with monthly mobile tracking during late spring/early summer.
- Coordinate data collection and record keeping with Southern Illinois University - Carbondale and USFWS.

FY 2017 Actions:

- Acquire and implant depth sensor tags in to surrogate species at Barrier I.
- Maintain levels of transmitter density per pool.
- Adjust/increase receiver locations as needed.
- Bi-monthly downloads with monthly mobile tracking during late spring/early summer.
- Coordinate data collection and record keeping with Southern Illinois University - Carbondale and USFWS.
- Continue agency coordination at the federal, state and local levels to combine monitoring practices at areas of interest to assess Asian carp population dynamics and emergent barrier technologies.

Expected Milestones:**FY 2016:**

- October 2015: Surgically implant 9 fishes with depth sensor tags and release into and around the Brandon Road Lock in conjunction with varying lock operations.
- November 2015: Surgically implant 40 fishes throughout the study area to maintain current level of tagged fish according to the study design.
- January 2016: Prepare and submit the annual report of findings to the MRWG.
- April 2016: Adjust acoustic receiver network as necessary to account for changes in Asian carp distributions.
- May 2016: Acquire additional receivers and associated equipment to extend VPS system over permanent Barrier I.
- June 2016: Surgically Implant an additional 100 fishes to maintain current level of transmitter density within each pool of the study area.
- September 2016: Install VPS around Barrier I and connect it with the existing VPS surrounding Barrier II.

FY 2017:

- October 2016: Acquire depth sensor tags for Barrier I efficacy trials and additional tags to maintain transmitter density within the project area.
- January 2017: Prepare and submit the annual report of findings to the MRWG.
- April 2017: Adjust acoustic receiver network as necessary to account for changes in Asian carp distributions.

- May-June 2017: Tag and release surrogate fishes and Asian carp to maintain density of transmitters within the project area.
- June 2017: Commence depth tag study at permanent Barrier I.
- September 2017: Complete depth tag study at permanent Barrier I.

Outcomes/Outputs:

Goal 1: *Determine if fish are able to approach and/or penetrate the Barrier (Barrier Efficacy)*

- *Objective* Monitor the movements of tagged fish (large and small) in the vicinity of the Barrier using receivers placed immediately upstream, within, and immediately downstream of the Barrier, in addition to mobile tracking.
- *Objective* Implant surrogate fishes near the barriers with depth sensor transmitters.
- *Objective* Analyze behavior and movement patterns of fish near the barriers as they interact with barge traffic.

Goal 2: *Determine if and how Asian carp pass through navigation locks in the Upper IWW*

- *Objective* Monitor the movements of tagged fish at Dresden Island, Brandon Road, and Lockport Locks and Dams using stationary receivers placed above and below each dam and within the lock chamber.
- *Objective* Determine if there is adequate detection coverage to effectively assess fish passage through lock structures or other bypass pathways.

Goal 3: *Determine the leading edge of the Asian carp population and habitat use*

- *Objective* Determine if the leading edge of Asian carp invasion; currently, RM 281.5 is the upstream location of Asian carp population.
- *Objective* Describe habitat use and movement in the areas of the Upper IWW and tributaries where Asian carp have been captured and relay information to the population reduction program undertaken by IDNR and commercial fishermen.

Objectives of interagency and academia coordination:

- *Objective* Integrate information between related acoustic telemetry studies.
- *Objective* Download, analyze and post telemetry data for information sharing.
- *Objective* Expand and increase existing acoustic network in Dresden Island and Kankakee River while maintaining capability to rapidly deploy to areas of interest in response to new information.

Potential Hurdles: Receiver deployment, retrieval and protection within the electrified water of the barriers could present a challenge in the future. Floating debris and navigation traffic could dislocate or damage submerged equipment which would require mitigation. These types of problems have occurred in previous years but have been remedied by the team on a case by case basis. Minor impacts to the project cost were incurred along with moderate impacts to schedule.

7. Monitoring and Response Team Support

Lead Agency: USACE

Agency Collaboration: USEPA, USGS, USFWS, Illinois DNR, MWRD and GLFC

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$200,000
FY 2017	\$0	\$200,000

Project Explanation: The proposed work is to be conducted by the USACE Regional Planning & Environmental Division North and the Rock Island District to support the Asian carp control efforts that has been developed by the Asian Carp Regional Coordinating Committee (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.

FY 2015 Actions:

- Collaboration, technical and field support for lead agencies with ACRCC agencies on the implementation of the 2015 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.

Proposed Actions:

FY 2016-17 Actions:

- See FY 2015 Actions

Expected Milestones: Defined annually by the ACRCC in the Asian Carp Action Plan and the Monitoring and Response Plan.

Outcomes/Outputs:

- Coordination and implementation of activities identified in the Asian Carp Action Plan and the Monitoring and Response Plan.
- Development of feasible Asian carp control measures in the IWW to prevent Asian carp colonization of the Great Lakes.

Potential Hurdles: Insufficient time to implement control strategies before Asian carp move into the Great Lakes.

39. Ohio – Erie Canal Pathway Closure Assessment

See project description for Project 39 under Ohio DNR.

44. Laboratory Analysis of Mitigation Measures to Address Barge Entrainment of Fish and Floating Species

Lead Agency: USACE

Agency Collaboration: USGS, USFWS

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$0
FY 2017	\$0	\$0

Project Description: Commercial tows operating within the CAWS produce residual currents and forces that could potentially transport fish and other passive constituents across control structures and aid their progress toward Lake Michigan. A previous study to investigate the effect of navigation on the transport of Asian carp through the CAWS was conducted by the USACE Engineer Research and Development Center (ERDC), with support from the USACE Chicago District. A 1:16.7 scale physical model with remote control tow and barges was used to evaluate the interactions of vessel, fluid motions, and nearly neutrally buoyant objects under a variety of vessel speeds and barge configurations typical of the CAWS. The results indicated that fish could be entrained within the recesses between barges or trapped in the residual currents and carried past simulated control structures (e.g., electric fish barriers) for a variety of tow configurations, speeds, and directions. In some cases, fish were carried over 2000 ft.

This project proposes to extend this work to investigate mitigation techniques to minimize barge entrainment of fish and other organisms. The goal is to develop and test methodologies to dislodge/remove species from the recesses between barges and vessel-induced eddies using submerged water jets and other technologies before vessels traverse a control point with the goal of implementing a field demonstration in calendar year 2016. The results will be applicable to the existing electric barrier network, and will provide guidance on the design of similar mitigation measures for other areas such as the approach channel for Brandon Road Lock.

FY 2016 Actions:

- Define a scope of work that would test in a laboratory setting mitigation measures for fish entrainment. The SOW would outline the time and cost required to carry out the study and provide a detailed description of methodologies and expected products.
- Define the potential mitigation measures that could be used to remove nearly neutrally buoyant objects from the protected areas. The ERDC engineering team has already defined a list of mitigation measures to be tested. Further approaches would be developed in consultation with the project participants including the Chicago District, partnering federal agencies and other consulting groups.
- Construct a scaled physical model. Using the existing facility, a series of new tests aimed at removing trapped fish would be carried out. Because this is an extension of previous work, testing procedures are already established. There is no need to modify the physical model and the only new requirement is to install features to model the proposed mitigation measures and to construct 2 new barges and purchase 2 new cameras for flow visualization.

- Conduct scaled model tests and evaluate mitigation alternatives. The first year of this study involves the evaluation of three mitigation measures: (1) water jets, (2) return current, and (3) tow speeds and barge configuration. Return current is the water displaced by vessel movement. This water travels in the opposite direction of vessel movement and may carry neutrally buoyant objects with it. Water jets will be used to dislodge trapped fish while the vessel is stationary or moving at slow speeds. Tests under different tow speeds and barge configurations will be conducted to determine the minimal speed to prevent neutrally buoyant fish from crossing the electric barrier array via the return current. All tests will be evaluated for efficacy, navigation safety, and other regulatory requirements (maximum safe speed, etc).
- Conduct a field demonstration of mitigation measures that appear to be effective based on physical model testing.

FY 2017 Actions:

- If not completed in FY 2016, continue field demonstration of mitigation measures.
- Depending on field demonstration results, flume studies may be conducted on additional mitigation measures.
- Conduct a field demonstration of mitigation measures that appear to be effective based on physical model testing.

Expected Milestones:

- Completed development of an SOW that would test in a laboratory setting mitigation measures for fish entrainment (September 2015).
- Modification of an existing test facility to evaluate mitigation measures (1st quarter FY 2016).
- Carry out a suite of tests to gauge the effectiveness of each of the mitigation measure (2nd & 3rd quarters FY 2016)
- Conduct a field demonstration of mitigation measures that appear to be effective based on physical model testing (4th quarter FY 2016).

Outcomes/Outputs:

- Based on physical model testing, identify mitigation measures that could reduce barge entrainment of nearly neutrally buoyant objects.
- Based on field demonstration, verify whether the mitigation measures that appear to be effective based on physical model testing are effective in the Chicago Sanitary and Ship Canal.

Potential Hurdles: Identifying mitigation measures that are effective at dislodging nearly neutrally buoyant objects.

45. Long-Term Deployment of Control Technologies at Brandon Road

Lead Agency: USACE/USGS

Agency Collaboration: USFWS, IDNR, USCG

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USACE	Total	USACE	USGS	Total
FY 2016	\$0	\$0	\$0	\$450,000	\$450,000	\$900,000
FY 2017	\$0	\$0	\$0	\$380,800	\$900,000	\$1,280,000

Project Explanation: Several potential control technologies are being considered to prevent Asian carp movement through Brandon Road Lock. The USGS has completed laboratory and field-scale tests, but has not deployed technologies in a barrier configuration for long-term testing at an actual working site, which offers additional complexities over the typical field installation testing. This project would allow testing of control technologies in the approach channel of the Brandon Road Lock; CO₂, complex sound and possibly other barrier technologies; for a period of up to 30 days each. This testing would allow the evaluation of deployment configurations, collect operation and maintenance information for longer deployments, and assess fish movement under longer deployments. The testing would also allow for testing on the impact to river navigation because the Brandon Road Lock is a functioning facility. Possible shorter term testing during this project could include evaluation of different approach channel materials, safety issues, and impacts on structures and vessels. Another objective of this project is to provide all potential parties with field experience in the deployment of these ANS control technologies.

Summary of Actions to Date:

- Field scale testing of integrated pest management using CO₂ was conducted at test ponds at the USGS Upper Midwest Environmental Sciences Center, completed in 2014.
- Field scale testing of complex sound was completed at test ponds at the USGS Upper Midwest Environmental Sciences Center in 2014.
- Field scale testing of CO₂, and complex sound were completed under different templates at Morris, Illinois in 2015.

FY 2016 Actions:

- Develop designs/plans for deployment of, complex noise, CO₂ and possibly other technology barriers of up to 30 days in the approach channel at the Brandon Road Lock and Dam.
- Develop plans for supplemental/additional testing of different configurations, materials, safety considerations, and vessels.
- Develop the plan to begin the technology transfer of these technologies from the USGS.

FY 2017 Actions:

- Implement a complex sound barrier for up to 30 days in the approach channel at the Brandon Road Lock and Dam, or longer depending on cost, weather, and logistical considerations. Collect fish movement, and other data as relevant and identified during the designs/plans developed FY 2016.

- Implement a CO₂ barrier for up to 30 days in the approach channel at the Brandon Road Lock and Dam, or longer depending on cost, weather, and logistical considerations. Collect fish movement, structural, and other data as relevant and identified during the designs/plans developed in FY 2016.
- Provide USACE and other parties with field experience in the deployment of these ANS control technologies.

Expected Milestones:

- Development of designs/plans for the long-term deployments: October 31, 2016
- Field deployment of both technologies for up to 30 days each: October 30, 2017

Outcomes/Outputs: Long-term deployment information for two technologies currently under development. Two USGS and one USACE report documenting the effectiveness, design considerations, and other information. Considerations for future larger-scaled design and deployment will be highlighted.

Potential Hurdles:

- Timeliness of funding with respect to field testing schedule.
- NEPA evaluations.
- Coordination with navigation and real estate.
- CO₂ storage locations and cost.
- Regulatory permitting.

46. Asian Carp Swim Speed Study

Lead Agency: USACE

Agency Collaboration: University of Minnesota, Minnesota DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$200,000
FY 2017	\$0	\$0

Project Explanation: Information on swimming performance of large (500-1000 mm TL) adult Bighead and Silver Carp is critical for assessing and developing barriers to dispersal. Data, however, are limited to qualitative field observations (mostly unpublished) and a few telemetry studies with low numbers of fish (e.g., Konogaya and Cai, 1987; Konogaya and Cai, 1989). Data from radio- or acoustic-tagged adult fishes over broad spatial scales provide a general sense of distance traveled over long time periods, and can offer insight into volitional swim speeds, but cannot accurately predict endurance-based swimming capabilities such as sustained, prolonged, and burst speeds. Additionally, telemetry studies are observations of specimens in the natural environment with many uncontrolled variables affecting the outcome (e.g., water temperature, water quality). Laboratory studies of Asian carp can control confounding environmental variables but have, to date, only been conducted on small juveniles (< 120 mm TL) or somewhat larger sub-adults (120-300 mm) (Hoover et al., 2012). Limited availability of swimming performance information reflects the scarcity of adequate testing chambers (i.e., large swim tunnels) and the difficulties of working with large, active, easily-stressed fishes (i.e., transport, acclimatization, etc.).

The U.S. Army Corps of Engineers Research and Development Center Environmental Laboratory (ERDC-EL) has recently constructed a large (2935 L total volume, 1525 L working volume) Brett-type swim tunnel similar to laboratory swim tunnels (Hoover et al., 2011) but which can be easily transported to and operated in the field. This swim tunnel is capable of accommodating large fish (greater than 35 kilograms) and generating precisely controlled flows (measurable within 5 cm/s). The swim tunnel has been used to study White Sturgeon (in 2013), Paddlefish (in 2014), and most recently Bighead and Silver Carp (March and June 2015). The carp study was funded by the University of Minnesota. This project consists of a study design (i.e., autumn and winter testing) that will complement the previous study of Asian carp and fill in the gaps of prior research. It will enable researchers and managers to predict swimming performance of both species across the calendar year, for a complete range of seasonally varying environmental parameters (e.g., water temperature, day length, etc.) and physiological status of fish (e.g., nutritional state, condition, reproductive stage).

A refined understanding of the swimming capabilities of Bighead and Silver Carp will strongly support both the CSSC Dispersal Barriers project and the GLMRIS Brandon Road feasibility study. Improved knowledge on burst, prolonged, and sustained swim speeds throughout the full year will reduce uncertainty involved in assessing the performance of both existing and planned future barriers. Swim speeds are also critical in evaluating probability of passage at lock and dam structures. Exposure time to the barrier and the ability of these fish to traverse high flows are strongly dependent upon the swimming capabilities that would be directly assessed with this project.



Figure 1: ERDC-EL researchers in trial testing a brand new and enlarged version of a Brett swim tunnel at a field location using the same water in which the fish was captured from. The swim tunnel is mobile and can be taken on site, which reduces handling and holding stress on the species of interest.

Summary of Actions to Date: Tests were conducted on 80 Asian carp during the spring and summer of 2015, which proved to be successful on both species, Bighead Carp and Silver Carp. Fewer than 15% of fish tested were non-performers (i.e., non-rheotactic). Swimming movements were regular and dominated by free-swimming in the water column. Endurance (i.e., time-to-fatigue) declined with increasing water velocity. Preliminary regression models were significant and showed high predictive ability for Bighead Carp ($R^2 > 0.70$, $N = 17$) and for Silver Carp ($R^2 > 0.27$, $N = 51$), with Silver Carp more variable and with higher maximum performance. Differences between genders were not apparent. Maximum documented swim speeds (< 3 body lengths/s) were comparable to typical volitional swim speeds of adult Asian carp determined in telemetry studies but below rarely employed maximum speeds (> 5 body lengths/s) and well below typical maximum burst speeds for fish in general (approximately 10 body lengths/s)(Konagaya and Cai, 1987; 1989; Videler and Wardle, 1991).

FY 2016 Actions: Receive funding and study design completed. Choose study site.

- Establish team structure and review protocols along with detailed schedule through project close out.
- Prepare study design and required materials for fall and winter trials. File all required permitting and coordination with the Institutional Animal Care and Use Committee (IACUC).

FY 2017 Actions:

- Conduct fall and winter trials.
- Prepare report.

Expected Milestones:**FY 2016:**

- Completed study design and recommend site selection for trials September 2016

FY 2017:

- Complete fall round of swim speed trials December 2016
- Complete winter round of swim speed trials February 2017
- Submit final report September 2017

Outcomes/Outputs: The final report will include swim speed assessments of Bighead and Silver Carp for river conditions representative of fall and winter months. This new information will be combined with existing data on spring and summer seasonal swim speeds to provide a year round representation of the swimming capabilities of both species across a wide range of water temperatures. Sufficient data will be collected to evaluate differences between species, genders, and among size classes. These data will be robust enough to generate statistically significant velocity-endurance regression models for each group of carp and to evaluate role of confounding variables (e.g., water quality) on swimming performance.

Data will enable planners, managers, and decision makers to assess risk of Asian carp passage (invasion) when evaluating existing or future physical barriers and other fish deterrent options and develop corrective response actions for carp at the leading edge of the invasion front. The former will entail comparisons of flow fields over/through river structures (e.g., lock-and-dams, electrical barriers) with Asian carp swimming abilities. The latter will entail objective determinations of displacement velocities for a given distance of managed waterway. Both are readily accomplished using simple algebraic/graphic techniques (e.g., Peake et al., 1997; Adams et al., 2000; Hoover et al., 2012).

Potential Hurdles: Risk of encountering hurdles to project completion is considered low. Problems that may have a minor effect on the project schedule and budget are mainly associated with field work interference due to weather. Severe weather or flooded river stage may prevent specimen collection and field trials on the scheduled date. Additionally, there is a slight risk that the correct proportion of Bighead and Silver Carp may not be able to be captured when needed. However, previous seasonal trials for spring and summer were able to generate significant values with a comparatively low sample size.

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47. H & H Support for Eagle Marsh II

Lead Agency: USACE

Agency Collaboration: NRCS, Indiana DNR, Little Rivers Wetlands Project, USGS, Maumee River Basin Commission

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$15,000
FY 2017	\$0	\$50,000

Project Explanation: This project involves preliminary coordination and H&H support for future planning of Phase II of the berm reconstruction at Eagle Marsh. Phase II of the project will provide complete basin separation up to the 0.01 annual chance of exceedance event. Construction to this level would require mitigation of flooding impacts. USACE would continue H&H planning and design expertise.

Summary of Actions to Date:

FY 2015 Actions: USACE provided periodic Engineering and Design During Construction support to NRCS relative to Phase I berm construction. Phase I is scheduled for completion in FY 2016.

Proposed Actions:

FY 2016 Actions: It is expected that Phase II planning will be initiated by a partnering agency in FY 2016. LRL will continue technical H&H support for this planning.

FY 2017 Actions: Continued H&H technical support to help understand required mitigation actions.

Expected Milestones: TBD

Outcomes/Outputs: A comprehensive strategy for defining and completing required mitigation in order to complete Phase II.

Potential Hurdles:

- No partnering agency assumes lead for acquisition.
- Funding to implement project is unavailable.

6. Great Lakes Asian Carp Monitoring Program

Lead Agency: USFWS

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

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,150,000	\$350,000
FY 2017	\$1,097,088	\$350,000

Project Explanation: 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. 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. 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.

FY 2015 Actions: 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.

Proposed Actions:

FY 2016 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.

FY 2017 Actions: USFWS and partner agencies will fully implement a comprehensive Great Lakes basin wide early detection and monitoring program for Asian carp and other AIS. USFWS staff/teams will be prepared, and may be mobilized, to respond to any Asian carp detected (using either traditional

gear or eDNA) in the Great Lakes. Efforts will continue on an annual basis to detect new invasions of Asian carp.

Expected Milestones:

- Fully implement a comprehensive and coordinated Great Lakes 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.

Outcomes/Outputs:

- Ongoing early detection, rapid assessment, and rapid response program for the Great Lakes.
- Information that will build upon existing knowledge of distribution and habitat requirements for Bighead, Silver, Grass, and Black Carp.

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.

7. Monitoring and Response Team Support

Lead Agency: USFWS

Agency Collaboration: Illinois DNR, USACE

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,015,000	\$820,000
FY 2017	\$300,000	\$820,000

*Assume flat line funding for Agency funding.

Project Explanation: This task encompasses long-term monitoring and rapid response activities regarding Asian carp throughout the CAWS, both above and below the Electric Barrier System. Enhanced sampling with both conventional (electrofishing, netting, sidescan sonar, hydro-acoustics, rotenone) and novel gears (DIDSON, Paupier net) will be used to document Asian carp population dynamics within the canal system and connecting waterways, provide data for modeling potential population movements (range expansion), document fish behavior in and around the barriers, and determine life stages of Asian carp potentially present. Response activities may be implemented where specific evidence indicates presence of Asian carp above the electric barriers, or if a catastrophic event necessitates immediate action.

Summary of Actions to Date: In 2013, Illinois DNR, USFWS, and USACE conducted extensive sampling efforts in search of Asian carp above and below the barriers following implementation of the ACRC Monitoring and Response Workgroup's updated 2013 Monitoring and Response Plan — which included additional and novel sampling gear types, a juvenile distribution study, additional telemetry and DIDSON evaluations, an evaluation of the impact of contract commercial fishing on Asian carp abundance, and a survey program of urban fishing ponds. Through June 2013, staff completed 400 electrofishing runs for a total of 100 hours. No Asian carp were observed through electrofishing. USFWS staff also conducted fish behavior studies (wild and caged) at the electric barriers. USFWS also participated in 5 responses, including Lake Calumet intensive surveillance, or barrier clearing exercises in 2013. In 2014, Illinois DNR, USFWS, and USACE again conducted extensive sampling efforts in search of Asian carp above and below the barriers following implementation of the ACRC Monitoring and Response Workgroup's updated 2014 Monitoring and Response Plan — which focused more efforts below the barriers and recommended evaluations at Brandon Road Lock. In 2014, four seasonal intensive monitoring events were completed in the CAWS. Staff completed 350 electrofishing runs and set over 200 trammel/gill nets. No Asian carp were observed in 2014. In 2015, staff completed 213 electrofishing runs during four weeks of seasonal intensive monitoring in the CAWS. No Asian carp were captured, but two Grass Carp were observed. Staff completed 16 fixed and 32 fixed site electrofishing runs over the course of two events in Dresden Island and Marseilles pools. Twenty-four Silver Carp and 1 Grass Carp were captured. As part of enhanced adult Asian carp monitoring efforts, staff set 14,300 yards of gill and trammel nets in Starved Rock Pool through Lockport Pool and completed 35 electrofishing runs. Eleven Grass Carp, 15 Bighead Carp, and 416 Silver Carp were captured.

FY 2016 Actions: A USFWS team(s) will support Asian carp monitoring and response activities throughout the region as necessary, and help implement actions called for under the annually updated MRP.

FY 2017 Actions: A USFWS team(s) will support Asian carp monitoring and response activities throughout the region as necessary, and help implement actions called for under the annually updated MRP.

Expected Milestones:

- Annual updating, approval, and implementation of the MRP.
- Attainment of goals and objectives set by the MRP.
- Completion of necessary monitoring with conventional and novel gears to determine the distribution and abundance of Asian carp in the CAWS.
- Participation in response efforts, as needed.
- Participation in necessary barrier clearing.

Outcomes/Outputs:

- Continued development of ACRCC's MRP, as needed to monitor the leading edge of the Asian carp expansion.
- Support of Incident Command System (ICS) response operations as needed.
- Provision of staff, equipment, supplies, and ICS team members as needed.

Potential Hurdles:

- Weather conditions.
- Staff availability.
- Possible negative impacts on commercial vessel traffic movement, recreational uses, and resident aquatic life (other than Asian carp) from activities associated with this template.
- Possible public resistance to continuing monitoring and response efforts.

8. Barge Entrainment and Interaction Study

Lead Agency: USFWS

Agency Collaboration: USACE and USGS

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$200,000	\$750,000
FY 2017	\$0	\$750,000

Project Explanation: This project encompasses both follow up investigations to studies conducted in 2015 and an evaluation of management actions that could potentially reduce or eliminate fish entrainment by barges in the CAWS. Work completed in 2015 showed that free swimming, surrogate fish could be entrained and retained in a “rake-to-box” junction of a barge tow, as well as through a lockage, across the electric dispersal barriers, and for long distances (~10 river miles). Further details of the 2015 results were shared with the ACRCC member agencies, CEQ, DOJ, and the maritime industry. Initial work was completed in a laboratory setting by the USACE. Field work was completed by USFWS in 2012, 2013, and 2015 which showed that live fish could be entrained across the electrical barriers in the CAWS by passing barges to varying degrees depending on barge configuration. The proposed work for FY 2016 aims to address questions raised by the USFWS, USACE, other agencies, and the maritime industry regarding behavior of fish in barge void spaces and distances fish may be entrained, and potential management actions that can eliminate or reduce the likelihood of entrainment.

Specific study objectives of the follow up investigations portion of this study are to: (1) continue to evaluate behavior of wild fish near and in the void spaces of barges as they traverse different sections of the CAWS; (2) determine the length of time and distance wild fish may be entrained in areas and void spaces of barges; (3) determine the size in which fish can vacate, of their own volition, the void spaces of a rake to box barge; (4) evaluate entrainment probabilities under different barge configurations; and (5) determine entrainment potential within the pocket eddy created in a rake to box barge junction. To answer questions related to the possibility of wild fish (free swimming, non-tethered) entering areas around barges, nets will be designed and deployed in the void spaces between the barges while barges traverse the CAWS. USFWS will deploy DIDSON (Dual-frequency identification sonar) units and video cameras around the barges. The images from the DIDSON or underwater cameras will be used to view and count wild fish in barge junctions over time and distance traveled. Additional data on temperature, flow, speed of the barges, location, electrical measurements, and distances traveled by the barges will also be collected and compared to the images collected. Surrogate live, untethered fish may also be collected and dropped into the areas in order to collect additional images of fish behavior under simulated entrainment conditions if warranted.

Specific study objectives of the management action portion of this study are to: (1) evaluate the use of several different types of management actions that could potentially reduce or eliminate wild fish entrainment by barges in the CAWS. Management actions to be tested may include, but are not limited to, the use of CO₂, complex sound, light, waterjets, inflatable or other bladders, and flushing of the barge junctions created by the tow boat under various operating conditions; (2) evaluate behavior of wild fish

near and in the void spaces of barges as different management actions are employed through different sections of the CAWS.

FY 2016 project work may also include field work to assess the relative likelihood/probability of barges encountering and entraining juvenile Asian carp in the CAWS.

The majority of project costs are to pay for contracts with barge companies to provide barges, time, and crew as a platform to conduct this work (est. 6 weeks of field work X approx. \$100,000/week). Remaining funds will be used to cover USFWS salary, operational costs, and potential development of exclusion/removal technologies for void spaces. Costs of this project could be reduced if barge operators were willing to provide barge platforms as an in-kind contribution.

Summary of Actions to Date: In 2013, USACE completed a laboratory based model study using a scaled down flume version of the CAWS barrier system and model fish and barges at its ERDC lab. This study showed that model fish assumed to be incapacitated by the barriers could be entrained beyond the barriers in void spaces between the barges. Further USACE studies of electric field strength around barges traversing the barriers showed distortion of the electric field and weakening of the electric field in some cases, particularly in the void space of a rake-to-box barge configuration. Field studies conducted by USFWS in 2012 and 2013 used tethered and wild surrogate fishes to test if barges would entrain these fish and propel them through the barrier system. Two general methods were used, one where fish were placed directly in the spaces around barges as they traversed the barrier, and another where fish were placed across the canal in front of north bound barges crossing the barrier. These studies (<http://www.fws.gov/midwest/fisheries/carterville/didson-barge.html>) found that live fish were entrained across the barriers by passing barges, to varying degrees depending barge configuration.

FY 2015 Actions: In 2015, USFWS crews collected barge entrainment data for four weeks regarding the potential for wild fish entrainment within a rake to box barge junction. This work included traversing the electric dispersal barrier as well as several lockages and long distances of almost 10 miles. Electrical measurements taken over the IIB narrow array showed a significant decrease in electrical levels as a barge passed over the barrier. Flow measurements were also collected around the barge and within the rake to box junction by the USGS while at the Brandon Road lock and dam. Preliminary 2015 study results showed that free-swimming, surrogate fish could be entrained and transported in a “rake-to-box” junction of a barge tow through the electrical dispersal barriers, through a lockage, and across distances as great as 9.9 miles.

Proposed Actions:

FY 2016 Actions: A USFWS team(s) will conduct additional studies as needed. Work completed in 2015 generated many more questions from several agencies and the maritime industry, similar to the manner in which work completed in past years generated additional questions from the Government/Barge Workgroup. Exact study designs are still in development but will build around further advancement and refinement of entrainment rates, likelihood and distances, and will focus on studying potential management actions to eliminate or reduce fish entrainment around barges.

FY 2017 Actions: A USFWS team(s) will conduct additional studies as needed. Exact study designs are still in development but will build around further advancement and refinement of entrainment rates, likelihood and distances, and will focus on studying potential management actions to eliminate or reduce fish entrainment around barges.

Expected Milestones:

- Data allowing agencies to determine the relative frequency of wild fish entering void spaces of barge tows.
- Data allowing agencies to determine the relative time spent and distance traveled by fish in void spaces of barge tows.
- Written project report(s) describing project results.

Outcomes/Outputs:

- Enhanced knowledge of behavior of fishes near barges and in void spaces of barge tows that could influence future operations in a manner that minimizes fish entrainment.
- Support of Government/Barge Workgroup.
- Satisfaction of USFWS partners in addressing potential entrainment issues at the barriers.

Potential Hurdles:

- Weather conditions.
- Turbulence and water clarity in and around barges may obscure systems used to monitor fish behavior.
- Possible issues regarding sampling site logistics.
- Potential difficulties in contracting or scheduling participation with barge operators.
- Potential conflicts with barrier maintenance activities.

9. Hydro-Acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River

Lead Agency: USFWS

Agency Collaboration: USACE

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$160,000	\$160,000
FY 2017	\$0	\$160,000

Project Explanation: There is great concern about upstream dispersal of Asian carp within the upper Illinois water way and the effects this dispersal could have on the ecosystems of the Great Lakes. The Brandon Road Lock may presently act, or provide opportunity to be modified, to serve as a barrier to fish movement within the upper Illinois water way. Preliminary results of USFWS hydro-acoustic surveys within the Brandon Road and Dresden Island pools suggest that fish density is greater below the Brandon Road Lock in the Dresden Island Pool than above the lock. Asian carp are known to inhabit the Dresden Island pool.

Here, it is proposed to extend and enhance our collective understanding of fish passage dynamics at the Brandon Rd. lock by making fine scale real time observations of fish passage within the lock, examining variables that effect fish passage such as commercial shipping and abiotic variables, and relating our observations to new understanding on lock mediated upstream dispersal by Asian carp. Specific study objectives are to: (1) Quantify the amount of upstream fish passage that occurs between the Dresden Island and Brandon Rd. pools via the Brandon Rd. lock; (2) Assess fish behavior within the Brandon Rd. lock before, during, and after lockage operations; (3) Compare fish passage at Brandon Rd. with Lockport Lock and Dam; (4) Determine if interactions between fish and commercial barge traffic, upon entry or exit from the Brandon Rd. lock, are a significant factor in fish passage dynamics; and (5) Understand lock mediated upstream dispersal dynamics of Asian carp by examining fish passage at a downstream lock and dam(s) where Asian carp are in high abundance.

The objectives of this project will be attained by use of several methods: (1) Mobile and stationary split beam hydro-acoustic assessments of fish abundance, location, and passage rates within and near the Brandon Rd. lock structure will be conducted under a variety of operational conditions in an attempt to determine the number and size frequency distribution of fish that are making upstream passage via the lock; (2) Dual frequency Identification Sonar (DIDSON) acoustic cameras will be deployed within the lock chamber at different operational conditions to assess the movement and behavior patterns of fish within the lock chamber; (3) A comparison of fish passage rates will be made between Brandon Rd. and Lockport lock using the above methods; and (4) An Asian carp lock mediated dispersal behavior study utilizing all of the above techniques will be performed at Starved Rock Lock and Dam; a lock on the Illinois River where abundances of Asian carp are high.

Summary of Actions to Date: A stationary split beam hydro-acoustic system utilizing 420kHz and 120 kHz transducers has been collecting data on fish density and movement directly above the Brandon Road Lock chamber 24 hours a day since June 25th 2015. This system allows us to quantify the number and size of fish present above the lock chamber. It also allows us to determine fish location within the water

column and describe movement direction. Each time the lock doors open a motion sensing, time stamped photo is taken. Data analyses will quantify the number of fish moving into and out of the lock chamber on each occasion that the upstream lock doors are opened.

Proposed Actions:

FY 2016 Actions: USFWS will conduct studies of fish behavior in and around the Brandon Rd. lock by deploying a split beam hydro-acoustic equipped research vessel and stationary hydro-acoustic fish detection system into and above and below the lock, to survey fish abundance and size distribution during lock operation. Work will be attempted throughout the year. Preliminary trials of DIDSON deployment will be attempted to better understand the most appropriate methods for deployment within the lock chamber. Asian carp behavior will be examined at a downstream lock using split beam hydro-acoustic and DIDSON techniques.

FY 2017 Actions: USFWS will conduct additional studies as needed. It is assumed that work completed in 2016 may generate more questions from the Brandon Rd. work group or the barge industry.

Expected Milestones:

- Data allowing the Brandon Rd. Workgroup and other collaborating agencies to determine the relative frequency and size structure of wild fish attaining passage from the Dresden Island pool upstream through the Brandon Rd. lock structure.
- Data allowing agencies to determine the fine scale spatial movement patterns of wild fish within and near the lock structure.
- Data that informs agencies and industry partners about potential fish passage vulnerabilities associated with commercial traffic.
- Data that describes lock mediated dispersal behavior of Asian carp.
- Written project report(s) and peer reviewed publication(s) describing project results.

Outcomes/Outputs:

- Enhanced knowledge of behavior of fishes near the Brandon Rd. lock and fish interactions with barge tows that could influence future operations in a manner that minimizes fish passage.
- Enhanced knowledge of lock mediated dispersal behavior of Asian carp.
- Collaboration with partner agencies (USGS, IDNR) to enhance value of individual research projects.

Potential Hurdles:

- Commercial traffic through the lock structure.
- Weather.
- Staff availability.
- Turbulence and air bubbles in and around the lock may obscure systems used to monitor fish behavior.
- Possible issues regarding sampling site logistics.

10. Characterizing Risk of Seasonal Changes on Electric Barrier Operating Parameters

Project was not funded in 2016.

11. Program Capacity for eDNA Sampling

Lead Agency: USFWS

Agency Collaboration: Great Lakes States, USACE

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,100,000	\$0
FY 2017	\$1,050,000	\$0

Project Explanation: USFWS Great Lakes Fish and Wildlife Conservation Offices are uniquely poised to collect samples from around the Great Lakes basin to be analyzed for Asian carp eDNA at the Midwest Fisheries Center, Whitney Genetics Lab. In FY 2013, the USFWS began to implement a comprehensive, effective, and efficient program in the Great Lakes to detect incipient invasions. This task will provide USFWS Fish and Wildlife Conservation Office facilities with resources and expertise to conduct integrated, long-term early detection activities in areas outside of the CAWS using eDNA. Funding received under this action item will support water sample collection around the entire Great Lakes Basin, and samples will be analyzed for eDNA at the Midwest Fisheries Center, Whitney Genetics Lab.

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. 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 from all 5 Great Lakes. In 2014, positive eDNA results were obtained from USFWS sampling in 3 Great Lakes locations.

FY 2015 Actions: In 2015, USFWS continued to expand its overall sampling efforts and collected over 4,500 eDNA water samples for eDNA analysis. No positive eDNA results were obtained from Great Lakes tributary locations.

Proposed Actions:

FY 2016 Actions: The USFWS, in cooperation with our partners, will continue to monitor for the presence of Asian carp eDNA in the Great Lakes basin utilizing a statistically tenable sampling protocol. The USFWS will continue to upgrade its field sampling infrastructure and its collection and sample processing techniques as new technologies emerge.

FY 2017 Actions: The USFWS, in cooperation with our partners, will continue to monitor for the presence of Asian carp eDNA in the Great Lakes basin utilizing a statistically tenable sampling protocol. The 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 southern Lake Michigan and other potential hotspots for Asian carp invasions.

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 Quality Assurance Project Plan to include any necessary updates for collection, handling, and processing of water samples.

Potential Hurdles:

- Possible issues with eDNA calibration outcomes/output.
- Limitations due to weather and difficulties accessing sites.
- Maintaining QA/QC process regarding sample contamination in the field.

12. Fisheries Capacity for eDNA Processing and Technology Refinement

Lead Agency: USFWS

Agency Collaboration: USACE, USGS, Great Lakes States

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,300,000	\$0
FY 2017	\$1,300,000	\$0

Project Explanation: This project will partially fund the processing of eDNA samples for Asian carp at the USFWS's Midwest Fisheries Center, Whitney Genetics Lab. Use of eDNA as a monitoring tool for Asian carp and other AIS is being improved through research efforts within federal agencies and academic institutions. In order to implement new techniques and methods as they are published, new methods and techniques must be tested and validated to be included in the QAPP, and then implemented in official monitoring programs. Adaptations from the methods must be researched and then validated in at least three different labs. Furthermore, as the Great Lakes monitoring program commences, and additional monitoring sites are added, the lab will be required to increase capacity and efficiency. Higher throughput can be realized with modifications to current procedures and methods, all of which require testing and validation in three labs in order to be adopted into the QAPP.

Summary of Actions to Date: The USFWS's Whitney Genetics Lab was constructed and staffed in 2012, and newly hired staff engaged USACE to transfer processing operations from ERDC to USFWS. A transition plan from USACE to the USFWS was implemented, and the USFWS assumed a lead role for processing eDNA samples from the CAWS and from additional invasional hotspots in the Great Lakes basin. Working with partners, USFWS staff reviewed and updated the eDNA Quality Assurance Plan (QAPP) as necessary. In 2013, the Whitney Genetics Lab processed 2,240 eDNA water samples collected by USFWS offices. In 2014, the Whitney Genetics Lab processed over 5,000 eDNA water samples collected by USFWS offices.

FY 2015 Actions: In 2015, USFWS expanded the scope of its overall sampling efforts and collected over 4,500 eDNA water samples from the Great Lakes. In 2015, no positive eDNA results were obtained from Great Lakes tributary locations.

Proposed Actions:

FY 2016 Actions: The USFWS will continue to process water samples collected by our Fish and Wildlife Conservation Offices, in collaboration with our partners, to detect the presence of Asian carp DNA in areas of concern. The USFWS will continue to evaluate and implement new collection and processing techniques for eDNA surveillance, to identify factors that may influence test results (e.g. detection capability of various sampling and processing techniques; environmental inhibitors), and to increase lab throughput.

FY 2017 Actions: The USFWS will continue to process water samples collected by our Fish and Wildlife Conservation Offices, in collaboration with our partners, to detect the presence of Asian carp DNA in areas of concern. The USFWS will continue to evaluate and implement new collection and processing techniques for eDNA surveillance, to identify factors that may influence test results (e.g.

detection capability of various sampling and processing techniques; environmental inhibitors) and to increase lab throughput.

Expected Milestones:

- Continued processing of water samples for Asian carp eDNA sampling from areas of concern.
- Continued updating of the Quality Assurance Project Plan 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:

- 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:

- Possible uncertainty in eDNA calibration outcomes.

13. Illegal Transport of Injurious Wildlife Enforcement

Project was not funded in 2016.

14. Asian Carp Website Operation and Maintenance

Lead Agency: USFWS

Agency Collaboration: Web content will be supplied by all members of the ACRCC

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$100,000	\$50,000
FY 2017	\$100,000	\$50,000

Project Explanation: The ability to provide information in a timely and accessible format is a critical component in the ACRCC's stakeholder participation efforts. The ongoing maintenance and continued expansion of [AsianCarp.us](#) as both a window into the ACRCC actions and source of trusted information on Asian carp requires extensive staff support.

Summary of Actions to Date: The USFWS has built and managed [AsianCarp.us](#) since 2011. In 2015, [AsianCarp.us](#) continued to be the ACRCC's central platform for public outreach and education. As the site administrator, the USFWS maintained and developed the website, working toward increased visitation. Since [AsianCarp.us](#) launched in 2011, the site has reached more than 200,000 unique visitors from around the world. Website highlights from the last year include creating space on the website to share information on the work now being done with state partners in the Upper Mississippi River Basin and the Ohio River Basin. Work also included growing the ACRCC's image library that offers high resolution downloads of Asian carp and Asian carp management images to the public and the media.

FY 2016 Actions: A primary goal for the website in 2016 will be to enhance public understanding and awareness of Grass Carp issues. The website will also continue to be expanded to reflect federal and state actions in the Upper Mississippi River Basin and the Ohio River Basin, as outlined in the Water Resources Reform and Development Act of 2014. After discussions with the ACRCC Communication Work Group, the website may also be expanded to include preliminary information on Black Carp if it is considered timely and relevant.

FY 2017 Actions: The website will be updated with current ACRCC documents and information. It will provide content that informs and educates the public on ACRCC actions and accomplishments.

Expected Milestones:

- The website will be enhanced with new information and outreach products in a routine and timely fashion beginning in 2016. It will take advantage of new and updated social media tools as appropriate.

Outcomes/Outputs:

- Fostering public understanding regarding the role of the ACRCC and the actions it undertakes.
- Identification of information gaps to better target outreach and communication activities.

Potential Hurdles: None.

15. Use of Novel Gear: Video Outreach

Project was not funded in 2016.

16. Registration of Microparticle Technologies

Lead Agency: USGS and USFWS

Agency Collaboration: Illinois DNR, USACE, Southern Illinois University, University of Illinois Urbana-Champaign

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS	Total
FY 2016	\$100,000	\$0	\$100,000	\$300,000	\$125,000	\$425,000
FY2017	\$100,000	\$0	\$100,000	\$650,000	\$225,000	\$775,000

Project Description: The goals of this project are to (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. This project supports a larger project that is evaluating the development of microparticles to selectively deliver chemical and/or potentially biological control agents to Asian carp. Currently, antimycin incorporated microparticles are being evaluated for the potential to control populations of Asian carp. This tool, however, must complete a rigorous registration process before it may be used within integrated pest management control programs of state and federal natural resource agencies. 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 chemical or biological 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 chemical and biological 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, National Environmental Policy Act (NEPA) and Migratory Bird Treaty Act compliance, and other regulatory requirements.

The USGS Upper Midwest Environmental Sciences Center (UMESC) will provide regulatory affairs support to the 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 (FIFRA), 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 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.

FY 2015 Actions:

- Completed a consultation with USEPA for a formulation review to determine registration data requirements of antimycin-incorporated microparticles.
- Assessed registration requirements of alternative control agents of Asian carp.
- USFWS continued development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of microparticle controls.
- USFWS will initiate Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at the Brandon Road Lock and Dam in the Illinois Waterways System, and other locations, if specified.

FY 2016 Actions:

- Complete review with USFWS to determine Section 7 ESA-consultation data requirements of antimycin incorporated microparticles in limited open-water application sites.
- Initiate submission of studies to complete USEPA registration of antimycin-incorporated microparticles to USEPA.
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles.
- Complete registration review with USEPA to determine registration data requirements of antimycin incorporated microparticles in limited open-water application sites.
- 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).
- Respond to USEPA and state regulatory agencies for review of data submitted to register antimycin-incorporated microparticles.

- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of antimycin-incorporated microparticles.

FY 2017 Actions:

- 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.
- Assist management agencies that plan to deploy antimycin-incorporated microparticles in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.
- 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.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.
- 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).

Expected Milestones:

- Determination of USEPA registration and Section 7 ESA-consultation data requirements for antimycin-incorporated microparticle registration.
- Acquisition of Experimental Use Permits to allow experimental use of antimycin-incorporated microparticles in limited open-water application sites to control Asian carp.
- Registration of an antimycin-incorporated microparticle formulation.

17. Registration of Carbon Dioxide Technologies

Lead Agency: USGS and USFWS

Agency Collaboration: Illinois DNR, USACE, Southern Illinois University, University of Illinois Urbana-Champaign, University of Minnesota-Duluth

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS	Total
FY 2016	\$50,000	\$0	\$50,000	\$175,000	\$125,000	\$300,000
FY 2017	\$25,000	\$0	\$25,000	\$175,000	\$125,000	\$300,000

Project Explanation: This project will support the use of CO₂ to control Asian carp. CO₂ is being evaluated as both a deterrent to minimize expansion of Asian carp and as a lethal control tool in specific situations. As a deterrent, CO₂ must be evaluated for its environmental impacts on species of concern to help meet the requirements of the Endangered Species Act (section 7 consultation). CO₂ as a lethal control tool must undergo a rigorous registration process before it may be used within integrated pest management control programs of federal or state natural resource agencies. The goals of this work will be to (1) provide regulatory affairs support for the use of CO₂ as a deterrent to control Asian carp and (2) develop registration-specific data to support the registration of CO₂ as a lethal pesticide control. This project supports a larger project that is evaluating CO₂ to control Asian carp. This project includes the development of comprehensive Standard Operating Procedures (SOPs) and institutional guidance for use by approved State and Federal agencies when implementing the chemical or biological control agents in prevention actions. The SOPs will be developed based on the model of the AFS Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management SOP manual currently in use nationally, and tailored to CO₂. The chemical and biological control SOPs will serve as core components of the documentation required to use CO₂ as either a deterrent or a lethal control agent, and will include protocols on safe transport, handling, storage, and dispersal of CO₂ 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, National Environmental Policy Act (NEPA) and Migratory Bird Treaty Act compliance, and other regulatory requirements.

The USGS's Upper Midwest Environmental Sciences Center (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 CO₂ 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 (FIFRA), 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 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 the consultation processes yields 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.

FY 2015 Actions:

- Completed a consultation with USEPA to determine the best approach for the registration of CO₂ as a deterrent for Asian carp. The consultation resulted in a determination that a Section 18 Emergency Exemption registration was the best approach.
- Completed a consultation with USEPA to determine the necessary data requirements to obtain a Section 18 Emergency Exemption for CO₂ as a deterrent for Asian carp.
- Coordinated a meeting between USFWS, ACOE, Illinois DNR, USCG, Illinois EPA, USEPA, and USGS to initiate discussion on site selection for application of CO₂ as a deterrent to Asian carp movement.
- Completed a review with USFWS to determine Section 7 ESA-consultation data requirements of a CO₂ deterrent zone or the use of CO₂ as a control agent in limited open-water application sites
- Compiled data to support a Section 18 Emergency Exemption application for the use of CO₂ as a deterrent to prevent the movement of Asian carp.
- Coordinated submission of studies to address USFWS Section 7 ESA-consultation data requirements of a CO₂ deterrent or the use of CO₂ as a control agent in limited open-water application sites.
- USFWS initiated Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at the Brandon Road Lock and Dam in the Illinois Waterways System.

FY 2016 Actions:

- Provide guidance for studies on effects of CO₂ on non-target organisms to ensure compliance with Section 7 ESA-consultation.
- Provide regulatory affairs support for control products registered by the USFWS and other public agencies.
- USFWS will continue development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO₂ for control of Asian carp.

- 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 control technologies at select site(s), TBD.
- USFWS will continue Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at other locations in the Illinois Waterways System.
- USFWS will 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.
- 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.
- Assist management agencies that plan to deploy CO₂ as a deterrent or the use of a CO₂ as a control agent in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

2017 Actions:

- 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.
- 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.
- Assist management agencies that plan to deploy CO₂ as a deterrent or the use of a CO₂ as a control agent in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements for CO₂ in applications as a deterrent or for open-water control applications.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

Expected Milestones:

- Determination of USEPA registration and Section 7-ESA consultation data requirements for 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.
- Registration of CO₂ as a deterrent or as a control agent in limited open-water application sites to control Asian carp.

48. Black Carp eDNA Marker Development

Lead Agency: USFWS - Whitney Genetics Laboratory (WGL)

Agency Collaboration: USACE ERDC

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$300,000
FY 2017	\$0	\$0

Project Explanation: Black Carp (*Mylopharyngodon piceus*) are an emerging invasive species threat within the Mississippi River drainage. Specimens have been collected as far north as Pool 24 of the Mississippi River, have been collected in the Missouri and Illinois Rivers, and are annually taken further south in the lower Mississippi and associated drainages. As of 2013, the USFWS ascertains that the species is already established or on the verge of establishment in the US. Black Carp are molluscivores and the United States has the greatest diversity of freshwater mussels in the world, with nearly 300 named mollusk species, many (~ 70) of which are Federally-listed threatened or endangered species. If North American Black Carp eventually undergo extreme population growth and subsequent rapid spread, the rich diversity of freshwater mussels found in North America will be significantly harmed. Tracking the geographic spread and changing population levels of Black Carp in North America will be essential for understanding associated ecological and economic impacts and for successful control efforts. As a tool, eDNA is the most sensitive means available for detecting new introductions or range expansions in aquatic organisms.

Currently, the only eDNA marker developed for Black Carp is a conventional PCR marker (primers BLC-COII-F and BLC-COII-R) designed and tested by Mahon et al. (2013). As described in a recently published paper (Farrington et al. 2015), ERDC researchers used next-generation mitogenomic sequencing to design 14 real-time quantitative PCR (qPCR) markers for Bighead and Silver Carp testing, of which 6 qPCR markers were found to perform ideally. By using mitogenomic sequencing ERDC was able to design primers with reduced risks for false negatives. It has been pointed out that careful testing of new markers for cross-reactivity (or cross-amplification) with nontarget species is critical (i.e., false positives; Farrington et al. 2015, Wilcox et al. 2013). Recent tests with potential cPCR markers for Black Carp (Table 1) clearly show that simply testing a few closely related fish for nontarget false positives is inadequate. As with the Farrington et al (2015) effort, ERDC researchers will test new Black Carp qPCR markers against an unprecedented battery of 29 nontarget species.

Summary of Actions to Date:

FY 2015 Actions:

Task 1.1 Mitogenomic sequencing – USFWS collected as many tissue samples from Black Carp as possible for mitogenomic sequencing. Mitogenomic sequencing and bioinformatic data analysis are being

conducted on 36 Black Carp from the United States, China, and Vietnam at the ERDC CeDAR¹ Lab following protocols in Farrington et al. 2014.

Task 1.2 qPCR Primer Design – USFWS has designed 5-10 *draft* qPCR primers targeting the mtDNA of Black Carp.

Task 1.3 qPCR Marker Intraspecific Tests – Draft qPCR markers are being tested to make sure they detect DNA from any Black Carp sample.

Task 1.4 qPCR Cross-amplification Testing – USFWS are testing all proposed primers against a battery of approximately 30 nontarget fish species. Our current battery (“ERDC Fish DNA Battery”) includes only about 23 different fish species, with 2-8 individual samples per species.

Task 1.5 Determine Sensitivities for qPCR markers – USFWS are determining the limits of quantification (LOQ), limits of detection (LOD), and low concentration detection probabilities for each marker.

Proposed Actions:

FY 2016 Actions:

Task 1.6 eDNA Testing of qPCR Markers – USFWS will test the best 3-5 qPCR markers against a maximum of 150 water samples taken from locations where Black Carp are occasionally captured and 50 water samples from areas where they have not been encountered. This test will allow us to both determine if the marker functions as expected and to determine if there are unforeseen nontarget amplification products that will confound qPCR monitoring. If any unforeseen positive detections occur, the PCR product will be sequenced to determine if Black Carp actually occur or if some other member of the aquatic community (e.g. fish or other organism) is responsible. The number of positive hits that might expect from areas with expected Black Carp populations may be very low because Black Carp do not appear to be very abundant, nor is it known to what degree, if any, their different natural history and behavior, relative to Silver and Bighead Carp, will require changes in sampling approaches.

Task 1.7 Round-robin Testing of qPCR Markers – ERDC will provide the Whitney Genetics Lab and one other laboratory (e.g. USGS Columbia Ecological Research Center or USGS Upper Mississippi Environmental Science Center) each with test sample sets of Black Carp DNA and water blanks. Each set will include 56 total samples (n = 16 per concentration class). Results from each lab will be compared to validate (or not) the efficacy of the selected markers.

Task 1.8 Publication of eDNA Marker Information and Trial Results in Peer-reviewed Journal – ERDC will develop a minimum of one scientific manuscript describing the new qPCR markers and submit it for publication in a peer-reviewed journal.

FY 2017 Actions: None

Expected Milestones:

Project Start - Finish: October 2014 – September 2016

¹ Center for eDNA Application & Research

Task 1.1 -- Mitogenomic sequencing and bioinformatics

- 80% completed as of 25 September 2015.
 - Adequate data obtained for proceeding with marker design.

Task 1.2 -- Completed design of nine potential qPCR markers as of 01 April 2015.

Task 1.3 -- *Intraspecific* tests largely completed as of 31 Aug 2015.

Task 1.4 -- *Interspecific* tests largely completed as of 31 Aug 2015.

Task 1.5 -- Completed as of 25 Sept 2015.

Task 1.6 -- eDNA Testing of qPCR Markers.

- Collect Black Carp habitat eDNA samples NLT 30 June 2016.
 - Atchafalaya River (Set 1), Cape Girardeau (Set 2).
- Obtain “no Black Carp” eDNA samples NLT June 2016.
 - UMR or Great Lakes from WGL (Negative Control Set).
- Expect completion by 31 Aug 2016.

Task 1.7 -- Round-robin Testing of qPCR Markers.

- Provide spiked environmental and pure-water samples to partner labs by 31 Dec 2015.
- Expect completion by 31 March 2016.

Task 1.8 -- Publication of eDNA Marker Information and Trial Results in Peer-reviewed Journal

- First draft provided for USFWS review by 31 July 2016.
- Submission to journal by 31 Aug 2016.
- Acceptance by journal NLT 31 September 2016.

Outcomes/Outputs: Development and validation of qPCR marker for Black Carp for use in USFWS eDNA early detection and monitoring programs.

Potential Hurdles: Procurement of environmental water samples requires considerable coordination and assistance from USFWS and states.

49. Analysis of Grass Carp in the CAWS

Lead Agency: USFWS

Agency Collaboration: Illinois DNR, USACE, USGS, Southern Illinois University

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$200,000
FY 2017	\$0	\$200,000

Project Explanation: This task encompasses analyzing Grass Carp populations in the CAWS to better understand their risk of invasion to the Great Lakes. USFWS will examine historical Grass Carp collection data, as well as collect data and specimens. Relative abundance, concentration areas, ploidy, age/growth, otoliths, and movements (telemetry) will be studied.

Summary of Actions to Date: This is a new project for 2016, however, Grass Carp have been collected through other actions (traditional sampling and rotenone) in the CAWS in the past.

FY 2016 Actions: A USFWS team(s) will mine prior data to determine hot spots and relative abundance of Grass Carp in the CAWS. A supplementary collection effort will be undertaken to collect additional fishes. These specimens will be used to determine ploidy, age, growth, otolith microchemistry (origin), and a subset will be tagged and tracked.

FY 2017 Actions: A USFWS team(s) will collect Grass Carp to determine ploidy, age, growth, otolith microchemistry (origin), and a subset will be tagged and tracked.

Expected Milestones: A more thorough understanding of Grass Carp populations in the CAWS

Outcomes/Outputs:

- Data that describe the Grass Carp population in the CAWS.
- Data and information that assist managers to determine potential Grass Carp management efforts in the CAWS.
- Written project report(s) and peer reviewed publication(s) describing project results.

Potential Hurdles:

- Weather conditions.
- Staff availability.
- Ability to capture Grass Carp in the CAWS.

50. Black Carp Assessment: CAWS and UMRB

Lead Agency: USFWS

Agency Collaboration: USFWS, Southern Illinois University-Carbondale (SIU)

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$200,000
FY 2017	\$0	\$200,000

Project Explanation: Black Carp (*Mylopharyngodon piceus*) is a large, molluscivorous species introduced to the United States primarily for biological control of aquaculture pond snails and is listed as an injurious species under the Lacey Act due to its potential threat to endangered riverine mollusks. The increasing frequency of Black Carp captures from the Mississippi River and tributaries since 2011 has raised concerns that this species may become established in the wild. Ploidy and otolith chemistry data from Black Carp caught during 2011-2015 have provided strong evidence that natural reproduction and recruitment to adulthood have occurred. However, despite evidence of an expanding Black Carp population in the Mississippi River and tributaries, there are no active sampling efforts focused on this species. Nearly all Black Carp detected in the Mississippi River and tributaries to date were caught and reported by a few commercial fishermen, which has likely resulted in underestimation of Black Carp relative abundance and distribution. No early life stage Black Carp have been caught in the wild due to the lack of directed sampling for this species, which has limited our understanding of where and when reproduction is occurring and habitat use by early life stages. In addition, most of the Black Carp caught by commercial fishermen had empty stomachs (many were collected during the colder months of the year or stomachs were examined too long after fish were initially caught in passive fishing gears and subsequently turned in by commercial fishermen), which has hindered assessment of Black Carp diet and their potential impact on native mussels and other benthic invertebrates. Thus, there is a clear need to develop an active sampling program for all life stages of Black Carp to better assess their geographic distribution (in conjunction with ongoing efforts to develop eDNA markers) and habitat use, population characteristics (e.g., relative abundance; timing, frequency, and location of reproduction; growth rates; age at maturity), and diet. Information gained from targeted Black Carp sampling will be useful for monitoring and assessing the risk of further increases in Black Carp abundance and range expansion, evaluating their ecological impacts, and guiding initial development of containment and control strategies.

Summary of Actions to Date: Ploidy, otolith chemistry, gonad histology, and age data have been obtained for all Black Carp reported by commercial fishermen since 2011. A standard protocol for handling, shipping, data collection and sharing, and dissemination of structures and tissues (to USFWS, USGS, and Southern Illinois University from Black Carp caught in the wild has been in place since 2013. Eyes are removed from each fish and sent to the USFWS Fish Health Laboratory in La Crosse, WI for determination of ploidy by flow cytometry. Stable isotope and microchemical analyses of otoliths (for determination of fish origin and environmental history) are performed by Southern Illinois University. Gonad histology (for determination of maturity status) and age estimation are conducted at the USGS Columbia Environmental Research Center; tissue samples for genetic analyses (including development of eDNA markers) have also been obtained. Collection data for all fish have been entered in the USGS Nonindigenous Aquatic Species database.

FY 2015 Actions: An incentive program (\$100 reward per fish) was established to encourage commercial fishermen to report and donate all wild-caught Black Carp for research. The reward program is part of an Illinois Department of Natural Resources (Illinois DNR) contract with Southern Illinois University. This project also supports Black Carp otolith chemistry analyses at Southern Illinois University, and continued partnerships between Southern Illinois University and the USFWS and USGS to conduct ploidy testing, gonad histology, and age estimation. While this study is continuing to provide valuable data on Black Carp in the Mississippi River and tributaries, there are some drawbacks to relying solely on commercial fishermen as a source of specimens (described in the Project Explanation section).

Proposed Actions: The proposed study will initiate a sampling program targeting all life stages of Black Carp that will complement and expand upon ongoing Black Carp research, addressing limitations of reliance on commercial fish collections as the sole source of information on Black Carp. Multiple sampling gears will be evaluated for their efficacy in capturing Black Carp and will be deployed in locations where Black Carp have previously been caught, as well as areas where Black Carp have not been reported, but would be likely to be present due to proximity and connectivity to their known range. Sampling areas will be guided by (but not limited to) locations where Black Carp have previously been caught and by locations that test positive for Black carp eDNA. Thus, the proposed study will complement Black Carp eDNA testing and surveillance that will begin in FY 2016 (positive eDNA samples will be used to direct sampling efforts, and sampling can be used to evaluate eDNA detections). Habitat characteristics (e.g., depth, velocity, substrate, temperature) will be assessed at all locations where Black Carp are caught. Sampling will include gears targeting early life stages of Black Carp; genetic analyses will be conducted as needed to distinguish larval Black Carp from Grass Carp. Gut contents will be removed from each fish and identified to characterize Black Carp diet, with particular attention to native mussel taxa found in stomach contents. Diet composition data will be used in a bioenergetics model to estimate Black Carp consumption rates on prey items, again with particular focus on native mussels (consumption rate calculations may be spatially explicit if diet composition or growth rates differ geographically).

FY 2016 Actions: Sampling during FY 2016 will focus on river segments within the known range of Black carp in the Mississippi River and tributaries. Sampling areas will be guided by (but not limited to) locations where Black Carp have previously been caught and by locations that test positive for Black Carp eDNA. Gut contents analysis will be conducted on all Black Carp. Tissues and structures from each fish will be taken for the related study on ploidy, otolith chemistry, gonad histology, age estimation, and genetic analyses.

FY 2017 Actions: Sampling during FY 2017 will be expanded to include other river segments where Black Carp have not previously been caught but may be present due to proximity and connectivity to their known range. Sampling locations will be guided by (but not limited to) locations that test positive for Black Carp eDNA. Gut contents analysis will be conducted on all Black Carp. Diet composition data will be used in a bioenergetics model to estimate Black Carp consumption rates by prey type. Tissues and structures from each fish will be taken for the related study on ploidy, otolith chemistry, gonad histology, age estimation, and genetic analyses.

Expected Milestones: Sampling for juvenile and adult fish will begin in 2016 and will be coordinated with eDNA surveillance. Sampling for early life stages of Black Carp will begin in late spring or early summer 2016. USFWS anticipate identifying the most effective gears for sampling Black Carp (depending on life stage and habitat) in FY 2016. USFWS expect that sufficient gut contents data will be obtained by FY 2017 to enable bioenergetics models estimates of prey consumption rates.

Outcomes/Outputs: The proposed study will provide updated and improved estimates of the current range of Black Carp in U.S. rivers, where and when natural reproduction is occurring, and habitat use across multiple life stages. An evaluation of sampling techniques and initiation of a targeted sampling program for Black Carp will also facilitate improved assessment of trends in Black Carp abundance and (along with eDNA) detection of fish in newly invaded locations, which will in turn facilitate rapid response to new invasions. While Black Carp clearly represent a potential threat to native mussels (and perhaps other components of river food webs), their actual ecological impacts within their invaded range are unknown. Data on diet and prey consumption rates will represent a first step to evaluate ecological impacts of Black Carp, particularly on native mussels. Information gathered in this study will also be useful for assessing the need for action to limit further expansion of Black Carp in the wild and development of containment and control strategies. In addition to required reports, results from the study will be disseminated via communication with management agencies, conference presentations, and at least two peer-reviewed publications.

Potential Hurdles: Other than the usual challenges associated with fish sampling in large rivers, no major hurdles to accomplishment of project objectives are anticipated.

51. Mass Removal and Monitoring of Juvenile Asian Carp

Lead Agency: USFWS

Agency Collaboration: Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$100,000	\$100,000
FY 2017	\$0	\$100,000

Project Explanation: In 2015 in the CAWS, juvenile Silver Carp have been captured over 50 miles closer to the electric dispersal barriers than in previous years. This may indicate an increase in abundance of juvenile Silver Carp, a change in distribution of juvenile Silver Carp, increased agency efforts to catch juvenile carp, or may be the result of deploying more efficient gears to capture juvenile fishes, as many of the juveniles sampled in 2015 were captured with a newly developed electrified butterfly trawl (i.e. Paupier Net).

In 2016, the USFWS wishes to deploy two small mesh lightweight purse-type nets to target concentrations of juvenile Asian carp and evaluate this gear's effectiveness and utility at capturing and decreasing juvenile Asian carp densities in large navigable rivers. To date, there is a large, ongoing, targeted effort to remove adult Asian carp by partner-contracted commercial fisherman; however, these efforts do not address the juvenile life stages of carp that may continue to pose a threat to the Great Lakes. Juvenile Asian carp are largely not vulnerable to the trammel nets used by commercial fisherman due to the relatively large mesh size of the commercial gear and the relatively small size of juvenile Asian carp. Deploying these purse-type nets will potentially allow us to better target small fish for removal and evaluate the effectiveness of this gear, while potentially halting the advance of juvenile Asian carp toward the Great Lakes.

Summary of Actions to Date: This is a new project for 2016, so no specific past actions have been taken under this template. However, the USFWS's Columbia FWCO has worked with USFWS experts and outside contractors to develop and modify a novel electrified butterfly trawl, which has been successfully used to capture juvenile Silver Carp in the CAWS at several locations across several sampling events.

Proposed Actions:

FY 2016 Actions: USFWS will work with appropriate partners to develop, adapt, and refine standard protocols for construction and sampling use of "Lampara" and "Danish" style purse seine nets in the CAWS. Emphasis will be placed on developing these gears for use by a standard river vessel and crew to target concentrations of juvenile carp as part of ongoing monitoring and removal efforts for Asian carp. Efforts will continue on an annual basis to detect and potentially remove new concentrations of juvenile Asian carp.

FY 2017 Actions: USFWS will continue to work with partners adapt and refine standard protocols for construction and sampling use of purse seine nets in the CAWS. Efforts will continue on an annual basis to detect and potentially remove new concentrations of juvenile Asian carp.

Expected Milestones:

- Development of a new and novel gear that can be used to more effectively target and remove juvenile Asian carp in the CAWS.
- Completion of necessary early detection and monitoring surveys with novel gears to better determine the distribution and abundance of juvenile Asian carp in the CAWS.
- Participation in response efforts or barrier clearings, as needed.

Outcomes/Outputs:

- An enhanced toolbox for conducting early detection, rapid assessment, rapid response, and removal efforts for Asian carp in the CAWS.
- Information that will build upon existing knowledge of distribution and habitat requirements for juvenile Bighead, Silver, Grass, and Black Carp.

Potential Hurdles:

- Coordination among agencies and contractors.
- Attainment of agreement regarding sampling gears and sampling design among diverse partners.
- Possible issues regarding sampling gear and/or site logistics.
- Weather conditions.
- Staff availability.
- Possible public resistance to continuing monitoring and response efforts.

52. Barrier Defense Using Novel Gear

Lead Agency: USFWS

Agency Collaboration: Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$100,000	\$80,000
FY 2017	\$0	\$80,000

Project Explanation: In 2015 in the CAWS, juvenile Silver Carp have been captured over 50 miles closer to the electric dispersal barriers than in previous years. This may indicate an increase in abundance of juvenile Silver Carp, a change in distribution of juvenile Silver Carp, increased agency efforts to catch juvenile carp, or may be the result of deploying more efficient gears to capture juvenile fishes, as many of the juveniles sampled in 2015 were captured during early detection efforts with a newly developed electrified butterfly trawl (i.e. Paupier Net).

In 2016, the USFWS wishes to systematically deploy its Paupier Net gear in concert with commercial fishing efforts in the Starved Rock Pool, and perhaps pools above Starved Rock Pool, as needed. Limited testing and sampling results in 2015 showed that the Paupier Net can be a viable tool to supplement commercial fishing removal efforts that target primarily larger fish, because the Paupier can capture a wider size range (adult to juvenile) of fish than commercial trammel nets. In fact, the Paupier net can even catch juvenile Asian carp down to age-0 fish.

The USFWS use of the Paupier net can assist partner-contracted commercial fishing efforts aimed at reducing populations of Asian carp by ensuring that younger and smaller year-classes are being targeted with removal efforts. To date, there is a large, ongoing, targeted effort to remove adult Asian carp by partner-contracted commercial fisherman; however, these efforts do not address the juvenile life stages of carp that may continue to pose a threat to the Great Lakes. Systematically deploying the Paupier nets will potentially allow us to better target both large and small fish for removal, while potentially halting the advance of juvenile Asian carp toward the electric dispersal barriers and the Great Lakes.

Summary of Actions to Date: This is a new project for 2016, so no specific past actions have been taken under this template. However, the USFWS's Columbia FWCO has worked over the last several years with USFWS experts and outside contractors to develop, modify, and test this novel gear. In 2015, the Paupier Net gear captured juvenile Silver Carp in the CAWS at several locations across several sampling events.

Proposed Actions:

FY 2016 Actions: USFWS will work with appropriate partners to develop and implement standard protocols for use of Paupier Nets in the CAWS. Emphasis will be placed on use of this gear to target concentrations of adult and juvenile carp as part of ongoing monitoring and removal efforts for Asian carp. Efforts will continue on an annual basis to detect and potentially remove new concentrations of juvenile Asian carp.

FY 2017 Actions: USFWS will continue to work with partners adapt and refine standard protocols for use of Paupier Nets in the CAWS. Efforts will continue on an annual basis to detect and potentially remove new concentrations of juvenile Asian carp.

Expected Milestones:

- Standardized use of a new and novel gear that can be used to more effectively target and remove adult and juvenile Asian carp in the CAWS.
- Completion of necessary early detection and monitoring surveys with novel gears to better determine the distribution and abundance of juvenile Asian carp in the CAWS.
- Participation in response efforts or barrier clearings, as needed.

Outcomes/Outputs:

- An enhanced toolbox for conducting early detection, rapid assessment, rapid response, and removal efforts for Asian carp in the CAWS.
- Information that will build upon existing knowledge of distribution and habitat requirements for juvenile Bighead, Silver, Grass, and Black Carp.

Potential Hurdles:

- Coordination among agencies and contractors.
- Attainment of agreement regarding sampling gears and sampling design among diverse partners.
- Possible issues regarding sampling gear and/or site logistics.
- Weather conditions.
- Staff availability.
- Possible public resistance to continuing monitoring and response efforts.

16. Registration of Microparticle Technologies

Lead Agency: USGS and USFWS

Agency Collaboration: Illinois DNR, USACE, Southern Illinois University, University of Illinois Urbana-Champaign

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS	Total
FY 2016	\$100,000	\$0	\$100,000	\$300,000	\$125,000	\$425,000
FY 2017	\$100,000	\$0	\$100,000	\$650,000	\$125,000	\$775,000

Project Description: The goals of this project are to (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. This project supports a larger project that is evaluating the development of microparticles to selectively deliver chemical and/or potentially biological control agents to Asian carp. Currently, antimycin incorporated microparticles are being evaluated for the potential to control populations of Asian carp. This tool, however, must complete a rigorous registration process before it may be used within integrated pest management control programs of state and federal natural resource agencies. 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 chemical or biological 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 chemical and biological 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, National Environmental Policy Act (NEPA) and Migratory Bird Treaty Act compliance, and other regulatory requirements.

The USGS's Upper Midwest Environmental Sciences Center (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 (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 (FIFRA), 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 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.

FY 2015 Actions:

- Completed a consultation with USEPA for a formulation review to determine registration data requirements of antimycin-incorporated microparticles.
- Assessed registration requirements of alternative control agents of Asian carp.
- USFWS continued development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of microparticle controls.
- USFWS will initiate Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at the Brandon Road Lock and Dam in the Illinois Waterways System, and other locations, if specified.

FY 2016 Actions:

- Complete review with USFWS to determine Section 7 ESA-consultation data requirements of antimycin incorporated microparticles in limited open-water application sites.
- Initiate submission of studies to complete USEPA registration of antimycin-incorporated microparticles to USEPA.
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles.
- Complete registration review with USEPA to determine registration data requirements of antimycin incorporated microparticles in limited open-water application sites.
- 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.
- Respond to USEPA and state regulatory agencies for review of data submitted to register antimycin-incorporated microparticles.
- Respond to USFWS review of data submitted to address Section 7 ESA-consultation of antimycin-incorporated microparticles.

FY 2017 Actions:

- 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.
- Assist management agencies that plan to deploy antimycin-incorporated microparticles in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.
- 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.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

Expected Milestones:

- Determination of USEPA registration and Section 7 ESA-consultation data requirements for antimycin-incorporated microparticle registration.
- Acquisition of Experimental Use Permits to allow experimental use of antimycin-incorporated microparticles in limited open-water application sites to control Asian carp.
- Registration of an antimycin-incorporated microparticle formulation.

17. Registration of Carbon Dioxide Technologies

Lead Agency: USGS and USFWS

Agency Collaboration: Illinois DNR, USACE, Southern Illinois University, University of Illinois Urbana-Champaign, University of Minnesota-Duluth

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USFWS	Total	USGS	USFWS	Total
FY 2016	\$50,000	\$0	\$50,000	\$175,000	\$125,000	\$300,000
FY 2017	\$25,000	\$0	\$25,000	\$175,000	\$125,000	\$300,000

Project Description: This project will support the use of CO₂ to control Asian carp. CO₂ is being evaluated as both a deterrent to minimize expansion of Asian carp and as a lethal control tool in specific situations. As a deterrent, CO₂ must be evaluated for its environmental impacts on species of concern to help meet the requirements of the Endangered Species Act (section 7 consultation). CO₂ as a lethal control tool must undergo a rigorous registration process before it may be used within integrated pest management control programs of federal or state natural resource agencies. The goals of this work will be to (1) provide regulatory affairs support for the use of CO₂ as a deterrent to control Asian carp and (2) develop registration-specific data to support the registration of CO₂ as a lethal pesticide control. This project supports a larger project that is evaluating CO₂ to control Asian carp. This project includes the development of comprehensive Standard Operating Procedures (SOPs) and institutional guidance for use by approved State and Federal agencies when implementing the chemical or biological control agents in prevention actions. The SOPs will be developed based on the model of the AFS Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management SOP manual currently in use nationally, and tailored to CO₂. The chemical and biological control SOPs will serve as core components of the documentation required to use CO₂ as either a deterrent or a lethal control agent, and will include protocols on safe transport, handling, storage, and dispersal of CO₂ 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, National Environmental Policy Act (NEPA) and Migratory Bird Treaty Act compliance, and other regulatory requirements.

The USGS's Upper Midwest Environmental Sciences Center (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 (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 CO₂ 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 (FIFRA), 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 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 the consultation processes yields 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, EPA, 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.

FY 2015 Actions:

- Completed a consultation with USEPA to determine the best approach for the registration of CO₂ as a deterrent for Asian carp. The consultation resulted in a determination that a Section 18 Emergency Exemption registration was the best approach.
- Completed a consultation with USEPA to determine the necessary data requirements to obtain a Section 18 Emergency Exemption for CO₂ as a deterrent for Asian carp.
- Coordinated a meeting between USFWS, USACE, Illinois DNR, USCG, Illinois EPA, USEPA, and USGS to initiate discussion on site selection for application of CO₂ as a deterrent to Asian carp movement.
- Completed a review with USFWS to determine Section 7 ESA-consultation data requirements of a CO₂ deterrent zone or the use of CO₂ as a control agent in limited open-water application sites.
- Compiled data to support a Section 18 Emergency Exemption application for the use of CO₂ as a deterrent to prevent the movement of Asian carp.
- Coordinated submission of studies to address USFWS Section 7 ESA-consultation data requirements of a CO₂ deterrent or the use of CO₂ as a control agent in limited open-water application sites.
- USFWS initiated Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at the Brandon Road Lock and Dam in the Illinois Waterways System.

FY 2016 Actions:

- Provide guidance for studies on effects of CO₂ on non-target organisms to ensure compliance with Section 7 ESA-consultation.
- Provide regulatory affairs support for control products registered by the USFWS and other public agencies.
- USFWS will continue development of protocols, SOPs, and supporting documentation in advance of registration and field allocation of CO₂ for control of Asian carp.

- 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 control technologies at select site(s), TBD.
- USFWS will continue Section 7 consultations and other necessary environmental regulatory reviews in preparation for potential implementation of control tools at other locations in the Illinois Waterways System.
- 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.
- 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.
- Assist management agencies that plan to deploy CO₂ as a deterrent or the use of a CO₂ as a control agent in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

FY 2017 Actions:

- 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.
- 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.
- Assist management agencies that plan to deploy CO₂ as a deterrent or the use of a CO₂ as a control agent in limited open-water application sites to control Asian carp.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.
- Coordinate submission of studies to address Section 7 ESA-consultation data requirements for CO₂ in applications as a deterrent or for open-water control applications.
- Provide regulatory affairs support for control products registered by USFWS and other public agencies.

Expected Milestones:

- Determination of USEPA registration and Section 7-ESA consultation data requirements for 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.
- Registration of CO₂ as a deterrent or as a control agent in limited open-water application sites to control Asian carp.

18. Development of Grass Carp Control Technologies

Lead Agency: USGS - GLSC, CERC, Illinois WSC

Agency Collaboration: Ohio DNR, Michigan DNR, University of Toledo, Bowling Green State University, University of Illinois, USFWS, Department of Fisheries and Oceans Canada

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$325,000	\$325,000
FY 2017	\$325,000	\$325,000

Project Explanation: 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, determined using otolith microchemistry that these fish were spawned in the Sandusky River and had no overlapping parentage, indicating a potentially large population of spawning fish. This was the first strong evidence, albeit circumstantial, of spawning of Grass Carp in a Great Lakes tributary.

Since 2012 more evidence has been assembled, both circumstantial and direct, of spawning of Grass Carp in the Sandusky River. In April 2015, a 2-year old, diploid, male Grass Carp was collected by a commercial fisherman on the north shore of Sandusky Bay. Otolith microchemical analysis is yet to be conducted, but a hydrograph event similar in nature and timing to the one suspected of producing the 2011 year class occurred in 2013, suggesting a second spawning event. During June and July 2015, a USGS-funded Master's student at the University of Toledo sampled nine suspected Grass Carp eggs in the Sandusky River on 5 different sampling dates during 3 separate high-flow events. Five eggs, at least one from each high-flow event, were confirmed as Grass Carp using quantitative PCR for a Grass Carp-specific marker. These discoveries confirmed directly that Grass Carp are using the Sandusky River for spawning, and it increased interest in developing a strategic research plan focusing on Grass Carp biology and reproduction in the Great Lakes. In 2015, the scope of the Grass Carp problem in Lake Erie expanded greatly with the discovery of several diploid Grass Carp of reproducing age (greater than about 4 years) in Ontario waters of Lake Ontario.

Understanding the extent of the invasion and whether the Grass Carp population is self-sustaining or expanding is critical to providing managers information they need to address their control in the Great Lakes. USGS scientists have already begun to determine Grass Carp spawning habitat and investigate egg survival concurrently with studies on Bighead Carp and Silver Carp. USGS will take an integrated pest management approach in addressing Grass Carp control, informed by adequate biological information as needed and researching a variety of complementary potential control mechanisms.

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 may 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. Furthermore, current research on the biology and control of Bighead Carp and Silver Carp may be useful for managers to respond to Grass Carp invasions.

USGS research on Grass Carp is diverse, focusing primarily on understanding biology and hydrologic factors related to biology. As knowledge on biology and hydrologic drivers expands USGS will build the base of knowledge for managers to formulate potential control and management strategies and tactics under the Integrated Pest Management (IPM) framework.

Ongoing biological and hydrological studies have focused on documenting spawning of Grass Carp in the Sandusky River and quantifying hydrologic conditions necessary and sufficient for spawning. USGS proposes to continue these studies. In response to other research activities conducted by partners and results of 2015 USGS research, USGS proposes herein additional studies to further advance knowledge of the Grass Carp population in Lake Erie and elsewhere in the Great Lakes.

Harvest of winter aggregations of common carp has been very successful in the control of that species in Midwestern lakes and reservoirs. Limited information on the winter behavior of Grass Carp in temperate zones indicates that they enter deep water wintering areas where they remain during the cold months, but there is no evidence on whether or not they form aggregations. If Grass Carp do form aggregations during this period, tactics similar to those used for common carp might be deployed by resource managers for harvest and control.

Location of winter aggregations would be most easily accomplished through the use of “Judas” fish, which could be telemetered and located in the winter. Sterile Judas fish would be most appropriate for this use, because they would not contribute to the spawning population. Even if Grass Carp do not form winter aggregations, the use of telemetered sterile fish has many other potential applications in other Judas fish work with Grass Carp or in the study of the habits of any Asian carp. However, 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. Ploidy is not known for these fish; efforts proposed here would inform whether knowing ploidy is relevant to understanding movements and winter locations.

Truman Reservoir offers an ideal location to answer these key questions. Grass Carp are currently present and reproducing that reservoir. The reservoir has several long tributaries of varying hydrology, and Grass Carp have been found to spawn in at least four of them. 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.

Direct evidence of spawning in the Sandusky River in 2015 provides the opportunity to model spawning events and potentially identify rearing areas for Grass Carp in the Sandusky River. The existing FluEgg model simulates the movement and development of eggs and larvae until larvae reach the gas bladder inflation stage based on the physical characteristics of flow, water temperature, and the biological characteristics of the eggs. The FluEgg model can be validated using egg developmental stage, water temperature, flow characteristics, and capture location of Grass Carp eggs from the 2015 spawning events. The egg developmental stage is determined by developmental times provided by previous USGS research. The egg developmental stage will be used to project the location where eggs were fertilized (spawning grounds) and how far downstream they were transported by hatching time. For validation purposes,

FluEgg-predicted spawning grounds will be compared against spawning grounds selected based on characteristics typically cited in literature (e.g., turbulent water and high turbidity).

In addition to knowing Grass Carp spawning and rearing areas in the Sandusky River, knowledge of the specific 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 Grass Carp react to are not known. In the Sandusky River, increased discharges are associated with increased velocity (until floodplain becomes inundated, then velocity decreases again), increased turbidity, and a slight decrease in temperature. Any or a combination of these might be specific cues. If the cues were known, efforts to mitigate or neutralize them might be developed or control efforts could be planned to coincide with the specific cues. Artificial streams at USGS Columbia Environmental Research Center (CERC) provide an environment suitable to studies of effects of increased velocity, increased turbidity, and decreased temperature using diploid fish in a controlled environment.

The directly observed 2015, suspected 2013, and circumstantially 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.

Summary of Actions to Date:

FY 2015 Actions:

- Completed trace chemical (including isotopic information) analysis of otoliths of Grass Carp collected in the Great Lakes basin, to determine locations of Grass Carp recruitment within the basin.
- Used Bongo nets to sample for eggs June through August and light traps to sample for larvae of Grass Carp July through September in the Sandusky River and headwaters of Sandusky Bay.
- Deployed 20 thermographs at 10 stations (2 thermographs per station separated by ~1 m depth and varied in depth from surface) along ~15km of the Sandusky River from just downstream of Brady Island to Swartz's seining operation. Data will be used in conjunction with egg stage data and hydrologic data to determine spawning locations and to model probability of successful hatch.
- Initiated collaborative sampling with our FWS colleagues to increase spatial scale of sampling for larvae following collection of confirmed Grass Carp eggs.
- Provided Michigan DNR light traps and bongo nets for sampling in the River Raisin, using the same protocols as used in the Sandusky River.
- Received Grass Carp collected by state and federal collaborators and to collect the parts as described above.
- Aged Grass Carp collected by state and federal collaborators 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. Continue 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.

- Updated the FluEgg tributary assessment model to incorporate Grass Carp, to be used in predicting adequacy of rivers for Grass Carp reproduction and recruitment.
- Processed hydraulic and water-quality data (Fall 2014).
- Updated and ran FluEgg model with data from additional tributaries (Fall 2014).
- Completed hydrologic habitat assessment of the Grand River (OH) to model suitability for spawning of Grass Carp (Spring 2015).
- Completed assessment of the Cuyahoga River and Muskingum River for spawning potential (2015).
- Wrote reports/publications and presented at professional meetings.

Proposed Actions:**FY 2016 Actions:**

- Continue to sample the Sandusky River and River Raisin for evidence of spawning of Grass Carp, and project spawning locations for known spawning events.
- Continue to collect water temperature data for use in modeling probability of spawning success. Begin mining weather data to use in conjunction with water temperature and flow data to model probability of spawning and hatching success.
- Continue to collect otolith core oxygen isotope data and otolith transect microchemistry and isotopes on Grass Carp that are captured within the Great Lakes basin to determine spawning locations and basin-wide movements.
- Collect fin clips and muscle samples for genetic analysis to estimate population size of Grass Carp in Lake Erie.
- Collaborate (CERC and GLSC) with Michigan DNR and DFO Canada on a research publication and presentation on growth of Grass Carp in the Great Lakes.
- Begin work on first-generation probabilistic models of risk of spawning using hydrologic and meteorologic variables.
- Finalize protocols for sampling eggs/larvae and monitoring river flow and temperature;
- Obtain mature diploid and triploid Grass Carp from various locations (e.g., Missouri, Illinois, Arkansas, ploidy determined by flow cytometry), tag with acoustic transmitters, and release into Truman Reservoir.
- Deploy 5-6 additional stationary receivers and thermal data loggers throughout Truman Reservoir, focusing on tributaries, and track tagged fish during the likely spawning season throughout the year.
- Sample aggregated Grass Carp during winter.
- Collect and compile fish movement, temperature, and hydrograph data, write reports, and present at professional meetings.
- Refine egg mortality model and incorporate into FluEgg.
- Use data on egg stage, location of capture, flow characteristics, and water temperature from 2015 spawning events to project location of spawning and potential larval rearing zones to inform future sampling and to begin to inform potential control measures.

- Assess historical recruitment of Grass Carp in the Sandusky River using data from captured diploid Grass Carp known to have been produced in the Sandusky River and FluEgg simulations of different spawning events coupled with an unsteady hydraulic model (Hec-Ras). The transport of eggs and larvae at different flow events and water temperature will be simulated to cross-correlate the capture of young fish (recruitment success) with historical flow characteristics. The simulation of egg transport and potential reproduction during known recruitment years will improve knowledge about risk of spawning.
- Assess the potential for success/prove concept that water velocity and turbidity can be manipulated and temperature depression can be achieved in CERC artificial streams.
- Observe general Grass Carp behavior in CERC artificial streams to assess their potential to be used for experiments on spawning cues.
- Initiate an inventory of data sources on aquatic vegetation in Lake Erie and conduct a “gap” analysis of such data. Begin to identify partners for a lake-wide vegetation collaborative to inventory.
- Complete first-generation maps of aquatic vegetation for western Lake Erie.
- Conduct first inventories of aquatic vegetation in areas of the Sandusky River and Sandusky Bay, including species composition and relative abundance, distributions, presence of non-native species and identification of areas with abundant vegetation.
- Identify potential partners for a Lake-Erie wide aquatic vegetation collaborative for inventorying and researching effects of herbivory by invasive species on aquatic vegetation;
- Write reports/publications and present at professional meetings.

FY 2017 Actions (Sandusky):

- Continue to sample the Sandusky River and River Raisin for evidence of spawning of Grass Carp, and project spawning locations for known spawning events, and continue to collect water temperature data for use in modeling probability of spawning success.
- Develop first-generation Bayesian hierarchical models of spawning risk in the Sandusky River.
- Continue to collect otolith core oxygen isotope data and transect elemental and isotopic microchemistry on Grass Carp that are captured within the Great Lakes basin to determine spawning locations and basin-wide movements.
- Use samples retained for genetic analyses to estimate population size of Grass Carp in Lake Erie, potentially elsewhere in the Great Lakes.
- Obtain additional Grass Carp to tag and track throughout the year in Truman Reservoir
- Purchase additional equipment if needed (e.g., transmitter tags, stationary receivers) and add throughout the Reservoir and tributaries.
- Sample aggregated Grass Carp during winter using a variety of methods (e.g., river bottom trawl, gill nets, trammel nets).
- Retrieve, process, and compile water temperature data, hydrograph and reservoir water levels, and data from recaptured Grass Carp.
- Write summary reports and present at professional meetings.
- Complete first-generation models predicting spawning and rearing locations and continue to develop models if additional spawning events are observed.

- Use FluEgg simulations to predict longitudinal distribution of Grass Carp larvae capable of swimming horizontally (gas bladder inflation) as a recommendation tool to determine and identify zones where larvae will be leaving the drift. These zones will be characterized as high-priority zones for habitat assessment, monitoring activities, and application of control alternatives using the Integrated Pest Management approach targeting early life stages of Grass Carp.
- Begin pilot experiments manipulating velocity, turbidity, and water temperature to determine which of these variables, or combination of variables, are direct cues for Grass Carp spawning.
- Complete maps of aquatic vegetation for all of Lake Erie (U.S. Side).
- Using results of gap analysis from 2016, identify high-priority areas for vegetation inventory and monitoring using both remote sensing and on-the-ground validation sampling compiled in a decision support tool.
- Develop a vegetation model for areas with inadequate imagery for mapping.
- Write reports/publications and present at professional meetings.

Expected Milestones (Sandusky):

- Demonstrate spawning/lack of spawning of Grass Carp in the Sandusky River – accomplished for 2014-2015, continuing 2016-2017.
- Models projecting spawning locations and spawning risk (2017).
- Identification of locations for potential deployment of control measures (2017).
- Determination of approximate population size and distribution of Grass Carp in Lake Erie (2017).
- Interactive map of vegetation throughout Lake Erie and establishment of a protocol for future monitoring of changes in vegetation and effects of (and on) invasive species (2017).
- Determine differences in habitat niche, movement patterns and spawning behaviors between diploid and triploid Grass Carp and their potential use as “Judas fish.”
- Provide a better understanding of the complex environmental requirements for spawning cues and migrations, spawning events, and successful Grass Carp reproduction and recruitment.
- Identification of targeted habitats (e.g., winter aggregations, spawning locations) and locations for removal and control.
- Use information gained from this study and apply to knowledge of the Great Lakes for use in predicting potential areas for successful reproduction, recruitment, and establishment. These data can then be helpful in management plans for prevention, control, and removal in the Great Lakes and other emerging and established Grass Carp populations.
- Establish whether CERC artificial streams are suitable for experiments on determining spawning cues (2016) and complete pilot experiments (2017).
- First vegetation surveys and gap analysis (2016).

Outcomes/Outputs:

- Direct evidence of spawning of Grass Carp in the Sandusky River. Three separate spawning events were observed in 2015 by collection of eggs. Samples of eggs from each event were verified genetically.
- A better understanding of which Great Lakes tributaries currently provide spawning conditions and contribute to the Great Lakes population of Grass Carp, and an understanding of the extent to which continued escapement of diploid Grass Carp from aquaculture contributes to the population. This information will be useful for managers, who can use the information to

determine where Grass Carp populations are established, and whether additional deterrence of illegal movement of diploid Grass Carp is necessary.

- Age at maturation of Grass Carp in the Great Lakes will be determined, if sufficient numbers of fish are collected. Age at maturation has been shown to be a critical factor in assessing the risk that Asian carp will become problematic in the Great Lakes.
- Completed assessment of the Cuyahoga River and Muskingum River for spawning potential (report/publication).
- Sandusky River work will generate one or more publications on risk of successful spawning of Asian carp.
- Development of a plan for potential control strategies in the Sandusky River in collaboration with state and federal partners.
- All work will result in numerous posters, presentations, reports, and peer-reviewed publications (one publication in press, two presentation abstracts in review).

Potential Hurdles:

- 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.
- Garnering interest in a Lake-Erie-scale vegetation collaborative.
- Lack of sufficient boundary condition data in Muddy Creek Bay is representative of seiche activity.

19. Assessment of Hydraulic and Water-Quality Influences on Waterways to Develop Control Options

Lead Agency: USGS

Agency Collaboration: Illinois DNR, USFWS, Metropolitan Water Reclamation District of Great Chicago (MWRD), Southern Illinois University, USACE, and Purdue

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$625,000	\$315,000
FY 2017	\$610,000	\$315,000

Project Explanation: A major objective of this project is to determine natural and managed controlling factor(s) that contribute to the stalled migration of Asian carp within the pools of the Illinois River and how one or more of these factors could be used to prevent future migration or to reduce Asian carp populations. The upstream movement of Asian carp through the Illinois River has been documented by the Illinois Department of Natural Resources (IL DNR), the USFWS, and the USACE. These efforts have documented the distribution of the Bighead and Silver Carp population within the pools of the Illinois River and have identified habitats favorable for Asian carp. Since 2006, the upstream expansion of the carp population has stalled in the Marseilles and Dresden Island Pools. Sharp contrasts in habitat, flow conditions, water quality, and food supply between these pools and the CAWS may be acting as controlling factors to the stalled migration.

Several techniques will be used to characterize these potential controlling factors and data collection will be coordinated with the other agencies efforts to provide maximum complementary data collection and analysis. Flow, velocity and a suite of water-quality parameters (water temperature, pH, dissolved oxygen, specific conductance, chlorophyll-a, blue-green algae, nitrate, and turbidity) will be collected continuously in the main channel and backwater areas of the river. These data will be compared to fish movement providing potential information on stimuli/behavioral responses in this paired main channel/backwater combination. Plankton sampling data will be used to characterize the available food supply in this reach of the river. Along with the continuous monitoring, discrete samples will be collected to analyze for contaminants not previously analyzed such as hormones and pharmaceuticals. Existing data, including long-term water-quality sampling by the Metropolitan Water Reclamation District (MWRD) of Greater Chicago will be reviewed. In addition to a greater understanding of why Asian carp have not moved further upstream, the velocity and flow data will be evaluated to determine optimum locations (channel constrictions, pinch points, backwater areas, etc.) within the river that may be suitable for the testing of Asian carp control strategies. The applicability of this methodology will be evaluated for the downstream sections of the Illinois River. Day-to-day movement of Asian carp recorded from field observations and telemetered fish (Illinois DNR/USFWS/USACE/Southern Illinois University/Indiana DNR/Purdue University) will be analyzed with the flow and water-quality data to evaluate fish response to changing flow conditions.

Existing hydrologic conditions and controls can be combined with the improved understanding of Asian carp life history to enhance application of new control technologies and contribute to larger scale control efforts. Hydrologic control applications can include the isolation of backwater areas critical to juvenile Asian carp through river level manipulation using river control structures. Another hydrologic control

could be the application of food attractants to draw adult fish into a backwater that has structural control over water levels. Once Asian carp are into the backwater the structural control can prevent the adult fish from escaping back to the river as they are harvested or targeted for killing with microparticle piscicides. Hydrologic controls use advances in the understanding of basic Asian carp life history combined with manipulation of river hydrology to have a larger, river-wide impact on the Asian carp population. The Illinois Waterway, with eight lock and dam structures and river levels maintained by the USACE, contains waterway infrastructure suited to implementing hydrologic control methods.

This project will evaluate suitability of backwater areas frequented by Asian carp along the Illinois Waterway to implement hydrologic control methods to enhance effectiveness of harvesting and IPM controls in decreasing populations of Asian carp. The physical and hydrologic characteristics of backwater areas frequented by Asian carp will be used in combination with fish telemetry data to evaluate the backwater areas suitability. The physical and hydrologic characteristics of backwater areas along the Illinois Waterway vary considerably. The channel bedslope gradient is much steeper in the upper Illinois Waterway (above Starved Rock) than in the lower Illinois Waterway. Mean channel velocity is generally higher in the upper waterway than in the lower waterway. Along the lower waterway (below Peoria), backwaters and side channels are more common than in the upper waterway. The physical connection of backwater areas to the main channel also varies. These hydrologic characteristics influence circulation within the backwater, water residence time, water quality and habitat. This project will use this information on characteristics of backwater areas along the Illinois Waterway in combination with Southern Illinois University's fish telemetry data to evaluate backwater areas used by Asian carp for implementation of hydrologic control methods. Hydrologic control methods, when combined with mechanical, chemical, and biological controls, have the potential for a larger, river-wide impact on entire year classes of Asian carp and thus present an opportunity to lower the risk of Asian carp reaching the Great Lakes through the Illinois Waterway.

More data are needed to examine and rank factors that influence hydrologic control of Asian carp movement, spawning, and recruitment from smaller rivers, like those that enter the Great Lakes that are at the lower end of the size range, used by Asian carp. Data from analogue settings with Asian carp populations, such as the Wabash River in Indiana, provide an opportunity to expand already successful efforts in larger rivers to examine factors that influence Asian carp movement, spawning, and recruitment. These rivers represent the lower end of the size range thought to be used by Asian carp for spawning and would provide an ideal setting to test the tributary assessment tool (FluEgg) developed in a previous template project. FluEgg simulates egg transport and can help in determining reach length required for successful egg hatching. For successful recruitment, egg hatching needs to occur in close proximity to suitable larval habitat, so FluEgg results will need to be linked with habitat data for a more complete picture of likely population growth in a river. The next evolution in tools and control approaches developed for the partner agencies will include the evaluation of habitat for young juveniles as an addition to the tributary assessment tool.

Summary of Actions to Date:

FY 2015 Actions:

- Hydraulic and Water-Quality data collection and analysis.
 - Published 2014 WY water quality data for Illinois River main channel and backwater sites.
 - Distributed a weekly "Illinois River conditions" email to stakeholder field crews.

- Continued mapping of water velocity and water quality in Illinois River main channel and backwater.
 - Collected water velocity and water quality data during spawning events to help inform sampling and for FluEgg simulation of Illinois River egg development and dispersal.
 - Collected water chemistry samples through study reach for detailed chemical analysis (including lab schedules for pharmaceuticals and hormones) for evaluation of potential effects on movement of Asian carp population.
- Spawning and Recruitment.
 - Conducted drifting egg sampling to build on models for improved understanding on reproductive ecology in smaller river analogue setting to represent viability in smaller Great Lakes tributaries(Wabash River-Purdue).
 - Began efforts to incorporate successful recruitment criteria (juvenile habitat, etc.) with existing egg transport characterization methodologies to determine probability for the establishment of sustainable populations.
 - Continued support of FluEgg model maintenance and increased functionality and usability (such as incorporation of larval drift and ability to display results in Google Earth).
 - Collected data on larval swimming speeds and behavior in Silver Carp to incorporate in larval drift models.
 - At request of USACE, used FluEgg to conduct a draft risk analysis of the CAWS by simulating spawning at the electric barrier and Brandon Rd.
 - Began development of a mortality model to include in the FluEgg model.
 - Conducted outreach to state and federal partners on how the FluEgg model can help them assess the risk of Asian carp spawning and recruitment in their rivers of concern.
 - Collected and analyzed data on juvenile migration further upstream in the Illinois River.
- Fish Telemetry.
 - Maintained real-time fish telemetry equipment in analogue setting (Wabash River), established telemetry equipment in upper Illinois River at Seneca and published the data collected.
 - Continued collaboration with Southern Illinois University fish telemetry groups to manage/interpret/present data. Engaged with the USFWS and states to integrate all available Asian carp location data into the developed database.
 - Presented a draft of the web tool for the telemetry database with Federal and State partners.
- GIS analysis
 - Discussions with Southern Illinois University, Illinois DNR, and USFWS about backwater sites in the Illinois Waterway.

Proposed Actions:**FY 2016 Actions:**

- Hydraulic and Water-Quality data collection and analysis.
 - Publish 2015 WY water quality data for Illinois River main channel and backwater sites.

- Continue velocity mapping of selected river reaches in support of IPM and spawning documentation activities (in coordination with Illinois DNR and other agencies).
- Collect final set of water-quality samples for detailed chemical analysis (including lab schedules for pharmaceuticals and hormones) for evaluation of potential effects on Asian carp population.
- Begin analysis of the water-quality sample results.
- Spawning and Recruitment.
 - Continue drifting egg sampling in the analogue setting (Wabash River) to inform potential efforts to control Asian carp at early life history stages (Purdue).
 - Continue to incorporate successful recruitment criteria (juvenile habitat, etc.) with existing egg transport characterization methodologies to determine which rivers may pose a greater probability for the establishment of sustainable populations.
 - Use egg data from Purdue sampling on the Wabash River (analogue setting) to verify FluEgg model and incorporate egg mortality in smaller Illinois waterway and Great Lake tributary rivers.
 - Use flow and velocity data collected during June 2015 spawning conditions on the Illinois River to do FluEgg simulations to track egg and larval drift from observed spawning locations and identify potential nursery habitat.
 - Assess larval swimming behavior of Grass Carp and/or Bighead Carp to provide data for FluEgg larval drift simulations.
 - Finalize risk analysis of Asian carp spawning in the CAWS to share with USACE.
- Fish Telemetry.
 - Install three additional telemetry receivers in the Illinois River system and discuss further expansion of the network with stakeholders. These data will be used to inform IPM activities.
 - Maintain real-time fish telemetry equipment on upper Illinois River and Wabash River and publish the data collected to the web. Wabash River equipment is still needed as the project to mitigate the risk at Eagle Marsh is still underway because of delays from extreme rainfall in 2015. That project is now scheduled for completion in mid-Summer 2016.
- GIS analysis.
 - Evaluate and consult with coordinated team of USGS, Illinois DNR, INHS, and other partners on potential backwater sites in the upper Illinois River.

FY 2017 Actions:

- Hydraulic and Water-Quality data collection and analysis.
 - Publish 2016 WY water quality data for Illinois River main channel and backwater sites.
 - Continue velocity mapping of selected river reaches in support of IPM and spawning documentation activities (in coordination with Illinois DNR and other agencies).
 - Publish water-quality analyses from FY 2015-2016 sampling effort.
 - Publish an SIR relating the Asian carp movement data and water-quality data.
- Spawning and Recruitment.
 - Outreach to state and federal partners on how the FluEgg model can help them assess the risk of Asian carp spawning and recruitment in their rivers of concern.

- Fish Telemetry.
 - Maintain real-time fish telemetry equipment on upper Illinois River and present the data collected on the web
- GIS analysis.
 - Continue evaluation of hydrologic control methods.

Expected Milestones:

- Annual water year publication of main channel and backwater water-quality data.
- Draft of FluEgg risk analysis in the CAWS (November 2015).
- Final water-quality sampling in Illinois River (October 2015).
- Draft of web tool for visualizing Asian carp movement with flow and water-quality parameters (January 2016).
- Presentation on larval swimming behavior at Midwest Fish and Wildlife Conference (January 2016).
- Presentation/poster on Illinois River work at Midwest Fish and Wildlife Conference (January 2016).
- New version of FluEgg model with larval drift and Google Earth output tools (July 2016).

Outcomes/Outputs:

- Greater understanding of Asian carp preferred habitat with regards to hydraulic and water-quality characteristics and insight into how habitat may be altered to deter them from spreading into new areas.
- Incorporate successful recruitment criteria (juvenile habitat, etc.) with existing egg transport characterization methodologies to determine which rivers may pose a greater probability for the establishment of sustainable populations.
- Increase the robustness of the FluEgg egg transport and dispersal model and disseminate it to the states to assist in the identification of rivers that pose elevated risk for reproduction of Asian carp by using hydraulic characteristics to simulate egg travel times and likelihood of staying in suspension until hatching.
- Web-based tool for visualizing fish telemetry data with river hydraulic and water-quality data for analysis of Asian carp movement.
- USGS NWIS-Web display of real-time counts of tagged fish with respect to fixed monitoring stations to monitor Asian carp movement relative to barriers.

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.
- The project relies on obtaining fish telemetry data from collaborators outside the project.

20. Characterization of Brandon Road Lock for Barrier Implementation

Lead Agency: USGS

Agency Collaboration: USACE, USFWS, MWRD, Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$450,000
FY 2017	\$0	\$300,000

Project Explanation: To help prevent the movement of Asian carp from the Mississippi River basin to the Great Lakes basin, additional barriers on the CAWS have been proposed at the Brandon Road Lock and Dam as a component of the GLMRIS Report developed by the USACE in 3 of the 8 alternative plans. The plans outlined by the USACE suggested implementing a combination of new electric barriers and a “GLMRIS Lock” with an estimated timeline of 10 years or longer. Newer barrier technologies to Asian carp movement, such as complex sound or injecting CO₂ to drive fish away, have been suggested by recent research as promising barrier approaches that could be implemented relatively quickly.

Implementing existing and new technologies at the Brandon Road location requires a better understanding of the impacts of lockages, structures, hydrologic conditions and characteristics that could constrain the deployment of these technologies. Assessment of hydrologic and water chemistry conditions and temporal variations associated with the river and lock and dam operation will help the USACE identify the potential impacts associated with the deployment of these technologies on or near their structures. An understanding of the hydrologic and water chemistry conditions also provides background information about how deployment of these new technologies could be designed to minimize the impact on movement of barges and other vessels through the lock and approaches. The scope of the work is dynamic as input from other cooperators and stakeholders, such as the USACE, USFWS, and Illinois DNR, require the USGS to be flexible to the needs identified.

Summary of Actions to Date:

FY 2015 Actions:

- Performed one set of synoptic velocity field mapping in December 2014 in the lock chamber and the channel downstream under “lock flushing” conditions as specified by the USACE engineering team.
- Performed velocity field mapping in the lock chamber under filling and emptying conditions.
- Collected bathymetric data in the Brandon Road dam spillway area to provide design support for USACE numerical modeling of the site.
- Installed two streamflow velocity gages downstream of the Brandon Road Lock and Dam to collect continuous velocity data in the channel.
- Installed two continuous water-quality gages (one upstream and one downstream) to monitor temperature, pH, specific conductance, dissolved oxygen, turbidity, and CO₂.
- Collected water-quality data under summer hydrologic conditions (moderate streamflows, higher temperature, higher algal productivity and dissolved oxygen) along several transects to provide the information needed for the design of a CO₂ barrier system. Data included basic field

parameters, major ions, including alkalinity and calcium, and other constituents needed to assess seasonal variability that would be encountered in CO₂ barrier operation.

- Compiled the historical water-quality data for the reach from Illinois DNR and Illinois EPA.
- Worked with the USFWS to characterize the flow field around barges to support studies of whether Asian carp can be entrained (trapped) and transported by barges traveling through a lock and past a barrier.

Proposed Actions:**FY 2016 Actions:**

- Collect additional velocity distribution data in lock chamber and channel downstream to define flow velocity distributions under representative of lock operations.
- Continue operation of velocity and water-quality gages to provide continuous data to identify typical and extreme hydrologic conditions relative to synoptic mapping events.
- Document the range of mixing environments near the lock and downstream due to the expected range of hydrologic/hydraulic variation. A dye tracer will be applied under normal flow and flushing conditions and tracked through the lock to document mixing zones and rates within the lock and downstream of the lock.
- Analyze and compile synoptic velocity field mapping and dye tracer study results.
- Complete water-quality data collection and analysis, including information to assist the USACE in assessing the potential effects of CO₂ on structures.
- Develop the scope of a reaeration study for the river below Brandon Road Lock needed to simulate retention in water and loss of CO₂ from water downstream from a barrier.
- Collaborate with USFWS on a report from the barge entrainment studies
- Begin writing reports documenting data for the USACE and contractors use to implement selected barriers. Reports expected on hydrology/hydraulic characterization and water-quality data for CO₂.

FY 2017 Actions:

- Possibly continue operation of velocity and water-quality gages.
- Complete reaeration study of river reach below Brandon Road Lock and draft a report of the results.
- Finalize and publish reports on hydraulic characterization and water-quality data for CO₂.

Expected Milestones:

- Dye study and additional velocity mapping (October 2015).
- Water-quality sampling (November 2015 and January/February 2016).
- Presentation of barge study velocity results at Midwest Fish and Wildlife Conference (January 2016).
- Draft of hydraulic report (Spring 2016).
- Draft of water-quality report (Fall 2016).

Outcomes/Outputs:

- Support for the models under development by USACE and a better understanding of how potential new barrier technologies could be used at the Brandon Road Lock and Dam to prevent

the movement of Asian carp. These data are needed to validate the models to be used to assess barrier feasibility and design.

Potential Hurdles:

- Field work components are subject to weather conditions and lock maintenance. Overall project completion and field activities dependent on timing of funding.
- Coordination with USACE is essential to getting the most value from this data collection.

21. Use of Seismic Technology to Divert and Eradicate Asian Carp

Lead Agency: USGS

Agency Collaboration: Illinois DNR, USACE, USFWS, Northern Illinois University, Southern Illinois University, University of Illinois Urbana-Champaign, University of Minnesota-Duluth

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$50,000	\$50,000
FY 2017	\$20,000	\$0

Project Explanation: Preventing the movement of Asian carp from the Mississippi watershed into the Great Lakes rests largely on a set of electric barriers in the Chicago Sanitary and Ship Canal (CSSC). Additional deterrents or complements to the CSSC electric barriers would likely improve the efficacy of deterring Asian carp from entering into the Great Lakes. Seismic sound generating technologies used for marine oil and gas exploration create high pressure underwater sound energy waves that may be heard or felt by aquatic organisms. It is hypothesized that if seismic technologies can be intentionally operated to affect Asian carp behavior, then they may be useful to supplement the CSSC electrical barriers or be deployed in other locations for fisheries management applications.

Two general seismic technologies exist: (1) air guns and (2) water guns. Air guns release a volume of high-pressure air causing a sound/pressure wave by the collapse and expansion of an air bubble. Water guns use high-pressure air to rapidly drive water out of a water-filled chamber with a shuttle-piston. The rapid expulsion of water from the chamber creates a void which is rapidly back-filled as the shuttle returns to its firing position creating a pulsed sound/pressure wave. If these tools are found to alter Asian carp behavior, they could potentially be used to drive fish out of unwanted areas, or be used as a standalone deterrent in fixed locations (e.g., near electrical barriers, locks, connecting waterways, spawning habitats, etc.). These different deployment scenarios will require varying deployment strategies based on numbers of air and/or water guns and size of air and/or water guns, specific depths of air and/or water gun deployments, depth of the specific environment of deployments, and deployment effective distances must be considered. Moreover, the improper use of these tools could result in unforeseen damages to biological organisms and aquatic structures so there is a need to carefully proceed with research activities to clearly define their limitations before implementation by management agencies. To address these variables, scientific research is needed to define how and where these tools can be used in a safe and effective manner.

USGS water gun research has been on-going since 2012. The potential impact of seismic technologies on navigational structures and canal walls is of particular concern. To address the potential for structural damage by water guns, pressure mapping data were collected in multiple locations to observe water gun pressure gradients at varying depths, measure the blast radii, multi-water gun arrays in multiple orientations. Data were also collected near navigational structures. The two sites in 2014 included the CSSC (Lemont, IL) and below Brandon Road Lock and Dam (BRLD; Joliet, IL). Using those data, engineers can begin to understand the geometry, directionality and pressure forces of seismic blast waves and how they change with distance. Pressure mapping is expected to help define specific distances that seismic sources should be arranged to minimize risk of structural damages, yet at the same time delineate

pressure coverage areas that will affect fish behavior and be used to develop predictive models that detail the seismic forces on structures consisting of varying building materials (e.g., concrete, brick, etc.).

To begin to understand how fish react to seismic energy, thirteen different controlled studies were conducted between 2012 and 2013 in a USGS test pond. Multiple firing pressures and water gun orientations were observed, pressure mapped, and multiple species of fish were included. Behavioral response data for wild fish were also collected in 2013 and 2014 in two different field locations. Those data are being processed and analyzed. In general, it appears two water guns arranged perpendicular to the long axis of a test pond or flowing channel in fixed locations were effective at reducing specific-sized fish abundance near the water guns, but as distance increases outward from the water guns apparent deterrence of fish declines. These outward decreasing levels of deterrence were expected based on pressure mapping data. However, these data are also still being processed for the many observational trials conducted to date, and it should be noted that fish abundance and behavior monitoring equipment varied from location to location too and these different strategies are also being compared to develop standard operating procedures for future fish monitoring activities.

Other research needs include categorizing the response of Asian carp to mobile deployments of water guns to drive fish out of an area, towards commercial fishing nets, or into areas where other control techniques could be applied. In addition, while some non-target effects data have been collected involving fish, the effects of water guns on invertebrates (e.g., freshwater mussels) are unknown. Work will be initiated in 2014, and repeated in 2015, to evaluate the effects of water guns on native mussels.

If water guns prove to be an effective tool for fish deterrence, and standard operating procedures are developed to prevent adverse effects on navigational structures and biological organisms these tools will be incorporated into fishery management strategies. To facilitate transition of seismic technologies into management programs, additional underwater seismic sound generation systems (air and/or water guns and associated equipment) will need to be acquired and proper safety training will need to be provided.

Summary of Actions to Date:

- Completed six trials in a USGS test pond.
- Completed pressure mapping in USGS test pond for single and dual 80-in³ water guns.
- Completed study to identify best methods to attach acoustic telemetry tags to juvenile Asian carp for short term studies.
- Conducted seven behavioral response trials with Asian carp. Four trials evaluated the response of only Asian carp (Silver and Bighead Carp) to water guns; three trials evaluated the response of Asian carp and 4 non-target fish species.
- Deployed water guns in a ~100-m wide side channel of the Illinois River near Morris, IL. Completed pressure mapping around water guns in a ~100-m wide side channel of the Illinois River near Morris, IL.
- Behavioral responses of Asian carp were monitored using fixed-location split-beam. Hydro-acoustics (USGS) and mobile split-beam hydro-acoustics and side-scan sonar (Southern Illinois University).
- Completed an integrated pest management (IPM) demonstration in an Illinois River backwater.
- Held a collaborative partner demonstration day to inform USACE, Illinois DNR, USGS, and USFWS stakeholders about seismic technology, fish monitoring instrumentation and commercial fishing to reduce local populations of Asian carp.
- Drafted a data report for the first water gun testing along the CSSC.

- Collected background noise pressure readings from barge traffic at BRLD.
- Completed Lemont, Illinois CSSC pressure mapping around water guns at depths ≤ 25 ft. deep
- Data report completed for Lemont, Illinois data acquisition.
- Completed Joliet, Illinois BRLD pressure mapping around water guns in multiple orientations and distances from authentic navigational approach structures.
- Began developing predictive pressure map models for water guns.
- Equipped a field testing site near Morris, Illinois with a 3D acoustic hydrophone array to improve fish behavior monitoring capabilities in conjunction with static and mobile split-beam hydro-acoustics.
- Added two autonomous acoustic tag receivers to an Illinois backwater for monitoring long-term adult Asian carp movement by Illinois DNR and Southern Illinois University.
- Completed two different static water gun barrier observations in an Illinois River backwater based on distance between water guns (i.e. distance between guns was reduced $\sim 10\%$ between trials).
- Held a collaborative partner demonstration day to inform USACE, Illinois DNR, USGS, and USFWS stakeholders about seismic technology and fish monitoring instrumentation.
- Initiated consultations for mobile water gun deployment system designs.
- Completed purchase actions to acquire new water guns, and acquired an old air gun.
- Initiated assessments of the effects of water gun exposure to native freshwater mussels to begin to address questions that may arise regarding aquatic species of concern (relative to USFWS Section 7 ESA-consultation).
- Started management agency (USFWS) collaborations to begin safety training for the proper use of water guns; and associated equipment.
- Discussions of implementation strategies started with USFWS.
- Discussions initiated with Illinois DNR to identify additional field locations to observe mobile and static water guns.
- Drafted publication of USGS test pond water gun fish behavior assessments.
- Completed pressure map characterization for 2015 Morris field trials.
- Initiated reports describing the effects of water guns on native mussel survival, shell damage and movement.
- Conducted training of management agency staff for field deployment of water guns and fish monitoring equipment.
- Conducted a field trials at Morris, Illinois assessing the efficacy of water guns as a barrier and/or deterrent to Asian carp.

FY 2016 Actions:

- Complete analysis of 2014 and 2015 field trials performed at Hansen Material Service near Morris, Illinois.
- Initiate publication of USGS test 2013 pond water gun fish behavior assessments.
- Initiate publication of 2014/15 field studies assessing the efficacy of water guns.
- Complete reports describing the effects of water guns on native mussel survival, shell damage and movement.

FY 2017 Actions:

- Continues to analyze data and write manuscripts on 2013 pond water gun fish behavior assessments.
- Continues to analyze data and write manuscripts on 2014/15 field studies assessing the efficacy of water guns.
- Complete reports describing the effects of water guns on native mussel survival, shell damage and movement.

Expected Milestones:

- Summarize behavioral responses of fish to water gun operation in an experimental pond.
- Summarize behavioral responses of fish to water gun operation in field conditions.
- Determine best practices for fish monitoring equipment to assess control tool effectiveness in varying environmental conditions.
- Determine the effects of seismic technology on non-target species (i.e. multiple native mussels and additional fish species).
- Develop Standard Operating Procedures for safe water gun operation and deployment.

Outcomes/Outputs:

- Develop a scientifically based understanding of the minimum water gun size and array orientation needed, specific operating pressures needed, and water gun discharge frequency needed to deter Asian carp while minimizing risk of damage to navigational structures and injury to non-target biological organisms.
- Produce reports summarizing data collection methods, and best practices.
- Produce journal publications of studies evaluating seismic technology as a tool to control Asian carp.

Potential Hurdles: Publication schedule is affected by the length of time required by data acquisition, analyses, syntheses, submission, acceptance and processing times.

22. Field Deployment of Carbon Dioxide Barrier to Deter Asian Carp

Lead Agency: USGS/IL DNR

Other Agencies Involved: University of Illinois Urbana-Champaign, USACE, USFWS, Southern Illinois University

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$300,000	\$500,000
FY 2017	\$300,000	\$400,000

Project Description: Currently, prevention of the movement of Asian carp from the Mississippi watershed into the Great Lakes rests on a single electric barrier located in the CAWS. Additional barriers and/or supplements to the electric barrier would improve the efficacy of deterring Asian carp movement into the Great Lakes through redundancy and “safety nets,” and offer greater confidence in their containment. For example, development of a chemical barrier that generated noxious water conditions might repel Asian carp, preventing them from approaching the electric barrier.

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. One candidate barrier chemical that has received a great deal of attention has been CO₂ gas. Adding CO₂ to water has two main effects: (1) a reduction in pH due to the formation of carbonic acid (a weak acid), and (2) elevation of dissolved CO₂ (hypercarbia). While the exact mechanism that induces avoidance for fish following CO₂ exposure has not yet been defined, it is believed that CO₂ functions by ‘irritating’ the gills of aquatic organisms. It is important to note that additions of CO₂ do not function as a “bubble curtain” (i.e., not a physical obstruction), CO₂ does not deter movement by causing hypoxia, and the inevitable change in pH associated with elevated CO₂ is not sufficient to cause fish to move. Rather, it is believed that fish have CO₂ receptors in their gills and are able to sense CO₂ in the water, and it is the presence of a concentration of CO₂ that is physiologically unacceptable, causing intolerable gill irritation, that likely induces avoidance as fish seek water containing near normal concentrations of CO₂. Additionally, CO₂ does not appear to be species specific, with all fishes impacted in a similar fashion; a CO₂ barrier would therefore likely prevent the movements of non-target fishes as well. In addition, CO₂ appears to impact smaller fishes as well as larger ones. Combined, this suggests a strong propensity for elevated CO₂ environments to act as a non-physical barrier to deter the movement of fishes across a range of sizes (small fingerlings to adults).

To date, a large-scale pond trial to assess behavioral responses of Bighead Carp and Silver Carp to CO₂ has been completed, along with the behavioral response of non-target fishes (bigmouth buffalo, channel catfish, paddlefish and yellow perch). Discussions with the USEPA regarding regulatory framework for research applications of CO₂ in open water applications including barrier operations have been initiated. An injection system has been manufactured that will allow for a large-scale open-water treatment of CO₂. The physiological response of native mussels to CO₂ have been completed under the guidance of Section 7 consultation by the USFWS. Results from these studies are currently being summarized into manuscripts for submission. Studies to assess the effectiveness of CO₂ as a barrier by creating a miniature Branden Road Lock and Dam have been completed. Results suggest that both Silver Carp and Bighead Carp avoid areas that have a CO₂ concentration of 70 mg/L. A manuscript has been developed and is

currently in review. Large-scale field trials were completed at Hansen Material Service site near Morris, Illinois. This was the first study that demonstrates the application of CO₂ into an area comparable to the approach channel at Branden Road Lock and Dam.

FY 2016 Actions:

- Analyze, summarize and publish data from the Morris, Illinois field studies that evaluated a large-scale CO₂ barrier.
- Continue to evaluate non-targeted affects.
 - Complete analysis and publish (peer-reviewed manuscript) results of toxicity and physiological response data for native mussels exposed to CO₂.
 - Studies will be conducted to assess if native mussel behavior is altered when exposed to elevated CO₂ in controlled pond studies.
- Determine if CO₂ administered under ice can enhance mortality in SVC, BHC, and GC or a surrogate species that has similar physiological attributes.
 - Incorporate ecological information to identify potential sites for deployment of CO₂ to enhance winterkill conditions.
- Identify the most efficient and cost-effective way to inject CO₂ into a large volume of water to identify the best way to administer CO₂ to create a barrier/deterrent.
 - Three methods to inject CO₂ (i.e. direct diffusion, Venturi, and speece cone) will be evaluated in a larger pond, 0.5 acre.
- Determine the lowest concentration of dissolved CO₂ that Asian carp will avoid.
 - Studies will be conducted in 0.01 acre ponds in flowing water using a push-pull design.
- Initiate studies to complete USEPA registration of a CO₂ barrier or the use of a CO₂ as a control agent in limited open-water application sites.
- Expand studies with potential non-target species (e.g. banded killifish, caddisfly, etc.) to address USFWS Section 7 ESA-consultation data requirements of a CO₂ barrier or the use of a CO₂ as a control agent in limited open-water application sites.

FY 2017 Actions:

- Assist management agencies that plan to deploy CO₂ as a barrier or as a control agent in limited open-water application sites to control Asian carp.
- Complete studies to complete USEPA registration of a CO₂ barrier or the use of a CO₂ as a control agent in limited open-water application sites.
- Complete studies to address USFWS Section 7 ESA-consultation data requirements of a CO₂ barrier or the use of a CO₂ as a control agent in limited open-water application sites.

Expected Milestones:

- Establish a minimum concentration for an effective CO₂ barrier.
- Identify the most efficient way to injection of CO₂ to create a barrier to Asian carp.
- Establish a method to administer CO₂ to enhance mortality during winter.
- Registration of CO₂ as a barrier or as a control agent in limited open-water applications.
- Completion of USFWS Section 7-ESA consultation.

Outcomes/Outputs:

- Define the ability of a CO₂ barrier, when deployed in the field at “real world” scales, to impede the movement of free-swimming Asian carp.
- Recommendations to management agencies on the operating conditions to establish a static deterrent barrier.

Potential Hurdles:

- Capacity of the CO₂ infusion system to evenly disperse CO₂-infused water within an uncontrolled flow environment to maintain an effective deterrent barrier.
- Potential effects of carbonic acid on in-water navigation/control structures.

23. Developing Targeted (Microparticle and Piscicide) Control Systems

Lead Agency: USGS

Other Agencies Involved: USFWS, South West Research Institute, Illinois Department of Natural Resources, University of Wisconsin-La Crosse, Viterbo University

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$630,000	\$600,000
FY 2017	\$830,000	\$400,000

Project Description: No current technology can specifically target Bighead or Silver Carp for control within aquatic ecosystems. Available toxicants used in AIS 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 with high specificity for Bighead and Silver Carp would increase the ability of management agencies to control or limit Asian carp while minimizing potential impacts on native species. Targeted selectivity can be achieved by understanding the habits and physiological characteristics of the target organism, and incorporating into delivery system technologies that will exploit those characteristics. Considerations such as food particle size, digestive physiology, feeding attractants/stimulants, and identification of species-selective chemicals can be brought together to develop a targeted delivery system.

The current lack of registered piscicides limits the tools that aquatic resources managers have available to control aquatic invasive fish. Developing a new suite of chemical tools specifically toxic to Bighead or Silver Carp 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. This project will analyze structures and activities of chemicals with known piscicidal capabilities described in a variety of industrial, pesticide, and pharmaceutical libraries. Chemicals similar in structure or activities to known piscicides will be evaluated for potential use in controlling Bighead or Silver Carp.

To date, a database of chemicals with known piscicidal activity has been created and a manuscript on the development of this database has been submitted for publication. This database is currently being used to identify structure-activity correlations to identify candidate fish toxicants. The ZINC Database of over 1.8 million compounds is being surveyed to determine suitable candidates. In collaboration with the USFWS La Crosse Fish Health Center, sources of native fish cell lines suitable for use in cytotoxicity (cell toxicity) assays have been established. Studies have been completed to determine digestive enzyme kinetics, gastric evacuation rates and the apparent digestibility of food (and thus microparticles) by Bighead and Silver Carp at three temperatures (12, 19, and 25°C). Manuscripts for these studies are currently in review. Buoyancy, leaching and size analysis have been completed on sample batches of second and third generation microparticles. Southwest Research Institute has provided 12 different types of particles and one formulation has been identified to have the characteristics needed to deliver a control agent to Asian carp. A spray atomizer has been built at UMESC that is capable of manufacturing microparticles using formulations developed for shellfish diets by the commercial aquaculture industry. Twelve different formulations have been manufactured and leaching studies completed: leaching has been minimized to less than 0.5%. Static toxicity tests to determine LC50s have been completed for native fishes (largemouth bass, bluegill, golden shiner, fathead minnow and paddlefish) and Asian carp.

Both Bighead Carp and Silver Carp were determined to be the most resistant to antimycin. Trials evaluating the efficacy of the UMESC microparticle have been completed with Asian carp and native fishes (largemouth bass, bluegill, golden shiner, fathead minnow and paddlefish). Results indicate that both Bighead Carp and Silver Carp are the most sensitive to the antimycin-latent microparticle. Both Bighead and Silver Carp died within 6 hours of microparticle application, while much more antimycin-sensitive native fishes survived. Additionally, it was determined that pH has a significant role in the toxicity of antimycin in Asian carp but a minor role in native fishes. Finally, USGS identified that antimycin is stabilized in the microparticle. It takes three days before 25% of the antimycin is released and degraded from the particle and seven days until more than 25% of the antimycin is degraded. Typically, antimycin in water is degraded within 24 hours.

FY 2016 Actions:

- Continue to screen through potential new control chemicals using cell lines.
- Conduct in vivo fish assays with only those chemicals that demonstrate high toxicity and selectivity for Asian carp.
- Initiate metabolomic and/or genomic studies to identify the mechanisms involved with resistance and sensitivity of fishes including Asian carp to potential control chemicals. This information will enable us to identify practices that will increase sensitivity and increase selectivity.
- Determine diurnal feeding behavior of Asian carp to improve microparticle formulations and improve delivery methods and increase acceptance.
- Identify other sources of antimycin for use in microparticles.
- Develop alternative formulations of microparticles that could be used at various places within the water column (e.g. surface, bottom, upper 1 m, etc.).
- Determine dispersal of microparticle with and without algal solutions under controlled settings.
- Determine the lethal dose ($\mu\text{g}/\text{kg}$ body weight) for Silver Carp and Bighead Carp.
- Evaluate the efficacy of “UMESC” microparticles in pond studies and attempt to minimize the impacts on native filter feeding fishes like paddlefish, which can be impacted by the antimycin-latent particles when exposed in an enclosed tank with limited space to avoid the particles.
- Evaluate effectiveness of the combination algal feeding stimulus for microparticle delivery to improve acceptance and efficacy of microparticles.
- Determine if Asian carp have a limited ability to buffer blood pH and if a different class of chemicals could be used to control Asian carp.
- Conduct studies to evaluate non-target species response to microparticle.
- Identify potential field sites along the Illinois River for field trials with microparticles.
- Begin to assess populations fishes and invertebrates in field sites where microparticles will be tested.
- Initiate studies to identify genetic based controls by conducting RNA-seq studies at critical development stages.
- Initiate studies to complete USEPA registration of antimycin-incorporated microparticles and obtain experimental use permit.
- Initiate studies to address USFWS Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles and obtain experimental use permit.

FY 2017 Actions:

- Complete analysis of metabolomic and/or genomic study to identify the mechanisms involved with resistance and sensitivity of fishes including Asian carp to potential control chemicals. This information will enable us to identify practices that will increase sensitivity and increase selectivity and allow for the development of a new type of genetic based control (i.e. CRISPR).
- Publish manuscript on the diurnal feeding behavior of Asian carp to improve microparticle formulations and improve delivery methods and increase acceptance.
- Continue to evaluate the efficacy of “UMESC” microparticles in pond studies and attempt to minimize the impacts on native filter feeding organisms, which can be impacted by the antimycin-latent particles.
- Publish manuscript on the ability of Asian carp to buffer blood pH.
- Conduct field trails to demonstrate efficacy of microparticles.
- Assess populations fishes and invertebrates in field sites pre and post microparticle application
- Continue studies to identify genetic based controls studies to identify critical development stages or characteristics.
- Continue in vitro cytotoxicity assays and in vivo fish assays.
- Continue studies to determine biologically-derived controls of Asian carp.
- Develop new population models that incorporate the use of commercial fishing and the use of microparticles.
- Develop a map that incorporates ecological information to identify the best locations for deployment of microparticles along the Illinois River between Starved Rock and Brandon Road Lock and Dam.
- Continue studies to complete USEPA registration of antimycin-incorporated microparticles.
- Continue studies to address USFWS Section 7 ESA-consultation data requirements of antimycin-incorporated microparticles.

Expected Milestones:

- In vitro cytotoxicity assays to assess chemical toxicity for Asian carp and native fishes.
- A selective targeted delivery system of antimycin to Asian carp.
- Non-target testing of a selective targeted delivery system to non-target native filter feeding species.
- Pond evaluations (≥ 0.01 acre) of the efficacy of using microparticles to deliver a control agent to Asian carp.
- Identify field site for initial deployment of microparticle.
- Better understanding of feeding behavior of Asian carp.

Outcomes/Outputs:

- Approximately one dozen candidate fish toxicants identified for further testing.
- Development of a selective targeted delivery system of antimycin for selective control of Bighead and Silver Carp.
- Development of a selective targeted delivery system of another chemical control agent or a biologically-derived control agent for selective control of Bighead and Silver Carp.

Potential Hurdles: Access to candidate fish toxicants from private chemical libraries.

24. Chemical Attractant Investigations to Increase Harvest and Control

Lead Agency: USGS-CERC

Agency Collaboration: USFWS, Illinois DNR, INHS

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$274,000	\$0
FY 2017	\$274,000	\$0

Project Explanation: Laboratory and field studies conducted at CERC and by independent researchers have consistently confirmed that an algal food stimulus is highly attractive to Asian carp and can increase the abundance of fish in areas where Asian carp have been conditioned to the food. Such attractions are sufficiently persistent to enhance capture and also to ensure the ingestion of microparticle poison bait.

The main objective of the feeding attractant studies is to increase harvest of carp by resource management agencies. Field studies will evaluate optimal application methods of the attractants to aid in the capture of wild carp using various harvesting nets, traps and electroshocking gear. Factors to be considered for increasing the efficiency of fish harvest are gear types, site location, river dynamics (flowing, backwater), seasonality and productivity of the system. Conditioned acoustic stimuli (conspecific, ambient, and synthesized) associated with the algal attractant will be included in the protocol to enhance attraction over greater distances than the algal plume. Feeding attractants will also be integrated with microparticle toxin technology to enhance efficacy and ingestion for the control of Asian carp. Various methods of introducing microparticles to carp will be tested and formulations will be modified to optimize microparticle application. This will include characterizing the feeding response to the microparticles, documenting distress and mortality at the feeding stations, and determining potential treatment of grass carp with microparticle treated vegetation.

Sonar technologies, verified and validated with DIDSON imagery, will be used to observe the response of wild carp to the algal stimulus in the field to document behavior in and around netting/trapping devices. Responses to be quantified include the number of fish in and around netting/trapping devices, the number of fish that enter/leave the mouth of the nets, characterizing the fish response to the algal stimulus when released near the net, as well as their response in the net. Fish activity and abundance will be evaluated within 50 feet of area of the algal stimulus plume.

The efficacy of chemical attractants to larval Asian carp, (Bighead or Silver Carp and Grass Carp) at various stages will be tested to determine whether the scent of food types (algae, zooplankton, or macrophyte foods) or the presence of other juvenile Asian carp (using water from tanks holding juvenile Asian carp and feces of juvenile carp) is important in attraction of larval fish to nursery areas. If these scents are attractive to Asian carp at very early stages of development, it could be used to draw Asian carp larvae into wetlands, where they could be most easily controlled.

Summary of Actions to Date:

- Video analyses of lab studies confirming Asian carp attraction to the algal stimulus solution have been completed.

- Attraction to algal stimulus solutions was verified in a mesocosm pit tag array using tagged juvenile Asian carp. The response of the carp was also verified using digital video imaging with underwater GoPro cameras that revealed active feeding responses among the fish attracted to the targeted area of release where the algal stimulus was presented. The response elicited by this stimulus was robust relative to the number of fish attracted to the area and the duration of time fish remained in the immediate vicinity of the algal plume. Fish began to move from the 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.
- Tests confirmed that carp can be conditioned to feeding stations and that such strong attraction can be used to facilitate their capture. Attraction to the feeding station was enhanced through the use of acoustic stimuli, however certain underwater sounds clearly repelled carp as well.
- We determined that fish readily avoided the areas when complex sounds were broadcast in tributaries of the Missouri and Illinois Rivers. Schools of carp of mixed ages could be moved over distances of at least a mile, using speakers mounted on boats.
- Studies determined that wild carp could be conditioned to 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. The abundance of fish catch was increased when feeding stations were positioned at the mouths of pound nets.
- Tests combining feeding stations with microparticle dosing were initiated and critical variables were identified for an expanded study design.

FY 2016 Actions:

- In expanded studies with the FWS, state agencies and commercial fishermen the algal stimulus will be applied as a lure in a variety of active and passive nets and traps to identify gear most effective for increasing abundance and harvest. Auditory stimuli will be paired with the presentation of the algal stimulus to increase responsiveness to the feeding station to enable greater harvest abundance. The stimulus may include conspecific, ambient, or synthesized sounds. An important facet of this research will be in optimizing the fishing effort relative to the time of year, habitat characteristics, gear selection and appropriate conditioning to the feeding station. Olfactory physiological and behavioral studies with component compounds found in the algal stimulus will be conducted to facilitate development of an attractant for microparticle poison bait in pond mesocosm studies. Evaluate the response of other species, including grass carp to the algal attractant and other food stimuli. In addition, studies will be conducted to determine the response of larval Asian carp to potential attractants and other environmental stimuli.

FY 2017 Actions:

- Studies with selected harvest techniques will be expanded to evaluate performance in different habitats and at different times of year.

Expected Milestones:

- Field trials with different nets and traps will be employed at feeding station locations to develop protocols and to determine if the feeding station increases harvest abundance. Electroshock applications will be conducted to determine if fish can be driven to concentrate fish at feeding stations and thereby increase capture efficiency. Controlled pond studies will be conducted to determine if it is feasible to integrate algal attractant with micro-particle technologies and to evaluate optimal sensory stimulation to ensure ingestion of fish toxins.

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.
- Report on feasibility of the use of chemical attractants and repellants in the capture and harvest of Asian carp.
- Conduct workshops on Integrated Pest Management Strategies and assist state agencies in their applications.
- Transfer of technology to state agencies.

Potential Hurdles: High river stages from unseasonal rainfall hinder research.

25. Use of Acoustic Technology to Determine Behavior

Lead Agency: USGS Columbia Environmental Research Center

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$144,000	\$0
FY 2017	\$50,000	\$0

Project Explanation: Asian carp have been expanding their range in North America since they were introduced in the early 1970s. They are now abundant in the Mississippi, Illinois, and Missouri River drainages and now threaten to enter the Great Lakes. These fishes are very skittish when approached by boat and are famously known for leaping out of the water when stressed by boat noise or when confronted with barriers like the shoreline, wing dikes, and gill nets. In many cases, Asian carp are seen simply leaping over nets and avoiding catch.

Dual-Frequency Identification Sonar (DIDSON) is a high-frequency sonar camera that produces images at a high enough rate observe fish swimming patterns, and guilds of fish species based on crude body shape and behavior. DIDSON sonar has been used in the past to conduct fish counts of salmonids passing specific areas in a river; investigate spawning behavior, and trawl net avoidance. With this tool USGS can accurately observe fish with minor interference. The ability of the DIDSON to discretely observe in situ Asian carp's behavior at night or in turbid water will broaden the understanding their behavior.

Asian carp are famously believed to have highly developed net avoidance behavior, which inhibits control methods based on harvest. However, simply comparing catch rates between different net types to assess their efficiency of carp harvest is hampered because different sets will be tested by different and unknown numbers of carp. Furthermore, improvement of harvest gear design is hampered due the lack of knowledge of the types of behaviors that allow Asian carp to avoid nets. USGS plans to assess the behavior of Asian carp in relation to different gear types and propose gear modifications that might enhance harvest efficiency.

Many thousands of Silver Carp and Bighead Carp have been caught with traditional gears. However, preliminary observations with the DIDSON have shown strong avoidance of the most common gear types by Asian carp. DIDSON images show hundreds of Asian carp, singly and in groups, approaching nets and then rebounding from them and quickly swimming away. In this study, fish behaviors in association with traditional gears will be classified and quantified. Water quality will be measured at each site, especially including water temperature, velocity, and turbidity, parameters which may influence avoidance behavior or net detection.

The goal of the project is to observe and quantify Asian carp behavior that results in net avoidance and form testable hypothesis regarding gear modifications that ameliorate or negate such behaviors.

Summary of Actions to Date:

FY 2015 Actions:

- Spring FY 2015 the remaining nets not purchased in FY 2014 were purchased and delivered. A new type of double density gill net was added to the study. Field work continued in FY 2015

when weather allowed. Hoop net sets were recorded with the DIDSON on the Mississippi and Des Moines rivers, and planned data collection for fish behavior in relation to hoop nets was completed. Gill and trammel nets were recorded with the DIDSON on the Missouri River, Cedar Creek, Lamine River, and Blackwater River. Missouri experienced record rainfalls with totals 7.5 – 10 cm above normal for each month from May to August 2015 (<http://climate.missouri.edu/>). As a result of the increased rainfall local rivers routinely became too flooded to conduct fieldwork safely resulting in delays till the rivers could recede. Despite the delays due to rain, a large portion of the field work necessary for the project was completed. Optimum DIDSON camera settings and modifications for turbid waters was found. DIDSON specific software was updated to the latest versions to help with minor glitches.

Proposed Actions:**FY 2016 Actions:**

- Continuing project field work and analysis of DIDSON footage.

FY 2017 Actions:

- Finish project field work if there are delays in FY 2016. Analyze data and prepare manuscript and submit for FSP.

Expected Milestones:**Fall/Winter FY 2016:**

- Continue project related fieldwork. Using an ADCP, assess the effect of hoop nets on currents downstream of the net, to aid in interpretation of already-recorded hoop net data. Record DIDSON footage on deep water entanglement nets of various types, and assess differences in behavior and capture and detection efficiencies when fish are driven and not driven, under coldwater conditions. Try to determine if Asian carp dive below nets in deeper water. Analyze footage with ArisFish program. Begin write up of project introduction and methods.

Spring FY 2016:

- Continue project related fieldwork. Record spring run footage on Hoop nets. Analyze footage with ArisFish program. Continue write up of project introduction and methods.

Summer FY 2016:

- Finish or continue project related fieldwork if there are flood delays. Analyze footage with ArisFish program. Continue write up of project introduction and methods.

Outcomes/Outputs: Outcomes from this project will be a description of behaviors of Asian carp encountering the different harvest gears. These behaviors will be quantified and the effect of gear type on behavior and capture efficiency will be assessed. Deployment methods that could enhance harvest will be identified and tested.

Potential Hurdles:

- Weather can always lead to delays and damage to nets will need time to repair if not replaced.
- Equipment problems such as DIDSON camera malfunctions and boat repairs can lead to delays.

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

Lead Agency: USGS

Agency Collaboration: USFWS, Purdue University, Minnesota Department of Natural Resources (MN DNR) and Wisconsin Department of Natural Resources (WI DNR) for field assistance and University of Minnesota (UM), University of Wisconsin (UW), Illinois Natural History Survey, South Dakota State University, University of Illinois at Urbana-Champaign, University of Missouri – Columbia (UMC)

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$800,000	\$110,000
FY 2017	\$800,000	\$110,000

Project Explanation: Early detection is a vital part of managing any invasive species, including the invasive Asian carp species Bighead Carp (BHC) and Silver Carp (SVC), collectively referred to as Asian carp (BC). Significant efforts have been made to detect BC at low abundances and identify their invasion front, but since BC avoid traditional capture gear, traditional gears have limited utility in finding BC at low density. An alternative method for monitoring BC is the detection of molecular signals (such as mitochondrial DNA – often termed eDNA) of BC in water samples.

The eDNA method has proven effective for detection of BC at low densities. Further improvements to eDNA technology will offer managers a “molecular toolbox” for detection and characterization of BC occurrence. Current applications include detection of spawning events, fish movement, habitat utilization, and evaluation of the effectiveness of management actions. Applications of eDNA technology under development include estimation of fish biomass and methods for determination of time since eDNA was shed from a live fish. Refinements to eDNA methodology are also being pursued to improve detection sensitivity, prevent false negatives caused by PCR inhibition, increase cost-effectiveness, and decrease time between sampling and results.

An innovative combination of human medical testing methodology with eDNA is also under development. Markers are being designed and optimized for incorporation into a rapid, portable DNA/RNA detection kit for use in the field to screen samples for the presence of DNA from BC. For example, DNA of BC in water from baitfish shipments could mean that BC are present in the baitfish shipment. The BC markers will be incorporated into commercial, handheld DNA detection kits similar to those available for human disease agents.

Further work is needed in correlating eDNA signals with actual live organisms. This project will aim to establish this relationship by investigating differential degradational patterns of DNA and identifying breakage ‘hotspots’ for development of new mitochondrial markers, development of eRNA or nuclear DNA markers, development of unique gut microbial markers, and assaying water samples for specific BC metabolites (i.e. pheromone, hormones, etc.).

Summary of Actions to Date:

- Identified significant spike in BC eDNA correlated with spawning event in the Wabash River and applied “stair-step” markers to eDNA samples, detecting BC sequences of greater than 800 base pairs that indicate freshly shed eDNA from live fish.
- In the Missouri River, identified a similar spike in BC eDNA correlated with a spring rise in water level and the presence of eggs, indicating a spawning event.
- Described a linear relationship over 4 orders of magnitude between BC biomass and eDNA shedding rate under controlled laboratory conditions.
- In laboratory experiments, showed that temperature does not alter eDNA shedding rates but feeding increases eDNA shedding by about 10-fold.
- Described degradation curve of eDNA from BC sperm under controlled laboratory conditions, showing a good fit to exponential decay with a half-life of about 8 hours.
- Three manuscripts/reports are accepted and four others in preparation from UMESC.
- One manuscript is published and four are in preparation from CERC.
- Validated new qPCR markers through a multi-lab round robin double-blind study for BC mitochondrial DNA to allow incorporation into USFWS eDNA monitoring program.
- Initiated validation of BC-specific microbial communities to detect BC.
- Initiated mitochondrial sequencing of select native cyprinids 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.
- Developed and validated the portable DNA/RNA detection kit.
- Completed eDNA sampling of sites along the Upper Mississippi River pools 8 and 26, where the expected invasion front is currently located as well as in the St. Croix River near the power plant where Bighead Carp were captured in 2015.
- Validated internal positive controls for incorporation into USFWS eDNA monitoring program to prevent false negatives from PCR inhibition.
- Initiated studies to determine the degradation of DNA in the environment.
- Initiated studies to evaluate the use of RNA as an alternative to eDNA.
- Conducted BC population density study in small pond mesocosms to connect laboratory and field results for eDNA shedding rates.
- Estimated relative BC 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.

FY 2016 Actions:

- Design, test and validate qPCR assays from the BC mitochondrial DNA genome to span multiple rapidly degraded sites to develop markers useful for tracking live fish.
- Complete studies evaluating eRNA as an alternative signal for tracking live fish.

- Develop next-generation sequencing protocols to analyze composite water samples, plankton tows, and ichthyoplankton tows for species composition/richness determination, BC biomass, spawning events/locations, etc.
- Complete validation of BC microbial source markers for potential inclusion into surveillance program in an effort to track live fish.
- Investigate usefulness of occupancy modeling on previously collected water samples from low BC abundance to high BC abundance on the Upper Mississippi River, Illinois River, and Wabash River.
- Validate digital droplet PCR (ddPCR) as an alternate to qPCR for quantifying eDNA concentrations.
- Validate use of ddPCR for “stair-step” cPCR markers to quantify eDNA in varying size ranges.
- Initiate mesocosm studies of eDNA shedding rates from larval BC.
- Complete analysis of eDNA quantity in 2014/15 samples from upper Mississippi sites with a gradient of known relative population densities of BC.
- Repeat sampling of upper Mississippi sites with a gradient of known relative population densities of BC, 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.
- Continue to sequence mitochondrial DNA of fishes native to Upper Mississippi River whose mitochondrial DNA sequences are underrepresented in GenBank.
- Initiate mesocosm studies of degradation of eDNA shed by BC.
- Complete analysis of BC population density study in small pond mesocosms to connect laboratory and field results for eDNA shedding rates.
- Initiate laboratory studies of degradation of eDNA from sperm in river water, comparing the Missouri and Mississippi Rivers.
- Complete analysis of relative BC density in Missouri River tributaries estimated with side-scan sonar and traditional capture methods, compared with simultaneous sampling for eDNA quantification to characterize habitat usage and fish movement.
- Initiate field studies testing the utility of eDNA for assessing the effects of management actions.
- Complete analysis of comparisons of water sampling methods from field and pond studies, to optimize water sampling methods for eDNA detection and quantification.
- Conduct a study that evaluates the distribution of BC and land-use practices by using eDNA and data from historical photos.
- Conduct a workshop to train law enforcement on the use of the portable DNA detection device.
- Assist in validation of eDNA markers in development by USACE for Grass Carp and Black Carp if needed.
- Design LAMP assay to detect Grass Carp and Black Carp with the portable DNA detection device.
- Conduct eDNA sampling of suitable and non-suitable habitats for Grass Carp as mapped by JC Nelson and others.

FY 2017 Actions:

- Complete development of eRNA or nuclear markers and evaluate usefulness in captive tank or field samples known to contain presence recently introduced live fish.

- Initiate studies to determine if metabolites excreted by BC can reliably detect their presence.
- Carry out technology transfer of developed next-generation sequencing 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.
- Complete the development of qPCR assays from BC DNA that span multiple restriction site regions of interest in an effort to develop markers useful for tracking live fish.
- Transition the use of BC-specific microbial communities as a compliment to eDNA to monitoring programs.
- Complete analysis of eDNA quantity in 2016 samples from upper Mississippi sites with a gradient of known relative population densities of BC.
- Repeat sampling of upper Mississippi sites with a gradient of known relative population densities of BC, 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.
- Complete analysis of mesocosm study of relationship between BC population density and eDNA quantity.
- Validate qPCR assays of rapidly degraded sites in the BC mitochondrial DNA genome to allow incorporation into USFWS eDNA monitoring program as an indicator of eDNA recently shed from live fish.
- Complete data analysis comparing eDNA quantification with estimates of relative BC density in Missouri River tributaries and wetlands from side-scan sonar and traditional capture methods, to characterize habitat usage and fish movement.
- Validate Grass Carp and Black Carp assay for use with the portable DNA detection device.
- Complete analysis of grass carp eDNA samples from mapped sites.

Outcomes/Outputs:

- Multiple validated methods to detect a variety of BC molecular signals including mitochondrial DNA (target of current eDNA surveillance programs).
- Tools to accurately identify the route of entry of BC molecular signals (such as eDNA) into a water body to discriminate between potential vectors and the presence of live fish.
- Characterization of eDNA signals associated with spawning events, fish movement, invasion fronts, and abundance.
- Use of eDNA quantity to estimate BC biomass.

Potential Hurdles:

- Identification of native species with similar DNA sequences.
- Collection of rare species for mitochondrial screening, though access to museum specimens may negate this hurdle.
- Collection of samples through winter months.
- Access to fish-eating bird colonies.
- Natural variation among samples in eDNA quantity due to clumped nature of shed cells containing eDNA.

27. Integrated Pest Management Program

Lead Agency: USGS

Agency Collaboration: Illinois DNR, USACE, USFWS, Southern Illinois University, University of Illinois Urbana-Champaign, University of Minnesota-Duluth, Purdue University

Funding Tables:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,750,000	\$1,000,000
FY 2017	\$1,750,000	\$850,000

Project Description: Integrated pest management (IPM) will be needed to monitor, control and contain Asian carp in the upper Illinois River to keep them from invading the Great Lakes. Two primary tactics are currently being deployed to meet this objective including electrical barriers in the CAWS and contract fishing between Starved Rock Dam and the electrical barriers. The area between Starved Rock and the electrical barriers is recognized as having reduced populations and limited reproduction as compared to downstream reaches and thus acts as a buffer between high densities of Asian carp and the electrical barriers that protect the Great Lakes. Contract fishing combined with minimal reproduction in this buffer zone acts to reduce Asian carp densities because the primary source of Asian carp is thought to be immigration from below Starved Rock rather than reproduction as evidenced by the decade long stall in population expansion. Minimizing the number of Asian carp in this buffer reduces the likelihood of Asian carp challenging the electrical barrier and thus the potential for propagules of Asian carp reaching the Great Lakes.

New technologies and surveillance to increase the efficacy of these 2 tactics (i.e., barriers and contract fishing) in the upper Illinois River would further minimize the risk of introducing Asian carp propagules into the Great Lakes. For example, redundant barrier technologies like sound and CO₂ in the CAWS might work better than a single technology because the efficacy of individual technologies is known to vary with environmental conditions and life stage of Asian carp. Tandem and redundant operations allow for protection across a greater range of conditions and life stages, and allows for backup in the case of failure of a single technology. Studies at Brandon Roads Lock and Dam are being conducted to help fill this need for redundancy in the long term. Deployment of CO₂ or sound at locks and dams downstream of Brandon Road might reduce Asian carp abundances in the buffer zone in the short term. As well deployment of CO₂, sound and algal attractants, can be integrated with contract fishing, and eventually other control technologies like microparticles, to further reduce Asian carp abundance in the buffer zone. Intensified surveillance in this zone with advanced telemetry methods (e.g., automated passive receivers, receiver arrays, and satellite-capable transmitters), newly developed techniques for the detection of larval (e.g., NGS and light traps,) and juvenile (e.g., surface trawls; USFWS) life stages of Asian carp will further enhance the efficacy of the existing tactics and inform new ones.

The USGS and its partners have been developing new control and surveillance technologies and information in lab and field studies at Morris and elsewhere to enhance the two existing tactics and inform the development of new ones, and are now poised to assist managers in the deployment of sound, CO₂, feeding attractants and enhanced surveillance techniques in an adaptive and integrated manner to reduce Asian carp abundance in the buffer zone above Starved Rock Lock and Dam. The integration of these new control and surveillance technologies with existing barriers (including the 5 high-head dams in

this reach) and contract fishing has the potential to greatly reduce the density of Asian carp and thus challenges to the electric barriers in the CAWS. This implementation phase of new technologies for containment, control and surveillance in an integrated manner to bolster the efficacy of the two existing tactics and inform developing technologies (e.g., microparticles) will necessarily be adaptive. Adaptive IPM calls for setting specific objectives associated with individual actions (i.e., the applications of integrated controls), and monitoring of appropriate performance measures to allow stringent evaluation of these applications to inform the next round of actions.

In this implementation phase, the USGS and its partners including Illinois DNR, Southern Illinois University, Western Illinois University, USFWS, and others will deploy sound, CO₂, feeding attractants and advanced and intensified surveillance techniques to maximize the efficacy of contract fishing and minimize immigration into and through the buffer zone. Rigorous evaluations of a priori established performance measures will be conducted to determine the efficacy of these integrated tactics to inform future actions. Several applications of these new tools are planned including the use of sound in a lock chamber at one of the high-head dams (e.g., Starved Rock) to deter fish from entering and passing upstream through the dam, the application of CO₂, sound and algal attractants to contain Asian carp at strategic locations and times to facilitate removal or deny them access to critical habitats (e.g., spawning, overwintering or nursery). Integrated and intensified surveillance efforts at strategic locations including 1) telemetry with automated real-time receivers, passive arrays and active tracking and 2) light traps and NGS to supplement on-going surveillance efforts for juvenile Asian carp to inform the applications of adaptive IPM using new and existing tools and tactics.

FY 2015 Actions:

- Completed experimental and control trials using water guns, sound, and CO₂ as barriers in backwater of the Marseilles Pool in Illinois River near Morris, Illinois from May-August 2015. USGS constructed a mock “lock chamber” using block nets to establish a canal (110 feet wide) to test water gun, sound, and CO₂ barriers. A fixed HTI telemetry array was installed with 36 hydrophones (18 on each side of the constructed channel) to track fish through each trial. Block nets were placed at each end of the experimental area (~ 200 m from the center of the constructed channel) to contain fish within the telemetry array. An initial trial without treatments established a need for minimal acclimation period before treatments were initiated. During all trials, 30 Bighead or Silver Carp were tagged with external acoustic transmitters and placed on each side of the barrier (15 fish per side). Fish were allowed to move freely within the experimental array. Length, sex, species, release location, and time of tagging were recorded for each fish.
- Sound barrier trials were conducted in a replicated and paired design from 22 July -1 August 2015. Complex sound (i.e., outboard motor recording) was played from six bi-directional speakers deployed across the middle of the constructed channel equidistant from each other at approximately 3 feet deep. Following the 24-hour sound period, sound was turned off, and the block nets were raised for 24 hours to allow fish to exit the study area. Following this 24-hour period, the block nets were lowered, 30 naïve fish were tagged, placed in the study area and allowed to move freely for 24 hours as a control period. USGS repeated this two additional times for a total of three paired trials (3 sound and 3 control). Sound mapping was conducted over the study area to determine sound intensity throughout the site. Analysis of barrier efficacy is underway for these trials.
- CO₂ barrier trials were conducted from 17 August – 1 September 2015. A Venturi injection system was deployed to disseminate CO₂ across the middle of the channel, into the water. Levels

of CO₂, pH, and other water quality parameters were measured continuously throughout the study. Analysis of barrier efficacy is underway for these trials.

- Watergun trials were conducted in June of 2015 using the same design as the sound trial with a single control and treatment period where guns were fired continuously for 24 hours to assess barrier efficacy. Preliminary analysis from these trials has been completed and shared with partners.
- Completed laboratory trails that demonstrated the efficacy of microparticles to deliver antimycin to Asian carp when mixed with native fishes
- Completed a report describing the integrated pest management operation conducted in FY 2013/2014
- Completed final year of field work for telemetry study on emerging population of Asian carp to inform contracting fishing efforts and the application of developing controls (e.g., CO₂ sound and microparticles).
- Completed preliminary analysis of ambient particle availability by season and habitat type to inform microparticle development and application.
- Completed second year of field sampling for juvenile Asian carp and potential predators to inform surveillance and control measures. This included sites across a gradient of Asian carp abundance.
- Completed first year of pond studies to inform surveillance and control measures for juvenile Asian carp using PIT-tag technology. This included 9 two-week experiments with 12 replicates each.
- Completed tests that confirmed that carp can be conditioned to algal feeding stations to facilitate their capture and that acoustic stimuli has the potential to enhance or deter the efficacy of this approach.
- Initial pond studies integrating feeding stations and microparticle treatments were conducted to inform field applications.

FY 2016 Actions:

- Plan for implementation and obtain permits for the integrated application of new technologies including CO₂, sound, and algal attractants with existing tactics for controlling Asian carp at strategic locations.
- Apply and evaluate the use of CO₂, sound and/or algal attractants at strategic locations and times to facilitate removal of Asian carp or deny them access to critical habitat (e.g., spawning, overwintering or nursery).
- Apply and evaluate the use of sound in a lock approach or at dam gates to prevent upstream movement past the dam.
- Apply and evaluate the integration of advanced and intensified surveillance efforts to inform removal of Asian carp in the upper Illinois River including the use of automated passive receivers, telemetry receiver arrays and gates, light traps, and NGS.
- Complete summary and analysis of 2014/2015 telemetry studies to inform contracting fishing efforts and the application of developing controls (e.g., CO₂ sound and microparticles).
- Complete analysis and publication of 2013/2014 study to assess reproduction of emerging population of Asian carp

- Complete summary and analysis of 2014/2015 field collections of juvenile Asian carp and predators to inform surveillance and control measures
- Complete second year of pond studies to inform surveillance and control measures for juvenile Asian carp using PIT-tag technology.

FY 2017 Actions:

- Continue application and evaluation of CO₂, sound and/or algal attractants at strategic locations and times to facilitate removal of Asian carp or deny them access to critical habitat (e.g., spawning, overwintering or nursery).
- Continue application and evaluation of sound in a lock approach or at dam gates to prevent upstream movement of Asian carp past the dam.
- Continue application and evaluation of advanced and intensified surveillance efforts to inform removal of Asian carp in the upper Illinois River including the use of automated passive receivers, telemetry receiver arrays and gates, light traps, and NGS.
- Complete analysis and publication of adult Asian carp feeding behavior, food availability, movement, and habitat use in relation to surveillance and control tactics for AC.

Expected Milestones:

- Evaluations of new integrated pest management tactics with existing ones to control Asian carp in the upper Illinois River.
- Evaluations of intense and advanced monitoring to inform adaptive IPM for Asian carp in the upper Illinois River.

Outcomes/Output: Recommendations to management agencies on incorporating new tactics and monitoring to control Asian carp in the upper Illinois River using adaptive IPM.

Potential Hurdles:

- Scaling of evaluated technologies to use in field trials.
- Obtaining needed permits/access to conduct field trials.
- Interagency coordination to conduct trials.

28. Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp

Lead Agency: USGS (Upper Mississippi Environmental Science Center; Illinois Water Science Center and Indiana Water Science Center)

Agency Collaboration: Western Illinois University

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$100,000	\$200,000
FY 2017	\$100,000	\$200,000

Project Description: Asian carp are invasive species originating from eastern Asia. They were first introduced to the southern United States in the 1970s as potential control agents for algae in ponds used for aquaculture. Subsequent escape into the wild has resulted in the establishment of invasive populations in southeastern and central regions of the United States. The fish are now poised to invade and potentially establish harmful populations in other ecologically-important systems including the Great Lakes, upper reaches of the Mississippi and Ohio Rivers, and other interior rivers, lakes and reservoirs in the Midwest. In efforts to keep Asian carp from establishing populations in other ecologically-important systems and control Asian carp where they are already established, the USGS and other collaborators are conducting ecological studies on established and emerging populations.

Advanced telemetry technologies have emerged that have great potential to inform control and containment efforts underway in the upper Illinois River and elsewhere. For example, the USGS in Indiana through previous GLRI support has developed techniques to detect wild bigheaded carps (BHC, *Hypophthalmichthys* spp.) that have been surgically radio tagged by university researchers through a system that integrates commercially available telemetry detectors and temperature sensors into several existing USGS streamflow gage sites. The result facilitates the following:

1. Real-time, hourly reporting of total detections and total counts of individual tagged Asian carp through the USGS National Water Information System internet interface (example of site at: http://waterdata.usgs.gov/in/nwis/uv?site_no=03323500).
2. Individual email and mobile phone notifications when total Bighead and Silver Carp detections and counts exceed a user-set threshold can be sent through the existing USGS Water Alert system (<http://water.usgs.gov/wateralert/>).
3. Acquisition, download, and analysis of data on detections of tagged individual Asian carp by researchers and State and Federal managers is accelerated through periodic remote, cellular-modem based data downloads from data loggers at the gage site.

Asian carp data from the USGS real-time sites would accelerate GLRI and State sponsored efforts to respond to and explain adult BHC movement events in the Illinois River watershed toward control measures that separate them from the Great Lakes. The Asian carp data would augment existing collection of quality assurance information on BHC presence from USGS and other use and validation testing of emerging rapid eDNA and microbial tracking methods of detecting BHC. In addition, real-time sites provide the future capability to integrate the data with emerging USGS capability to process and present Asian carp movement information using geographic information system (GIS) based tools.

The USGS will procure, install, and operate for up to three years, (1) three automated receivers annually for 2 consecutive years (6 total) at or near existing USGS stream gage sites in the upper Illinois River to monitor and transmit real-time data on the movements of acoustically tagged BHC and (2) temperature sensors at these sites to indicate thermal conditions favorable to BHC migration. Installation of USGS real-time detectors of acoustically tagged BHC at USGS stream gages in the Illinois River Basin will enable real-time streamflow data to be evaluated in connection with BHC detection. BHC detection data from the real-time sites will be reported on-line at approximately 1-4 hour intervals through the existing USGS National Water Information System NWIS-WEB system (<http://waterdata.usgs.gov/in/nwis/rt>) and archived in that system.

Geolocator tags are another advanced telemetry technology with potential application in the efforts to control and contain Asian carp in the upper Illinois River by providing reliable and easier to obtain (as compared to traditional manual tracking telemetry) location data to assess movement and habitat use at fine temporal and spatial scales. This technology integrates GPS satellite capabilities into standard-sized telemetry tags providing the potential to obtain continuous location data on Bighead and Silver Carp with accuracies of 15 to 75 m. This technology relies on a tethered or direct-attach tag that is capable of downloading positional satellite information to pinpoint the fish. For initial feasibility testing, researchers from Western Illinois University will use tags that store positional information from satellites and allow tracking and data download via VHF radio. Final tag design will allow downloads via Argos satellite and eliminate the need for manual tracking to recover stored positional data. This technology would allow for satellite to internet interface for real-time tracking of bighead carp and Silver Carp. The initial VHF tags will be evaluated in closed ponds or raceways in Fall 2015 to determine the best method for attaching tags to the fish, tag accuracy, transmission efficiency, tag retention, and feasibility of tag recovery. After tag capabilities and attachment methods have been tested and optimized in pond studies, researchers will conduct field trials with 10-12 VHF tags at Hanson Material Services in the Marseilles reach of the Illinois River in Fall 2015 or Spring 2016 (dependent on tag procurement and delivery schedules). Bighead and Silver Carp will be captured and implanted with tags and released. After several weeks, the fish will be manually tracked using VHF radio tracking equipment to recover stored data. Following download attempts, efforts will be made by commercial fishers to capture tagged fish to recover tags for reuse. Following VHF tag testing, a field deployment of an Argos-capable version of these tags will be conducted in 2016-17 to evaluate their capabilities for tracking Bighead and Silver Carp. If all testing phases are successful, researchers will make recommendation regarding the deployment of this technology in an integrated approach with existing and developing control and containment tactics in the upper Illinois River from Starved Rock Pool through Dresden Pool.

FY 2015 Actions:

- Automated real-time telemetry receivers:
 - In consultation with USFWS, USACE, Illinois DNR and Southern Illinois University, USGS identified potential sites for placement of automated real-time receivers to detect tagged Asian carp. Rapid response purpose sites included Brandon Road Dam tailwater and Lockport Pool below electric barrier. Inform removal effort sites included Bulls Island side channel (Starved Rock Pool), below Starved Rock dam, downstream of Dresden Island Lock and Dam, at Hanson Materials backwater entrance (Marseilles Pool), downstream of Hansen Material entrance (Marseilles Pool).
 - Initiated procurement of hydrophones, software, and related supplies.

- Geolocator tags:
 - Completed closed-system evaluation of tag accuracy, VHF capabilities, and optimize tag attachment design.
 - Initiated field evaluation of 10 prototype geolocator tags in Dresden Pool near the mouth of the Kankakee River to monitor Bighead and Silver Carp movement for a test of feasibility.

FY 2016 Actions:

- Automated real-time telemetry receivers:
 - Install and implement real-time telemetry (automated) receivers and temperature sensors at three initial sites in the upper Illinois River to detect and report data on tagged Asian carp.
 - Quality assure system operation of the initial 3 automated receivers offline for up to three months before full rollout to open USGS system.
 - Implement full release of data from the initial 3 automated receivers to open USGS system.
 - In consultation with USFWS, USACE, Illinois DNR and Southern Illinois University, identify additional sites for placement of automated real-time receivers to detect tagged Asian carp as part of IPM in the upper Illinois River.
 - Initiate procurement of hydrophones, software, and related supplies for an additional 3 automated receivers.
- Geolocator tags:
 - Complete field evaluation report of 10 prototype geolocator tags (not satellite capable) in Dresden Pool near the mouth of the Kankakee River to monitor Bighead and Silver Carp movement for a test of feasibility.
 - Initiate initial field trial of 15 geolocator tags (satellite capable) in Dresden Pool.

FY 2017 Actions:

- Automated real-time telemetry receivers:
 - Develop GIS methods to process and periodically report Asian carp movement information to researchers and managers.
 - Install and implement real-time telemetry receivers and temperature sensors at three additional sites in the upper Illinois River to detect and report data on tagged Asian carp.
 - Quality assure system operation of the 3 additional automated receivers offline for up to three months before full rollout to open USGS system.
 - Implement full release of data from the additional 3 automated receivers to open USGS system.
 - Assess effectiveness of automated receivers as part of IPM in the upper Illinois River as part of the IPM template.
- Geolocator tags:
 - Report on initial field trial of 15 prototype geolocator tags (satellite capable) in Dresden Pool.
 - Initiate 2nd field trial of 15 geolocator tags (satellite capable) modified in accordance with recommendations from first field trial.

- Report on success of field trials and make recommendations on whether suitable for full scale implementation as part of Integrated Pest Management in the upper Illinois River.

Expected Milestones (FY 2016-17):

- Automated real-time telemetry receivers:
 - Procure, install and test automated receivers and necessary cables, data loggers and cellular modems. Data loggers, many cables and temperature probes can be procured through existing USGS contracts. Stationary receivers and dedicated cables will require a dedicated purchase. 5-6 months from start (about February 2016).
 - Install access points from bridges. Deploy passive monitors and temperature probes. Transmit data real-time to USGS NWIS system. Post temperature data on-line. Have BHC detections retrievable to researchers from dedicated IP access at their duty stations.
 - Assess effectiveness of automated receivers to inform IPM in the upper Illinois River.
- Geolocator tags:
 - Complete pond and field testing of tags to determine the efficacy of GPS tags to inform IPM in the Upper Illinois River.

Outcome/Outputs:

- Automated receivers:
 - Improve IPM of Asian carp in the upper Illinois River by informing existing control and containment tactics and rapid response.
- Geolocator tags
 - Determine tag design and attachment for optimum retention on Bighead and Silver Carp.
 - Define the efficacy of using GPS tags to monitor Bighead and Silver Carp movement in the upper Illinois River to inform IPM.

Potential Hurdles:

- Automated real-time telemetry receivers:
 - Delays in funding adverse hydrologic conditions (i.e., flooding).
- Geolocator tags:
 - Delays in funding, procurement and delivery of geolocator tags would result in commensurate delays in actions and milestones.

29. Assessing Techniques to Enhance Barrier Characteristics of High-Head Navigation Dams on the Upper Illinois River

Lead Agency: USGS

Agency Collaboration: Illinois DNR, USACE, USFWS, and Southern Illinois University

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$75,000
FY 2017	\$0	\$75,000

Project Description: Minimizing propagule pressure is a key objective or first principal in minimizing the establishment of invasive species in new areas. Further enhancing the barrier characteristics of the “high-head” dams in the upper Illinois River dams via best management practices (BMP) of gate and lock operations, and deterrents in lock chambers would add another measure of protection against Asian carp invasion into the Great Lakes. These practices and deterrents (e.g., sound or CO₂) might come at relatively low cost (installation and operation) and be implementable in relatively short timeframes. Enhancing barrier-characteristics via BMP and relatively low cost deterrents could also be implemented at Brandon Road until the more comprehensive deliberate barrier is complete.

Currently, the electrical barriers located in the CAWS near Romeoville, Illinois are the only deliberate barriers in the Illinois River to keep Asian carp from moving from the Mississippi watershed into the Great Lakes. Additional deliberate barriers are being considered including at Brandon Roads Lock and Dam to provide redundancy to the electrical barriers in the CAWS. Brandon Roads or Lockport lock and dam make tactical sense as a barrier because of their strategic location and existing barrier characteristics (i.e., relatively high head and controlled gate and lock operations). Designing and installing comprehensive barriers like Brandon Roads and the electrical barriers in the CAWs cost tens of millions of dollars and take years to complete. Further, annual operating costs in the form of electricity and personnel for these deliberate barriers run in the millions of dollars and make large numbers of them cost prohibitive.

Below the electrical barrier are 4 other (in addition to Brandon Road) relatively “high-head” navigation dams including Starved Rock, Marseilles, Dresden, and Lock Port. Evidence in the form of continued low abundance of Asian carp in the navigation pools above Starved Rock dam suggests that these other high-head dams in the upper Illinois River might be acting as partial barriers to Asian carp because of their design (i.e., gated, with relatively high head). Further, there has been no evidence of reproduction in the reaches above Starved Rock dam suggesting that the river below Starved Rock dam might be the only source of adult Asian carp in the reaches above that dam. The design of these dams might generally limit Asian carp passage 1) to times when gates are open or submerged during high discharge events or 2) via lock chambers. If the barrier characteristics of these high-head dams under various hydrologic conditions and seasons can be better understood and enhanced with low cost measures, then the number of Asian carp present available to challenge the more comprehensive barriers would be reduced. This in turn would reduce the likelihood of Asian carp getting into the Great Lakes to act as propagules.

To determine if these dams act as barriers and if barrier-characteristics of these dams can be enhanced, USGS will use reach-specific hydrologic data, dam-specific design and operations data, and existing

telemetry data (Southern Illinois University) on Asian carp dam passage to assess under what conditions and how Asian carp are passing through these dams. Alongside or following this assessment, USGS will begin to study whether a combination of best management practices at locks and acoustic or CO₂ deterrents in the approach channel to or in locks can deter Asian carp from entering or using the lock chamber (see IPM template). Field experience (i.e., Silver carp jumping in response to boat motors and both Bighead and Silver Carp fleeing areas being disturbed by fishers) and controlled experiments suggest that sound or CO₂ are effective at deterring Asian carp. This assessment of BMPs and barrier characteristics associated with hydrology will complement or inform sound or CO₂ deterrent application in the approach channel or lock chamber that are being conducted at Starved Rock Dam (most downstream high-head dam) or one of the other high-head dams in the upper Illinois River as part of the IPM template.

FY 2015 Actions:

- Formed and met with a partner collaborative to scope issue, and articulate objectives and methods.
- Obtained preliminary hydraulic information from USACE on Starved Rock and Dresden dams to characterize timing and frequency of open river conditions thought to be necessary for fish passage through gates and inform further request for data to complete the assessment.
- Reviewed pertinent literature on fish passage at navigation dams.

FY 2016 Actions:

- Assemble hydrologic, metrological, and telemetry data into analyzable data set and initiate analysis to determine conditions that deter or permit Asian carp passage though high-head dams on the upper Illinois River.
- Determine standard practices for dam operations and locking vessels upstream through dams.
- Report on analysis of Asian carp passage in relation to hydrologic and meteorological conditions.

FY 2017 Actions:

- Complete summary and analysis of barrier characteristics of high-head dams to inform application of BMPs and deterrent technologies (e.g., CO₂ and sound).
- Report findings at partner meetings, scientific conferences and literature.

Expected Milestones:

- Better understanding of the existing barrier-characteristics of high-head dams on the upper Illinois River and its relationship to the Asian carp life cycle.
- Potential ways to enhance the barrier-characteristics of these high-head dams using BMPs and acoustic deterrents.

Outcomes/Outputs:

- If the source of the Asian carp in the upper Illinois River is from upstream migration rather than reproduction as evidence suggests and the barrier-characteristics of these high-head dams can be enhanced with BMPs and acoustic deterrents, then the overall numbers of adult Asian carp will be reduced. A reduction in abundance of Asian carp in this reach via reduced movement through high-head dams and harvest via contracted fishing will equate to reduced likelihood of challenges to the existing and planned deliberate barriers. This reduced likelihood of challenges to the

deliberate barriers would result in commensurate decreased likelihood of Asian carp propagules in the Great Lakes.

- Reduced Asian carp abundance in the upper Illinois River will also likely act to reduce the chance of successful reproduction in this reach to act as another source of adult Asian carp available to challenge the deliberate barriers.

Potential Hurdles:

- Delayed funding and hiring would result in commensurate delays in initiating and completing project actions and milestones.

45. Field Deployment of Barriers at Brandon Road Lock

Lead Agency: USACE/USGS

Agency Collaboration: USFWS, Illinois DNR, USCG

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USGS	USACE	Total	USGS	USACE	Total
FY 2016	\$0	\$0	\$0	\$450,000	\$450,000	\$900,000
FY 2017	\$0	\$0	\$0	\$900,000	\$380,800	\$1,280,000

Project Explanation: Several potential control technologies are being considered to prevent Asian carp movement through Brandon Road Lock. The USGS has completed laboratory and field-scale tests, but has not deployed technologies in a barrier configuration for long-term testing at an actual working site, which offers additional complexities over the typical field installation testing. This project would allow testing of control technologies in the approach channel of the Brandon Road Lock; CO₂, complex sound and possibly other barrier technologies; for a period of up to 30 days each. This testing would allow the evaluation of deployment configurations, collect operation and maintenance information for longer deployments, and assess fish movement under longer deployments. The testing would also allow for testing on the impact to river navigation because the Brandon Road Lock is a functioning facility. Possible shorter term testing during this project could include evaluation of different approach channel materials, safety issues, and impacts on structures and vessels. Another objective of this project is to provide all potential parties with field experience in the deployment of these ANS control technologies.

Summary of Actions to Date:

- Field scale testing of integrated pest management using CO₂ was conducted at test ponds at the USGS Upper Midwest Environmental Sciences Center, completed in 2014.
- Field scale testing of complex sound was completed at test ponds at the USGS Upper Midwest Environmental Sciences Center in 2014.
- Field scale testing of CO₂, and complex sound were completed under different templates at Morris, Illinois in 2015.

FY 2016 Actions:

- Develop designs/plans for deployment of, complex noise, CO₂ and possibly other technology barriers of up to 30 days in the approach channel at the Brandon Road Lock and Dam.
- Develop plans for supplemental/additional testing of different configurations, materials, safety considerations, and vessels.
- Develop the plan to begin the technology transfer of these technologies from the USGS.

FY 2017 Actions:

- Implement a complex sound barrier for up to 30 days in the approach channel at the Brandon Road Lock and Dam, or longer depending on cost, weather, and logistical considerations. Collect fish movement, and other data as relevant and identified during the designs/plans developed FY 2016.

- Implement a CO₂ barrier for up to 30 days in the approach channel at the Brandon Road Lock and Dam, or longer depending on cost, weather, and logistical considerations. Collect fish movement, structural, and other data as relevant and identified during the designs/plans developed in FY 2016.
- Provide USACE and other parties with field experience in the deployment of these ANS control technologies.

Expected Milestones:

- Development of designs/plans for the long-term deployments by October 31, 2016.
- Field deployment of both technologies for up to 30 days each by October 30, 2017.

Outcomes/Outputs:

- Long-term deployment information for two technologies currently under development.
- Two USGS and one USACE report documenting the effectiveness, design considerations and other information.
- Considerations for future larger-scaled design and deployment will be highlighted.

Potential Hurdles:

- Timeliness of funding with respect to field testing schedule.
- NEPA evaluations.
- Coordination with navigation and real estate.
- CO₂ storage locations and cost.
- Regulatory permitting.

53. Use of Complex Sound to Alter Behavior of Asian Carp

Lead Agency: USGS

Agency Collaboration: USFWS, University of Minnesota-Duluth

Funding Tables:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$200,000
FY 2017	\$0	\$0

Project Description: 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 electric barrier. This barrier has been found to be less effective on small fish and its' effectiveness is dependent on water quality so additional barriers and/or supplements to the electric barrier are highly desired. The use of multiple barrier technologies would improve the efficacy of deterring Asian carp movement into the Great Lakes through redundancy and create a 'buffer zone', which should offer greater confidence in their containment.

Some work has been done to identify potential biological and physical techniques that are candidates for barriers that may serve to deter the movement of Bighead Carp and Silver Carp while allowing for shipping to continue. One candidate barrier that has received a great deal of attention has been the use of complex sound. Previous studies have indicated that both species react negatively to sound. These studies have indicated that the Asian carp will repeatedly respond to complex sound while many native fish respond little to that same sound, but some basic questions still need to be answered. For example, no studies have assessed whether Asian carp can hear high frequencies that are outside of the hearing range of most native fishes. Nor has the optimal sound level been determined to ensure minimal to no damage occurs with the deployment of an acoustic barrier. Therefore, the goal of this project is to determine the optimal sound frequencies and amplitudes to optimize repulsion while preventing injury to native species.

FY 2016 Actions:

- Test effectiveness of acoustic stimuli for excluding Asian carp from preferred habitats and driving them to target locations for increased removal.
- Build on 2015 sound research to focus acoustic stimuli for excluding Asian carp from preferred habitats.
- Determine the potential long-term habituation of Asian carp to sound stimuli.
- Conduct trials to determine the synergistic and/or compensatory effects of CO₂ and sound used in tandem.
- Conduct sound trials using alternate configurations of speakers and sounds to deter Asian carp passage at locks and dams.
- Determine the high-range hearing capacity of Silver and Bighead Carp to identify the optimal range for enhancing the effectiveness of sound barriers.

FY 2017 Actions:

- Analyze data and write reports/manuscripts.

Expected Milestones:

- Identification of the hearing capacity of Asian carp.
- Determine if Asian carp habituate to sound.
- Identify the optimal frequency for efficacy.
- Identify a configuration of speakers to enhance efficacy of sound to deter Asian carp.

Outcomes/Outputs:

- Understanding of how to integrate sound to alter the behavior of Asian carp and to enhance existing controls for Asian carp.
- Recommendations to management agencies on operating conditions to establish deterrent barriers or mobile herding systems.

Potential Hurdles: Scaling of evaluated technologies to use in field trials.

54. Hot Water and Ozone Use for Lock Treatment

Lead Agency: USGS and USACE

Agency Collaboration: USFWS, The Nature Conservancy

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$70,000	\$300,000
FY2017	\$25,000	\$100,000

Project Description: Many interest groups desire to stop the two-way movement of all Aquatic Invasive Species (AIS) through CAWS from Lake Michigan, as well as from the Illinois River. One option under consideration is to develop a lock treatment process that stops AIS from entering (and moving through) the CAWS, while at the same time not unduly impeding the movement of barges and other boat traffic between Lake Michigan and the Mississippi River. Treatment of locks or approach channels to locks is one option that potentially could be implemented in a relatively short time. Initial discussions have favored the idea of establishing measures centered around the locks at the upper (O'Brien) and lower (Brandon Road) end of the CAWS to create one way barriers that together would prevent movement of organisms into and through the canal system. This project will evaluate the potential to use chemicals to effect control of aquatic invasive organisms that might be associated with vessels during locking activities.

The USGS Upper Midwest Environmental Sciences Center (UMESC) conducted a literature review and developed a preliminary evaluation of potential treatments that could be used to kill AIS present during locking operations. Based on available data concerning effectiveness, environmental impacts, human safety, availability, impacts to vessels and structure, and regulatory issues, the initial screen suggested that hot water and ozone are the options most likely to meet the stated objectives. Testing to better define the necessary contact times and to determine the range of taxa that could be controlled needs to be conducted. UMESC will develop the methods and conduct the necessary toxicity trials to provide the data to evaluate the use of hot water and ozone for lethal AIS control in lock operations.

FY 2015 Actions:

- Developed protocols and study plans for conducting toxicity tests on hot water and ozone.
- Conducted initial assessment of engineering requirements for hot water and/or ozone.
- Initiated sourcing of representative test organisms for each of the different taxa to be tested.

FY 2016 Actions:

- Develop husbandry methods for taxa and life stages (representative selected species of amphibians, crustaceans, fish, mollusks, phytoplankton, and zooplankton) of interest as needed.
- Conduct toxicity tests on hot water and ozone, singly and in combination, against a broad range of taxa and life stages to determine effectiveness.
- Assist with transfer of technology for the development of engineering designs.
- Provide regulatory affairs support for registration of treatment technologies.
- Prepare summary report on test results.

FY 2017 Actions:

- Conduct toxicity tests with hot water and ozone, singly and in combination, on a broad range of taxa and life stages to determine effectiveness.
- Assist with transfer of technology for the development of engineering designs.
- Provide regulatory affairs support for registration of treatment technologies.
- Prepare summary report on test results.

Expected Milestones:

- Determination of concentrations and contact times for hot water, ozone, and hot water-ozone combinations.
- Determination of the range of taxa and life stages that can be controlled by these options.
- Registration of treatment technologies.

Outcomes:

- Information technology transfer to support the development of lock treatment technologies.
- Chemicals for control of AIS during locking operations.

Potential Hurdles:

- Availability of taxa and life stages and development of husbandry techniques to provide organisms of consistent quality for testing.

55. Other Program Support

Lead Agency: USGS

Agency Collaboration: USACE, USFWS, Southern Illinois University, UIUC, Purdue, State Departments of Natural Resources or Fisheries

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$10,000	\$40,000
FY 2017	\$10,000	\$0

Project Explanation: As new control technologies have and will be developed to control and monitor the Asian carp, such as CO₂ barriers, food cues, and microparticles, results will need to be communicated to managers responsible for implementing the control technologies. The USGS will communicate these results through coordination of site visits to demonstrate how technologies are applied, focused meetings with partners, and production of fact sheets, publications, and other information. USGS will coordinate the communication approach across multiple projects to most efficiently demonstrate technologies and get the information to the stakeholders and managers.

Summary of Actions to Date:

FY 2015 Actions:

- Drafted a fact sheet with an overview of USGS Asian carp science.
- Continued to engage in the Chicago Area Waterways Advisory Group on how USGS Asian carp control technologies can be used to reduce the risk of spread into the Great Lakes.

Proposed Actions:

FY 2016 Actions:

- On-site demonstration of control technologies.
- Ongoing technology transfers or informational meetings for state and other partners through webinars and/or workshops.
- Updates to USGS website summarizing project progress.
- Potential focused science/resource managers meeting in late summer 2016 organized by USFWS and USGS.

FY 2017 Actions:

- On-site demonstration of control technologies.
- Ongoing technology transfers or informational meetings for state and other partners through webinars and/or workshops.

Expected Milestones:

- Publish factsheet on USGS Asian carp control science efforts including highlighting on asiancarp.us and the USGS GLRI website.
- Hold an Asian carp science/resource managers meeting to discuss management issues and to communicate and discuss technologies and research that may help address those issues.

Outcomes/Outputs:

- Greater understanding of Asian carp control technology for the management community.
- Interaction between scientists developing technologies and the expected technology users.

Potential Hurdles: Partners have limited travel budgets to travel to on-site demonstrations.

56. Black Carp Control, Bait, and Attractant Use

Lead Agency: USGS Columbia Environmental Research Center

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$150,000
FY 2017	\$0	\$150,000

Project Explanation: Black Carp captures in the Illinois and Middle Mississippi rivers have increased substantially in recent years, and almost all of the captured fish have been diploid (fertile). Otolith stable isotope data indicates that these fish are the result of natural reproduction in the Mississippi River Basin. Age and growth data from captured fish indicates that they are growing extremely rapidly and maturing at younger ages in the Mississippi River than has usually been reported in wild populations. Although little information exists on the diets of Black Carp outside of aquaculture, they are considered to be primarily molluscivores. North America has the largest diversity of freshwater mussels in the world, and a majority of the species are threatened or endangered. Black Carp are gape-limited predators, but equipped with enormous crushing molars, and are thought to be able to crush and consume any mollusk that can be taken into the mouth. Because Black Carp are the largest of the four “Asian carp”, reaching sizes of greater than 70 kg, nearly any native mollusk could be consumed, even at adult sizes. A single Black Carp could eradicate all of an endangered species within a given small population in a single year. For these reasons, Black Carp are considered to be a serious threat to native mollusk populations. The intention of this project is to develop an efficacious bait for Black Carp that could be used to protect endangered mussels, but have little potential effect on native fishes or the public.

Summary of Actions to Date:

This is a new project, but CERC has been working with the USFWS and Southern Illinois University to process Black Carp captured by commercial fishers to generate age, growth, and diet information, to provide parts of fish to collaborators for determination of ploidy, source, maturity and gonad histology, and to archive samples for potential future genetic work.

Proposed Actions:

The goal of this project is to develop a bait specific to Black Carp, capitalizing on its propensity and ability to consume large, hard objects, such as unionid mussels, and the unique crushing ability of the Black Carp teeth. One option would be to deploy a hollow bead filled with a toxicant such as antimycin. The bead would be consumed along with the bait, and crushed by the molars in the Black Carp’s throat, releasing the toxicant. The bead could be glued to the shell of a live mollusk or contained within an artificial hard bait that is attractive to Black Carp. Such baits would pose little risk to native species, because few if any native species could consume the large, hard, bait, or be able to crush the toxic bead. If deployed in trays from which a live bait could not escape or from which an artificial bait would not wash out, uneaten baits could be retrieved. Toxic baits could be deployed in areas where endangered mollusks are threatened by Black Carp, or could be deployed as a rapid response or even a prophylactic to Black Carp detections or releases. Markers for eDNA detection for Black Carp are under development. If Black

Carp eDNA is detected in the vicinity of endangered mussels, baits could be deployed to protect the endangered species, with little risk to those species or other native organisms.

Despite the simplicity of this strategy, there are many hurdles which must be surmounted before the bait could be deployed. A toxicant must be selected, and the susceptibility of Black Carp to an oral dose of the toxicant must be determined. An acceptable method of encapsulating the toxicant in a bead that has the desired level of strength/fragility must be developed, as well as confirming that the bead can remain affixed within or on the bait. Because little is known about the diets selected and preferred by Black Carp in the wild, studies of diet selectivity must be performed. A method is required to deploy the baits in a manner in which Black Carp will feed on them, but from which the baits will not escape or wash out. If live baits are to be used, it will be necessary to use organisms resident in the locations where bait is deployed (to avoid introduction of unwanted species); therefore, it may be important to determine diet selectivity of Black Carp based on guilds of organisms or organism characteristics, rather than individual species. Lastly, Black Carp research will be most easily performed in states where Black Carp are currently in use in aquaculture, because of Lacey Act restrictions and because many or most states might object to the use or culture of live Black Carp within their boundaries.

FY 2016 Actions:

- It is assumed that funding will not be available until most of fiscal 2016 has passed, but if funding was made available earlier, some listed 2017 activities might be accelerated into FY 2016.
- Establish agreement with aquaculturist in Arkansas to work with Black Carp in Arkansas facility. At least one aquaculturist has verbally agreed to work with us on this project if paid for the facility use and for fish used in the research, but contract would have to be finalized. A less attractive alternative would be to perform certain parts of this research in China, where Black Carp are native, with Chinese collaborators who are also interested.
- Design and begin tests of oral toxicity of rotenone and antimycin to Black Carp of two different sizes.
- 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. Using molecular methods on gut extracts, attempt to increase available information on Black Carp diets, beyond that which is available from extremely limited numbers of collected fish still containing food in the gut.

FY 2017 Actions:

- Complete trials of oral toxicity of piscicides to Black Carp.
- Begin trials of food item selection using Black Carp.
- Design and test beads for delivery of toxicant.
- Begin tests of food item scents for attractiveness to Black Carp.
- Design and test trays for efficacy in retention of bait and acceptability as feeding stations to naïve Black Carp.
- 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. Using molecular methods on gut extracts, attempt to increase available information on Black Carp diets, beyond that which is available from extremely limited numbers of collected fish still containing food in the gut.

Expected Milestones:

- Submit paper on oral toxicity of rotenone and antimycin December 2017.

Outcomes/Outputs:

- The expected product would be a 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.

Potential Hurdles:

- Availability and efficacy of the delivery vehicle (most likely a glass or plastic bead).
- Regulatory hurdles in deployment of the developed bait.
- Unknown difficulties in development of artificial baits that are attractive to Black Carp.

30. Enhanced Monitoring Above and Below Electric Barriers

Lead Agency: Illinois DNR

Agency Collaboration: Illinois DNR, USACE, and USFWS worked continually and extensively on the creation of the MRRP and monitoring efforts and plans.

Funding Table

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$1,350,000
FY 2017	\$0	\$1,950,000

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 the following:

- 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 larval and small fish detection and evaluation in upper Illinois Waterway, 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 is able to 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.
- Continue to statistically evaluate monitoring program and evaluate for efficiencies in program, gears, and coordination of efforts.
- Specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement, in part identified in the Great Lakes/Mississippi River Interbasin Study (GLMRIS) and support decision making processes in developments of alternative and/or additional measures. These efforts will include collaboration with other projects, including:

- Telemetry efforts.
- Floy tagging efforts.
- Hydro-acoustic/side scan sonar efforts.
- Traditional and contracted monitoring 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.
- 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 to support response exercises, capacity, and communication to further prevent establishment of Asian carp in the Great Lakes.
- Support ACRCC and MRWG efforts, outreach, reports, and communication of results to partners, public, and other interested parties.
- Lead role in development/updates of multiyear MRP based on results and findings of ongoing efforts as necessary.
- Implementing Integrated Pest Management Strategies which will include implementation of the Chinese Unified techniques observed in fall 2015 at least one Upper Illinois River backwater.

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.

FY 2016-17 Actions:

Fixed Site Monitoring Upstream of the Dispersal Barrier

These activities will continue in 2016-18 at the same level in past 2 years. Seasonal Intensive Monitoring (as called in the 2015 MRP) 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 seasonal intensive monitoring activities, including pulsed DC-electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets and Great Lake pound nets to detect, capture and subsequently remove any Asian carp present. To date, only 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 2016 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 (Figure 6). Fixed and random site electrofishing will take place bi-weekly from March through November. Contracted commercial netting will take place bi-weekly from March through December, except during June and September, and will include four fixed sites and 13, 13, and 24 random sites in the Lockport, Brandon Road, and Dresden Island pools, respectively. Provide monitoring of lower Kankakee River, which drains into Dresden Island Pool to provide information on life stages within river. Contracted commercial netting in the Marseilles pool will occur at four fixed sites and four random sites. Effort in the Marseilles pool will remain the same as effort in 2013.

Young-of-Year and Juvenile Asian Carp Monitoring

As in the past, 2016-2017 sampling for young-of-year 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 2016 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, and their relative abundance in the Upper Illinois Waterway would 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 Monitoring and Response Workgroup Partners are developing an updated response decision support matrix to further outline emergency response actions, as well as situational awareness and concerns throughout the agencies working as part of this Action Plan. This updated plan is to be included in the 2016 Monitoring and Response Plan and be shared and vetted with ACRC partners from fall 2015 – spring 2016.

IDNR contracts with a small set of commercial fishing crews as responders. These responders will fish during Seasonal Intensive Monitoring events, but also can be deployed to maximize removal efforts with any of the commercial tools, including seines up to ¾ mile long as IDNR 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 Maintenance Fish Suppression

The IDNR will work with federal and local partners to remove fish >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 >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.

Expected Milestones:

- Throughout 2016-17: Evaluation of threat in CAWS both above and below the electric barrier system.
- Throughout 2016-17: Maintain high level of surveillance and increase efficiency and information from surveillance efforts.
- Throughout 2016-17: Contract commercial fishing surveillance in the CAWS both above and below the electric barrier system.
- Throughout 2016-17: Application of new gear into surveillance as warranted.
- Throughout 2016-17: Monthly reporting of monitoring results to www.asiancarp.us and informing ACRCC partners.
- Throughout 2016-17: MRWG meeting to share and communicate significant findings as well as identifying needs to modify or update current monitoring plans as needed.
- 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 (< 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).

New Actions in 2016-2017:

- Development of updated Decision Support Matrix to better communicate response actions across multiple agencies to be completed and included.
- Updating communication strategy and materials using contracted and agency personnel in coordination with other ACRCC and MRWG partners to best share information and updates.
- Provide monitoring and evaluation of the lower Kankakee River watershed to best characterize carp life stages that may be present.
- Working with USGS and Contract fishers project will seek increased Integrated Pest Management Strategy, specifically characterizing a new Chinese fishing method (Unified method) in target areas of Marseilles Pool and seeking to integrate mobile, electric barrier as practicable in these efforts.

31. Illinois River Stock Assessment/Management Alternatives

Lead Agency: Illinois DNR

Agency Collaboration: Southern Illinois University, Feeding Illinois

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2015	\$0	\$300,000
FY 2016	\$0	\$300,000

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 2014, 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.

This project encompasses multiple studies with the goal of determining estimates of Asian carp abundance, biomass, size structure, demographics (e.g., growth and mortality), natal origin, and rates of hybridization 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 2014 the project will specifically gather information around several known bottlenecks (Brandon Road, Lockport, and Starved Rock lock and dams) to prevent upstream movement as noted in prior year's work, and in part identified in the Great Lakes/Mississippi River Interbasin Study (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. 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.

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.

FY 2016-2017 Actions:

- 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. (2016-2017)
- 2015 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 Great Lakes/Mississippi River Interbasin Study (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.

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-passing bottlenecks.

Expected Milestones:

- Population estimate 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.
- Identify areas of control.
- Identify areas 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 Illinois Waterway.
- 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.

New Actions in 2016-2017:

- Efforts will be heightened in 2016 to evaluate fish passage at Starved Rock Dam during high water events (what if any operational techniques can slow this immigration?).
- Heightened evaluation of fish populations below Brandon Road Lock and Dam.

32. Contract Fishing for Asian Carp Detection and Removal

Lead Agency: Illinois DNR

Agency Collaboration: USGS during Integrated Pest Management field trials.

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$1,400,000
FY 2017	\$0	\$1,200,000

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.

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.

FY 2016 – 2017 Actions:

Barrier Defense Asian Carp Removal Project

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 Dispersal Barrier. 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 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.

Efforts will be heightened in 2016 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.

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

Expected Milestones:

- Throughout 2016-17: 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 Illinois Waterway annually.
- Deploy seines to maximize removal at least 10 times annually.
- Maintain or further reduce estimated Asian carp populations in Dresden Island Pool using hydro-acoustic efforts to aid in this assessment.

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).

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.

New Actions in 2016-2017:

- Efforts will be heightened in 2016 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.

33. Interim and Long-Term Strategy and Tactics Development at Starved Rock

Project was not funded in 2016.

34. Reducing the Risk of Asian Carp Upstream Movement: Applying Improved Fishery Gears and Designs at Brandon Road

Project was not funded in 2016.

35. Use of Improved Gear and Novel Designs at Brandon Road

Lead Agency: Illinois DNR

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$350,000
FY 2017	\$0	\$150,000

Project Explanation: Current research is evaluating netting and capture technologies that can capture or increase capture efficiencies within the CAWS or specific habitats within the CAWS. A working group of net makers, fisheries biologists, Great Lakes and riverine commercial fishers, and hydro-acoustic and pheromone experts has developed several tools/items of gear to use in the CAWS and Illinois Waterway. Deep panel gill nets, large hoop nets (6 feet), and Great Lakes style pound nets are currently being evaluated as appropriate gears that increase our ability to detect Asian carp in the CAWS and upper Illinois Waterway. Additional locations and gears, as well as combination of gears and fine-tuning is ongoing to further increase detection rates of Asian carp. Pheromone research by cooperating agencies have identified some baits and lures that also may aid in capture of Asian carp, these tools may be implemented as available. Through these efforts gears can be fine-tuned and recommended for full implementation and inclusion in response, removal, or monitoring efforts. In particular, downstream of Brandon Road Lock and Dam has been identified as a location where increased efforts should be focused. This project will assist in further customizing gears for this specific area as well as other areas to fully implement gears with highest efficiency throughout MRP areas and activities as appropriate. This may also replenish appropriate gears as needed to achieve MRP objectives.

Additional emphasis on small fish detection will occur in 2016 with detection rates of small fish (< 6 inches in upper Illinois Waterway during 2015. Increasing surveillance in mouth of Kankakee with multiple gears and increasing frequency of sampling by the INHS crews. Efforts will be coordinated with USFWS small fish sampling crews to facilitate comparisons of efforts to maximize ability to detect and characterize this life stage.

Water content/chemistry still appears to be restricting carp upstream movements, thus analysis of stress genes by INHS can determine where the fish are experiencing push back from the environmental conditions regardless of habitat, chemical, or other factors. Such analysis by University of Illinois will then be offered to USGS and others to focus in on geographical area and chemically assess what, if anything, may be restricting/stressing fish or fish movement. If significant stressors are identified, actions can be taken to take advantage of this stressor/fish sensitivity to heighten fish repelling or minimally assure that Illinois DNR is aware of the relationship.

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.

FY 2016-2017 Actions:

- Will fish pound nets in new locations and deploy in novel ways to increase catches where carp are present, as well as implement mobile electric barrier when available for trial and assessment.
- Pound nets designed for new areas will be evaluated.
- Maintaining novel gears.
- Testing novel gears (Mamou and Paupier nets) in Illinois Waterway 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.
- Expand small fish detection work in response to immigration from downstream to further inform on abundance source.
- Evaluate plausible stressors in range expansion to Asian carp by documenting stress gene activation in upper IWW.
- Evaluate newly procured mobile (Spring 2016), electric barrier and deploy to evaluate efficacy and uses.

Expected Milestones:

- Demonstrate additional gears to use in upper Illinois Waterway where fish are rare.
- Demonstrate additional gears to use in lower Illinois Waterway where fish abundance is high.
- Construct total list of gears, specifications, and sources to share with partner agencies.
- Demonstrate mobile electric barrier in Illinois Waterway.

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.

New Actions in 2016-2017:

- Receipt and deployment of a mobile, electric barrier system.
- Evaluation of mobile, electric barrier system.
- Increased emphasis on small fish gears and efficiencies.
- 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.

36. Assessing the Distribution of *Apocorhium lacustre* in the Chicago Area Waterway System

Project was completed in 2016.

37. Community Action Initiatives to Increase Awareness, Surveillance, and Enforcement of Unlawful Live Asian Carp

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

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$300,000
FY 2017	\$0	\$300,000

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 (Action Item 2.7.1). 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.

IL DNR staff and Conservation Police Officers 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. Conservation Police officers (CPOs) will also be tasked with ensuring adherence to other laws and regulations by commercial fisherman.

Interpretive materials will be developed for distribution to increase awareness of enforcement and additional outreach materials will be important for non-English speaking business owners and consumers.

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. The following activities will occur:

Urban Fishing Pond Surveys:

- Thirty-two Bighead Carp have been removed from five Chicago area ponds using electrofishing and trammel/gill nets since 2011.
- Sampled four ponds with electrofishing and trammel/gill nets during 2013.
- Estimated 165 person-hours were spent sampling Chicago area ponds in 2013.
- Sampled 179 fish representing 5 species and 1 hybrid group.
- Six Bighead Carp were removed from Humboldt Park and Flatfoot Lake; a replica of the carp from Flatfoot Lake has been made for outreach and educational events.

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.

FY 2016-17 Actions:

- In 2016 and subsequent years 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:

- Develop outreach and interpretive materials for businesses and consumers for awareness.
- 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.

Outcomes/Outputs:

- Develop outreach and interpretive materials for businesses and consumers for awareness.
- Increase enforcement and establish expectations regarding live fish sales in Illinois.
- Increase 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 ANS movement and enforce regulations.

Potential Hurdles:

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

38. Killbuck Creek Pathway Closure Assessment

Lead Agency: Ohio Department of Natural Resources (Ohio DNR)

Agency Collaboration: Ohio DNR, Natural Resources Conservation Service (NRCS), Medina County Soil and Water Conservation District (Medina SWCD)

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$150,000
FY 2017	\$0	\$1,000,000

Project Explanation: Closure of the AIS pathway at LKC

Summary of Actions to Date: The Great Lakes and Mississippi River watershed divide was assessed under the USACE Great Lakes Mississippi River Interbasin Study (GLMRIS) to determine if there were viable pathways for the transfer of AIS. The GLMRIS Aquatic Pathway Assessment Report developed by the USACE for the LKC connection determined the risk for the transfer of AIS between both the Mississippi River and the Great Lakes basins. For the movement of AIS between the Mississippi River Basin and the Great Lakes Basin, this connection was rated a medium risk for the transfer of Silver Carp, Silver Carp, Black Carp, inland silverside, and northern snakehead and a low risk for the transfer of skipjack herring. For the movement of AIS between the Great Lakes Basin and the Mississippi River Basin, this connection was rated a medium risk for the transfer of three spine stickleback, ruffe, tubenose goby, parasitic copepod, and viral hemorrhagic septicemia and a low risk for the transfer of European fingernail clam and European stream valvata.

The Ohio DNR has facilitated numerous meetings with the Medina SWCD, NRCS, and the main landowner. Following is a timeline of the meetings and activities:

- November 19, 2012: Ohio DNR met with the Medina SWCD and the local NRCS representative to discuss the LKC GLMRIS study.
- September 19, 2013: Ohio DNR, Medina SWCD, and NRCS met with the primary landowner (Dewey Hall) to discuss the LKC GLMRIS study and the alternatives for closure (other land uses, non-structural alternatives, and structural alternatives).
- November 25, 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 14, 2014: NRCS developed preliminary alternatives for structural closure. These alternatives were discussed on March 17th, 2014. The two alternatives are to improve the current dike system or construction of a new dike along the historical watershed boundary.
- February 24, 2014: As part of the Governors State-of-the-State speech in Medina County, Ohio, the Ohio DNR Director met with the primary landowner and media to discuss the project.
- March 17, 2014: Ohio DNR met with Medina SWCD and NRCS to discuss the NRCS alternatives.

- April 24, 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. The primary land owner is open to further discussion of the closure options and it was decided that Ohio DNR would conduct a preliminary analysis of the options and mitigation for impacts to farming operations.
- October 1, 2014: Kabil Associates was selected to conduct a preliminary investigation of closure options at LKC. This study will be used to narrow down the closure options so that a final engineering study can be completed.
- September 30, 2015: Kabil Associates will complete the preliminary design for closing the LKC connection.

FY 2015 Actions:

- September 2015: Kabil Associates will complete the preliminary design for closing the LKC connection.

FY 2016 Actions:

- October 2015: Ohio DNR will meet with the primary landowner and other PAIs to evaluate and determine the preferred alternative for closure. This alternative will be based on cost and potential impacts to local landowners.
- April 2016: Ohio DNR will contract with a consultant to develop final design plans for closure, including mitigation of impacts to the local landowners (ex. loss of production, changes to irrigation) using current GLRI Action Plan funding (F13AP00884 - \$250,000.00 and F15AP00874 - \$96,117.00) and an additional \$150,000 in FY2016 funding.
- September 2016: Ohio DNR anticipates having 50 percent plans developed during this time period.

FY 2017 Actions:

- February 2017: Ohio DNR anticipates having final plans developed and will work on permitting and final planning for the project during this time period.
- March 2017: Once the final engineering design is complete, Ohio DNR will facilitate a meeting with the Potentially Affected Interests (PAIs) to present the connection closure alternative(s) and the preferred path forward for closing the connection.
- September 2017: Using the preferred alternative design generated by the consultant, Ohio DNR will select a contractor to complete closure actions for the LKC.
- September 2017: Ohio DNR will secure the necessary permits for the project.

Expected Milestones:

- September 2015: Consultant completes preliminary assessment of the closure options.
- February 2017: Final closure design will be completed and Ohio DNR initiate outreach, permitting and closure work.

Outcomes/Outputs: Closure of the LKC connection to the movement of AIS between the basins.

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

39. Ohio-Erie Canal Pathway Closure Assessment

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

Agencies Collaboration: Ohio Department of Natural Resources (ODNR)

Funding Table:

Funding	Agency Funding			GLRI Funding		
	USACE	ODNR	Total	USACE	ODNR	Total
FY 2016	\$0	\$0	\$0	\$258,000	\$292,000	\$550,000
FY 2017	\$0	\$0	\$0	\$1,050,000	\$0	\$1,050,000

Project Explanation: Closure of the Aquatic Invasive Species (AIS) pathway at the OEC

Summary of Actions to Date: The Great Lakes and Mississippi River watershed divide was assessed under the USACE Great Lakes Mississippi River Interbasin Study (GLMRIS) to determine if there were viable pathways for the transfer of AIS. The GLMRIS Aquatic Pathway Assessment Report developed for the OEC connection determined the risk for the transfer of AIS from the Mississippi River Basin to the Great Lakes Basin as a medium risk for Silver Carp, Bighead Carp, Black Carp, and northern snakehead and low for skipjack herring.

- February 2013: Ohio DNR met with the City of Akron to discuss the Aquatic Pathway Assessment Report. The Ohio DNR and the USACE discussed the two primary areas of concern:
 - The direct transfer of water from the Mississippi River Basin to the Great Lakes Basin at the feeder gates that transfer water from Long Lake to the OEC.
 - Flooding at the tow path that allows water to move from the Mississippi River Basin to the Great Lakes Basin.
- October 2013: Ohio DNR facilitated funding for the USACE to conduct a preliminary assessment of closure options at OEC.
- March 2014 – August 2015: Ohio DNR has met with USACE on numerous occasions to discuss closure options and determine a path forward.
- September 2014: USACE completed the preliminary closure assessment in September 2014 and identified six connection points at the OEC as presented in the “Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures” (September 30, 2014).
- September 29, 2014: The array of options for closure was presented to the Ohio DNR.

FY 2015 Actions:

- Ohio DNR provided comments and direction with respect to USACE’s “Ohio-Erie Canal Aquatic Nuisance Species Control Conceptual Design Measures”. USACE received FY2015 GLRI funding to complete the assessment of closure options with 100% design plans and finalized cost for closure implementation. The USACE will be the lead agency for the FY2015 assessment work which will be completed by September 30, 2016.
- Ohio DNR met with the USACE on August 20, 2015 to discuss the final closure design. The USACE identified a potential alternative to the primary closure option at a low head dam downstream of the connection on the Tuscarawas River at Massillon, Ohio. The USACE will conduct further investigation of this site to determine if it is a viable option. If viable, they will

develop a 50% design for the Massillon location and develop 100% design at the OEC location for the top areas of concern using FY 2015 Framework funds (\$400,000). If the Massillon connection is determined not viable as a result of the preliminary evaluation, the USACE will concentrate on the primary closure option at the Ohio Erie Canal.

FY 2016 Actions:

- June 2016: During the USACE final engineering process, the Ohio DNR and USACE will facilitate a meeting with Potentially Affected Interests (PAIs) to present the connection closure alternative(s) and the preferred path forward for closing the connection.
- September 30, 2016: Final engineering design will be completed.
- October 1, 2015 - September 30, 2016: Ohio DNR and USACE will work with Ohio DNR Engineering on design and implementation of replacement/repair of Long Lake Flood Gates.
- October 1, 2015 - September 30, 2016: Ohio DNR and USACE will work on permitting, outreach, and implementation of closure options when they are actionable.

FY 2017 Actions:

- October 1, 2016 – September 30, 2017: USACE and ODNR will work on project permitting and closure construction.

Expected Milestones:

- September 30, 2016: USACE completion of 100% design plans for closure alternatives.
- June, 2016: Ohio DNR /USACE to present options to PAIs including the preferred alternative and complete permitting for the closure.

Outcomes/Outputs: Closure of the OEC to the movement of AIS between the basins.

Potential Hurdles: Development of a separation option that prevents the movement of AIS across the basin divide; is acceptable the PAI's; and satisfies State Historic Preservation Office requirements.

59. Development of Grass Carp Response Capabilities in Ohio

Lead Agency: Ohio Department of Natural Resources (Ohio DNR)

Agency Collaboration: Michigan Department of Natural Resources (Michigan DNR); USGS and USFWS

Additional agency supporters: Pennsylvania Fish and Boat Commission, New York Department of Environmental Conservation, Ontario Ministry of Natural Resources and Forestry

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$0	\$180,000
FY 2017	\$0	\$100,000

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 (pers. comm. Roger Knight, Ohio DNR). However, due to the presumption that these fish were likely escapees from the permitted triploid Grass Carp stockings in the Lake Erie drainage basin, poor records of occurrence have been kept. For example, the Nonindigenous Aquatic Species Database only details eight captures of Grass Carp prior to 2011, however, Ohio DNR, Division of Wildlife fisheries staff recalls years prior to 2011 when multiple Grass Carp were handled from both recreational and commercial fisheries.

Recently, documented reports of Grass Carp have increased in the Lake Erie system in all jurisdictions. The increase in documented reports has led to the perception that Grass Carp populations are increasing. Even with the increase in documented reports, Grass Carp are likely under-reported as several annual reports of Grass Carp occur post-annual reporting. Reproductive status of individuals prior to 2011 was unknown, but as described previously they were presumed triploid and thus sterile.

In 2011, because of the increase in documented reports of Grass Carp in Lake Erie, Ohio DNR, Division of Wildlife staff began collaborating with researchers from the University of Notre Dame and The Nature Conservancy to explore the risks, frequency, distribution, and ploidy status of Grass Carp captured in the Great Lakes Basin, and developed initial eDNA surveillance for Grass Carp (Wittmann et al. 2014). Since 2011, Michigan DNR and Ohio DNR staff initiated other activities in an attempt 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. This exercise resulted in the collection of two Grass Carp, using assets from ten agencies (60 personnel)

to administer 96 hours of electrofishing effort, 59 hours of gillnet soak time, seven trap net lifts, and three commercial seine hauls.

Results of the above activities have been useful and suggest several things to Ohio DNR regarding targeted response efforts including:

- Grass Carp continue to exist in Lake Erie at low abundance levels (if invasion is occurring, they are very early in the invasion curve).
- Multiple agencies can effectively implement a broad or targeted response action while preserving staff health and safety.
- Existing information is not adequate to affect meaningful actions for control/eradication.
- New information from on-going and proposed research will be critical to help further inform the spatial and temporal scale of actions that can lead to potential effective control/eradication efforts for Asian carp in Lake Erie.

Because of the lack of information (historically and currently) on Grass Carp reproductive status, distribution, abundance, production, movement, and behavior, most agencies struggle with what an effective control/eradication strategy will look like (spatial and temporal extent, when and where to implement activities, size and scope of response, etc.).

As a part of Ohio's Asian Carp Tactical Plan (2014-2020), a detailed Risk/Return matrix describes how Ohio DNR will respond to new information (e.g. eDNA, Asian carp captures) in specific locations. In the Risk/Return matrix, some of the outcomes in general locations, are "planned responses", however, the plan does not currently detail what these "planned responses" will look like. From the above experiences, it seems clear that more information is necessary to develop effective response strategies. 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).

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 provide assistance 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.

Summary of Actions to Date: 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. The research projects that were funded and on-going in collaboration between Michigan DNR, Ohio DNR, USGS, UT, Michigan State University, and Central Michigan University are addressing the following objectives:

Ploidy, Natal Origin, Surveillance Project

- Identify the utility of genetic surveillance tools (i.e., eDNA) for guiding Grass Carp sampling efforts in western Lake Erie.
- Determine the ploidy status for all Grass Carp caught in western Lake Erie.
- Determine the natal origins for any Grass Carp caught in western Lake Erie.
- Egg and larval sampling for Grass Carp in selected tributaries (primarily the Sandusky River).

Habitat Use Project

- Identify tributary use of Grass Carp in western Lake Erie.
- Determine how far upstream fish migrate and locate areas of spawning aggregation.
- Determine the extent of inter-basin movements of Grass Carp in Lake Erie and potential for expansion into lakes St. Clair and Huron.

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.

FY 2015 Actions: In FY 2015, the Michigan DNR and Ohio DNR continued to collaborate with partners to address the objectives listed above (1-6). The projects were initiated in 2014 and 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. Aside from the adult sampling efforts detailed above, in 2015 Ohio DNR collaborated with USGS and the University of Toledo to conduct early life history sampling in the Sandusky River, and previously supported development of both FLU-EGG

and HEC-RAS hydraulic models in the Sandusky River, which is an area with suitable discharge levels for Grass Carp egg suspension, and has been suggested as the origin of several juvenile/adult Grass Carp collected in Lake Erie proper. Sampling was conducted during the expected spawning season to determine if reproduction was occurring. During 2015, eight confirmed Grass Carp eggs, in early developmental stages, were collected from the Sandusky River. Additional targeted larval/juvenile sampling in both the Sandusky River (USGS/UT) and Sandusky Bay (USFWS) did not result in additional Grass Carp eggs or larvae.

Proposed Actions:

FY 2016 Actions: In FY 2016, our goal is to further develop information from Grass Carp egg collections in the Sandusky River (USGS/UT), using pre-existing hydraulic models (FLUEGG/HEC-RAS) and egg stage information into predicted reproductive locations for Grass Carp. Combining this information with reproductive life history characteristics including spawning temperatures, and flow requirements (Stanley et al. 2011) should provide both space and time-bound predictions of adult Grass Carp aggregations. The specific actions for FY 2016 include:

- Continue and supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River.
- Further develop and analyze hydraulic models and couple with egg stage development information for 2015 samples to generate predicted locations of fertilization for collected eggs.
- Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry, in partnership with Central Michigan University and USGS.
- Estimate age, growth rates, and maturity status of all Grass Carp removed from the Great Lakes, in partnership with USGS.
- Travel to communicate results and represent Ohio at regional Asian carp meetings (i.e., ACRCC, Great Lakes Panel for Aquatic Nuisance Species, CAWS Advisory Group, GLMRIS Executive Steering Committee, etc.).

FY 2017 Actions: In FY 2017 our goal is to validate information provided during FY 2016 (e.g. time- and space-bound predictions of adult spawning aggregations), through intense targeted traditional gear sampling. The specific actions for FY 2017 include:

- Continue and supplement ongoing USGS/UT early life history sampling for Grass Carp in the Sandusky River.
- 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.
- Travel to communicate results and represent Ohio at regional Asian carp meetings (i.e., ACRCC, Great Lakes Panel for Aquatic Nuisance Species, CAWS Advisory Group, GLMRIS Executive Steering Committee, etc.).
- Develop and implement intense, targeted traditional gear sampling plan using information from FY 2016 activities at specified locations in the Sandusky River.

Expected Milestones:**FY 2016:**

- Develop space- and time-bound predictions of adult Grass Carp spawning aggregations.
- Achieve outcomes associated with activities 3-5 (FY 2016-18) above on an annual basis.

FY 2017:

- FY 2017, Ohio DNR expects to implement the response action activity as guided by information from FY 2016 activities 1-2.

The information gained through the sampling efforts and data analyses will be synthesized and written in time to meet reporting milestones and will be provided at other information exchange venues, upon request (e.g. quarterly reporting through ACRCC; annual reporting per requirements, presentations at appropriate venues).

Outcomes/Outputs: The use of ongoing research and assessment surveys will help inform Ohio's AIS planned responses and other management actions. These planned responses and management actions will be incorporated into several Ohio (and other) planning documents to help guide AIS responses into the future. In addition, the increased knowledge of Grass Carp life history in western Lake Erie that will be gained through the proposed project will allow resource agencies to evaluate the science based management approaches for eradication and control action that is described within the Action Plan. Understanding life history characteristics and habitat use from this proposed project will aid managers in implementing effective plans that are spatially and temporally targeted in areas with the greatest likelihood of capture and removal of Grass Carp. In addition, resource agencies will be able to model the potential for Grass Carp population expansion by understanding of the proportion of the population that is reproductively viable. Furthermore, combined results of past Grass Carp projects and the proposed project will allow managers in other areas of the Great Lakes to proactively plan for Grass Carp (and other Asian carp) management and control throughout the basin.

Potential Hurdles: 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. This conundrum is paradoxical with the beginning of an invasion process where Ohio DNR has the greatest likelihood of eradication actions having long-term effectiveness, but the effort is stymied by difficulty in gaining information on populations in low abundance.

40. Manage Waterway Traffic in Support of Asian Carp Control Activities

Lead Agency: USCG

Agency Collaboration: USACE, Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$1,600	\$5,000
FY 2017	\$1,600	\$105,000

Project Explanation: 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 an 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 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 may need to acquire 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 Unity (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 ACRCC meetings and teleconferences.

Summary of Actions to Date: On May 1, 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.

- On December 2, 2010, the USCG put in place a Temporary Interim Rule that established an 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.
- On July 18, 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 May, 2010 (33 CFR 165.930).
- On December 12, 2011, the USCG 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).
- On July 15, 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.

- On September 17, 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.

Proposed Actions:

FY 2016 Actions: 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 2016. The USCG may also develop new safety zones or RNAs to support new aquatic nuisance species initiatives.

FY 2017 Actions: 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 2017. The USCG may also develop new safety zones or RNAs to support new aquatic nuisance species initiatives.

Expected Milestones: None. Activities are carried out on an as-needed basis

Outcomes/Outputs: Appropriate control of vessel traffic to protect vessels and persons from the hazards associated with any federal and state efforts to control aquatic nuisance species.

Potential Hurdles: 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.

41. Brandon Road Lock and Dam Risk Assessment

Lead Agency: USCG

Agency Collaboration: USACE, Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$2,000	\$100,000
FY 2017	\$2,000	\$600,000

Project Explanation: Research how new species control technologies can influence the scope of potential risk-loss opportunities at BRLD before new control measure installation (preliminary risk assessment).

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

1. Conduct in-depth, data collection and analysis to determine scope of potential risk opportunities, regarding each of the different possible invasive species control measures.
2. 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.
3. Tabulate and develop risk scenario matrices

Summary of Actions to Date: As a result of international commerce, travel, and local practices, ANS have been introduced and have spread throughout the Great Lakes and Mississippi River basins. ANS threaten the diversity and abundance of native species; threaten the ecological stability of infested waters; or threaten the commercial, agricultural, or recreational activities dependent on such waters.

In Section 3061(d) of the *Water Resources Development Act of 2007*, Congress directed the Secretary of the Army, acting through the Chief of Engineers, to conduct a study evaluating a range of options and technologies available to prevent the transfer of ANS between the Great Lakes and Mississippi River basins via aquatic pathways.

USACE conducted the Great Lakes & Mississippi River Interbasin Study (GLMRIS) in consultation with other federal agencies, Native American tribes, state agencies, local governments and nongovernmental organizations, and published their findings in a report titled, “The GLMRIS Report” (January 2014).

The CAWS is Focus Area I of GLMRIS, as it is the primary, continuous aquatic connection between the Mississippi River basin and the Great Lakes.

The GLMRIS Report demonstrates that implementation of the most effective range of alternatives to control ANS transfer would require a substantial investment of time and money. Given the potential urgency of the ANS threat – with particular attention to Asian carp species – and in response to a growing consensus among Congressional, nongovernmental, and public stakeholders, the Assistant Secretary of the Army for Civil Works, in coordination with the USACE study team, determined further investigation of possible interim measures is an appropriate next step in GLMRIS.

As a next step in GLMRIS, the Assistant Secretary of the Army (Civil Works) has directed the USACE to proceed with a formal evaluation of potential ANS control technologies for Brandon Road Lock & Dam.

The GLMRIS - Brandon Road effort will assess the viability of establishing a single point to control the one-way, upstream transfer of ANS from the Mississippi River basin into the Great Lakes basin near the Brandon Road Lock and Dam located in Joliet, Illinois.

Brandon Road is a valuable control point for species of particular concern – the Silver and Bighead Carp. Placement of technologies at – or downstream of – Brandon Road enhances effectiveness of controls by incorporating a mechanical fail–safe (lock closure) in the event technology malfunctions.

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.

USCG will require RDC 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.

USACE is still collecting data for their initial risk assessment. Consequently, there is no timeline established for USACE control evaluations, construction, or final safety testing.

FY 2016 Actions: Begin preliminary data acquisition program to determine nature of present risk scenarios, then project those scenarios onto a regime of one or multiple ANS control strategies

Proposed Actions: USCG seek RDC assistance in the following areas:

- Helping USACE design engineering tests that, in addition to evaluating ANS control technologies, also examine associated risks to vessels and mariners transiting Brandon Road Lock and Dam.
- Reviewing USACE evaluation of potential ANS control technologies for Brandon Road Lock and Dam to advise D9, Sector Lake Michigan, and MSU Chicago on associated risks to vessels and mariners.
- Interpreting the results of USACE control measure testing during installation and/or after construction.
- Conducting additional safety testing if USACE evaluation is insufficient or fails to properly evaluate associated risks to vessels and mariners.
- Recommending risk mitigation measures as appropriate based on USACE and, potentially, RDC testing.

FY 2017 Actions: To be determined.

Expected Milestones: None

Outcomes/Outputs: Ideally, helping USACE in the test design process (objective 1) will eliminate the need for independent USCG follow-up testing (objective 4) and reduce the time needed for USCG approval of the final control technology installations.

Potential Hurdles: 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. This assessment is included here to quantify the commercial vessel traffic within the requested study area. Note that the CAWS includes the deep draft ports on Lake Michigan, and not just the CSSC. Here is a summary of their findings (See GLMRIS Appendix D – Economic Analyses, D.10 Commercial Cargo Navigation, D.10.1.3 Key Findings).

“Since a spike to 25 million tons in 1994, traffic on the CAWS has remained flat to declining. After achieving a five-year low in recession year 2010 at 13.2 million tons, CAWS shallow draft traffic, vessels with a draft less than fifteen feet, experienced a slight increase to 13.6 million tons. However, deep draft traffic, vessels with a draft of fifteen feet or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last ten years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage.”

“In 2011, the total traffic was 22.0 million tons with the three main shallow draft commodities in the CAWS being coal (33 percent), iron and steel (15 percent), and aggregates (12 percent) and the three main deep draft commodities being coal (45 percent), ores and minerals (19 percent), and all other group (13 percent).”

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

RDC POCs for prior Asian carp efforts include: Marion “Lew” Lewandowski, Jim Fletcher, and Penny Herring (Herring, since retired).

42. Electric Barrier Construction and Operation Risk Assessment

Lead Agency: USCG

Agency Collaboration: USACE, USEPA

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$2,000	\$4,000
FY 2017	\$2,000	\$400,000

Project Explanation: Coordinate CG and USACE safety and electric field testing for “new” CSSC Barrier I at Romeoville, IL. This testing is to advance the scientific and technical knowledge of influences to the CSSC fish barrier electric field when additional barriers are brought on line. RDC to work with USACE Engineering Research and Development Center (ERDC) Civil Engineering Research Lab (CERL) to maximize commonality in safety test development and field measurement research to minimize separate USACE and CG tests and experiments. This includes field test design and conduct to determine changes in the electric field associated with the CSSC barrier system, and the implicit change in marine safety risk.

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

From the outset, USACE and the USCG were aware the actual effects of high-voltage barriers on vessel traffic and marine safety were not well known. Before getting USCG agreement that waterway navigation could safely continue during barrier operation, U.S. Army Engineer Research and Development Center - Construction Engineering Research Laboratory (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 RDC 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.

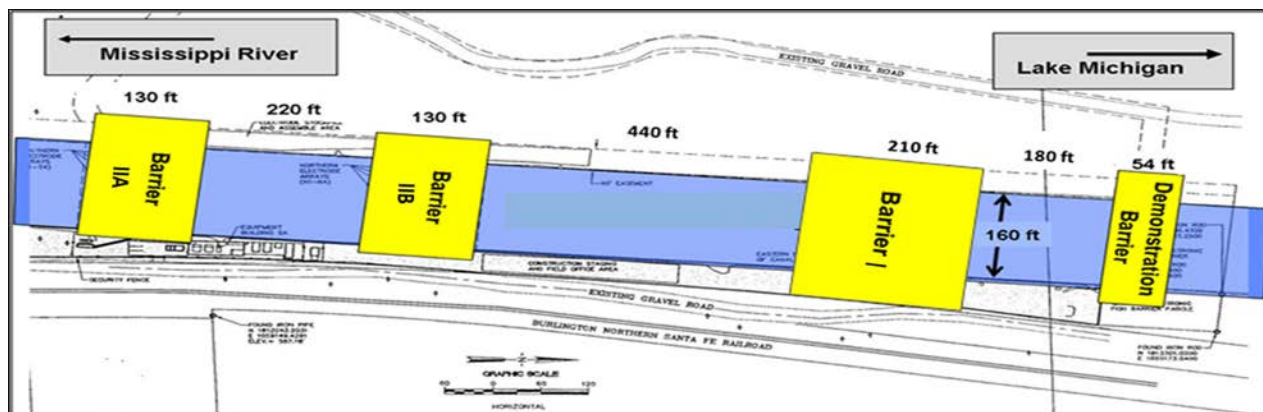
These elements all became the basis for various provisions in 33 CFR §165.923 as the rule developed. In 2010 and 2011, RDC conducted tests to identify the hazards associated with rescue of a person in electrified water, with operating guidance and recommendations for rescuer safety. In 2013, RDC completed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

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

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

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

Once Barrier 1 is complete (estimated FY 2017) the USACE intends to conduct a series of engineering tests to determine the physical effects of vessel traffic interaction with the electrified waters near the barrier system. The local Captain of the Port and Ninth USCG District lack the knowledge to determine if these tests are sufficient to accurately identify risks to vessels and mariners transiting the CSSC or interpret the results of the tests to determine the adequacy of existing mitigation measures.



FY 2016 Actions: USCG seek RDC support in:

- Helping the USACE develop appropriate engineering tests to evaluate risks posed by the barrier system to personnel and vessels transiting the CSSC once Barrier I is activated.
- Interpret the results of USACE testing to determine if existing mitigation measures are sufficient for the risks.
- Conduct additional safety testing if USACE testing is not sufficient to properly identify or evaluate the risks to vessels and mariners.
- Recommend additional mitigation measures (to update 33 CFR §165.923) as appropriate based on USACE and, potentially, RDC testing.

FY 2017 Actions: To be determined.

Expected Milestones: None

Outcomes/Outputs: Ideally, objective 1 (helping the USACE in the test design process) will eliminate the need for independent USCG follow-up testing (objective 3) and reduce the time needed for USCG approval of the final barrier operating parameters. History suggests senior USACE leadership will push for rapid USCG review and concurrence once barrier system construction and testing is complete.

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

“Since a spike to 25 million tons in 1994, traffic on the CAWS has remained flat to declining. After achieving a five-year low in recession year 2010 at 13.2 million tons, CAWS shallow draft traffic, vessels with a draft less than fifteen feet, experienced a slight increase to 13.6 million tons. However, deep draft traffic, vessels with a draft of fifteen feet or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last ten years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage.”

“In 2011, the total traffic was 22.0 million tons with the three main shallow draft commodities in the CAWS being coal (33 percent), iron and steel (15 percent), and aggregates (12 percent) and the three main deep draft commodities being coal (45 percent), ores and minerals (19 percent), and all other group (13 percent).”

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

RDC POCs for prior Asian carp efforts include: Marion “Lew” Lewandowski, Jim Fletcher, and Penny Herring.

63. Asian Carp Barge Entrainment Mitigation Risk Assessment

Lead Agency: USCG

Agency Collaboration: USFWS, Illinois DNR

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$2,000	\$100,000
FY 2017	\$2,000	\$200,000

Project Explanation: Understand the emerging technologies for barge fish entrainment control and research the potential impacts of those technologies on the marine-safety risks. Investigate barge-entrainment control measure risk scenarios

- Develop scoping study in conjunction with U.S. Fish and Wildlife Service and USACE ERDC Waterways Experiment Station (WES) effort to define possible control measures to prevent or mitigate possible entrainment of carp due to barge-tow configuration.
- Investigate whether control measures lead to marine-safety risk scenarios that need further evaluation.
- Tabulate and develop risk scenario matrices

Summary of Actions to Date: As a result of international commerce, travel, and local practices, ANS have been introduced and have spread throughout the Great Lakes and Mississippi River basins. ANS threaten the diversity and abundance of native species; threaten the ecological stability of infested waters; or threaten the commercial, agricultural, or recreational activities dependent on such waters.

In Section 3061(d) of the *Water Resources Development Act of 2007*, Congress directed the Secretary of the Army, acting through the Chief of Engineers, to conduct a study evaluating a range of options and technologies available to prevent the transfer of ANS between the Great Lakes and Mississippi River basins via aquatic pathways.

USACE conducted the Great Lakes & Mississippi River Interbasin Study (GLMRIS) in consultation with other federal agencies, Native American tribes, state agencies, local governments and nongovernmental organizations, and published their findings in a report titled, “The GLMRIS Report” (January 2014).

The CAWS is Focus Area I of GLMRIS, as it is the primary, continuous aquatic connection between the Mississippi River basin and the Great Lakes.

The GLMRIS Report demonstrates that implementation of the most effective range of alternatives to control ANS transfer would require a substantial investment of time and money. Given the potential urgency of the ANS threat – with particular attention to Asian carp species – and in response to a growing consensus among Congressional, nongovernmental, and public stakeholders, the Assistant Secretary of the Army for Civil Works, in coordination with the USACE study team, determined further investigation of possible interim measures is an appropriate next step in GLMRIS.

As a next step in GLMRIS, the Assistant Secretary of the Army (Civil Works) has directed the USACE to proceed with a formal evaluation of potential ANS control technologies for Brandon Road Lock & Dam.

The GLMRIS - Brandon Road effort will assess the viability of establishing a single point to control the one-way, upstream transfer of ANS from the Mississippi River basin into the Great Lakes basin near the Brandon Road Lock and Dam located in Joliet, Illinois.

Brandon Road is a valuable control point for species of particular concern – the Silver and Bighead Carp. Placement of technologies at – or downstream of – Brandon Road enhances effectiveness of controls by incorporating a mechanical fail–safe (lock closure) in the event technology malfunctions.

In addition to engineered control measures, USFWS has expressed concern over the potential for species entrainment by barges, downstream of the proposed Brandon Road control measures. However, there no evidence of barge-entrained invasive carp species entering the area of the Brandon Road Lock and Dam to date, preliminary USFWS testing indicates a possibility that fish of certain size groups may travel in the rake-to-box end barge configuration and potentially avoid engineered control measures.

Operational control measures under discussion (full astern wheel wash, reconfiguring tow make-up configurations, and others) may add opportunities for vessel or mariner casualties. USCG requires an independent RDC evaluation, in conjunction with industry interests, to analyze and quantify associated risks to vessels and mariners of imposing operational control measures, and identifying mitigation strategies for safety risks associated with operational controls incorporated to prevent barge entrainment.

FY 2016 Actions: Begin preliminary data acquisition program to determine nature of present risk scenarios, then project those scenarios onto a regime of one or multiple ANS control strategies

Proposed Actions: USCG will seek RDC assistance in the following areas:

- Reviewing USFWS-designed engineering tests that, in addition to evaluating ANS control technologies, to examine associated risks to vessels and mariners involved in preventing the inadvertent barge entrainment of ANS.
- Reviewing USFWS evaluation of potential ANS control technologies for barge entrainment prevention and advising D9, Sector Lake Michigan, and MSU Chicago on associated risks to vessels and mariners.
- Conducting additional operational analysis as to methodologies and locations where operational control measures may occur.
- Recommending risk mitigation measures as appropriate based on USFWS and, potentially, RDC testing.

FY 2017 Actions: To be determined.

Expected Milestones: None

Outcomes/Outputs: Ideally, early involvement with control measure analysis as regards marine safety will assist USCG regulators in determining best practicable and most risk-averse methods for implementing and enforcing a regulatory scheme for the Illinois Waterway.

Potential Hurdles: 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. This assessment is included here to quantify the commercial vessel traffic within the requested study area. Note that the CAWS includes the deep draft

ports on Lake Michigan, and not just the CSSC. Here is a summary of their findings (See GLMRIS Appendix D – Economic Analyses, D.10 Commercial Cargo Navigation, D.10.1.3 Key Findings).

“Since a spike to 25 million tons in 1994, traffic on the CAWS has remained flat to declining. After achieving a five-year low in recession year 2010 at 13.2 million tons, CAWS shallow draft traffic, vessels with a draft less than fifteen feet, experienced a slight increase to 13.6 million tons. However, deep draft traffic, vessels with a draft of fifteen feet or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last ten years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage.”

“In 2011, the total traffic was 22.0 million tons with the three main shallow draft commodities in the CAWS being coal (33 percent), iron and steel (15 percent), and aggregates (12 percent) and the three main deep draft commodities being coal (45 percent), ores and minerals (19 percent), and all other group (13 percent).”

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

RDC POCs for prior Asian carp efforts include: Marion “Lew” Lewandowski, Jim Fletcher, and Penny Herring (Herring, since retired).

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

Lead Agency: NOAA GLERL

Agency Collaboration: None

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$152,128	\$0
FY 2017	\$0	\$184,590

Project Explanation: Work under this template continues our modeling efforts of potential risk of Asian carp (Bighead, Silver, Black, Grass) on Great Lakes food webs. The project includes using ecosystem models to assess potential risk of Bighead and Silver Carp affecting Great Lakes food webs. The information from this project will inform risk assessments for AC in the Great Lakes, such as the ACOE's GLMRIS evaluation of ecological effects of a proposed installation of the Brandon Road lock and dam. Three types of ecosystem models have been developed to assess effects of Asian carp on Great Lakes food webs in Lake Huron, Lake Erie and Lake Michigan. The Ecopath with Ecosim 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 over vertical spatial scales. A spatially-explicit, individual-based bioenergetics model includes temperature as a forcing variable and tracks bioenergetics growth and metabolism in individual Asian carp and selected fish species within nearshore or offshore habitats. The Atlantis Ecosystem model tracks population dynamics and predator prey interactions within heterogeneous habitats in each Great Lake, and includes effects of lake physics and chemistry.

This project will also model effects of Asian carp on the remaining two Great Lakes (Ontario and Superior) and some key embayments (Saginaw and Green Bays), tributaries (Muskegon Lake), and their related wetland food webs and ecosystems. To date, Asian carp food web effects on these important and productive habitats have been ignored. NOAA proposes to model Bighead and Silver carp effects on ecosystems in Green Bay and the Muskegon River watershed, where extensive data already exist on food web interactions, fish biomass, nutrients and hydrology. NOAA will also conduct analysis of Grass Carp effects on food webs on the Lake St. Clair ecosystem, which receives more use by recreational boaters and fishers than any of the Great Lakes. The Lake St. Clair food web is particularly susceptible to harm by Grass Carp because it has extensive areas of submerged aquatic vegetation, and supports world class fisheries for muskellunge, northern pike, and bass. Finally, NOAA will continue the food web modeling efforts of Bighead and Silver Carp effects on Lake Ontario and Lake Superior.

Summary of Actions to Date: The Ecopath with Ecosim food web models were configured for Lake Huron, Lake Michigan and Lake Erie. Models were calibrated using existing data collected by resource agencies that captured temporal changes in species groups over time. The analysis was completed of Asian carp effects on species biomass changes in the Lake Erie food web.

The Atlantis Ecosystem model was configured and calibrated for Lake Michigan, and calibrated for Lake Erie. Preliminary simulations of Asian carp effects on the Lake Michigan food web were run and are being analyzed. Further work is needed to complete model simulations for Lake Erie and to configure, calibrate and run simulations for Lake Huron.

The individual-based bioenergetics model was developed for Saginaw Bay Lake Huron and simulations were completed. A manuscript describing the results is being written. The model is being configured and calibrated for Lake Erie and Lake Michigan nearshore environments.

FY 2015 Actions: A manuscript was written describing The Ecopath with Ecosim model analysis of potential effects of Asian carps on the Lake Erie food web. The manuscript was submitted for peer review, and accepted for publication. A scoping meeting was held with ACOE members to communicate results of model simulations of Asian carp effects on the Lake Erie food web and on the Saginaw Bay food web. It was agreed that biomass changes potentially resulting from Asian carp effects would be relayed to ACOE staff working on the GLMRIS evaluation of Brandon Road Lock and Dam. These biomass changes were then communicated to Dr. Frank Lupi at Michigan State University who then translated biotic changes into changes in fishing effort and expenditures.

Model simulations also were run using an individual based bioenergetics model to quantify the minimum number of Asian carps needed to establish a population in Lake Huron. Results were communicated to ACOE members.

FY2016 Actions: Ecopath with Ecosim model simulations will be conducted of Asian carp effects on food webs in Saginaw Bay and main basin of Lake Huron, and on the Lake Michigan food web. Initial conditions for model simulations will be standardized across Great Lakes habitats. The results will be expressed as a change in biomass of species groups, and communicated to the ACOE team evaluating the GLMRIS Brandon Road Lock and Dam. The results also will be communicated to Dr. Frank Lupi, who will translate biotic changes into changes in fishing effort and expenditures.

IBM and Atlantis model simulations of Asian carp effects on Lake Erie and Lake Huron food webs will be completed.

FY2017 Actions: TBD

Expected Milestones: Produce an evaluation of ecological changes in 3 Great Lakes resulting from a potential invasion of Asian carp.

Outcomes/Outputs:

- Given the model simulations of Asian carp effects on Great Lakes food webs, economic assessments of Asian carp effects can be realized and a more complete assessment can be developed of risk from Asian carp invasion of the Great Lakes that will result in more effective management strategies.
- Manuscripts describing model simulations of the ecological impacts of Asian carp on the Great Lakes and its major embayments and tributaries.

Potential Hurdles: Limited NOAA base-funding will preclude work on this project to continue beyond FY 2016.

60. Grass Carp Eradication in Western Lake Erie

Lead Agency: Michigan Department of Natural Resources (Michigan DNR)

Agency Collaboration: Ohio Department of Natural Resources (Ohio DNR), Department of Fisheries and Wildlife; USGS, and USFWS

Additional agency supporters: Pennsylvania Fish and Boat Commission, New York Department of Environmental Conservation, Ontario Ministry of Natural Resources and Forestry

Funding Table:

Funding	Agency Funding	GLRI Funding
FY 2016	\$150,000**	\$200,000
FY 2017	\$150,000**	\$150,000

**State match is salary and travel, etc. support of Michigan DNR Fisheries Division Aquatic Invasive Species Coordinator who will lead this effort.

Project Explanation: Despite multiple on-going Grass Carp research efforts in western Lake Erie there are critical knowledge gaps that remain. These knowledge gaps limit the ability to develop and implement effective and science based control measures in an attempt to eradicate Grass Carp from western Lake Erie. To address these concerns Michigan DNR proposes to develop an Adaptive Management Framework for Grass Carp Eradication in Lake Erie with our partner agencies while continuing to support efforts to obtain information. The adaptive management framework will be informed through activities that increase the intensity of sampling for all Grass Carp life stages in western Lake Erie. Partner collaborations will include analyzing captured individuals to determine ploidy status, natal origin, maturity status, growth dynamics, and movement patterns. Commercial fishers will be used to increase targeted sampling efforts using large seines (approximately 3000 feet), which have been the most effective capture gear for Grass Carp in Lake Erie, as well as increase agency capacity to increase sampling efforts using traditional and other novel gears (as tested through the ACRC Action Plan) to remove Grass Carp. Sampling efforts will be guided by the adaptive management framework and modifications to sampling will be based on information gained from captured individuals in 2016-2017. The information this project will provide will build upon existing life history knowledge gained from previous efforts that were funded and completed in 2015. The need to determine spatial and temporal dynamics of Grass Carp in western Lake Erie persists because of low sample sizes from previous studies. The additional information gained from the proposed project will be summarized and used to implement Grass Carp control efforts in western Lake Erie. In addition to the adaptive management framework for Grass Carp and increased sampling efforts during the proposed project, response efforts that implement Incident Command System (ICS) will be conducted, as deemed necessary.

Summary of Actions to Date: Since 2012, the Michigan and Ohio DNR 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 science 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. The research projects that were funded and on-going in collaboration between Michigan DNR, Ohio DNR, Michigan State University, and Central Michigan University are addressing the following objectives,

Ploidy, Natal Origin, surveillance project: Central Michigan University

- Identify the utility of genetic surveillance tools (i.e., eDNA) for guiding Grass Carp sampling efforts in western Lake Erie.
- Determine the ploidy status for all Grass Carp caught in western Lake Erie.
- Determine the natal origins for any Grass Carp caught in western Lake Erie.

Habitat Use Project: Michigan State University

- Identify tributary use of Grass Carp in western Lake Erie.
- Determine how far upstream fish migrate and locate areas of spawning aggregation.
- Determine the extent of inter-basin movements of Grass Carp in Lake Erie and potential for expansion into lakes St. Clair and Huron.

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. However, because of low sample sizes many of the knowledge gaps persist, thus jeopardizing the effectiveness of control measures.

FY 2015 Actions: In FY 2015, the Michigan DNR and Ohio DNR continued to collaborate with Michigan State University and Central Michigan University to address the objectives listed above (1-6). The projects were initiated in 2014 and Michigan and Ohio have actively assisted with developing the study design and have participated with sample collections. 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 eradicate Grass Carp. In 2015, eradication was deemed not possible for these projects, so the next goal was to use research information to develop control strategies. In addition to the research projects, the Michigan DNR contracted commercial fishermen to increase targeted seining operations to capture and remove Grass Carp from western Lake Erie. The Grass Carp that were captured and removed have been analyzed for natal origin using otolith microchemistry, ploidy status, and growth dynamics. Aside from the adult sampling efforts, in 2015 the Michigan DNR collaborated with USGS and the University of Toledo to conduct early life history sampling in the River Raisin, which is an area with suitable discharge levels for Grass Carp egg suspension. Sampling was conducted during the expected spawning season to determine if reproduction was occurring (samples are still being processed). Furthermore, the information gained from Grass Carp work conducted by the Michigan DNR and Ohio DNR was provided to the Great Lakes Fishery Commission and Department of Fisheries and Oceans Canada to inform the Great Lakes Grass Carp Risk Assessment.

Proposed Actions:

FY 2016 Actions: In FY 2016 our goal is to develop an Adaptive Management Framework for Grass Carp Eradication in Lake Erie. The success of implementation and evaluation of this proposed framework will be dependent upon collecting additional information on life history dynamics of Grass Carp in western Lake Erie. The specific actions to increase sampling for collecting additional life history information are listed here:

- Increase targeted sampling for Grass Carp using Lake Erie commercial fishermen (propose 40 seine hauls at \$1,000/haul).

- Conduct early life history sampling in western Lake Erie tributaries during expected spawning season, which will be in partnership with USGS and University of Toledo and consistent with ongoing sampling in the Sandusky River, OH.
- Analyze all Grass Carp removed for determination of ploidy status and natal origin using otolith microchemistry, in partnership with Central Michigan University and USGS.
- Estimate age, growth rates, and maturity status of all Grass Carp removed from the Great Lakes, in partnership with USGS.
- Travel to communicate results and represent Michigan at regional Asian carp meetings (i.e., ACRCC, Great Lakes Panel for Aquatic Nuisance Species, CAWS Advisory Group, GLMRIS Executive Steering Committee, etc.).

FY 2017 Actions: Plan to continue same sampling and analyses efforts described in FY 2016 actions to inform management actions per the proposed Adaptive Management Framework for Grass Carp Eradication in Lake Erie, which will be developed in 2016.

Expected Milestones: The Adaptive Management Framework for Grass Carp Eradication will be drafted and reviewed through the proper channels (i.e., Lake Erie Committee, ACRCC, etc.) in 2016. Michigan DNR also expects to achieve outcomes associated with activities 1-5 above on an annual basis. The information gained through the sampling efforts and data analyses will be synthesized and written in time to meet reporting milestones and will be provided at other information exchange venues, upon request (e.g. quarterly reporting through ACRCC; annual reporting per requirements, presentations at appropriate venues).

Outcomes/Outputs: The development of the Adaptive Management Framework for Grass Carp Eradication in Lake Erie will provide specific guidelines that will inform management actions and the success of those actions. The framework will likely be a template that is utilized by other resource agencies throughout the Great Lakes basin to address Grass Carp issues, and of particular interest the Lake Erie Committee given the current concerns. In addition, the increased knowledge of Grass Carp life history in western Lake Erie that will be gained through the proposed project will allow resource agencies to evaluate the science based management approaches for eradication and control action that is described within the framework. Understanding life history characteristics and habitat use from this proposed project will aid managers in implementing effective plans that are spatially and temporally targeted in areas with the greatest likelihood of capture and removal of Grass Carp. In addition, resource agencies will be able to model the potential for Grass Carp population expansion by understanding of the proportion of the population that is reproductively viable. Furthermore, combined results of past Grass Carp projects and the proposed project will allow managers in other areas of the Great Lakes to proactively plan for Grass Carp management and control throughout the basin.

Potential Hurdles: The largest potential hurdle for the proposed project is low sample size. The development of an effective control plans 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. This conundrum is paradoxical with the beginning of an invasion process where Michigan DNR has the greatest likelihood of eradication actions having long-term effectiveness, but the effort is stymied by difficulty in gaining information on populations in low abundance.

43. Program Support for Asian Carp Activities

Lead Agency: USEPA

Agency Collaboration: ACRCC member agencies

Funding Table:

Funding	Agency Funding	GLRI Funding*
FY 2016	\$75,000*	\$1,713,000
FY 2017	\$0	\$969,610

Fiscal Year 2016 USEPA Support: [Response Actions (\$1,173,000), Transportation Study (\$290,000), CAWS Advisory Committee (\$75,000), Contract Support (\$100,000), ACRCC Support (\$75,000)].

*Agency funding is for USFWS.

Project Description: Support for Great Lakes National Program Office, and federal agency activities. The threat of Asian carp introduction into the Great Lakes directly affects the Great Lakes ecosystem, the eight Great Lakes states, and the economics of several associated industries. A variety of actions and activities are contained in this Action Plan item. These include 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; contractor support to the agencies in developing reports, tracking activities, and providing field support as necessary; development and deployment of training and exercises throughout the basin to enhance agencies' rapid response capabilities; continued support of USEPA's Asian carp director and deputy to enhance collaborations among the federal, state, local, and tribal agency partners; and provision to senior executives and the ACRCC of continued communication and outreach support activities.

Actions Undertaken to Date: USEPA has continued to work closely with its Asian carp stakeholder partners since 2009 to mitigate the effects that Asian carp may have on local ecosystems and to decrease potential for the species to spread to new waterways. With GLRI funding, USEPA has supported 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 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.
- Facilitation of research and development and of additional field studies to test alternative methods to capture, control, identification, or eradicate Asian carp.
- Procurement of equipment to accelerate calibration studies and provide additional tools for field detections and quantification surveys of both Bighead and Silver carp.

- Funding to enhance Lacey Act enforcement activities by developing outreach and training tools for increased vigilance and interdiction of illegal live shipments of Asian carp.
- Acceleration of GLMRIS efforts for waterway separation and support for increasing USACE capacity to meet the congressional mandates of completion.
- Funding to allow continuation of engagement of White House-appointed staff in these efforts.

FY 2015 Actions: No funding was provided in 2015.

FY 2016 Actions: Funding will be used for Asian carp efforts to include the following:

- Response Actions, if determined necessary.
- Development of a Transportation Study to assist with development of control barriers in the Upper Illinois Waterway.
- Continuation of the CAWS Advisory Committee efforts.
- Contract support for USEPA.
- Contract support for ACRCC.

FY 2017 Actions: To be determined.

Expected Milestones: None

Outcomes: None

Potential Hurdles: None

Appendix C

2016 Asian Carp Action Plan: Long-Term Planning Horizon

LONG-TERM PLANNING HORIZON

The 2016 Action Plan summarizes the actions that federal, state, and provincial agencies plan to implement during U.S. federal fiscal years (FY) 2016 and 2017 using Agency and Great Lakes Restoration Initiative funding. In addition, the Asian Carp Regional Coordinating Committee (ACRCC) has identified key actions that could be undertaken in the future to achieve its mission of preventing the introduction, establishment, and spread of Asian carp in the Great Lakes. The information below is not a commitment to future funding. All out-year, future actions beyond FY 2016 may be adjusted annually based on appropriations and allocations.

The table below outlines the many new or continuing initiatives that fall under the three focus areas of the Action Plan.

Focus Areas	Objectives	Actions	Measures of Progress
<u>PREVENTION</u>			
Pathway closures & control measures	<p>Ensure the electric dispersal barrier system is effective in keeping Asian carp from moving upstream of the electric barriers.</p> <p>Identify and close control points that would allow Asian carp to enter the Great Lakes basin.</p>	<ol style="list-style-type: none"> 1. Construction of a new electric barrier. 2. Improve and maintain current barriers. 3. Address barge entrainment. 4. Development of control options at Brandon Road. 5. Closure of Eagle Marsh pathway. 6. Closure of Little Killbuck Creek pathway. 7. Closure of Ohio Erie Canal pathway. 	<ol style="list-style-type: none"> 1. The new electric barrier will be completed. 2. All barriers will be functioning at optimum levels. 3. Identification of effective control mechanism will be in place to address barge entrainment. 4. Chief's Report will be completed for the Brandon Road study. 5. Phase I Eagle Marsh closure project will be completed and Phase II will be underway. 6. Little Killbuck Creek closure will be completed. 7. Ohio Erie Canal closure will be completed.

Focus Areas	Objectives	Actions	Measures of Progress
<u>DETECTION, MANAGEMENT AND CONTROL</u>			
Undertaking responses	Identify and initiate response actions to reduce the Asian carp population in the Upper Illinois River while controlling the propagule pressure on the electric barriers.	<ol style="list-style-type: none"> 1. Contract fishing, seining and netting. 2. Development of chemical attractants. 3. Development of procedures for temporary lock closures necessary to support discrete response actions. 4. Fish toxicant will be considered as a control measure. 5. Development of emergencies, authorities and control action strategies. 6. Control illegal transport. 	<ol style="list-style-type: none"> 1. Contract fishing and seining/netting will be on-going until a one-way barrier is completed. 2. Chemical attractants will be developed and used in the field. 3. Procedures will be developed for temporary lock closures when necessary to support rotenone or fishing responses. 4. Fish toxicant (rotenone) will be considered for response action. Authorities will be identified and control action strategies in place in the ACRCC Monitoring and Response Plan to protect the efficacy of the electric barrier system. 5. Emergencies, authorities and control action strategies will be developed. 6. Enforcement of current laws will continue for vectors of high concern.
Development of new control technologies and strategies	Identify and develop new control technologies that can be used to control Asian carp, including Black and Grass Carp.	<ol style="list-style-type: none"> 1. Development of acoustic technology. 2. Development of carbon dioxide (CO₂), hot water, ozone, menadione and other chemicals 3. Development of microparticles. 4. Identify potential control technologies for Black and Grass Carp. 5. Development of eradication strategies for Grass Carp in Sandusky Bay and Western Lake Erie. 	<ol style="list-style-type: none"> 1. Acoustic technology will be field tested and a determination of viability will be completed. 2. CO₂, hot water, ozone, menadione and other chemicals will be tested and a determination of their viability will be completed for potential use in a two-way barrier system. 3. The microparticle will be permitted and available for use. 4. Potential control strategies will be developed and implemented. 5. Control strategies will be developed and implemented for Grass carp in Sandusky Bay and Western Lake Erie.
Monitoring/Assessment	Ensure an understanding of where and to what extent Asian carp are in the CAWS, Upper Illinois River and the Great Lakes	<ol style="list-style-type: none"> 1. Monitor Chicago Area Waterway System (CAWS)/Upper Illinois River. 2. Monitor Great Lakes. 3. Deploy monitoring resources based on on-going risk assessment activities. 4. Monitor Black and Grass Carp. 	<ol style="list-style-type: none"> 1. CAWS/Upper Illinois River monitoring will continue to assess the risk of Asian carp movement. 2. On-going monitoring will be used to assess risk in the Great Lakes to determine resource allocation needs. 3. Establish a system to deploy monitoring resources based on on-going risk assessment activities. 4. Continue monitoring to assess risk of Black Carp moving up the Upper Illinois River, and incorporate use of a Black Carp marker for environmental DNA (eDNA), once completed. Continue monitoring to assess risk of Grass Carp in the Great Lakes and other areas of the Illinois River, and Upper Mississippi River/Ohio River basins.

Focus Areas	Objectives	Actions	Measures of Progress
<u>MANAGEMENT</u>			
Communication/ Outreach	Develop and maintain effective mechanisms for communication and collaboration of Asian carp control activities	<ol style="list-style-type: none"> 1. Continue AsianCarp.us website. 2. Provide Congressional and Executive office briefings. 3. Engage industry and other private interests 4. Continue CAWS Advisory Committee. 5. Continue community engagement through ACRCC meetings. 	<ol style="list-style-type: none"> 1. The AsianCarp.us website will be updated and expanded to include other areas of the U.S. to improve content development, and ability to find appropriate information. 2. Provide Congressional and Executive Office briefings, as needed. 3. Seek opportunities to engage industry on relevant issues and venues for collaboration (e.g. barge entrainment) 4. Continue to work with CAWS Advisory Committee on Brandon Road efforts and a long term, acceptable two-way barrier system. 5. Continue community engagement through ACRCC meetings and other methods.
Interbasin collaboration	Support interbasin coordination for Asian carp prevention and control efforts between ACRCC and other multijurisdictional basinwide partnerships to leverage available resources and to maximize conservation benefits.	<ol style="list-style-type: none"> 1. Identify opportunities for potential coordination on annual strategic planning with other basinwide partnerships, including the Ohio River and Upper Mississippi River Basins. 2. Identify potential interbasin pathways/vulnerabilities. 3. Develop appropriate collaborative strategies and actions to evaluate or mitigate vulnerabilities, as needed. 	<ol style="list-style-type: none"> 1. Identify new control and technologies under development with potential for implementation in other basins, with availability of adequate designated resources. 2. Convene annual/semi-annual interbasin planning meetings to establish shared best-practices and protocols for data collection and evaluation, reporting, and tracking. 3. Develop comprehensive strategy for coordinated communications to stakeholders and the public on Asian carp issues and information across multiple basins, to include: Great Lakes (ACRCC), Ohio River basin, and Upper Mississippi River basin, and other priority locations, as appropriate.

The following Measures of Progress could be used to evaluate progress towards the long term control efforts:

- Rate at which new prevention/control technologies are developed and deployed to support prevention strategies and Integrated Pest Management Plans (following all necessary environmental and regulatory requirements).
- Percentage of Objectives identified in annual ACRCC Monitoring and Response Plan that are fully implemented, as prescribed by the Monitoring and Response Work Group.
- Number of new Asian carp prevention/control technologies fully tested and developed. (deployment-ready upon completion or required permitting and regulatory compliance)
- Percentage of defined watershed (such as the CAWS and the Illinois Waterway [IWW]) with current and accurate scientific information on occurrence and population status of all life stages of Asian carp.

- Of the three Other Aquatic Pathways identified in Great Lakes and Mississippi River Interbasin Study (GLMRIS), what number have closure efforts being developed and what number have been completed?
- Number of Great Lakes Restoration Initiative (GLRI)-funded early detection monitoring activities conducted.
- Number of GLRI-funded Great Lakes rapid responses or exercises conducted.
- Number of technologies, strategies and methods field tested by GLRI-funded projects
- Number of collaborative efforts developed/enhanced with GLRI funding.
- Annual Asian Carp Action Plan completed.
- Annual Asian Carp Monitoring and Response Plan (MRP) and MRP Interim Summary Reports completed.

The actions identified above will build on the work carried out under the earlier Asian Carp Control Strategy Frameworks, with a major focus on:

- Pathway closures and control measures.
- Undertaking responses actions.
- Development of new control technologies and strategies.
- Monitoring and assessment.
- Communication and outreach.
- Interbasin collaboration.